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10 CFR 50.90

W3F1-2019-0005

February 15, 2019

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Response to U. S. Nuclear Regulatory Commission Request for Additional Information Regarding Proposed Change to Technical Specification 3/4.7.4 for Ultimate Heat Sink Design Basis Update

Waterford Steam Electric Station, Unit 3 (Waterford 3)
NRC Docket No. 50-382
Renewed Facility Operating License No. NPF-38

By letter dated March 26, 2018 (Reference 1), Entergy requested an amendment to revise Technical Specification 3/4.7.4 associated with the Ultimate Heat Sink for Waterford 3.

By letter dated May 4, 2018 (Reference 2), the NRC notified Entergy that the NRC staff reviewed the submittal and determined that additional information was necessary to enable the staff to make an independent assessment regarding the acceptability of the proposed amendment in terms of regulatory requirements and the protection of public health and safety and the environment. By letter dated May 17, 2018 (Reference 3), Entergy provided the supplemental information requested by the NRC.

By letter dated January 28, 2019 (Reference 4), the NRC staff informed Entergy that they have reviewed the license amendment request and the supplemental information and have determined that additional information is required to complete the review. A clarification call between the NRC and Entergy was previously held on January 17, 2019.

The additional information requested by the NRC in Reference 4 is provided in the Enclosure to this letter.

Attached to the Enclosure are:

- Engineering Report WF3-ME-18-00008, Revision 0, "National Weather Service Forecast Accuracy Study for Waterford 3 Ambient Temperature" (Attachment 1).
- Engineering Report WF3-ME-16-00001, Revision 0, "Meteorological Parameters and Parameter Relationships for Design and Operability of the Waterford 3 Ultimate Heat Sink" (Attachment 2).
- Engineering Report WF3-ME-15-00013, Revision 0, "Waterford 3 Ultimate Heat Sink Project UHS Model" (Attachment 3)
- Engineering Report WF3-ME-15-00014, Revision 0, "Waterford3 Ultimate Heat Sink: CFD Investigation of the Dry Cooling Tower Deflector Wall" (Attachment 4)
- Engineering Report WF3-ME-15-00011, Revision 1, "Waterford 3 Ultimate Heat Sink Project Weather Investigation" (Attachment 5)

This submittal contains no new regulatory commitments.

If you have any questions or require additional information, please contact the Acting Regulatory Assurance Manager, John V. Signorelli, at (504) 739-6032.

I declare under penalty of perjury that the foregoing is true and correct. This performed on February 15, 2019.

Respectfully,

John C. Dinelli

JCD/mmz

References:

1. Entergy Operations, Inc. (Entergy) letter W3F1-2017-0050, "License Amendment Request Proposed Change to Technical Specification 3/4.7.4 for Ultimate Heat Sink Design Basis," dated March 26, 2018 (ADAMS Accession Number ML18085B196)

2. NRC letter to Entergy, "Waterford Steam Electric Station, Unit 3 – Supplemental Information Needed for Acceptance of Request for Licensing Action Re: Revision of Technical Specification 3/4.7.4, "Ultimate Heat Sink (EPID L-2018-LLA-0080)," dated May 4, 2018 (ADAMS Accession Number ML18122A097)

3. Entergy letter W3F1-2018-0025, Supplemental Information Supporting the License Amendment Request Regarding Proposed Change to Technical Specification 3/4.7.4 for Ultimate Heat Sink Design Basis Update," dated May 17, 2018 (ADAMS Accession Number ML18137A494)

4. NRC letter to Entergy, " Waterford Steam Electric Station, Unit 3 – Request for Additional Information Regarding License Amendment Request for Revision of Technical Specification 3/4.7.4, 'Ultimate Heat Sink' (EPID L-2018-LLA-0080)," dated January 28, 2019 (ADAMS Accession Number ML19018A010)

Enclosure: Response to NRC Request for Additional Information
Attachment 1: Engineering Report WF3-ME-18-00008
Attachment 2: Engineering Report WF3-ME-16-00001
Attachment 3: Engineering Report WF3-ME-15-00013
Attachment 4: Engineering Report WF3-ME-15-00014
Attachment 5: Engineering Report WF3-ME-15-00011

cc: NRC Region IV Regional Administrator
NRC Senior Resident Inspector – Waterford Steam Electric Station, Unit 3
NRR Project Manager
Louisiana Department of Environmental Quality, Office of Environmental Compliance, Surveillance Division

ENCLOSURE

W3F1-2019-0005

Entergy Operations, Inc.

Response to NRC Request for Additional Information

Attachment 1: **Engineering Report WF3-ME-18-00008**

Attachment 2: **Engineering Report WF3-ME-16-00001**

Attachment 3: **Engineering Report WF3-ME-15-00013**

Attachment 4: **Engineering Report WF3-ME-15-00014**

Attachment 5: **Engineering Report WF3-ME-15-00011**

Additional Information Requested by the NRC:

Request 1:

Section 2.2, "Technical Specification 3.7.4 Action c," of the LAR dated March 26, 2018, states that the technical specification will be revised to read (all text in **BOLD** is revised text, as indicated in the LAR):

> **This action applies only when UHS tornado required equipment is inoperable.** With a Tornado Watch **or Warning** in effect **with the forecast 7 day average ambient dry bulb temperature greater than 74 ºF** [degrees Fahrenheit]**, all 6 DCT tube bundles and all** 9 DCT fans **associated with** the missile protected portion **of both trains** of the DCT shall be OPERABLE. **With a Tornado Watch or Warning in effect with the forecast 7 day average ambient dry bulb temperature less than or equal to 74 ºF, all 6 DCT tube bundles and at least 8 DCT fans associated with the missile protected portion of both trains of the DCT shall be OPERABLE.**

The proposed text to be included in the above technical specification does not include a discussion on the mechanisms in place (or to be added) for monitoring or receiving tornado watches and warnings. Discuss how tornado watches and warnings are received and monitored to ensure that the correct number of DCT tube bundles and DCT fans associated with missile protection are operable.

Entergy Response:

Tornado watches and warnings are received from the National Weather Service. The National Weather Service is monitored in the Control Room. Procedure OP-901-521, Revision 327, "Severe Weather and Flooding," is entered when the National Weather Service issues a tornado watch or tornado warning. Section E2, Tornado Watch/Warning, Step 3 directs Operations personnel to verify operability of required Cooling Tower fans located within the missile protected area.

Request 2:

Section 2.3, "Technical Specification 3.7.4 Action d," of the LAR dated March 26, 2018, states that the technical specification will be revised to read (all text in **BOLD** is revised text, as indicated in the LAR):

> **When Table 3.7-3 dry bulb temperature restrictions apply w**ith UHS fan**(s)** inoperable, determine the **forecast** ambient temperature**s** and verify that the minimum fan requirements of Table 3.7-3 are satisfied (required only if the associated UHS is OPERABLE). **The more restrictive fan requirement shall apply when 1 hour and 3 day average temperatures allow different configurations.**

The discussion in the LAR does not include sufficient information regarding the calculation of the average 1-hour and 3-day temperatures. Provide additional details on the methods proposed to calculate the 1-hour and 3-day average temperatures, so that the NRC staff may determine the adequacy of the calculations.

Entergy Response:

Engineering Report WF3-ME-18-00008, Revision 0, "National Weather Service Forecast Accuracy Study for Waterford 3 Ambient Temperature" (Attachment 1), describes the proposed methods for calculating the 1-hour and 3-day average temperatures that would be used to determine that the minimum fan requirements of Technical Specification Table 3.7-3 are satisfied. Specifically, the conclusions and recommendations Section 7.0 provides detailed instructions for determining conservative 1-hour, 3-day, and 7-day average temperatures for establishing the Technical Specification 3.7.4 Ultimate Heat Sink fan operability requirements.

Request 3:

Section 4.5.4, "Meteorological Parameters," of the LAR dated March 26, 2018, states, in part, that:

> Historical studies were used to establish bounding conditions included in UFSAR [Updated Final Safety Analysis Report] section 2.3. A constant recirculation effect was applied to both dry bulb and wet bulb temperature.
>
> Engineering Report WF3-ME-15-00011 (Reference 7.23) determines the bounding relationship between wind speed, wind direction, and ambient temperature. This information is used in Engineering Report WF3-ME-15-00014 for the determination of the cooling tower maximum recirculation effects.

Provide additional details on the data and methods used to determine the bounding combinations of the wind speed, wind direction, and ambient temperature, so that the NRC staff may determine the adequacy of the calculations. This information should include data sources, data summaries, details on the use of historical studies, and descriptions of the methods used to compile the summary tables in the LAR.

Entergy Response:

Engineering Report WF3-ME-16-00001, Revision 0, "Meteorological Parameters and Parameter Relationships for Design and Operability of the Waterford 3 Ultimate Heat Sink" (Attachment 2), provides the details of the data and methods used to determine the bounding combinations of the wind speed, wind direction, and ambient temperature. Engineering Reports WF3-ME-15-00013, Revision 0, "Waterford 3 Ultimate Heat Sink Project UHS Model" (Attachment 3), and WF3-ME-15-00014, Revision 0, "Waterford 3 Ultimate Heat Sink: CFD Investigation of the Dry Cooling Tower Deflector Wall" (Attachment 4), provide details of the data and methods used to determine the bounding combinations of ambient temperature, wind speed, wind direction, and recirculation effect. Engineering Report WF3-ME-15-00011, Revision 1, "Waterford 3 Ultimate Heat Sink Project Weather Investigation" [8.4] (Attachment 5) addresses an investigation of the Waterford 3 site meteorology, specifically the combination of wind speed, wind direction, and ambient temperature. The WF3-ME-15-00011 report statistically evaluates ambient wind and temperature combinations in order to substantiate the conservatism of the data used to evaluate bounding recirculation in report WF3-ME-15-00014. Each of the reports mentioned above include data sources, data summaries, details on the use of historical studies, and descriptions of the methods used to compile the summary tables in the LAR.

Request 4:

Section 4.5.4.2, "Meteorological Parameters for Critical Time Periods," of the LAR dated March 26, 2018, states, in part, that:

> Engineering report WF3-ME-16-00001 (Reference 7.24) used historical studies for the development of bounding meteorological parameter relationships for the design of the ultimate heat sink which is consistent with the methods described in the UFSAR and also meet the requirements of Regulatory Guide 1.27 in that it determines the most severe combinations of controlling parameters for the duration of the critical time periods, based on examination of regional climatological (>30 years) measurements that are demonstrated to be representative of the site.

Section 4.5.4.2 also states that:

> Engineering report WF3-ME-16-00001 provided the data for the next table, which gives the maximum average dry bulb temperature as a function of the time of year by month. This information will be added to the UFSAR (Enclosure Attachment 3 - Commitment). This new UFSAR table will be used to evaluate the average temperature restrictions as the forecast data when online forecast data is not available. It may also be conservatively used when the time of year is such that online forecast data is not needed to demonstrate the temperature requirements will be met.

Provide additional details on the data and methods used to determine: (1) the bounding meteorological parameter relationships for the design of the ultimate heat sink, and (2) the maximum average dry bulb temperature as a function of month, as presented in Section 4.5.4.2 of the LAR, so that the NRC staff may determine the adequacy of the calculations. This information should include data sources, data summaries, details on the use of historical studies, and descriptions of the methods used to compile the summary tables in the LAR.

Entergy Response:

Engineering Report WF3-ME-16-00001, Revision 0, "Meteorological Parameters and Parameter Relationships for Design and Operability of the Waterford 3 Ultimate Heat Sink" (Attachment 2), provides the details of the data and methods used to determine the bounding meteorological parameter relationships for the design of the ultimate heat sink and the maximum average dry bulb temperature as a function of month as presented in Section 4.5.4.2 of the LAR. The report includes data sources, data summaries, details on the use of historical studies, and descriptions of the methods used to compile the summary tables in the LAR.

Request 5:

Section 2.4, "New Technical Specification 3.7.4 Action e and New Surveillance 4.7.4.c," of the LAR dated March 26, 2018, describes the new Surveillance Requirement (SR) 4.7.4.c which will state: "Verify that each wet tower basis [*sic*] cross-connect valve is OPERABLE in accordance with the INSERVICE TESTING PROGRAM." The language of the new SR is justified by the statement "The existing in-service testing requirements for testing the open safety function of the wet cooling tower basin cross-connect isolation valves satisfy the new Technical Specification surveillance requirement."

The amendment request did not provide information regarding the frequency of the existing in-service testing requirements for the wet cooling tower basin cross-connect isolation valves. Please provide information regarding the frequency at which the INSERVICE TESTING PROGRAM requires the wet cooling tower cross-connect valves to be tested.

Entergy response:

The testing of valves ACC-138A and ACC-138B that will be required by the new SR 4.7.4.c is currently performed as part of the Waterford 3 Inservice Testing Program. Document, SEP-WF3-IST-2, "WF3 Inservice Testing Plan," Revision 7, currently requires that this test be performed at a frequency of every 2 years.

ENCLOSURE, ATTACHMENT 1

W3F1-2019-0005

Attachment 1: Engineering Report WF3-ME-18-00008

Engineering Report No. WF3-ME-18-00008 Rev 0
Page 1 of 214

Entergy

ENTERGY NUCLEAR
Engineering Report Cover Sheet

Engineering Report Title:
National Weather Service Forecast Accuracy Study for Waterford 3 Ambient Temperature

Engineering Report Type:

New ☒ Revision ☐ Cancelled ☐ Superseded ☐
Superseded by: ______

Applicable Site(s)

IP1	☐	IP2	☐	IP3	☐	JAF	☐	PNPS	☐	VY	☐	WPO	☐
ANO1	☐	ANO2	☐	ECH	☐	GGNS	☐	RBS	☐	WF3	☒	PLP	☐

EC No. **52043 (FCR-EC-54161)**

Report Origin: ☒ Entergy ☐ Vendor
Vendor Document No.: ______

Quality-Related: ☒ Yes ☐ No

Prepared by: Dale V. Gallodoro / [signature] Date: 11-12-2018
Responsible Engineer (Print Name/Sign)

Design Verified: Alex Tojeiro / [signature] Date: 11/17/2018
Design Verifier (if required) (Print Name/Sign)

______ ______

Approved by: Nicholas Petit / [signature] Date: 11-29-18
Supervisor / Manager (Print Name/Sign)

Table of Contents

Revision Summary

Revision	Summary of Changes
0	Initial Issue

1.0 Scope and Objectives

1.1 This report describes an acceptable process for obtaining and using ambient temperature forecast data for accurately predicting the upcoming daily one-hour high, three-day average, and seven-day average ambient temperatures for determining the number of Ultimate Heat Sink (UHS) fans required to meet Technical Specification (TS) 3.7.4 [Reference 8.3].

1.2 This report collects National Weather Service (NWS) forecast data for the area around Waterford 3 and compares the forecasted temperatures to actual temperatures recorded in the Plant Monitoring Computer (PMC) PI data archives for the same time period. Several months of data are analyzed to justify a high level of confidence in the accuracy of future forecasts.

1.3 This report provides the basis for concluding that the NWS forecast of ambient temperatures in the area around Waterford 3 have been sufficiently accurate to justify future use, in accordance with the guidance in this report, without independent verification.

2.0 Design Inputs

2.1 UHS Design Basis

2.1.1 Calculation ECM95-008 [Reference 8.4] and Engineering Report WF3-ME-16-00001 [Reference 8.7] identify the design basis of the UHS and establish meteorological parameter relationships and TS fan requirements.

2.1.2 Dry bulb temperature is the controlling parameter for the Dry Cooling Tower (DCT) performance. ECM95-008 [Reference 8.4] and WF3-ME-16-00001 [Reference 8.7] justify using bounding mathematical relationships as a function of only dry bulb temperature for determining the other pertinent meteorological parameters for the design and operability of the UHS.

2.1.3 The potential for hot air recirculation is accounted for in the design basis analyses. WF3-ME-15-00014 [Reference 8.6] demonstrates that the conservatism in the design basis cooling tower recirculation effect is sufficient to allow for the small potential for deviations between the forecast and actual ambient temperature.

2.1.4 TS 3.7.4 [Reference 8.3] provides the limiting conditions for operation of the UHS. TS Table 3.7-3 specifies the UHS minimum fan requirements as a function of one-hour and three-day average ambient dry bulb temperature. TS 3.7.4 c specifies the number of operable DCT fans for the missile protected tube bundles during a tornado watch or warning as

a function of one-hour average ambient temperature.

2.1.5 Using forecast temperatures for the critical time periods unique to the specific design of the UHS more appropriately accounts for potential changes in ambient conditions as compared to using only the current ambient conditions.

2.1.6 For example, the average dry bulb temperature on the order of one hour is an appropriate controlling parameter for limiting Component Cooling Water (CCW) supply temperature. Looking ahead at the high temperature for the upcoming several hours is more conservative than only relying on the current ambient temperature reading.

2.1.7 Also, for example, the average dry bulb temperature on the order of three days is a conservative controlling parameter for limiting Wet Cooling Tower (WCT) water consumption, which is analyzed to be required for up to eight days before the DCT is capable of providing all of the plant's post-accident cooling needs. Using a reliable average temperature forecast provides an appropriate basis for determining the upcoming three-day average temperature.

2.1.8 For a complete set of design inputs, including the meteorological parameter relationships and the TS fan requirements, see ECM95-008 [Reference 8.4] and WF3-ME-16-00001 [Reference 8.7].

2.2 Ambient Temperature Forecast

2.2.1 The NWS Forecast Office is a part of the National Oceanic and Atmospheric Administration (NOAA) under the US Department of Commerce. The NWS Forecast Office publishes a website that can be found under: https://forecast.weather.gov/MapClick.php?w0=t&w3u=1&w10u=0&w12u=1&w13u=1&AheadHour=0&Submit=Submit&FcstType=digital&textField1=29.9911&textField2=-90.4481&site=all&unit=0&dd=&bw=

2.2.2 The website provides hourly temperature forecasts for up to six days in tabular form. The table can be easily copied into an excel spreadsheet for comparison to actual temperatures after the forecast times are reached. The website also provides an estimate of the high temperature seven days. Attachment 9.1 shows a screenshot of the website.

2.2.3 To determine the upcoming three day average temperature, take the average of the hourly temperature forecasts for the upcoming three day period.

2.2.4 To conservatively determine the upcoming seven day average temperature, take the average of the hourly temperature forecasts for the upcoming six day period (T_{ave_6day}) and then take the forecasted high temperature for the seventh day out (T_{high_7day}) and perform a weighted average of those two values:

2.2.4.1 $T_{ave\_7day} = (6 * T_{ave\_6day} + T_{high\_7day}) / 7$

2.3 Actual Ambient Temperature Measurements

2.3.1 The meteorological towers for Waterford 3 provide instrumentation necessary to monitor meteorological data on a continuous basis. Data collected from the instruments at elevation +30 feet MSL on these towers, which are located at the same elevation and approximately 1700 feet east of the cooling towers, is considered to be representative of the atmospheric conditions at the inlet of the cooling towers before adding a penalty for recirculation. Temperature and other meteorological data is transmitted to the Plant Monitoring Computer (PMC). The data collected from the instruments since July 2000 is stored in the PI data archives.

2.3.2 The archived data for the following PMC points were imported to Excel using the PI-Datalink Add-in every hour for the following:

2.3.2.1 Primary Tower 33' Air Temperature "A" – C48517

2.3.2.2 Backup Tower 33' Air Temperature – C48608

2.3.2.3 Primary Tower 33' Air Temperature, 1 hr, F – C48558

2.3.2.4 Backup Tower 33' Air Temperature, 1 hr, C – C48623

2.3.3 Regular scheduled semi-annual calibrations are performed for both towers. The routine semi-annual calibration is performed in order to maintain a high availability of meteorological data. Non-routine and corrective maintenance is also performed, as needed, in order to restore instrumentation to service and maintain a high data collection rate.

2.3.4 ECI91-029 [Reference 8.15] shows that the PMC loop uncertainty for ambient temperature is 0.498°C (0.896°F). This small amount of uncertainty is insignificant considering the conservatism in the recirculation effect used in the design basis analysis.

2.3.5 Data storage for the PMC has provided very good performance. Very few gaps are present in the data recorded by the PMC in the PI data system. The gaps in PI data were of short duration. These periods of missing data were caused by periodic PMC shutdowns/outages. PMC reboots/rebuilds also cause a momentary loss of the ability to store this data in PI. It is reasonable to conclude that the relatively small amount of unavailable data would not have significantly impacted the overall conclusions of this report.

2.3.6 The combined set of data used for this six month study included over 10,000 data points for ambient temperature. The data used for producing the charts in this report is stored electronically in MS Excel spreadsheets and in pdf form.

3.0 Assumptions

3.1 There are no assumptions that affect the conclusions in this report.

4.0 Detailed Discussion

4.1 Calculation ECM95-008 [Reference 8.4] and Engineering Report WF3-ME-16-00001 [Reference 8.7] identify the design basis of the UHS and establish meteorological parameter relationships and TS fan requirements based on ambient dry bulb temperature forecasts.

4.2 The Waterford 3 UHS design analysis allows for taking fans out-of-service for maintenance when controlling meteorological parameters support the required UHS performance requirements and water inventory margin with only the remaining operable fans. Therefore, this report provides a basis for the accuracy of the NWS forecast for determining the upcoming dry bulb temperatures to allow for establishing fan requirements based on forecast ambient temperature conditions.

4.3 Data Analysis

4.3.1 NWS forecast data was collected in real time over several months from March 2018 to October 2018, as follows:

4.3.1.1 Tabular hourly forecast data was obtained at several random times each week.

4.3.1.2 The website used for Taft, LA was: https://forecast.weather.gov/MapClick.php?w0=t&w3u=1&w10u=0&w12u=1&w13u=1&AheadHour=0&Submit=Submit&FcstType=digital&textField1=29.9911&textField2=-90.4481&site=all&unit=0&dd=&bw= .

4.3.1.3 The forecast data was copied into a spreadsheet with a separate worksheet for each day's data. Attachment 9.3 shows examples of forecast data sheets.

4.3.2 Data from the PMC archives for hourly average ambient temperature was gathered for comparison to the forecast temperatures.

4.3.2.1 The PI archive excel add-in was used to obtain data with the following example function: =PICalcVal(C4,$B7+0/24,$B7+1/24,"average",1,0,), where C4 is the tag name for the data point and column B contains the dates. There is a column for each hour of the day. Attachment 9.2 shows the actual temperature data sheet.

4.3.3 Attachment 9.4 is a summary of the comparison and shows that using the NWS forecast data as described in this report provides for a

conservative forecast with respect to the actual one-hour, three-day, and seven-day average temperatures for complying with TS Table 3.7-3.

4.3.3.1 There were only 23 instances out of 163 trials during the study when one of the forecast average temperatures was lower than the actual average temperature.

Date	Deviation (forecast – actual), °F		
	3 day	24 hr high	7 day
4/2/2018 2pm	-0.1	0.6	5.5
5/14/2018 1pm	-1.5	1.2	1.1
6/29/2018 11am	3.4	-0.5	3.9
7/19/2018 10am	-0.3	3.4	2.2
7/20/2018 2pm	-0.5	3.1	1.7
7/30/2018 1pm	2.5	-0.7	2.9
8/1/2018 9am	1.6	-0.4	3.6
8/20/2018 6am	-1.0	1.6	1.3
8/21/2018 6am	-1.3	-1.2	1.3
9/3/2018 8am	0.9	-2.8	2.6
9/4/2018 8am	0.9	-0.4	3.1
9/5/2018 1pm	1.9	-1.3	2.6
10/4/2018 1pm	-0.2	3.1	1.8
10/9/2018 9pm	2.5	3.5	-0.7
10/10/2018 9pm	0.2	2.9	-1.0
10/11/2018 7am	-0.1	2.9	-1.1
10/11/2018 7pm	-0.8	1.0	-1.1
10/12/2018 6am	0.5	4.0	-0.1
10/15/2018 2pm	0.0	-0.1	0.7
10/16/2018 6am	-0.9	-2.1	0.6
10/20/2018 8am	-0.3	-0.3	1.9
10/22/2018 6am	0.0	3.4	-0.1
10/24/2018 7am	1.6	1.7	-0.6
10/25/2018 8am	2.2	-0.3	-0.1

Positive deviation indicates forecast temperature was higher than actual temperature.

4.3.3.2 The 24 hour high temperature forecast was conservative 93% of

the time, with an average conservatism of 2.9°F. The maximum non-conservative deviation was 2.8°F. The average non-conservative deviation was 0.9°F.

4.3.3.2.1 The chart on page 1 of attachment 9.5 illustrates that probability that actual hourly temperature will be no more than 0.4°F above the forecast hourly temperature for the upcoming 24 hours is 95%. WF3-ME-15-00014 [Reference 8.6] demonstrates that the conservatism in the design basis cooling tower recirculation effect is sufficient to allow for the small potential for deviations between the forecast and actual ambient temperature.

4.3.3.3 The 3-day average forecast was conservative 91% of the time, with an average conservatism of 2.0°F. The maximum non-conservative deviation was 1.5°F. The average non-conservative deviation was 0.5°F.

4.3.3.3.1 The chart on page 2 of attachment 9.5 illustrates that probability that actual three day average temperature will be no more than 0.5°F above the forecast three day average temperature for the upcoming three days is 95%. WF3-ME-15-00014 [Reference 8.6] demonstrates that the conservatism in the design basis cooling tower recirculation effect is sufficient to allow for the small potential for deviations between the forecast and actual ambient temperature.

4.3.3.4 The 7-day average forecast was conservative 95% of the time, with an average conservatism of 3.0°F. The maximum non-conservative deviation was 1.1°F. The average non-conservative deviation was 0.6°F

4.3.3.4.1 The chart on page 3 of attachment 9.5 illustrates that probability that actual seven day average temperature will be lower than 0.4°F below the forecast seven day average temperature for the upcoming seven days is 95%. Therefore, there is at least 95% confidence that that the forecast seven day average temperature will be conservatively high.

4.3.3.5 The apparent consistent conservatism in the NWS forecast temperatures is somewhat expected because the forecast temperature is the high temperature for each hour, whereas the actual measurements are the average temperature for each hour.

4.3.4 The PMC data is from the Primary Meteorological Tower. Attachment 9.6 demonstrates the similarity of the Backup Tower data, which adds to the confidence in the accuracy of the actual readings.

5.0 <u>Operating Experience (OE)</u>

5.1 This report is intended to establish a basis for concluding that the NWS forecast is sufficiently accurate to use for maintaining the operability of UHS fans within the requirements of TS Table 3.7-3 [Reference 8.3]. The ICES database was used with keywords [UHS temperature]; ["ambient temperature" forecast]; ["national weather service" forecast]; ["NWS"]; [forecast] with the following results. None of the OE were related to forecasting ambient air temperature for predicting UHS performance capacity. A search was also performed for existing published information about weather forecast accuracy and is documented in 5.1.5.

5.1.1 INPO 12-005 – Must-Know Operating Experience

5.1.1.1 The INPO report has a section about environmental conditions. Changes in environmental conditions, created by man or natural phenomena (that occurred suddenly or slowly over time) have exceeded design basis assumptions. These environmental effects have led to unexpected or sudden losses of systems important to safety and have resulted in forced outages and equipment damage. Contributing were monitoring techniques and prediction methods that did not provide sufficient early warning to manage slowly changing environmental conditions. In addition, reviews of original design and changes to plant design did not identify vulnerabilities created by environmental conditions. The INPO report recommends periodically verifying that environmental parameters do not exceed design basis assumptions or equipment maintenance strategies intended to mitigate environmental effects. This engineering report evaluates the accuracy of the NWS forecasts for determining the number of UHS fans required to meet TS 3.7.4 and so meets the intent of the INPO report.

5.1.2 SOER 07-2 – Intake Cooling Water Blockage

5.1.2.1 The INPO SOER is also related to environment conditions. The same discussion for INPO 12-005 applies.

5.1.2.2 The Waterford 3 UHS does not rely on the Circulating Water system or the river water intake structure. However, changes in environmental conditions could impact the design assumptions associated with the dry cooling towers. The basis for the UHS fan requirements assumes that accurate temperature forecasts are available for determining the capacity of the UHS with fewer operable fans. This report determines the accuracy of the NWS forecasts and evaluates limitations for their use in determining the required number of UHS fans for complying with TS 3.7.4. SOER 07-2 is periodically reviewed for environmental changes that could impact the design assumptions.

5.1.3 OE15013 - CONFLICTING WEATHER ADVISORIES AFFECT RIVER BEND PLANT RESPONSE

5.1.3.1 This OE identifies conflicting information between the NWS and local forecasts for hurricane information. Therefore, this OE is not applicable to ambient air temperature forecasts.

5.1.4 #300956 - Unplanned Entry into UHS Tech Spec Required Plant Shutdown

5.1.4.1 Millstone was shut down due to exceeding TS temperature limits for UHS water supply. The cooling water is supplied from Niantic Bay. Ambient air temperature is not a factor. Therefore, this OE is not applicable to ambient air temperature forecasts. However, this is an example of where a plant used actual temperatures to determine that it was necessary to shut down due to exceeding the UHS temperature limits. Waterford 3, on the other hand, plans to use forecast data to conservatively enter a TS LCO based on a prediction that the UHS temperature limits may be exceeded in the future.

5.1.5 Independent Investigations of Forecast Accuracy

5.1.5.1 Lauterbach EM (2018) "A Comparison of Paid Versus Free Weather Services for Site Specific Weather Forecasts for Construction Projects", 8th International Conference on Engineering, Project, and Product Management (EPPM 2017) Springer International Publishing concludes that using free weather forecast services provides similar results as using paid site specific weather services. Specific to high temperature forecasts five days out, the report shows that the NWS forecast temperature was more accurate than the paid forecast service.

5.1.5.2 The website https://www.forecastadvisor.com/docs/resources/ provides a list of major forecast websites. The list was reviewed and the NWS website has the most user friendly format for collecting and analyzing the forecast data.

5.1.5.3 Murphy, AH (1977) "Can Weather Forecasters Formulate Reliable Probability Forecasts of Precipitation and Temperatures?" is a study that shows that, as far back as 1977, forecasts by meteorologists were more reliable than forecasts based upon climatological data. The accuracy described in this report is much better than the accuracy described in the 1977 study. This exemplifies the how accurate and reliable temperature forecasts are today in comparison to when Waterford 3 was first licenced.

5.1.5.4 Murphy, AH (1993) "What is a Good Forecast? An Essay on the Nature of Goodness in Weather Forecasting" defines the quality

of a forecast as the degree of correspondence between forecasts and observations. Consistency and value are also discussed as important factors in the goodness of forecasts.

6.0 Summary of Results

6.1 The NWS forecast may be used to accurately predict the upcoming daily one-hour high temperature and the three-day and seven-day average ambient temperatures for determining the number of UHS fans required to meet TS 3.7.4 [Reference 8.3].

6.1.1 NWS forecast temperatures for the area around Waterford 3 were collected and compared to the actual temperatures recorded in the Plant Monitoring Computer (PMC) PI data archives for the same time period for several months. Analysis of the data shows that the forecasts are consistently accurate and justifies a high level of confidence in the accuracy of future forecasts.

7.0 Conclusions and Recommendations

7.1 The NWS forecast may be used for accurately predicting ambient temperatures for establishing TS 3.7.4 UHS fan operability requirements to maintain the UHS capacity in accordance with the analysis that demonstrates compliance with the regulatory position of RG1.27 [Reference 8.1].

7.2 Use the NWS website for the hourly forecast for Taft, LA: https://forecast.weather.gov/MapClick.php?w0=t&w3u=1&w10u=0&w12u=1&w13u=1&AheadHour=0&Submit=Submit&FcstType=digital&textField1=29.9911&textField2=-90.4481&site=all&unit=0&dd=&bw= .

7.2.1 The website provides hourly forecast temperatures for the next six days.

7.3 For the one-hour average temperature, use the highest forecast temperature for the next 12 hours.

7.4 Copy the forecast hourly temperatures into a spreadsheet for calculating the average temperature for the three-day period.

7.5 For the seven-day average, take the weighted average of the calculated six-day average from the NWS website along with the forecast high temperature of the seventh day from the NWS website.

7.5.1 $T_{ave\_7day} = (6 * T_{ave\_6day} + T_{high\_7day}) / 7$

7.5.2 The following link should be used to determine the seventh day high temperature: https://forecast.weather.gov/MapClick.php?w0=t&AheadHour=0&Submit

=Submit&FcstType=text&textField1=29.9911&textField2=-90.4481&site=all

7.6 These methods result in temperature forecasts that are accurate to within the conservatism in the analysis of the UHS, including the analysis of the bounding DCT recirculation effect.

8.0 References

8.1 Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants"

8.2 W3-DBD-4, "Component Cooling Water / Auxiliary Component Cooling Water Design Basis Document"

8.3 Technical Specifications Section 3/4.7.4, "Ultimate Heat Sink"

8.4 ECM95-008, "Ultimate Heat Sink Design Basis"

8.5 WF3-ME-15-00011, "Waterford 3 Ultimate Heat Sink Project Weather Investigation" (LPI Report A13326-R-001)

8.6 WF3-ME-15-00014, "Waterford 3 Ultimate Heat Sink CFD Investigation of the Dry Cooling Tower Deflector Wall Modification"

8.7 WF3-ME-16-00001, "Meteorological Parameters and Parameter Relationships for Design and Operability of the Waterford 3 Ultimate Heat Sink"

8.8 Waterford 3 Updated Final Safety Analysis Report

8.9 Waterford 3 Updated Final Safety Analysis Report (FSAR)

8.9.1 FSAR Section 2.3, "Meteorological Conditions"

8.9.2 FSAR Table 2.3-2(a), Ultimate Heat Sink Meteorological Design Parameters

8.9.3 FSAR Table 2.3.2(b), Ultimate Heat Sink Meteorological Design Parameters by Month

8.9.4 FSAR Table 2.3-29, Average Monthly and Annual Temperatures for Selected Stations in the New Orleans Area (1931 – 1960)

8.9.5 FSAR Table 2.3-30, Mean Monthly and Annual Maximum, Minimum, and Average Temperatures Moisant International Airport (1931 – 1960)

8.9.6 FSAR Table 2.3-31, Temperature Extremes Moisant International Airport, New Orleans, Louisiana

8.9.7 FSAR Table 2.3-32, Average Monthly Occurrences of Extreme Temperatures Moisant International Airport, New Orleans, Louisiana (1947 – 1972)

8.9.8 FSAR Table 2.3-33, Mean Monthly and Annual Maximum, Minimum, and Average Temperatures Waterford Nuclear Unit 3 On Site Data (July 1972 – June 1975 and February 1977 – February 1978)

8.9.9 FSAR Table 2.3-138, Waterford Onsite Meteorological Monitoring System Overall System Inaccuracies of One Hour Averages

8.9.10 FSAR Table 2.3-141, Waterford 3 Operational Meteorological Monitoring System Accuracies

8.9.11 FSAR Section 9.2.5, “Ultimate Heat Sink”

8.10 EC-52043, “Ultimate Heat Sink Margin Restoration Project”

8.11 CR-WF3-2012-2332, “Non-Conservative Cooling Tower Recirculation”

8.12 ES-LOU-1-76, “Meteorological Conditions Following Tornado Passage”, April 29, 1976

8.13 ES-LOU-87-77, “Design Meteorological Data for Ultimate Heat Sink” , July 18, 1977

8.14 ES-LOU-91-77, “FSAR Table 2.3-2(a) – Ultimate Heat Sink Design Parameters”, August 2, 1977

8.15 ECI91-029, “Meteorological Tower Uncertainty Calculation”

8.16 Annual Meteorological Monitoring Program Reports – 2000 through 2014

9.0 Attachments

9.1 Snapshot of NWS Website Used for Temperature Forecasts (3 pages)

9.2 Actual Hourly Ambient Temperatures – March 2018 – October 2018 (4 pages)

9.3 Forecast vs Actual Comparison Worksheets (163 pages)

9.4 Forecast vs Actual Summary (5 pages)

9.5 Probability of Ambient Temperature Deviating from Forecast (3 pages)

9.6 Primary vs Backup Met Tower Comparison Worksheet (22 pages)

weather.gov

National Weather Service Forecast Office
New Orleans/Baton Rouge, LA

Home News Organization Search for: NWS All NOAA Go

Point Forecast: 2 Miles NW Hahnville LA
30N 90.45W

Last Update: 7:18 am CDT Oct 29, 2018

Tabular Forecast

[hide menu] | **Font Size:** A A A XML

Weather Elements	Fire Weather	Aviation Weather
☑ Temperature (°F)	☐ Mixing Height x100ft	☐ Ceiling Height
☐ Dewpoint (°F)	☐ Lightning Activity Level	☐ Visibility
☐ Heat Index (°F)	☐ Trans. Wind mph	☐ Thunder Potential
☐ Surface Wind mph	☐ 20ft Wind mph	
☐ Sky Cover (%)	☐ Atmospheric Dispersion Index	
☐ Precipitation Potential (%)	☐ Low Visibility Occurrence Risk Index	
☐ Relative Humidity (%)		
☐ Rain		
☐ Thunder		
☐ Fog		

48-Hour Period Starting: 7am Mon, Oct 29 2018 Submit Back 2 Days Forward 2 Days

Date	10/29																	10/30						
Hour (CDT)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06
Temperature (°F)	64	66	68	72	75	77	79	81	81	80	79	76	74	71	69	67	66	65	64	64	63	62	61	61

Date																		10/31						
Hour (CDT)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06
Temperature (°F)	62	66	70	74	78	80	81	82	82	81	79	76	74	72	71	70	70	69	69	69	69	68	68	68

Radar and Satellite Images

Additional Forecasts & Information

International System of Units Forecast Discussion
7-Day Forecast | Hourly Weather Graph
Surface Analysis | Rivers & Lakes AHPS
Experimental Radar Image | Interactive Graphical Forecast
Marine Weather | Aviation Weather
NWS New Orleans/Baton Rouge Home

Webmaster
NOAA's National Weather Service
New Orleans/Baton Rouge, LA

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NATIONAL WEATHER SERVICE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Unsettled Weather in the West

Multiple periods of rain and high elevation snow will impact the Pacific Northwest and Northern Rockies through midweek, which could cause accumulating snow of up to 8 inches. There is the potential for a storm that will bring rain and significant amounts of snow to the Front Range of the Colorado Rockies extending southward into northern New Mexico Tuesday night and Wednesday. Read More >

Hazardous Weather Conditions

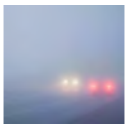
- Hazardous Weather Outlook

En Español Share |

Current conditions at

New Orleans, New Orleans International Airport (KMSY)

Lat: 29.99°N **Lon:** 90.25°W **Elev:** 3ft.



Fog/Mist

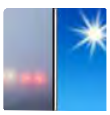
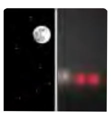
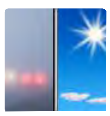
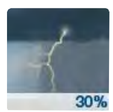
66°F

19°C

Humidity	100%
Wind Speed	W 3 mph
Barometer	30.17 in (1021.8 mb)
Dewpoint	66°F (19°C)
Visibility	1.25 mi
Last update	29 Oct 7:53 am CDT

Extended Forecast for

2 Miles NW Hahnville LA

Today	Tonight	Tuesday	Tuesday Night	Wednesday	Wednesday Night	Thursday	Thursday Night	Friday
								
Patchy Fog then Sunny	Clear then Patchy Fog	Patchy Dense Fog then Sunny	Increasing Clouds	Chance T-storms	Chance T-storms then T-storms	T-storms Likely	Mostly Clear	Sunny
High: 81 °F	**Low: 61 °F**	**High: 82 °F**	**Low: 68 °F**	**High: 82 °F**	**Low: 70 °F**	**High: 71 °F**	**Low: 53 °F**	**High: 68 °F**

Detailed Forecast

Today
Patchy fog before 9am. Otherwise, sunny, with a high near 81. Northwest wind around 5 mph.

Tonight
Patchy fog after 1am. Otherwise, clear, with a low around 61. Calm wind.

Tuesday
Patchy dense fog before 9am. Otherwise, sunny, with a high near 82. Calm wind becoming south around 5 mph in the afternoon.

Tuesday Night
Increasing clouds, with a low around 68. Southeast wind around 5 mph.

Wednesday
A 30 percent chance of showers and thunderstorms. Mostly cloudy, with a high near 82. South wind 5 to 10 mph.

Wednesday Night
Showers and thunderstorms, mainly after 1am. Low around 70. South wind around 10 mph. Chance of precipitation is 90%.

Thursday
Showers and thunderstorms likely before 1pm. Partly sunny, with a high near 71. West wind 10 to 15 mph. Chance of precipitation is 60%.

Thursday Night
Mostly clear, with a low around 53. North wind around 10 mph.

Friday
Sunny, with a high near 68. North wind 5 to 10 mph.

Friday Night
Clear, with a low around 51. Northwest wind around 5 mph.

Saturday
Sunny, with a high near 70. Northwest wind around 5 mph becoming northeast in the afternoon.

Saturday Night
Clear, with a low around 56. East wind around 5 mph.

Sunday
Sunny, with a high near 76. Southeast wind 5 to 10 mph.

Forecast Area

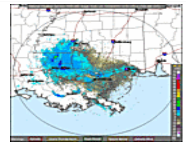
Point Forecast:
2 Miles NW Hahnville LA
30°N 90.45°W

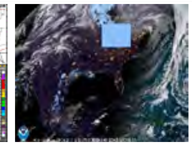
Last Update:
7:18 am CDT Oct 29, 2018

Forecast Valid:
7am CDT Oct 29, 2018-6pm CST Nov 4, 2018

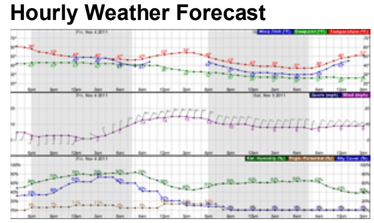
Additional Resources

Radar & Satellite Image





Hourly Weather Forecast



33 ft ambient F C48517 backup C48608

Date	Hour of day 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	low	high	average
7/11/2017 0:00	73.4	73.2	73.2	72.7	73.1	74.6	75.0	76.2	78.2	80.6	81.9	82.2	84.2	75.6	75.5	77.2	79.1	80.1	80.1	79.6	78.9	77.4	77.4	77.2	72.7	84.2	77.4
7/12/2017 0:00	76.7	76.9	76.8	76.4	76.1	76.4	76.2	77.0	79.3	80.9	82.8	85.4	84.4	77.7	77.9	79.6	81.6	82.4	82.4	81.6	79.1	78.3	77.7	77.8	76.1	85.4	79.2
7/13/2017 0:00	78.6	78.8	77.4	77.4	76.5	75.2	75.5	77.5	79.3	80.7	82.3	81.3	83.1	86.6	82.5	82.3	84.7	84.9	80.2	75.8	75.5	77.0	77.6	76.4	75.2	86.6	79.5
7/14/2017 0:00	75.1	75.2	74.9	75.9	77.3	77.6	77.8	79.0	80.3	78.1	78.5	77.7	77.7	78.3	80.6	84.4	84.0	76.1	76.9	77.0	76.1	76.2	76.9	76.1	74.9	84.4	77.8
7/15/2017 0:00	75.9	76.2	76.3	74.8	76.3	75.5	75.8	77.3	79.3	80.9	81.7	82.9	82.4	84.2	85.8	87.1	85.7	79.8	76.2	77.0	76.8	76.4	76.5	76.5	74.8	87.1	79.0
7/16/2017 0:00	75.5	74.9	74.7	74.7	74.7	74.8	75.9	75.9	79.6	81.5	80.6	83.1	83.6	84.9	86.5	84.9	85.4	84.6	84.7	82.4	80.1	78.6	79.0	77.6	74.7	86.5	79.9
7/17/2017 0:00	77.5	77.0	76.5	76.4	77.0	76.4	75.9	76.1	76.5	78.3	81.2	83.9	86.2	87.8	88.1	79.8	75.4	80.5	81.8	80.5	78.1	-13.3	-6117.2	-6999.0	-6999.0	88.1	-477.4
7/18/2017 0:00	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-5874.2	-6999.0	-6980.9	-6999.0	-6999.0	-6999.0	-3694.9	-2944.4	-6573.2	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-2944.4	-6627.0
7/19/2017 0:00	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-5578.8	0.0	0.0	-6294.2	-6999.0	-6999.0	-5608.9	-6911.5	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	-6999.0	0.0	-6265.6
3/5/2018 0:00	59.9	60.5	60.2	60.3	61.1	61.8	61.6	60.8	63.3	67.3	71.3	74.1	74.6	76.4	77.0	76.9	75.9	75.4	74.3	71.2	69.3	67.6	66.1	65.7	59.9	77.0	68.0
3/6/2018 0:00	65.8	66.2	67.3	66.9	67.0	67.0	61.6	55.0	55.6	53.3	53.2	54.4	56.0	58.2	60.5	63.3	64.8	65.4	65.0	62.5	59.7	59.6	58.1	57.0	53.2	67.3	61.0
3/7/2018 0:00	56.3	58.7	58.3	55.3	55.4	55.1	54.0	52.8	52.1	52.0	52.1	52.5	53.5	55.1	57.1	58.3	59.1	59.1	57.7	55.0	53.6	52.4	50.7	49.5	49.5	59.1	54.8
3/8/2018 0:00	48.7	48.3	48.5	47.6	47.6	48.3	48.1	46.9	47.6	49.5	51.4	53.9	55.2	56.9	58.5	59.2	60.1	61.0	60.8	58.9	56.0	53.2	50.6	49.3	46.9	61.0	52.8
3/9/2018 0:00	46.7	48.0	47.7	47.2	46.3	47.0	44.4	47.0	51.0	55.0	59.1	61.4	62.5	63.4	64.4	65.2	65.2	64.4	63.2	61.2	59.7	59.5	58.9	57.3	44.4	65.2	56.1
3/10/2018 0:00	56.8	56.8	57.1	57.6	58.1	57.7	58.6	60.0	60.9	62.6	63.1	68.9	71.8	73.4	70.6	74.6	74.5	72.6	70.8	69.6	67.7	66.1	64.8	63.1	56.8	74.6	64.9
3/11/2018 0:00	62.9	62.9	62.5	62.0	62.2	63.0	63.3	63.5	64.6	66.0	67.1	65.9	59.1	60.0	62.0	63.5	65.2	66.5	64.7	63.2	62.7	61.9	62.6	61.8	59.1	67.1	63.3
3/12/2018 0:00	61.0	60.1	59.0	57.6	55.9	53.1	51.0	49.6	49.6	49.7	50.5	52.5	54.5	56.0	57.4	58.5	59.5	60.2	60.0	58.7	56.9	55.7	53.7	52.2	49.6	61.0	55.5
3/13/2018 0:00	51.2	50.0	49.3	48.6	48.9	48.2	48.0	49.1	50.4	51.2	51.3	51.8	53.8	56.0	57.9	59.6	61.4	61.9	61.7	60.1	57.9	56.5	55.4	54.5	48.0	61.9	53.9
3/14/2018 0:00	53.1	51.2	50.0	48.9	48.6	48.2	46.7	44.0	47.4	52.8	54.3	55.6	57.6	59.3	60.6	62.2	63.5	64.4	64.0	61.3	58.1	56.5	54.7	52.6	44.0	64.4	54.8
3/15/2018 0:00	49.0	48.0	45.4	45.5	44.4	43.3	43.1	47.0	52.9	56.2	59.9	62.6	64.3	66.0	67.5	68.6	68.4	67.2	65.0	62.4	59.7	58.3	57.4	57.2	43.1	68.6	56.6
3/16/2018 0:00	58.3	58.8	59.6	59.9	59.4	60.2	60.7	61.3	63.5	66.2	69.1	71.1	73.0	74.1	74.4	71.3	72.6	71.6	69.2	68.5	67.8	67.1	66.2	65.6	58.3	74.4	66.2
3/17/2018 0:00	65.7	65.1	64.5	64.2	64.5	64.8	65.2	65.1	66.0	70.6	72.8	74.5	76.5	76.1	75.7	78.0	79.0	77.8	76.6	74.3	72.2	70.4	69.4	68.2	64.2	79.0	70.7
3/18/2018 0:00	67.8	67.7	68.1	68.1	67.8	67.5	67.8	67.7	68.7	70.7	74.2	77.2	77.6	77.9	79.3	79.2	80.4	79.5	77.6	74.6	70.7	70.5	69.9	69.9	67.5	80.4	72.5
3/19/2018 0:00	69.8	70.1	69.1	68.8	68.2	68.4	68.7	68.3	69.7	72.0	75.1	77.9	78.6	79.8	80.9	82.0	82.9	82.8	80.9	76.7	73.6	71.8	70.8	69.6	68.2	82.9	74.0
3/20/2018 0:00	68.7	67.7	67.3	66.9	64.9	62.3	60.7	59.1	58.5	59.1	59.8	60.8	62.4	63.4	64.4	64.6	64.3	63.3	61.8	59.6	57.9	57.1	55.2	53.3	53.3	68.7	61.8
3/21/2018 0:00	52.1	50.9	50.0	49.9	48.5	48.3	48.1	49.2	52.6	56.6	58.6	60.6	62.6	63.6	64.4	65.7	66.4	66.6	65.4	63.0	60.6	59.8	58.0	57.1	48.1	66.6	57.4
3/22/2018 0:00	55.4	55.4	54.8	54.4	54.5	53.9	53.9	52.6	54.3	56.3	58.1	59.6	60.9	61.3	62.8	63.9	65.5	66.9	67.2	63.8	60.4	57.8	55.5	53.5	52.6	67.2	58.4
3/23/2018 0:00	52.4	51.6	51.4	50.7	50.6	50.7	51.3	52.1	56.0	61.5	66.7	69.2	70.1	70.7	71.4	71.4	71.0	70.8	68.3	65.5	63.8	63.2	62.9	62.7	50.6	71.4	61.5
3/24/2018 0:00	63.1	63.0	63.2	62.6	61.9	61.8	62.7	64.2	67.1	71.2	73.5	75.3	76.5	77.6	78.2	77.7	76.6	75.4	73.1	71.1	69.8	68.6	66.4	65.8	61.8	78.2	69.4
3/25/2018 0:00	66.2	65.5	64.9	64.6	64.9	64.8	65.2	65.8	68.3	72.4	75.0	77.6	79.2	80.8	81.7	81.2	80.2	79.4	77.5	74.0	71.0	69.1	67.5	66.3	64.6	81.7	71.8
3/26/2018 0:00	66.3	66.0	65.9	66.1	66.4	66.3	67.0	67.1	68.8	72.6	76.0	77.4	78.4	78.4	79.1	78.7	77.6	77.0	75.2	73.1	72.1	71.5	71.0	70.5	65.9	79.1	72.0
3/27/2018 0:00	70.1	69.5	68.9	68.6	67.9	67.3	67.8	68.0	69.3	71.4	72.9	74.1	75.8	77.3	77.9	78.0	77.2	76.6	75.3	73.9	72.7	72.9	72.7	72.4	67.3	78.0	72.4
3/28/2018 0:00	72.1	71.8	71.6	71.5	71.4	71.5	71.5	71.7	72.3	74.1	76.6	77.8	77.6	78.3	79.2	79.0	76.6	76.2	75.2	73.3	72.2	71.7	71.9	72.1	71.4	79.2	74.0
3/29/2018 0:00	71.7	71.6	71.8	72.4	72.1	71.9	71.7	71.0	72.1	73.5	61.0	60.9	60.5	59.7	59.1	61.0	62.0	62.6	63.1	62.1	61.5	62.0	60.8	59.5	59.1	73.5	65.6
3/30/2018 0:00	58.8	58.0	58.5	58.2	59.4	59.5	59.3	60.3	61.3	62.8	63.3	63.6	64.6	66.1	67.6	68.9	69.7	68.7	68.1	67.1	66.6	65.3	64.3	63.4	58.0	69.7	63.5
3/31/2018 0:00	63.0	63.0	61.6	60.8	61.1	61.0	60.6	60.4	61.8	64.2	66.1	67.7	69.0	68.1	68.0	68.1	68.8	68.7	69.0	65.9	63.7	62.2	61.3	60.5	60.4	69.0	64.4
4/1/2018 0:00	59.2	58.3	57.7	57.8	58.8	58.0	56.1	56.8	60.1	63.6	66.6	66.8	68.7	69.3	71.6	73.7	74.2	73.2	71.0	68.3	66.3	64.5	63.4	62.5	56.1	74.2	64.4
4/2/2018 0:00	61.8	61.4	61.4	61.4	61.3	61.5	61.7	62.7	66.6	71.4	74.0	76.4	78.2	75.2	72.3	73.5	74.2	78.4	77.3	73.8	71.3	69.3	68.4	69.5	61.3	78.4	69.3
4/3/2018 0:00	69.4	69.0	68.6	68.4	68.8	68.3	67.8	67.6	70.7	75.0	77.6	79.7	79.8	80.4	81.4	81.3	80.1	78.8	77.7	75.5	73.8	72.2	71.7	71.5	67.6	81.4	74.0
4/4/2018 0:00	71.6	72.1	68.7	63.7	63.7	63.6	63.6	60.4	55.7	55.8	55.9	58.4	61.2	65.0	66.7	67.9	68.3	68.6	67.6	65.9	64.1	62.9	61.8	59.7	55.7	72.1	63.9
4/5/2018 0:00	57.8	57.5	56.9	56.3	55.8	55.4	54.9	55.1	56.7	58.3	59.7	61.6	63.7	66.9	66.2	67.0	66.4	65.3	64.9	63.1	62.9	63.1	62.6	62.0	54.9	67.0	60.8
4/6/2018 0:00	61.9	61.8	60.3	60.0	61.3	61.1	61.0	62.4	63.9	67.8	71.3	72.3	73.7	74.5	75.3	75.7	75.9	75.5	74.1	72.2	71.3	71.0	70.5	70.1	60.0	75.9	68.5
4/7/2018 0:00	69.6	69.5	69.1	69.8	69.6	68.8	64.5	64.1	64.8	67.1	68.9	68.7	69.2	68.3	67.8	67.3	63.4	58.3	54.6	54.0	52.1	50.7	50.0	48.8	48.8	69.8	63.3
4/8/2018 0:00	48.0	46.9	47.0	46.9	47.0	47.2	46.9	47.3	48.4	49.1	49.5	50.0	50.5	51.4	52.0	52.8	53.8	54.5	55.1	55.3	54.8	54.2	54.8	56.1	46.9	56.1	50.8
4/9/2018 0:00	56.9	57.2	56.3	56.0	55.6	55.6	55.6	56.8	58.6	58.7	59.2	60.9	61.4	62.5	64.1	65.8	67.0	67.5	67.7	67.1	66.6	66.6	65.8	65.4	55.6	67.7	61.5
4/10/2018 0:00	64.9	63.4	62.9	61.6	60.0	59.6	60.2	60.0	60.6	62.0	64.6	66.4	67.5	68.5	69.8	71.1	71.9	72.2	71.6	69.4	66.8	64.8	63.6	62.1	59.6	72.2	65.2
4/11/2018 0:00	60.4	58.7	57.3	56.0	54.9	54.6	54.2	54.3	55.9	57.7	59.2	61.2	63.4	65.9	68.1	69.3	70.6	71.0	70.8	66.9	63.0	60.3	58.4	57.0	54.2	71.0	61.2
4/12/2018 0:00	56.5	56.0	54.6	53.8	53.9	53.9	55.4	58.9	63.4	67.3	70.6	72.3	73.2	74.0	75.5	75.5	74.5	74.2	72.2	69.9	68.0	67.4	66.8	66.1	53.8	75.5	65.6
4/13/2018 0:00	66.5	66.5	66.1	66.4	66.8	65.5	64.7	66.4	70.3	73.7	76.0	76.1	77.1	77.1	77.3	77.8	76.6	76.3	75.5	74.6	74.3	74.3	74.1	73.9	64.7	77.8	72.2
4/14/2018 0:00	73.8	74.6	74.7	74.7	74.9	75.2	75.3	75.2	75.9	75.4	64.1	61.5	61.7	62.5	63.6	63.1	61.3	61.5	61.2	60.9	61.1	60.9	60.1	55.8	55.8	75.9	67.0
4/15/2018 0:00	54.6	53.6	52.4	51.0	49.8	48.4	48.0	49.3	51.8	52.5	52.5	53.0	53.9	55.1	56.7	58.3	59.2	59.8	59.6	57.8	55.6	52.6	50.7	51.1	48.0	59.8	53.6
4/16/2018 0:00	50.6	51.1	50.1	49.3	47.6	45.6	45.7	47.3	51.9	55.2	57.8	60.5	62.8	65.0	66.6	67.8	69.1	70.0	68.5	64.8	61.4	59.3	57.2	56.9	45.6	70.0	57.6
4/17/2018 0:00	55.6	56.3	56.3	55.0	53.0	52.4	52.2	54.0	60.6	66.6	69.9	73.0	74.5	75.9	77.0	77.0	76.8	75.5	72.8	68.7	65.6	63.4	61.5	61.3	52.2	77.0	64.8
4/18/2018 0:00	61.0	60.6	61.1	61.4	60.3	60.7	61.8	62.1	67.5	71.0	73.2	74.6	76.0	76.8	77.9	78.7	78.5	78.3	76.4	72.9	70.3	68.7	67.3	66.2	60.3	78.7	69.3
4/19/2018 0:00	65.6	66.1	65.7	65.0	65.0	64.8	66.1	65.3	65.2	65.9	67.7	68.5	69.8	71.2	72.3	72.9	73.2	73.1	71.8	69.1	66.1	63.7	61.3	59.2	59.2	73.2	67.3
4/20/2018 0:00	57.5	56.0	54.9	53.9	54.8	54.9	54.3	54.5	54.5	55.2	56.8	58.3	59.6	60.8	62.5	63.6	63.6	63.7	63.1	62.4	60.5	58.4	58.8	56.2	53.9	63.7	58.3
4/21/2018 0:00	55.1	55.6	56.0	56.2	59.3	60.0	59.7	59.8	64.0	66.1	69.2	71.0	72.4	74.4	75.0	73.9	73.9	74.1	72.3	70.7	70.0	69.7	69.5	69.3	55.1	75.0	66.5
4/22/2018 0:00	69.1	68.6	68.6	68.7	68.8	68.1	68.5	68.6	68.8	69.6	71.0	72.6	74.1	77.1	77.7	76.4	77.0	77.2	76.2	73.3	69.8	66.7	63.8	62.0	62.0	77.7	70.9
4/23/2018 0:00	60.7	59.6	57.6	56.6	56.1	54.5	54.2	55.8	59.9	62.2	64.3	66.1	67.2	68.8	70.0	71.1	71.7	71.3	70.8	69.3	66.5	64.4	63.7	63.4	54.2	71.7	63.6
4/24/2018 0:00	62.6	61.4	60.3	60.5	59.7	58.9	58.0	59.8	63.7	66.2	69.1	71.6	73.4	74.8	76.0	76.8	77.1	76.3	74.8	73.2	70.5	69.5	67.1	65.9	58.0	77.1	67.8
4/25/2018 0:00	64.5	62.6	60.7	59.4	58.2	57.9	57.8	61.2	65.1	68.5	70.0	72.1	74.4	76.1	77.5	78.3	78.5	78.4	77.1	74.2	72.7	70.5	68.9	67.9	57.8	78.5	68.9
4/26/2018 0:00	67.6	67.0	66.9	67.6	67.7	67.0	63.5	61.4	60.7	62.1	65.7	67.3	68.5	70.1	71.1	71.2	71.3	71.0	69.7	67.5	65.4	63.1	61.2	60.1	60.1	71.3	66.4
4/27/2018 0:00	58.4	57.6	56.5	55.4	55.5	55.3	54.5	56.7	60.2	63.8	66.0	67.4	68.9	69.9	70.6	71.2	72.0	72.4	71.8	70.1	67.0	65.0	64.2	64.2	54.5	72.4	63.9
4/28/2018 0:00	61.9	60.9	60.2	59.2	56.5	55.7	56.5	59.1	65.7	69.3	72.2	73.5	74.6	76.1	77.6	77.9	76.8	77.8	77.0	74.9	69.8	68.2	66.8	65.4	55.7	77.9	68.1
4/29/2018 0:00	64.3	62.9	62.9	62.2	61.6	61.3	62.0	64.0	67.2	69.5	72.0	73.3	74.4	74.9	77.2	78.7	79.4	79.5	79.0	76.0	72.7	69.7	68.4	67.7	61.3	79.5	70.0
4/30/2018 0:00	65.1	62.5	62.9	63.9	64.7	66.7	66.0	67.6	70.4	72.5	74.3	76.1	74.9	76.0	76.4	77.0	78.9	78.4	76.8	73.7	70.1	67.4	66.4	66.6	62.5	78.9	70.6
5/1/2018 0:00	66.0	66.3	64.3	64.4	64.7	65.3	65.9	68.1	70.7	73.0	76.0	78.4	79.3	80.5	81.1	81.4	80.7	79.6	78.5	76.4	74.4	73.8	73.2	72.2	64.3	81.4	73.1
5/2/2018 0:00	71.9	71.8	72.1	72.7	72.0	71.0	71.3	71.7	76.0	79.1	81.2	82.6	83.1	82.8	82.2	81.5	81.2	80.5	78.7	76.6	74.5	73.4	72.7	72.5	71.0	83.1	76.4
5/3/2018 0:00	71.7	70.8	69.9	69.2	69.1	69.1	69.3	70.4	72.1	74.7	76.9	78.3	79.6	79.7	80.6	80.5	80.8	79.9	78.4	75.9	73.9	73.5	72.5	72.3	69.1	80.8	74.6
5/4/2018 0:00	71.7	70.5	70.1	68.5	67.6	67.2	67.6	69.3	73.2	76.2	78.6	79.5	80.3	79.8	78.8	79.6	80.1	80.3	78.9	78.3	75.6	74.1	72.7	71.4	67.2	80.3	74.6
5/5/2018 0:00	70.7	70.6	69.9	68.9	68.3	67.9	68.3	70.1	73.3	75.2	76.4	77.8	74.5	74.6	74.9	74.4	74.4	73.8	74.0	73.2	71.9	70.6	69.9	68.2	67.9	77.8	72.2
5/6/2018 0:00	67.1	66.3	64.7	65.0	63.8	63.7	63.7	66.1	68.9	72.5	74.8	76.3	78.0	80.1	81.2	81.9	82.6	82.9	82.2	79.6	77.2	72.6	71.3	70.0	63.7	82.9	73.0
5/7/2018 0:00	67.4	65.6	65.0	63.9	63.7	63.7	63.7	67.0	70.8	75.4	79.2	81.8	83.5	84.5	85.6	86.0	86.4	86.2	85.0	82.0	78.0	73.8	71.3	71.1	63.7	86.4	75.0

33 ft ambient F C48517 backup C48608

Date	Hour of day 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	low	high	average
5/8/2018 0:00	70.8	69.3	68.3	66.8	66.0	64.5	64.7	69.1	72.5	74.8	77.3	81.8	83.4	84.4	85.3	86.1	86.6	86.3	85.4	83.2	78.8	75.7	73.7	73.1	64.5	86.6	76.2
5/9/2018 0:00	72.9	71.5	70.5	70.1	68.8	68.6	68.8	70.8	75.6	78.9	81.6	83.0	83.9	84.5	84.1	83.7	83.6	83.2	80.8	78.0	74.6	72.2	70.5	69.3	68.6	84.5	76.2
5/10/2018 0:00	68.8	68.1	66.2	66.1	65.7	64.9	65.0	69.1	75.4	78.4	80.8	82.7	83.5	84.3	84.9	84.6	84.0	83.2	81.7	78.8	75.5	72.1	70.0	69.8	64.9	84.9	75.2
5/11/2018 0:00	68.7	68.5	67.4	67.4	67.7	68.1	67.6	71.2	75.7	79.1	81.4	83.4	84.2	84.9	85.4	85.1	84.9	84.1	82.1	78.9	75.5	73.4	72.3	71.7	67.4	85.4	76.2
5/12/2018 0:00	72.0	70.8	69.3	69.5	69.7	69.7	70.1	73.8	76.9	79.2	80.7	81.9	82.1	81.4	83.0	83.3	81.2	79.4	78.2	77.1	76.4	75.5	75.0	74.4	69.3	83.3	76.3
5/13/2018 0:00	74.2	73.9	72.8	72.3	70.8	70.7	70.2	71.9	76.6	78.6	80.2	81.5	82.7	83.4	84.5	85.0	84.7	84.8	84.0	83.2	80.6	77.7	75.6	73.7	70.2	85.0	78.1
5/14/2018 0:00	73.6	72.8	71.9	71.1	70.9	72.2	71.6	73.4	77.7	80.0	83.4	84.5	85.9	87.4	88.5	89.4	89.8	89.8	87.8	84.3	80.7	80.6	80.8	79.8	70.9	89.8	80.3
5/15/2018 0:00	78.4	76.3	74.7	73.1	72.0	72.2	71.2	73.4	76.0	80.1	83.5	86.3	88.0	89.5	89.8	90.7	91.1	91.2	90.0	86.6	83.0	81.8	79.2	77.1	71.2	91.2	81.5
5/16/2018 0:00	75.6	74.8	73.8	73.6	73.1	74.4	74.5	75.6	77.6	81.4	84.5	86.8	88.4	89.8	91.1	91.9	91.7	91.5	91.0	84.2	81.7	79.6	78.4	76.8	73.1	91.9	81.7
5/17/2018 0:00	76.8	75.4	74.4	73.9	73.1	72.7	72.6	74.6	79.0	82.2	84.5	87.0	88.4	90.4	90.4	90.9	90.6	90.5	89.3	85.1	82.0	79.9	78.3	76.9	72.6	90.9	81.6
5/18/2018 0:00	76.0	75.1	74.9	75.3	75.4	75.5	75.4	77.1	79.0	81.4	83.9	85.8	86.2	88.0	89.0	87.4	77.9	72.9	69.2	69.5	69.9	70.0	71.3	70.6	69.2	89.0	77.4
5/19/2018 0:00	69.5	69.0	68.6	69.7	69.5	70.1	70.5	74.1	78.6	80.8	82.6	84.2	85.4	86.8	87.4	87.4	86.6	86.0	85.4	82.3	78.9	77.2	76.2	75.4	68.6	87.4	78.4
5/20/2018 0:00	74.7	74.4	74.3	73.4	73.7	73.7	74.5	77.1	78.6	81.1	83.7	85.1	86.1	86.7	84.8	85.9	86.9	86.5	85.0	82.2	78.7	77.1	76.3	75.4	73.4	86.9	79.8
5/21/2018 0:00	74.2	73.4	72.5	72.4	72.6	72.6	71.1	72.4	77.0	79.6	81.1	81.0	82.3	83.7	84.6	84.7	84.9	84.1	83.2	81.2	78.7	77.8	75.8	74.8	71.1	84.9	78.2
5/22/2018 0:00	75.1	74.2	74.2	73.1	73.0	72.3	72.8	74.3	78.5	80.3	81.9	83.3	84.0	84.5	85.7	84.5	86.4	85.3	83.9	81.4	79.5	77.3	76.0	76.1	72.3	86.4	79.1
5/23/2018 0:00	75.1	75.0	74.0	73.2	73.3	73.1	73.2	75.1	78.8	81.1	82.8	83.9	84.2	85.4	86.4	87.1	87.2	87.3	86.7	82.4	80.2	78.3	78.3	77.1	73.1	87.3	80.0
5/24/2018 0:00	76.0	75.8	75.6	74.8	75.7	75.3	74.3	76.2	78.8	80.4	81.2	81.9	82.6	78.3	72.6	71.8	72.9	74.2	75.3	75.5	74.4	73.8	75.3	75.6	71.8	82.6	76.2
5/25/2018 0:00	74.4	73.2	72.3	72.2	72.6	73.3	72.8	73.4	75.8	78.2	79.6	80.7	76.1	74.4	76.3	79.0	79.0	80.5	80.6	79.0	76.8	75.3	74.8	74.0	72.2	80.7	76.0
5/26/2018 0:00	73.3	72.8	71.9	72.0	71.6	71.1	70.6	74.6	77.8	80.2	81.9	82.6	82.9	80.1	75.4	73.2	75.6	77.2	76.8	76.6	74.3	74.0	74.2	75.3	70.6	82.9	75.7
5/27/2018 0:00	74.0	73.5	71.6	71.4	73.1	73.8	74.2	75.8	77.5	78.9	80.1	81.1	81.9	83.2	84.4	85.0	85.6	85.4	84.8	84.1	82.1	80.5	78.8	76.6	71.4	85.6	79.1
5/28/2018 0:00	74.9	74.2	74.4	74.2	73.5	74.5	74.1	74.2	77.1	79.8	81.4	83.1	84.5	86.1	87.3	88.2	88.6	88.8	87.5	85.3	83.2	82.1	81.2	78.5	73.5	88.8	80.7
5/29/2018 0:00	76.1	75.5	74.5	73.9	74.1	74.0	75.4	77.3	79.7	82.9	85.8	86.6	87.7	89.2	90.2	90.8	90.1	90.7	89.6	86.5	84.0	82.2	80.9	80.3	73.9	90.8	82.4
5/30/2018 0:00	78.4	77.9	77.4	76.5	76.0	75.7	76.1	79.4	82.4	84.2	85.6	86.9	88.3	89.5	90.5	90.7	90.2	89.1	87.8	85.1	82.2	79.5	77.5	76.9	75.7	90.7	82.7
5/31/2018 0:00	76.7	76.1	75.7	74.8	74.5	74.4	75.2	78.9	82.4	84.0	86.0	86.7	87.9	88.8	90.1	90.5	90.1	89.4	87.5	84.7	81.5	79.5	78.1	77.0	74.4	90.5	82.1
6/1/2018 0:00	76.6	76.1	75.8	75.3	75.6	75.5	75.9	79.5	83.0	85.3	86.9	87.8	88.0	88.5	89.5	90.3	89.8	89.1	87.5	85.2	82.6	80.8	79.7	78.6	75.3	90.3	82.6
6/2/2018 0:00	77.7	77.3	76.5	75.7	75.8	75.7	76.1	79.4	82.8	84.7	86.7	87.1	89.5	91.1	91.1	90.7	90.4	89.2	87.5	85.3	83.2	81.8	81.1	80.2	75.7	91.1	83.2
6/3/2018 0:00	79.1	78.3	77.3	76.8	76.3	75.8	75.9	77.6	79.5	82.9	85.7	87.5	88.3	89.8	89.8	90.6	90.7	90.2	88.8	86.8	84.8	83.1	81.8	81.0	75.8	90.7	83.3
6/4/2018 0:00	80.3	79.5	79.3	78.0	77.8	78.9	79.1	79.7	80.9	81.8	82.6	84.3	85.6	86.7	87.7	83.5	80.6	78.7	76.6	76.5	75.7	75.3	75.3	74.9	74.9	87.7	80.0
6/5/2018 0:00	74.5	74.4	75.6	76.5	77.2	76.7	76.8	78.3	80.1	82.6	84.5	86.4	87.8	85.5	73.8	72.5	71.5	71.0	71.8	71.9	71.8	71.1	70.0	69.3	69.3	87.8	76.3
6/6/2018 0:00	69.3	70.5	69.7	68.5	67.8	68.2	68.5	69.6	71.8	73.9	76.1	77.7	79.2	80.3	81.6	82.9	84.0	84.4	84.1	83.2	80.9	77.7	75.3	74.8	67.8	84.4	75.8
6/7/2018 0:00	73.1	73.2	72.5	72.0	71.1	71.1	71.6	74.9	78.8	80.9	82.7	84.4	85.2	86.1	86.5	87.9	88.4	88.5	88.0	87.2	86.5	85.8	85.1	84.4	71.1	88.5	81.1
6/8/2018 0:00	83.6	82.9	82.2	81.5	80.8	80.1	79.3	78.6	80.6	82.3	84.5	85.3	86.1	86.3	84.8	84.6	85.8	84.7	84.6	82.3	79.6	77.5	76.4	75.5	75.5	86.3	82.1
6/9/2018 0:00	74.7	73.6	73.0	72.4	73.1	71.9	72.6	74.4	79.8	82.6	84.4	85.8	86.7	87.5	89.4	89.7	90.3	90.0	86.3	83.2	80.6	78.2	77.5	76.6	71.9	90.3	80.6
6/10/2018 0:00	76.0	74.9	74.4	74.7	75.5	74.1	74.0	78.1	81.9	84.3	86.3	82.5	74.4	75.8	80.5	80.4	80.5	81.7	80.8	79.0	76.7	74.5	74.3	73.6	73.6	86.3	77.9
6/11/2018 0:00	73.1	72.7	72.4	71.9	73.2	73.8	73.8	75.3	78.6	81.0	83.5	85.0	82.5	79.4	77.2	78.4	77.1	78.5	79.1	78.7	78.2	78.4	76.5	75.9	71.9	85.0	77.3
6/12/2018 0:00	75.9	75.9	75.3	74.8	75.1	75.0	75.7	79.0	82.6	84.1	85.3	87.1	87.7	88.7	85.2	80.0	77.0	78.3	77.3	73.7	69.7	69.7	69.7	69.9	69.7	88.7	78.0
6/13/2018 0:00	71.3	70.9	70.7	70.8	70.9	72.0	73.5	74.3	76.7	78.9	82.4	84.9	86.0	85.7	81.2	79.5	78.6	78.9	80.5	79.6	76.9	75.5	74.6	74.3	70.7	86.0	77.0
6/14/2018 0:00	73.5	73.6	73.8	73.3	73.3	73.1	73.8	75.1	80.3	82.9	84.5	83.7	85.6	84.4	83.7	83.8	84.8	85.5	83.9	80.9	78.3	77.5	76.5	76.2	73.1	85.6	79.2
6/15/2018 0:00	76.4	76.1	75.6	75.6	75.0	75.2	75.7	77.9	80.2	82.8	84.6	85.5	82.8	80.4	76.8	78.1	80.2	81.5	81.6	80.3	79.0	77.6	77.0	76.7	75.0	85.5	78.9
6/16/2018 0:00	75.9	75.3	75.5	76.0	75.2	74.5	74.9	76.6	79.2	81.4	82.6	82.9	82.6	81.1	86.1	81.7	81.8	82.1	84.2	83.2	80.9	79.4	79.3	78.6	74.5	86.1	79.6
6/17/2018 0:00	77.4	77.1	77.6	76.7	77.2	78.2	77.4	74.0	76.8	80.1	83.1	85.1	85.9	85.3	84.7	86.3	85.4	83.7	77.8	78.8	79.1	79.9	80.6	81.0	74.0	86.3	80.4
6/18/2018 0:00	81.0	80.7	80.7	80.7	80.8	81.0	80.9	80.8	75.7	73.1	75.3	76.8	72.3	72.6	73.8	73.3	74.4	75.3	77.1	78.1	78.3	78.8	79.9	80.1	72.3	81.0	77.6
6/19/2018 0:00	79.9	79.7	79.7	79.9	79.8	80.0	80.3	80.9	81.9	83.1	85.1	85.9	86.6	86.9	83.1	77.9	79.6	81.1	82.0	81.4	80.3	79.1	78.2	77.7	77.7	86.9	81.3
6/20/2018 0:00	77.1	77.2	76.9	76.3	77.3	78.5	78.8	78.7	81.4	83.5	85.4	86.6	87.3	87.7	87.7	86.7	85.8	85.0	84.3	83.0	80.9	79.3	78.3	77.5	76.3	87.7	81.7
6/21/2018 0:00	76.8	76.4	76.5	75.9	75.4	75.5	75.3	76.8	79.9	82.6	84.5	85.6	86.8	87.9	88.2	86.7	86.0	85.5	84.5	83.4	81.3	79.9	78.8	78.5	75.3	88.2	81.2
6/22/2018 0:00	77.7	76.5	75.9	75.6	76.4	77.1	76.9	79.3	81.7	83.3	85.4	86.8	87.6	88.5	89.1	89.1	89.0	88.4	87.1	84.5	81.5	79.0	77.2	76.4	75.6	89.1	82.1
6/23/2018 0:00	76.4	75.4	75.6	75.4	75.3	75.0	75.6	79.0	82.5	84.2	86.5	88.0	88.5	89.2	89.9	90.3	90.8	89.6	86.8	85.8	82.5	79.9	78.4	77.5	75.0	90.8	82.4
6/24/2018 0:00	76.8	77.1	77.4	77.0	76.7	76.5	76.7	79.9	83.3	85.4	87.3	87.5	89.6	90.1	87.9	88.5	89.2	89.0	88.0	86.0	82.5	80.3	78.9	77.7	76.5	90.1	82.9
6/25/2018 0:00	77.0	76.1	76.1	75.7	75.5	75.5	75.9	79.2	82.6	84.6	86.4	88.2	89.5	90.5	91.0	90.1	90.6	90.3	89.1	87.7	84.0	81.4	79.8	79.0	75.5	91.0	83.2
6/26/2018 0:00	78.0	77.5	77.4	76.5	76.8	76.3	76.8	79.4	82.8	83.8	85.0	86.3	86.9	87.2	87.8	79.6	78.9	84.8	85.5	83.8	81.4	79.6	79.0	78.5	76.3	87.8	81.2
6/27/2018 0:00	78.4	78.1	77.2	76.9	76.6	76.3	77.0	79.9	83.2	84.3	85.9	87.8	88.6	84.8	87.6	88.7	89.4	88.2	86.2	85.7	83.2	81.6	80.2	79.2	76.3	89.4	82.7
6/28/2018 0:00	79.0	78.7	77.7	76.9	76.6	76.5	77.4	80.9	83.3	84.9	86.8	88.1	89.7	90.7	91.9	92.0	92.0	90.0	88.6	87.3	85.0	83.2	82.0	81.0	76.5	92.0	84.2
6/29/2018 0:00	80.5	80.0	80.3	80.0	79.0	78.5	77.7	79.9	81.9	83.5	85.3	87.5	89.4	90.5	91.2	91.6	92.5	92.3	89.8	80.9	76.2	76.0	75.5	75.9	75.5	92.5	83.2
6/30/2018 0:00	75.3	75.8	76.3	76.4	76.2	76.5	76.6	78.6	81.6	84.0	85.8	87.6	88.9	89.2	91.0	92.3	91.9	85.0	82.8	82.1	81.2	79.9	79.4	78.0	75.3	92.3	82.2
7/1/2018 0:00	73.6	72.6	72.8	73.4	73.5	73.5	73.9	76.0	79.8	82.7	85.0	86.6	88.3	89.3	90.4	91.6	91.1	86.9	82.5	80.6	79.8	78.9	79.9	79.4	72.6	91.6	80.9
7/2/2018 0:00	76.2	75.4	75.9	75.9	75.7	75.7	75.6	77.0	80.0	82.6	85.1	86.7	88.3	89.9	90.5	91.1	80.1	78.8	77.6	77.5	75.7	75.8	75.9	76.1	75.4	91.1	80.0
7/3/2018 0:00	74.8	74.6	74.3	74.6	76.0	75.7	76.3	76.6	76.2	76.5	77.2	79.1	80.7	79.2	75.8	76.6	77.1	77.4	77.3	76.9	75.9	75.4	75.3	75.1	74.3	80.7	76.4
7/4/2018 0:00	75.5	75.8	76.3	75.8	76.8	76.5	77.1	78.2	80.6	82.8	84.2	85.6	86.2	85.5	86.0	85.5	79.9	82.2	84.5	82.4	80.2	78.4	77.0	77.9	75.5	86.2	80.4
7/5/2018 0:00	77.7	77.0	76.1	75.8	75.7	76.2	77.6	79.3	81.0	82.4	83.1	84.2	85.4	83.5	80.5	79.0	81.8	83.1	82.8	81.0	80.8	80.7	80.8	79.4	75.7	85.4	80.2
7/6/2018 0:00	79.6	79.2	78.9	78.6	78.4	78.5	79.3	79.1	80.1	82.2	82.4	78.0	77.2	78.9	78.6	84.0	82.5	80.6	80.4	80.7	79.2	77.4	75.9	75.5	75.5	84.0	79.4
7/7/2018 0:00	75.4	75.9	77.6	75.9	76.5	76.2	75.2	77.1	79.4	80.3	78.1	75.4	80.3	83.8	84.3	85.5	86.0	85.6	85.4	82.1	78.3	77.1	75.2	75.4	75.2	86.0	79.3
7/8/2018 0:00	75.0	74.5	74.4	74.7	74.3	73.9	73.5	73.7	75.9	77.3	80.4	82.1	83.9	81.2	77.3	76.9	77.2	81.5	83.3	80.9	77.3	75.4	74.5	74.0	73.5	83.9	77.2
7/9/2018 0:00	73.9	73.6	73.4	73.8	74.3	73.6	74.6	78.0	80.8	83.2	84.8	86.3	86.7	87.0	87.0	76.8	74.5	75.9	76.1	75.6	75.1	75.3	76.0	74.5	73.4	87.0	77.9
7/10/2018 0:00	74.2	74.1	73.7	73.4	73.2	73.3	73.7	76.2	79.3	81.5	82.6	83.8	85.2	86.6	88.0	88.2	87.9	86.9	83.5	82.9	81.1	80.3	80.7	79.4	73.2	88.2	80.4
7/11/2018 0:00	78.4	77.6	77.3	77.0	76.4	76.3	76.8	78.5	81.1	83.3	85.0	86.2	86.5	86.2	86.7	78.8	77.0	76.4	76.7	76.9	76.5	75.5	74.4	73.9	73.9	86.7	79.1
7/12/2018 0:00	72.5	73.7	74.5	75.5	75.2	74.6	73.9	74.7	77.3	79.7	82.8	84.8	86.2	86.3	84.6	85.6	88.7	89.3	88.6	85.4	82.6	80.1	79.5	79.1	72.5	89.3	80.6
7/13/2018 0:00	77.8	76.9	76.3	75.7	75.7	74.7	74.3	77.2	81.1	82.9	84.9	85.9	84.5	88.5	85.0	83.1	85.7	88.8	88.4	83.8	81.2	78.8	77.9	77.7	74.3	88.8	81.1
7/14/2018 0:00	77.8	77.4	77.5	77.5	77.1	76.9	77.1	78.7	81.5	84.3	86.1	87.8	88.5	90.0	90.9	91.0	90.9	88.1	83.4	81.5	80.4	80.2	80.5	80.2	76.9	91.0	82.7
7/15/2018 0:00	79.4	79.2	78.1	77.4	77.3	77.1	77.1	77.8	81.0	83.9	85.5	86.8	87.9	88.8	90.1	90.8	89.3	89.9	85.5	83.5	81.3	79.9	79.7	78.8	77.1	90.8	82.8
7/16/2018 0:00	79.2	79.3	79.0	78.3	78.3	78.0	77.8	79.9	82.9	85.0	87.1	87.9	89.8	90.0	86.8	81.0	75.9	77.2	78.6	78.8	79.2	75.9	73.7	73.8	73.7	90.0	80.6
7/17/2018 0:00	74.1	74.5	75.0	75.1	75.8	77.0	77.5	77.8	78.7	79.5	80.5	82.6	84.0	85.5	86.8	85.1	83.3	82.4	81.7	80.5	79.4	78.7	78.2	78.1	74.1	86.8	79.7
7/18/2018 0:00	78.8	78.8	78.8	79.4	79.5	79.2	79.1	79.8	81.1	83.6	83.4	82.0	83.3	82.4	80.4	82.0	78.5	78.1	78.2	77.2	76.5	75.7	75.0	74.4	74.4	83.6	79.4
7/19/2018 0:00	74.3	74.2	74.0	74.4	75.1	75.6	75.8	77.0	79.8	82.1	83.1	85.2	86.4	88.3	89.6	90.1	90.6	90.3	89.7	87.6	85.5	83.8	82.0	81.0	74.0	90.6	82.3
7/20/2018 0:00	80.3	79.7	79.1	78.4	77.8	77.3	77.4	78.5	80.4	83.3	86.0	88.1	89.4	90.4	91.8	92.7	92.9	92.8	91.7	89.7	87.9	88.0	88.0	88.1	77.3	92.9	85.4
7/21/2018 0:00	88.2	88.2	88.3	88.3	88.4	88.5	88.5	88.6	88.6	88.7	88.8	88.8	88.9	90.3	91.2	92.0	92.1	91.6	90.4	87.9	85.5	83.9	82.7	81.7	81.7	92.1	88.3
7/22/2018 0:00	81.0	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	81.4	87.7	90.0	91.0	92.0	93.3	93.6	93.7	92.8	90.6	88.1	86.0	84.3	83.5	83.1	80.6	93.7	85.7
7/23/2018 0:00	82.8	82.1	81.3	81.1	80.9	80.7	80.4	80.5	81.6	83.5	84.4	86.2	88.0	89.8	91.2	91.8	91.6	86.5	84.8	79.6	78.2	77.3	77.2	77.7	77.2	91.8	83.3

33 ft ambient F C48517 backup C48608

Date	Hour of day 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	low	high	average
7/24/2018 0:00	78.7	76.7	76.8	78.5	78.2	77.2	77.3	78.9	80.3	81.4	82.8	83.9	85.2	86.9	87.8	88.5	89.1	88.6	87.9	85.6	84.5	83.2	82.4	81.6	76.7	89.1	82.6
7/25/2018 0:00	80.4	79.5	78.7	78.0	77.4	76.9	76.4	76.8	78.9	80.5	82.2	83.9	84.7	85.6	86.5	87.6	88.1	88.2	87.8	86.9	84.3	85.4	84.6	80.5	76.4	88.2	82.5
7/26/2018 0:00	78.4	78.0	78.7	77.9	78.2	78.7	78.3	78.7	81.0	83.5	84.8	86.6	88.1	88.8	89.5	90.1	90.4	90.2	88.3	84.3	81.2	79.7	78.8	78.2	77.9	90.4	82.9
7/27/2018 0:00	77.3	76.6	76.2	76.5	75.3	75.7	76.8	77.4	82.0	84.1	85.5	87.2	87.7	89.2	89.7	90.3	90.8	86.5	83.7	80.9	78.9	77.8	76.7	76.2	75.3	90.8	81.6
7/28/2018 0:00	75.5	75.4	75.3	75.2	77.2	76.2	76.5	78.8	81.2	83.2	86.0	87.7	88.6	90.0	91.1	90.6	91.0	88.5	84.6	80.4	78.1	78.3	78.3	77.2	75.2	91.1	81.9
7/29/2018 0:00	78.1	75.9	76.0	75.7	75.7	75.7	75.5	77.0	79.2	80.4	82.5	84.5	84.2	85.3	86.6	84.9	85.7	81.4	80.4	78.4	77.2	77.5	77.4	76.6	75.5	86.6	79.7
7/30/2018 0:00	76.0	75.6	75.1	75.1	74.9	75.2	75.3	77.5	81.7	83.9	85.3	84.5	84.3	84.7	81.6	82.0	85.5	88.3	87.4	83.1	81.8	80.1	78.2	77.5	74.9	88.3	80.6
7/31/2018 0:00	76.3	75.5	75.7	75.0	74.8	74.5	74.4	66.7	85.0	92.7	90.6	82.1	75.7	76.5	78.8	79.7	81.1	79.5	78.5	77.9	77.3	77.1	76.3	76.1	66.7	92.7	78.2
8/1/2018 0:00	75.9	74.7	74.0	73.2	72.6	73.3	74.6	75.7	79.6	80.4	82.4	82.3	83.8	84.8	85.4	86.4	86.3	85.6	83.1	79.9	77.7	76.5	75.7	73.0	72.6	86.4	79.0
8/2/2018 0:00	72.6	72.2	71.9	72.1	73.1	73.0	73.6	76.0	78.2	79.6	81.6	83.7	85.1	85.9	87.1	87.2	87.1	86.0	84.7	81.3	77.3	75.9	75.6	74.7	71.9	87.2	79.0
8/3/2018 0:00	73.6	72.9	72.6	72.3	72.8	73.0	73.9	77.0	79.6	79.7	82.6	82.7	84.2	84.2	83.3	79.5	82.0	83.4	82.5	79.7	78.5	77.3	77.1	77.0	72.3	84.2	78.4
8/4/2018 0:00	76.8	76.8	77.4	76.5	77.6	76.7	76.8	74.5	72.3	73.9	77.2	77.0	78.0	79.2	81.6	82.5	83.4	84.2	83.4	81.8	79.7	79.0	78.6	77.0	72.3	84.2	78.4
8/5/2018 0:00	78.2	79.3	79.7	80.1	79.5	78.6	77.9	79.5	81.2	84.2	85.8	85.0	82.5	86.6	88.0	87.3	86.5	86.1	84.9	83.2	81.5	81.0	79.7	78.6	77.9	88.0	82.3
8/6/2018 0:00	79.3	80.2	79.2	79.3	78.9	79.8	80.6	81.4	82.3	84.3	85.7	86.8	86.6	85.6	81.4	79.5	79.9	81.9	82.0	81.2	80.0	80.1	79.4	78.9	78.9	86.8	81.4
8/7/2018 0:00	77.8	78.2	78.8	77.7	77.4	76.7	77.4	78.6	80.7	83.0	85.6	84.8	85.3	86.5	86.1	85.9	88.4	85.3	77.0	72.2	73.1	73.4	73.1	73.2	72.2	88.4	79.8
8/8/2018 0:00	73.6	72.8	72.5	72.6	73.6	73.3	75.1	75.7	79.3	83.2	85.4	84.3	85.5	86.6	86.3	83.8	87.5	87.2	85.2	81.9	80.1	77.4	78.4	77.3	72.5	87.5	80.0
8/9/2018 0:00	76.8	75.7	75.7	75.5	75.3	75.0	74.9	77.6	82.2	84.2	85.6	87.4	85.0	84.9	80.4	77.6	79.3	81.0	80.4	78.6	77.2	76.2	75.7	75.2	74.9	87.4	79.1
8/10/2018 0:00	75.1	75.6	75.5	75.5	75.4	76.1	76.2	76.9	80.9	83.6	83.9	80.1	77.4	78.9	74.8	76.7	78.2	78.8	79.7	78.3	77.1	76.6	76.1	75.8	74.8	83.9	77.6
8/11/2018 0:00	75.4	74.7	74.2	74.1	74.5	74.4	74.3	75.9	79.5	82.8	85.0	86.3	86.3	82.3	76.5	76.4	79.0	80.2	80.2	79.4	77.8	77.2	76.8	76.5	74.1	86.3	78.3
8/12/2018 0:00	76.3	75.9	74.6	74.6	74.3	74.4	74.8	75.9	79.0	81.8	84.0	85.3	86.7	87.5	88.8	90.2	90.7	90.4	89.3	86.7	85.0	81.5	83.5	82.6	74.3	90.7	82.2
8/13/2018 0:00	75.9	74.2	74.4	73.6	73.6	75.2	76.2	76.8	79.3	81.7	83.8	85.7	87.2	88.1	88.9	89.7	88.8	88.0	87.2	85.2	83.2	80.8	79.5	77.8	73.6	89.7	81.5
8/14/2018 0:00	78.3	77.9	78.0	77.8	77.1	76.6	76.6	78.0	79.4	82.1	84.4	86.7	88.2	88.7	89.6	90.1	90.3	90.6	86.0	82.1	79.9	78.5	77.6	77.0	76.6	90.6	82.1
8/15/2018 0:00	76.8	76.9	76.8	75.8	75.4	75.7	76.9	76.9	80.9	83.4	85.7	87.2	88.4	89.3	89.5	87.6	81.2	79.7	79.7	78.7	77.9	77.9	77.5	77.6	75.4	89.5	80.6
8/16/2018 0:00	77.3	77.4	77.6	77.5	77.4	77.0	77.0	77.9	80.2	81.9	84.6	84.4	84.9	86.1	87.0	83.1	79.8	80.6		80.0	79.2	78.2	77.3	76.9	76.9	87.0	80.1
8/17/2018 0:00	77.1	77.0	76.8	77.1	77.3	76.7	76.0	76.3	79.0	84.2	85.3	85.8	80.9	80.2	74.1	76.6	78.4	78.8	77.1	76.9	76.1	76.0	75.9	75.8	74.1	85.8	78.1
8/18/2018 0:00	76.1	76.0	76.0	76.1	75.9	75.3	75.5	76.5	80.4	83.8	85.3	86.9	82.1	75.8	74.3	74.5	76.0	78.3	78.5	77.3	76.3	76.5	75.7	76.1	74.3	86.9	77.7
8/19/2018 0:00	75.9	75.8	76.4	76.6	76.7	76.2	75.8	76.5	80.4	84.3	84.9	78.3	79.6	81.2	80.5	79.1	79.4	74.0	75.9	75.9	75.7	75.5	75.7	75.1	74.0	84.9	77.7
8/20/2018 0:00	74.9	75.3	75.1	74.9	75.2	75.7	75.5	76.9	81.4	84.7	85.7	87.1	88.4	82.4	77.1	80.0	80.7	78.1	76.7	76.5	76.0	75.6	76.0	76.2	74.9	88.4	78.6
8/21/2018 0:00	76.8	77.0	76.6	76.3	76.5	76.8	77.6	78.3	79.6	83.6	85.7	87.8	89.0	89.6	90.6	91.1	91.2	90.9	90.4	90.4	90.4	90.4	90.4	90.4	76.3	91.2	84.9
8/22/2018 0:00	90.4	90.4	90.4	90.4	90.4	90.4	90.4	88.6	79.5	81.1	82.7	83.7	84.7	86.1	87.3	88.3	88.7	88.6	86.2	84.4	83.7	83.0	81.6	80.8	79.5	90.4	86.3
8/23/2018 0:00	80.0	79.3	78.7	77.8	76.1	77.0	76.9	77.7	79.5	80.6	81.4	82.0	83.3	83.9	84.5	84.7	85.1	85.1	84.8	84.1	81.8	79.2	80.3	79.1	76.1	85.1	80.9
8/24/2018 0:00	78.2	77.0	76.0	74.5	73.6	73.5	74.7	74.6	78.8	80.9	82.1	83.4	85.0	85.7	86.9	87.3	87.0	86.4	85.4	83.1	80.4	79.4	78.5	77.7	73.5	87.3	80.4
8/25/2018 0:00	76.9	76.6	77.3	77.6	76.6	77.5	77.0	78.7	79.5	81.3	84.2	86.0	85.3	85.5	85.9	86.7	87.1	86.9	86.0	84.0	82.0	80.6	80.9	81.6	76.6	87.1	81.7
8/26/2018 0:00	80.5	79.5	80.3	81.2	80.9	80.1	80.2	81.1	83.2	85.2	86.7	86.1	84.3	81.3	87.3	84.3	80.1	80.0	80.7	79.3	80.4	79.4	79.6	81.2	79.3	87.3	81.8
8/27/2018 0:00	80.9	80.1	78.7	80.1	79.2	79.3	79.9	81.0	83.2	85.0	86.1	86.7	87.3	83.8	86.3	79.4	81.2	82.2	80.2	77.2	79.5	79.9	79.1	79.3	77.2	87.3	81.5
8/28/2018 0:00	78.8	77.8	78.1	77.0	76.4	76.5	76.5	79.1	79.7	80.8	81.2	80.2	81.4	81.4	77.2	76.4	77.1	78.9	79.0	79.2	79.1	79.4	79.3	78.6	76.4	81.4	78.7
8/29/2018 0:00	77.9	79.0	78.9	78.5	78.3	78.6	79.1	79.3	80.0	81.8	85.2	83.4	75.0	75.1	76.7	78.1	80.2	81.2	80.4	79.3	78.7	78.1	76.9	77.4	75.0	85.2	79.1
8/30/2018 0:00	77.5	77.8	76.0	74.7	75.6	75.1	74.3	76.8	79.2	79.9	77.2	76.5	76.7	77.6	79.9	80.3	81.3	82.7	81.9	80.4	80.0	79.6	78.9	79.2	74.3	82.7	78.3
8/31/2018 0:00	79.2	78.7	77.3	76.9	77.4	76.6	77.7	78.4	79.5	80.3	78.5	79.5	78.2	78.5	79.0	78.0	79.0	79.9	80.1	79.8	78.5	78.0	79.0	78.9	76.6	80.3	78.6
9/1/2018 0:00	78.7	77.5	78.0	78.3	78.2	78.2	77.6	78.8	79.3	81.8	82.9	81.9	79.8	77.6	78.6	78.8	81.1	79.5	76.8	76.1	76.6	76.6	76.5	76.8	76.1	82.9	78.6
9/2/2018 0:00	76.8	76.6	77.4	77.3	76.7	76.4	77.3	76.1	78.4	73.9	73.5	74.8	77.4	78.2	79.1	80.6	80.6	80.1	80.2	79.8	78.9	76.3	76.6	77.4	73.5	80.6	77.5
9/3/2018 0:00	77.8	78.3	77.4	78.4	78.5	79.7	79.8	80.1	81.0	82.9	84.3	85.0	85.4	85.6	85.8	84.8	82.1	79.1	79.3	77.6	79.2	80.3	80.4	80.2	77.4	85.8	81.0
9/4/2018 0:00	80.2	80.8	79.0	78.8	79.2	78.5	77.5	76.9	76.9	78.2	79.8	80.7	81.4	83.1	82.9	83.3	83.4	82.8	79.0	78.1	78.9	78.6	77.6	76.1	76.1	83.4	79.6
9/5/2018 0:00	75.2	75.0	75.0	73.6	71.8	71.5	71.4	72.2	75.2	78.2	80.1	82.2	84.2	85.0	86.5	87.3	87.3	86.9	84.2	81.0	79.3	78.5	77.8	77.3	71.4	87.3	79.0
9/6/2018 0:00	77.0	76.5	76.2	76.4	76.2	76.4	76.5	77.6	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	76.4	75.9	73.1	83.0	78.0
9/7/2018 0:00	76.3	76.3	76.1	75.8	75.4	75.4	74.8	76.3	78.9	80.5	81.2	81.2	78.5	80.3	80.9	82.3	80.7	81.1	80.0	77.6	76.2	76.8	76.0	75.6	74.8	82.3	78.1
9/8/2018 0:00	75.2	76.9	76.4	73.8	76.8	75.4	73.7	75.1	77.7	80.1	81.9	83.6	83.9	85.3	84.2	84.5	82.8	82.7	78.5	78.0	76.6	75.4	75.6	75.8	73.7	85.3	78.7
9/9/2018 0:00	75.5	75.3	75.4	74.8	74.6	74.4	74.2	75.1	78.0	81.5	82.3	85.0	86.7	88.0	86.2	86.3	86.8	84.9	83.0	80.5	79.5	78.2	77.5	77.6	74.2	88.0	80.1
9/10/2018 0:00	77.2	75.3	75.0	75.0	74.9	74.5	74.1	74.8	78.7	81.2	83.4	84.3	84.5	84.1	78.3	78.3	78.2	76.4	76.4	77.1	76.5	76.0	76.1	75.5	74.1	84.5	77.7
9/11/2018 0:00	75.8	74.8	74.7	74.2	74.5	76.1	76.6	78.0	81.3	82.7	82.5	79.6	77.6	77.8	77.8	76.3	77.7	78.4	78.0	77.8	77.8	76.9	78.3	77.9	74.2	82.7	77.6
9/12/2018 0:00	77.9	78.1	77.6	77.7	76.8	77.1	78.9	79.4	80.8	81.9	82.3	83.6	84.7	84.9	84.6	85.6	85.8	85.4	83.6	81.6	79.9	79.8	80.7	80.6	76.8	85.8	81.2
9/13/2018 0:00	79.1	80.0	79.9	80.2	79.9	80.1	79.2	80.3	82.1	83.7	85.9	86.7	84.5	79.1	80.8	83.1	84.1	83.5	81.9	80.7	80.6	80.4	79.4	77.4	77.4	86.7	81.4
9/14/2018 0:00	76.1	76.4	76.9	76.5	74.8	75.8	75.8	75.7	79.6	82.1	82.9	84.5	85.8	86.9	88.2	89.1	89.3	89.4	84.0	81.6	79.9	78.9	78.7	78.1	74.8	89.4	81.1
9/15/2018 0:00	77.2	76.8	76.4	76.2	76.6	76.2	75.3	77.0	79.0	81.7	84.6	86.9	88.6	89.7	90.6	91.5	91.9	91.7	90.2	85.2	84.3	82.7	80.5	78.4	75.3	91.9	82.9
9/16/2018 0:00	77.1	76.6	76.8	76.7	76.2	75.8	76.0	76.2	79.3	82.3	85.9	88.5	89.8	90.5	91.9	92.3	92.6	91.5	87.4	83.6	81.1	79.3	78.3	77.4	75.8	92.6	82.6
9/17/2018 0:00	76.6	76.3	75.9	76.0	76.0	75.4	75.1	76.8	80.4	83.7	86.8	88.1	89.7	91.1	91.8	91.7	90.2	83.4	81.1	79.7	79.4	78.1	77.0	77.8	75.1	91.8	81.6
9/18/2018 0:00	77.7	76.8	76.2	75.5	76.8	75.9	75.4	75.6	79.4	84.0	87.6	89.7	91.7	90.6	91.3	92.0	91.2	85.4	84.0	82.4	80.3	79.3	78.6	77.4	75.4	92.0	82.3
9/19/2018 0:00	77.7	77.9	76.9	76.7	77.7	77.4	76.9	76.8	79.0	83.2	85.5	87.6	89.5	90.8	90.8	90.6	89.9	85.9	82.6	80.2	79.2	78.0	77.2	76.2	76.2	90.8	81.8
9/20/2018 0:00	75.4	75.3	73.8	74.3	74.0	74.2	75.2	75.4	80.1	82.6	84.5	85.9	85.8	85.5	79.4	80.0	83.1	80.2	77.6	77.0	76.2	77.3	76.5	76.2	73.8	85.9	78.6
9/21/2018 0:00	77.3	77.1	76.7	77.2	78.9	78.7	78.5	80.1	81.6	84.3	86.2	87.8	88.7	85.2	85.1	85.3	80.9	80.6	79.3	78.3	77.9	77.5	78.4	78.2	76.7	88.7	80.8
9/22/2018 0:00	77.9	77.1	77.0	76.8	78.0	77.5	77.3	78.5	81.5	84.0	86.0	86.6	86.9	85.3	81.8	81.6	78.4	74.1	74.0	74.4	74.7	74.5	74.4	75.2	74.0	86.9	78.9
9/23/2018 0:00	74.6	75.2	76.9	75.4	75.2	75.2	76.1	76.6	80.0	82.9	84.7	86.5	87.3	86.0	82.8	81.7	79.7	78.4	78.9	79.4	79.1	77.6	77.6	77.6	74.6	87.3	79.4
9/24/2018 0:00	77.4	77.0	76.3	76.0	75.9	75.5	75.1	76.1	80.9	83.5	84.3	82.3	83.5	83.5	85.6	85.6	85.2	84.6	82.9	79.9	78.0	77.3	76.7	76.1	75.1	85.6	80.0
9/25/2018 0:00	76.0	75.5	75.5	75.5	75.3	75.8	76.0	76.5	80.2	83.1	80.0	84.2	80.8	78.6	79.7	79.3	79.5	78.7	78.4	77.4	76.5	76.0	76.1	76.3	75.3	84.2	77.9
9/26/2018 0:00	75.8	76.4	76.3	76.5	76.5	75.8	73.4	73.2	73.3	73.9	75.1	76.9	77.5	79.0	80.6	81.1	80.9	79.6	78.4	76.4	75.7	75.4	74.6	74.5	73.2	81.1	76.5
9/27/2018 0:00	74.5	73.9	73.6	73.6	74.0	74.1	74.1	74.3	75.9	77.1	76.7	76.7	76.4	79.6	79.6	77.6	73.8	73.6	73.8	73.7	74.3	73.4	72.9	73.1	72.9	79.6	75.0
9/28/2018 0:00	72.8	72.8	73.0	73.0	73.3	73.5	73.7	73.4	73.9	76.1	77.8	79.4	80.0	80.1	81.1	81.6	79.5	75.5	73.0	72.8	73.0	74.1	75.2	77.6	72.8	81.6	75.7
9/29/2018 0:00	77.0	76.7	76.7	76.8	76.8	76.5	76.2	76.1	76.6	77.1	77.3	78.2	78.9	79.9	80.2	80.2	80.5	80.3	78.4	76.7	75.0	76.2	74.9	74.8	74.8	80.5	77.4
9/30/2018 0:00	74.8	75.6	76.0	77.4	77.9	78.5	78.4	78.5	79.1	79.8	80.3	80.8	81.4	81.7	81.9	73.7	69.9	70.6	71.0	72.4	73.8	75.8	76.9	78.1	69.9	81.9	76.8
10/1/2018 0:00	78.1	77.9	78.0	77.9	77.6	77.5	78.3	79.9	81.9	83.1	84.4	83.5	81.6	77.8	76.5	77.9	78.9	77.6	78.4	78.9	78.6	79.1	79.5	79.7	76.5	84.4	79.3
10/2/2018 0:00	79.9	79.3	78.8	78.7	79.5	78.1	79.0	79.1	79.2	80.4	82.0	83.1	83.8	85.3	85.7	86.5	86.1	85.8	84.7	81.6	79.2	78.5	77.5	79.5	77.5	86.5	81.3
10/3/2018 0:00	78.5	77.4	77.2	77.1	76.6	77.0	77.4	79.3	81.4	83.1	84.6	83.8	83.7	81.5	80.4	85.0	84.9	84.5	82.9	82.4	80.5	79.9	79.3	78.9	76.6	85.0	80.7
10/4/2018 0:00	78.0	77.1	77.6	77.9	77.7	77.7	76.3	76.7	80.3	82.4	84.2	83.9	84.0	84.4	84.9	85.9	84.3	84.7	84.2	82.3	80.4	79.5	77.8	77.8	76.3	85.9	80.8
10/5/2018 0:00	76.4	75.1	76.4	74.2	74.9	73.3	74.8	76.4	76.9	79.8	82.1	83.6	84.8	85.2	84.0	86.0	86.4	85.4	84.3	82.9	81.8	81.0	80.1	78.7	73.3	86.4	80.2
10/6/2018 0:00	79.1	79.0	78.0	78.6	79.0	79.0	78.9	79.1	79.5	81.3	83.1	85.0	86.2	86.8	87.3	86.5	86.2	85.0	83.4	81.5	79.5	77.8	77.5	79.3	77.5	87.3	81.5
10/7/2018 0:00	79.0	78.6	78.5	77.0	76.9	78.0	78.9	77.6	78.6	80.7	82.9	83.5	85.0	86.0	86.8	85.3	78.2	80.5	81.4	77.9	78.9	78.9	79.1	78.8	76.9	86.8	80.3
10/8/2018 0:00	78.3	78.1	77.3	77.6	77.5	77.2	78.1	78.1	80.2	81.4	82.4	79.5	81.2	81.2	81.2	82.0	79.0	80.6	80.1	77.0	74.6	75.8	76.6	76.9	74.6	82.4	78.8

33 ft ambient F C48517 backup C48608

Date	Hour of day 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	low	high	average
10/9/2018 0:00	77.4	77.3	76.6	76.8	77.8	77.9	78.3	78.1	78.5	80.3	78.3	79.6	80.7	82.5	83.3	82.9	82.6	82.0	81.7	81.5	81.5	80.4	78.5	77.7	76.6	83.3	79.7
10/10/2018 0:00	77.6	77.2	76.6	76.1	75.2	75.4	75.5	74.9	75.9	77.9	79.8	82.9	84.1	84.5	84.5	84.2	84.4	84.2	82.9	79.7	78.2	77.1	75.1	73.6	73.6	84.5	79.1
10/11/2018 0:00	72.0	70.4	69.2	68.4	68.5	68.5	68.0	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	69.7	67.8	67.1	67.1	79.1	72.1
10/12/2018 0:00	66.7	65.4	64.3	63.6	63.2	63.4	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	67.5	66.5	65.0	63.2	77.0	68.2
10/13/2018 0:00	65.4	63.5	63.0	63.2	63.8	64.5	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	73.6	72.4	72.7	71.6	71.3	63.0	82.8	72.3
10/14/2018 0:00	70.4	70.6	71.2	72.6	72.8	72.4	72.4	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	76.7	75.8	76.2	76.1	75.7	70.4	85.4	77.6
10/15/2018 0:00	75.7	75.7	75.8	75.8	75.0	74.6	74.8	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	75.8	76.2	77.3	76.7	75.2	74.6	86.4	78.3
10/16/2018 0:00	74.4	73.8	73.6	73.5	74.1	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9	72.9	85.1	78.5
10/17/2018 0:00	72.2	72.5	72.3	71.7	71.2	71.3	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3	70.1	73.3	71.4
10/18/2018 0:00	69.8	69.5	68.9	67.3	66.1	65.4	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1	65.4	76.6	71.0
10/19/2018 0:00	70.8	69.9	69.3	68.8	68.9	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4	68.3	80.6	74.7
10/20/2018 0:00	73.4	73.6	73.0	72.8	73.0	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6	67.6	83.3	74.6
10/21/2018 0:00	66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0	62.0	68.3	65.0
10/22/2018 0:00	61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5	59.8	69.6	65.0
10/23/2018 0:00	67.3	67.1	66.7	66.2	66.0	66.3	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0	66.0	67.9	66.8
10/24/2018 0:00	66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3	63.3	72.3	68.3
10/25/2018 0:00	72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3	66.3	80.3	72.6
10/26/2018 0:00	65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0	58.8	68.2	63.0
10/27/2018 0:00	58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8	54.1	71.8	62.2
10/28/2018 0:00	59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4	57.0	80.5	68.6
10/29/2018 0:00	66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1	66.4	80.9	71.7
10/30/2018 0:00	65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9	61.9	79.1	69.2
10/31/2018 0:00	69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4	69.5	80.6	75.0
11/1/2018 0:00	74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5	56.5	74.6	66.3
11/2/2018 0:00	55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9	51.2	64.6	56.6
11/3/2018 0:00	51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9	43.7	71.5	61.2
11/4/2018 0:00	64.9	65.1	65.4	65.3	65.5	65.7	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0	63.0	74.8	67.4
11/5/2018 0:00	63.8	63.6	63.1	62.8	62.8	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2	62.8	81.0	70.9
11/6/2018 0:00	73.4	73.5	73.7	73.8	73.6	73.3	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0	71.7	81.4	74.6
11/7/2018 0:00	72.1	72.0	71.2	72.1	72.2	72.7	72.5	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8	69.6	79.1	72.9
11/8/2018 0:00	70.7	70.2	69.7	68.9	68.7	69.0	69.7	70.3	71.2	72.1	71.8	69.8	71.1	70.9	69.3	68.4	67.1	66.8	67.0	67.2	67.3	66.9	66.5	66.7	66.5	72.1	69.1
11/9/2018 0:00	66.8	67.1	67.0	67.1	67.4	67.8	68.0	68.3	69.0	67.0	64.0	60.8	59.6	58.4	56.7	55.8	54.1	51.6	50.6	50.3	50.6	50.9	50.9	50.5	50.3	69.0	60.0
11/10/2018 0:00	49.7	49.3	48.0	47.4	47.6	47.9	47.1	47.2	47.4	47.6	48.6	50.8	52.6	53.9	54.5	54.7	54.0	52.4	51.1	51.1	51.5	51.3	50.7	50.3	47.1	54.7	50.3
11/11/2018 0:00	49.9	49.7	49.9	49.2	49.0	49.2	49.0	49.8	50.8	52.5	54.7	55.8	56.8	57.2	58.4	59.7	60.1	59.0	59.6	59.2	59.3	59.9	59.5	59.2	49.0	60.1	54.9
11/12/2018 0:00	57.0	56.4	56.1	56.6	57.0	57.5	58.4	60.0	62.5	66.5	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API error: -11059	56.1	66.5	58.8
11/13/2018 0:00																											
11/14/2018 0:00																											
11/15/2018 0:00																											
11/16/2018 0:00																											

Date	11-Jul								12-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	low	high	ave
Temperature (°F)	86	85	84	80	79	78	77	77	77	77	77	76	76	76	76	77	82	84	86	87	87	88	88	88		88	
Actual	79.1	80.1	80.1	79.6	78.9	77.4	77.4	77.2	76.7	76.9	76.8	76.4	76.1	76.4	76.2	77.0	79.3	80.9	82.8	85.4	84.4	77.7	77.9	79.6	76.1	85.4	78.8

Date									13-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	88	87	86	85	84	83	82	81	80	79	79	78	78	77	77	78	83	84	86	87	88	89	90	90		90	
Actual	81.6	82.4	82.4	81.6	79.1	78.3	77.7	77.8	78.6	78.8	77.4	77.4	76.5	75.2	75.5	77.5	79.3	80.7	82.3	81.3	83.1	86.6	82.5	82.3	75.2	86.6	79.8

Date	13-Jul								14-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	91	89	87	85	84	83	82	81	80	80	79	78	77	77	76	77	80	83	86	87	88	89	90	90		91	
	84.7	84.9	80.2	75.8	75.5	77.0	77.6	76.4	75.1	75.2	74.9	75.9	77.3	77.6	77.8	79.0	80.3	78.1	78.5	77.7	77.7	78.3	80.6	84.4	74.9	84.9	78.4

Date									15-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	91	91	89	86	85	84	83	82	82	81	80	79	79	78	77	78	79	81	82	85	87	89	89	90		91	
	84.0	76.1	76.9	77.0	76.1	76.2	76.9	76.1	75.9	76.2	76.3	74.8	76.3	75.5	75.8	77.3	79.3	80.9	81.7	82.9	82.4	84.2	85.8	87.1	74.8	87.1	78.8

Date	15-Jul								16-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	90	89	87	86	85	83	82	82	81	81	80	80	79	79	78	79	81	82	84	85	87	88	88	89		90	
	85.7	79.8	76.2	77.0	76.8	76.4	76.5	76.5	75.5	74.9	74.7	74.7	74.7	74.8	75.9	75.9	79.6	81.5	80.6	83.1	83.6	84.9	86.5	84.9	74.7	86.5	78.8

Date									17-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	89	88	87	85	85	84	83	82	81	81	80	79	78	78	77	78	80	81	83	84	86	87	88	88		89	
	85.4	84.6	84.7	82.4	80.1	78.6	79.0	77.6	77.5	77.0	76.5	76.4	77.0	76.4	75.9	76.1	76.5	78.3	81.2	83.9	86.2	87.8	88.1	79.8	75.9	88.1	80.3

Date									18-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)																										88	
	75.4	80.5	81.8	80.5	78.1																				75.4	81.8	79.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/11/2017 4pm	83.0	79.1	82.6	79.0	88.0	85.4	88	83.7	79.1	3.8	3.6	2.6	4.6

Date	12-Jul								13-Jul																	
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	low	high	ave
Temperature (°F)	88	87	88	85	83	82	80	80	79	79	78	78	77	77	76	77	80	82	85	86	87	88	88	89		89	
	81.6	82.4	82.4	81.6	79.1	78.3	77.7	77.8	78.6	78.8	77.4	77.4	76.5	75.2	75.5	77.5	79.3	80.7	82.3	81.3	83.1	86.6	82.5	82.3	75.2	86.6	79.8
Date									14-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	89	87	86	85	84	82	81	80	80	79	79	78	77	77	76	77	80	83	86	86	87	87	88	89		89	
	84.7	84.9	80.2	75.8	75.5	77.0	77.6	76.4	75.1	75.2	74.9	75.9	77.3	77.6	77.8	79.0	80.3	78.1	78.5	77.7	77.7	78.3	80.6	84.4	74.9	84.9	78.4
Date	14-Jul								15-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	90	88	87	85	84	84	83	82	82	81	80	79	79	78	77	78	80	82	84	85	87	88	88	89		90	
	84.0	76.1	76.9	77.0	76.1	76.2	76.9	76.1	75.9	76.2	76.3	74.8	76.3	75.5	75.8	77.3	79.3	80.9	81.7	82.9	82.4	84.2	85.8	87.1	74.8	87.1	78.8
Date									16-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	89	88	87	85	84	83	82	81	81	80	80	79	78	78	77	78	79	81	82	84	86	88	88	88		89	
	85.7	79.8	76.2	77.0	76.8	76.4	76.5	76.5	75.5	74.9	74.7	74.7	74.7	74.8	75.9	75.9	79.6	81.5	80.6	83.1	83.6	84.9	86.5	84.9	74.7	86.5	78.8
Date	16-Jul								17-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	88	87	86	84	83	82	81	80	80	79	79	78	77	77	76	77	79	81	83	85	86	88	88	89		89	
	85.4	84.6	84.7	82.4	80.1	78.6	79.0	77.6	77.5	77.0	76.5	76.4	77.0	76.4	75.9	76.1	76.5	78.3	81.2	83.9	86.2	87.8	88.1	79.8	75.9	88.1	80.3
Date									18-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	89	87	86	85	84	83	82	81	80	79	79	78	77	77	76	78	80	81	83	85	86	88	88	89		89	
	75.4	80.5	81.8	80.5	78.1																				75.4	81.8	79.3
Date									19-Jul																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)																										89	
																									0	0	#DIV/0!

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/12/2017 4pm	82.7	79.2	82.8	79.0	89.0	86.6	89	83.6	79.2	3.4	3.8	2.4	4.3

Date	5-Mar												6-Mar													
Hour (CST)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	low	high	ave
Temperature (°F)	78	80	80	79	78	76	75	73	72	71	70	69	68	68	68	67	66	64	63	61	60	60	60	61		80	
	74.6	76.4	77.0	76.9	75.9	75.4	74.3	71.2	69.3	67.6	66.1	65.7	65.8	66.2	67.3	66.9	67.0	67.0	61.6	55.0	55.6	53.3	53.2	54.4	53.2	77.0	66.8
Date													7-Mar														
Hour (CST)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	63	64	66	67	66	65	63	61	60	58	57	56	55	54	53	52	50	48	48	49	52	55	56	58		67	
	56.0	58.2	60.5	63.3	64.8	65.4	65.0	62.5	59.7	59.6	58.1	57.0	56.3	58.7	58.3	55.3	55.4	55.1	54.0	52.8	52.1	52.0	52.1	52.5	52.0	65.4	57.7
Date	7-Mar												8-Mar														
Hour (CST)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	59	61	62	62	61	59	56	54	52	50	49	47	46	45	44	44	42	42	42	44	47	51	55	58		62	
	53.5	55.1	57.1	58.3	59.1	59.1	57.7	55.0	53.6	52.4	50.7	49.5	48.7	48.3	48.5	47.6	47.6	48.3	48.1	46.9	47.6	49.5	51.4	53.9	46.9	59.1	52.0
Date													9-Mar														
Hour (CST)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	61	63	63	63	62	61	59	58	56	55	53	51	50	48	47	46	46	47	48	51	55	59	63	67		67	
	55.2	56.9	58.5	59.2	60.1	61.0	60.8	58.9	56.0	53.2	50.6	49.3	46.7	48.0	47.7	47.2	46.3	47.0	44.4	47.0	51.0	55.0	59.1	61.4	44.4	61.4	53.4
Date	9-Mar												10-Mar														
Hour (CST)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	70	71	71	70	68	66	65	64	63	62	62	62	62	61	61	61	61	61	62	64	66	69	71	73		73	
	62.5	63.4	64.4	65.2	65.2	64.4	63.2	61.2	59.7	59.5	58.9	57.3	56.8	56.8	57.1	57.6	58.1	57.7	58.6	60.0	60.9	62.6	63.1	68.9	56.8	68.9	61.0
Date													11-Mar														
Hour (CST)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	75	76	76	75	74	74	73	72	72	71	71	70	69	68	66	64	63	62	62	63	65	67	69	71		76	
	71.8	73.4	70.6	74.6	74.5	72.6	70.8	69.6	67.7	66.1	64.8	63.1	62.9	62.9	62.5	62.0	62.2	63.0	63.3	63.5	64.6	66.0	67.1	65.9	62.0	74.6	66.9
Date													12-Mar														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)																										76	
	59.1	60.0	62.0	63.5	65.2	66.5	64.7	63.2	62.7	61.9	62.6	61.8	61.0	60.1	59.0	57.6	55.9	53.1	51.0	49.6	49.6	49.7	50.5	52.5	49.6	66.5	58.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
3/5/2018 12pm	61.4	59.6	59.4	58.8	80.0	77.0	76	63.5	59.5	1.8	0.5	3.0	4.0

Date	13-Mar																14-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	47	49	52	55	57	58	60	63	65	66	65	64	62	60	58	56	55	53	52	51	50	49	47	46		66	
Actual	49.1	50.4	51.2	51.3	51.8	53.8	56.0	57.9	59.6	61.4	61.9	61.7	60.1	57.9	56.5	55.4	54.5	53.1	51.2	50.0	48.9	48.6	48.2	46.7	46.7	61.9	54.1

Date																	15-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	46	49	52	56	58	59	61	63	64	65	64	62	59	56	54	51	50	49	48	47	46	45	43	43		65	
	44.0	47.4	52.8	54.3	55.6	57.6	59.3	60.6	62.2	63.5	64.4	64.0	61.3	58.1	56.5	54.7	52.6	49.0	48.0	45.4	45.5	44.4	43.3	43.1	43.1	64.4	53.7

Date	15-Mar																16-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	45	49	55	60	64	67	69	71	72	72	70	68	65	63	61	59	59	58	58	58	58	58	58	59		72	
	47.0	52.9	56.2	59.9	62.6	64.3	66.0	67.5	68.6	68.4	67.2	65.0	62.4	59.7	58.3	57.4	57.2	58.3	58.8	59.6	59.9	59.4	60.2	60.7	47.0	68.6	60.7

Date																	17-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	60	62	65	67	70	72	74	75	75	75	74	73	72	71	70	69	68	67	66	66	65	64	64	64		75	
	61.3	63.5	66.2	69.1	71.1	73.0	74.1	74.4	71.3	72.6	71.6	69.2	68.5	67.8	67.1	66.2	65.6	65.7	65.1	64.5	64.2	64.5	64.8	65.2	61.3	74.4	67.8

Date	17-Mar																18-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	66	67	70	73	76	78	79	80	80	79	77	76	74	73	72	71	70	69	68	66	65	64	63	63		80	
	65.1	66.0	70.6	72.8	74.5	76.5	76.1	75.7	78.0	79.0	77.8	76.6	74.3	72.2	70.4	69.4	68.2	67.8	67.7	68.1	68.1	67.8	67.5	67.8	65.1	79.0	71.6

Date																	19-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	64	66	69	72	75	77	79	80	80	79	78	76	74	73	71	70	69	68	67	66	65	65	65	66		80	
	67.7	68.7	70.7	74.2	77.2	77.6	77.9	79.3	79.2	80.4	79.5	77.6	74.6	70.7	70.5	69.9	69.9	69.8	70.1	69.1	68.8	68.2	68.4	68.7	67.7	80.4	72.9

Date																	20-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										79	
	68.3	69.7	72.0	75.1	77.9	78.6	79.8	80.9	82.0	82.9	82.8	80.9	76.7	73.6	71.8	70.8	69.6	68.7	67.7	67.3	66.9	64.9	62.3	60.7	60.7	82.9	73.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
3/13/2018 7am	63.8	63.4	57.0	56.1	66.0	61.9	79	66.0	64.8	0.4	0.9	4.1	1.2

Date	15-Mar																16-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	45	49	55	60	64	67	70	71	72	72	70	68	66	63	61	60	59	58	59	59	59	59	58	58		72	
	47.0	52.9	56.2	59.9	62.6	64.3	66.0	67.5	68.6	68.4	67.2	65.0	62.4	59.7	58.3	57.4	57.2	58.3	58.8	59.6	59.9	59.4	60.2	60.7	47.0	68.6	60.7

Date																	17-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	59	61	64	67	70	72	74	75	75	75	75	74	73	71	69	67	67	67	67	68	68	67	66	65		75	
	61.3	63.5	66.2	69.1	71.1	73.0	74.1	74.4	71.3	72.6	71.6	69.2	68.5	67.8	67.1	66.2	65.6	65.7	65.1	64.5	64.2	64.5	64.8	65.2	61.3	74.4	67.8

Date	17-Mar																18-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	65	67	69	72	74	76	77	78	79	79	77	75	73	72	70	69	68	67	66	66	66	66	66	66		79	
	65.1	66.0	70.6	72.8	74.5	76.5	76.1	75.7	78.0	79.0	77.8	76.6	74.3	72.2	70.4	69.4	68.2	67.8	67.7	68.1	68.1	67.8	67.5	67.8	65.1	79.0	71.6

Date																	19-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	66	68	70	73	75	78	79	80	80	79	78	77	75	73	72	70	69	69	69	69	68	68	67	66		80	
	67.7	68.7	70.7	74.2	77.2	77.6	77.9	79.3	79.2	80.4	79.5	77.6	74.6	70.7	70.5	69.9	69.9	69.8	70.1	69.1	68.8	68.2	68.4	68.7	67.7	80.4	72.9

Date	19-Mar																20-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	66	68	70	73	75	77	79	80	81	81	79	77	75	73	71	69	67	66	64	64	63	61	59	58		81	
	68.3	69.7	72.0	75.1	77.9	78.6	79.8	80.9	82.0	82.9	82.8	80.9	76.7	73.6	71.8	70.8	69.6	68.7	67.7	67.3	66.9	64.9	62.3	60.7	60.7	82.9	73.0

Date																	21-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	58	60	63	66	68	69	70	71	73	73	72	69	66	63	61	59	58	57	56	55	55	54	52	51		73	
	59.1	58.5	59.1	59.8	60.8	62.4	63.4	64.4	64.6	64.3	63.3	61.8	59.6	57.9	57.1	55.2	53.3	52.1	50.9	50.0	49.9	48.5	48.3	48.1	48.1	64.6	57.2

Date																	22-Mar										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										72	
	49.2	52.6	56.6	58.6	60.6	62.6	63.6	64.4	65.7	66.4	66.6	65.4	63.0	60.6	59.8	58.0	57.1	55.4	55.4	54.8	54.4	54.5	53.9	53.9	49.2	66.6	58.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
3/15/2018 7am	67.9	67.2	67.2	66.7	72.0	68.6	72	68.5	66.0	0.7	0.5	3.4	2.5

Date	20-Mar																	21-Mar								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	57	56	56	57	58	60	63	66	67	68	68	66	64	61	58	56	54	53	52	51	50	50	49	48		68	
	60.7	59.1	58.5	59.1	59.8	60.8	62.4	63.4	64.4	64.6	64.3	63.3	61.8	59.6	57.9	57.1	55.2	53.3	52.1	50.9	50.0	49.9	48.5	48.3	48.3	64.6	57.7

Date																		22-Mar								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	47	48	50	54	58	61	64	66	67	68	68	67	65	62	60	57	55	54	53	53	52	52	51	50		68	
	48.1	49.2	52.6	56.6	58.6	60.6	62.6	63.6	64.4	65.7	66.4	66.6	65.4	63.0	60.6	59.8	58.0	57.1	55.4	55.4	54.8	54.4	54.5	53.9	48.1	66.6	58.6

Date	22-Mar																	23-Mar								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	49	50	53	57	61	64	66	68	69	70	70	68	66	63	60	58	56	54	54	54	53	53	52	51		70	
	53.9	52.6	54.3	56.3	58.1	59.6	60.9	61.3	62.8	63.9	65.5	66.9	67.2	63.8	60.4	57.8	55.5	53.5	52.4	51.6	51.4	50.7	50.6	50.7	50.6	67.2	57.6

Date																		24-Mar								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	51	52	56	62	67	70	72	74	75	75	75	73	71	69	66	64	63	62	61	61	61	61	61	60		75	
	51.3	52.1	56.0	61.5	66.7	69.2	70.1	70.7	71.4	71.4	71.0	70.8	68.3	65.5	63.8	63.2	62.9	62.7	63.1	63.0	63.2	62.6	61.9	61.8	51.3	71.4	64.3

Date	24-Mar																	25-Mar								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	60	61	64	68	71	74	76	78	79	80	80	79	76	74	72	71	69	68	68	67	67	67	66	66		80	
	62.7	64.2	67.1	71.2	73.5	75.3	76.5	77.6	78.2	77.7	76.6	75.4	73.1	71.1	69.8	68.6	66.4	65.8	66.2	65.5	64.9	64.6	64.9	64.8	62.7	78.2	70.1

Date																		26-Mar								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	65	65	67	70	73	76	78	80	81	81	81	79	78	76	74	72	71	70	70	69	69	68	67	67		81	
	65.2	65.8	68.3	72.4	75.0	77.6	79.2	80.8	81.7	81.2	80.2	79.4	77.5	74.0	71.0	69.1	67.5	66.3	66.3	66.0	65.9	66.1	66.4	66.3	65.2	81.7	72.1

Date																		27-Mar								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										81	
	67.0	67.1	68.8	72.6	76.0	77.4	78.4	78.4	79.1	78.7	77.6	77.0	75.2	73.1	72.1	71.5	71.0	70.5	70.1	69.5	68.9	68.6	67.9	67.3	67.0	79.1	72.7

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
3/20/2018 6am	63.9	63.4	58.2	58.0	68.0	64.6	81	66.3	64.7	0.5	0.2	3.4	1.6

Date	2-Apr										3-Apr																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	low	high	ave
Temperature (°F)	77	78	78	78	77	75	73	72	69	69	69	68	68	68	67	67	67	67	70	72	75	79	80	81		81	
	72.3	73.5	74.2	78.4	77.3	73.8	71.3	69.3	68.4	69.5	69.4	69.0	68.6	68.4	68.8	68.3	67.8	67.6	70.7	75.0	77.6	79.7	79.8	80.4	67.6	80.4	72.5
Date											4-Apr																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	82	82	81	80	78	76	75	73	71	70	69	68	68	67	66	65	63	61	60	60	60	62	63	65		82	
	81.4	81.3	80.1	78.8	77.7	75.5	73.8	72.2	71.7	71.5	71.6	72.1	68.7	63.7	63.7	63.6	63.6	60.4	55.7	55.8	55.9	58.4	61.2	65.0	55.7	81.4	68.5
Date	4-Apr										5-Apr																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	67	68	69	68	67	65	63	60	59	57	56	56	55	54	52	51	51	51	53	56	59	63	66	68		69	
	66.7	67.9	68.3	68.6	67.6	65.9	64.1	62.9	61.8	59.7	57.8	57.5	56.9	56.3	55.8	55.4	54.9	55.1	56.7	58.3	59.7	61.6	63.7	66.9	54.9	68.6	61.3
Date											6-Apr																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	70	70	70	69	68	66	65	63	62	61	59	58	57	56	56	56	57	59	62	65	69	72	75	77		77	
	66.2	67.0	66.4	65.3	64.9	63.1	62.9	63.1	62.6	62.0	61.9	61.8	60.3	60.0	61.3	61.1	61.0	62.4	63.9	67.8	71.3	72.3	73.7	74.5	60.0	74.5	64.9
Date	6-Apr										7-Apr																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	78	78	77	76	74	73	71	70	69	69	68	67	66	66	65	65	65	66	68	69	72	74	75	77		78	
	75.3	75.7	75.9	75.5	74.1	72.2	71.3	71.0	70.5	70.1	69.6	69.5	69.1	69.8	69.6	68.8	64.5	64.1	64.8	67.1	68.9	68.7	69.2	68.3	64.1	75.9	70.1
Date											8-Apr																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	77	77	76	75	74	72	71	70	68	67	66	65	63	62	61	61	61	62	65	67	70	73	76	78		78	
	67.8	67.3	63.4	58.3	54.6	54.0	52.1	50.7	50.0	48.8	48.0	46.9	47.0	46.9	47.0	47.2	46.9	47.3	48.4	49.1	49.5	50.0	50.5	51.4	46.9	67.8	51.8
Date											9-Apr																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)																										78	
	52.0	52.8	53.8	54.5	55.1	55.3	54.8	54.2	54.8	56.1	56.9	57.2	56.3	56.0	55.6	55.6	55.6	56.8	58.6	58.7	59.2	60.9	61.4	62.5	52.0	62.5	56.4

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
4/2/2018 2pm	67.6	64.8	67.3	67.4	81.0	80.4	78	69.1	63.6	2.8	-0.1	0.6	5.5

																									low	high	ave
Date	3-Apr															4-Apr											
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	71	73	76	78	80	81	82	82	82	80	79	77	75	73	72	71	70	70	70	69	68	64	62	60		82	
	70.7	75.0	77.6	79.7	79.8	80.4	81.4	81.3	80.1	78.8	77.7	75.5	73.8	72.2	71.7	71.5	71.6	72.1	68.7	63.7	63.7	63.6	63.6	60.4	60.4	81.4	73.1
Date																	5-Apr										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	59	58	57	61	64	67	69	70	70	69	68	66	64	62	60	59	58	57	56	55	54	53	52	53		70	
	55.7	55.8	55.9	58.4	61.2	65.0	66.7	67.9	68.3	68.6	67.6	65.9	64.1	62.9	61.8	59.7	57.8	57.5	56.9	56.3	55.8	55.4	54.9	55.1	54.9	68.6	60.6
Date	5-Apr																6-Apr										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	55	59	62	65	68	70	71	73	73	73	71	70	67	65	63	61	60	59	59	59	58	58	58	59		73	
	56.7	58.3	59.7	61.6	63.7	66.9	66.2	67.0	66.4	65.3	64.9	63.1	62.9	63.1	62.6	62.0	61.9	61.8	60.3	60.0	61.3	61.1	61.0	62.4	56.7	67.0	62.5
Date																	7-Apr										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	61	64	68	71	74	77	78	78	77	76	75	74	72	71	70	69	68	67	67	66	65	65	65	66		78	
	63.9	67.8	71.3	72.3	73.7	74.5	75.3	75.7	75.9	75.5	74.1	72.2	71.3	71.0	70.5	70.1	69.6	69.5	69.1	69.8	69.6	68.8	64.5	64.1	63.9	75.9	70.8
Date	7-Apr																8-Apr										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	67	69	70	72	74	75	75	75	74	73	71	70	68	67	65	64	62	61	60	59	59	59	60	61		75	
	64.8	67.1	68.9	68.7	69.2	68.3	67.8	67.3	63.4	58.3	54.6	54.0	52.1	50.7	50.0	48.8	48.0	46.9	47.0	46.9	47.0	47.2	46.9	47.3	46.9	69.2	56.3
Date																	9-Apr										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	63	65	67	70	72	74	75	76	76	76	75	74	73	72	71	70	69	68	67	67	67	68	69	70		76	
	48.4	49.1	49.5	50.0	50.5	51.4	52.0	52.8	53.8	54.5	55.1	55.3	54.8	54.2	54.8	56.1	56.9	57.2	56.3	56.0	55.6	55.6	55.6	56.8	48.4	57.2	53.8
Date	9-Apr																10-Apr										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										76	
	58.6	58.7	59.2	60.9	61.4	62.5	64.1	65.8	67.0	67.5	67.7	67.1	66.6	66.6	65.8	65.4	64.9	63.4	62.9	61.6	60.0	59.6	60.2	60.0	58.6	67.7	63.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
4/3/2018 8am	67.7	62.9	66.1	65.4	82.0	81.4	76	68.9	62.9	4.8	0.7	0.6	6.0

Date	17-Apr																18-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	53	57	63	69	73	76	78	79	80	80	79	77	74	71	67	65	64	63	64	64	63	62	61	61		80	
	54.0	60.6	66.6	69.9	73.0	74.5	75.9	77.0	77.0	76.8	75.5	72.8	68.7	65.6	63.4	61.5	61.3	61.0	60.6	61.1	61.4	60.3	60.7	61.8	54.0	77.0	66.7
Date																	19-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	62	66	70	75	78	79	81	82	82	82	80	78	76	74	71	69	68	67	66	65	65	64	63	62		82	
	62.1	67.5	71.0	73.2	74.6	76.0	76.8	77.9	78.7	78.5	78.3	76.4	72.9	70.3	68.7	67.3	66.2	65.6	66.1	65.7	65.0	65.0	64.8	66.1	62.1	78.7	70.6
Date	19-Apr																	20-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	63	65	67	70	72	74	75	76	77	77	76	74	72	69	66	64	63	62	61	60	59	58	57	56		77	
	65.3	65.2	65.9	67.7	68.5	69.8	71.2	72.3	72.9	73.2	73.1	71.8	69.1	66.1	63.7	61.3	59.2	57.5	56.0	54.9	53.9	54.8	54.9	54.3	53.9	73.2	64.3
Date																		21-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	56	58	62	65	68	70	72	73	74	74	74	73	71	68	65	63	62	61	61	60	60	59	58	58		74	
	54.5	54.5	55.2	56.8	58.3	59.6	60.8	62.5	63.6	63.6	63.7	63.1	62.4	60.5	58.4	58.8	56.2	55.1	55.6	56.0	56.2	59.3	60.0	59.7	54.5	63.7	58.9
Date	21-Apr																	22-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	60	64	69	74	77	78	79	79	80	80	79	76	74	72	70	68	67	67	67	67	67	67	66	66		80	
	59.8	64.0	66.1	69.2	71.0	72.4	74.4	75.0	73.9	73.9	74.1	72.3	70.7	70.0	69.7	69.5	69.3	69.1	68.6	68.6	68.7	68.8	68.1	68.5	59.8	75.0	69.8
Date																		23-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	67	69	71	74	76	78	78	79	79	78	77	76	74	72	70	68	66	65	63	62	62	60	59	58		79	
	68.6	68.8	69.6	71.0	72.6	74.1	77.1	77.7	76.4	77.0	77.2	76.2	73.3	69.8	66.7	63.8	62.0	60.7	59.6	57.6	56.6	56.1	54.5	54.2	54.2	77.7	67.6
Date	23-Apr																	24-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										79	
	55.8	59.9	62.2	64.3	66.1	67.2	68.8	70.0	71.1	71.7	71.3	70.8	69.3	66.5	64.4	63.7	63.4	62.6	61.4	60.3	60.5	59.7	58.9	58.0	55.8	71.7	64.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
4/17/2018 7am	69.0	66.3	69.2	67.2	80.0	77.0	79	70.5	66.1	2.7	2.0	3.0	4.4

Date	18-Apr									19-Apr																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	low	high	ave
Temperature (°F)	84	84	84	82	80	77	75	72	70	68	66	65	64	63	62	62	61	61	62	64	66	68	71	72		84	
	77.9	78.7	78.5	78.3	76.4	72.9	70.3	68.7	67.3	66.2	65.6	66.1	65.7	65.0	65.0	64.8	66.1	65.3	65.2	65.9	67.7	68.5	69.8	71.2	64.8	78.7	69.5

Date											20-Apr															
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	74	74	74	73	71	69	67	64	62	60	59	58	57	56	55	53	52	52	55	58	62	64	66	68		74	
	72.3	72.9	73.2	73.1	71.8	69.1	66.1	63.7	61.3	59.2	57.5	56.0	54.9	53.9	54.8	54.9	54.3	54.5	54.5	55.2	56.8	58.3	59.6	60.8	53.9	73.2	61.2

Date	20-Apr										21-Apr															
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	69	70	70	70	69	67	65	62	60	59	59	59	59	58	57	56	56	58	62	67	72	75	77	78		78	
	62.5	63.6	63.6	63.7	63.1	62.4	60.5	58.4	58.8	56.2	55.1	55.6	56.0	56.2	59.3	60.0	59.7	59.8	64.0	66.1	69.2	71.0	72.4	74.4	55.1	74.4	62.1

Date											22-Apr															
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	78	78	77	76	75	72	70	67	65	64	64	64	64	64	64	63	63	64	66	69	73	75	77	78		78	
	75.0	73.9	73.9	74.1	72.3	70.7	70.0	69.7	69.5	69.3	69.1	68.6	68.6	68.7	68.8	68.1	68.5	68.6	68.8	69.6	71.0	72.6	74.1	77.1	68.1	77.1	70.9

Date	22-Apr										23-Apr															
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	79	80	80	79	77	75	72	70	68	67	65	64	63	63	62	61	60	60	62	65	67	70	73	75		80	
	77.7	76.4	77.0	77.2	76.2	73.3	69.8	66.7	63.8	62.0	60.7	59.6	57.6	56.6	56.1	54.5	54.2	55.8	59.9	62.2	64.3	66.1	67.2	68.8	54.2	77.7	65.2

Date											24-Apr															
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	76	76	76	75	74	72	69	66	64	63	62	62	61	60	59	58	57	58	60	64	67	70	72	74		76	
	70.0	71.1	71.7	71.3	70.8	69.3	66.5	64.4	63.7	63.4	62.6	61.4	60.3	60.5	59.7	58.9	58.0	59.8	63.7	66.2	69.1	71.6	73.4	74.8	58.0	74.8	65.9

Date	24-Apr										25-Apr															
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)																										75	
	76.0	76.8	77.1	76.3	74.8	73.2	70.5	69.5	67.1	65.9	64.5	62.6	60.7	59.4	58.2	57.9	57.8	61.2	65.1	68.5	70.0	72.1	74.4	76.1	57.8	77.1	68.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
4/18/2018 2pm	67.1	65.8	65.8	64.3	84.0	78.7	75	68.2	66.1	1.3	1.6	5.3	2.1

Date	23-Apr																24-Apr										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	56	59	62	65	67	69	71	72	73	74	74	73	74	71	69	66	64	63	61	61	60	59	58	58		74	
	55.8	59.9	62.2	64.3	66.1	67.2	68.8	70.0	71.1	71.7	71.3	70.8	69.3	66.5	64.4	63.7	63.4	62.6	61.4	60.3	60.5	59.7	58.9	58.0	55.8	71.7	64.5
Date																		25-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	59	62	65	69	72	75	77	78	79	79	78	77	76	74	72	70	68	66	64	63	62	61	60	60		79	
	59.8	63.7	66.2	69.1	71.6	73.4	74.8	76.0	76.8	77.1	76.3	74.8	73.2	70.5	69.5	67.1	65.9	64.5	62.6	60.7	59.4	58.2	57.9	57.8	57.8	77.1	67.8
Date	25-Apr																	26-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	61	63	66	69	71	73	75	77	78	78	77	76	74	72	70	68	66	65	63	63	62	61	60	60		78	
	61.2	65.1	68.5	70.0	72.1	74.4	76.1	77.5	78.3	78.5	78.4	77.1	74.2	72.7	70.5	68.9	67.9	67.6	67.0	66.9	67.6	67.7	67.0	63.5	61.2	78.5	70.8
Date																		27-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	60	61	63	66	68	71	73	75	76	76	76	75	74	72	70	68	66	63	61	60	58	57	57	58		76	
	61.4	60.7	62.1	65.7	67.3	68.5	70.1	71.1	71.2	71.3	71.0	69.7	67.5	65.4	63.1	61.2	60.1	58.4	57.6	56.5	55.4	55.5	55.3	54.5	54.5	71.3	63.4
Date	27-Apr																	28-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	59	62	65	69	72	75	77	79	79	79	77	76	74	73	71	69	68	66	64	62	60	59	58	58		79	
	56.7	60.2	63.8	66.0	67.4	68.9	69.9	70.6	71.2	72.0	72.4	71.8	70.1	67.0	65.0	64.2	64.2	61.9	60.9	60.2	59.2	56.5	55.7	56.5	55.7	72.4	64.7
Date																		29-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	59	61	63	66	70	73	75	76	77	77	76	75	73	71	69	67	65	63	61	60	59	58	58	59		77	
	59.1	65.7	69.3	72.2	73.5	74.6	76.1	77.6	77.9	76.8	77.8	77.0	74.9	69.8	68.2	66.8	65.4	64.3	62.9	62.9	62.2	61.6	61.3	62.0	59.1	77.9	69.2
Date	29-Apr																	30-Apr									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										76	
	64.0	67.2	69.5	72.0	73.3	74.4	74.9	77.2	78.7	79.4	79.5	79.0	76.0	72.7	69.7	68.4	67.7	65.1	62.5	62.9	63.9	64.7	66.7	66.0	62.5	79.5	70.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
4/23/2018 7am	67.8	66.7	68.0	67.7	74.0	71.7	76	68.9	67.3	1.1	0.3	2.3	1.7

Date	30-Apr																1-May										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	64	68	73	78	81	83	85	85	85	84	83	81	78	73	69	65	63	63	63	63	63	62	61	61		85	
	67.6	70.4	72.5	74.3	76.1	74.9	76.0	76.4	77.0	78.9	78.4	76.8	73.7	70.1	67.4	66.4	66.6	66.0	66.3	64.3	64.4	64.7	65.3	65.9	64.3	78.9	70.8
Date																		2-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	63	68	73	78	82	83	84	85	85	84	83	81	79	76	74	73	72	72	71	71	70	68	67	67		85	
	68.1	70.7	73.0	76.0	78.4	79.3	80.5	81.1	81.4	80.7	79.6	78.5	76.4	74.4	73.8	73.2	72.2	71.9	71.8	72.1	72.7	72.0	71.0	71.3	68.1	81.4	75.0
Date	2-May																	3-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	68	71	75	78	81	82	83	84	84	84	83	81	79	77	75	73	71	69	68	67	67	67	66	66		84	
	71.7	76.0	79.1	81.2	82.6	83.1	82.8	82.2	81.5	81.2	80.5	78.7	76.6	74.5	73.4	72.7	72.5	71.7	70.8	69.9	69.2	69.1	69.1	69.3	69.1	83.1	75.8
Date																		4-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	67	70	74	78	81	83	85	86	86	86	85	84	82	79	76	73	71	71	70	70	70	69	68	68		86	
	70.4	72.1	74.7	76.9	78.3	79.6	79.7	80.6	80.5	80.8	79.9	78.4	75.9	73.9	73.5	72.5	72.3	71.7	70.5	70.1	68.5	67.6	67.2	67.6	67.2	80.8	74.3
Date	4-May																	5-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	69	72	76	80	82	84	85	85	85	85	84	82	80	78	76	73	71	70	69	69	69	69	68	67		85	
	69.3	73.2	76.2	78.6	79.5	80.3	79.8	78.8	79.6	80.1	80.3	78.9	78.3	75.6	74.1	72.7	71.4	70.7	70.6	69.9	68.9	68.3	67.9	68.3	67.9	80.3	74.6
Date																		6-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	67	70	73	76	79	80	81	82	82	81	80	78	76	74	71	70	69	69	68	68	67	66	65	65		82	
	70.1	73.3	75.2	76.4	77.8	74.5	74.6	74.9	74.4	74.4	73.8	74.0	73.2	71.9	70.6	69.9	68.2	67.1	66.3	64.7	65.0	63.8	63.7	63.7	63.7	77.8	70.9
Date	6-May																	7-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										80	
	66.1	68.9	72.5	74.8	76.3	78.0	80.1	81.2	81.9	82.6	82.9	82.2	79.6	77.2	72.6	71.3	70.0	67.4	65.6	65.0	63.9	63.7	63.7	63.7	63.7	82.9	73.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
4/30/2018 7am	74.7	73.6	74.2	73.9	85.0	78.9	80	75.5	73.5	1.1	0.3	6.1	2.0

Date	3-May									4-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	low	high	ave
Temperature (°F)	86	86	85	83	81	78	75	73	71	70	69	69	68	68	67	67	68	71	74	78	80	82	84	85		86	
	80.5	80.8	79.9	78.4	75.9	73.9	73.5	72.5	72.3	71.7	70.5	70.1	68.5	67.6	67.2	67.6	69.3	73.2	76.2	78.6	79.5	80.3	79.8	78.8	67.2	80.8	74.4

Date										5-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	85	85	84	83	81	79	76	73	71	70	69	69	69	68	67	67	68	71	75	79	82	83	83	83		85	
	79.6	80.1	80.3	78.9	78.3	75.6	74.1	72.7	71.4	70.7	70.6	69.9	68.9	68.3	67.9	68.3	70.1	73.3	75.2	76.4	77.8	74.5	74.6	74.9	67.9	80.3	73.9

Date	5-May									6-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	83	82	81	79	77	75	72	70	69	68	68	68	68	67	66	66	67	70	73	77	79	81	82	83		83	
	74.4	74.4	73.8	74.0	73.2	71.9	70.6	69.9	68.2	67.1	66.3	64.7	65.0	63.8	63.7	63.7	66.1	68.9	72.5	74.8	76.3	78.0	80.1	81.2	63.7	81.2	70.9

Date										7-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	83	83	82	81	79	77	73	71	69	69	69	68	67	66	65	64	65	68	72	76	79	81	83	84		84	
	81.9	82.6	82.9	82.2	79.6	77.2	72.6	71.3	70.0	67.4	65.6	65.0	63.9	63.7	63.7	63.7	67.0	70.8	75.4	79.2	81.8	83.5	84.5	85.6	63.7	85.6	74.2

Date	7-May									8-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	85	85	84	82	80	76	73	71	70	69	69	68	67	65	64	64	65	68	72	76	79	80	82	83		85	
	86.0	86.4	86.2	85.0	82.0	78.0	73.8	71.3	71.1	70.8	69.3	68.3	66.8	66.0	64.5	64.7	69.1	72.5	74.8	77.3	81.8	83.4	84.4	85.3	64.5	86.4	75.8

Date										9-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	85	85	84	82	79	76	73	70	68	67	67	66	65	64	63	63	64	68	73	78	82	84	85	86		86	
	86.1	86.6	86.3	85.4	83.2	78.8	75.7	73.7	73.1	72.9	71.5	70.5	70.1	68.8	68.6	68.8	70.8	75.6	78.9	81.6	83.0	83.9	84.5	84.1	68.6	86.6	77.6

Date	9-May									10-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)																										86	
	83.7	83.6	83.2	80.8	78.0	74.6	72.2	70.5	69.3	68.8	68.1	66.2	66.1	65.7	64.9	65.0	69.1	75.4	78.4	80.8	82.7	83.5	84.3	84.9	64.9	84.9	75.0

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
5/3/2018 3pm	74.6	74.5	75.1	73.1	86.0	80.8	86	76.2	74.5	0.1	2.0	5.2	1.6

Date	8-May																	9-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	69	73	78	83	85	87	87	89	90	91	90	88	86	83	80	77	75	73	73	72	71	70	69	68		91	
	69.1	72.5	74.8	77.3	81.8	83.4	84.4	85.3	86.1	86.6	86.3	85.4	83.2	78.8	75.7	73.7	73.1	72.9	71.5	70.5	70.1	68.8	68.6	68.8	68.6	86.6	77.0

Date																		10-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	69	73	79	83	87	88	89	89	89	89	87	86	83	80	77	75	73	72	71	70	68	67	66	66		89	
	70.8	75.6	78.9	81.6	83.0	83.9	84.5	84.1	83.7	83.6	83.2	80.8	78.0	74.6	72.2	70.5	69.3	68.8	68.1	66.2	66.1	65.7	64.9	65.0	64.9	84.5	75.1

Date	10-May																	11-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	67	71	75	80	84	86	87	88	88	87	86	85	83	81	78	76	74	72	70	69	69	68	68	68		88	
	69.1	75.4	78.4	80.8	82.7	83.5	84.3	84.9	84.6	84.0	83.2	81.7	78.8	75.5	72.1	70.0	69.8	68.7	68.5	67.4	67.4	67.7	68.1	67.6	67.4	84.9	75.6

Date																		12-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	69	71	75	78	82	85	87	88	88	87	86	84	82	80	78	76	75	73	72	70	70	69	69	70		88	
	71.2	75.7	79.1	81.4	83.4	84.2	84.9	85.4	85.1	84.9	84.1	82.1	78.9	75.5	73.4	72.3	71.7	72.0	70.8	69.3	69.5	69.7	69.7	70.1	69.3	85.4	76.9

Date	12-May																	13-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	71	73	76	79	82	84	86	87	87	86	85	84	82	80	79	77	75	74	73	71	70	70	70	71		87	
	73.8	76.9	79.2	80.7	81.9	82.1	81.4	83.0	83.3	81.2	79.4	78.2	77.1	76.4	75.5	75.0	74.4	74.2	73.9	72.8	72.3	70.8	70.7	70.2	70.2	83.3	76.8

Date																		14-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	72	75	77	81	83	86	87	88	88	86	85	83	81	79	78	77	75	74	73	72	71	70	70	70		88	
	71.9	76.6	78.6	80.2	81.5	82.7	83.4	84.5	85.0	84.7	84.8	84.0	83.2	80.6	77.7	75.6	73.7	73.6	72.8	71.9	71.1	70.9	72.2	71.6	70.9	85.0	78.0

Date	14-May																	15-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										87	
	73.4	77.7	80.0	83.4	84.5	85.9	87.4	88.5	89.4	89.8	89.8	87.8	84.3	80.7	80.6	80.8	79.8	78.4	76.3	74.7	73.1	72.0	72.2	71.2	71.2	89.8	80.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
5/8/2018 7am	78.2	76.6	78.4	75.9	91.0	86.6	87	79.5	77.2	1.6	2.5	4.4	2.3

Date	**9-May**																	**10-May**									
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	low	high	ave
Temperature (°F)	70	74	80	85	88	89	90	90	90	90	89	87	84	81	77	75	73	72	71	70	68	67	66	66		90	
	70.8	75.6	78.9	81.6	83.0	83.9	84.5	84.1	83.7	83.6	83.2	80.8	78.0	74.6	72.2	70.5	69.3	68.8	68.1	66.2	66.1	65.7	64.9	65.0	64.9	84.5	75.1

Date																		**11-May**									
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	68	72	77	81	85	87	88	89	89	89	87	85	83	80	77	74	72	71	70	69	68	67	66	66		89	
	69.1	75.4	78.4	80.8	82.7	83.5	84.3	84.9	84.6	84.0	83.2	81.7	78.8	75.5	72.1	70.0	69.8	68.7	68.5	67.4	67.4	67.7	68.1	67.6	67.4	84.9	75.6

Date	**11-May**																	**12-May**									
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	67	70	74	79	83	86	89	90	90	89	87	85	82	80	77	75	73	71	70	70	69	69	69	69		90	
	71.2	75.7	79.1	81.4	83.4	84.2	84.9	85.4	85.1	84.9	84.1	82.1	78.9	75.5	73.4	72.3	71.7	72.0	70.8	69.3	69.5	69.7	69.7	70.1	69.3	85.4	76.9

Date																		**13-May**									
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	70	72	75	79	82	85	87	88	88	87	86	85	83	82	80	79	77	76	74	73	71	70	70	70		88	
	73.8	76.9	79.2	80.7	81.9	82.1	81.4	83.0	83.3	81.2	79.4	78.2	77.1	76.4	75.5	75.0	74.4	74.2	73.9	72.8	72.3	70.8	70.7	70.2	70.2	83.3	76.8

Date	**13-May**																	**14-May**									
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	71	73	76	79	82	85	87	88	88	88	87	85	84	82	80	78	76	74	72	71	70	69	69	70		88	
	71.9	76.6	78.6	80.2	81.5	82.7	83.4	84.5	85.0	84.7	84.8	84.0	83.2	80.6	77.7	75.6	73.7	73.6	72.8	71.9	71.1	70.9	72.2	71.6	70.9	85.0	78.0

Date																		**15-May**									
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	71	73	76	79	82	85	87	88	88	87	86	85	83	81	79	77	75	73	71	70	69	69	69	70		88	
	73.4	77.7	80.0	83.4	84.5	85.9	87.4	88.5	89.4	89.8	89.8	87.8	84.3	80.7	80.6	80.8	79.8	78.4	76.3	74.7	73.1	72.0	72.2	71.2	71.2	89.8	80.9

Date	**15-May**																	**16-May**									
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)																										88	
	73.4	76.0	80.1	83.5	86.3	88.0	89.5	89.8	90.7	91.1	91.2	90.0	86.6	83.0	81.8	79.2	77.1	75.6	74.8	73.8	73.6	73.1	74.4	74.5	73.1	91.2	81.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
5/9/2018 7am	78.2	77.2	78.0	75.9	90.0	84.5	88	79.6	77.8	1.0	2.1	5.5	1.8

Date	14-May											15-May															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	low	high	ave
Temperature (°F)	90	91	91	91	90	88	86	83	79	76	74	74	73	73	73	72	71	70	71	75	80	85	88	89		91	
	87.4	88.5	89.4	89.8	89.8	87.8	84.3	80.7	80.6	80.8	79.8	78.4	76.3	74.7	73.1	72.0	72.2	71.2	73.4	76.0	80.1	83.5	86.3	88.0	71.2	89.8	81.0
Date												16-May															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	90	91	91	90	89	87	85	82	79	76	75	74	74	73	73	72	71	71	72	75	79	82	85	87		91	
	89.5	89.8	90.7	91.1	91.2	90.0	86.6	83.0	81.8	79.2	77.1	75.6	74.8	73.8	73.6	73.1	74.4	74.5	75.6	77.6	81.4	84.5	86.8	88.4	73.1	91.2	81.8
Date	16-May											17-May															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	88	89	89	88	86	83	80	78	76	74	74	73	73	73	72	71	71	72	75	78	82	85	87		89	
	89.8	91.1	91.9	91.7	91.5	91.0	84.2	81.7	79.6	78.4	76.8	76.8	75.4	74.4	73.9	73.1	72.7	72.6	74.6	79.0	82.2	84.5	87.0	88.4	72.6	91.9	81.8
Date												18-May															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	89	90	89	88	86	83	80	78	76	74	74	73	73	72	72	71	71	72	75	79	82	85	87		90	
	90.4	90.4	90.9	90.6	90.5	89.3	85.1	82.0	79.9	78.3	76.9	76.0	75.1	74.9	75.3	75.4	75.5	75.4	77.1	79.0	81.4	83.9	85.8	86.2	74.9	90.9	81.9
Date	18-May											19-May															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	89	89	88	87	86	84	81	78	76	74	73	73	72	72	71	70	70	71	75	80	84	86	88		89	
	88.0	89.0	87.4	77.9	72.9	69.2	69.5	69.9	70.0	71.3	70.6	69.5	69.0	68.6	69.7	69.5	70.1	70.5	74.1	78.6	80.8	82.6	84.2	85.4	68.6	89.0	75.3
Date												20-May															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	89	89	88	87	85	83	80	78	76	74	74	73	72	72	71	70	70	71	75	80	84	86	88		89	
	86.8	87.4	87.4	86.6	86.0	85.4	82.3	78.9	77.2	76.2	75.4	74.7	74.4	74.3	73.4	73.7	73.7	74.5	77.1	78.6	81.1	83.7	85.1	86.1	73.4	87.4	80.0
Date	20-May											21-May															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)																										90	
	86.7	84.8	85.9	86.9	86.5	85.0	82.2	78.7	77.1	76.3	75.4	74.2	73.4	72.5	72.4	72.6	72.6	71.1	72.4	77.0	79.6	81.1	81.0	82.3	71.1	86.9	78.7

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
5/14/2018 1pm	79.7	80.3	80.0	81.5	91.0	89.8	90	81.2	80.1	-0.6	-1.5	1.2	1.1

Date	15-May														16-May											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	81	85	88	90	92	93	93	93	91	89	86	84	81	79	78	77	76	76	75	74	73	73	74	77		93	
	80.11103	83.45399	86.32912	87.99773	89.47982	89.8177	90.69083	91.14631	91.15582	90.01288	86.60818	82.98917	81.78557	79.2271	77.05271	75.62489	74.82904	73.84829	73.64381	73.06254	74.41142	74.54454	75.56926	77.60925	73.06254	91.15582	81.70837

Date															17-May											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	81	85	88	89	91	92	92	92	90	88	86	84	82	79	77	76	75	75	74	74	73	72	73	76		92	
	81.4463	84.50996	86.78291	88.35895	89.77886	91.09343	91.89244	91.66382	91.49589	91.02866	84.20332	81.71207	79.60352	78.39022	76.79549	76.79258	75.38506	74.37017	73.85675	73.10367	72.69643	72.56418	74.63986	78.98267	72.56418	91.89244	81.71447

Date	17-May														18-May											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	80	84	88	90	91	92	92	91	90	89	87	85	84	82	80	78	77	75	74	73	73	73	75	77		92	
	82.2233	84.50948	86.96504	88.36642	90.39281	90.39455	90.88093	90.63086	90.49624	89.30715	85.10854	82.03738	79.87728	78.25728	76.94881	76.01835	75.14722	74.92961	75.29739	75.35996	75.45721	75.43774	77.05697	78.98214	74.92961	90.88093	82.08678

Date															19-May											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	79	82	85	87	89	90	90	89	88	87	85	83	82	80	79	77	76	74	73	72	72	72	74	76		90	
	81.4141	83.86247	85.7755	86.15292	87.95035	88.96059	87.43479	77.9084	72.91821	69.23219	69.54714	69.89994	70.04187	71.29975	70.56533	69.51217	68.95836	68.6415	69.71244	69.54581	70.12502	70.46424	74.06177	78.58703	68.6415	88.96059	75.52383

Date	19-May														20-May											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	79	82	85	88	90	91	91	90	89	87	85	83	82	80	78	77	76	74	73	72	72	72	74	76		91	
	80.78875	82.60203	84.17841	85.43256	86.7512	87.44403	87.41243	86.56961	85.99121	85.41	82.31793	78.87789	77.16883	76.16026	75.4094	74.69911	74.35918	74.27912	73.40886	73.73309	73.685	74.54961	77.09905	78.62309	73.40886	87.44403	79.87294

Date															21-May											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	78	81	85	87	89	90	90	89	88	87	85	83	82	80	79	77	76	74	73	72	72	72	74	76		90	
	81.07401	83.68768	85.10889	86.13633	86.74448	84.83153	85.93575	86.92011	86.52333	85.0111	82.24187	78.69517	77.07029	76.31617	75.37202	74.23901	73.44906	72.45557	72.38404	72.5507	72.57436	71.09758	72.41686	76.97626	71.09758	86.92011	79.15884

Date	21-May														22-May											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										90	
	79.60243	81.05373	80.9528	82.26842	83.72743	84.62891	84.74558	84.90329	84.13506	83.20719	81.24934	78.71478	77.79359	75.75658	74.8222	75.10751	74.22002	74.2424	73.14096	73.02253	72.26024	72.84602	74.3494	78.48302	72.26024	84.90329	78.55139

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average			Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual		6day	3day	24 hr high	7 day
5/15/2018 9am	81.6	80.0	82.3	81.8	93.0	91.2	90	82.8	79.8		1.6	0.4	1.8	3.0

Date	17-May									18-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	low	high	ave
Temperature (°F)	93	93	92	91	89	85	81	77	76	75	75	74	74	73	73	73	73	77	81	86	88	90	91	91		93	
	90.9	90.6	90.5	89.3	85.1	82.0	79.9	78.3	76.9	76.0	75.1	74.9	75.3	75.4	75.5	75.4	77.1	79.0	81.4	83.9	85.8	86.2	88.0	89.0	74.9	90.9	81.7

Date										19-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	92	92	91	89	87	83	80	77	76	75	75	74	74	73	72	72	73	77	81	85	89	91	91	91		92	
	87.4	77.9	72.9	69.2	69.5	69.9	70.0	71.3	70.6	69.5	69.0	68.6	69.7	69.5	70.1	70.5	74.1	78.6	80.8	82.6	84.2	85.4	86.8	87.4	68.6	87.4	75.2

Date	19-May									20-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	91	91	90	89	86	83	81	78	77	76	76	75	75	74	74	74	74	78	82	85	89	89	89	89		91	
	87.4	86.6	86.0	85.4	82.3	78.9	77.2	76.2	75.4	74.7	74.4	74.3	73.4	73.7	73.7	74.5	77.1	78.6	81.1	83.7	85.1	86.1	86.7	84.8	73.4	87.4	79.9

Date										21-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	89	89	89	86	84	81	79	77	75	74	74	74	74	74	73	73	74	77	82	85	88	89	89	89		89	
	85.9	86.9	86.5	85.0	82.2	78.7	77.1	76.3	75.4	74.2	73.4	72.5	72.4	72.6	72.6	71.1	72.4	77.0	79.6	81.1	81.0	82.3	83.7	84.6	71.1	86.9	78.5

Date	21-May									22-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	89	89	87	86	84	82	79	77	75	74	74	73	73	73	73	73	74	77	80	84	86	88	89	90		90	
	84.7	84.9	84.1	83.2	81.2	78.7	77.8	75.8	74.8	75.1	74.2	74.2	73.1	73.0	72.3	72.8	74.3	78.5	80.3	81.9	83.3	84.0	84.5	85.7	72.3	85.7	78.9

Date										23-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	90	89	88	86	83	81	78	76	74	73	73	73	73	73	73	73	73	76	81	85	87	89	90	90		90	
	84.5	86.4	85.3	83.9	81.4	79.5	77.3	76.0	76.1	75.1	75.0	74.0	73.2	73.3	73.1	73.2	75.1	78.8	81.1	82.8	83.9	84.2	85.4	86.4	73.1	86.4	79.4

Date	23-May									24-May																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)																										90	
	87.1	87.2	87.3	86.7	82.4	80.2	78.3	78.3	77.1	76.0	75.8	75.6	74.8	75.7	75.3	74.3	76.2	78.8	80.4	81.2	81.9	82.6	78.3	72.6	72.6	87.3	79.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
5/17/2018 3pm	81.2	78.9	81.9	78.9	93.0	90.9	90	82.4	79.0	2.2	2.9	2.1	3.5

Date	22-May																23-May										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	72	76	81	85	88	89	90	90	90	90	89	87	85	83	80	78	77	76	76	75	74	74	73	73		90	
	74.3494	78.48302	80.26244	81.88683	83.33204	84.04361	84.50103	85.73371	84.45721	86.36111	85.32337	83.91895	81.40659	79.47043	77.2987	75.99876	76.11936	75.05214	75.03416	74.02438	73.16962	73.27293	73.12575	73.1544	73.12575	86.36111	79.1575
Date																		24-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	78	82	85	87	89	90	90	91	91	89	87	85	83	81	80	78	77	76	76	75	75	74	74		91	
	75.11254	78.81221	81.06749	82.82854	83.86444	84.15479	85.35462	86.3933	87.14433	87.1599	87.25892	86.66619	82.3695	80.19647	78.30991	78.25946	77.07166	75.95611	75.7897	75.60326	74.80728	75.68622	75.29064	74.33221	74.33221	87.25892	80.3954
Date	24-May																	25-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	81	83	85	86	87	87	88	88	87	85	82	81	79	78	77	77	76	75	75	74	74	74		88	
	76.19471	78.8369	80.41736	81.18968	81.943	82.56528	78.25185	72.59634	71.76318	72.91801	74.18826	75.25261	75.521	74.40913	73.80566	75.28607	75.62849	74.44589	73.15569	72.29442	72.21255	72.58273	73.2625	72.76241	71.76318	82.56528	75.47849
Date																		26-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	76	78	80	82	84	85	86	86	85	84	83	82	80	79	78	76	75	74	73	73	72	72	72		86	
	73.4	75.8	78.2	79.6	80.7	76.1	74.4	76.3	79.0	79.0	80.5	80.6	79.0	76.8	75.3	74.8	74.0	73.3	72.8	71.9	72.0	71.6	71.1	70.6	70.6	80.7	75.7
Date	26-May																	27-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	73	75	77	79	81	83	85	86	86	86	85	84	83	82	81	79	78	76	75	74	73	72	72	72		86	
	74.6	77.8	80.2	81.9	82.6	82.9	80.1	75.4	73.2	75.6	77.2	76.8	76.6	74.3	74.0	74.2	75.3	74.0	73.5	71.6	71.4	73.1	73.8	74.2	71.4	82.9	76.0
Date																		28-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	73	75	78	80	83	85	87	88	88	88	87	86	84	83	81	79	77	75	74	73	72	72	72	73		88	
	75.8	77.5	78.9	80.1	81.1	81.9	83.2	84.4	85.0	85.6	85.4	84.8	84.1	82.1	80.5	78.8	76.6	74.9	74.2	74.4	74.2	73.5	74.5	74.1	73.5	85.6	79.4
Date	28-May																	29-May									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	74.2	77.1	79.8	81.4	83.1	84.5	86.1	87.3	88.2	88.6	88.8	87.5	85.3	83.2	82.1	81.2	78.5	76.1	75.5	74.5	73.9	74.1	74.0	75.4	73.9	88.8	80.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
5/22/2018 7am	80.2	77.7	81.3	78.3	90.0	86.4	88	81.3	78.1	2.5	2.9	3.6	3.2

Date	24-May																		25-May								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	73	75	78	81	85	87	89	90	90	90	89	87	86	84	81	79	77	77	76	76	75	74	74	73		90	
	74.3	76.2	78.8	80.4	81.2	81.9	82.6	78.3	72.6	71.8	72.9	74.2	75.3	75.5	74.4	73.8	75.3	75.6	74.4	73.2	72.3	72.2	72.6	73.3	71.8	82.6	75.5
Date																			26-May								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	73	75	79	83	86	88	88	88	87	87	86	85	84	82	80	79	77	76	75	74	74	73	73	72		88	
	72.8	73.4	75.8	78.2	79.6	80.7	76.1	74.4	76.3	79.0	79.0	80.5	80.6	79.0	76.8	75.3	74.8	74.0	73.3	72.8	71.9	72.0	71.6	71.1	71.1	80.7	75.8
Date	26-May																		27-May								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	72	73	76	79	83	85	85	86	86	86	86	85	84	83	81	79	77	76	76	76	75	75	74	73		86	
	70.6	74.6	77.8	80.2	81.9	82.6	82.9	80.1	75.4	73.2	75.6	77.2	76.8	76.6	74.3	74.0	74.2	75.3	74.0	73.5	71.6	71.4	73.1	73.8	70.6	82.9	75.9
Date																			28-May								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	73	74	77	80	83	85	86	87	87	87	87	86	84	83	81	79	77	77	76	76	75	74	73	72		87	
	74.2	75.8	77.5	78.9	80.1	81.1	81.9	83.2	84.4	85.0	85.6	85.4	84.8	84.1	82.1	80.5	78.8	76.6	74.9	74.2	74.4	74.2	73.5	74.5	73.5	85.6	79.4
Date	28-May																		29-May								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	72	73	76	79	83	85	87	88	89	89	89	88	87	85	84	82	80	78	77	76	76	76	75	74		89	
	74.1	74.2	77.1	79.8	81.4	83.1	84.5	86.1	87.3	88.2	88.6	88.8	87.5	85.3	83.2	82.1	81.2	78.5	76.1	75.5	74.5	73.9	74.1	74.0	73.9	88.8	80.8
Date																			30-May								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	78	82	85	88	89	90	91	91	91	90	88	86	83	81	79	77	77	76	76	76	75	74		91	
	75.4	77.3	79.7	82.9	85.8	86.6	87.7	89.2	90.2	90.8	90.1	90.7	89.6	86.5	84.0	82.2	80.9	80.3	78.4	77.9	77.4	76.5	76.0	75.7	75.4	90.8	83.0
Date	30-May																		31-May								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										90	
	76.1	79.4	82.4	84.2	85.6	86.9	88.3	89.5	90.5	90.7	90.2	89.1	87.6	85.1	82.2	79.5	77.5	76.9	76.7	76.1	75.7	74.8	74.5	74.4	74.4	90.7	82.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
5/24/2018 6am	80.7	78.4	80.3	75.7	90.0	82.6	90	82.0	79.0	2.3	4.6	7.4	3.1

Date	24-May													25-May													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	low	high	ave
Temperature (°F)	87	89	90	90	90	89	87	86	84	81	79	77	77	76	76	75	74	74	73	73	75	79	83	86		90	
	81.9	82.6	78.3	72.6	71.8	72.9	74.2	75.3	75.5	74.4	73.8	75.3	75.6	74.4	73.2	72.3	72.2	72.6	73.3	72.8	73.4	75.8	78.2	79.6	71.8	82.6	75.1

Date														26-May													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	88	88	88	87	87	86	85	84	82	80	79	77	76	75	74	74	73	73	72	72	73	76	79	83		88	
	80.7	76.1	74.4	76.3	79.0	79.0	80.5	80.6	79.0	76.8	75.3	74.8	74.0	73.3	72.8	71.9	72.0	71.6	71.1	70.6	74.6	77.8	80.2	81.9	70.6	81.9	76.0

Date	26-May													27-May													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	85	85	86	86	86	86	85	84	83	81	79	77	76	76	76	75	75	74	73	73	74	77	80	83		86	
	82.6	82.9	80.1	75.4	73.2	75.6	77.2	76.8	76.6	74.3	74.0	74.2	75.3	74.0	73.5	71.6	71.4	73.1	73.8	74.2	75.8	77.5	78.9	80.1	71.4	82.9	75.9

Date														28-May													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	85	86	87	87	87	87	86	84	83	81	79	77	77	76	76	75	74	73	72	72	73	76	79	83		87	
	81.1	81.9	83.2	84.4	85.0	85.6	85.4	84.8	84.1	82.1	80.5	78.8	76.6	74.9	74.2	74.4	74.2	73.5	74.5	74.1	74.2	77.1	79.8	81.4	73.5	85.6	79.4

Date	28-May													29-May													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	85	87	88	89	89	89	88	87	85	84	82	80	78	77	76	76	76	75	74	74	75	78	82	85		89	
	83.1	84.5	86.1	87.3	88.2	88.6	88.8	87.5	85.3	83.2	82.1	81.2	78.5	76.1	75.5	74.5	73.9	74.1	74.0	75.4	77.3	79.7	82.9	85.8	73.9	88.8	81.4

Date														30-May													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	88	89	90	91	91	91	90	88	86	83	81	79	77	77	76	76	76	75	74	74	75	79	83	88		91	
	86.6	87.7	89.2	90.2	90.8	90.1	90.7	89.6	86.5	84.0	82.2	80.9	80.3	78.4	77.9	77.4	76.5	76.0	75.7	76.1	79.4	82.4	84.2	85.6	75.7	90.8	83.3

Date	30-May													31-May													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)																										90	
	86.9	88.3	89.5	90.5	90.7	90.2	89.1	87.6	85.1	82.2	79.5	77.5	76.9	76.7	76.1	75.7	74.8	74.5	74.4	75.2	78.9	82.4	84.0	86.0	74.4	90.7	82.2

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
5/24/2018 11am	80.7	78.5	80.2	75.7	90.0	82.6	90	82.1	79.0	2.2	4.6	7.4	3.0

Date	29-May																	30-May									
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	75	76	79	83	86	89	90	91	92	92	91	90	88	86	84	82	81	80	79	79	79	78	78	77		92	
	75.4	77.3	79.7	82.9	85.8	86.6	87.7	89.2	90.2	90.8	90.1	90.7	89.6	86.5	84.0	82.2	80.9	80.3	78.4	77.9	77.4	76.5	76.0	75.7	75.4	90.8	83.0

Date																		31-May									
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	78	80	83	86	88	90	91	91	91	91	90	88	86	83	81	79	78	77	76	76	75	74	74		91	
	76.1	79.4	82.4	84.2	85.6	86.9	88.3	89.5	90.5	90.7	90.2	89.1	87.6	85.1	82.2	79.5	77.5	76.9	76.7	76.1	75.7	74.8	74.5	74.4	74.4	90.7	82.3

Date	31-May																	1-Jun									
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	77	79	83	86	89	91	92	93	93	93	92	91	89	86	83	81	80	79	79	78	77	76	76		93	
	75.2	78.9	82.4	84.0	86.0	86.7	87.9	88.8	90.1	90.5	90.1	89.4	87.5	84.7	81.5	79.5	78.1	77.0	76.6	76.1	75.8	75.3	75.6	75.5	75.2	90.5	82.2

Date																		2-Jun									
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	79	82	84	87	90	92	93	93	93	92	91	89	88	86	84	82	81	79	78	77	76	76		93	
	75.9	79.5	83.0	85.3	86.9	87.8	88.0	88.5	89.5	90.3	89.8	89.1	87.5	85.2	82.6	80.8	79.7	78.6	77.7	77.3	76.5	75.7	75.8	75.7	75.7	90.3	82.8

Date	2-Jun																	3-Jun									
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	78	80	82	85	88	91	93	94	94	94	93	92	90	88	87	85	83	81	79	78	77	76	76		94	
	76.11	79.44	82.78	84.73	86.70	87.13	89.51	91.11	91.11	90.66	90.41	89.17	87.48	85.32	83.17	81.83	81.07	80.25	79.05	78.35	77.29	76.85	76.27	75.78	75.78	91.11	83.40

Date																		4-Jun									
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	78	80	83	86	89	91	93	94	94	93	92	91	89	88	86	84	83	82	80	79	78	77	77		94	
	75.9	77.6	79.5	82.9	85.7	87.5	88.3	89.8	89.8	90.6	90.7	90.2	88.8	86.8	84.8	83.1	81.8	81.0	80.3	79.5	79.3	78.0	77.8	78.9	75.9	90.7	83.7

Date	4-Jun																	5-Jun									
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										92	
	79.1	79.7	80.9	81.8	82.6	84.3	85.6	86.7	87.7	83.5	80.6	78.7	76.6	76.5	75.7	75.3	75.3	74.9	74.5	74.4	75.6	76.5	77.2	76.7	74.4	87.7	79.2

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
5/29/2018 6am	84.1	82.9	83.4	82.5	92.0	90.8	92	85.3	82.4	1.3	0.9	1.2	2.9

Date	30-May												31-May														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	low	high	ave
Temperature (°F)	90	91	91	91	91	90	89	87	85	82	80	78	78	77	77	77	76	76	76	77	80	83	86	89		91	
	88.3	89.5	90.5	90.7	90.2	89.1	87.6	85.1	82.2	79.5	77.5	76.9	76.7	76.1	75.7	74.8	74.5	74.4	75.2	78.9	82.4	84.0	86.0	86.7	74.4	90.7	82.2

Date													1-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	91	92	93	93	93	92	91	88	85	82	79	77	77	77	76	76	75	75	75	77	80	84	87	90		93	
	87.9	88.8	90.1	90.5	90.1	89.4	87.5	84.7	81.5	79.5	78.1	77.0	76.6	76.1	75.8	75.3	75.6	75.5	75.9	79.5	83.0	85.3	86.9	87.8	75.3	90.5	82.4

Date	1-Jun												2-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	92	93	93	93	93	92	91	90	88	86	84	82	80	79	78	77	76	76	76	77	79	82	85	88		93	
	88.0	88.5	89.5	90.3	89.8	89.1	87.5	85.2	82.6	80.8	79.7	78.6	77.7	77.3	76.5	75.7	75.8	75.7	76.1	79.4	82.8	84.7	86.7	87.1	75.7	90.3	82.7

Date													3-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	91	93	94	94	93	92	91	89	87	86	85	83	82	81	80	79	78	78	79	80	82	85	87	90		94	
	89.5	91.1	91.1	90.7	90.4	89.2	87.5	85.3	83.2	81.8	81.1	80.2	79.1	78.3	77.3	76.8	76.3	75.8	75.9	77.6	79.5	82.9	85.7	87.5	75.8	91.1	83.1

Date	3-Jun												4-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	93	94	95	95	94	92	90	89	87	85	84	82	81	80	78	77	76	76	76	77	79	82	85	88		95	
	88.3	89.8	89.8	90.6	90.7	90.2	88.8	86.8	84.8	83.1	81.8	81.0	80.3	79.5	79.3	78.0	77.8	78.9	79.1	79.7	80.9	81.8	82.6	84.3	77.8	90.7	83.7

Date													5-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	90	92	94	94	94	93	91	90	88	86	84	82	80	78	77	76	75	75	76	77	79	82	86	89		94	
	85.6	86.7	87.7	83.5	80.6	78.7	76.6	76.5	75.7	75.3	75.3	74.9	74.5	74.4	75.6	76.5	77.2	76.7	76.8	78.3	80.1	82.6	84.5	86.4	74.4	87.7	79.2

Date	5-Jun												6-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)																										92	
	87.8	85.5	73.8	72.5	71.5	71.0	71.8	71.9	71.8	71.1	70.0	69.3	69.3	70.5	69.7	68.5	67.8	68.2	68.5	69.6	71.8	73.9	76.1	77.7	67.8	87.8	72.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
5/30/2018 12pm	84.4	82.2	83.8	82.4	91.0	90.7	92	85.5	80.8	2.2	1.3	0.3	4.7

Date	30-May								31-May																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	low	high	ave
Temperature (°F)	91	90	89	89	86	83	81	79	79	78	78	78	77	77	77	78	81	84	87	89	90	91	92	93		93	
	90.2	89.1	87.6	85.1	82.2	79.5	77.5	76.9	76.7	76.1	75.7	74.8	74.5	74.4	75.2	78.9	82.4	84.0	86.0	86.7	87.9	88.8	90.1	90.5	74.4	90.5	82.1

Date									1-Jun																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	93	92	90	88	85	83	82	80	79	78	78	78	77	77	77	78	81	85	88	90	91	92	93	93		93	
	90.1	89.4	87.5	84.7	81.5	79.5	78.1	77.0	76.6	76.1	75.8	75.3	75.6	75.5	75.9	79.5	83.0	85.3	86.9	87.8	88.0	88.5	89.5	90.3	75.3	90.3	82.4

Date	1-Jun								2-Jun																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	93	92	90	88	86	84	82	80	79	77	77	76	76	76	76	77	79	82	85	88	90	92	93	93		93	
	89.8	89.1	87.5	85.2	82.6	80.8	79.7	78.6	77.7	77.3	76.5	75.7	75.8	75.7	76.1	79.4	82.8	84.7	86.7	87.1	89.5	91.1	91.1	90.7	75.7	91.1	83.0

Date									3-Jun																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	93	92	90	88	87	85	84	82	81	80	79	78	78	78	79	80	82	85	88	90	93	94	95	95		95	
	90.4	89.2	87.5	85.3	83.2	81.8	81.1	80.2	79.1	78.3	77.3	76.8	76.3	75.8	75.9	77.6	79.5	82.9	85.7	87.5	88.3	89.8	89.8	90.6	75.8	90.6	82.9

Date	3-Jun								4-Jun																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	94	93	91	89	88	86	84	83	81	80	78	77	76	75	75	76	78	81	84	87	90	92	93	93		94	
	90.7	90.2	88.8	86.8	84.8	83.1	81.8	81.0	80.3	79.5	79.3	78.0	77.8	78.9	79.1	79.7	80.9	81.8	82.6	84.3	85.6	86.7	87.7	83.5	77.8	90.7	83.0

Date									5-Jun																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	93	92	90	89	87	85	84	82	80	79	77	76	75	75	75	77	79	82	85	88	90	92	93	93		93	
	80.6	78.7	76.6	76.5	75.7	75.3	75.3	74.9	74.5	74.4	75.6	76.5	77.2	76.7	76.8	78.3	80.1	82.6	84.5	86.4	87.8	85.5	73.8	72.5	72.5	87.8	78.2

Date	5-Jun								6-Jun																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)																										92	
	72.5	71.5	71.0	71.8	71.9	71.8	71.1	70.0	69.3	69.3	70.5	69.7	68.5	67.8	68.2	68.5	69.6	71.8	73.9	76.1	77.7	79.2	80.3	81.6	67.8	81.6	72.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
5/30/2018 4pm	84.4	81.9	84.1	82.5	93.0	90.5	92	85.5	80.6	2.5	1.6	2.5	4.9

Date	31-May									1-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	low	high	ave
Temperature (°F)	93	93	92	91	89	87	84	82	80	80	79	79	79	78	77	77	78	80	84	87	89	91	92	93		93	
	90.5	90.1	89.4	87.5	84.7	81.5	79.5	78.1	77.0	76.6	76.1	75.8	75.3	75.6	75.5	75.9	79.5	83.0	85.3	86.9	87.8	88.0	88.5	89.5	75.3	90.5	82.4

Date										2-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	93	93	93	91	89	86	83	81	79	78	78	78	78	77	76	76	77	79	83	87	89	91	93	93		93	
	90.3	89.8	89.1	87.5	85.2	82.6	80.8	79.7	78.6	77.7	77.3	76.5	75.7	75.8	75.7	76.1	79.4	82.8	84.7	86.7	87.1	89.5	91.1	91.1	75.7	91.1	83.0

Date	2-Jun									3-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	93	93	92	92	90	87	84	82	81	80	80	80	79	78	77	77	78	81	84	88	91	92	94	94		94	
	90.7	90.4	89.2	87.5	85.3	83.2	81.8	81.1	80.2	79.1	78.3	77.3	76.8	76.3	75.8	75.9	77.6	79.5	82.9	85.7	87.5	88.3	89.8	89.8	75.8	90.7	82.9

Date										4-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	95	95	95	94	92	89	87	84	83	82	81	80	79	78	76	75	75	78	82	85	88	90	91	92		95	
	90.6	90.7	90.2	88.8	86.8	84.8	83.1	81.8	81.0	80.3	79.5	79.3	78.0	77.8	78.9	79.1	79.7	80.9	81.8	82.6	84.3	85.6	86.7	87.7	77.8	90.7	83.3

Date	4-Jun									5-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	93	93	92	91	89	86	84	81	80	79	79	78	78	77	76	76	77	80	84	88	90	92	93	93		93	
	83.5	80.6	78.7	76.6	76.5	75.7	75.3	75.3	74.9	74.5	74.4	75.6	76.5	77.2	76.7	76.8	78.3	80.1	82.6	84.5	86.4	87.8	85.5	73.8	73.8	87.8	78.7

Date										6-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	93	93	92	91	89	86	82	80	78	77	77	77	77	76	75	75	76	79	83	86	89	91	92	92		93	
	72.5	71.5	71.0	71.8	71.9	71.8	71.1	70.0	69.3	69.3	70.5	69.7	68.5	67.8	68.2	68.5	69.6	71.8	73.9	76.1	77.7	79.2	80.3	81.6	67.8	81.6	72.2

Date	6-Jun									7-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)																										92	
	82.9	84.0	84.4	84.1	83.2	80.9	77.7	75.3	74.8	73.1	73.2	72.5	72.0	71.1	71.1	71.6	74.9	78.8	80.9	82.7	84.4	85.2	86.1	86.5	71.1	86.5	78.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
5/31/2018 3pm	84.6	80.4	84.8	82.8	93.0	90.5	92	85.7	80.2	4.2	2.0	2.5	5.5

Date	4-Jun																	5-Jun								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	76	77	79	81	84	86	88	90	91	91	91	90	88	87	84	82	80	79	78	77	77	76	76	75		91	
	79.1	79.7	80.9	81.8	82.6	84.3	85.6	86.7	87.7	83.5	80.6	78.7	76.6	76.5	75.7	75.3	75.3	74.9	74.5	74.4	75.6	76.5	77.2	76.7	74.4	87.7	79.2
Date																			6-Jun								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	79	82	86	88	90	90	89	87	86	85	84	84	82	80	78	77	76	76	76	75	75	74		90	
	76.8	78.3	80.1	82.6	84.5	86.4	87.8	85.5	73.8	72.5	71.5	71.0	71.8	71.9	71.8	71.1	70.0	69.3	69.3	70.5	69.7	68.5	67.8	68.2	67.8	87.8	74.6
Date	6-Jun																		7-Jun								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	77	81	84	85	86	87	88	89	89	89	87	86	83	81	79	78	77	76	76	75	74	74		89	
	68.5	69.6	71.8	73.9	76.1	77.7	79.2	80.3	81.6	82.9	84.0	84.4	84.1	83.2	80.9	77.7	75.3	74.8	73.1	73.2	72.5	72.0	71.1	71.1	68.5	84.4	76.6
Date																			8-Jun								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	77	80	82	85	87	89	90	90	90	89	88	86	85	83	82	80	79	77	76	75	74	74		90	
	71.6	74.9	78.8	80.9	82.7	84.4	85.2	86.1	86.5	87.9	88.4	88.5	88.0	87.2	86.5	85.8	85.1	84.4	83.6	82.9	82.2	81.5	80.8	80.1	71.6	88.5	83.5
Date	8-Jun																		9-Jun								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	78	81	83	86	89	90	91	91	90	88	87	85	83	82	80	79	78	77	76	75	74	74		91	
	79.3	78.6	80.6	82.3	84.5	85.3	86.1	86.3	84.8	84.6	85.8	84.7	84.6	82.3	79.6	77.5	76.4	75.5	74.7	73.6	73.0	72.4	73.1	71.9	71.9	86.3	79.9
Date																			10-Jun								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	76	78	80	83	85	88	89	90	90	89	88	86	84	83	81	80	78	77	76	75	74	74	74		90	
	72.6	74.4	79.8	82.6	84.4	85.8	86.7	87.5	89.4	89.7	90.3	90.0	86.3	83.2	80.6	78.2	77.5	76.6	76.0	74.9	74.4	74.7	75.5	74.1	72.6	90.3	81.0
Date	10-Jun																		11-Jun								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										90	
	74.0	78.1	81.9	84.3	86.3	82.5	74.4	75.8	80.5	80.4	80.5	81.7	80.8	79.0	76.7	74.5	74.3	73.6	73.1	72.7	72.4	71.9	73.2	73.8	71.9	86.3	77.4

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/4/2018 6am	81.7	79.1	81.7	76.8	91.0	87.7	90	82.9	78.9	2.6	4.9	3.3	4.0

Date	6-Jun												7-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	low	high	ave
Temperature (°F)	83	84	86	88	89	89	88	86	83	80	77	76	75	74	73	72	72	71	71	73	76	81	85	88		89	
	79.2	80.3	81.6	82.9	84.0	84.4	84.1	83.2	80.9	77.7	75.3	74.8	73.1	73.2	72.5	72.0	71.1	71.1	71.6	74.9	78.8	80.9	82.7	84.4	71.1	84.4	78.1

Date													8-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	90	91	92	93	93	92	90	87	85	82	79	77	76	75	74	73	73	72	72	74	77	82	86	88		93	
	85.2	86.1	86.5	87.9	88.4	88.5	88.0	87.2	86.5	85.8	85.1	84.4	83.6	82.9	82.2	81.5	80.8	80.1	79.3	78.6	80.6	82.3	84.5	85.3	78.6	88.5	84.2

Date	8-Jun												9-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	90	91	92	93	93	92	90	87	84	82	79	78	77	76	75	74	73	73	73	75	77	80	83	86		93	
	86.1	86.3	84.8	84.6	85.8	84.7	84.6	82.3	79.6	77.5	76.4	75.5	74.7	73.6	73.0	72.4	73.1	71.9	72.6	74.4	79.8	82.6	84.4	85.8	71.9	86.3	79.4

Date													10-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	89	91	92	92	91	90	88	86	85	83	81	80	78	77	76	75	74	74	75	76	78	81	84	86		92	
	86.7	87.5	89.4	89.7	90.3	90.0	86.3	83.2	80.6	78.2	77.5	76.6	76.0	74.9	74.4	74.7	75.5	74.1	74.0	78.1	81.9	84.3	86.3	82.5	74.0	90.3	81.4

Date	10-Jun												11-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	89	91	92	92	91	90	89	87	86	84	82	81	79	78	77	76	75	75	76	77	79	82	85	88		92	
	74.4	75.8	80.5	80.4	80.5	81.7	80.8	79.0	76.7	74.5	74.3	73.6	73.1	72.7	72.4	71.9	73.2	73.8	73.8	75.3	78.6	81.0	83.5	85.0	71.9	85.0	77.0

Date													12-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	90	92	93	93	92	91	90	88	86	85	83	81	80	78	77	76	76	76	77	78	80	82	85	87		93	
	82.5	79.4	77.2	78.4	77.1	78.5	79.1	78.7	78.2	78.4	76.5	75.9	75.9	75.9	75.3	74.8	75.1	75.0	75.7	79.0	82.6	84.1	85.3	87.1	74.8	87.1	78.6

Date	12-Jun												13-Jun														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)																										92	
	87.7	88.7	85.2	80.0	77.0	78.3	77.3	73.7	69.7	69.7	69.7	69.9	71.3	70.9	70.7	70.8	70.9	72.0	73.5	74.3	76.7	78.9	82.4	84.9	69.7	88.7	76.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/6/2018 12pm	82.4	79.8	81.5	80.6	89.0	84.4	92	83.8	79.2	2.6	0.9	4.6	4.5

Date	11-Jun																12-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	79	82	85	87	87	88	87	86	85	85	83	83	81	80	79	78	78	78	78	77	77	77	77		88	
	75.3	78.6	81.0	83.5	85.0	82.5	79.4	77.2	78.4	77.1	78.5	79.1	78.7	78.2	78.4	76.5	75.9	75.9	75.9	75.3	74.8	75.1	75.0	75.7	74.8	85.0	78.0

Date																	13-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	82	85	87	90	90	90	89	88	87	85	84	82	81	79	79	78	78	78	78	77	76	75		90	
	79.0	82.6	84.1	85.3	87.1	87.7	88.7	85.2	80.0	77.0	78.3	77.3	73.7	69.7	69.7	69.7	69.9	71.3	70.9	70.7	70.8	70.9	72.0	73.5	69.7	88.7	76.9

Date	13-Jun																14-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	82	86	89	90	91	91	91	90	89	88	86	84	82	80	79	78	78	77	76	75	75	75		91	
	74.3	76.7	78.9	82.4	84.9	86.0	85.7	81.2	79.5	78.6	78.9	80.5	79.6	76.9	75.5	74.6	74.3	73.5	73.6	73.8	73.3	73.3	73.1	73.8	73.1	86.0	77.6

Date																	15-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	84	86	89	90	91	91	90	89	87	86	84	82	80	79	78	76	76	75	75	75	76		91	
	75.1	80.3	82.9	84.5	83.7	85.6	84.4	83.7	83.8	84.8	85.5	83.9	80.9	78.3	77.5	76.5	76.2	76.4	76.1	75.6	75.6	75.0	75.2	75.7	75.0	85.6	79.9

Date	15-Jun																16-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	82	85	87	89	90	91	91	90	89	88	86	85	83	82	81	80	78	77	77	76	76	76		91	
	77.9	80.2	82.8	84.6	85.5	82.8	80.4	76.8	78.1	80.2	81.5	81.6	80.3	79.0	77.6	77.0	76.7	75.9	75.3	75.5	76.0	75.2	74.5	74.9	74.5	85.5	78.8

Date																	17-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	81	83	86	88	89	90	90	90	89	87	86	84	83	81	80	78	77	76	76	76	76	77		90	
	76.6	79.2	81.4	82.6	82.9	82.6	81.1	86.1	81.7	81.8	82.1	84.2	83.2	80.9	79.4	79.3	78.6	77.4	77.1	77.6	76.7	77.2	78.2	77.4	76.6	86.1	80.2

Date	17-Jun																18-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										90	
	74.0	76.8	80.1	83.1	85.1	85.9	85.3	84.7	86.3	85.4	83.7	77.8	78.8	79.1	79.9	80.6	81.0	81.0	80.7	80.7	80.7	80.8	81.0	80.9	74.0	86.3	81.4

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/11/2018 7am	82.4	78.6	82.2	77.5	88.0	85.0	90	83.5	79.0	3.8	4.7	3.0	4.5

Date	12-Jun																	13-Jun								
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	83	84	85	86	88	89	90	91	91	90	88	87	85	84	83	81	80	78	77	76	75	75	75	76		91	
	79.0	82.6	84.1	85.3	87.1	87.7	88.7	85.2	80.0	77.0	78.3	77.3	73.7	69.7	69.7	69.7	69.9	71.3	70.9	70.7	70.8	70.9	72.0	73.5	69.7	88.7	76.9

Date																		14-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	82	86	88	91	91	90	90	89	88	87	85	83	81	80	78	78	77	77	77	76	75	75		91	
	74.3	76.7	78.9	82.4	84.9	86.0	85.7	81.2	79.5	78.6	78.9	80.5	79.6	76.9	75.5	74.6	74.3	73.5	73.6	73.8	73.3	73.3	73.1	73.8	73.1	86.0	77.6

Date	14-Jun																	15-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	84	87	89	90	91	91	91	91	90	88	86	84	82	80	79	78	78	77	77	77	76	76		91	
	75.1	80.3	82.9	84.5	83.7	85.6	84.4	83.7	83.8	84.8	85.5	83.9	80.9	78.3	77.5	76.5	76.2	76.4	76.1	75.6	75.6	75.0	75.2	75.7	75.0	85.6	79.9

Date																		16-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	80	83	86	88	90	91	91	91	90	88	87	85	84	82	81	79	78	77	77	76	76	76		91	
	77.9	80.2	82.8	84.6	85.5	82.8	80.4	76.8	78.1	80.2	81.5	81.6	80.3	79.0	77.6	77.0	76.7	75.9	75.3	75.5	76.0	75.2	74.5	74.9	74.5	85.5	78.8

Date	16-Jun																	17-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	81	83	85	87	88	89	89	88	87	86	84	83	81	80	79	78	77	76	75	75	75	76		89	
	76.6	79.2	81.4	82.6	82.9	82.6	81.1	86.1	81.7	81.8	82.1	84.2	83.2	80.9	79.4	79.3	78.6	77.4	77.1	77.6	76.7	77.2	78.2	77.4	76.6	86.1	80.2

Date																		18-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	80	81	83	84	85	86	86	86	85	84	83	82	81	80	79	78	78	77	76	76	76	77		86	
	74.0	76.8	80.1	83.1	85.1	85.9	85.3	84.7	86.3	85.4	83.7	77.8	78.8	79.1	79.9	80.6	81.0	81.0	80.7	80.7	80.7	80.8	81.0	80.9	74.0	86.3	81.4

Date	18-Jun																	19-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	80.8	75.7	73.1	75.3	76.8	72.3	72.6	73.8	73.3	74.4	75.3	77.1	78.1	78.3	78.8	79.9	80.1	79.9	79.7	79.7	79.9	79.8	80.0	80.3	72.3	80.8	77.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/12/2018 7am	82.4	79.1	83.0	78.1	91.0	88.7	88	83.2	78.9	3.2	4.8	2.3	4.3

Date	14-Jun														15-Jun												
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	83	86	88	89	89	89	89	88	88	87	85	83	80	78	76	76	76	76	76	76	75	75	76	78		89	
	82.9	84.5	83.7	85.6	84.4	83.7	83.8	84.8	85.5	83.9	80.9	78.3	77.5	76.5	76.2	76.4	76.1	75.6	75.6	75.0	75.2	75.7	77.9	80.2	75.0	85.6	80.0
Date																16-Jun											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	82	85	87	89	89	89	89	88	87	86	84	83	81	79	78	77	77	77	77	77	76	76	77	80		89	
	82.8	84.6	85.5	82.8	80.4	76.8	78.1	80.2	81.5	81.6	80.3	79.0	77.6	77.0	76.7	75.9	75.3	75.5	76.0	75.2	74.5	74.9	76.6	79.2	74.5	85.5	78.7
Date	16-Jun															17-Jun											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	83	86	88	88	88	88	87	86	86	85	84	82	81	79	78	78	78	78	77	77	77	77	77	79		88	
	81.4	82.6	82.9	82.6	81.1	86.1	81.7	81.8	82.1	84.2	83.2	80.9	79.4	79.3	78.6	77.4	77.1	77.6	76.7	77.2	78.2	77.4	74.0	76.8	74.0	86.1	80.0
Date																18-Jun											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	82	85	86	86	86	86	86	86	86	86	85	84	82	80	80	79	79	79	79	78	77	77	78	80		86	
	80.1	83.1	85.1	85.9	85.3	84.7	86.3	85.4	83.7	77.8	78.8	79.1	79.9	80.6	81.0	81.0	80.7	80.7	80.7	80.8	81.0	80.9	80.8	75.7	75.7	86.3	81.6
Date	18-Jun															19-Jun											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	84	87	88	89	90	90	90	90	89	88	86	84	82	80	79	79	79	78	77	77	76	76	78	80		90	
	73.1	75.3	76.8	72.3	72.6	73.8	73.3	74.4	75.3	77.1	78.1	78.3	78.8	79.9	80.1	79.9	79.7	79.7	79.9	79.8	80.0	80.3	80.9	81.9	72.3	81.9	77.6
Date																20-Jun											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	84	87	88	89	89	89	89	89	88	87	85	83	81	79	78	78	77	77	76	76	76	76	76	79		89	
	83.1	85.1	85.9	86.6	86.9	83.1	77.9	79.6	81.1	82.0	81.4	80.3	79.1	78.2	77.7	77.1	77.2	76.9	76.3	77.3	78.5	78.8	78.7	81.4	76.3	86.9	80.4
Date	20-Jun															21-Jun											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										88	
	83.5	85.4	86.6	87.3	87.7	87.7	86.7	85.8	85.0	84.3	83.0	80.9	79.3	78.3	77.5	76.8	76.4	76.5	75.9	75.4	75.5	75.3	76.8	79.9	75.3	87.7	81.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/14/2018 9am	82.2	79.7	81.9	79.6	89.0	85.6	88	83.1	79.9	2.5	2.4	3.4	3.1

Date	18-Jun																19-Jun								low	high	ave
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	87	87	87	87	87	86	85	85	85	84	82	80	79	78	78	78	77	77	77	77	77		87	
	80.8	75.7	73.1	75.3	76.8	72.3	72.6	73.8	73.3	74.4	75.3	77.1	78.1	78.3	78.8	79.9	80.1	79.9	79.7	79.7	79.9	79.8	80.0	80.3	72.3	80.8	77.3

Date																	20-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	85	86	87	88	88	88	88	87	86	85	84	82	81	80	79	78	78	78	77	77	77		88	
	80.9	81.9	83.1	85.1	85.9	86.6	86.9	83.1	77.9	79.6	81.1	82.0	81.4	80.3	79.1	78.2	77.7	77.1	77.2	76.9	76.3	77.3	78.5	78.8	76.3	86.9	80.5

Date	20-Jun																21-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	87	88	89	89	89	89	89	88	88	87	85	84	82	81	79	78	77	77	77	77	77		89	
	78.7	81.4	83.5	85.4	86.6	87.3	87.7	87.7	86.7	85.8	85.0	84.3	83.0	80.9	79.3	78.3	77.5	76.8	76.4	76.5	75.9	75.4	75.5	75.3	75.3	87.7	81.3

Date																	22-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	82	84	86	88	89	90	90	89	89	87	86	85	84	82	81	80	79	78	77	76	76	76		90	
	76.8	79.9	82.6	84.5	85.6	86.8	87.9	88.2	86.7	86.0	85.5	84.5	83.4	81.3	79.9	78.8	78.5	77.7	76.5	75.9	75.6	76.4	77.1	76.9	75.6	88.2	81.4

Date	22-Jun																23-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	81	83	85	86	87	88	88	87	86	85	84	83	81	80	79	78	78	77	76	76	76	77		88	
	79.3	81.7	83.3	85.4	86.8	87.6	88.5	89.1	89.1	89.0	88.4	87.1	84.5	81.5	79.0	77.2	76.4	76.4	75.4	75.6	75.4	75.3	75.0	75.6	75.0	89.1	81.8

Date																	24-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	79	81	83	85	87	88	89	89	88	88	86	85	84	83	82	81	80	79	78	78	77	77	77		89	
	79.0	82.5	84.2	86.5	88.0	88.5	89.2	89.9	90.3	90.8	89.6	86.8	85.8	82.5	79.9	78.4	77.5	76.8	77.1	77.4	77.0	76.7	76.5	76.7	76.5	90.8	82.8

Date	24-Jun																25-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	79.9	83.3	85.4	87.3	87.5	89.6	90.1	87.9	88.5	89.2	89.0	88.0	86.0	82.5	80.3	78.9	77.7	77.0	76.1	76.1	75.7	75.5	75.5	75.9	75.5	90.1	82.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/18/2018 7am	82.4	80.8	82.5	79.7	87.0	80.8	88	83.2	81.09963	1.6	2.8	6.2	2.1

Date	19-Jun									20-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	low	high	ave
Temperature (°F)	87	87	86	85	83	82	81	80	79	79	78	78	78	77	77	77	79	81	85	87	89	90	90	90		90	
	77.9	79.6	81.1	82.0	81.4	80.3	79.1	78.2	77.7	77.1	77.2	76.9	76.3	77.3	78.5	78.8	78.7	81.4	83.5	85.4	86.6	87.3	87.7	87.7	76.3	87.7	80.7

Date										21-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	89	89	88	87	86	84	82	80	79	78	78	77	77	76	76	76	78	81	84	87	89	90	90	90		90.0	
	86.7	85.8	85.0	84.3	83.0	80.9	79.3	78.3	77.5	76.8	76.4	76.5	75.9	75.4	75.5	75.3	76.8	79.9	82.6	84.5	85.6	86.8	87.9	88.2	75.3	88.2	81.0

Date	21-Jun									22-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	89	89	88	87	86	84	82	80	78	78	77	77	77	77	76	76	77	79	83	86	88	89	90	90		90.0	
	86.7	86.0	85.5	84.5	83.4	81.3	79.9	78.8	78.5	77.7	76.5	75.9	75.6	76.4	77.1	76.9	79.3	81.7	83.3	85.4	86.8	87.6	88.5	89.1	75.6	89.1	81.8

Date										23-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	90	90	89	88	86	84	81	79	79	78	78	78	78	77	76	76	77	80	83	87	89	90	91	91		91.0	
	89.1	89.0	88.4	87.1	84.5	81.5	79.0	77.2	76.4	76.4	75.4	75.6	75.4	75.3	75.0	75.6	79.0	82.5	84.2	86.5	88.0	88.5	89.2	89.9	75.0	89.9	82.0

Date	23-Jun									24-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	91	91	90	90	88	86	83	81	80	79	79	78	78	77	77	77	78	81	84	86	89	90	91	91		91.0	
	90.3	90.8	89.6	86.8	85.8	82.5	79.9	78.4	77.5	76.8	77.1	77.4	77.0	76.7	76.5	76.7	79.9	83.3	85.4	87.3	87.5	89.6	90.1	87.9	76.5	90.8	82.9

Date										25-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	90	90	89	89	88	86	83	81	80	79	79	79	78	78	77	77	78	80	84	87	88	89	90	91		91.0	
	88.5	89.2	89.0	88.0	86.0	82.5	80.3	78.9	77.7	77.0	76.1	76.1	75.7	75.5	75.5	75.9	79.2	82.6	84.6	86.4	88.2	89.5	90.5	91.0	75.5	91.0	82.7

Date	25-Jun									26-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)																										88	
	90.1	90.6	90.3	89.1	87.7	84.0	81.4	79.8	79.0	78.0	77.5	77.4	76.5	76.8	76.3	76.8	79.4	82.8	83.8	85.0	86.3	86.9	87.2	87.8	76.3	90.6	82.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/19/2018 3pm	83.2	81.9	82.8	81.2	90.0	87.7	88	83.9	82.0	1.3	1.6	2.3	1.9

Date	20-Jun																21-Jun								low	high	ave
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	87	88	90	90	90	89	89	88	88	86	84	82	80	79	78	78	77	77	77	76	76		90	
	78.7	81.4	83.5	85.4	86.6	87.3	87.7	87.7	86.7	85.8	85.0	84.3	83.0	80.9	79.3	78.3	77.5	76.8	76.4	76.5	75.9	75.4	75.5	75.3	75.3	87.7	81.3

Date																	22-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	83	86	88	89	89	89	88	87	87	86	85	83	80	78	77	76	76	77	77	76	75	75		89	
	76.8	79.9	82.6	84.5	85.6	86.8	87.9	88.2	86.7	86.0	85.5	84.5	83.4	81.3	79.9	78.8	78.5	77.7	76.5	75.9	75.6	76.4	77.1	76.9	75.6	88.2	81.4

Date	22-Jun																23-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	82	85	88	89	90	90	91	91	91	90	89	86	83	80	79	79	79	78	77	76	76	76		91	
	79.3	81.7	83.3	85.4	86.8	87.6	88.5	89.1	89.1	89.0	88.4	87.1	84.5	81.5	79.0	77.2	76.4	76.4	75.4	75.6	75.4	75.3	75.0	75.6	75.0	89.1	81.8

Date																	24-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	83	86	89	90	91	91	90	90	89	89	87	85	82	80	79	78	78	78	78	77	77	77		91	
	79.0	82.5	84.2	86.5	88.0	88.5	89.2	89.9	90.3	90.8	89.6	86.8	85.8	82.5	79.9	78.4	77.5	76.8	77.1	77.4	77.0	76.7	76.5	76.7	76.5	90.8	82.8

Date	24-Jun																25-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	83	86	88	90	91	91	90	90	89	89	88	85	83	81	79	79	78	78	78	77	76	76		91	
	79.9	83.3	85.4	87.3	87.5	89.6	90.1	87.9	88.5	89.2	89.0	88.0	86.0	82.5	80.3	78.9	77.7	77.0	76.1	76.1	75.7	75.5	75.5	75.9	75.5	90.1	82.6

Date																	26-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	89	90	91	91	91	91	90	89	88	85	83	81	80	79	79	79	78	78	77	77		91	
	79.2	82.6	84.6	86.4	88.2	89.5	90.5	91.0	90.1	90.6	90.3	89.1	87.7	84.0	81.4	79.8	79.0	78.0	77.5	77.4	76.5	76.8	76.3	76.8	76.3	91.0	83.5

Date	26-Jun																27-Jun										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	79.4	82.8	83.8	85.0	86.3	86.9	87.2	87.8	79.6	78.9	84.8	85.5	83.8	81.4	79.6	79.0	78.5	78.4	78.1	77.2	76.9	76.6	76.3	77.0	76.3	87.8	81.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/20/2018 7am	83.2	82.2	82.7	81.5	90.0	87.7	88	83.8	82.1	0.9	1.2	2.3	1.8

Date	21-Jun									22-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	low	high	ave
Temperature (°F)	91	88	88	88	86	85	83	81	79	78	77	77	76	76	76	77	78	81	84	87	89	90	91	92		92	
	86.7	86.0	85.5	84.5	83.4	81.3	79.9	78.8	78.5	77.7	76.5	75.9	75.6	76.4	77.1	76.9	79.3	81.7	83.3	85.4	86.8	87.6	88.5	89.1	75.6	89.1	81.8

Date										23-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	92	92	91	90	88	85	83	81	80	79	78	77	77	76	76	77	79	82	86	89	92	93	93	93		93	
	89.1	89.0	88.4	87.1	84.5	81.5	79.0	77.2	76.4	76.4	75.4	75.6	75.4	75.3	75.0	75.6	79.0	82.5	84.2	86.5	88.0	88.5	89.2	89.9	75.0	89.9	82.0

Date	23-Jun									24-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	92	92	91	91	89	87	83	81	80	79	80	80	79	78	77	77	78	82	87	91	93	94	94	94		94	
	90.3	90.8	89.6	86.8	85.8	82.5	79.9	78.4	77.5	76.8	77.1	77.4	77.0	76.7	76.5	76.7	79.9	83.3	85.4	87.3	87.5	89.6	90.1	87.9	76.5	90.8	82.9

Date										25-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	94	94	93	91	90	88	86	85	83	82	80	79	77	76	76	76	77	79	82	85	88	90	92	94		94	
	88.5	89.2	89.0	88.0	86.0	82.5	80.3	78.9	77.7	77.0	76.1	76.1	75.7	75.5	75.5	75.9	79.2	82.6	84.6	86.4	88.2	89.5	90.5	91.0	75.5	91.0	82.7

Date	25-Jun									26-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	94	94	93	92	90	88	86	85	83	81	79	78	77	76	76	77	78	80	82	85	88	91	92	94		94	
	90.1	90.6	90.3	89.1	87.7	84.0	81.4	79.8	79.0	78.0	77.5	77.4	76.5	76.8	76.3	76.8	79.4	82.8	83.8	85.0	86.3	86.9	87.2	87.8	76.3	90.6	82.9

Date										27-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	94	94	93	92	90	88	86	84	82	80	79	78	77	76	76	77	78	80	82	85	87	89	91	92		94	
	79.6	78.9	84.8	85.5	83.8	81.4	79.6	79.0	78.5	78.4	78.1	77.2	76.9	76.6	76.3	77.0	79.9	83.2	84.3	85.9	87.8	88.6	84.8	87.6	76.3	88.6	81.4

Date	27-Jun									28-Jun																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)																										94	
	88.7	89.4	88.2	86.2	85.7	83.2	81.6	80.2	79.2	79.0	78.7	77.7	76.9	76.6	76.5	77.4	80.9	83.3	84.9	86.8	88.1	89.7	90.7	91.9	76.5	91.9	83.4

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/21/2018 3pm	84.6	82.3	84.4	82.2	92.0	89.1	94	85.9	82.4	2.3	2.1	2.9	3.5

Date	25-Jun																	26-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	81	83	87	90	92	92	93	93	93	93	92	91	89	87	85	83	82	81	81	80	79	79	78	78		93	
	79.2	82.6	84.6	86.4	88.2	89.5	90.5	91.0	90.1	90.6	90.3	89.1	87.7	84.0	81.4	79.8	79.0	78.0	77.5	77.4	76.5	76.8	76.3	76.8	76.30725	91.03291	83.47384
Date																		27-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	80	83	86	90	91	92	92	92	92	92	91	90	88	86	83	81	80	80	80	79	78	77	77	77		92	
	79.4	82.8	83.8	85.0	86.3	86.9	87.2	87.8	79.6	78.9	84.8	85.5	83.8	81.4	79.6	79.0	78.5	78.4	78.1	77.2	76.9	76.6	76.3	77.0	76.3179	87.83884	81.28359
Date	27-Jun																	28-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	79	82	85	88	90	91	92	92	92	91	90	89	87	85	83	82	81	81	81	80	79	78	78	78		92	
	79.9	83.2	84.3	85.9	87.8	88.6	84.8	87.6	88.7	89.4	88.2	86.2	85.7	83.2	81.6	80.2	79.2	79.0	78.7	77.7	76.9	76.6	76.5	77.4	76.45029	89.35291	82.79314
Date																		29-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	80	82	85	87	89	90	91	91	91	91	90	90	88	86	83	81	80	79	79	79	79	78	77	77		91	
	80.9	83.3	84.9	86.8	88.1	89.7	90.7	91.9	92.0	92.0	90.0	88.6	87.3	85.0	83.2	82.0	81.0	80.5	80.0	80.3	80.0	79.0	78.5	77.7	77.6573	92.03379	84.71733
Date	29-Jun																	30-Jun									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	85	88	90	91	92	92	92	92	92	91	90	87	85	83	82	81	81	81	80	79	78	78		92	
	79.9	81.9	83.5	85.3	87.5	89.4	90.5	91.2	91.6	92.5	92.3	89.8	80.9	76.2	76.0	75.5	75.9	75.3	75.8	76.3	76.4	76.2	76.5	76.6	75.27842	92.53915	82.21556
Date																		1-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	79	82	86	89	91	92	93	93	93	93	93	92	90	88	85	83	82	82	82	81	80	79	78	78		93	
	78.6	81.6	84.0	85.8	87.6	88.9	89.2	91.0	92.3	91.9	85.0	82.8	82.1	81.2	79.9	79.4	78.0	73.6	72.6	72.8	73.4	73.5	73.5	73.9	72.60972	92.319	81.3576
Date	1-Jul																	2-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										92	
	76.0	79.8	82.7	85.0	86.6	88.3	89.3	90.4	91.6	91.1	86.9	82.5	80.6	79.8	78.9	79.9	79.4	76.2	75.4	75.9	75.9	75.7	75.7	75.6	75.41412	91.63389	81.64194

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/25/2018 7am	85.2	82.6	85.2	82.5	93.0	91.0	92	86.17262	82.49757	2.6	2.7	2.0	3.675049

Date	**28-Jun**														**29-Jun**												
Hour (CDT)	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	low	high	ave
Temperature (°F)	88	91	92	93	93	92	92	91	91	90	88	86	84	83	83	83	82	81	80	80	80	81	83	86		93	
	86.8	88.1	89.7	90.7	91.9	92.0	92.0	90.0	88.6	87.3	85.0	83.2	82.0	81.0	80.5	80.0	80.3	80.0	79.0	78.5	77.7	79.9	81.9	83.5	77.6573	92.03379	84.56052

Date															**30-Jun**												
Hour (CDT)	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**			
Temperature (°F)	89	90	92	93	93	93	93	92	91	89	87	84	82	81	81	81	80	79	78	78	78	80	82	85		93	
	85.3	87.5	89.4	90.5	91.2	91.6	92.5	92.3	89.8	80.9	76.2	76.0	75.5	75.9	75.3	75.8	76.3	76.4	76.2	76.5	76.6	78.6	81.6	84.0	75.27842	92.53915	82.16997

Date	**30-Jun**														**1-Jul**												
Hour (CDT)	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**			
Temperature (°F)	88	90	91	92	92	92	92	91	91	89	87	84	82	81	81	81	81	81	80	79	79	80	82	86		92	
	85.8	87.6	88.9	89.2	91.0	92.3	91.9	85.0	82.8	82.1	81.2	79.9	79.4	78.0	73.6	72.6	72.8	73.4	73.5	73.5	73.9	76.0	79.8	82.7	72.60972	92.319	81.11832

Date															**2-Jul**												
Hour (CDT)	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**			
Temperature (°F)	88	90	91	91	91	91	91	90	90	88	87	84	82	80	79	79	78	78	79	78	78	78	80	82		91	
	85.0	86.6	88.3	89.3	90.4	91.6	91.1	86.9	82.5	80.6	79.8	78.9	79.9	79.4	76.2	75.4	75.9	75.9	75.7	75.7	75.6	77.0	80.0	82.6	75.41412	91.63389	81.69282

Date	**2-Jul**														**3-Jul**												
Hour (CDT)	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**			
Temperature (°F)	84	86	87	88	88	88	88	87	87	86	84	83	82	81	81	81	80	80	80	79	79	80	81	84		88	
	85.1	86.7	88.3	89.9	90.5	91.1	80.1	78.8	77.6	77.5	75.7	75.8	75.9	76.1	74.8	74.6	74.3	74.6	76.0	75.7	76.3	76.6	76.2	76.5	74.29929	91.06246	79.36217

Date															**4-Jul**												
Hour (CDT)	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**			
Temperature (°F)	86	87	88	88	88	88	88	87	86	85	83	81	80	78	77	77	77	77	77	76	76	77	79	82		88	
	77.2	79.1	80.7	79.2	75.8	76.6	77.1	77.4	77.3	76.9	75.9	75.4	75.3	75.1	75.5	75.8	76.3	75.8	76.8	76.5	77.1	78.2	80.6	82.8	75.09372	82.8065	77.26624

Date	**4-Jul**														**5-Jul**												
Hour (CDT)	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**			
Temperature (°F)																										88	
	84.2	85.6	86.2	85.5	86.0	85.5	79.9	82.2	84.5	82.4	80.2	78.4	77.0	77.9	77.7	77.0	76.1	75.8	75.7	76.2	77.6	79.3	81.0	82.4	75.72107	86.22097	80.59054

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/28/2018 10am	84.5	81.0	85.8	82.6	93.0	92.0	88	85.0	81.0	3.5	3.2	1.0	4.1

Date	29-Jun												30-Jun													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	low	high	ave
Temperature (°F)	90	91	92	92	92	92	92	91	89	87	85	82	81	80	80	80	79	79	78	78	79	81	85	88		92	
	87.5	89.4	90.5	91.2	91.6	92.5	92.3	89.8	80.9	76.2	76.0	75.5	75.9	75.3	75.8	76.3	76.4	76.2	76.5	76.6	78.6	81.6	84.0	85.8	75.27842	92.53915	82.1917

Date													1-Jul													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	90	91	92	92	92	92	92	91	89	87	84	82	81	81	81	80	79	78	78	78	80	82	85	88		92	
	87.6	88.9	89.2	91.0	92.3	91.9	85.0	82.8	82.1	81.2	79.9	79.4	78.0	73.6	72.6	72.8	73.4	73.5	73.5	73.9	76.0	79.8	82.7	85.0	72.60972	92.319	81.08434

Date	1-Jul												2-Jul													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	90	91	92	92	92	92	91	90	88	86	84	82	81	80	80	79	79	79	78	78	79	81	83	86		92	
	86.6	88.3	89.3	90.4	91.6	91.1	86.9	82.5	80.6	79.8	78.9	79.9	79.4	76.2	75.4	75.9	75.9	75.7	75.7	75.6	77.0	80.0	82.6	85.1	75.41412	91.63389	81.69514

Date													3-Jul													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	88	89	90	90	90	90	89	89	87	85	82	81	80	79	79	79	78	77	76	76	76	78	79	80		90	
	86.7	88.3	89.9	90.5	91.1	80.1	78.8	77.6	77.5	75.7	75.8	75.9	76.1	74.8	74.6	74.3	74.6	76.0	75.7	76.3	76.6	76.2	76.5	77.2	74.29929	91.06246	79.03183

Date	3-Jul												4-Jul													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	82	83	83	84	83	83	84	84	83	82	80	79	78	78	79	78	77	77	76	76	77	80	83	85		85	
	79.1	80.7	79.2	75.8	76.6	77.1	77.4	77.3	76.9	75.9	75.4	75.3	75.1	75.5	75.8	76.3	75.8	76.8	76.5	77.1	78.2	80.6	82.8	84.2	75.09372	84.17639	77.55872

Date													5-Jul													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	87	87	88	88	88	88	87	86	85	83	81	79	78	77	77	77	76	76	75	75	76	79	82	85		88	
	85.6	86.2	85.5	86.0	85.5	79.9	82.2	84.5	82.4	80.2	78.4	77.0	77.9	77.7	77.0	76.1	75.8	75.7	76.2	77.6	79.3	81.0	82.4	83.1	75.72107	86.22097	80.54451

Date	5-Jul												6-Jul													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)																										90	
	84.2	85.4	83.5	80.5	79.0	81.8	83.1	82.8	81.0	80.8	80.7	80.8	79.4	79.6	79.2	78.9	78.6	78.4	78.5	79.3	79.1	80.1	82.2	82.4	78.38026	85.43599	80.80835

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
6/29/2018 11am	83.3	80.4	85.0	81.7	92.0	92.5	90	84.3	80.4	3.0	3.4	-0.5	3.9

Date	1-Jul								2-Jul																	
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	low	high	ave
Temperature (°F)	93	92	92	91	88	86	84	82	82	81	81	80	79	78	78	79	81	84	88	90	92	93	92	90		93	
	91.1	86.9	82.5	80.6	79.8	78.9	79.9	79.4	76.2	75.4	75.9	75.9	75.7	75.7	75.6	77.0	80.0	82.6	85.1	86.7	88.3	89.9	90.5	91.1	75.41412	91.1403	81.69999

Date									3-Jul																	
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	87	85	83	82	80	78	77	76	76	76	76	76	76	75	75	76	79	83	86	86	85	84	84	85		87	
	80.1	78.8	77.6	77.5	75.7	75.8	75.9	76.1	74.8	74.6	74.3	74.6	76.0	75.7	76.3	76.6	76.2	76.5	77.2	79.1	80.7	79.2	75.8	76.6	74.29929	80.68368	76.73555

Date	3-Jul								4-Jul																	
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	86	85	83	81	80	80	79	79	78	78	77	77	76	75	75	76	79	83	86	88	90	90	90	89		90	
	77.1	77.4	77.3	76.9	75.9	75.4	75.3	75.1	75.5	75.8	76.3	75.8	76.8	76.5	77.1	78.2	80.6	82.8	84.2	85.6	86.2	85.5	86.0	85.5	75.09372	86.22097	79.11974

Date									5-Jul																	
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	89	88	87	86	85	84	82	81	79	78	77	76	75	75	75	76	78	80	82	84	86	88	89	89		89	
	79.9	82.2	84.5	82.4	80.2	78.4	77.0	77.9	77.7	77.0	76.1	75.8	75.7	76.2	77.6	79.3	81.0	82.4	83.1	84.2	85.4	83.5	80.5	79.0	75.72107	85.43599	79.87107

Date	5-Jul								6-Jul																	
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	89	88	87	86	84	82	81	79	78	77	76	75	75	75	76	78	80	82	85	87	89	90	91	91		91	
	81.8	83.1	82.8	81.0	80.8	80.7	80.8	79.4	79.6	79.2	78.9	78.6	78.4	78.5	79.3	79.1	80.1	82.2	82.4	78.0	77.2	78.9	78.6	84.0	77.20155	84.00608	80.14101

Date									7-Jul																	
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	90	89	87	86	84	82	81	79	78	77	76	75	75	75	76	77	79	81	84	86	88	89	90	90		90	
	82.5	80.6	80.4	80.7	79.2	77.4	75.9	75.5	75.4	75.9	77.6	75.9	76.5	76.2	75.2	77.1	79.4	80.3	78.1	75.4	80.3	83.8	84.3	85.5	75.23921	85.5461	78.72917

Date	7-Jul								8-Jul																	
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)																										91	
	86.0	85.6	85.4	82.1	78.3	77.1	75.2	75.4	75.0	74.5	74.4	74.7	74.3	73.9	73.5	73.7	75.9	77.3	80.4	82.1	83.9	81.2	77.3	76.9	73.45379	86.0241	78.08315

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/1/2018 4pm	82.4	79.4	82.5	79.2	93.0	91.1	91	83.6	79.2	3.0	3.3	1.9	4.4

Date	3-Jul																4-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	76	77	79	81	83	84	84	83	82	81	81	81	80	79	78	78	78	78	78	77	77	76	76	76		84	
	76.6	76.2	76.5	77.2	79.1	80.7	79.2	75.8	76.6	77.1	77.4	77.3	76.9	75.9	75.4	75.3	75.1	75.5	75.8	76.3	75.8	76.8	76.5	77.1	75.1	80.7	76.8
Date																		5-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	88	89	90	90	90	89	89	88	86	85	83	81	79	79	78	78	78	77	77	76	76		90	
	78.2	80.6	82.8	84.2	85.6	86.2	85.5	86.0	85.5	79.9	82.2	84.5	82.4	80.2	78.4	77.0	77.9	77.7	77.0	76.1	75.8	75.7	76.2	77.6	75.7	86.2	80.5
Date	5-Jul																	6-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	84	86	87	88	88	88	87	86	85	83	81	79	78	77	77	77	76	75	74	74	74		88	
	79.3	81.0	82.4	83.1	84.2	85.4	83.5	80.5	79.0	81.8	83.1	82.8	81.0	80.8	80.7	80.8	79.4	79.6	79.2	78.9	78.6	78.4	78.5	79.3	78.4	85.4	80.9
Date																		7-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	79	82	84	86	88	88	88	87	86	85	83	82	81	79	78	77	77	76	75	75	75	76		88	
	79.1	80.1	82.2	82.4	78.0	77.2	78.9	78.6	84.0	82.5	80.6	80.4	80.7	79.2	77.4	75.9	75.5	75.4	75.9	77.6	75.9	76.5	76.2	75.2	75.2	84.0	78.6
Date	7-Jul																	8-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	81	83	85	87	88	89	89	88	87	86	85	83	82	81	80	79	78	77	76	75	75	75		89	
	77.1	79.4	80.3	78.1	75.4	80.3	83.8	84.3	85.5	86.0	85.6	85.4	82.1	78.3	77.1	75.2	75.4	75.0	74.5	74.4	74.7	74.3	73.9	73.5	73.5	86.0	78.7
Date																		9-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	83	85	87	88	89	89	88	87	86	84	83	82	80	79	78	77	76	75	75	75	76		89	
	73.7	75.9	77.3	80.4	82.1	83.9	81.2	77.3	76.9	77.2	81.5	83.3	80.9	77.3	75.4	74.5	74.0	73.9	73.6	73.4	73.8	74.3	73.6	74.6	73.4	83.9	77.1
Date	9-Jul																	10-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										90	
	78.0	80.8	83.2	84.8	86.3	86.7	87.0	87.0	76.8	74.5	75.9	76.1	75.6	75.1	75.3	76.0	74.5	74.2	74.1	73.7	73.4	73.2	73.3	73.7	73.2	87.0	77.9

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/3/2018 7am	81.2	78.8	81.0	79.4	84.0	80.7	90	82.5	78.6	2.4	1.6	3.3	3.8

Date	5-Jul																	6-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	77	78	80	83	87	89	90	90	90	89	89	88	87	86	84	82	80	80	80	80	80	79	78	77		90	
	77.6	79.3	81.0	82.4	83.1	84.2	85.4	83.5	80.5	79.0	81.8	83.1	82.8	81.0	80.8	80.7	80.8	79.4	79.6	79.2	78.9	78.6	78.4	78.5	77.6	85.4	80.8

Date																		7-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	78	81	83	86	88	89	89	89	89	88	87	86	85	83	81	79	79	78	78	78	78	77	77		89	
	79.3	79.1	80.1	82.2	82.4	78.0	77.2	78.9	78.6	84.0	82.5	80.6	80.4	80.7	79.2	77.4	75.9	75.5	75.4	75.9	77.6	75.9	76.5	76.2	75.4	84.0	78.7

Date	7-Jul																	8-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	79	81	84	86	88	89	89	89	88	87	87	86	84	82	79	78	77	78	78	77	76	75	74		89	
	75.2	77.1	79.4	80.3	78.1	75.4	80.3	83.8	84.3	85.5	86.0	85.6	85.4	82.1	78.3	77.1	75.2	75.4	75.0	74.5	74.4	74.7	74.3	73.9	73.9	86.0	78.8

Date																		9-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	76	79	82	85	87	89	90	90	90	90	88	87	85	83	80	79	78	77	77	77	76	75	75		90	
	73.5	73.7	75.9	77.3	80.4	82.1	83.9	81.2	77.3	76.9	77.2	81.5	83.3	80.9	77.3	75.4	74.5	74.0	73.9	73.6	73.4	73.8	74.3	73.6	73.4	83.9	77.0

Date	9-Jul																	10-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	77	80	83	87	89	90	91	91	91	91	90	89	87	85	83	81	80	79	78	78	78	77	76		91	
	74.6	78.0	80.8	83.2	84.8	86.3	86.7	87.0	87.0	76.8	74.5	75.9	76.1	75.6	75.1	75.3	76.0	74.5	74.2	74.1	73.7	73.4	73.2	73.3	73.2	87.0	77.9

Date																		11-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	81	85	89	91	92	92	92	92	92	92	91	89	87	84	81	80	79	78	78	78	77	76		92	
	73.7	76.2	79.3	81.5	82.6	83.8	85.2	86.6	88.0	88.2	87.9	86.9	83.5	82.9	81.1	80.3	80.7	79.4	78.4	77.6	77.3	77.0	76.4	76.3	73.7	88.2	81.3

Date	11-Jul																	12-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										91	
	76.8	78.5	81.1	83.3	85.0	86.2	86.5	86.2	86.7	78.8	77.0	76.4	76.7	76.9	76.5	75.5	74.4	73.9	72.5	73.7	74.5	75.5	75.2	74.6	72.5	86.7	78.4

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/5/2018 6am	83.0	79.1	82.7	79.5	90.0	85.4	91	84.2	79.0	3.9	3.2	4.6	5.2

																									low	high	ave
Date	5-Jul						6-Jul																				
Hour (CDT)	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
Temperature (°F)	87	83	81	80	79	78	78	78	77	77	76	76	76	77	79	81	84	85	86	87	86	86	85	84		87	
	82.8	81.0	80.8	80.7	80.8	79.4	79.6	79.2	78.9	78.6	78.4	78.5	79.3	79.1	80.1	82.2	82.4	78.0	77.2	78.9	78.6	84.0	82.5	80.6	77.2	84.0	80.1
Date							7-Jul																				
Hour (CDT)	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
Temperature (°F)	83	83	82	80	79	78	77	76	76	76	75	75	75	76	79	82	85	87	88	88	88	87	86	85		88	
	80.4	80.7	79.2	77.4	75.9	75.5	75.4	75.9	77.6	75.9	76.5	76.2	75.2	77.1	79.4	80.3	78.1	75.4	80.3	83.8	84.3	85.5	86.0	85.6	75.2	86.0	79.1
Date	7-Jul						8-Jul																				
Hour (CDT)	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
Temperature (°F)	84	82	81	79	78	77	77	77	77	77	76	75	74	75	78	81	85	86	87	87	87	88	88	87		88	
	85.4	82.1	78.3	77.1	75.2	75.4	75.0	74.5	74.4	74.7	74.3	73.9	73.5	73.7	75.9	77.3	80.4	82.1	83.9	81.2	77.3	76.9	77.2	81.5	73.5	85.4	77.5
Date							9-Jul																				
Hour (CDT)	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
Temperature (°F)	86	84	82	81	80	78	77	77	76	75	75	75	76	77	78	80	82	85	87	88	89	89	89	88		89	
	83.3	80.9	77.3	75.4	74.5	74.0	73.9	73.6	73.4	73.8	74.3	73.6	74.6	78.0	80.8	83.2	84.8	86.3	86.7	87.0	87.0	76.8	74.5	75.9	73.4	87.0	78.5
Date	9-Jul						10-Jul																				
Hour (CDT)	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
Temperature (°F)	87	86	85	83	82	81	80	79	77	77	76	76	76	77	79	82	84	86	89	90	91	91	91	90		91	
	76.1	75.6	75.1	75.3	76.0	74.5	74.2	74.1	73.7	73.4	73.2	73.3	73.7	76.2	79.3	81.5	82.6	83.8	85.2	86.6	88.0	88.2	87.9	86.9	73.2	88.2	78.9
Date							11-Jul																				
Hour (CDT)	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
Temperature (°F)	88	87	85	84	82	81	80	78	77	77	76	76	76	77	79	81	84	86	88	89	90	90	89	89		90	
	83.5	82.9	81.1	80.3	80.7	79.4	78.4	77.6	77.3	77.0	76.4	76.3	76.8	78.5	81.1	83.3	85.0	86.2	86.5	86.2	86.7	78.8	77.0	76.4	76.3	86.7	80.6
Date	11-Jul						12-Jul																				
Hour (CDT)	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
Temperature (°F)																										93	
	76.7	76.9	76.5	75.5	74.4	73.9	72.5	73.7	74.5	75.5	75.2	74.6	73.9	74.7	77.3	79.7	82.8	84.8	86.2	86.3	84.6	85.6	88.7	89.3	72.5	89.3	78.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/5/2018 6pm	81.8	79.1	81.0	78.9	87.0	84.0	93	83.4	79.1	2.6	2.1	3.0	4.3

Date	8-Jul																9-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	76	78	82	85	87	88	88	88	87	86	85	84	83	81	79	77	77	77	77	77	76	76	75	75		88	
	73.7	75.9	77.3	80.4	82.1	83.9	81.2	77.3	76.9	77.2	81.5	83.3	80.9	77.3	75.4	74.5	74.0	73.9	73.6	73.4	73.8	74.3	73.6	74.6	73.4	83.9	77.1

Date																	10-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	86	88	89	89	88	88	87	86	86	84	83	81	79	78	77	76	76	76	75	75	75		89	
	78.0	80.8	83.2	84.8	86.3	86.7	87.0	87.0	76.8	74.5	75.9	76.1	75.6	75.1	75.3	76.0	74.5	74.2	74.1	73.7	73.4	73.2	73.3	73.7	73.2	87.0	77.9

Date	10-Jul																11-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	88	90	91	92	92	92	92	91	89	88	85	83	81	80	79	78	78	77	77	76	76		92	
	76.2	79.3	81.5	82.6	83.8	85.2	86.6	88.0	88.2	87.9	86.9	83.5	82.9	81.1	80.3	80.7	79.4	78.4	77.6	77.3	77.0	76.4	76.3	76.8	76.2	88.2	81.4

Date																	12-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	83	86	88	88	89	89	89	89	88	87	86	84	82	80	78	77	77	77	77	77	76	76		89	
	78.5	81.1	83.3	85.0	86.2	86.5	86.2	86.7	78.8	77.0	76.4	76.7	76.9	76.5	75.5	74.4	73.9	72.5	73.7	74.5	75.5	75.2	74.6	73.9	72.5	86.7	78.3

Date	12-Jul																13-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	83	86	88	90	91	91	91	91	90	89	88	85	83	81	80	80	80	79	78	77	76	76		91	
	74.7	77.3	79.7	82.8	84.8	86.2	86.3	84.6	85.6	88.7	89.3	88.6	85.4	82.6	80.1	79.5	79.1	77.8	76.9	76.3	75.7	75.7	74.7	74.3	74.3	89.3	81.1

Date																	14-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	83	86	88	89	90	90	90	90	89	88	86	84	82	80	79	79	79	78	77	76	76	76		90	
	77.2	81.1	82.9	84.9	85.9	84.5	88.5	85.0	83.1	85.7	88.8	88.4	83.8	81.2	78.8	77.9	77.7	77.8	77.4	77.5	77.5	77.1	76.9	77.1	76.9	88.8	81.5

Date	14-Jul																15-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										91	
	78.7	81.5	84.3	86.1	87.8	88.5	90.0	90.9	91.0	90.9	88.1	83.4	81.5	80.4	80.2	80.5	80.2	79.4	79.2	78.1	77.4	77.3	77.1	77.1	77.1	91.0	82.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/8/2018 7am	82.6	79.6	82.2	78.8	88.0	83.9	91	83.8	80.0	3.1	3.4	4.1	3.8

Date	9-Jul																10-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	80	83	87	89	90	91	91	90	89	88	87	85	83	80	79	78	77	77	77	76	75	75	75		91	
	78.0	80.8	83.2	84.8	86.3	86.7	87.0	87.0	76.8	74.5	75.9	76.1	75.6	75.1	75.3	76.0	74.5	74.2	74.1	73.7	73.4	73.2	73.3	73.7	73.2	87.0	77.9
Date																		11-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	88	90	91	92	92	92	92	91	90	88	85	83	81	80	80	80	79	78	77	76	76		92	
	76.2	79.3	81.5	82.6	83.8	85.2	86.6	88.0	88.2	87.9	86.9	83.5	82.9	81.1	80.3	80.7	79.4	78.4	77.6	77.3	77.0	76.4	76.3	76.8	76.2	88.2	81.4
Date	11-Jul																	12-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	88	90	91	91	91	90	89	89	89	88	86	83	80	78	77	77	77	77	77	76	76		91	
	78.5	81.1	83.3	85.0	86.2	86.5	86.2	86.7	78.8	77.0	76.4	76.7	76.9	76.5	75.5	74.4	73.9	72.5	73.7	74.5	75.5	75.2	74.6	73.9	72.5	86.7	78.3
Date																		13-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	89	90	90	90	89	89	88	88	87	85	82	80	79	79	79	78	78	77	76	76		90	
	74.7	77.3	79.7	82.8	84.8	86.2	86.3	84.6	85.6	88.7	89.3	88.6	85.4	82.6	80.1	79.5	79.1	77.8	76.9	76.3	75.7	75.7	74.7	74.3	74.3	89.3	81.1
Date	13-Jul																	14-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	83	86	88	89	90	90	90	90	89	88	86	84	82	80	79	79	78	78	77	77	76	76		90	
	77.2	81.1	82.9	84.9	85.9	84.5	88.5	85.0	83.1	85.7	88.8	88.4	83.8	81.2	78.8	77.9	77.7	77.8	77.4	77.5	77.5	77.1	76.9	77.1	76.9	88.8	81.5
Date																		15-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	89	90	91	91	91	91	90	89	87	85	83	81	80	80	79	79	78	78	77	77		91	
	78.7	81.5	84.3	86.1	87.8	88.5	90.0	90.9	91.0	90.9	88.1	83.4	81.5	80.4	80.2	80.5	80.2	79.4	79.2	78.1	77.4	77.3	77.1	77.1	77.1	91.0	82.9
Date	15-Jul																	16-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										91	
	77.8	81.0	83.9	85.5	86.8	87.9	88.8	90.1	90.8	89.3	89.9	85.5	83.5	81.3	79.9	79.7	78.8	79.2	79.3	79.0	78.3	78.3	78.0	77.8	77.8	90.8	82.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/9/2018 7am	83.4	80.5	83.4	79.2	91.0	87.0	91	84.5	80.9	2.8	4.2	4.0	3.6

Date	10-Jul								11-Jul																		
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	low	high	ave
Temperature (°F)	89	89	88	88	87	85	83	81	80	79	79	79	78	78	77	77	78	80	84	87	88	89	90	90		90	
	88.2	87.9	86.9	83.5	82.9	81.1	80.3	80.7	79.4	78.4	77.6	77.3	77.0	76.4	76.3	76.8	78.5	81.1	83.3	85.0	86.2	86.5	86.2	86.7	76.3	88.2	81.8
Date									12-Jul																		
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	90	90	89	87	85	84	82	81	80	79	78	78	78	78	77	77	78	80	84	87	89	90	90	90		90	
	78.8	77.0	76.4	76.7	76.9	76.5	75.5	74.4	73.9	72.5	73.7	74.5	75.5	75.2	74.6	73.9	74.7	77.3	79.7	82.8	84.8	86.2	86.3	84.6	72.5	86.3	77.6
Date	12-Jul									13-Jul																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	89	89	88	88	86	85	82	81	79	79	78	78	78	77	76	76	77	80	83	86	88	89	90	90		90	
	85.6	88.7	89.3	88.6	85.4	82.6	80.1	79.5	79.1	77.8	76.9	76.3	75.7	75.7	74.7	74.3	77.2	81.1	82.9	84.9	85.9	84.5	88.5	85.0	74.3	89.3	81.7
Date										14-Jul																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	90	90	89	88	86	84	81	79	78	77	77	77	77	77	76	76	77	79	83	86	88	89	90	90		90	
	83.1	85.7	88.8	88.4	83.8	81.2	78.8	77.9	77.7	77.8	77.4	77.5	77.5	77.1	76.9	77.1	78.7	81.5	84.3	86.1	87.8	88.5	90.0	90.9	76.9	90.9	82.3
Date	14-Jul									15-Jul																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	90	90	89	88	87	85	83	81	80	79	79	79	78	78	77	77	78	80	84	87	88	89	90	90		90	
	91.0	90.9	88.1	83.4	81.5	80.4	80.2	80.5	80.2	79.4	79.2	78.1	77.4	77.3	77.1	77.1	77.8	81.0	83.9	85.5	86.8	87.9	88.8	90.1	77.1	91.0	82.7
Date										16-Jul																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)	91	91	91	89	88	85	83	81	80	80	80	79	78	77	77	77	78	81	84	87	89	89	90	90		91	
	90.8	89.3	89.9	85.5	83.5	81.3	79.9	79.7	78.8	79.2	79.3	79.0	78.3	78.3	78.0	77.8	79.9	82.9	85.0	87.1	87.9	89.8	90.0	86.8	77.8	90.8	83.2
Date	16-Jul									17-Jul																	
Hour (CDT)	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Temperature (°F)																										89	
	81.0	75.9	77.2	78.6	78.8	79.2	75.9	73.7	73.8	74.1	74.5	75.0	75.1	75.8	77.0	77.5	77.8	78.7	79.5	80.5	82.6	84.0	85.5	86.8	73.7	86.8	78.3

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/10/2018 3pm	83.3	81.5	83.3	80.4	90.0	88.2	89	84.1	81.1	1.8	2.9	1.8	3.1

Date	11-Jul																	12-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	78	81	85	88	90	90	90	90	90	90	89	87	85	83	81	79	78	77	77	77	77	77	76	76		90	
	78.5	81.1	83.3	85.0	86.2	86.5	86.2	86.7	78.8	77.0	76.4	76.7	76.9	76.5	75.5	74.4	73.9	72.5	73.7	74.5	75.5	75.2	74.6	73.9	72.5	86.7	78.3

Date																		13-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	88	91	92	92	91	90	89	88	88	86	84	81	79	77	76	76	76	76	76	75	75		92	
	74.7	77.3	79.7	82.8	84.8	86.2	86.3	84.6	85.6	88.7	89.3	88.6	85.4	82.6	80.1	79.5	79.1	77.8	76.9	76.3	75.7	75.7	74.7	74.3	74.3	89.3	81.1

Date	13-Jul																	14-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	80	84	88	90	91	91	91	90	90	89	88	87	85	82	80	78	77	77	77	77	77	76	76		91	
	77.2	81.1	82.9	84.9	85.9	84.5	88.5	85.0	83.1	85.7	88.8	88.4	83.8	81.2	78.8	77.9	77.7	77.8	77.4	77.5	77.5	77.1	76.9	77.1	76.9	88.8	81.5

Date																		15-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	90	91	91	90	89	88	88	87	86	84	82	79	78	77	77	77	77	77	76	76		91	
	78.7	81.5	84.3	86.1	87.8	88.5	90.0	90.9	91.0	90.9	88.1	83.4	81.5	80.4	80.2	80.5	80.2	79.4	79.2	78.1	77.4	77.3	77.1	77.1	77.1	91.0	82.9

Date	15-Jul																	16-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	83	87	89	91	91	91	90	90	89	88	87	85	84	82	81	80	79	79	79	78	77	77		91	
	77.8	81.0	83.9	85.5	86.8	87.9	88.8	90.1	90.8	89.3	89.9	85.5	83.5	81.3	79.9	79.7	78.8	79.2	79.3	79.0	78.3	78.3	78.0	77.8	77.8	90.8	82.9

Date																		17-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	87	89	90	91	91	91	91	90	89	87	85	83	82	81	81	80	80	79	78	77	77		91	
	79.9	82.9	85.0	87.1	87.9	89.8	90.0	86.8	81.0	75.9	77.2	78.6	78.8	79.2	75.9	73.7	73.8	74.1	74.5	75.0	75.1	75.8	77.0	77.5	73.7	90.0	79.7

Date	17-Jul																	18-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										90	
	77.8	78.7	79.5	80.5	82.6	84.0	85.5	86.8	85.1	83.3	82.4	81.7	80.5	79.4	78.7	78.2	78.1	78.8	78.8	78.8	79.4	79.5	79.2	79.1	77.8	86.8	80.7

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/11/2018 7am	83.3	81.1	83.0	80.3	90.0	86.7	90	84.3	81.0	2.2	2.7	3.3	3.3

Date	11-Jul							12-Jul																		
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	low	high	ave
Temperature (°F)	89	87	84	82	81	79	79	78	78	78	78	77	77	77	78	81	83	86	88	89	90	89	88	88		90	
	76.4	76.7	76.9	76.5	75.5	74.4	73.9	72.5	73.7	74.5	75.5	75.2	74.6	73.9	74.7	77.3	79.7	82.8	84.8	86.2	86.3	84.6	85.6	88.7	72.5	88.7	78.4

Date								13-Jul																		
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Temperature (°F)	87	86	85	83	81	79	79	78	77	77	77	77	76	76	77	79	83	87	89	91	91	90	89	88		91	
	89.3	88.6	85.4	82.6	80.1	79.5	79.1	77.8	76.9	76.3	75.7	75.7	74.7	74.3	77.2	81.1	82.9	84.9	85.9	84.5	88.5	85.0	83.1	85.7	74.3	89.3	81.4

Date	13-Jul							14-Jul																		
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Temperature (°F)	87	86	85	84	82	80	79	78	77	77	77	76	76	76	78	80	84	87	89	91	91	91	91	90		91	
	88.8	88.4	83.8	81.2	78.8	77.9	77.7	77.8	77.4	77.5	77.5	77.1	76.9	77.1	78.7	81.5	84.3	86.1	87.8	88.5	90.0	90.9	91.0	90.9	76.9	91.0	82.8

Date								15-Jul																		
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Temperature (°F)	89	88	86	85	83	82	81	79	78	77	76	76	76	77	78	80	82	85	87	89	90	91	91	90		91	
	88.1	83.4	81.5	80.4	80.2	80.5	80.2	79.4	79.2	78.1	77.4	77.3	77.1	77.1	77.8	81.0	83.9	85.5	86.8	87.9	88.8	90.1	90.8	89.3	77.1	90.8	82.6

Date	15-Jul							16-Jul																		
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Temperature (°F)	89	88	86	85	83	82	81	80	79	78	77	77	77	78	79	80	82	85	87	89	90	90	90	89		90	
	89.9	85.5	83.5	81.3	79.9	79.7	78.8	79.2	79.3	79.0	78.3	78.3	78.0	77.8	79.9	82.9	85.0	87.1	87.9	89.8	90.0	86.8	81.0	75.9	75.9	90.0	82.3

Date								17-Jul																		
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Temperature (°F)	87	86	84	83	81	80	79	78	77	77	76	76	76	77	78	79	81	83	85	87	88	89	89	89		89	
	77.2	78.6	78.8	79.2	75.9	73.7	73.8	74.1	74.5	75.0	75.1	75.8	77.0	77.5	77.8	78.7	79.5	80.5	82.6	84.0	85.5	86.8	85.1	83.3	73.7	86.8	78.7

Date	17-Jul							18-Jul																		
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Temperature (°F)																										90	
	82.4	81.7	80.5	79.4	78.7	78.2	78.1	78.8	78.8	78.8	79.4	79.5	79.2	79.1	79.8	81.1	83.6	83.4	82.0	83.3	82.4	80.4	82.0	78.5	78.1	83.6	80.4

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/11/2018 5pm	82.8	81.0	82.8	80.9	90.0	88.7	90	83.8	80.9	1.7	1.9	1.3	2.9

Date	12-Jul																13-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	79	81	85	88	90	91	92	92	92	92	91	90	88	85	83	81	80	79	79	78	78	77	76	76		92	
	74.7	77.3	79.7	82.8	84.8	86.2	86.3	84.6	85.6	88.7	89.3	88.6	85.4	82.6	80.1	79.5	79.1	77.8	76.9	76.3	75.7	75.7	74.7	74.3	74.3	89.3	81.1
Date																		14-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	85	88	90	91	91	91	91	91	90	89	87	85	83	81	79	78	77	77	77	77	76	76		91	
	77.2	81.1	82.9	84.9	85.9	84.5	88.5	85.0	83.1	85.7	88.8	88.4	83.8	81.2	78.8	77.9	77.7	77.8	77.4	77.5	77.5	77.1	76.9	77.1	76.9	88.8	81.5
Date	14-Jul																	15-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	83	86	89	90	91	91	91	90	89	88	86	84	82	80	79	79	78	78	77	77	76	76		91	
	78.7	81.5	84.3	86.1	87.8	88.5	90.0	90.9	91.0	90.9	88.1	83.4	81.5	80.4	80.2	80.5	80.2	79.4	79.2	78.1	77.4	77.3	77.1	77.1	77.1	91.0	82.9
Date																		16-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	89	90	91	91	91	91	90	89	87	85	83	81	80	79	79	79	78	78	77	77		91	
	77.8	81.0	83.9	85.5	86.8	87.9	88.8	90.1	90.8	89.3	89.9	85.5	83.5	81.3	79.9	79.7	78.8	79.2	79.3	79.0	78.3	78.3	78.0	77.8	77.8	90.8	82.9
Date	16-Jul																	17-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	85	88	90	91	91	90	90	89	89	89	88	85	83	81	79	79	79	78	78	77	76	76		91	
	79.9	82.9	85.0	87.1	87.9	89.8	90.0	86.8	81.0	75.9	77.2	78.6	78.8	79.2	75.9	73.7	73.8	74.1	74.5	75.0	75.1	75.8	77.0	77.5	73.7	90.0	79.7
Date																		18-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	85	88	89	90	90	90	90	89	89	87	84	82	80	79	80	80	79	78	77	76	76		90	
	77.8	78.7	79.5	80.5	82.6	84.0	85.5	86.8	85.1	83.3	82.4	81.7	80.5	79.4	78.7	78.2	78.1	78.8	78.8	79.4	79.5	79.2	79.1		77.8	86.8	80.8
Date	18-Jul																	19-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										91	
	79.8	81.1	83.6	83.4	82.0	83.3	82.4	80.4	82.0	78.5	78.1	78.2	77.2	76.5	75.7	75.0	74.4	74.3	74.2	74.0	74.4	75.1	75.6	75.8	74.0	83.6	78.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/12/2018 7am	83.6	81.5	83.7	81.8	92.0	89.3	91	84.7	81.0	2.2	1.9	2.7	3.7

Date	14-Jul														15-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	low	high	ave
Temperature (°F)	87	89	91	92	93	93	93	92	90	88	86	84	83	81	80	79	79	78	78	77	77	78	81	85		93	
	86.1	87.8	88.5	90.0	90.9	91.0	90.9	88.1	83.4	81.5	80.4	80.2	80.5	80.2	79.4	79.2	78.1	77.4	77.3	77.1	77.1	77.8	81.0	83.9	77.1	91.0	82.8

Date															16-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	89	91	93	93	94	94	93	92	91	89	86	84	82	81	79	79	79	79	79	78	77	78	80	84		94	
	85.5	86.8	87.9	88.8	90.1	90.8	89.3	89.9	85.5	83.5	81.3	79.9	79.7	78.8	79.2	79.3	79.0	78.3	78.3	78.0	77.8	79.9	82.9	85.0	77.8	90.8	83.1

Date	16-Jul														17-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	87	89	90	90	90	91	91	90	88	86	84	83	81	80	79	79	78	78	78	77	77	78	79	81		91	
	87.1	87.9	89.8	90.0	86.8	81.0	75.9	77.2	78.6	78.8	79.2	75.9	73.7	73.8	74.1	74.5	75.0	75.1	75.8	77.0	77.5	77.8	78.7	79.5	73.7	90.0	79.2

Date															18-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	83	85	87	89	89	88	87	86	84	83	82	81	80	79	79	78	77	77	76	76	76	77	78	80		89	
	80.5	82.6	84.0	85.5	86.8	85.1	83.3	82.4	81.7	80.5	79.4	78.7	78.2	78.1	78.8	78.8	78.8	79.4	79.5	79.2	79.1	79.8	81.1	83.6	78.1	86.8	81.0

Date	18-Jul														19-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	83	85	86	88	88	88	87	86	85	84	83	82	81	80	80	79	77	76	75	75	75	76	78	80		88	
	83.4	82.0	83.3	82.4	80.4	82.0	78.5	78.1	78.2	77.2	76.5	75.7	75.0	74.4	74.3	74.2	74.0	74.4	75.1	75.6	75.8	77.0	79.8	82.1	74.0	83.4	77.9

Date															20-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	83	85	88	89	90	90	89	88	87	86	84	83	82	81	80	79	78	77	77	77	78	79	81	83		90	
	83.1	85.2	86.4	88.3	89.6	90.1	90.6	90.3	89.7	87.6	85.5	83.8	82.0	81.0	80.3	79.7	79.1	78.4	77.8	77.3	77.4	78.5	80.4	83.3	77.3	90.6	83.6

Date	20-Jul														21-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)																										91	
	86.0	88.1	89.4	90.4	91.8	92.7	92.9	92.8	91.7	89.7	87.9	88.0	88.0	88.1	88.2	88.2	88.3	88.3	88.4	88.5	88.5	88.6	88.6	88.7	86.0	92.9	89.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/14/2018 10am	83.3	81.3	84.5	81.7	93.0	91.0	91	84.4	82.4	2.0	2.8	2.0	2.0

Date	15-Jul			16-Jul																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	low	high	ave
Temperature (°F)	84	83	82	81	81	80	80	79	78	78	79	82	85	88	90	91	92	92	92	91	89	86	84	82		92	
	79.9	79.7	78.8	79.2	79.3	79.0	78.3	78.3	78.0	77.8	79.9	82.9	85.0	87.1	87.9	89.8	90.0	86.8	81.0	75.9	77.2	78.6	78.8	79.2	75.9	90.0	81.2

Date				17-Jul																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	81	81	80	79	79	78	77	76	76	76	78	80	83	86	89	91	93	93	93	91	90	88	86	85		93	
	75.9	73.7	73.8	74.1	74.5	75.0	75.1	75.8	77.0	77.5	77.8	78.7	79.5	80.5	82.6	84.0	85.5	86.8	85.1	83.3	82.4	81.7	80.5	79.4	73.7	86.8	79.2

Date	17-Jul			18-Jul																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	83	81	80	78	78	77	78	78	77	77	78	80	83	86	88	89	90	90	90	89	88	87	85	84		90	
	78.7	78.2	78.1	78.8	78.8	78.8	79.4	79.5	79.2	79.1	79.8	81.1	83.6	83.4	82.0	83.3	82.4	80.4	82.0	78.5	78.1	78.2	77.2	76.5	76.5	83.6	79.8

Date				19-Jul																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	83	82	81	81	80	79	78	77	77	77	78	80	82	85	87	89	90	91	91	90	89	87	86	85		91	
	75.7	75.0	74.4	74.3	74.2	74.0	74.4	75.1	75.6	75.8	77.0	79.8	82.1	83.1	85.2	86.4	88.3	89.6	90.1	90.6	90.3	89.7	87.6	85.5	74.0	90.6	81.4

Date	19-Jul			20-Jul																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	84	83	82	81	80	79	78	77	77	77	79	81	83	86	89	91	93	94	94	93	92	91	90	88		94	
	83.8	82.0	81.0	80.3	79.7	79.1	78.4	77.8	77.3	77.4	78.5	80.4	83.3	86.0	88.1	89.4	90.4	91.8	92.7	92.9	92.8	91.7	89.7	87.9	77.3	92.9	84.7

Date				21-Jul																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	87	85	84	82	81	79	78	77	77	77	78	80	83	85	88	91	92	93	93	92	91	90	88	86		93	
	88.0	88.0	88.1	88.2	88.2	88.3	88.3	88.4	88.5	88.5	88.6	88.6	88.7	88.8	88.8	88.9	90.3	91.2	92.0	92.1	91.6	90.4	87.9	85.5	85.5	92.1	89.0

Date	21-Jul			22-Jul																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)																										94	
	83.9	82.7	81.7	81.0	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	81.4	87.7	90.0	91.0	92.0	93.3	93.6	93.7	92.8	90.6	88.1	86.0	80.6	93.7	85.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/15/2018 9pm	84.1	82.5	83.8	80.0	92.0	90.0	94	85.5	83.0	1.6	3.7	2.0	2.6

Date	17-Jul																18-Jul										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	79	80	82	84	86	87	87	86	85	83	82	80	79	77	76	76	76	76	77	77	77	77	77		87	
	77.8	78.7	79.5	80.5	82.6	84.0	85.5	86.8	85.1	83.3	82.4	81.7	80.5	79.4	78.7	78.2	78.1	78.8	78.8	78.8	79.4	79.5	79.2	79.1	77.8	86.8	80.7
Date																		19-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	81	84	86	89	91	91	90	89	88	87	86	85	83	81	80	80	79	79	78	78	77	77		91	
	79.8	81.1	83.6	83.4	82.0	83.3	82.4	80.4	82.0	78.5	78.1	78.2	77.2	76.5	75.7	75.0	74.4	74.3	74.2	74.0	74.4	75.1	75.6	75.8	74.0	83.6	78.1
Date	19-Jul																	20-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	82	85	87	89	89	90	90	89	88	87	85	84	83	82	81	80	80	79	78	78	77	77		90	
	77.0	79.8	82.1	83.1	85.2	86.4	88.3	89.6	90.1	90.6	90.3	89.7	87.6	85.5	83.8	82.0	81.0	80.3	79.7	79.1	78.4	77.8	77.3	77.4	77.0	90.6	83.4
Date																		21-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	79	82	85	87	90	92	93	93	93	92	90	89	87	86	84	83	81	80	79	78	78	78	79		93	
	78.5	80.4	83.3	86.0	88.1	89.4	90.4	91.8	92.7	92.9	92.8	91.7	89.7	87.9	88.0	88.0	88.1	88.2	88.2	88.3	88.3	88.4	88.5	88.5	78.5	92.9	88.3
Date	21-Jul																	22-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	80	82	84	87	90	92	93	94	94	93	92	91	89	88	87	85	84	83	82	80	80	79	79	79		94	
	88.6	88.6	88.7	88.8	88.8	88.9	90.3	91.2	92.0	92.1	91.6	90.4	87.9	85.5	83.9	82.7	81.7	81.0	80.6	80.6	80.6	80.6	80.6	80.6	80.6	92.1	86.1
Date																		23-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	81	83	85	88	90	93	94	95	95	94	93	92	90	88	87	86	84	83	82	81	80	79	79	79		95	
	80.6	80.6	81.4	87.7	90.0	91.0	92.0	93.3	93.6	93.7	92.8	90.6	88.1	86.0	84.3	83.5	83.1	82.8	82.1	81.3	81.1	80.9	80.7	80.4	80.4	93.7	85.9
Date	23-Jul																	24-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										95	
	80.5	81.6	83.5	84.4	86.2	88.0	89.8	91.2	91.8	91.6	86.5	84.8	79.6	78.2	77.3	77.2	77.7	78.7	76.7	76.8	78.5	78.2	77.2	77.3	76.7	91.8	82.2

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/17/2018 7am	84.0	83.7	82.2	80.7	87.0	86.8	95	85.6	83.5	0.3	1.4	0.2	2.1

Date	18-Jul																	19-Jul									
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	75	76	78	82	85	88	90	92	92	92	90	89	87	86	84	82	81	80	79	78	78	77	77	76		92	
	79.1	79.8	81.1	83.6	83.4	82.0	83.3	82.4	80.4	82.0	78.5	78.1	78.2	77.2	76.5	75.7	75.0	74.4	74.3	74.2	74.0	74.4	75.1	75.6	74.0	83.6	78.3

Date																			20-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	79	83	87	90	92	93	93	93	91	90	88	87	85	83	82	81	80	79	79	78	78	77		93	
	75.8	77.0	79.8	82.1	83.1	85.2	86.4	88.3	89.6	90.1	90.6	90.3	89.7	87.6	85.5	83.8	82.0	81.0	80.3	79.7	79.1	78.4	77.8	77.3	75.8	90.6	83.3

Date	20-Jul																	21-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	88	90	92	94	95	95	95	94	92	90	88	86	84	82	81	79	78	77	77	77	78		95	
	78.5	80.4	83.3	86.0	88.1	89.4	90.4	91.8	92.7	92.9	92.8	91.7	89.7	87.9	88.0	88.0	88.1	88.2	88.2	88.3	88.3	88.4	88.5	88.5	78.5	92.9	88.3

Date																		22-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	79	81	84	87	90	92	94	95	95	94	93	92	90	89	87	86	84	82	81	80	79	78	78	79		95	
	88.6	88.6	88.7	88.8	88.8	88.9	90.3	91.2	92.0	92.1	91.6	90.4	87.9	85.5	83.9	82.7	81.7	81.0	80.6	80.6	80.6	80.6	80.6	80.6	80.6	92.1	86.1

Date	22-Jul																	23-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	80	82	85	88	91	93	95	96	96	95	94	92	91	89	87	86	84	83	82	81	80	79	79	80		96	
	80.6	80.6	81.4	87.7	90.0	91.0	92.0	93.3	93.6	93.7	92.8	90.6	88.1	86.0	84.3	83.5	83.1	82.8	82.1	81.3	81.1	80.9	80.7	80.4	80.4	93.7	85.9

Date																		24-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	81	83	86	88	91	94	95	96	96	95	94	92	90	89	88	86	85	83	82	80	79	78	77	77		96	
	80.5	81.6	83.5	84.4	86.2	88.0	89.8	91.2	91.8	91.6	86.5	84.8	79.6	78.2	77.3	77.2	77.7	78.7	76.7	76.8	78.5	78.2	77.2	77.3	76.7	91.8	82.2

Date	24-Jul																	25-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										95	
	78.9	80.3	81.4	82.8	83.9	85.2	86.9	87.8	88.5	89.1	88.6	87.9	85.6	84.5	83.2	82.4	81.6	80.4	79.5	78.7	78.0	77.4	76.9	76.4	76.4	89.1	82.7

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/18/2018 7am	85.5	84.0	84.3	83.3	92.0	83.6	95	86.9	83.8	1.5	1.0	8.4	3.0

Date	19-Jul														20-Jul											
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	low	high	ave
Temperature (°F)	87	90	93	94	94	93	92	90	88	86	85	83	82	80	79	78	78	78	77	77	77	78	81	85		94	
	83.1	85.2	86.4	88.3	89.6	90.1	90.6	90.3	89.7	87.6	85.5	83.8	82.0	81.0	80.3	79.7	79.1	78.4	77.8	77.3	77.4	78.5	80.4	83.3	77.3	90.6	83.6
Date															21-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	88	91	93	95	96	96	96	94	93	90	87	85	82	81	80	79	79	78	78	77	77	78	81	84		96	
	86.0	88.1	89.4	90.4	91.8	92.7	92.9	92.8	91.7	89.7	87.9	88.0	88.0	88.1	88.2	88.2	88.3	88.3	88.4	88.5	88.5	88.6	88.6	88.7	86.0	92.9	89.2
Date	21-Jul														22-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	88	92	94	95	96	96	95	94	93	91	89	87	86	84	82	81	80	79	78	78	79	80	82	85		96	
	88.8	88.8	88.9	90.3	91.2	92.0	92.1	91.6	90.4	87.9	85.5	83.9	82.7	81.7	81.0	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	81.4	80.6	92.1	85.1
Date															23-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	88	91	94	96	97	97	96	95	94	92	90	88	87	85	83	81	80	79	78	78	79	80	82	85		97	
	87.7	90.0	91.0	92.0	93.3	93.6	93.7	92.8	90.6	88.1	86.0	84.3	83.5	83.1	82.8	82.1	81.3	81.1	80.9	80.7	80.4	80.5	81.6	83.5	80.4	93.7	86.0
Date	23-Jul														24-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	88	91	94	95	96	96	95	93	92	90	88	87	86	84	83	81	80	78	77	76	76	77	79	82		96	
	84.4	86.2	88.0	89.8	91.2	91.8	91.6	86.5	84.8	79.6	78.2	77.3	77.2	77.7	78.7	76.7	76.8	78.5	78.2	77.2	77.3	78.9	80.3	81.4	76.7	91.8	82.0
Date															25-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	86	89	92	94	94	93	92	90	88	86	84	83	82	82	81	80	80	79	78	78	78	79	81	83		94	
	82.8	83.9	85.2	86.9	87.8	88.5	89.1	88.6	87.9	85.6	84.5	83.2	82.4	81.6	80.4	79.5	78.7	78.0	77.4	76.9	76.4	76.8	78.9	80.5	76.4	89.1	82.6
Date	25-Jul														26-Jul												
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)																										92	
	82.2	83.9	84.7	85.6	86.5	87.6	88.1	88.2	87.8	86.9	84.3	85.4	84.6	80.5	78.4	78.0	78.7	77.9	78.2	78.7	78.3	78.7	80.6	83.3	77.9	88.2	82.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/19/2018 10am	85.8	84.8	85.7	86.0	94.0	90.6	92	86.7	84.5	1.1	-0.3	3.4	2.2

Date	20-Jul										21-Jul																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	low	high	ave
Temperature (°F)	96	96	94	92	90	88	86	84	82	80	80	79	79	79	78	77	77	78	81	85	89	92	95	96		96	
	91.8	92.7	92.9	92.8	91.7	89.7	87.9	88.0	88.0	88.1	88.2	88.2	88.3	88.3	88.4	88.5	88.5	88.6	88.6	88.7	88.8	88.8	88.9	90.3	87.9	92.9	89.4

Date											22-Jul																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	97	97	96	95	94	92	89	86	83	82	81	80	80	79	79	78	78	79	81	84	88	91	94	96		97	
	91.2	92.0	92.1	91.6	90.4	87.9	85.5	83.9	82.7	81.7	81.0	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	81.4	87.7	90.0	91.0	92.0	80.6	92.1	85.3

Date	22-Jul										23-Jul																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	97	97	96	95	93	90	88	87	85	83	82	80	79	78	78	78	78	79	81	84	88	91	93	95		97	
	93.3	93.6	93.7	92.8	90.6	88.1	86.0	84.3	83.5	83.1	82.8	82.1	81.3	81.1	80.9	80.7	80.4	80.5	81.6	83.5	84.4	86.2	88.0	89.8	80.4	93.7	85.5

Date											24-Jul																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	96	96	95	93	92	90	89	87	86	85	83	82	80	79	78	77	77	78	80	82	85	87	90	92		96	
	91.2	91.8	91.6	86.5	84.8	79.6	78.2	77.3	77.2	77.7	78.7	76.7	76.8	78.5	78.2	77.2	77.3	78.9	80.3	81.4	82.8	83.9	85.2	86.9	76.7	91.8	81.6

Date	24-Jul										25-Jul																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	92	91	89	88	87	85	84	83	82	81	80	80	79	78	77	77	77	78	80	83	85	88	90	92		92	
	87.8	88.5	89.1	88.6	87.9	85.6	84.5	83.2	82.4	81.6	80.4	79.5	78.7	78.0	77.4	76.9	76.4	76.8	78.9	80.5	82.2	83.9	84.7	85.6	76.4	89.1	82.5

Date											26-Jul																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	92	92	91	89	88	86	85	83	82	81	80	79	78	77	76	76	76	77	79	81	84	86	89	90		92	
	86.5	87.6	88.1	88.2	87.8	86.9	84.3	85.4	84.6	80.5	78.4	78.0	78.7	77.9	78.2	78.7	78.3	78.7	81.0	83.5	84.8	86.6	88.1	88.8	77.9	88.8	83.3

Date	26-Jul										27-Jul																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)																										91	
	89.5	90.1	90.4	90.2	88.3	84.3	81.2	79.7	78.8	78.2	77.3	76.6	76.2	76.5	75.3	75.7	76.8	77.4	82.0	84.1	85.5	87.2	87.7	89.2	75.3	90.4	82.4

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/20/2018 2pm	85.2	84.6	86.2	86.7	96.0	92.9	91	86.0	84.3	0.6	-0.5	3.1	1.7

Date	21-Jul															22-Jul										
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	87	91	94	95	97	97	98	98	97	96	94	91	88	86	84	83	83	82	81	80	79	79	80	83		98	
	88.7	88.8	88.8	88.9	90.3	91.2	92.0	92.1	91.6	90.4	87.9	85.5	83.9	82.7	81.7	81.0	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	80.6	92.1	85.4
Date																23-Jul										
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	87	90	92	93	94	95	97	98	98	96	94	90	87	84	82	81	81	81	80	80	79	79	80	81		98	
	81.4	87.7	90.0	91.0	92.0	93.3	93.6	93.7	92.8	90.6	88.1	86.0	84.3	83.5	83.1	82.8	82.1	81.3	81.1	80.9	80.7	80.4	80.5	81.6	80.4	93.7	85.9
Date	23-Jul															24-Jul										
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	83	86	88	91	92	93	94	94	94	93	91	89	87	85	84	83	82	82	81	80	79	78	78	80		94	
	83.5	84.4	86.2	88.0	89.8	91.2	91.8	91.6	86.5	84.8	79.6	78.2	77.3	77.2	77.7	78.7	76.7	76.8	78.5	78.2	77.2	77.3	78.9	80.3	76.7	91.8	82.1
Date																25-Jul										
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	83	86	88	90	91	92	92	92	91	90	88	86	83	81	80	79	79	78	77	76	75	75	76	79		92	
	81.4	82.8	83.9	85.2	86.9	87.8	88.5	89.1	88.6	87.9	85.6	84.5	83.2	82.4	81.6	80.4	79.5	78.7	78.0	77.4	76.9	76.4	76.8	78.9	76.4	89.1	82.6
Date	25-Jul															26-Jul										
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	83	86	89	90	91	91	91	91	90	89	87	85	83	81	80	79	78	78	78	77	76	76	77	80		91	
	80.5	82.2	83.9	84.7	85.6	86.5	87.6	88.1	88.2	87.8	86.9	84.3	85.4	84.6	80.5	78.4	78.0	78.7	77.9	78.2	78.7	78.3	78.7	81.0	77.9	88.2	82.7
Date																27-Jul										
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	84	88	90	91	92	92	92	92	91	90	88	86	84	81	80	80	79	79	79	78	77	77	78	81		92	
	83.5	84.8	86.6	88.1	88.8	89.5	90.1	90.4	90.2	88.3	84.3	81.2	79.7	78.8	78.2	77.3	76.6	76.2	76.5	75.3	75.7	76.8	77.4	82.0	75.3	90.4	82.3
Date	27-Jul															28-Jul										
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										92	
	84.1	85.5	87.2	87.7	89.2	89.7	90.3	90.8	86.5	83.7	80.9	78.9	77.8	76.7	76.2	75.5	75.4	75.3	75.2	77.2	76.2	76.5	78.8	81.2	75.2	90.8	81.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/21/2018 9am	85.6	83.5	87.3	84.5	98.0	92.1	92	86.5	83.2	2.1	2.9	5.9	3.3

Date	23-Jul																		24-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	81	82	83	85	87	88	89	91	92	94	95	94	92	89	87	85	84	83	82	82	81	80	80	79		95	
	80.4	80.5	81.6	83.5	84.4	86.2	88.0	89.8	91.2	91.8	91.6	86.5	84.8	79.6	78.2	77.3	77.2	77.7	78.7	76.7	76.8	78.5	78.2	77.2	76.7	91.8	82.4
Date																			25-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	78	78	80	83	86	89	90	92	93	94	94	93	91	90	88	86	84	82	81	81	80	80	80	78		94	
	77.3	78.9	80.3	81.4	82.8	83.9	85.2	86.9	87.8	88.5	89.1	88.6	87.9	85.6	84.5	83.2	82.4	81.6	80.4	79.5	78.7	78.0	77.4	76.9	76.9	89.1	82.8
Date	25-Jul																		26-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	77	80	84	87	90	92	93	94	94	94	93	92	90	88	85	83	81	80	79	78	77	76	76		94	
	76.4	76.8	78.9	80.5	82.2	83.9	84.7	85.6	86.5	87.6	88.1	88.2	87.8	86.9	84.3	85.4	84.6	80.5	78.4	78.0	78.7	77.9	78.2	78.7	76.4	88.2	82.4
Date																			27-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	78	80	83	86	90	92	94	95	95	93	92	90	88	86	84	83	81	80	79	78	77	76	76		95	
	78.3	78.7	81.0	83.5	84.8	86.6	88.1	88.8	89.5	90.1	90.4	90.2	88.3	84.3	81.2	79.7	78.8	78.2	77.3	76.6	76.2	76.5	75.3	75.7	75.3	90.4	82.4
Date	27-Jul																		28-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	78	80	83	87	90	92	94	95	95	94	92	91	89	87	85	84	82	81	80	79	78	77	77		95	
	76.8	77.4	82.0	84.1	85.5	87.2	87.7	89.2	89.7	90.3	90.8	86.5	83.7	80.9	78.9	77.8	76.7	76.2	75.5	75.4	75.3	75.2	77.2	76.2	75.2	90.8	81.5
Date																			29-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	79	81	83	86	88	91	92	93	93	92	91	89	88	86	85	83	82	81	80	79	78	77	77		93	
	76.5	78.8	81.2	83.2	86.0	87.7	88.6	90.0	91.1	90.6	91.0	88.5	84.6	80.4	78.1	78.3	78.3	77.2	78.1	75.9	76.0	75.7	75.7	75.7	75.7	91.1	82.0
Date	29-Jul																		30-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										93	
	75.5	77.0	79.2	80.4	82.5	84.5	84.2	85.3	86.6	84.9	85.7	81.4	80.4	78.4	77.2	77.5	77.4	76.6	76.0	75.6	75.1	75.1	74.9	75.2	74.9	86.6	79.4

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/23/2018 6am	85.2	82.2	85.5	82.5	95.0	91.8	93	86.3	81.8	2.9	3.0	3.2	4.5

Date	24-Jul																25-Jul									
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	80	83	86	88	90	91	92	92	92	91	90	89	87	85	83	82	81	81	81	80	80	79	78	79		92	
	80.3	81.4	82.8	83.9	85.2	86.9	87.8	88.5	89.1	88.6	87.9	85.6	84.5	83.2	82.4	81.6	80.4	79.5	78.7	78.0	77.4	76.9	76.4	76.8	76.4	89.1	82.6

Date																	26-Jul									
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	85	88	90	92	93	94	95	95	95	93	91	89	86	84	82	81	80	80	80	79	78	77	78		95	
	78.9	80.5	82.2	83.9	84.7	85.6	86.5	87.6	88.1	88.2	87.8	86.9	84.3	85.4	84.6	80.5	78.4	78.0	78.7	77.9	78.2	78.7	78.3	78.7	77.9	88.2	82.6

Date	26-Jul																27-Jul									
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	85	89	92	93	94	95	95	95	94	92	90	88	86	83	82	81	80	79	78	78	77	77	78		95	
	81.0	83.5	84.8	86.6	88.1	88.8	89.5	90.1	90.4	90.2	88.3	84.3	81.2	79.7	78.8	78.2	77.3	76.6	76.2	76.5	75.3	75.7	76.8	77.4	75.3	90.4	82.3

Date																	28-Jul									
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	83	86	89	92	94	95	95	94	93	91	89	88	86	85	83	82	81	80	79	78	78	78	80		95	
	82.0	84.1	85.5	87.2	87.7	89.2	89.7	90.3	90.8	86.5	83.7	80.9	78.9	77.8	76.7	76.2	75.5	75.4	75.3	75.2	77.2	76.2	76.5	78.8	75.2	90.8	81.6

Date	28-Jul																29-Jul									
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	82	84	87	90	92	94	95	95	94	93	92	90	89	87	85	83	82	80	79	78	77	77	78	79		95	
	81.2	83.2	86.0	87.7	88.6	90.0	91.1	90.6	91.0	88.5	84.6	80.4	78.1	78.3	78.3	77.2	78.1	75.9	76.0	75.7	75.7	75.7	75.5	77.0	75.5	91.1	81.8

Date																	30-Jul									
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	83	86	88	90	92	93	93	92	91	90	89	87	85	84	82	81	80	78	78	77	77	77	79		93	
	79.2	80.4	82.5	84.5	84.2	85.3	86.6	84.9	85.7	81.4	80.4	78.4	77.2	77.5	77.4	76.6	76.0	75.6	75.1	75.1	74.9	75.2	75.3	77.5	74.9	86.6	79.5

Date	30-Jul																31-Jul									
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										91	
	81.7	83.9	85.3	84.5	84.3	84.7	81.6	82.0	85.5	88.3	87.4	83.1	81.8	80.1	78.2	77.5	76.3	75.5	75.7	75.0	74.8	74.5	74.4	66.7	66.7	88.3	80.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/24/2018 8am	85.6	81.7	85.7	82.5	92.0	89.1	91	86.3	81.5	3.8	3.1	2.9	4.8

																									low	high	ave
Date	25-Jul																26-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	83	87	89	91	93	94	94	94	93	92	90	88	85	82	81	80	80	79	78	77	76	76	77		94	
	78.9	80.5	82.2	83.9	84.7	85.6	86.5	87.6	88.1	88.2	87.8	86.9	84.3	85.4	84.6	80.5	78.4	78.0	78.7	77.9	78.2	78.7	78.3	78.7	77.9	88.2	82.6
Date																	27-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	85	88	91	92	93	93	94	94	93	91	89	86	83	81	80	79	78	78	77	77	76	76	77		94	
	81.0	83.5	84.8	86.6	88.1	88.8	89.5	90.1	90.4	90.2	88.3	84.3	81.2	79.7	78.8	78.2	77.3	76.6	76.2	76.5	75.3	75.7	76.8	77.4	75.3	90.4	82.3
Date	27-Jul																28-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	85	89	92	94	95	96	96	95	94	92	89	87	85	83	82	81	80	79	78	77	77	77	78		96	
	82.0	84.1	85.5	87.2	87.7	89.2	89.7	90.3	90.8	86.5	83.7	80.9	78.9	77.8	76.7	76.2	75.5	75.4	75.3	75.2	77.2	76.2	76.5	78.8	75.2	90.8	81.6
Date																	29-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	83	87	90	92	94	95	95	94	93	91	89	88	86	85	84	82	81	80	78	77	77	77	78		95	
	81.2	83.2	86.0	87.7	88.6	90.0	91.1	90.6	91.0	88.5	84.6	80.4	78.1	78.3	78.3	77.2	78.1	75.9	76.0	75.7	75.7	75.7	75.5	77.0	75.5	91.1	81.8
Date	29-Jul																30-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	83	86	88	91	92	93	93	92	90	89	87	85	84	82	81	80	79	77	77	76	76	76	78		93	
	79.2	80.4	82.5	84.5	84.2	85.3	86.6	84.9	85.7	81.4	80.4	78.4	77.2	77.5	77.4	76.6	76.0	75.6	75.1	75.1	74.9	75.2	75.3	77.5	74.9	86.6	79.5
Date																	31-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	82	84	86	88	90	90	90	89	87	86	84	83	82	81	80	80	79	78	78	77	77	77	78		90	
	81.7	83.9	85.3	84.5	84.3	84.7	81.6	82.0	85.5	88.3	87.4	83.1	81.8	80.1	78.2	77.5	76.3	75.5	75.7	75.0	74.8	74.5	74.4	66.7	66.7	88.3	80.1
Date	31-Jul																1-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										89	
	85.0	92.7	90.6	82.1	75.7	76.5	78.8	79.7	81.1	79.5	78.5	77.9	77.3	77.1	76.3	76.1	75.9	74.7	74.0	73.2	72.6	73.3	74.6	75.7	72.6	92.7	78.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/25/2018 8am	84.6	81.3	85.1	82.2	94.0	88.2	89	85.3	80.9	3.3	3.0	5.8	4.4

Date	26-Jul															27-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	81	86	89	92	93	94	94	95	95	94	92	90	87	84	82	81	81	80	80	79	78	77	77	78		95	
	81.0	83.5	84.8	86.6	88.1	88.8	89.5	90.1	90.4	90.2	88.3	84.3	81.2	79.7	78.8	78.2	77.3	76.6	76.2	76.5	75.3	75.7	76.8	77.4	75.3	90.4	82.3

Date																28-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	84	88	90	92	93	94	94	93	92	90	88	86	84	82	81	80	79	79	78	78	77	77	78		94	
	82.0	84.1	85.5	87.2	87.7	89.2	89.7	90.3	90.8	86.5	83.7	80.9	78.9	77.8	76.7	76.2	75.5	75.4	75.3	75.2	77.2	76.2	76.5	78.8	75.2	90.8	81.6

Date	28-Jul															29-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	85	89	92	94	95	96	96	95	94	93	91	88	85	83	82	82	81	80	79	77	77	77	78		96	
	81.2	83.2	86.0	87.7	88.6	90.0	91.1	90.6	91.0	88.5	84.6	80.4	78.1	78.3	78.3	77.2	78.1	75.9	76.0	75.7	75.7	75.7	75.5	77.0	75.5	91.1	81.8

Date																30-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	83	86	89	91	93	93	92	91	90	88	86	84	83	82	81	80	79	78	78	77	77	77	78		93	
	79.2	80.4	82.5	84.5	84.2	85.3	86.6	84.9	85.7	81.4	80.4	78.4	77.2	77.5	77.4	76.6	76.0	75.6	75.1	75.1	74.9	75.2	75.3	77.5	74.9	86.6	79.5

Date	30-Jul															31-Jul										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	82	85	87	89	91	91	90	89	88	86	84	83	82	81	80	79	78	77	77	76	76	76	77		91	
	81.7	83.9	85.3	84.5	84.3	84.7	81.6	82.0	85.5	88.3	87.4	83.1	81.8	80.1	78.2	77.5	76.3	75.5	75.7	75.0	74.8	74.5	74.4	66.7	66.7	88.3	80.1

Date																1-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	81	84	86	88	90	90	90	89	88	86	84	82	81	79	77	76	75	74	73	73	73	74	76		90	
	85.0	92.7	90.6	82.1	75.7	76.5	78.8	79.7	81.1	79.5	78.5	77.9	77.3	77.1	76.3	76.1	75.9	74.7	74.0	73.2	72.6	73.3	74.6	75.7	72.6	92.7	78.3

Date	1-Aug															2-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										89	
	79.6	80.4	82.4	82.3	83.8	84.8	85.4	86.4	86.3	85.6	83.1	79.9	77.7	76.5	75.7	73.0	72.6	72.2	71.9	72.1	73.1	73.0	73.6	75.6	71.9	86.4	78.6

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/26/2018 8am	84.1	80.6	85.7	81.9	95.0	90.4	89	84.8	80.3	3.5	3.8	4.6	4.5

Date	27-Jul											28-Jul														
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	low	high	ave
Temperature (°F)	93	94	95	95	95	91	88	86	84	82	81	80	79	78	78	78	77	77	78	80	83	87	90	93		95	
	89.2	89.7	90.3	90.8	86.5	83.7	80.9	78.9	77.8	76.7	76.2	75.5	75.4	75.3	75.2	77.2	76.2	76.5	78.8	81.2	83.2	86.0	87.7	88.6	75.2	90.8	81.6
Date												29-Jul															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	94	95	95	94	93	91	89	86	84	82	81	80	80	79	78	77	77	77	79	81	84	87	89	91		95	
	90.0	91.1	90.6	91.0	88.5	84.6	80.4	78.1	78.3	78.3	77.2	78.1	75.9	76.0	75.7	75.7	75.7	75.5	77.0	79.2	80.4	82.5	84.5	84.2	75.5	91.1	81.2
Date	29-Jul											30-Jul															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	92	92	92	91	90	89	87	85	83	81	80	79	79	77	76	75	75	76	77	80	83	86	88	90		92	
	85.3	86.6	84.9	85.7	81.4	80.4	78.4	77.2	77.5	77.4	76.6	76.0	75.6	75.1	75.1	74.9	75.2	75.3	77.5	81.7	83.9	85.3	84.5	84.3	74.9	86.6	79.8
Date												31-Jul															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	92	92	91	90	88	86	85	83	82	81	80	79	78	78	77	76	76	76	77	79	81	83	86	87		92	
	84.7	81.6	82.0	85.5	88.3	87.4	83.1	81.8	80.1	78.2	77.5	76.3	75.5	75.7	75.0	74.8	74.5	74.4	66.7	85.0	92.7	90.6	82.1	75.7	66.7	92.7	80.4
Date	31-Jul											1-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	89	89	89	88	86	85	83	82	81	80	79	78	77	76	75	74	74	74	75	77	79	82	84	86		89	
	76.5	78.8	79.7	81.1	79.5	78.5	77.9	77.3	77.1	76.3	76.1	75.9	74.7	74.0	73.2	72.6	73.3	74.6	75.7	79.6	80.4	82.4	82.3	83.8	72.6	83.8	77.5
Date												2-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	89	89	89	88	86	85	83	82	81	79	78	77	76	75	74	74	74	76	78	80	83	86	88		89	
	84.8	85.4	86.4	86.3	85.6	83.1	79.9	77.7	76.5	75.7	73.0	72.6	72.2	71.9	72.1	73.1	73.0	73.6	76.0	78.2	79.6	81.6	83.7	85.1	71.9	86.4	78.6
Date	2-Aug											3-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)																										90	
	85.9	87.1	87.2	87.1	86.0	84.7	81.3	77.3	75.9	75.6	74.7	73.6	72.9	72.6	72.3	72.8	73.0	73.9	77.0	79.6	79.7	82.6	82.7	84.2	72.3	87.2	79.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/27/2018 1pm	83.1	79.9	84.6	80.9	95.0	90.8	90	84.1	79.8	3.3	3.7	4.2	4.4

Date	28-Jul																		29-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	77	78	80	82	84	86	88	90	92	94	93	92	90	89	88	87	86	85	84	83	82	81	80	78		94	
	76.5	78.8	81.2	83.2	86.0	87.7	88.6	90.0	91.1	90.6	91.0	88.5	84.6	80.4	78.1	78.3	78.3	77.2	78.1	75.9	76.0	75.7	75.7	75.7	75.7	91.1	82.0

Date																			30-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	79	81	83	84	86	88	89	91	93	92	91	90	89	88	86	85	84	83	82	81	80	79	78		93	
	75.5	77.0	79.2	80.4	82.5	84.5	84.2	85.3	86.6	84.9	85.7	81.4	80.4	78.4	77.2	77.5	77.4	76.6	76.0	75.6	75.1	75.1	74.9	75.2	74.9	86.6	79.4

Date	30-Jul																		31-Jul								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	79	81	82	84	86	87	89	91	93	92	91	90	89	87	86	85	84	83	82	81	80	79	78		93	
	75.3	77.5	81.7	83.9	85.3	84.5	84.3	84.7	81.6	82.0	85.5	88.3	87.4	83.1	81.8	80.1	78.2	77.5	76.3	75.5	75.7	75.0	74.8	74.5	74.5	88.3	80.6

Date																			1-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	78	80	81	82	84	85	86	88	89	88	87	85	84	83	82	81	80	79	78	77	76	75	74		89	
	74.4	66.7	85.0	92.7	90.6	82.1	75.7	76.5	78.8	79.7	81.1	79.5	78.5	77.9	77.3	77.1	76.3	76.1	75.9	74.7	74.0	73.2	72.6	73.3	66.7	92.7	77.9

Date	1-Aug																		2-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	77	79	81	83	86	87	88	88	88	87	86	85	83	82	81	79	78	77	76	75	74	74		88	
	74.6	75.7	79.6	80.4	82.4	82.3	83.8	84.8	85.4	86.4	86.3	85.6	83.1	79.9	77.7	76.5	75.7	73.0	72.6	72.2	71.9	72.1	73.1	73.0	71.9	86.4	78.7

Date																			3-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	77	79	82	84	86	88	88	88	87	85	84	82	81	80	79	78	77	76	75	75	74	74		88	
	73.6	76.0	78.2	79.6	81.6	83.7	85.1	85.9	87.1	87.2	87.1	86.0	84.7	81.3	77.3	75.9	75.6	74.7	73.6	72.9	72.6	72.3	72.8	73.0	72.3	87.2	79.1

Date	3-Aug																		4-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										87	
	73.9	77.0	79.6	79.7	82.6	82.7	84.2	84.2	83.3	79.5	82.0	83.4	82.5	79.7	78.5	77.3	77.1	77.0	76.8	76.8	77.4	76.5	77.6	76.7	73.9	84.2	79.4

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/28/2018 6am	83.0	79.6	85.1	80.7	94.0	91.1	87	83.6	79.6	3.4	4.4	2.9	4.0

Date	28-Jul			29-Jul																						
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	low	high	ave
Temperature (°F)	82	80	80	79	79	78	78	78	78	78	78	80	82	84	86	87	88	88	88	88	87	87	85	84		88	
	78.3	78.3	77.2	78.1	75.9	76.0	75.7	75.7	75.7	75.5	77.0	79.2	80.4	82.5	84.5	84.2	85.3	86.6	84.9	85.7	81.4	80.4	78.4	77.2	75.5	86.6	79.7
Date				30-Jul																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	82	81	79	78	78	78	77	77	77	77	78	81	84	88	90	91	91	92	92	91	90	88	86	85		92	
	77.5	77.4	76.6	76.0	75.6	75.1	75.1	74.9	75.2	75.3	77.5	81.7	83.9	85.3	84.5	84.3	84.7	81.6	82.0	85.5	88.3	87.4	83.1	81.8	74.9	88.3	80.4
Date	30-Jul			31-Jul																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	84	83	81	80	79	78	78	78	77	77	78	80	84	86	88	88	88	88	88	88	87	86	85	84		88	
	80.1	78.2	77.5	76.3	75.5	75.7	75.0	74.8	74.5	74.4	66.7	85.0	92.7	90.6	82.1	75.7	76.5	78.8	79.7	81.1	79.5	78.5	77.9	77.3	66.7	92.7	78.5
Date				1-Aug																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	83	82	80	79	78	76	75	75	75	75	75	76	78	80	83	85	86	87	87	87	86	85	84	83		87	
	77.1	76.3	76.1	75.9	74.7	74.0	73.2	72.6	73.3	74.6	75.7	79.6	80.4	82.4	82.3	83.8	84.8	85.4	86.4	86.3	85.6	83.1	79.9	77.7	72.6	86.4	79.2
Date	1-Aug			2-Aug																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	82	80	79	78	77	76	75	74	74	74	76	78	80	83	85	87	89	89	89	88	86	84	83	81		89	
	76.5	75.7	73.0	72.6	72.2	71.9	72.1	73.1	73.0	73.6	76.0	78.2	79.6	81.6	83.7	85.1	85.9	87.1	87.2	87.1	86.0	84.7	81.3	77.3	71.9	87.2	78.9
Date				3-Aug																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	80	79	78	77	76	75	74	74	74	74	74	76	79	81	84	86	88	88	88	87	85	84	83	81		88	
	75.9	75.6	74.7	73.6	72.9	72.6	72.3	72.8	73.0	73.9	77.0	79.6	79.7	82.6	82.7	84.2	84.2	83.3	79.5	82.0	83.4	82.5	79.7	78.5	72.3	84.2	78.2
Date	3-Aug			4-Aug																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)																										89	
	77.3	77.1	77.0	76.8	76.8	77.4	76.5	77.6	76.7	76.8	74.5	72.3	73.9	77.2	77.0	78.0	79.2	81.6	82.5	83.4	84.2	83.4	81.8	79.7	72.3	84.2	78.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/28/2018 9pm	81.9	79.2	83.1	79.6	88.0	86.6	89	82.9	79.0	2.8	3.6	1.4	3.9

Date	29-Jul																30-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	78	80	83	85	87	89	89	89	89	88	87	86	84	83	82	81	80	79	79	78	78	77	77	77		89	
	77.0	79.2	80.4	82.5	84.5	84.2	85.3	86.6	84.9	85.7	81.4	80.4	78.4	77.2	77.5	77.4	76.6	76.0	75.6	75.1	75.1	74.9	75.2	75.3	74.9	86.6	79.4
Date																	31-Jul									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	83	86	88	89	90	90	90	89	88	86	85	83	82	81	80	79	78	78	77	77	76	76		90	
	77.5	81.7	83.9	85.3	84.5	84.3	84.7	81.6	82.0	85.5	88.3	87.4	83.1	81.8	80.1	78.2	77.5	76.3	75.5	75.7	75.0	74.8	74.5	74.4	74.4	88.3	80.6
Date	31-Jul																1-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	88	88	88	87	87	86	86	85	84	83	82	80	79	78	77	77	76	76	75	75		88	
	66.7	85.0	92.7	90.6	82.1	75.7	76.5	78.8	79.7	81.1	79.5	78.5	77.9	77.3	77.1	76.3	76.1	75.9	74.7	74.0	73.2	72.6	73.3	74.6	66.7	92.7	77.9
Date																	2-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	76	78	80	83	85	87	87	88	87	87	86	84	83	82	81	79	78	77	76	75	75	74	75		88	
	75.7	79.6	80.4	82.4	82.3	83.8	84.8	85.4	86.4	86.3	85.6	83.1	79.9	77.7	76.5	75.7	73.0	72.6	72.2	71.9	72.1	73.1	73.0	73.6	71.9	86.4	78.6
Date	2-Aug																3-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	82	85	87	88	89	88	87	86	85	83	82	81	80	79	78	77	76	75	74	74	74		89	
	76.0	78.2	79.6	81.6	83.7	85.1	85.9	87.1	87.2	87.1	86.0	84.7	81.3	77.3	75.9	75.6	74.7	73.6	72.9	72.6	72.3	72.8	73.0	73.9	72.3	87.2	79.1
Date																	4-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	79	82	84	86	87	88	88	87	86	84	83	82	80	79	78	77	76	76	75	75	75	75		88	
	77.0	79.6	79.7	82.6	82.7	84.2	84.2	83.3	79.5	82.0	83.4	82.5	79.7	78.5	77.3	77.1	77.0	76.8	76.8	77.4	76.5	77.6	76.7	76.8	76.5	84.2	79.5
Date	4-Aug																5-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	74.5	72.3	73.9	77.2	77.0	78.0	79.2	81.6	82.5	83.4	84.2	83.4	81.8	79.7	79.0	78.6	77.0	78.2	79.3	79.7	80.1	79.5	78.6	77.9	72.3	84.2	79.0

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/29/2018 7am	81.6	79.2	82.5	79.3	89.0	86.6	88	82.5	79.2	2.4	3.2	2.4	3.4

Date	30-Jul											31-Jul															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	low	high	ave
Temperature (°F)	92	92	92	91	90	88	86	84	82	81	79	79	78	78	78	77	76	76	77	80	84	87	88	88		92	
	84.7	81.6	82.0	85.5	88.3	87.4	83.1	81.8	80.1	78.2	77.5	76.3	75.5	75.7	75.0	74.8	74.5	74.4	66.7	85.0	92.7	90.6	82.1	75.7	66.7	92.7	80.4

Date												1-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	87	86	85	84	84	84	83	82	80	78	77	76	75	74	74	74	73	73	74	76	79	81	83	85		87	
	76.5	78.8	79.7	81.1	79.5	78.5	77.9	77.3	77.1	76.3	76.1	75.9	74.7	74.0	73.2	72.6	73.3	74.6	75.7	79.6	80.4	82.4	82.3	83.8	72.6	83.8	77.5

Date	1-Aug											2-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	86	88	89	89	88	86	84	83	82	80	79	77	75	75	75	75	75	75	75	77	79	82	84	87		89	
	84.8	85.4	86.4	86.3	85.6	83.1	79.9	77.7	76.5	75.7	73.0	72.6	72.2	71.9	72.1	73.1	73.0	73.6	76.0	78.2	79.6	81.6	83.7	85.1	71.9	86.4	78.6

Date												3-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	89	89	88	87	85	84	82	81	80	79	78	77	76	75	74	74	74	75	77	79	82	84	86		89	
	85.9	87.1	87.2	87.1	86.0	84.7	81.3	77.3	75.9	75.6	74.7	73.6	72.9	72.6	72.3	72.8	73.0	73.9	77.0	79.6	79.7	82.6	82.7	84.2	72.3	87.2	79.2

Date	3-Aug											4-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	88	88	86	85	83	82	80	79	78	77	76	75	75	74	74	74	75	76	77	80	82	84	86		88	
	84.2	83.3	79.5	82.0	83.4	82.5	79.7	78.5	77.3	77.1	77.0	76.8	76.8	77.4	76.5	77.6	76.7	76.8	74.5	72.3	73.9	77.2	77.0	78.0	72.3	84.2	78.2

Date												5-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	89	89	89	88	87	86	85	83	82	81	80	79	78	77	77	77	78	79	80	82	85	87	89		89	
	79.2	81.6	82.5	83.4	84.2	83.4	81.8	79.7	79.0	78.6	77.0	78.2	79.3	79.7	80.1	79.5	78.6	77.9	79.5	81.2	84.2	85.8	85.0	82.5	77.0	85.8	80.9

Date	5-Aug											6-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)																										90	
	86.6	88.0	87.3	86.5	86.1	84.9	83.2	81.5	81.0	79.7	78.6	79.3	80.2	79.2	79.3	78.9	79.8	80.6	81.4	82.3	84.3	85.7	86.8	86.6	78.6	88.0	82.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
7/30/2018 1pm	81.4	79.1	81.3	78.9	92.0	92.7	90	82.6	79.7	2.2	2.5	-0.7	2.9

Date	31-Jul					1-Aug																				
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	low	high	ave
Temperature (°F)	81	80	78	78	77	77	77	76	76	76	75	75	76	77	80	82	84	86	86	87	87	86	85	84		87	
	77.9	77.3	77.1	76.3	76.1	75.9	74.7	74.0	73.2	72.6	73.3	74.6	75.7	79.6	80.4	82.4	82.3	83.8	84.8	85.4	86.4	86.3	85.6	83.1	72.6	86.4	79.1

Date						2-Aug																				
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	82	80	79	77	76	76	75	75	74	74	73	73	74	76	79	82	85	87	88	88	89	88	87	85		89	
	79.9	77.7	76.5	75.7	73.0	72.6	72.2	71.9	72.1	73.1	73.0	73.6	76.0	78.2	79.6	81.6	83.7	85.1	85.9	87.1	87.2	87.1	86.0	84.7	71.9	87.2	78.9

Date	2-Aug					3-Aug																				
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	83	82	80	79	77	76	76	76	76	76	75	74	75	77	81	85	87	88	89	88	88	87	86	85		89	
	81.3	77.3	75.9	75.6	74.7	73.6	72.9	72.6	72.3	72.8	73.0	73.9	77.0	79.6	79.7	82.6	82.7	84.2	84.2	83.3	79.5	82.0	83.4	82.5	72.3	84.2	78.2

Date						4-Aug																				
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	83	82	81	79	78	77	76	75	74	74	74	75	76	78	80	83	85	87	89	89	89	89	88	87		89	
	79.7	78.5	77.3	77.1	77.0	76.8	76.8	77.4	76.5	77.6	76.7	76.8	74.5	72.3	73.9	77.2	77.0	78.0	79.2	81.6	82.5	83.4	84.2	83.4	72.3	84.2	78.1

Date	4-Aug					5-Aug																				
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	86	85	84	83	82	81	80	79	78	77	77	77	78	80	83	85	88	90	91	92	92	91	89	88		92	
	81.8	79.7	79.0	78.6	77.0	78.2	79.3	79.7	80.1	79.5	78.6	77.9	79.5	81.2	84.2	85.8	85.0	82.5	86.6	88.0	87.3	86.5	86.1	84.9	77.0	88.0	82.0

Date						6-Aug																				
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	86	85	84	83	82	81	80	79	78	77	77	77	78	80	82	85	87	90	91	92	92	91	90	89		92	
	83.2	81.5	81.0	79.7	78.6	79.3	80.2	79.2	79.3	78.9	79.8	80.6	81.4	82.3	84.3	85.7	86.8	86.6	85.6	81.4	79.5	79.9	81.9	82.0	78.6	86.8	81.6

Date	6-Aug					7-Aug																				
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)																										92	
	81.2	80.0	80.1	79.4	78.9	77.8	78.2	78.8	77.7	77.4	76.7	77.4	78.6	80.7	83.0	85.6	84.8	85.3	86.5	86.1	85.9	88.4	85.3	77.0	76.7	88.4	81.3

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
7/31/2018 7pm	81.8	79.7	80.5	78.7	87.0	86.4	92	83.2	79.9	2.1	1.7	0.6	3.3

Date	1-Aug														2-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	80	82	83	84	85	86	86	86	85	83	82	80	79	77	76	76	75	75	75	74	74	74	75	78		86	
	80.4	82.4	82.3	83.8	84.8	85.4	86.4	86.3	85.6	83.1	79.9	77.7	76.5	75.7	73.0	72.6	72.2	71.9	72.1	73.1	73.0	73.6	76.0	78.2	71.9	86.4	78.6

Date															3-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	80	83	85	87	88	89	89	89	88	86	84	82	80	78	77	76	76	76	76	76	75	74	74	77		89	
	79.6	81.6	83.7	85.1	85.9	87.1	87.2	87.1	86.0	84.7	81.3	77.3	75.9	75.6	74.7	73.6	72.9	72.6	72.3	72.8	73.0	73.9	77.0	79.6	72.3	87.2	79.2

Date	3-Aug														4-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	80	84	86	88	89	89	88	88	87	85	84	82	80	79	78	78	77	77	76	75	74	74	75	76		89	
	79.7	82.6	82.7	84.2	84.2	83.3	79.5	82.0	83.4	82.5	79.7	78.5	77.3	77.1	77.0	76.8	76.8	77.4	76.5	77.6	76.7	76.8	74.5	72.3	72.3	84.2	79.1

Date															5-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	79	81	84	86	88	89	89	89	88	86	85	84	82	81	80	79	78	77	76	76	76	77	78	79		89	
	73.9	77.2	77.0	78.0	79.2	81.6	82.5	83.4	84.2	83.4	81.8	79.7	79.0	78.6	77.0	78.2	79.3	79.7	80.1	79.5	78.6	77.9	79.5	81.2	73.9	84.2	79.6

Date	5-Aug														6-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	82	84	86	88	89	90	90	90	89	88	87	86	84	83	82	81	80	79	78	77	77	77	78	80		90	
	84.2	85.8	85.0	82.5	86.6	88.0	87.3	86.5	86.1	84.9	83.2	81.5	81.0	79.7	78.6	79.3	80.2	79.2	79.3	78.9	79.8	80.6	81.4	82.3	78.6	88.0	82.6

Date															7-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	83	85	88	90	91	92	92	91	90	88	87	85	84	83	82	81	80	78	77	76	76	76	77	79		92	
	84.3	85.7	86.8	86.6	85.6	81.4	79.5	79.9	81.9	82.0	81.2	80.0	80.1	79.4	78.9	77.8	78.2	78.8	77.7	77.4	76.7	77.4	78.6	80.7	76.7	86.8	80.7

Date	7-Aug														8-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										92	
	83.0	85.6	84.8	85.3	86.5	86.1	85.9	88.4	85.3	77.0	72.2	73.1	73.4	73.1	73.2	73.6	72.8	72.5	72.6	73.6	73.3	75.1	74.7	79.3	72.2	88.4	78.4

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/1/2018 9am	81.9	80.0	80.6	79.0	86.0	86.4	92	83.3	79.7	1.9	1.6	-0.4	3.6

Date	2-Aug																3-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	76	78	81	84	87	89	90	91	91	91	90	88	86	84	81	79	78	78	77	77	77	76	75	75		91	
	76.0	78.2	79.6	81.6	83.7	85.1	85.9	87.1	87.2	87.1	86.0	84.7	81.3	77.3	75.9	75.6	74.7	73.6	72.9	72.6	72.3	72.8	73.0	73.9	72.3	87.2	79.1
Date																	4-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	83	87	88	89	89	89	88	88	87	86	84	82	79	77	77	76	76	76	76	75	74	74		89	
	77.0	79.6	79.7	82.6	82.7	84.2	84.2	83.3	79.5	82.0	83.4	82.5	79.7	78.5	77.3	77.1	77.0	76.8	76.8	77.4	76.5	77.6	76.7	76.8	76.5	84.2	79.5
Date	4-Aug																5-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	78	82	86	88	89	90	90	89	89	88	87	86	84	81	80	78	78	78	78	78	78	77	77		90	
	74.5	72.3	73.9	77.2	77.0	78.0	79.2	81.6	82.5	83.4	84.2	83.4	81.8	79.7	79.0	78.6	77.0	78.2	79.3	79.7	80.1	79.5	78.6	77.9	72.3	84.2	79.0
Date																	6-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	87	89	90	90	90	89	89	88	87	86	85	83	82	81	80	79	79	79	78	77	77		90	
	79.5	81.2	84.2	85.8	85.0	82.5	86.6	88.0	87.3	86.5	86.1	84.9	83.2	81.5	81.0	79.7	78.6	79.3	80.2	79.2	79.3	78.9	79.8	80.6	78.6	88.0	82.5
Date	6-Aug																7-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	85	88	90	91	92	92	92	92	91	90	88	85	83	81	80	79	79	78	78	77	76	76		92	
	81.4	82.3	84.3	85.7	86.8	86.6	85.6	81.4	79.5	79.9	81.9	82.0	81.2	80.0	80.1	79.4	78.9	77.8	78.2	78.8	77.7	77.4	76.7	77.4	76.7	86.8	80.9
Date																	8-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	81	85	89	92	93	93	93	92	92	91	89	88	85	83	81	80	79	78	78	78	77	76	76		93	
	78.6	80.7	83.0	85.6	84.8	85.3	86.5	86.1	85.9	88.4	85.3	77.0	72.2	73.1	73.4	73.1	73.2	73.6	72.8	72.5	72.6	73.6	73.3	75.1	72.2	88.4	78.6
Date	8-Aug																9-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										91	
	75.7	79.3	83.2	85.4	84.3	85.5	86.6	86.3	83.8	87.5	87.2	85.2	81.9	80.1	77.4	78.4	77.3	76.8	75.7	75.7	75.5	75.3	75.0	74.9	74.9	87.5	80.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/2/2018 7am	83.2	79.9	82.2	79.2	91.0	87.2	91	84.3	80.0	3.2	3.0	3.8	4.3

Date	3-Aug														4-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	83	85	87	88	88	89	90	90	90	88	84	83	81	79	78	78	77	77	76	76	75	75	76	79		90	
	79.7	82.6	82.7	84.2	84.2	83.3	79.5	82.0	83.4	82.5	79.7	78.5	77.3	77.1	77.0	76.8	76.8	77.4	76.5	77.6	76.7	76.8	74.5	72.3	72.3	84.2	79.1

Date															5-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	83	85	87	88	88	89	90	90	90	88	85	83	81	80	79	78	78	78	77	77	76	76	77	80		90	
	73.9	77.2	77.0	78.0	79.2	81.6	82.5	83.4	84.2	83.4	81.8	79.7	79.0	78.6	77.0	78.2	79.3	79.7	80.1	79.5	78.6	77.9	79.5	81.2	73.9	84.2	79.6

Date	5-Aug														6-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	84	86	88	89	89	90	91	91	91	88	85	83	81	80	78	78	77	77	76	76	75	75	76	80		91	
	84.2	85.8	85.0	82.5	86.6	88.0	87.3	86.5	86.1	84.9	83.2	81.5	81.0	79.7	78.6	79.3	80.2	79.2	79.3	78.9	79.8	80.6	81.4	82.3	78.6	88.0	82.6

Date															7-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	84	87	89	90	90	91	92	92	92	89	86	84	82	81	79	79	78	78	77	77	76	76	77	81		92	
	84.3	85.7	86.8	86.6	85.6	81.4	79.5	79.9	81.9	82.0	81.2	80.0	80.1	79.4	78.9	77.8	78.2	78.8	77.7	77.4	76.7	77.4	78.6	80.7	76.7	86.8	80.7

Date	7-Aug														8-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	86	88	91	92	92	93	94	94	94	91	87	85	83	81	80	79	79	78	77	77	76	76	77	81		94	
	83.0	85.6	84.8	85.3	86.5	86.1	85.9	88.4	85.3	77.0	72.2	73.1	73.4	73.1	73.2	73.6	72.8	72.5	72.6	73.6	73.3	75.1	75.7	79.3	72.2	88.4	78.4

Date															9-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	84	87	89	90	90	91	92	92	92	89	86	84	82	81	79	79	78	78	77	77	76	76	77	80		92	
	83.2	85.4	84.3	85.5	86.6	86.3	83.8	87.5	87.2	85.2	81.9	80.1	77.4	78.4	77.3	76.8	75.7	75.7	75.5	75.3	75.0	74.9	77.6	82.2	74.9	87.5	80.8

Date	9-Aug														10-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										91	
	84.2	85.6	87.4	85.0	84.9	80.4	77.6	79.3	81.0	80.4	78.6	77.2	76.2	75.7	75.2	75.1	75.6	75.5	75.5	75.4	76.1	76.2	76.9	80.9	75.1	87.4	79.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/3/2018 9am	83.2	80.2	82.5	80.4	90.0	84.2	91	84.3	80.0	3.0	2.0	5.8	4.3

Date	4-Aug															5-Aug										
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	84	86	88	88	89	89	90	89	90	88	85	83	81	80	79	79	78	78	77	77	76	76	77	80		90	
	73.9	77.2	77.0	78.0	79.2	81.6	82.5	83.4	84.2	83.4	81.8	79.7	79.0	78.6	77.0	78.2	79.3	79.7	80.1	79.5	78.6	77.9	79.5	81.2	73.9	84.2	79.6
Date																6-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	84	86	88	88	89	90	90	90	90	88	86	84	82	81	80	79	79	79	78	78	77	77	78	82		90	
	84.2	85.8	85.0	82.5	86.6	88.0	87.3	86.5	86.1	84.9	83.2	81.5	81.0	79.7	78.6	79.3	80.2	79.2	79.3	78.9	79.8	80.6	81.4	82.3	78.6	88.0	82.6
Date	6-Aug															7-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	86	88	90	90	91	91	92	91	92	90	87	85	82	82	80	80	79	79	78	78	77	77	78	82		92	
	84.3	85.7	86.8	86.6	85.6	81.4	79.5	79.9	81.9	82.0	81.2	80.0	80.1	79.4	78.9	77.8	78.2	78.8	77.7	77.4	76.7	77.4	78.6	80.7	76.7	86.8	80.7
Date																8-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	86	89	91	91	92	92	93	92	93	90	87	85	82	81	80	79	79	78	77	77	76	76	77	81		93	
	83.0	85.6	84.8	85.3	86.5	86.1	85.9	88.4	85.3	77.0	72.2	73.1	73.4	73.1	73.2	73.6	72.8	72.5	72.6	73.6	73.3	75.1	75.7	79.3	72.2	88.4	78.4
Date	8-Aug															9-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	86	88	91	91	92	92	93	92	93	90	88	85	83	82	80	80	80	79	78	78	77	77	78	81		93	
	83.2	85.4	84.3	85.5	86.6	86.3	83.8	87.5	87.2	85.2	81.9	80.1	77.4	78.4	77.3	76.8	75.7	75.7	75.5	75.3	75.0	74.9	77.6	82.2	74.9	87.5	80.8
Date																10-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	85	87	89	89	90	91	91	91	91	89	86	84	82	81	80	80	79	79	78	78	77	77	78	81		91	
	84.2	85.6	87.4	85.0	84.9	80.4	77.6	79.3	81.0	80.4	78.6	77.2	76.2	75.7	75.2	75.1	75.6	75.5	75.5	75.4	76.1	76.2	76.9	80.9	75.1	87.4	79.0
Date	10-Aug															11-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										90	
	83.6	83.9	80.1	77.4	78.9	74.8	76.7	78.2	78.8	79.7	78.3	77.1	76.6	76.1	75.8	75.4	74.7	74.2	74.1	74.5	74.4	74.3	75.9	79.5	74.1	83.9	77.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/4/2018 9am	83.9	80.2	83.5	81.0	90.0	84.2	90	84.8	79.8	3.8	2.6	5.8	5.0

Date	5-Aug																	6-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	76	79	83	86	89	89	89	90	91	90	91	89	86	84	82	81	80	79	79	78	78	78	77	77		91	
	79.5	81.2	84.2	85.8	85.0	82.5	86.6	88.0	87.3	86.5	86.1	84.9	83.2	81.5	81.0	79.7	78.6	79.3	80.2	79.2	79.3	78.9	79.8	80.6	78.6	88.0	82.5
Date																		7-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	85	87	90	90	90	91	92	91	92	90	87	85	82	81	80	79	79	78	78	78	77	77		92	
	81.4	82.3	84.3	85.7	86.8	86.6	85.6	81.4	79.5	79.9	81.9	82.0	81.2	80.0	80.1	79.4	78.9	77.8	78.2	78.8	77.7	77.4	76.7	77.4	76.7	86.8	80.9
Date	7-Aug																	8-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	85	88	90	90	91	92	92	92	93	90	87	84	82	81	79	79	78	78	77	77	76	76		93	
	78.6	80.7	83.0	85.6	84.8	85.3	86.5	86.1	85.9	88.4	85.3	77.0	72.2	73.1	73.4	73.1	73.2	73.6	72.8	72.5	72.6	73.6	73.3	75.1	72.2	88.4	78.6
Date																		9-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	90	90	90	91	92	91	92	89	86	84	81	80	78	78	78	77	76	76	76	75		92	
	75.7	79.3	83.2	85.4	84.3	85.5	86.6	86.3	83.8	87.5	87.2	85.2	81.9	80.1	77.4	78.4	77.3	76.8	75.7	75.7	75.5	75.3	75.0	74.9	74.9	87.5	80.6
Date	9-Aug																	10-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	83	86	88	88	89	90	90	90	91	88	85	83	81	80	79	78	78	77	77	77	76	76		91	
	77.6	82.2	84.2	85.6	87.4	85.0	84.9	80.4	77.6	79.3	81.0	80.4	78.6	77.2	76.2	75.7	75.2	75.1	75.6	75.5	75.5	75.4	76.1	76.2	75.1	87.4	79.1
Date																		11-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	83	85	87	87	88	88	89	88	89	87	84	83	80	80	79	78	78	77	77	77	76	76		89	
	76.9	80.9	83.6	83.9	80.1	77.4	78.9	74.8	76.7	78.2	78.8	79.7	78.3	77.1	76.6	76.1	75.8	75.4	74.7	74.2	74.1	74.5	74.4	74.3	74.1	83.9	77.3
Date	11-Aug																	12-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										91	
	75.9	79.5	82.8	85.0	86.3	86.3	82.3	76.5	76.4	79.0	80.2	80.2	79.4	77.8	77.2	76.8	76.5	76.3	75.9	74.6	74.6	74.3	74.4	74.8	74.3	86.3	78.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/5/2018 7am	83.3	79.8	83.8	80.6	91.0	88.0	91	84.4	79.6	3.5	3.2	3.0	4.8

Date	6-Aug																		7-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	77	78	81	84	87	89	89	90	90	90	90	89	87	85	83	82	80	79	79	78	78	78	77	76		90	
	80.6	81.4	82.3	84.3	85.7	86.8	86.6	85.6	81.4	79.5	79.9	81.9	82.0	81.2	80.0	80.1	79.4	78.9	77.8	78.2	78.8	77.7	77.4	76.7	76.7	86.8	81.0

Date																			8-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	80	83	87	89	91	91	92	92	91	90	88	86	84	83	81	80	79	78	78	77	77	76		92	
	77.4	78.6	80.7	83.0	85.6	84.8	85.3	86.5	86.1	85.9	88.4	85.3	77.0	72.2	73.1	73.4	73.1	73.2	73.6	72.8	72.5	72.6	73.6	73.3	72.2	88.4	78.7

Date	8-Aug																		9-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	80	83	87	89	89	90	91	91	91	90	89	87	85	83	81	80	79	78	77	77	76	76		91	
	75.1	75.7	79.3	83.2	85.4	84.3	85.5	86.6	86.3	83.8	87.5	87.2	85.2	81.9	80.1	77.4	78.4	77.3	76.8	75.7	75.7	75.5	75.3	75.0	75.0	87.5	80.6

Date																			10-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	79	81	84	87	89	90	91	91	90	89	87	86	84	83	82	80	79	78	77	77	76	76		91	
	74.9	77.6	82.2	84.2	85.6	87.4	85.0	84.9	80.4	77.6	79.3	81.0	80.4	78.6	77.2	76.2	75.7	75.2	75.1	75.6	75.5	75.5	75.4	76.1	74.9	87.4	79.0

Date	10-Aug																		11-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	79	81	83	85	87	88	89	89	88	87	86	85	83	82	81	80	79	78	78	77	76	76		89	
	76.2	76.9	80.9	83.6	83.9	80.1	77.4	78.9	74.8	76.7	78.2	78.8	79.7	78.3	77.1	76.6	76.1	75.8	75.4	74.7	74.2	74.1	74.5	74.4	74.1	83.9	77.4

Date																			12-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	79	81	83	85	87	88	89	89	89	88	87	86	85	83	82	81	80	79	77	77	76	76		89	
	74.3	75.9	79.5	82.8	85.0	86.3	86.3	82.3	76.5	76.4	79.0	80.2	80.2	79.4	77.8	77.2	76.8	76.5	76.3	75.9	74.6	74.6	74.3	74.4	74.3	86.3	78.4

Date	12-Aug																		13-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										91	
	74.8	75.9	79.0	81.8	84.0	85.3	86.7	87.5	88.8	90.2	90.7	90.4	89.3	86.7	85.0	81.5	83.5	82.6	75.9	74.2	74.4	73.6	73.6	75.2	73.6	90.7	82.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/6/2018 6am	82.9	79.2	83.4	80.1	90.0	86.8	91	84.1	79.6	3.7	3.3	3.2	4.5

Date	7-Aug																8-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	79	83	87	89	91	91	92	92	91	90	88	86	84	83	81	80	79	78	78	77	77	76	76	77		92	
	80.7	83.0	85.6	84.8	85.3	86.5	86.1	85.9	88.4	85.3	77.0	72.2	73.1	73.4	73.1	73.2	73.6	72.8	72.5	72.6	73.6	73.3	75.1	75.7	72.2	88.4	78.5

Date																	9-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	84	88	89	90	90	90	91	91	90	88	86	84	82	80	79	77	76	76	76	75	75	75	76		91	
	79.3	83.2	85.4	84.3	85.5	86.6	86.3	83.8	87.5	87.2	85.2	81.9	80.1	77.4	78.4	77.3	76.8	75.7	75.7	75.5	75.3	75.0	74.9	77.6	74.9	87.5	80.7

Date	9-Aug																10-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	82	85	88	89	90	90	89	88	87	87	85	84	82	80	79	78	78	77	77	76	76	76	77		90	
	82.2	84.2	85.6	87.4	85.0	84.9	80.4	77.6	79.3	81.0	80.4	78.6	77.2	76.2	75.7	75.2	75.1	75.6	75.5	75.5	75.4	76.1	76.2	76.9	75.1	87.4	79.1

Date																	11-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	80	83	86	88	90	91	91	90	89	88	86	85	83	82	81	79	78	77	76	75	75	75	76		91	
	80.9	83.6	83.9	80.1	77.4	78.9	74.8	76.7	78.2	78.8	79.7	78.3	77.1	76.6	76.1	75.8	75.4	74.7	74.2	74.1	74.5	74.4	74.3	75.9	74.1	83.9	77.3

Date	11-Aug																12-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	80	83	85	88	89	90	90	90	89	88	86	85	84	83	82	80	79	78	78	77	77	77	78		90	
	79.5	82.8	85.0	86.3	86.3	82.3	76.5	76.4	79.0	80.2	80.2	79.4	77.8	77.2	76.8	76.5	76.3	75.9	74.6	74.6	74.3	74.4	74.8	75.9	74.3	86.3	78.5

Date																	13-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	82	84	87	89	90	91	91	91	90	88	87	85	84	82	81	79	78	77	76	76	76	77	78		91	
	79.0	81.8	84.0	85.3	86.7	87.5	88.8	90.2	90.7	90.4	89.3	86.7	85.0	81.5	83.5	82.6	75.9	74.2	74.4	73.6	73.6	75.2	76.2	76.8	73.6	90.7	82.2

Date	13-Aug																14-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										92	
	79.3	81.7	83.8	85.7	87.2	88.1	88.9	89.7	88.8	88.0	87.2	85.2	83.2	80.8	79.5	77.8	78.3	77.9	78.0	77.8	77.1	76.6	76.6	78.0	76.6	89.7	82.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/7/2018 8am	83.0	79.4	82.9	79.4	92.0	88.4	92	84.3	79.8	3.6	3.6	3.6	4.5

Date	8-Aug																	9-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	75	79	84	88	90	91	91	92	92	92	90	88	86	83	81	80	79	79	79	78	77	76	75	75		92	
	75.7	79.3	83.2	85.4	84.3	85.5	86.6	86.3	83.8	87.5	87.2	85.2	81.9	80.1	77.4	78.4	77.3	76.8	75.7	75.7	75.5	75.3	75.0	74.9	74.9	87.5	80.6
Date																		10-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	83	86	89	91	91	91	90	89	88	87	86	84	82	80	79	78	77	77	77	76	75	75		91	
	77.6	82.2	84.2	85.6	87.4	85.0	84.9	80.4	77.6	79.3	81.0	80.4	78.6	77.2	76.2	75.7	75.2	75.1	75.6	75.5	75.5	75.4	76.1	76.2	75.1	87.4	79.1
Date	10-Aug																	11-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	80	84	88	90	91	91	91	91	91	89	88	86	84	82	80	79	78	78	77	77	77	76	76		91	
	76.9	80.9	83.6	83.9	80.1	77.4	78.9	74.8	76.7	78.2	78.8	79.7	78.3	77.1	76.6	76.1	75.8	75.4	74.7	74.2	74.1	74.5	74.4	74.3	74.1	83.9	77.3
Date																		12-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	80	83	86	88	90	91	91	90	89	88	87	85	84	83	81	80	79	78	77	76	76	76		91	
	75.9	79.5	82.8	85.0	86.3	86.3	82.3	76.5	76.4	79.0	80.2	80.2	79.4	77.8	77.2	76.8	76.5	76.3	75.9	74.6	74.6	74.3	74.4	74.8	74.3	86.3	78.5
Date	12-Aug																	13-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	82	85	87	90	91	92	92	91	90	88	87	85	84	83	81	80	79	78	77	76	76	76		92	
	75.9	79.0	81.8	84.0	85.3	86.7	87.5	88.8	90.2	90.7	90.4	89.3	86.7	85.0	81.5	83.5	82.6	75.9	74.2	74.4	73.6	73.6	75.2	76.2	73.6	90.7	82.2
Date																		14-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	82	85	88	91	92	93	93	92	91	89	88	86	85	83	82	81	80	78	77	76	76	76		93	
	76.8	79.3	81.7	83.8	85.7	87.2	88.1	88.9	89.7	88.8	88.0	87.2	85.2	83.2	80.8	79.5	77.8	78.3	77.9	78.0	77.8	77.1	76.6	76.6	76.6	89.7	82.3
Date	14-Aug																	15-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										93	
	78.0	79.4	82.1	84.4	86.7	88.2	88.7	89.6	90.1	90.3	90.6	86.0	82.1	79.9	78.5	77.6	77.0	76.8	76.9	76.8	75.8	75.4	75.7	76.9	75.4	90.6	81.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/8/2018 7am	83.4	80.0	83.1	79.0	92.0	87.5	93	84.8	80.2	3.4	4.1	4.5	4.5

Date	9-Aug																10-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	80	83	87	90	91	92	92	91	90	88	87	86	84	82	81	80	79	78	78	78	77	76	76		92	
	77.6	82.2	84.2	85.6	87.4	85.0	84.9	80.4	77.6	79.3	81.0	80.4	78.6	77.2	76.2	75.7	75.2	75.1	75.6	75.5	75.5	75.4	76.1	76.2	75.1	87.4	79.1

Date																	11-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	88	90	91	91	90	89	88	87	85	84	82	81	80	78	77	77	76	76	75	75	75		91	
	76.9	80.9	83.6	83.9	80.1	77.4	78.9	74.8	76.7	78.2	78.8	79.7	78.3	77.1	76.6	76.1	75.8	75.4	74.7	74.2	74.1	74.5	74.4	74.3	74.1	83.9	77.3

Date	11-Aug																12-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	83	86	88	90	91	92	92	91	90	88	86	84	83	82	81	79	78	77	77	77	76	76		92	
	75.9	79.5	82.8	85.0	86.3	86.3	82.3	76.5	76.4	79.0	80.2	80.2	79.4	77.8	77.2	76.8	76.5	76.3	75.9	74.6	74.6	74.3	74.4	74.8	74.3	86.3	78.5

Date																	13-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	81	84	88	90	92	93	93	91	90	88	86	84	83	82	81	81	80	79	78	77	77	77		93	
	75.9	79.0	81.8	84.0	85.3	86.7	87.5	88.8	90.2	90.7	90.4	89.3	86.7	85.0	81.5	83.5	82.6	75.9	74.2	74.4	73.6	73.6	75.2	76.2	73.6	90.7	82.2

Date	13-Aug																14-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	82	85	88	90	92	93	93	93	92	91	89	88	86	85	83	81	80	78	77	76	76	76		93	
	76.8	79.3	81.7	83.8	85.7	87.2	88.1	88.9	89.7	88.8	88.0	87.2	85.2	83.2	80.8	79.5	77.8	78.3	77.9	78.0	77.8	77.1	76.6	76.6	76.6	89.7	82.3

Date																	15-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	85	88	90	92	93	93	92	91	90	89	87	86	84	83	81	80	78	77	76	76	76		93	
	78.0	79.4	82.1	84.4	86.7	88.2	88.7	89.6	90.1	90.3	90.6	86.0	82.1	79.9	78.5	77.6	77.0	76.8	76.9	76.8	75.8	75.4	75.7	76.9	75.4	90.6	81.8

Date	15-Aug																16-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										93	
	76.9	80.9	83.4	85.7	87.2	88.4	89.3	89.5	87.6	81.2	79.7	79.7	78.7	77.9	77.9	77.5	77.6	77.3	77.4	77.6	77.5	77.4	77.0	77.0	76.9	89.5	80.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/9/2018 7am	83.7	80.2	83.1	78.3	92.0	87.4	93	85.0	80.3	3.5	4.8	4.6	4.7

																									low	high	ave
Date	10-Aug					11-Aug																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	85	83	80	79	78	77	76	76	75	76	75	75	76	80	85	87	90	90	89	89	89	87	89	87		90	
	78.3	77.1	76.6	76.1	75.8	75.4	74.7	74.2	74.1	74.5	74.4	74.3	75.9	79.5	82.8	85.0	86.3	86.3	82.3	76.5	76.4	79.0	80.2	80.2	74.1	86.3	78.2
Date						12-Aug																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	85	83	81	79	79	78	77	77	76	76	76	76	77	81	86	89	92	92	91	91	90	88	90	89		92	
	79.4	77.8	77.2	76.8	76.5	76.3	75.9	74.6	74.6	74.3	74.4	74.8	75.9	79.0	81.8	84.0	85.3	86.7	87.5	88.8	90.2	90.7	90.4	89.3	74.3	90.7	80.9
Date	12-Aug					13-Aug																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	86	84	81	80	79	78	77	77	76	77	76	76	77	82	88	91	95	95	93	94	93	91	93	91		95	
	86.7	85.0	81.5	83.5	82.6	75.9	74.2	74.4	73.6	73.6	75.2	76.2	76.8	79.3	81.7	83.8	85.7	87.2	88.1	88.9	89.7	88.8	88.0	87.2	73.6	89.7	82.0
Date						14-Aug																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	88	86	82	81	80	78	78	77	77	77	76	76	77	82	88	90	94	94	92	93	92	90	92	90		94	
	85.2	83.2	80.8	79.5	77.8	78.3	77.9	78.0	77.8	77.1	76.6	76.6	78.0	79.4	82.1	84.4	86.7	88.2	88.7	89.6	90.1	90.3	90.6	86.0	76.6	90.6	82.6
Date	14-Aug					15-Aug																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	88	85	82	80	79	78	78	77	76	77	76	76	77	82	88	90	94	94	92	93	92	90	92	90		94	
	82.1	79.9	78.5	77.6	77.0	76.8	76.9	76.8	75.8	75.4	75.7	76.9	76.9	80.9	83.4	85.7	87.2	88.4	89.3	89.5	87.6	81.2	79.7	79.7	75.4	89.5	80.8
Date						16-Aug																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	88	85	82	80	79	78	78	77	76	77	76	76	77	81	86	89	92	92	91	91	91	89	91	89		92	
	78.7	77.9	77.9	77.5	77.6	77.3	77.4	77.6	77.5	77.4	77.0	77.0	77.9	80.2	81.9	84.6	84.4	84.9	86.1	87.0	83.1	79.8	80.6		77.0	87.0	80.1
Date	16-Aug					17-Aug																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)																										92	
	80.0	79.2	78.2	77.3	76.9	77.1	77.0	76.8	77.1	77.3	76.7	76.0	76.3	79.0	84.2	85.3	85.8	80.9	80.2	74.1	76.6	78.4	78.8	77.1	74.1	85.8	78.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/10/2018 7pm	83.8	80.8	83.4	80.4	90.0	86.3	92	85.0	80.4	3.1	3.0	3.7	4.5

Date	11-Aug														12-Aug												
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	81	83	85	85	86	87	87	87	86	85	84	83	82	81	80	80	79	79	78	78	77	77	78	81		87	
	82.8	85.0	86.3	86.3	82.3	76.5	76.4	79.0	80.2	80.2	79.4	77.8	77.2	76.8	76.5	76.3	75.9	74.6	74.6	74.3	74.4	74.8	75.9	79.0	74.3	86.3	78.4
Date																13-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	85	89	90	91	92	92	92	92	90	88	86	84	83	81	79	78	77	77	77	77	76	76	77	80		92	
	81.8	84.0	85.3	86.7	87.5	88.8	90.2	90.7	90.4	89.3	86.7	85.0	81.5	83.5	82.6	75.9	74.2	74.4	73.6	73.6	75.2	76.2	76.8	79.3	73.6	90.7	82.2
Date	13-Aug															14-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	83	87	89	91	92	92	93	93	92	90	88	86	84	82	81	80	79	78	78	78	77	77	78	79		93	
	81.7	83.8	85.7	87.2	88.1	88.9	89.7	88.8	88.0	87.2	85.2	83.2	80.8	79.5	77.8	78.3	77.9	78.0	77.8	77.1	76.6	76.6	78.0	79.4	76.6	89.7	82.3
Date																15-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	82	84	87	90	92	93	93	92	91	90	89	87	85	84	82	81	80	79	78	77	77	77	79	80		93	
	82.1	84.4	86.7	88.2	88.7	89.6	90.1	90.3	90.6	86.0	82.1	79.9	78.5	77.6	77.0	76.8	76.9	76.8	75.8	75.4	75.7	76.9	76.9	80.9	75.4	90.6	81.8
Date	15-Aug															16-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	82	85	87	89	90	91	91	90	89	88	86	85	83	82	81	80	78	77	77	76	76	76	77	79		91	
	83.4	85.7	87.2	88.4	89.3	89.5	87.6	81.2	79.7	79.7	78.7	77.9	77.9	77.5	77.6	77.3	77.4	77.6	77.5	77.4	77.0	77.0	77.9	80.2	77.0	89.5	80.9
Date																17-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	82	84	86	89	90	91	91	90	89	88	86	85	83	82	80	79	78	77	76	76	76	77	78	80		91	
	81.9	84.6	84.4	84.9	86.1	87.0	83.1	79.8	80.6		80.0	79.2	78.2	77.3	76.9	77.1	77.0	76.8	77.1	77.3	76.7	76.0	76.3	79.0	76.0	87.0	79.9
Date	17-Aug															18-Aug											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										91	
	84.2	85.3	85.8	80.9	80.2	74.1	76.6	78.4	78.8	77.1	76.9	76.1	76.0	75.9	75.8	76.1	76.0	76.0	76.1	75.9	75.3	75.5	76.5	80.4	74.1	85.8	77.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/11/2018 9am	83.5	80.9	83.4	81.0	87.0	86.3	91	84.6	80.5	2.6	2.4	0.7	4.1

Date	12-Aug		13-Aug																								
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	low	high	ave
Temperature (°F)	80	79	79	78	78	78	77	77	76	77	80	83	86	88	89	90	91	91	91	90	88	86	84	82		91	
	83.5	82.6	75.9	74.2	74.4	73.6	73.6	75.2	76.2	76.8	79.3	81.7	83.8	85.7	87.2	88.1	88.9	89.7	88.8	88.0	87.2	85.2	83.2	80.8	73.6	89.7	81.8

Date			14-Aug																								
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	81	80	79	79	78	78	77	76	76	77	80	84	88	90	92	93	93	93	93	92	91	89	86	84		93	
	79.5	77.8	78.3	77.9	78.0	77.8	77.1	76.6	76.6	78.0	79.4	82.1	84.4	86.7	88.2	88.7	89.6	90.1	90.3	90.6	86.0	82.1	79.9	78.5	76.6	90.6	82.3

Date	14-Aug		15-Aug																								
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	81	80	78	78	77	77	76	76	76	77	80	82	85	87	88	89	90	91	91	89	87	84	83	81		91	
	77.6	77.0	76.8	76.9	76.8	75.8	75.4	75.7	76.9	76.9	80.9	83.4	85.7	87.2	88.4	89.3	89.5	87.6	81.2	79.7	79.7	78.7	77.9	77.9	75.4	89.5	80.5

Date			16-Aug																								
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	80	79	79	78	77	77	76	76	76	77	79	81	84	86	88	89	90	90	89	88	86	85	83	82		90	
	77.5	77.6	77.3	77.4	77.6	77.5	77.4	77.0	77.0	77.9	80.2	81.9	84.6	84.4	84.9	86.1	87.0	83.1	79.8	80.6		80.0	79.2	78.2	77.0	87.0	80.2

Date	16-Aug		17-Aug																								
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	81	80	79	78	77	76	76	76	77	78	80	82	84	86	88	90	90	90	89	88	86	85	84	83		90	
	77.3	76.9	77.1	77.0	76.8	77.1	77.3	76.7	76.0	76.3	79.0	84.2	85.3	85.8	80.9	80.2	74.1	76.6	78.4	78.8	77.1	76.9	76.1	76.0	74.1	85.8	78.3

Date			18-Aug																								
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	82	81	80	79	78	78	77	77	77	78	80	82	84	86	88	90	91	91	90	89	88	86	85	83		91	
	75.9	75.8	76.1	76.0	76.0	76.1	75.9	75.3	75.5	76.5	80.4	83.8	85.3	86.9	82.1	75.8	74.3	74.5	76.0	78.3	78.5	77.3	76.3	76.5	74.3	86.9	77.7

Date	18-Aug		19-Aug																								
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)																										91	
	75.7	76.1	75.9	75.8	76.4	76.6	76.7	76.2	75.8	76.5	80.4	84.3	84.9	78.3	79.6	81.2	80.5	79.1	79.4	74.0	75.9	75.9	75.7	75.5	74.0	84.9	77.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/12/2018 10pm	83.1	80.1	83.5	81.5	91.0	89.7	91	84.2	79.8	3.0	1.9	1.3	4.5

Date	14-Aug										15-Aug																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	low	high	ave
Temperature (°F)	94	94	94	93	92	90	87	85	82	81	81	80	80	79	78	77	77	78	82	86	90	92	93	93		94	
	89.6	90.1	90.3	90.6	86.0	82.1	79.9	78.5	77.6	77.0	76.8	76.9	76.8	75.8	75.4	75.7	76.9	76.9	80.9	83.4	85.7	87.2	88.4	89.3	75.4	90.6	82.0
Date											16-Aug																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	92	92	91	91	89	88	85	83	81	80	79	78	78	78	77	76	76	77	80	84	87	89	91	91		92	
	89.5	87.6	81.2	79.7	79.7	78.7	77.9	77.9	77.5	77.6	77.3	77.4	77.6	77.5	77.4	77.0	77.0	77.9	80.2	81.9	84.6	84.4	84.9	86.1	77.0	89.5	80.4
Date	16-Aug										17-Aug																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	91	91	90	88	87	85	83	81	80	78	77	77	77	77	77	76	76	77	80	83	87	89	90	91		91	
	87.0	83.1	79.8	80.6		80.0	79.2	78.2	77.3	76.9	77.1	77.0	76.8	77.1	77.3	76.7	76.0	76.3	79.0	84.2	85.3	85.8	80.9	80.2	76.0	87.0	79.6
Date											18-Aug																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	91	91	91	89	88	86	84	83	81	80	80	79	79	78	78	77	77	78	81	84	87	89	90	91		91	
	74.1	76.6	78.4	78.8	77.1	76.9	76.1	76.0	75.9	75.8	76.1	76.0	76.0	76.1	75.9	75.3	75.5	76.5	80.4	83.8	85.3	86.9	82.1	75.8	74.1	86.9	77.8
Date	18-Aug										19-Aug																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	91	91	91	90	89	87	85	82	80	80	79	79	79	79	78	77	77	78	80	84	87	89	90	91		91	
	74.3	74.5	76.0	78.3	78.5	77.3	76.3	76.5	75.7	76.1	75.9	75.8	76.4	76.6	76.7	76.2	75.8	76.5	80.4	84.3	84.9	78.3	79.6	81.2	74.3	84.9	77.6
Date											20-Aug																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	91	91	91	90	89	87	85	83	81	80	80	79	79	78	78	77	77	78	81	85	88	90	91	92		92	
	80.5	79.1	79.4	74.0	75.9	75.9	75.7	75.5	75.7	75.1	74.9	75.3	75.1	74.9	75.2	75.7	75.5	76.9	81.4	84.7	85.7	87.1	88.4	82.4	74.0	88.4	78.3
Date	20-Aug										21-Aug																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)																										92	
	77.1	80.0	80.7	78.1	76.7	76.5	76.0	75.6	76.0	76.2	76.8	77.0	76.6	76.3	76.5	76.8	77.6	78.3	79.6	83.6	85.7	87.8	89.0	89.6	75.6	89.6	79.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/14/2018 2pm	84.1	79.3	84.2	80.7	94.0	90.6	92	85.2	79.3	4.8	3.5	3.4	5.9

Date	15-Aug																16-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	81	87	91	93	94	94	94	94	94	92	90	87	85	83	81	80	79	78	78	78	77	76	76	77		94	
	80.9	83.4	85.7	87.2	88.4	89.3	89.5	87.6	81.2	79.7	79.7	78.7	77.9	77.9	77.5	77.6	77.3	77.4	77.6	77.5	77.4	77.0	77.0	77.9	77.0	89.5	80.9
Date																	17-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	85	89	91	92	92	92	91	91	90	88	87	85	83	81	80	79	78	78	78	77	76	76	77		92	
	80.2	81.9	84.6	84.4	84.9	86.1	87.0	83.1	79.8	80.6		80.0	79.2	78.2	77.3	76.9	77.1	77.0	76.8	77.1	77.3	76.7	76.0	76.3	76.0	87.0	79.9
Date	17-Aug																18-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	84	87	89	91	91	91	90	90	89	87	86	84	82	80	79	78	78	77	77	76	76	76	78		91	
	79.0	84.2	85.3	85.8	80.9	80.2	74.1	76.6	78.4	78.8	77.1	76.9	76.1	76.0	75.9	75.8	76.1	76.0	76.0	76.1	75.9	75.3	75.5	76.5	74.1	85.8	77.9
Date																	19-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	84	87	89	90	91	91	91	90	89	88	86	85	83	82	81	81	80	80	79	78	77	77	78		91	
	80.4	83.8	85.3	86.9	82.1	75.8	74.3	74.5	76.0	78.3	78.5	77.3	76.3	76.5	75.7	76.1	75.9	75.8	76.4	76.6	76.7	76.2	75.8	76.5	74.3	86.9	77.8
Date	19-Aug																20-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	84	87	90	91	91	91	90	90	89	87	86	84	82	81	80	79	79	79	79	78	77	77	78		91	
	80.4	84.3	84.9	78.3	79.6	81.2	80.5	79.1	79.4	74.0	75.9	75.9	75.7	75.5	75.7	75.1	74.9	75.3	75.1	74.9	75.2	75.7	75.5	76.9	74.0	84.9	77.5
Date																	21-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	84	87	90	91	91	92	92	91	90	88	86	84	82	81	80	79	78	78	78	77	76	76	77		92	
	81.4	84.7	85.7	87.1	88.4	82.4	77.1	80.0	80.7	78.1	76.7	76.5	76.0	75.6	76.0	76.2	76.8	77.0	76.6	76.3	76.5	76.8	77.6	78.3	75.6	88.4	79.1
Date	21-Aug																22-Aug										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										92	
	79.6	83.6	85.7	87.8	89.0	89.6	90.6	91.1	91.2	90.9	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	88.6	79.6	91.2	89.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average			Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual		6day	3day	24 hr high	7 day
8/15/2018 8am	83.9	78.8	84.1	79.6	94.0	89.5	92	85.1	80.3		5.1	4.5	4.5	4.8

Date	**16-Aug**										**17-Aug**																
Hour (CDT)	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	low	high	ave
Temperature (°F)	91	90	89	87	85	84	82	81	80	78	78	77	77	77	77	76	76	77	80	84	87	90	91	91		91	
	87.0	83.1	79.8	80.6		80.0	79.2	78.2	77.3	76.9	77.1	77.0	76.8	77.1	77.3	76.7	76.0	76.3	79.0	84.2	85.3	85.8	80.9	80.2	76.0	87.0	79.6
Date											**18-Aug**																
Hour (CDT)	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**			
Temperature (°F)	91	90	88	87	86	85	83	82	81	80	79	78	78	78	77	76	76	77	80	83	86	89	90	90		91	
	74.1	76.6	78.4	78.8	77.1	76.9	76.1	76.0	75.9	75.8	76.1	76.0	76.0	76.1	75.9	75.3	75.5	76.5	80.4	83.8	85.3	86.9	82.1	75.8	74.1	86.9	77.8
Date	**18-Aug**										**19-Aug**																
Hour (CDT)	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**			
Temperature (°F)	90	89	88	87	86	84	83	82	81	80	79	79	79	78	78	77	77	78	81	84	87	89	90	90		90	
	74.3	74.5	76.0	78.3	78.5	77.3	76.3	76.5	75.7	76.1	75.9	75.8	76.4	76.6	76.7	76.2	75.8	76.5	80.4	84.3	84.9	78.3	79.6	81.2	74.3	84.9	77.6
Date											**20-Aug**																
Hour (CDT)	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**			
Temperature (°F)	90	89	89	87	86	84	83	81	80	79	79	79	78	78	77	76	76	77	80	83	87	89	90	91		91	
	80.5	79.1	79.4	74.0	75.9	75.9	75.7	75.5	75.7	75.1	74.9	75.3	75.1	74.9	75.2	75.7	75.5	76.9	81.4	84.7	85.7	87.1	88.4	82.4	74.0	88.4	78.3
Date	**20-Aug**										**21-Aug**																
Hour (CDT)	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**			
Temperature (°F)	91	91	91	89	88	86	84	83	81	80	80	79	79	78	78	77	77	78	81	85	88	90	91	92		92	
	77.1	80.0	80.7	78.1	76.7	76.5	76.0	75.6	76.0	76.2	76.8	77.0	76.6	76.3	76.5	76.8	77.6	78.3	79.6	83.6	85.7	87.8	89.0	89.6	75.6	89.6	79.3
Date											**22-Aug**																
Hour (CDT)	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**			
Temperature (°F)	92	92	92	91	90	88	86	84	82	80	78	78	78	78	78	77	76	77	79	83	87	89	90	91		92	
	90.6	91.1	91.2	90.9	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	88.6	79.5	81.1	82.7	83.7	84.7	86.1	79.5	91.2	88.6
Date	**22-Aug**										**23-Aug**																
Hour (CDT)	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**			
Temperature (°F)																										91	
	87.3	88.3	88.7	88.6	86.2	84.4	83.7	83.0	81.6	80.8	80.0	79.3	78.7	77.8	76.1	77.0	76.9	77.7	79.5	80.6	81.4	82.0	83.3	83.9	76.1	88.7	81.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/16/2018 2pm	83.3	80.2	82.9	78.3	91.0	87.0	91	84.4	80.5	3.1	4.6	4.0	3.9

Date	17-Aug																18-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	78	82	86	89	91	91	91	90	90	89	88	86	85	83	82	80	79	78	77	77	77	77	76	76		91	
	76.3	79.0	84.2	85.3	85.8	80.9	80.2	74.1	76.6	78.4	78.8	77.1	76.9	76.1	76.0	75.9	75.8	76.1	76.0	76.0	76.1	75.9	75.3	75.5	74.1	85.8	77.8
Date																		19-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	81	86	90	92	92	92	91	91	90	89	87	85	83	81	79	78	78	78	78	78	78	77	77		92	
	76.5	80.4	83.8	85.3	86.9	82.1	75.8	74.3	74.5	76.0	78.3	78.5	77.3	76.3	76.5	75.7	76.1	75.9	75.8	76.4	76.6	76.7	76.2	75.8	74.3	86.9	77.8
Date	19-Aug																	20-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	88	90	91	91	91	90	89	89	87	86	85	83	81	80	79	78	78	78	78	77	77		91	
	76.5	80.4	84.3	84.9	78.3	79.6	81.2	80.5	79.1	79.4	74.0	75.9	75.9	75.7	75.5	75.7	75.1	74.9	75.3	75.1	74.9	75.2	75.7	75.5	74.0	84.9	77.4
Date																		21-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	87	90	91	91	91	91	90	89	88	86	85	83	82	80	80	79	79	78	78	77	77		91	
	76.9	81.4	84.7	85.7	87.1	88.4	82.4	77.1	80.0	80.7	78.1	76.7	76.5	76.0	75.6	76.0	76.2	76.8	77.0	76.6	76.3	76.5	76.8	77.6	75.6	88.4	79.0
Date	21-Aug																	22-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	84	87	90	91	91	91	90	90	89	87	86	84	82	80	79	78	77	77	76	76	75	75		91	
	78.3	79.6	83.6	85.7	87.8	89.0	89.6	90.6	91.1	91.2	90.9	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	78.3	91.2	88.9
Date																		23-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	85	87	88	89	90	90	90	88	87	85	83	81	80	78	78	77	77	76	75	74	74		90	
	88.6	79.5	81.1	82.7	83.7	84.7	86.1	87.3	88.3	88.7	88.6	86.2	84.4	83.7	83.0	81.6	80.8	80.0	79.3	78.7	77.8	76.1	77.0	76.9	76.1	88.7	82.7
Date	23-Aug																	24-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										92	
	77.7	79.5	80.6	81.4	82.0	83.3	83.9	84.5	84.7	85.1	85.1	84.8	84.1	81.8	79.2	80.3	79.1	78.2	77.0	76.0	74.5	73.6	73.5	74.7	73.5	85.1	80.2

Date	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/17/2018 7am	83.3	80.6	83.5	77.7	91.0	85.8	92	84.5	80.6	2.7	5.8	5.2	4.0

																									low	high	ave
Date	18-Aug																	19-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	80	85	89	90	90	89	88	88	87	86	85	83	82	80	79	78	78	78	78	78	78	77	77		90	
	76.5	80.4	83.8	85.3	86.9	82.1	75.8	74.3	74.5	76.0	78.3	78.5	77.3	76.3	76.5	75.7	76.1	75.9	75.8	76.4	76.6	76.7	76.2	75.8	74.3	86.9	77.8
Date																		20-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	84	87	89	90	90	89	88	87	85	84	82	81	79	79	79	79	79	79	78	77	76	76		90	
	76.5	80.4	84.3	84.9	78.3	79.6	81.2	80.5	79.1	79.4	74.0	75.9	75.9	75.7	75.5	75.7	75.1	74.9	75.3	75.1	74.9	75.2	75.7	75.5	74.0	84.9	77.4
Date	20-Aug																	21-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	83	86	88	90	90	90	89	87	86	85	84	82	81	80	79	79	78	78	78	77	76	76		90	
	76.9	81.4	84.7	85.7	87.1	88.4	82.4	77.1	80.0	80.7	78.1	76.7	76.5	76.0	75.6	76.0	76.2	76.8	77.0	76.6	76.3	76.5	76.8	77.6	75.6	88.4	79.0
Date																		22-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	89	91	91	91	90	90	89	88	86	84	82	80	79	78	78	78	78	78	77	76		91	
	78.3	79.6	83.6	85.7	87.8	89.0	89.6	90.6	91.1	91.2	90.9	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	78.3	91.2	88.9
Date	22-Aug																	23-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	82	85	87	89	90	91	91	91	90	88	86	84	81	79	78	77	77	77	76	76	75	75		91	
	88.6	79.5	81.1	82.7	83.7	84.7	86.1	87.3	88.3	88.7	88.6	86.2	84.4	83.7	83.0	81.6	80.8	80.0	79.3	78.7	77.8	76.1	77.0	76.9	76.1	88.7	82.7
Date																		24-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	84	87	89	91	92	92	92	91	89	87	83	80	78	77	76	76	76	76	75	74	74		92	
	77.7	79.5	80.6	81.4	82.0	83.3	83.9	84.5	84.7	85.1	85.1	84.8	84.1	81.8	79.2	80.3	79.1	78.2	77.0	76.0	74.5	73.6	73.5	74.7	73.5	85.1	80.2
Date	24-Aug																	25-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										91	
	74.6	78.8	80.9	82.1	83.4	85.0	85.7	86.9	87.3	87.0	86.4	85.4	83.1	80.4	79.4	78.5	77.7	76.9	76.6	77.3	77.6	76.6	77.5	77.0	74.6	87.3	80.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/18/2018 7am	82.5	81.0	82.4	78.1	90.0	86.9	91	83.8	81.0	1.5	4.3	3.1	2.8

Date	20-Aug																		21-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	77	78	81	85	88	90	90	89	89	86	87	86	86	85	83	81	80	80	79	79	78	78	78	77		90	
	75.5	76.9	81.4	84.7	85.7	87.1	88.4	82.4	77.1	80.0	80.7	78.1	76.7	76.5	76.0	75.6	76.0	76.2	76.8	77.0	76.6	76.3	76.5	76.8	75.5	88.4	79.0

Date																			22-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	77	78	81	86	89	91	91	90	89	86	87	86	86	84	82	79	79	77	77	76	75	75	75	74		91	
	77.6	78.3	79.6	83.6	85.7	87.8	89.0	89.6	90.6	91.1	91.2	90.9	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	77.6	91.2	88.3

Date	22-Aug																		23-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	79	85	90	92	92	91	90	87	88	87	87	85	83	80	80	78	78	77	76	76	76	75		92	
	90.4	88.6	79.5	81.1	82.7	83.7	84.7	86.1	87.3	88.3	88.7	88.6	86.2	84.4	83.7	83.0	81.6	80.8	80.0	79.3	78.7	77.8	76.1	77.0	76.1	90.4	83.3

Date																			24-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	79	84	88	90	90	89	88	85	86	85	86	83	81	79	78	77	76	76	75	75	75	74		90	
	76.9	77.7	79.5	80.6	81.4	82.0	83.3	83.9	84.5	84.7	85.1	85.1	84.8	84.1	81.8	79.2	80.3	79.1	78.2	77.0	76.0	74.5	73.6	73.5	73.5	85.1	80.3

Date	24-Aug																		25-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	79	85	89	91	91	90	89	86	87	86	87	84	82	80	79	78	77	77	76	76	76	75		91	
	74.7	74.6	78.8	80.9	82.1	83.4	85.0	85.7	86.9	87.3	87.0	86.4	85.4	83.1	80.4	79.4	78.5	77.7	76.9	76.6	77.3	77.6	76.6	77.5	74.6	87.3	80.8

Date																			26-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	80	85	89	91	91	90	89	86	87	86	87	84	82	80	79	78	77	77	76	76	76	75		91	
	77.0	78.7	79.5	81.3	84.2	86.0	85.3	85.5	85.9	86.7	87.1	86.9	86.0	84.0	82.0	80.6	80.9	81.6	80.5	79.5	80.3	81.2	80.9	80.1	77.0	87.1	82.6

Date	26-Aug																		27-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										92	
	80.2	81.1	83.2	85.2	86.7	86.1	84.3	81.3	87.3	84.3	80.1	80.0	80.7	79.3	80.4	79.4	79.6	81.2	80.9	80.1	78.7	80.1	79.2	79.3	78.7	87.3	81.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/20/2018 6am	82.2	82.4	82.5	83.5	90.0	88.4	92	83.6	82.3	-0.2	-1.0	1.6	1.3

Date	21-Aug																		22-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	77	78	80	83	86	87	88	89	90	90	90	89	88	87	85	83	81	80	79	78	78	77	77	76		90	
	77.6	78.3	79.6	83.6	85.7	87.8	89.0	89.6	90.6	91.1	91.2	90.9	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	77.6	91.2	88.3

Date																			23-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	78	81	85	87	89	90	91	91	91	90	88	86	84	82	81	80	79	78	77	77	76	75		91	
	90.4	88.6	79.5	81.1	82.7	83.7	84.7	86.1	87.3	88.3	88.7	88.6	86.2	84.4	83.7	83.0	81.6	80.8	80.0	79.3	78.7	77.8	76.1	77.0	76.1	90.4	83.3

Date	23-Aug																		24-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	78	82	85	87	88	89	90	90	90	89	88	85	83	80	79	78	78	78	77	76	75	74		90	
	76.9	77.7	79.5	80.6	81.4	82.0	83.3	83.9	84.5	84.7	85.1	85.1	84.8	84.1	81.8	79.2	80.3	79.1	78.2	77.0	76.0	74.5	73.6	73.5	73.5	85.1	80.3

Date																			25-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	79	83	87	90	90	91	91	91	91	90	89	87	85	82	80	78	78	77	77	77	76	75		91	
	74.7	74.6	78.8	80.9	82.1	83.4	85.0	85.7	86.9	87.3	87.0	86.4	85.4	83.1	80.4	79.4	78.5	77.7	76.9	76.6	77.3	77.6	76.6	77.5	74.6	87.3	80.8

Date	25-Aug																		26-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	79	82	86	88	89	90	90	90	89	88	87	85	83	81	79	78	77	76	76	76	76	75		90	
	77.0	78.7	79.5	81.3	84.2	86.0	85.3	85.5	85.9	86.7	87.1	86.9	86.0	84.0	82.0	80.6	80.9	81.6	80.5	79.5	80.3	81.2	80.9	80.1	77.0	87.1	82.6

Date																			27-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	79	83	87	90	91	91	92	92	91	90	88	86	84	82	81	80	79	78	78	78	77	76		92	
	80.2	81.1	83.2	85.2	86.7	86.1	84.3	81.3	87.3	84.3	80.1	80.0	80.7	79.3	80.4	79.4	79.6	81.2	80.9	80.1	78.7	80.1	79.2	79.3	78.7	87.3	81.6

Date	27-Aug																		28-Aug								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										90	
	79.9	81.0	83.2	85.0	86.1	86.7	87.3	83.8	86.3	79.4	81.2	82.2	80.2	77.2	79.5	79.9	79.1	79.3	78.8	77.8	78.1	77.0	76.4	76.5	76.4	87.3	80.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/21/2018 6am	82.8	82.8	82.7	84.0	90.0	91.2	90	83.8	82.5	0.0	-1.3	-1.2	1.3

Date	23-Aug														24-Aug												
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	82	84	86	86	87	89	91	90	88	87	85	83	81	80	80	79	78	78	78	77	76	76	76	79		91	
	80.6	81.4	82.0	83.3	83.9	84.5	84.7	85.1	85.1	84.8	84.1	81.8	79.2	80.3	79.1	78.2	77.0	76.0	74.5	73.6	73.5	74.7	74.6	78.8	73.5	85.1	80.0

Date															25-Aug												
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	83	86	88	90	91	91	91	90	89	88	86	84	82	80	79	78	78	78	77	76	75	75	76	79		91	
	80.9	82.1	83.4	85.0	85.7	86.9	87.3	87.0	86.4	85.4	83.1	80.4	79.4	78.5	77.7	76.9	76.6	77.3	77.6	76.6	77.5	77.0	78.7	79.5	76.6	87.3	81.1

Date	25-Aug														26-Aug												
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	83	87	89	90	90	90	90	90	88	87	85	83	82	81	80	79	78	77	77	77	77	76	77	78		90	
	81.3	84.2	86.0	85.3	85.5	85.9	86.7	87.1	86.9	86.0	84.0	82.0	80.6	80.9	81.6	80.5	79.5	80.3	81.2	80.9	80.1	80.2	81.1	83.2	79.5	87.1	83.0

Date															27-Aug												
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	80	83	85	87	88	89	89	88	87	85	84	83	82	81	80	79	78	78	77	76	76	77	78	79		89	
	85.2	86.7	86.1	84.3	81.3	87.3	84.3	80.1	80.0	80.7	79.3	80.4	79.4	79.6	81.2	80.9	80.1	78.7	80.1	79.2	79.3	79.9	81.0	83.2	78.7	87.3	81.6

Date	27-Aug														28-Aug												
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	81	84	86	88	89	89	89	88	87	85	84	83	82	81	80	80	79	78	77	76	76	77	78	79		89	
	85.0	86.1	86.7	87.3	83.8	86.3	79.4	81.2	82.2	80.2	77.2	79.5	79.9	79.1	79.3	78.8	77.8	78.1	77.0	76.4	76.5	76.5	79.1	79.7	76.4	87.3	80.5

Date															29-Aug												
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	81	83	85	87	89	89	89	88	87	86	84	83	82	81	80	79	78	78	77	76	76	77	78	79		89	
	80.8	81.2	80.2	81.4	81.4	77.2	76.4	77.1	78.9	79.0	79.2	79.1	79.4	79.3	78.6	77.9	79.0	78.9	78.5	78.3	78.6	79.1	79.3	80.0	76.4	81.4	79.1

Date	29-Aug														30-Aug												
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										90	
	81.8	85.2	83.4	75.0	75.1	76.7	78.1	80.2	81.2	80.4	79.3	78.7	78.1	76.9	77.4	77.5	77.8	76.0	74.7	75.6	75.1	74.3	76.8	79.2	74.3	85.2	78.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/23/2018 9am	82.5	80.9	82.7	81.4	91.0	85.1	90	83.5	80.5	1.6	1.4	5.9	3.0

Date	24-Aug													25-Aug													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	low	high	ave
Temperature (°F)	86	88	89	90	91	92	91	89	86	84	82	80	79	79	78	78	77	76	76	75	76	79	82	85		92	
	83.4	85.0	85.7	86.9	87.3	87.0	86.4	85.4	83.1	80.4	79.4	78.5	77.7	76.9	76.6	77.3	77.6	76.6	77.5	77.0	78.7	79.5	81.3	84.2	76.6	87.3	81.2

Date														26-Aug													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	86	88	89	89	90	90	90	87	84	83	81	80	80	79	79	78	78	77	77	76	77	80	83	86		90	
	86.0	85.3	85.5	85.9	86.7	87.1	86.9	86.0	84.0	82.0	80.6	80.9	81.6	80.5	79.5	80.3	81.2	80.9	80.1	80.2	81.1	83.2	85.2	86.7	79.5	87.1	83.2

Date	26-Aug													27-Aug													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	87	87	88	89	89	90	90	88	85	84	82	81	80	80	79	78	77	77	76	75	76	78	81	83		90	
	86.1	84.3	81.3	87.3	84.3	80.1	80.0	80.7	79.3	80.4	79.4	79.6	81.2	80.9	80.1	78.7	80.1	79.2	79.3	79.9	81.0	83.2	85.0	86.1	78.7	87.3	81.6

Date														28-Aug													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	85	86	88	89	89	90	90	87	84	83	83	82	81	80	79	79	78	77	76	75	76	79	81	84		90	
	86.7	87.3	83.8	86.3	79.4	81.2	82.2	80.2	77.2	79.5	79.9	79.1	79.3	78.8	77.8	78.1	77.0	76.4	76.5	76.5	79.1	79.7	80.8	81.2	76.4	87.3	80.2

Date	28-Aug													29-Aug													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	85	86	87	88	89	90	90	87	84	83	83	82	81	81	80	79	78	78	77	76	77	79	81	83		90	
	80.2	81.4	81.4	77.2	76.4	77.1	78.9	79.0	79.2	79.1	79.4	79.3	78.6	77.9	79.0	78.9	78.5	78.3	78.6	79.1	79.3	80.0	81.8	85.2	76.4	85.2	79.3

Date														30-Aug													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)	84	86	87	88	89	90	89	87	84	83	83	82	81	80	79	79	78	77	76	75	76	78	81	83		90	
	83.4	75.0	75.1	76.7	78.1	80.2	81.2	80.4	79.3	78.7	78.1	76.9	77.4	77.5	77.8	76.0	74.7	75.6	75.1	74.3	76.8	79.2	79.9	77.2	74.3	83.4	77.7

Date	30-Aug													31-Aug													
Hour (CDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10			
Temperature (°F)																										91	
	76.5	76.7	77.6	79.9	80.3	81.3	82.7	81.9	80.4	80.0	79.6	78.9	79.2	79.2	78.7	77.3	76.9	77.4	76.6	77.7	78.4	79.5	80.3	78.5	76.5	82.7	79.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/24/2018 11am	82.6	80.5	82.7	82.0	92.0	87.3	91	83.8	80.3	2.1	0.7	4.7	3.5

Date	25-Aug												26-Aug														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	low	high	ave
Temperature (°F)	89	90	90	90	90	89	87	85	83	81	80	79	79	79	79	78	77	76	76	77	80	84	87	89		90	
	85.3	85.5	85.9	86.7	87.1	86.9	86.0	84.0	82.0	80.6	80.9	81.6	80.5	79.5	80.3	81.2	80.9	80.1	80.2	81.1	83.2	85.2	86.7	86.1	79.5	87.1	83.2

Date													27-Aug														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	91	91	91	91	90	88	86	85	83	82	81	80	79	78	78	78	77	76	76	77	80	84	87	90		91	
	84.3	81.3	87.3	84.3	80.1	80.0	80.7	79.3	80.4	79.4	79.6	81.2	80.9	80.1	78.7	80.1	79.2	79.3	79.9	81.0	83.2	85.0	86.1	86.7	78.7	87.3	81.6

Date	27-Aug												28-Aug														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	91	91	91	90	88	86	84	82	81	80	79	78	78	78	77	77	76	75	75	76	79	83	86	89		91	
	87.3	83.8	86.3	79.4	81.2	82.2	80.2	77.2	79.5	79.9	79.1	79.3	78.8	77.8	78.1	77.0	76.4	76.5	76.5	79.1	79.7	80.8	81.2	80.2	76.4	87.3	79.9

Date													29-Aug														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	90	91	91	91	90	88	86	84	82	81	80	79	79	78	78	78	77	76	76	77	79	83	86	88		91	
	81.4	81.4	77.2	76.4	77.1	78.9	79.0	79.2	79.1	79.4	79.3	78.6	77.9	79.0	78.9	78.5	78.3	78.6	79.1	79.3	80.0	81.8	85.2	83.4	76.4	85.2	79.5

Date	29-Aug												30-Aug														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	89	89	90	90	90	88	87	85	83	82	80	79	79	78	78	77	77	76	76	77	80	84	87	89		90	
	75.0	75.1	76.7	78.1	80.2	81.2	80.4	79.3	78.7	78.1	76.9	77.4	77.5	77.8	76.0	74.7	75.6	75.1	74.3	76.8	79.2	79.9	77.2	76.5	74.3	81.2	77.4

Date													31-Aug														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	90	91	91	91	91	90	89	87	84	82	80	79	78	77	77	77	76	75	75	76	79	83	87	89		91	
	76.7	77.6	79.9	80.3	81.3	82.7	81.9	80.4	80.0	79.6	78.9	79.2	79.2	78.7	77.3	76.9	77.4	76.6	77.7	78.4	79.5	80.3	78.5	79.5	76.6	82.7	79.1

Date	31-Aug												1-Sep														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)																										91	
	78.2	78.5	79.0	78.0	79.0	79.9	80.1	79.8	78.5	78.0	79.0	78.9	78.7	77.5	78.0	78.3	78.2	78.2	77.6	78.8	79.3	81.8	82.9	81.9	77.5	82.9	79.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/25/2018 12pm	82.9	80.1	82.8	81.6	90.0	87.1	91	84.0	80.0	2.8	1.2	2.9	4.1

Date	26-Aug																27-Aug										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	81	87	90	92	91	91	90	89	91	89	90	86	84	82	82	80	80	80	79	78	78	77	77		92	
	81.1	83.2	85.2	86.7	86.1	84.3	81.3	87.3	84.3	80.1	80.0	80.7	79.3	80.4	79.4	79.6	81.2	80.9	80.1	78.7	80.1	79.2	79.3	79.9	78.7	87.3	81.6
Date																		28-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	81	86	89	91	91	90	90	88	90	89	89	86	83	82	81	80	80	79	79	78	78	77	77		91	
	81.0	83.2	85.0	86.1	86.7	87.3	83.8	86.3	79.4	81.2	82.2	80.2	77.2	79.5	79.9	79.1	79.3	78.8	77.8	78.1	77.0	76.4	76.5	76.5	76.4	87.3	80.8
Date	28-Aug																	29-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	81	87	90	92	91	91	90	89	91	89	90	86	84	82	82	80	80	80	79	78	78	77	77		92	
	79.1	79.7	80.8	81.2	80.2	81.4	81.4	77.2	76.4	77.1	78.9	79.0	79.2	79.1	79.4	79.3	78.6	77.9	79.0	78.9	78.5	78.3	78.6	79.1	76.4	81.4	79.1
Date																		30-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	81	87	90	92	91	91	90	89	91	89	89	86	83	82	81	80	79	79	78	78	77	76	76		92	
	79.3	80.0	81.8	85.2	83.4	75.0	75.1	76.7	78.1	80.2	81.2	80.4	79.3	78.7	78.1	76.9	77.4	77.5	77.8	76.0	74.7	75.6	75.1	74.3	74.3	85.2	78.3
Date	30-Aug																	31-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	81	87	91	93	92	92	91	89	92	90	90	86	83	81	80	79	78	78	77	77	76	75	75		93	
	76.8	79.2	79.9	77.2	76.5	76.7	77.6	79.9	80.3	81.3	82.7	81.9	80.4	80.0	79.6	78.9	79.2	79.2	78.7	77.3	76.9	77.4	76.6	77.7	76.5	82.7	78.8
Date																		1-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	80	86	90	92	91	91	90	89	91	89	89	86	83	82	81	80	79	79	78	78	77	76	76		92	
	78.4	79.5	80.3	78.5	79.5	78.2	78.5	79.0	78.0	79.0	79.9	80.1	79.8	78.5	78.0	79.0	78.9	78.7	77.5	78.0	78.3	78.2	78.2	77.6	77.5	80.3	78.7
Date	1-Sep																	2-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										91	
	78.8	79.3	81.8	82.9	81.9	79.8	77.6	78.6	78.8	81.1	79.5	76.8	76.1	76.6	76.6	76.5	76.8	76.8	76.6	77.4	77.3	76.7	76.4	77.3	76.1	82.9	78.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/26/2018 7am	83.9	79.5	84.1	80.5	92.0	87.3	91	84.9	79.4	4.4	3.6	4.7	5.6

Date	27-Aug																28-Aug										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	81	88	91	93	93	92	92	90	92	91	90	88	86	84	84	82	82	82	81	81	80	79	79		93	
	81.0	83.2	85.0	86.1	86.7	87.3	83.8	86.3	79.4	81.2	82.2	80.2	77.2	79.5	79.9	79.1	79.3	78.8	77.8	78.1	77.0	76.4	76.5	76.5	76.4	87.3	80.8
Date																		29-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	79	83	88	90	92	92	91	91	89	91	90	89	88	86	84	83	82	82	81	81	81	80	79	79		92	
	79.1	79.7	80.8	81.2	80.2	81.4	81.4	77.2	76.4	77.1	78.9	79.0	79.2	79.1	79.4	79.3	78.6	77.9	79.0	78.9	78.5	78.3	78.6	79.1	76.4	81.4	79.1
Date	29-Aug																	30-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	79	82	87	90	91	91	90	90	88	90	89	88	87	85	83	82	81	81	80	80	80	79	78	78		91	
	79.3	80.0	81.8	85.2	83.4	75.0	75.1	76.7	78.1	80.2	81.2	80.4	79.3	78.7	78.1	76.9	77.4	77.5	77.8	76.0	74.7	75.6	75.1	74.3	74.3	85.2	78.3
Date																		31-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	82	87	90	92	92	91	91	89	91	90	89	87	85	83	82	81	80	80	79	79	78	77	77		92	
	76.8	79.2	79.9	77.2	76.5	76.7	77.6	79.9	80.3	81.3	82.7	81.9	80.4	80.0	79.6	78.9	79.2	79.2	78.7	77.3	76.9	77.4	76.6	77.7	76.5	82.7	78.8
Date	31-Aug																	1-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	81	86	89	91	91	90	90	88	90	89	88	87	85	83	82	81	81	80	80	80	79	78	78		91	
	78.4	79.5	80.3	78.5	79.5	78.2	78.5	79.0	78.0	79.0	79.9	80.1	79.8	78.5	78.0	79.0	78.9	78.7	77.5	78.0	78.3	78.2	78.2	77.6	77.5	80.3	78.7
Date																		2-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	82	87	90	92	92	91	91	89	91	90	89	87	85	83	83	81	81	81	80	80	79	78	78		92	
	78.8	79.3	81.8	82.9	81.9	79.8	77.6	78.6	78.8	81.1	79.5	76.8	76.1	76.6	76.6	76.5	76.8	76.8	76.6	77.4	77.3	76.7	76.4	77.3	76.1	82.9	78.3
Date	2-Sep																	3-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										91	
	76.1	78.4	73.9	73.5	74.8	77.4	78.2	79.1	80.6	80.6	80.1	80.2	79.8	78.9	76.3	76.6	77.4	77.8	78.3	77.4	78.4	78.5	79.7	79.8	73.5	80.6	78.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/27/2018 7am	84.9	79.0	85.3	79.4	93.0	87.3	91	85.8	78.8	5.9	5.9	5.7	7.0

Date	28-Aug																29-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	75	79	85	87	89	89	88	88	87	88	87	87	85	84	82	82	81	80	80	80	79	79	78	78		89	
	79.1	79.7	80.8	81.2	80.2	81.4	81.4	77.2	76.4	77.1	78.9	79.0	79.2	79.1	79.4	79.3	78.6	77.9	79.0	78.9	78.5	78.3	78.6	79.1	76.4	81.4	79.1

Date																	30-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	82	86	89	90	90	89	89	88	89	88	88	86	85	83	83	82	81	81	81	80	80	79	79		90	
	79.3	80.0	81.8	85.2	83.4	75.0	75.1	76.7	78.1	80.2	81.2	80.4	79.3	78.7	78.1	76.9	77.4	77.5	77.8	76.0	74.7	75.6	75.1	74.3	74.3	85.2	78.3

Date	30-Aug																31-Aug									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	79	82	86	89	90	90	89	89	88	89	88	88	86	85	83	83	82	81	81	81	80	80	79	79		90	
	76.8	79.2	79.9	77.2	76.5	76.7	77.6	79.9	80.3	81.3	82.7	81.9	80.4	80.0	79.6	78.9	79.2	79.2	78.7	77.3	76.9	77.4	76.6	77.7	76.5	82.7	78.8

Date																	1-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	79	83	87	90	91	91	90	89	88	90	89	89	87	85	83	83	81	81	80	80	80	79	78	78		91	
	78.4	79.5	80.3	78.5	79.5	78.2	78.5	79.0	78.0	79.0	79.9	80.1	79.8	78.5	78.0	79.0	78.9	78.7	77.5	78.0	78.3	78.2	78.2	77.6	77.5	80.3	78.7

Date	1-Sep																2-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	82	87	90	91	91	90	89	88	90	89	89	87	85	83	83	81	81	80	80	80	79	78	78		91	
	78.8	79.3	81.8	82.9	81.9	79.8	77.6	78.6	78.8	81.1	79.5	76.8	76.1	76.6	76.6	76.5	76.8	76.8	76.6	77.4	77.3	76.7	76.4	77.3	76.1	82.9	78.3

Date																	3-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	82	86	89	90	90	89	88	87	89	88	88	86	84	82	82	80	80	79	79	79	78	77	77		90	
	76.1	78.4	73.9	73.5	74.8	77.4	78.2	79.1	80.6	80.6	80.1	80.2	79.8	78.9	76.3	76.6	77.4	77.8	78.3	77.4	78.4	78.5	79.7	79.8	73.5	80.6	78.0

Date	3-Sep																4-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										91	
	80.1	81.0	82.9	84.3	85.0	85.4	85.6	85.8	84.8	82.1	79.1	79.3	77.6	79.2	80.3	80.4	80.2	80.2	80.8	79.0	78.8	79.2	78.5	77.5	77.5	85.8	81.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/28/2018 7am	84.1	78.5	84.0	78.7	89.0	81.4	91	85.1	78.9	5.6	5.3	7.6	6.2

Date	29-Aug											30-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	low	high	ave
Temperature (°F)	90	89	88	90	89	89	87	85	84	83	82	81	81	81	80	80	79	79	79	82	86	89	89	90		90	
	75.1	76.7	78.1	80.2	81.2	80.4	79.3	78.7	78.1	76.9	77.4	77.5	77.8	76.0	74.7	75.6	75.1	74.3	76.8	79.2	79.9	77.2	76.5	76.7	74.3	81.2	77.5

Date												31-Aug															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	90	90	89	90	88	89	86	84	83	83	81	81	80	80	79	79	78	78	78	81	85	88	88	89		90	
	77.6	79.9	80.3	81.3	82.7	81.9	80.4	80.0	79.6	78.9	79.2	79.2	78.7	77.3	76.9	77.4	76.6	77.7	78.4	79.5	80.3	78.5	79.5	78.2	76.6	82.7	79.2

Date	31-Aug											1-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	89	89	88	89	88	88	86	84	83	83	82	81	81	81	80	80	79	79	79	82	85	87	87	88		89	
	78.5	79.0	78.0	79.0	79.9	80.1	79.8	78.5	78.0	79.0	78.9	78.7	77.5	78.0	78.3	78.2	78.2	77.6	78.8	79.3	81.8	82.9	81.9	79.8	77.5	82.9	79.2

Date												2-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	88	87	88	87	87	85	83	82	81	80	79	79	79	78	78	77	77	77	80	84	87	87	88		88	
	77.6	78.6	78.8	81.1	79.5	76.8	76.1	76.6	76.6	76.5	76.8	76.8	76.6	77.4	77.3	76.7	76.4	77.3	76.1	78.4	73.9	73.5	74.8	77.4	73.5	81.1	77.0

Date	2-Sep											3-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	88	87	88	87	87	85	84	83	82	82	81	81	80	80	80	79	79	79	82	86	88	88	89		89	
	78.2	79.1	80.6	80.6	80.1	80.2	79.8	78.9	76.3	76.6	77.4	77.8	78.3	77.4	78.4	78.5	79.7	79.8	80.1	81.0	82.9	84.3	85.0	85.4	76.3	85.4	79.9

Date												4-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	89	89	88	89	88	88	86	84	83	83	82	81	81	81	80	80	79	79	79	82	86	88	88	89		89	
	85.6	85.8	84.8	82.1	79.1	79.3	77.6	79.2	80.3	80.4	80.2	80.2	80.8	79.0	78.8	79.2	78.5	77.5	76.9	76.9	78.2	79.8	80.7	81.4	76.9	85.8	80.1

Date	4-Sep											5-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)																										89	
	83.1	82.9	83.3	83.4	82.8	79.0	78.1	78.9	78.6	77.6	76.1	75.2	75.0	75.0	73.6	71.8	71.5	71.4	72.2	75.2	78.2	80.1	82.2	84.2	71.4	84.2	77.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/29/2018 1pm	83.9	78.8	84.3	78.6	90.0	81.2	89	84.7	78.7	5.2	5.7	8.8	6.0

Date	30-Aug		31-Aug																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	low	high	ave
Temperature (°F)	80	79	78	77	77	77	76	75	75	76	80	84	88	89	88	88	88	88	88	86	84	83	81	81		89	
	78.9	79.2	79.2	78.7	77.3	76.9	77.4	76.6	77.7	78.4	79.5	80.3	78.5	79.5	78.2	78.5	79.0	78.0	79.0	79.9	80.1	79.8	78.5	78.0	76.6	80.3	78.6

Date			1-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	80	79	78	77	77	78	77	76	75	76	79	83	87	88	87	87	87	87	87	86	84	82	80	79		88	
	79.0	78.9	78.7	77.5	78.0	78.3	78.2	78.2	77.6	78.8	79.3	81.8	82.9	81.9	79.8	77.6	78.6	78.8	81.1	79.5	76.8	76.1	76.6	76.6	76.1	82.9	78.8

Date	1-Sep		2-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	79	78	77	77	77	77	77	76	75	75	77	80	83	85	85	86	86	86	86	85	83	82	81	80		86	
	76.5	76.8	76.8	76.6	77.4	77.3	76.7	76.4	77.3	76.1	78.4	73.9	73.5	74.8	77.4	78.2	79.1	80.6	80.6	80.1	80.2	79.8	78.9	76.3	73.5	80.6	77.5

Date			3-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	80	80	79	79	78	77	76	75	75	76	78	80	82	85	87	88	88	88	87	85	84	82	81	81		88	
	76.6	77.4	77.8	78.3	77.4	78.4	78.5	79.7	79.8	80.1	81.0	82.9	84.3	85.0	85.4	85.6	85.8	84.8	82.1	79.1	79.3	77.6	79.2	80.3	76.6	85.8	80.7

Date	3-Sep		4-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	80	80	80	79	78	77	77	76	76	77	78	80	83	85	87	88	89	88	87	86	85	84	82	82		89	
	80.4	80.2	80.2	80.8	79.0	78.8	79.2	78.5	77.5	76.9	76.9	78.2	79.8	80.7	81.4	83.1	82.9	83.3	83.4	82.8	79.0	78.1	78.9	78.6	76.9	83.4	79.9

Date			5-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	81	80	80	79	78	77	76	76	76	76	78	79	82	84	85	87	87	87	87	86	85	83	82	81		87	
	77.6	76.1	75.2	75.0	75.0	73.6	71.8	71.5	71.4	72.2	75.2	78.2	80.1	82.2	84.2	85.0	86.5	87.3	87.3	86.9	84.2	81.0	79.3	78.5	71.4	87.3	79.0

Date	5-Sep		6-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)																										88	
	77.8	77.3	77.0	76.5	76.2	76.4	76.2	76.4	76.5	77.6	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	73.1	83.0	78.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/30/2018 10pm	81.4	79.1	81.3	78.3	89.0	80.3	88	82.3	78.9	2.3	3.0	8.7	3.4

Date	31-Aug																1-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	76	80	84	87	88	88	87	86	86	86	85	83	82	81	80	79	79	79	78	78	78	77	76	76		88	
	78.4	79.5	80.3	78.5	79.5	78.2	78.5	79.0	78.0	79.0	79.9	80.1	79.8	78.5	78.0	79.0	78.9	78.7	77.5	78.0	78.3	78.2	78.2	77.6	77.5	80.3	78.7

Date																	2-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	83	85	87	87	87	86	86	85	84	83	81	80	79	78	78	77	77	77	77	77	76	75		87	
	78.8	79.3	81.8	82.9	81.9	79.8	77.6	78.6	78.8	81.1	79.5	76.8	76.1	76.6	76.6	76.5	76.8	76.8	76.6	77.4	77.3	76.7	76.4	77.3	76.1	82.9	78.3

Date	2-Sep																3-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	83	86	87	87	86	86	86	86	85	84	83	81	79	78	78	78	78	78	77	77	76	76		87	
	76.1	78.4	73.9	73.5	74.8	77.4	78.2	79.1	80.6	80.6	80.1	80.2	79.8	78.9	76.3	76.6	77.4	77.8	78.3	77.4	78.4	78.5	79.7	79.8	73.5	80.6	78.0

Date																	4-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	80	82	84	86	88	88	88	87	86	84	83	82	82	81	80	80	79	78	77	76	76	76		88	
	80.1	81.0	82.9	84.3	85.0	85.4	85.6	85.8	84.8	82.1	79.1	79.3	77.6	79.2	80.3	80.4	80.2	80.2	80.8	79.0	78.8	79.2	78.5	77.5	77.5	85.8	81.1

Date	4-Sep																5-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	80	83	85	87	88	88	87	86	85	83	82	81	80	79	79	79	78	77	76	76	75	75		88	
	76.9	76.9	78.2	79.8	80.7	81.4	83.1	82.9	83.3	83.4	82.8	79.0	78.1	78.9	78.6	77.6	76.1	75.2	75.0	75.0	73.6	71.8	71.5	71.4	71.4	83.4	78.0

Date																	6-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	77	79	82	84	86	87	88	88	87	86	85	83	82	81	80	79	78	78	77	76	75	75	75		88	
	72.2	75.2	78.2	80.1	82.2	84.2	85.0	86.5	87.3	87.3	86.9	84.2	81.0	79.3	78.5	77.8	77.3	77.0	76.5	76.2	76.4	76.2	76.4	76.5	72.2	87.3	79.9

Date	6-Sep																7-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	77.6	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	76.4	75.9	76.3	76.3	76.1	75.8	75.4	75.4	74.8	73.1	83.0	77.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/31/2018 7am	81.2	79.0	81.3	78.3	88.0	80.3	88	82.2	78.8	2.2	2.9	7.7	3.4

Date	31-Aug		1-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	low	high	ave
Temperature (°F)	78	78	78	77	77	77	77	76	76	77	79	82	84	85	85	84	83	82	82	81	80	79	79	78		85	
	79.0	78.9	78.7	77.5	78.0	78.3	78.2	78.2	77.6	78.8	79.3	81.8	82.9	81.9	79.8	77.6	78.6	78.8	81.1	79.5	76.8	76.1	76.6	76.6	76.1	82.9	78.8

Date			2-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	78	77	77	77	77	77	77	76	75	76	78	82	85	85	84	83	83	84	85	84	82	80	79	78		85	
	76.5	76.8	76.8	76.6	77.4	77.3	76.7	76.4	77.3	76.1	78.4	73.9	73.5	74.8	77.4	78.2	79.1	80.6	80.6	80.1	80.2	79.8	78.9	76.3	73.5	80.6	77.5

Date	2-Sep		3-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	78	77	76	76	77	78	78	77	76	76	78	82	84	86	86	87	87	87	87	85	84	82	81	80		87	
	76.6	77.4	77.8	78.3	77.4	78.4	78.5	79.7	79.8	80.1	81.0	82.9	84.3	85.0	85.4	85.6	85.8	84.8	82.1	79.1	79.3	77.6	79.2	80.3	76.6	85.8	80.7

Date			4-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	80	79	79	78	77	77	76	76	76	77	78	80	82	84	86	87	87	86	85	84	82	81	80	79		87	
	80.4	80.2	80.2	80.8	79.0	78.8	79.2	78.5	77.5	76.9	76.9	78.2	79.8	80.7	81.4	83.1	82.9	83.3	83.4	82.8	79.0	78.1	78.9	78.6	76.9	83.4	79.9

Date	4-Sep		5-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	78	77	77	76	75	75	74	74	74	75	77	79	81	83	85	87	87	87	86	85	83	82	81	81		87	
	77.6	76.1	75.2	75.0	75.0	73.6	71.8	71.5	71.4	72.2	75.2	78.2	80.1	82.2	84.2	85.0	86.5	87.3	87.3	86.9	84.2	81.0	79.3	78.5	71.4	87.3	79.0

Date			6-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)	80	79	79	78	77	76	75	75	75	76	78	80	82	84	86	88	88	88	87	86	85	83	82	81		88	
	77.8	77.3	77.0	76.5	76.2	76.4	76.2	76.4	76.5	77.6	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	73.1	83.0	78.2

Date	6-Sep		7-Sep																							
Hour (CDT)	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Temperature (°F)																										88	
	76.4	75.9	76.3	76.3	76.1	75.8	75.4	75.4	74.8	76.3	78.9	80.5	81.2	81.2	78.5	80.3	80.9	82.3	80.7	81.1	80.0	77.6	76.2	76.8	74.8	82.3	78.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
8/31/2018 1pm	80.4	79.0	80.3	79.0	85.0	82.9	88	81.5	78.9	1.4	1.3	2.1	2.6

Date	1-Sep															2-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	79	82	84	85	85	84	83	82	81	80	79	78	78	77	77	77	77	77	77	77	77	76	75	76		85	
	79.3	81.8	82.9	81.9	79.8	77.6	78.6	78.8	81.1	79.5	76.8	76.1	76.6	76.6	76.5	76.8	76.8	76.6	77.4	77.3	76.7	76.4	77.3	76.1	76.1	82.9	78.1

Date																3-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	83	87	87	86	85	85	86	87	85	83	81	80	79	79	78	77	77	78	79	79	77	76	77		87	
	78.4	73.9	73.5	74.8	77.4	78.2	79.1	80.6	80.6	80.1	80.2	79.8	78.9	76.3	76.6	77.4	77.8	78.3	77.4	78.4	78.5	79.7	79.8	80.1	73.5	80.6	78.2

Date	3-Sep															4-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	84	87	88	88	87	87	87	87	86	84	82	81	81	80	80	80	79	78	77	77	76	76	77		88	
	81.0	82.9	84.3	85.0	85.4	85.6	85.8	84.8	82.1	79.1	79.3	77.6	79.2	80.3	80.4	80.2	80.2	80.8	79.0	78.8	79.2	78.5	77.5	76.9	76.9	85.8	81.0

Date																5-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	80	83	85	87	88	88	87	86	84	82	81	80	79	78	77	77	76	76	75	74	74	74	75		88	
	76.9	78.2	79.8	80.7	81.4	83.1	82.9	83.3	83.4	82.8	79.0	78.1	78.9	78.6	77.6	76.1	75.2	75.0	75.0	73.6	71.8	71.5	71.4	72.2	71.4	83.4	77.8

Date	5-Sep															6-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	77	79	81	83	85	87	87	87	86	85	84	83	82	81	80	79	78	77	77	76	75	75	75	76		87	
	75.2	78.2	80.1	82.2	84.2	85.0	86.5	87.3	87.3	86.9	84.2	81.0	79.3	78.5	77.8	77.3	77.0	76.5	76.2	76.4	76.2	76.4	76.5	77.6	75.2	87.3	80.2

Date																7-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	80	82	84	86	87	88	88	87	86	85	84	83	82	81	80	79	78	77	76	75	75	75	76		88	
	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	76.4	75.9	76.3	76.3	76.1	75.8	75.4	75.4	74.8	76.3	73.1	83.0	77.8

Date	7-Sep															8-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										89	
	78.9	80.5	81.2	81.2	78.5	80.3	80.9	82.3	80.7	81.1	80.0	77.6	76.2	76.8	76.0	75.6	75.2	76.9	76.4	73.8	76.8	75.4	73.7	75.1	73.7	82.3	78.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/1/2018 8am	80.8	78.8	80.9	79.1	85.0	82.9	89	82.0	78.7	2.0	1.8	2.1	3.2

Date	2-Sep																3-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	79	82	84	84	83	82	83	83	84	83	81	79	79	78	78	77	77	76	77	78	78	77	76		84	
	76.1	78.4	73.9	73.5	74.8	77.4	78.2	79.1	80.6	80.6	80.1	80.2	79.8	78.9	76.3	76.6	77.4	77.8	78.3	77.4	78.4	78.5	79.7	79.8	73.5	80.6	78.0

Date																	4-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	83	86	88	88	88	88	88	88	86	84	82	81	80	80	80	80	80	80	79	78	77	77		88	
	80.1	81.0	82.9	84.3	85.0	85.4	85.6	85.8	84.8	82.1	79.1	79.3	77.6	79.2	80.3	80.4	80.2	80.2	80.8	79.0	78.8	79.2	78.5	77.5	77.5	85.8	81.1

Date	4-Sep																5-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	85	86	87	86	86	86	85	84	82	81	80	80	80	80	79	78	78	77	76	75	75		87	
	76.9	76.9	78.2	79.8	80.7	81.4	83.1	82.9	83.3	83.4	82.8	79.0	78.1	78.9	78.6	77.6	76.1	75.2	75.0	75.0	73.6	71.8	71.5	71.4	71.4	83.4	78.0

Date																	6-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	77	79	81	83	85	86	87	87	87	87	86	85	84	83	81	80	79	78	77	76	75	75	75		87	
	72.2	75.2	78.2	80.1	82.2	84.2	85.0	86.5	87.3	87.3	86.9	84.2	81.0	79.3	78.5	77.8	77.3	77.0	76.5	76.2	76.4	76.2	76.4	76.5	72.2	87.3	79.9

Date	6-Sep																7-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	82	85	87	88	88	88	87	86	85	84	83	82	81	80	79	78	77	76	75	75	75		88	
	77.6	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	76.4	75.9	76.3	76.3	76.1	75.8	75.4	75.4	74.8	73.1	83.0	77.8

Date																	8-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	83	86	88	89	89	89	87	86	84	82	81	80	79	78	77	76	76	75	74	74	74		89	
	76.3	78.9	80.5	81.2	81.2	78.5	80.3	80.9	82.3	80.7	81.1	80.0	77.6	76.2	76.8	76.0	75.6	75.2	76.9	76.4	73.8	76.8	75.4	73.7	73.7	82.3	78.0

Date	8-Sep																9-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	75.1	77.7	80.1	81.9	83.6	83.9	85.3	84.2	84.5	82.8	82.7	78.5	78.0	76.6	75.4	75.6	75.8	75.5	75.3	75.4	74.8	74.6	74.4	74.2	74.2	85.3	78.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/2/2018 7am	81.1	78.8	81.0	79.0	84.0	80.6	88	82.1	78.8	2.3	2.0	3.4	3.3

Date	3-Sep															4-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	79	80	82	83	83	83	83	83	82	82	81	80	80	80	80	79	79	79	79	79	79	78	78	78		83	
	81.0	82.9	84.3	85.0	85.4	85.6	85.8	84.8	82.1	79.1	79.3	77.6	79.2	80.3	80.4	80.2	80.2	80.8	79.0	78.8	79.2	78.5	77.5	76.9	76.9	85.8	81.0
Date																	5-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	82	85	86	86	86	86	86	86	84	82	81	80	80	80	79	78	77	77	78	77	76	75	75		86	
	76.9	78.2	79.8	80.7	81.4	83.1	82.9	83.3	83.4	82.8	79.0	78.1	78.9	78.6	77.6	76.1	75.2	75.0	75.0	73.6	71.8	71.5	71.4	72.2	71.4	83.4	77.8
Date	5-Sep																6-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	77	80	82	83	83	84	84	86	86	85	84	82	81	80	79	79	78	78	77	77	76	76	75	75		86	
	75.2	78.2	80.1	82.2	84.2	85.0	86.5	87.3	87.3	86.9	84.2	81.0	79.3	78.5	77.8	77.3	77.0	76.5	76.2	76.4	76.2	76.4	76.5	77.6	75.2	87.3	80.2
Date																	7-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	76	78	80	82	84	85	86	86	85	84	83	82	81	80	79	79	78	77	77	76	75	75	75	76		86	
	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	76.4	75.9	76.3	76.3	76.1	75.8	75.4	75.4	74.8	76.3	73.1	83.0	77.8
Date	7-Sep																8-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	80	83	85	87	88	89	89	88	87	86	84	83	82	81	80	79	78	77	76	75	75	75	76		89	
	78.9	80.5	81.2	81.2	78.5	80.3	80.9	82.3	80.7	81.1	80.0	77.6	76.2	76.8	76.0	75.6	75.2	76.9	76.4	73.8	76.8	75.4	73.7	75.1	73.7	82.3	78.0
Date																	9-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	80	82	85	86	88	88	88	87	85	84	82	81	80	79	78	77	76	76	75	74	74	74	75		88	
	77.7	80.1	81.9	83.6	83.9	85.3	84.2	84.5	82.8	82.7	78.5	78.0	76.6	75.4	75.6	75.8	75.5	75.3	75.4	74.8	74.6	74.4	74.2	75.1	74.2	85.3	78.6
Date	9-Sep																10-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										88	
	78.0	81.5	82.3	85.0	86.7	88.0	86.2	86.3	86.8	84.9	83.0	80.5	79.5	78.2	77.5	77.6	77.2	75.3	75.0	75.0	74.9	74.5	74.1	74.8	74.1	88.0	80.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/3/2018 8am	80.6	78.9	80.5	79.6	83.0	85.8	88	81.7	79.1	1.8	0.9	-2.8	2.6

Date	3-Sep				4-Sep																						
Hour (CDT)	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	low	high	ave
Temperature (°F)	79	79	79	78	78	78	78	78	78	77	76	76	79	82	84	85	85	84	84	84	84	83	82	81		85	
	79.2	80.3	80.4	80.2	80.2	80.8	79.0	78.8	79.2	78.5	77.5	76.9	76.9	78.2	79.8	80.7	81.4	83.1	82.9	83.3	83.4	82.8	79.0	78.1	76.9	83.4	80.0

Date					5-Sep																						
Hour (CDT)	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19			
Temperature (°F)	80	79	79	78	78	78	77	77	76	76	75	75	78	81	84	85	86	87	87	87	87	85	84	82		87	
	78.9	78.6	77.6	76.1	75.2	75.0	75.0	73.6	71.8	71.5	71.4	72.2	75.2	78.2	80.1	82.2	84.2	85.0	86.5	87.3	87.3	86.9	84.2	81.0	71.4	87.3	79.0

Date	5-Sep				6-Sep																						
Hour (CDT)	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19			
Temperature (°F)	82	81	81	80	80	79	79	79	78	77	76	77	79	83	86	88	88	88	88	88	88	87	85	84		88	
	79.3	78.5	77.8	77.3	77.0	76.5	76.2	76.4	76.2	76.4	76.5	77.6	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	73.1	83.0	78.3

Date					7-Sep																						
Hour (CDT)	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19			
Temperature (°F)	83	82	81	80	79	79	78	77	76	76	76	77	79	81	83	85	87	88	89	89	88	87	86	84		89	
	77.0	76.5	76.4	75.9	76.3	76.3	76.1	75.8	75.4	75.4	74.8	76.3	78.9	80.5	81.2	81.2	78.5	80.3	80.9	82.3	80.7	81.1	80.0	77.6	74.8	82.3	78.2

Date	7-Sep				8-Sep																						
Hour (CDT)	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19			
Temperature (°F)	83	82	81	80	79	78	77	75	74	74	74	75	77	79	82	84	86	88	88	88	87	85	84	82		88	
	76.2	76.8	76.0	75.6	75.2	76.9	76.4	73.8	76.8	75.4	73.7	75.1	77.7	80.1	81.9	83.6	83.9	85.3	84.2	84.5	82.8	82.7	78.5	78.0	73.7	85.3	78.8

Date					9-Sep																						
Hour (CDT)	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19			
Temperature (°F)	81	80	79	79	78	77	76	75	74	74	74	75	77	79	82	84	86	88	88	88	87	85	84	82		88	
	76.6	75.4	75.6	75.8	75.5	75.3	75.4	74.8	74.6	74.4	74.2	75.1	78.0	81.5	82.3	85.0	86.7	88.0	86.2	86.3	86.8	84.9	83.0	80.5	74.2	88.0	79.7

Date	9-Sep				10-Sep																						
Hour (CDT)	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19			
Temperature (°F)																										88	
	79.5	78.2	77.5	77.6	77.2	75.3	75.0	75.0	74.9	74.5	74.1	74.8	78.7	81.2	83.4	84.3	84.5	84.1	78.3	78.3	78.2	76.4	76.4	77.1	74.1	84.5	78.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/3/2018 8pm	81.2	79.0	81.3	79.1	85.0	83.4	88	82.2	78.9	2.2	2.2	1.6	3.3

Date	4-Sep															5-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	79	80	81	82	82	83	83	83	82	81	80	79	78	78	77	77	76	76	76	75	75	75	74	74		83	
	76.9	78.2	79.8	80.7	81.4	83.1	82.9	83.3	83.4	82.8	79.0	78.1	78.9	78.6	77.6	76.1	75.2	75.0	75.0	73.6	71.8	71.5	71.4	72.2	71.4	83.4	77.8

Date																	6-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	76	79	81	81	82	82	82	82	82	81	81	85	82	80	79	79	78	77	77	76	76	76	75	75		85	
	75.2	78.2	80.1	82.2	84.2	85.0	86.5	87.3	87.3	86.9	84.2	81.0	79.3	78.5	77.8	77.3	77.0	76.5	76.2	76.4	76.2	76.4	76.5	77.6	75.2	87.3	80.2

Date	6-Sep																7-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	75	78	80	82	84	85	86	87	87	87	86	85	82	80	79	79	78	77	77	76	76	76	75	75		87	
	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	76.4	75.9	76.3	76.3	76.1	75.8	75.4	75.4	74.8	76.3	73.1	83.0	77.8

Date																	8-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	75	78	81	84	86	87	89	90	90	90	89	87	83	81	80	79	78	77	77	76	75	75	74	74		90	
	78.9	80.5	81.2	81.2	78.5	80.3	80.9	82.3	80.7	81.1	80.0	77.6	76.2	76.8	76.0	75.6	75.2	76.9	76.4	73.8	76.8	75.4	73.7	75.1	73.7	82.3	78.0

Date	8-Sep																9-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	74	77	81	83	86	87	89	90	90	90	89	87	83	81	80	79	78	77	77	76	75	75	74	74		90	
	77.7	80.1	81.9	83.6	83.9	85.3	84.2	84.5	82.8	82.7	78.5	78.0	76.6	75.4	75.6	75.8	75.5	75.3	75.4	74.8	74.6	74.4	74.2	75.1	74.2	85.3	78.6

Date																	10-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	74	77	80	83	85	86	88	89	89	89	88	86	83	81	80	79	78	77	76	76	75	75	74	74		89	
	78.0	81.5	82.3	85.0	86.7	88.0	86.2	86.3	86.8	84.9	83.0	80.5	79.5	78.2	77.5	77.6	77.2	75.3	75.0	75.0	74.9	74.5	74.1	74.8	74.1	88.0	80.1

Date	10-Sep																11-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										90	
	78.7	81.2	83.4	84.3	84.5	84.1	78.3	78.3	78.2	76.4	76.4	77.1	76.5	76.0	76.1	75.5	75.8	74.8	74.7	74.2	74.5	76.1	76.6	78.0	74.2	84.5	77.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/4/2018 8am	80.4	78.7	79.5	78.6	83.0	83.4	90	81.7	78.6	1.6	0.9	-0.4	3.1

Date	5-Sep											6-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	low	high	ave
Temperature (°F)	86	86	86	86	85	83	82	81	80	79	78	78	78	77	77	77	77	76	76	79	81	83	84	86		86	
	85.0	86.5	87.3	87.3	86.9	84.2	81.0	79.3	78.5	77.8	77.3	77.0	76.5	76.2	76.4	76.2	76.4	76.5	77.6	81.1	83.0	80.8	78.0	73.1	73.1	87.3	80.0
Date												7-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	86	86	86	86	85	83	82	81	80	79	78	77	77	77	77	77	76	75	75	77	81	84	86	87		87	
	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	76.4	75.9	76.3	76.3	76.1	75.8	75.4	75.4	74.8	76.3	78.9	80.5	81.2	81.2	78.5	74.4	83.0	78.0
Date	7-Sep											8-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	87	87	87	86	85	84	82	82	81	80	79	78	77	76	75	75	74	74	75	76	78	81	84	86		87	
	80.3	80.9	82.3	80.7	81.1	80.0	77.6	76.2	76.8	76.0	75.6	75.2	76.9	76.4	73.8	76.8	75.4	73.7	75.1	77.7	80.1	81.9	83.6	83.9	73.7	83.9	78.3
Date												9-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	87	88	88	87	86	84	83	82	81	80	79	78	77	76	75	74	74	74	75	77	79	81	83	85		88	
	85.3	84.2	84.5	82.8	82.7	78.5	78.0	76.6	75.4	75.6	75.8	75.5	75.3	75.4	74.8	74.6	74.4	74.2	75.1	78.0	81.5	82.3	85.0	86.7	74.2	86.7	78.8
Date	9-Sep											10-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	87	87	87	85	84	83	81	80	79	79	78	78	77	76	75	74	74	74	75	77	79	81	84	86		87	
	88.0	86.2	86.3	86.8	84.9	83.0	80.5	79.5	78.2	77.5	77.6	77.2	75.3	75.0	75.0	74.9	74.5	74.1	74.8	78.7	81.2	83.4	84.3	84.5	74.1	88.0	80.1
Date												11-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	88	88	87	85	84	82	81	80	79	78	77	77	76	75	74	74	74	75	77	79	82	84	86		88	
	84.1	78.3	78.3	78.2	76.4	76.4	77.1	76.5	76.0	76.1	75.5	75.8	74.8	74.7	74.2	74.5	76.1	76.6	78.0	81.3	82.7	82.5	79.6	77.6	74.2	84.1	77.5
Date	11-Sep											12-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)																										87	
	77.8	77.8	76.3	77.7	78.4	78.0	77.8	77.8	76.9	78.3	77.9	77.9	78.1	77.6	77.7	76.8	77.1	78.9	79.4	80.8	81.9	82.3	83.6	84.7	76.3	84.7	78.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/5/2018 1pm	80.5	78.8	80.7	78.7	86.0	87.3	87	81.4	78.8	1.7	1.9	-1.3	2.6

Date	6-Sep																7-Sep										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	79	82	84	85	85	85	84	83	83	82	81	80	79	78	78	78	78	78	77	77	76	75	75		85	
	77.6	81.1	83.0	80.8	78.0	73.1	74.4	78.0	80.8	83.0	82.7	81.0	78.4	77.0	76.5	76.4	75.9	76.3	76.3	76.1	75.8	75.4	75.4	74.8	73.1	83.0	77.8
Date																		8-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	82	83	84	85	87	88	87	86	85	83	82	80	79	78	78	77	77	77	77	76	75	75		88	
	76.3	78.9	80.5	81.2	81.2	78.5	80.3	80.9	82.3	80.7	81.1	80.0	77.6	76.2	76.8	76.0	75.6	75.2	76.9	76.4	73.8	76.8	75.4	73.7	73.7	82.3	78.0
Date	8-Sep																	9-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	83	84	85	85	86	87	87	86	85	83	81	80	78	77	77	77	76	76	76	75	75		87	
	75.1	77.7	80.1	81.9	83.6	83.9	85.3	84.2	84.5	82.8	82.7	78.5	78.0	76.6	75.4	75.6	75.8	75.5	75.3	75.4	74.8	74.6	74.4	74.2	74.2	85.3	78.6
Date																		10-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	77	79	82	85	87	88	89	88	87	86	84	82	81	80	79	78	78	77	76	76	75	75	75		89	
	75.1	78.0	81.5	82.3	85.0	86.7	88.0	86.2	86.3	86.8	84.9	83.0	80.5	79.5	78.2	77.5	77.6	77.2	75.3	75.0	75.0	74.9	74.5	74.1	74.1	88.0	80.1
Date	10-Sep																	11-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	77	79	82	84	86	87	87	86	85	84	82	81	80	80	79	78	78	77	76	75	75	74	74		87	
	74.8	78.7	81.2	83.4	84.3	84.5	84.1	78.3	78.3	78.2	76.4	76.4	77.1	76.5	76.0	76.1	75.5	75.8	74.8	74.7	74.2	74.5	76.1	76.6	74.2	84.5	77.8
Date																		12-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	79	81	84	86	87	87	86	85	84	83	81	80	80	79	78	78	77	76	75	74	74	74		87	
	78.0	81.3	82.7	82.5	79.6	77.6	77.8	77.8	76.3	77.7	78.4	78.0	77.8	77.8	76.9	78.3	77.9	77.9	78.1	77.6	77.7	76.8	77.1	78.9	76.3	82.7	78.3
Date	12-Sep																	13-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	79.4	80.8	81.9	82.3	83.6	84.7	84.9	84.6	85.6	85.8	85.4	83.6	81.6	79.9	79.8	80.7	80.6	79.1	80.0	79.9	80.2	79.9	80.1	79.2	79.1	85.8	81.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/6/2018 7am	80.4	78.4	80.4	78.1	85.0	83.0	88	81.4	78.9	1.9	2.3	2.0	2.5

Date	7-Sep												8-Sep														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	low	high	ave
Temperature (°F)	84	83	83	83	83	83	82	81	80	79	78	78	77	77	76	76	75	75	75	75	78	81	83	85		85	
	78.5	80.3	80.9	82.3	80.7	81.1	80.0	77.6	76.2	76.8	76.0	75.6	75.2	76.9	76.4	73.8	76.8	75.4	73.7	75.1	77.7	80.1	81.9	83.6	73.7	83.6	78.0

Date													9-Sep														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	86	87	88	88	87	86	84	82	80	79	78	77	76	76	75	75	75	74	74	75	77	80	82	84		88	
	83.9	85.3	84.2	84.5	82.8	82.7	78.5	78.0	76.6	75.4	75.6	75.8	75.5	75.3	75.4	74.8	74.6	74.4	74.2	75.1	78.0	81.5	82.3	85.0	74.2	85.3	78.7

Date	9-Sep												10-Sep														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	85	86	87	87	86	84	82	80	79	79	78	78	77	76	75	75	74	74	74	74	76	77	80	82		87	
	86.7	88.0	86.2	86.3	86.8	84.9	83.0	80.5	79.5	78.2	77.5	77.6	77.2	75.3	75.0	75.0	74.9	74.5	74.1	74.8	78.7	81.2	83.4	84.3	74.1	88.0	80.2

Date													11-Sep														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	83	85	85	85	84	83	81	80	79	78	77	77	76	75	75	74	74	74	74	75	77	79	81	83		85	
	84.5	84.1	78.3	78.3	78.2	76.4	76.4	77.1	76.5	76.0	76.1	75.5	75.8	74.8	74.7	74.2	74.5	76.1	76.6	78.0	81.3	82.7	82.5	79.6	74.2	84.5	77.8

Date	11-Sep												12-Sep														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	84	85	85	84	84	82	81	80	79	79	78	78	77	76	76	75	74	74	74	75	77	79	81	84		85	
	77.6	77.8	77.8	76.3	77.7	78.4	78.0	77.8	77.8	76.9	78.3	77.9	77.9	78.1	77.6	77.7	76.8	77.1	78.9	79.4	80.8	81.9	82.3	83.6	76.3	83.6	78.5

Date													13-Sep														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)	86	87	87	86	85	84	82	81	80	79	78	77	77	76	75	75	74	74	74	75	77	79	81	83		87	
	84.7	84.9	84.6	85.6	85.8	85.4	83.6	81.6	79.9	79.8	80.7	80.6	79.1	80.0	79.9	80.2	79.9	80.1	79.2	80.3	82.1	83.7	85.9	86.7	79.1	86.7	82.3

Date	13-Sep												14-Sep														
Hour (CDT)	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11			
Temperature (°F)																										88	
	84.5	79.1	80.8	83.1	84.1	83.5	81.9	80.7	80.6	80.4	79.4	77.4	76.1	76.4	76.9	76.5	74.8	75.8	75.8	75.7	79.6	82.1	82.9	84.5	74.8	84.5	79.7

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/7/2018 12pm	79.5	79.3	79.7	79.0	85.0	83.6	88	80.7	79.3	0.2	0.8	1.4	1.4

Date	8-Sep														9-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	80	83	84	86	87	88	89	88	87	86	84	83	81	80	80	79	78	78	77	77	76	75	76	78		89	
	80.1	81.9	83.6	83.9	85.3	84.2	84.5	82.8	82.7	78.5	78.0	76.6	75.4	75.6	75.8	75.5	75.3	75.4	74.8	74.6	74.4	74.2	75.1	78.0	74.2	85.3	78.6

Date															10-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	81	84	86	87	88	88	88	88	86	85	83	81	80	79	79	78	78	78	77	76	76	75	76	78		88	
	81.5	82.3	85.0	86.7	88.0	86.2	86.3	86.8	84.9	83.0	80.5	79.5	78.2	77.5	77.6	77.2	75.3	75.0	75.0	74.9	74.5	74.1	74.8	78.7	74.1	88.0	80.1

Date	10-Sep														11-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	81	84	86	86	85	85	84	83	82	81	79	79	78	78	78	77	77	77	76	76	75	75	75	76		86	
	81.2	83.4	84.3	84.5	84.1	78.3	78.3	78.2	76.4	76.4	77.1	76.5	76.0	76.1	75.5	75.8	74.8	74.7	74.2	74.5	76.1	76.6	78.0	81.3	74.2	84.5	78.0

Date															12-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	78	80	82	84	86	86	86	85	83	82	81	80	80	79	79	79	78	77	76	75	75	74	75	76		86	
	82.7	82.5	79.6	77.6	77.8	77.8	76.3	77.7	78.4	78.0	77.8	77.8	76.9	78.3	77.9	77.9	78.1	77.6	77.7	76.8	77.1	78.9	79.4	80.8	76.3	82.7	78.4

Date	12-Sep														13-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	78	79	81	83	84	85	85	84	83	82	82	81	80	80	79	79	78	77	75	75	74	74	75	76		85	
	81.9	82.3	83.6	84.7	84.9	84.6	85.6	85.8	85.4	83.6	81.6	79.9	79.8	80.7	80.6	79.1	80.0	79.9	80.2	79.9	80.1	79.2	80.3	82.1	79.1	85.8	81.9

Date															14-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	79	81	84	86	87	88	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	74	75	77		88	
	83.7	85.9	86.7	84.5	79.1	80.8	83.1	84.1	83.5	81.9	80.7	80.6	80.4	79.4	77.4	76.1	76.4	76.9	76.5	74.8	75.8	75.8	75.7	79.6	74.8	86.7	80.0

Date	14-Sep														15-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										90	
	82.1	82.9	84.5	85.8	86.9	88.2	89.1	89.3	89.4	84.0	81.6	79.9	78.9	78.7	78.1	77.2	76.8	76.4	76.2	76.6	76.2	75.3	77.0	79.0	75.3	89.4	81.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/8/2018 9am	80.5	79.5	80.9	78.9	89.0	85.3	90	81.9	79.8	1.0	2.0	3.7	2.1

Date	9-Sep											10-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	low	high	ave
Temperature (°F)	86	87	89	88	87	85	84	81	79	78	78	77	77	77	76	76	75	75	77	78	82	85	85	85		89	
	88.0	86.2	86.3	86.8	84.9	83.0	80.5	79.5	78.2	77.5	77.6	77.2	75.3	75.0	75.0	74.9	74.5	74.1	74.8	78.7	81.2	83.4	84.3	84.5	74.1	88.0	80.1

Date												11-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	85	85	85	84	83	81	80	79	78	78	77	77	76	76	76	75	74	74	75	78	82	85	86	86		86	
	84.1	78.3	78.3	78.2	76.4	76.4	77.1	76.5	76.0	76.1	75.5	75.8	74.8	74.7	74.2	74.5	76.1	76.6	78.0	81.3	82.7	82.5	79.6	77.6	74.2	84.1	77.5

Date	11-Sep											12-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	85	84	84	83	81	80	78	77	76	76	76	76	76	76	75	75	74	74	75	76	78	80	82	84		85	
	77.8	77.8	76.3	77.7	78.4	78.0	77.8	77.8	76.9	78.3	77.9	77.9	78.1	77.6	77.7	76.8	77.1	78.9	79.4	80.8	81.9	82.3	83.6	84.7	76.3	84.7	78.8

Date												13-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	85	86	86	85	84	84	83	82	81	81	80	79	78	77	76	75	74	74	75	77	79	82	84	87		87	
	84.9	84.6	85.6	85.8	85.4	83.6	81.6	79.9	79.8	80.7	80.6	79.1	80.0	79.9	80.2	79.9	80.1	79.2	80.3	82.1	83.7	85.9	86.7	84.5	79.1	86.7	82.3

Date	13-Sep											14-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	88	89	89	88	87	86	85	83	82	81	80	79	78	76	75	74	74	74	75	78	80	83	86	89		89	
	79.1	80.8	83.1	84.1	83.5	81.9	80.7	80.6	80.4	79.4	77.4	76.1	76.4	76.9	76.5	74.8	75.8	75.8	75.7	79.6	82.1	82.9	84.5	85.8	74.8	85.8	79.8

Date												15-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	91	91	90	89	87	86	84	83	82	81	81	80	79	78	76	75	74	74	75	77	79	82	85	88		91	
	86.9	88.2	89.1	89.3	89.4	84.0	81.6	79.9	78.9	78.7	78.1	77.2	76.8	76.4	76.2	76.6	76.2	75.3	77.0	79.0	81.7	84.6	86.9	88.6	75.3	89.4	81.5

Date	15-Sep											16-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)																										90	
	89.7	90.6	91.5	91.9	91.7	90.2	85.2	84.3	82.7	80.5	78.4	77.1	76.6	76.8	76.7	76.2	75.8	76.0	76.2	79.3	82.3	85.9	88.5	89.8	75.8	91.9	83.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/9/2018 1pm	80.6	80.0	79.8	78.8	89.0	88.0	90	81.9	80.4	0.6	1.0	1.0	1.5

Date	10-Sep																	11-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	75	76	79	81	85	85	86	86	86	86	85	84	82	80	79	78	77	77	76	76	76	76	76	75		86	
	74.1	74.8	78.7	81.2	83.4	84.3	84.5	84.1	78.3	78.3	78.2	76.4	76.4	77.1	76.5	76.0	76.1	75.5	75.8	74.8	74.7	74.2	74.5	76.1	74.1	84.5	77.7

Date																		12-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	78	81	83	84	85	86	86	86	86	84	82	80	79	79	79	78	78	77	77	77	76	75		86	
	76.6	78.0	81.3	82.7	82.5	79.6	77.6	77.8	77.8	76.3	77.7	78.4	78.0	77.8	77.8	76.9	78.3	77.9	77.9	78.1	77.6	77.7	76.8	77.1	76.3	82.7	78.3

Date	12-Sep																	13-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	79	81	84	85	86	87	87	88	88	87	85	83	81	80	79	79	79	78	77	77	76	75		88	
	78.9	79.4	80.8	81.9	82.3	83.6	84.7	84.9	84.6	85.6	85.8	85.4	83.6	81.6	79.9	79.8	80.7	80.6	79.1	80.0	79.9	80.2	79.9	80.1	78.9	85.8	81.8

Date																		14-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	77	79	82	84	87	88	89	89	88	87	86	85	83	82	81	80	79	78	76	75	74	74		89	
	79.2	80.3	82.1	83.7	85.9	86.7	84.5	79.1	80.8	83.1	84.1	83.5	81.9	80.7	80.6	80.4	79.4	77.4	76.1	76.4	76.9	76.5	74.8	75.8	74.8	86.7	80.4

Date	14-Sep																	15-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	77	80	83	86	89	90	91	91	90	88	87	85	84	82	81	80	79	78	77	76	75	75		91	
	75.8	75.7	79.6	82.1	82.9	84.5	85.8	86.9	88.2	89.1	89.3	89.4	84.0	81.6	79.9	78.9	78.7	78.1	77.2	76.8	76.4	76.2	76.6	76.2	75.7	89.4	81.3

Date																		16-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	78	81	83	86	88	90	90	90	88	87	85	84	83	82	81	81	80	79	78	77	76	75		90	
	75.3	77.0	79.0	81.7	84.6	86.9	88.6	89.7	90.6	91.5	91.9	91.7	90.2	85.2	84.3	82.7	80.5	78.4	77.1	76.6	76.8	76.7	76.2	75.8	75.3	91.9	82.9

Date	16-Sep																	17-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										90	
	76.0	76.2	79.3	82.3	85.9	88.5	89.8	90.5	91.9	92.3	92.6	91.5	87.4	83.6	81.1	79.3	78.3	77.4	76.6	76.3	75.9	76.0	76.0	75.4	75.4	92.6	82.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/10/2018 6am	81.2	80.4	80.5	79.2	86.0	84.5	90	82.5	80.7	0.9	1.3	1.5	1.8

Date	11-Sep																12-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	78	81	84	85	86	86	86	86	85	84	82	80	79	79	78	78	77	77	77	76	76	75	75	76		86	
	81.3	82.7	82.5	79.6	77.6	77.8	77.8	76.3	77.7	78.4	78.0	77.8	77.8	76.9	78.3	77.9	77.9	78.1	77.6	77.7	76.8	77.1	78.9	79.4	76.3	82.7	78.4
Date																	13-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	81	85	87	88	89	89	89	88	86	85	83	82	81	80	79	78	78	77	77	77	76	76	77		89	
	80.8	81.9	82.3	83.6	84.7	84.9	84.6	85.6	85.8	85.4	83.6	81.6	79.9	79.8	80.7	80.6	79.1	80.0	79.9	80.2	79.9	80.1	79.2	80.3	79.1	85.8	81.9
Date	13-Sep																14-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	81	84	86	87	88	89	89	88	86	84	82	80	79	78	77	76	76	76	76	76	75	75	76		89	
	82.1	83.7	85.9	86.7	84.5	79.1	80.8	83.1	84.1	83.5	81.9	80.7	80.6	80.4	79.4	77.4	76.1	76.4	76.9	76.5	74.8	75.8	75.8	75.7	74.8	86.7	80.1
Date																	15-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	81	85	87	89	90	90	90	89	87	85	83	81	80	79	78	77	77	77	77	77	76	75	76		90	
	79.6	82.1	82.9	84.5	85.8	86.9	88.2	89.1	89.3	89.4	84.0	81.6	79.9	78.9	78.7	78.1	77.2	76.8	76.4	76.2	76.6	76.2	75.3	77.0	75.3	89.4	81.3
Date	15-Sep																16-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	82	86	88	89	89	90	90	89	88	86	84	82	81	80	79	79	78	78	77	77	76	76	77		90	
	79.0	81.7	84.6	86.9	88.6	89.7	90.6	91.5	91.9	91.7	90.2	85.2	84.3	82.7	80.5	78.4	77.1	76.6	76.8	76.7	76.2	75.8	76.0	76.2	75.8	91.9	82.9
Date																	17-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	82	85	87	88	89	90	90	90	89	87	85	84	82	81	80	79	78	78	78	77	77	76	76		90	
	79.3	82.3	85.9	88.5	89.8	90.5	91.9	92.3	92.6	91.5	87.4	83.6	81.1	79.3	78.3	77.4	76.6	76.3	75.9	76.0	76.0	75.4	75.1	76.8	75.1	92.6	82.5
Date	17-Sep																18-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										91	
	80.4	83.7	86.8	88.1	89.7	91.1	91.8	91.7	90.2	83.4	81.1	79.7	79.4	78.1	77.0	77.8	77.7	76.8	76.2	75.5	76.8	75.9	75.4	75.6	75.4	91.8	81.7

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
9/11/2018 8am	81.7	81.2	81.0	80.1	86.0	82.7	91	83.0	81.2	0.5	0.9	3.3	1.8

Date	11-Sep										12-Sep																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	low	high	ave
Temperature (°F)	86	86	85	84	82	80	79	78	78	78	77	77	77	76	76	75	75	76	78	81	84	86	87	88		88	
	77.8	76.3	77.7	78.4	78.0	77.8	77.8	76.9	78.3	77.9	77.9	78.1	77.6	77.7	76.8	77.1	78.9	79.4	80.8	81.9	82.3	83.6	84.7	84.9	76.3	84.9	79.1
Date											13-Sep																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	88	89	89	87	85	83	82	81	80	79	78	78	77	77	77	76	76	77	79	82	85	87	88	89		89	
	84.6	85.6	85.8	85.4	83.6	81.6	79.9	79.8	80.7	80.6	79.1	80.0	79.9	80.2	79.9	80.1	79.2	80.3	82.1	83.7	85.9	86.7	84.5	79.1	79.1	86.7	82.0
Date	13-Sep										14-Sep																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	89	90	90	88	85	83	82	81	80	79	78	78	77	77	77	76	76	77	79	82	86	88	89	90		90	
	80.8	83.1	84.1	83.5	81.9	80.7	80.6	80.4	79.4	77.4	76.1	76.4	76.9	76.5	74.8	75.8	75.8	75.7	79.6	82.1	82.9	84.5	85.8	86.9	74.8	86.9	80.1
Date											15-Sep																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	91	91	90	89	87	85	83	82	81	80	79	79	78	77	76	75	75	76	78	81	84	86	89	90		91	
	88.2	89.1	89.3	89.4	84.0	81.6	79.9	78.9	78.7	78.1	77.2	76.8	76.4	76.2	76.6	76.2	75.3	77.0	79.0	81.7	84.6	86.9	88.6	89.7	75.3	89.7	81.6
Date	15-Sep										16-Sep																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	91	90	89	88	86	84	83	82	81	80	79	78	77	77	76	76	76	77	79	81	84	86	88	90		91	
	90.6	91.5	91.9	91.7	90.2	85.2	84.3	82.7	80.5	78.4	77.1	76.6	76.8	76.7	76.2	75.8	76.0	76.2	79.3	82.3	85.9	88.5	89.8	90.5	75.8	91.9	83.1
Date											17-Sep																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	91	90	90	89	87	86	85	83	82	81	80	79	77	76	76	75	76	77	78	81	83	86	88	90		91	
	91.9	92.3	92.6	91.5	87.4	83.6	81.1	79.3	78.3	77.4	76.6	76.3	75.9	76.0	76.0	75.4	75.1	76.8	80.4	83.7	86.8	88.1	89.7	91.1	75.1	92.6	82.6
Date	17-Sep										18-Sep																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)																										91	
	91.8	91.7	90.2	83.4	81.1	79.7	79.4	78.1	77.0	77.8	77.7	76.8	76.2	75.5	76.8	75.9	75.4	75.6	79.4	84.0	87.6	89.7	91.7	90.6	75.4	91.8	81.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/11/2018 2pm	82.1	81.4	81.6	80.4	88.0	84.9	91	83.4	81.5	0.7	1.2	3.1	1.9

Date	12-Sep																13-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	76	78	81	84	86	87	88	88	89	89	87	85	83	82	81	80	79	78	78	77	77	77	76	76		89	
	79.4	80.8	81.9	82.3	83.6	84.7	84.9	84.6	85.6	85.8	85.4	83.6	81.6	79.9	79.8	80.7	80.6	79.1	80.0	79.9	80.2	79.9	80.1	79.2	79.1	85.8	81.8

Date																	14-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	85	87	88	89	89	90	90	88	85	83	82	81	80	79	78	78	77	77	77	76	76		90	
	80.3	82.1	83.7	85.9	86.7	84.5	79.1	80.8	83.1	84.1	83.5	81.9	80.7	80.6	80.4	79.4	77.4	76.1	76.4	76.9	76.5	74.8	75.8	75.8	74.8	86.7	80.3

Date	14-Sep																15-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	86	88	89	90	91	91	90	89	87	85	83	82	81	80	79	79	78	77	76	75	75		91	
	75.7	79.6	82.1	82.9	84.5	85.8	86.9	88.2	89.1	89.3	89.4	84.0	81.6	79.9	78.9	78.7	78.1	77.2	76.8	76.4	76.2	76.6	76.2	75.3	75.3	89.4	81.2

Date																	16-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	84	86	89	90	91	90	89	88	86	84	83	82	81	80	79	78	77	77	76	76	76		91	
	77.0	79.0	81.7	84.6	86.9	88.6	89.7	90.6	91.5	91.9	91.7	90.2	85.2	84.3	82.7	80.5	78.4	77.1	76.6	76.8	76.7	76.2	75.8	76.0	75.8	91.9	82.9

Date	16-Sep																17-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	81	84	86	88	90	91	90	90	89	87	86	85	83	82	81	80	79	77	76	76	75	76		91	
	76.2	79.3	82.3	85.9	88.5	89.8	90.5	91.9	92.3	92.6	91.5	87.4	83.6	81.1	79.3	78.3	77.4	76.6	76.3	75.9	76.0	76.0	75.4	75.1	75.1	92.6	82.5

Date																	18-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	81	83	86	88	90	91	91	90	89	87	86	84	83	82	80	79	78	77	76	75	75	75		91	
	76.8	80.4	83.7	86.8	88.1	89.7	91.1	91.8	91.7	90.2	83.4	81.1	79.7	79.4	78.1	77.0	77.8	77.7	76.8	76.2	75.5	76.8	75.9	75.4	75.4	91.8	81.7

Date	18-Sep																19-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										90	
	75.6	79.4	84.0	87.6	89.7	91.7	90.6	91.3	92.0	91.2	85.4	84.0	82.4	80.3	79.3	78.6	77.4	77.7	77.9	76.9	76.7	77.7	77.4	76.9	75.6	92.0	82.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/12/2018 7am	82.4	81.7	82.3	81.1	89.0	85.8	90	83.5	81.9	0.7	1.2	3.2	1.7

																									low	high	ave
Date	**13-Sep**																**14-Sep**										
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	77	79	82	85	87	88	89	90	91	90	88	85	82	81	80	80	79	77	77	77	77	77	76	75		91	
	80.3	82.1	83.7	85.9	86.7	84.5	79.1	80.8	83.1	84.1	83.5	81.9	80.7	80.6	80.4	79.4	77.4	76.1	76.4	76.9	76.5	74.8	75.8	75.8	74.8	86.7	80.3
Date																	**15-Sep**										
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	75	78	82	86	89	91	92	92	92	90	89	87	85	84	82	81	79	78	77	77	77	77	76	75		92	
	75.7	79.6	82.1	82.9	84.5	85.8	86.9	88.2	89.1	89.3	89.4	84.0	81.6	79.9	78.9	78.7	78.1	77.2	76.8	76.4	76.2	76.6	76.2	75.3	75.3	89.4	81.2
Date	**15-Sep**																**16-Sep**										
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	75	78	82	85	89	91	92	92	91	90	89	87	85	83	81	80	78	78	77	77	76	76	75	75		92	
	77.0	79.0	81.7	84.6	86.9	88.6	89.7	90.6	91.5	91.9	91.7	90.2	85.2	84.3	82.7	80.5	78.4	77.1	76.6	76.8	76.7	76.2	75.8	76.0	75.8	91.9	82.9
Date																	**17-Sep**										
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	76	78	80	84	87	90	91	92	92	90	89	87	85	84	82	81	81	80	79	78	77	76	76	76		92	
	76.2	79.3	82.3	85.9	88.5	89.8	90.5	91.9	92.3	92.6	91.5	87.4	83.6	81.1	79.3	78.3	77.4	76.6	76.3	75.9	76.0	76.0	75.4	75.1	75.1	92.6	82.5
Date	**17-Sep**																**18-Sep**										
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	78	80	82	85	88	90	92	92	91	90	89	87	85	84	83	82	81	80	79	78	77	76	76	76		92	
	76.8	80.4	83.7	86.8	88.1	89.7	91.1	91.8	91.7	90.2	83.4	81.1	79.7	79.4	78.1	77.0	77.8	77.7	76.8	76.2	75.5	76.8	75.9	75.4	75.4	91.8	81.7
Date																	**19-Sep**										
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)	77	79	82	85	87	89	91	91	90	89	88	86	85	83	82	81	80	79	78	78	77	76	76	76		91	
	75.6	79.4	84.0	87.6	89.7	91.7	90.6	91.3	92.0	91.2	85.4	84.0	82.4	80.3	79.3	78.6	77.4	77.7	77.9	76.9	76.7	77.7	77.4	76.9	75.6	92.0	82.6
Date	**19-Sep**																**20-Sep**										
Hour (CDT)	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	**5**	**6**			
Temperature (°F)																										91	
	76.8	79.0	83.2	85.5	87.6	89.5	90.8	90.8	90.6	89.9	85.9	82.6	80.2	79.2	78.0	77.2	76.2	75.4	75.3	73.8	74.3	74.0	74.2	75.2	73.8	90.8	81.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/13/2018 7am	82.8	81.9	82.5	81.5	91.0	86.7	91	83.9	81.7	0.9	1.1	4.3	2.2

																										low	high	ave
Date	14-Sep							15-Sep																				
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Temperature (°F)	88	87	85	84	82	81	80	80	79	78	78	77	77	76	76	79	83	86	88	89	91	92	92	93			93	
	89.4	84.0	81.6	79.9	78.9	78.7	78.1	77.2	76.8	76.4	76.2	76.6	76.2	75.3	77.0	79.0	81.7	84.6	86.9	88.6	89.7	90.6	91.5	91.9		75.3	91.9	81.9
Date								16-Sep																				
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Temperature (°F)	90	88	85	84	82	81	80	80	79	79	78	77	77	76	77	80	82	85	87	88	90	91	91	92			92	
	91.7	90.2	85.2	84.3	82.7	80.5	78.4	77.1	76.6	76.8	76.7	76.2	75.8	76.0	76.2	79.3	82.3	85.9	88.5	89.8	90.5	91.9	92.3	92.6		75.8	92.6	83.2
Date	16-Sep							17-Sep																				
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Temperature (°F)	90	88	86	85	83	82	81	81	80	80	79	78	78	77	77	80	84	87	88	90	91	91	92	92			92	
	91.5	87.4	83.6	81.1	79.3	78.3	77.4	76.6	76.3	75.9	76.0	76.0	75.4	75.1	76.8	80.4	83.7	86.8	88.1	89.7	91.1	91.8	91.7	90.2		75.1	91.8	82.5
Date								18-Sep																				
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Temperature (°F)	90	87	85	84	83	82	81	81	80	79	78	78	77	76	77	79	82	84	86	88	90	90	91	91			91	
	83.4	81.1	79.7	79.4	78.1	77.0	77.8	77.7	76.8	76.2	75.5	76.8	75.9	75.4	75.6	79.4	84.0	87.6	89.7	91.7	90.6	91.3	92.0	91.2		75.4	92.0	81.8
Date	18-Sep							19-Sep																				
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Temperature (°F)	89	87	85	84	83	82	81	81	80	79	78	78	77	76	77	79	82	84	86	89	91	91	92	92			92	
	85.4	84.0	82.4	80.3	79.3	78.6	77.4	77.7	77.9	76.9	76.7	77.7	77.4	76.9	76.8	79.0	83.2	85.5	87.6	89.5	90.8	90.8	90.6	89.9		76.7	90.8	82.2
Date								20-Sep																				
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Temperature (°F)	89	87	84	83	81	80	79	79	78	78	77	76	76	75	76	78	80	82	84	85	87	88	89	90			90	
	85.9	82.6	80.2	79.2	78.0	77.2	76.2	75.4	75.3	73.8	74.3	74.0	74.2	75.2	75.4	80.1	82.6	84.5	85.9	85.8	85.5	79.4	80.0	83.1		73.8	85.9	79.3
Date	20-Sep							21-Sep																				
Hour (CDT)	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Temperature (°F)																											89	
	80.2	77.6	77.0	76.2	77.3	76.5	76.2	77.3	77.1	76.7	77.2	78.9	78.7	78.5	80.1	81.6	84.3	86.2	87.8	88.7	85.2	85.1	85.3	80.9		76.2	88.7	80.4

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/14/2018 5pm	83.2	81.8	83.6	82.6	93.0	91.9	89	84.0	81.6	1.4	1.1	1.1	2.4

Date	15-Sep																16-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	79	83	86	88	90	91	92	93	93	91	88	86	84	83	83	82	80	80	79	79	79	78	77	78		93	
	79.0	81.7	84.6	86.9	88.6	89.7	90.6	91.5	91.9	91.7	90.2	85.2	84.3	82.7	80.5	78.4	77.1	76.6	76.8	76.7	76.2	75.8	76.0	76.2	75.8	91.9	82.9

Date																	17-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	83	87	89	91	92	93	93	93	91	90	88	86	85	84	82	81	81	80	80	80	79	78	79		93	
	79.3	82.3	85.9	88.5	89.8	90.5	91.9	92.3	92.6	91.5	87.4	83.6	81.1	79.3	78.3	77.4	76.6	76.3	75.9	76.0	76.0	75.4	75.1	76.8	75.1	92.6	82.5

Date	17-Sep																18-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	81	85	88	90	92	92	93	93	92	91	89	87	85	84	83	82	81	81	80	79	78	78	77	77		93	
	80.4	83.7	86.8	88.1	89.7	91.1	91.8	91.7	90.2	83.4	81.1	79.7	79.4	78.1	77.0	77.8	77.7	76.8	76.2	75.5	76.8	75.9	75.4	75.6	75.4	91.8	81.7

Date																	19-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	81	84	87	90	91	92	92	91	89	88	86	85	83	82	81	81	79	78	77	76	76	76	77		92	
	79.4	84.0	87.6	89.7	91.7	90.6	91.3	92.0	91.2	85.4	84.0	82.4	80.3	79.3	78.6	77.4	77.7	77.9	76.9	76.7	77.7	77.4	76.9	76.8	76.7	92.0	82.6

Date	19-Sep																20-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	80	82	85	88	91	92	92	91	89	87	85	83	81	80	80	79	79	78	77	76	76	75	75	76		92	
	79.0	83.2	85.5	87.6	89.5	90.8	90.8	90.6	89.9	85.9	82.6	80.2	79.2	78.0	77.2	76.2	75.4	75.3	73.8	74.3	74.0	74.2	75.2	75.4	73.8	90.8	81.0

Date																	21-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	80	83	85	88	89	89	88	87	85	83	82	81	81	81	80	80	80	79	78	77	76	76	76		89	
	80.1	82.6	84.5	85.9	85.8	85.5	79.4	80.0	83.1	80.2	77.6	77.0	76.2	77.3	76.5	76.2	77.3	77.1	76.7	77.2	78.9	78.7	78.5	80.1	76.2	85.9	79.7

Date	21-Sep																22-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										88	
	81.6	84.3	86.2	87.8	88.7	85.2	85.1	85.3	80.9	80.6	79.3	78.3	77.9	77.5	78.4	78.2	77.9	77.1	77.0	76.8	78.0	77.5	77.3	78.5	76.8	88.7	80.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/15/2018 8am	83.6	81.7	84.8	82.3	93.0	91.9	88	84.3	81.6	1.9	2.5	1.1	2.7

Date	16-Sep																17-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	80	84	87	89	90	92	93	93	94	92	89	87	86	84	83	82	82	81	80	79	79	78	77		94	
	76.2	79.3	82.3	85.9	88.5	89.8	90.5	91.9	92.3	92.6	91.5	87.4	83.6	81.1	79.3	78.3	77.4	76.6	76.3	75.9	76.0	76.0	75.4	75.1	75.1	92.6	82.5

Date																	18-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	81	85	88	89	91	92	92	93	93	91	89	87	86	84	83	82	82	81	80	79	79	78	77		93	
	76.8	80.4	83.7	86.8	88.1	89.7	91.1	91.8	91.7	90.2	83.4	81.1	79.7	79.4	78.1	77.0	77.8	77.7	76.8	76.2	75.5	76.8	75.9	75.4	75.4	91.8	81.7

Date	18-Sep																19-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	82	85	87	89	91	91	92	92	90	88	86	85	84	83	82	81	80	79	78	78	77	76		92	
	75.6	79.4	84.0	87.6	89.7	91.7	90.6	91.3	92.0	91.2	85.4	84.0	82.4	80.3	79.3	78.6	77.4	77.7	77.9	76.9	76.7	77.7	77.4	76.9	75.6	92.0	82.6

Date																	20-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	84	86	89	91	91	92	92	89	86	83	83	82	82	81	80	79	79	78	77	76	75		92	
	76.8	79.0	83.2	85.5	87.6	89.5	90.8	90.8	90.6	89.9	85.9	82.6	80.2	79.2	78.0	77.2	76.2	75.4	75.3	73.8	74.3	74.0	74.2	75.2	73.8	90.8	81.1

Date	20-Sep																21-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	83	85	86	88	89	89	90	87	85	82	82	81	81	80	79	79	78	78	77	77	76		90	
	75.4	80.1	82.6	84.5	85.9	85.8	85.5	79.4	80.0	83.1	80.2	77.6	77.0	76.2	77.3	76.5	76.2	77.3	77.1	76.7	77.2	78.9	78.7	78.5	75.4	85.9	79.5

Date																	22-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	82	83	85	86	87	88	89	86	84	81	81	80	80	80	79	79	78	78	77	77	76		89	
	80.1	81.6	84.3	86.2	87.8	88.7	85.2	85.1	85.3	80.9	80.6	79.3	78.3	77.9	77.5	78.4	78.2	77.9	77.1	77.0	76.8	78.0	77.5	77.3	76.8	88.7	80.7

Date	22-Sep																23-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	78.5	81.5	84.0	86.0	86.6	86.9	85.3	81.8	81.6	78.4	74.1	74.0	74.4	74.7	74.5	74.4	75.2	74.6	75.2	76.9	75.4	75.2	75.2	76.1	74.0	86.9	78.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/16/2018 7am	83.3	81.3	84.6	82.2	94.0	92.6	88	84.0	80.9	2.0	2.3	1.4	3.1

Date	17-Sep																	18-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	78	81	85	89	91	92	92	93	94	94	92	89	86	85	84	83	82	82	81	80	80	79	78	77		94	
	76.8	80.4	83.7	86.8	88.1	89.7	91.1	91.8	91.7	90.2	83.4	81.1	79.7	79.4	78.1	77.0	77.8	77.7	76.8	76.2	75.5	76.8	75.9	75.4	75.4	91.8	81.7

Date																		19-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	78	80	84	88	90	91	92	92	92	92	90	88	85	83	82	80	79	79	78	78	77	77	76	76		92	
	75.6	79.4	84.0	87.6	89.7	91.7	90.6	91.3	92.0	91.2	85.4	84.0	82.4	80.3	79.3	78.6	77.4	77.7	77.9	76.9	76.7	77.7	77.4	76.9	75.6	92.0	82.6

Date	19-Sep																	20-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	85	87	89	90	91	91	90	88	86	84	82	81	80	79	79	78	77	76	75	75	75		91	
	76.8	79.0	83.2	85.5	87.6	89.5	90.8	90.8	90.6	89.9	85.9	82.6	80.2	79.2	78.0	77.2	76.2	75.4	75.3	73.8	74.3	74.0	74.2	75.2	73.8	90.8	81.1

Date																		21-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	83	86	88	90	90	90	89	87	86	85	84	83	82	81	80	80	79	78	77	76	76		90	
	75.4	80.1	82.6	84.5	85.9	85.8	85.5	79.4	80.0	83.1	80.2	77.6	77.0	76.2	77.3	76.5	76.2	77.3	77.1	76.7	77.2	78.9	78.7	78.5	75.4	85.9	79.5

Date	21-Sep																	22-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	81	83	86	88	89	90	90	89	88	86	85	84	83	82	82	81	80	79	78	77	76	76		90	
	80.1	81.6	84.3	86.2	87.8	88.7	85.2	85.1	85.3	80.9	80.6	79.3	78.3	77.9	77.5	78.4	78.2	77.9	77.1	77.0	76.8	78.0	77.5	77.3	76.8	88.7	80.7

Date																		23-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	80	83	85	87	89	89	89	87	86	84	83	82	81	80	79	79	78	77	76	75	75	75		89	
	78.5	81.5	84.0	86.0	86.6	86.9	85.3	81.8	81.6	78.4	74.1	74.0	74.4	74.7	74.5	74.4	75.2	74.6	75.2	76.9	75.4	75.2	75.2	76.1	74.0	86.9	78.3

Date	23-Sep																	24-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										90	
	76.6	80.0	82.9	84.7	86.5	87.3	86.0	82.8	81.7	79.7	78.4	78.9	79.4	79.1	77.6	77.6	77.6	77.4	77.0	76.3	76.0	75.9	75.5	75.1	75.1	87.3	79.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/17/2018 7am	83.0	80.6	83.8	81.8	94.0	91.8	90	84.0	80.5	2.4	2.0	2.2	3.5

Date	18-Sep																		19-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	76	77	81	86	90	92	93	93	94	94	93	92	90	87	85	83	81	80	79	78	78	78	77	76		94	
	75.4	75.6	79.4	84.0	87.6	89.7	91.7	90.6	91.3	92.0	91.2	85.4	84.0	82.4	80.3	79.3	78.6	77.4	77.7	77.9	76.9	76.7	77.7	77.4	75.4	92.0	82.5

Date																			20-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	80	83	86	88	90	90	91	91	90	89	87	85	83	81	80	79	78	78	77	77	77	76		91	
	76.9	76.8	79.0	83.2	85.5	87.6	89.5	90.8	90.8	90.6	89.9	85.9	82.6	80.2	79.2	78.0	77.2	76.2	75.4	75.3	73.8	74.3	74.0	74.2	73.8	90.8	81.1

Date	20-Sep																		21-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	79	83	86	88	89	90	91	91	90	88	85	83	81	80	79	78	77	77	77	77	77	76		91	
	75.2	75.4	80.1	82.6	84.5	85.9	85.8	85.5	79.4	80.0	83.1	80.2	77.6	77.0	76.2	77.3	76.5	76.2	77.3	77.1	76.7	77.2	78.9	78.7	75.2	85.9	79.3

Date																			22-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	79	82	85	87	88	89	89	89	88	86	84	82	81	80	79	78	78	78	78	77	77	76		89	
	78.5	80.1	81.6	84.3	86.2	87.8	88.7	85.2	85.1	85.3	80.9	80.6	79.3	78.3	77.9	77.5	78.4	78.2	77.9	77.1	77.0	76.8	78.0	77.5	76.8	88.7	80.7

Date	22-Sep																		23-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	79	82	84	87	88	89	89	89	88	86	84	82	80	79	78	77	77	77	77	76	76	75		89	
	77.3	78.5	81.5	84.0	86.0	86.6	86.9	85.3	81.8	81.6	78.4	74.1	74.0	74.4	74.7	74.5	74.4	75.2	74.6	75.2	76.9	75.4	75.2	75.2	74.0	86.9	78.4

Date																			24-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	78	81	84	86	88	90	90	90	88	87	85	83	81	79	78	77	76	76	76	76	76	75		90	
	76.1	76.6	80.0	82.9	84.7	86.5	87.3	86.0	82.8	81.7	79.7	78.4	78.9	79.4	79.1	77.6	77.6	77.6	77.4	77.0	76.3	76.0	75.9	75.5	75.5	87.3	79.6

Date	24-Sep																		25-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										89	
	75.1	76.1	80.9	83.5	84.3	82.3	83.5	83.5	85.6	85.6	85.2	84.6	82.9	79.9	78.0	77.3	76.7	76.1	76.0	75.5	75.5	75.5	75.3	75.8	75.1	85.6	79.8

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/18/2018 6am	82.4	80.3	83.3	81.0	94.0	92.0	89	83.3	80.2	2.1	2.3	2.0	3.1

Date	19-Sep																	20-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	80	84	88	91	93	94	95	95	94	92	90	87	85	83	82	80	79	78	78	77	77	76	76		95	
	76.8	79.0	83.2	85.5	87.6	89.5	90.8	90.8	90.6	89.9	85.9	82.6	80.2	79.2	78.0	77.2	76.2	75.4	75.3	73.8	74.3	74.0	74.2	75.2	73.8	90.8	81.1
Date																		21-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	90	91	92	92	92	90	88	86	83	81	80	79	78	77	77	77	77	77	76	76		92	
	75.4	80.1	82.6	84.5	85.9	85.8	85.5	79.4	80.0	83.1	80.2	77.6	77.0	76.2	77.3	76.5	76.2	77.3	77.1	76.7	77.2	78.9	78.7	78.5	75.4	85.9	79.5
Date	21-Sep																	22-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	80	84	87	89	90	90	90	90	89	87	85	83	81	80	79	79	78	78	78	78	77	76	76		90	
	80.1	81.6	84.3	86.2	87.8	88.7	85.2	85.1	85.3	80.9	80.6	79.3	78.3	77.9	77.5	78.4	78.2	77.9	77.1	77.0	76.8	78.0	77.5	77.3	76.8	88.7	80.7
Date																		23-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	85	88	89	90	90	90	89	87	85	83	81	80	78	77	77	76	76	75	75	74	74		90	
	78.5	81.5	84.0	86.0	86.6	86.9	85.3	81.8	81.6	78.4	74.1	74.0	74.4	74.7	74.5	74.4	75.2	74.6	75.2	76.9	75.4	75.2	75.2	76.1	74.0	86.9	78.3
Date	23-Sep																	24-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	81	84	87	88	89	89	89	88	86	84	82	80	78	77	76	75	75	75	75	75	74	74		89	
	76.6	80.0	82.9	84.7	86.5	87.3	86.0	82.8	81.7	79.7	78.4	78.9	79.4	79.1	77.6	77.6	77.6	77.4	77.0	76.3	76.0	75.9	75.5	75.1	75.1	87.3	79.6
Date																		25-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	81	84	86	87	87	88	88	87	86	84	82	80	79	78	78	77	77	77	76	76	75	75		88	
	76.1	80.9	83.5	84.3	82.3	83.5	83.5	85.6	85.6	85.2	84.6	82.9	79.9	78.0	77.3	76.7	76.1	76.0	75.5	75.5	75.5	75.3	75.8	76.0	75.3	85.6	79.8
Date	25-Sep																	26-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	76.5	80.2	83.1	80.0	84.2	80.8	78.6	79.7	79.3	79.5	78.7	78.4	77.4	76.5	76.0	76.1	76.3	75.8	76.4	76.3	76.5	76.5	75.8	73.4	73.4	84.2	78.0

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
9/19/2018 7am	82.1	79.8	83.3	80.4	95.0	90.8	88	83.0	79.6	2.3	2.9	4.2	3.4

Date	20-Sep											21-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	low	high	ave
Temperature (°F)	94	94	94	92	90	88	86	84	83	82	81	80	79	79	79	78	77	76	77	81	86	90	92	92		94	
	85.5	79.4	80.0	83.1	80.2	77.6	77.0	76.2	77.3	76.5	76.2	77.3	77.1	76.7	77.2	78.9	78.7	78.5	80.1	81.6	84.3	86.2	87.8	88.7	76.2	88.7	80.1

Date												22-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	92	92	92	91	89	86	84	83	82	81	80	80	79	78	78	77	76	76	77	80	85	88	90	91		92	
	85.2	85.1	85.3	80.9	80.6	79.3	78.3	77.9	77.5	78.4	78.2	77.9	77.1	77.0	76.8	78.0	77.5	77.3	78.5	81.5	84.0	86.0	86.6	86.9	76.8	86.9	80.5

Date	22-Sep											23-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	91	92	92	91	89	87	84	82	81	80	80	79	79	78	77	77	76	75	76	78	80	83	87	89		92	
	85.3	81.8	81.6	78.4	74.1	74.0	74.4	74.7	74.5	74.4	75.2	74.6	75.2	76.9	75.4	75.2	75.2	76.1	76.6	80.0	82.9	84.7	86.5	87.3	74.0	87.3	78.1

Date												24-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	91	91	90	89	87	85	83	82	81	80	80	79	78	77	76	76	75	75	76	78	81	84	86	88		91	
	86.0	82.8	81.7	79.7	78.4	78.9	79.4	79.1	77.6	77.6	77.6	77.4	77.0	76.3	76.0	75.9	75.5	75.1	76.1	80.9	83.5	84.3	82.3	83.5	75.1	86.0	79.3

Date	24-Sep											25-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	90	90	89	88	86	85	83	82	81	80	80	79	78	77	76	76	75	75	76	78	81	83	86	88		90	
	83.5	85.6	85.6	85.2	84.6	82.9	79.9	78.0	77.3	76.7	76.1	76.0	75.5	75.5	75.5	75.3	75.8	76.0	76.5	80.2	83.1	80.0	84.2	80.8	75.3	85.6	79.6

Date												26-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	89	89	89	87	86	84	83	82	81	80	80	79	78	77	76	76	75	75	76	78	80	83	85	87		89	
	78.6	79.7	79.3	79.5	78.7	78.4	77.4	76.5	76.0	76.1	76.3	75.8	76.4	76.3	76.5	76.5	75.8	73.4	73.2	73.3	73.9	75.1	76.9	77.5	73.2	79.7	76.5

Date	26-Sep											27-Sep															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)																										89	
	79.0	80.6	81.1	80.9	79.6	78.4	76.4	75.7	75.4	74.6	74.5	74.5	73.9	73.6	73.6	74.0	74.1	74.1	74.3	75.9	77.1	76.7	76.7	76.4	73.6	81.1	76.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/20/2018 1pm	82.7	79.0	83.7	79.6	94.0	88.7	89	83.6	78.6	3.7	4.1	5.3	5.0

Date	21-Sep																22-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	80	85	88	90	91	90	90	90	90	89	88	85	83	81	80	79	78	77	77	76	76	75	75	75		91	
	81.6	84.3	86.2	87.8	88.7	85.2	85.1	85.3	80.9	80.6	79.3	78.3	77.9	77.5	78.4	78.2	77.9	77.1	77.0	76.8	78.0	77.5	77.3	78.5	76.8	88.7	80.6
Date																	23-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	84	87	90	91	90	90	90	90	89	88	85	82	80	79	78	77	77	76	75	75	74	74	74		91	
	81.5	84.0	86.0	86.6	86.9	85.3	81.8	81.6	78.4	74.1	74.0	74.4	74.7	74.5	74.4	75.2	74.6	75.2	76.9	75.4	75.2	75.2	76.1	76.6	74.0	86.9	78.3
Date	23-Sep																24-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	83	86	89	90	89	90	90	89	88	87	84	82	80	79	78	78	77	77	76	76	75	75	75		90	
	80.0	82.9	84.7	86.5	87.3	86.0	82.8	81.7	79.7	78.4	78.9	79.4	79.1	77.6	77.6	77.6	77.4	77.0	76.3	76.0	75.9	75.5	75.1	76.1	75.1	87.3	79.6
Date																	25-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	83	86	88	89	88	89	89	88	87	86	84	82	80	79	78	78	77	76	76	76	75	75	75		89	
	80.9	83.5	84.3	82.3	83.5	83.5	85.6	85.6	85.2	84.6	82.9	79.9	78.0	77.3	76.7	76.1	76.0	75.5	75.5	75.5	75.3	75.8	76.0	76.5	75.3	85.6	79.8
Date	25-Sep																26-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	79	83	86	89	90	89	90	90	89	88	87	84	82	80	79	78	78	77	77	76	76	75	75	75		90	
	80.2	83.1	80.0	84.2	80.8	78.6	79.7	79.3	79.5	78.7	78.4	77.4	76.5	76.0	76.1	76.3	75.8	76.4	76.3	76.5	76.5	75.8	73.4	73.2	73.2	84.2	77.9
Date																	27-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	78	83	86	88	89	88	88	88	88	87	86	83	81	79	78	77	76	75	75	74	74	73	73	73		89	
	73.3	73.9	75.1	76.9	77.5	79.0	80.6	81.1	80.9	79.6	78.4	76.4	75.7	75.4	74.6	74.5	74.5	73.9	73.6	73.6	74.0	74.1	74.1	74.3	73.3	81.1	76.0
Date	27-Sep																28-Sep										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										88	
	75.9	77.1	76.7	76.7	76.4	79.6	79.6	77.6	73.8	73.6	73.8	73.7	74.3	73.4	72.9	73.1	72.8	72.8	73.0	73.0	73.3	73.5	73.7	73.4	72.8	79.6	74.7

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/21/2018 8am	82.0	78.7	82.4	79.5	91.0	88.7	88	82.9	78.1	3.3	2.9	2.3	4.7

Date	22-Sep																23-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	76	80	84	87	90	91	91	91	91	90	89	87	84	82	80	80	79	78	77	77	76	76	75	75		91	
	78.5	81.5	84.0	86.0	86.6	86.9	85.3	81.8	81.6	78.4	74.1	74.0	74.4	74.7	74.5	74.4	75.2	74.6	75.2	76.9	75.4	75.2	75.2	76.1	74.0	86.9	78.3

Date																	24-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	79	83	86	89	90	90	90	90	89	88	86	84	82	80	79	79	77	77	76	76	76	75	75		90	
	76.6	80.0	82.9	84.7	86.5	87.3	86.0	82.8	81.7	79.7	78.4	78.9	79.4	79.1	77.6	77.6	77.6	77.4	77.0	76.3	76.0	75.9	75.5	75.1	75.1	87.3	79.6

Date	24-Sep																25-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	79	83	86	89	90	90	90	90	89	88	86	84	82	80	79	79	77	77	76	76	76	75	75		90	
	76.1	80.9	83.5	84.3	82.3	83.5	83.5	85.6	85.6	85.2	84.6	82.9	79.9	78.0	77.3	76.7	76.1	76.0	75.5	75.5	75.5	75.3	75.8	76.0	75.3	85.6	79.8

Date																	26-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	79	83	86	89	90	90	90	90	89	88	86	84	82	80	79	79	77	77	76	76	76	75	75		90	
	76.5	80.2	83.1	80.0	84.2	80.8	78.6	79.7	79.3	79.5	78.7	78.4	77.4	76.5	76.0	76.1	76.3	75.8	76.4	76.3	76.5	76.5	75.8	73.4	73.4	84.2	78.0

Date	26-Sep																27-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	78	82	85	88	89	89	89	89	88	87	85	83	81	79	78	78	76	76	75	75	75	74	74		89	
	73.2	73.3	73.9	75.1	76.9	77.5	79.0	80.6	81.1	80.9	79.6	78.4	76.4	75.7	75.4	74.6	74.5	74.5	73.9	73.6	73.6	74.0	74.1	74.1	73.2	81.1	76.0

Date																	28-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	74	78	82	85	88	89	89	89	89	88	87	85	83	81	79	78	78	76	76	75	75	75	74	74		89	
	74.3	75.9	77.1	76.7	76.7	76.4	79.6	79.6	77.6	73.8	73.6	73.8	73.7	74.3	73.4	72.9	73.1	72.8	72.8	73.0	73.0	73.3	73.5	73.7	72.8	79.6	74.8

Date	28-Sep																29-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										89	
	73.4	73.9	76.1	77.8	79.4	80.0	80.1	81.1	81.6	79.5	75.5	73.0	72.8	73.0	74.1	75.2	77.6	77.0	76.7	76.7	76.8	76.8	76.5	76.2	72.8	81.6	76.7

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/22/2018 7am	81.9	77.7	82.3	79.2	91.0	86.9	89	82.9	77.6	4.2	3.1	4.1	5.3

Date	**23-Sep**																			**24-Sep**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	low	high	ave
Temperature (°F)	76	76	75	78	83	86	88	89	89	89	88	87	86	85	83	81	80	79	78	78	77	77	76	76		89	
	75.2	76.1	76.6	80.0	82.9	84.7	86.5	87.3	86.0	82.8	81.7	79.7	78.4	78.9	79.4	79.1	77.6	77.6	77.6	77.4	77.0	76.3	76.0	75.9	75.2	87.3	79.6
Date																				**25-Sep**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	76	76	75	78	83	86	88	89	89	89	88	87	86	85	83	81	80	79	78	78	77	77	76	76		89	
	75.5	75.1	76.1	80.9	83.5	84.3	82.3	83.5	83.5	85.6	85.6	85.2	84.6	82.9	79.9	78.0	77.3	76.7	76.1	76.0	75.5	75.5	75.5	75.3	75.1	85.6	79.8
Date	**25-Sep**																			**26-Sep**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	76	76	75	79	83	86	89	90	90	90	89	88	87	86	84	82	80	79	79	78	77	77	76	76		90	
	75.8	76.0	76.5	80.2	83.1	80.0	84.2	80.8	78.6	79.7	79.3	79.5	78.7	78.4	77.4	76.5	76.0	76.1	76.3	75.8	76.4	76.3	76.5	76.5	75.8	84.2	78.1
Date																				**27-Sep**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	76	76	75	78	83	86	88	89	89	89	88	87	86	85	83	81	79	78	78	77	76	76	75	75		89	
	75.8	73.4	73.2	73.3	73.9	75.1	76.9	77.5	79.0	80.6	81.1	80.9	79.6	78.4	76.4	75.7	75.4	74.6	74.5	74.5	73.9	73.6	73.6	74.0	73.2	81.1	76.0
Date	**27-Sep**																			**28-Sep**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	75	75	74	78	82	85	88	89	89	89	88	87	86	85	83	81	79	78	78	77	76	76	75	75		89	
	74.1	74.1	74.3	75.9	77.1	76.7	76.7	76.4	79.6	79.6	77.6	73.8	73.6	73.8	73.7	74.3	73.4	72.9	73.1	72.8	72.8	73.0	73.0	73.3	72.8	79.6	74.8
Date																				**29-Sep**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	75	75	74	78	83	86	89	90	90	90	89	88	87	86	83	81	79	79	78	77	76	76	75	75		90	
	73.5	73.7	73.4	73.9	76.1	77.8	79.4	80.0	80.1	81.1	81.6	79.5	75.5	73.0	72.8	73.0	74.1	75.2	77.6	77.0	76.7	76.7	76.8	76.8	72.8	81.6	76.5
Date	**29-Sep**																			**30-Sep**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)																										89	
	76.5	76.2	76.1	76.6	77.1	77.3	78.2	78.9	79.9	80.2	80.2	80.5	80.3	78.4	76.7	75.0	76.2	74.9	74.8	74.8	75.6	76.0	77.4	77.9	74.8	80.5	77.3

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
9/23/2018 5am	81.6	77.5	81.8	79.2	89.0	87.3	89	82.7	77.4	4.1	2.7	1.7	5.2

Date	24-Sep																		25-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	75	76	79	83	87	89	89	88	89	89	88	87	85	82	80	79	78	78	77	77	77	76	76	75		89	
	75.1	76.1	80.9	83.5	84.3	82.3	83.5	83.5	85.6	85.6	85.2	84.6	82.9	79.9	78.0	77.3	76.7	76.1	76.0	75.5	75.5	75.5	75.3	75.8	75.1	85.6	79.8

Date																			26-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	79	83	87	88	88	88	88	89	88	86	83	81	80	80	80	79	78	77	77	76	76	75		89	
	76.0	76.5	80.2	83.1	80.0	84.2	80.8	78.6	79.7	79.3	79.5	78.7	78.4	77.4	76.5	76.0	76.1	76.3	75.8	76.4	76.3	76.5	76.5	75.8	75.8	84.2	78.1

Date	26-Sep																		27-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	79	83	87	89	89	88	88	88	87	85	84	82	81	80	79	78	77	76	76	76	75	74		89	
	73.4	73.2	73.3	73.9	75.1	76.9	77.5	79.0	80.6	81.1	80.9	79.6	78.4	76.4	75.7	75.4	74.6	74.5	74.5	73.9	73.6	73.6	74.0	74.1	73.2	81.1	76.0

Date																			28-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	74	75	77	80	83	85	87	87	87	86	85	83	82	80	79	79	78	77	77	76	75	74	74		87	
	74.1	74.3	75.9	77.1	76.7	76.7	76.4	79.6	79.6	77.6	73.8	73.6	73.8	73.7	74.3	73.4	72.9	73.1	72.8	72.8	73.0	73.0	73.3	73.5	72.8	79.6	74.8

Date	28-Sep																		29-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	75	77	80	82	85	87	88	89	88	87	86	84	83	82	81	80	79	78	77	76	75	75	74		89	
	73.7	73.4	73.9	76.1	77.8	79.4	80.0	80.1	81.1	81.6	79.5	75.5	73.0	72.8	73.0	74.1	75.2	77.6	77.0	76.7	76.7	76.8	76.8	76.5	72.8	81.6	76.6

Date																			30-Sep								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	78	80	83	86	88	89	89	89	87	85	83	82	81	80	79	79	79	78	77	76	75	75		89	
	76.2	76.1	76.6	77.1	77.3	78.2	78.9	79.9	80.2	80.2	80.5	80.3	78.4	76.7	75.0	76.2	74.9	74.8	74.8	75.6	76.0	77.4	77.9	78.5	74.8	80.5	77.4

Date	30-Sep																		1-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										90	
	78.4	78.5	79.1	79.8	80.3	80.8	81.4	81.7	81.9	73.7	69.9	70.6	71.0	72.4	73.8	75.8	76.9	78.1	78.1	77.9	78.0	77.9	77.6	77.5	69.9	81.9	77.1

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
9/24/2018 6am	81.1	77.1	81.5	77.9	89.0	85.6	90	82.3	77.1	4.0	3.6	3.4	5.2

Date	25-Sep																	26-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	76	79	83	87	88	88	87	86	85	84	83	82	81	80	79	78	78	77	77	77	76	76	75	75		88	
	76.5	80.2	83.1	80.0	84.2	80.8	78.6	79.7	79.3	79.5	78.7	78.4	77.4	76.5	76.0	76.1	76.3	75.8	76.4	76.3	76.5	76.5	75.8	73.4	73.4	84.2	78.0

Date																		27-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	82	86	87	87	87	86	86	84	83	81	80	79	78	77	76	75	75	75	75	75	74	73		87	
	73.2	73.3	73.9	75.1	76.9	77.5	79.0	80.6	81.1	80.9	79.6	78.4	76.4	75.7	75.4	74.6	74.5	74.5	73.9	73.6	73.6	74.0	74.1	74.1	73.2	81.1	76.0

Date	27-Sep																	28-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	74	76	79	82	84	85	86	87	87	86	85	83	81	79	79	78	78	77	77	76	75	74	73	73		87	
	74.3	75.9	77.1	76.7	76.7	76.4	79.6	79.6	77.6	73.8	73.6	73.8	73.7	74.3	73.4	72.9	73.1	72.8	72.8	73.0	73.0	73.3	73.5	73.7	72.8	79.6	74.8

Date																		29-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	74	76	78	81	84	86	88	88	88	86	85	83	82	80	80	79	79	78	78	77	76	75	74	74		88	
	73.4	73.9	76.1	77.8	79.4	80.0	80.1	81.1	81.6	79.5	75.5	73.0	72.8	73.0	74.1	75.2	77.6	77.0	76.7	76.7	76.8	76.8	76.5	76.2	72.8	81.6	76.7

Date	29-Sep																	30-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	79	82	85	87	88	89	88	87	86	84	83	82	81	80	80	79	79	78	77	76	75	75		89	
	76.1	76.6	77.1	77.3	78.2	78.9	79.9	80.2	80.2	80.5	80.3	78.4	76.7	75.0	76.2	74.9	74.8	74.8	75.6	76.0	77.4	77.9	78.5	78.4	74.8	80.5	77.5

Date																		1-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	83	86	88	90	90	89	88	86	85	83	82	81	80	79	79	78	77	76	75	74	74		90	
	78.5	79.1	79.8	80.3	80.8	81.4	81.7	81.9	73.7	69.9	70.6	71.0	72.4	73.8	75.8	76.9	78.1	78.1	77.9	78.0	77.9	77.6	77.5	78.3	69.9	81.9	77.1

Date	1-Oct																	2-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										90	
	79.9	81.9	83.1	84.4	83.5	81.6	77.8	76.5	77.9	78.9	77.6	78.4	78.9	78.6	79.1	79.5	79.7	79.9	79.3	78.8	78.7	79.5	78.1	79.0	76.5	84.4	79.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/25/2018 7am	80.6	76.7	80.1	76.3	88.0	84.2	90	81.9	77.1	3.9	3.8	3.8	4.8

Date	26-Sep														27-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	81	85	87	87	87	86	85	84	82	80	78	77	77	76	76	75	75	75	75	75	74	73	74	77		87	
	73.9	75.1	76.9	77.5	79.0	80.6	81.1	80.9	79.6	78.4	76.4	75.7	75.4	74.6	74.5	74.5	73.9	73.6	73.6	74.0	74.1	74.1	74.3	75.9	73.6	81.1	76.2

Date															28-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	81	84	86	86	86	86	86	86	84	82	80	79	77	76	75	75	75	75	75	75	74	73	73	76		86	
	77.1	76.7	76.7	76.4	79.6	79.6	77.6	73.8	73.6	73.8	73.7	74.3	73.4	72.9	73.1	72.8	72.8	73.0	73.0	73.3	73.5	73.7	73.4	73.9	72.8	79.6	74.6

Date	28-Sep														29-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	79	83	85	86	86	87	87	86	85	82	81	80	79	79	79	78	78	77	76	75	74	74	75	76		87	
	76.1	77.8	79.4	80.0	80.1	81.1	81.6	79.5	75.5	73.0	72.8	73.0	74.1	75.2	77.6	77.0	76.7	76.7	76.8	76.8	76.5	76.2	76.1	76.6	72.8	81.6	76.9

Date															30-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	79	81	84	86	88	88	87	86	85	83	82	80	80	79	78	78	77	76	75	74	74	74	75	77		88	
	77.1	77.3	78.2	78.9	79.9	80.2	80.2	80.5	80.3	78.4	76.7	75.0	76.2	74.9	74.8	74.8	75.6	76.0	77.4	77.9	78.5	78.4	78.5	79.1	74.8	80.5	77.7

Date	30-Sep														1-Oct											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	80	83	85	87	89	89	88	87	85	83	81	80	79	78	78	77	77	76	75	74	74	74	75	78		89	
	79.8	80.3	80.8	81.4	81.7	81.9	73.7	69.9	70.6	71.0	72.4	73.8	75.8	76.9	78.1	78.1	77.9	78.0	77.9	77.6	77.5	78.3	79.9	81.9	69.9	81.9	77.3

Date															2-Oct											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	80	83	86	88	90	90	89	88	86	84	82	80	79	79	78	77	77	76	75	74	74	74	75	77		90	
	83.1	84.4	83.5	81.6	77.8	76.5	77.9	78.9	77.6	78.4	78.9	78.6	79.1	79.5	79.7	79.9	79.3	78.8	78.7	79.5	78.1	79.0	79.1	79.2	76.5	84.4	79.5

Date	2-Oct														3-Oct											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)																										89	
	80.4	82.0	83.1	83.8	85.3	85.7	86.5	86.1	85.8	84.7	81.6	79.2	78.5	77.5	79.5	78.5	77.4	77.2	77.1	76.6	77.0	77.4	79.3	81.4	76.6	86.5	80.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/26/2018 9am	80.1	77.0	79.6	75.9	87.0	81.1	89	81.4	77.6	3.1	3.7	5.9	3.8

Date	27-Sep																28-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	75	77	80	82	83	84	84	84	84	84	82	81	79	78	77	76	76	75	75	74	74	73	72	71		84	
	74.3	75.9	77.1	76.7	76.7	76.4	79.6	79.6	77.6	73.8	73.6	73.8	73.7	74.3	73.4	72.9	73.1	72.8	72.8	73.0	73.0	73.3	73.5	73.7	72.8	79.6	74.8

Date																	29-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	72	74	78	82	84	85	85	86	86	85	84	82	80	78	77	77	76	76	75	75	75	74	73	73		86	
	73.4	73.9	76.1	77.8	79.4	80.0	80.1	81.1	81.6	79.5	75.5	73.0	72.8	73.0	74.1	75.2	77.6	77.0	76.7	76.7	76.8	76.8	76.5	76.2	72.8	81.6	76.7

Date	29-Sep																30-Sep									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	74	76	80	82	84	85	85	86	87	87	85	82	80	79	78	78	78	77	77	77	76	76	75	74		87	
	76.1	76.6	77.1	77.3	78.2	78.9	79.9	80.2	80.2	80.5	80.3	78.4	76.7	75.0	76.2	74.9	74.8	74.8	75.6	76.0	77.4	77.9	78.5	78.4	74.8	80.5	77.5

Date																	1-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	74	75	78	80	83	86	87	88	88	87	85	84	83	81	81	80	79	78	78	77	76	75	75	75		88	
	78.5	79.1	79.8	80.3	80.8	81.4	81.7	81.9	73.7	69.9	70.6	71.0	72.4	73.8	75.8	76.9	78.1	78.1	77.9	78.0	77.9	77.6	77.5	78.3	69.9	81.9	77.1

Date	1-Oct																2-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	84	86	88	90	90	89	88	86	84	82	81	80	79	79	78	77	77	76	75	75	75		90	
	79.9	81.9	83.1	84.4	83.5	81.6	77.8	76.5	77.9	78.9	77.6	78.4	78.9	78.6	79.1	79.5	79.7	79.9	79.3	78.8	78.7	79.5	78.1	79.0	76.5	84.4	79.6

Date																	3-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	83	86	88	89	89	88	87	85	83	81	80	79	79	78	78	77	77	76	75	75	75		89	
	79.1	79.2	80.4	82.0	83.1	83.8	85.3	85.7	86.5	86.1	85.8	84.7	81.6	79.2	78.5	77.5	79.5	78.5	77.4	77.2	77.1	76.6	77.0	77.4	76.6	86.5	80.8

Date	3-Oct																4-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	79.3	81.4	83.1	84.6	83.8	83.7	81.5	80.4	85.0	84.9	84.5	82.9	82.4	80.5	79.9	79.3	78.9	78.0	77.1	77.6	77.9	77.7	77.7	76.3	76.3	85.0	80.8

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
9/27/2018 7am	80.0	77.8	79.0	76.3	84.0	79.6	88	81.1	78.2	2.2	2.7	4.4	3.0

Date	28-Sep														29-Sep											
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	low	high	ave
Temperature (°F)	81	83	85	85	86	86	85	84	81	79	78	77	76	76	75	75	74	74	73	72	72	73	76	80		86	
	77.8	79.4	80.0	80.1	81.1	81.6	79.5	75.5	73.0	72.8	73.0	74.1	75.2	77.6	77.0	76.7	76.7	76.8	76.8	76.5	76.2	76.1	76.6	77.1	72.8	81.6	77.0

Date															30-Sep											
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	84	85	85	85	86	86	85	83	80	78	77	77	78	77	76	76	76	76	76	75	74	74	77	80		86	
	77.3	78.2	78.9	79.9	80.2	80.2	80.5	80.3	78.4	76.7	75.0	76.2	74.9	74.8	74.8	75.6	76.0	77.4	77.9	78.5	78.4	78.5	79.1	79.8	74.8	80.5	77.8

Date	30-Sep														1-Oct											
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	83	84	85	85	86	87	87	85	83	81	80	79	78	78	78	77	77	76	76	75	75	76	77	80		87	
	80.3	80.8	81.4	81.7	81.9	73.7	69.9	70.6	71.0	72.4	73.8	75.8	76.9	78.1	78.1	77.9	78.0	77.9	77.6	77.5	78.3	79.9	81.9	83.1	69.9	83.1	77.4

Date															2-Oct											
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	82	85	87	89	89	88	87	85	84	82	81	80	79	78	78	77	77	76	75	75	75	76	78	81		89	
	84.4	83.5	81.6	77.8	76.5	77.9	78.9	77.6	78.4	78.9	78.6	79.1	79.5	79.7	79.9	79.3	78.8	78.7	79.5	78.1	79.0	79.1	79.2	80.4	76.5	84.4	79.4

Date	2-Oct														3-Oct											
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	84	86	88	90	90	89	88	87	85	83	82	81	80	79	79	78	77	76	75	75	75	76	78	81		90	
	82.0	83.1	83.8	85.3	85.7	86.5	86.1	85.8	84.7	81.6	79.2	78.5	77.5	79.5	78.5	77.4	77.2	77.1	76.6	77.0	77.4	79.3	81.4	83.1	76.6	86.5	81.0

Date															4-Oct											
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	84	86	89	90	90	89	88	86	85	83	82	81	80	80	79	78	77	76	75	75	75	76	78	81		90	
	84.6	83.8	83.7	81.5	80.4	85.0	84.9	84.5	82.9	82.4	80.5	79.9	79.3	78.9	78.0	77.1	77.6	77.9	77.7	77.7	76.3	76.7	80.3	82.4	76.3	85.0	80.6

Date	4-Oct														5-Oct											
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
																										90	
	84.2	83.9	84.0	84.4	84.9	85.9	84.3	84.7	84.2	82.3	80.4	79.5	77.8	77.8	76.4	75.1	76.4	74.2	74.9	73.3	74.8	76.4	76.9	79.8	73.3	85.9	79.9

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
9/28/2018 10am	80.5	78.9	79.4	77.4	86.0	81.6	90	81.8	79.0	1.6	2.0	4.4	2.8

Date	29-Sep														30-Sep											
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	low	high	ave
Temperature (°F)	79	81	82	82	82	83	84	84	83	81	79	78	78	78	78	77	77	77	77	77	76	76	76	78		84	
	77.1	77.3	78.2	78.9	79.9	80.2	80.2	80.5	80.3	78.4	76.7	75.0	76.2	74.9	74.8	74.8	75.6	76.0	77.4	77.9	78.5	78.4	78.5	79.1	74.8	80.5	77.7

Date															1-Oct										
Hour (CDT)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8			
Temperature (°F)	81	83	85	85	86	86	86	86	84	82	80	79	79	79	78	78	77	76	76	76	75	75	76	78		86	
	79.8	80.3	80.8	81.4	81.7	81.9	73.7	69.9	70.6	71.0	72.4	73.8	75.8	76.9	78.1	78.1	77.9	78.0	77.9	77.6	77.5	78.3	79.9	81.9	69.9	81.9	77.3

Date	1-Oct														2-Oct										
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	85	87	89	89	90	89	88	86	84	82	81	80	80	79	78	78	77	77	76	76	76	76	78	80		90	
	83.1	84.4	83.5	81.6	77.8	76.5	77.9	78.9	77.6	78.4	78.9	78.6	79.1	79.5	79.7	79.9	79.3	78.8	78.7	79.5	78.1	79.0	79.1	79.2	76.5	84.4	79.5

Date															3-Oct										
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	83	86	88	89	89	89	87	86	84	82	81	80	79	79	78	78	77	76	75	75	75	76	78	81		89	
	80.4	82.0	83.1	83.8	85.3	85.7	86.5	86.1	85.8	84.7	81.6	79.2	78.5	77.5	79.5	78.5	77.4	77.2	77.1	76.6	77.0	77.4	79.3	81.4	76.6	86.5	80.9

Date	3-Oct														4-Oct										
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	84	86	88	90	90	89	87	85	84	82	81	80	79	79	78	78	77	76	75	75	75	76	78	81		90	
	83.1	84.6	83.8	83.7	81.5	80.4	85.0	84.9	84.5	82.9	82.4	80.5	79.9	79.3	78.9	78.0	77.1	77.6	77.9	77.7	77.7	76.3	76.7	80.3	76.3	85.0	80.6

Date															5-Oct										
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)	83	86	88	89	90	89	88	86	84	83	81	80	79	78	77	76	75	74	73	73	74	75	77	79		90	
	82.4	84.2	83.9	84.0	84.4	84.9	85.9	84.3	84.7	84.2	82.3	80.4	79.5	77.8	77.8	76.4	75.1	76.4	74.2	74.9	73.3	74.8	76.4	76.9	73.3	85.9	80.0

Date	5-Oct														6-Oct										
Hour (CDT)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9			
Temperature (°F)																										89	
	79.8	82.1	83.6	84.8	85.2	84.0	86.0	86.4	85.4	84.3	82.9	81.8	81.0	80.1	78.7	79.1	79.0	78.0	78.6	79.0	79.0	78.9	79.1	79.5	78.0	86.4	81.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/29/2018 10am	80.8	79.3	80.4	78.2	84.0	80.5	89	81.9	79.6	1.4	2.3	3.5	2.3

Date	30-Sep																1-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	75	77	79	80	81	83	83	83	83	83	82	81	80	79	78	77	77	77	77	77	77	77	76	76		83	
	78.5	79.1	79.8	80.3	80.8	81.4	81.7	81.9	73.7	69.9	70.6	71.0	72.4	73.8	75.8	76.9	78.1	78.1	77.9	78.0	77.9	77.6	77.5	78.3	69.9	81.9	77.1

Date																	2-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	85	85	86	87	87	88	88	87	84	82	81	80	79	78	78	78	78	77	77	76	75		88	
	79.9	81.9	83.1	84.4	83.5	81.6	77.8	76.5	77.9	78.9	77.6	78.4	78.9	78.6	79.1	79.5	79.7	79.9	79.3	78.8	78.7	79.5	78.1	79.0	76.5	84.4	79.6

Date	2-Oct																3-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	84	85	86	87	87	88	88	86	84	81	80	80	79	79	78	77	77	77	76	76	75		88	
	79.1	79.2	80.4	82.0	83.1	83.8	85.3	85.7	86.5	86.1	85.8	84.7	81.6	79.2	78.5	77.5	79.5	78.5	77.4	77.2	77.1	76.6	77.0	77.4	76.6	86.5	80.8

Date																	4-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	76	79	81	84	86	88	88	88	86	85	83	82	81	80	79	78	78	77	77	76	75	75	75		88	
	79.3	81.4	83.1	84.6	83.8	83.7	81.5	80.4	85.0	84.9	84.5	82.9	82.4	80.5	79.9	79.3	78.9	78.0	77.1	77.6	77.9	77.7	77.7	76.3	76.3	85.0	80.8

Date	4-Oct																5-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	82	85	87	88	88	88	86	85	84	82	81	80	79	78	77	76	76	75	74	74	74		88	
	76.7	80.3	82.4	84.2	83.9	84.0	84.4	84.9	85.9	84.3	84.7	84.2	82.3	80.4	79.5	77.8	77.8	76.4	75.1	76.4	74.2	74.9	73.3	74.8	73.3	85.9	80.1

Date																	6-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	80	82	85	87	88	88	87	86	85	83	82	81	80	80	79	79	78	77	76	76	75	75		88	
	76.4	76.9	79.8	82.1	83.6	84.8	85.2	84.0	86.0	86.4	85.4	84.3	82.9	81.8	81.0	80.1	78.7	79.1	79.0	78.0	78.6	79.0	79.0	78.9	76.4	86.4	81.3

Date	6-Oct																7-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										87	
	79.1	79.5	81.3	83.1	85.0	86.2	86.8	87.3	86.5	86.2	85.0	83.4	81.5	79.5	77.8	77.5	79.3	79.0	78.6	78.5	77.0	76.9	78.0	78.9	76.9	87.3	81.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
9/30/2018 7am	80.6	80.0	80.5	79.2	83.0	81.9	87	81.5	80.2	0.6	1.3	1.1	1.3

Date	1-Oct																	2-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	73	76	80	84	86	86	85	86	86	86	84	82	81	80	79	79	78	78	78	77	77	77	76	76		86	
	79.9	81.9	83.1	84.4	83.5	81.6	77.8	76.5	77.9	78.9	77.6	78.4	78.9	78.6	79.1	79.5	79.7	79.9	79.3	78.8	78.7	79.5	78.1	79.0	76.5	84.4	79.6
Date																		3-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	79	82	84	86	87	88	88	89	89	87	84	82	80	80	79	79	78	77	77	76	76	75	75		89	
	79.1	79.2	80.4	82.0	83.1	83.8	85.3	85.7	86.5	86.1	85.8	84.7	81.6	79.2	78.5	77.5	79.5	78.5	77.4	77.2	77.1	76.6	77.0	77.4	76.6	86.5	80.8
Date	3-Oct																	4-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	84	86	87	87	88	88	87	86	84	82	81	80	80	79	78	77	77	76	75	75	75		88	
	79.3	81.4	83.1	84.6	83.8	83.7	81.5	80.4	85.0	84.9	84.5	82.9	82.4	80.5	79.9	79.3	78.9	78.0	77.1	77.6	77.9	77.7	77.7	76.3	76.3	85.0	80.8
Date																		5-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	83	86	88	89	89	88	87	85	83	81	80	79	78	77	77	76	75	74	73	73	73		89	
	76.7	80.3	82.4	84.2	83.9	84.0	84.4	84.9	85.9	84.3	84.7	84.2	82.3	80.4	79.5	77.8	77.8	76.4	75.1	76.4	74.2	74.9	73.3	74.8	73.3	85.9	80.1
Date	5-Oct																	6-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	74	76	79	82	85	87	89	89	88	87	86	84	82	81	80	80	79	78	78	77	76	75	75	75		89	
	76.4	76.9	79.8	82.1	83.6	84.8	85.2	84.0	86.0	86.4	85.4	84.3	82.9	81.8	81.0	80.1	78.7	79.1	79.0	78.0	78.6	79.0	79.0	78.9	76.4	86.4	81.3
Date																		7-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	83	85	87	88	88	87	86	84	82	80	79	79	78	78	78	77	77	76	75	75	75		88	
	79.1	79.5	81.3	83.1	85.0	86.2	86.8	87.3	86.5	86.2	85.0	83.4	81.5	79.5	77.8	77.5	79.3	79.0	78.6	78.5	77.0	76.9	78.0	78.9	76.9	87.3	81.3
Date	7-Oct																	8-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										88	
	77.6	78.6	80.7	82.9	83.5	85.0	86.0	86.8	85.3	78.2	80.5	81.4	77.9	78.9	78.9	79.1	78.8	78.3	78.1	77.3	77.6	77.5	77.2	78.1	77.2	86.8	80.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/1/2018 7am	80.8	80.7	81.0	80.4	86.0	84.4	88	81.8	80.6	0.1	0.6	1.6	1.2

Date	2-Oct																	3-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	77	79	82	84	86	87	88	88	88	88	87	84	82	81	80	79	79	78	77	77	77	77	76	75		88	
	79.1	79.2	80.4	82.0	83.1	83.8	85.3	85.7	86.5	86.1	85.8	84.7	81.6	79.2	78.5	77.5	79.5	78.5	77.4	77.2	77.1	76.6	77.0	77.4	76.6	86.5	80.8
Date																		4-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	84	86	87	88	88	88	87	86	84	82	81	80	79	79	78	78	77	76	75	75	75		88	
	79.3	81.4	83.1	84.6	83.8	83.7	81.5	80.4	85.0	84.9	84.5	82.9	82.4	80.5	79.9	79.3	78.9	78.0	77.1	77.6	77.9	77.7	77.7	76.3	76.3	85.0	80.8
Date	4-Oct																	5-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	83	86	88	88	88	88	87	85	83	82	81	80	79	78	77	77	76	75	74	74	74		88	
	76.7	80.3	82.4	84.2	83.9	84.0	84.4	84.9	85.9	84.3	84.7	84.2	82.3	80.4	79.5	77.8	77.8	76.4	75.1	76.4	74.2	74.9	73.3	74.8	73.3	85.9	80.1
Date																		6-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	80	82	85	87	88	88	88	87	85	83	82	81	80	79	78	78	77	77	76	75	75	75		88	
	76.4	76.9	79.8	82.1	83.6	84.8	85.2	84.0	86.0	86.4	85.4	84.3	82.9	81.8	81.0	80.1	78.7	79.1	79.0	78.0	78.6	79.0	79.0	78.9	76.4	86.4	81.3
Date	6-Oct																	7-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	83	85	86	86	86	86	85	84	82	81	80	79	79	78	78	77	77	76	75	75	75		86	
	79.1	79.5	81.3	83.1	85.0	86.2	86.8	87.3	86.5	86.2	85.0	83.4	81.5	79.5	77.8	77.5	79.3	79.0	78.6	78.5	77.0	76.9	78.0	78.9	76.9	87.3	81.3
Date																		8-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	77	80	82	85	87	87	87	87	86	84	82	80	80	80	80	79	79	79	78	78	77	76	76		87	
	77.6	78.6	80.7	82.9	83.5	85.0	86.0	86.8	85.3	78.2	80.5	81.4	77.9	78.9	78.9	79.1	78.8	78.3	78.1	77.3	77.6	77.5	77.2	78.1	77.2	86.8	80.2
Date	8-Oct																	9-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										86	
	78.1	80.2	81.4	82.4	79.5	81.2	81.2	81.2	82.0	79.0	80.6	80.1	77.0	74.6	75.8	76.6	76.9	77.4	77.3	76.6	76.8	77.8	77.9	78.3	74.6	82.4	78.7

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/2/2018 7am	80.9	80.7	81.1	80.6	88.0	86.5	86	81.6	80.5	0.1	0.6	1.5	1.2

Date	4-Oct											5-Oct															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	low	high	ave
Temperature (°F)	89	89	89	88	86	84	82	80	79	78	77	76	75	75	75	75	74	73	74	76	80	83	85	87		89	
	84.4	84.9	85.9	84.3	84.7	84.2	82.3	80.4	79.5	77.8	77.8	76.4	75.1	76.4	74.2	74.9	73.3	74.8	76.4	76.9	79.8	82.1	83.6	84.8	73.3	85.9	79.8

Date												6-Oct															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	87	88	89	88	86	83	80	79	78	78	78	77	77	77	76	76	75	75	76	78	82	84	86	87		89	
	85.2	84.0	86.0	86.4	85.4	84.3	82.9	81.8	81.0	80.1	78.7	79.1	79.0	78.0	78.6	79.0	79.0	78.9	79.1	79.5	81.3	83.1	85.0	86.2	78.0	86.4	81.7

Date	6-Oct											7-Oct															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	87	88	89	89	87	84	82	81	80	79	78	77	76	76	77	76	76	75	75	76	79	82	85	87		89	
	86.8	87.3	86.5	86.2	85.0	83.4	81.5	79.5	77.8	77.5	79.3	79.0	78.6	78.5	77.0	76.9	78.0	78.9	77.6	78.6	80.7	82.9	83.5	85.0	76.9	87.3	81.1

Date												8-Oct															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	89	89	88	86	84	82	81	79	79	78	78	77	77	77	76	75	75	75	76	77	80	82	84	86		89	
	86.0	86.8	85.3	78.2	80.5	81.4	77.9	78.9	78.9	79.1	78.8	78.3	78.1	77.3	77.6	77.5	77.2	78.1	78.1	80.2	81.4	82.4	79.5	81.2	77.2	86.8	79.9

Date	8-Oct											9-Oct															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	87	87	86	85	84	82	81	80	79	78	77	77	76	76	75	75	75	75	76	78	80	82	84	86		87	
	81.2	81.2	82.0	79.0	80.6	80.1	77.0	74.6	75.8	76.6	76.9	77.4	77.3	76.6	76.8	77.8	77.9	78.3	78.1	78.5	80.3	78.3	79.6	80.7	74.6	82.0	78.4

Date												10-Oct															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)	87	87	86	85	84	82	81	80	79	78	78	77	77	76	75	74	74	74	75	77	79	81	83	85		87	
	82.5	83.3	82.9	82.6	82.0	81.7	81.5	81.5	80.4	78.5	77.7	77.6	77.2	76.6	76.1	75.2	75.4	75.5	74.9	75.9	77.9	79.8	82.9	84.1	74.9	84.1	79.3

Date	10-Oct											11-Oct															
Hour (CDT)	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12			
Temperature (°F)																										86	
	84.5	84.5	84.2	84.4	84.2	82.9	79.7	78.2	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.0	67.5	68.8	70.1	71.9	73.9	76.0	67.5	84.5	75.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/4/2018 1pm	80.4	80.1	80.7	80.9	89.0	85.9	86	81.2	79.3	0.3	-0.2	3.1	1.8

Date	5-Oct																6-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	74	77	82	86	88	89	89	90	90	89	87	85	82	80	79	78	77	76	76	76	76	76	75	75		90	
	76.4	76.9	79.8	82.1	83.6	84.8	85.2	84.0	86.0	86.4	85.4	84.3	82.9	81.8	81.0	80.1	78.7	79.1	79.0	78.0	78.6	79.0	79.0	78.9	76.4	86.4	81.3
Date																	7-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	79	83	86	88	89	89	89	89	88	85	83	81	80	79	79	78	77	76	76	75	75	74	74		89	
	79.1	79.5	81.3	83.1	85.0	86.2	86.8	87.3	86.5	86.2	85.0	83.4	81.5	79.5	77.8	77.5	79.3	79.0	78.6	78.5	77.0	76.9	78.0	78.9	76.9	87.3	81.3
Date	7-Oct																8-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	80	83	85	87	88	88	88	87	84	82	80	79	78	78	77	77	77	76	76	75	75	75		88	
	77.6	78.6	80.7	82.9	83.5	85.0	86.0	86.8	85.3	78.2	80.5	81.4	77.9	78.9	78.9	79.1	78.8	78.3	78.1	77.3	77.6	77.5	77.2	78.1	77.2	86.8	80.2
Date																	9-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	77	79	81	84	86	87	87	86	85	83	82	80	79	78	77	77	76	76	76	75	75	75	75		87	
	78.1	80.2	81.4	82.4	79.5	81.2	81.2	81.2	82.0	79.0	80.6	80.1	77.0	74.6	75.8	76.6	76.9	77.4	77.3	76.6	76.8	77.8	77.9	78.3	74.6	82.4	78.7
Date	9-Oct																10-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	80	82	84	85	86	86	85	84	83	81	80	79	78	78	78	77	77	76	75	74	74	74		86	
	78.1	78.5	80.3	78.3	79.6	80.7	82.5	83.3	82.9	82.6	82.0	81.7	81.5	81.5	80.4	78.5	77.7	77.6	77.2	76.6	76.1	75.2	75.4	75.5	75.2	83.3	79.3
Date																	11-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	77	79	81	83	85	86	86	85	84	82	81	80	79	78	78	78	77	77	76	75	75	74	74		86	
	74.9	75.9	77.9	79.8	82.9	84.1	84.5	84.5	84.2	84.4	84.2	82.9	79.7	78.2	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.0	68.0	84.5	77.0
Date	11-Oct																12-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										86	
	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	63.2	79.1	70.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/5/2018 7am	80.2	79.7	80.9	80.9	90.0	86.4	86	81.1	78.4	0.6	0.0	3.6	2.7

																									low	high	ave
Date	5-Oct			6-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	79	79	78	78	77	77	77	76	75	75	76	79	83	86	88	88	88	87	87	86	85	82	80	79		88	
	81.0	80.1	78.7	79.1	79.0	78.0	78.6	79.0	79.0	78.9	79.1	79.5	81.3	83.1	85.0	86.2	86.8	87.3	86.5	86.2	85.0	83.4	81.5	79.5	78.0	87.3	81.7
Date				7-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	79	78	77	76	76	76	76	76	75	75	76	78	80	83	84	85	86	87	88	88	86	83	80	79		88	
	77.8	77.5	79.3	79.0	78.6	78.5	77.0	76.9	78.0	78.9	77.6	78.6	80.7	82.9	83.5	85.0	86.0	86.8	85.3	78.2	80.5	81.4	77.9	78.9	76.9	86.8	80.2
Date	7-Oct			8-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	78	78	78	77	77	77	76	76	75	75	76	78	80	83	84	86	86	86	85	84	82	80	79	78		86	
	78.9	79.1	78.8	78.3	78.1	77.3	77.6	77.5	77.2	78.1	78.1	80.2	81.4	82.4	79.5	81.2	81.2	81.2	82.0	79.0	80.6	80.1	77.0	74.6	74.6	82.4	79.1
Date				9-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	78	77	77	77	77	76	76	75	75	75	76	77	79	81	83	84	85	85	84	83	82	81	80	79		85	
	75.8	76.6	76.9	77.4	77.3	76.6	76.8	77.8	77.9	78.3	78.1	78.5	80.3	78.3	79.6	80.7	82.5	83.3	82.9	82.6	82.0	81.7	81.5	81.5	75.8	83.3	79.4
Date	9-Oct			10-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	79	79	79	79	78	78	77	76	75	75	75	77	78	80	82	83	84	84	83	82	80	79	78	77		84	
	80.4	78.5	77.7	77.6	77.2	76.6	76.1	75.2	75.4	75.5	74.9	75.9	77.9	79.8	82.9	84.1	84.5	84.5	84.2	84.4	84.2	82.9	79.7	78.2	74.9	84.5	79.5
Date				11-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	76	76	76	75	75	75	74	73	73	73	74	75	77	80	82	84	85	85	85	84	82	81	80	79		85	
	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.0	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	67.5	79.1	73.0
Date	11-Oct			12-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)																										86	
	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	63.2	77.0	68.4

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/5/2018 9pm	79.6	78.8	80.4	80.4	88.0	87.3	86	80.5	77.3	0.8	0.0	0.7	3.2

Date	6-Oct																	7-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	75	76	79	83	87	88	89	89	89	89	88	86	83	81	79	79	78	78	77	77	77	76	76	75		89	
	78.9	79.1	79.5	81.3	83.1	85.0	86.2	86.8	87.3	86.5	86.2	85.0	83.4	81.5	79.5	77.8	77.5	79.3	79.0	78.6	78.5	77.0	76.9	78.0	76.9	87.3	81.3

Date																		8-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	76	78	81	84	86	87	87	88	88	87	85	82	79	78	77	77	76	76	76	76	76	76	75		88	
	78.9	77.6	78.6	80.7	82.9	83.5	85.0	86.0	86.8	85.3	78.2	80.5	81.4	77.9	78.9	78.9	79.1	78.8	78.3	78.1	77.3	77.6	77.5	77.2	77.2	86.8	80.2

Date	8-Oct																	9-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	74	74	77	81	84	86	87	87	87	87	85	84	81	79	79	78	78	77	77	76	77	77	76	76		87	
	78.1	78.1	80.2	81.4	82.4	79.5	81.2	81.2	81.2	82.0	79.0	80.6	80.1	77.0	74.6	75.8	76.6	76.9	77.4	77.3	76.6	76.8	77.8	77.9	74.6	82.4	78.7

Date																		10-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	75	76	77	79	82	83	85	85	85	84	83	82	81	80	80	79	79	79	78	77	77	76	76		85	
	78.3	78.1	78.5	80.3	78.3	79.6	80.7	82.5	83.3	82.9	82.6	82.0	81.7	81.5	81.5	80.4	78.5	77.7	77.6	77.2	76.6	76.1	75.2	75.4	75.2	83.3	79.4

Date	10-Oct																	11-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	78	80	82	84	85	86	86	85	85	83	82	81	80	80	79	79	78	77	76	75	74	73		86	
	75.5	74.9	75.9	77.9	79.8	82.9	84.1	84.5	84.5	84.2	84.4	84.2	82.9	79.7	78.2	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.4	84.5	77.3

Date																		12-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	73	74	75	77	80	82	84	86	86	86	85	83	82	80	79	78	78	77	76	75	74	72	71	70		86	
	68.0	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	79.1	70.8

Date	12-Oct																	13-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										85	
	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.0	77.0	68.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/6/2018 6am	80.0	78.0	80.6	80.1	89.0	87.3	85	80.7	76.6	2.0	0.5	1.7	4.2

Date	6-Oct																7-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	76	79	83	87	88	89	89	89	89	88	86	83	81	79	79	78	78	77	77	77	76	76	75	75		89	
	79.1	79.5	81.3	83.1	85.0	86.2	86.8	87.3	86.5	86.2	85.0	83.4	81.5	79.5	77.8	77.5	79.3	79.0	78.6	78.5	77.0	76.9	78.0	78.9	76.9	87.3	81.3
Date																		8-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	76	78	81	84	86	87	87	88	88	87	85	82	79	78	77	77	76	76	76	76	76	76	75	74		88	
	77.6	78.6	80.7	82.9	83.5	85.0	86.0	86.8	85.3	78.2	80.5	81.4	77.9	78.9	78.9	79.1	78.8	78.3	78.1	77.3	77.6	77.5	77.2	78.1	77.2	86.8	80.2
Date	8-Oct																	9-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	74	77	81	84	86	87	87	87	87	85	84	81	79	79	78	78	77	77	76	77	77	76	76	75		87	
	78.1	80.2	81.4	82.4	79.5	81.2	81.2	81.2	82.0	79.0	80.6	80.1	77.0	74.6	75.8	76.6	76.9	77.4	77.3	76.6	76.8	77.8	77.9	78.3	74.6	82.4	78.7
Date																		10-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	75	76	77	79	82	83	85	85	85	84	83	82	81	80	80	79	79	79	78	77	77	76	76	76		85	
	78.1	78.5	80.3	78.3	79.6	80.7	82.5	83.3	82.9	82.6	82.0	81.7	81.5	81.5	80.4	78.5	77.7	77.6	77.2	76.6	76.1	75.2	75.4	75.5	75.2	83.3	79.3
Date	10-Oct																	11-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	77	78	80	82	84	85	86	86	85	85	83	82	81	80	80	79	79	78	77	76	75	74	73	73		86	
	74.9	75.9	77.9	79.8	82.9	84.1	84.5	84.5	84.2	84.4	84.2	82.9	79.7	78.2	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.0	68.0	84.5	77.0
Date																		12-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	74	75	77	80	82	84	86	86	86	85	83	82	80	79	78	78	77	76	75	74	72	71	70	70		86	
	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	63.2	79.1	70.6
Date	12-Oct																	13-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										85	
	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.6	63.0	77.0	68.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/6/2018 7am	80.0	77.9	80.6	80.1	89.0	87.3	85	80.7	76.5	2.1	0.5	1.7	4.2

Date	6-Oct								7-Oct																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	low	high	ave
Temperature (°F)	88	86	83	82	81	80	80	79	79	78	78	77	76	75	75	76	78	81	84	85	86	86	87	87		88	
	86.2	85.0	83.4	81.5	79.5	77.8	77.5	79.3	79.0	78.6	78.5	77.0	76.9	78.0	78.9	77.6	78.6	80.7	82.9	83.5	85.0	86.0	86.8	85.3	76.9	86.8	81.0
Date									8-Oct																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	86	85	82	80	79	79	79	78	78	78	77	77	77	76	75	76	78	80	83	84	84	84	84	84		86	
	78.2	80.5	81.4	77.9	78.9	78.9	79.1	78.8	78.3	78.1	77.3	77.6	77.5	77.2	78.1	78.1	80.2	81.4	82.4	79.5	81.2	81.2	81.2	82.0	77.2	82.4	79.4
Date	8-Oct								9-Oct																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	84	82	81	79	78	78	78	78	77	77	77	77	77	77	76	76	78	80	81	82	82	81	81	82		84	
	79.0	80.6	80.1	77.0	74.6	75.8	76.6	76.9	77.4	77.3	76.6	76.8	77.8	77.9	78.3	78.1	78.5	80.3	78.3	79.6	80.7	82.5	83.3	82.9	74.6	83.3	78.6
Date									10-Oct																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	81	81	80	79	78	78	78	78	77	77	77	77	76	76	76	76	77	79	80	81	82	83	83	83		83	
	82.6	82.0	81.7	81.5	81.5	80.4	78.5	77.7	77.6	77.2	76.6	76.1	75.2	75.4	75.5	74.9	75.9	77.9	79.8	82.9	84.1	84.5	84.5	84.2	74.9	84.5	79.5
Date	10-Oct								11-Oct																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	82	81	80	79	78	78	77	77	76	75	74	73	73	72	72	72	74	75	77	79	81	82	82	82		82	
	84.4	84.2	82.9	79.7	78.2	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.0	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	67.5	84.4	74.3
Date									12-Oct																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)	81	80	78	77	76	75	74	73	72	71	70	69	69	68	68	69	70	72	74	76	77	79	79	79		81	
	78.9	78.1	75.6	73.2	71.5	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	63.2	78.9	69.2
Date	12-Oct								13-Oct																		
Hour (CDT)	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Temperature (°F)																										84	
	77.0	74.3	70.8	69.3	68.0	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	63.0	82.8	70.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/6/2018 4pm	78.4	77.0	80.1	79.7	88.0	86.8	84	79.2	76.1	1.4	0.5	1.2	3.1

Date	7-Oct																		8-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	75	76	79	82	85	87	88	89	89	89	88	85	83	80	79	79	79	79	79	78	78	77	77	76		89	
	78.9	77.6	78.6	80.7	82.9	83.5	85.0	86.0	86.8	85.3	78.2	80.5	81.4	77.9	78.9	78.9	79.1	78.8	78.3	78.1	77.3	77.6	77.5	77.2	77.2	86.8	80.2
Date																			9-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	77	80	84	88	88	88	88	88	89	89	87	85	83	81	80	79	79	78	78	78	78	78	77		89	
	78.1	78.1	80.2	81.4	82.4	79.5	81.2	81.2	81.2	82.0	79.0	80.6	80.1	77.0	74.6	75.8	76.6	76.9	77.4	77.3	76.6	76.8	77.8	77.9	74.6	82.4	78.7
Date	9-Oct																		10-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	76	79	82	85	86	86	85	85	85	85	84	82	80	80	80	80	80	79	78	77	76	76	75		86	
	78.3	78.1	78.5	80.3	78.3	79.6	80.7	82.5	83.3	82.9	82.6	82.0	81.7	81.5	81.5	80.4	78.5	77.7	77.6	77.2	76.6	76.1	75.2	75.4	75.2	83.3	79.4
Date																			11-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	75	75	77	78	81	82	84	85	85	84	83	82	80	79	78	77	76	76	75	74	73	72	71	71		85	
	75.5	74.9	75.9	77.9	79.8	82.9	84.1	84.5	84.5	84.2	84.4	84.2	82.9	79.7	78.2	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.4	84.5	77.3
Date	11-Oct																		12-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	71	72	73	75	78	80	82	84	84	84	83	82	80	78	77	76	74	73	71	70	68	66	65	64		84	
	68.0	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	79.1	70.8
Date																			13-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	64	65	67	69	72	75	78	80	81	81	80	79	78	76	74	73	71	69	68	66	65	63	62	62		81	
	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.0	77.0	68.0
Date	13-Oct																		14-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										80	
	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	73.6	72.4	72.7	71.6	71.3	70.4	70.6	71.2	72.6	72.8	72.4	63.6	82.8	74.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/7/2018 6am	78.3	75.8	81.5	79.5	89.0	86.8	80	78.5	75.5	2.5	2.0	2.2	3.0

Date	8-Oct																		9-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	74	75	78	81	84	86	87	88	88	87	86	84	81	79	78	78	78	78	77	76	76	77	77	76		88	
	78.1	78.1	80.2	81.4	82.4	79.5	81.2	81.2	81.2	82.0	79.0	80.6	80.1	77.0	74.6	75.8	76.6	76.9	77.4	77.3	76.6	76.8	77.8	77.9	74.6	82.4	78.7

Date																			10-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	76	78	80	82	83	83	83	83	83	82	81	79	78	78	78	78	78	77	77	77	77	77	76		83	
	78.3	78.1	78.5	80.3	78.3	79.6	80.7	82.5	83.3	82.9	82.6	82.0	81.7	81.5	81.5	80.4	78.5	77.7	77.6	77.2	76.6	76.1	75.2	75.4	75.2	83.3	79.4

Date	10-Oct																		11-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	76	76	77	78	79	81	83	84	85	85	84	83	81	79	79	79	79	77	76	74	74	75	75	74		85	
	75.5	74.9	75.9	77.9	79.8	82.9	84.1	84.5	84.5	84.2	84.4	84.2	82.9	79.7	78.2	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.4	84.5	77.3

Date																			12-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	72	71	72	73	76	79	81	83	83	83	82	81	80	78	77	75	74	72	70	69	67	65	64	63		83	
	68.0	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	79.1	70.8

Date	12-Oct																		13-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	62	63	65	67	70	73	76	78	79	79	79	78	76	75	73	72	71	69	68	66	65	63	62	61		79	
	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.0	77.0	68.0

Date																			14-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	61	62	64	67	70	73	76	78	79	79	78	77	76	74	72	71	70	69	67	66	65	64	63	63		79	
	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	73.6	72.4	72.7	71.6	71.3	70.4	70.6	71.2	72.6	72.8	72.4	63.6	82.8	74.2

Date	14-Oct																		15-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										77	
	72.4	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	76.7	75.8	76.2	76.1	75.7	75.7	75.7	75.8	75.8	75.0	74.6	72.4	85.4	78.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/8/2018 6am	75.6	74.8	79.5	78.5	88.0	82.4	77	75.8	75.3	0.8	1.0	5.6	0.5

Date	9-Oct			10-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	low	high	ave
Temperature (°F)	79	79	79	78	77	77	77	77	77	76	76	77	78	80	82	85	87	88	88	88	86	85	83	82		88	
	80.4	78.5	77.7	77.6	77.2	76.6	76.1	75.2	75.4	75.5	74.9	75.9	77.9	79.8	82.9	84.1	84.5	84.5	84.2	84.4	84.2	82.9	79.7	78.2	74.9	84.5	79.5
Date				11-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	81	81	80	80	79	77	76	74	73	71	71	72	75	77	79	80	81	82	83	83	81	78	75	74		83	
	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.0	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	67.5	79.1	73.0
Date	11-Oct			12-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	73	71	70	68	67	65	64	63	61	59	59	62	67	72	74	75	76	78	79	79	78	75	72	70		79	
	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	63.2	77.0	68.4
Date				13-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	69	68	67	66	64	63	61	60	59	59	60	63	66	70	74	77	79	80	80	78	76	75	73	71		80	
	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	73.6	72.4	63.0	82.8	71.6
Date	13-Oct			14-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	71	70	69	69	68	68	67	67	67	68	69	72	75	78	81	83	85	85	84	82	80	78	76	75		85	
	72.7	71.6	71.3	70.4	70.6	71.2	72.6	72.8	72.4	72.4	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	76.7	75.8	70.4	85.4	77.1
Date				15-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	74	73	73	73	73	72	71	70	69	69	69	71	73	75	77	79	80	80	79	77	76	74	72	70		80	
	76.2	76.1	75.7	75.7	75.7	75.8	75.8	75.0	74.6	74.8	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	75.8	76.2	74.6	86.4	78.2

Date	15-Oct			16-Oct																								
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				
Temperature (°F)																										76		80 mon/ 76 tue
	77.3	76.7	75.2	74.4	73.8	73.6	73.5	74.1	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	73.5	85.1	78.9	

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/9/2018 9pm	74.3	74.6	76.1	73.6	88.0	84.5	76	74.5	75.2	-0.4	2.5	3.5	-0.7

Date	10-Oct			11-Oct																						
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	low	high	ave
Temperature (°F)	79	78	77	76	75	74	73	72	70	69	69	70	72	75	78	80	81	82	82	81	79	76	74	71		82	
	77.1	75.1	73.6	72.0	70.4	69.2	68.4	68.5	68.5	68.0	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	67.5	79.1	73.0
Date				12-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	69	68	67	66	65	64	63	62	60	59	59	61	64	68	70	73	75	77	78	79	78	76	73	70		79	
	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	63.2	77.0	68.4
Date	12-Oct			13-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	67	64	63	62	62	62	62	62	61	61	62	64	68	71	74	76	78	80	81	81	80	78	76	74		81	
	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	73.6	72.4	63.0	82.8	71.6
Date				14-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	72	71	70	69	68	67	66	65	65	65	67	69	72	76	79	82	84	85	85	84	82	81	79	77		85	
	72.7	71.6	71.3	70.4	70.6	71.2	72.6	72.8	72.4	72.4	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	76.7	75.8	70.4	85.4	77.1
Date	14-Oct			15-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	76	74	73	72	71	70	69	68	68	68	69	71	74	76	79	81	82	82	81	80	78	76	74	73		82	
	76.2	76.1	75.7	75.7	75.7	75.8	75.8	75.0	74.6	74.8	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	75.8	76.2	74.6	86.4	78.2
Date				16-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)	72	70	69	68	67	66	64	63	62	62	63	65	67	70	73	76	78	78	77	76	75	73	72	71		78	
	77.3	76.7	75.2	74.4	73.8	73.6	73.5	74.1	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	73.5	85.1	78.9
Date	16-Oct			17-Oct																							
Hour (CDT)	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Temperature (°F)																										80	76 wed/ 80 thu
	74.9	73.0	72.9	72.2	72.5	72.3	71.7	71.2	71.3	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	74.9	71.8

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/10/2018 9pm	72.0	74.5	71.2	71.0	82.0	79.1	80	73.1	74.1	-2.5	0.2	2.9	-1.0

Date	11-Oct																12-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	69	73	77	79	80	81	82	80	78	78	78	75	70	67	65	64	64	63	62	62	60	60	60	60		82	
	67.5	68.8	70.1	71.9	73.9	76.0	77.5	78.7	79.1	78.9	78.1	75.6	73.2	71.5	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	63.2	79.1	70.6

Date																	13-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	59	65	71	74	76	77	79	78	76	76	76	74	71	68	67	66	66	66	65	65	64	64	64	63		79	
	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.6	63.0	77.0	68.0

Date	13-Oct																14-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	63	68	74	77	79	80	82	81	79	80	79	78	74	72	71	70	70	70	69	69	68	68	68	67		82	
	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	73.6	72.4	72.7	71.6	71.3	70.4	70.6	71.2	72.6	72.8	72.4	72.4	64.7	82.8	74.6

Date																	15-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	67	73	79	82	84	85	87	86	84	84	84	82	78	75	74	73	73	72	71	71	70	70	70	69		87	
	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	76.7	75.8	76.2	76.1	75.7	75.7	75.7	75.8	75.8	75.0	74.6	74.8	74.2	85.4	78.7

Date	15-Oct																16-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	69	73	77	79	81	82	83	82	79	80	79	77	72	69	67	66	66	66	64	64	63	63	63	63		83	
	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	75.8	76.2	77.3	76.7	75.2	74.4	73.8	73.6	73.5	74.1	74.7	75.1	73.5	86.4	77.9

Date																	17-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	62	67	71	74	76	76	78	77	75	75	75	73	69	67	65	65	65	64	63	63	62	62	62	61		78	
	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9	72.2	72.5	72.3	71.7	71.2	71.3	70.3	70.3	85.1	77.8

Date	17-Oct																18-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										80	
	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3	69.8	69.5	68.9	67.3	66.1	65.4	65.4	65.4	73.3	70.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/11/2018 7am	71.7	74.6	71.0	71.1	82.0	79.1	80	72.9	74.0	-2.9	-0.1	2.9	-1.1

Date	11-Oct					12-Oct																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	low	high	ave
Temperature (°F)	72	70	68	67	66	64	62	61	61	60	59	58	59	62	66	71	73	75	76	77	78	78	76	73		78	
	73.2	71.5	69.7	67.8	67.1	66.7	65.4	64.3	63.6	63.2	63.4	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	63.2	77.0	68.7

Date						13-Oct																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	70	68	67	66	65	65	64	64	64	63	62	61	62	65	70	75	78	79	80	81	82	82	80	77		82	
	69.3	68.0	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	63.0	82.8	71.2

Date	13-Oct					14-Oct																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	75	73	72	71	71	71	70	70	70	69	68	68	69	73	77	81	84	85	85	86	86	85	84	81		86	
	73.6	72.4	72.7	71.6	71.3	70.4	70.6	71.2	72.6	72.8	72.4	72.4	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	70.4	85.4	76.8

Date						15-Oct																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	79	77	75	74	73	72	71	70	69	69	69	70	71	73	76	79	82	84	85	85	84	82	79	77		85	
	76.7	75.8	76.2	76.1	75.7	75.7	75.7	75.8	75.8	75.0	74.6	74.8	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	74.6	86.4	78.2

Date	15-Oct					16-Oct																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	75	73	72	71	70	69	68	67	67	66	66	66	67	69	71	74	76	78	79	79	78	77	76	75		79	
	75.8	76.2	77.3	76.7	75.2	74.4	73.8	73.6	73.5	74.1	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	73.5	85.1	78.7

Date						17-Oct																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)	73	72	71	70	69	68	67	66	65	64	63	63	64	66	68	71	73	76	77	78	78	77	76	74		78	
	79.5	77.2	74.9	73.0	72.9	72.2	72.5	72.3	71.7	71.2	71.3	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	70.2	79.5	72.5

Date	17-Oct					18-Oct																					
Hour (CDT)	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Temperature (°F)																										76	
	71.0	70.7	70.2	70.1	70.3	69.8	69.5	68.9	67.3	66.1	65.4	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	65.4	76.6	70.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/11/2018 7pm	72.1	74.4	71.5	72.3	78.0	77.0	76	72.7	73.8	-2.2	-0.8	1.0	-1.1

Date	12-Oct																		13-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	59	58	64	71	74	77	79	81	80	78	79	78	76	72	69	69	68	67	66	66	65	64	64	64		81	
	63.2	63.3	64.6	66.1	67.8	69.7	72.0	73.5	74.7	76.4	77.0	74.3	70.8	69.3	68.0	67.5	66.5	65.0	65.4	63.5	63.0	63.2	63.8	64.5	63.0	77.0	68.0
Date																			14-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	63	63	68	75	78	80	82	84	83	81	82	82	80	76	73	73	72	72	71	70	70	69	69	69		84	
	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	73.6	72.4	72.7	71.6	71.3	70.4	70.6	71.2	72.6	72.8	72.4	63.6	82.8	74.2
Date	14-Oct																		15-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	68	68	73	79	81	84	85	87	86	84	85	85	83	79	76	76	75	75	74	73	73	72	72	72		87	
	72.4	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	76.7	75.8	76.2	76.1	75.7	75.7	75.7	75.8	75.8	75.0	74.6	72.4	85.4	78.6
Date																			16-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	71	71	75	79	81	82	84	85	84	83	83	83	81	77	75	75	74	74	73	72	72	71	71	70		85	
	74.8	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	75.8	76.2	77.3	76.7	75.2	74.4	73.8	73.6	73.5	74.1	74.7	73.5	86.4	77.9
Date	16-Oct																		17-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	70	70	73	76	78	79	80	81	80	79	79	79	77	73	71	71	70	70	69	68	68	67	67	66		81	
	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9	72.2	72.5	72.3	71.7	71.2	71.3	71.2	85.1	78.0
Date																			18-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	66	66	68	71	72	73	74	75	74	73	74	73	72	69	67	67	66	66	65	65	64	64	64	63		75	
	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3	69.8	69.5	68.9	67.3	66.1	65.4	65.4	73.3	70.4
Date	18-Oct																		19-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										76	
	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1	70.8	69.9	69.3	68.8	68.9	68.6	65.4	76.6	71.4

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/12/2018 6am	73.6	74.5	74.1	73.6	81.0	77.0	76	73.9	74.1	-0.9	0.5	4.0	-0.1

Date	**13-Oct**																		**14-Oct**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**	low	high	ave
Temperature (°F)	63	63	62	67	73	76	79	81	83	82	81	82	81	79	76	74	73	72	72	71	71	70	69	69		83	
	64.5	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	73.6	72.4	72.7	71.6	71.3	70.4	70.6	71.2	72.6	72.8	63.6	82.8	73.9

Date																				**15-Oct**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	69	68	68	73	79	82	84	86	88	87	86	86	86	84	81	79	77	77	76	75	75	74	73	73		88	
	72.4	72.4	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	76.7	75.8	76.2	76.1	75.7	75.7	75.7	75.8	75.8	75.0	72.4	85.4	78.5

Date	**15-Oct**																			**16-Oct**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	73	72	72	76	81	83	85	86	88	87	86	86	86	84	81	78	77	76	75	74	74	73	72	72		88	
	74.6	74.8	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	75.8	76.2	77.3	76.7	75.2	74.4	73.8	73.6	73.5	74.1	73.5	86.4	77.9

Date																				**17-Oct**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	72	71	71	73	76	78	79	80	81	80	79	80	79	78	75	73	72	72	71	71	70	70	69	69		81	
	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9	72.2	72.5	72.3	71.7	71.2	71.2	85.1	78.1

Date	**17-Oct**																			**18-Oct**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	69	68	68	70	73	74	75	76	77	76	75	76	75	74	71	69	68	68	67	67	66	66	65	65		77	
	71.3	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3	69.8	69.5	68.9	67.3	66.1	66.1	73.3	70.7

Date																				**19-Oct**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)	65	64	64	67	71	73	74	75	77	76	76	76	76	74	72	70	69	69	68	67	67	67	66	66		77	
	65.4	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1	70.8	69.9	69.3	68.8	68.9	65.4	76.6	71.3

Date	**19-Oct**																			**20-Oct**							
Hour (CDT)	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**0**	**1**	**2**	**3**	**4**			
Temperature (°F)																										80	
	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4	73.4	73.6	73.0	72.8	73.0	68.3	80.6	75.5

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/13/2018 5am	74.5	75.1	77.1	76.8	83.0	82.8	80	75.3	75.1	-0.6	0.4	0.2	0.2

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
65.4	63.5	63.0	63.2	63.8	64.5	63.6	64.7	69.3	73.2	76.2	78.4	80.6	81.8	82.8	82.3	81.2	79.5	76.2	73.6	72.4	72.7	71.6	71.3
70.4	70.6	71.2	72.6	72.8	72.4	72.4	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	76.7	75.8	76.2	76.1	75.7
75.7	75.7	75.8	75.8	75.0	74.6	74.8	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	75.8	76.2	77.3	76.7	75.2
74.4	73.8	73.6	73.5	74.1	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9
72.2	72.5	72.3	71.7	71.2	71.3	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3
69.8	69.5	68.9	67.3	66.1	65.4	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1
70.8	69.9	69.3	68.8	68.9	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4
73.4	73.6	73.0	72.8	73.0	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6

Date	14-Oct																		15-Oct								
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	low	high	ave
Temperature (°F)	71	71	71	75	80	83	85	87	89	89	89	88	87	85	81	78	77	76	76	74	74	73	72	72		89	
	72.4	72.4	74.2	76.2	79.8	81.5	83.4	84.5	85.4	84.5	84.7	83.9	82.7	79.1	76.7	75.8	76.2	76.1	75.7	75.7	75.7	75.8	75.8	75.0	72.4	85.4	78.5
Date																				16-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	72	72	71	74	79	81	83	84	86	86	86	85	85	83	80	79	78	77	77	76	76	76	75	75		86	
	74.6	74.8	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	75.8	76.2	77.3	76.7	75.2	74.4	73.8	73.6	73.5	74.1	73.5	86.4	77.9
Date	16-Oct																			17-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	75	74	74	76	79	81	82	83	84	84	84	83	83	81	77	75	74	73	73	72	72	71	70	70		84	
	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9	72.2	72.5	72.3	71.7	71.2	71.2	85.1	78.1
Date																				18-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	70	69	69	71	73	74	75	76	77	77	77	76	76	74	71	69	68	67	67	66	65	65	64	64		77	
	71.3	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3	69.8	69.5	68.9	67.3	66.1	66.1	73.3	70.7
Date	18-Oct																			19-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	64	63	63	66	71	73	75	76	78	78	78	77	77	76	73	71	71	70	70	69	69	69	68	68		78	
	65.4	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1	70.8	69.9	69.3	68.8	68.9	65.4	76.6	71.3
Date																				20-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	68	67	67	70	75	78	80	81	83	83	83	82	82	80	77	75	74	74	73	72	72	72	71	71		83	
	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4	73.4	73.6	73.0	72.8	73.0	68.3	80.6	75.5
Date	20-Oct																			21-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)																										80	
	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6	66.9	66.0	65.6	65.4	64.9	64.9	83.3	73.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/14/2018 5am	75.5	75.3	78.5	78.2	89.0	85.4	80	76.1	75.0	0.2	0.3	3.6	1.2

Date	15-Oct										16-Oct															
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	low	high	ave
Temperature (°F)	85	85	84	83	81	79	79	78	77	76	76	75	75	74	74	74	73	73	74	75	77	79	81	82		85	
	81.3	82.2	78.7	77.7	75.7	75.8	76.2	77.3	76.7	75.2	74.4	73.8	73.6	73.5	74.1	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	73.5	85.1	77.8
Date											17-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	82	81	81	79	78	77	75	74	73	73	72	72	71	70	69	69	69	69	69	69	70	72	75	77		82	
	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9	72.2	72.5	72.3	71.7	71.2	71.3	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	70.2	84.6	74.6
Date	17-Oct										18-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	77	76	76	75	74	73	73	72	72	71	70	69	68	66	65	64	64	65	66	68	71	73	76	76		77	
	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3	69.8	69.5	68.9	67.3	66.1	65.4	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	65.4	74.0	69.9
Date											19-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	76	76	76	76	75	74	73	73	72	72	71	71	70	69	68	68	68	70	72	74	78	80	83	85		85	
	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1	70.8	69.9	69.3	68.8	68.9	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	68.3	80.5	73.2
Date	19-Oct										20-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	85	84	83	81	79	77	76	75	74	74	73	73	72	72	71	71	71	72	73	74	76	77	78	78		85	
	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4	73.4	73.6	73.0	72.8	73.0	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	72.1	83.3	76.7
Date											21-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	78	77	75	74	72	71	70	69	68	67	66	65	64	63	62	61	60	60	61	63	65	67	69	70		78	
	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6	66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	63.4	76.2	68.2
Date	21-Oct										22-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)																										70	
	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0	61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	59.8	68.3	63.6

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/15/2018 2pm	73.2	73.4	74.1	74.1	85.0	85.1	70	72.7	72.0	-0.2	0.0	-0.1	0.7

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
75.7	75.7	75.8	75.8	75.0	74.6	74.8	75.2	77.3	81.6	83.8	85.7	86.4	84.0	81.3	82.2	78.7	77.7	75.7	75.8	76.2	77.3	76.7	75.2
74.4	73.8	73.6	73.5	74.1	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9
72.2	72.5	72.3	71.7	71.2	71.3	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3
69.8	69.5	68.9	67.3	66.1	65.4	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1
70.8	69.9	69.3	68.8	68.9	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4
73.4	73.6	73.0	72.8	73.0	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6
66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0
61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5

Date	16-Oct																		17-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	74	74	75	76	78	80	82	83	83	82	81	79	78	77	75	74	73	73	73	72	71	71	70	70		83	
	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9	72.2	72.5	72.3	71.7	71.2	71.3	71.2	85.1	78.0
Date																			18-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	70	70	70	68	68	71	73	73	73	73	73	73	73	73	72	71	70	70	69	68	66	65	64	63		73	
	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3	69.8	69.5	68.9	67.3	66.1	65.4	65.4	73.3	70.4
Date	18-Oct																		19-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	63	64	65	66	69	71	74	76	78	78	78	76	75	73	72	72	71	71	71	70	69	68	67	67		78	
	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1	70.8	69.9	69.3	68.8	68.9	68.6	65.4	76.6	71.4
Date																			20-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	67	69	71	74	78	82	85	86	86	86	85	83	80	78	77	76	75	74	74	73	72	71	71	70		86	
	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4	73.4	73.6	73.0	72.8	73.0	72.1	68.3	80.6	75.6
Date	20-Oct																		21-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	70	71	72	74	76	79	80	81	81	80	78	77	75	73	72	71	70	69	68	67	65	63	61	60		81	
	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6	66.9	66.0	65.6	65.4	64.9	64.5	64.5	83.3	72.7
Date																			22-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	59	59	60	62	65	68	70	72	73	73	72	71	70	68	67	66	64	63	62	60	59	58	57	56		73	
	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0	61.1	60.6	60.3	60.3	60.5	60.1	60.1	68.3	63.7
Date	22-Oct																		23-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										72	
	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5	67.3	67.1	66.7	66.2	66.0	66.3	59.8	69.6	66.5

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/16/2018 6am	71.8	72.0	72.3	73.3	83.0	85.1	72	71.8	71.2	-0.2	-0.9	-2.1	0.6

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
74.4	73.8	73.6	73.5	74.1	74.7	75.1	75.9	78.9	80.3	82.2	84.0	84.9	85.1	84.4	84.6	83.8	83.0	80.8	79.5	77.2	74.9	73.0	72.9
72.2	72.5	72.3	71.7	71.2	71.3	70.3	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3
69.8	69.5	68.9	67.3	66.1	65.4	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1
70.8	69.9	69.3	68.8	68.9	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4
73.4	73.6	73.0	72.8	73.0	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6
66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0
61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5
67.3	67.1	66.7	66.2	66.0	66.3	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0

Date	17-Oct																	18-Oct								
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	69	70	72	73	74	75	76	77	78	79	77	76	74	73	73	72	71	71	70	69	69	68	67	67		79	
	70.2	70.6	70.9	70.9	70.6	71.0	71.7	73.0	73.3	72.9	72.8	72.2	71.0	70.7	70.2	70.1	70.3	69.8	69.5	68.9	67.3	66.1	65.4	65.4	65.4	73.3	70.2

Date																		19-Oct								
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	66	66	67	70	73	77	80	81	81	80	80	80	80	80	79	78	77	77	76	75	73	72	70	69		81	
	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1	70.8	69.9	69.3	68.8	68.9	68.6	68.3	65.9	76.6	71.5

Date	19-Oct																	20-Oct								
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	69	72	76	80	83	86	87	87	85	83	82	81	81	80	80	79	78	76	75	74	72	71	71	71		87	
	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4	73.4	73.6	73.0	72.8	73.0	72.1	72.2	68.9	80.6	75.8

Date																		21-Oct								
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	71	73	76	79	82	83	83	82	80	78	76	74	72	71	71	70	70	70	69	68	66	65	63	62		83	
	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6	66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.5	83.3	72.4

Date	21-Oct																	22-Oct								
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	62	62	64	67	70	72	72	72	72	72	72	71	70	69	68	67	66	65	64	62	61	59	58	58		72	
	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0	61.1	60.6	60.3	60.3	60.5	60.1	59.8	59.8	68.3	63.6

Date																		23-Oct								
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	59	61	64	66	69	72	73	73	72	70	67	64	63	62	62	63	65	66	66	65	64	62	61	61		73	
	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5	67.3	67.1	66.7	66.2	66.0	66.3	66.4	60.2	69.6	66.8

Date	23-Oct																	24-Oct								
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										76	
	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0	66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.3	67.9	66.3

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/17/2018 7am	71.8	70.0	75.4	72.5	79.0	73.3	76	72.4	69.5	1.8	2.9	5.7	2.9

Date	18-Oct																	19-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	65	65	67	70	72	75	77	78	79	78	77	75	73	73	72	72	71	70	70	69	69	68	67	67		79	
	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1	70.8	69.9	69.3	68.8	68.9	68.6	68.3	65.9	76.6	71.5

Date																		20-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	67	70	74	78	81	83	85	85	85	83	81	79	78	76	76	75	74	74	73	73	72	72	70	70		85	
	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4	73.4	73.6	73.0	72.8	73.0	72.1	72.2	68.9	80.6	75.8

Date	20-Oct																	21-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	70	72	75	79	81	82	83	83	82	81	80	78	76	73	71	70	68	67	66	65	63	61	60	60		83	
	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6	66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.5	83.3	72.4

Date																		22-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	60	62	64	67	69	71	73	73	72	71	70	68	67	66	64	63	62	61	60	59	57	56	56	56		73	
	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0	61.1	60.6	60.3	60.3	60.5	60.1	59.8	59.8	68.3	63.6

Date	22-Oct																	23-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	57	60	63	66	69	72	73	74	74	72	70	68	66	65	65	65	65	65	65	64	63	62	62	62		74	
	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5	67.3	67.1	66.7	66.2	66.0	66.3	66.4	60.2	69.6	66.8

Date																		24-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	63	65	67	70	72	74	76	76	75	74	73	71	70	69	68	68	68	68	67	66	65	65	65	65		76	
	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0	66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.3	67.9	66.3

Date	24-Oct																	25-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										79	
	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3	72.1	71.8	70.5	69.9	70.5	71.3	71.3	63.8	72.3	70.1

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/18/2018 7am	70.1	69.4	73.6	73.2	79.0	76.6	79	71.4	69.5	0.7	0.4	2.4	1.9

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
69.8	69.5	68.9	67.3	66.1	65.4	65.4	65.9	67.3	68.6	69.8	71.1	72.6	74.0	75.1	76.0	76.6	76.2	74.5	73.6	73.2	72.7	72.7	72.1
70.8	69.9	69.3	68.8	68.9	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4
73.4	73.6	73.0	72.8	73.0	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6
66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0
61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5
67.3	67.1	66.7	66.2	66.0	66.3	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0
66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3
72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	72.3	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API erro	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API error: -11059

Date	19-Oct																			20-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	low	high	ave
Temperature (°F)	68	67	68	70	74	77	81	83	85	86	86	85	83	81	79	77	76	76	75	75	75	74	73	73		86	
	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4	73.4	73.6	73.0	72.8	73.0	68.3	80.6	75.5

Date																				21-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	72	71	72	74	76	79	81	83	84	84	84	82	80	77	75	72	71	69	68	67	66	65	64	63		84	
	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6	66.9	66.0	65.6	65.4	64.9	64.9	83.3	73.0

Date	21-Oct																			22-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	62	61	60	61	63	65	68	70	72	72	72	70	68	66	64	62	61	59	58	57	57	57	57	57		72	
	64.5	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0	61.1	60.6	60.3	60.3	60.5	60.3	68.3	63.9

Date																				23-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	56	56	57	59	62	66	69	73	75	76	76	75	73	71	70	69	68	68	68	67	67	67	66	65		76	
	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5	67.3	67.1	66.7	66.2	66.0	59.8	69.6	66.3

Date	23-Oct																			24-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	65	65	66	67	69	71	73	75	76	76	75	74	73	71	70	69	69	69	69	69	68	68	67	66		76	
	66.3	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0	66.2	65.7	65.3	64.6	64.1	64.1	67.9	66.5

Date																				25-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	66	66	67	68	70	73	75	77	78	78	78	77	75	74	73	72	72	72	72	71	71	70	69	69		78	
	63.3	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3	72.1	71.8	70.5	69.9	70.5	63.3	72.3	69.5

Date	25-Oct																			26-Oct							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)																										78	
	71.3	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3	65.0	63.7	63.2	62.6	61.8	61.8	80.3	71.0

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/19/2018 5am	70.7	69.1	71.5	70.8	86.0	80.6	78	71.7	69.4	1.6	0.6	5.4	2.3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
70.8	69.9	69.3	68.8	68.9	68.6	68.3	68.9	70.4	73.5	76.9	79.4	80.0	80.5	80.6	80.1	79.9	79.5	79.3	78.0	76.5	75.5	75.0	74.4
73.4	73.6	73.0	72.8	73.0	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6
66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0
61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5
67.3	67.1	66.7	66.2	66.0	66.3	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0
66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3
72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3
65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0

Date	20-Oct																21-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	73	76	79	80	81	83	82	81	80	78	75	73	71	70	69	67	67	66	65	63	63	62	61	60		83	
	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6	66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.0	64.0	83.3	72.1

Date																	22-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	61	62	64	66	67	68	70	70	70	68	66	63	61	60	59	58	58	57	57	56	56	55	55	56		70	
	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0	61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	59.8	68.3	63.4

Date	22-Oct																23-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	59	63	66	69	71	73	74	74	74	72	71	69	68	68	67	67	66	66	66	66	66	66	65	65		74	
	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5	67.3	67.1	66.7	66.2	66.0	66.3	66.4	66.1	61.2	69.6	67.0

Date																	24-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	66	67	69	71	73	74	74	74	73	72	71	70	70	70	70	70	70	69	68	67	66	65	65	65		74	
	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0	66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.8	63.3	67.9	66.2

Date	24-Oct																25-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	67	69	71	73	75	76	76	75	74	73	72	71	70	70	70	70	70	70	69	68	68	67	67	67		76	
	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3	72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	64.9	72.3	70.5

Date																	26-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	68	70	71	73	74	75	75	74	74	72	71	70	69	68	67	67	66	66	65	65	64	64	64	65		75	
	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3	65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	59.3	80.3	69.6

Date	26-Oct																27-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										72	
	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0	58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	54.1	68.2	60.9

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/20/2018 8am	68.5	68.1	67.2	67.5	83.0	83.3	72	69.0	67.1	0.4	-0.3	-0.3	1.9

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
73.4	73.6	73.0	72.8	73.0	72.1	72.2	72.4	74.7	76.4	79.7	81.8	83.2	83.3	76.2	75.0	73.8	74.2	73.8	74.2	73.8	71.2	68.4	67.6
66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0
61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5
67.3	67.1	66.7	66.2	66.0	66.3	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0
66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3
72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3
65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0
58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8

Date	21-Oct																		22-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	63	62	62	64	66	67	69	70	71	71	70	69	67	65	63	62	60	59	59	58	58	58	58	57		71	
	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0	61.1	60.6	60.3	60.3	60.5	60.1	60.1	68.3	63.7
Date																			23-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	57	57	59	63	67	70	72	73	74	74	73	71	69	68	67	67	67	66	65	64	64	63	63	62		74	
	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5	67.3	67.1	66.7	66.2	66.0	66.3	59.8	69.6	66.5
Date	23-Oct																		24-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	61	62	63	65	68	70	71	71	71	70	70	69	69	68	67	66	65	65	65	65	65	65	64	63		71	
	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0	66.2	65.7	65.3	64.6	64.1	63.3	63.3	67.9	66.4
Date																			25-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	63	64	65	67	69	71	72	73	74	74	73	72	71	70	69	69	69	68	68	68	67	66	66	65		74	
	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3	72.1	71.8	70.5	69.9	70.5	71.3	63.4	72.3	69.8
	25-Oct																		26-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	65	65	66	67	68	69	70	70	70	69	68	67	66	65	65	64	64	64	64	63	63	62	62	62		70	
	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3	65.0	63.7	63.2	62.6	61.8	61.2	61.2	80.3	70.6
Date																			27-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	62	62	63	65	66	68	69	70	70	69	69	68	67	66	65	64	63	63	62	61	60	59	58	57		70	
	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0	58.4	57.7	56.3	55.7	54.9	54.7	54.7	68.2	61.3
	27-Oct																		28-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										73	
	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8	59.7	58.6	58.0	57.6	57.0	58.4	54.1	71.8	62.7

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/21/2018 6am	66.0	66.4	65.6	65.6	71.0	68.3	73	67.0	65.9	-0.4	0.0	2.7	1.1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
66.9	66.0	65.6	65.4	64.9	64.5	64.6	64.0	63.4	63.4	63.4	64.0	65.1	66.2	67.4	68.2	68.3	67.6	65.5	64.0	63.3	63.5	63.1	62.0
61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5
67.3	67.1	66.7	66.2	66.0	66.3	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0
66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3
72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3
65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0
58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8
59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4

Date	22-Oct																23-Oct										
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	55	58	61	65	68	70	71	73	73	73	72	70	69	68	68	68	67	67	67	66	66	65	65	64		73	
	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5	67.3	67.1	66.7	66.2	66.0	66.3	66.4	60.2	69.6	66.8
Date																		24-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	64	65	67	69	71	72	73	73	72	71	70	69	68	68	67	67	66	66	65	65	64	64	63	62		73	
	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0	66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.3	67.9	66.3
Date	24-Oct																	25-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	62	64	66	69	72	74	75	75	74	73	72	71	70	69	69	68	67	66	65	65	65	65	64	63		75	
	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3	72.1	71.8	70.5	69.9	70.5	71.3	71.3	63.8	72.3	70.1
Date																		26-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	63	64	65	67	69	71	73	73	73	72	71	69	68	67	65	64	62	61	60	59	57	57	56	56		73	
	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3	65.0	63.7	63.2	62.6	61.8	61.2	60.7	60.7	80.3	70.1
Date	26-Oct																	27-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	57	58	60	62	65	66	68	68	68	67	66	65	64	63	62	61	60	59	57	56	54	53	52	52		68	
	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0	58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.5	68.2	61.1
Date																		28-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	53	56	60	63	67	71	73	74	74	73	71	69	68	67	66	66	65	65	64	62	60	57	56	55		74	
	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8	59.7	58.6	58.0	57.6	57.0	58.4	59.3	54.1	71.8	62.9
Date	28-Oct																	29-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										74	
	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4	66.9	66.7	66.4	67.1	67.1	67.7	67.7	59.1	80.5	71.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/22/2018 7am	65.6	66.2	67.7	67.7	73.0	69.6	74	66.8	66.9	-0.6	0.0	3.4	-0.1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
61.1	60.6	60.3	60.3	60.5	60.1	59.8	60.2	61.2	63.1	64.4	66.1	67.1	67.6	68.4	68.5	68.7	69.2	69.6	69.2	69.5	69.0	67.7	67.5
67.3	67.1	66.7	66.2	66.0	66.3	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0
66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3
72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3
65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0
58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8
59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4
66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1

Date	23-Oct																		24-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	68	68	69	70	72	72	72	71	71	70	70	68	67	66	66	67	68	67	66	66	66	67	68	67		72	
	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0	66.2	65.7	65.3	64.6	64.1	63.3	63.3	67.9	66.4

Date																			25-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	66	66	67	68	70	73	75	76	76	75	73	72	71	70	70	70	70	70	70	70	70	70	70	70		76	
	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3	72.1	71.8	70.5	69.9	70.5	71.3	63.4	72.3	69.8

Date	25-Oct																		26-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	70	70	71	71	72	74	76	77	78	78	77	75	73	70	69	68	67	66	65	64	62	61	60	59		78	
	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3	65.0	63.7	63.2	62.6	61.8	61.2	61.2	80.3	70.6

Date																			27-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	59	59	60	61	63	65	67	68	68	68	67	66	65	64	64	63	62	61	60	59	57	55	54	53		68	
	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0	58.4	57.7	56.3	55.7	54.9	54.7	54.7	68.2	61.3

Date	27-Oct																		28-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	53	54	57	60	64	68	72	74	75	75	74	72	70	69	67	67	66	66	65	64	63	61	60	58		75	
	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8	59.7	58.6	58.0	57.6	57.0	58.4	54.1	71.8	62.7

Date																			29-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	58	59	60	63	66	70	72	74	75	75	73	72	70	68	66	65	64	63	62	61	60	59	58	57		75	
	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4	66.9	66.7	66.4	67.1	67.1	67.7	59.1	80.5	70.8

Date	29-Oct																		30-Oct								
Hour (CDT)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										76	
	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1	65.6	64.6	64.8	63.7	63.0	61.9	61.9	80.9	70.9

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/23/2018 6am	67.0	66.9	69.6	68.9	72.0	67.9	76	68.3	67.5	0.0	0.7	4.1	0.8

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
67.3	67.1	66.7	66.2	66.0	66.3	66.4	66.1	66.0	66.2	66.9	67.1	67.3	67.3	67.5	67.8	67.9	67.7	67.5	67.1	66.6	66.4	66.3	66.0
66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3
72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3
65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0
58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8
59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4
66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1
65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9

Date	24-Oct																	25-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	65	66	67	69	70	72	73	74	74	73	72	71	70	70	70	70	70	70	70	71	72	73	73	72		74	
	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3	72.1	71.8	70.5	69.9	70.5	71.3	71.3	63.8	72.3	70.1
Date																		26-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	72	72	74	75	77	78	79	80	80	79	78	76	74	72	71	70	69	67	66	65	64	63	62	61		80	
	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3	65.0	63.7	63.2	62.6	61.8	61.2	60.7	60.7	80.3	70.1
Date	26-Oct																	27-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	60	60	61	63	65	67	69	70	71	71	70	68	66	65	63	62	62	61	61	60	59	58	56	55		71	
	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0	58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.5	68.2	61.1
Date																		28-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	55	57	60	64	69	72	75	76	76	74	73	71	69	67	66	65	64	63	62	61	60	59	58	58		76	
	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8	59.7	58.6	58.0	57.6	57.0	58.4	59.3	54.1	71.8	62.9
Date	28-Oct																	29-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	60	62	66	69	73	76	78	79	78	77	75	73	71	70	69	68	67	67	65	64	62	60	58	57		79	
	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4	66.9	66.7	66.4	67.1	67.1	67.7	67.7	59.1	80.5	71.2
Date																		30-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	57	58	60	63	66	68	70	71	71	70	69	67	65	63	61	60	58	56	55	53	51	50	50	50		71	
	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1	65.6	64.6	64.8	63.7	63.0	61.9	62.3	61.9	80.9	70.7
Date	30-Oct																	31-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										72	
	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9	69.5	69.7	69.6	69.5	69.9	70.4	70.8	62.5	79.1	71.0

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/24/2018 7am	66.8	67.7	68.7	67.1	74.0	72.3	72	67.6	68.2	-0.9	1.6	1.7	-0.6

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
66.2	65.7	65.3	64.6	64.1	63.3	63.4	63.8	64.9	66.4	67.7	68.9	70.3	71.6	71.6	70.9	70.2	70.1	71.2	71.2	71.1	71.8	71.5	72.3
72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3
65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0
58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8
59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4
66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1
65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9
69.5	69.7	69.6	69.5	69.9	70.4	70.8	71.4	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API erro	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API error: -11059

Date	25-Oct																26-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	71	72	74	76	78	79	80	80	79	78	76	74	72	71	70	68	67	65	64	63	62	61	60	60		80	
	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3	65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	59.3	80.3	69.6

Date																	27-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	61	63	64	66	67	69	70	72	72	71	68	66	65	64	63	62	61	60	60	60	59	57	56	56		72	
	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0	58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	54.1	68.2	60.9

Date	27-Oct																28-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	58	62	66	69	71	73	75	75	74	72	70	68	66	64	64	63	62	62	61	60	59	59	59	61		75	
	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8	59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	56.3	71.8	63.1

Date																	29-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	63	66	70	73	76	78	79	79	77	76	74	72	71	70	69	68	67	65	64	62	60	59	58	58		79	
	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4	66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	62.7	80.5	71.5

Date	29-Oct																30-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	60	62	64	67	69	70	71	71	70	68	66	64	63	61	60	58	57	55	54	53	52	52	52	52		71	
	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1	65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	61.9	80.9	70.5

Date																	31-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	55	58	61	65	67	69	70	70	68	67	65	63	64	64	64	64	64	64	64	64	64	64	64	64		70	
	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9	69.5	69.7	69.6	69.5	69.9	70.4	70.8	71.4	63.8	79.1	71.4

Date	31-Oct																1-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										79	
																									0.0	0.0	#DIV/0!

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/25/2018 8am	65.8	67.8	66.7	64.5	80.0	80.3	79	67.7	67.8	-2.0	2.2	-0.3	-0.1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
72.1	71.8	70.5	69.9	70.5	71.3	71.3	71.9	72.4	72.3	72.3	72.8	75.0	78.2	80.3	80.1	78.2	76.2	74.1	70.9	69.4	68.1	66.9	66.3
65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0
58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8
59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4
66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1
65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9
69.5	69.7	69.6	69.5	69.9	70.4	70.8	71.4	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API erro	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API error: -11059

Date	26-Oct										27-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	low	high	ave
Temperature (°F)	69	70	70	68	66	64	62	61	61	60	58	57	57	56	55	54	53	53	56	59	63	66	68	71		71	
	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0	58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	54.1	69.5	60.9

Date											28-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	73	75	75	73	70	68	66	65	64	64	63	62	62	61	60	59	59	60	64	68	73	76	79	80		80	
	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8	59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	57.0	79.4	65.5

Date	28-Oct										29-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	82	82	81	80	77	75	73	72	71	69	68	67	67	66	65	64	63	63	64	67	71	74	77	79		82	
	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4	66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	66.4	80.5	71.8

Date											30-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	80	80	78	76	74	72	71	69	68	67	65	64	63	62	61	61	62	63	66	69	72	76	79	80		80	
	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1	65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	61.9	80.9	69.4

Date	30-Oct										31-Oct																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	81	80	79	77	75	73	72	71	70	70	69	69	68	67	66	66	66	68	70	72	75	78	81	82		82	
	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9	69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	76.4	78.8	79.7	80.5	80.6	80.1	68.9	80.6	73.9

Date											1-Nov																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)	82	81	79	77	74	72	71	70	69	68	68	67	67	66	66	65	65	65	66	67	68	70	71	72		82	
	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4	74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.9	65.6	66.9	68.4	69.5	69.7	64.5	79.5	71.5

Date	1-Nov										2-Nov																
Hour (CDT)	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13			
Temperature (°F)																										73	
	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5	55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	53.6	56.2	58.7	60.3	62.0	63.4	51.2	69.8	58.9

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/26/2018 2pm	68.9	68.8	66.8	66.1	71.0	69.5	73	69.5	67.4	0.1	0.8	1.5	2.1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
65.0	63.7	63.2	62.6	61.8	61.2	60.7	59.3	58.8	60.3	62.2	64.0	66.0	67.3	68.0	68.2	67.8	66.6	64.1	62.7	60.3	59.4	59.5	59.0
58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8
59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4
66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1
65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9
69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4
74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5
55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9

Date	27-Oct																28-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	57	60	64	66	68	70	72	74	74	73	70	67	66	65	64	63	63	62	62	62	61	60	59	60		74	
	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8	59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	56.3	71.8	63.1

Date																	29-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	63	68	73	77	79	80	81	82	81	79	77	74	73	72	71	70	68	67	66	65	65	64	64	64		82	
	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4	66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	62.7	80.5	71.5

Date	29-Oct																30-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	66	68	71	74	77	79	81	82	81	79	76	73	71	70	69	68	67	66	65	64	63	63	63	64		82	
	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1	65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	61.9	80.9	70.5

Date																	31-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	67	70	74	77	80	82	83	82	80	78	76	74	73	71	71	70	70	69	69	68	68	68	68	70		83	
	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9	69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	63.8	79.1	71.5

Date	31-Oct																1-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	71	74	76	79	81	82	82	82	81	79	78	76	75	74	72	71	70	69	68	67	66	65	65	66		82	
	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4	74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.5	80.6	74.4

Date																	2-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	67	69	71	73	75	76	76	76	75	74	72	70	69	67	65	63	62	60	59	58	57	57	57	58		76	
	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5	55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	51.2	69.8	61.0

Date	2-Nov																3-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										70	
	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9	51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	51.6	64.6	56.5

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
10/27/2018 8am	70.3	68.7	69.2	68.4	74.0	71.8	70	70.2	66.9	1.6	0.9	2.2	3.3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
58.4	57.7	56.3	55.7	54.9	54.7	54.5	54.1	56.3	60.2	62.6	64.9	67.3	69.5	70.9	71.8	71.7	70.7	68.2	64.3	64.0	62.4	60.8	60.8
59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4
66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1
65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9
69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4
74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5
55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9
51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9

Date	28-Oct																29-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	59	60	62	65	71	76	80	82	82	81	80	78	76	75	73	72	70	69	68	66	65	64	63	63		82	
	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4	66.9	66.7	66.4	67.1	67.1	67.7	67.7	59.1	80.5	71.2
Date																	30-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	63	63	64	65	68	72	76	80	82	82	81	80	78	76	75	74	73	72	70	69	68	66	65	63		82	
	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1	65.6	64.6	64.8	63.7	63.0	61.9	62.3	61.9	80.9	70.7
Date	28-Oct																29-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	59	60	62	65	71	76	80	82	82	81	80	78	76	75	73	72	70	69	68	66	65	64	63	63		82	
	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9	69.7	69.6	69.5	69.9	70.4	70.8	71.4	62.5	79.1	71.1
Date																	30-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	63	63	64	65	68	72	76	80	82	82	81	80	78	76	75	74	73	72	70	69	68	66	65	63		82	
	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4	74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	80.6	74.8
Date	1-Nov																2-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	70	73	69	72	72	71	70	69	67	65	64	62	61	60	59	58	58	57	57	56	55	54	53	53		73	
	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5	55.5	54.7	53.4	52.4	52.1	51.7	51.2	51.2	69.8	61.6
Date																	3-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	54	56	59	62	66	68	70	71	71	69	67	66	64	63	62	62	61	61	59	57	55	53	51	50		71	
	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9	51.9	51.7	52.1	52.3	51.6	51.9	52.1	51.6	64.6	56.3
Date	3-Nov																4-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										68	
	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9	64.9	65.1	65.4	65.3	65.5	65.7	65.7	43.7	71.5	65.2

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/28/2018 7am	68.3	67.6	71.2	71.0	82.0	80.5	68	68.2	67.3	0.7	0.2	1.5	1.0

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
59.7	58.6	58.0	57.6	57.0	58.4	59.3	59.1	62.7	68.9	73.6	75.9	78.2	79.4	80.1	80.5	80.0	78.6	75.1	72.2	70.1	68.8	68.1	67.4
66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1
65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9
69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4
74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5
55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9
51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9
64.9	65.1	65.4	65.3	65.5	65.7	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0

Date	29-Oct																	30-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	64	66	68	72	75	77	79	81	81	80	79	76	74	71	69	67	66	65	64	64	63	62	61	61		81	
	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1	65.6	64.6	64.8	63.7	63.0	61.9	62.3	61.9	80.9	70.7
Date																		31-Oct									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	62	66	70	74	78	80	81	82	82	81	79	76	74	72	71	70	70	69	69	69	69	68	68	68		82	
	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9	69.7	69.6	69.5	69.9	70.4	70.8	71.4	62.5	79.1	71.1
Date	31-Oct																	1-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	69	71	74	77	79	80	81	82	82	81	79	77	75	74	74	74	75	75	74	74	73	72	72	72		82	
	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4	74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	80.6	74.8
Date																		2-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	71	71	70	70	69	69	70	70	70	70	68	66	64	63	62	60	59	58	57	56	56	55	54	53		71	
	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5	55.5	54.7	53.4	52.4	52.1	51.7	51.2	51.2	69.8	61.6
Date	2-Nov																	3-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	53	54	56	59	61	64	66	67	68	68	66	65	62	60	59	57	55	54	53	53	53	52	52	51		68	
	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9	51.9	51.7	52.1	52.3	51.6	51.9	52.1	51.6	64.6	56.3
Date																		4-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	52	54	58	61	64	66	68	69	70	70	69	67	65	63	61	60	60	59	59	59	58	58	57	56		70	
	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9	64.9	65.1	65.4	65.3	65.5	65.7	65.7	43.7	71.5	65.2
Date	4-Nov																	5-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										76	
	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0	63.8	63.6	63.1	62.8	62.8	63.4	63.1	62.8	74.8	66.8

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/29/2018 7am	67.2	66.6	72.9	72.2	81.0	80.9	76	68.4	66.6	0.6	0.7	0.1	1.8

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
66.9	66.7	66.4	67.1	67.1	67.7	67.7	67.1	66.9	69.0	73.4	77.2	78.8	79.9	80.9	75.7	78.6	78.4	75.6	73.4	71.1	70.0	67.9	67.1
65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9
69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4
74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5
55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9
51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9
64.9	65.1	65.4	65.3	65.5	65.7	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0
63.8	63.6	63.1	62.8	62.8	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2

Date	30-Oct																31-Oct										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	low	high	ave
Temperature (°F)	66	70	75	79	81	83	84	84	83	80	77	74	72	70	69	68	68	69	69	69	69	68	68	69		84	
	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9	69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	63.8	79.1	71.5

Date																	1-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	71	75	79	83	85	87	87	86	85	82	80	78	77	77	77	77	77	77	77	76	76	75	75	74		87	
	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4	74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.5	80.6	74.4

Date	1-Nov																2-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	75	71	73	73	73	74	74	74	73	71	69	66	65	64	63	61	59	58	57	56	55	55	54	54		75	
	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5	55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	51.2	69.8	61.0

Date																	3-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	55	56	58	60	63	65	66	67	67	65	62	60	57	56	55	54	53	53	52	52	52	51	50	51		67	
	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9	51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	51.6	64.6	56.5

Date	3-Nov																4-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	53	56	59	63	65	67	69	70	70	68	65	62	61	59	59	58	57	57	57	56	56	55	55	56		70	
	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9	64.9	65.1	65.4	65.3	65.5	65.7	65.7	67.4	43.7	71.5	65.6

Date																	5-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)	59	63	67	70	72	74	75	75	74	73	71	68	66	65	64	64	63	63	62	62	61	60	60	61		75	
	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0	63.8	63.6	63.1	62.8	62.8	63.4	63.1	63.2	62.8	74.8	66.6

Date	5-Nov																6-Nov										
Hour (CDT)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7			
Temperature (°F)																										78	
	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2	73.4	73.5	73.7	73.8	73.6	73.3	73.0	73.4	64.5	81.0	74.3

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/30/2018 8am	67.0	65.9	72.6	69.0	84.0	79.1	78	68.6	67.1	1.1	3.6	4.9	1.4

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
65.6	64.6	64.8	63.7	63.0	61.9	62.3	62.5	63.8	65.4	67.6	70.2	74.8	77.6	79.1	79.0	77.8	75.9	72.5	70.3	69.5	69.3	69.8	68.9
69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4
74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5
55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9
51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9
64.9	65.1	65.4	65.3	65.5	65.7	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0
63.8	63.6	63.1	62.8	62.8	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2
73.4	73.5	73.7	73.8	73.6	73.3	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0

Date	31-Oct																	1-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	70	72	74	77	80	82	84	84	83	81	79	77	75	74	73	73	72	72	73	73	73	73	72	71		84	
	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4	74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	80.6	74.8
Date																		2-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	70	71	69	69	70	71	74	76	76	75	74	72	70	69	67	66	64	62	61	59	58	57	55	54		76	
	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5	55.5	54.7	53.4	52.4	52.1	51.7	51.2	51.2	69.8	61.6
Date	2-Nov																	3-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	54	54	55	56	58	60	62	64	65	65	63	61	59	57	55	54	53	52	52	52	52	51	50	50		65	
	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9	51.9	51.7	52.1	52.3	51.6	51.9	52.1	51.6	64.6	56.3
Date																		4-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	51	54	59	63	67	69	70	72	72	71	70	67	64	62	60	59	58	58	57	57	57	57	57	57		72	
	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9	64.9	65.1	65.4	65.3	65.5	65.7	65.7	43.7	71.5	65.2
Date	4-Nov																	5-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	58	61	65	68	72	74	76	77	77	76	74	71	69	67	66	66	66	66	66	66	66	66	65	65		77	
	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0	63.8	63.6	63.1	62.8	62.8	63.4	63.1	62.8	74.8	66.8
Date																		6-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	66	67	70	72	75	77	78	79	79	78	76	74	72	71	70	70	69	69	69	68	68	67	67	66		79	
	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2	73.4	73.5	73.7	73.8	73.6	73.3	73.0	63.2	81.0	73.9
Date	6-Nov																	7-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										79	
	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0	72.1	72.0	71.2	72.1	72.2	72.7	72.5	71.2	81.4	74.2

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
10/31/2018 7am	66.9	66.4	66.4	64.2	84.0	80.6	79	68.6	67.5	0.4	2.2	3.4	1.1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
69.7	69.6	69.5	69.9	70.4	70.8	71.4	73.8	76.4	78.8	79.7	80.5	80.6	80.1	79.5	78.2	77.6	76.0	74.7	74.2	74.5	75.2	74.7	75.4
74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5
55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9
51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9
64.9	65.1	65.4	65.3	65.5	65.7	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0
63.8	63.6	63.1	62.8	62.8	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2
73.4	73.5	73.7	73.8	73.6	73.3	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0
72.1	72.0	71.2	72.1	72.2	72.7	72.5	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8

Date	1-Nov																2-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	low	high	ave
Temperature (°F)	73	71	71	71	71	72	73	73	73	73	71	70	68	66	65	63	61	60	59	57	56	54	53	53		73	
	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5	55.5	54.7	53.4	52.4	52.1	51.7	51.2	51.2	69.8	61.6

Date																	3-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	53	54	56	57	59	61	63	64	65	65	63	61	58	57	56	55	54	53	53	53	52	52	51	50		65	
	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9	51.9	51.7	52.1	52.3	51.6	51.9	52.1	51.6	64.6	56.3

Date	3-Nov																4-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	51	54	58	63	66	69	70	72	72	71	69	67	64	63	62	61	60	59	58	58	58	57	57	57		72	
	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9	64.9	65.1	65.4	65.3	65.5	65.7	65.7	43.7	71.5	65.2

Date																	5-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	59	61	64	68	72	75	77	78	78	77	75	73	71	70	69	68	68	67	67	66	65	65	65	65		78	
	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0	63.8	63.6	63.1	62.8	62.8	63.4	63.1	62.8	74.8	66.8

Date	5-Nov																6-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	67	69	72	75	78	81	82	82	81	80	78	76	74	73	72	72	71	71	71	70	69	69	68	68		82	
	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2	73.4	73.5	73.7	73.8	73.6	73.3	73.0	63.2	81.0	73.9

Date																	7-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)	69	71	73	75	77	79	80	80	80	79	77	76	74	73	72	70	69	68	66	64	62	61	59	59		80	
	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0	72.1	72.0	71.2	72.1	72.2	72.7	72.5	71.2	81.4	74.2

Date	7-Nov																8-Nov									
Hour (CDT)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6			
Temperature (°F)																										73	
	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8	70.7	70.2	69.7	68.9	68.7	69.0	69.7	68.7	79.1	72.2

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
11/1/2018 7am	66.5	66.3	61.6	61.0	73.0	69.8	73	67.5	67.2	0.2	0.6	3.2	0.3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
74.6	73.1	73.2	70.2	64.8	64.9	64.5	64.5	64.9	65.6	66.9	68.4	69.5	69.7	69.8	68.6	67.7	66.3	64.5	62.8	61.5	60.6	58.3	56.5
55.5	54.7	53.4	52.4	52.1	51.7	51.2	52.1	53.6	56.2	58.7	60.3	62.0	63.4	64.4	64.6	63.8	60.8	57.2	56.2	55.6	54.7	52.5	51.9
51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9
64.9	65.1	65.4	65.3	65.5	65.7	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0
63.8	63.6	63.1	62.8	62.8	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2
73.4	73.5	73.7	73.8	73.6	73.3	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0
72.1	72.0	71.2	72.1	72.2	72.7	72.5	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8
70.7	70.2	69.7	68.9	68.7	69.0	69.7	70.3	71.2	72.1	71.8	69.8	71.1	70.9	69.3	68.4	67.1	66.8	67.0	67.2	67.3	66.9	66.5	66.7

Date	3-Nov																			4-Nov							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	low	high	ave
Temperature (°F)	51	51	52	55	60	64	68	70	72	74	74	73	71	67	64	63	63	62	62	62	62	62	62	62		74	
	51.9	52.1	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9	64.9	65.1	65.4	65.3	65.5	43.7	71.5	64.0

Date																				5-Nov							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	62	62	62	65	69	73	75	76	77	78	78	77	75	73	71	69	69	68	68	68	67	67	67	66		78	
	65.7	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0	63.8	63.6	63.1	62.8	62.8	62.8	74.8	67.0

Date	5-Nov																			6-Nov							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	66	66	67	69	72	74	77	79	81	81	81	79	78	76	75	74	74	73	73	73	73	72	71	71		81	
	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2	73.4	73.5	73.7	73.8	73.6	63.1	81.0	73.1

Date																				7-Nov							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	70	70	71	72	74	76	78	80	81	81	80	78	77	75	73	71	70	69	68	67	66	64	63	62		81	
	73.3	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0	72.1	72.0	71.2	72.1	72.2	71.2	81.4	74.3

Date	7-Nov																			8-Nov							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	61	61	62	63	66	69	72	74	76	76	75	74	72	70	68	67	66	65	65	65	65	65	65	65		76	
	72.7	72.5	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8	70.7	70.2	69.7	68.9	68.7	68.7	79.1	72.5

Date																				9-Nov							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	65	65	65	65	66	68	71	73	74	75	75	74	73	71	70	68	67	65	64	63	61	61	61	61		75	
	69.0	69.7	70.3	71.2	72.1	71.8	69.8	71.1	70.9	69.3	68.4	67.1	66.8	67.0	67.2	67.3	66.9	66.5	66.7	66.8	67.1	67.0	67.1	67.4	66.5	72.1	68.5

Date	9-Nov																			10-Nov							
Hour (CDT)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)																										66	
	67.8	68.0	68.3	69.0	67.0	64.0	60.8	59.6	58.4	56.7	55.8	54.1	51.6	50.6	50.3	50.6	50.9	50.9	50.5	49.7	49.3	48.0	47.4	47.6	47.4	69.0	56.1

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)			
Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day
11/3/2018 5am	69.2	69.9	69.2	68.0	74.0	71.5	66	68.8	67.9	-0.7	1.2	2.5	0.8

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
51.9	51.7	52.1	52.3	51.6	51.9	52.1	56.0	62.2	65.9	68.3	69.8	70.9	71.5	43.7	70.5	69.0	67.3	66.0	65.3	65.0	64.8	64.9	64.9
64.9	65.1	65.4	65.3	65.5	65.7	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0
63.8	63.6	63.1	62.8	62.8	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2
73.4	73.5	73.7	73.8	73.6	73.3	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0
72.1	72.0	71.2	72.1	72.2	72.7	72.5	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8
70.7	70.2	69.7	68.9	68.7	69.0	69.7	70.3	71.2	72.1	71.8	69.8	71.1	70.9	69.3	68.4	67.1	66.8	67.0	67.2	67.3	66.9	66.5	66.7
66.8	67.1	67.0	67.1	67.4	67.8	68.0	68.3	69.0	67.0	64.0	60.8	59.6	58.4	56.7	55.8	54.1	51.6	50.6	50.3	50.6	50.9	50.9	50.5
49.7	49.3	48.0	47.4	47.6	47.9	47.1	47.2	47.4	47.6	48.6	50.8	52.6	53.9	54.5	54.7	54.0	52.4	51.1	51.1	51.5	51.3	50.7	50.3

Date	4-Nov																	5-Nov								
Hour (CST)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	low	high	ave
Temperature (°F)	63	66	69	72	74	75	76	77	77	76	75	72	70	69	68	67	66	66	66	66	67	67	67	67		77	
	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0	63.8	63.6	63.1	62.8	62.8	63.4	62.8	74.8	66.9
Date																			6-Nov								
Hour (CST)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	68	70	72	75	78	80	81	82	82	80	78	76	74	73	72	72	72	72	73	73	72	72	71	71		82	
	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2	73.4	73.5	73.7	73.8	73.6	73.3	63.1	81.0	73.5
Date	6-Nov																		7-Nov								
Hour (CST)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	71	72	74	76	78	79	80	81	81	80	79	76	74	72	70	69	68	67	66	65	64	63	63	63		81	
	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0	72.1	72.0	71.2	72.1	72.2	72.7	71.2	81.4	74.2
Date																			8-Nov								
Hour (CST)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	64	66	69	71	74	76	77	77	76	75	73	71	69	68	68	68	68	68	68	68	68	67	67	67		77	
	72.5	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8	70.7	70.2	69.7	68.9	68.7	69.0	68.7	79.1	72.3
Date	8-Nov																		9-Nov								
Hour (CST)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	68	70	72	74	77	79	79	79	79	78	76	75	73	72	70	70	69	68	67	66	65	64	64	63		79	
	69.7	70.3	71.2	72.1	71.8	69.8	71.1	70.9	69.3	68.4	67.1	66.8	67.0	67.2	67.3	66.9	66.5	66.7	66.8	67.1	67.0	67.1	67.4	67.8	66.5	72.1	68.5
Date																			10-Nov								
Hour (CST)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)	63	63	64	65	66	67	67	66	65	64	62	61	60	58	57	57	56	55	54	52	51	50	49	48		67	
	68.0	68.3	69.0	67.0	64.0	60.8	59.6	58.4	56.7	55.8	54.1	51.6	50.6	50.3	50.6	50.9	50.9	50.5	49.7	49.3	48.0	47.4	47.6	47.9	47.4	69.0	55.3
Date	10-Nov																		11-Nov								
Hour (CST)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5			
Temperature (°F)																										65	
	47.1	47.2	47.4	47.6	48.6	50.8	52.6	53.9	54.5	54.7	54.0	52.4	51.1	51.1	51.5	51.3	50.7	50.3	49.9	49.7	49.9	49.2	49.0	49.2	47.1	54.7	50.6

Date	Six Day Average Forecast	Six Day Average Actual	Three Day Average Forecast	Three Day Average Actual	24 hr High Forecast	24 hr High Actual	7 day High Forecast	7 day Average Forecast	7 day Average Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
11/4/2018 6am	69.6	68.4	72.2	71.5	77.0	74.8	65	68.9	65.9	1.1	0.7	2.2	3.0

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
64.9	65.1	65.4	65.3	65.5	65.7	65.7	67.4	68.9	70.2	71.8	73.7	74.8	73.9	72.3	70.0	68.2	65.9	64.2	63.6	64.0	64.2	63.7	63.0
63.8	63.6	63.1	62.8	62.8	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2
73.4	73.5	73.7	73.8	73.6	73.3	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0
72.1	72.0	71.2	72.1	72.2	72.7	72.5	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8
70.7	70.2	69.7	68.9	68.7	69.0	69.7	70.3	71.2	72.1	71.8	69.8	71.1	70.9	69.3	68.4	67.1	66.8	67.0	67.2	67.3	66.9	66.5	66.7
66.8	67.1	67.0	67.1	67.4	67.8	68.0	68.3	69.0	67.0	64.0	60.8	59.6	58.4	56.7	55.8	54.1	51.6	50.6	50.3	50.6	50.9	50.9	50.5
49.7	49.3	48.0	47.4	47.6	47.9	47.1	47.2	47.4	47.6	48.6	50.8	52.6	53.9	54.5	54.7	54.0	52.4	51.1	51.1	51.5	51.3	50.7	50.3
49.9	49.7	49.9	49.2	49.0	49.2	49.0	49.8	50.8	52.5	54.7	55.8	56.8	57.2	58.4	59.7	60.1	59.0	59.6	59.2	59.3	59.9	59.5	59.2

Date	5-Nov																			6-Nov							
Hour (CST)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	low	high	ave
Temperature (°F)	63	63	64	68	73	76	79	81	82	82	82	81	80	77	76	75	75	75	74	74	74	73	73	73		82	
	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2	73.4	73.5	73.7	73.8	73.6	63.1	81.0	73.1

Date																				7-Nov							
Hour (CST)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	72	72	73	75	78	80	81	82	83	83	83	82	80	76	75	74	74	73	72	72	72	71	71	70		83	
	73.3	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0	72.1	72.0	71.2	72.1	72.2	71.2	81.4	74.3

Date	7-Nov																			8-Nov							
Hour (CST)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	70	69	70	72	75	77	78	79	80	80	80	79	77	74	72	71	71	71	70	70	69	69	68	68		80	
	72.7	72.5	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8	70.7	70.2	69.7	68.9	68.7	68.7	79.1	72.5

Date																				9-Nov							
Hour (CST)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	68	67	68	70	73	75	76	77	78	78	77	77	74	69	67	66	66	65	64	64	63	63	62	61		78	
	69.0	69.7	70.3	71.2	72.1	71.8	69.8	71.1	70.9	69.3	68.4	67.1	66.8	67.0	67.2	67.3	66.9	66.5	66.7	66.8	67.1	67.0	67.1	67.4	66.5	72.1	68.5

Date	9-Nov																			10-Nov							
Hour (CST)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	61	60	60	62	64	65	66	67	67	67	66	66	63	58	56	55	55	54	53	53	52	52	51	50		67	
	67.8	68.0	68.3	69.0	67.0	64.0	60.8	59.6	58.4	56.7	55.8	54.1	51.6	50.6	50.3	50.6	50.9	50.9	50.5	49.7	49.3	48.0	47.4	47.6	47.4	69.0	56.1

Date																				11-Nov							
Hour (CST)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)	50	49	50	52	55	57	59	60	61	61	61	60	59	56	55	54	54	54	53	53	53	52	52	52		61	
	47.9	47.1	47.2	47.4	47.6	48.6	50.8	52.6	53.9	54.5	54.7	54.0	52.4	51.1	51.1	51.5	51.3	50.7	50.3	49.9	49.7	49.9	49.2	49.0	47.1	54.7	50.5

Date	11-Nov																			12-Nov							
Hour (CST)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4			
Temperature (°F)																										69	
	49.2	49.0	49.8	50.8	52.5	54.7	55.8	56.8	57.2	58.4	59.7	60.1	59.0	59.6	59.2	59.3	59.9	59.5	59.2	57.0	56.4	56.1	56.6	57.0	49.0	60.1	56.4

Date	Six Day Average Forecast	Actual	Three Day Average Forecast	Actual	24 hr High Forecast	Actual	7 day High Forecast	7 day Average Forecast	Actual	Deviation (forecast - actual) 6day	3day	24 hr high	7 day
11/5/2018 5am	68.0	65.8	74.7	73.3	82.0	81.0	69	68.1	64.5	2.2	1.4	1.0	3.7

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
63.8	63.6	63.1	62.8	62.8	63.4	63.1	63.2	64.5	67.0	70.6	75.1	78.3	80.7	81.0	80.1	78.7	76.4	75.0	74.7	74.0	73.4	73.2	73.2
73.4	73.5	73.7	73.8	73.6	73.3	73.0	73.4	75.1	76.7	80.4	81.4	75.4	75.5	76.2	77.4	76.0	74.3	73.6	73.0	71.7	72.6	71.9	72.0
72.1	72.0	71.2	72.1	72.2	72.7	72.5	73.4	75.1	77.4	79.1	77.1	75.9	73.6	72.1	72.8	72.6	72.1	71.4	71.3	71.2	70.9	69.6	69.8
70.7	70.2	69.7	68.9	68.7	69.0	69.7	70.3	71.2	72.1	71.8	69.8	71.1	70.9	69.3	68.4	67.1	66.8	67.0	67.2	67.3	66.9	66.5	66.7
66.8	67.1	67.0	67.1	67.4	67.8	68.0	68.3	69.0	67.0	64.0	60.8	59.6	58.4	56.7	55.8	54.1	51.6	50.6	50.3	50.6	50.9	50.9	50.5
49.7	49.3	48.0	47.4	47.6	47.9	47.1	47.2	47.4	47.6	48.6	50.8	52.6	53.9	54.5	54.7	54.0	52.4	51.1	51.1	51.5	51.3	50.7	50.3
49.9	49.7	49.9	49.2	49.0	49.2	49.0	49.8	50.8	52.5	54.7	55.8	56.8	57.2	58.4	59.7	60.1	59.0	59.6	59.2	59.3	59.9	59.5	59.2
57.0	56.4	56.1	56.6	57.0	57.5	58.4	60.0	62.5	66.5	PI-API errc	PI-API errc	PI-API errc	PI-API erro	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API errc	PI-API error: -11059

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)				Normal Distribution Probability			
Forecast Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day	6day	3day	24 hr high	7 day
7/11/2017 4pm	83.0	79.1	82.6	79.0	88.0	85.4	88.0	83.7	79.1	3.8	3.6	2.6	4.6	90%	85%	43%	84%
7/12/2017 4pm	82.7	79.2	82.8	79.0	89.0	86.6	89.0	83.6	79.2	3.4	3.8	2.4	4.3	85%	88%	40%	80%
3/5/2018 12pm	61.4	59.6	59.4	58.8	80.0	77.0	76.0	63.5	59.5	1.8	0.5	3.0	4.0	48%	17%	50%	74%
3/13/2018 7am	63.8	63.4	57.0	56.1	66.0	61.9	79.0	66.0	64.8	0.4	0.9	4.1	1.2	17%	23%	72%	12%
3/15/2018 7am	67.9	67.2	67.2	66.7	72.0	68.6	72.0	68.5	66.0	0.7	0.5	3.4	2.5	22%	17%	59%	37%
3/20/2018 6am	63.9	63.4	58.2	58.0	68.0	64.6	81.0	66.3	64.7	0.5	0.2	3.4	1.6	19%	12%	58%	19%
4/2/2018 2pm	67.6	64.8	67.3	67.4	81.0	80.4	78.0	69.1	63.6	2.8	-0.1	0.6	5.5	73%	8%	12%	94%
4/3/2018 8am	67.7	62.9	66.1	65.4	82.0	81.4	76.0	68.9	62.9	4.8	0.7	0.6	6.0	97%	20%	12%	97%
4/17/2018 7am	69.0	66.3	69.2	67.2	80.0	77.0	79.0	70.5	66.1	2.7	2.0	3.0	4.4	71%	49%	51%	81%
4/18/2018 2pm	67.1	65.8	65.8	64.3	84.0	78.7	75.0	68.2	66.1	1.3	1.6	5.3	2.1	36%	39%	88%	29%
4/23/2018 7am	67.8	66.7	68.0	67.7	74.0	71.7	76.0	68.9	67.3	1.1	0.3	2.3	1.7	30%	13%	37%	20%
4/30/2018 7am	74.7	73.6	74.2	73.9	85.0	78.9	80.0	75.5	73.5	1.1	0.3	6.1	2.0	32%	14%	94%	26%
5/3/2018 3pm	74.6	74.5	75.1	73.1	86.0	80.8	86.0	76.2	74.5	0.1	2.0	5.2	1.6	13%	51%	87%	20%
5/8/2018 7am	78.2	76.6	78.4	75.9	91.0	86.6	87.0	79.5	77.2	1.6	2.5	4.4	2.3	44%	62%	76%	32%
5/9/2018 7am	78.2	77.2	78.0	75.9	90.0	84.5	88.0	79.6	77.8	1.0	2.1	5.5	1.8	28%	53%	90%	22%
5/14/2018 1pm	79.7	80.3	80.0	81.5	91.0	89.8	90.0	81.2	80.1	-0.6	-1.5	1.2	1.1	6%	1%	20%	12%
5/15/2018 9am	81.6	80.0	82.3	81.8	93.0	91.2	90.0	82.8	79.8	1.6	0.4	1.8	3.0	43%	15%	30%	50%
5/17/2018 3pm	81.2	78.9	81.9	78.9	93.0	90.9	90.0	82.4	79.0	2.2	2.9	2.1	3.5	60%	73%	34%	61%
5/22/2018 7am	80.2	77.7	81.3	78.3	90.0	86.4	88.0	81.3	78.1	2.5	2.9	3.6	3.2	66%	72%	63%	55%
5/24/2018 6am	80.7	78.4	80.3	75.7	90.0	82.6	90.0	82.0	79.0	2.3	4.6	7.4	3.1	61%	95%	99%	52%
5/24/2018 11am	80.7	78.5	80.2	75.7	90.0	82.6	90.0	82.1	79.0	2.2	4.6	7.4	3.0	59%	95%	99%	51%
5/29/2018 6am	84.1	82.9	83.4	82.5	92.0	90.8	92.0	85.3	82.4	1.3	0.9	1.2	2.9	35%	24%	19%	48%
5/30/2018 12pm	84.4	82.2	83.8	82.4	91.0	90.7	92.0	85.5	80.8	2.2	1.3	0.3	4.7	58%	33%	10%	85%
5/30/2018 4pm	84.4	81.9	84.1	82.5	93.0	90.5	92.0	85.5	80.6	2.5	1.6	2.5	4.9	65%	40%	42%	89%
5/31/2018 3pm	84.6	80.4	84.8	82.8	93.0	90.5	92.0	85.7	80.2	4.2	2.0	2.5	5.5	93%	50%	42%	94%
6/4/2018 6am	81.7	79.1	81.7	76.8	91.0	87.7	90.0	82.9	78.9	2.6	4.9	3.3	4.0	68%	97%	56%	74%
6/6/2018 12pm	82.4	79.8	81.5	80.6	89.0	84.4	92.0	83.8	79.2	2.6	0.9	4.6	4.5	69%	23%	79%	83%
6/11/2018 7am	82.4	78.6	82.2	77.5	88.0	85.0	90.0	83.5	79.0	3.8	4.7	3.0	4.5	90%	96%	50%	83%
6/12/2018 7am	82.4	79.1	83.0	78.1	91.0	88.7	88.0	83.2	78.9	3.2	4.8	2.3	4.3	81%	97%	37%	80%
6/14/2018 9am	82.2	79.7	81.9	79.6	89.0	85.6	88.0	83.1	79.9	2.5	2.4	3.4	3.1	67%	60%	59%	54%
6/18/2018 7am	82.4	80.8	82.5	79.7	87.0	80.8	88.0	83.2	81.1	1.6	2.8	6.2	2.1	43%	70%	94%	29%
6/19/2018 3pm	83.2	81.9	82.8	81.2	90.0	87.7	88.0	83.9	82.0	1.3	1.6	2.3	1.9	36%	39%	37%	24%
6/20/2018 7am	83.2	82.2	82.7	81.5	90.0	87.7	88.0	83.8	82.1	0.9	1.2	2.3	1.8	27%	30%	37%	22%
6/21/2018 3pm	84.6	82.3	84.4	82.2	92.0	89.1	94.0	85.9	82.4	2.3	2.1	2.9	3.5	61%	54%	50%	62%
6/25/2018 7am	85.2	82.6	85.2	82.5	93.0	91.0	92.0	86.2	82.5	2.6	2.7	2.0	3.7	67%	67%	32%	67%
6/28/2018 10am	84.5	81.0	85.8	82.6	93.0	92.0	88.0	85.0	81.0	3.5	3.2	1.0	4.1	85%	77%	17%	75%
6/29/2018 11am	83.3	80.4	85.0	81.7	92.0	92.5	90.0	84.3	80.4	3.0	3.4	-0.5	3.9	77%	81%	4%	71%
7/1/2018 4pm	82.4	79.4	82.5	79.2	93.0	91.1	91.0	83.6	79.2	3.0	3.3	1.9	4.4	77%	81%	30%	82%
7/3/2018 7am	81.2	78.8	81.0	79.4	84.0	80.7	90.0	82.5	78.6	2.4	1.6	3.3	3.8	65%	40%	57%	70%
7/5/2018 6am	83.0	79.1	82.7	79.5	90.0	85.4	91.0	84.2	79.0	3.9	3.2	4.6	5.2	91%	79%	79%	92%

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)				Normal Distribution Probability			
Forecast Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day	6day	3day	24 hr high	7 day
7/5/2018 6pm	81.8	79.1	81.0	78.9	87.0	84.0	93.0	83.4	79.1	2.6	2.1	3.0	4.3	69%	54%	51%	79%
7/8/2018 7am	82.6	79.6	82.2	78.8	88.0	83.9	91.0	83.8	80.0	3.1	3.4	4.1	3.8	79%	82%	72%	70%
7/9/2018 7am	83.4	80.5	83.4	79.2	91.0	87.0	91.0	84.5	80.9	2.8	4.2	4.0	3.6	74%	92%	70%	65%
7/10/2018 3pm	83.3	81.5	83.3	80.4	90.0	88.2	89.0	84.1	81.1	1.8	2.9	1.8	3.1	48%	72%	29%	52%
7/11/2018 7am	83.3	81.1	83.0	80.3	90.0	86.7	90.0	84.3	81.0	2.2	2.7	3.3	3.3	60%	67%	57%	57%
7/11/2018 5pm	82.8	81.0	82.8	80.9	90.0	88.7	90.0	83.8	80.9	1.7	1.9	1.3	2.9	47%	47%	21%	47%
7/12/2018 7am	83.6	81.5	83.7	81.8	92.0	89.3	91.0	84.7	81.0	2.2	1.9	2.7	3.7	58%	46%	45%	67%
7/14/2018 10am	83.3	81.3	84.5	81.7	93.0	91.0	91.0	84.4	82.4	2.0	2.8	2.0	2.0	53%	69%	32%	26%
7/15/2018 9pm	84.1	82.5	83.8	80.0	92.0	90.0	94.0	85.5	83.0	1.6	3.7	2.0	2.6	43%	87%	33%	40%
7/17/2018 7am	84.0	83.7	82.2	80.7	87.0	86.8	95.0	85.6	83.5	0.3	1.4	0.2	2.1	15%	35%	9%	28%
7/18/2018 7am	85.5	84.0	84.3	83.3	92.0	83.6	95.0	86.9	83.8	1.5	1.0	8.4	3.0	40%	26%	100%	51%
7/19/2018 10am	85.8	84.8	85.7	86.0	94.0	90.6	92.0	86.7	84.5	1.1	-0.3	3.4	2.2	30%	7%	59%	32%
7/20/2018 2pm	85.2	84.6	86.2	86.7	96.0	92.9	91.0	86.0	84.3	0.6	-0.5	3.1	1.7	21%	5%	53%	22%
7/21/2018 9am	85.6	83.5	87.3	84.5	98.0	92.1	92.0	86.5	83.2	2.1	2.9	5.9	3.3	57%	71%	93%	58%
7/23/2018 6am	85.2	82.2	85.5	82.5	95.0	91.8	93.0	86.3	81.8	2.9	3.0	3.2	4.5	76%	74%	55%	82%
7/24/2018 8am	85.6	81.7	85.7	82.5	92.0	89.1	91.0	86.3	81.5	3.8	3.1	2.9	4.8	90%	77%	50%	88%
7/25/2018 8am	84.6	81.3	85.1	82.2	94.0	88.2	89.0	85.3	80.9	3.3	3.0	5.8	4.4	83%	74%	92%	81%
7/26/2018 8am	84.1	80.6	85.7	81.9	95.0	90.4	89.0	84.8	80.3	3.5	3.8	4.6	4.5	86%	87%	79%	83%
7/27/2018 1pm	83.1	79.9	84.6	80.9	95.0	90.8	90.0	84.1	79.8	3.3	3.7	4.2	4.4	82%	87%	73%	81%
7/28/2018 6am	83.0	79.6	85.1	80.7	94.0	91.1	87.0	83.6	79.6	3.4	4.4	2.9	4.0	84%	94%	49%	74%
7/28/2018 9pm	81.9	79.2	83.1	79.6	88.0	86.6	89.0	82.9	79.0	2.8	3.6	1.4	3.9	72%	85%	23%	72%
7/29/2018 7am	81.6	79.2	82.5	79.3	89.0	86.6	88.0	82.5	79.2	2.4	3.2	2.4	3.4	65%	78%	40%	60%
7/30/2018 1pm	81.4	79.1	81.3	78.9	92.0	92.7	90.0	82.6	79.7	2.2	2.5	-0.7	2.9	59%	62%	4%	48%
7/31/2018 7pm	81.8	79.7	80.5	78.7	87.0	86.4	92.0	83.2	79.9	2.1	1.7	0.6	3.3	56%	43%	13%	59%
8/1/2018 9am	81.9	80.0	80.6	79.0	86.0	86.4	92.0	83.3	79.7	1.9	1.6	-0.4	3.6	51%	41%	5%	64%
8/2/2018 7am	83.2	79.9	82.2	79.2	91.0	87.2	91.0	84.3	80.0	3.2	3.0	3.8	4.3	81%	74%	67%	79%
8/3/2018 9am	83.2	80.2	82.5	80.4	90.0	84.2	91.0	84.3	80.0	3.0	2.0	5.8	4.3	77%	51%	92%	80%
8/4/2018 9am	83.9	80.2	83.5	81.0	90.0	84.2	90.0	84.8	79.8	3.8	2.6	5.8	5.0	89%	65%	92%	90%
8/5/2018 7am	83.3	79.8	83.8	80.6	91.0	88.0	91.0	84.4	79.6	3.5	3.2	3.0	4.8	85%	78%	51%	87%
8/6/2018 6am	82.9	79.2	83.4	80.1	90.0	86.8	91.0	84.1	79.6	3.7	3.3	3.2	4.5	89%	80%	54%	83%
8/7/2018 8am	83.0	79.4	82.9	79.4	92.0	88.4	92.0	84.3	79.8	3.6	3.6	3.6	4.5	87%	84%	62%	83%
8/8/2018 7am	83.4	80.0	83.1	79.0	92.0	87.5	93.0	84.8	80.2	3.4	4.1	4.5	4.5	84%	92%	77%	83%
8/9/2018 7am	83.7	80.2	83.1	78.3	92.0	87.4	93.0	85.0	80.3	3.5	4.8	4.6	4.7	85%	97%	79%	86%
8/10/2018 7pm	83.8	80.8	83.4	80.4	90.0	86.3	92.0	85.0	80.4	3.1	3.0	3.7	4.5	78%	74%	64%	83%
8/11/2018 9am	83.5	80.9	83.4	81.0	87.0	86.3	91.0	84.6	80.5	2.6	2.4	0.7	4.1	67%	61%	14%	75%
8/12/2018 10pm	83.1	80.1	83.5	81.5	91.0	89.7	91.0	84.2	79.8	3.0	1.9	1.3	4.5	77%	48%	21%	82%
8/14/2018 2pm	84.1	79.3	84.2	80.7	94.0	90.6	92.0	85.2	79.3	4.8	3.5	3.4	5.9	97%	83%	59%	97%
8/15/2018 8am	83.9	78.8	84.1	79.6	94.0	89.5	92.0	85.1	80.3	5.1	4.5	4.5	4.8	98%	95%	78%	87%
8/16/2018 2pm	83.3	80.2	82.9	78.3	91.0	87.0	91.0	84.4	80.5	3.1	4.6	4.0	3.9	78%	95%	70%	72%
8/17/2018 7am	83.3	80.6	83.5	77.7	91.0	85.8	92.0	84.5	80.6	2.7	5.8	5.2	4.0	70%	99%	86%	73%
8/18/2018 7am	82.5	81.0	82.4	78.1	90.0	86.9	91.0	83.8	81.0	1.5	4.3	3.1	2.8	42%	93%	52%	44%
8/20/2018 6am	82.2	82.4	82.5	83.5	90.0	88.4	92.0	83.6	82.3	-0.2	-1.0	1.6	1.3	9%	3%	25%	14%

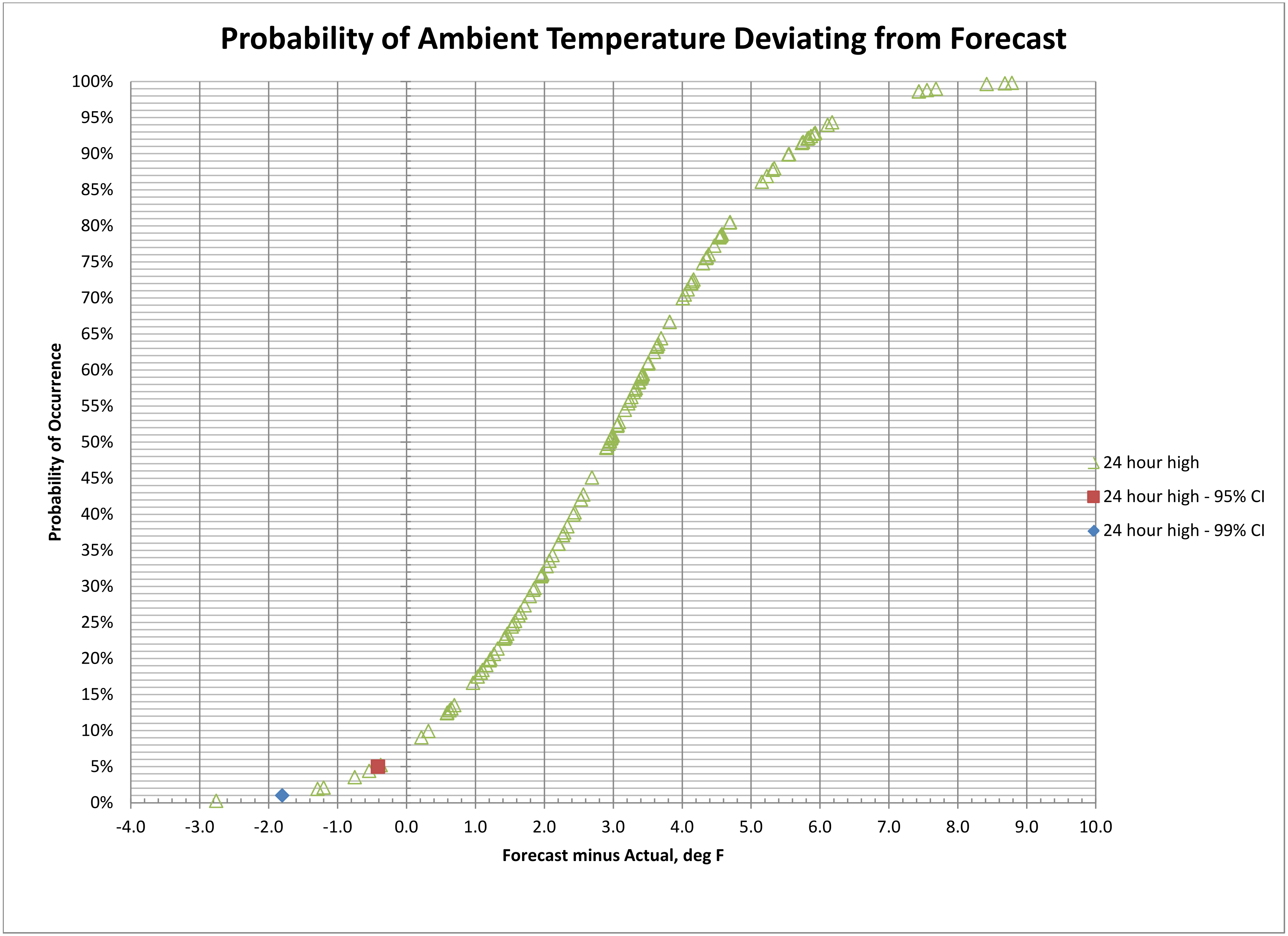
	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)				Normal Distribution Probability			
Forecast Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day	6day	3day	24 hr high	7 day
8/21/2018 6am	82.8	82.8	82.7	84.0	90.0	91.2	90.0	83.8	82.5	0.0	-1.3	-1.2	1.3	11%	2%	2%	14%
8/23/2018 9am	82.5	80.9	82.7	81.4	91.0	85.1	90.0	83.5	80.5	1.6	1.4	5.9	3.0	42%	34%	93%	51%
8/24/2018 11am	82.6	80.5	82.7	82.0	92.0	87.3	91.0	83.8	80.3	2.1	0.7	4.7	3.5	55%	20%	80%	62%
8/25/2018 12pm	82.9	80.1	82.8	81.6	90.0	87.1	91.0	84.0	80.0	2.8	1.2	2.9	4.1	72%	31%	49%	75%
8/26/2018 7am	83.9	79.5	84.1	80.5	92.0	87.3	91.0	84.9	79.4	4.4	3.6	4.7	5.6	95%	85%	81%	95%
8/27/2018 7am	84.9	79.0	85.3	79.4	93.0	87.3	91.0	85.8	78.8	5.9	5.9	5.7	7.0	100%	99%	91%	99%
8/28/2018 7am	84.1	78.5	84.0	78.7	89.0	81.4	91.0	85.1	78.9	5.6	5.3	7.6	6.2	99%	98%	99%	98%
8/29/2018 1pm	83.9	78.8	84.3	78.6	90.0	81.2	89.0	84.7	78.7	5.2	5.7	8.8	6.0	98%	99%	100%	97%
8/30/2018 10pm	81.4	79.1	81.3	78.3	89.0	80.3	88.0	82.3	78.9	2.3	3.0	8.7	3.4	62%	75%	100%	60%
8/31/2018 7am	81.2	79.0	81.3	78.3	88.0	80.3	88.0	82.2	78.8	2.2	2.9	7.7	3.4	59%	72%	99%	59%
8/31/2018 1pm	80.4	79.0	80.3	79.0	85.0	82.9	88.0	81.5	78.9	1.4	1.3	2.1	2.6	39%	32%	34%	41%
9/1/2018 8am	80.8	78.8	80.9	79.1	85.0	82.9	89.0	82.0	78.7	2.0	1.8	2.1	3.2	52%	44%	34%	56%
9/2/2018 7am	81.1	78.8	81.0	79.0	84.0	80.6	88.0	82.1	78.8	2.3	2.0	3.4	3.3	61%	50%	59%	58%
9/3/2018 8am	80.6	78.9	80.5	79.6	83.0	85.8	88.0	81.7	79.1	1.8	0.9	-2.8	2.6	47%	23%	0%	41%
9/3/2018 8pm	81.2	79.0	81.3	79.1	85.0	83.4	88.0	82.2	78.9	2.2	2.2	1.6	3.3	60%	55%	26%	59%
9/4/2018 8am	80.4	78.7	79.5	78.6	83.0	83.4	90.0	81.7	78.6	1.6	0.9	-0.4	3.1	44%	24%	5%	53%
9/5/2018 1pm	80.5	78.8	80.7	78.7	86.0	87.3	87.0	81.4	78.8	1.7	1.9	-1.3	2.6	46%	48%	2%	41%
9/6/2018 7am	80.4	78.4	80.4	78.1	85.0	83.0	88.0	81.4	78.9	1.9	2.3	2.0	2.5	51%	57%	31%	38%
9/7/2018 12pm	79.5	79.3	79.7	79.0	85.0	83.6	88.0	80.7	79.3	0.2	0.8	1.4	1.4	15%	21%	23%	16%
9/8/2018 9am	80.5	79.5	80.9	78.9	89.0	85.3	90.0	81.9	79.8	1.0	2.0	3.7	2.1	30%	51%	64%	30%
9/9/2018 1pm	80.6	80.0	79.8	78.8	89.0	88.0	90.0	81.9	80.4	0.6	1.0	1.0	1.5	20%	25%	17%	17%
9/10/2018 6am	81.2	80.4	80.5	79.2	86.0	84.5	90.0	82.5	80.7	0.9	1.3	1.5	1.8	26%	32%	23%	23%
9/11/2018 8am	81.7	81.2	81.0	80.1	86.0	82.7	91.0	83.0	81.2	0.5	0.9	3.3	1.8	20%	24%	58%	23%
9/11/2018 2pm	82.1	81.4	81.6	80.4	88.0	84.9	91.0	83.4	81.5	0.7	1.2	3.1	1.9	22%	30%	52%	24%
9/12/2018 7am	82.4	81.7	82.3	81.1	89.0	85.8	90.0	83.5	81.9	0.7	1.2	3.2	1.7	23%	29%	56%	20%
9/13/2018 7am	82.8	81.9	82.5	81.5	91.0	86.7	91.0	83.9	81.7	0.9	1.1	4.3	2.2	27%	27%	75%	31%
9/14/2018 5pm	83.2	81.8	83.6	82.6	93.0	91.9	89.0	84.0	81.6	1.4	1.1	1.1	2.4	38%	27%	18%	36%
9/15/2018 8am	83.6	81.7	84.8	82.3	93.0	91.9	88.0	84.3	81.6	1.9	2.5	1.1	2.7	52%	62%	18%	43%
9/16/2018 7am	83.3	81.3	84.6	82.2	94.0	92.6	88.0	84.0	80.9	2.0	2.3	1.4	3.1	54%	59%	23%	53%
9/17/2018 7am	83.0	80.6	83.8	81.8	94.0	91.8	90.0	84.0	80.5	2.4	2.0	2.2	3.5	63%	49%	36%	63%
9/18/2018 6am	82.4	80.3	83.3	81.0	94.0	92.0	89.0	83.3	80.2	2.1	2.3	2.0	3.1	56%	58%	31%	53%
9/19/2018 7am	82.1	79.8	83.3	80.4	95.0	90.8	88.0	83.0	79.6	2.3	2.9	4.2	3.4	62%	72%	72%	61%
9/20/2018 1pm	82.7	79.0	83.7	79.6	94.0	88.7	89.0	83.6	78.6	3.7	4.1	5.3	5.0	88%	91%	88%	89%
9/21/2018 8am	82.0	78.7	82.4	79.5	91.0	88.7	88.0	82.9	78.1	3.3	2.9	2.3	4.7	82%	72%	38%	86%
9/22/2018 7am	81.9	77.7	82.3	79.2	91.0	86.9	89.0	82.9	77.6	4.2	3.1	4.1	5.3	93%	76%	71%	93%
9/23/2018 5am	81.6	77.5	81.8	79.2	89.0	87.3	89.0	82.7	77.4	4.1	2.7	1.7	5.2	93%	67%	27%	92%
9/24/2018 6am	81.1	77.1	81.5	77.9	89.0	85.6	90.0	82.3	77.1	4.0	3.6	3.4	5.2	91%	84%	58%	92%
9/25/2018 7am	80.6	76.7	80.1	76.3	88.0	84.2	90.0	81.9	77.1	3.9	3.8	3.8	4.8	91%	88%	67%	88%
9/26/2018 9am	80.1	77.0	79.6	75.9	87.0	81.1	89.0	81.4	77.6	3.1	3.7	5.9	3.8	78%	87%	92%	69%
9/27/2018 7am	80.0	77.8	79.0	76.3	84.0	79.6	88.0	81.1	78.2	2.2	2.7	4.4	3.0	60%	68%	76%	49%
9/28/2018 10am	80.5	78.9	79.4	77.4	86.0	81.6	90.0	81.8	79.0	1.6	2.0	4.4	2.8	44%	51%	76%	46%
9/29/2018 10am	80.8	79.3	80.4	78.2	84.0	80.5	89.0	81.9	79.6	1.4	2.3	3.5	2.3	39%	57%	61%	33%

	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)				Normal Distribution Probability			
Forecast Date	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day	6day	3day	24 hr high	7 day
9/30/2018 7am	80.6	80.0	80.5	79.2	83.0	81.9	87.0	81.5	80.2	0.6	1.3	1.1	1.3	21%	32%	18%	15%
10/1/2018 7am	80.8	80.7	81.0	80.4	86.0	84.4	88.0	81.8	80.6	0.1	0.6	1.6	1.2	13%	18%	25%	13%
10/2/2018 7am	80.9	80.7	81.1	80.6	88.0	86.5	86.0	81.6	80.5	0.1	0.6	1.5	1.2	13%	18%	24%	12%
10/4/2018 1pm	80.4	80.1	80.7	80.9	89.0	85.9	86.0	81.2	79.3	0.3	-0.2	3.1	1.8	16%	8%	52%	23%
10/5/2018 7am	80.2	79.7	80.9	80.9	90.0	86.4	86.0	81.1	78.4	0.6	0.0	3.6	2.7	20%	10%	63%	43%
10/5/2018 9pm	79.6	78.8	80.4	80.4	88.0	87.3	86.0	80.5	77.3	0.8	0.0	0.7	3.2	24%	10%	13%	55%
10/6/2018 6am	80.0	78.0	80.6	80.1	89.0	87.3	85.0	80.7	76.6	2.0	0.5	1.7	4.2	54%	17%	26%	77%
10/6/2018 7am	80.0	77.9	80.6	80.1	89.0	87.3	85.0	80.7	76.5	2.1	0.5	1.7	4.2	56%	17%	26%	78%
10/6/2018 4pm	78.4	77.0	80.1	79.7	88.0	86.8	84.0	79.2	76.1	1.4	0.5	1.2	3.1	38%	16%	20%	53%
10/7/2018 6am	78.3	75.8	81.5	79.5	89.0	86.8	80.0	78.5	75.5	2.5	2.0	2.2	3.0	66%	51%	36%	49%
10/8/2018 6am	75.6	74.8	79.5	78.5	88.0	82.4	77.0	75.8	75.3	0.8	1.0	5.6	0.5	25%	25%	90%	6%
10/9/2018 9pm	74.3	74.6	76.1	73.6	88.0	84.5	76.0	74.5	75.2	-0.4	2.5	3.5	-0.7	8%	62%	61%	1%
10/10/2018 9pm	72.0	74.5	71.2	71.0	82.0	79.1	80.0	73.1	74.1	-2.5	0.2	2.9	-1.0	0%	12%	49%	1%
10/11/2018 7am	71.7	74.6	71.0	71.1	82.0	79.1	80.0	72.9	74.0	-2.9	-0.1	2.9	-1.1	0%	9%	49%	1%
10/11/2018 7pm	72.1	74.4	71.5	72.3	78.0	77.0	76.0	72.7	73.8	-2.2	-0.8	1.0	-1.1	0%	3%	17%	0%
10/12/2018 6am	73.6	74.5	74.1	73.6	81.0	77.0	76.0	73.9	74.1	-0.9	0.5	4.0	-0.1	4%	17%	70%	2%
10/13/2018 5am	74.5	75.1	77.1	76.8	83.0	82.8	80.0	75.3	75.1	-0.6	0.4	0.2	0.2	6%	14%	9%	4%
10/14/2018 5am	75.5	75.3	78.5	78.2	89.0	85.4	80.0	76.1	75.0	0.2	0.3	3.6	1.2	14%	13%	62%	12%
10/15/2018 2pm	73.2	73.4	74.1	74.1	85.0	85.1	70.0	72.7	72.0	-0.2	0.0	-0.1	0.7	9%	9%	7%	8%
10/16/2018 6am	71.8	72.0	72.3	73.3	83.0	85.1	72.0	71.8	71.2	-0.2	-0.9	-2.1	0.6	9%	3%	1%	7%
10/17/2018 7am	71.8	70.0	75.4	72.5	79.0	73.3	76.0	72.4	69.5	1.8	2.9	5.7	2.9	48%	71%	91%	48%
10/18/2018 7am	70.1	69.4	73.6	73.2	79.0	76.6	79.0	71.4	69.5	0.7	0.4	2.4	1.9	23%	14%	40%	24%
10/19/2018 5am	70.7	69.1	71.5	70.8	86.0	80.6	78.0	71.7	69.4	1.6	0.6	5.4	2.3	42%	19%	89%	34%
10/20/2018 8am	68.5	68.1	67.2	67.5	83.0	83.3	72.0	69.0	67.1	0.4	-0.3	-0.3	1.9	17%	7%	6%	25%
10/21/2018 6am	66.0	66.4	65.6	65.6	71.0	68.3	73.0	67.0	65.9	-0.4	0.0	2.7	1.1	7%	10%	44%	12%
10/22/2018 7am	65.6	66.2	67.7	67.7	73.0	69.6	74.0	66.8	66.9	-0.6	0.0	3.4	-0.1	6%	9%	60%	3%
10/23/2018 6am	67.0	66.9	69.6	68.9	72.0	67.9	76.0	68.3	67.5	0.0	0.7	4.1	0.8	12%	20%	72%	8%
10/24/2018 7am	66.8	67.7	68.7	67.1	74.0	72.3	72.0	67.6	68.2	-0.9	1.6	1.7	-0.6	4%	39%	28%	1%
10/25/2018 8am	65.8	67.8	66.7	64.5	80.0	80.3	79.0	67.7	67.8	-2.0	2.2	-0.3	-0.1	1%	56%	6%	2%
10/26/2018 2pm	68.9	68.8	66.8	66.1	71.0	69.5	73.0	69.5	67.4	0.1	0.8	1.5	2.1	12%	21%	24%	28%
10/27/2018 8am	70.3	68.7	69.2	68.4	74.0	71.8	70.0	70.2	66.9	1.6	0.9	2.2	3.3	43%	23%	36%	57%
10/28/2018 7am	68.3	67.6	71.2	71.0	82.0	80.5	68.0	68.2	67.3	0.7	0.2	1.5	1.0	22%	12%	23%	10%
10/29/2018 7am	67.2	66.6	72.9	72.2	81.0	80.9	76.0	68.4	66.6	0.6	0.7	0.1	1.8	20%	20%	8%	23%
10/30/2018 8am	67.0	65.9	72.6	69.0	84.0	79.1	78.0	68.6	67.1	1.1	3.6	4.9	1.4	30%	84%	83%	16%
10/31/2018 7am	66.9	66.4	66.4	64.2	84.0	80.6	79.0	68.6	67.5	0.4	2.2	3.4	1.1	18%	54%	60%	11%
11/1/2018 7am	66.5	66.3	61.6	61.0	73.0	69.8	73.0	67.5	67.2	0.2	0.6	3.2	0.3	15%	19%	55%	5%
11/3/2018 5am	69.2	69.9	69.2	68.0	74.0	71.5	66.0	68.8	67.9	-0.7	1.2	2.5	0.8	5%	30%	41%	9%
11/4/2018 6am	69.6	68.4	72.2	71.5	77.0	74.8	65.0	68.9	65.9	1.1	0.7	2.2	3.0	32%	19%	36%	51%
11/5/2018 5am	68.0	65.8	74.7	73.3	82.0	81.0	69.0	68.1	64.5	2.2	1.4	1.0	3.7	58%	35%	17%	66%

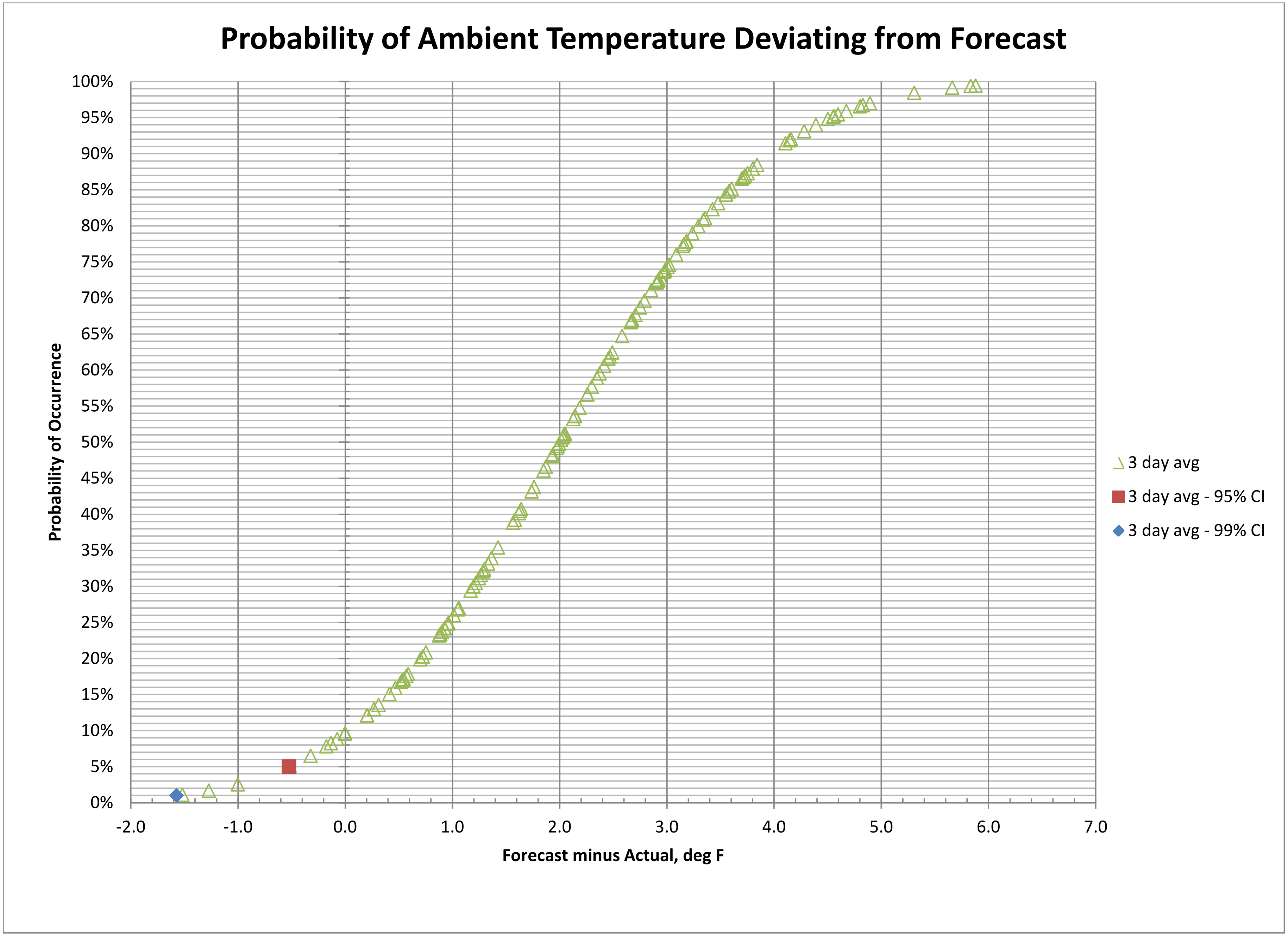
Forecast Date	Six Day Average		Three Day Average		24 hr High		7 day High	7 day Average		Deviation (forecast - actual)				Normal Distribution Probability			
	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Forecast	Actual	6day	3day	24 hr high	7 day	6day	3day	24 hr high	7 day

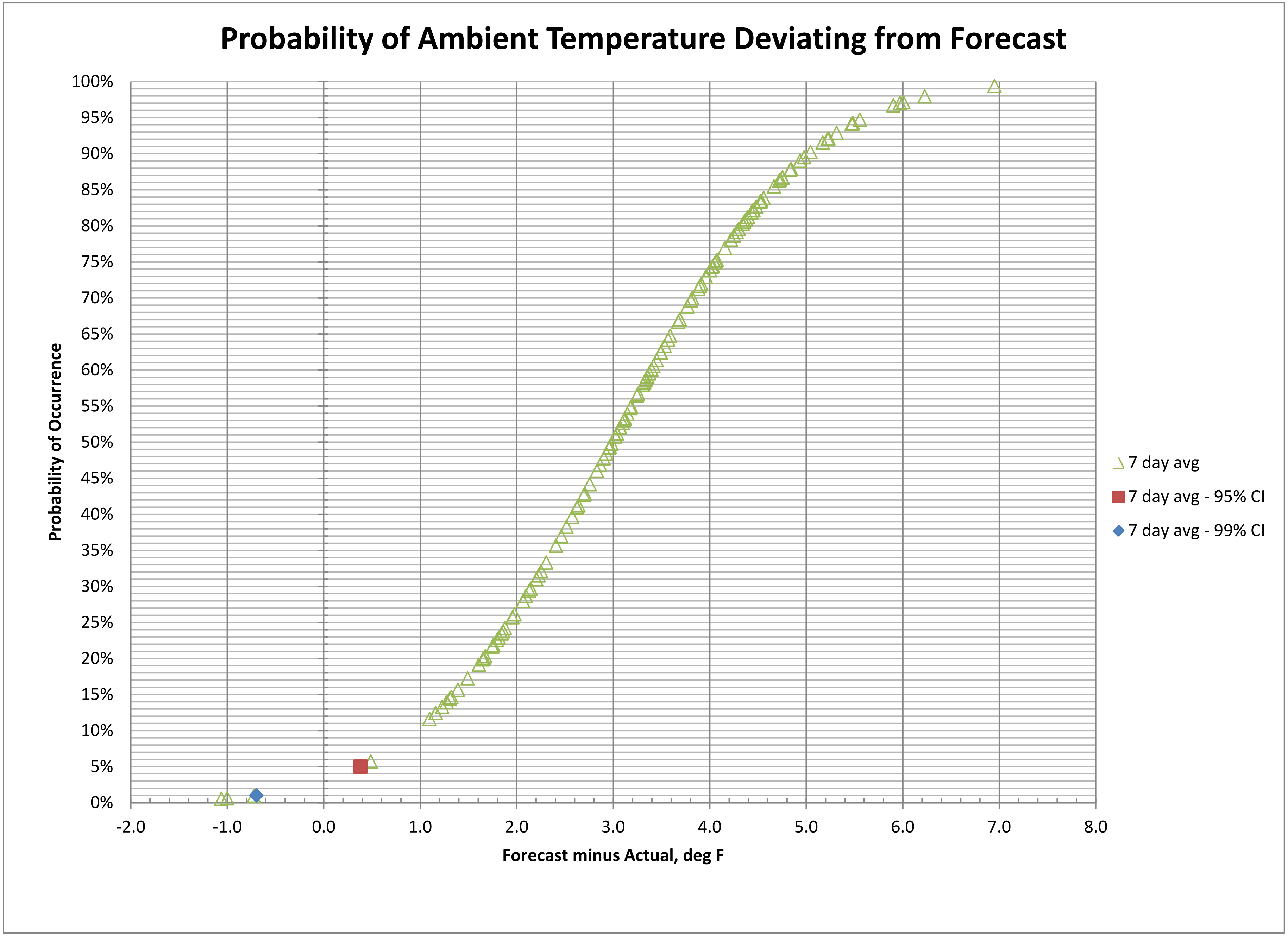
	6day	3day	24 hr high	7 day				
Average Deviation (positive indicates forecast is higher than actual)	1.9	2.0	2.9	3.0				
Median Deviation	2.0	2.0	3.0	3.1				
sample size	163	163	163	163				
successes	147	149	152	155				
percent conservative	90%	91%	93%	95%				
percent non-conservative	10%	9%	7%	5%				
Maximum Negative Deviation	-2.9	-1.5	-2.8	-1.1				
Average Negative Deviation	-1.0	-0.5	-0.9	-0.6				
stdev.s	1.5	1.5	2.0	1.6	Cumulative Probability			
					6day	3day	24 hr high	7 day
95% Confidence (forecast minus actual)	-0.7	-0.5	-0.4	0.4	5%	5%	5%	5%
99% Confidence (forecast minus actual)	-1.7	-1.6	-1.8	-0.7	1%	1%	1%	1%

Red indicates forecast deviation was negative.



Probability of Ambient Temperature Deviating from Forecast
Probability of Occurrence
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
-4.0
-3.0
-2.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Forecast minus Actual, deg F
24 hour high
24 hour high - 95% CI
24 hour high - 99% CI


Probability of Ambient Temperature Deviating from Forecast
Probability of Occurrence
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
-2.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Forecast minus Actual, deg F
3 day avg
3 day avg - 95% CI
3 day avg - 99% CI


Probability of Ambient Temperature Deviating from Forecast
Probability of Occurrence
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
-2.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Forecast minus Actual, deg F
7 day avg
7 day avg - 95% CI
7 day avg - 99% CI

Primary vs Backup Met Tower Temperatures

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
3/15/2018 12:00	63.8	61.7	62.1	61.3
3/15/2018 18:00	66.2	65.6	67.6	66.8
3/16/2018 0:00	57.3	58.2	57.3	57.8
3/16/2018 6:00	61.1	61.7	59.9	60.5
3/16/2018 12:00	72.3	71.8	70.4	69.8
3/16/2018 18:00	69.1	68.8	72.4	71.9
3/17/2018 0:00	65.6	65.1	65.7	65.1
3/17/2018 6:00	64.4	64.1	64.8	64.3
3/17/2018 12:00	75.7	75.7	74.1	73.5
3/17/2018 18:00	77.5	77.0	78.0	77.3
3/18/2018 0:00	68.1	67.5	68.4	67.8
3/18/2018 6:00	67.7	67.1	67.6	67.0
3/18/2018 12:00	78.2	77.8	76.6	76.1
3/18/2018 18:00	79.0	78.4	79.8	79.0
3/19/2018 0:00	69.6	69.3	69.9	69.4
3/19/2018 6:00	68.6	67.9	68.3	67.7
3/19/2018 12:00	77.3	76.7	77.7	76.8
3/19/2018 18:00	82.2	81.7	83.0	82.3
3/20/2018 0:00	69.0	68.6	69.9	69.5
3/20/2018 6:00	61.1	61.6	62.8	63.2
3/20/2018 12:00	62.5	61.0	60.5	59.8
3/20/2018 18:00	63.1	62.1	63.5	63.1
3/21/2018 0:00	52.6	52.2	53.3	53.8
3/21/2018 6:00	48.6	49.0	48.1	48.8
3/21/2018 12:00	61.6	61.4	60.2	59.5
3/21/2018 18:00	66.3	66.1	66.5	65.9
3/22/2018 0:00	56.1	55.8	57.5	57.0
3/22/2018 6:00	53.9	53.5	54.0	53.7
3/22/2018 12:00	59.7	59.0	59.3	58.9
3/22/2018 18:00	67.9	66.6	66.5	65.7
3/23/2018 0:00	52.8	53.3	53.9	53.8
3/23/2018 6:00	51.1	51.9	50.8	51.0
3/23/2018 12:00	69.7	68.8	68.7	68.1
3/23/2018 18:00	70.1	69.7	70.8	70.0
3/24/2018 0:00	63.1	62.4	62.7	62.3
3/24/2018 6:00	62.7	62.1	61.6	61.3
3/24/2018 12:00	77.8	75.8	74.8	74.2
3/24/2018 18:00	74.2	73.6	75.7	75.0
3/25/2018 0:00	65.7	65.3	65.9	65.5
3/25/2018 6:00	64.9	64.4	64.8	64.3
3/25/2018 12:00	78.9	77.2	77.1	76.2
3/25/2018 18:00	78.5	77.8	79.7	78.9
3/26/2018 0:00	66.2	66.0	66.5	66.2
3/26/2018 6:00	67.0	66.7	66.3	66.1

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
3/26/2018 12:00	78.4	79.8	77.1	78.0
3/26/2018 18:00	76.1	75.9	77.1	77.5
3/27/2018 0:00	70.3	70.0	70.6	70.1
3/27/2018 6:00	67.8	67.0	67.3	67.2
3/27/2018 12:00	74.7	75.3	73.7	74.4
3/27/2018 18:00	76.0	75.7	76.9	77.1
3/28/2018 0:00	72.2	71.9	72.4	72.2
3/28/2018 6:00	71.8	71.3	71.5	71.2
3/28/2018 12:00	78.8	80.1	77.6	78.6
3/28/2018 18:00	75.7	75.3	76.2	75.5
3/29/2018 0:00	71.8	71.5	72.1	71.8
3/29/2018 6:00	72.0	71.5	71.9	71.4
3/29/2018 12:00	60.8	60.2	60.8	60.1
3/29/2018 18:00	62.9	62.1	62.5	61.8
3/30/2018 0:00	59.5	58.6	59.8	59.3
3/30/2018 6:00	58.2	58.0	59.6	58.9
3/30/2018 12:00	64.0	62.6	63.5	62.6
3/30/2018 18:00	68.7	68.1	68.9	67.8
3/31/2018 0:00	63.5	62.7	63.5	63.0
3/31/2018 6:00	60.7	60.4	61.2	60.4
3/31/2018 12:00	68.6	67.7	67.4	66.4
3/31/2018 18:00	69.4	69.0	68.6	67.6
4/1/2018 0:00	60.2	60.3	60.5	61.2
4/1/2018 6:00	57.7	56.9	58.4	58.5
4/1/2018 12:00	68.3	66.9	66.4	65.9
4/1/2018 18:00	71.9	71.5	73.6	72.8
4/2/2018 0:00	62.2	61.9	62.8	62.6
4/2/2018 6:00	61.7	61.4	61.4	61.0
4/2/2018 12:00	77.3	76.5	76.2	75.4
4/2/2018 18:00	78.1	77.5	77.7	76.8
4/3/2018 0:00	69.5	68.9	69.3	68.8
4/3/2018 6:00	68.0	67.4	68.5	67.8
4/3/2018 12:00	79.6	79.2	79.4	78.8
4/3/2018 18:00	78.6	77.8	78.9	78.2
4/4/2018 0:00	71.4	70.9	71.5	71.1
4/4/2018 6:00	63.6	63.7	63.6	63.3
4/4/2018 12:00	59.2	59.0	57.7	57.3
4/4/2018 18:00	68.4	67.9	68.6	68.0
4/5/2018 0:00	58.6	58.5	60.3	60.0
4/5/2018 6:00	55.1	54.9	55.5	55.4
4/5/2018 12:00	61.6	60.9	61.3	60.4
4/5/2018 18:00	66.7	65.2	65.4	64.8
4/6/2018 0:00	62.1	60.9	62.0	60.9
4/6/2018 6:00	61.0	60.9	61.2	60.5
4/6/2018 12:00	72.9	72.3	72.1	71.5

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
4/6/2018 18:00	75.1	74.6	75.6	75.0
4/7/2018 0:00	69.8	69.2	70.3	69.6
4/7/2018 6:00	65.1	65.0	69.6	68.8
4/7/2018 12:00	69.1	68.8	68.8	68.2
4/7/2018 18:00	55.7	55.5	59.6	59.3
4/8/2018 0:00	48.2	48.0	49.1	48.6
4/8/2018 6:00	47.4	46.9	47.1	46.7
4/8/2018 12:00	50.5	49.7	49.7	49.3
4/8/2018 18:00	54.7	54.2	54.4	54.0
4/9/2018 0:00	56.7	56.1	55.8	55.3
4/9/2018 6:00	55.5	55.0	55.6	55.0
4/9/2018 12:00	61.2	60.5	60.5	60.0
4/9/2018 18:00	67.6	67.1	67.4	66.7
4/10/2018 0:00	65.2	63.9	65.6	64.2
4/10/2018 6:00	59.8	59.4	59.5	59.1
4/10/2018 12:00	66.9	65.7	66.2	65.5
4/10/2018 18:00	72.1	71.6	72.2	71.5
4/11/2018 0:00	61.4	61.0	62.5	62.0
4/11/2018 6:00	54.5	54.1	54.6	54.3
4/11/2018 12:00	61.5	60.7	60.6	60.0
4/11/2018 18:00	71.5	70.6	70.9	70.1
4/12/2018 0:00	56.7	56.9	57.3	57.8
4/12/2018 6:00	54.7	53.9	53.6	53.9
4/12/2018 12:00	72.6	72.3	72.0	70.9
4/12/2018 18:00	73.1	72.6	74.1	73.2
4/13/2018 0:00	66.2	66.3	66.2	66.4
4/13/2018 6:00	64.8	65.6	65.8	65.6
4/13/2018 12:00	77.3	75.7	76.1	75.5
4/13/2018 18:00	75.7	75.3	76.5	75.8
4/14/2018 0:00	73.8	73.1	73.9	73.3
4/14/2018 6:00	75.5	74.8	75.1	74.5
4/14/2018 12:00	61.6	60.8	61.6	61.0
4/14/2018 18:00	61.4	61.7	61.5	60.8
4/15/2018 0:00	54.9	55.0	56.7	56.7
4/15/2018 6:00	48.1	47.9	48.6	48.8
4/15/2018 12:00	53.1	53.0	52.8	52.1
4/15/2018 18:00	60.0	59.3	59.6	59.4
4/16/2018 0:00	51.4	52.6	51.0	52.2
4/16/2018 6:00	45.5	45.1	45.8	45.8
4/16/2018 12:00	62.9	61.3	59.9	59.3
4/16/2018 18:00	69.7	69.0	69.9	69.2
4/17/2018 0:00	57.3	56.4	56.9	55.9
4/17/2018 6:00	52.9	52.7	52.2	52.0
4/17/2018 12:00	74.5	73.2	72.4	71.5
4/17/2018 18:00	74.2	73.5	76.0	75.2

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
4/18/2018 0:00	61.1	60.6	61.3	60.8
4/18/2018 6:00	61.8	61.0	60.3	59.7
4/18/2018 12:00	76.1	74.2	74.2	73.5
4/18/2018 18:00	77.6	76.7	78.4	77.6
4/19/2018 0:00	65.6	65.6	66.4	66.3
4/19/2018 6:00	65.2	65.1	64.8	64.4
4/19/2018 12:00	69.4	68.9	68.3	67.4
4/19/2018 18:00	72.7	72.0	73.2	72.4
4/20/2018 0:00	58.4	58.2	59.7	59.3
4/20/2018 6:00	54.6	54.2	55.0	54.7
4/20/2018 12:00	58.5	58.4	58.0	57.3
4/20/2018 18:00	63.4	62.8	63.7	63.1
4/21/2018 0:00	54.7	55.6	56.9	57.3
4/21/2018 6:00	59.7	58.7	59.8	58.9
4/21/2018 12:00	71.8	72.4	70.8	70.2
4/21/2018 18:00	73.4	72.8	74.3	73.5
4/22/2018 0:00	69.2	69.0	69.3	69.0
4/22/2018 6:00	68.1	67.9	68.2	67.9
4/22/2018 12:00	72.6	72.1	72.5	71.8
4/22/2018 18:00	77.2	76.9	77.0	76.6
4/23/2018 0:00	61.4	60.9	62.4	61.7
4/23/2018 6:00	53.9	54.0	54.8	54.9
4/23/2018 12:00	67.0	66.0	65.8	65.0
4/23/2018 18:00	71.6	71.1	71.4	70.9
4/24/2018 0:00	62.5	62.9	63.5	62.8
4/24/2018 6:00	57.8	58.7	59.2	58.7
4/24/2018 12:00	72.0	71.3	71.0	70.2
4/24/2018 18:00	75.5	74.8	76.7	75.9
4/25/2018 0:00	65.3	64.5	66.0	65.8
4/25/2018 6:00	56.8	59.3	58.1	59.5
4/25/2018 12:00	74.4	73.5	71.5	70.7
4/25/2018 18:00	78.1	76.7	78.5	77.2
4/26/2018 0:00	67.8	67.6	68.0	67.9
4/26/2018 6:00	64.6	64.1	67.7	67.2
4/26/2018 12:00	68.2	66.6	67.1	66.1
4/26/2018 18:00	70.5	70.2	71.2	70.4
4/27/2018 0:00	59.4	58.4	60.3	59.6
4/27/2018 6:00	54.7	55.4	55.6	55.8
4/27/2018 12:00	67.8	67.0	67.1	66.5
4/27/2018 18:00	72.1	71.6	72.4	71.7
4/28/2018 0:00	63.6	63.8	64.7	63.4
4/28/2018 6:00	55.3	57.2	55.7	56.5
4/28/2018 12:00	74.0	74.0	73.3	72.8
4/28/2018 18:00	76.7	75.9	77.8	77.0
4/29/2018 0:00	64.9	64.9	65.7	65.7

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
4/29/2018 6:00	61.5	61.9	61.2	61.2
4/29/2018 12:00	74.8	72.9	72.7	71.7
4/29/2018 18:00	79.5	78.7	79.5	78.7
4/30/2018 0:00	68.2	68.6	67.8	68.2
4/30/2018 6:00	67.6	66.5	66.5	65.8
4/30/2018 12:00	76.3	73.5	75.8	74.4
4/30/2018 18:00	77.7	77.1	78.7	77.7
5/1/2018 0:00	66.9	66.7	66.5	66.9
5/1/2018 6:00	64.3	63.3	65.7	64.7
5/1/2018 12:00	78.5	77.5	78.1	77.3
5/1/2018 18:00	79.1	78.9	79.9	78.9
5/2/2018 0:00	71.9	71.6	72.4	72.0
5/2/2018 6:00	70.9	71.8	71.2	71.5
5/2/2018 12:00	84.8	82.1	82.2	81.5
5/2/2018 18:00	79.4	79.4	80.8	80.1
5/3/2018 0:00	72.2	71.9	72.4	72.2
5/3/2018 6:00	68.9	69.4	69.1	69.0
5/3/2018 12:00	80.1	77.9	78.2	77.5
5/3/2018 18:00	79.3	78.5	80.2	79.2
5/4/2018 0:00	72.0	71.7	72.5	72.2
5/4/2018 6:00	67.6	67.2	67.2	66.8
5/4/2018 12:00	80.8	79.8	79.3	78.3
5/4/2018 18:00	79.5	78.1	80.4	79.6
5/5/2018 0:00	71.1	70.7	71.6	71.3
5/5/2018 6:00	68.0	67.5	67.8	67.7
5/5/2018 12:00	74.6	73.9	78.0	77.4
5/5/2018 18:00	74.0	73.2	73.9	73.2
5/6/2018 0:00	67.6	66.9	68.6	67.9
5/6/2018 6:00	63.2	63.4	63.8	63.6
5/6/2018 12:00	76.5	75.9	76.1	75.3
5/6/2018 18:00	82.5	81.6	82.9	81.8
5/7/2018 0:00	67.7	68.3	70.8	71.3
5/7/2018 6:00	63.1	65.1	63.6	63.8
5/7/2018 12:00	82.9	82.1	81.3	80.3
5/7/2018 18:00	85.7	84.6	86.3	85.1
5/8/2018 0:00	71.2	70.3	71.6	71.4
5/8/2018 6:00	64.3	64.8	64.8	65.3
5/8/2018 12:00	81.7	81.3	81.0	80.0
5/8/2018 18:00	86.0	85.0	86.4	85.1
5/9/2018 0:00	73.6	73.8	73.1	73.0
5/9/2018 6:00	67.5	69.0	68.5	68.5
5/9/2018 12:00	84.9	82.2	82.7	81.6
5/9/2018 18:00	82.1	82.2	83.5	82.7
5/10/2018 0:00	68.8	69.0	69.5	69.6
5/10/2018 6:00	64.4	65.2	65.2	65.6

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
5/10/2018 12:00	82.6	81.8	82.4	81.5
5/10/2018 18:00	82.8	81.5	83.5	82.8
5/11/2018 0:00	69.5	69.4	69.8	69.7
5/11/2018 6:00	68.0	67.6	68.1	67.6
5/11/2018 12:00	83.5	84.1	83.2	82.4
5/11/2018 18:00	83.3	82.8	84.4	83.5
5/12/2018 0:00	71.8	73.0	71.5	71.6
5/12/2018 6:00	69.7	69.3	69.6	69.9
5/12/2018 12:00	82.1	82.3	81.8	81.3
5/12/2018 18:00	78.7	78.4	79.6	79.1
5/13/2018 0:00	73.9	74.0	74.7	74.4
5/13/2018 6:00	70.7	70.1	70.8	70.3
5/13/2018 12:00	82.0	80.5	81.4	80.5
5/13/2018 18:00	84.3	82.6	84.9	83.7
5/14/2018 0:00	73.8	74.4	74.1	74.2
5/14/2018 6:00	71.4	70.8	72.1	71.5
5/14/2018 12:00	85.1	84.3	84.3	83.4
5/14/2018 18:00	89.3	88.4	89.8	88.7
5/15/2018 0:00	79.9	79.8	80.0	79.2
5/15/2018 6:00	71.4	72.7	72.1	72.1
5/15/2018 12:00	85.8	86.0	85.8	84.7
5/15/2018 18:00	90.7	90.0	91.2	90.2
5/16/2018 0:00	76.4	75.7	77.6	77.0
5/16/2018 6:00	74.3	73.4	74.3	73.6
5/16/2018 12:00	88.1	86.9	86.3	85.4
5/16/2018 18:00	91.9	90.1	91.5	90.3
5/17/2018 0:00	76.2	76.6	77.1	77.4
5/17/2018 6:00	72.6	72.6	72.8	72.6
5/17/2018 12:00	87.7	88.2	86.3	85.2
5/17/2018 18:00	89.6	89.0	90.6	90.1
5/18/2018 0:00	76.5	76.7	77.2	77.1
5/18/2018 6:00	75.2	74.6	75.5	75.0
5/18/2018 12:00	86.2	85.6	85.3	84.4
5/18/2018 18:00	68.2	67.7	74.7	74.0
5/19/2018 0:00	70.6	70.4	70.8	70.4
5/19/2018 6:00	70.0	69.7	69.9	69.3
5/19/2018 12:00	84.4	84.2	83.8	82.9
5/19/2018 18:00	86.1	85.2	86.1	85.3
5/20/2018 0:00	74.4	74.7	75.7	75.5
5/20/2018 6:00	74.5	73.5	73.4	73.5
5/20/2018 12:00	85.7	85.1	84.8	84.3
5/20/2018 18:00	86.0	85.4	86.8	85.9
5/21/2018 0:00	74.7	74.9	75.8	75.8
5/21/2018 6:00	71.5	70.7	72.6	72.9
5/21/2018 12:00	80.5	80.1	81.2	80.4

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
5/21/2018 18:00	83.4	82.6	84.4	83.2
5/22/2018 0:00	74.5	74.5	75.0	74.9
5/22/2018 6:00	72.9	73.2	72.4	73.0
5/22/2018 12:00	83.5	82.3	83.2	82.0
5/22/2018 18:00	85.1	84.3	85.6	84.6
5/23/2018 0:00	75.6	74.7	76.0	76.0
5/23/2018 6:00	72.8	72.8	73.2	73.1
5/23/2018 12:00	84.0	85.3	83.7	82.6
5/23/2018 18:00	86.8	86.1	87.3	86.4
5/24/2018 0:00	76.5	75.5	77.5	77.1
5/24/2018 6:00	75.0	74.3	75.5	74.8
5/24/2018 12:00	82.0	82.2	81.6	80.5
5/24/2018 18:00	75.0	74.4	73.9	73.6
5/25/2018 0:00	76.5	76.0	75.4	75.2
5/25/2018 6:00	72.1	72.7	73.4	73.3
5/25/2018 12:00	80.7	79.9	80.5	79.9
5/25/2018 18:00	80.6	79.9	80.0	79.4
5/26/2018 0:00	73.6	72.8	74.2	74.4
5/26/2018 6:00	70.6	71.5	71.2	70.9
5/26/2018 12:00	82.5	82.2	82.5	81.4
5/26/2018 18:00	76.4	75.8	77.1	76.4
5/27/2018 0:00	74.7	74.5	75.2	75.1
5/27/2018 6:00	74.1	73.7	73.7	73.3
5/27/2018 12:00	81.5	80.5	80.8	80.0
5/27/2018 18:00	85.0	84.2	85.6	84.6
5/28/2018 0:00	75.2	75.5	77.3	77.4
5/28/2018 6:00	74.4	73.7	74.5	74.0
5/28/2018 12:00	84.4	82.8	82.6	81.7
5/28/2018 18:00	88.7	87.3	88.8	87.5
5/29/2018 0:00	76.2	77.0	79.3	79.3
5/29/2018 6:00	74.3	74.8	74.1	74.4
5/29/2018 12:00	86.6	86.1	86.5	85.8
5/29/2018 18:00	91.0	90.6	90.5	89.9
5/30/2018 0:00	79.3	78.9	80.5	79.9
5/30/2018 6:00	75.7	75.3	75.8	75.2
5/30/2018 12:00	86.6	88.0	86.7	85.6
5/30/2018 18:00	88.9	87.6	89.4	88.3
5/31/2018 0:00	76.9	76.3	77.0	76.5
5/31/2018 6:00	74.5	74.5	74.4	74.3
5/31/2018 12:00	87.2	86.0	86.5	85.6
5/31/2018 18:00	88.5	87.6	89.5	88.4
6/1/2018 0:00	76.7	76.1	77.2	76.7
6/1/2018 6:00	75.6	75.5	75.5	75.2
6/1/2018 12:00	88.3	87.1	87.6	86.9
6/1/2018 18:00	88.7	87.6	89.4	88.6

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
6/2/2018 0:00	77.8	77.7	78.9	78.5
6/2/2018 6:00	75.7	75.8	75.7	75.5
6/2/2018 12:00	87.5	86.3	86.9	86.3
6/2/2018 18:00	88.7	87.6	89.5	88.8
6/3/2018 0:00	79.7	79.4	80.4	80.1
6/3/2018 6:00	75.7	75.9	75.9	76.2
6/3/2018 12:00	87.5	87.7	87.2	86.7
6/3/2018 18:00	90.3	89.2	90.1	89.5
6/4/2018 0:00	80.6	80.2	81.2	80.8
6/4/2018 6:00	79.6	78.8	78.4	78.8
6/4/2018 12:00	84.9	83.6	83.9	83.1
6/4/2018 18:00	77.0	76.7	79.6	79.2
6/5/2018 0:00	74.7	74.3	75.1	74.7
6/5/2018 6:00	76.7	76.4	76.8	76.4
6/5/2018 12:00	87.5	87.3	85.9	85.6
6/5/2018 18:00	71.1	70.8	71.0	70.4
6/6/2018 0:00	69.0	69.5	69.4	69.5
6/6/2018 6:00	68.3	67.7	68.2	67.4
6/6/2018 12:00	78.9	78.1	77.2	76.9
6/6/2018 18:00	84.2	83.6	84.3	83.7
6/7/2018 0:00	74.7	75.5	75.1	75.7
6/7/2018 6:00	70.6	72.5	71.0	71.6
6/7/2018 12:00	84.9	84.3	84.3	83.5
6/7/2018 18:00	88.3	87.5	88.6	87.9
6/8/2018 0:00	84.0	83.5	83.0	83.0
6/8/2018 6:00	79.7	79.5	77.5	78.1
6/8/2018 12:00	86.0	85.1	85.2	84.4
6/8/2018 18:00	84.4	83.7	85.3	84.5
6/9/2018 0:00	74.8	76.1	75.9	75.7
6/9/2018 6:00	72.1	73.5	72.0	72.6
6/9/2018 12:00	85.9	84.8	85.5	84.6
6/9/2018 18:00	88.7	87.9	90.3	89.3
6/10/2018 0:00	76.1	75.7	76.9	76.4
6/10/2018 6:00	73.8	73.2	74.6	74.5
6/10/2018 12:00	76.2	75.9	84.3	83.5
6/10/2018 18:00	82.4	81.5	81.4	80.6
6/11/2018 0:00	73.0	72.3	73.9	73.7
6/11/2018 6:00	73.8	73.5	73.8	73.4
6/11/2018 12:00	86.5	86.8	84.6	83.9
6/11/2018 18:00	79.3	78.6	78.1	77.4
6/12/2018 0:00	76.1	75.9	76.0	75.8
6/12/2018 6:00	75.2	75.1	75.1	74.8
6/12/2018 12:00	87.3	86.4	87.0	86.1
6/12/2018 18:00	78.4	78.0	78.1	78.1
6/13/2018 0:00	70.3	69.8	69.9	69.6

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
6/13/2018 6:00	72.8	73.1	71.6	71.7
6/13/2018 12:00	85.6	84.7	84.6	83.6
6/13/2018 18:00	79.6	78.9	78.7	78.2
6/14/2018 0:00	74.2	73.7	74.3	74.2
6/14/2018 6:00	73.2	73.7	73.1	73.3
6/14/2018 12:00	85.5	84.9	83.4	82.9
6/14/2018 18:00	84.3	83.8	85.5	84.5
6/15/2018 0:00	75.9	76.2	76.2	76.4
6/15/2018 6:00	75.7	76.2	75.0	75.5
6/15/2018 12:00	84.4	83.3	85.5	84.7
6/15/2018 18:00	82.0	81.0	81.3	80.6
6/16/2018 0:00	76.5	76.5	76.6	76.2
6/16/2018 6:00	74.6	74.7	74.7	74.3
6/16/2018 12:00	82.0	80.1	83.3	82.5
6/16/2018 18:00	82.8	82.7	81.8	82.0
6/17/2018 0:00	78.0	78.4	78.9	79.7
6/17/2018 6:00	78.3	77.8	78.0	78.1
6/17/2018 12:00	85.5	84.3	84.7	84.0
6/17/2018 18:00	79.3	79.0	84.2	83.7
6/18/2018 0:00	80.9	80.0	81.0	79.8
6/18/2018 6:00	81.1	80.4	80.9	80.6
6/18/2018 12:00	75.8	75.3	76.7	76.0
6/18/2018 18:00	76.4	75.8	75.0	74.5
6/19/2018 0:00	80.1	79.0	80.1	79.1
6/19/2018 6:00	80.0	79.4	79.9	79.5
6/19/2018 12:00	86.8	86.1	85.7	85.2
6/19/2018 18:00	81.6	81.6	80.8	80.6
6/20/2018 0:00	77.7	77.2	77.9	77.7
6/20/2018 6:00	78.7	79.0	78.3	78.5
6/20/2018 12:00	87.0	85.7	86.4	85.5
6/20/2018 18:00	85.1	84.3	85.0	84.3
6/21/2018 0:00	77.1	76.8	77.7	77.5
6/21/2018 6:00	75.1	75.1	75.6	75.4
6/21/2018 12:00	87.2	85.5	85.3	84.4
6/21/2018 18:00	84.8	84.8	85.6	85.4
6/22/2018 0:00	78.3	77.8	78.6	78.3
6/22/2018 6:00	76.9	76.3	77.1	76.6
6/22/2018 12:00	86.8	86.4	86.5	85.7
6/22/2018 18:00	87.7	87.2	88.6	87.6
6/23/2018 0:00	76.5	76.1	76.5	75.9
6/23/2018 6:00	75.4	75.1	74.9	74.6
6/23/2018 12:00	88.6	87.4	87.8	86.8
6/23/2018 18:00	87.8	87.1	90.1	89.2
6/24/2018 0:00	76.8	76.4	77.8	77.1
6/24/2018 6:00	76.4	75.9	76.6	76.2

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
6/24/2018 12:00	89.1	88.5	87.5	86.7
6/24/2018 18:00	88.4	87.6	89.2	88.3
6/25/2018 0:00	77.3	77.2	77.9	77.4
6/25/2018 6:00	75.3	74.5	75.7	75.4
6/25/2018 12:00	89.7	88.0	87.6	87.0
6/25/2018 18:00	89.0	88.2	90.6	89.7
6/26/2018 0:00	78.3	78.4	79.2	78.9
6/26/2018 6:00	77.5	78.2	75.9	77.2
6/26/2018 12:00	86.3	85.8	86.0	85.6
6/26/2018 18:00	85.7	85.1	83.8	83.3
6/27/2018 0:00	78.5	78.7	78.6	78.5
6/27/2018 6:00	76.5	76.4	76.4	76.1
6/27/2018 12:00	88.7	87.1	87.7	87.0
6/27/2018 18:00	85.7	85.2	89.1	88.1
6/28/2018 0:00	78.9	78.3	79.3	78.8
6/28/2018 6:00	76.5	76.0	76.4	76.0
6/28/2018 12:00	88.4	86.7	87.9	86.9
6/28/2018 18:00	89.1	88.6	90.8	90.0
6/29/2018 0:00	80.8	80.9	81.1	80.8
6/29/2018 6:00	78.2	78.7	78.5	79.2
6/29/2018 12:00	88.3	87.8	86.9	86.3
6/29/2018 18:00	92.4	91.5	92.4	91.7
6/30/2018 0:00	76.0	75.9	75.8	75.7
6/30/2018 6:00	76.5	77.4	76.3	76.6
6/30/2018 12:00	88.1	88.6	87.3	86.3
6/30/2018 18:00	84.0	83.3	86.5	85.8
7/1/2018 0:00	74.9	74.1	79.1	78.7
7/1/2018 6:00	73.5	73.7	73.6	73.6
7/1/2018 12:00	87.8	86.3	86.2	85.6
7/1/2018 18:00	84.1	83.5	87.8	86.8
7/2/2018 0:00	77.3	76.3	79.9	79.6
7/2/2018 6:00	75.7	76.0	75.7	76.4
7/2/2018 12:00	87.4	86.5	86.5	86.0
7/2/2018 18:00	77.9	77.4	79.1	79.2
7/3/2018 0:00	75.2	74.9	76.2	76.2
7/3/2018 6:00	75.8	75.5	75.8	75.6
7/3/2018 12:00	80.3	79.6	78.6	78.1
7/3/2018 18:00	77.3	76.7	77.4	76.8
7/4/2018 0:00	74.9	74.7	75.3	75.1
7/4/2018 6:00	76.5	77.2	76.5	76.4
7/4/2018 12:00	86.9	86.1	85.2	84.3
7/4/2018 18:00	85.6	84.8	80.8	79.6
7/5/2018 0:00	78.0	77.7	77.5	77.8
7/5/2018 6:00	76.5	77.4	75.9	76.9
7/5/2018 12:00	85.1	83.8	83.9	83.2

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
7/5/2018 18:00	83.7	82.9	82.9	82.1
7/6/2018 0:00	79.5	79.0	79.5	79.6
7/6/2018 6:00	79.1	77.8	78.4	77.8
7/6/2018 12:00	74.8	74.2	79.4	78.7
7/6/2018 18:00	82.5	81.7	79.8	78.8
7/7/2018 0:00	75.0	75.4	75.5	76.6
7/7/2018 6:00	76.0	75.8	76.4	76.2
7/7/2018 12:00	77.9	77.8	75.0	75.0
7/7/2018 18:00	85.2	84.1	85.8	84.8
7/8/2018 0:00	75.2	75.0	75.3	75.6
7/8/2018 6:00	73.5	73.0	74.0	73.5
7/8/2018 12:00	83.9	83.2	81.5	80.6
7/8/2018 18:00	82.8	81.7	80.5	80.1
7/9/2018 0:00	74.1	73.7	74.2	73.9
7/9/2018 6:00	73.0	74.6	73.9	74.0
7/9/2018 12:00	87.2	85.2	85.9	85.0
7/9/2018 18:00	76.1	75.2	75.6	75.2
7/10/2018 0:00	74.0	74.4	74.7	75.1
7/10/2018 6:00	73.4	73.5	73.4	74.2
7/10/2018 12:00	83.8	83.4	83.4	83.2
7/10/2018 18:00	82.8	81.9	88.3	87.2
7/11/2018 0:00	78.6	78.3	79.7	79.4
7/11/2018 6:00	76.7	77.3	76.2	76.6
7/11/2018 12:00	86.0	86.1	85.9	85.4
7/11/2018 18:00	76.5	75.9	76.3	76.0
7/12/2018 0:00	73.8	73.5	74.0	73.6
7/12/2018 6:00	73.6	73.7	74.6	75.1
7/12/2018 12:00	85.7	84.8	84.4	83.5
7/12/2018 18:00	89.3	88.2		
7/13/2018 0:00	78.6	78.6	79.2	79.1
7/13/2018 6:00	74.2	75.1	75.1	75.3
7/13/2018 12:00	86.4	87.4	85.6	85.0
7/13/2018 18:00	89.2	88.3	88.4	87.3
7/14/2018 0:00	78.1	77.8	77.6	77.4
7/14/2018 6:00	76.9	76.6	76.9	76.6
7/14/2018 12:00	88.5	86.8	87.5	86.4
7/14/2018 18:00	84.1	83.3	89.8	88.8
7/15/2018 0:00	79.5	79.3	80.4	80.3
7/15/2018 6:00	76.8	77.3	77.2	77.1
7/15/2018 12:00	88.4	86.1	86.5	85.8
7/15/2018 18:00	89.9	89.7	89.7	88.7
7/16/2018 0:00	79.1	79.3	78.9	79.0
7/16/2018 6:00	77.7	77.5	78.1	77.9
7/16/2018 12:00	89.3	89.0	87.4	87.0
7/16/2018 18:00	78.2	77.8	76.6	76.3

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
7/17/2018 0:00	73.8	73.1	73.7	73.1
7/17/2018 6:00	77.8	77.8	76.6	76.5
7/17/2018 12:00	83.5	83.1	82.1	81.6
7/17/2018 18:00	82.4	81.7	82.5	82.2
7/18/2018 0:00	78.6	78.0	78.1	77.4
7/18/2018 6:00	79.1	78.8	79.2	79.1
7/18/2018 12:00	83.0	82.9	81.9	81.9
7/18/2018 18:00	78.4	77.9	78.1	77.7
7/19/2018 0:00	74.2	73.4	74.5	73.8
7/19/2018 6:00	75.7	74.8	75.4	74.7
7/19/2018 12:00	85.4	85.1	84.8	84.4
7/19/2018 18:00	90.3	89.6	90.4	89.8
7/20/2018 0:00	80.6	80.4	81.2	80.7
7/20/2018 6:00	77.3	76.8	77.3	77.0
7/20/2018 12:00	88.5	88.0	87.7	86.9
7/20/2018 18:00	92.5	92.2	92.9	92.4
7/21/2018 0:00	88.1	87.8	89.3	88.8
7/21/2018 6:00	88.5	88.4	88.7	88.1
7/21/2018 12:00	88.8	88.9	88.1	87.5
7/21/2018 18:00	91.1	90.9	91.9	91.2
7/22/2018 0:00	81.4	80.9	81.9	81.4
7/22/2018 6:00	80.6	80.2	81.2	80.7
7/22/2018 12:00	91.1	90.3	89.6	89.2
7/22/2018 18:00	91.8	91.4	93.1	92.9
7/23/2018 0:00	82.9	82.4	83.2	82.7
7/23/2018 6:00	80.8	80.4	80.7	80.4
7/23/2018 12:00	87.1	87.5	85.7	85.2
7/23/2018 18:00	86.8	86.1	86.8	85.9
7/24/2018 0:00	78.7	78.5	77.2	77.8
7/24/2018 6:00	76.8	76.5	77.3	76.9
7/24/2018 12:00	85.6	83.5	83.6	82.8
7/24/2018 18:00	88.2	87.7	88.8	88.2
7/25/2018 0:00	81.3	80.7	81.8	81.4
7/25/2018 6:00	76.7	76.1	77.0	76.6
7/25/2018 12:00	84.2	83.9	83.5	83.0
7/25/2018 18:00	87.9	87.3	88.2	87.4
7/26/2018 0:00	79.4	79.5	81.4	82.6
7/26/2018 6:00	78.5	78.0	78.9	78.5
7/26/2018 12:00	86.7	86.1	86.2	85.5
7/26/2018 18:00	89.9	89.1	90.3	89.5
7/27/2018 0:00	78.2	78.2	78.2	78.2
7/27/2018 6:00	77.4	77.0	75.4	75.7
7/27/2018 12:00	87.2	86.6	87.0	86.3
7/27/2018 18:00	84.4	83.0	88.1	87.1
7/28/2018 0:00	75.7	74.9	76.4	76.4

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
7/28/2018 6:00	76.2	76.2	76.3	76.2
7/28/2018 12:00	88.0	87.3	87.3	86.6
7/28/2018 18:00	86.8	86.0	89.7	88.8
7/29/2018 0:00	79.3	78.7	76.6	76.8
7/29/2018 6:00	76.0	76.7	75.6	76.1
7/29/2018 12:00	85.5	84.6	84.2	83.5
7/29/2018 18:00	80.9	80.5	82.3	81.6
7/30/2018 0:00	76.2	76.1	76.9	76.8
7/30/2018 6:00	75.7	75.2	75.1	75.2
7/30/2018 12:00	85.3	85.8	84.6	84.4
7/30/2018 18:00	88.7	86.5	87.8	85.8
7/31/2018 0:00	76.5	78.5	77.8	78.0
7/31/2018 6:00	74.2	75.9	74.7	75.6
7/31/2018 12:00	76.5	76.0	85.0	83.4
7/31/2018 18:00	78.4	77.7	80.2	79.0
8/1/2018 0:00	76.2	77.0	76.1	76.4
8/1/2018 6:00	73.8	74.5	73.0	75.1
8/1/2018 12:00	83.3	81.7	82.3	81.0
8/1/2018 18:00	84.2	84.2	86.0	84.6
8/2/2018 0:00	72.6	74.2	73.6	73.6
8/2/2018 6:00	72.8	74.0	73.0	73.5
8/2/2018 12:00	83.7	81.1	83.4	81.1
8/2/2018 18:00	85.2	83.4	86.4	85.0
8/3/2018 0:00	74.3	77.5	74.8	77.3
8/3/2018 6:00	75.3	77.5	72.6	77.0
8/3/2018 12:00	84.1	82.9	82.9	81.6
8/3/2018 18:00	83.5	82.7	83.3	82.5
8/4/2018 0:00	77.2	77.3	76.9	76.7
8/4/2018 6:00	77.9	77.5	76.8	76.8
8/4/2018 12:00	77.3	76.9	77.2	76.1
8/4/2018 18:00	83.4	82.6	84.2	83.6
8/5/2018 0:00	75.0	78.0	77.3	78.6
8/5/2018 6:00	77.3	77.7	78.9	78.5
8/5/2018 12:00	84.4	83.4	85.6	84.3
8/5/2018 18:00	85.6	85.2	86.4	85.7
8/6/2018 0:00	79.5	79.7	78.5	78.6
8/6/2018 6:00	80.5	79.9	79.7	79.8
8/6/2018 12:00	87.5	85.7	86.6	85.3
8/6/2018 18:00	82.7	82.5	81.1	81.0
8/7/2018 0:00	78.8	77.8	78.9	79.6
8/7/2018 6:00	76.3	77.7	76.7	77.0
8/7/2018 12:00	84.8	84.0	85.1	84.3
8/7/2018 18:00	83.5	82.3	86.8	85.7
8/8/2018 0:00	71.8	74.4	73.3	73.1
8/8/2018 6:00	76.2	76.1	72.8	74.1

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
8/8/2018 12:00	85.1	84.7	84.5	83.6
8/8/2018 18:00	86.3	85.7	87.5	86.7
8/9/2018 0:00	77.8	77.9	77.6	78.1
8/9/2018 6:00	75.0	75.4	75.1	75.1
8/9/2018 12:00	87.6	87.3	87.0	86.3
8/9/2018 18:00	81.3	80.6	80.8	80.2
8/10/2018 0:00	74.7	74.5	75.3	74.8
8/10/2018 6:00	76.1	76.0	75.9	75.7
8/10/2018 12:00	76.9	76.5	81.9	81.1
8/10/2018 18:00	79.4	79.0	78.7	78.6
8/11/2018 0:00	75.9	75.7	75.7	75.3
8/11/2018 6:00	73.7	74.2	74.4	74.4
8/11/2018 12:00	87.7	86.9	86.1	85.6
8/11/2018 18:00	80.3	79.9	80.2	79.8
8/12/2018 0:00	76.5	76.1	76.5	76.3
8/12/2018 6:00	74.5	74.0	74.5	74.2
8/12/2018 12:00	86.0	85.2	84.9	84.5
8/12/2018 18:00	89.8	89.8	90.6	90.5
8/13/2018 0:00	81.9	81.2	83.0	82.7
8/13/2018 6:00	76.4	76.1	74.7	75.1
8/13/2018 12:00	86.6	85.6	85.3	84.7
8/13/2018 18:00	87.9	87.6	87.9	87.1
8/14/2018 0:00	78.5	78.4	78.0	77.6
8/14/2018 6:00	76.9	76.0	76.7	77.4
8/14/2018 12:00	87.8	86.6	86.2	85.5
8/14/2018 18:00	90.7	89.4	90.5	89.9
8/15/2018 0:00	76.8	76.1	77.0	76.3
8/15/2018 6:00	76.5	76.8	75.4	76.0
8/15/2018 12:00	88.2	87.1	86.8	86.2
8/15/2018 18:00	79.9	79.3	79.7	79.1
8/16/2018 0:00	77.3	77.1	77.5	77.1
8/16/2018 6:00	76.9	76.6	77.2	76.7
8/16/2018 12:00	83.1	82.4	85.0	84.3
8/16/2018 18:00				
8/17/2018 0:00	77.4	77.0	76.8	76.4
8/17/2018 6:00	76.4	75.7	77.0	76.5
8/17/2018 12:00	82.8	82.1	86.7	85.2
8/17/2018 18:00	77.9	77.2	79.0	78.5
8/18/2018 0:00	75.8	75.0	75.9	75.9
8/18/2018 6:00	75.5	75.2	75.4	75.4
8/18/2018 12:00	88.3	86.2	86.6	85.9
8/18/2018 18:00	78.9	78.1	77.9	77.3
8/19/2018 0:00	76.3	75.5	76.0	75.4
8/19/2018 6:00	76.1	75.4	76.4	75.7
8/19/2018 12:00	78.9	78.4	79.2	78.5

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
8/19/2018 18:00	75.4	74.7	74.6	74.1
8/20/2018 0:00	74.6	73.9	75.3	74.7
8/20/2018 6:00	75.9	75.4	75.6	75.1
8/20/2018 12:00	88.0	86.9	86.8	86.1
8/20/2018 18:00	76.6	76.1	78.8	78.1
8/21/2018 0:00	76.5	76.1	76.1	75.4
8/21/2018 6:00	77.5	76.9	76.6	76.0
8/21/2018 12:00	88.5	87.8	87.2	86.9
8/21/2018 18:00	90.4	90.4	91.0	90.7
8/22/2018 0:00	90.4	90.4	91.0	90.7
8/22/2018 6:00	90.4	90.4	91.0	90.7
8/22/2018 12:00	83.7	84.2	83.5	82.9
8/22/2018 18:00	87.7	87.7	88.7	88.1
8/23/2018 0:00	80.3	80.0	81.0	80.9
8/23/2018 6:00	77.1	76.8	76.8	76.5
8/23/2018 12:00	82.3	82.0	81.9	81.2
8/23/2018 18:00	84.7	84.4	85.1	84.6
8/24/2018 0:00	78.2	80.0	79.9	81.8
8/24/2018 6:00	73.3	74.3	73.3	74.5
8/24/2018 12:00	84.3	83.7	82.9	82.8
8/24/2018 18:00	85.7	85.5	86.5	85.9
8/25/2018 0:00	77.5	77.3	77.7	77.6
8/25/2018 6:00	76.9	77.7	77.5	78.1
8/25/2018 12:00	85.6	84.4	85.3	84.6
8/25/2018 18:00	86.6	85.9	87.1	86.5
8/26/2018 0:00	81.7	81.5	81.6	81.6
8/26/2018 6:00	79.7	79.7	80.3	80.4
8/26/2018 12:00	85.3	83.8	86.5	85.7
8/26/2018 18:00	80.9	80.2	79.5	79.1
8/27/2018 0:00	80.7	80.3	81.1	81.3
8/27/2018 6:00	79.7	79.5	79.2	79.2
8/27/2018 12:00	88.4	86.5	86.4	85.1
8/27/2018 18:00	81.9	82.1	82.3	81.7
8/28/2018 0:00	79.9	79.5	79.2	79.1
8/28/2018 6:00	75.6	75.9	76.8	76.8
8/28/2018 12:00	80.1	79.4	80.3	79.4
8/28/2018 18:00	79.4	78.9	78.5	78.2
8/29/2018 0:00	78.3	78.2	78.8	79.1
8/29/2018 6:00	79.3	78.0	78.3	78.7
8/29/2018 12:00	77.0	77.0	85.1	83.5
8/29/2018 18:00	80.8	80.2	81.3	80.7
8/30/2018 0:00	75.9	76.6	77.4	77.8
8/30/2018 6:00	74.5	76.2	75.2	76.5
8/30/2018 12:00	77.8	78.0	76.6	76.9
8/30/2018 18:00	82.9	81.9	82.6	81.6

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
8/31/2018 0:00	78.7	78.4	79.2	78.5
8/31/2018 6:00	75.7	77.7	76.6	77.0
8/31/2018 12:00	78.9	78.2	79.2	78.4
8/31/2018 18:00	80.1	79.6	79.6	79.0
9/1/2018 0:00	79.1	78.1	78.9	78.2
9/1/2018 6:00	77.7	77.5	78.2	77.1
9/1/2018 12:00	81.7	81.4	81.9	80.9
9/1/2018 18:00	77.6	76.9	80.2	79.2
9/2/2018 0:00	77.2	76.6	76.7	76.3
9/2/2018 6:00	76.9	76.4	76.6	76.2
9/2/2018 12:00	76.3	75.6	74.5	74.1
9/2/2018 18:00	80.1	80.2	80.1	79.6
9/3/2018 0:00	77.8	77.2	77.2	76.8
9/3/2018 6:00	80.1	78.5	79.6	78.2
9/3/2018 12:00	84.8	83.9	85.1	84.6
9/3/2018 18:00	79.7	81.8	80.0	79.7
9/4/2018 0:00	80.3	79.5	80.1	79.2
9/4/2018 6:00	77.7	77.5	78.8	78.0
9/4/2018 12:00	80.0	79.6	80.8	79.8
9/4/2018 18:00	80.6	79.6	83.2	82.4
9/5/2018 0:00	75.5	75.6	76.4	76.1
9/5/2018 6:00	71.3	71.6	71.5	71.3
9/5/2018 12:00	83.3	82.1	81.7	81.1
9/5/2018 18:00	85.3	85.3	87.0	86.4
9/6/2018 0:00	77.3	76.7	77.4	76.7
9/6/2018 6:00	76.6	76.1	76.4	75.8
9/6/2018 12:00	72.8	72.2	79.5	78.9
9/6/2018 18:00	82.4	81.7	83.0	82.1
9/7/2018 0:00	75.7	75.3	76.0	75.7
9/7/2018 6:00	75.1	76.4	75.1	75.3
9/7/2018 12:00	80.5	79.5	81.5	80.8
9/7/2018 18:00	81.1	80.1	80.8	80.3
9/8/2018 0:00	74.9	74.9	75.9	75.7
9/8/2018 6:00	73.3	74.6	76.1	75.7
9/8/2018 12:00	84.0	83.6	83.2	82.5
9/8/2018 18:00	79.6	79.1	83.0	82.5
9/9/2018 0:00	75.7	75.2	75.9	75.6
9/9/2018 6:00	74.2	73.8	74.4	74.0
9/9/2018 12:00	85.2	84.4	84.0	83.4
9/9/2018 18:00	84.0	83.6	85.4	84.8
9/10/2018 0:00	78.5	78.5	77.7	77.9
9/10/2018 6:00	74.1	74.3	74.7	75.1
9/10/2018 12:00	85.7	84.8	84.1	83.4
9/10/2018 18:00	76.1	75.9	76.7	76.1
9/11/2018 0:00	76.3	75.7	75.5	75.3

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
9/11/2018 6:00	75.8	77.2	75.6	75.9
9/11/2018 12:00	82.5	80.7	79.7	78.8
9/11/2018 18:00	78.3	77.8	78.3	77.8
9/12/2018 0:00	77.5	77.4	78.2	77.3
9/12/2018 6:00	78.3	77.8	76.7	76.7
9/12/2018 12:00	83.5	83.2	83.3	82.5
9/12/2018 18:00	84.6	84.3	85.6	84.8
9/13/2018 0:00	79.7	80.0	80.6	80.3
9/13/2018 6:00	79.7	80.0	80.1	79.6
9/13/2018 12:00	85.1	84.4	86.7	85.4
9/13/2018 18:00	82.8	81.9	83.7	82.8
9/14/2018 0:00	76.9	76.5	77.9	78.7
9/14/2018 6:00	76.7	75.7	75.3	75.7
9/14/2018 12:00	84.9	84.2	84.2	83.4
9/14/2018 18:00	86.9	86.8	89.7	89.1
9/15/2018 0:00	77.5	78.1	78.3	78.6
9/15/2018 6:00	76.0	76.2	76.5	76.6
9/15/2018 12:00	88.3	86.7	86.4	86.0
9/15/2018 18:00	91.7	91.1	91.9	91.3
9/16/2018 0:00	77.5	78.4	78.7	78.9
9/16/2018 6:00	75.4	76.8	76.0	76.3
9/16/2018 12:00	89.2	88.8	88.0	87.3
9/16/2018 18:00	90.0	89.9	91.9	91.7
9/17/2018 0:00	76.8	76.6	77.7	77.7
9/17/2018 6:00	75.5	74.8	75.5	76.4
9/17/2018 12:00	88.3	88.1	87.8	88.6
9/17/2018 18:00	82.4	82.1	84.5	84.1
9/18/2018 0:00	78.0	75.5	77.7	75.4
9/18/2018 6:00	75.5	74.0	76.3	74.4
9/18/2018 12:00	92.6	89.3	89.0	89.2
9/18/2018 18:00	84.1	84.5	86.8	86.3
9/19/2018 0:00	77.4	74.8	77.6	75.3
9/19/2018 6:00	77.2	74.2	77.5	75.1
9/19/2018 12:00	88.7	89.9	87.2	88.4
9/19/2018 18:00	84.2	83.6	87.0	86.1
9/20/2018 0:00	76.1	76.5	76.3	77.1
9/20/2018 6:00	75.5	76.4	73.8	74.9
9/20/2018 12:00	85.8	85.5	85.7	85.0
9/20/2018 18:00	77.8	77.4	81.2	80.5
9/21/2018 0:00	76.6	77.3	76.5	76.4
9/21/2018 6:00	79.7	79.3	78.8	79.3
9/21/2018 12:00	88.2	87.7	87.5	86.7
9/21/2018 18:00	80.0	79.4	80.7	80.3
9/22/2018 0:00	78.1	77.3	78.4	77.3
9/22/2018 6:00	77.8	77.8	77.6	78.5

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
9/22/2018 12:00	87.7	86.8	86.4	85.8
9/22/2018 18:00	74.0	73.7	74.2	73.9
9/23/2018 0:00	75.2	75.8	75.2	76.1
9/23/2018 6:00	75.5	75.7	75.2	75.4
9/23/2018 12:00	86.8	86.2	86.3	85.3
9/23/2018 18:00	78.5	78.4	78.4	78.4
9/24/2018 0:00	77.0	77.1	77.8	78.7
9/24/2018 6:00	75.4	75.3	75.6	75.3
9/24/2018 12:00	83.7	82.5	82.0	81.2
9/24/2018 18:00	83.6	83.0	85.0	84.4
9/25/2018 0:00	76.2	75.9	76.2	75.8
9/25/2018 6:00	76.0	75.3	75.6	75.4
9/25/2018 12:00	83.9	83.4	83.1	82.8
9/25/2018 18:00	79.2	77.8	78.7	78.3
9/26/2018 0:00	77.2	76.2	76.0	75.4
9/26/2018 6:00	73.4	72.9	76.6	75.8
9/26/2018 12:00	77.3	77.0	76.6	76.2
9/26/2018 18:00	79.3	78.7	79.7	79.5
9/27/2018 0:00	74.2	74.5	74.5	74.0
9/27/2018 6:00	74.2	73.8	74.0	73.5
9/27/2018 12:00	75.9	75.6	77.0	76.5
9/27/2018 18:00	73.9	73.2	73.5	73.1
9/28/2018 0:00	72.9	72.4	73.1	72.3
9/28/2018 6:00	73.5	73.1	73.5	73.1
9/28/2018 12:00	79.4	79.0	78.9	78.2
9/28/2018 18:00	72.9	72.8	76.8	76.4
9/29/2018 0:00	77.1	76.6	77.4	76.6
9/29/2018 6:00	76.4	75.9	76.4	75.9
9/29/2018 12:00	78.7	77.6	78.0	77.0
9/29/2018 18:00	80.1	79.6	80.4	79.7
9/30/2018 0:00	75.0	74.4	74.7	74.4
9/30/2018 6:00	78.5	77.5	78.4	77.8
9/30/2018 12:00	81.0	80.5	80.7	80.0
9/30/2018 18:00	71.1	71.2	70.5	70.8
10/1/2018 0:00	77.5	76.9	78.1	77.4
10/1/2018 6:00	77.2	77.3	77.6	76.9
10/1/2018 12:00	82.9	81.8	83.9	82.9
10/1/2018 18:00	77.5	76.9	77.9	77.7
10/2/2018 0:00	79.7	79.2	79.7	78.7
10/2/2018 6:00	78.5	78.0	78.3	78.2
10/2/2018 12:00	83.8	83.8	83.0	82.3
10/2/2018 18:00	86.0	84.7	85.8	84.9
10/3/2018 0:00	78.6	79.4	79.3	78.8
10/3/2018 6:00	75.0	76.8	77.3	76.5
10/3/2018 12:00	83.1	82.5	84.3	82.7

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
10/3/2018 18:00	84.1	83.6	84.5	84.0
10/4/2018 0:00	78.1	77.9	79.2	79.2
10/4/2018 6:00	77.1	76.3	77.8	77.1
10/4/2018 12:00	82.7	82.0	84.4	83.4
10/4/2018 18:00	84.7	83.9	84.2	83.8
10/5/2018 0:00	84.7	83.9	84.2	83.8
10/5/2018 6:00	84.7	83.9	84.2	83.8
10/5/2018 12:00	84.7	83.9	84.2	83.8
10/5/2018 18:00	84.7	83.9	84.2	83.8
10/6/2018 0:00	84.7	83.9	84.2	83.8
10/6/2018 6:00	84.7	83.9	84.2	83.8
10/6/2018 12:00	84.7	83.9	84.2	83.8
10/6/2018 18:00	84.7	83.9	84.2	83.8
10/7/2018 0:00	84.7	83.9	84.2	83.8
10/7/2018 6:00	84.7	83.9	84.2	83.8
10/7/2018 12:00	84.7	83.9	84.2	83.8
10/7/2018 18:00	84.7	83.9	84.2	83.8
10/8/2018 0:00	84.7	83.9	84.2	83.8
10/8/2018 6:00	84.7	83.9	84.2	83.8
10/8/2018 12:00	79.3	78.7	80.0	79.2
10/8/2018 18:00	80.1	79.4	80.6	79.4
10/9/2018 0:00	77.4	76.9	76.7	76.0
10/9/2018 6:00	77.8	76.9	78.2	77.3
10/9/2018 12:00	79.4	78.7	79.3	78.6
10/9/2018 18:00	82.2	81.2	82.2	81.3
10/10/2018 0:00	77.5	77.3	77.8	77.4
10/10/2018 6:00	76.0	75.3	75.3	74.9
10/10/2018 12:00	83.7	84.3	82.2	81.4
10/10/2018 18:00	83.5	82.6	84.4	83.7
10/11/2018 0:00	72.7	72.1	73.9	73.4
10/11/2018 6:00	68.2	68.2	68.7	68.8
10/11/2018 12:00	74.7	74.5	73.4	72.8
10/11/2018 18:00	77.2	76.4	78.3	77.9
10/12/2018 0:00	67.2	67.2	67.1	67.2
10/12/2018 6:00	63.7	63.2	63.3	63.2
10/12/2018 12:00	70.0	69.0	69.2	68.6
10/12/2018 18:00	71.8	71.9	75.0	74.3
10/13/2018 0:00	65.3	66.5	64.9	66.5
10/13/2018 6:00	62.9	64.0	64.9	65.4
10/13/2018 12:00	80.0	79.0	77.8	77.7
10/13/2018 18:00	78.4	77.9	80.0	79.4
10/14/2018 0:00	70.5	71.4	71.6	73.1
10/14/2018 6:00	72.8	73.3	72.4	72.2
10/14/2018 12:00	83.8	83.7	82.9	82.2
10/14/2018 18:00	81.3	81.0	83.1	82.5

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
10/15/2018 0:00	75.8	75.6	75.8	76.0
10/15/2018 6:00	74.0	75.5	74.8	75.8
10/15/2018 12:00	86.6	85.5	85.2	84.4
10/15/2018 18:00	76.6	76.2	78.2	77.5
10/16/2018 0:00	74.3	73.8	75.5	74.9
10/16/2018 6:00	75.0	74.4	74.6	74.0
10/16/2018 12:00	84.8	84.1	83.3	82.8
10/16/2018 18:00	81.6	81.3	83.3	82.7
10/17/2018 0:00	72.7	72.2	72.9	72.4
10/17/2018 6:00	71.1	70.4	71.3	70.9
10/17/2018 12:00	70.6	70.1	70.7	70.1
10/17/2018 18:00	72.8	72.2	72.8	72.3
10/18/2018 0:00	70.0	69.5	70.3	69.9
10/18/2018 6:00	65.3	64.9	65.6	65.2
10/18/2018 12:00	71.5	70.5	70.8	70.0
10/18/2018 18:00	75.6	75.4	76.5	75.9
10/19/2018 0:00	71.2	71.1	72.3	71.9
10/19/2018 6:00	68.7	68.2	68.6	68.2
10/19/2018 12:00	80.3	79.8	79.0	78.0
10/19/2018 18:00	79.5	78.5	79.6	79.1
10/20/2018 0:00	72.2	73.8	74.8	73.9
10/20/2018 6:00	70.6	72.5	72.5	72.3
10/20/2018 12:00	81.8	81.3	81.8	81.2
10/20/2018 18:00	74.2	73.5	74.0	73.6
10/21/2018 0:00	67.3	67.0	67.8	67.4
10/21/2018 6:00	64.6	64.3	64.5	64.1
10/21/2018 12:00	64.1	64.1	63.8	63.2
10/21/2018 18:00	66.8	66.6	67.9	67.6
10/22/2018 0:00	61.2	61.1	62.3	62.0
10/22/2018 6:00	60.1	59.6	60.3	59.9
10/22/2018 12:00	66.3	66.1	65.8	65.3
10/22/2018 18:00	70.0	69.0	69.1	68.6
10/23/2018 0:00	67.3	66.8	67.5	67.2
10/23/2018 6:00	66.6	66.2	66.2	65.8
10/23/2018 12:00	67.3	66.7	67.1	66.5
10/23/2018 18:00	67.6	66.9	67.8	67.1
10/24/2018 0:00	66.3	65.8	66.0	65.6
10/24/2018 6:00	63.4	63.2	63.4	63.1
10/24/2018 12:00	71.1	70.1	70.0	69.1
10/24/2018 18:00	71.3	70.6	70.9	70.0
10/25/2018 0:00	72.2	71.3	72.1	71.3
10/25/2018 6:00	72.0	70.5	71.3	70.6
10/25/2018 12:00	76.6	75.7	74.5	74.1
10/25/2018 18:00	72.0	72.0	74.7	74.2
10/26/2018 0:00	64.0	64.1	65.4	65.3

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
10/26/2018 6:00	60.4	60.7	60.8	61.0
10/26/2018 12:00	67.4	66.5	65.7	65.1
10/26/2018 18:00	63.3	63.1	64.6	65.1
10/27/2018 0:00	58.0	58.7	58.6	59.5
10/27/2018 6:00	54.5	53.8	54.3	54.1
10/27/2018 12:00	68.7	67.8	66.7	66.1
10/27/2018 18:00	66.3	67.3	68.9	69.4
10/28/2018 0:00	59.3	59.3	60.2	60.3
10/28/2018 6:00	59.1	58.2	59.4	59.1
10/28/2018 12:00	78.7	77.8	77.7	77.2
10/28/2018 18:00	73.4	73.8	75.9	75.5
10/29/2018 0:00	66.8	66.2	67.0	66.5
10/29/2018 6:00	67.7	67.5	67.7	67.5
10/29/2018 12:00	78.5	78.3	78.5	77.9
10/29/2018 18:00	74.9	74.5	76.1	76.6
10/30/2018 0:00	64.8	64.4	66.1	65.6
10/30/2018 6:00	62.4	62.2	62.2	62.1
10/30/2018 12:00	78.2	76.1	73.5	73.8
10/30/2018 18:00	71.3	70.8	73.4	72.9
10/31/2018 0:00	69.6	69.4	69.4	69.3
10/31/2018 6:00	70.9	70.6	70.8	70.8
10/31/2018 12:00	81.2	80.3	80.2	79.6
10/31/2018 18:00	75.0	75.2	76.4	76.0
11/1/2018 0:00	75.6	75.1	75.2	74.8
11/1/2018 6:00	65.3	64.4	64.9	64.5
11/1/2018 12:00	69.1	68.7	68.0	67.6
11/1/2018 18:00	65.8	65.8	66.6	66.7
11/2/2018 0:00	55.8	55.6	56.8	56.7
11/2/2018 6:00	51.4	51.8	51.8	52.1
11/2/2018 12:00	61.2	60.1	60.0	59.4
11/2/2018 18:00	58.7	59.0	61.7	62.0
11/3/2018 0:00	52.9	52.4	51.9	52.0
11/3/2018 6:00	52.1	51.4	51.9	51.9
11/3/2018 12:00	70.0	69.7	69.5	69.1
11/3/2018 18:00	66.6	66.5	67.6	67.1
11/4/2018 0:00	65.0	64.6	64.9	64.9
11/4/2018 6:00	65.4	65.7	65.6	65.7
11/4/2018 12:00	73.8	73.4	73.4	73.0
11/4/2018 18:00	64.5	64.1	66.5	65.6
11/5/2018 0:00	63.3	63.0	63.1	62.8
11/5/2018 6:00	63.5	62.2	63.2	62.5
11/5/2018 12:00	76.6	76.4	74.0	73.7
11/5/2018 18:00	75.5	74.9	76.9	76.3
11/6/2018 0:00	73.2	72.7	73.2	72.7
11/6/2018 6:00	72.9	72.9	73.4	73.0

	Pri Inst C48517	Back Inst C48608	Pri 1hr C48558	Back 1hr C48623
11/6/2018 12:00	80.1	78.2	81.4	80.4
11/6/2018 18:00	74.0	73.6	74.6	74.1
Average	76.1	75.7	76.2	75.8

Primary Tower reads slightly higher than Backup Tower. Therefore, it is more conservative to use Primary Tower readings for actual temperature comparison to forecast.

ENCLOSURE, ATTACHMENT 2

W3F1-2019-0005

Attachment 2: Engineering Report WF3-ME-16-00001

Engineering Report No. WF3-ME-16-00001 Rev 0
Page 1 of 48

ENTERGY NUCLEAR
Engineering Report Cover Sheet

Engineering Report Title:
Meteorological Parameters and Parameter Relationships for Design and Operability of the Waterford 3 Ultimate Heat Sink

Engineering Report Type:

New ☒ Revision ☐ Cancelled ☐ Superseded ☐
Superseded by: ____________

Applicable Site(s)

IP1	☐	IP2	☐	IP3	☐	JAF	☐	PNPS	☐	VY	☐	WPO	☐
ANO1	☐	ANO2	☐	ECH	☐	GGNS	☐	RBS	☐	WF3	☒	PLP	☐

EC No. 52043

Report Origin: ☒ Entergy ☐ Vendor
Vendor Document No.: ____________

Quality-Related: ☒ Yes ☐ No

Prepared by: Dale V. Gallodoro / See EC-52043 Date: See EC-52043
Responsible Engineer (Print Name/Sign)

Design Verified: Alex Tojeiro / See EC-52043 Date: See EC-52043
Design Verifier (if required) (Print Name/Sign)

Approved by: Nicholas Petit / See EC-52043 Date: See EC-52043
Supervisor / Manager (Print Name/Sign)

Table of Contents

Revision Summary

Revision	Summary of Changes
0	Initial Issue

1.0 Scope and Objectives

1.1 This report provides meteorological parameters for design of the Ultimate Heat Sink (UHS).

1.2 This report summarizes and analyzes meteorological data for the area around Waterford 3 and develops useful relationships among meteorological parameters. The relationships may be used to simplify the variables needed for determining the limiting UHS performance capacity and water consumption for establishing fan requirements and water inventory margin.

1.3 Design basis meteorological conditions were revisited as part of an investigation to ensure bounding ambient cooling tower inlet temperatures were used in the UHS capacity and water inventory requirements analyses. CR-WF3-2012-2332 [8.12] identified that startup test data conflicted with the assumed maximum recirculation effect. This report establishes a basis for bounding recirculation effects after installation of Dry Cooling Tower Recirculation Barriers (DCTRB) in accordance with EC-52043 [8.11].

1.4 This report also provides bounding ambient temperatures by month that can be used as a basis for predicting short term UHS performance capacity for Core Offload Evaluations, Operability Evaluations, etc.

2.0 Design Inputs

2.1 Regulatory Guide 1.27, Rev. 3 [8.1] describes methods and procedures acceptable to the NRC that licensees can use to establish UHS features of plant systems required by NRC rules and regulatations. RG1.27 [8.1] provides the regulatory position that the UHS should be capable of providing sufficient cooling for at least 30 days to ensure that design basis temperatures of safety-related equipment are not exceeded.

2.1.1 RG 1.27 [8.1] identifies the two principal safety functions of the UHS: (1) dissipation of residual heat after reactor shutdown, and (2) dissipation of residual heat after an accident.

2.1.2 RG1.27 [8.1] provides guidance for selecting the meteorological conditions for a bounding UHS analysis. The analysis should account for all variations of design parameters and the full range of operating conditions that may exist at the time of a postulated event. The bases and procedures used to select and develop bounding meteorological conditions should be provided and justified.

2.1.2.1 Meteorological conditions evaluated should be the worst combination of controlling parameters. For evaporation and drift losses, use the worst bounding combination of controlling

parameters that result in the maximum cooling water loss. For cooling water temperature, use the worst combination of controlling parameters, including diurnal variations where appropriate, for the critical time periods unique to the specific design of the UHS. The following are acceptable methods for selecting these conditions:

2.1.2.1.1 Transient analyses used to predict the maximum intake water temperature to the plant and the maximum 30-day water usage should be based on regional climatological data, with substantiation of the conservatism of the data for site use. The climatological measurements used for this analysis should be based on a recent period of record at least 30 years in length and should be demonstrated to be representative of conditions that may occur at the site. If significantly less than 30 years of representative data are available, other historical regional data (including, if available, quality assured onsite meteorological data) should be examined to determine the controlling meteorological conditions for the critical time period(s). If an examination of other historical regional data indicates that the controlling meteorological conditions did not occur within the period of record for the available representative data, these conditions should be correlated with the available representative data and appropriate adjustments should be made for site conditions. Current literature on possible changes in the climatological conditions in the site region should also be reviewed to be confident that the methods used to predict weather extremes are reasonable.

2.1.2.1.2 Less severe meteorological conditions may be assumed when it can be demonstrated that the consequences of exceeding lesser design basis conditions for short time periods are acceptable. Information on magnitude, persistence, and frequency of occurrence of controlling meteorological parameters that exceed the design basis conditions, based on acceptable data as discussed above, should be presented.

2.2 FSAR Section 2.3.2 and 2.3.3 [8.10.1] describe local meteorology and the onsite meteorological measurement program, respectively. Table 2.3-2 lists fastest measured wind speeds. Table 2.3-2(a) lists the UHS meteorological design parameters. Tables 2.3-3 through 2.3-15A list percentage frequencies of wind direction and speed. Table 2.3-31 lists temperature extremes by month. Table 2.3-33 lists mean monthly maximum temperatures at the site. Tables 2.3-42 through 2.3-132 list wind distributions at the site by month. Some of the parameters recorded in the FSAR are from surrounding more urban areas where higher temperatures than at the site are generally expected.

2.3 FSAR Section 9.2.5 [8.10.38] describes the Waterford 3 UHS and the associated meteorological parameters for design. Critical time periods associated with the various event analyses are discussed. CR-WF3-2012-2332 [8.12] identified that startup test data conflicted with the original license basis maximum recirculation effect.

2.4 MNQ9-52 [8.7] provides a compilation of historical data related to the Waterford 3 UHS, including test reports.

2.5 ECM03-007 [8.9] demonstrates that the ambient environmental temperature data collected on site from 1997 to 2001 was consistent with that used to develop the original design basis ambient environmental temperature limits, which are documented in the Waterford 3 FSAR.

2.6 Actual site meteorological data for the most recent fifteen years was reviewed during the preparation of this report to confirm that the previously evaluated meteorological parameters remain bounding and to establish bounding relationships among various parameters.

2.6.1 The meteorological towers for Waterford 3 provide instrumentation necessary to monitor meteorological data on a continuous basis. Data collected from these towers is considered to be representative of the atmospheric conditions at the inlet of the cooling towers before adding a penalty for recirculation. Hourly and fifteen minute averaged values are calculated locally at each tower and are transmitted to the Plant Monitoring Computer (PMC). The data collected from the instruments since July 2000 is stored in the PI data archives.

2.6.2 The archived data for the following PMC points were imported to Excel using the PI-Datalink Add-in every 15 minutes for the following:

2.6.2.1 Primary Tower 33' Air Temperature, 1 hr, F – C48558

2.6.2.2 Primary Tower 33' Wind Speed, 1 hr, mph – C48545

2.6.2.3 Backup Tower 33' Wind Speed, 1 hr, mph – C48625

2.6.2.4 Backup Tower 33' Air Temperature, 1 hr, C – C48623

2.6.2.5 Primary Tower Wet Bulb 1 hr, F – C48560

2.6.2.6 Primary Tower 33' Wind Direction, 1 hr – C48543

2.6.2.7 Backup Tower 33' Wind Direction, 1 hr – C48622

2.6.2.8 Primary Tower Relative Humidity, 1 hr – C48553

2.6.3 Regular scheduled semi-annual calibrations are performed for both towers. The routine semi-annual calibration is performed in order to maintain a high availability of meteorological data. Non-routine and corrective maintenance is also performed, as needed, in order to restore

instrumentation to service and maintain a high data collection rate.

2.6.4 Data storage for the PMC has provided very good performance. Very few gaps are present in the data recorded by the PMC in the PI data system. The gaps in PI data were of short duration. These periods of missing data were caused by periodic PMC shutdowns/outages. PMC reboots/rebuilds also cause a momentary loss of the ability to store this data in PI. It is reasonable to conclude that the relatively small amount of unavailable data would not have significantly impacted the overall conclusions of this report.

2.6.5 The combined set of data included over 500,000 data points for each site meteorological parameter of temperature, wet bulb temperature, wind speed, and relative humidity for a 15 year period. The data used for producing the charts in this report is stored electronically in MS Excel spreadsheets and in pdf form.

2.6.6 Data Analysis

2.6.6.1 Data obtained from PMC archives show relationships between various weather parameters. Specifically, this report demonstrates useful relationships between the following meteorological parameters:

2.6.6.1.1 Wet Bulb Temperature vs Ambient Dry Bulb Temperature

2.6.6.1.2 Wind Speed vs Ambient Dry Bulb Temperature

2.6.6.1.3 Relative Humidity vs Ambient Dry Bulb Temperature

2.6.6.2 Data for the following critical time periods are tabulated and plotted: 1 hour, 1 day, 3 day, and 7 day.

2.6.6.2.1 To establish the averages of each parameter, the Excel average() function was used for the time period.

2.6.6.2.2 Examples of the tabulated data and the spread sheet functions are provided in Attachment 9.19.

2.6.6.3 Most of the data is from the Primary Meteorological Tower. For periods where the Primary Tower was out-of-service, data from the Backup Tower was substituted, if available.

2.6.6.4 Certain suspect points that did not meet the following criteria were eliminated from the data set or were replaced by the backup data, if the backup data met the criteria:

2.6.6.4.1 Met Tower and PMC operational for recording data

2.6.6.4.2 Positive numerical data point value

2.6.6.4.3 Value is non-repeating for three or more consecutive points

2.6.6.4.4 Surrounding data is smooth with no unusual data spikes that

don't correspond to backup tower data.

2.6.6.5 The Chemistry department prepares an Annual Meteorological Monitoring Program Report. The reports for the years 2000 – 2014 were reviewed to determine when each Tower was considered out-of-service. Primary Tower data during those periods was replaced with Backup Tower data if it met the above criteria.

2.6.6.5.1 The data points eliminated was a very small fraction of the total and will not have any significant impact on the overall results.

2.6.6.6 The meteorological data for the period from 2000 to 2015 was reviewed for validity, completeness, and adequacy for establishing a basis for meteorological parameter relationships. The following table provides statistical information about the data where the values are the percent of valid :

Meteorological Parameter Data Completeness				
Year	Dry Bulb Temperature	Wind Speed	Wet Bulb Temperature	Relative Humidity
2000	99.7%	99.9%	99.7%	99.7%
2001	99.7%	99.9%	99.2%	99.7%
2002	99.8%	99.9%	99.2%	99.5%
2003	80.6%	81.1%	80.4%	80.4%
2004	99.7%	99.9%	99.5%	99.5%
2005	99.3%	99.9%	99.4%	99.4%
2006	85.9%	86.1%	84.4%	84.0%
2007	99.8%	99.9%	99.6%	99.5%
2008	99.6%	99.9%	99.6%	99.6%
2009	98.5%	98.7%	97.7%	97.7%
2010	99.9%	99.9%	99.9%	99.9%
2011	97.7%	97.7%	96.4%	96.1%
2012	99.9%	99.9%	99.9%	99.9%
2013	99.9%	99.9%	99.5%	99.5%
2014	99.9%	99.9%	99.9%	99.9%
2015	99.9%	99.9%	99.9%	99.9%

Meteorological Parameter Data Completeness				
Year	Dry Bulb Temperature	Wind Speed	Wet Bulb Temperature	Relative Humidity
Valid Points	530,128	531,816	529,025	529,025

2.7 FSAR Chapter 2 [8.10.1] meteorological data is mainly based on observations from major weather stations such as New Orleans International Airport, which are archived by the National Oceanographic and Atmospheric Administration (NOAA). As discussed in Engineering Report WF3-ME-15-00011 [8.4], the most comparable NOAA data to the available MET wind data consisted of peak daily temperatures and average daily wind speeds. This data does not allow for meaningful relationships to be developed between one-hour average wind and corresponding one-hour average temperature conditions. Therefore, the PMC data is the most appropriate data for developing a bounding relationship for combination average wind speed and average temperature. Similarly, the PMC data is appropriate for developing bounding wet bulb temperature and relative humidity relationships with dry bulb temperature. The PMC data consists of orders of magnitude more data points than are available from NOAA for the same time period and collects data directly applicable to the plant site. FSAR section 2.3.1.2.7 [8.10.1] discusses using 17 years of dry bulb and wet bulb data for the original licensing basis with statistical extrapolations. Therefore, using 15 years of one hour data to develop bounding parameter relationships rather than the normally required 30 years is justified. Additionally, the relationships established in this report bound the previously accepted dry bulb temperature – wet bulb temperature combinations described in FSAR table 2.3-2a, including 102F dry bulb – 77F wet bulb, 98F dry bulb – 83F wet bulb, and 91.3F dry bulb – 84.9F wet bulb, and the 24 hour combination 92F dry bulb – 76F wet bulb, which are based on over 30 years of data.

2.8 ECI91-029 [8.16] shows that the PMC loop uncertainty for ambient temperature is 0.498°C (0.896°F).

2.9 Report WF3-ME-15-00011 [8.4] addresses an investigation of the Waterford 3 site meteorology, specifically the combination of wind speed, wind direction, and ambient temperature. The report statistically evaluates ambient wind and temperature combinations in order to substantiate the conservatism of the data.

2.10 Report WF3-ME-15-00014 [8.6] documents Computational Fluid Dynamics (CFD) investigations of the Waterford 3 cooling towers to establish a

conceptual design for modifications that would reduce recirculation to acceptable levels. A relationship is established between bounding recirculation effects and wind speed.

3.0 Assumptions

3.1 There are no assumptions that affect the conclusions in this report.

4.0 Detailed Discussion

4.1 Ultimate Heat Sink Design

4.1.1 The Waterford 3 UHS consists of a Dry Cooling Tower (DCT), a Wet Cooling Tower (WCT), and the water stored in the WCT basins. The DCT and WCT are forced draft with multiple fans.

4.1.2 Component Cooling Water (CCW) picks up heat from the containment and auxiliary equipment and is cooled by the DCT and then a CCW Heat Exchanger (HX). Auxiliary Component Cooling Water (ACCW) from the WCT basin picks up heat from the CCW HX and is cooled by the WCT before being returned to the WCT basin.

4.1.3 Dry bulb temperature is the controlling parameter for the DCT performance. Wet bulb temperature is the controlling parameter for the WCT performance. Wind speed and direction influence the recirculation of hot exhaust back to the intake of the cooling towers and effectively influence the ambient temperatures for the cooling towers. Relative humidity influences water consumption rate.

4.1.4 The Waterford 3 UHS design analysis allows for taking fans out-of-service for maintenance when controlling meteorological parameters support the required UHS performance requirements and water inventory margin with only the remaining operable fans. Therefore, this report establishes bounding meteorological relationships for a range of ambient dry bulb temperatures to allow for establishing fan requirements based on actual ambient temperature conditions.

4.1.5 For example, the highest recorded dry bulb temperature on the order of one hour is the controlling parameter for the DCT for maximizing cooling water temperature during a LOCA. The highest wet bulb temperature corresponding to the highest dry bulb temperature would be the appropriate controlling parameter for the WCT for the evaluation.

4.2 Meteorological Parameter Combinations

4.2.1 Consistent with RG 1.27, the UHS capacity is to be determined using the most severe combination of controlling meteorological parameters for the critical time periods unique to the specific design of the UHS. For the Waterford 3 UHS, the controlling meteorological parameters are dry

bulb temperature, wet bulb temperature, wind speed and direction, and relative humidity. The critical time periods are 1 hour (LOCA Peak Heat Load), 1 day (Natural Circulation Cooldown), 3 day (LOCA Water Consumption), and 7 day (Tornado UHS Heat Load).

4.2.2 This report examines the most severe combinations of the controlling parameters and establishes relationships to simplify selection of the parameter combinations.

4.2.3 Bounding relationships for wet bulb temperature, wind speed, recirculation, and relative humidity will be established as functions of dry bulb temperature for various fan configurations and critical time periods associated with the design of the UHS.

4.2.4 A Mathcad worksheet is provided in Attachment 9.18 that can be referenced in the overall UHS Mathematical model described in Engineering Report WF3-ME-15-00013 [8.5] to simplify meteorological parameter inputs for analyzing UHS performance for various events and fan configurations.

4.3 Dry Bulb Temperature

4.3.1 Dry bulb temperature is selected as the controlling variable for establishing UHS capacity based on the following:

4.3.1.1 Dry bulb temperature is the most significant parameter for water storage requirements of the ultimate heat sink because it determines heat removed by dry cooling towers. A high dry bulb reduces the heat removal capacity of the dry towers, so the wet towers must reject more heat and thus evaporate more water.

4.3.1.2 A bounding relationship can be established for determining maximum wet bulb temperature as a function of dry bulb temperature. This bounding relationship will result in the most severe combination of dry bulb and wet bulb temperatures for evaluating UHS performance and is therefore consistent with RG 1.27.

4.3.1.3 A bounding relationship can be established for determining maximum wind speed as a function of dry bulb temperature. Report WF3-ME-15-00011 [8.4] demonstrates the confidence level for predicting maximum average wind speed as a function of dry bulb temperature.

4.3.1.4 A bounding relationship can be established for determining maximum recirculation as a function of dry bulb temperature and the number of fans that could allow backflow. Report WF3-ME-15-00014 [8.6] provides an evaluation of the expected recirculation of hot exhaust air back to the intake of the cooling towers. The report establishes a relationship between wind

speed and bounding recirculation effect. The bounding wind speed – temperature relationship and bounding recirculation effect – wind speed relationship can be combined to develop a bounding recirculation effect – ambient dry bulb temperature relationship for various critical time periods.

4.4 Wet Bulb Temperature

4.4.1 The original licensing of Waterford Unit 3 involved an extensive site meteorological assessment that is summarized in Chapter 2 of the Final Safety Analysis Report (FSAR) [8.10]. Particular emphasis is given to the Ultimate Heat Sink (UHS) temperature parameters and atmospheric design parameters that are reported in Chapter 9 of the FSAR.

4.4.2 Based on study calculations MNQ9-52 [8.7], Letters ES-LOU-1-76 [8.13] and ES-LOU87-77 [8.14], and ES-LOU-91-77 [8.15], ECM03-007 [8.9], and supported by Engineering Report WF3-ME-15-00011 [8.4], and validated by a review of environmental monitoring data from 2000 – 2015 summarized in Attachments 9.1 – 9-17, the bounding meteorological parameters for design based on historical data and the licensing basis are:

Critical Time Period	Bounding Average Inlet Temperature	
	Dry Bulb, °F	Wet Bulb, °F
One Hour	102 / 98	78 / 83*
One Day	92	77*
Three Day	89	76*
Seven Day	86	78*

* based on maximum wet bulb relationship

4.4.3 The charts in Attachments 9.1 – 9.4 illustrate the bounding relationships between wet bulb and dry bulb temperatures for various critical time periods unique to the Waterford 3 UHS design.

4.5 Wind

4.5.1 The relationship between wind and ambient temperature was studied in Engineering Report WF3-ME-15-00011 [8.4]. The report supports establishing the following bounding temperature and wind conditions:

Ambient Dry Bulb Temperature, °F	Bounding Average 1 Hour Wind Speed , mph
102	0

Ambient Dry Bulb Temperature, °F	Bounding Average 1 Hour Wind Speed , mph
76	51

4.5.2 The charts in attachments 9.5 – 9.8 illustrate that a linear relationship produces conservative 1 hour average wind speeds vs. ambient temperatures.

4.5.3 The extreme wind cases are associated with major storms, which occur in a small band of dry bulb temperature conditions. Therefore, the linear relationship will not extend to temperatures less than 76°F and a constant bounding wind speed is conservatively assumed for temperatures less than 76°F.

4.6 Recirculation Effect

4.6.1 The recirculation effect is the difference between remote ambient temperature and the temperature at the inlet of the cooling tower, due to hot air recirculating from the tower exhaust. EC-52043 [8.11] installs new Dry Cooling Tower Recirculation Barriers (DCTRB) as an improvement to reduce recirculation.

4.6.2 The relationship between wind and ambient temperature was studied in Engineering Report WF3-ME-15-00011 [8.4]. The relationship between wind and recirculation effect was studied in Engineering Report WF3-ME-15-00014 [8.6]. The reports support establishing the following bounding recirculation effects and wind conditions:

DCT Train	Wind Speed, mph	Bounding Recirculation Effect , °F
A	0	0.0
A	10	2.2
A	30	5.6
B	0	0.2
B	10	4.7
B	30	7.7

NE wind produces worst recirculation on Train A.
S wind produces worst recirculation on Train B.

4.6.3 Engineering Report WF3-ME-15-00014 [8.6] shows that backflow through idle DCT fans causes additional recirculation that is bounded by 3°F per out-of-service fan. If backflow is prevented, then the additional recirculation would not apply.

4.6.4 Wet Cooling Tower recirculation is bounded by 8°F for all wind conditions that create any significant recirculation effect for the Dry

Cooling Towers.

4.7 Critical Time Periods

4.7.1.1 The appropriate conservative critical time periods for establishing meteorological parameters for design for each analyzed event are as follows:

4.7.1.1.1 LOCA

4.7.1.1.1.1 Peak – 1 hr

4.7.1.1.1.2 Long Term Cooling – 3 day

4.7.1.1.2 Limiting Shutdown – BTP 5-4 - 1 day

4.7.1.1.3 Tornado –

4.7.1.1.3.1 0 to 2 hr – 1 hr

4.7.1.1.3.2 2 to 6 hr – 1 hr

4.7.1.1.3.3 6 hr with FPC – 1 hr

4.7.1.1.3.4 6hr to SDC – 7 day

4.7.1.1.3.5 SDC to 30 days – 7 day

4.7.1.1.4 Full Core Offload – 1 hr

4.7.1.1.5 Normal Shutdown - 1 hr

4.7.1.1.6 Refueling - 1 hr (Spring or Fall months)

4.7.1.1.7 Normal Operation - 1 hr

4.7.1.2 The appropriate seasonal meteorological parameters for design for evaluating UHS performance capacity during cooler parts of the year are provided in Section [6.2.5].

4.8 This report does not supersede previous bounding meteorological temperature parameters for design of the UHS. The originally established bounding combinations of 102°F dry bulb / 77°F wet bulb, 98°F dry bulb / 83°F wet bulb, and 91.3°F dry bulb / 84.9°F wet bulb are bounded or matched by the relationships developed in this report.

5.0 <u>Operating Experience</u>

5.1 Regulatory Guide 1.27 [8.1] provides guidance for establishing meteorological parameters for design of the UHS at nuclear power plants. NUREG-0693 [8.18], NUREG-0733 [8.19], and a technical report [8.20], are cited for techniques for selecting the meteorological conditions for minimum heat transfer and examples for performing the transient analysis for wet cooling towers. This report is intended to establish bounding meteorological condition relationships that minimize heat transfer and

maximize water evaporation to meet the intent of RG 1.27 and its references.

6.0 Summary of Results

6.1 The Mathcad worksheet shown in Attachment 9.18 provides mathematical relationships for the various meteorological parameters for design of the Waterford 3 UHS.

6.1.1.1 The charts in Attachments 9.1 – 9.12 illustrate the bounding relationships of the various parameters with dry bulb temperature.

6.2 The following relationships are justified as illustrated on Attachments 9.1 – 9.12:

6.2.1 Bounding Wet Bulb vs. Dry Bulb Temperature

6.2.1.1 One Hour

6.2.1.1.1 For $T_{db} \leq 85°F$, $T_{wb}(T_{db}) = T_{db}$

6.2.1.1.2 For $85°F < T_{db} \leq 92°F$, $T_{wb}(T_{db}) = 85°F$

6.2.1.1.3 For $92°F < T_{db} \leq 98°F$, $T_{wb}(T_{db}) = (-1/3)T_{db} + 115.67°F$

6.2.1.1.4 For $98°F < T_{db} \leq 102°F$, $T_{wb}(T_{db}) = (-5/4)T_{db} + 205.5°F$

6.2.1.2 One Day

6.2.1.2.1 For $T_{db} \leq 83°F$, $T_{wb}(T_{db}) = T_{db}$

6.2.1.2.2 For $83°F < T_{db} \leq 84°F$, $T_{wb}(T_{db}) = 83°F$

6.2.1.2.3 For $84°F < T_{db} \leq 88°F$, $T_{wb}(T_{db}) = (-1/4)T_{db} + 104°F$

6.2.1.2.4 For $88°F < T_{db} \leq 92°F$, $T_{wb}(T_{db}) = (-5/4)T_{db} + 192°F$

6.2.1.3 Three Day

6.2.1.3.1 For $T_{db} \leq 83°F$, $T_{wb}(T_{db}) = T_{db}$

6.2.1.3.2 For $83°F < T_{db} \leq 84°F$, $T_{wb}(T_{db}) = 83°F$

6.2.1.3.3 For $84°F < T_{db} \leq 88°F$, $T_{wb}(T_{db}) = (-1/4)T_{db} + 104°F$

6.2.1.3.4 For $88°F < T_{db} \leq 89°F$, $T_{wb}(T_{db}) = (-6)T_{db} + 610°F$

6.2.1.4 Seven Day

6.2.1.4.1 For $T_{db} \leq 80°F$, $T_{wb}(T_{db}) = T_{db}$

6.2.1.4.2 For $80°F < T_{db} \leq 82°F$, $T_{wb}(T_{db}) = (1/2)T_{db} + 40°F$

6.2.1.4.3 For $82°F < T_{db} \le 85°F$, $T_{wb}(T_{db}) = 81°F$

6.2.1.4.4 For $85°F < T_{db} \le 86°F$, $T_{wb}(T_{db}) = (-3)T_{db} + 336°F$

6.2.2 Bounding Wind Speed (WS) (in mph) vs. Dry Bulb Temperature

6.2.2.1 One Hour

6.2.2.1.1 $WS(T_{db}) = \max(0, \min(51, (-55/27)T_{db} + 207.78))$

6.2.2.2 One Day

6.2.2.2.1 $WS(T_{db}) = \max(0, \min(35, (-35/13)T_{db} + 247.7))$

6.2.2.3 Three Day

6.2.2.3.1 $WS(T_{db}) = \max(0, (\min(23.5, (-22/8)T_{db} + 246.75))$

6.2.2.4 Seven Day

6.2.2.4.1 $WS(T_{db}) = \max(0, (\min(14.5, (-3)T_{db} + 263))$

6.2.3 Bounding Relative Humidity (RH) (in %) vs. Dry Bulb Temperature

6.2.3.1 One Hour

6.2.3.1.1 $RH(T_{db}) = (4/5)T_{db} - 45$

6.2.3.2 One Day

6.2.3.2.1 $RH(T_{db}) = (30/24)T_{db} - 53.75$

6.2.3.3 Three Day

6.2.3.3.1 $RH(T_{db}) = (34/27)T_{db} - 43.1$

6.2.3.4 Seven Day

6.2.3.4.1 $RH(T_{db}) = (23/26)T_{db} - 9.1$

6.2.4 Bounding Recirculation Effect (°F) vs. Wind Speed (mph)

6.2.4.1 Dry Cooling Tower

6.2.4.1.1 The bounding relationship between recirculation effect and wind speed is established in report WF3-ME-15-00014 [8.6] and summarized in section [4.6] of this report.

6.2.4.1.2 The data points are interpolated using the Mathcad *regress* and *interp* functions to develop a mathematical relationship between recirculation and ambient dry bulb temperature and critical time period.

6.2.4.1.3 An additional N_{fan} term is included to account for the additional recirculation through out-of-service DCT fans.

6.2.4.1.4 See attachment 9.18 for details.

6.2.4.2 Wet Cooling Tower

6.2.4.2.1 $T_{R\_WCT}(WS) = 5°F$

6.2.5 Maximum Average Dry Bulb Temperature vs. Time of Year

6.2.5.1 One Hour – FSAR Table 2.3-31 – PMC Data

6.2.5.1.1 January............. 83°F .... 81°F

6.2.5.1.2 February........... 84°F .... 82°F

6.2.5.1.3 March .... 87°F .... 85°F

6.2.5.1.4 April .... 91°F .... 89°F

6.2.5.1.5 May .... 96°F .... 95°F

6.2.5.1.6 June .... 102°F .... 96°F

6.2.5.1.7 July .... 99°F .... 96°F

6.2.5.1.8 August .... 100°F .... 98°F

6.2.5.1.9 September......... 97°F .... 93°F

6.2.5.1.10 October............. 92°F .... 90°F

6.2.5.1.11 November.......... 86°F .... 83°F

6.2.5.1.12 December.......... 83°F .... 80°F

6.2.5.2 One Day – PMC Data

6.2.5.2.1 January............. .... 75°F

6.2.5.2.2 February........... .... 75°F

6.2.5.2.3 March .... 77°F

6.2.5.2.4 April .... 81°F

6.2.5.2.5 May .... 85°F

6.2.5.2.6 June .... 87°F

6.2.5.2.7 July .... 89°F

6.2.5.2.8 August .... 89°F

6.2.5.2.9 September......... .... 88°F

6.2.5.2.10 October............. .... 83°F

6.2.5.2.11 November.......... .... 78°F

6.2.5.2.12 December.......... .... 75°F

6.2.5.3 Three Day – PMC Data

6.2.5.3.1 January............ .... 73°F

6.2.5.3.2 February........... .... 74°F

6.2.5.3.3 March .... 76°F

6.2.5.3.4 April .... 80°F

6.2.5.3.5 May .... 83°F

6.2.5.3.6 June .... 86°F

6.2.5.3.7 July.................. .... 88°F

6.2.5.3.8 August .... 88°F

6.2.5.3.9 September........ .... 85°F

6.2.5.3.10 October............ .... 83°F

6.2.5.3.11 November......... .... 75°F

6.2.5.3.12 December......... .... 73°F

6.2.5.4 Seven Day – PMC Data

6.2.5.4.1 January............ .... 69°F

6.2.5.4.2 February........... .... 71°F

6.2.5.4.3 March .... 74°F

6.2.5.4.4 April .... 79°F

6.2.5.4.5 May .... 82°F

6.2.5.4.6 June .... 85°F

6.2.5.4.7 July.................. .... 86°F

6.2.5.4.8 August .... 86°F

6.2.5.4.9 September........ .... 84°F

6.2.5.4.10 October............ .... 80°F

6.2.5.4.11 November......... .... 73°F

6.2.5.4.12 December......... .... 71°F

6.2.5.5 Thirty Day – FSAR Table 2.3-29 – PMC Data

6.2.5.5.1 January.............55.5°F.................. 60°F

6.2.5.5.2 February............57.7°F.................. 62°F

6.2.5.5.3 March ....62.1°F.................. 70°F

6.2.5.5.4 April ....68.9°F.................. 75°F

6.2.5.5.5 May ....75.5°F.................. 78°F

6.2.5.5.6 June ....81.1°F.................. 83°F

6.2.5.5.7 July....................82.6°F.................. 84°F

6.2.5.5.8 August ....82.5°F.................. 84°F

6.2.5.5.9 September.........78.9°F.................. 82°F

6.2.5.5.10 October.............71.1°F.................. 75°F

6.2.5.5.11 November..........61.1°F.................. 64°F

6.2.5.5.12 December..........56.6°F.................. 60°F

6.2.5.5.13 It is noted that the FSAR Table 2.3-29 temperatures are average monthly temperatures for 30 years from 1931 – 1960. The PMC data indicates the highest 30 day average temperatures over the most recent 15 years for the respective month. These values are compared for information only and do not necessarily represent a trend.

7.0 Conclusions and Recommendations

7.1 The bounding meteorological parameters and relationships provided in this report may be used in design basis UHS calculations and operability evaluations for meteorological parameter inputs and will support analysis of the UHS that meets the regulatory position of RG1.27 [8.1].

7.2 This report establishes a basis for selecting bounding recirculation effects after installation of Dry Cooling Tower Recirculation Barriers (DCTRB) in accordance with EC-52043 [8.11].

8.0 References

8.1 Regulatory Guide 1.27, “Ultimate Heat Sink for Nuclear Power Plants”

8.2 W3-DBD-4, “Component Cooling Water / Auxiliary Component Cooling Water Design Basis Document”

8.3 Technical Specifications Section 3/4.7.4, “Ultimate Heat Sink”

8.4 WF3-ME-15-00011, “Waterford 3 Ultimate Heat Sink Project Weather Investigation” (LPI Report A13326-R-001)

8.5 WF3-ME-15-00013, (LPI Report No. A13326-R-003) “Waterford 3 Ultimate Heat Sink Project UHS Model”

8.6 WF3-ME-15-00014, “Waterford 3 Ultimate Heat Sink: CFD Investigation of the Dry Cooling Tower Deflector Wall Modification” (LPI Report A14386-R-001)

8.7 MNQ9-52, “Ultimate Heat Sink Performance Study”

8.8 Waterford 3 Updated Final Safety Analysis Report

8.9 ECM03-007, “Study Calculation for the Review of UHS Atmospheric Temperature Design Parameters to Support EPU”

8.10 Waterford 3 Updated Final Safety Analysis Report (FSAR)

8.10.1 FSAR Section 2.3, “Meteorological Conditions”

8.10.2 FSAR Table 2.3-2(a), Ultimate Heat Sink Meteorological Design Parameters

8.10.3 FSAR Table 2.3-3, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) – January

8.10.4 FSAR Table 2.3-4, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - February

8.10.5 FSAR Table 2.3-5, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - March

8.10.6 FSAR Table 2.3-6, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - April

8.10.7 FSAR Table 2.3-7, New Orleans, LA Moisant International Airport

Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - May

8.10.8 FSAR Table 2.3-8, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - June

8.10.9 FSAR Table 2.3-9, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - July

8.10.10 FSAR Table 2.3-10, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - August

8.10.11 FSAR Table 2.3-11, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - September

8.10.12 FSAR Table 2.3-12, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - October

8.10.13 FSAR Table 2.3-13, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - November

8.10.14 FSAR Table 2.3-14, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960) - December

8.10.15 FSAR Table 2.3-15, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (1951 – 1960)

8.10.16 FSAR Table 2.3-15A, New Orleans, LA Moisant International Airport Percentage Frequencies of Wind Direction and Speed (July 1972 – June 1975 and Feb. 1977 – Feb. 1978)

8.10.17 FSAR Table 2.3-16, [Wind Rose Data for January] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.18 FSAR Table 2.3-17, [Wind Rose Data for February] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.19 FSAR Table 2.3-18, [Wind Rose Data for March] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.20 FSAR Table 2.3-19, [Wind Rose Data for April] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.21 FSAR Table 2.3-20, [Wind Rose Data for May] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.22 FSAR Table 2.3-21, [Wind Rose Data for June] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.23 FSAR Table 2.3-22, [Wind Rose Data for July] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.24 FSAR Table 2.3-23, [Wind Rose Data for August] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.25 FSAR Table 2.3-24, [Wind Rose Data for September] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.26 FSAR Table 2.3-25, [Wind Rose Data for October] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.27 FSAR Table 2.3-26, [Wind Rose Data for November] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.28 FSAR Table 2.3-27, [Wind Rose Data for December] 1973 – 1975 and 1978 at Waterford 3 Site

8.10.29 FSAR Table 2.3-28, Annual Wind Rose Data for July 1972 – June 1975 and February 1977 – February 1978 at Waterford 3 Site

8.10.30 FSAR Table 2.3-29, Average Monthly and Annual Temperatures for Selected Stations in the New Orleans Area (1931 – 1960)

8.10.31 FSAR Table 2.3-30, Mean Monthly and Annual Maximum, Minimum, and Average Temperatures Moisant International Airport (1931 – 1960)

8.10.32 FSAR Table 2.3-31, Temperature Extremes Moisant International Airport, New Orleans, Louisiana

8.10.33 FSAR Table 2.3-32, Average Monthly Occurrences of Extreme Temperatures Moisant International Airport, New Orleans, Louisiana (1947 – 1972)

8.10.34 FSAR Table 2.3-33, Mean Monthly and Annual Maximum, Minimum, and Average Temperatures Waterford Nuclear Unit 3 On Site Data (July 1972 – June 1975 and February 1977 – February 1978)

8.10.35 FSAR Table 2.3-34, Mean Relative Humidity and Number of Days with Heavy Fog Moisant International Airport, New Orleans, Louisiana (1949 – 1972)

8.10.36 FSAR Table 2.3-138, Waterford Onsite Meteorological Monitoring System Overall System Inaccuracies of One Hour Averages

8.10.37 FSAR Table 2.3-141, Waterford 3 Operational Meteorological Monitoring System Accuracies

8.10.38 FSAR Section 9.2.5, “Ultimate Heat Sink”

8.11 EC-52043, “Ultimate Heat Sink Margin Restoration Project”

8.12 CR-WF3-2012-2332, “Non-Conservative Cooling Tower Recirculation”

8.13 ES-LOU-1-76, “Meteorological Conditions Following Tornado Passage”, April 29, 1976

8.14 ES-LOU-87-77, “Design Meteorological Data for Ultimate Heat Sink” , July 18, 1977

8.15 ES-LOU-91-77, “FSAR Table 2.3-2(a) – Ultimate Heat Sink Design Parameters”, August 2, 1977

8.16 ECI91-029, “Meteorological Tower Uncertainty Calculation”

8.17 Annual Meteorological Monitoring Program Reports – 2000 through 2014

8.18 NUREG-0693, “Analysis of Ultimate Heat Sink Cooling Ponds”

8.19 NUREG-0733, “Analysis of Ultimate Heat Sink Spray Ponds”

8.20 Dunn, W. E. and Sullivan, S. M., “Method for Analysis of Ultimate Heat Sink Cooling Tower Performance,” University of Illinois at Urbana-Champaign, April 1986 (ADAMS Accession No. ML12146A145)

9.0 Attachments

9.1 1 Hour Average Wet vs. Dry Bulb Temperature

9.2 1 Day Average Wet vs. Dry Bulb Temperature

9.3 3 Day Average Wet vs. Dry Bulb Temperature

9.4 7 Day Average Wet vs. Dry Bulb Temperature

9.5 1 Hour Average Wind Speed vs. Temperature

9.6 1 Day Average Wind Speed vs. Temperature

9.7 3 Day Average Wind Speed vs. Temperature

9.8 7 Day Average Wind Speed vs. Temperature

9.9 1 Hour Average Relative Humidity vs. Dry Bulb Temperature

9.10 1 Day Average Relative Humidity vs. Dry Bulb Temperature

9.11 3 Day Average Relative Humidity vs. Dry Bulb Temperature

9.12 7 Day Average Relative Humidity vs. Dry Bulb Temperature

9.13 1 Hour Average Temperature vs. Time of Year

9.14 1 Day Average Temperature vs. Time of Year

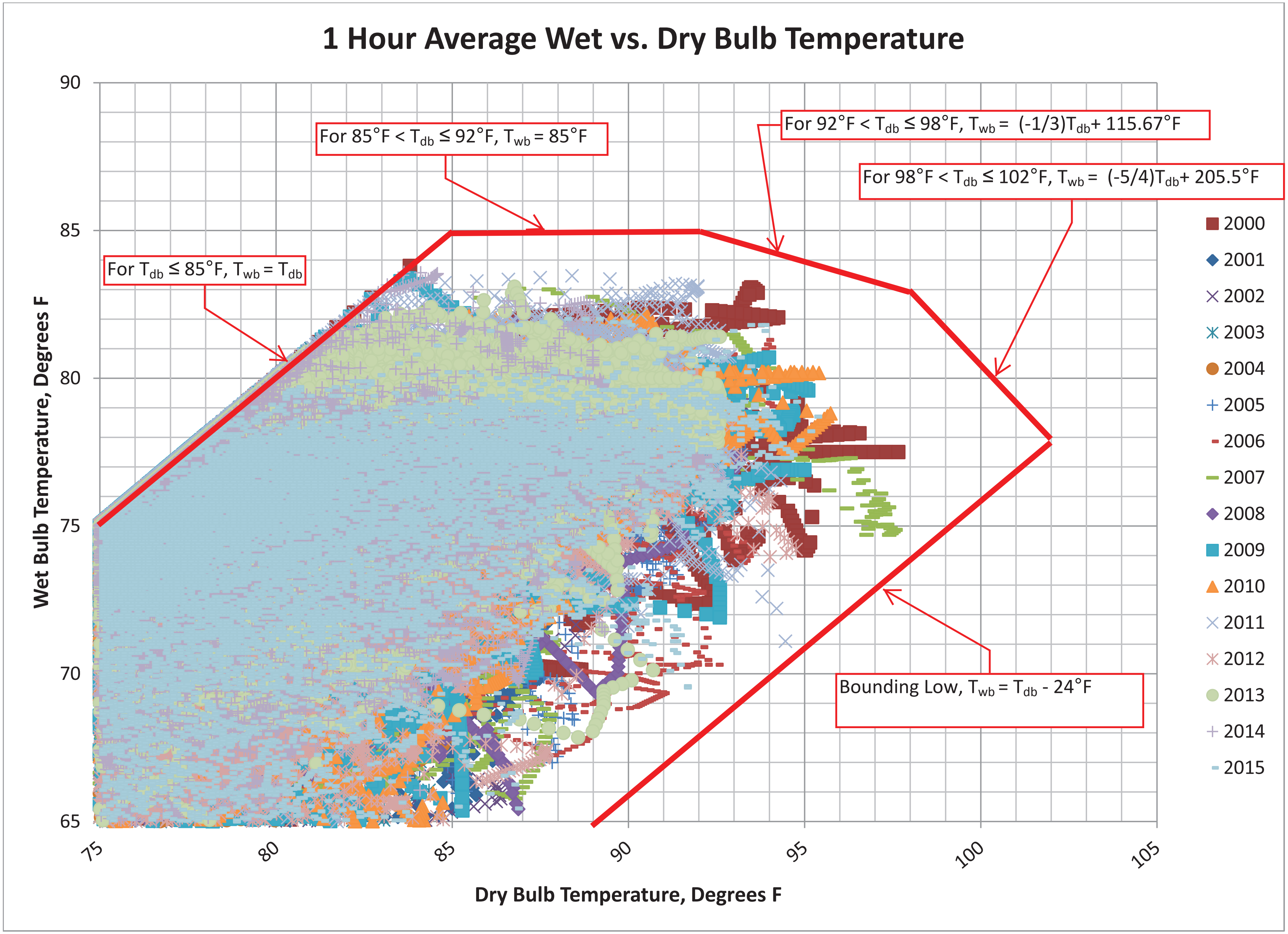
9.15 3 Day Average Temperature vs. Time of Year

9.16 7 Day Average Temperature vs. Time of Year

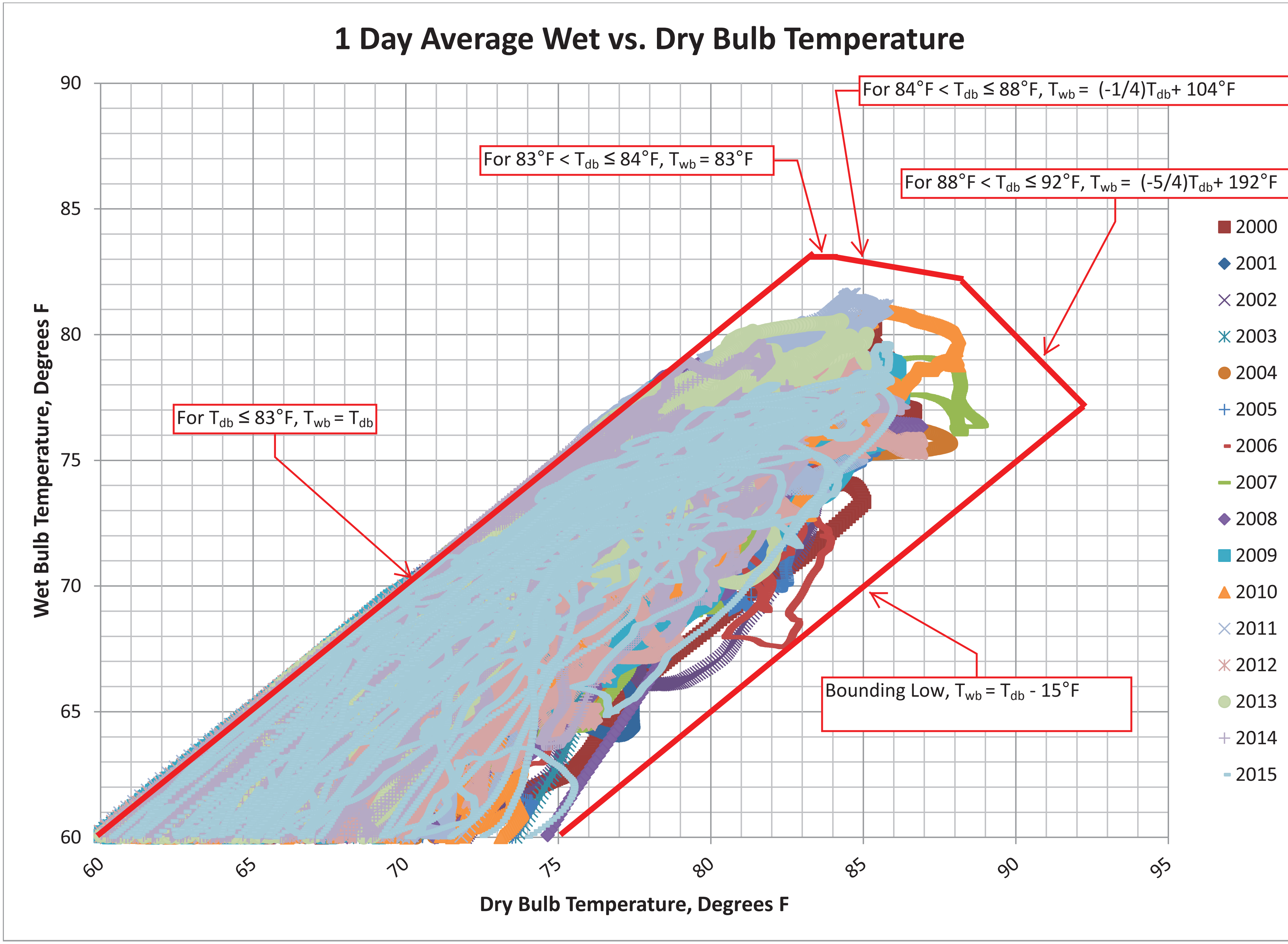
9.17 30 Day Average Temperature vs. Time of Year

9.18 Mathcad Worksheet for Meteorological Parameter Relationships

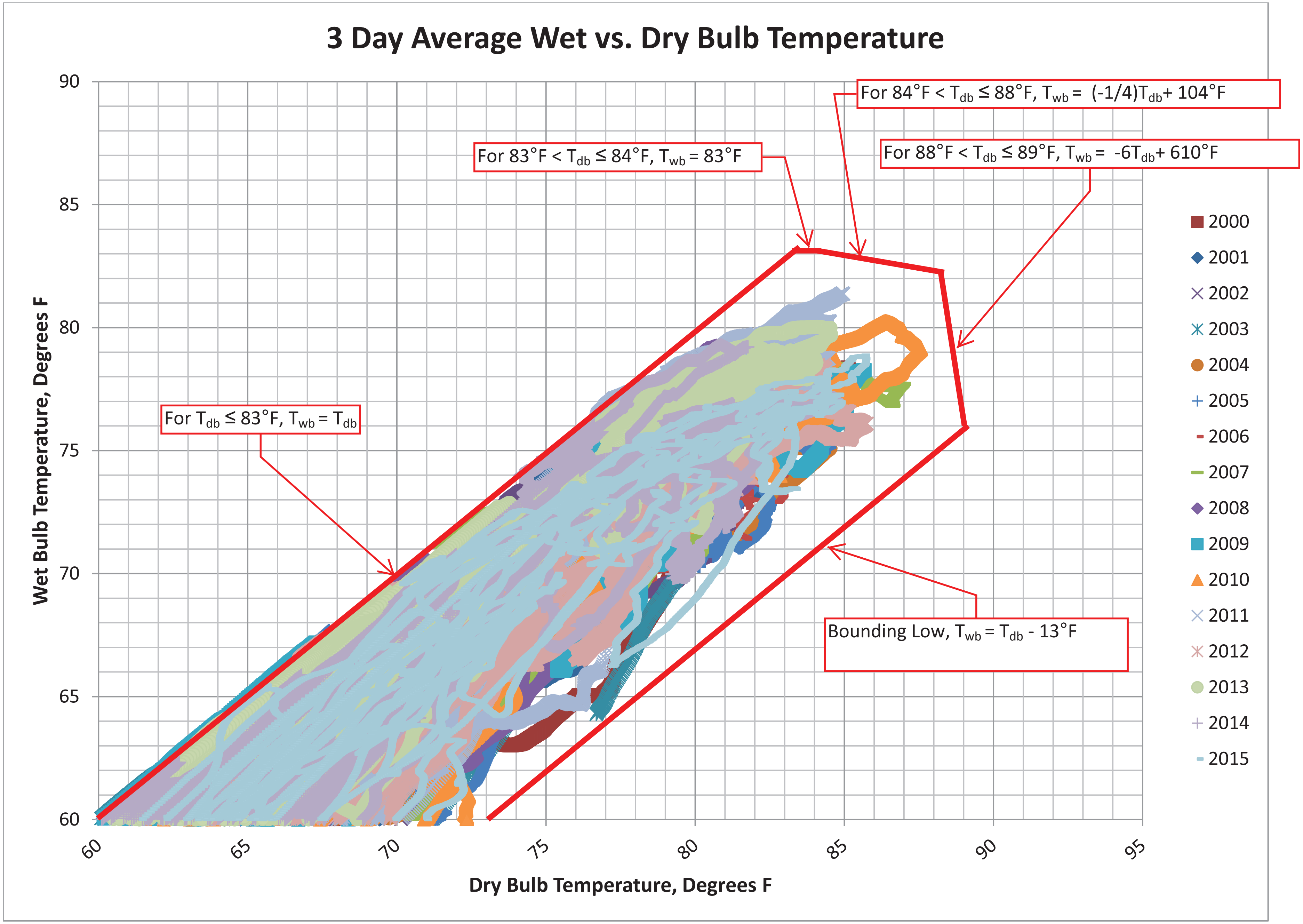
9.19 Examples of Tabulated Meteorological Data and Spreadsheet Functions Used for Charts



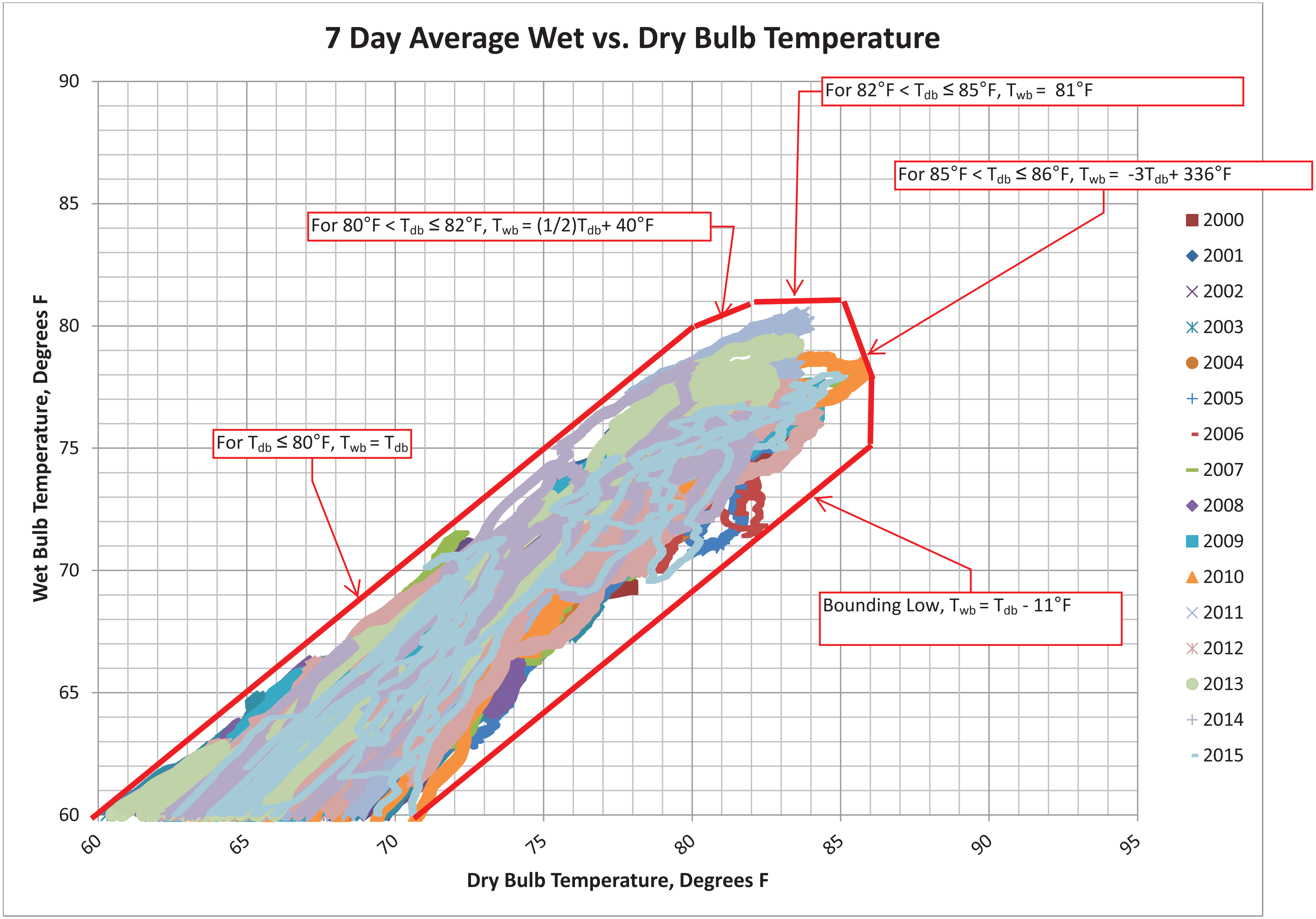
1 Hour Average Wet vs. Dry Bulb Temperature
For $T_{db} \le 85°F$, $T_{wb} = T_{db}$
For $85°F < T_{db} \le 92°F$, $T_{wb} = 85°F$
For $92°F < T_{db} \le 98°F$, $T_{wb} = (-1/3)T_{db} + 115.67°F$
For $98°F < T_{db} \le 102°F$, $T_{wb} = (-5/4)T_{db} + 205.5°F$
Bounding Low, $T_{wb} = T_{db} - 24°F$
Wet Bulb Temperature, Degrees F
Dry Bulb Temperature, Degrees F
90
85
80
75
70
65
75
80
85
90
95
100
105
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015



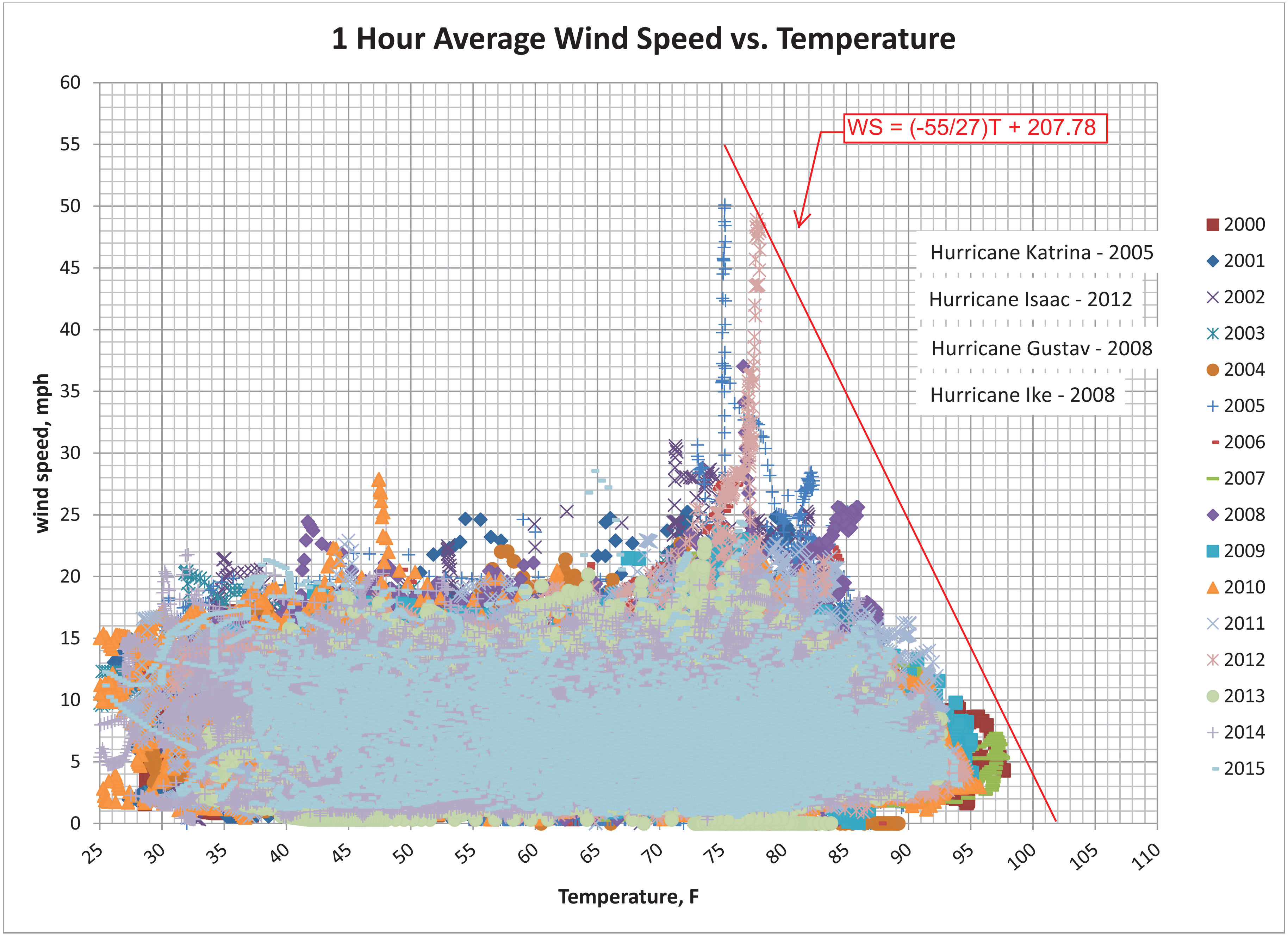
1 Day Average Wet vs. Dry Bulb Temperature
For 84°F < Tdb ≤ 88°F, Twb = (-1/4)Tdb+ 104°F
For 83°F < Tdb ≤ 84°F, Twb = 83°F
For 88°F < Tdb ≤ 92°F, Twb = (-5/4)Tdb+ 192°F
For Tdb ≤ 83°F, Twb = Tdb
Bounding Low, Twb = Tdb - 15°F
Wet Bulb Temperature, Degrees F
Dry Bulb Temperature, Degrees F
90
85
80
75
70
65
60
60
65
70
75
80
85
90
95
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015



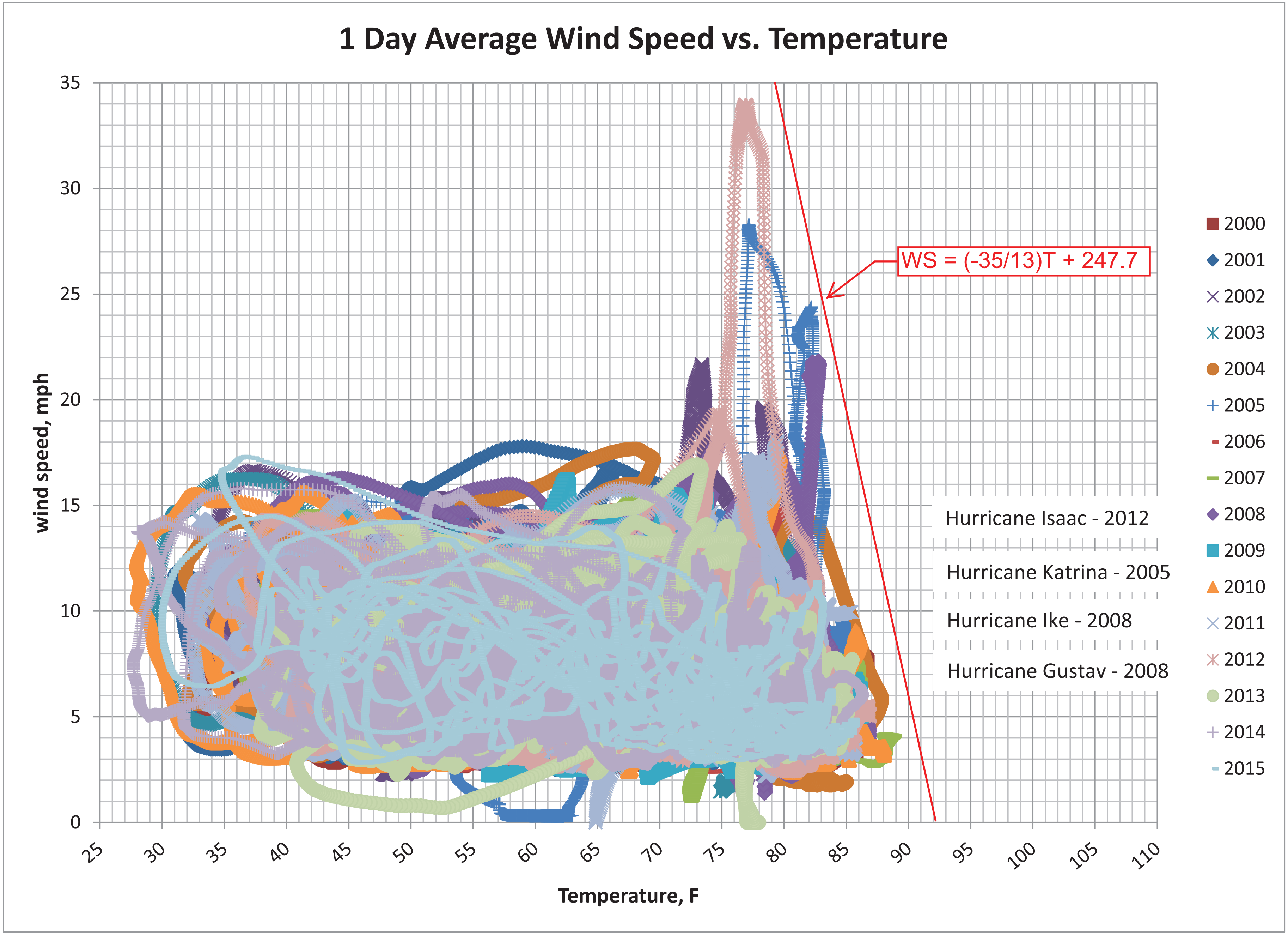
3 Day Average Wet vs. Dry Bulb Temperature
For 84°F < Tdb ≤ 88°F, Twb = (-1/4)Tdb+ 104°F
For 83°F < Tdb ≤ 84°F, Twb = 83°F
For 88°F < Tdb ≤ 89°F, Twb = -6Tdb+ 610°F
For Tdb ≤ 83°F, Twb = Tdb
Bounding Low, Twb = Tdb - 13°F
Wet Bulb Temperature, Degrees F
Dry Bulb Temperature, Degrees F
90
85
80
75
70
65
60
60
65
70
75
80
85
90
95
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015



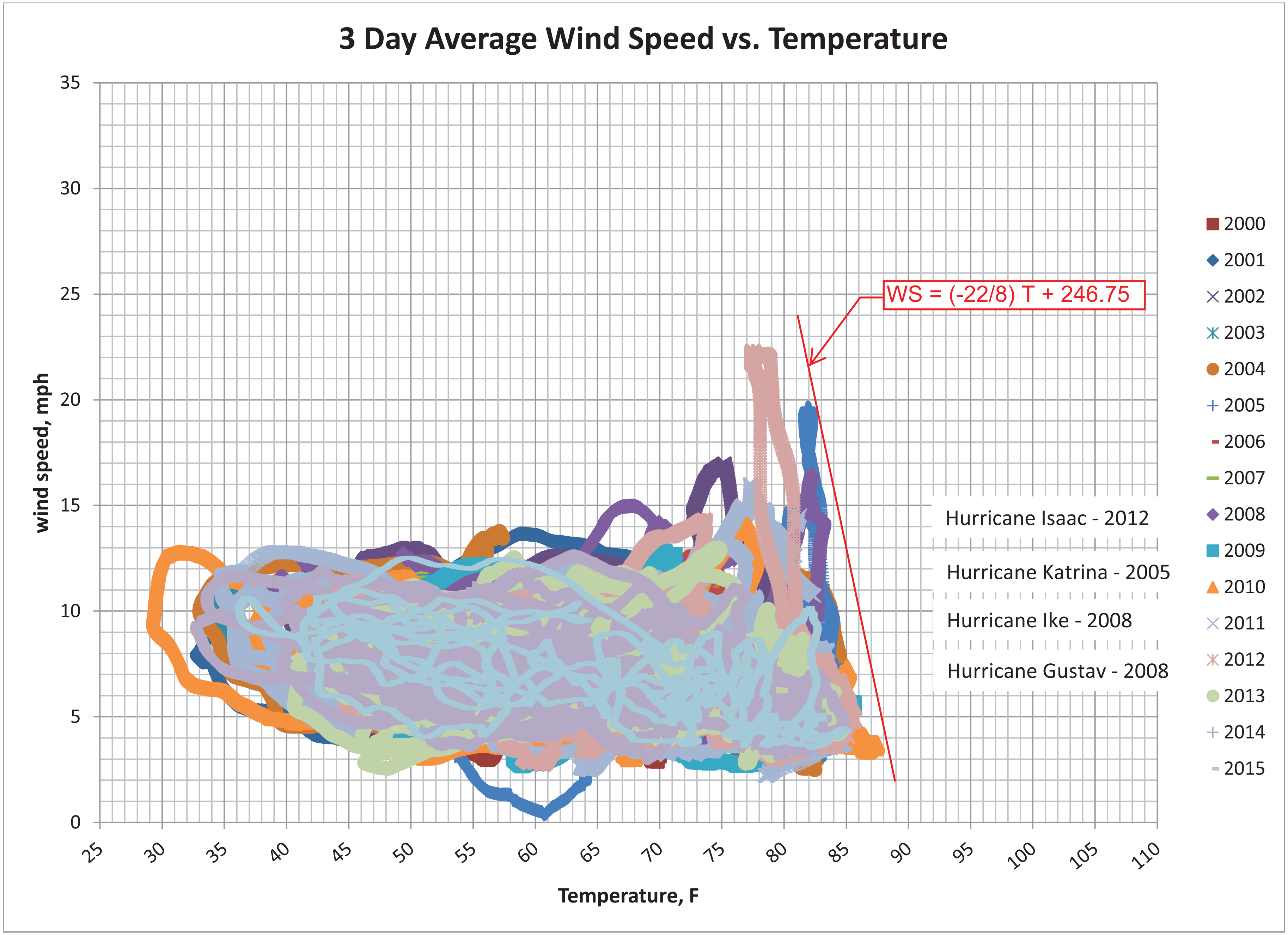
7 Day Average Wet vs. Dry Bulb Temperature
For 82°F < Tdb ≤ 85°F, Twb = 81°F
For 85°F < Tdb ≤ 86°F, Twb = -3Tdb+ 336°F
For 80°F < Tdb ≤ 82°F, Twb = (1/2)Tdb+ 40°F
For Tdb ≤ 80°F, Twb = Tdb
Bounding Low, Twb = Tdb - 11°F
Wet Bulb Temperature, Degrees F
Dry Bulb Temperature, Degrees F
90
85
80
75
70
65
60
60
65
70
75
80
85
90
95
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

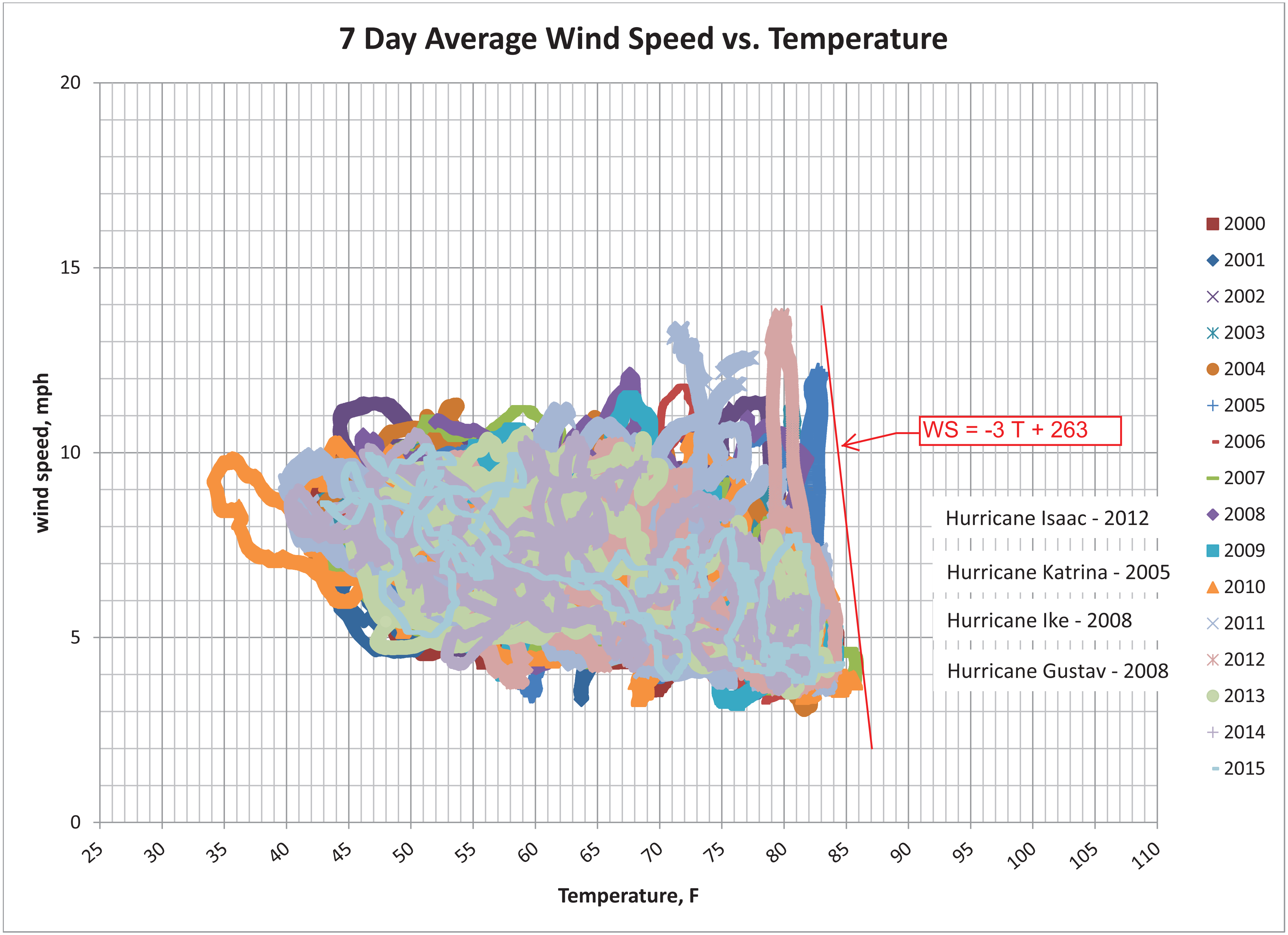


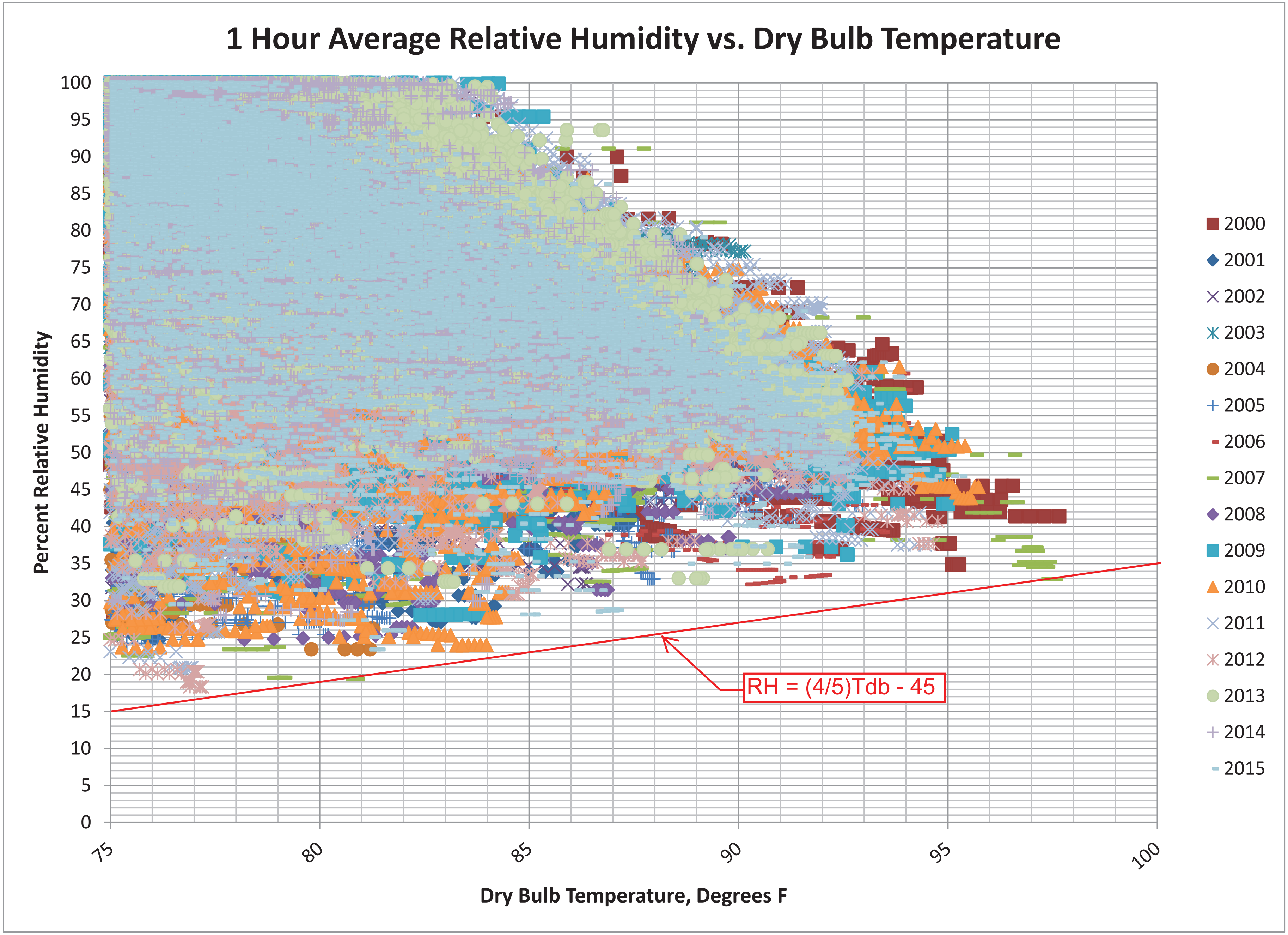
1 Hour Average Wind Speed vs. Temperature
WS = (-55/27)T + 207.78
Hurricane Katrina - 2005
Hurricane Isaac - 2012
Hurricane Gustav - 2008
Hurricane Ike - 2008
wind speed, mph
Temperature, F
0
5
10
15
20
25
30
35
40
45
50
55
60
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

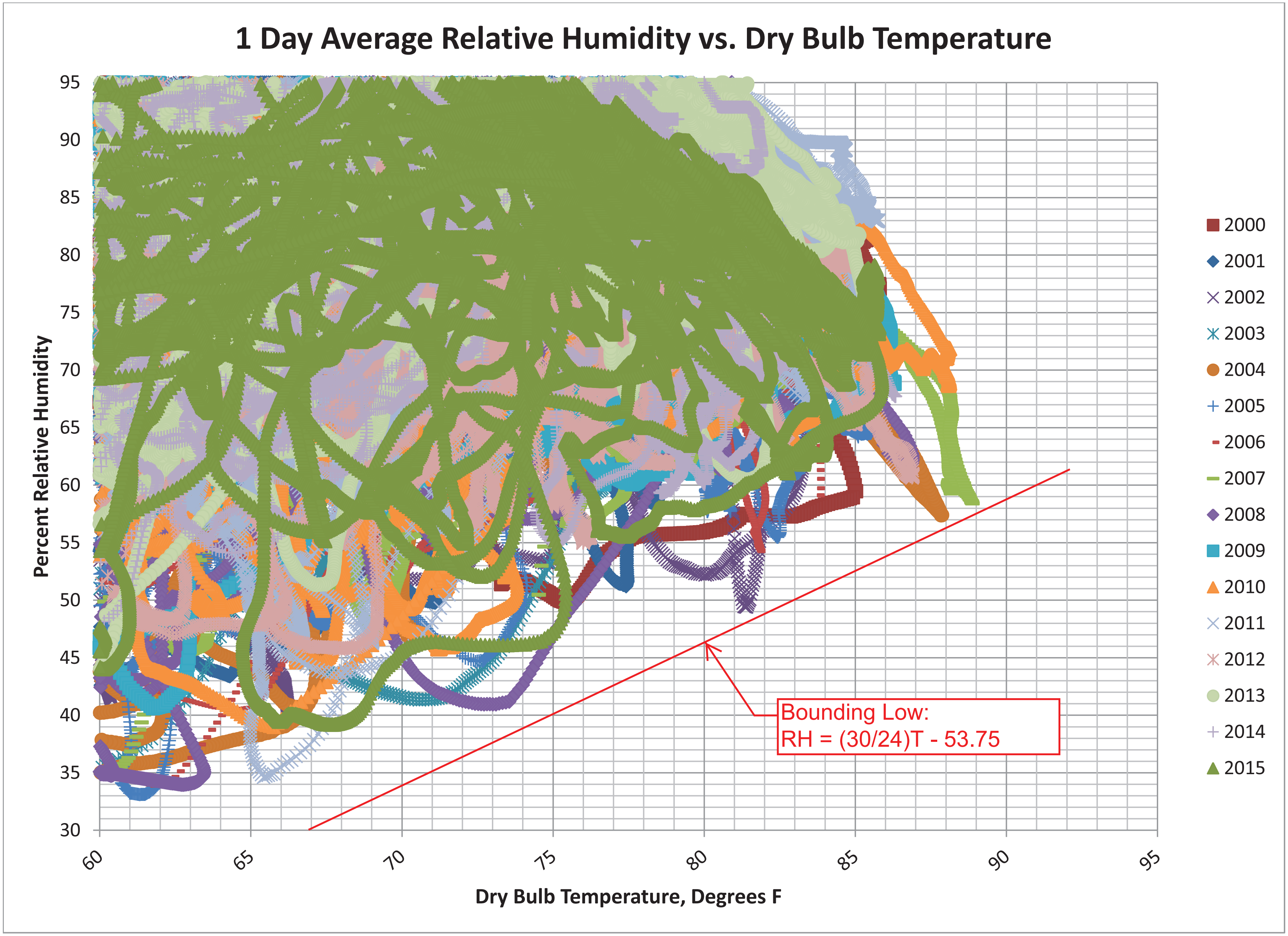


1 Day Average Wind Speed vs. Temperature
wind speed, mph
Temperature, F
35
30
25
20
15
10
5
0
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
WS = (-35/13)T + 247.7
Hurricane Isaac - 2012
Hurricane Katrina - 2005
Hurricane Ike - 2008
Hurricane Gustav - 2008
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

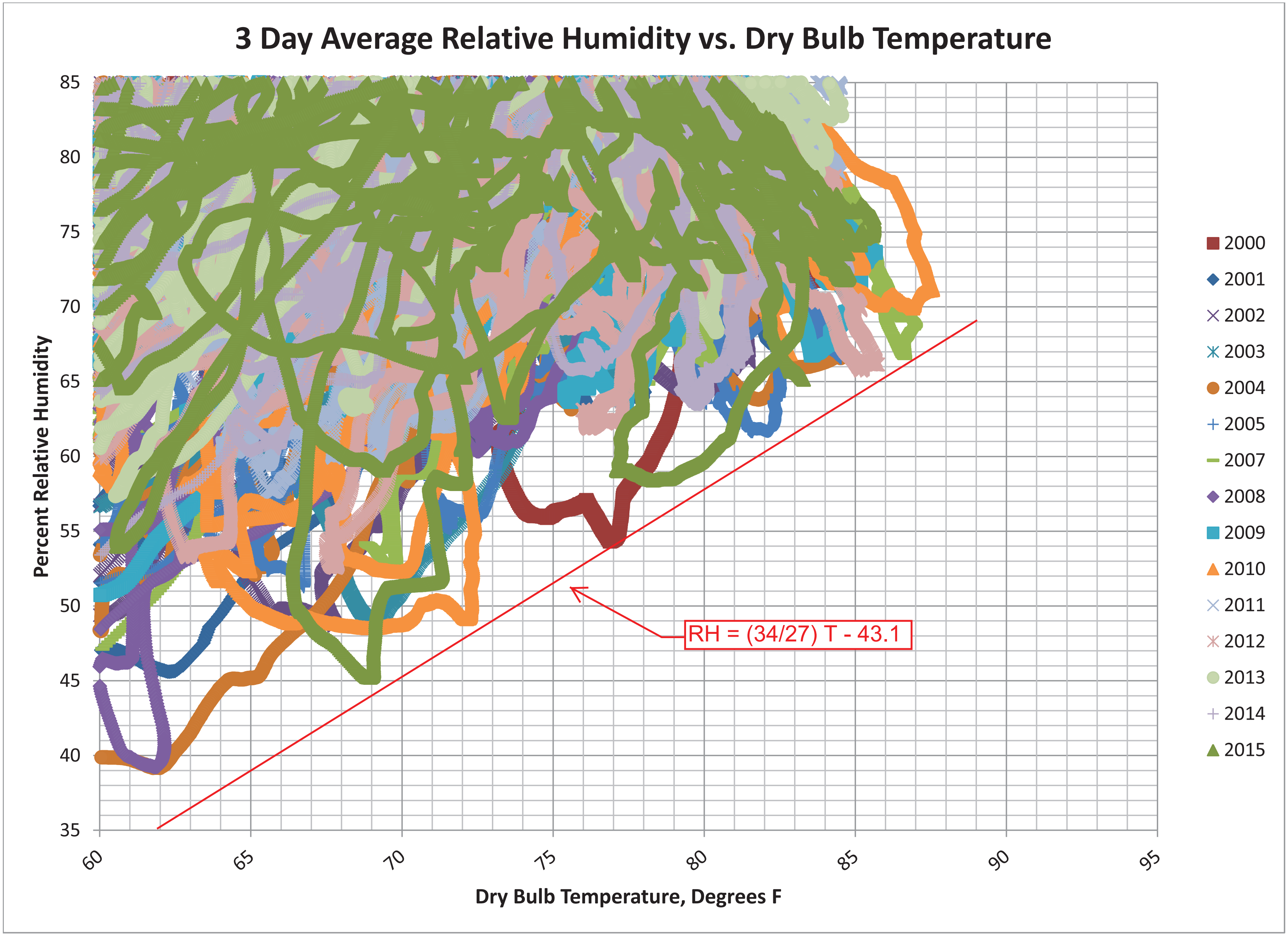

3 Day Average Wind Speed vs. Temperature
wind speed, mph
Temperature, F
35
30
25
20
15
10
5
0
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
WS = (-22/8) T + 246.75
Hurricane Isaac - 2012
Hurricane Katrina - 2005
Hurricane Ike - 2008
Hurricane Gustav - 2008
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015


7 Day Average Wind Speed vs. Temperature
wind speed, mph
Temperature, F
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
WS = -3 T + 263
Hurricane Isaac - 2012
Hurricane Katrina - 2005
Hurricane Ike - 2008
Hurricane Gustav - 2008
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

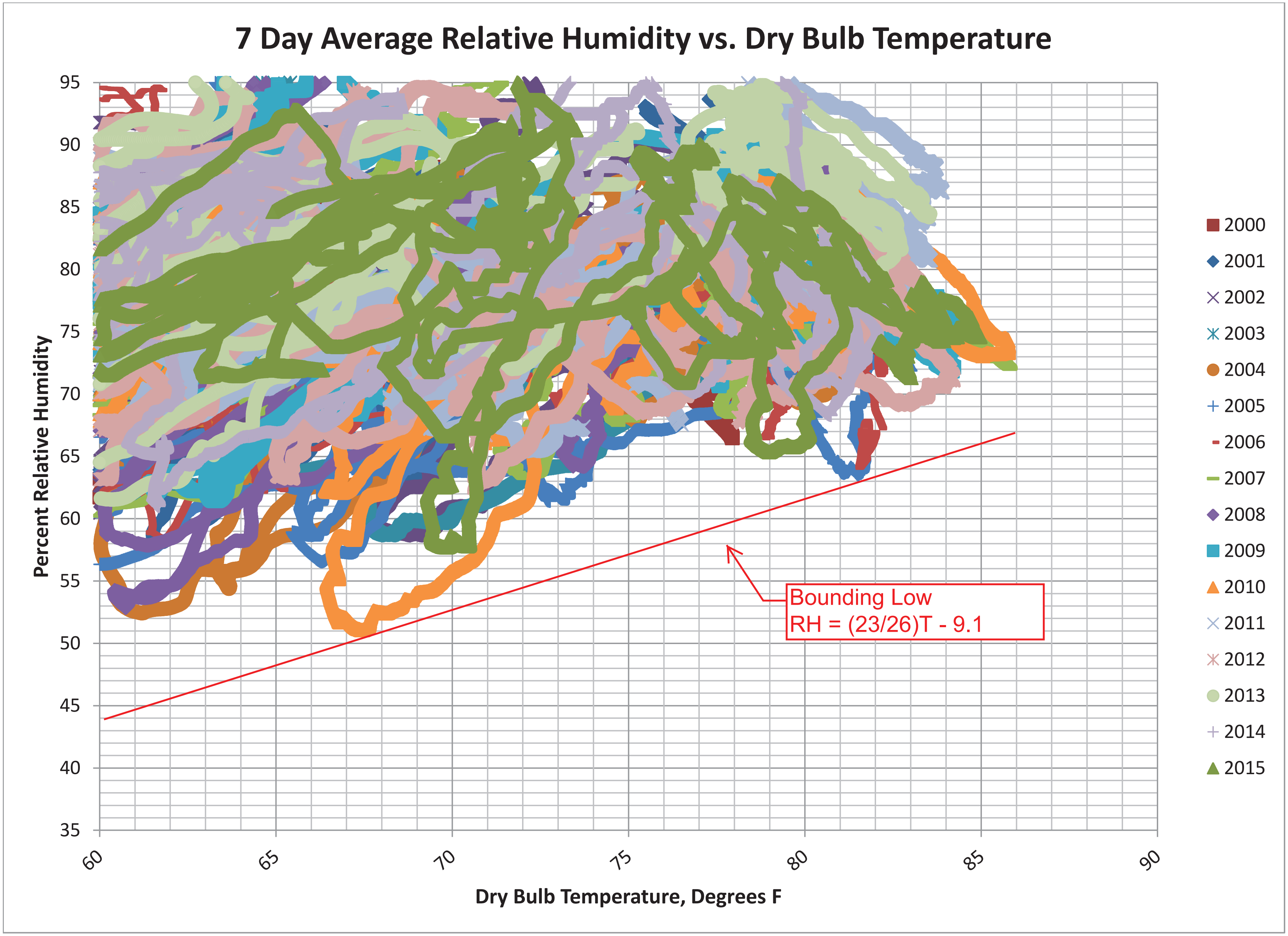

1 Hour Average Relative Humidity vs. Dry Bulb Temperature
Percent Relative Humidity
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
75
80
85
90
95
100
Dry Bulb Temperature, Degrees F
RH = (4/5)Tdb - 45
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015



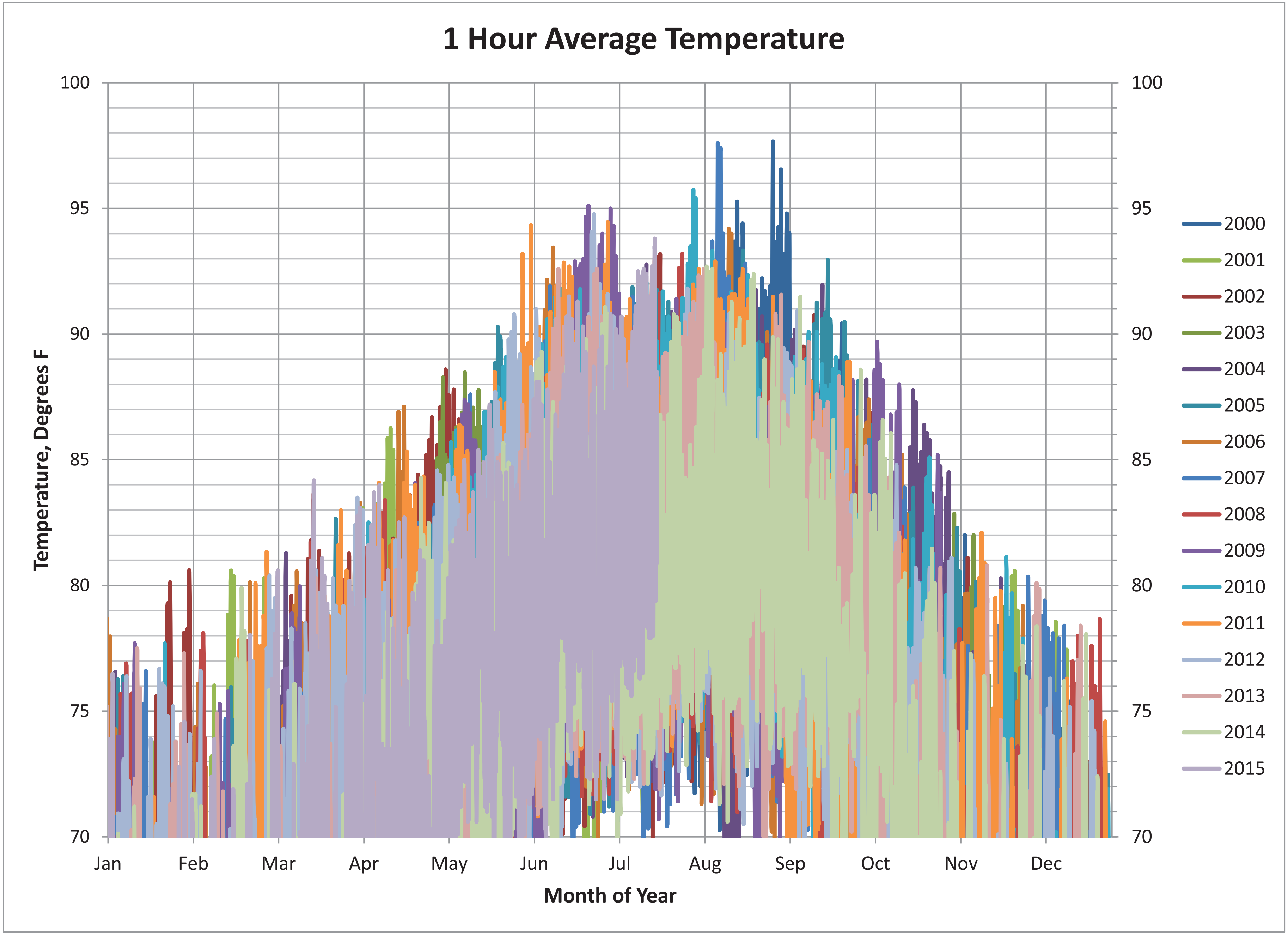
WF3-ME-16-00001, Attachment 9.10



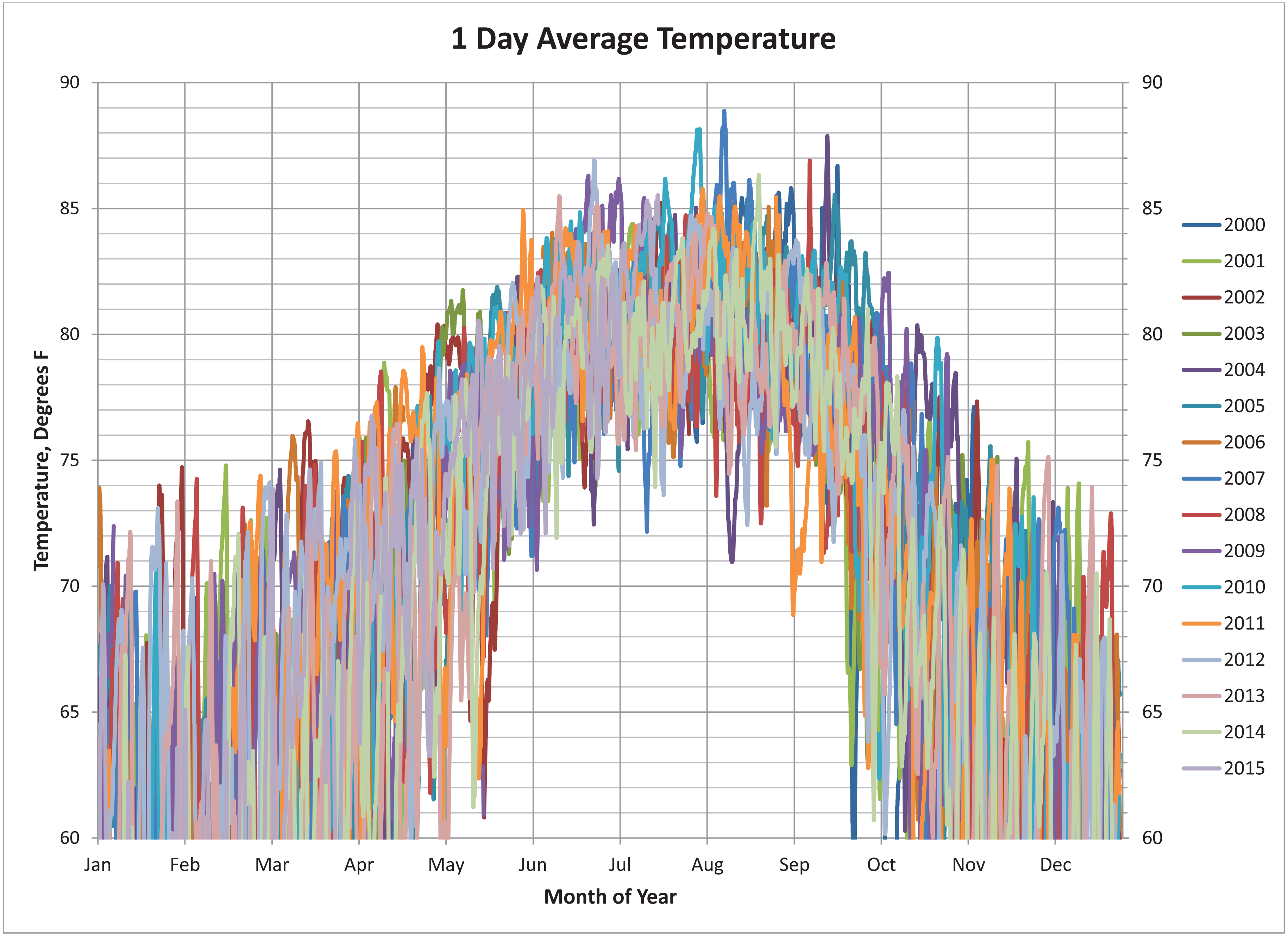
3 Day Average Relative Humidity vs. Dry Bulb Temperature
Percent Relative Humidity
85
80
75
70
65
60
55
50
45
40
35
60
65
70
75
80
85
90
95
Dry Bulb Temperature, Degrees F
RH = (34/27) T - 43.1
2000
2001
2002
2003
2004
2005
2007
2008
2009
2010
2011
2012
2013
2014
2015



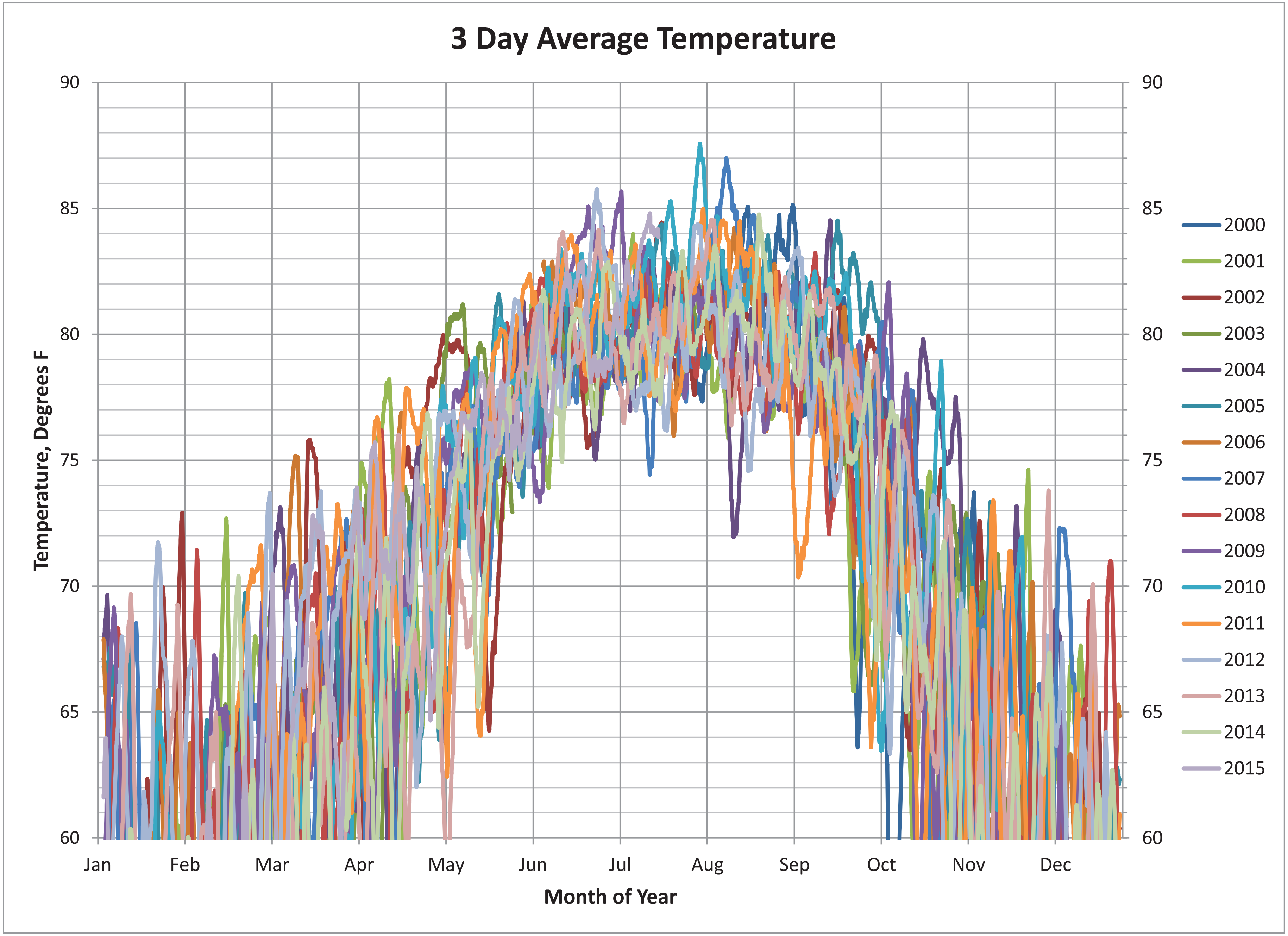
WF3-ME-16-00001, Attachment 9.12

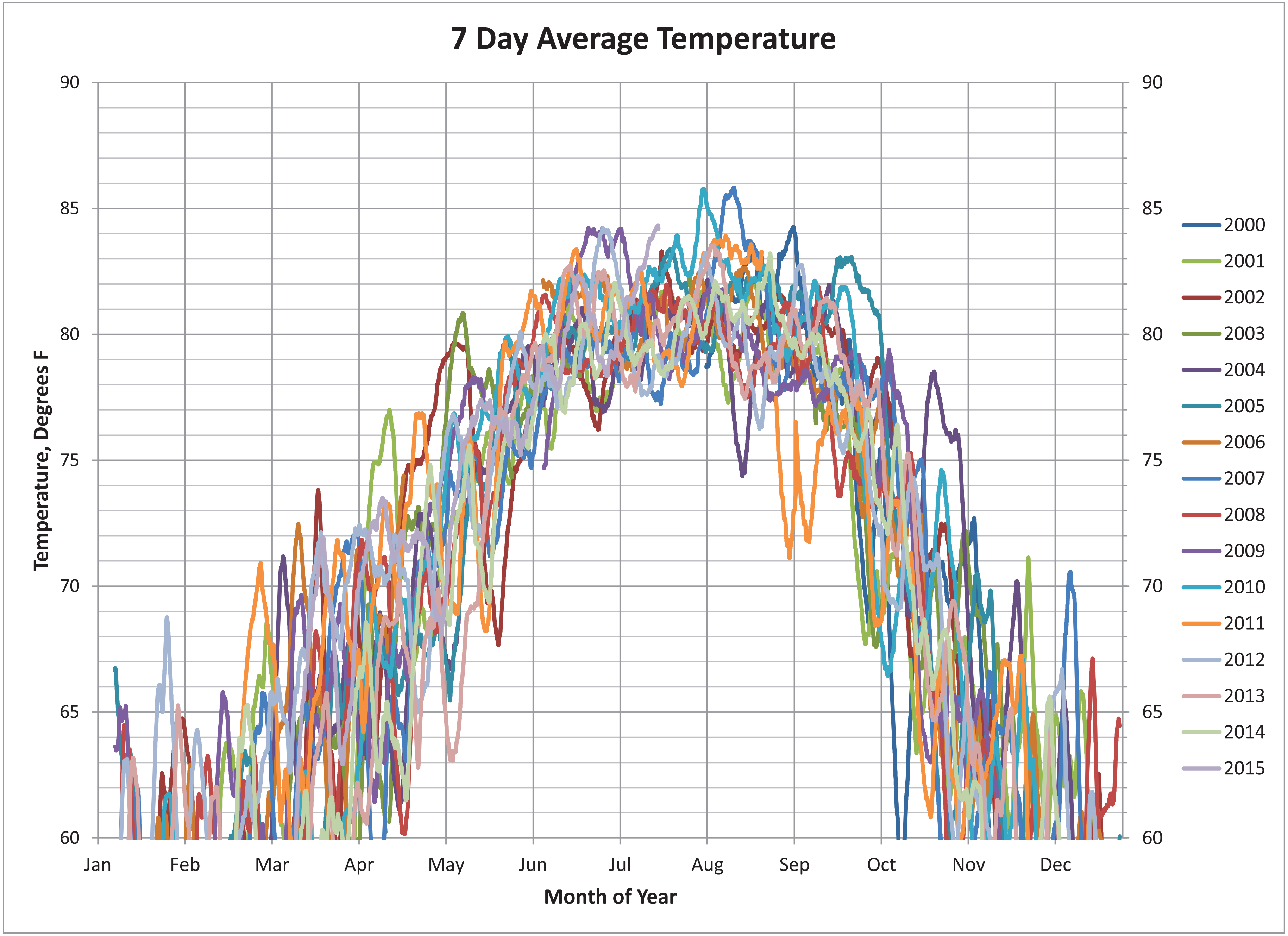


1 Hour Average Temperature
Temperature, Degrees F
Month of Year
100
95
90
85
80
75
70
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015



WF3-ME-16-00001, Attachment 9.14


3 Day Average Temperature
Temperature, Degrees F
Month of Year
90
85
80
75
70
65
60
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015



7 Day Average Temperature
Temperature, Degrees F
90
85
80
75
70
65
60
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month of Year
2000
2001
2002
2003
2004
2005
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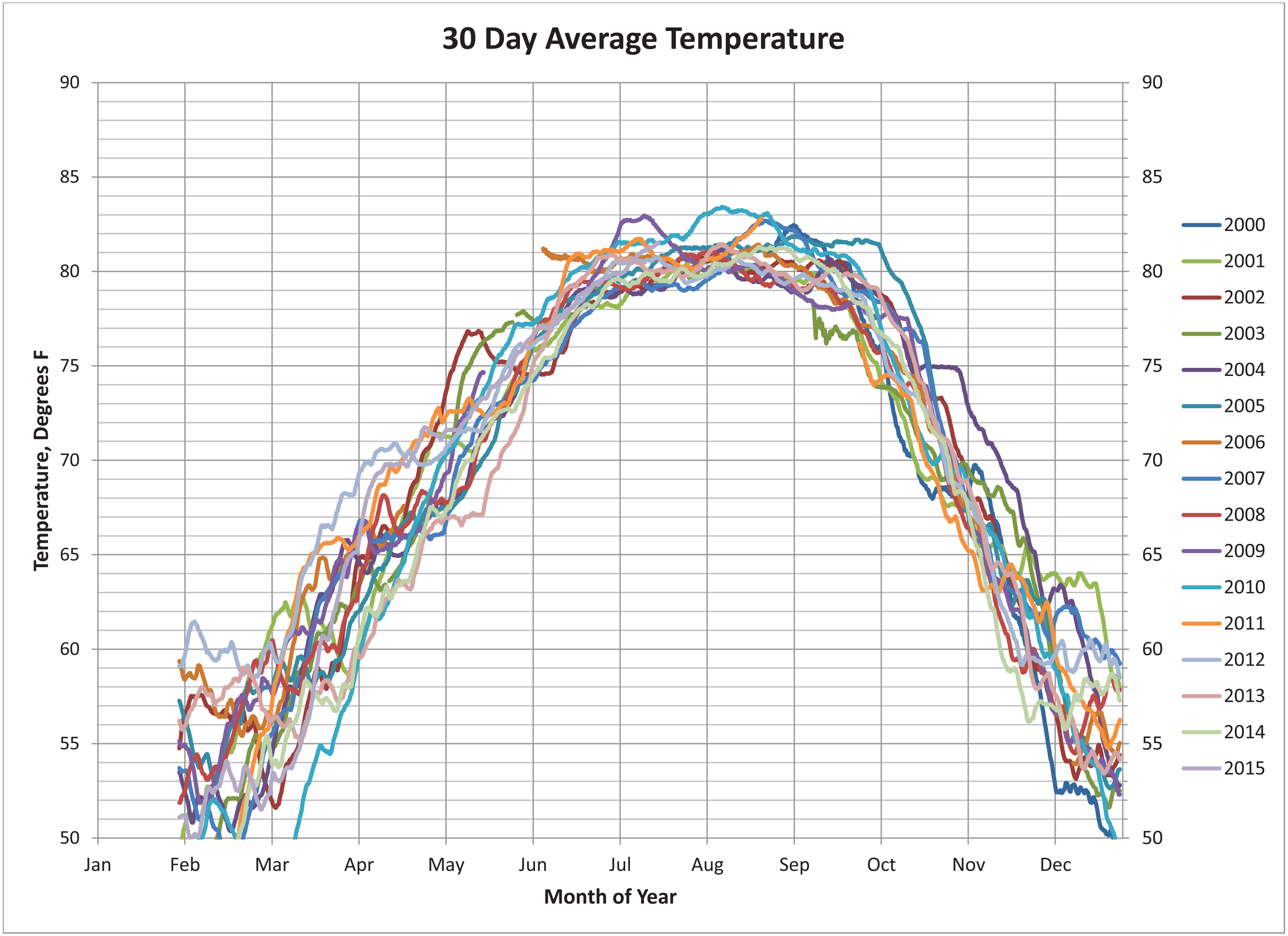
2007
2008
2009
2010
2011
2012
2013
2014
2015



WF3-ME-16-00001, Attachment 9.17

This worksheet develops bounding relationships between various meteorological parameters for design of the Ultimate Heat Sink to simplify the analysis. The resulting parameters are conservative and minimize the heat transfer capacity and maximize the water consumption in accordance with the guidance in Regulatory Guide 1.27.

Bounding Dry Bulb Temperature as a Function of Critical Time Period

$T_{db} := 32, 33 .. 102$

$$T_{db\_max}(t_{crit}) := \begin{cases} \min(102, T_{db}) & \text{if } t_{crit} = 1hr \\ \min(92, T_{db}) & \text{if } t_{crit} = 1day \\ \min(89, T_{db}) & \text{if } t_{crit} = 3day \\ \min(86, T_{db}) & \text{if } t_{crit} = 7day \end{cases}$$

Bounding Wet Bulb Temperature as a Function of Dry Bulb Temperature for Various Critical Time Periods

$$TWBMAX\_1hr(T_{db}) := \begin{cases} T_{db} & \text{if } T_{db} \le 85 \\ 85 & \text{if } 85 < T_{db} \le 92 \\ -\frac{1}{3} \cdot T_{db} + 115.67 & \text{if } 92 < T_{db} \le 98 \\ -\frac{5}{4} T_{db} + 205.5 & \text{if } 98 < T_{db} \le 102 \\ NaN & \text{otherwise} \end{cases}$$

$$TWBMAX\_1day(T_{db}) := \begin{cases} T_{db} & \text{if } T_{db} \le 83 \\ 83 & \text{if } 83 < T_{db} \le 84 \\ -\frac{1}{4} \cdot T_{db} + 104 & \text{if } 84 < T_{db} \le 88 \\ -\frac{5}{4} T_{db} + 192 & \text{if } 88 < T_{db} \le 92 \\ NaN & \text{otherwise} \end{cases}$$

$$TWBMAX\_3day(T_{db}) := \begin{cases} T_{db} & \text{if } T_{db} \le 83 \\ 83 & \text{if } 83 < T_{db} \le 84 \\ -\frac{1}{4} \cdot T_{db} + 104 & \text{if } 84 < T_{db} \le 88 \\ -6T_{db} + 610 & \text{if } 88 < T_{db} \le 89 \\ NaN & \text{otherwise} \end{cases}$$

$$TWBMAX\_7day(T_{db}) := \begin{cases} T_{db} & \text{if } T_{db} \le 80 \\ \frac{1}{2} \cdot T_{db} + 40 & \text{if } 80 < T_{db} \le 82 \\ 81 & \text{if } 82 < T_{db} \le 85 \\ -3T_{db} + 336 & \text{if } 85 < T_{db} \le 86 \\ NaN & \text{otherwise} \end{cases}$$

$$T_{wb}(t_{crit}, T_{db}) := \begin{cases} TWBMAX\_1hr(T_{db}) & \text{if } t_{crit} = 1hr \\ TWBMAX\_1day(T_{db}) & \text{if } t_{crit} = 1day \\ TWBMAX\_3day(T_{db}) & \text{if } t_{crit} = 3day \\ TWBMAX\_7day(T_{db}) & \text{if } t_{crit} = 7day \end{cases}$$

Bounding Wind Speed as a Function of Dry Bulb Temperature for Various Critical Time Periods

$$WS_{max}(t_{crit}, T_{db}) := \begin{cases} \min\left(51, -\frac{55}{27} T_{db} + 207.78\right) & \text{if } t_{crit} = 1hr \\ \min\left(35, -\frac{35}{13} T_{db} + 247.7\right) & \text{if } t_{crit} = 1day \\ \min\left(23.5, -\frac{22}{8} T_{db} + 246.75\right) & \text{if } t_{crit} = 3day \\ \min\left(14.5, -3T_{db} + 263\right) & \text{if } t_{crit} = 7day \end{cases}$$

The cap on wind speed is based on 99% confidence level using WF3-ME-15-00011.

Bounding Relative Humidity as a Function of Dry Bulb Temperature for Various Critical Time Periods

$$RH_{min}(t_{crit}, T_{db}) := \begin{cases} \frac{4}{5} T_{db} - 45 & \text{if } t_{crit} = 1hr \\ \frac{30}{24} T_{db} - 53.75 & \text{if } t_{crit} = 1day \\ \frac{34}{27} T_{db} - 43.1 & \text{if } t_{crit} = 3day \\ \frac{23}{26} T_{db} - 9.1 & \text{if } t_{crit} = 7day \end{cases}$$

Bounding Recirculation Effect as a Function of Dry Bulb Temperature and Number of Operable Fans for Various Critical Time Periods based on Wind Speed relationship above.

A second order polynomial curve fit is produced with the Mathcad regress and interp functions for the recirculation values determined in WF3-ME-15-00014.

$$WS_R := \begin{pmatrix} 0 \\ 10 \\ 30 \end{pmatrix} \qquad T_{R\_DCTA} := \begin{pmatrix} 0.0 \\ 2.2 \\ 5.6 \end{pmatrix} \qquad T_{R\_DCTB} := \begin{pmatrix} 0.2 \\ 4.7 \\ 7.7 \end{pmatrix}$$

$$COEF_A := \text{regress}\left(WS_R, T_{R\_DCTA}, 2\right) \qquad COEF_B := \text{regress}\left(WS_R, T_{R\_DCTB}, 2\right)$$

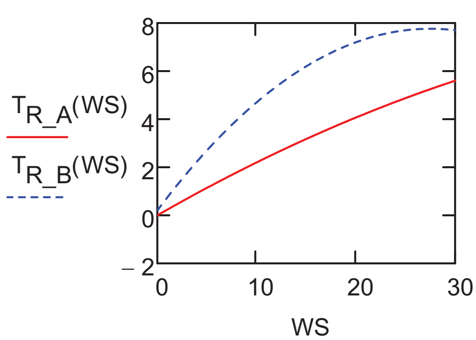
$$COEF_A = \begin{pmatrix} 3 \\ 3 \\ 2 \\ 0 \\ 0.237 \\ -1.667 \times 10^{-3} \end{pmatrix} \qquad COEF_B = \begin{pmatrix} 3 \\ 3 \\ 2 \\ 0.2 \\ 0.55 \\ -10 \times 10^{-3} \end{pmatrix}$$

$$T_{R\_A}(WS) := \text{interp}\left(COEF_A, WS_R, T_{R\_DCTA}, WS\right)$$

$$T_{R\_A}(28) = 5.32$$

$$T_{R\_B}(WS) := \begin{cases} \text{interp}\left(COEF_B, WS_R, T_{R\_DCTB}, WS\right) & \text{if } WS \le 30 \\ 7.7 & \text{otherwise} \end{cases}$$

$$T_{R\_B}(28) = 7.76$$

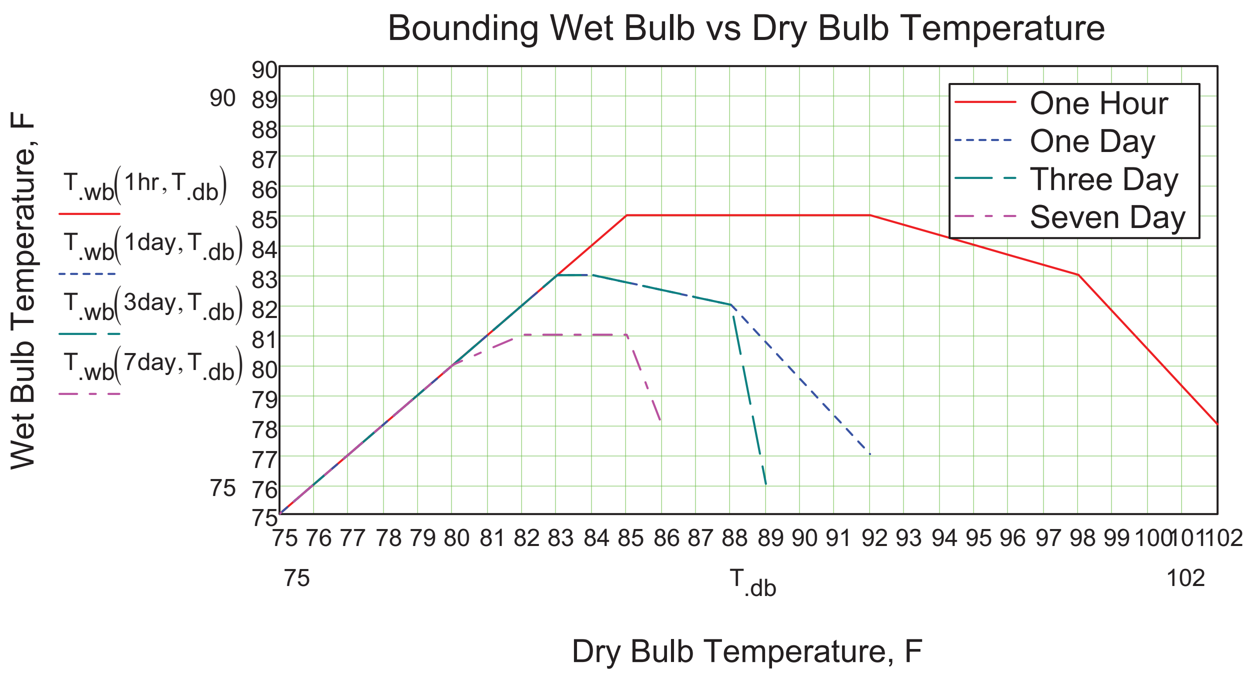


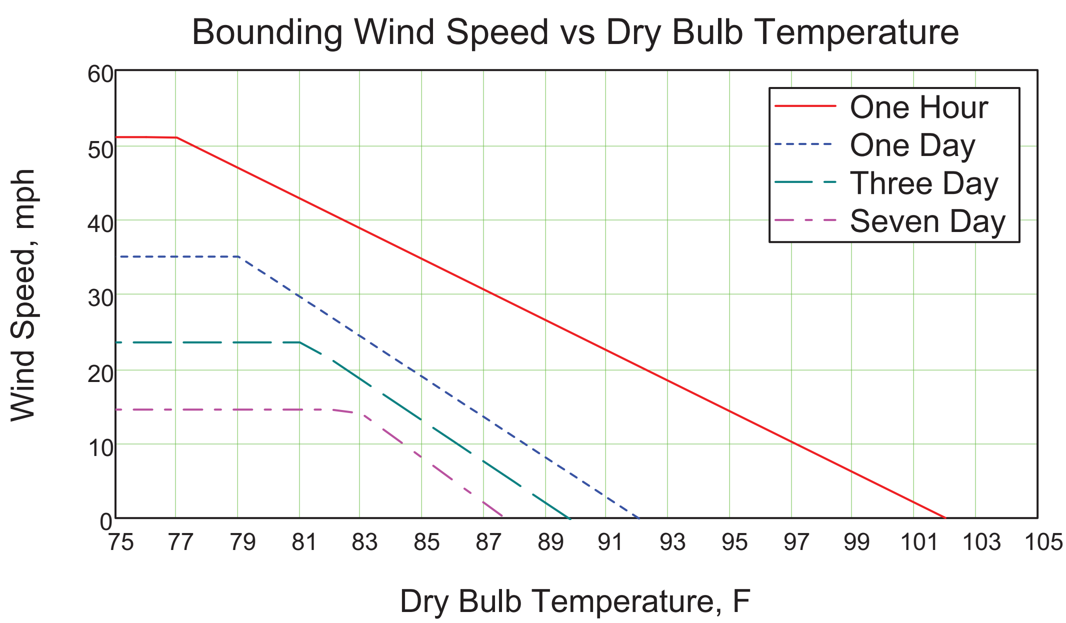
The chart shows that the B train recirculation is generally bounding and should be used in the analysis.

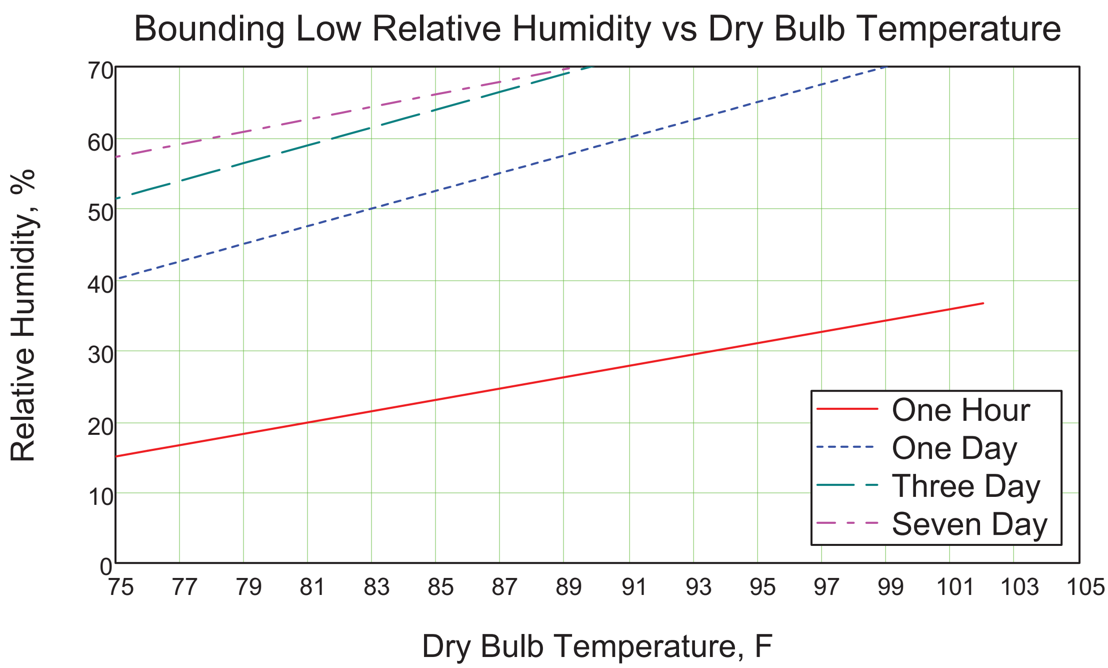
The recirculation from out-of-service fan backflow is added:

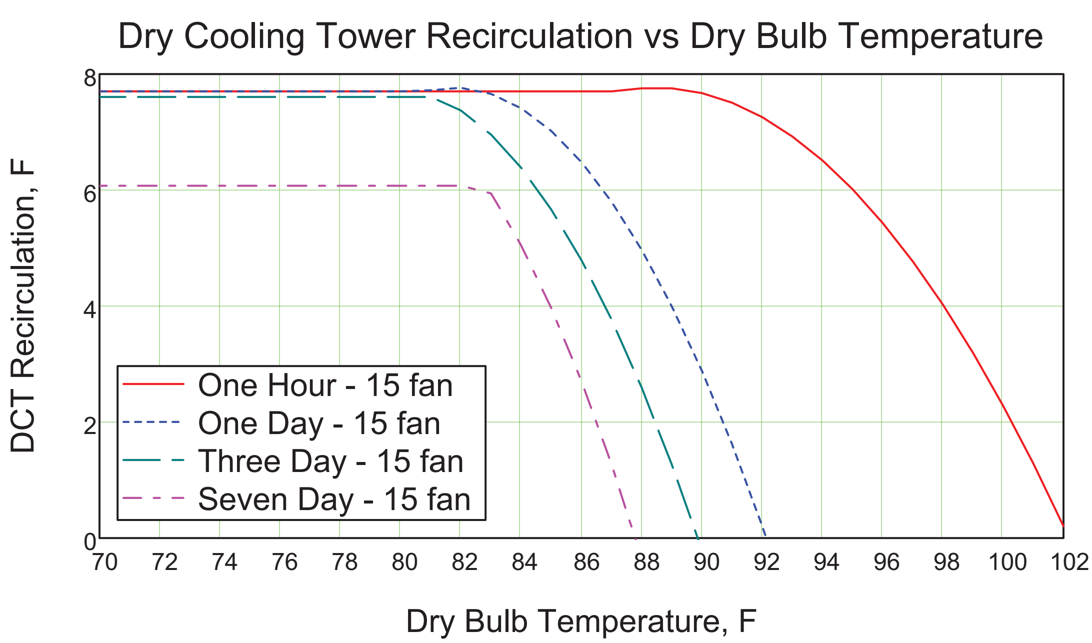
$$T_{R\_DCT}\left(t_{crit}, T_{db}, N_{fans}\right) := T_{R\_B}\left(WS_{max}\left(t_{crit}, T_{db}\right)\right) + 3\cdot\left(15 - N_{fans}\right)$$

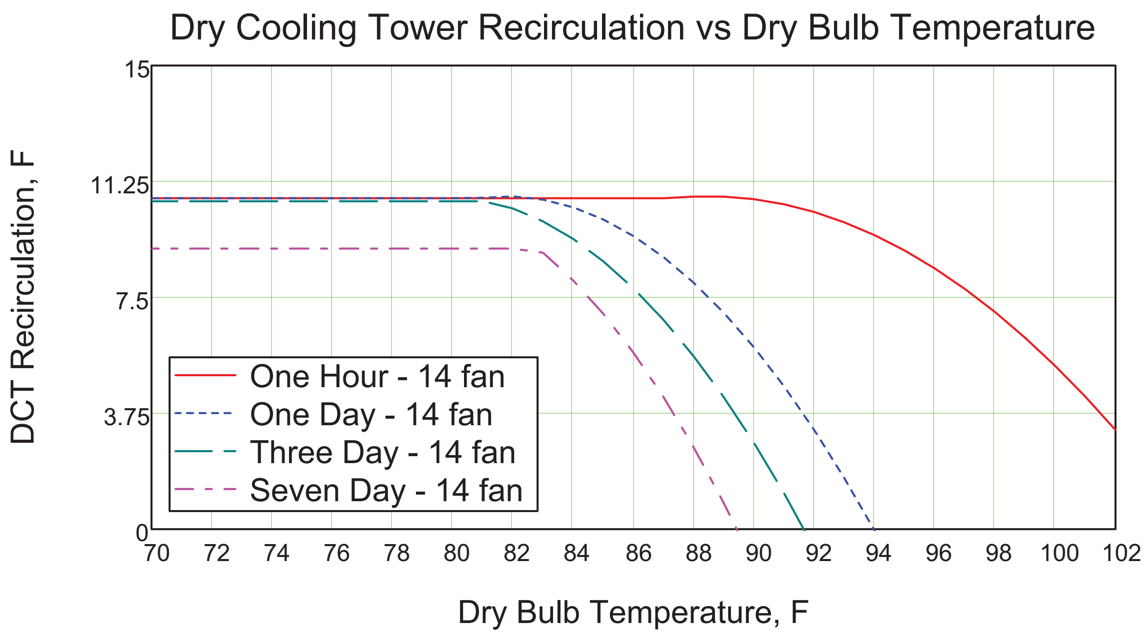
The equations are used to create plots to illustrate the bounding relationships.



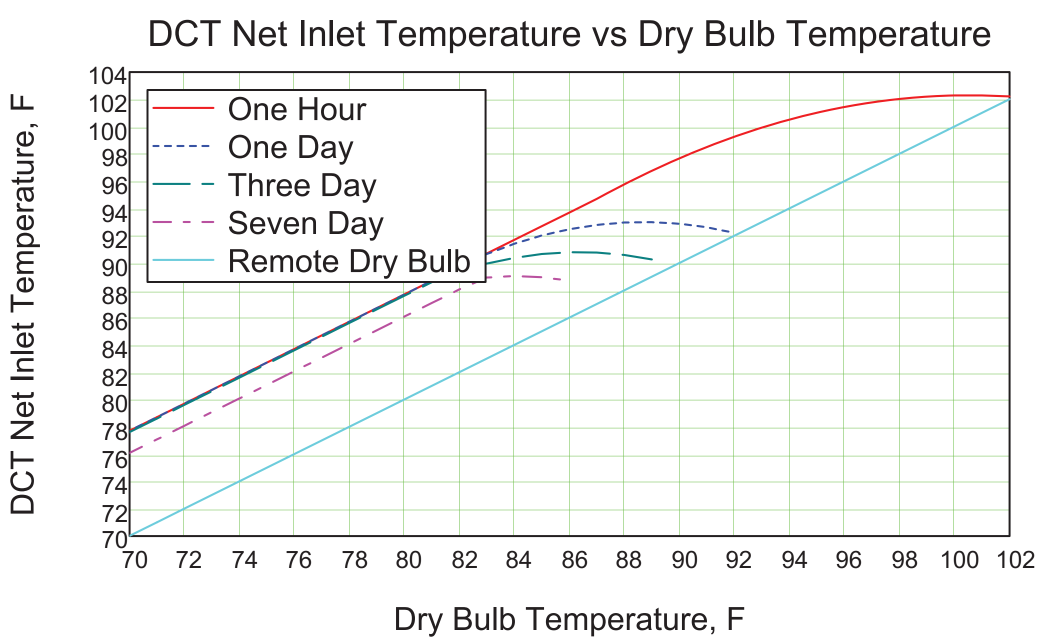



Bounding Low Relative Humidity vs Dry Bulb Temperature
Relative Humidity, %
Dry Bulb Temperature, F
0
10
20
30
40
50
60
70
75
77
79
81
83
85
87
89
91
93
95
97
99
101
103
105
One Hour
One Day
Three Day
Seven Day


Dry Cooling Tower Recirculation vs Dry Bulb Temperature
DCT Recirculation, F
Dry Bulb Temperature, F
0
2
4
6
8
70
72
74
76
78
80
82
84
86
88
90
92
94
96
98
100
102
One Hour - 15 fan
One Day - 15 fan
Three Day - 15 fan
Seven Day - 15 fan



$$T_{NET}(t_{crit}, T_{db}, N_{fans}) := \begin{cases} NaN & \text{if } T_{db} > T_{db\_max}(t_{crit}) \\ (T_{db} + T_{R\_DCT}(t_{crit}, T_{db}, N_{fans})) & \text{if } T_{db} \le T_{db\_max}(t_{crit}) \end{cases}$$



$T_{R\_DCT}(7day, 84, 15) = 5.04$ $T_{R\_DCT}(1hr, 96.6, 15) = 5.041$

$T_{R\_DCT}(3day, 85.7, 15) = 5.065$ $T_{R\_DCT}(1day, 88, 15) = 4.966$

Examples of Tabulated Meteorological Data and Spreadsheet Functions Used for Charts

Meteorological Parameters

Day of Year	Date, Time	TimeCode	Primary Tower 33' 1 hr Avg Temperature, °F	Primary Tower 33' Wind Speed 1hr Avg, MPH	Backup Tower 33' Wind Speed 1hr Avg, MPH	Backup Tower 1hr Ambient, °C*9/5+32	1hr Wet Bulb, °F	1 hr Relative Humidity	Bin Rang	Ave 1 day	Ave 3 day dry bulb	Ave 7 day	Ave 30 day	Ave 3 day wet bulb	Ave 3 day RH	Ave 3 day wind speed, MPH	Ave 1 day wind speed, MPH	Ave 7 day wind speed, MPH	Ave 1 day WB	Ave 7 day WB	Ave 1 day RH	Ave 7 day RH
	Date, Time	TimeCode	C48558	C48545	C48625	C48623	C48560	C48553														
18.42708333	1/19/2015 10:15	42023.43	53.53	2.27			44.53	53.98		52.56	50.22	47.64		44.34	65.58	4.17	4.45	6.66	43.71	44.62	50.88	81.20
18.4375	1/19/2015 10:30	42023.44	54.93	2.22			44.79	53.98		52.54	50.26	47.62		44.36	65.53	4.15	4.37	6.66	43.69	44.59	50.90	81.13
18.44791667	1/19/2015 10:45	42023.45	56.24	2.17			45.05	53.98		52.54	50.31	47.61		44.38	65.47	4.13	4.28	6.66	43.67	44.56	50.91	81.06
18.45833333	1/19/2015 11:00	42023.46	57.64	2.12			45.30	37.48		52.55	50.36	47.60		44.40	65.41	4.11	4.20	6.65	43.66	44.54	50.93	81.00
18.46875	1/19/2015 11:15	42023.47	59.04	3.04			45.58	37.48		52.56	50.41	47.59		44.42	65.32	4.09	4.12	6.65	43.65	44.51	50.78	80.90
18.47916667	1/19/2015 11:30	42023.48	60.43	4.45			46.18	37.48		52.58	50.47	47.58		44.44	65.24	4.07	4.04	6.65	43.64	44.48	50.74	80.81
18.48958333	1/19/2015 11:45	42023.49	61.50	5.97			46.78	37.48		52.60	50.53	47.58		44.46	65.15	4.06	3.98	6.65	43.65	44.46	50.70	80.72
18.5	1/19/2015 12:00	42023.50	62.14	7.50			47.38	33.28		52.64	50.59	47.57		44.49	65.07	4.05	3.93	6.65	43.66	44.43	50.67	80.62
18.51041667	1/19/2015 12:15	42023.51	62.76	7.52			47.98	33.28		52.68	50.66	47.56		44.51	64.99	4.05	3.89	6.65	43.67	44.40	50.58	80.52
18.52083333	1/19/2015 12:30	42023.52	63.34	7.54			48.58	33.28		52.72	50.72	47.56		44.54	64.92	4.05	3.86	6.66	43.70	44.38	50.60	80.43
18.53125	1/19/2015 12:45	42023.53	63.96	7.57			49.18	33.28		52.77	50.78	47.55		44.57	64.85	4.05	3.82	6.66	43.73	44.35	50.62	80.33
18.54166667	1/19/2015 13:00	42023.54	64.65	7.59			49.78	34.97		52.82	50.84	47.55		44.60	64.77	4.04	3.78	6.67	43.77	44.33	50.64	80.23
18.55208333	1/19/2015 13:15	42023.55	65.19	7.61			50.07	34.97		52.88	50.91	47.55		44.63	64.72	4.04	3.75	6.67	43.82	44.30	50.68	80.14
18.5625	1/19/2015 13:30	42023.56	65.48	7.63			50.26	34.97		52.94	50.97	47.54		44.67	64.68	4.04	3.73	6.67	43.87	44.28	50.73	80.06
18.57291667	1/19/2015 13:45	42023.57	65.78	7.65			50.44	34.97		53.00	51.04	47.54		44.70	64.63	4.04	3.72	6.67	43.92	44.26	50.78	79.97
18.58333333	1/19/2015 14:00	42023.58	66.07	7.72			50.63	33.80		53.07	51.10	47.54		44.73	64.58	4.04	3.73	6.67	43.98	44.24	50.83	79.89
18.59375	1/19/2015 14:15	42023.59	66.37	7.78			50.81	33.80		53.12	51.16	47.53		44.77	64.52	4.05	3.74	6.67	44.03	44.22	50.86	79.81

Meteorological Parameters

[illegible]

Complete data set is stored electronically in PDF and Excel formats.

ENCLOSURE, ATTACHMENT 3

W3F1-2019-0005

Attachment 3: Engineering Report WF3-ME-15-00013

Entergy

ENTERGY NUCLEAR
Engineering Report Cover Sheet

Engineering Report Title:
Waterford 3 Ultimate Heat Sink Project UHS Model

Engineering Report Type:

New ☒ Revision ☐ Cancelled ☐ Superseded ☐
Superseded by: ____________

Applicable Site(s)

IP1 ☐	IP2 ☐	IP3 ☐	JAF ☐	PNPS ☐	VY ☐	WPO ☐
ANO1 ☐	ANO2 ☐	ECH ☐	GGNS ☐	RBS ☐	WF3 ☒	PLP ☐

EC No. 52043

Report Origin: ☐ Entergy ☒ Vendor
Vendor Document No.: A13326-R-003

Quality-Related: ☒ Yes ☐ No

Prepared by:	LPI, Inc. Responsible Engineer (Print Name/Sign)	Date:	See Vendor Report
Design Verified:	LPI, Inc. Design Verifier (if required) (Print Name/Sign)	Date:	See Vendor Report
Reviewed by:	Dale V. Gallodoro / Reviewer (Print Name/Sign)	Date:	
Approved by:	Nicholas Petit / Supervisor / Manager (Print Name/Sign)	Date:	

LPI, Inc. Consulting Engineers
Advanced Analysis & Fitness for Service
Failure & Materials Evaluation
Nondestructive Engineering
Est. 1885

WATERFORD 3 ULTIMATE HEAT SINK PROJECT
UHS MODEL

Report No.:
A13326-R-003
Revision No: 4

March 2017

Prepared For
ENTERGY OPERATIONS, INC.
Waterford 3 Steam Electric Station

Prepared By
LPI, Inc.

Lucius Pitkin – established 1885
36 Main Street • Amesbury, MA 01913 • 978.517.3100
New York • Boston • Richland • Sydney • www.lpiny.com

DOCUMENT RECORD

Document Type:	☐ Calculation ☒ Report ☐ Procedure				
Document No:	**A13326-R-003**				
Document Title:	**Waterford 3 UHS Project UHS Model**				
Client:	Entergy Operations, Inc.				
Client Facility:	Waterford 3 Steam Electric Station				
Client PO No:	10478555-01				
Quality Assurance:	**Nuclear Safety Related?** ☐ **No** ☒ **Yes**				
Computer Software Used:	☒ **No**[1] ☐ **Yes**[2]	1. Check NO when EXCEL, MathCAD and/or similar programs are used since algorithms are explicitly displayed. 2. Include Software Record for each computer program utilized			
Instrument Used	☒ **No** ☐ **Yes**[3]	3. Include Document Instrument Record.			

Revision	**Approval Date**	**Preparer**[5]	**Checker**[5]	**Design Verification**[5]	**Approver**[4,5]
0	5/8/14	Gregory Zysk	F. Mulcahy	J. Cooper	Paul Bruck
1	4/18/16	Gregory Zysk	F. Mulcahy	J. Cooper	Paul Bruck
2	10/7/16	Gregory Zysk	F. Mulcahy	J. Cooper	Paul Bruck
3	1/31/17	Gregory Zysk	F. Mulcahy	J. Cooper	Paul Bruck
4	3/15/17	Gregory Zysk	F. Mulcahy	J. Cooper	Paul Bruck

[4] The Approver of this document attests that all project examinations, inspections, tests and analysis (as applicable) have been conducted using approved LPI Procedures and are in conformance to the contract/purchase order.

[5] Electronic signatures may be used only with prior concurrence.

Page 2 of 174 Total Pages (include any Title Sheet and Attachments in page count. Document Back Cover, if utilized, not included in page count)

*Form: LPI-3.1-Rev-**9**-Fig-5-2*

	DESIGN VERIFICATION CHECKLIST						
	Document No(s)[1]:	A13326-R-003				Rev.:	4
	Review Method:	X	Document Review		Alternate Calculation		Test

	Criteria	DV[2]
1	Were the inputs correctly selected and incorporated into design?	JC
2	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed? If applicable, has an as built verification been performed and reconciled?	JC
3	Are the appropriate quality and quality assurance requirements specified?	JC
4	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?	JC
5	Have applicable construction and operating experience been considered, including operation procedures?	JC
6	Have the design interface requirements been satisfied?	n/a
7	Was an appropriate design method used?	n/a
8	Is the output reasonable compared to inputs?	JC
9	Are the specified parts, equipment, and processes suitable for the required application?	n/a
10	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	n/a
11	Have adequate maintenance features and requirements been specified?	n/a
12	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?	n/a
13	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?	n/a
14	Has the design properly considered radiation exposure to the public and plant personnel?	n/a
15	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	JC
16	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	n/a
17	Are adequate handling, storage, cleaning and shipping requirements specified?	n/a
18	If software was used, have the computer type and operating system been properly identified? Is use of the software, hardware and O/S appropriate for the conditions, components evaluated? Has a V&V been performed?	n/a
19	Are requirements for identification, record preparation review, approval, retention, etc., adequately specified?	n/a
20	Has an internal design review been performed for applicable design projects? Have comments from the Internal Design Review been appropriately considered/addressed?	JC

(1) Include any drawings developed from reviewed documents, or include separate checklist sheet for drawings
(2) Design Verifier shall initial indicating review and mark N/A where not applicable

	Printed Name:	Signature	Date:
DV Completed By:	John Cooper	[signature]	3/15/17

Page	1	of	1	Total Pages	(include DV Checklist and Comment Resolution sheets in page count)

Form: LPI-3.1-Rev-9-Fig-5-5

Record of Revision

Revision No.	Date	Description of Change	Reason
0	5/8/2014	n/a	Original Issue
1	4/18/2016	Section 2: Completely rewritten to provide updated user instructions. Section 3: Assumption 2 modified and Assumptions 4-7 added. Section 4: Added reference to Attachment A models. Section 4.1: Circuit model equation set updated to reflect current model. Section 4.2.1: Removed discussion of alternate loads that can be added by user. This option is not available. Updated heat load Figures 4-1 and 4-2. Added Section 4.2.2: BTP-5.4 loads. Renumbered all following sections in 4.2 and Section 4 figures. Section 4.2.3: Edited to show new FPC load options. Section 4.3: Added discussion of percent area input to DCT model and DCT airflow model. Section 4.4: Added number of fans to WCT discussion. Added discussion of WCT curves and added Figure 4-11. Changed error vs. test data. Section 4.6: Clarified EC and auxiliary loads and added tornado and normal load options. Section 4.7: New Section. Section 5.1: Updated LOCA evaluation with new heat loads and results. Section 5.2: Updated LOCA water consumption with new results. Section 5.3: Core Offload Analysis Removed. Section 7: Update removed references. Added	Updated model to accommodate technical changes and user format requests.

		References 21 through 27. Added table of attachment cross references. Attachment A: All pages revised for modular format mathcad sheets. Attachment C: Modified Title Attachment D: New Fans Out of Service Curves Added. Minor editorial changes made, repaginated and updated figure numbers and references throughout.	
2	10/7/16	Section 4.7 updated with description of new recirculation model. Section 5.2: Model results updated with new flat plate design and recirculation. Attachment A: new Recirc model and UHS model referencing the Recirc module. Changes indicated with revision bar. Attachment D: New 4 Fans in 1 Cell Out of Service Curves Added.	Updated model to accommodate changes for flat deflector design and modified recirculation model.
3	See document record.	Section 4.4 updated WCT curves Section 5.2: Model results updated with new WCT curves. Attachments A&D: new WCT model and UHS model referencing the WCT module.	Updated model to capture low ACCW flow performance of WCT.
4	See document record.	Section 2.2, 4, Att. A: Modified name “BTP5.4 Loads” to “Non-LOCA Shutdown”. Section 3.2, 4, Att. A: Modified DCT description and model to add fin efficiency term Section 4: Modified EC loads for 2 UHS operation. Att. A: No. of fans added to WCT curve data. Design clean condition added to CCWHX benchmark cases. Restricted max wind velocity for recirculation. Changes indicated in yellow highlight (body) and with revision bar (Att A).	Review comment and improved accuracy of DCT air flow correction term.

Form: LPI-3.1-Rev-9-Fig-5-7

Table of Contents

ATTACHMENTS Total Pages

Table of Figures

Acronyms

ACCW	Auxiliary Component Cooling Water
CCW	Component Cooling Water
CCWHx	CCW heat exchanger
CFC	Containment Fan Coolers
CWT	Cold water temperature
DCT	Dry Cooling Towers
EC	Essential Chillers
FPC	Fuel Pool Cooling
HPSI	High Pressure Safety Injection
HWT	Hot water temperature
LOCA	Loss Of Coolant Accident
PMID	Plant Maintenance Issue Document
SDCHx	Shutdown Cooler Heat Exchanger
UHS	Ultimate Heat Sink

WCT	Wet Cooling Towers
WF3	Waterford 3

Variables

c_p	= specific heat
E	= Evaporation Rate
EC_{sw}	= used to apply loads to ACCW (EC_{sw} = 0) or CCW loop (EC_{sw} = 1)
ff	= fouling factor
G	= Gas (air) flow rate
GPMaccw	= ACCW loop flow rate
GPMccw	= CCW loop flow rate
h_i	= inlet enthalpy
h_e	= exit enthalpy
L	= Liquid (water) flow rate
L/G or LG	= Liquid to Gas ratio
m`	= mass flow (lb/m)
Nfans	= number of fans in operation
ρ	= density
Q	= heat transfer (BTU/hr of MBTU/hr = 10^6 BTU/hr)
Rg or Range	= Temperature difference between Outlet and Inlet Temperatures
ΔT	= Temperature change (F)
Taccw_out	= ACCW temperature exiting CCWHx
Tccw_out	= Temperature of CCW entering containment
TCW	= CCW set point temperature for control of ACCW flow rate
Tcon_out	= Temperatureof CCW leaving containment
TCIN, TCOUT	= FPC_HX incoming, outgoing CCW temperature
Tdb	= Dry bulb Temperature
Tdct_in	= DCT inlet temperature
Tdct_out	= DCT outlet temperature
Tec_out	= EC outlet temperature
TFIN, TFOUT	= FPC_Hx incoming, outgoing fuel pool temperature
Twb	= Wet bulb temperature
Twct_in	= WCT inlet temperature
Twct_out	= WCT outlet temperature
U	= heat exchanger heat transfer coefficient
w_i	= inlet humidity ratio
w_e	= exit humidity ratio

1 Introduction and Purpose

The Waterford 3 (WF3) Ultimate Heat Sink (UHS) system provides a means to cool heat loads from the reactor and auxiliaries during normal and accident conditions. Heat is removed by the Component Cooling Water (CCW) system to the Dry Cooling Towers (DCT) and CCW heat exchanger. The CCW heat exchanger transfers heat to a second Auxiliary Component Cooling Water (ACCW) loop that discharges heat through the Wet Cooling Towers (WCT). Heat removed is dispersed to the atmosphere by the DCTs and WCTs. A simplified diagram of the UHS system is presented in Figure 1-1 [8a][1].

Several issues have been raised with respect to the UHS system and its ability to maintain the design and license basis cooling water supply temperature and water inventory margin. These include questionable design basis assumptions and methodology regarding DCT and WCT recirculation effects, out-of-service fans, cooling water temperature control, and other performance issues. The recirculation effect refers to the potential for the DCT or WCT to draw hotter exhaust side air into the inlet side, increasing the effective ambient temperature and reducing heat removal performance (see also CR-WF3-2012-2332 [8a]).

The overall project is intended to revise the UHS design and licensing basis. This will be accomplished through a calculation methodology that considers the accurate modeling of components' heat removal performance and interaction with CCW/ACCW loop temperatures. Additionally, modifications will be implemented as necessary to restore adequate design basis margin to accommodate degraded and nonconforming conditions that may potentially arise.

[1] Numbers in brackets [xx] identify numbered references provided in Section 7.

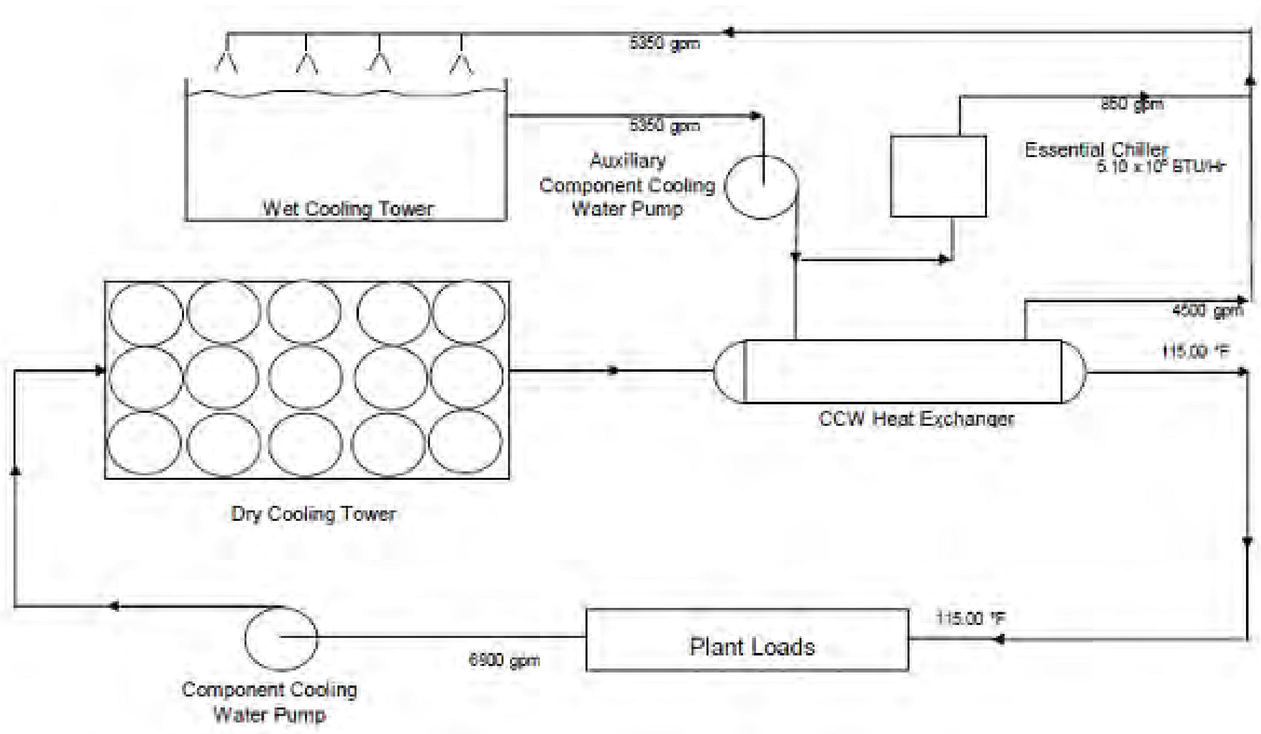


Figure 1-1: Simplified Diagram of the UHS

1.1 Scope

The scope of this report addresses the development of a heat transfer mathematical model of the UHS system (UHS model), including modeling of component heat transfer performance and interaction with CCW/ACCW loop temperatures.

The work included herein is performed in accordance with the requirements of Entergy Contract Number 10478555-01 [1].

1.2 UHS Mathematical Model Approach

The UHS model described herein is an integrated analysis model for the evaluation of a variety of heat loads and conditions in the CCW and ACCW loops. The analysis method is integrated in that the calculation of heat flows around each loop is balanced with component heat transfer models without requiring external software or tabular data.

The analysis model is developed in Mathcad14 [11] and the Mathcad worksheets are a deliverable for this project. Hard copies of the Mathcad worksheets with all formulas are provided in Attachment A. It is intended that an individual user of the analysis model select appropriate boundary conditions and heat loads for detailed analysis. Some input conditions are provided in the model, including heat loads from LOCA analyses. Example analysis results using specific inputs are provided in Section 5.

It should be noted that Mathcad provides a calculation method and not a locked executable program. The worksheets are set up to show the results of benchmark validation cases. Verification checks are performed upon each use and can be used to demonstrate that the worksheets are performing as expected for the particular set of parameters selected. However, any application of the methods provided herein require checking and verification by the end user.

INPUT CONDITIONS ARE PROVIDED FOR THE USER'S CONVENIENCE ONLY. RESULTS PROVIDED HEREIN DO NOT REPRESENT A DESIGN BASIS ANALYSIS.

User instructions are provided in Section 2.

2 User Instructions

This section provides a brief description of the input options for use of the UHS model. The user should be familiar with the requirements of Mathcad14 [11] to run the model. Details of the development of specific component models and inputs that are included in the UHS model are provided in the following sections.

2.1 General Information

Component Module File Description

The base Mathcad model is named UHS1.xmcdz. Only the UHS1.xmcdz file needs to be opened in Mathcad to evaluate a specific condition. All other (component) modules are written as separate files that are called up by this base file using a relative address.

The component modules include the following:

Water Properties.xmcdz – This module returns water density and thermodynamic properties as a function of temperature.

LOCA Loads.xmcdz – This module contains transient heat loads as a function of time (see also Section 4.2). Containment LOCA loads are per [5b]. Fuel Pool Cooling Loads are per [5e]. Branch Technical Position (BTP) 5.4 provides the basis for shutdown loads, referred to herein as BTP 5.4 loads. See also NUREG 0800 Section 5 [28].

DCT.xmcdz – This module provides the Dry Cooling Tower (DCT) heat transfer as a function of CCW flow rate and temperature, dry bulb temperature, number of fans in service, and percentage of DCT available.

WCT.xmcdz – This module provides the Wet Cooling Tower (WCT) heat transfer as a function of ACCW flow rate and temperature, wet bulb temperature, and number of fans in service.

CCWHX.xmcdz – This module provides the Component Cooling Water Heat Exchanger (CCWHX) heat transfer as a function of CCW and ACCW flow rates and temperature, and tube plugging and fouling.

Recirc.xmcdz – This module provides bounding ambient conditions for a selected analysis time period and recirculation values for the DCT and WCT.

Automatic Calculation

If mathcad is set to receive inputs without automatic calculation (menu…/tools/calculate/), press "F9" to perform evaluation up to the current screen location.

Scriptable Components

Mathcad14 [11] permits the use of scriptable components which are applied herein as pull-down menus for the user. The scriptable components should NOT BE disabled.

Verification of Component Modules

Within the base UHS1.xmcdz module, each component module is called and checked to provide acceptable results against benchmark tests as described within this report (see Section 4). Each of the checks should produce an "OK" indicating acceptable results.

Security

All component modules are locked and cannot be edited by the user. The base UHS1.xmcdz module is locked, but input variables, highlighted in yellow, can be edited. Seed values may also be edited but are not highlighted (see also page 19). Locked items may be edited in the master file, which is password controlled. Changing locked items will require a revision to this report to address the changes.

Mathcad Default Worksheet Options

The mathcad default values for array origin (0), convergence and constraint tolerance (0.001), should remain unchanged for appropriate model operation.

2.2 User Inputs

Example input screens from UHS1 are shown in Figure 2-1 and Figure 2-2 and the inputs are described in more detail below.

Analysis types, boundary conditions, and various plant parameters are included in the model. It is the responsibility of the calculation preparer to develop boundary and analysis conditions applicable to the specific analyzed event.

Type of Analysis

The user may select from a pull-down menu for the evaluation types listed below. The EVAL variable tracks the analysis type.

LOCA and Non-LOCA shutdown analyses provide evaluations of transient conditions by repeating a steady state calculation at each time step and heat load (see also Section 3.2, Assumption 1). The remaining analysis types (Tornado, Core Offload, Normal Operation) provide a single solution only.

- LOCA Cold Leg or Hot Leg Break (EVAL=0 or 1): These evaluations solve for temperatures and ACCW flows based on a design basis Loss of Coolant Accident (LOCA) heat load profile (BTU/sec) over a period of time. An individual solution is

provided for the maximum heat load. A cumulative solution is provided to determine water consumption in the WCT basin.

- Non-LOCA Shutdown (EVAL=2): This evaluation solves for temperatures and ACCW flows based on a heat load profile (BTU/sec) as described in BTP5.4 over a period of time. An individual solution is provided for the maximum heat load. A cumulative solution is provided to determine water consumption in the WCT basin for loads defined over a time period.
- Post-Tornado Fixed Loads (EVAL=3): An individual solution is developed for the input tornado loads and analysis boundary conditions. CCW and ACCW loop temperatures and heat loads are determined. It is recommended that the user perform several solutions representing various time periods during the event based on the assumed availability of the UHS components and their heat loads
- Operating Loads (EVAL=4): A single heat load is input by the user. CCW and ACCW loop temperatures and heat loads are determined.

Time: The time period associated with the analysis is selected. Typically, a 1 hour period is selected to maximize ambient conditions for upper bound heat transfer evaluations to demonstrate the limiting temperatures and heat transfer of the UHS. Longer time periods can be selected, as appropriate, for conditions in which WCT water consumption is evaluated.

Analysis Boundary Conditions

The user may enter input data into each highlighted region. To use the default values, the default variable is entered as the definition, e.g. $T_{db}=T_{db}$. Alternatively, a fixed number may be entered, e.g. $T_{db}=100$.

1. Dry Bulb temperature: This is the ambient temperature condition in ^{o}F. The maximum (TDBMAX) is provided as a default based on the selected time period.

2. DCT Recirculation: This is the expected increase in inlet temperature (in ^{o}F) due to recirculation of the DCT. The default values are based on evaluation of DCT performance and include a penalty for up to 3 DCT non-covered fans out of service.

3. Wet Bulb temperature (in ^{o}F). This input includes two choices for maximum and minimum bound wet bulb temperatures.

   a. The function T_{wbmax} provides an upper bound wet bulb temperature for a given dry bulb temperature, based on plant MET tower data. Upper bound wet bulb temperature is conservative for evaluating the limiting CCW and ACCW temperatures and heat transfer of the UHS and is the default for 1

hour evaluations. The maximum WCT recirculation value is added to the upper bound wet bulb temperature value.

b. The function T_{wbmin} provides a lower bound wet bulb temperature for a given dry bulb temperature, based on plant MET tower data. WCT water consumption is maximized by lower bound wet bulb temperature conditions and is the default for longer duration evaluations (1-day tthrough 7-day). No WCT recirculation is included.

4. Resulting Boundary Condition Values: For user convenience, the boundary condition temperature data is provided. The WS_{max} value is the maximum wind speed associated with the given dry bulb temperature, and it is used in the evaluation of DCT recirculation.

5. CCW flow rate: This is the CCW loop flow in gpm.

6. ACCW flow rate: This is the ACCW flow rate in gpm.

7. TCW: This is the CCW temperature (in ^{o}F) setting for the CCW supply to containment equipment coolers. This is used for the transient cases in which ACCW flow is varied to maintain this constant temperature. For example, this variable may be set using an instrument uncertainty to a lower control point of e.g. 115 ^{o}F -2.6 ^{o}F = 112.4^{o}F for LOCA analysis. Lower temperatures should be used as appropriate for non-LOCA evaluations.

8. N_{UHS}: This is the number of operating UHS loops (1 or 2). This divides all loads applied between 1 or 2 loops.

9. DCT_{fans} and DCT_{OOS}: DCT fans in service and out of service without covers. The user may select between 1 and 15 DCT fans in service. The "DCT_{fans}" variable linearly reduces the DCT full heat transfer in proportion to the available fans. The DCT_{OOS} variable adjusts for increased DCT recirculation effects for uncovered, out of service fans.

10. WCT_{fans}: WCT fans in service: The user may select the number of fans in service for the WCT. Curves for performance with a reduced number of fans were developed as part of this project and are contained in the WCT module. Note that this input is not used in natural draft mode (see also Section 4.4).

11. P_{dct}: The user may select the percentage of DCT area available to reflect plugging or other changes to available tube area. The Hudson Products heat transfer curves for 100% area and 95% area are interpolated to provide reduced heat transfer between these two area conditions. The user should exercise caution for values beyond this range (see also Section 4.3).

12. AIR: This variable is used to define the fan flow rate (acfm) and adjust the heat transfer characteristics of the DCT to address modified air flow through the DCT. The default value is a calculated lower bound based on CFD evaluation of the DCT performance [19].

User Input Section

In this section, the type of analysis (LOCA, Shutdown, etc.) and the steady state or transient analysis conditions are selected. Transient analysis conditions are only available for LOCA conditions for which tables of heat loads with time are provided as input. Transient analyses are performed as a series of repeated steady state evaluations to determine long term water consumption over the heat load period.

Type of Analysis

Select options from menus

EVAL :=
- LOCA Cold Leg (RCP) Break
- LOCA Hot Leg Break
- BTP 5.4 Shutdown
- Post Tornado Fixed Loads
- Operating Loads

time :=
- 1 hour
- 1 day
- 3 day
- 7 day

$EVAL = 0$

$t_{crit} := TC(time)$

Analysis Boundary Conditions

Type in input value or function for each highlighted field.

Select Default Limits or Enter Values	Default Limits	User Entered
Drybulb Temperature (deg F)	$T_{db} := TDBMAX(t_{crit})$	$T_{db} := T_{db}$
DCT Recirculation Temperature Increase (deg F)	$DCT_R := T_{R\_DCT}(t_{crit}, T_{db}, DCT_{OOS})$	$DCT_R := DCT_R$
Wetbulb Temperature (deg F) *For conservatism, MAX + max recirc for max heat removal and MIN + 0 for WCT water consumption*	$T_{wb} := \begin{cases} TWBMAX(t_{crit}, T_{db}) + 8.8 & \text{if } t_{crit} = 1hr \\ TWBMIN(t_{crit}, T_{db}) & \text{otherwise} \end{cases}$	$T_{wb} := T_{wb}$

Resulting Boundary Condition Values

$T_{db} = 89$ $DCT_R = 1.3$ $WS_{max}(t_{crit}, T_{db}) = 2$ $T_{db} + DCT_R = 90.3$ $T_{wb} = 76$

Flow Rates

CCW flow rate (gpm)	$GPM_{ccw} := 6900$
ACCW flow rate (gpm)	$GPM_{accw} := 5350$
CCW Control Temperature (deg F)	$TCW := 112.4$
Number of UHS Loops in Service *Note: N_{UHS}=2 divides loads equally between 2 Loops.*	$N_{UHS} := 1$

DCT/WCT Fan Conditions

Number of DCT fans in service — *Note DCT Recirc is increased for 1-3 fans OOS without covers* — $DCT_{fans} \equiv 15$

Number of DCT OOS without covers — $DCT_{OOS\_noc} \equiv 15 - DCT_{fans}$ — $DCT_{OOS} \equiv DCT_{OOS\_noc}$

Number of WCT fans in service — $WCT_{fans} := 8$

Complete WCT cell out of service (4 fans/1 cell)? 1=yes, 0=no — $WCT_{cell\_out} := 0$

Percentage DCT Area available (95%-100%) — $P_{dct} := 99.75\%$

Average DCT Air Flow (1000 cfm) — $AIR := -0.46 \cdot (WS_{max}(t_{crit}, T_{db})) + 179.86$ — $AIR := AIR$ — $AIR = 178.9$

Figure 2-1: UHS1 Input Page 1

Heat Loads and Options

Fuel Pool Cooling Loads

Fuel Pool Cooling (FPC) loads can be input by 2 methods. First, the FPC transient heat loads with time can be included for the transient cases (LOCA and Non-LOCA/BTP 5.4) by selecting FP_{sw}="On". These time dependent loads are included in the LOCA Loads module (see also Section 4.2). The transient FPC loads do not affect steady state analysis types (Tornado, etc.) Second, a constant FPC load (BTU/hr) can be applied using the FPC variable. This load is applied to all analysis types and is additive with the transient FPC loads, if selected.

Essential Chillers

The user may input the Essential Chiller (EC) heat loads (Q_{EC} in BTU/hr), the flow rate to the EC (GPM_{chill} in gpm), and a switch (EC_{sw}) to determine the loop to which the EC loads should be applied, i.e. to the CCW or ACCW loops.

Auxiliary Loads

The user may input auxiliary heat loads from the EDG, HPSI, and containment spray systems (Q_{aux} in BTU/hr). These loads are added directly to the LOCA or other heat loads for all analysis types.

CCW Heat Exchanger (CCWHX)

The user may input criteria for evaluating the CCWHX effectiveness including the number of tubes plugged (N_{plug}) and fouling factors (ff_o, ff_i in hr-ft^2-^{o}F/BTU) for both shell and tube side. These parameters, along with the flow rates defined above, are used in the evaluation of the CCWHx heat transfer coefficient.

Options for Tornado Analysis

WCT_{ND}: This switch may be used to set the WCT to operate in normal or natural draft mode. Performance curves for both modes are contained in the WCT module.

Q_{Tor}: The user may input post-tornado heat loads (in BTU/hr) applied only to the post-tornado analysis type (EVAL=3).

Options for Normal Operation Analysis

Q_{Norm}: The user may input a normal heat load in BTU/hr that is applied to Operating Loads analysis (EVAL=4).

Heat Loads and Options

Type in input value or function for each highlighted field.

Fuel Pool Cooling Loads

Note: FPC transient loads and/or constant values can be included with LOCA and BTP5.4 transients. Constant value FPC loads need to be input for other evaluation conditions.

Include FPC transient loads for LOCA and BTP5.4	FP_{sw} := On / Off
Constant FP loads (BTU/hr)	$FPC := 0 \cdot 10^{6}$
Essential Chillers	
Essential Chillers heat load (BTU/hr)	$Q_{EC} := 5.1 \cdot 10^{6}$
Essential Chiller Flow (gpm)	$GPM_{chill} := 850$
Loop selection switch for EC loads, *select option* if ECsw = 0, ACCW if ECsw = 1, CCW	EC_{sw} := ACCW Loop / CCW Loop
Auxiliary Loads	
Heat load from EDG, HPSI, LPSI, and Containment Spray (BTU/hr)	$Q_{aux} := (10) \cdot 10^{6}$
CCW Heat Exchanger	
CCWHX Number of plugged tubes	$N_{plug} := 63$
CCWHX Fouling factor, shell side	$ff_{o} := 0.0012 \cdot \left(hr \cdot ft^{2} \cdot F\right) \cdot BTU^{-1}$
CCWHX Fouling factor, tube side	$ff_{i} := 0.0 \cdot \left(hr \cdot ft^{2} \cdot F\right) \cdot BTU^{-1}$
Options for Tornado Analysis	
WCT Natural draft mode or normal operation Logical switch = 0 for normal, 1 for natural draft	WCT_{ND} := Normal Operation / Natural Draft Mode
Post-Tornado Analysis Heat Load (BTU/hr)	$Q_{Tor} := (0) \cdot 10^{6}$ *Note: This heat load only used if EVAL=3.*
Options for Normal Operation, Heat Load (BTU/Hr)	$Q_{Norm} := (0) \cdot 10^{6}$

Figure 2-2: UHS1 Input Page 2

Additional Options for Water Loss Model

Several additional options are available to the user to optimize the water loss evaluation. These options are highlighted in yellow and can be found on the pages in Att. A as noted below.

"Limit" variable (pg A12). This variable permits the user to set a DCT outlet temperature to determine the time in the transient analysis at which the DCT returns this limit temperature ($T_{project1}$). A second projected time ($T_{project2}$) is evaluated (pg A13) to determine the time in the transient analysis at which the DCT capacity exceeds the heat load. Either of these projected times can be used to evaluate a termination point for the transient (*Calculate Conditions for CCW Loop to return limit temperature from DCT*). In this calculation, all conditions defined above (T_{db}, T_{wb}, recirc, etc.) are used. Because this is a multi-day forward projection, appropriate multi-day time periods should be selected.

Options for Water Loss Model (pg A14)

The margin (MAR) variable permits the user to input a flow rate (gpm) above the EC flow rate to ensure that a minimum amount of ACCW water passes through the CCWHX. This is needed to terminate the transient model for conditions of the ACCW flow rate being reduced to amounts lower than can be reliably analyzed for low heat loads that occur late in the transient model.

The projected time ($T_{project}$) is a forward time projection beyond the end of the transient analysis used for estimation of WCT water use, typically selected as the minimum of $T_{project1}$ and $T_{project2}$. If the transient is terminated (ACCW < MAR) before reaching a DCT outlet temperature equal to the user defined limit (see "limit variable", above) or before the DCT capacity exceeds the heat load, the projected time is used with the final calculated WCT water use rate to project water use until the projected time is reached. This produces a conservative result for decreasing heat loads late in the transient.

Additionally, it is noted that under some user input conditions, the multi-equation solver within Mathcad may not converge on a solution to the 8 equations in the circuit model. The seed values (pg A6, "initial seed values") chosen have been successfully tested for all plant analysis cases to date. However, these values may be changed by the user to help the model converge under conditions not currently tested. While edit can be made, the seed variables are not highlighted as they are not expected to require change for most analysis cases.

This summarizes the available user input options. The remainder of the UHS worksheet consists of heat transfer models for the system components (DCT, WCT, CCWHx) as described below.

3 Inputs and Assumptions

3.1 Inputs

Inputs to this investigation are identified as References in Section 7 of this report.

3.2 Assumptions

1. Steady State Conditions. The heat transfer through the UHS is considered to occur at steady state conditions. The CCW water temperature supplied to containment is assumed to start at the design basis temperature control setpoint and temperatures throughout the system are calculated based on verified heat exchanger performance characteristics and ambient conditions. This is a conservative assumption in that it ignores the heat absorption capacity of the mass of water in the CCW and ACCW loops, which will lower and delay the effects of peak containment heat loads on the CCW system. Note that under these assumptions, the WCT is assumed to be fully operating based on instantaneous rise of the basin temperature to require all fans.

2. The DCT is assumed to operate in its service condition, based on the heat transfer parameters described in [6h]. This is a conservative assumption based on the closed cooling water being a closed loop system that has not exhibited fouling problems. The DCT is periodically inspected and cleaned to ensure performance is not degraded. PMIDs 14508, 14509, 5382, and 8549 [16] define the requirements for inspection and cleaning the tube bundles and performing periodic maintenance on the fans.

3. Heat transfer from CCW and ACCW piping is not credited. This is very conservative because heat load from piping contributes significantly to the Essential Chiller heat load. The Essential Chillers attempt to maintain design basis room temperatures in the Reactor Auxiliary Building. The room temperatures are lower than the CCW piping, which runs through them and is not insulated. Therefore, as per calculations 5-T [5l] and its references, significant heat is transferred from the warm CCW piping and external surfaces of component heat exchangers to the room coolers. That heat transfer is conservatively accounted for only as gross heat load to the Essential Chillers in determining the capacity of the UHS but could be realistically treated as removed from the total UHS heat load by the piping.

4. The WCT curves for operation under one or more fans out of service, including all fans out of service (natural draft), are developed from analyses considering the WCT fan curves, fill flow characteristics, ambient conditions, etc. The natural draft

curves are correlated to a tested condition. However, it is assumed that WCT performance curves with one or more fans out of service will be verified by testing.

5. The WCT curves for operation under one or more fans out of service do not consider back-flow or short-cutting through the open fan. It is assumed that a cover will be placed over the out of service fan to prevent this flow reversal, unless all four fans within one cell are out of service. The WCT is divided into 2 cells and it is assumed there is no air flow between cells.
6. It is assumed that the user shall input appropriate conservative input values including ambient conditions, bounding flow rates, heat loads, etc, including DCT and WCT recirculation. Default values are provided for recirculation based on evaluation of the DCT with deflector panels in place to control recirculation.
7. The ambient conditions applicable to analyses over various time periods were developed based on observed conditions as documented in [5p]. This report is accepted as an input, and since it is based on historical data, it is not expected to change. Verification of the final inputs should be made prior to use of the mathcad worksheets developed herein.

There are no other assumptions that affect the conclusions drawn in this report.

4 Methodology

This section of the report addresses the methodology used in the development of the UHS model including a detailed discussion of component models. The following subsections contain descriptions of the model approach, the conditions used for the default calculation, instructions for user modification of these inputs, and demonstration of model accuracy. All models are presented in detail in Attachment A.

4.1 Heat Balance Model

The calculation of CCW and ACCW temperatures is based on steady state conditions around two loops to which the heat added or removed changes the water temperature across each component by conservation of energy [12]:

$$Q = m' \cdot c_p \cdot \Delta T$$

Where:

Q = heat transfer rate (BTU/hr)
m` = mass flow (lb/hr)
c_p = specific heat of water (BTU/lb-^oF)
ΔT = temperature change (^oF)

A diagram of the two loop model is provided in Figure 4-1 with primary heat flows in red. As described in Section 1, each major component provides heat transfer to or from the CCW and ACCW loops. Starting at the bottom, the containment/auxiliary heat loads provide heat into the CCW loop as a function of the CCWHx outlet temperature, i.e. Qin(Tccw_out). For a LOCA analysis, the heat is removed from Containment Fan Coolers (CFCs) and other accident loads. Similarly, the DCT, WCT, CCWHx and Essential Chillers (EC) exchange heat with the CCW and ACCW loops as described above. Across each component, the temperature change is determined per the reordered heat balance equation, $\Delta T = Q/m` \cdot c_p$.

Under normal operating conditions, the EC heat loads are included in the CCW loop as indicated by the dashed line in Figure 4-1. The ECs switch from the CCW loop to the ACCW loop based on the CCW temperature exiting the CCWHx reaching 105^{o}F [3]. The ECs are included in the ACCW loop under design basis LOCA heat loads. As stated in Section 3.2, this is assumed as a steady state condition for this calculation method and switching points are not evaluated.

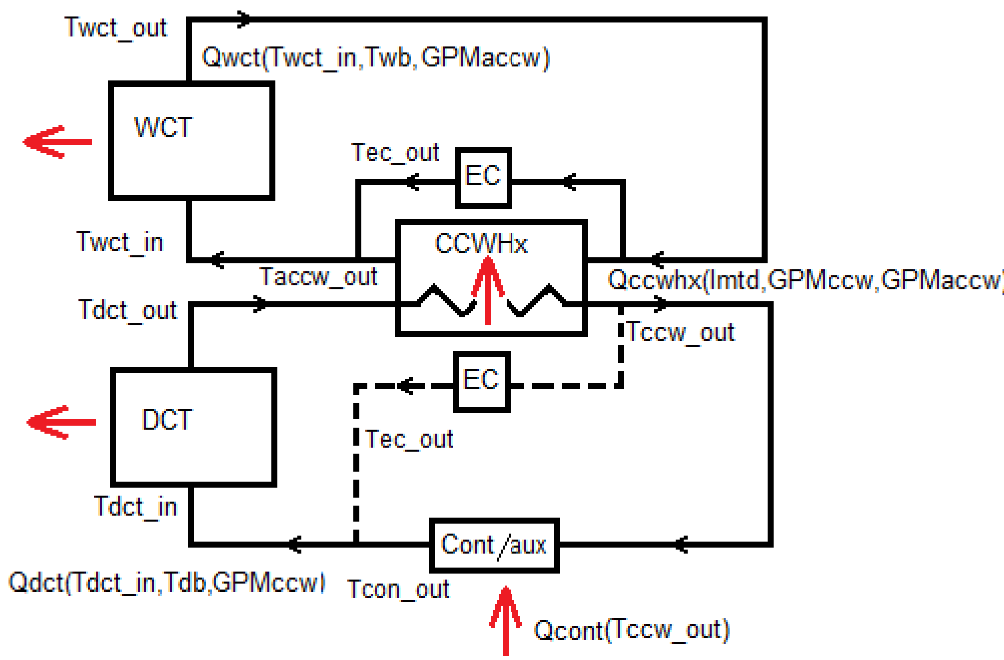


Figure 4-1: Diagram of CCW/ACCW Loop Models

Under steady state conditions, temperatures and heat flow must balance, leading to a set of seven equations and seven variables. In the following notation, Q_{wtr}=m`$c_p\Delta T$ and Q_{cont}, Q_{dct}, Q_{wct}, Q_{ccw} are the component heat transfer models as described in the following sections. The CCW and ACCW flow rates are GPMccw and GPMaccw, respectively. The EC load is added by a mass weighted average of the temperatures of the combining flows.

The unknown variables are:

Tccw_out or GPMaccw	= Either temperature of CCW entering containment or ACCW flow rate
Tcon_out	= Temperature of CCW leaving containment/auxiliaries
Tdct_in	= DCT inlet temperature
Tdct_out	= DCT outlet temperature
Taccw_out	= ACCW temperature exiting CCWHx
Twct_in	= WCT inlet temperature
Twct_out	= WCT outlet temperature
Tec_out	= EC outlet temperature

The equations balancing heat flow across each component with the temperature change of the loop are as follows, with EC_{sw} = 0 to apply EC loads to the ACCW loop or EC_{sw} = 1 for the CCW loop:

1) Heat in from Containment increases CCW temp

$$Q_{cont}(time, Tccw\_out) = Q_{wtr}\left(GPM_{ccw} - GPM_{chill} \cdot EC_{sw}, Tcon\_out, Tccw\_out\right)$$

2) DCT discharges heat and reduces CCW with added DCT recirc

$$Q_{dctx}\left(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_{R} \cdot QRF\left(Q_{cont}(time, Tccw\_out), EVAL\right), DCT_{fans}, AIR\right) = Q_{wtr}\left(GPM_{ccw}, Tdct\_in, Tdct\_out\right)$$

3) CCW Hx discharges from ccw

$$Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_{i}, ff_{o}, N_{plug}\right] = Q_{wtr}\left(GPM_{ccw}, Tdct\_out, Tccw\_out\right)$$

4) CCW Hx adds heat to accw

$$Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_{i}, ff_{o}, N_{plug}\right] \ldots = 0$$
$$+ -Q_{wtr}\left[GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), Taccw\_out, Twct\_out\right]$$

5-7) EC Heat is added to either wct_out or ccw_out based on ECsw = 0 (ACCW) or 1 (CCW)

$$Q_{EC} = Q_{wtr}\left(GPM_{chill}, Tec\_out, Twct\_out\right) \cdot \left(1 - EC_{sw}\right) + Q_{wtr}\left(GPM_{chill}, Tec\_out, Tccw\_out\right) \cdot \left(EC_{sw}\right)$$

$$GPM_{accw} \cdot Twct\_in = GPM_{chill} \cdot Tec\_out \cdot \left(1 - EC_{sw}\right) + \left[GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right)\right] \cdot Taccw\_out$$
$$GPM_{ccw} \cdot Tdct\_in = GPM_{chill} \cdot Tec\_out \cdot EC_{sw} + \left[GPM_{ccw} - GPM_{chill} \cdot \left(EC_{sw}\right)\right] \cdot Tcon\_out$$

8) WCT discharges heat

$$Q_{wct}\left(GPM_{accw}, Twct\_in, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}\right) = Q_{wtr}\left(GPM_{accw}, Twct\_in, Twct\_out\right)$$

For LOCA cases, CCW temperature is controlled at the user specified temperature TCW (typically 115^{o}F with an adjustment to account for instrument uncertainty) by varying ACCW flow rate. However, actual CCW may exceed TCW at full ACCW capacity depending on boundary conditions, typically due to high dry bulb temperature. For normal operation, CCW is controlled below 95^{o}F by ACCW flow rate or DCT fan operation.

For LOCA analysis, the UHS model calculates the CCW/ACCW loop conditions in two steps. First, the user input ACCW flow rate is applied [5g] and the resulting temperatures around the CCW and ACCW loops are determined. Second, the temperature of the CCW returning to containment/auxiliaries (Tccw_out) is limited to the user specified TCW temperature and the ACCW flow rate is allowed to vary to satisfy this returning temperature, up to the maximum pump flow of 5350gpm [5g]. The resulting temperatures around the CCW and ACCW loops are determined, except for Tccw_out. From these two result sets, the set corresponding to the greater Tccw_out is returned. All non-transient analysis uses only the first set of results.

Water properties (c_p, density) are determined as a function of temperature based on a curve fit to Table A-3 water properties data from [12]. For each component, the average of the inlet and outlet temperatures are used to determine water properties.

4.2 Heat Loads

Heat loads are provided as input into the UHS model based on external modeling of heat transfer. These heat loads drive the resulting temperatures in the CCW loop and thus heat transfer to the major components (DCT, WCT, CCWHx). Several evaluation types can be selected as described in Section 2. The heat loads that result from the evaluation type selected are described below.

4.2.1 LOCA Analysis Heat Loads

If the user selects a LOCA analysis, heat loads for a design basis Loss of Coolant Accident (LOCA) are provided as heat input per time (BTU/hr) at specific time steps [5b]. The containment heat load is transferred to the UHS primarily through containment fan coolers (CFC) that cool the containment atmosphere and a shutdown cooling heat exchanger (SDCHx) that cools the containment spray water during the recirculation mode.

Two LOCA heat load profiles are available and load the model if EVAL=0 or 1 is selected by the user. The user may select Cold Leg (Reactor Coolant Pump) or Hot Leg Break loads. The heat load profiles associated with these accident conditions are provided in Figure 4-2 and Figure 4-3 and are included in the LOCA Loads module.

Heat transfer to the CCW is a function of the incoming CCW temperature [5b]. Therefore, a linear interpolation function was written to determine the heat loads within a range of CCW temperatures from 112^{o}F to 120^{o}F. The accuracy of this method was shown (see Att A) to match the 115^{o}F values, and a plot showing the replication at 112^{o}F and 120^{o}F is provided in Figure 4-5. The interpolated heat loads are used directly in the UHS model. No specific models of the containment CFC or SDCHx are developed as part of this analysis. Therefore, all conservatisms of the design basis heat load analysis [5b] are maintained.

Two analysis are performed: First, a (single) solution set corresponding to the maximum LOCA heat load is reported. Second, the evaluation is repeated at each time step to determine conditions and resulting WCT water consumption. This repeated evaluation over time is only performed for the LOCA and Non-LOCA Shutdown (BTP5.4) evaluations for which WCT basin inventory is a concern.

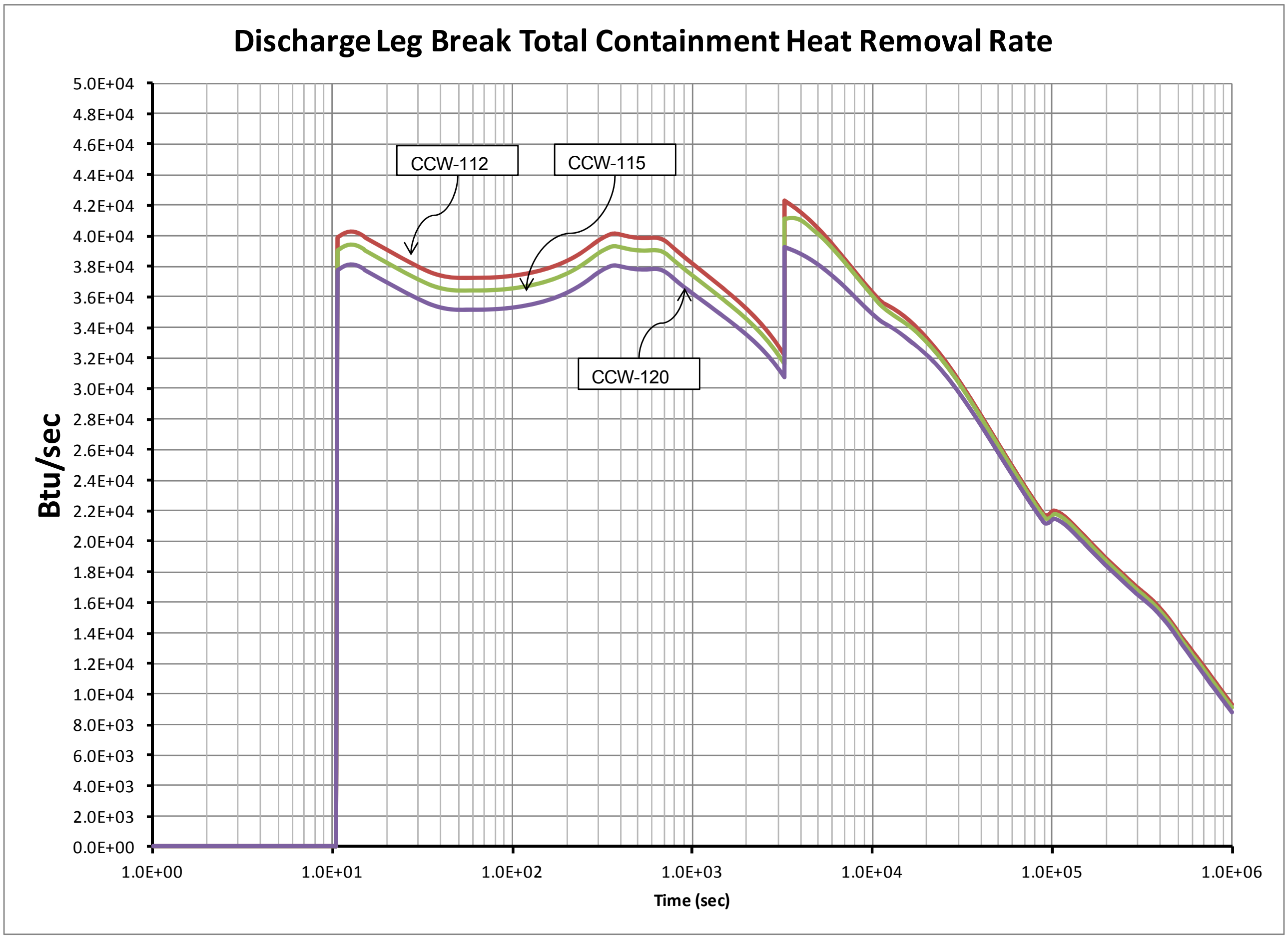


Figure 4-2: Cold Leg (RCP Discharge) Break LOCA Heat Load Profile

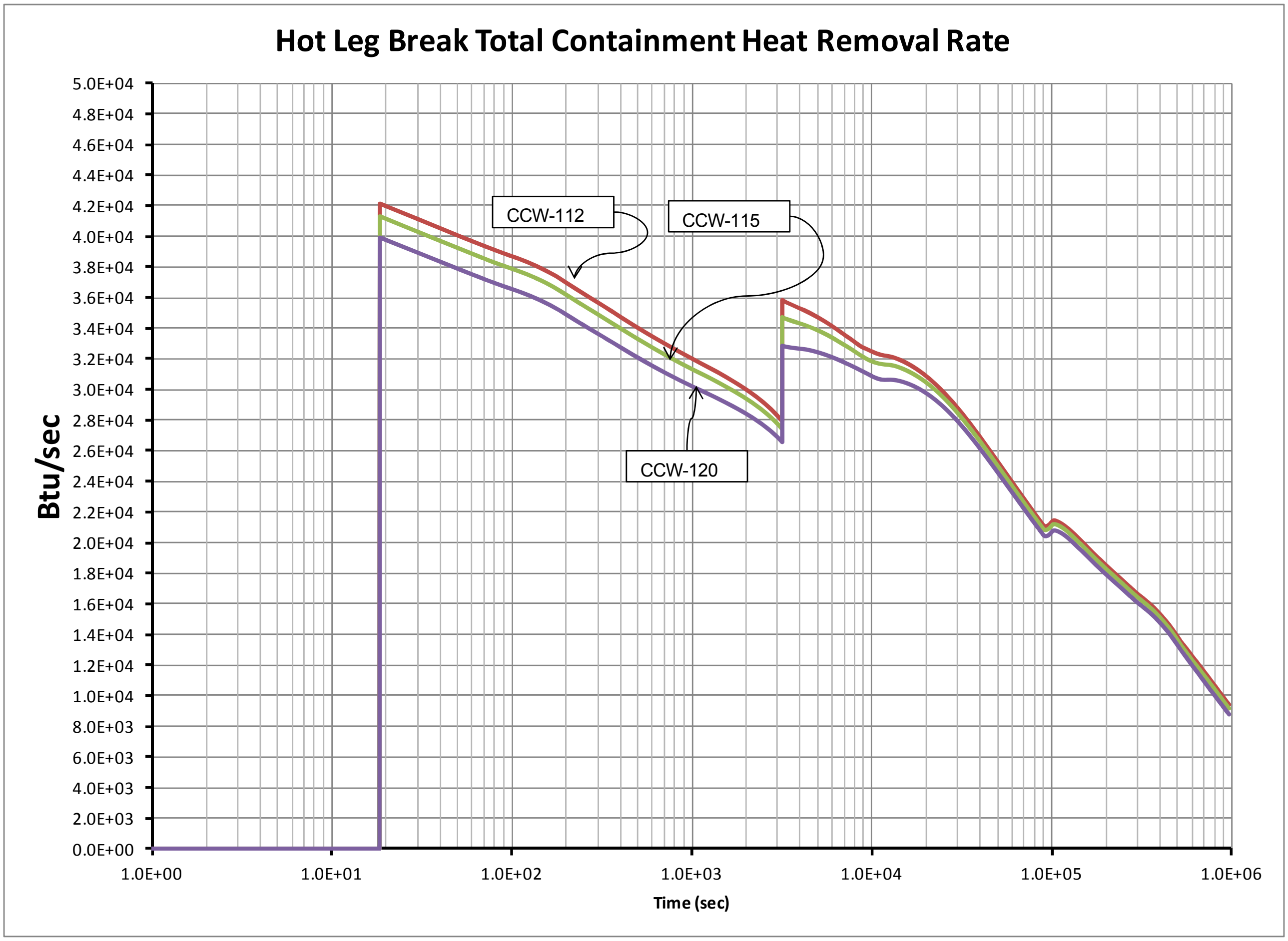


Figure 4-3: Hot Leg Break LOCA Heat Load Profile

4.2.2 Non-LOCA Shutdown Loads

NUREG-0800 Branch Technical Position 5.4 [28] requires the plant to be brought to cold shutdown from full power using only safety systems satisfying Design Criteria 1-5. Shutdown cooling heat loads associated with this process are presented in Figure 4-4 [5o] and are included in the LOCA Loads module. These loads are conservative in that they are independent of incoming CCW temperature, and are applied if Non-LOCA Shutdown (EVAL=2) is selected by the user.

Two analysis are performed: First, a (single) solution set corresponding to the maximum heat load is reported. Second, the evaluation is repeated at each time step to determine conditions and resulting WCT water consumption. As stated previously, this repeated evaluation over time is only performed for the LOCA and Non-LOCA Shutdown evaluation in which WCT basin inventory is a concern.

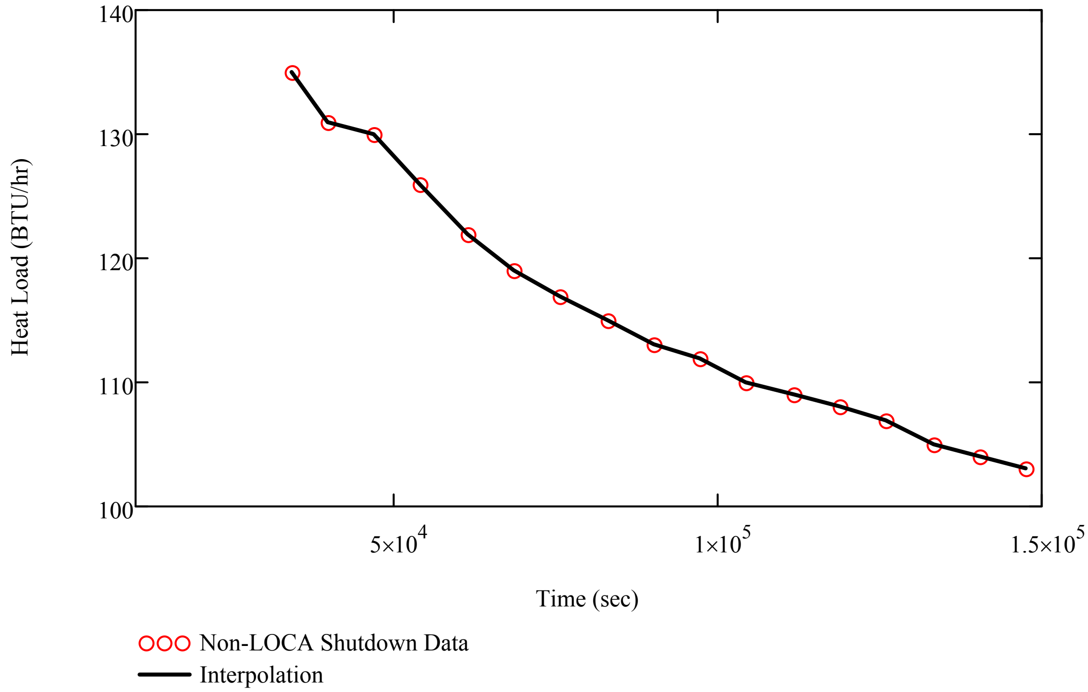
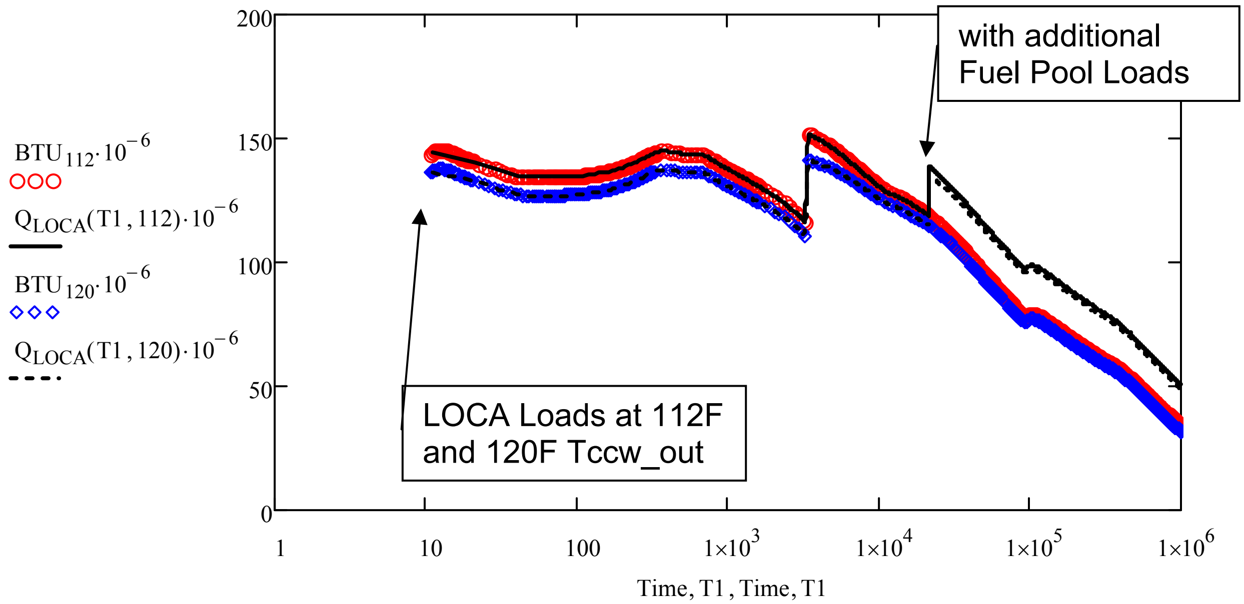


Figure 4-4: Non-LOCA Shutdown Loads and Interpolation

4.2.3 Fuel Pool Loads

If the user selects to include transient fuel pool cooling (FPC) loads, fuel pool loads are added directly to the LOCA or Non-LOCA Shutdown heat loads starting at 6 hours from the initiation of the transient. Fuel pool loads are provided as heat input per time (BTU/hr) at specific time steps per [5m]. These loads are added to the transient load profile for all transient analyses. An example plot of the UHS model simulation of the loads added to the LOCA case is included in Figure 4-5. The transient fuel pool loads only apply to the transient analysis cases, 0, 1, and 2. For the non-transient cases, fuel pool heat loads are included as a single value in variable FPC.



FP :=

hours	Time (sec)	MBTU/hr
0	0.000	0
5.99	21564	0
6	21600	20.4
24	86400	19.88
48	172800	19.52
72	259200	19.19
96	345600	18.88
120	432000	18.59
144	518400	18.32
168	604800	18.07
192	691200	17.83
216	777600	17.61
240	864000	17.39
360	1296000	16.47
480	1728000	15.73
600	2160000	15.11
730.3	2629008	14.37
1461	5259600	12.31
2191	7887600	11.11
2778	10000008	10.44
2922	10519200	10.3
3653	13149000	9.69

<u>Notes</u>

In the above figure:

BTU_{112} (red) and BTU_{120} (blue) are the digitized RCP break heat loads in MBTU/hr.

Q_{LOCA} (black) are the curve fit functions for the heat loads at time T1 and Tccw_out = 112°F and 115°F.

FP = Fuel Pool Loads, added at 6 hours (21,600 sec). See table, left [5e, p.124].

Figure 4-5: Example LOCA and FPC Heat Loads

4.3 DCT Model

The Dry Cooling Tower model is based on empirical data from Hudson products. Performance curves per [6d] provide heat transfer, (Q, in 10^6 BTU/hr) and Range (R, ^oF) vs. tower outlet temperature ($T_{out,}$ ^oF). Range is defined as the temperature difference between the inlet and outlet sides of the DCT. Separate curves are provided for CCW flow rates of 6000, 6500, and 7500 gpm. Hudson products curves (lines) are parallel for different dry bulb temperatures (T_{db}) but vary slightly with flow. An example of the 6500 gpm curve set is presented in Figure 4-6.

For use in the UHS model, the desired relationship is transformed to provide heat transfer (Q) as a function of inlet water temperature (T_{in}) and dry bulb temperature. The inlet water temperature is determined from the definition of range, i.e. $T_{in} = T_{out}$ + Range. The curve slope is determined by interpolation between curves at two flow rates and shifted linearly for dry bulb temperature.

The DCT performance curves are based on the 95% and 100% area availability curves with no fouling. The user may select a percentage area between these two values, and the DCT heat transfer performance is interpolated. Previous testing has shown these curves to be conservative by 10-20% [5c] and actual heat transfer is greater than predicted by the DCT curves. This is demonstrated in Section 4.3.1.

Two flow specific curves are defined by two points per curve. These curves are embedded as an MSExcel spreadsheet in the worksheet as shown in Figure 4-7.

The "number of fans in service" variable provides a method to linearly reduce the DCT full heat transfer in proportion to the available fans (1-15). This method is conservative since it does not credit continued minor heat removal due to natural convection on the outside of non-isolated tubes. Due to the large height of the DCT coil structure (~60ft), this would be expected even without fan air flow.

The AIR variable is used to define the fan flow rate (acfm) and adjust the heat transfer characteristics of the DCT to address modified air flow through the DCT. This is accomplished by determining the overall DCT heat transfer coefficient (119.5 BTU/hr-ft^2-^oF per the Fin-Fan specification [6h] from its constituent parts including internal forced (water) convection, through wall conduction, fouling, and external forced (air) convection. From this, the external air forced convection term is scaled to air flow to adjust the overall term (see also Section 4.7, below).

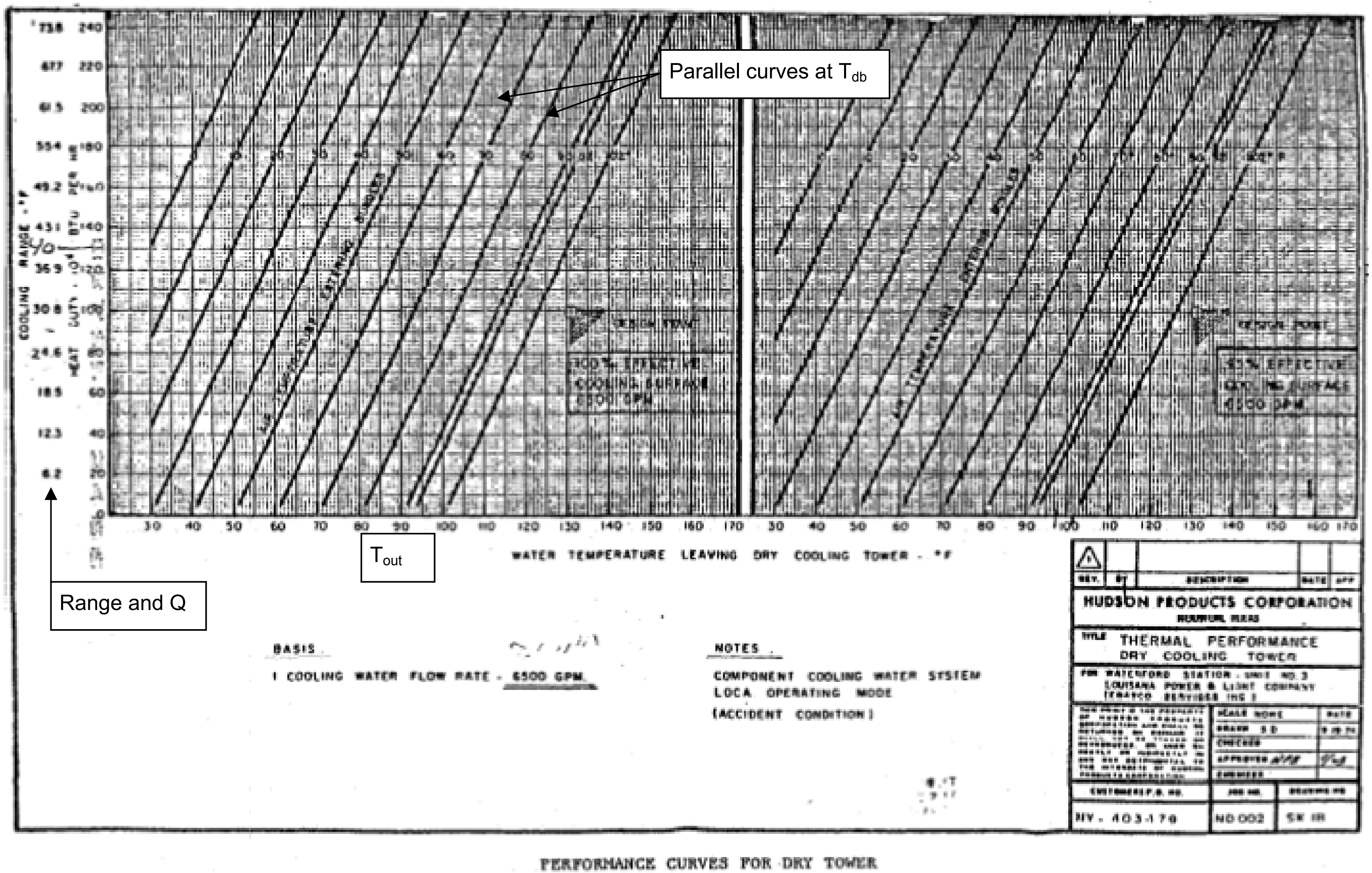
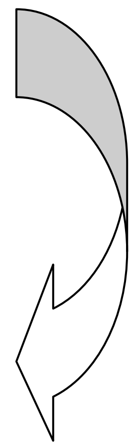


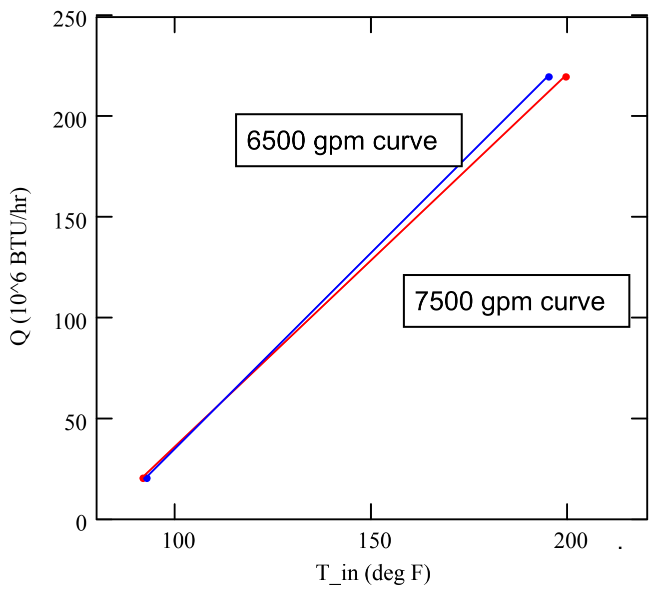
Figure 4-6: Hudson Products DCT Curve

DCT :=

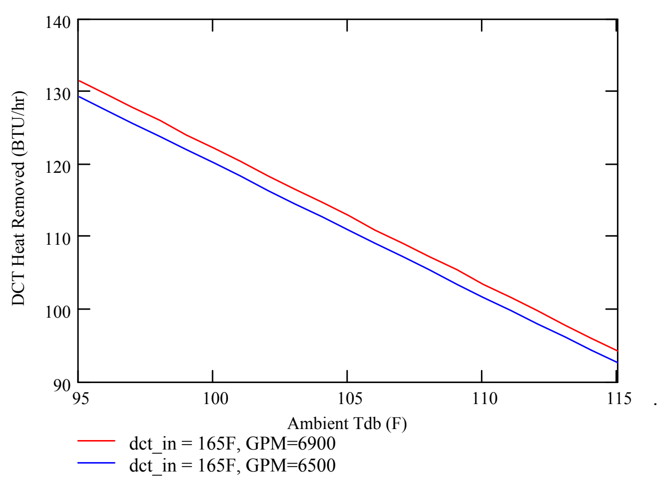
Simplified DCT curve input				
GPM	6500	6500	7500	7500
Q	220	20	220	20
R	67.7	6.2	58.7	5.3
Tdb	80	80	80	80
Tout	131.5	84.5	136	84.5
Tin	199.2	90.7	194.7	89.8
Slope as a function of GPM			1.843	1.907
Y int as a function of GPM			-147.189	-151.211

Hudson product curve points: GPM, Q, Range (R), T_{db}, T_{out} (highlighted)





Derived Q vs. T_{in} Curves at different GPM



Derived Q vs. T_{db} Curves at constant T_{in}

Figure 4-7: DCT Performance Model

To evaluate the effect of reduced fan air flow, the overall fan Heat Transfer Coefficient (HTC) is calculated. The HTC represents a series of transfer functions from the internal CCW fluid to the wall and fins, and then to the air. Only the last term is affected by fan air flow. A diagram of the heat transfer from the hot CCW (left) to the air passing over the coils (right) is depicted in Figure 4-8.

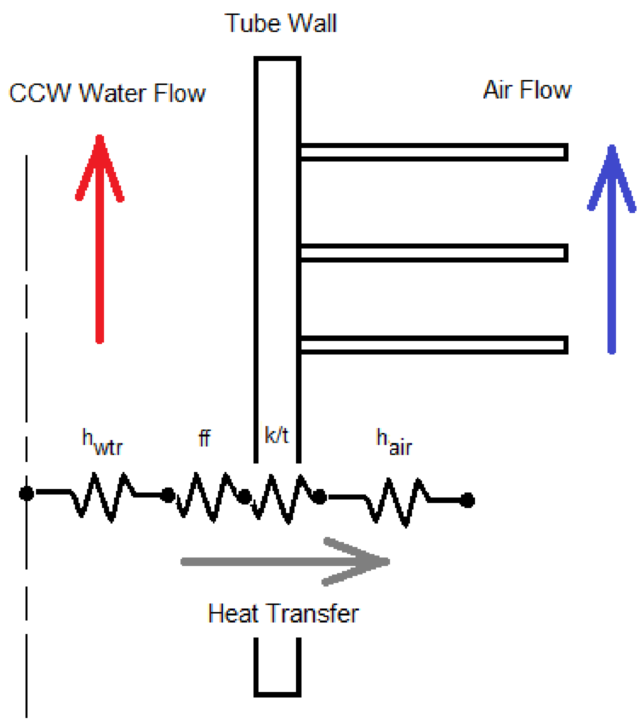


Figure 4-8: Heat Transfer Process through DCT Tube Wall

Per [12], the overall heat transfer coefficient (U) can be determined by the series resistances of the water film coefficient (h_{wtr}), the internal fouling factor (ff), the radial conduction resistance ($OD*ln(OD/ID)/k_{tube}$) and the external air film coefficient (h_{air}) normalized to the tube area and considering the fin efficiency (η_f).

$$U = \frac{1}{\frac{OD}{ID \cdot h_{wtr}} + ff_{wtr} + \frac{OD \cdot \ln\left(\frac{OD}{ID}\right)}{2k_{tube}} + \frac{A_{tubeOD}}{A_{fin} \cdot h_{air2} \cdot \left[1 - \frac{A_{finN}}{A_{fin}}\left(1 - \eta_f\right)\right]}}$$

The external film coefficient for a tube bank in cross flow is a function of the velocity, non-dimensionalized to the Reynolds number (Re). The remaining terms k_{air} (air thermal conductivity), C1, C2, m2 (constants for multi-tube bank [23]), and tube OD remain

constant for the given temperature conditions.

$$h_{.air2} = \frac{k_{.air}}{OD} \cdot (C1 \cdot C2) \cdot Re_{.air}^{\,m2}$$

Thus, for an air flow rate that differs from the base-line condition of 181,000 cfm, the external film coefficient term is simply scaled by the velocity to a constant (m2) power. The following equation shows the overall HTC scaled for air flow rate (Q) expressed in 1000 cfm. The calculated HTC matches the Hudson products HTC using a fin efficiency (η_f) of 0.777 and total area with fins (A_{fin}) and fin area without tube area (A_{finN}) in the following equation.

$$U_{tubeC}(Q) = \cfrac{1}{\cfrac{OD}{ID \cdot h_{wtr}} + ff_{wtr} + \cfrac{OD \cdot \ln\left(\frac{OD}{ID}\right)}{2k_{tube}} + \cfrac{A_{tubeOD}}{A_{fin} \cdot h_{air2} \cdot \left(\frac{Q}{181}\right)^{m2} \left[1 - \frac{A_{finN}}{A_{fin}}\left(1 - \eta_f\right)\right]}}$$

4.3.1 Benchmark and Testing

To demonstrate accuracy of the DCT model vs. Hudson Products data, a test set of published curve points [7h, see Attachment B] was used and plotted against the results from the DCT Model. The data set provided in Table 4-1 show the selected flow rates, T_{db}, Range, T_{out} and Q. The Tin was derived from the T_{out} + Range. The model calculated heat transfer (DCT Model) and published Q are shaded and compared. The DCT model predicts heat transfer within 1.06% with one outlier. There is, on average, a negative bias (model under-predicts heat transfer) which is conservative and ensures the results can be applied without adjustment for error.

Table 4-1: DCT Model Benchmark

GPM	T_{db}	Range	T_{out}	Q ($x10^6$)	T_{in}	DCT Model ($x10^6$)	Error (%)
6000	80	26.7	97	80	123.7	79.25	-0.94
6000	90	33.3	111	100	144.3	98.41	-1.59
6000	102	40	127.3	120	167.3	118.29	-1.43
6500	80	30.8	103.1	100	133.9	99.63	-0.37
6500	90	36.9	118.1	120	155	120.09	0.08
6500	102	43.1	132.3	140	175.4	135.58	-3.16
7500	80	32	110.1	120	142.1	119.23	-0.64
7500	90	37.3	125	140	162.3	138.77	-0.88
7500	102	42.7	142.2	160	184.9	159.08	-0.57

To demonstrate the conservatism of the DCT model vs. actual plant performance, test data was used. Test data from 1982 is presented in Figure 4-9 [5c, Attachment B]. The test conditions are identified in red. Important conditions include the DCT heat load (125.42 MBTU/hr), the inlet water temperature (DCT-HWT=152.48^{o}F), the ambient dry bulb (TDB = 85.87F), and the DCT water flow rate (6902 gpm). Also of note is the 7.78^{o}F DCT recirculation effect, producing a net inlet of 85.87+7.78 = 93.65^{o}F (see also analysis boundary conditions input, Section 2).

Using the DCT model developed herein, the heat rejection rate prediction using test conditions with the given ambient temperature is 124.995 MBTU/hr or -0.34% (lower than actual). Using the test conditions with the recirculation 7.78F added to the ambient, the prediction is 110.428 MBTU/hr or -11.95% (lower than actual). While not as great as the described DCT performance of 120% over design, this testing shows that when with the recirculation penalty, the Hudson Products curves and the DCT model herein are at approximately 12% conservative (lower) relative to tested heat rejection rate. This conservatism is expected to remain valid as there are no reported tube plugging or fouling issues.

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MNQ 9-52 Rev 2 — 9 9 73

Revision 1

BY [signature] DATE 3-30-84

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SHEET 6 OF 70

OFS NO. 5234.007 DEPT. NO. 709

CLIENT LPL

PROJECT WSES

SUBJECT UHS Performance Based on Test Data

LOCA PEAK SIMULATION SUMMARY TABLE

System Parameter	Design Conditions** Predicted	Design Conditions** Limits	Test Value	Test Adjusted to Design
Heat Loads (10^6 Btu/Hr):				
Dry Cooling Tower	117.28	117.28 Max	125.417	117.547
CCWHX	56.02	56.02 Max	50.47	55.753
Chillers	5.1	5.1 Max	-	5.10
Wet Cooling Tower	61.12	61.12 Max	50.47	60.853
Total	178.4	178.4 Max	175.89	178.40
Temperatures (°F)				
CCWHX-CCWS-CWT	115	115 Max	99.161	115.0***
DCT-HWT	169.39	-	152.4825	167.843
DCT-CWT/CCWHX-CCWS-HWT	133.63	-	115.9435	132.0
WCT-HWT	-	-	105.006	121.37
WCT-CWT	85-105	105 Max	85.876	91.12
Ambient TDB	102	102 Max	85.87	102
Recirculation	1.9	1.9 Max	7.78	7.98*
DCT-TDBI	103.9	103.9 Max	93.65	109.98
Ambient TWB	83	83 Max	77.149	83
Recirculation	1.0	1.0 Max	2.461	2.461
WCT-TWBI	84.0	84.0 Max	79.610	85.461
Water Flow (GPM/10^6 Lb/Hr)				
DCT	6559/3.2795	-	6902/3.451	6559/3.2795
WCT	-	6500/3.25 Max	5324/2.662	5256/2.628
Performance (%)				
DCT	100	100	120.3	120.3
WCT	100	100	117.5	115.5*
CCWHX	100	100	105.3	105.3

* Adjusted for additional conservatism
** Per FSAR
*** Set Point

Figure 4-9: 1982 Test Data

4.4 WCT Model

The Wet Cooling Tower model is based on empirical data from Zurn Industries with 8 fans operating. Performance curves per [6e] provide outlet water temperature, (Tout, ^oF) vs. wet bulb temperature (T_{wb}, ^oF) with Range (^oF). As above, Range is defined as the temperature difference between the inlet and outlet sides of the WCT. Separate curves are provided for ACCW flow rates of 2500, 3000, 4500, 6000 and 7000 gpm. Additional curves were generated for various numbers of fans out of service [22], including an evaluation of the natural draft mode of operation. A polynomial curve fit relating flow, wet bulb, number of fans and range was developed to fit the published curves. This curve is developed using the mathcad "regress" function. An example of the 5000 gpm curve set with the curve fit overlay is presented in Figure 4-10.

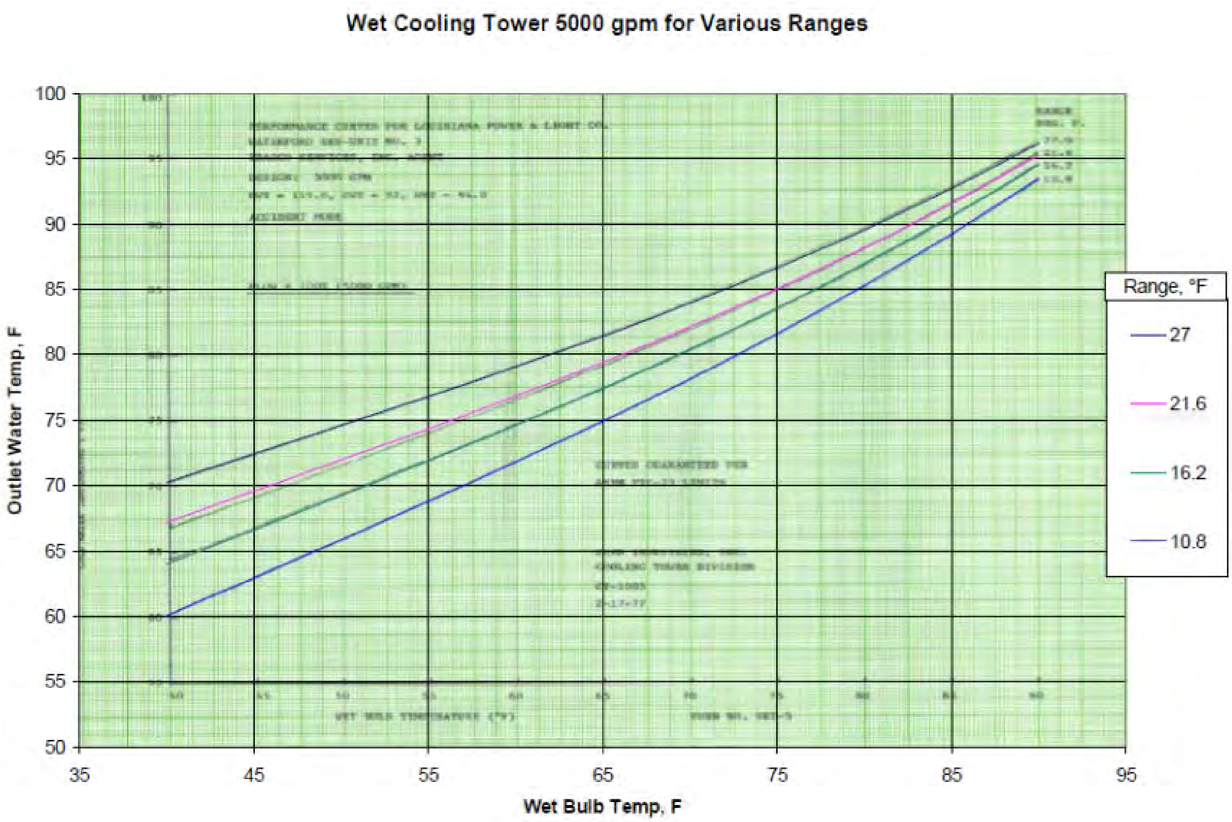


Figure 4-10: Zurn Industries Example WCT Curve

Natural draft curves were generated in collaboration with John Cooper and Associates. These curves address ACCW flow rates of 1400 gpm to 6500 gpm and relate wet bulb and inlet hot water temperatures to cold water temperature. These curves are calibrated to 1982 test data. An example curve set at 5350gpm is presented in Figure 4-11. A second

order polynomial curve fit relating flow, wet bulb and range was developed to fit these curves using the mathcad “regress” function

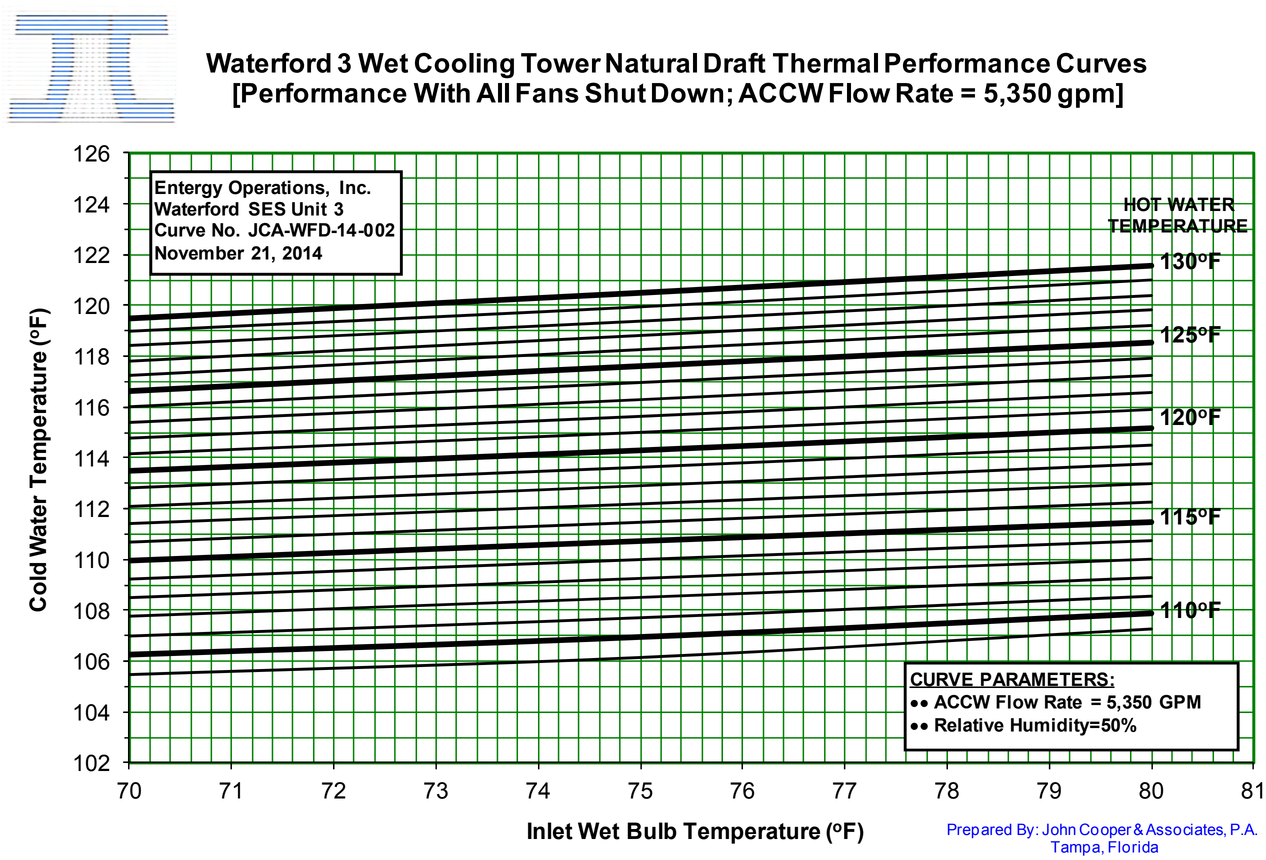


Figure 4-11: Example WCT Natural Draft Curve

For use in the UHS model, the desired relationship is transformed to heat transfer (Q) as a function of inlet water temperature (T_{in}) and wetbulb temperature. The inlet water temperature is determined from the definition of range, i.e. $T_{in} = T_{out} + \text{Range}$. From this relationship, the iterative solution solver within mathcad was used to derive the range and inlet temperatures that satisfy the performance curves.

Evaporative water loss (E) is calculated based on the gas flow and change in air humidity ratio across the WCT ($w_e - w_i$). The gas flow (G) is provided by the water flow (L) divided by the liquid gas ratio (L/G, defined as variable LG in Att A). Per [5h], this formulation is:

$$E = \frac{GPM}{\frac{L}{G}} \cdot \left(w_e - w_i \right)$$

The inlet humidity ratio (w_i) is based on the ambient dry and wet bulb temperatures.

$$W1\left(T_{db}, T_{wb}\right) := \frac{\left(1093 - .556T_{wb}\right)\cdot W\left(T_{wb}, 100\%\right) - .240\cdot\left(T_{db} - T_{wb}\right)}{1093 + .444T_{db} - T_{wb}}$$

The design liquid/gas (L/G) ratio is 1.748 at 6500 gpm and 58,160 cfm per fan per [6c]. This L/G ratio is decreased by the actual liquid flow rate and air flow as shown below.

L/G = 1.748*(5350gpm/6500gpm)*(58,160cfm/60,467cfm) = 1.384

In this case, the low end of tested air flow [7g] was used. The air flow ratio in cfm (58,160/60,467 = 0.962) compares well with the air flow that could be derived from measured fan motor horsepower compared to design horsepower, raised to the 1/3 power per fan laws. Using the high tested motor power of 26BHP [7a through 7f] to design 28.8BHP [6c] produces a ratio of $(26/28.8)^{1/3}$ = 0.966.

To determine the exit air humidity ratio, the exit air enthalpy was determined from the inlet enthalpy and range as follows:

$$h_e = \frac{L}{G}\cdot(\text{Range}) + h_i$$

From the enthalpy, the humidity ratio for saturated moist air is determined from ASHRAE formulation [15]. Total loss includes a drift loss term equal to 0.1% of ACCW flow, which is conservative relative to measured 0.026% per [5c]. This method of calculating water loss was evaluated against more detailed calculations considering the variation in air flow rate with water loading [22], and was found to produce conservatively high evaporation rates in all cases.

The evaporative water loss is modified for operation under natural draft conditions. This is necessary because the low air flow rates without fan flow change the L/G ratio and thus the evaporation rate. For this condition, predictions for the natural draft mode evaporation rate are based on a 2nd order polynomial curve fit of WCT performance from [22].

The WCT performance curves are based on 100% availability and no fouling. Previous testing has shown these curves to be conservative by 5-15% [7a through 7f] and actual heat transfer is greater than predicted by the WCT curves.

The performance curves for the WCT are embedded in the worksheet and are not modified by the user.

4.4.1 Benchmark and Testing

The polynomial curve fit to the Zurn curves produces results that are very close and slightly conservative in that they predict higher basin water temperature for a given heat load or range and wet bulb temperature for wet bulb temperatures above 60°F. The average deviation from the Zurn performance curves is 0°F and the maximum is 0.27°F for Tbasin for wet bulb temperatures above 60°F.

To evaluate the WCT model against plant test data, a set of performance data was obtained from 1982 (start-up) testing through recent 2009 tests. The test data provided in Table 4-2 provides flow rate (GPM), Wet Bulb temperature (Twb), inlet and outlet temperatures (T_in, T_out) and heat transferred by the WCT (Q). For three tests, the heat transferred by the WCT was not explicitly provided but was derived from the temperature change and flow rate.

From the 1982 start-up tests, the peak water loss is described as 84.2 gpm under a WCT heat load of 50.47 MBTU/hr. Water loss under simulation of the benchmark startup test is described in Section 5.3 and a complete analysis listing is provided in Att A. From this evaluation, a water loss rate of 5049.3/60=84.16 gpm was calculated.

It can be seen that the WCT model matches the test data within -10.2%, with better accuracy for flow rates of approximately 6000gpm or less, and is conservative for all tests. It is therefore concluded that the WCT model is accurate within the curve fit range of 2500 to 7000 gpm, which covers the accident ACCW flow rate of 5350gpm [3,5g] that is used herein for LOCA evaluations. Flow rates above 7000gpm are not recommended. It is noted that the errors are conservative (WCT model predicts less heat transfer than test) for all ACCW flows, and therefore no adjustment is made for WCT model error.

Table 4-2: WCT Test Data

GPM	Twb (^oF)	T_in (^oF)	T_out (^oF)	Q ($x10^6$ BTU/hr)	WCT Model ($x10^6$ BTU/hr)	Error (%)	Ref
5324	77.15	105	85.88	50.47	48.95	-3.02	MN(Q)9-52
6386.7	71.1	96.24	83.15	(41.52)[1]	40.34	-2.83	WCB Test 5/8/98
6019.8	71.73	92.95	81.77	(33.44)[1]	33.42	-0.07	WCA Test 5/12/98
6657	62.34	86.37	75.36	(36.48)[1]	32.76	-10.19	WCA Test 4/10/00
6254	56	84.73	72.46	38.4	36.68	-4.47	WCB Test 12/11/01
5976.4	51.76	84.54	70.44	42.03	40.35	-3.99	WCB Test 12/10/08
6419.13	62.18	86.96	75.25	37.5	34.01	-9.3	WCA Test 3/31/09

Note:1 Q derived from GPM, T_in and T_out.

4.5 CCW Heat Exchanger Model

The CCW heat exchangers are designed to provide heat transfer from the CCW to the ACCW System when additional heat removal capabilities are required of the ultimate heat sink. Two (one per train) horizontal, counter-flow, straight tube rolled into tube sheet heat exchangers perform this function. The CCW flows through the tube side and the ACCW flows through the shell side of the heat exchanger.

The CCW heat exchanger model is a first principles model based on the Taborek model [13, 14] for the shell side flows and a Dittus-Boetler relationship for the tube internal flow [12]. The essential elements of the calculation are the determination of an external heat transfer coefficient for flow over tubes between baffle regions with corrections to the flows based on leakage through baffle gaps, tube gaps, tube exterior areas, and other bypass flows. Application of the calculation method is provided in Attachment A, and a detailed description of the model is provided in Attachment C.

The calculation solves for the heat transfer coefficients and resulting temperatures based on the CCW/ACCW flow rates and conditions.

Performance testing (see Attachment B) was conducted, and these tests demonstrate that the heat transfer capability of the CCWHx is greater than or equal to the modeled heat transfer properties.

The heat transfer relationships for the CCWHx are embedded in the worksheet and are not modified by the user. The user may change the parameters for tube plugging and tube fouling factors.

4.5.1 Benchmark and Testing

The calculation method is verified by benchmark tests against accepted CCWHx heat transfer evaluations contained within existing design basis calculations. Benchmark studies obtained from other calculations and test data are provided in Attachment B.

The criterion used for the benchmark is the overall heat transfer coefficient (U) as calculated in existing evaluations vs. the method developed herein. A comparison of the results is provided in Table 4-3. It can be seen that the model results match the accepted test results with an error of <1%. Since the error is conservative (CCWHx model transfers less heat than existing methodology), no adjustment is made for this error.

Table 4-3: CCWHX Benchmark Data

CCW (gpm)	T_in (°F)	T_out (°F)	ACCW (gpm)	T_in (°F)	T_out (°F)	ff	U BTU/ hr-ft²-F	Model BTU/ hr-ft²-F	Error (%)	Reference: see also Att B for copies of all test data, below
6882.6	131.11	115	4490.7	89.3	113.77	0.00159	257.09	255.56	-0.59	ECM95-008R3, Att 7.2
6878.4	128	115	4492	91.03	112.14	0.00197	233.9	232.67	-0.53	ECM95-008R3, Att 7.2
6545	134.1	114.55	4500	90.41	118.57	0.0008	321.41	318.82	-0.81	B Test 12/11/01
6500	100.65	95	4500	87	95.17	0.00114	274.47	273.44	-0.39	MNQ9-10 Att 8.5
6500	112.73	105	4500	88	99.19	0.00364	164.66	164.15	-0.31	MNQ9-10 Att 8.6
6500	100.16	95	4500	87	94.46	0.00156	246.03	245.08	-0.39	MNQ9-10 Att 8.7
6545	134	115	4500	89.31	116.9	0	429	0	-1.91	Spec 1564.75

4.6 Other Heat Loads

The Essential Chillers (EC) provide heat input into the ACCW system when the CCW temperature exiting the CCWHx exceeds 105°F [3]. The user specified EC loads are added directly to the ACCW in parallel with the CCWHx.

The user may change the EC loads to apply to the CCW or ACCW loop as required for normal or design basis accident analysis. This is accomplished by selecting the ACCW or CCW loop, setting the EC_sw variable to 0 or 1.

Auxiliary Loads include all other loads from the EDG, HPSI, Containment Spray, etc. added directly to the containment loads. The auxiliary loads are specified by the user and are applied to all analysis types.

Tornado loads can be specified by the user and are applied specifically for the tornado analysis.

Normal operating loads can be specified by the user and are applied specifically for the normal operating analysis.

4.7 Ambient Conditions and Recirculation

To simplify user input, relationships for boundary condition temperatures and recirculation effects are included in the model. These relationships can be used directly or over-written by user defined inputs.

The site ambient wind speed, wet bulb, and dry bulb temperature conditions were investigated by Entergy and LPI [17]. Based on input from Entergy [5p], bounding combinations of these inputs were identified. Specifically, time periods (t_{crit}) corresponding to 1 hour, 1 day, 3 day, and 7 day averages were considered. Over these time periods, bounding dry bulb temperatures (TDBMAX) and wind speed as a function of dry bulb temperature (WS) were identified. An example plot is shown in Figure 4-12.

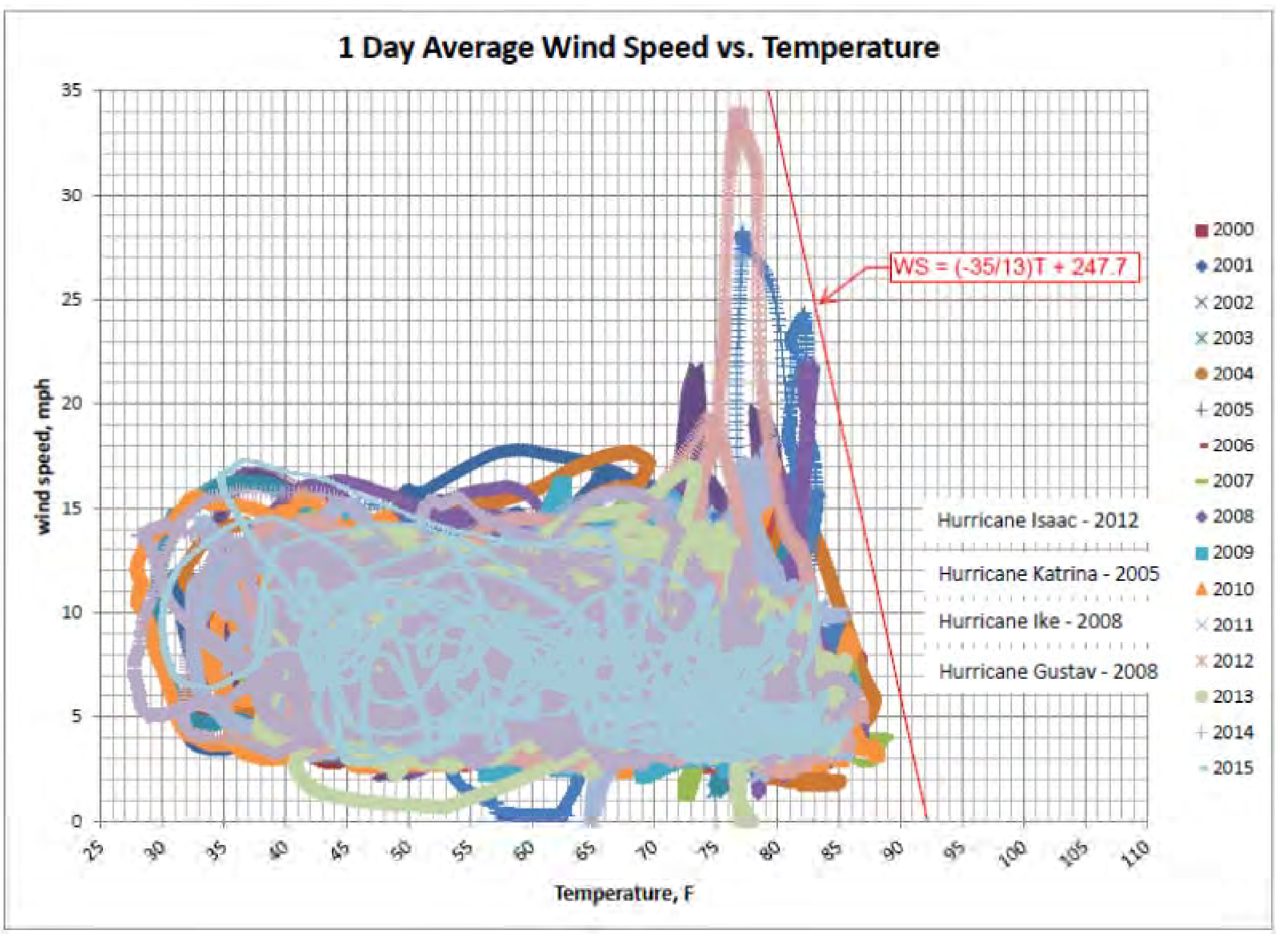


Figure 4-12: Example Wind Speed vs. Temperature Data [5p]

For each time period, comparison of measured dry bulb and wet bulb temperature data provided upper and lower bounds (TWBMAX, TWBMIN) that were characterized by linear relationships. For the upper bound, the data set was bounded by multiple segments, whereas the lower bound was characterized by a single line. An example plot is shown in Figure 4-13. To this input, the maximum WCT recirculation temperature correction (6.4°F [19]) is added to the upper bound and 0.0°F recirculation is added to the lower bound. The upper bound (TWBMAX) input would conservatively bound cases in which the system heat removal maximum capacity is analyzed. The TWBMAX input is conservative because the higher wet bulb conditions limit the heat removal capacity of the WCT, and therefore return higher ACCW and CCW temperatures. The TWBMIN input would conservatively bound cases in which WCT basin water capacity is evaluated because the lower wet bulb temperature will maximize the evaporative losses from the WCT.

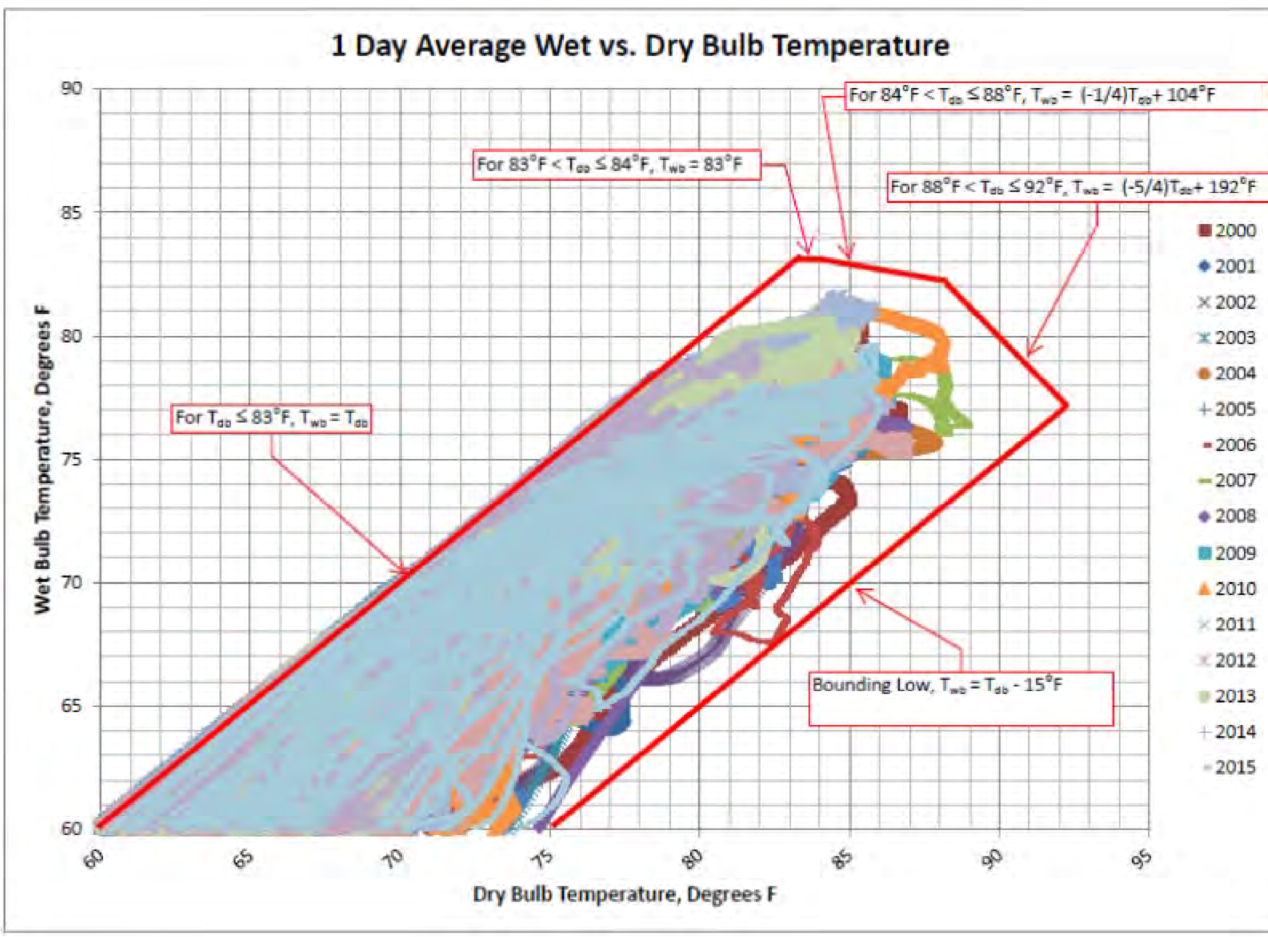


Figure 4-13: Example Wet Bulb vs. Dry Bulb Temperature [5p]

From CFD analysis of the DCT under a range of wind conditions [19], data for recirculation and DCT fan flow rate with wind speed were developed. The fan flow rate and wind speed

relationship, with a curve to define lower bound fan flow, is shown in Figure 4-14. B Train recirculation in combination with B Train Fan Flow is conservative. Lower bound fan flow is conservative under all conditions because it lowers the heat transfer coefficient for the DCT, limiting overall heat removal and transferring heat to the WCT. This effect is calculated as described in Section 4.3.

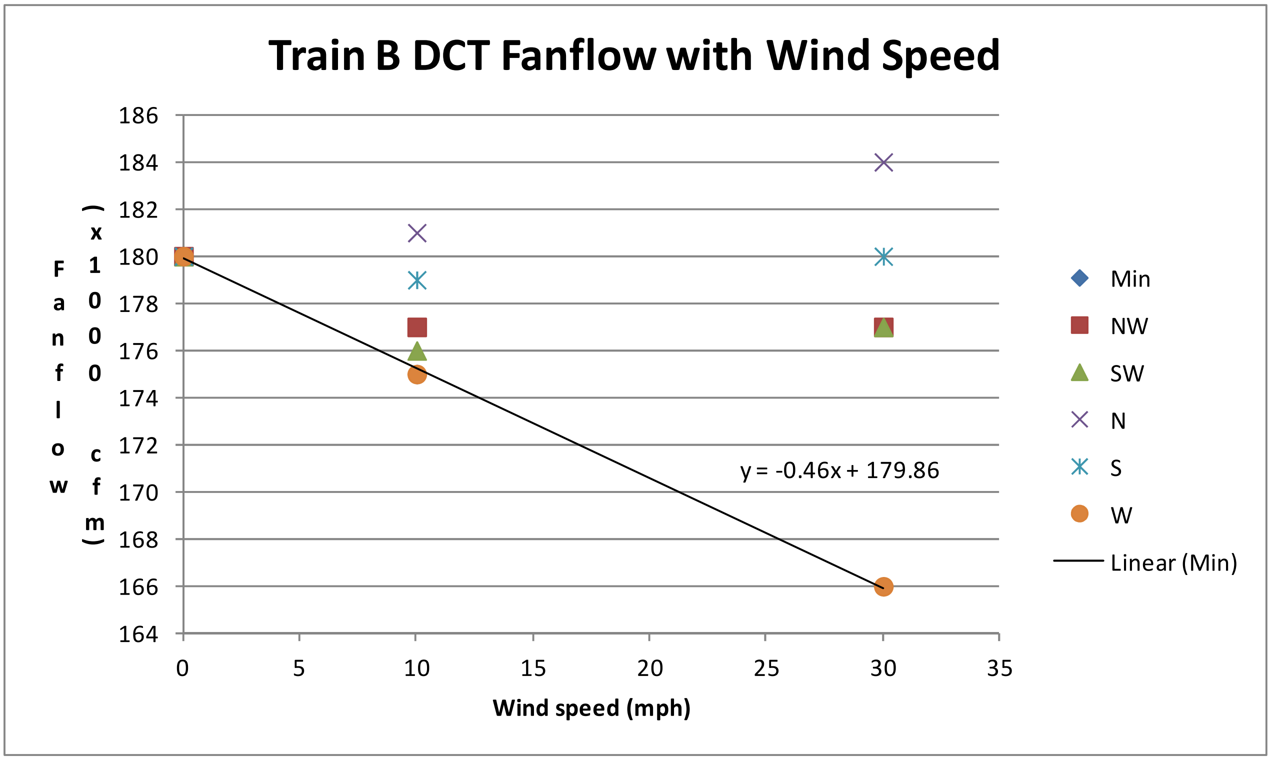


Figure 4-14: DCT Fan Flow vs. Wind Speed

The DCT recirculation effect causes an increase in the inlet temperature above the ambient dry bulb temperature. This added recirculation temperature (T_{R_DCT}) as a function of wind speed was derived from CFD studies [19] of the system with deflector panels installed over the DCT. Data for both the A and B train studies were fit using second order curves as shown in Figure 4-15. As the B train is bounding, this curve was used to provide recirculation for a given wind speed. The DCT recirculation temperature is then added to the ambient temperature to determine DCT heat removal.

The DCT recirculation value is further modified to reflect decreasing heat load and its effect on DCT outlet temperature. Under transient LOCA conditions, the heat load from containment decreases, particularly after approximately 2.2×10^4 seconds (see Figure 4-5). The effect of reduced heat load was studied in [19]. LOCA and other heat loads produce DCT outlet air temperature of over 140F at peak loads to 120F at approximately 50 MTBU/hr. Since the recirculation shown in Figure 4-15 is based on peak heat loads, the

recirculation is reduced from 7.7F to 5.7F (74%) with reduced loads. Due to the change in recirculation with heat load, the DCT heat load term (Q_{dctx}) is modified to include the inlet air temperature with recirculation at each analysis step.

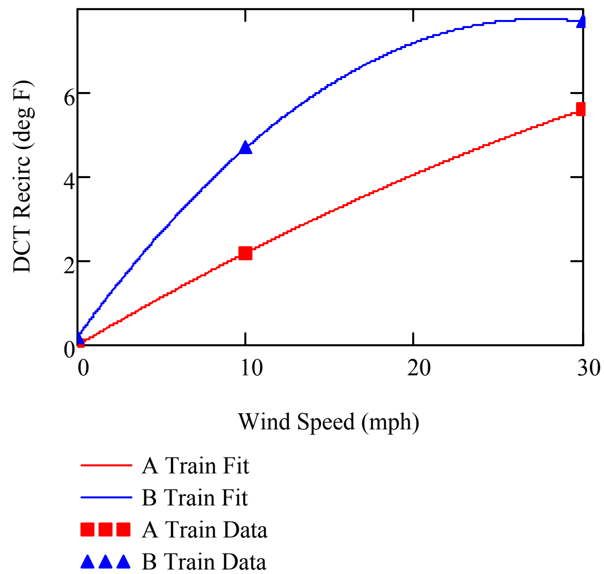


Figure 4-15: Recirculation with Wind Speed Curves [19]

4.8 Mathcad

Evaluations were automated using the commercially available computer program, Mathcad [11]. All equations in Mathcad are presented and can be independently reviewed and verified. All units are converted within Mathcad with conversion terms generally not shown. The significant numbers of digits shown in results are rounded off values; Mathcad carries out all operations to 15 digits and such values are carried internally through a particular calculation.

Detailed calculations of all evaluated cases are provided in Attachment A.

The Mathcad "Find" function provides a non-linear solver for the system of equations defined above. The default convergence and constraint tolerance values of 0.001 (0.1%) were used. As an error check, the sum of the heat flows to each loop (CCW, ACCW) were compared to the total and found to be less than 0.03% after solution as shown in Attachment A. The resulting difference in heat flows (162 x 0.0003 < 0.05MBTU/hr) is bounded by the conservatisms in the input heat loads, which are typically rounded up to the nearest 0.1MBTU/hr. Additionally, the source documents for input loads [5b, 5o] provide conservatism in excess of 0.05MBTU/hr heat rate.

5 Evaluation

The evaluation results from several example cases are provided below. It is recommended that these examples be replicated by the end user to confirm worksheet consistency with the version defined within this report.

5.1 Example LOCA Evaluation

An example evaluation was made based on the RCP Discharge (Cold Leg) Break LOCA heat loads and includes a peak containment heat load of 147.25 MBTU/hr plus 10 MBTU/hr auxiliary heat load on the CCW loop and 5.1 MBTU/hr EC heat load applied to the ACCW. The default 1 hour conditions were selected, providing an ambient dry bulb temperature of 102^{o}F with +0.2^{o}F recirculation, and ambient wet bulb of 78^{o}F with +8.8^{o}F recirculation. The CCW flow rate was conservatively bounded as 6900gpm [5f] and the ACCW flow rate was conservatively considered as 5350gpm [5g], with 850gpm [5g] to the EC. Based on these conditions, the CCW and ACCW temperatures are as shown in Figure 5-1. In this case, the CCW temperature returning to containment equipment coolers is not met by the 112.4^{o}F TCW control temperature, but enters containment at 114.5^{o}F for a limiting ACCW flow (GPM_accw) of 5350 gpm.

$$X = \begin{pmatrix} 114.5 \\ 161.2 \\ 128.6 \\ 115.1 \\ 113.6 \\ 93.5 \\ 105.6 \\ 161.2 \end{pmatrix} \quad \begin{matrix} 0\ \text{Tccw\_out or GPM\_accw} \\ 1\ \text{Tdct\_in} \\ 2\ \text{Tdct\_out} \\ 3\ \text{Taccw\_out} \\ 4\ \text{Twct\_in} \\ 5\ \text{Twct\_out} \\ 6\ \text{Tec\_out} \\ 7\ \text{Tcon\_out} \end{matrix}$$

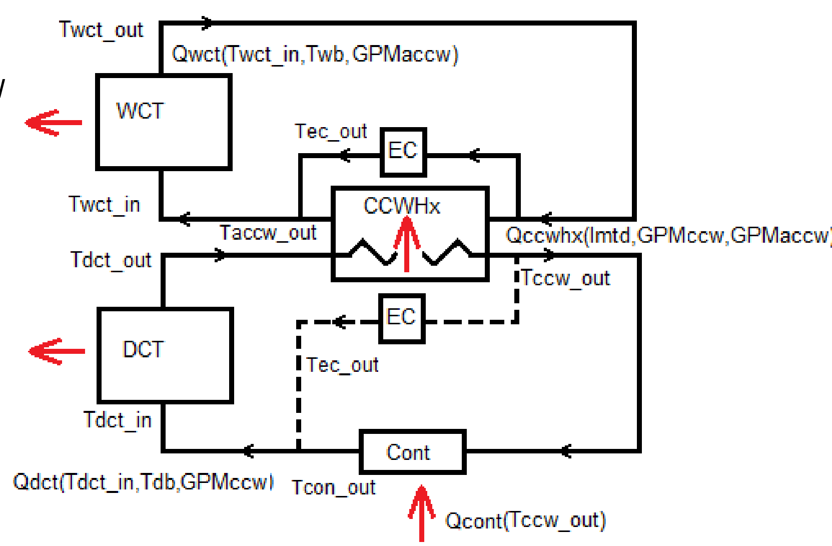


Figure 5-1: UHS Loop Temperature Output from Example Conditions

5.2 LOCA Water Consumption

To evaluate long term water consumption in the WCT basin, the above Cold Leg break analysis was modified to the 3-day default values, providing a dry bulb ambient temperature of 89°F +1.3°F recirculation for a 2mph wind with a wet bulb temperature of 76°F with no recirculation. The following plot shows the temperatures and ACCW flow rate over the analysis period. Water consumption by the WCT based on these conditions is 61,880 gal before the simulation is terminated at 24.8 hours due to insufficient flows to the ACCW loop (MAR=300gpm). Using a projected time of 63.2 hours until DCT capacity is greater than heat load ($T_{project2}$), the projected water use is 165,500 gal with WCT fans on and 139,100 gal with WCT fans off.

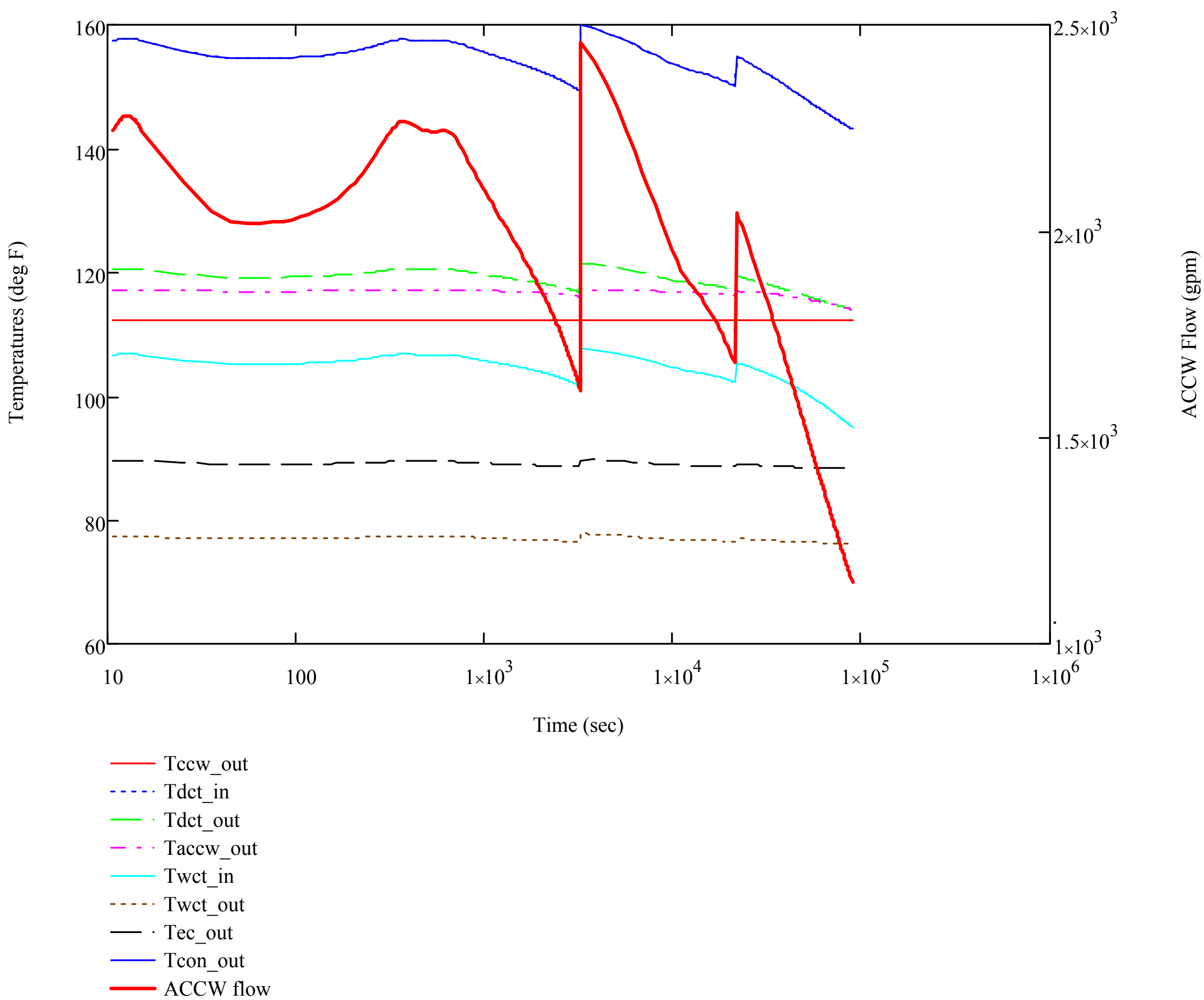


Figure 5-2: Loop Temperatures and ACCW flow

5.3 Start-Up Test Benchmark

A benchmark analysis against Waterford 3 plant startup testing was performed to demonstrate the accuracy and conservatism of the overall UHS model. Previously, it was shown above that individual components (DCT, WCT, and CCWHX) were accurate within several percent. However, this section demonstrates the combined conservatism of the system against measured data.

The test data used is based on 8/19/1982 data captured in MNQ9-52 [5c] (See also Figure 4-9). Several simulations were run as described below. For all models, the CCWHX fouling was set low (0.0001) with no tubes plugged to simulate a new heat exchanger. DCT fan flow was set to 177,000 cfm per fan based on a review of the wind conditions [5c] and previous model results [18].

Model 1: A model with minimal modification was run to show base results. Recirculation values (7.78^{o}F DCT, 2.46^{o}F WCT) were maintained. The results show somewhat lower heat removal than measured (121.1 vs. 125.42 MTBU/hr) for the DCT, which subsequently increases the load for the WCT (54.7 vs. 50.47 MBTU/hr). This model is identical to that provided for UHS analysis with the inputs as noted above and in Table 5-1.

Model 2: As shown in Section 4.3.1 and Attachment A, the DCT curves are low (11.95%). To more accurately capture test data, the DCT curves are increased by a linear 11.95%. Resulting DCT heat loads and temperatures are very close to tested results. This model was prepared for demonstration purposes only and is not be provided for future UHS analysis.

Heat Loads: It should be noted there are several discrepancies in the tested data. First, the reported heat loads do not match the test data. The total heat load of 175.89 MTBU/hr appears to be based on the sum of the DCT and WCT loads implied by their temperature change. The heat increase across the boiler from 99.16^{o}F to 152.48^{o}F at 6902 gpm is actually 181.97MTBU/hr. The DCT heat load obtained from the temperature loss from 152.48^{o}F to 115.94^{o}F at 6902 gpm is 124.43 MTBU/hr vs. the reported 125.42 MTBU/hr. It is believed that these lower heat loads are due to losses in the return piping to the boiler, as evidenced by the low (99.16^{o}F) boiler inlet temperature. These additional losses are real and increase conservatism as they are not credited in the model.

Table 5-1: Start-Up Test Benchmark

Variable	Test	Model 1	Model 2
Heat Load (MBTU/hr)	175.89	175.89	175.89
TDB (^oF)	85.87	85.87	85.87
DCT Recirc (^oF)	7.78	7.78	7.78
TWB (^oF)	77.15	77.15	77.15
WCT Recirc (^oF)	2.46	2.46	2.46
CCWHX Tube Plugging	Not specified	0	0
CCWHX Fouling	Not specified	0.0001	0.0001
CCW Flow (gpm)	6902	6902	6902
ACCW Flow (gpm)	5324	5324	5324
DCT Air flow (x1000 cfm)	Not specified	177	177
Other			DCT curve x 1.1195
Outputs			
DCT Heat Load (MBTU/hr)	125.42	121.1	128.7
WCT Heat Load (MBTU/hr)	50.47	54.7	47.1
CCWHX Out (^oF)	99.16	106.9	103.7
DCT In (^oF)	152.48	158.6	155.3
DCT Out (^oF)	115.94	123.0	117.5
WCT In (^oF)	105.01	109.4	105.7
WCT Out (^oF)	85.88	88.7	87.9

6 Conclusions

The heat transfer model developed herein provides a Mathcad worksheet for the evaluation of the UHS that can be used to develop design basis calculations demonstrating acceptable behavior of the system. The calculation methodology considers accurate modeling of the heat removal components' performance and interaction with CCW/ACCW loop temperatures. Included in the model are transient containment loads, fuel pool cooling loads, and other auxiliary loads and DCT, WCT, and CCWHx performance. Input variables are provided to permit the user to evaluate a range of ambient temperatures, additional temperatures for recirculation effects, heat loads, tube plugging, or other plant performance parameters. Additionally, the model permits the study of potential modifications that can be implemented as necessary to improve design basis margin.

The component models included in the overall UHS model are benchmarked herein against available test data. The models are shown to be conservative relative to tested performance and can be used to demonstrate acceptable UHS performance.

The evaluation results from several example cases are also provided. It is recommended that these examples be replicated by the end user to confirm worksheet consistency with the version defined within this report.

It should be noted that the Mathcad worksheets provide a calculation method and not a locked executable program. Therefore, any application of the methods provided herein require checking and verification by the end user.

INPUT CONDITIONS ARE PROVIDED FOR THE USER'S CONVENIENCE ONLY. RESULTS PROVIDED HEREIN DO NOT REPRESENT A DESIGN BASIS ANALYSIS.

WCT PERFORMANCE WITH FANS OUT OF SERVICE SHOULD BE VERIFIED BY TESTING BEFORE USE OF THIS FEATURE OF THE CALCULATION METHOD.

7 References

1 Purchase Order 10478555-01.

2 Waterford Design Input Transmittal DITv2, 3/12/2015.

3 Waterford 3, W3-DBD-4, Rev 302, "Design Basis Document, Component Cooling Water and Auxiliary Component Cooling Water"

4 Waterford 3 drawings

a. 1564-G-160, Sheets 1-6, Flow Diagram, Component Closed Cooling Water System

b. 5817-10750 R0, CCWHx Baffles and Hinge Details

5 Waterford 3 Calculations

a. ECM95-008 Rev 3, "Ultimate Heat Sink Design Basis"

b. ECS05-013 Rev 2, "Ultimate Heat Sink Containment Heat Loads"

c. MN(Q) 9-52 Rev 2, "Ultimate Heat Sink Performance" (Study, non-design basis)

d. ECI91-036 Rev 1, "Component Cooling Water Heat Exchanger Outlet Water Temperature (Dry Fan Cooler) Instrument Loop Uncertainty Calculation"

e. ECM98-067, Limiting Single Failure Thermal Hydraulic Analysis for Spent Fuel Pool Cooling

f. MNQ 9-2 Rev 1, "Component Cooling Water System"

g. MNQ 9-50 Rev 2, "ACCW System Resistance"

h. MNQ 9-9 Rev 5 (EC-8465, 34480, 42927), "Wet Cooling Tower Losses During LOCA"

i. 9C2-5Y Rev 1, "Essential Chiller Loads"

j. MNQ 9-10 R2 (EC-8465), "DCT & WCT Capacities in Different Cases"

k. *(not used)* MN(Q) 9-3 R3, "Heat Removal Capacities of the DCT and WCT After LOCA".

l. 5-T R5, "Essential Chilled Water Cooling Loads and Coil Performance Determination".

m. MNQ 9-17 R3, "Tornado Multiple Missile Protection of Cooling Towers".

n. ECS-96-003 R0, "Spent Fuel Pool Loads for a Full Spent Fuel Pool and SFP Cask Storage Area",

o. CN-SEE-II-08-6 R1, "Shutdown Cooling Analysis for the Waterford-3 RSG Program"

p. WF3-ME-16-00001, R0, "Meteorological Parameters and Parameter Relationships for Design and Operability of the Waterford 3 Ultimate Heat Sink".

6 Entergy and Vendor Specifications

a. Ebasco Services, Inc. Specification 1564.075 Rev 9, "Component Cooling Water Heat Exchangers"

b. Specification 1564.086 Rev 8 (DRN00-1247, 04-526, 05-1609, EC-8465), "Component Cooling Water System Dry Cooling Towers"

c. Specification 1564.114A R10 (EC8465, DRN04-529, 05-1608), "Mechanical Draft Cooling Towers and Accessories"
d. Hudson Products, TD-H291.0015 R0, TD-H291.0025 R0, TD-H291.0035 R0
e. Zurn Industries, Inc., TD-Z010.0025, "Instruction Manual for Zurn Mechanical Draft Cooling Towers", 2/6/79
f. Entergy Vendor Manual 457002178, "Spent Fuel Cooling Heat Exchanger", Rev 0, 8/19/85.
g. Atlas TD-A545.0015, Rev 0, "Atlas Fuel Pool Heat Exchanger Technical Manual"
h. Specification 1564-4983-0, DRN97-2456_1
i. Specification 5817-10747
j. Specification 5817-10750

7 Entergy Test Data

a. Cooper, J., "Waterford 3 SES Wet Cooling Tower B Capability Summary Report", 5/21/98.
b. Cooper, J., "Waterford 3 SES Wet Cooling Tower A Capability Summary Report", 5/21/98.
c. Engineering Report W3-ME-00-0002, "Wet Cooling Tower A Thermal Capability Test 4/10/00", 4/28/00.
d. Entergy Report, "B CCW Heat Exchanger and Wet Cooling Tower Test 12/11/01", 12/20/01
e. Entergy WO-WF3-00041082, "Perform a Thermal Performance Test on the Train B Wet Cooling Tower
f. Entergy WO-WF3-00144200, "Perform a Thermal Performance Test on the Train A Wet Cooling Tower
g. SFG36-004 R0, "Wet and Dry Cooling Tower Fan Performance Evaluation – Official Test Copy".
h. Cooper, J. to Gallodoro, D., "Assessment of the Impact of Recirculation on the Thermal Performance of the Waterford Dry Cooling Towers", 5/3/2012
i. Drummond, J. (Ebasco) to Stampley, R. "Waterford SES Unit 3 Ultimate Heat Sink Test Evaluation, Tornado Case", 12/22/1982.

8 Waterford 3 Operability Evaluations

a. CR-WF3-2012-2332, "Operability Evaluation", 5/17/12
b. CR-WF3-2012-2870

9 not used

10 "Software Control," LPI Procedure LPI 4.1, Rev. 3

11 Mathcad software, version 14.0.2.5, Parametric Technology Corporation.

12 Kreith, "Principles of Heat Transfer", International Textbook, 1965.

13 Wolverine Tube Company, "Engineering Data Book III", J. Thome, 2004.

14 Taborek, J. Shell and Tube Heat Exchangers: Single Phase Flow, Heat Exchanger Design Handbook, Chapter 3.3, Hemisphere, NY, 1983.
15 ASHRAE Handbook, "Fundamentals" 2001
16 Waterford Preventative Maintenance Identification Numbers (PMIDs): 14508, 14509, 5382, and 8549.
17 LPI Technical Report A13326-R-001, R1 "Waterford 3 Ultimate Heat Sink Project Weather Investigation".
18 LPI Technical Report A13326-R-002, R1, "Waterford 3 Ultimate Heat Sink Project CFD Investigation of the Wet And Dry Cooling Towers".
19 LPI Technical Report A14386-R-001, R1, "Waterford3 Ultimate Heat Sink: CFD Investigation of the Dry Cooling Tower Deflector Wall Modification".
20 Waterford Updated Final Safety Analysis Report, Section 9.2
21 EPRI Technical Report TR-107397, "Service Water Heat Exchanger Testing Guidelines", 3/1998.
22 J. Cooper and Associates, Technical Letter JCA-LPI-0115987 Rev 3 to G. Zysk, 12/9/2016, "Waterford3 Wet Cooling Tower Performance with Fans Out of Service".
23 Incropera, F and DeWitt, D, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1985.
24 Letter, ESLOU87-77, "Design Meteorological Data for Ultimate Heat Sink".
25 Letter, ESLOU1-76, "Meteorological Conditions Following Tornado Passage".
26 Letter, ESLOU91-77, "Table 2.3-2(a) Ultimate Heat Sink Design Parameters".
27 J.A. Goff and S. Gratch, "Thermodynamic Properties of Moist Air" (ASHVE Transactions, Vol. 51, 1945, p.125)
28 NUREG 0800, Section 5
29 J. Cooper and Associates, Technical Letter JCA-LPI-0916988 to G. Zysk, 9/14/2016, "Waterford3 WCT Performance with 4 Fans in One Cell Taken Out of Service".

Attachment A:

Listing of UHS Model Calculations

The UHS model is presented in detail in this attachment. The base UHS model and each component module are presented. Following the component modules, alternate sets of inputs are provided for several cases described below.

UHS Model, pages A-3 to A-58

This UHS model listing shows a design basis LOCA analysis for a RCP discharge line (Cold Leg) break, demonstrating the results presented in Section 5.2. All component models are expanded to show calculation details.

Module	Number of pages	Attachment pages
UHS Model	17	A-3 to A-19
Water properties	2	A-20 to A-21
LOCA Loads	4	A-22 to A-25
DCT	9	A-26 to A-34
WCT	14	A-35 to A-48
CCWHX	6	A-49 to A-54
Recirculation	4	A-55 to A-58

Note 1: Revision 4 to this report changes the DCT module with respect to the air flow correction term, and other changes as described in the table of revisions. The results from each simulation are therefore changed from Rev 3. Revisions are individually identified with revision bars in the attachments. All pages updated to Rev 4.

UHS Model (9 pages) A-59 to A-67

The second listing provides the Benchmark Evaluation, Model 2, as described in Section 5.3. Heat loads are input as "Normal" loads and EC loads were set to 0 on the CCW loop. DCT curves are increased 11.95% per Section 4.3.1. The CCWHX fouling was set low (0.0001) with no tubes plugged to simulate a new heat exchanger.

UHS Model (9 pages) A-68 to A-76

The third listing provides the evaluation of the bounding FSAR conditions at 102^{o}F dry bulb and 78^{o}F wet bulb temperatures, demonstrating the results presented in Section 5.1.

Cross Reference List for References Used in Mathcad Worksheets

The calculation methodology shown in Attachment A was prepared as individual worksheets using the Mathcad software [11] with input conditions referenced within each worksheet. A cross reference list is provided to show the Attachment A references relative to the listed items in Section 7.

Water Properties

WP-1, [12] Kreith

LOCA Loads

LL-1, [5b] Calculation ECS-05-013

LL-2, [5m] Calculation MN(Q) 9-17

LL-3, [5o] Calculation CN-SEE-2-08-6

DCT

DCT-1, [6d] Specification TD-H291.0015

DCT-2, [6h] Specification 1564-4893-0 DRN97-2456_1

WCT

WCT-1, [6e] Specification TD-Z010-0025

WCT-2, [12] Kreith

WCT-3, [15] ASHRAE

WCT-4, [22] Letter JCA-LPI-0115987

WCT-5, [27] Thermodynamic Properties of Moist Air

WCT-6, [29] Letter JCA-LPI-0115987

CCWHX

CCWHX-1, [6a] Specification 1564.075 R9

CCWHX-2, [23] Incropera

CCWHX-3, [12] Kreith

CCWHX-4 [6i] Specification 5817-10747

CCWHX-5 [6j] Specification 5817-10750

Recirc

REC-1, [19] A14386-R-001

REC-2, [5p] WF3-ME-16-0001

Waterford 3 Ultimate Heat Sink (UHS) Model

This is the base module for a multi-component heat transfer model of the UHS system. The model evaluates temperatures for the closed cooling water (CCW) and Auxiliary Closed Cooling Water (ACCW) loops in an integrated manner with heat transfer at major components. This Mathcad worksheet is formatted to permit user input for analysis type and boundary conditions.

1. Scriptable components are used to enable pull-down menus for user input. The user must select "No", do not disable scriptable components for this worksheet.

2.Separate modules are included to calculate the performance of major system components (DCT, WCT, and CCWHx). The following files are required in the same directory as this input and analysis module:

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD R4\Water Properties.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD R4\LOCA Loads.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD R4\DCT.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD R4\WCT.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD R4\CCWHX.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD R4\Recirc.xmcdz(R)

3. If the worksheet is not set up for automatic calculation, press "F9" to perform evaluation up to the current location.

4. All input fields are highlighted in yellow and can be modified. All non-input fields are protected from edits.

5. All Mathcad default values for array origin (0), convergence and constraint tolerance (0.001), should remain unchanged for appropriate model operation

Verification of Component Modules

Each module is checked to provide acceptable results against benchmark tests. Each of the following checks should produce an "OK" indicating acceptable results from the module.

Check water properties module	$\text{if}[\text{checkWP} < (.0001), \text{"OK"}, \text{"Not OK"}] = \text{"OK"}$
Check LOCA Loads function vs data	$\text{if}[\lvert\max(\text{Diff})\rvert < (.0001), \text{"OK"}, \text{"Not OK"}] = \text{"OK"}$
Check DCT module error < 1.06%	$\text{if}(\lvert\text{mean}(\text{DCT\_ER})\rvert < 0.0106, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$
Check WCT module error < 4.9%	$\text{if}(\lvert\text{mean}(\text{WCT\_ER})\rvert < 0.049, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$
Check CCWHX module error < 0.7%	$\text{if}(\lvert\text{mean}(\text{UERR})\rvert < 0.007, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$
Check Recirc module	$\text{if}(\text{round}(T_{R\_DCT}(1\text{hr}, 102, 0), 10) = 0.2012221728, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$

User Input Section

In this section, the type of analysis (LOCA, Shutdown, etc.) and the steady state or transient analysis conditions are selected. Transient analysis conditions are only available for LOCA conditions for which tables of heat loads with time are provided as input. Transient analyses are performed as a series of repeated steady state evaluations to determine long term water consumption over the heat load period.

Type of Analysis *Select options from menus*

EVAL :=
- **LOCA Cold Leg (RCP) Break** (selected)
- LOCA Hot Leg Break
- Non-LOCA Shutdown
- Post Tornado Fixed Loads
- Operating Loads

time :=
- 1 hour
- 1 day
- **3 day** (selected)
- 7 day

$EVAL = 0$

$t_{crit} := TC(time)$

Analysis Boundary Conditions

Type in input value or function for each highlighted field.

Select Default Limits or Enter Values	Default Limits	User Entered
Drybulb Temperature (deg F)	$T_{db} := TDBMAX(t_{crit})$	$T_{db} := T_{db}$
DCT Recirculation Temperature Increase (deg F)	$DCT_R := T_{R\_DCT}(t_{crit}, T_{db}, DCT_{OOS})$	$DCT_R := DCT_R$
Wetbulb Temperature (deg F) *For conservatism, MAX + max recirc for max heat removal and MIN + 0 for WCT water consumption*	$T_{wb} := \begin{cases} TWBMAX(t_{crit}, T_{db}) + 8.8 & \text{if } t_{crit} = 1hr \\ TWBMIN(t_{crit}, T_{db}) & \text{otherwise} \end{cases}$	$T_{wb} := T_{wb}$

Resulting Boundary Condition Values

$T_{db} = 89$ $DCT_R = 1.3$ $WS_{max}(t_{crit}, T_{db}) = 2$ $T_{db} + DCT_R = 90.3$ $T_{wb} = 76$

Flow Rates

CCW flow rate (gpm)	$GPM_{ccw} := 6900$
ACCW flow rate (gpm)	$GPM_{accw} := 5350$
CCW Control Temperature (deg F)	$TCW := 112.4$
Number of UHS Loops in Service *Note: N_{UHS}=2 divides loads equally between 2 Loops.*	$N_{UHS} := 1$

DCT/WCT Fan Conditions

Number of DCT fans in service *Note DCT Recirc is increased for 1-3 fans OOS without covers* — $DCT_{fans} \equiv 15$

Number of DCT OOS without covers — $DCT_{OOS\_noc} \equiv 15 - DCT_{fans}$ — $DCT_{OOS} \equiv DCT_{OOS\_noc}$

Number of WCT fans in service — $WCT_{fans} := 8$

Complete WCT cell out of service (4 fans/1 cell)? 1=yes, 0=no — $WCT_{cell\_out} := 0$

Percentage DCT Area available (95%-100%) — $P_{dct} := 99.75\%$

Average DCT Air Flow (1000 cfm) — $AIR := -0.46 \cdot (WS_{max}(t_{crit}, T_{db})) + 179.86$ — $AIR := AIR$ — $AIR = 178.9$

Heat Loads and Options

Type in input value or function for each highlighted field.

Fuel Pool Cooling Loads

Note: FPC transient loads and/or constant values can be included with LOCA and BTP5.4 transients.
Constant value FPC loads need to be input for other evaluation conditions.

Include FPC transient loads for LOCA and BTP5.4 — FP_{sw} := [On / Off] (On selected)

Constant FP loads (BTU/hr) — $FPC := 0 \cdot 10^6$

Essential Chillers

Essential Chillers heat load (BTU/hr) — $Q_{EC} := 5.1 \cdot 10^6$

Essential Chiller Flow (gpm) — $GPM_{chill} := 850$

Loop selection switch for EC loads, *select option* — EC_{sw} := [ACCW Loop / CCW Loop] (ACCW Loop selected)

if ECsw = 0, ACCW
if ECsw = 1, CCW

Auxiliary Loads

Heat load from EDG, HPSI, LPSI, and Containment Spray (BTU/hr) — $Q_{aux} := (10) \cdot 10^6$

CCW Heat Exchanger

CCWHX Number of plugged tubes — $N_{plug} := 63$

CCWHX Fouling factor, shell side — $ff_o := 0.0012 \cdot \left(hr \cdot ft^2 \cdot F\right) \cdot BTU^{-1}$

CCWHX Fouling factor, tube side — $ff_i := 0.0 \cdot \left(hr \cdot ft^2 \cdot F\right) \cdot BTU^{-1}$

Options for Tornado Analysis

WCT Natural draft mode or normal operation — WCT_{ND} := [Normal Operation / Natural Draft Mode] (Normal Operation selected)

Logical switch = 0 for normal, 1 for natural draft

Post-Tornado Analysis Heat Load (BTU/hr) — $Q_{Tor} := (0) \cdot 10^6$

Note: This heat load only used if EVAL=3.

Options for Normal Operation, Heat Load (BTU/Hr) — $Q_{Norm} := (0) \cdot 10^6$

Summary of Containment Heat Loads

$$Q_{cont}(Tm,T) := \frac{1}{N_{UHS}} \cdot \begin{cases} Q_{LOCA}(Tm,T,EVAL) + (1 - FP_{sw}) \cdot FPL(Tm) + FPC + Q_{aux} & \text{if } EVAL < 2 \\ Q_{BTP}(Tm) + (1 - FP_{sw}) \cdot FPL(Tm) + FPC + Q_{aux} & \text{if } EVAL = 2 \\ Q_{Tor} + FPC + Q_{aux} & \text{if } EVAL = 3 \\ Q_{Norm} + FPC + Q_{aux} & \text{if } EVAL = 4 \\ Q_{aux} & \text{otherwise} \end{cases}$$

Circuit Model

Determine time of maximum heat load.

$$TT := \begin{cases} Time(EVAL) & \text{if } EVAL < 2 \\ TTT & \text{if } EVAL = 2 \\ 0 & \text{otherwise} \end{cases} \qquad time := \begin{cases} Time\_max(EVAL) & \text{if } EVAL < 2 \\ t_{BTPMAX} & \text{if } EVAL = 2 \\ 0 & \text{otherwise} \end{cases}$$

Check

$time = 3254.44$

$Q_{cont}(time, TCW) = 161.65 \times 10^6$

Note: This containment load is approximate based on selected TCW.

Initial seed values, over-written by calculated temperatures and flows

$Tccw\_out := TCW$

$Tcon\_out := 165.01$

$Tdct\_in := 165.02$

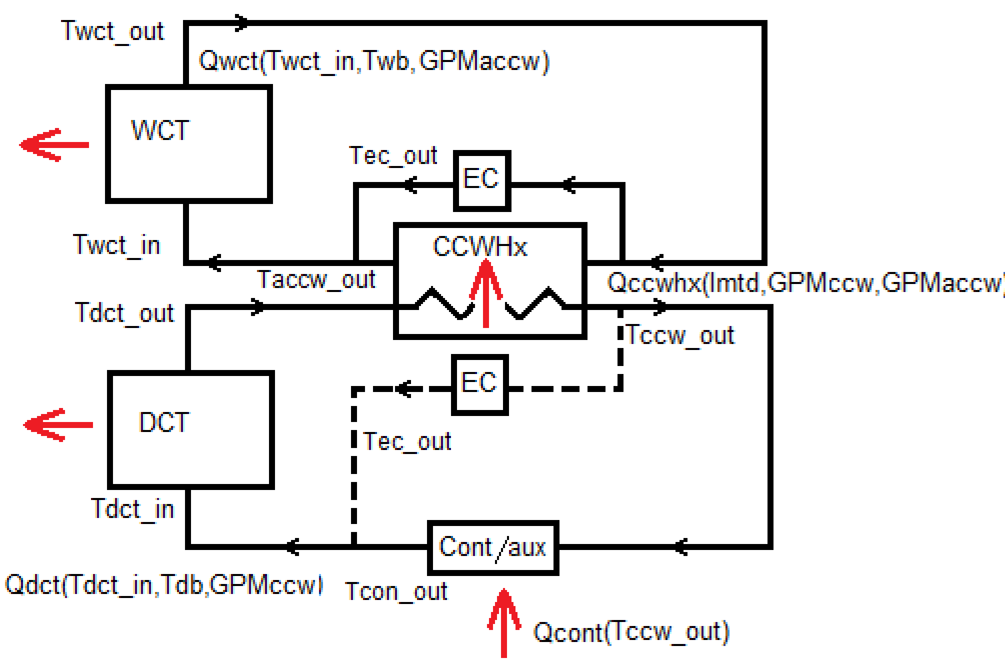
$Tdct\_out := 125.01$

$Taccw\_out := 115.01$

$Tec\_out := 100$

$Twct\_in := 105.01$

$$Twct\_out := \begin{cases} 110 & \text{if } EVAL = 3 \\ T_{wb} + .1 & \text{otherwise} \end{cases}$$



Calculate Conditions based on fixed ACCW flow

Given

1) Heat in from Containment increases CCW temp

$$Q_{cont}(time, Tccw\_out) = Q_{wtr}(GPM_{ccw} - GPM_{chill} \cdot EC_{sw}, Tcon\_out, Tccw\_out)$$

2) DCT discharges heat and reduces CCW with added DCT recirc

$$Q_{dctx}(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF(Q_{cont}(time, Tccw\_out), EVAL), DCT_{fans}, AIR) = Q_{wtr}(GPM_{ccw}, Tdct\_in, Tdct\_out)$$

3) CCW Hx discharges from ccw

$$Q_{ccw}[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}] = Q_{wtr}(GPM_{ccw}, Tdct\_out, Tccw\_out)$$

4) CCW Hx adds heat to accw

$$Q_{ccw}[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}] \ldots = 0$$
$$+ -Q_{wtr}[GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), Taccw\_out, Twct\_out]$$

5-7) EC Heat is added to either wct_out or ccw_out based on ECsw = 0 (ACCW) or 1 (CCW)

$$Q_{EC} = Q_{wtr}(GPM_{chill}, Tec\_out, Twct\_out) \cdot (1 - EC_{sw}) + Q_{wtr}(GPM_{chill}, Tec\_out, Tccw\_out) \cdot (EC_{sw})$$

$$GPM_{accw} \cdot Twct\_in = GPM_{chill} \cdot Tec\_out \cdot (1 - EC_{sw}) + [GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw})] \cdot Taccw\_out$$
$$GPM_{ccw} \cdot Tdct\_in = GPM_{chill} \cdot Tec\_out \cdot EC_{sw} + [GPM_{ccw} - GPM_{chill} \cdot (EC_{sw})] \cdot Tcon\_out$$

8) WCT discharges heat

$$Q_{wct}(GPM_{accw}, Twct\_in, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}) = Q_{wtr}(GPM_{accw}, Twct\_in, Twct\_out)$$

$$R1(time, EC_{sw}) := Find(Tccw\_out, Tdct\_in, Tdct\_out, Taccw\_out, Twct\_in, Twct\_out, Tec\_out, Tcon\_out)$$

$$A := R1(time, EC_{sw})$$

Title: Waterford3 UHS Model

Calculate Conditions based on fixed CCW return temperature:

$TCW = 112.4$ $EVAL = 0$

Given

1) Heat in from Containment increases CCW temp

$$Q_{cont}(time, TCW) = Q_{wtr}(GPM_{ccw} - GPM_{chill} \cdot EC_{sw}, Tcon\_out, TCW)$$

2) DCT discharges heat and reduces CCW with added DCT recirc

$$Q_{dctx}(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF(Q_{cont}(time, TCW), EVAL), DCT_{fans}, AIR) = Q_{wtr}(GPM_{ccw}, Tdct\_in, Tdct\_out)$$

3) CCW Hx discharges from ccw

$$Q_{ccw}\left[Tdct\_out, TCW, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}\right] = Q_{wtr}(GPM_{ccw}, Tdct\_out, TCW)$$

4) CCW Hx adds heat to accw

$$Q_{ccw}\left[Tdct\_out, TCW, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}\right] \dots = 0$$
$$+ -Q_{wtr}\left[GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), Taccw\_out, Twct\_out\right]$$

5-7) EC Heat is added to either wct_out or ccw_out based on ECsw = 0 (ACCW) or 1 (CCW)

$$Q_{EC} = Q_{wtr}(GPM_{chill}, Tec\_out, Twct\_out) \cdot (1 - EC_{sw}) + Q_{wtr}(GPM_{chill}, Tec\_out, TCW) \cdot (EC_{sw})$$

$$GPM_{accw} \cdot Twct\_in = GPM_{chill} \cdot Tec\_out \cdot (1 - EC_{sw}) + \left[GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw})\right] \cdot Taccw\_out$$

$$GPM_{ccw} \cdot Tdct\_in = GPM_{chill} \cdot Tec\_out \cdot EC_{sw} + \left[GPM_{ccw} - GPM_{chill} \cdot (EC_{sw})\right] \cdot Tcon\_out$$

8) WCT discharges heat

$$Q_{wct}(GPM_{accw}, Twct\_in, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}) = Q_{wtr}(GPM_{accw}, Twct\_in, Twct\_out)$$

$$R2(time, EC_{sw}) := Find(GPM_{accw}, Tdct\_in, Tdct\_out, Taccw\_out, Twct\_in, Twct\_out, Tec\_out, Tcon\_out)$$

Provide Result Sets for 2 Calculations (LOCA, BTP5.4 only)

$$B := \begin{vmatrix} A & \text{if } EVAL > 2 \\ A & \text{if } A_0 > TCW \\ R2(time, EC_{sw}) & \text{otherwise} \end{vmatrix}$$

$$X := \begin{vmatrix} A & \text{if } B_0 \ge GPM_{accw} \\ B & \text{otherwise} \end{vmatrix}$$

$$A = \begin{pmatrix} 105.56 \\ 153.14 \\ 118.58 \\ 105.82 \\ 104.57 \\ 85.88 \\ 97.96 \\ 153.14 \end{pmatrix} \qquad B = \begin{pmatrix} 2459.47 \\ 159.91 \\ 121.58 \\ 117.17 \\ 107.75 \\ 77.87 \\ 89.93 \\ 159.91 \end{pmatrix}$$

Determine Tccw_out and GPMaccw from results

$$Tccw\_out := \begin{cases} X_0 & \text{if } X = A \\ TCW & \text{otherwise} \end{cases} \qquad GPM_{accw} := \begin{cases} \min(B_0, GPM_{accw}) & \text{if } (EVAL < 3) \wedge B_0 \neq A_0 \\ GPM_{accw} & \text{otherwise} \end{cases}$$

$Tccw\_out = 112.4$ $GPM_{accw} = 2459.47$ $T_{db} = 89$ $T_{wb} = 76$

Final Result Set

$$X = \begin{pmatrix} 2459.5 \\ 159.9 \\ 121.6 \\ 117.2 \\ 107.8 \\ 77.9 \\ 89.9 \\ 159.9 \end{pmatrix}$$

0 Tccw_out or GPM_accw
1 Tdct_in
2 Tdct_out
3 Taccw_out
4 Twct_in
5 Twct_out
6 Tec_out
7 Tcon_out

$Tdct\_in := X_1$
$Tdct\_out := X_2$
$Taccw\_out := X_3$
$Twct\_in := X_4$
$Twct\_out := X_5$
$Tec\_out := X_6$
$Tcon\_out := X_7$

Check heat flows

Heat Load $QC := Q_{cont}(time, Tccw\_out)$ $QC = 161.65 \times 10^6$

DCT $QD := Q_{dctx}\left(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(time, TCW), EVAL\right), DCT_{fans}, AIR\right)$ $QD = 130.22 \times 10^6$

CCWHX $QCW := Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right]$

$QCW = 31.39 \times 10^6$

EC Load $QE := Q_{wtr}\left[GPM_{chill}, Tec\_out, Twct\_out \cdot \left(1 - EC_{sw}\right) + Tccw\_out \cdot EC_{sw}\right]$ $QE = 5.1 \times 10^6$

WCT $QW := Q_{wct}\left(GPM_{accw}, Twct\_in, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}\right)$ $QW = 36.49 \times 10^6$

Error Check - CCW Loop

$$\frac{\begin{bmatrix} Q_{cont}(time, Tccw\_out) + Q_{EC} \cdot EC_{sw} \ldots \\ + -1 \cdot Q_{dctx}\left(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(time, Tccw\_out), EVAL\right), DCT_{fans}, AIR\right) \ldots \\ + -1 \cdot Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] \end{bmatrix}}{Q_{cont}(time, Tccw\_out)} = 0.024 \cdot \%$$

Error Check - ACCW Loop

$$\frac{\begin{bmatrix} Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] \ldots \\ + Q_{EC} \cdot \left(1 - EC_{sw}\right) - Q_{wct}\left(GPM_{accw}, Twct\_in, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}\right) \end{bmatrix}}{Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right]} = 0.01 \cdot \%$$

WCT water loss

Inlet enthalpy $h_i := h(T_{wb})$ $h_i = 39.57$ at $T_{wb} = 76$

Range $Range := Twct\_in - Twct\_out$ $Range = 29.88$

Outlet enthalpy $h_e := LG(GPM_{accw} \cdot gpm) \cdot Range + h_i$ $h_e = 58.58$ at $LG(GPM_{accw} \cdot gpm) = 0.636$

Evaporative loss (WCT fans on)

$$EV(GPM_{accw}, h_e, T_{db}, T_{wb}) = 1.07 \cdot \frac{gal}{sec}$$

Check air exit conditions

$$W(Temp(h_e), 100\%) = 0.033 \qquad Temp(h_e) = 91.87$$

Drift loss $DL(G) := .001 \cdot G$ $DL(GPM_{accw} \cdot gpm) = 0.04 \cdot \frac{gal}{sec}$

Hourly rate (WCT fans on or off)

$$WCT_{use} := \left[(1 - WCT_{ND}) \cdot EV(GPM_{accw}, h_e, T_{db}, T_{wb}) + WCT_{ND} \cdot EV_{wctND}(GPM_{accw}, T_{wb}, Range) \ldots + DL(GPM_{accw} \cdot gpm)\right]$$

$$\boxed{WCT_{use} = 4014.3 \cdot \frac{gal}{hr}}$$

Repeat WCT water loss calculation for only EC loads, i.e. after ACCW isolation, using WCT pool temp

Given $Q_{EC} = Q_{wtr}(GPM_{chill}, Twct\_in, Twct\_out)$ $TWCT := Find(Twct\_in)$ $TWCT = 89.93$

Range $R_{EC} := TWCT - Twct\_out$ $R_{EC} = 12.06$

Outlet enthalpy $h_{e\_EC} := LG(GPM_{chill} \cdot gpm) \cdot R_{EC} + h_i$ $h_{e\_EC} = 42.22$ $h_i = 39.57$

Evaporative and Drift loss $EV_{chill\_1} := (EV(GPM_{chill}, h_{e\_EC}, T_{db}, T_{wb}) + DL(GPM_{chill} \cdot gpm))$ $EV_{chill\_1} = 1182.19 \cdot \frac{gal}{hr}$

Repeat WCT water loss calculation for only EC loads, i.e. after ACCW isolation, using WCT pool temp with **WCT fans off**

Given $Q_{EC} = Q_{wtr}(GPM_{chill}, Twct\_in, Twct\_out)$ $TWCT := Find(Twct\_in)$ $TWCT = 89.93$

Range $R_{EC} := TWCT - Twct\_out$ $R_{EC} = 12.06$

Evaporative and Drift loss $EV_{chill\_2} := (EV_{wctND}(GPM_{chill}, T_{wb}, R_{EC}) + DL(GPM_{chill} \cdot gpm))$ $EV_{chill\_2} = 563.87 \cdot \frac{gal}{hr}$

Provide table of conditions/settings

$$SET1 := \begin{pmatrix} EVAL & \frac{t_{crit}}{hr} & T_{db} & DCT_R & T_{wb} & GPM_{ccw} & GPM_{accw} & TCW & N_{UHS} & DCT_{fans} \\ WCT_{fans} & P_{dct} & AIR & FP_{sw} & FPC & Q_{EC} & GPM_{chill} & EC_{sw} & Q_{aux} & N_{plug} \\ \frac{ff_o \cdot 1000BTU}{hr \cdot ft^2 \cdot R} & WCT_{ND} & Q_{Tor} & Q_{Norm} & Q_{cont}(time, TCW) & Tccw\_out & Tdct\_in & Tdct\_out & Taccw\_out & Twct\_in \\ Twct\_out & Tec\_out & Tcon\_out & QC & QD & QCW & QE & QW & WCT_{use} \cdot \frac{hr}{gal} & EV_{chill\_2} \cdot \frac{hr}{gal} \end{pmatrix}$$

SET1 =

	0	1	2	3	4	5	6	7	8	9
0	0	72	89	1.26	76	6900	2459.4662	112.4	1	15
1	8	0.9975	178.94	0	0	$5.1 \cdot 10^6$	850	0	$1 \cdot 10^7$	63
2	1.2	0	0	0	$.6165 \cdot 10^8$	112.4	159.9124	121.5833	117.166	107.7548
3	77.8708	89.9347	159.9124	$.6165 \cdot 10^8$	$.3022 \cdot 10^8$	$3.139 \cdot 10^7$	$5.1 \cdot 10^6$	$.6487 \cdot 10^7$	4014.2632	563.8704

WCT Water Loss Model (LOCA-BTP5.4)

Calculate Conditions for CCW Loop to return limit temperature from DCT $limit := 110$

This routine calculates the time when the outlet temperature from the DCT is below a defined limit. This is used for setting a projected time for water use, below.

Given

1) Heat in from Containment increases CCW temp

$$Q_{cont}(time, limit) = Q_{wtr}(GPM_{ccw}, Tdct\_in, limit)$$

2) DCT discharges heat and reduces CCW with added DCT recirc

$$Q_{dctx}\left(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(time, limit), EVAL\right), DCT_{fans}, AIR\right) = Q_{wtr}\left(GPM_{ccw}, Tdct\_in, Tdct\_out\right)$$

$$TTest(time) := Find(Tdct\_in, Tdct\_out)$$

$$T_{project1} := \begin{cases} 0 & \text{if } EVAL > 2 \\ \begin{aligned} &\text{for } i \in 0..\,last(TT) \\ &\quad A^{\langle i \rangle} \leftarrow TTest(TT_i) \\ &\quad Res \leftarrow TT_i \\ &\quad \text{break} \;\text{ if } \left(A_{1,i} \le limit\right) \end{aligned} & \text{otherwise} \end{cases}$$

seconds

$$T_{project1} = 3.76 \times 10^5$$

hours

$$\frac{T_{project1}}{3600} = 104.55$$

Heat Load at Projected Time

$$Q_{cont}\left(T_{project1}, limit\right) = 82.7 \times 10^6$$

DCT Load at Projected Time

$$Q_{dctx}\left(P_{dct}, GPM_{ccw}, TTest\left(T_{project1}\right)_0, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(time, limit), EVAL\right), DCT_{fans}, AIR\right) = 82.29 \times 10^6$$

$$TTest\left(T_{project1}\right)_0 = 134.22$$

$$TTest\left(T_{project1}\right)_1 = 109.99$$

Title: Waterford3 UHS Model

Sheet No: 11 of 17

This routine calculates the time when the DCT heat removal capacity is greater than the containment heat load. This is used for setting a projected time for water use, below.

Given

1) Heat in from Containment increases CCW temp

$$Q_{cont}(time, TCW) = Q_{wtr}(GPM_{ccw}, Tdct\_in, TCW)$$

2) DCT discharges heat and reduces CCW with added DCT recirc

$$Q_{dctx}\left(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(time, TCW), EVAL\right), DCT_{fans}, AIR\right) = Q_{wtr}(GPM_{ccw}, Tdct\_in, Tdct\_out)$$

$$TTest(time) := Find(Tdct\_in, Tdct\_out)$$

$$T_{project2} := \begin{array}{l} 0 \;\; \text{if } EVAL > 2 \\ \text{for } i \in 0..\,last(TT) \qquad\qquad \text{otherwise} \\ \quad A \leftarrow TTest(TT_i)_0 \\ \quad QDCTX \leftarrow Q_{dctx}\left(P_{dct}, GPM_{ccw}, A, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(time, TCW), EVAL\right), DCT_{fans}, AIR\right) \\ \quad Res \leftarrow TT_i \\ \quad \text{break } \text{ if } \left(Q_{cont}(TT_i, TCW) \le QDCTX\right) \end{array}$$

seconds	hours
$T_{project2} = 2.24 \times 10^5$	$\frac{T_{project2}}{3600} = 62.17$

Heat Load at Projected Time

$$Q_{cont}(T_{project2}, Tccw\_out) = 91.68 \times 10^6$$

DCT Load at Projected Time

$$Q_{dctx}\left(P_{dct}, GPM_{ccw}, TTest(T_{project2})_0, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(time, TCW), EVAL\right), DCT_{fans}, AIR\right) = 91.71 \times 10^6$$

$$TTest(T_{project2}) = \begin{pmatrix} 139.27 \\ 112.28 \end{pmatrix}$$

Title: Waterford3 UHS Model

Repeat for multiple time steps for LOCA heat loads vs time $EVAL = 0$

Output Controls for Repeated Time Steps

Margin variable for flow above EC requirement (gpm) $MAR := 300$

Time for Forward Projection (sec) $T_{project} := \min(T_{project1}, T_{project2})$ $\frac{T_{project}}{3600} = 62.17$

Use Tproject from above or overwrite with fixed value

Heat Load at Projected Time $Q_{cont}(T_{project}, Tccw\_out) = 91.68 \times 10^6$

Check initial values for R2 $INIT := R2(time, EC_{sw})$

$$INIT = \begin{pmatrix} 2459.47 \\ 159.91 \\ 121.58 \\ 117.17 \\ 107.75 \\ 77.87 \\ 89.93 \\ 159.91 \end{pmatrix}$$

```
Res := | break  if  INIT_0 < GPM_chill + MAR
       | for  i ∈ 0 .. last(TT)
       |   | A^<i> ← R1(TT_i, EC_sw)
       |   | B^<i> ← R2(TT_i, EC_sw)
       |   | X_0,i ← max(TCW, A_0,i)
       |   | X_8,i ← min(B_0,i, 5350)
       |   | for  j ∈ 1 .. 7
       |   |   | X_j,i ← A_j,i  if  B_0,i ≥ 5350
       |   |   | X_j,i ← B_j,i  otherwise
       |   | Res ← X
       |   | break  if  (X_8,i < GPM_chill + MAR)
       |   | break  if  TT_i > T_project
```

Res =

	0	1	2	3
0	112.4	112.4	112.4	112.4
1	157.4	157.4	157.5	157.6
2	120.4	120.5	120.5	120.5
3	117.1	117.1	117.1	117.1
4	106.6	106.7	106.7	106.7
5	77.4	77.4	77.4	77.4
6	89.4	89.4	89.5	89.5
7	157.4	157.4	157.5	157.6
8	2243.2	2249.9	2256.2	...

0 Tccw_out
1 Tdct_in
2 Tdct_out
3 Taccw_out
4 Twct_in
5 Twct_out
6 Tec_out
7 Tcon_out
8 ACCW flow

Note: Due to space limits, only first several columns are shown.
A solution set is provided for each time step.

$cols(Res) = 326$

Last time step before ACCW stops (hours): $\frac{TT_{cols(Res)-1}}{3600} = 24.794$

Heat Load at last time step $QL := Q_{cont}(TT_{cols(Res)-1}, Tccw\_out)$

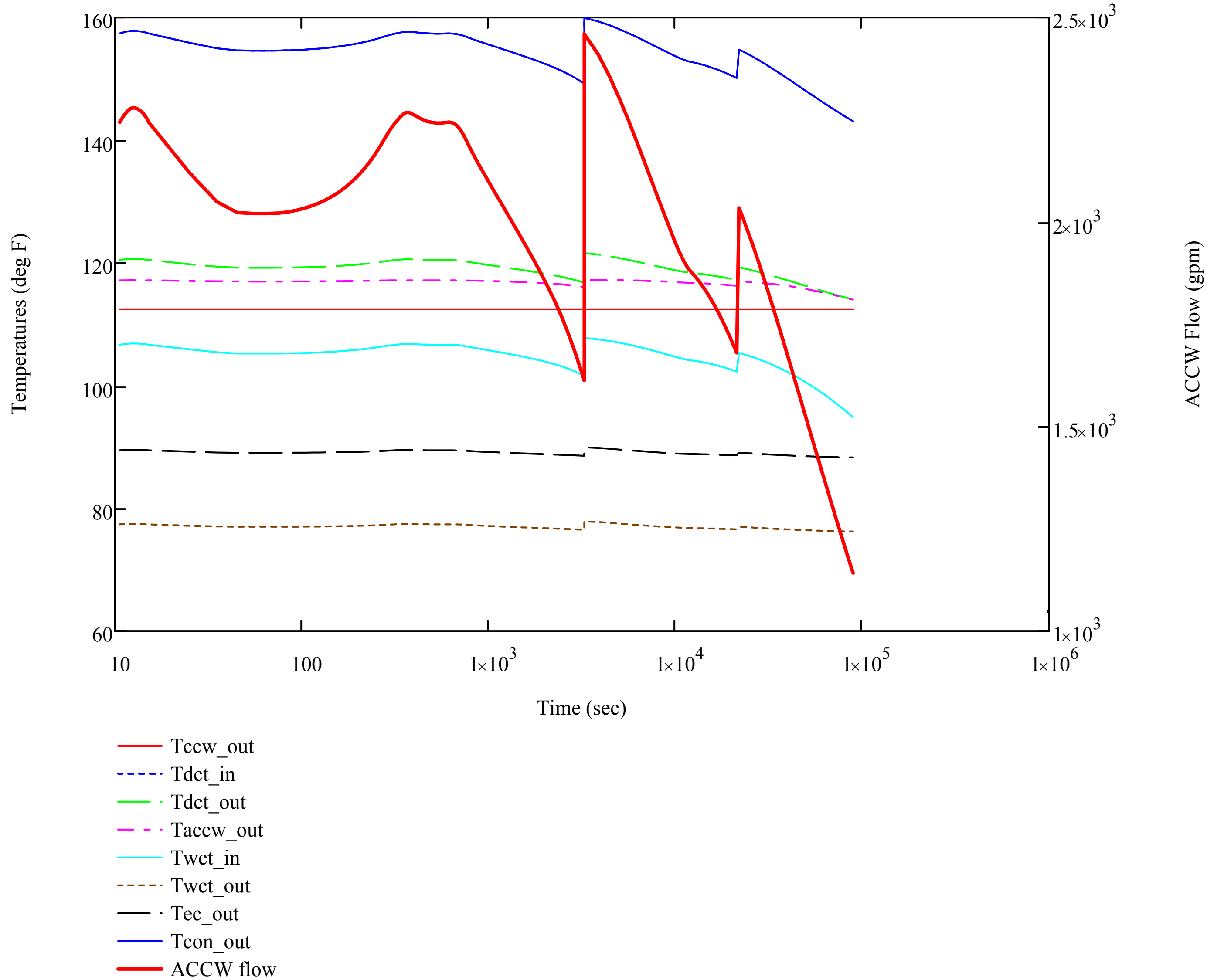
$QL = 104.58 \times 10^6$

Title: Waterford3 UHS Model

Sheet No: 13 of 17

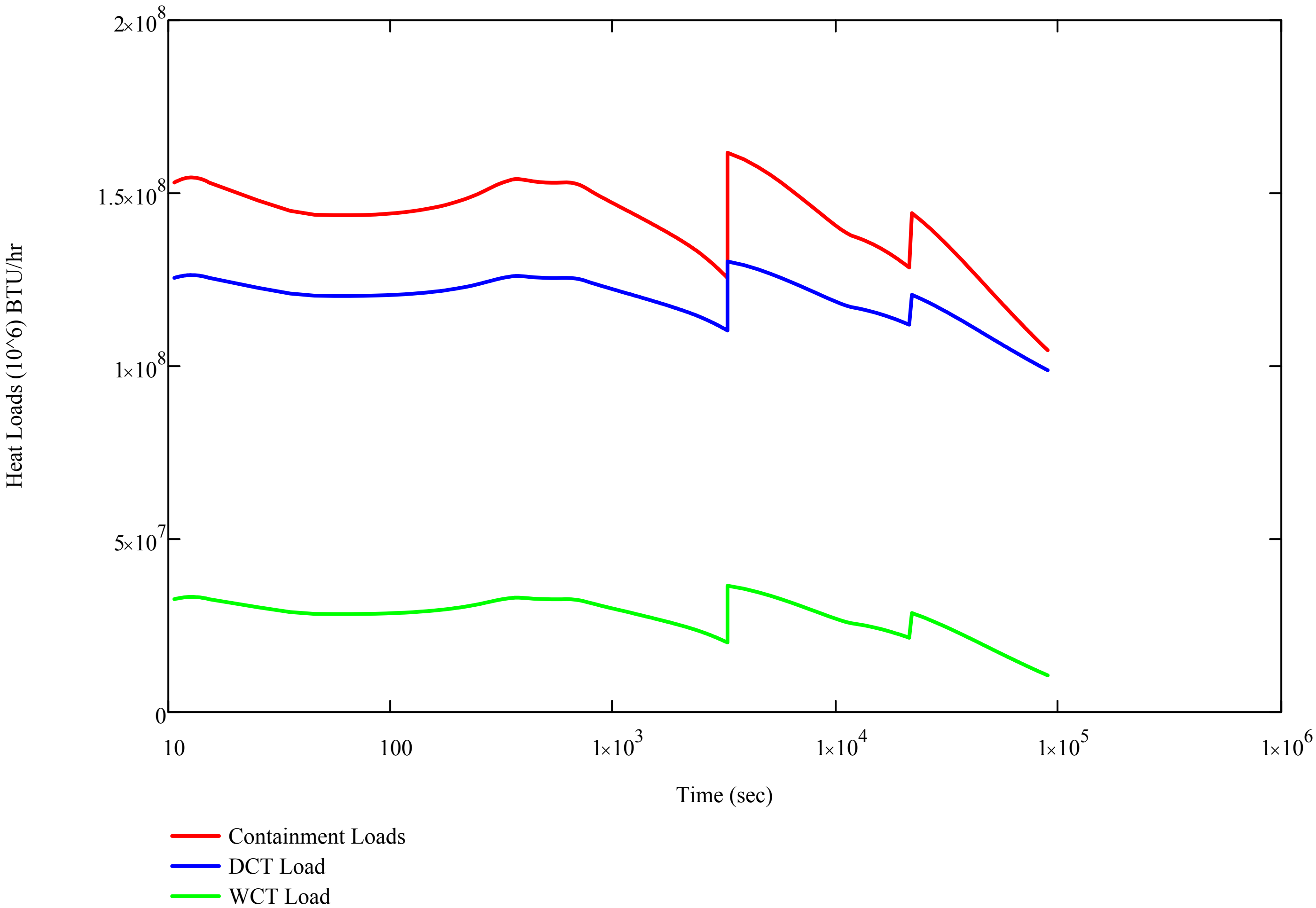
Plot Temperatures with time

$j := 0 .. \text{cols}(Res) - 1$ $\text{cols}(Res) = 326$



Title: Waterford3 UHS Model

Plot Heat Loads with Time



Note: The DCT loads in the above plot are calculated with constant recirculation (DCT_R) and not credited with DCT outlet temperature reduction late in the transient.

Error Check - CCW Loop

$$CCW_{err_j} := \frac{\begin{bmatrix} Q_{cont}\left(TT_j, Res_{0,j}\right) \ldots \\ + -1 \cdot Q_{dctx}\left(P_{dct}, GPM_{ccw}, Res_{1,j}, T_{db} + DCT_R \cdot QRF\left(Q_{cont}\left(time, Res_{0,j}\right), EVAL\right), DCT_{fans}, AIR\right) + Q_{EC} \cdot EC_{sw} \ldots \\ + -1 \cdot Q_{ccw}\left[Res_{2,j}, Res_{0,j}, Res_{5,j}, Res_{3,j}, GPM_{ccw}, Res_{8,j} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] \end{bmatrix}}{Q_{cont}\left(TT_j, Res_{0,j}\right)}$$

$$CCW_{err_0} = 5.14 \times 10^{-4}$$

$$\max\left(CCW_{err}\right) = 0.3 \cdot \%$$

$$\min\left(CCW_{err}\right) = 0.02 \cdot \%$$

Error Check - ACCW Loop

$$ACCW_{err_j} := \frac{\begin{bmatrix} Q_{ccw}\left[Res_{2,j}, Res_{0,j}, Res_{5,j}, Res_{3,j}, GPM_{ccw}, Res_{8,j} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] \ldots \\ + Q_{EC} \cdot \left(1 - EC_{sw}\right) - Q_{wct}\left(Res_{8,j}, Res_{4,j}, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}\right) \end{bmatrix}}{Q_{ccw}\left[Res_{2,j}, Res_{0,j}, Res_{5,j}, Res_{3,j}, GPM_{ccw}, Res_{8,j} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right]}$$

$$ACCW_{err_0} = 8.49 \times 10^{-5}$$

$$\max\left(ACCW_{err}\right) = 0.01 \cdot \%$$

$$\min\left(ACCW_{err}\right) = -0.06 \cdot \%$$

WCT water loss

$$Range_j := Res_{4,j} - Res_{5,j}$$

$$h_{e_j} := LG\left(Res_{8,j}\cdot gpm\right)\cdot Range_j + h_i$$

$$h_i := h\left(T_{wb}\right)$$

Evaporative loss

$$Evap_j := \left(1 - WCT_{ND}\right)\cdot EV\left(Res_{8,j}, h_{e_j}, T_{db}, T_{wb}\right) + WCT_{ND}\cdot EV_{wctND}\left(Res_{8,j}, T_{wb}, Range_j\right)$$

Drift loss

$$DL(G) := .001\cdot G$$

WCT loss rate at each time step

$$z := 0 .. cols(Res) - 2$$

$$WL_z := \left(Evap_z + DL\left(Res_{8,z}\cdot gpm\right)\right)$$

$$WL_0 = 60.87\ gpm$$

Water loss summation through end of analysis

$$GAL := \sum_{i=0}^{cols(Res)-2} \left[\left[.5\cdot\left(Evap_i + Evap_{i+1}\right) + DL\left(Res_{8,i}\cdot gpm\right)\right]\cdot\left(TT_{i+1} - TT_i\right)\cdot sec\right]$$

$$GAL = 61.88\times 10^3\cdot gal$$

Final water loss rate

$$End\_rate := Evap_{cols(Res)-1} + DL\left(Res_{8,cols(Res)-1}\cdot gpm\right)$$

$$End\_rate = 27.67\ gpm$$

Last Analysis time step (hour)

$$TT_{cols(Res)-1}\cdot 3600^{-1} = 24.79$$

Projected time (hour)

$$T_{project}\cdot 3600^{-1} = 62.17 \qquad T_{project1} = 3.78\times 10^5 \qquad T_{project2} = 2.24\times 10^5$$

Forward projection to specified time with WCT fans ON for EC only load

$$GAL_{proj\_1} := GAL + .5\cdot\left(End\_rate + EV_{chill\_1}\right)\cdot\left(T_{project} - TT_{cols(Res)-1}\right)\cdot sec\ ... + EV_{chill\_1}\cdot\left(T_{project1} - T_{project2}\right)\cdot sec$$

$$GAL_{proj\_1} = 165.5\times 10^3\ gal$$

Forward projection to specified time with WCT fans OFF for EC only load

$$GAL_{proj\_2} := GAL + .5\cdot\left(End\_rate + EV_{chill\_1}\right)\cdot\left(T_{project} - TT_{cols(Res)-1}\right)\cdot sec\ ... + EV_{chill\_2}\cdot\left(T_{project1} - T_{project2}\right)\cdot sec$$

$$GAL_{proj\_2} = 139.09\times 10^3\ gal$$

Provide settings and conditions in tabular format

$$SET2 := \begin{pmatrix} limit & T_{project1} & T_{project2} & T_{project} & MAR & QL & max(CCW_{err}) & min(CCW_{err}) & 0 & 0 \\ max(ACCW_{err}) & min(ACCW_{err}) & \frac{GAL}{gal} & \frac{End\_rate}{gpm} & TT_{cols(Res)-1} & \frac{GAL_{proj\_1}}{gal} & \frac{GAL_{proj\_2}}{gal} & 0 & 0 & 0 \end{pmatrix}$$

SET2 =

	0	1	2	3	4	5	6	7	8	9
0	110	$3.76 \cdot 10^{5}$	$2.24 \cdot 10^{5}$	$2.24 \cdot 10^{5}$	300	$1.05 \cdot 10^{8}$	0	$2.37 \cdot 10^{-4}$	0	0
1	$9.84 \cdot 10^{-5}$	$6.49 \cdot 10^{-4}$	$6.19 \cdot 10^{4}$	27.67	$8.93 \cdot 10^{4}$	$1.65 \cdot 10^{5}$	$1.39 \cdot 10^{5}$	0	0	0

out0 := WRITEPRN("TIME" , TT)

out1 := WRITEPRN("TEMP" , Res)

$$out2 := WRITEPRN\left("WCT\_loss" , \frac{WL}{gpm}\right)$$

WCT Water Loss Model (LOCA-BTP5.4)

Title: Waterford3 UHS Model

Water Properties

This module provides water properties over a range bounding the CCW and ACCW performance (32-300F). Properties are developed from look-up tables from Kreith.

References used in this module:

WP-1, [12] Kreith, "Principles of Heat Transfer", International Textbook, 1965.

Water properties per Kreith Table A-3 [WP-1]

Water :=

Temp (F)	rho (lb/ft^3)	cp (BTU/lbF)	mux1000 (lb/ft-sec)	k (BTU/hrftF)	Pr
32	62.4	1.01	1.2	0.319	13.7
40	62.4	1	1.04	0.325	11.6
50	62.4	1	0.88	0.332	9.55
60	62.3	0.999	0.76	0.34	8.03
70	62.3	0.998	0.658	0.347	6.82
80	62.2	0.998	0.578	0.353	5.89
90	62.1	0.997	0.514	0.359	5.13
100	62	0.998	0.458	0.364	4.52
150	61.2	1	0.292	0.384	2.74
200	60.1	1	0.205	0.394	1.88
250	58.8	1.01	0.158	0.396	1.45
300	57.3	1.03	0.126	0.395	1.18

Define common units

$F := R$

$gpm := \frac{gal}{min}$

Define look-up functions for water properties
For verification, the functions are run against a specific test temperature

Test functions at $Test := 150$

$pos := match\left(Test, Water^{\langle 0 \rangle}\right)_0$

$pos = 8$

$$\rho(T) := interp\left(cspline\left(Water^{\langle 0 \rangle}, Water^{\langle 1 \rangle}\right), Water^{\langle 0 \rangle}, Water^{\langle 1 \rangle}, T\right)\cdot\frac{lb}{ft^3}$$

$$\rho(Test) = 61.2\frac{lb}{ft^3}$$

$$c_p(T) := interp\left(cspline\left(Water^{\langle 0 \rangle}, Water^{\langle 2 \rangle}\right), Water^{\langle 0 \rangle}, Water^{\langle 2 \rangle}, T\right)\cdot\frac{BTU}{lb\cdot F}$$

$$c_p(Test) = 1\cdot\frac{BTU}{lb\cdot F}$$

$$\mu(T) := interp\left(cspline\left(Water^{\langle 0 \rangle}, Water^{\langle 3 \rangle}\right), Water^{\langle 0 \rangle}, Water^{\langle 3 \rangle}, T\right)\cdot\frac{lb}{ft\cdot sec\cdot 1000}$$

$$\mu(Test) = 2.92\times 10^{-4}\frac{lb}{s\cdot ft}$$

$$k(T) := interp\left(cspline\left(Water^{\langle 0 \rangle}, Water^{\langle 4 \rangle}\right), Water^{\langle 0 \rangle}, Water^{\langle 4 \rangle}, T\right)\cdot\frac{BTU}{hr\cdot ft\cdot F}$$

$$k(Test) = 0.384\cdot\frac{BTU}{hr\cdot ft\cdot F}$$

$$Pr(T) := interp\left(cspline\left(Water^{\langle 0 \rangle}, Water^{\langle 5 \rangle}\right), Water^{\langle 0 \rangle}, Water^{\langle 5 \rangle}, T\right)$$

$$Pr(Test) = 2.74$$

Title: Waterford3 UHS Model

Sheet No: WP-2 of 2
Water Properties Module

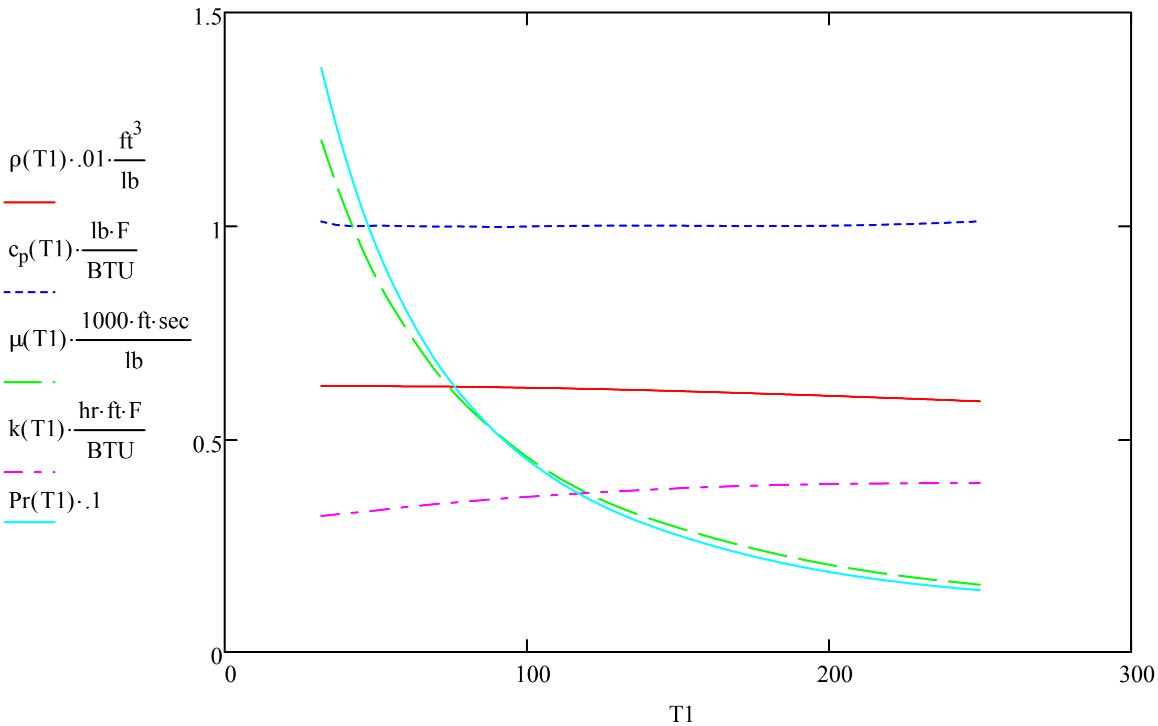
Verify functions

$$check\_max := max\left(\frac{\rho(Test)\cdot\frac{ft^3}{lb}}{Water_{pos,1}}, \frac{c_p(Test)\cdot\frac{lb\cdot F}{BTU}}{Water_{pos,2}}, \frac{\mu(Test)\cdot\frac{ft\cdot s}{lb}}{\frac{Water_{pos,3}}{1000}}, \frac{k(Test)\cdot\frac{hr\cdot ft\cdot F}{BTU}}{Water_{pos,4}}, \frac{Pr(Test)}{Water_{pos,5}}\right) \qquad check\_max = 1$$

$$check\_min := min\left(\frac{\rho(Test)\cdot\frac{ft^3}{lb}}{Water_{pos,1}}, \frac{c_p(Test)\cdot\frac{lb\cdot F}{BTU}}{Water_{pos,2}}, \frac{\mu(Test)\cdot\frac{ft\cdot s}{lb}}{\frac{Water_{pos,3}}{1000}}, \frac{k(Test)\cdot\frac{hr\cdot ft\cdot F}{BTU}}{Water_{pos,4}}, \frac{Pr(Test)}{Water_{pos,5}}\right) \qquad check\_min = 1$$

$$checkWP := max(check\_max - 1, 1 - check\_min) \qquad checkWP = 0$$

Show water property values over a range or temperatures $T1 := 32..250$ Note: scales modified to fit



Heat Balance Across Component

Define function for heat flow from change in water temperature $Q = m'\cdot c_p\cdot\Delta T$

Use average temperarure for water properties T = 1/2 x (T1 + T2)

$$Q_{wtr}(G,T1,T2) := G\cdot gpm\cdot\rho[.5\cdot(T1+T2)]\cdot c_p[.5\cdot(T1+T2)]\cdot(T1-T2)F\cdot\frac{hr}{BTU}$$

Title: Waterford3 UHS Model

Sheet No: LL-1 of 4
LOCA Loads Module

LOCA Analysis

This module provides the containment heat loads from a CLB or HLB as a function of time and incoming CCW temperature.

References used in the module:

LL-1, [5b] Calculation ECS05-013 R1, "Ultimate Heat Sink Containment Heat Loads"
LL-2, [5m] Calculation MN(Q)9-17.
LL-3. [5o[Calculation CN-SEE-II-08-6, Case 4.

Containment Heat Loads are input as a time x BTU/sec in the following two tables for Cold Leg Break (CLB or RCP break) and Hot leg Break HLB.. Note that only 19 time steps (of 1086 and 1024 for the CLB and HLB, respctively) are shown. Complete time step heat loads are provided in reference LL-1.
Note that a single set of time steps (Time) used for the heat loads at each CCW temperature (112, 115, 120). Heat loads per [LL-1]

CCW Temperatures

CLB :=

Index	Time (sec)	BTU/sec at 112F	BTU/sec at 115F	BTU/sec at 120F
0	1.0646E+01	3.9844E+04	3.9045E+04	3.7717E+04
1	1.0846E+01	3.9920E+04	3.9120E+04	3.7792E+04
2	1.1060E+01	3.9992E+04	3.9192E+04	3.7863E+04
3	1.1282E+01	4.0056E+04	3.9256E+04	3.7927E+04
4	1.1570E+01	4.0128E+04	3.9327E+04	3.7997E+04
5	1.1770E+01	4.0170E+04	3.9370E+04	3.8039E+04
6	1.1970E+01	4.0203E+04	3.9403E+04	3.8072E+04
7	1.2170E+01	4.0227E+04	3.9427E+04	3.8095E+04
8	1.2370E+01	4.0242E+04	3.9442E+04	3.8110E+04
9	1.2570E+01	4.0249E+04	3.9449E+04	3.8117E+04
10	1.2770E+01	4.0248E+04	3.9448E+04	3.8117E+04
11	1.2970E+01	4.0241E+04	3.9441E+04	3.8110E+04
12	1.3170E+01	4.0229E+04	3.9429E+04	3.8097E+04
13	1.3370E+01	4.0211E+04	3.9411E+04	3.8080E+04
14	1.3570E+01	4.0188E+04	3.9388E+04	3.8057E+04
15	1.3770E+01	4.0161E+04	3.9361E+04	3.8031E+04
16	1.3970E+01	4.0134E+04	3.9334E+04	3.8004E+04
17	1.4170E+01	4.0105E+04	3.9305E+04	3.7976E+04
18	1.4370E+01	4.0064E+04	3.9264E+04	3.7935E+04
19	1.4570E+01	4.0020E+04	3.9220E+04	3.7891E+04

CCW Temperatures

HLB :=

Index	Time (sec)	BTU/sec at 112F	BTU/sec at 115F	BTU/sec at 120F
0	1.8407E+01	4.2107E+04	4.1302E+04	3.9950E+04
1	1.8507E+01	4.2111E+04	4.1306E+04	3.9954E+04
2	1.8607E+01	4.2104E+04	4.1299E+04	3.9947E+04
3	1.8707E+01	4.2092E+04	4.1288E+04	3.9936E+04
4	1.8807E+01	4.2081E+04	4.1276E+04	3.9925E+04
5	1.8907E+01	4.2069E+04	4.1265E+04	3.9913E+04
6	1.9007E+01	4.2057E+04	4.1253E+04	3.9902E+04
7	1.9107E+01	4.2046E+04	4.1241E+04	3.9890E+04
8	1.9207E+01	4.2034E+04	4.1230E+04	3.9879E+04
9	1.9307E+01	4.2023E+04	4.1219E+04	3.9868E+04
10	1.9407E+01	4.2012E+04	4.1208E+04	3.9857E+04
11	1.9507E+01	4.2001E+04	4.1197E+04	3.9846E+04
12	1.9607E+01	4.1990E+04	4.1186E+04	3.9835E+04
13	1.9707E+01	4.1979E+04	4.1175E+04	3.9825E+04
14	1.9807E+01	4.1968E+04	4.1164E+04	3.9814E+04
15	1.9907E+01	4.1958E+04	4.1153E+04	3.9803E+04
16	2.0011E+01	4.1947E+04	4.1143E+04	3.9793E+04
17	7.0074E+01	3.9346E+04	3.8552E+04	3.7238E+04
18	1.2007E+02	3.8328E+04	3.7544E+04	3.6248E+04
19	1.7007E+02	3.7470E+04	3.6697E+04	3.5419E+04

Define function to determine 1 Hr position in matrix

$$
\mathrm{HR1(EVAL)} := \left|\begin{array}{l} X \leftarrow CLB^{\langle 1\rangle} \text{ if } EVAL = 0 \\ X \leftarrow HLB^{\langle 1\rangle} \text{ otherwise} \\ \text{for } i \in 1..1100 \\ \quad \left|\begin{array}{l} I \leftarrow i \\ \text{break if } X_i > 3600 \end{array}\right. \end{array}\right.
$$

<u>Test</u>

$\mathrm{HR1}(1) = 97$ $\quad \mathrm{HR1}(0) = 185$

$HLB_{HR1(1),1} = 3686.51$ $\quad CLB_{HR1(0),1} = 3857.22$

Define double interpolation function for containment heat loads (Time x Temperature) for either CLB or HLB loads, selected by LOCA type (LOC = 0 or 1).

$$Q_{LOCA}(Tm,T,EVAL) := \begin{array}{|l} X \leftarrow CLB \text{ if } EVAL = 0 \\ X \leftarrow HLB \text{ otherwise} \\ Temp_0 \leftarrow 112 \\ Temp_1 \leftarrow 115 \\ Temp_2 \leftarrow 120 \\ Q_0 \leftarrow \text{linterp}\left(X^{\langle 1 \rangle}, X^{\langle 2 \rangle} \cdot 3600, Tm\right) \\ Q_1 \leftarrow \text{linterp}\left(X^{\langle 1 \rangle}, X^{\langle 3 \rangle} \cdot 3600, Tm\right) \\ Q_2 \leftarrow \text{linterp}\left(X^{\langle 1 \rangle}, X^{\langle 4 \rangle} \cdot 3600, Tm\right) \\ QC \leftarrow \text{linterp}(Temp, Q, \max(T, 112)) \end{array}$$

Show accuracy of function vs. 115F CLB heat load

$$i := 0 .. \text{length}\left(CLB^{\langle 0 \rangle}\right) - 1$$

Test value at each time step

$$QT_i := \frac{Q_{LOCA}\left(CLB_{i,1}, 115, 0\right)}{3600} \qquad Diff_i := \frac{QT_i - CLB_{i,3}}{QT_i} \qquad \max(Diff) = 1.94 \times 10^{-14} \cdot \%$$

$$Time(EVAL) := \begin{array}{|l} CLB^{\langle 1 \rangle} \text{ if } EVAL = 0 \\ HLB^{\langle 1 \rangle} \text{ otherwise} \end{array} \qquad Time(0)_0 = 10.65$$

$$Time\_max(EVAL) := \begin{array}{|l} X \leftarrow CLB^{\langle 3 \rangle} \text{ if } EVAL = 0 \\ X \leftarrow HLB^{\langle 3 \rangle} \text{ otherwise} \\ MAX \leftarrow \max(X) \\ T \leftarrow \text{lookup}(MAX, X, Time(EVAL))_0 \end{array}$$

Max CLB

$$Time\_max(0) = 3254.44$$

Max HLB

$$Time\_max(1) = 18.51$$

Max CLB $Q_{LOCA}(Time\_max(0), 112, 0) = 152.1904 \times 10^6$

Max HLB $Q_{LOCA}(Time\_max(1), 112, 1) = 151.5982 \times 10^6$

Title: Waterford3 UHS Model

Sheet No: LL-3 of 4
LOCA Loads Module

Additional Fuel Pool Loads defined in BTU/hr at time (sec) per [LL-2 15 Att. 8.5.2, Table 1]

FP :=

hours	Time (sec)	MBTU/hr
0	0.000	0
5.99	21564	0
6	21600	16.7
24	86400	16.5
48	172800	16.3
72	259200	16.1
96	345600	15.9
120	432000	15.7
144	518400	15.5
168	604800	15.4
192	691200	15.2
216	777600	15.1
240	864000	14.9
360	1296000	14.3
480	1728000	13.7
600	2160000	13.2
730.3	2629008	12.8
1461	5259600	11.1
2191	7887600	10.1
2778	10000008	9.56
2922	10519200	9.44
3653	13149000	8.89

Define curve fit function

$$FPL(Tm) := \text{linterp}\left(FP^{\langle 1\rangle}, FP^{\langle 2\rangle}, Tm\right)\cdot 10^{6}$$

Test

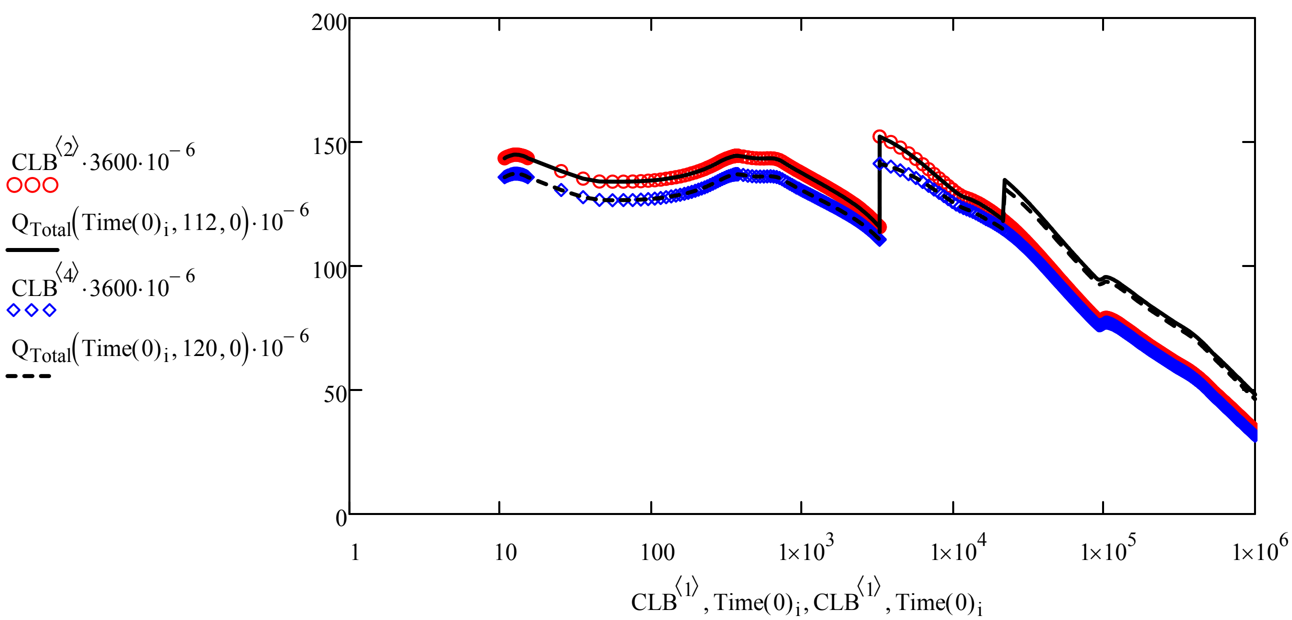
$$FPL(21600) = 16.7 \times 10^{6}$$

$$Q_{LOCA}(21600, 115, 0) = 117.51 \times 10^{6}$$

Add heat to containment loads for plot, below

$$Q_{Total}(Tm, T, EVAL) := Q_{LOCA}(Tm, T, EVAL) + FPL(Tm)$$

Show function results over time, vs data at different temperatures



Non-LOCA shutdown (per BTP 5-4) Loads defined in BTU/hr at time (sec) per [LL-3]. Do not include zero load periods before or after main transient.

BTP54 :=

hours	Time (sec)	MBTU/hr
9.5	34200	135
11	39600	131
13	46800	130
15	54000	126
17	61200	122
19	68400	119
21	75600	117
23	82800	115
25	90000	113
27	97200	112
29	104400	110
31	111600	109
33	118800	108
35	126000	107
37	133200	105
39	140400	104
41	147600	103

Define curve fit function

$$Q_{BTP}(Tm) := \text{linterp}\left(BTP54^{\langle 1 \rangle}, BTP54^{\langle 2 \rangle}, Tm\right) \cdot 10^6$$

Test $Q_{BTP}(40000) = 130.94 \times 10^6$

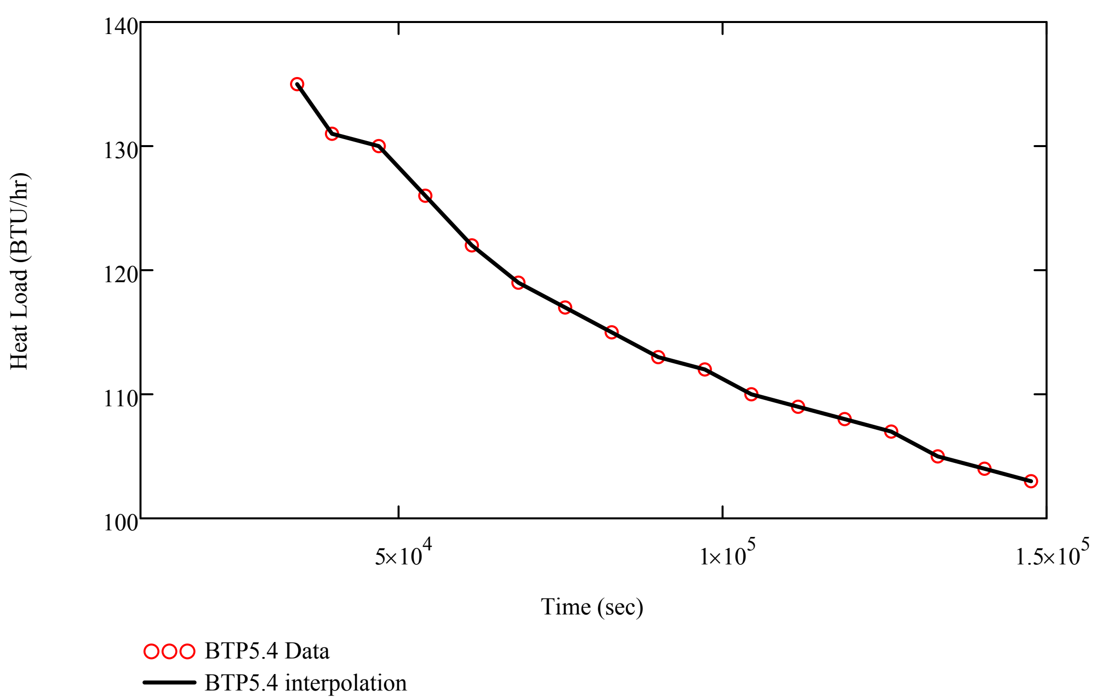
$Q_{BTPMAX} := \max\left(BTP54^{\langle 2 \rangle}\right)$ $Q_{BTPMAX} = 135$

$BTPMAX := \text{match}\left(Q_{BTPMAX}, BTP54\right)_0$ $BTPMAX_0 = 0$

$t_{BTPMAX} := BTP54_{BTPMAX_0, 1}$ $t_{BTPMAX} = 3.42 \times 10^4$

$t_{range} := BTP54_{\text{last}\left(BTP54^{\langle 1 \rangle}\right), 1} - BTP54_{0,1}$ $t_{range} = 1.13 \times 10^5$

$TTT := BTP54^{\langle 1 \rangle}$



Dry Cooling Tower (DCT)

This module develops DCT performance per Hudson Products curves. A function is developed to provide DCT heat transfer as a function of CCW flow, CCW incoming temperature, and ambient temperature.

References used in this module:

DCT-1 [6d] Specification TD-H291.0015, Hudson Products Spec
DCT-2 [6h] Specification 1564-4983-0 DRN97-2456_1

Four points are used to define 2 linear curves at 6500, 7500 gpm x 2 Tout values. Inputs in yellow areas only. Hudson products curves (lines) are parallel for a fixed flow at different Tdb, and they provide Q (10^6 BTU/hr) and R (range) vs. Tout. Tin and slopes are calculated within the spreadsheet.

DCT :=

Simplified DCT curve input				
GPM	6500	6500	7500	7500
Q	220	20	220	20
R	67.7	6.2	58.7	5.3
Tdb	80	80	80	80
Tout	131.5	84.5	136	85
Tin	199.2	90.7	194.7	90.3
Slope as a function of GPM			1.843	1.916
Y int as a function of GPM			-147.189	-152.989

$$Slope := \begin{pmatrix} DCT_{8,2} \\ DCT_{8,3} \end{pmatrix} \quad GPM := \begin{pmatrix} DCT_{0,0} \\ DCT_{0,2} \end{pmatrix} \quad T_{in1} := \begin{pmatrix} DCT_{6,0} \\ DCT_{6,2} \end{pmatrix} \quad Q := \begin{pmatrix} DCT_{1,0} \\ DCT_{1,2} \end{pmatrix}$$

Test values

$TDB1 := 102$

$G1 := 6900$

$i := 0 .. 1$

Interpolate slope from gpm between 2 curves

$m(G) := \text{linterp}(GPM, Slope, G)$

Test functions

$m(G1) = 1.87$

Determine Y intercepts

$Y_i := Q_i - Slope_i \cdot T_{in1_i}$

$$Y = \begin{pmatrix} -147.19 \\ -152.99 \end{pmatrix}$$

Interpolate Y intercepts for gpm

$b(G) := \text{linterp}(GPM, Y, G)$

$b(G1) = -149.51$

Shift Y intercept for dry bulb (slope constant)

$b1(G, Tdb) := b(G) + (80 - Tdb) \cdot m(G)$

$b1(G1, TDB1) = -190.7$

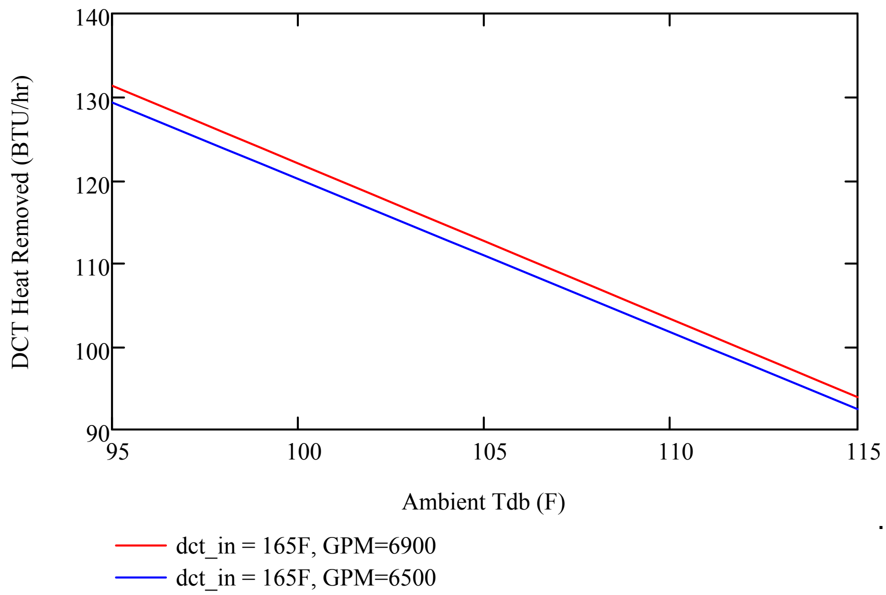
Write DCT heat function of Tin, Tdb, gpm

$Q_{dct}(G, Tin, Tdb) := (m(G) \cdot Tin + b1(G, Tdb)) \cdot 10^6$

$Q_{dct}(G1, 148.7, TDB1) = 87.71 \times 10^6$

Plot results for DCT heat transfer for a range of Tdb

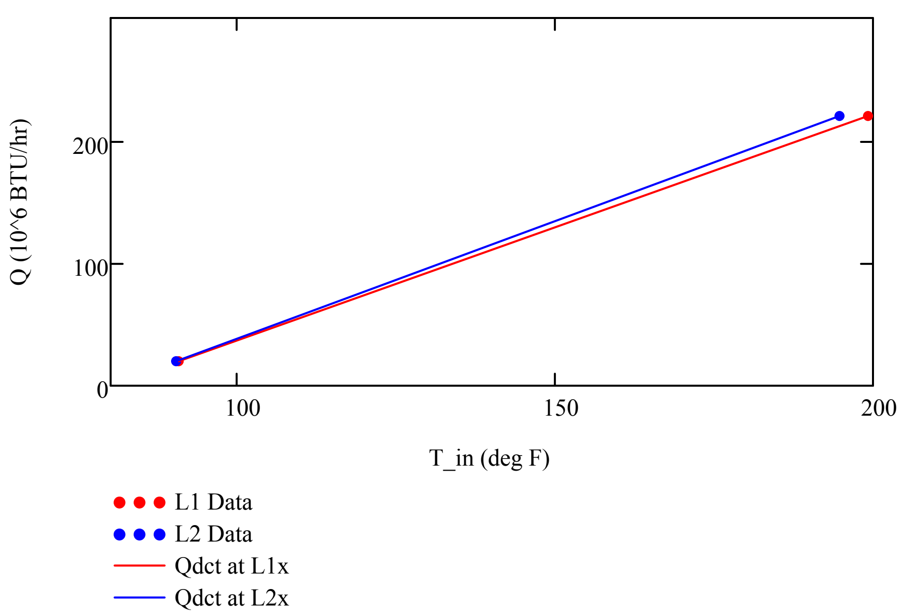
$Tdb := 95, 96 .. 115$



Show comparison of function to Hudson products data points per above table

Data points:

$$L1x := \begin{pmatrix} DCT_{6,0} \\ DCT_{6,1} \end{pmatrix} \quad L2x := \begin{pmatrix} DCT_{6,2} \\ DCT_{6,3} \end{pmatrix} \quad L1y := \begin{pmatrix} DCT_{1,0} \\ DCT_{1,1} \end{pmatrix} \quad L2y := \begin{pmatrix} DCT_{1,2} \\ DCT_{1,3} \end{pmatrix}$$



Demonstrate Performance
Test DCT model results against a range of input conditions $i := 0..8$

DCT_Test :=

GPM	Tdb	Range	T_out	Q	Tin
6000	80	26.7	97	80	123.7
6000	90	33.3	111	100	144.3
6000	102	40	127.3	120	167.3
6500	80	30.8	103.1	100	133.9
6500	90	36.9	118.1	120	155
6500	102	43.1	132.3	140	175.4
7500	80	32	110.1	120	142.1
7500	90	37.3	125	140	162.3
7500	102	42.7	142.2	160	184.9

$G1 := DCT\_Test^{\langle 0 \rangle}$

$TDB1 := DCT\_Test^{\langle 1 \rangle}$

$TIN1 := DCT\_Test^{\langle 5 \rangle}$

$Q1 := DCT\_Test^{\langle 4 \rangle}$

Heat removed per DCT Model

$$DCT\_Model_i := Q_{dct}\left(G1_i, TIN1_i, TDB1_i\right)$$

Error

$$DCT\_ER_i := \frac{DCT\_Model_i}{Q1_i \cdot 10^6} - 1$$

$$\frac{DCT\_Model}{10^6} = \begin{pmatrix} 79.25 \\ 98.41 \\ 118.29 \\ 99.63 \\ 120.09 \\ 135.58 \\ 119.23 \\ 138.77 \\ 159.08 \end{pmatrix} \qquad DCT\_ER = \begin{pmatrix} -0.94 \\ -1.59 \\ -1.43 \\ -0.37 \\ 0.08 \\ -3.16 \\ -0.64 \\ -0.88 \\ -0.57 \end{pmatrix} \cdot \%$$

$$mean(DCT\_ER) = -1.06 \cdot \%$$

Testing per MN(Q)9-52

Test heat load $QDCT\_Test := 125.42 \cdot 10^6$

Model predicted heat removal and error

$$Q_{dct}(6902, 152.48, 85.87) = 124.995 \times 10^6 \qquad \frac{Q_{dct}(6902, 152.48, 85.87)}{QDCT\_Test} - 1 = -0.34 \cdot \%$$

Model predicted heat removal and error with recirculation

$$Q_{dct}(6902, 152.48, 85.87 + 7.78) = 110.428 \times 10^6 \qquad \frac{Q_{dct}(6902, 152.48, 85.87 + 7.78)}{QDCT\_Test} - 1 = -11.95 \cdot \%$$

Additional Curves for 95% Available area

Four points are used to define 2 linear curves at 6500, 7500 gpm x 2 Tout values. Inputs in yellow areas only. Hudson products curves (lines) are parallel for a fixed flow at different Tdb, and they provide Q (10^6 BTU/hr) and R (range) vs. Tout. Tin and slopes are calculated within the spreadsheet.

DCT95 :=

Simplified DCT curve input				
GPM	6500	6500	7500	7500
Q	220	20	220	20
R	67.7	6.2	58.7	5.3
Tdb	80	80	80	80
Tout	132.5	84.5	138	85
Tin	200.2	90.7	196.7	90.3
Slope as a function of GPM			1.826	1.880
Y int as a function of GPM			-145.662	-149.737

$$Slope := \begin{pmatrix} DCT95_{8,2} \\ DCT95_{8,3} \end{pmatrix} \quad GPM := \begin{pmatrix} DCT95_{0,0} \\ DCT95_{0,2} \end{pmatrix} \quad T_{in1} := \begin{pmatrix} DCT95_{6,0} \\ DCT95_{6,2} \end{pmatrix} \quad Q := \begin{pmatrix} DCT95_{1,0} \\ DCT95_{1,2} \end{pmatrix}$$

Test values

$TDB1 := 102$

$G1 := 6900$

$i := 0 .. 1$

Interpolate slope from gpm between 2 curves

$m95(G) := linterp(GPM, Slope, G)$

Determine Y intercepts

$Y95_i := Q_i - Slope_i \cdot T_{in1_i}$

Interpolate Y intercepts for gpm

$b95(G) := linterp(GPM, Y95, G)$

Shift Y intercept for dry bulb (slope constant)

$b195(G, Tdb) := b95(G) + (80 - Tdb) \cdot m95(G)$

Write DCT heat function of Tin, Tdb, gpm

$Q_{dct95}(G, Tin, Tdb) := (m95(G) \cdot Tin + b195(G, Tdb)) \cdot 10^6$

Test functions

$m95(G1) = 1.85$

$Y95 = \begin{pmatrix} -145.66 \\ -149.74 \end{pmatrix}$

$b95(G1) = -147.29$

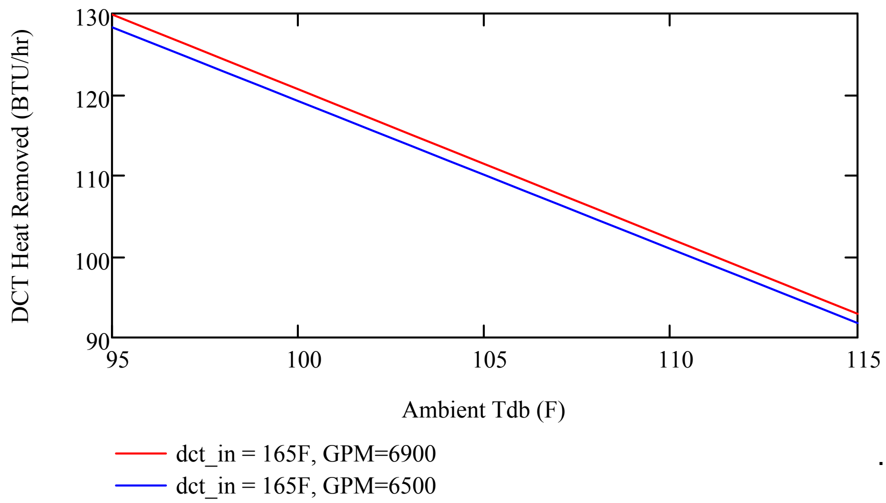
$b195(G1, TDB1) = -187.94$

$Q_{dct95}(G1, 148.7, TDB1) = 86.82 \times 10^6$

Title: Waterford3 UHS Model

Plot results for DCT heat transfer for a range of Tdb

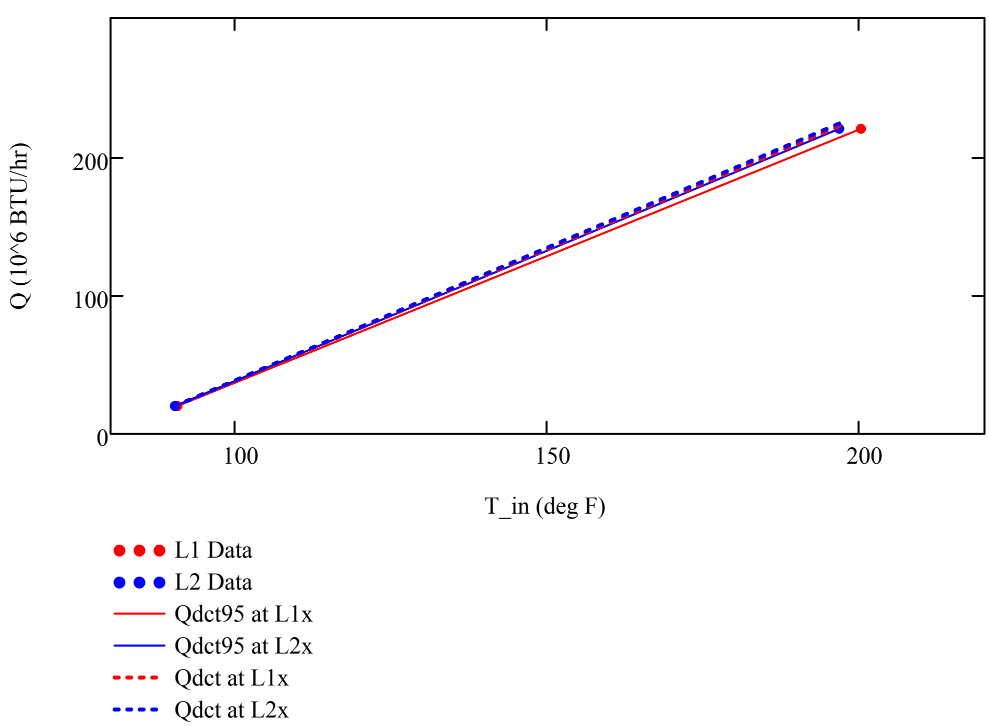
$Tdb := 95, 96 .. 115$



Show comparison of function to Hudson products data points per above table

Data points:

$$L1x := \begin{pmatrix} DCT95_{6,0} \\ DCT95_{6,1} \end{pmatrix} \quad L2x := \begin{pmatrix} DCT95_{6,2} \\ DCT95_{6,3} \end{pmatrix} \quad L1y := \begin{pmatrix} DCT95_{1,0} \\ DCT95_{1,1} \end{pmatrix} \quad L2y := \begin{pmatrix} DCT95_{1,2} \\ DCT95_{1,3} \end{pmatrix}$$



Adjust curves to interpolate between 95% and 100% (Percentage P) from above curves

Interpolate slope

$$mx(P, G1) := m95(G1) + \frac{(P - 95\%)}{5\%} \cdot (m(G1) - m95(G1)) \qquad mx(97.5\%, G1) = 1.86$$

Interpolate y intercept

$$b1x(P, G1, Tdb) := b195(G1, Tdb) + \frac{(P - 95\%)}{5\%} \cdot (b1(G1, Tdb) - b195(G1, Tdb))$$

$$b1x(97.5\%, G1, TDB1) = -189.32$$

Redefine heat transfer function and include number of fans in service

$$Q_{dctx}(P, G, Tin, Tdb, N_{fans}) := \left[Q_{dct95}(G, Tin, Tdb) + \frac{(P - 95\%)}{5\%} \cdot \left(Q_{dct}(G, Tin, Tdb) - Q_{dct95}(G, Tin, Tdb)\right)\right] \cdot \frac{N_{fans}}{15}$$

$$Q_{dctx}(95\%, G1, 148.7, TDB1, 15) = 86.82 \times 10^{6} \qquad Q_{dctx}(95\%, G1, 161, TDB1, 15) = 109.55 \times 10^{6}$$

$$Q_{dctx}(97.5\%, G1, 148.7, TDB1, 15) = 87.26 \times 10^{6} \qquad Q_{dctx}(97.5\%, G1, 161, TDB1, 15) = 110.14 \times 10^{6}$$

$$Q_{dctx}(100\%, G1, 148.7, TDB1, 15) = 87.71 \times 10^{6} \qquad Q_{dctx}(100\%, G1, 161, TDB1, 15) = 110.74 \times 10^{6}$$

Consider extrapolation to 1 DCT coil isolated. Note that heat reduction is not proportional (~2% not 10%)

$$Q_{dctx}(90\%, G1, 148.7, TDB1, 15) = 85.93 \times 10^{6} \qquad Q_{dctx}(90\%, G1, 161, TDB1, 15) = 108.36 \times 10^{6}$$

$$\frac{Q_{dctx}(90\%, G1, 148.7, TDB1, 15)}{Q_{dctx}(100\%, G1, 148.7, TDB1, 15)} = 0.98 \qquad \frac{Q_{dctx}(90\%, G1, 161, TDB1, 15)}{Q_{dctx}(100\%, G1, 161, TDB1, 15)} = 0.98$$

Adjusted Curves for Reduced Air Flow

Per [DCT-2 Fin-Fan spec sheet] the current DCT curves are based on an air flow rate of: $AIR1 := 181044cfm$

This section develops a heat transfer coefficient to match the [DCT-2] heat transfer and then provides an adjustment to the above curves based on the air-flow change to this value.

Define water and air properties:

Water Side ~150F $\quad q_{wtr} := 6500gpm$

$k_{wtr} := .384 \cdot \frac{BTU}{hr \cdot ft \cdot R}$ $\quad \mu_{wtr} := .292 \cdot 10^{-3} \cdot \frac{lb}{ft \cdot sec}$ $\quad Pr_{wtr} := 2.74$ $\quad cp_{wtr} := 0.999 \frac{BTU}{lb \cdot R}$ $\quad \rho_{wtr} := 61.2 \cdot \frac{lb}{ft^3}$

Air Side ~100F $\quad q_{air} := 15 \cdot AIR1$

$k_{air} := .0154 \cdot \frac{BTU}{hr \cdot ft \cdot R}$ $\quad \mu_{air} := 1.285 \cdot 10^{-5} \cdot \frac{lb}{ft \cdot sec}$ $\quad Pr_{air} := .72$ $\quad cp_{air} := .24 \cdot \frac{BTU}{lb \cdot R}$ $\quad \rho_{air} := .071 \cdot \frac{lb}{ft^3}$

Tube geometry

$OD := 1in$ $\quad t_{wall} := 0.085in$ $\quad ID := OD - 2 \cdot t_{wall}$ $\quad L := 48ft$ $\quad n := 336 \cdot 10$

$A_{tubeOD} := n \cdot \pi \cdot OD \cdot L$ $\quad A_{tubeOD} = 4.22 \times 10^4 \, ft^2$ $\quad A_{tubeID} := n \cdot \pi \cdot ID \cdot L$ $\quad A_{tube} := 42255ft^2$

$S_T := 2.5in$ $\quad S_L := 2.3in$ $\quad D_{avg} := .5 \cdot (1in + 2.25in)$ $\quad S_D := 2.25in$

Fin geometry

$OD_{fin} := 2.25in$ $\quad ID_{fin} := OD$ $\quad nfin := \frac{10}{in}$ $\quad t_{fin} := 0.015in$ per WF3 field measurement

$A_{fin} := 895813ft^2$ total area with fins

$A_{finN} := A_{fin} - A_{tube} = 853558 \, ft^2$ fin area without tube area

Fluid Velocities

$V_{air} := \frac{q_{air}}{10 \cdot 12ft \cdot 48ft}$ $\quad V_{air} = 471.5 \cdot \frac{ft}{min}$

$V_{max} := V_{air} \cdot \frac{S_T}{2 \cdot (S_D - D_{avg})}$ $\quad V_{max} = 15.72 \frac{ft}{s}$

$V_{wtr} := \frac{q_{wtr}}{n \cdot \frac{\pi}{4} \cdot ID^2}$ $\quad V_{wtr} = 1.15 \frac{ft}{s}$

External forced convection

$Re_{air} := \frac{\rho_{air} \cdot V_{max} \cdot D_{avg}}{\mu_{air}}$ $\quad Re_{air} = 11.759 \times 10^3$

Incropera 7.58, 7.61 for multiple tubes

$C1 := .46$ $C2 := .95$ $m2 := .562$ $\frac{S_T}{D_{avg}} = 1.54$ $\frac{S_L}{D_{avg}} = 1.42$

$h_{air2} := \frac{k_{air}}{OD} \cdot (C1 \cdot C2) \cdot Re_{air}^{m2}$ $h_{air2} = 15.66 \cdot \frac{BTU}{hr \cdot ft^2 \cdot R}$

Internal forced convection

Reynolds number, $Re_{wtr} := \frac{\rho_{wtr} \cdot V_{wtr} \cdot ID}{\mu_{wtr}}$ $Re_{wtr} = 16.629 \times 10^3$

Dittus-Boetler [Incropera, EQ 8.58] $h_{wtr} := \frac{k_{wtr}}{ID} \cdot 0.023 \cdot Re_{wtr}^{.8} \cdot Pr_{wtr}^{0.3}$ $h_{wtr} = 411.33 \cdot \frac{BTU}{hr \cdot ft^2 \cdot R}$

Fouling, service condition [DCT-2] $ff_{wtr} := .00132 \cdot \frac{hr \cdot ft^2 \cdot R}{BTU}$ $k_{tube} := 26.5 \cdot \frac{BTU}{hr \cdot ft \cdot R}$

Define Fin Efficiency $\eta_f := 0.777$ Note, based on [Incropera] Fig 3.18 with rectangular fin and Lc term ~0.6+, adjusted to match specified U data per [DCT-2]

$m := 3.28ft$ $k_{fin} := 168 \cdot \frac{watt}{m \cdot K}$ [Incropera, Table A.1, cast alloy]

$L_2 := .5 \cdot (OD_{fin} - ID_{fin}) = 0.63 \cdot in$ $L_c := L_2 + t_{fin}$ $A_p := L_c \cdot t_{fin}$ $L_c^{1.5} \cdot \sqrt{\frac{h_{air2}}{k_{fin} \cdot A_p}} = 0.6$

Overall HTC [Kreith 11-22]

$$U_{tubeC}(Q) := \frac{1}{\frac{OD}{ID \cdot h_{wtr}} + 0 \cdot ff_{wtr} + \frac{OD \cdot \ln\left(\frac{OD}{ID}\right)}{2k_{tube}} + \frac{A_{tubeOD}}{A_{fin} \cdot h_{air2} \cdot \left(\frac{Q}{181}\right)^{m2} \left[1 - \frac{A_{finN}}{A_{fin}}(1 - \eta_f)\right]}}$$

$U_{tubeC}(181) = 141.953 \cdot \frac{BTU}{hr \cdot ft^2 \cdot R}$

this HTC matches the reported 142

$$U_{tubeC}(Q) := \frac{1}{\frac{OD}{ID \cdot h_{wtr}} + 1 \cdot ff_{wtr} + \frac{OD \cdot \ln\left(\frac{OD}{ID}\right)}{2k_{tube}} + \frac{A_{tubeOD}}{A_{fin} \cdot h_{air2} \cdot \left(\frac{Q}{181}\right)^{m2} \cdot \left[1 - \frac{A_{finN}}{A_{fin}}(1 - \eta_f)\right]}}$$

$U_{tubeC}(181) = 119.552 \cdot \frac{BTU}{hr \cdot ft^2 \cdot R}$

this HTC matches the reported 119.5

Show performance at design conditions [DCT-2]

$mtd1 := \frac{(161.4 + 130.7)R}{2} - \frac{(107.9 + 144.4)R}{2}$ $mtd1 = 19.9 \cdot R$

Title: Waterford3 UHS Model

$Q_{test} := U_{tubeC}(181) \cdot A_{tube} \cdot mtd1$ $\qquad$ $Q_{test} = 100.53 \times 10^6 \cdot \frac{BTU}{hr}$ $\qquad$ this matches the 100 MBTU/hr

Compare to DCT curves, above: $\qquad$ $Q_{dctx}(100\%, G1, 161.4, 107.9, 15) = 100.44 \times 10^6$

The relevant coefficients are as follows

$$A1 := \left(\frac{OD}{ID \cdot h_{wtr}} + 1 \cdot ff_{wtr} + \frac{OD \cdot \ln\left(\frac{OD}{ID}\right)}{2k_{tube}} \right) \cdot \left(\frac{BTU}{hr \cdot ft^2 \cdot R} \right) \qquad A1 = 4.542 \times 10^{-3}$$

$$B1 := \left[\frac{A_{tubeOD}}{A_{fin} \cdot h_{air2} \cdot \left[1 - \frac{A_{finN}}{A_{fin}} \left(1 - \eta_f\right) \right]} \right] \cdot \left(\frac{BTU}{hr \cdot ft^2 \cdot R} \right) \qquad B1 = 3.822 \times 10^{-3}$$

The air flow adjusted curves are therefore factored to the original HTC by the adjustment factors:

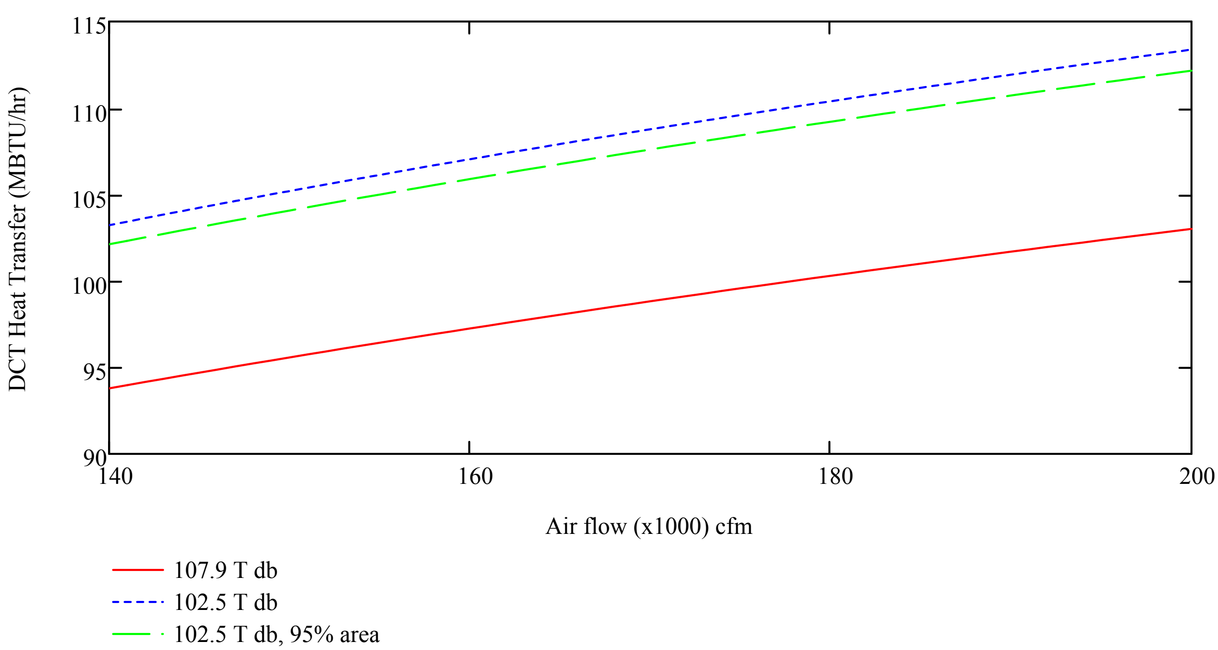
$$Q_{dctx}\left(P, G, Tin, Tdb, N_{fans}, AIR\right) := Q_{dctx}\left(P, G, Tin, Tdb, N_{fans}\right) \cdot \frac{\left[\dfrac{1}{A1 + B1 \cdot \left(\frac{AIR}{181}\right)^{-m2}} \right]}{119.552}$$

Test Function

$Q_{dctx}(100\%, G1, 161.4, 107.9, 15, 181) = 100.44 \times 10^6$ $\qquad$ $Q_{dctx}(100\%, G1, 161.4, 107.9, 15, 166) = 98.2 \times 10^6$

Show DCT heat transfer for a range of AIR flows. Define air range $\qquad$ $i := 0 .. 60$ $\qquad$ $AIR_{test_i} := 140 + i \cdot 1$

Three cases are shown corresponding to 107.9F dry bulb temperature, 102.5F dry bulb temperature, and 102.5F dry bulb temperature with 95% tube area available.



Title: Waterford3 UHS Model

Wet Cooling Tower (WCT)

This module develops WCT performance per Zurn curves. A function is developed to provide WCT heat transfer as a function of CCW flow, CCW incoming temperature, and ambient temperature.

References used in this module:

WCT-1 [6a] Zurn Specification TD-Z010-0025
WCT-2, [12] Kreith, Principles of Heat Transfer, International Textbook, 1965
WCT-3, [15] ASHRAE Handbook, “Fundamentals” 2001
WCT-4, [22] Letter JCA-LPI-0115987, J. Cooper to G. Zysk,
WCT-5, [27] J.A. Goff and S. Gratch, “Thermodynamic Properties of Moist Air”
WCT-6 [29] Letter JCA-LPI-0916988, J. Cooper to G. Zysk

WCT heat transfer properties are obtained per empirical curve fit of the Zurn curves.
Curve fit is based on a polynomial regression using mathcad "regress" function.
Zurn Curve Data is defined in Matrix M with the cold water temperature in Tc_w. 469 data points shown in multiple columns.

$M :=$

GPM	Twb	Range	N_Fans
7000	90	25	8
7000	83	25	8
7000	80	25	8
7000	70	25	8
7000	60	25	8
7000	50	25	8
7000	40	25	8
7000	90	20	8
7000	83	20	8
7000	80	20	8
7000	70	20	8
7000	60	20	8
7000	50	20	8
7000	40	20	8
7000	90	15	8
7000	83	15	8
7000	80	15	8
7000	70	15	8
7000	60	15	8
7000	50	15	8
7000	40	15	8
7000	90	10	8
7000	83	10	8
7000	80	10	8
7000	70	10	8
7000	60	10	8
7000	50	10	8
7000	40	10	8
7000	90	5	8
7000	83	5	8
7000	80	5	8
7000	70	5	8
7000	60	5	8
7000	50	5	8
7000	40	5	8
6000	90	25	8
6000	83	25	8
6000	80	25	8
6000	70	25	8
6000	60	25	8
6000	50	25	8
6000	40	25	8
6000	90	20	8
6000	83	20	8
6000	80	20	8
6000	70	20	8
6000	60	20	8
6000	50	20	8
6000	40	20	8
6000	90	15	8
6000	83	15	8
6000	80	15	8
6000	70	15	8
6000	60	15	8
6000	50	15	8
6000	40	15	8
6000	90	10	8

$Tc_w :=$

Tc
102.29
98.49
96.96
92.26
88.1
84.4
81.07
100.74
96.6
94.93
89.71
85.04
80.83
76.98
98.94
94.37
92.51
86.63
81.27
76.34
71.76
96.71
91.58
89.46
82.67
76.33
70.36
64.7
93.82
87.91
85.43
77.35
69.56
62.02
54.66
98.73
94.45
92.73
87.4
82.66
78.41
74.55
97.57
93
91.13
85.32
80.07
75.3
70.91
96.27
91.31
89.27
82.85
76.92
71.44
66.3
94.67

Data points 58-120

$M =$

	0	1	2	3
57	6000	83	10	8
58	6000	80	10	8
59	6000	70	10	8
60	6000	60	10	8
61	6000	50	10	8
62	6000	40	10	8
63	6000	90	5	8
64	6000	83	5	8
65	6000	80	5	8
66	6000	70	5	8
67	6000	60	5	8
68	6000	50	5	8
69	6000	40	5	8
70	4500	90	25	8
71	4500	83	25	8
72	4500	80	25	8
73	4500	70	25	8
74	4500	60	25	8
75	4500	50	25	8
76	4500	40	25	8
77	4500	90	20	8
78	4500	83	20	8
79	4500	80	20	8
80	4500	70	20	8
81	4500	60	20	8
82	4500	50	20	8
83	4500	40	20	8
84	4500	90	15	8
85	4500	83	15	8
86	4500	80	15	8
87	4500	70	15	8
88	4500	60	15	8
89	4500	50	15	8
90	4500	40	15	8
91	4500	90	10	8
92	4500	83	10	8
93	4500	80	10	8
94	4500	70	10	8
95	4500	60	10	8
96	4500	50	10	8
97	4500	40	10	8
98	4500	90	5	8
99	4500	83	5	8
100	4500	80	5	8
101	4500	70	5	8
102	4500	60	5	8
103	4500	50	5	8
104	4500	40	5	8
105	3000	90	25	8
106	3000	83	25	8
107	3000	80	25	8
108	3000	70	25	8
109	3000	60	25	8
110	3000	50	25	8
111	3000	40	25	8
112	3000	90	20	8
113	3000	83	20	8
114	3000	80	20	8
115	3000	70	20	8
116	3000	60	20	8
117	3000	50	20	8
118	3000	40	20	8
119	3000	90	15	8
120	3000	83	15	8
121	3000	80	15	...

$Tc_w =$

	0
57	89.23
58	86.96
59	79.71
60	72.87
61	66.39
62	60.2
63	92.64
64	86.54
65	83.96
66	75.57
67	67.44
68	59.53
69	51.77
70	94.27
71	89.17
72	87.09
73	80.64
74	74.82
75	69.53
76	64.68
77	93.65
78	88.31
79	86.12
80	79.25
81	72.97
82	67.18
83	61.78
84	92.98
85	87.26
86	85.04
87	77.66
88	70.79
89	64.35
90	58.24
91	92.2
92	86.23
93	83.74
94	75.71
95	68.08
96	60.77
97	53.71
98	91.23
99	84.81
100	82.1
101	73.22
102	64.58
103	56.12
104	47.78
105	91.26
106	85.19
107	82.69
108	74.79
109	67.54
110	60.85
111	54.6
112	91.04
113	84.83
114	82.26
115	74.08
116	66.47
117	59.35
118	52.61
119	90.83
120	84.48
121	81.82
122	73.31
123	65.28
124	57.65
125	50.33
126	...

Title: Waterford3 UHS Model

Sheet No: WCT-2 of 14
Wet Cooling Tower Module

M =

	0	1	2	3
121	3000	80	15	8
122	3000	70	15	8
123	3000	60	15	8
124	3000	50	15	8
125	3000	40	15	8
126	3000	90	10	8
127	3000	83	10	8
128	3000	80	10	8
129	3000	70	10	8
130	3000	60	10	8
131	3000	50	10	8
132	3000	40	10	8
133	3000	90	5	8
134	3000	80	5	8
135	3000	70	5	8
136	3000	60	5	8
137	3000	50	5	8
138	3000	40	5	8
139	2500	90	25	8
140	2500	80	25	8
141	2500	70	25	8
142	2500	60	25	8
143	2500	50	25	8
144	2500	40	25	8
145	2500	90	20	8
146	2500	80	20	8
147	2500	70	20	8
148	2500	60	20	8
149	2500	50	20	8
150	2500	40	20	8
151	2500	90	15	8
152	2500	80	15	8
153	2500	70	15	8
154	2500	60	15	8
155	2500	50	15	8
156	2500	40	15	8
157	2500	90	10	8
158	2500	80	10	8
159	2500	70	10	8
160	2500	60	10	8
161	2500	50	10	8
162	2500	40	10	8
163	7000	90	25	6
164	7000	83	25	6
165	7000	80	25	6
166	7000	70	25	6
167	7000	60	25	6
168	7000	50	25	6
169	7000	40	25	6
170	7000	90	20	6
171	7000	83	20	6
172	7000	80	20	6
173	7000	70	20	6
174	7000	60	20	6
175	7000	50	20	6
176	7000	40	20	6
177	7000	90	15	6
178	7000	83	15	6
179	7000	80	15	6
180	7000	70	15	6
181	7000	60	15	6
182	7000	50	15	6
183	7000	40	15	6
184	7000	90	10	6
185	7000	83	10	6
186	7000	80	10	6
187	7000	70	10	6
188	7000	60	10	6
189	7000	50	10	6
190	7000	40	10	6
191	7000	90	5	6
192	7000	83	5	6
193	7000	80	5	6
194	7000	70	5	6
195	7000	60	5	6
196	7000	50	5	6
197	7000	40	5	6
198	6000	90	25	6
199	6000	83	25	6
200	6000	80	25	6
201	6000	70	25	6
202	6000	60	25	6
203	6000	50	25	6
204	6000	40	25	6
205	6000	90	20	6
206	6000	83	20	6
207	6000	80	20	6
208	6000	70	20	6
209	6000	60	20	6
210	6000	50	20	6
211	6000	40	20	6
212	6000	90	15	6
213	6000	83	15	6
214	6000	80	15	6
215	6000	70	15	6
216	6000	60	15	6
217	6000	50	15	6
218	6000	40	15	6
219	6000	90	10	6
220	6000	83	10	...

Data 121-220

Tc_w =

	0
121	81.82
122	73.31
123	65.28
124	57.65
125	50.33
126	90.6
127	84.08
128	81.33
129	72.43
130	63.88
131	55.63
132	47.59
133	90.33
134	80.73
135	71.34
136	62.15
137	53.11
138	44.18
139	90.67
140	81.63
141	73.19
142	65.37
143	58.09
144	51.25
145	90.55
146	81.35
147	72.68
148	64.56
149	56.91
150	49.63
151	90.43
152	81.08
153	72.16
154	63.69
155	55.61
156	47.82
157	90.31
158	80.78
159	71.58
160	62.69
161	54.09
162	45.69
163	103.96
164	100.37
165	98.93
166	94.52
167	90.65
168	87.23
169	84.17
170	102.21
171	98.28
172	96.69
173	91.77
174	87.38
175	83.45
176	79.88
177	100.18
178	95.8
179	94.02
180	88.41
181	83.32
182	78.67
183	74.37
184	97.65
185	92.68
186	90.62
187	84.07
188	77.97
189	72.26
190	66.86
191	94.36
192	88.56
193	86.12
194	78.2
195	70.58
196	63.23
197	56.07
198	100.19
199	96.15
200	94.52
201	89.52
202	85.09
203	81.16
204	77.59
205	98.86
206	94.5
207	92.73
208	87.24
209	82.29
210	77.82
211	73.74
212	97.34
213	92.58
214	90.63
215	84.48
216	78.85
217	73.66
218	68.83
219	95.49
220	...

M =

	0	1	2	3
221	6000	80	10	6
222	6000	70	10	6
223	6000	60	10	6
224	6000	50	10	6
225	6000	40	10	6
226	6000	90	5	6
227	6000	83	5	6
228	6000	80	5	6
229	6000	70	5	6
230	6000	60	5	6
231	6000	50	5	6
232	6000	40	5	6
233	4500	90	25	6
234	4500	83	25	6
235	4500	80	25	6
236	4500	70	25	6
237	4500	60	25	6
238	4500	50	25	6
239	4500	40	25	6
240	4500	90	20	6
241	4500	83	20	6
242	4500	80	20	6
243	4500	70	20	6
244	4500	60	20	6
245	4500	50	20	6
246	4500	40	20	6
247	4500	90	15	6
248	4500	83	15	6
249	4500	80	15	6
250	4500	70	15	6
251	4500	60	15	6
252	4500	50	15	6
253	4500	40	15	6
254	4500	90	10	6
255	4500	83	10	6
256	4500	80	10	6
257	4500	70	10	6
258	4500	60	10	6
259	4500	50	10	6
260	4500	40	10	6
261	4500	90	5	6
262	4500	83	5	6
263	4500	80	5	6
264	4500	70	5	6
265	4500	60	5	6
266	4500	50	5	6
267	4500	40	5	6
268	3000	90	25	6
269	3000	80	25	6
270	3000	70	25	6
271	3000	60	25	6
272	3000	50	25	6
273	3000	40	25	6
274	3000	90	20	6
275	3000	80	20	6
276	3000	70	20	6
277	3000	60	20	6
278	3000	50	20	6
279	3000	40	20	6
280	3000	90	15	6
281	3000	80	15	6
282	3000	70	15	6
283	3000	60	15	6
284	3000	50	15	6
285	3000	40	15	6
286	3000	90	10	6
287	3000	80	10	6
288	3000	70	10	6
289	3000	60	10	6
290	3000	50	10	6
291	3000	40	10	6
292	2500	90	25	6
293	2500	80	25	6
294	2500	70	25	6
295	2500	60	25	6
296	2500	50	25	6
297	2500	40	25	6
298	2500	90	20	6
299	2500	80	20	6
300	2500	70	20	6
301	2500	60	20	6
302	2500	50	20	6
303	2500	40	20	6
304	2500	90	15	6
305	2500	80	15	6
306	2500	70	15	6
307	2500	60	15	6
308	2500	50	15	6
309	2500	40	15	6
310	2500	90	10	6
311	2500	80	10	6
312	2500	70	10	6
313	2500	60	10	6
314	2500	50	10	6
315	2500	40	10	6
316	7000	90	25	4
317	7000	83	25	4
318	7000	80	25	4
319	7000	70	25	4
320	7000	60	25	...

Data 221-320

Tc_w =

	0
221	88
222	80.98
223	74.39
224	68.17
225	62.25
226	93.11
227	87.1
228	84.57
229	76.32
230	68.35
231	60.63
232	53.06
233	95.31
234	90.46
235	88.49
236	82.39
237	76.92
238	71.99
239	67.49
240	94.55
241	89.44
242	87.35
243	80.82
244	74.86
245	69.41
246	64.35
247	93.73
248	88.3
249	86.07
250	78.98
251	72.41
252	66.27
253	60.48
254	92.76
255	86.94
256	84.51
257	76.71
258	69.32
259	62.27
260	55.47
261	91.54
262	85.21
263	82.54
264	73.8
265	65.3
266	57
267	48.83
268	91.76
269	83.5
270	75.95
271	69.06
272	62.73
273	56.86
274	91.46
275	82.96
276	75.09
277	67.8
278	61.02
279	54.63
280	91.17
281	82.4
282	74.15
283	66.39
284	59.06
285	52.04
286	90.85
287	81.75
288	73.05
289	64.71
290	56.68
291	48.87
292	90.98
293	82.21
294	74.09
295	66.61
296	59.7
297	53.23
298	90.81
299	81.84
300	73.46
301	65.64
302	58.32
303	51.37
304	90.64
305	81.48
306	72.8
307	64.59
308	56.78
309	49.26
310	90.46
311	81.08
312	72.04
313	63.35
314	54.96
315	46.77
316	108.62
317	105.56
318	104.34
319	100.63
320	...

Title: Waterford3 UHS Model

Sheet No: WCT-3 of 14
Wet Cooling Tower Module

Data Points 321-420

M =

	0	1	2	3
321	7000	50	25	4
322	7000	40	25	4
323	7000	90	20	4
324	7000	83	20	4
325	7000	80	20	4
326	7000	70	20	4
327	7000	60	20	4
328	7000	50	20	4
329	7000	40	20	4
330	7000	90	15	4
331	7000	83	15	4
332	7000	80	15	4
333	7000	70	15	4
334	7000	60	15	4
335	7000	50	15	4
336	7000	40	15	4
337	7000	90	10	4
338	7000	83	10	4
339	7000	80	10	4
340	7000	70	10	4
341	7000	60	10	4
342	7000	50	10	4
343	7000	40	10	4
344	7000	90	5	4
345	7000	83	5	4
346	7000	80	5	4
347	7000	70	5	4
348	7000	60	5	4
349	7000	50	5	4
350	7000	40	5	4
351	6000	90	25	4
352	6000	83	25	4
353	6000	80	25	4
354	6000	70	25	4
355	6000	60	25	4
356	6000	50	25	4
357	6000	40	25	4
358	6000	90	20	4
359	6000	83	20	4
360	6000	80	20	4
361	6000	70	20	4
362	6000	60	20	4
363	6000	50	20	4
364	6000	40	20	4
365	6000	90	15	4
366	6000	83	15	4
367	6000	80	15	4
368	6000	70	15	4
369	6000	60	15	4
370	6000	50	15	4
371	6000	40	15	4
372	6000	90	10	4
373	6000	83	10	4
374	6000	80	10	4
375	6000	70	10	4
376	6000	60	10	4
377	6000	50	10	4
378	6000	40	10	4
379	6000	90	5	4
380	6000	83	5	4
381	6000	80	5	4
382	6000	70	5	4
383	6000	60	5	4
384	6000	50	5	4
385	6000	40	5	4
386	4500	90	25	4
387	4500	83	25	4
388	4500	80	25	4
389	4500	70	25	4
390	4500	60	25	4
391	4500	50	25	4
392	4500	40	25	4
393	4500	90	20	4
394	4500	83	20	4
395	4500	80	20	4
396	4500	70	20	4
397	4500	60	20	4
398	4500	50	20	4
399	4500	40	20	4
400	4500	90	15	4
401	4500	83	15	4
402	4500	80	15	4
403	4500	70	15	4
404	4500	60	15	4
405	4500	50	15	4
406	4500	40	15	4
407	4500	90	10	4
408	4500	83	10	4
409	4500	80	10	4
410	4500	70	10	4
411	4500	60	10	4
412	4500	50	10	4
413	4500	40	10	4
414	4500	90	5	4
415	4500	83	5	4
416	4500	80	5	4
417	4500	70	5	4
418	4500	60	5	4
419	4500	50	5	4
420	4500	40	5	...

Tc_w =

	0
321	94.62
322	92.14
323	106.4
324	102.98
325	101.6
326	97.38
327	93.66
328	90.38
329	87.44
330	103.75
331	99.85
332	98.26
333	93.33
334	88.91
335	84.93
336	81.3
337	100.41
338	95.84
339	93.96
340	88.01
341	82.54
342	77.49
343	72.76
344	96
345	90.46
346	88.14
347	80.65
348	73.5
349	66.66
350	60.04
351	104.36
352	100.89
353	99.5
354	95.26
355	91.56
356	88.32
357	85.42
358	102.58
359	98.76
360	97.22
361	92.47
362	88.25
363	84.5
364	81.11
365	100.5
366	96.22
367	94.48
368	89.04
369	84.11
370	79.63
371	75.53
372	97.89
373	93.01
374	90.98
375	84.57
376	78.61
377	73.06
378	67.83
379	94.51
380	88.76
381	86.34
382	78.51
383	70.99
384	63.74
385	56.69
386	98.44
387	94.2
388	92.49
389	87.24
390	82.59
391	78.46
392	74.73
393	97.31
394	92.76
395	90.91
396	85.18
397	80.02
398	75.35
399	71.08
400	96.03
401	91.1
402	89.08
403	82.71
404	76.87
405	71.47
406	66.45
407	94.49
408	89.06
409	86.8
410	79.59
411	72.81
412	66.4
413	60.28
414	92.53
415	86.43
416	83.86
417	75.49
418	67.39
419	59.51
420	...

Data Points through 469

M =

	0	1	2	3
421	3000	90	25	4
422	3000	80	25	4
423	3000	70	25	4
424	3000	60	25	4
425	3000	50	25	4
426	3000	40	25	4
427	3000	90	20	4
428	3000	80	20	4
429	3000	70	20	4
430	3000	60	20	4
431	3000	50	20	4
432	3000	40	20	4
433	3000	90	15	4
434	3000	80	15	4
435	3000	70	15	4
436	3000	60	15	4
437	3000	50	15	4
438	3000	40	15	4
439	3000	90	10	4
440	3000	80	10	4
441	3000	70	10	4
442	3000	60	10	4
443	3000	50	10	4
444	3000	40	10	4
445	2500	90	25	4
446	2500	80	25	4
447	2500	70	25	4
448	2500	60	25	4
449	2500	50	25	4
450	2500	40	25	4
451	2500	90	20	4
452	2500	80	20	4
453	2500	70	20	4
454	2500	60	20	4
455	2500	50	20	4
456	2500	40	20	4
457	2500	90	15	4
458	2500	80	15	4
459	2500	70	15	4
460	2500	60	15	4
461	2500	50	15	4
462	2500	40	15	4
463	2500	90	10	4
464	2500	80	10	4
465	2500	70	10	4
466	2500	60	10	4
467	2500	50	10	4
468	2500	40	10	...
469				
470				

Tc_w =

	0
421	93.45
422	86.01
423	79.32
424	73.29
425	67.83
426	62.81
427	92.91
428	85.15
429	78.06
430	71.57
431	65.6
432	60.03
433	92.36
434	84.21
435	76.63
436	69.57
437	62.95
438	56.67
439	91.73
440	83.1
441	74.91
442	67.12
443	59.66
444	52.44
445	92.15
446	84.12
447	76.81
448	70.18
449	64.12
450	58.51
451	91.8
452	83.49
453	75.84
454	68.79
455	62.24
456	56.11
457	91.44
458	82.83
459	74.77
460	67.21
461	60.08
462	53.28
463	91.05
464	82.07
465	73.5
466	65.32
467	57.45
468	...
469	
470	

Title: Waterford3 UHS Model

Define new curves based on 1 of 2 WCT cells (4 fans) turned off while 4 fans run, i.e. tower half-operating.
Curve data based on [29 letter, JC to LPI]

$M1 :=$

GPM	Twb	Range	N_Fans
5350	70	50	4
5350	75	50	4
5350	80	50	4
5350	85	50	4
5350	70	40	4
5350	75	40	4
5350	80	40	4
5350	85	40	4
5350	70	30	4
5350	75	30	4
5350	80	30	4
5350	85	30	4
5350	70	20	4
5350	75	20	4
5350	80	20	4
5350	85	20	4
5350	70	10	4
5350	75	10	4
5350	80	10	4
5350	85	10	4
4200	70	50	4
4200	75	50	4
4200	80	50	4
4200	85	50	4
4200	70	40	4
4200	75	40	4
4200	80	40	4
4200	85	40	4
4200	70	30	4
4200	75	30	4
4200	80	30	4
4200	85	30	4
4200	70	20	4
4200	75	20	4
4200	80	20	4
4200	85	20	4
4200	70	10	4
4200	75	10	4
4200	80	10	4
4200	85	10	4
1400	70	50	4
1400	75	50	4
1400	80	50	4
1400	85	50	4
1400	70	40	4
1400	75	40	4
1400	80	40	4
1400	85	40	4
1400	70	30	4
1400	75	30	4
1400	80	30	4
1400	85	30	4
1400	70	25	4
1400	75	25	4
1400	80	25	4
1400	85	25	4

$Tc1_w :=$

Tc
115.25
117.41
119.75
122.28
108.3
110.66
113.19
115.9
100.88
103.5
106.3
109.28
92.61
95.66
98.85
102.21
82.91
86.64
90.49
94.44
108.76
111.42
114.28
117.36
102.26
105.11
108.15
111.41
95.45
98.56
101.85
105.33
88.13
91.61
95.24
99.04
79.99
84.03
88.18
92.44
96.39
100.8
105
109.3
91.1
95.58
100.27
104.75
85.83
90.54
95.36
100.2
83.2
87.95
92.8
97.7

Title: Waterford3 UHS Model

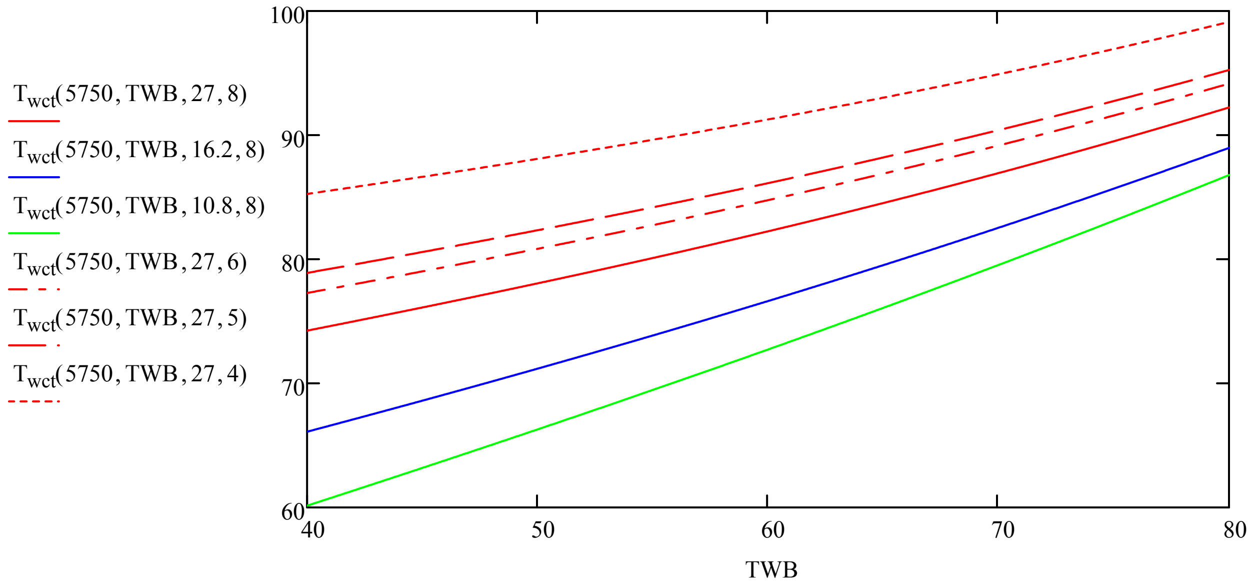
Sheet No: WCT-5 of 14
Wet Cooling Tower Module

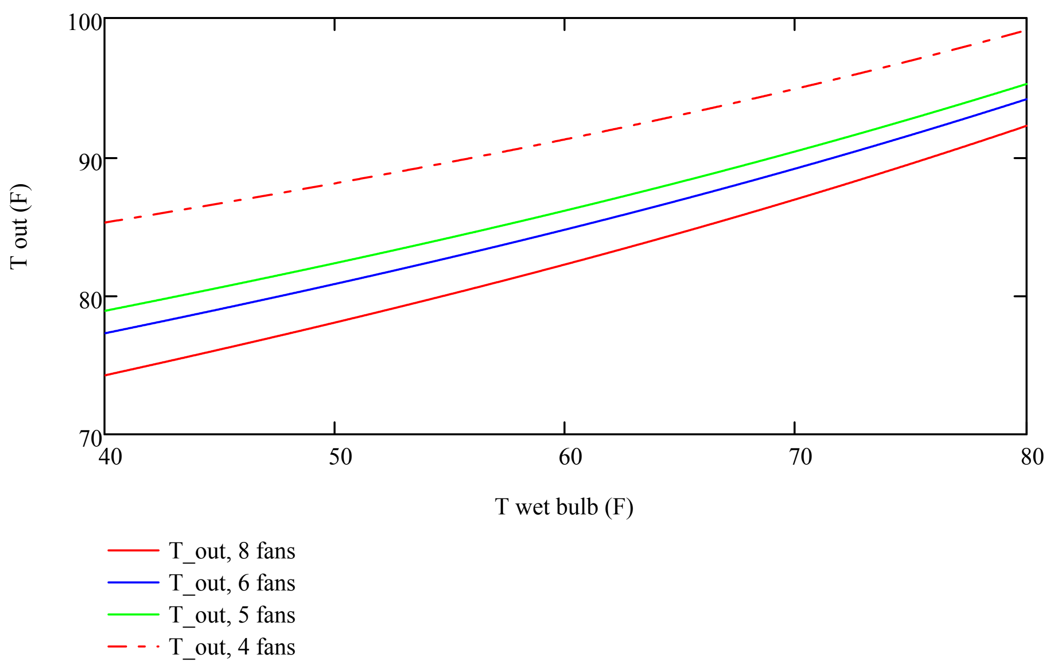
Define WCT function for cold water outlet temperature based on flow, Twb, and Range, based on 4th order polynomial regression:

$$Reg := regress(M, Tc_w, 4) \qquad T_{wct}(GPM, T_{wb}, Rg, NF) := interp\left[Reg, M, Tc_w, \begin{pmatrix} GPM \\ T_{wb} \\ Rg \\ NF \end{pmatrix}\right]$$

Test function $T_{wct}(5350, 78, 35, 8) = 90.77$

Plot function





Evaluate Error between Curve Fit and Data

$z := 0 .. \mathrm{last}\left(M^{\langle 0 \rangle}\right)$ $Test_z := T_{wct}\left(M_{z,0}, M_{z,1}, M_{z,2}, M_{z,3}\right)$ $ER_z := 1 - \frac{Test_z}{Tc_{w_z}}$ $\max(ER) = 0.34 \cdot \%$

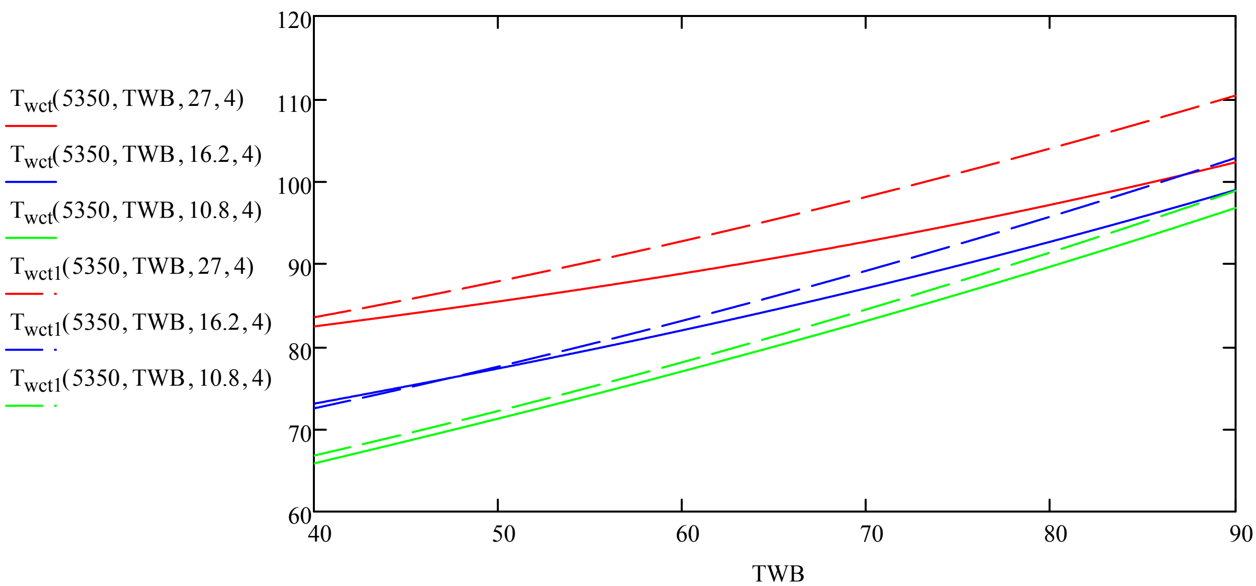
Define similar WCT function for cold water outlet temperature based on flow, Twb, and Range, based on 2nd order polynomial regression **FOR THE CONDITION WITH 1 OF 2 CELLS OPERATING**:

$Reg1 := \mathrm{regress}\left(M1, Tc1_w, 2\right)$ $T_{wct1}\left(GPM, T_{wb}, Rg, NF\right) := \mathrm{interp}\left[Reg1, M1, Tc1_w, \begin{pmatrix} GPM \\ T_{wb} \\ Rg \\ NF \end{pmatrix}\right]$

Test function $T_{wct1}(5350, 78, 35, 4) = 108.64$

Plot function $T_{wct}(5350, 78, 35, 4) = 99.13$

Compare the cold water temperature with 4 fans OOS split in 2 cells vs. 4 fans in 1 cell



Water Properties

The water properties module is required in order to permit the WCT module to run in a stand-alone mode.

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD R4\Water Properties.xmcdz(R)

Seed values for solution $Tout := 89$ $Tin := 105$ $Rg := Tin - Tout$ $Twb := 77.149$ $GPM := 5324$

Iterative solution for WCT Tout $NF := 4$

Given $Tout = T_{wct}(GPM, Twb, Tin - Tout, NF)$ $Tout > Twb$ Check function

$TOUT(GPM, Tin, Twb, NF) := Find(Tout)$ $TOUT(GPM, Tin, Twb, NF) = 90.18$

Define function for WCT heat removal (include number of fans in service removed)

$$Q_{wct}(GPM, T_{in}, T_{wb}, NF) := Q_{wtr}(GPM, T_{in}, TOUT(GPM, T_{in}, T_{wb}, NF)) \quad Q_{wct}(GPM, Tin, Twb, NF) = 39.16 \times 10^6$$

$TOUT(6518, 79.4, 44.4, 8) = 67.54$ $TOUT(6518, 79.4, 40.4, 8) = 66.61$

$TOUT(6518, 80.6, 44.4, 7) = 68.97$ $TOUT(6518, 80.6, 40.4, 7) = 68.11$

Define same WCT Tout function as above for 1 cell operating (4 fans) and 1 cell out (4 fans)

Iterative solution for WCT Tout $Tout1 := 89$

Given $Tout1 = T_{wct1}(GPM, Twb, Tin - Tout, NF)$ $Tout1 > Twb$ Check function

$TOUT1(GPM, Tin, Twb, NF) := Find(Tout1)$ $TOUT1(GPM, Tin, Twb, NF) = 93.56$

Define function for WCT heat removal (include number of fans in service removed)

$$Q_{wct1}(GPM, T_{in}, T_{wb}, NF) := Q_{wtr}(GPM, T_{in}, TOUT1(GPM, T_{in}, T_{wb}, NF)) \quad Q_{wct1}(GPM, Tin, Twb, NF) = 30.228 \times 10^6$$

Define logic to select which case is used

$$Q_{wct}(GPM, T_{in}, T_{wb}, NF, WCT_{cellout}) := \begin{cases} Q_{wct1}(GPM, T_{in}, T_{wb}, 4) & \text{if } WCT_{cellout} = 1 \\ Q_{wct}(GPM, T_{in}, T_{wb}, NF) & \text{otherwise} \end{cases}$$

Test function $WCTCO := 0$ $Q_{wct}(GPM, Tin, Twb, NF, WCTCO) = 39.16 \times 10^6$

Demonstrate Performance
Test WCT model results against a range of input conditions

WCT_Test :=

GPM	Twb	T_in	T_out	Q	Ref
5324	77.15	105	85.88	50.47	MN(Q)9-52
6386.7	71.1	96.24	83.15		WCB Test 5/8/98
6019.8	71.73	92.95	81.77		WCA Test 5/12/98
6656.5	62.34	86.37	75.36		WCA Test 4/10/00
6254	56	84.73	72.46	38.4	WCB Test 12/11/01
5976.4	51.76	84.54	70.44	42.03	WCB Test 12/10/08
6419.13	62.18	86.96	75.26	37.5	WCA Test 3/31/09

$j := 0..6$

$G2 := WCT\_Test^{\langle 0\rangle}$

$TWB2 := WCT\_Test^{\langle 1\rangle}$

$TIN2 := WCT\_Test^{\langle 2\rangle}$

$TOUT2 := WCT\_Test^{\langle 3\rangle}$

$Q2 := WCT\_Test^{\langle 4\rangle}$

Heat removed per WCT Model

$$WCT\_Model_j := Q_{wct}(G2_j, TIN2_j, TWB2_j, 8, 0)$$

For comparison to tests, replace zero recorded heat removal (Q) from test with calculated values based on flow and temperature change

$$Q2 := \left| \begin{array}{l} \text{for } j \in 0..6 \\ \quad \left| \begin{array}{l} Q_j \leftarrow Q_{wtr}(G2_j, TIN2_j, TOUT2_j)\cdot 10^{-6} \text{ if } Q2_j = 0 \\ Q_j \leftarrow 0 \text{ otherwise} \end{array}\right. \\ Q_{est} \leftarrow Q2 + Q \end{array}\right.$$

Calculate error

$$WCT\_ER_j := \frac{WCT\_Model_j}{Q2_j\cdot 10^6} - 1$$

Compare heat removal

$$\frac{WCT\_Model}{10^6} = \begin{pmatrix} 48.95 \\ 40.34 \\ 33.42 \\ 32.76 \\ 36.68 \\ 40.35 \\ 34.01 \end{pmatrix} \quad Q2 = \begin{pmatrix} 50.47 \\ 41.52 \\ 33.44 \\ 36.48 \\ 38.4 \\ 42.03 \\ 37.5 \end{pmatrix} \quad WCT\_ER = \begin{pmatrix} -3.02 \\ -2.83 \\ -0.07 \\ -10.19 \\ -4.47 \\ -3.99 \\ -9.3 \end{pmatrix}\cdot\%$$

$$mean(WCT\_ER) = -4.84\cdot\%$$

$$stdev(WCT\_ER) = 3.37\cdot\%$$

Negative Error (conservative), based on higher outlet temperature from WCT model vs. tested values. Note that small temperature difference (1F) provide large heat differences.

$$WCT\_OUT_j := TOUT(G2_j, TIN2_j, TWB2_j, 8) \quad WCT\_OUT = \begin{pmatrix} 86.48 \\ 83.52 \\ 81.78 \\ 76.48 \\ 72.95 \\ 70.99 \\ 76.31 \end{pmatrix} \quad TOUT2 = \begin{pmatrix} 85.88 \\ 83.15 \\ 81.77 \\ 75.36 \\ 72.46 \\ 70.44 \\ 75.26 \end{pmatrix}$$

Wet Cooling Tower Water Loss
Note: The L/G ratio is defined herein as "LG".

Test functions

Liquid to Gas ratio (L/G) [WCT-1] at 6500gpm and 58160 cfm per fan $LG_o := 1.748$

L/G factored to WCT flow $LG(GPM) := LG_o \cdot \frac{GPM}{6500gpm} \cdot \frac{58160}{60467}$ $LG(5350gpm) = 1.384$

ASHRAE [WCT-3] equations for moist air, note T = abs

6.2 EQ6

$C_8 := -1.0440397 \cdot 10^4$ $C_{10} := -2.7022355 \cdot 10^{-2}$ $C_{12} := -2.4780681 \cdot 10^{-9}$

$C_9 := -1.1294650 \cdot 10^1$ $C_{11} := 1.2890360 \cdot 10^{-5}$ $C_{13} := 6.5459673 \cdot 1$

$$p_{ws}(T) := e^{\left(\frac{C_8}{T} + C_9 + C_{10} \cdot T + C_{11} \cdot T^2 + C_{12} \cdot T^3 + C_{13} \cdot \ln(T)\right)}$$

$p_{ws}(95 + 459.67) = 0.816$ psia

6.2 EQ 24 $p_w(T, \phi) := p_{ws}(T + 459.67) \cdot \phi$ $p_w(95, 50\%) = 0.408$ psia

6.2 EQ 22 Humidity ratio at Tdb and RH

$$W(T, \phi) := 0.62198 \cdot \left(\frac{p_w(T, \phi)}{14.7 - p_w(T, \phi)} \right)$$

$W(95, 50\%) = 0.018$

6.2 EQ 35 Humidity ratio at Tdb, Twb

$$W1(T_{db}, T_{wb}) := \frac{(1093 - .556T_{wb}) \cdot W(T_{wb}, 100\%) - .240 \cdot (T_{db} - T_{wb})}{1093 + .444T_{db} - T_{wb}}$$

$W1(89, 80) = 0.0201$

[WCT-5], air enthalpy as a function of Twb

$$h(T) := \frac{168.97373 + T \cdot \left[T \cdot \left[T \cdot \left[T \cdot \left[T \cdot \left(T \cdot 4.2331 \cdot 10^{-11} - 6.294 \times 10^{-8}\right) + 1.849 \cdot 10^{-5}\right] + 1.45748 \cdot 10^{-3}\right] - .107504\right] + 62.20922\right]}{212 - T}$$

$h(95) = 63.32$

Find exit temperature from enthalpy and 100% exit humidity

Define seed values $h1 := 61$ $T1 := 80$

Given $h1 = h(T1)$ $Temp(h1) := Find(T1)$ $Temp(h1) = 93.5$

$h(Temp(h1)) = 61$

Write Evaporation function at defined conditions (GPM, h1, Tdb, Twb using 100% exit humidity).
Note: these are re-calc'd based on ACCW heat flows and ambient conditions, solved below.

$$EV(GPM, h1, T_{db}, T_{wb}) := \frac{GPM}{LG(GPM)} \cdot \left(W(Temp(h1), 100\%) - W1(T_{db}, T_{wb})\right)$$

$EV(5350, h1, 95, 80) = 1.04 \cdot \frac{gal}{sec}$

Title: Waterford3 UHS Model

Sheet No: WCT-10 of 14
Wet Cooling Tower Module

Wet Cooling Tower Natural Draft Mode
NOTE: Performance curve points below [WCT-4, J. Cooper] to match measured performance.

$MND :=$

GPM	Twb	Range
6500	70	10.39
6500	72	10.09
6500	74	9.74
6500	76	9.43
6500	78	9.04
6500	80	8.66
6500	70	8.41
6500	72	8.07
6500	74	7.78
6500	76	7.41
6500	78	7.11
6500	80	6.76
6500	70	6.69
6500	72	6.4
6500	74	6.09
6500	76	5.78
6500	78	5.47
6500	80	5.17
6500	70	5.26
6500	72	5
6500	74	4.74
6500	76	4.4
6500	78	4.12
6500	80	3.86
6500	70	4.02
6500	72	3.77
6500	74	3.53
6500	76	3.29
6500	78	3.04
6500	80	2.81
5350	70	10.49
5350	75	9.49
5350	80	8.43
5350	70	8.38
5350	75	7.38
5350	80	6.44
5350	70	6.49
5350	75	5.68
5350	80	4.8
5350	70	5.03
5350	75	4.26
5350	80	3.51
5350	70	3.76
5350	75	3.06
5350	80	2.11
4200	70	10.44
4200	75	9.62
4200	80	8.44
4200	70	8.53
4200	75	7.38
4200	80	6.26
4200	70	6.58
4200	75	5.52
4200	80	4.51
4200	70	4.91
4200	75	4
4200	80	3.1
4200	70	3.53
4200	75	2.79
4200	80	1.72
3000	70	11.21
3000	75	10
3000	80	8.36
3000	70	8.8
3000	75	7.43
3000	80	6
3000	70	6.59
3000	75	5.35
3000	80	4.03
3000	70	4.73
3000	75	3.54
3000	80	2.52
1400	70	20.9
1400	75	18.25
1400	80	15.5
1400	85	12.78

$Tc_{ND} :=$

Tc
124.61
124.91
125.26
125.57
125.96
126.34
121.59
121.93
122.22
122.59
122.89
123.24
118.31
118.6
118.91
119.22
119.53
119.83
114.74
115
115.26
115.6
115.88
116.14
110.98
111.23
111.47
111.71
111.96
112.19
119.51
120.51
121.57
116.62
117.62
118.56
113.51
114.32
115.20
109.97
110.74
111.49
106.24
106.94
107.89
114.56
115.38
116.56
111.47
112.62
113.74
108.42
109.48
110.49
105.09
106.00
106.90
101.47
102.21
103.28
107.79
109.00
110.64
105.20
106.57
108.00
102.41
103.65
104.97
99.27
100.46
101.48
97.1
99.75
102.5
105.22

Remaining data points through 83, truncated from left

$MND =$

	0	1	2
57	4200	70	3.53
58	4200	75	2.79
59	4200	80	1.72
60	3000	70	11.21
61	3000	75	10
62	3000	80	8.36
63	3000	70	8.8
64	3000	75	7.43
65	3000	80	6
66	3000	70	6.59
67	3000	75	5.35
68	3000	80	4.03
69	3000	70	4.73
70	3000	75	3.54
71	3000	80	2.52
72	1400	70	20.9
73	1400	75	18.25
74	1400	80	15.5
75	1400	85	12.78
76	1400	70	15
77	1400	75	12.54
78	1400	80	9.87
79	1400	85	7.38
80	1400	70	9.81
81	1400	75	7.69
82	1400	80	5.35
83	1400	85	...

$Tc_{ND} =$

	0
57	101.47
58	102.21
59	103.28
60	107.79
61	109
62	110.64
63	105.2
64	106.57
65	108
66	102.41
67	103.65
68	104.97
69	99.27
70	100.46
71	101.48
72	97.1
73	99.75
74	102.5
75	105.22
76	96
77	98.46
78	101.13
79	103.62
80	94.19
81	96.31
82	98.65
83	...

Define regression function for WCT natural draft cold water temperature with flow, Twb, and range

$$Reg_{ND} := \mathrm{regress}\left(MND, Tc_{ND}, 2\right) \qquad T_{wctND}\left(GPM, T_{wb}, Rg\right) := \mathrm{interp}\left[Reg_{ND}, MND, Tc_{ND}, \begin{pmatrix} GPM \\ T_{wb} \\ Rg \end{pmatrix}\right]$$

Test function $T_{wctND}(5350, 78, 10) = 123.24$

Iterative solution for WCT Tout Provide seed values $Tout := 120$ $Twb = 77.15$

Given

$Tout = T_{wctND}(GPM, Twb, Tin - Tout)$

$Tin - Tout < 10$

$TOND(GPM, Tin, Twb) := \mathrm{Find}(Tout)$

Check function

$TOND(GPM, 105, Twb) = 104.01$

$TOND(GPM, 110, Twb) = 107.6$

Define function for WCT heat removal in Natural Draft mode $GPM = 5324$ $Tin = 105$ $Twb = 77.15$

$$Q_{wctND}\left(GPM, T_{in}, T_{wb}\right) := Q_{wtr}\left(GPM, T_{in}, TOND\left(GPM, T_{in}, T_{wb}\right)\right)$$

$Q_{wctND}(GPM, Tin, Twb) = 2.613 \times 10^{6}$

$Q_{wctND}(GPM, 110, Twb) = 6.339 \times 10^{6}$

Define operation in normal, natural draft mode, or single cell OOS

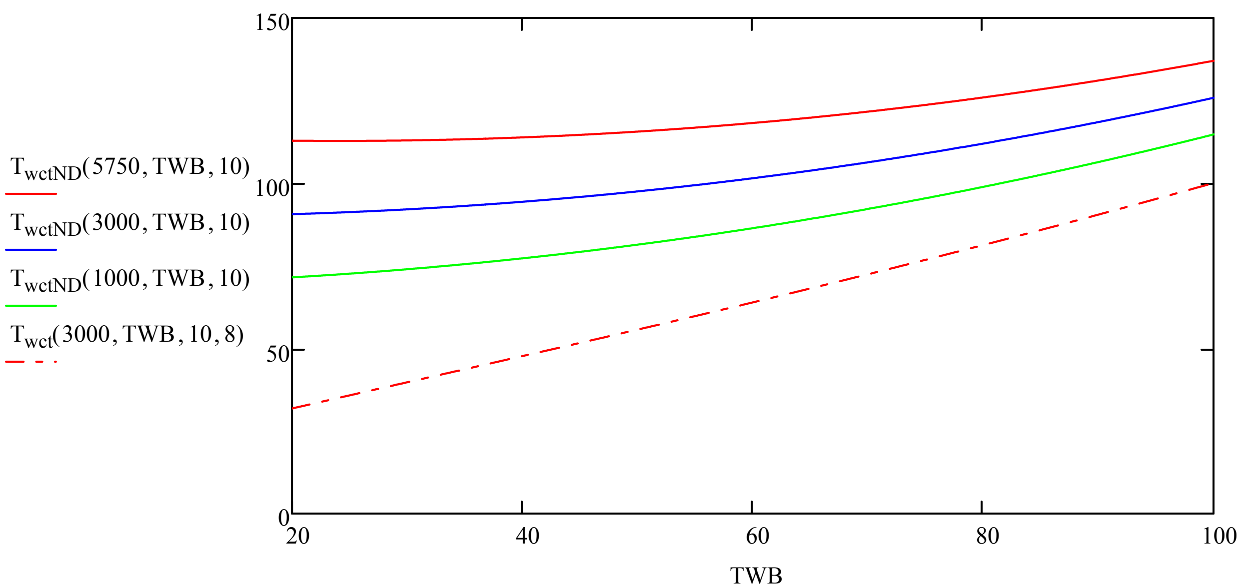
$$Q_{wct}\left(GPM, T_{in}, T_{wb}, WCT_{ND}, NF, CO\right) := \left(1 - WCT_{ND}\right)\cdot Q_{wct}\left(GPM, T_{in}, T_{wb}, NF, CO\right) + WCT_{ND}\cdot Q_{wctND}\left(GPM, T_{in}, T_{wb}\right)$$

Test net operation

$Q_{wct}(GPM, 102, 78, 1, 8, 0) = 40.17 \times 10^{3}$

$Q_{wct}(GPM, 100, 70, 1, 8, 0) = 2.32 \times 10^{6}$

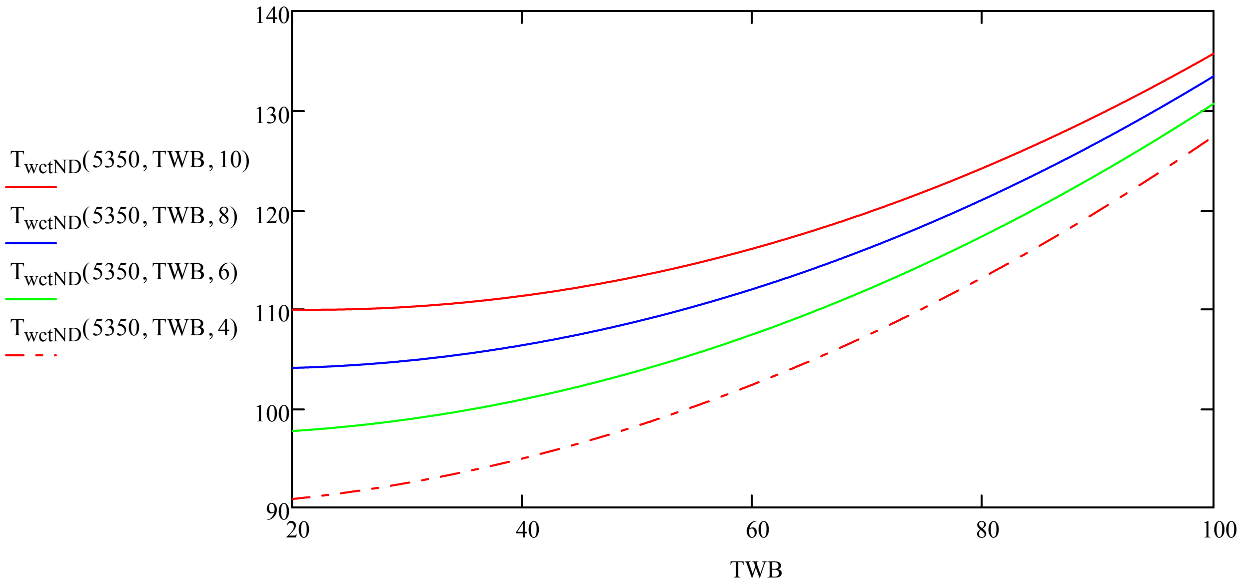
Compare T_out for various flow rates



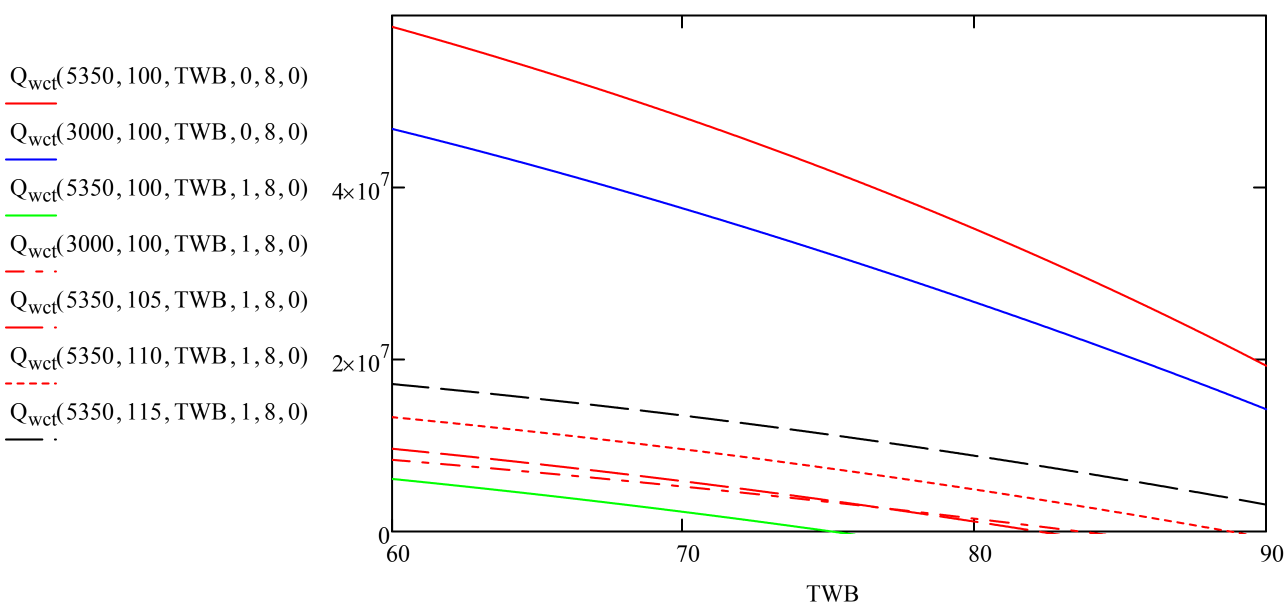
Title: Waterford3 UHS Model

Sheet No: WCT-12 of 14
Wet Cooling Tower Module

Compare T_out for various range



Compare Heat for inlet temps



Title: Waterford3 UHS Model

Sheet No: WCT-13 of 14
Wet Cooling Tower Module

WCT Natural Draft Evaporation Rate

Define a new matrix of natural draft operating data (ND_D) and associated natural draft evaporation rate (ND_E). Performance curve points below [WCT-4, J. Cooper] to match measured performance.

ND_D :=

GPM	Twb	Range
6500	80	10
6500	80	9
6500	80	8
6500	80	7
6500	80	6
6500	80	5
6500	80	4
6500	80	3
5350	80	10
5350	80	9
5350	80	8
5350	80	7
5350	80	6
5350	80	5
5350	80	4
5350	80	3
4200	80	10
4200	80	9
4200	80	8
4200	80	7
4200	80	6
4200	80	5
4200	80	4
4200	80	3
3000	80	10
3000	80	9
3000	80	8
3000	80	7
3000	80	6
3000	80	5
3000	80	4
3000	80	3
6500	75	10
6500	75	9
6500	75	8
6500	75	7
6500	75	6
6500	75	5
6500	75	4
6500	75	3
5350	75	10
5350	75	9
5350	75	8
5350	75	7
5350	75	6
5350	75	5
5350	75	4
5350	75	3
4200	75	10
4200	75	9
4200	75	8
4200	75	7
4200	75	6
4200	75	5
4200	75	4
4200	75	3
3000	75	10
3000	75	9
3000	75	8
3000	75	7
3000	75	6
3000	75	5
3000	75	4
3000	75	3
6500	70	10
6500	70	9
6500	70	8
6500	70	7
6500	70	6
6500	70	5
6500	70	4
6500	70	3
5350	70	10

ND_E :=

EV
53.46
47.83
42.27
36.79
31.36
26.04
20.75
15.51
43.69
39.07
34.59
30.14
25.73
21.37
17.04
12.79
34.26
30.66
27.14
23.66
20.22
16.8
13.43
10.09
24.64
22.08
19.55
17.06
14.6
12.14
9.72
7.33
52.98
47.35
41.78
36.39
31.04
25.66
20.42
15.29
43.25
38.65
34.21
29.72
25.35
21.02
16.76
12.55
33.8
30.27
26.8
23.32
19.9
16.53
13.2
9.93
24.31
21.75
19.27
16.79
14.34
11.94
9.55
7.19
52.46
46.87
41.33
35.97
30.56
25.32
20.11
14.99
42.77

Data Points through 110

ND_D =

	0	1	2
72	5350	70	10
73	5350	70	9
74	5350	70	8
75	5350	70	7
76	5350	70	6
77	5350	70	5
78	5350	70	4
79	5350	70	3
80	4200	70	10
81	4200	70	9
82	4200	70	8
83	4200	70	7
84	4200	70	6
85	4200	70	5
86	4200	70	4
87	4200	70	3
88	3000	70	10
89	3000	70	9
90	3000	70	8
91	3000	70	7
92	3000	70	6
93	3000	70	5
94	3000	70	4
95	3000	70	3
96	1400	80	4
97	1400	80	5
98	1400	80	6
99	1400	80	8
100	1400	80	9
101	1400	80	10
102	1400	80	11
103	1400	80	12
104	1400	80	13
105	1400	80	14
106	1400	80	15
107	1400	80	16
108	1400	80	17
109	1400	80	18
110	1400	80	...

ND_E =

	0
72	42.77
73	38.21
74	33.71
75	29.33
76	25.01
77	20.72
78	16.48
79	12.34
80	33.35
81	29.87
82	26.38
83	22.95
84	19.58
85	16.24
86	12.95
87	9.71
88	23.89
89	21.4
90	18.92
91	16.48
92	14.07
93	11.7
94	9.35
95	7.04
96	4.78
97	5.95
98	8.32
99	9.47
100	10.6
101	11.75
102	12.89
103	14.01
104	15.14
105	16.3
106	17.42
107	18.59
108	19.72
109	20.86
110	...

Test points

$inc := 32 \qquad j := 0..2$

$D1_j := ND\_D_{j \cdot inc, 1}$

$E1_j := ND\_E_{j \cdot inc, 0}$

$D2_j := ND\_D_{j \cdot inc + inc - 8, 1}$

$E2_j := ND\_E_{j \cdot inc + inc - 8, 0}$

$D3 := ND\_D_{101, 1}$

$E3 := ND\_E_{101, 0}$

$$D1 = \begin{pmatrix} 80 \\ 75 \\ 70 \end{pmatrix} \qquad D2 = \begin{pmatrix} 80 \\ 75 \\ 70 \end{pmatrix} \qquad D3 = 80$$

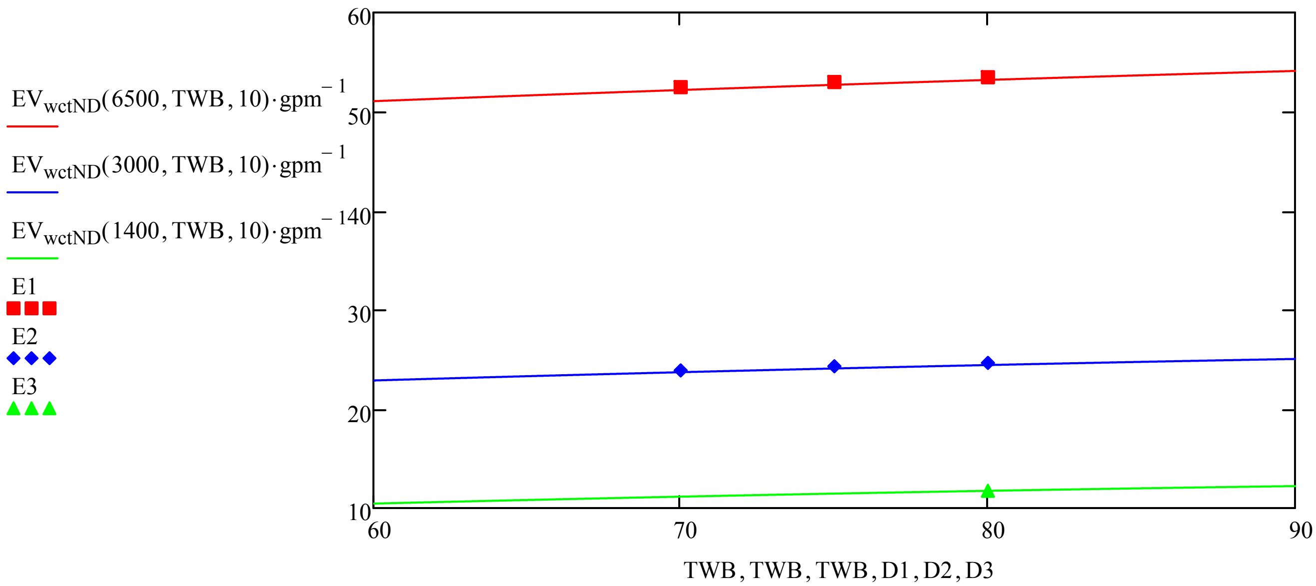
$$E1 = \begin{pmatrix} 53.46 \\ 52.98 \\ 52.46 \end{pmatrix} \qquad E2 = \begin{pmatrix} 24.64 \\ 24.31 \\ 23.89 \end{pmatrix} \qquad E3 = 11.75$$

Define linear regression for evaporation function.

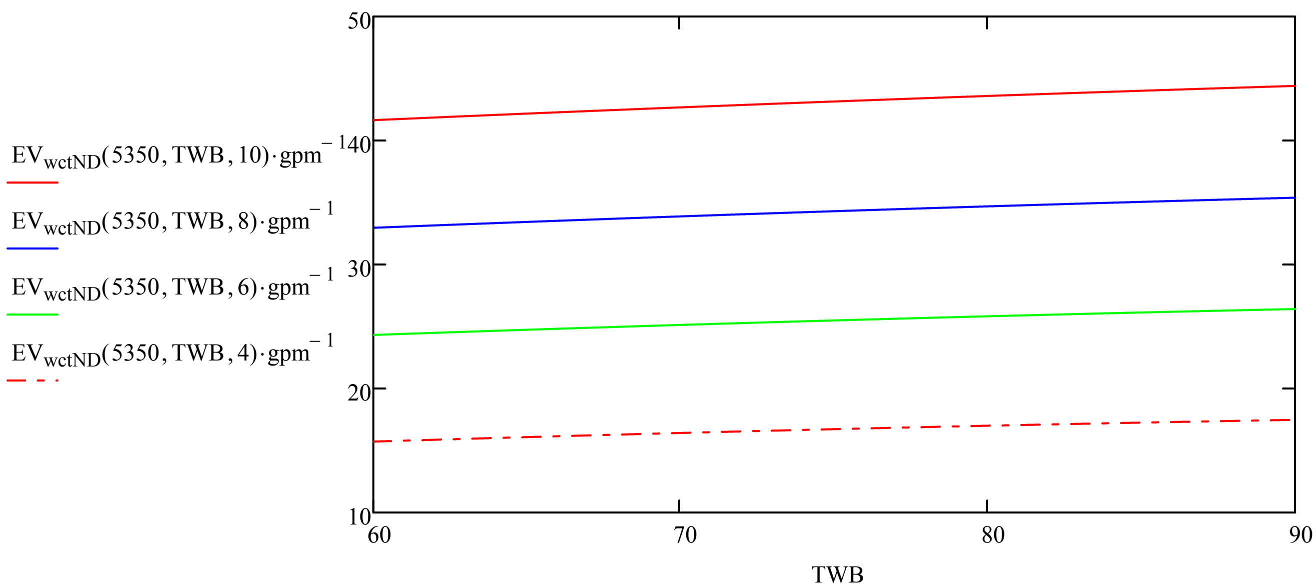
$$Reg_{NDE} := \mathrm{regress}(ND\_D, ND\_E, 2) \qquad EV_{wctND}(GPM, T_{wb}, Rg) := \mathrm{interp}\left[Reg_{NDE}, ND\_D, ND\_E, \begin{pmatrix} GPM \\ T_{wb} \\ Rg \end{pmatrix}\right] \cdot gpm$$

Test function $EV_{wctND}(6500, 80, 10) = 53.2\ gpm$ $\qquad EV_{wctND}(1400, 80, 10) = 11.74\ gpm$

Compare ND Evaporation for various flow rates with data points



Compare ND Evaporation for various ranges



Title: Waterford3 UHS Model

Sheet No: CCWHX-1 of 6
CCWHX Module

CCW Heat Exchanger

This module provides a first principles model of the heat transfer coefficient for a Shell-Tube Heat exchanger using a Taborek/Delaware model for the shell side flows and a Dittus-Boetler relationship for the tube internal flow.

References used in this module:

CCWHX-1 [6a] Ebasco Specification 1564.075R9, "Component Cooling Water Heat Exchangers"
CCWHX-2 [23] Incropera & DeWitt, "Fundamentals of Heat and Mass Transfer", Wiley, 1985.
CCWHX-3 [12] Kreith, "Principles of Heat Transfer", International Textbook, 1965
CCWHX-4 [6i] Specification 5817-10747
CCWHX-5 [6j] Specification 5817-10750

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD R4\Water Properties.xmcdz(R)

Input Data [CCWHX-1]

Shell ID	$D_s := 45in$	baffle gap	$L_{sb} := .375in$
No. of tubes	$N_{tt} := 1276$	bundle gap x 2 sides	$L_{bb} := 1in \cdot 2$
Tube diameter	$D_t := .75in$	baffle tube gap	$L_{tb} := .0156in$
Tube wall thk.	$t_{wall} := .028in$	sealing strips	$N_{ss} := 0$
Effective Tube length	$L_t := 42ft$	bypass width between tubes	$L_{pl} := 0in$
Tube bundle diam thru tube CL	$D_{ctl} := D_s - L_{bb} - D_t$	baffle spacing	$L_{bc} := 92in$
Tube bundle outer diam	$D_{otl} := D_s - L_{bb}$	inlet spacing	$L_{bi} := 114in$
Tube mat'l conductivity	$k_{tube} := 8.70 \cdot \frac{BTU}{hr \cdot ft \cdot R}$	outlet spacing	$L_{bo} := 114in$
Tube spacing CL-CL	$L_{tp} := .9375in$	Number of baffle compartments (baffles +1)	$N_b := 5$
Baffle cut fraction	$B_c := 21.11\%$		
Tube Layout	30 degrees		

User supplied inputs: These terms are variables in the heat transfer function.
Test Data is provided herein to confirm function values

Number of plugged tubes $NP := 63$

	Fouling Factor	Inlet Temperature	Outlet Temperature	Flow Rate
Tube side	$FFI := 0.0 \cdot \frac{hr \cdot ft^2 \cdot R}{BTU}$	$TI_i := 131.11$	$TI_o := 89.3$	$GI := 6882.58$
Shell side	$FFO := 0.00012 \cdot \frac{hr \cdot ft^2 \cdot R}{BTU}$	$TO_i := 115$	$TO_o := 113.77$	$GO := 4490.71$

Average Temperatures $TI := .5 \cdot (TI_i + TI_o)$ $TO := .5 \cdot (TO_i + TO_o)$

Shell-Tube Heat exchanger evaluation using Taborek/Delaware model (HEDH) - per Wolverine Products Databook III
See Attachment C

Baffle Cut Correction

[3.4.5] $\theta_{ctl} := 2\cdot acos\left[\frac{D_s}{D_{ctl}}\cdot(1 - 2\cdot B_c)\right]$ $\theta_{ctl} = 104.04\cdot deg$

[3.4.4] $F_w := \frac{\theta_{ctl}}{360deg} - \frac{\sin(\theta_{ctl})}{2\cdot\pi}$ $F_w = 0.13$

[3.4.3] $F_c := 1 - 2\cdot F_w$

[3.4.2] $J_C := 0.55 + 0.72\cdot F_c$ $J_C = 1.08$ OK, 0.65 < Jc < 1.175

Baffle Leakage Correction

[3.4.12] $\theta_{ds} := 2\cdot acos(1 - 2\cdot B_c)$ $\theta_{ds} = 109.41\cdot deg$

[3.4.11] $S_m := L_{bc}\cdot\left[L_{bb} + \frac{D_{ctl}}{L_{tp}}\cdot(L_{tp} - D_t)\right]$ $S_m = 6.68\ ft^2$

[3.4.10] $S_{tb} := \left[\frac{\pi}{4}\cdot\left[(D_t + L_{tb})^2 - D_t^2\right]\right]\cdot N_{tt}\cdot(1 - F_w)$ $S_{tb} = 0.14\ ft^2$

[3.4.9] $S_{sb} := 0.00436\cdot D_s\cdot L_{sb}\cdot(360deg - \theta_{ds})$ $S_{sb} = 0\ ft^2$

[3.4.8] $r_{lm} := \frac{S_{sb} + S_{tb}}{S_m}$

[3.4.7] $r_s := \frac{S_{sb}}{S_{sb} + S_{tb}}$

[3.4.6] $J_L := 0.44\cdot(1 - r_s) + [1 - 0.44\cdot(1 - r_s)]\cdot e^{-2.2\cdot r_{lm}}$ $J_L = 0.97$

Bundle Bypass Correction

[3.4.17] $N_{tcc} := \frac{D_s}{0.866L_{tp}}\cdot(1 - 2B_c)$

[3.4.16] $r_{ss} := \frac{N_{ss}}{N_{tcc}}$

[3.4.15] $S_b := L_{bc}\cdot[(D_s - D_{otl}) + L_{pl}]$

[3.4.14] $F_{sbp} := \frac{S_b}{S_m}$

$C_{bh} := 1.25$ for turbulent flows

[3.4.13] $J_B := e^{-C_{bh}\cdot F_{sbp}}$ for $r_{ss} = 0$ $J_B = 0.79$

Unequal Baffle Spacing Correction

$n := 0.6$ for turbulent flow

[3.4.18]
$$J_S := \frac{(N_b - 1) + \left(\frac{L_{bi}}{L_{bc}}\right)^{1-n} + \left(\frac{L_{bo}}{L_{bc}}\right)^{1-n}}{(N_b - 1) + \left(\frac{L_{bi}}{L_{bc}}\right) + \left(\frac{L_{bo}}{L_{bc}}\right)}$$
$J_S = 0.95$

Laminar Flow Correction (n/a, flow is turbulent) $J_R := 1$

Wall Viscosity Correction (n/a, temperatures of 2 fluids are very close) $J_\mu := 1$

Ideal Tube Bank HTC Use test shell side (outside) temperature and flows of:

Test function

[3.4.31] $A_o(N_{plug}) := \pi \cdot D_t \cdot L_t \cdot (N_{tt} - N_{plug})$ $A_o(NP) = 10003.2\ ft^2$

[3.4.30] n/a, lookup function used per Kreith Table A-3 [see water properties.xmcdz] $Pr(115) = 3.8$

[3.4.28] $m'(G,T) := \frac{G \cdot gpm \cdot \rho(T)}{S_m}$ $m'(GO,TO) = 92.64\ \frac{lb}{s \cdot ft^2}$

[3.4.29] $Re(G,T) := \frac{D_t \cdot m'(G,T)}{\mu(T)}$ $Re(GO,TO) = 14.718 \times 10^3$

Constants based on Re > 10^4, Table 3.1 (see Attachment C)

$a_1 := 0.321$ $a_2 := -0.388$ $a_3 := 1.450$ $a_4 := 0.519$

[3.4.27] $a(G,T) := \frac{a_3}{1 + 0.14 \cdot Re(G,T)^{a_4}}$ $a(GO,TO) = 0.07$

[3.4.26] $j_I(G,T) := a_1 \cdot \left[\frac{1.33}{\left(\frac{L_{tp}}{D_t}\right)}\right]^{a(G,T)} \cdot Re(G,T)^{a_2}$ $j_I(GO,TO) = 0.01$

[3.4.25] $\alpha_I(G,T) := j_I(G,T) \cdot c_p(T) \cdot m'(G,T) \cdot Pr(T)^{\frac{-2}{3}}$ $\alpha_I(GO,TO) = 1.06 \times 10^3 \cdot \frac{BTU}{hr \cdot ft^2 \cdot F}$

Shell side HTC

[3.4.1] $h_o(G,T) := (J_C \cdot J_L \cdot J_B \cdot J_R \cdot J_S \cdot J_\mu) \cdot \alpha_I(G,T)$ $h_o(GO,TO) = 834 \cdot \frac{BTU}{hr \cdot ft^2 \cdot F}$

Tube side HTC per Incropera [CCWHX-2], Dittus-Boetler equation

Tube internal diameter $ID_t := D_t - 2 \cdot t_{wall}$

Test function

Mass flux, (Att C, Wolverine) [3.4.28]

$$m'_i(G,T,N_{plug}) := \frac{(G \cdot gpm \cdot \rho(T))}{\frac{\pi}{4} \cdot ID_t^2 \cdot (N_{tt} - N_{plug})}$$

$$m'_i(GI,TI,NP) = 297.77 \frac{lb}{s \cdot ft^2}$$

Reynolds number, (Att C, Wolverine) [3.4.29]

$$Re_i(G,T,N_{plug}) := \frac{ID_t \cdot m'_i(G,T,N_{plug})}{\mu(T)}$$

$$Re_i(GI,TI,NP) = 41.973 \times 10^3$$

Dittus-Boetler [CCWHX-2, Incropera, [EQ 8.58]

$$Nu_D(G,T,N_{plug}) := 0.023 \cdot Re_i(G,T,N_{plug})^{\frac{4}{5}} \cdot Pr(T)^{.4}$$

$$Nu_D(GI,TI,NP) = 200.18$$

Note: Dittus-Boetler formulation can be written with Pr^0.3 based on heat direction. The current relationship is maintained based on improved agreement with test data.

$$h_i(G,T,N_{plug}) := \frac{k(T)}{ID_t} \cdot Nu_D(G,T,N_{plug})$$

$$h_i(GI,TI,NP) = 1276.1 \cdot \frac{BTU}{hr \cdot ft^2 \cdot R}$$

Tube internal area with plugging

$$A_i(N_{plug}) := \pi \cdot ID_t \cdot L_t \cdot (N_{tt} - N_{plug})$$

Overall HTC [CCWHX-3, Kreith 11-22]

$$U_{ccwhx}(G_i,G_o,T_i,T_o,ff_i,ff_o,N_{plug}) := \frac{1}{\frac{1}{h_o(G_o,T_o)} + ff_o + \frac{t_{wall}}{k_{tube}} + ff_i \cdot \frac{A_o(N_{plug})}{A_i(N_{plug})} + \frac{A_o(N_{plug})}{h_i(G_i,T_i,N_{plug}) \cdot A_i(N_{plug})}}$$

Test function

$$U_{ccwhx}(GI,GO,TI,TO,FFI,FFO,NP) = 410.8 \cdot \frac{BTU}{hr \cdot ft^2 \cdot F}$$

Log Mean Temp Difference [CCWHX-2, Incropera EQ 11.15, 11.17]

$$LMTD(T1_i,T1_o,T2_i,T2_o) := \frac{(T1_i - T2_o) - (T1_o - T2_i)}{\ln\left[\frac{(T1_i - T2_o)}{(T1_o - T2_i)}\right]}$$

$$LMTD(131F,111F,89F,119F) = 16.5 \cdot F$$

Define heat flow across CCWHx with U defined for average temperature over inlet to outlet, units removed

$$Q_{ccw}(TI_i,TI_o,TO_i,TO_o,GI,GO,ff_i,ff_o,N_{plug}) := A_o(N_{plug}) \cdot U_{ccwhx}\left[GI,GO,\frac{(TI_i + TI_o)}{2},\frac{(TO_i + TO_o)}{2},ff_i,ff_o,N_{plug}\right] \cdot LMTD(TI_i,TI_o,TO$$

(Note: Section terminated by page border) $LMTD(TI_i,TI_o,TO_i,TO_o) \cdot \frac{F \cdot hr}{BTU}$

Test function

$$Q_{ccw}(131.11,115,89.3,113.77,GI,GO,FFI,FFO,NP) = 86.999 \times 10^6$$

Demonstrate Performance
Test CCWHx model results against a range of test conditions

CCWHX_Test :=

CCW	T_in	T_out	ACCW	T_in	T_out	ff	U	Nplug	Ref
6882.6	131.11	115	4490.7	89.3	113.77	0.00159	257.09	63	ECM95-008R3, Att 7.2
6878.4	128	115	4492	91.03	112.14	0.00197	233.9	63	ECM95-008R3, Att 7.2
6545	134.1	114.55	4500	90.41	118.57	0.0008	321.41	64	B Test 12/11/01
6500	100.65	95	4500	87	95.17	0.00114	274.47	63	MNQ9-10 Att 8.5
6500	112.73	105	4500	88	99.19	0.00364	164.66	63	MNQ9-10 Att 8.6
6500	100.16	95	4500	87	94.46	0.00156	246.03	63	MNQ9-10 Att 8.7
6545	134	115	4500	89.31	116.9	0	429	0	Spec 1564.75

$i := 0..6$

$GC := CCWHX\_Test^{\langle 0 \rangle}$ $GA := CCWHX\_Test^{\langle 3 \rangle}$ $FF := CCWHX\_Test^{\langle 6 \rangle} \cdot \left(\frac{hr \cdot ft^2 \cdot F}{BTU}\right)$

$TINC := CCWHX\_Test^{\langle 1 \rangle}$ $TINA := CCWHX\_Test^{\langle 4 \rangle}$ $UCCW := CCWHX\_Test^{\langle 7 \rangle}$

$TOUTC := CCWHX\_Test^{\langle 2 \rangle}$ $TOUTA := CCWHX\_Test^{\langle 5 \rangle}$ $PLUG := CCWHX\_Test^{\langle 8 \rangle}$

$U_{ccwhx}\left[GC_i, GA_i, .5 \cdot \left(TINC_i + TOUTC_i\right), .5\left(TINA_i + TOUTA_i\right), 0, FF_i, PLUG_i\right] =$

$$\begin{pmatrix} 255.56 \\ 232.67 \\ 318.88 \\ 273.44 \\ 164.15 \\ 245.08 \\ 420.8 \end{pmatrix} \cdot \frac{BTU}{hr \cdot ft^2 \cdot F}$$

$$UERR_i := \frac{U_{ccwhx}\left[GC_i, GA_i, .5 \cdot \left(TINC_i + TOUTC_i\right), .5 \cdot \left(TINA_i + TOUTA_i\right), 0, FF_i, PLUG_i\right]}{UCCW_i \cdot \frac{BTU}{hr \cdot ft^2 \cdot F}} - 1$$

$$UERR = \begin{pmatrix} -0.59 \\ -0.53 \\ -0.79 \\ -0.38 \\ -0.31 \\ -0.39 \\ -1.91 \end{pmatrix} \cdot \%$$

$mean(UERR) = -0.699 \cdot \%$

Note: Benchmark results obtained with tubes plugged and fouling factor (ff) as shown in above table.
Input conditions (N_{plug}, ff) in calculations are as specified by user input.

Define equation solution to determine outlet temperatures based on energy balance across HX.

Seed values $TI_o := 120$ $TO_o := .5 \cdot TI_o$ $TI_i = 131.11$

Given

Tube side $Q_{wtr}(GI, TI_i, TI_o) = Q_{ccw}(TI_i, TI_o, TO_i, TO_o, GI, GO, FFI, FFO, NP)$

Shell side $Q_{wtr}(GO, TO_i, TO_o) = -Q_{ccw}(TI_i, TI_o, TO_i, TO_o, GI, GO, FFI, FFO, NP)$

Solve for outlet temperatures

$$TF(TI_i, TO_i, GI, GO, FFI, FFO, NP) := \text{Find}(TI_o, TO_o) \qquad TF(TI_i, TO_i, GI, GO, FFI, FFO, NP) = \begin{pmatrix} 123.41 \\ 126.78 \end{pmatrix}$$

Write general expression for heat transfer based on inlet temperatures

$$QCCW(TI_i, TO_i, GI, GO, FFI, FFO, NP) := Q_{ccw}(TI_i, TF(TI_i, TO_i, GI, GO, FFI, FFO, NP)_0, TO_i, TF(TI_i, TO_i, GI, GO, FFI, FFO, NP)_1, GI,$$

Reproduction of above equation to show terminated section

$$QCCW(TI_{.i}, TO_{.i}, GI, GO, FFI, FFO, NP) := Q_{.ccw}(TI_{.i}, TF(TI_{.i}, TO_{.i}, GI, GO, FFI, FFO, NP)_0, TO_{.i}, TF(TI_{.i}, TO_{.i}, GI, GO, FFI, FFO, NP)_1, GI, GO, FFI, FFO, NP)$$

Title: Waterford3 UHS Model

Sheet No: REC-1 of 4
Recirculation Module

Meterological and Recirculation Effects

This module provides relationships between the dry bulb and wet bulb temperature, humiduty, and wind as dervied from the ststaion MET tower data [5p]. Recirculation properties per [19].

References used in this module:

REC-1, [19] A14386-R-001
REC-2, [5p] WF3-ME-16-00001

Critical Time Period (for evaluation)

$$TC(time) := \begin{cases} (1 \cdot hr) & \text{if } time = 0 \\ (1day) & \text{if } time = 1 \\ (3day) & \text{if } time = 2 \\ (7day) & \text{if } time = 3 \end{cases}$$

Bounding Dry Bulb Temperature as a Function of Critical Time Period

$$TDBMAX(t_{crit}) := \begin{cases} 102 & \text{if } t_{crit} = 1hr \\ 92 & \text{if } t_{crit} = 1day \\ 89 & \text{if } t_{crit} = 3day \\ 86 & \text{if } t_{crit} = 7day \end{cases}$$

Bounding Wind Speed as a Function of Dry Bulb Temperature for Various Critical Time Periods. Includes max wind per [5p] plus 0.4 mph to address NOAA data per [17].

$$WS_{max}(t_{crit}, T_{db}) := \begin{cases} \max\left(0, \min\left(51, -\frac{55}{27} T_{db} + 207.78\right)\right) & \text{if } t_{crit} = 1hr \\ \max\left(0, \min\left(35, -\frac{35}{13} T_{db} + 247.7\right)\right) & \text{if } t_{crit} = 1day \\ \max\left(0, \min\left(23.5, -\frac{22}{8} T_{db} + 246.75\right)\right) & \text{if } t_{crit} = 3day \\ \max(0, \min(14.5, -3T_{db} + 263)) & \text{if } t_{crit} = 7day \end{cases}$$

$$WS_{max}(1hr, 102) = 0$$

Title: Waterford3 UHS Model

Sheet No: REC-2 of 4
Recirculation Module

Bounding Wet Bulb Temperature as a Function of Dry Bulb Temperature for Various Critical Time Periods

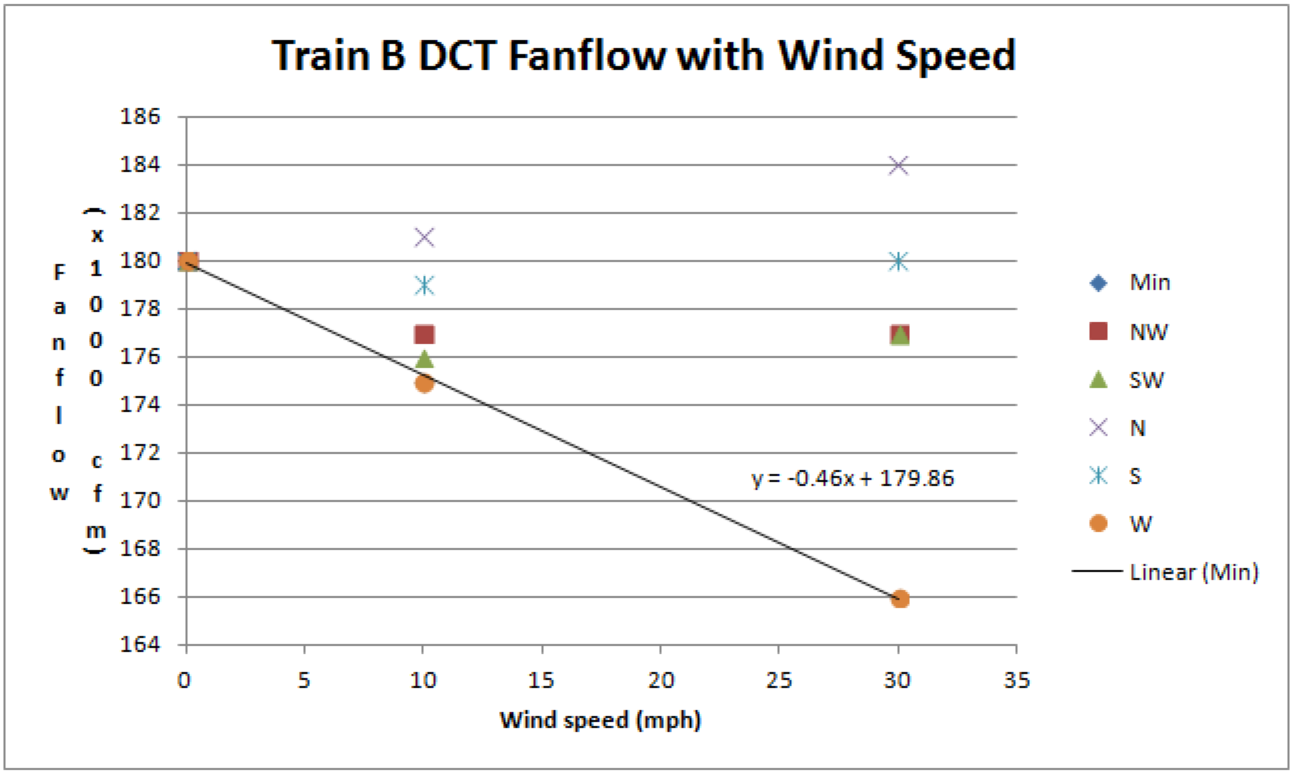
$$
\mathrm{TWBMAX}(t_{crit}, T_{db}) := \begin{cases}
\text{if } t_{crit} = 1\,\mathrm{hr} & \begin{cases} T_{db} & \text{if } T_{db} \le 85 \\ 85 & \text{if } 85 < T_{db} \le 92 \\ -\frac{1}{3}\cdot T_{db} + 115.67 & \text{if } 92 < T_{db} \le 98 \\ -\frac{5}{4} T_{db} + 205.5 & \text{if } 98 < T_{db} \le 102 \\ \min(T_{db}, 85) & \text{otherwise} \end{cases} \\
\text{if } t_{crit} = 1\,\mathrm{day} & \begin{cases} T_{db} & \text{if } T_{db} \le 83 \\ 83 & \text{if } 83 < T_{db} \le 84 \\ -\frac{1}{4}\cdot T_{db} + 104 & \text{if } 84 < T_{db} \le 88 \\ -\frac{5}{4} T_{db} + 192 & \text{if } 88 < T_{db} \le 92 \\ \min(T_{db}, 85) & \text{otherwise} \end{cases} \\
\text{if } t_{crit} = 3\,\mathrm{day} & \begin{cases} T_{db} & \text{if } T_{db} \le 83 \\ 83 & \text{if } 83 < T_{db} \le 84 \\ -\frac{1}{4}\cdot T_{db} + 104 & \text{if } 84 < T_{db} \le 88 \\ -6T_{db} + 610 & \text{if } 88 < T_{db} \le 89 \\ \min(T_{db}, 85) & \text{otherwise} \end{cases} \\
\text{if } t_{crit} = 7\,\mathrm{day} & \begin{cases} T_{db} & \text{if } T_{db} \le 80 \\ \frac{1}{2}\cdot T_{db} + 40 & \text{if } 80 < T_{db} \le 82 \\ 81 & \text{if } 82 < T_{db} \le 85 \\ -3T_{db} + 336 & \text{if } 85 < T_{db} \le 86 \\ \min(T_{db}, 85) & \text{otherwise} \end{cases} \\
\mathrm{NaN} & \text{otherwise}
\end{cases}
$$

$$
\mathrm{TWBMIN}(t_{crit}, T_{db}) := \begin{cases}
T_{db} - 24 & \text{if } t_{crit} = 1\,\mathrm{hr} \\
T_{db} - 15 & \text{if } t_{crit} = 1\,\mathrm{day} \\
T_{db} - 13 & \text{if } t_{crit} = 3\,\mathrm{day} \\
T_{db} - 11 & \text{if } t_{crit} = 7\,\mathrm{day} \\
\mathrm{NaN} & \text{otherwise}
\end{cases}
$$

Title: Waterford3 UHS Model

Sheet No: REC-3 of 4
Recirculation Module

DCT air flow as a function of wind speed. Function added to UHS1. Data shown below.
B Train recirculation in combination with B Train Fan Flow is conservative.



Bounding Recirculation Effect as a Function of Dry Bulb Temperature and Number of Operable Fans for Various Critical Time Periods based on Wind Speed relationship above.

A second order polynomial curve fit is produced with the Mathcad regress and interp functions for the recirculation values determined in WF3-ME-15-00014/A14386-R-001 [19].

$$WS_R := \begin{pmatrix} 0 \\ 10 \\ 30 \end{pmatrix} \qquad T_{R\_DCTA} := \begin{pmatrix} 0 \\ 2.2 \\ 5.6 \end{pmatrix} \qquad T_{R\_DCTB} := \begin{pmatrix} 0.2 \\ 4.7 \\ 7.7 \end{pmatrix}$$

$$COEF_A := \text{regress}\left(WS_R, T_{R\_DCTA}, 2\right) \qquad COEF_B := \text{regress}\left(WS_R, T_{R\_DCTB}, 2\right)$$

$$COEF_A = \begin{pmatrix} 3 \\ 3 \\ 2 \\ 0 \\ 0.24 \\ -0 \end{pmatrix} \qquad COEF_B = \begin{pmatrix} 3 \\ 3 \\ 2 \\ 0.2 \\ 0.55 \\ -0.01 \end{pmatrix}$$

Title: Waterford3 UHS Model

Sheet No: REC-4 of 4
Recirculation Module

$T_{R\_A}(WS) := interp(COEF_A, WS_R, T_{R\_DCTA}, WS)$

$$T_{R\_B}(WS) := \begin{cases} interp(COEF_B, WS_R, T_{R\_DCTB}, WS) & \text{if } WS \le 30 \\ 7.7 & \text{otherwise} \end{cases}$$

$T_{R\_A}(10) = 2.2$

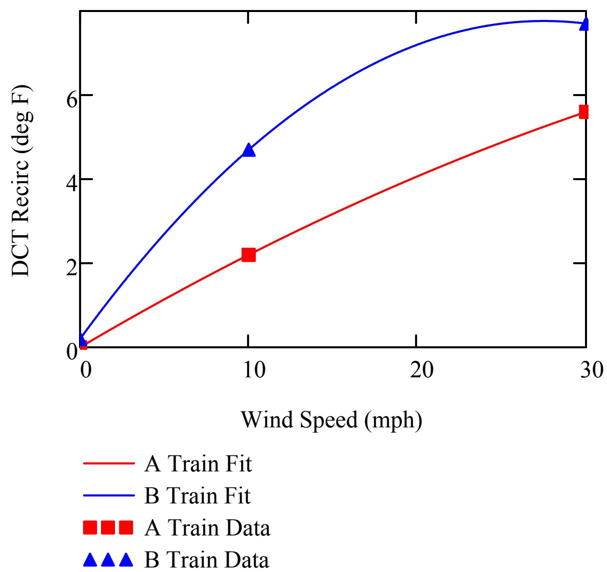
$T_{R\_A}(51) = 7.73$

$T_{R\_B}(0) = 0.2$

$T_{R\_B}(2) = 1.26$

$T_{R\_B}(10) = 4.7$

$T_{R\_B}(28) = 7.76$



The chart shows that the B train recirculation is bounding and should be used in the analysis.

Consider an additional factor to linearly reduce recirculation from a maximum at full heat load to a minimum at 50E6 BTU/hr heat load

$Q_{max} := 161.38 \cdot 10^6$

$Q_{min} := 50 \cdot 10^6$

$$QRF(Q, EVAL) := \begin{cases} \text{if } EVAL < 2 \\ \quad \begin{cases} .00233 \cdot \dfrac{Q}{10^6} + .624 & \text{if } Q \ge 50 \cdot 10^6 \\ 0.74 & \text{if } Q < 50 \cdot 10^6 \end{cases} \\ 1.0 \quad \text{otherwise} \end{cases}$$

$QRF(161.4 \cdot 10^6, 0) = 1$

$QRF(50 \cdot 10^6, 0) = 0.74$

factor between 0 and 74%
(5.7/7.7 = 74%)
to reduce recirc with load

The recirculation from out-of-service fan backflow is added, up to a limit of 3 fans:

$$T_{R\_DCT}(t_{crit}, T_{db}, DCT_{OOS}) := \begin{cases} T_{R\_B}(WS_{max}(t_{crit}, T_{db})) + 3 \cdot DCT_{OOS} & \text{if } DCT_{OOS} \le 3 \\ T_{R\_B}(WS_{max}(t_{crit}, T_{db})) & \text{otherwise} \end{cases}$$

Title: Waterford3 UHS Model

Waterford 3 Ultimate Heat Sink (UHS) Model

This is the base module for a multi-component heat transfer model of the UHS system. The model evaluates temperatures for the closed cooling water (CCW) and Auxiliary Closed Cooling Water (ACCW) loops in an integrated manner with heat transfer at major components. This Mathcad worksheet is formatted to permit user input for analysis type and boundary conditions.

1. Scriptable components are used to enable pull-down menus for user input. The user must select "No", do not disable scriptable components for this worksheet.

2.Separate modules are included to calculate the performance of major system components (DCT, WCT, and CCWHx). The following files are required in the same directory as this input and analysis module:

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\Water Properties.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\LOCA Loads.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\DCT.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\WCT.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\CCWHX.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\Recirc.xmcdz(R)

3. If the worksheet is not set up for automatic calculation, press "F9" to perform evaluation up to the current location.

4. All input fields are highlighted in yellow and can be modified. All non-input fields are protected from edits.

5. All Mathcad default values for array origin (0), convergence and constraint tolerance (0.001), should remain unchanged for appropriate model operation

Verification of Component Modules

Each module is checked to provide acceptable results against benchmark tests. Each of the following checks should produce an "OK" indicating acceptable results from the module.

Check water properties module $\text{if}[\text{checkWP} < (.0001), \text{"OK"}, \text{"Not OK"}] = \text{"OK"}$

Check LOCA Loads function vs data $\text{if}[\,|\text{max}(\text{Diff})| < (.0001), \text{"OK"}, \text{"Not OK"}] = \text{"OK"}$

Check DCT module error < 1.06% $\text{if}(|\text{mean}(\text{DCT\_ER})| < 0.0106, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$

Check WCT module error < 4.9% $\text{if}(|\text{mean}(\text{WCT\_ER})| < 0.049, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$

Check CCWHX module error < 0.5% $\text{if}(|\text{mean}(\text{UERR})| < 0.005, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$

Check Recirc module $\text{if}\left(\text{round}\left(T_{R\_DCT}(1\text{hr}, 102, 0), 10\right) = 0.2012221728, \text{"OK"}, \text{"Not OK"}\right) = \text{"OK"}$

Increase DCT Capacity by 11.95%

$$Q_{dctx}\left(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db}, DCT_{fans}, AIR\right) := 1.1195\, Q_{dctx}\left(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db}, DCT_{fans}, AIR\right)$$

Title: Waterford3 UHS Model

User Input Section

In this section, the type of analysis (LOCA, Shutdown, etc.) and the steady state or transient analysis conditions are selected. Transient analysis conditions are only available for LOCA conditions for which tables of heat loads with time are provided as input. Transient analyses are performed as a series of repeated steady state evaluations to determine long term water consumption over the heat load period.

Type of Analysis

Select options from menus

EVAL :=
- LOCA Cold Leg (RCP) Break
- LOCA Hot Leg Break
- BTP 5.4 Shutdown
- Post Tornado Fixed Loads
- Operating Loads (selected)

time :=
- 1 hour (selected)
- 1 day
- 3 day
- 7 day

$EVAL = 4$

$t_{crit} := TC(time)$

Analysis Boundary Conditions

Type in input value or function for each highlighted field.

Select Default Limits or Enter Values	Default Limits	User Entered
Drybulb Temperature (deg F)	$T_{db} := TDBMAX(t_{crit})$	$T_{db} := 85.87$
DCT Recirculation Temperature Increase (deg F)	$DCT_R := T_{R\_DCT}(t_{crit}, T_{db}, DCT_{OOS})$	$DCT_R := 7.78$
Wetbulb Temperature (deg F) *For conservatism, MAX + max recirc for max heat removal and MIN + 0 for WCT water consumption*	$T_{wb} := \begin{cases} TWBMAX(t_{crit}, T_{db}) + 8.8 & \text{if } t_{crit} = 1hr \\ TWBMIN(t_{crit}, T_{db}) & \text{otherwise} \end{cases}$	$T_{wb} := 77.15 + 2.46$

Resulting Boundary Condition Values

$T_{db} = 85.87$ $\quad DCT_R = 7.8$ $\quad WS_{max}(t_{crit}, T_{db}) = 32.86$ $\quad T_{db} + DCT_R = 93.7$ $\quad T_{wb} = 79.6$

Flow Rates

CCW flow rate (gpm)		$GPM_{ccw} := 6902$
ACCW flow rate (gpm)		$GPM_{accw} := 5324$
CCW Control Temperature (deg F)		$TCW := 112.4$
Number of UHS Loops in Service *Note: N_{UHS}=2 divides loads equally between 2 Loops.*		$N_{UHS} := 1$

DCT/WCT Fan Conditions

Number of DCT fans in service	*Note DCT Recirc is increased for 1-3 fans OOS without covers*	$DCT_{fans} \equiv 15$
Number of DCT OOS without covers	$DCT_{OOS\_noc} \equiv 15 - DCT_{fans}$	$DCT_{OOS} \equiv DCT_{OOS\_noc}$
Number of WCT fans in service		$WCT_{fans} := 8$
Complete WCT cell out of service (4 fans/1 cell)? 1=yes, 0=no	$WCT_{cell\_out} := 0$	
Percentage DCT Area available (95%-100%)		$P_{dct} := 99.75\%$
Average DCT Air Flow (1000 cfm)	$AIR := -0.46 \cdot (WS_{max}(t_{crit}, T_{db})) + 179.86$	$AIR := 177$ $\quad AIR = 177$

Title: Waterford3 UHS Model

Sheet No: 3 of 9

Heat Loads and Options

Type in input value or function for each highlighted field.

Fuel Pool Cooling Loads

Note: FPC transient loads and/or constant values can be included with LOCA and BTP5.4 transients. Constant value FPC loads need to be input for other evaluation conditions.

Include FPC transient loads for LOCA and BTP5.4 — $FP_{sw} :=$ [On / Off] (selected: On)

Constant FP loads (BTU/hr) — $FPC := 0 \cdot 10^6$

Essential Chillers

Essential Chillers heat load (BTU/hr) — $Q_{EC} := 0 \cdot 10^6$

Essential Chiller Flow (gpm) — $GPM_{chill} := 850$

Loop selection switch for EC loads, *select option* — $EC_{sw} :=$ [ACCW Loop / CCW Loop] (selected: ACCW Loop)

if ECsw = 0, ACCW
if ECsw = 1, CCW

Auxiliary Loads

Heat load from EDG, HPSI, LPSI, and Containment Spray (BTU/hr) — $Q_{aux} := (0) \cdot 10^6$

CCW Heat Exchanger

CCWHX Number of plugged tubes — $N_{plug} := 63$

CCWHX Fouling factor, shell side — $ff_o := 0.0001 \cdot \left(hr \cdot ft^2 \cdot F\right) \cdot BTU^{-1}$

CCWHX Fouling factor, tube side — $ff_i := 0.0 \cdot \left(hr \cdot ft^2 \cdot F\right) \cdot BTU^{-1}$

Options for Tornado Analysis

WCT Natural draft mode or normal operation — $WCT_{ND} :=$ [Normal Operation / Natural Draft Mode] (selected: Normal Operation)

Logical switch = 0 for normal, 1 for natural draft

Post-Tornado Analysis Heat Load (BTU/hr) — $Q_{Tor} := (0) \cdot 10^6$

Note: This heat load only used if EVAL=3.

Options for Normal Operation, Heat Load (BTU/Hr) — $Q_{Norm} := (175.89) \cdot 10^6$

Summary of Containment Heat Loads

$$Q_{cont}(Tm,T) := \frac{1}{N_{UHS}} \cdot \begin{cases} Q_{LOCA}(Tm,T,EVAL) + (1 - FP_{sw}) \cdot FPL(Tm) + FPC + Q_{aux} & \text{if } EVAL < 2 \\ Q_{BTP}(Tm) + (1 - FP_{sw}) \cdot FPL(Tm) + FPC + Q_{aux} & \text{if } EVAL = 2 \\ Q_{Tor} + FPC + Q_{aux} & \text{if } EVAL = 3 \\ Q_{Norm} + FPC + Q_{aux} & \text{if } EVAL = 4 \\ Q_{aux} & \text{otherwise} \end{cases}$$

Circuit Model

Determine time of maximum heat load.

$$TT := \begin{cases} Time(EVAL) & \text{if } EVAL < 2 \\ TTT & \text{if } EVAL = 2 \\ 0 & \text{otherwise} \end{cases} \qquad time := \begin{cases} Time\_max(EVAL) & \text{if } EVAL < 2 \\ t_{BTPMAX} & \text{if } EVAL = 2 \\ 0 & \text{otherwise} \end{cases}$$

Check

$time = 0$

$Q_{cont}(time, TCW) = 175.89 \times 10^{6}$

Note: This containment load is approximate based on selected TCW.

Initial seed values, over-written by calculated temperatures and flows

$Tccw\_out := TCW$

$Tcon\_out := 165.01$

$Tdct\_in := 165.02$

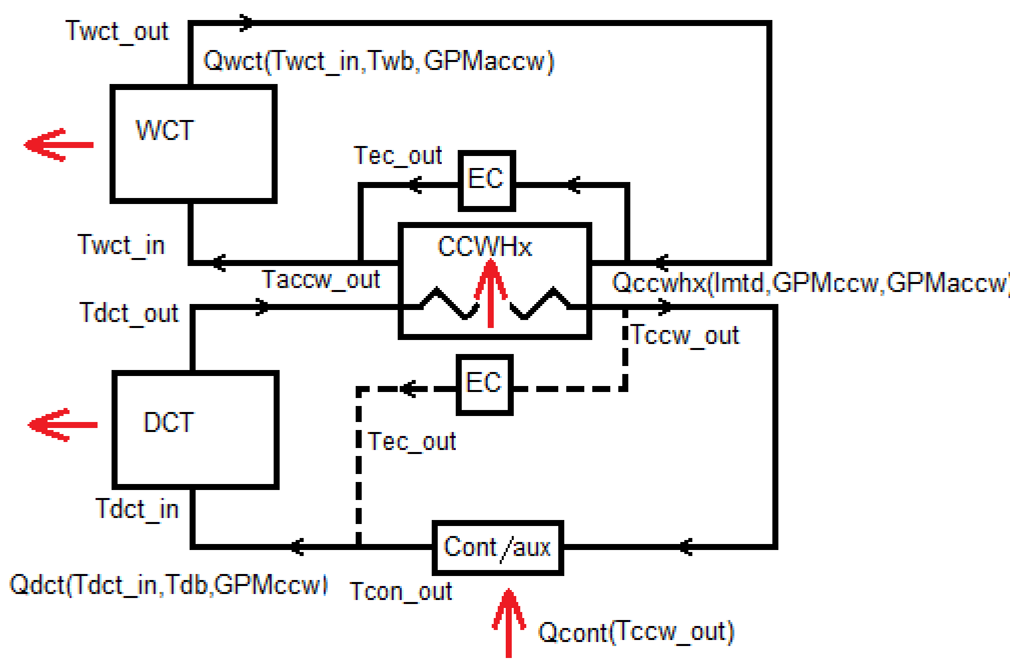
$Tdct\_out := 125.01$

$Taccw\_out := 115.01$

$Tec\_out := 100$

$Twct\_in := 105.01$

$$Twct\_out := \begin{cases} 110 & \text{if } EVAL = 3 \\ T_{wb} + .1 & \text{otherwise} \end{cases}$$



Title: Waterford3 UHS Model

Calculate Conditions based on fixed ACCW flow

Given

1) Heat in from Containment increases CCW temp

$$Q_{cont}(time, Tccw\_out) = Q_{wtr}\left(GPM_{ccw} - GPM_{chill} \cdot EC_{sw}, Tcon\_out, Tccw\_out\right)$$

2) DCT discharges heat and reduces CCW with added DCT recirc

$$Q_{dctx}\left(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(time, Tccw\_out), EVAL\right), DCT_{fans}, AIR\right) = Q_{wtr}\left(GPM_{ccw}, Tdct\_in, Tdct\_out\right)$$

3) CCW Hx discharges from ccw

$$Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] = Q_{wtr}\left(GPM_{ccw}, Tdct\_out, Tccw\_out\right)$$

4) CCW Hx adds heat to accw

$$Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] \ldots = 0$$
$$+ -Q_{wtr}\left[GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), Taccw\_out, Twct\_out\right]$$

5-7) EC Heat is added to either wct_out or ccw_out based on ECsw = 0 (ACCW) or 1 (CCW)

$$\frac{Q_{EC}}{N_{UHS}} = Q_{wtr}\left(GPM_{chill}, Tec\_out, Twct\_out\right) \cdot \left(1 - EC_{sw}\right) + Q_{wtr}\left(GPM_{chill}, Tec\_out, Tccw\_out\right) \cdot \left(EC_{sw}\right)$$

$$GPM_{accw} \cdot Twct\_in = GPM_{chill} \cdot Tec\_out \cdot \left(1 - EC_{sw}\right) + \left[GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right)\right] \cdot Taccw\_out$$

$$GPM_{ccw} \cdot Tdct\_in = GPM_{chill} \cdot Tec\_out \cdot EC_{sw} + \left[GPM_{ccw} - GPM_{chill} \cdot \left(EC_{sw}\right)\right] \cdot Tcon\_out$$

8) WCT discharges heat

$$Q_{wct}\left(GPM_{accw}, Twct\_in, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}\right) = Q_{wtr}\left(GPM_{accw}, Twct\_in, Twct\_out\right)$$

$$R1\left(time, EC_{sw}\right) := Find(Tccw\_out, Tdct\_in, Tdct\_out, Taccw\_out, Twct\_in, Twct\_out, Tec\_out, Tcon\_out)$$

$$A := R1\left(time, EC_{sw}\right)$$

Title: Waterford3 UHS Model

Sheet No: 6 of 9

Calculate Conditions based on fixed CCW return temperature:

$TCW = 112.4$ $EVAL = 4$

Given

1) Heat in from Containment increases CCW temp

$$Q_{cont}(time, TCW) = Q_{wtr}(GPM_{ccw} - GPM_{chill} \cdot EC_{sw}, Tcon\_out, TCW)$$

2) DCT discharges heat and reduces CCW with added DCT recirc

$$Q_{dctx}(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF(Q_{cont}(time, TCW), EVAL), DCT_{fans}, AIR) = Q_{wtr}(GPM_{ccw}, Tdct\_in, Tdct\_out)$$

3) CCW Hx discharges from ccw

$$Q_{ccw}\left[Tdct\_out, TCW, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}\right] = Q_{wtr}(GPM_{ccw}, Tdct\_out, TCW)$$

4) CCW Hx adds heat to accw

$$Q_{ccw}\left[Tdct\_out, TCW, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}\right] \ldots = 0$$
$$+ -Q_{wtr}\left[GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), Taccw\_out, Twct\_out\right]$$

5-7) EC Heat is added to either wct_out or ccw_out based on ECsw = 0 (ACCW) or 1 (CCW)

$$\frac{Q_{EC}}{N_{UHS}} = Q_{wtr}(GPM_{chill}, Tec\_out, Twct\_out) \cdot (1 - EC_{sw}) + Q_{wtr}(GPM_{chill}, Tec\_out, TCW) \cdot (EC_{sw})$$

$$GPM_{accw} \cdot Twct\_in = GPM_{chill} \cdot Tec\_out \cdot (1 - EC_{sw}) + \left[GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw})\right] \cdot Taccw\_out$$

$$GPM_{ccw} \cdot Tdct\_in = GPM_{chill} \cdot Tec\_out \cdot EC_{sw} + \left[GPM_{ccw} - GPM_{chill} \cdot (EC_{sw})\right] \cdot Tcon\_out$$

8) WCT discharges heat

$$Q_{wct}(GPM_{accw}, Twct\_in, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}) = Q_{wtr}(GPM_{accw}, Twct\_in, Twct\_out)$$

$$R2(time, EC_{sw}) := Find(GPM_{accw}, Tdct\_in, Tdct\_out, Taccw\_out, Twct\_in, Twct\_out, Tec\_out, Tcon\_out)$$

Provide Result Sets for 2 Calculations (LOCA, BTP5.4 only)

$$B := \begin{cases} A & \text{if } EVAL > 2 \\ A & \text{if } A_0 > TCW \\ R2(time, EC_{sw}) & \text{otherwise} \end{cases}$$

$$X := \begin{cases} A & \text{if } B_0 \ge GPM_{accw} \\ B & \text{otherwise} \end{cases}$$

$$A = \begin{pmatrix} 103.71 \\ 155.3 \\ 117.47 \\ 109.11 \\ 105.73 \\ 87.9 \\ 87.9 \\ 155.3 \end{pmatrix} \qquad B = \begin{pmatrix} 103.71 \\ 155.3 \\ 117.47 \\ 109.11 \\ 105.73 \\ 87.9 \\ 87.9 \\ 155.3 \end{pmatrix}$$

Title: Waterford3 UHS Model

Sheet No: 7 of 9

Determine Tccw_out and GPMaccw from results

$$\text{Tccw\_out} := \begin{cases} X_0 & \text{if } X = A \\ \text{TCW} & \text{otherwise} \end{cases} \qquad GPM_{accw} := \begin{cases} \min(B_0, GPM_{accw}) & \text{if } (EVAL < 3) \wedge B_0 \neq A_0 \\ GPM_{accw} & \text{otherwise} \end{cases}$$

$\text{Tccw\_out} = 103.71$ $\quad GPM_{accw} = 5324$ $\quad T_{db} = 85.87$ $\quad T_{wb} = 79.61$

Final Result Set

$$X = \begin{pmatrix} 103.7 \\ 155.3 \\ 117.5 \\ 109.1 \\ 105.7 \\ 87.9 \\ 87.9 \\ 155.3 \end{pmatrix}$$

0 Tccw_out or GPM_accw
1 Tdct_in
2 Tdct_out
3 Taccw_out
4 Twct_in
5 Twct_out
6 Tec_out
7 Tcon_out

$\text{Tdct\_in} := X_1$

$\text{Tdct\_out} := X_2$

$\text{Taccw\_out} := X_3$

$\text{Twct\_in} := X_4$

$\text{Twct\_out} := X_5$

$\text{Tec\_out} := X_6$

$\text{Tcon\_out} := X_7$

Check heat flows

Heat Load $QC := Q_{cont}(\text{time}, \text{Tccw\_out})$ $\qquad QC = 175.89 \times 10^6$

DCT $QD := Q_{dctx}\left(P_{dct}, GPM_{ccw}, \text{Tdct\_in}, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(\text{time}, TCW), EVAL\right), DCT_{fans}, AIR\right)$ $\qquad QD = 128.72 \times 10^6$

CCWHX $QCW := Q_{ccw}\left[\text{Tdct\_out}, \text{Tccw\_out}, \text{Twct\_out}, \text{Taccw\_out}, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right]$

$QCW = 47.1 \times 10^6$

EC Load $QE := Q_{wtr}\left[GPM_{chill}, \text{Tec\_out}, \text{Twct\_out} \cdot \left(1 - EC_{sw}\right) + \text{Tccw\_out} \cdot EC_{sw}\right]$ $\qquad QE = 0 \times 10^0$

WCT $QW := Q_{wct}\left(GPM_{accw}, \text{Twct\_in}, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}\right)$ $\qquad QW = 47.1 \times 10^6$

Error Check - CCW Loop

$$\frac{\begin{bmatrix} Q_{cont}(\text{time}, \text{Tccw\_out}) + Q_{EC} \cdot EC_{sw} \ldots \\ + -1 \cdot Q_{dctx}\left(P_{dct}, GPM_{ccw}, \text{Tdct\_in}, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(\text{time}, \text{Tccw\_out}), EVAL\right), DCT_{fans}, AIR\right) \ldots \\ + -1 \cdot Q_{ccw}\left[\text{Tdct\_out}, \text{Tccw\_out}, \text{Twct\_out}, \text{Taccw\_out}, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] \end{bmatrix}}{Q_{cont}(\text{time}, \text{Tccw\_out})} = 0.04 \cdot \%$$

Error Check - ACCW Loop

$$\frac{\begin{bmatrix} Q_{ccw}\left[\text{Tdct\_out}, \text{Tccw\_out}, \text{Twct\_out}, \text{Taccw\_out}, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] \ldots \\ + Q_{EC} \cdot \left(1 - EC_{sw}\right) - Q_{wct}\left(GPM_{accw}, \text{Twct\_in}, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}\right) \end{bmatrix}}{Q_{ccw}\left[\text{Tdct\_out}, \text{Tccw\_out}, \text{Twct\_out}, \text{Taccw\_out}, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right]} = -0.004 \cdot \%$$

WCT water loss

Inlet enthalpy $h_i := h(T_{wb})$ $h_i = 43.26$ at $T_{wb} = 79.61$

Range $Range := Twct\_in - Twct\_out$ $Range = 17.82$

Outlet enthalpy $h_e := LG(GPM_{accw} \cdot gpm) \cdot Range + h_i$ $h_e = 67.81$ at $LG(GPM_{accw} \cdot gpm) = 1.377$

Evaporative loss (WCT fans on)

$$EV(GPM_{accw}, h_e, T_{db}, T_{wb}) = 1.26 \cdot \frac{gal}{sec}$$

Check air exit conditions

$W(Temp(h_e), 100\%) = 0.04$ $Temp(h_e) = 97.75$

Drift loss $DL(G) := .001 \cdot G$ $DL(GPM_{accw} \cdot gpm) = 0.09 \cdot \frac{gal}{sec}$

Hourly rate (WCT fans on or off)

$$WCT_{use} := \left[(1 - WCT_{ND}) \cdot EV(GPM_{accw}, h_e, T_{db}, T_{wb}) + WCT_{ND} \cdot EV_{wctND}(GPM_{accw}, T_{wb}, Range) \ldots \atop + DL(GPM_{accw} \cdot gpm) \right]$$

$$\boxed{WCT_{use} = 4847.8 \cdot \frac{gal}{hr}}$$

Repeat WCT water loss calculation for only EC loads, i.e. after ACCW isolation, using WCT pool temp

Given $Q_{EC} = Q_{wtr}(GPM_{chill}, Twct\_in, Twct\_out)$ $TWCT := Find(Twct\_in)$ $TWCT = 87.9$

Range $R_{EC} := TWCT - Twct\_out$ $R_{EC} = 0$

Outlet enthalpy $h_{e\_EC} := LG(GPM_{chill} \cdot gpm) \cdot R_{EC} + h_i$ $h_{e\_EC} = 43.26$ $h_i = 43.26$

Evaporative and Drift loss $EV_{chill\_1} := (EV(GPM_{chill}, h_{e\_EC}, T_{db}, T_{wb}) + DL(GPM_{chill} \cdot gpm))$ $EV_{chill\_1} = 395.88 \cdot \frac{gal}{hr}$

Repeat WCT water loss calculation for only EC loads, i.e. after ACCW isolation, using WCT pool temp with **WCT fans off**

Given $Q_{EC} = Q_{wtr}(GPM_{chill}, Twct\_in, Twct\_out)$ $TWCT := Find(Twct\_in)$ $TWCT = 87.9$

Range $R_{EC} := TWCT - Twct\_out$ $R_{EC} = 0$

Evaporative and Drift loss $EV_{chill\_2} := (EV_{wctND}(GPM_{chill}, T_{wb}, R_{EC}) + DL(GPM_{chill} \cdot gpm))$ $EV_{chill\_2} = 139.63 \cdot \frac{gal}{hr}$

Title: Waterford3 UHS Model **Sheet No:** 9 of 9

Provide table of conditions/settings

$$SET1 := \begin{pmatrix} EVAL & \frac{t_{crit}}{hr} & T_{db} & DCT_R & T_{wb} & GPM_{ccw} & GPM_{accw} & TCW & N_{UHS} & DCT_{fans} \\ WCT_{fans} & P_{dct} & AIR & FP_{sw} & FPC & Q_{EC} & GPM_{chill} & EC_{sw} & Q_{aux} & N_{plug} \\ \frac{ff_o \cdot 1000BTU}{hr \cdot ft^2 \cdot R} & WCT_{ND} & Q_{Tor} & Q_{Norm} & Q_{cont}(time, TCW) & Tccw\_out & Tdct\_in & Tdct\_out & Taccw\_out & Twct\_in \\ Twct\_out & Tec\_out & Tcon\_out & QC & QD & QCW & QE & QW & WCT_{use} \cdot \frac{hr}{gal} & EV_{chill\_2} \cdot \frac{hr}{gal} \end{pmatrix}$$

SET1 =

	0	1	2	3	4	5	6	7	8	9
0	4	1	85.87	7.78	79.61	6902	5324	112.4	1	15
1	8	1	177	0	0	0	850	0	0	63
2	0.1	0	0	$1.76 \cdot 10^8$	$1.76 \cdot 10^8$	103.71	155.3	117.47	109.11	105.73
3	87.9	87.9	155.3	$1.76 \cdot 10^8$	$1.29 \cdot 10^8$	$4.71 \cdot 10^7$	0	$4.71 \cdot 10^7$	4847.79	139.63

WCT Water Loss Model (LOCA-BTP5.4)

Waterford 3 Ultimate Heat Sink (UHS) Model

This is the base module for a multi-component heat transfer model of the UHS system. The model evaluates temperatures for the closed cooling water (CCW) and Auxiliary Closed Cooling Water (ACCW) loops in an integrated manner with heat transfer at major components. This Mathcad worksheet is formatted to permit user input for analysis type and boundary conditions.

1. Scriptable components are used to enable pull-down menus for user input. The user must select "No", do not disable scriptable components for this worksheet.

2.Separate modules are included to calculate the performance of major system components (DCT, WCT, and CCWHx). The following files are required in the same directory as this input and analysis module:

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\Water Properties.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\LOCA Loads.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\DCT.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\WCT.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\CCWHX.xmcdz(R)

Reference:C:\Users\GZysk\Documents\016 Projects\A16197 Waterford UHS Design 2\OUT\MCAD update\Recirc.xmcdz(R)

3. If the worksheet is not set up for automatic calculation, press "F9" to perform evaluation up to the current location.

4. All input fields are highlighted in yellow and can be modified. All non-input fields are protected from edits.

5. All Mathcad default values for array origin (0), convergence and constraint tolerance (0.001), should remain unchanged for appropriate model operation

Verification of Component Modules

Each module is checked to provide acceptable results against benchmark tests. Each of the following checks should produce an "OK" indicating acceptable results from the module.

Check water properties module $\text{if}[\text{checkWP} < (.0001), \text{"OK"}, \text{"Not OK"}] = \text{"OK"}$

Check LOCA Loads function vs data $\text{if}[|\text{max}(\text{Diff})| < (.0001), \text{"OK"}, \text{"Not OK"}] = \text{"OK"}$

Check DCT module error < 1.06% $\text{if}(|\text{mean}(\text{DCT\_ER})| < 0.0106, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$

Check WCT module error < 4.9% $\text{if}(|\text{mean}(\text{WCT\_ER})| < 0.049, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$

Check CCWHX module error < 0.5% $\text{if}(|\text{mean}(\text{UERR})| < 0.005, \text{"OK"}, \text{"Not OK"}) = \text{"OK"}$

Check Recirc module $\text{if}\left(\text{round}\left(T_{R\_DCT}(1\text{hr}, 102, 0), 10\right) = 0.2012221728, \text{"OK"}, \text{"Not OK"}\right) = \text{"OK"}$

User Input Section

In this section, the type of analysis (LOCA, Shutdown, etc.) and the steady state or transient analysis conditions are selected. Transient analysis conditions are only available for LOCA conditions for which tables of heat loads with time are provided as input. Transient analyses are performed as a series of repeated steady state evaluations to determine long term water consumption over the heat load period.

Type of Analysis

Select options from menus

EVAL :=
- LOCA Cold Leg (RCP) Break (selected)
- LOCA Hot Leg Break
- BTP 5.4 Shutdown
- Post Tornado Fixed Loads
- Operating Loads

time :=
- 1 hour (selected)
- 1 day
- 3 day
- 7 day

$EVAL = 0$

$t_{crit} := TC(time)$

Analysis Boundary Conditions

Type in input value or function for each highlighted field.

Select Default Limits or Enter Values	Default Limits	User Entered
Drybulb Temperature (deg F)	$T_{db} := TDBMAX(t_{crit})$	$T_{db} := T_{db}$
DCT Recirculation Temperature Increase (deg F)	$DCT_R := T_{R\_DCT}(t_{crit}, T_{db}, DCT_{OOS})$	$DCT_R := DCT_R$
Wetbulb Temperature (deg F) *For conservatism, MAX + max recirc for max heat removal and MIN + 0 for WCT water consumption*	$T_{wb} := \begin{cases} TWBMAX(t_{crit}, T_{db}) + 8.8 & \text{if } t_{crit} = 1hr \\ TWBMIN(t_{crit}, T_{db}) & \text{otherwise} \end{cases}$	$T_{wb} := T_{wb}$

Resulting Boundary Condition Values

$T_{db} = 102$ $DCT_R = 0.2$ $WS_{max}(t_{crit}, T_{db}) = 0$ $T_{db} + DCT_R = 102.2$ $T_{wb} = 86.8$

Flow Rates

CCW flow rate (gpm)	$GPM_{ccw} := 6900$
ACCW flow rate (gpm)	$GPM_{accw} := 5350$
CCW Control Temperature (deg F)	$TCW := 112.4$
Number of UHS Loops in Service *Note: N_{UHS}=2 divides loads equally between 2 Loops.*	$N_{UHS} := 1$

DCT/WCT Fan Conditions

Number of DCT fans in service *Note DCT Recirc is increased for 1-3 fans OOS without covers* $DCT_{fans} \equiv 15$

Number of DCT OOS without covers $DCT_{OOS\_noc} \equiv 15 - DCT_{fans}$ $DCT_{OOS} \equiv DCT_{OOS\_noc}$

Number of WCT fans in service $WCT_{fans} := 8$

Complete WCT cell out of service (4 fans/1 cell)? 1=yes, 0=no $WCT_{cell\_out} := 0$

Percentage DCT Area available (95%-100%) $P_{dct} := 99.75\%$

Average DCT Air Flow (1000 cfm) $AIR := -0.46 \cdot (WS_{max}(t_{crit}, T_{db})) + 179.86$ $AIR := AIR$ $AIR = 179.9$

Heat Loads and Options

Type in input value or function for each highlighted field.

Fuel Pool Cooling Loads

Note: FPC transient loads and/or constant values can be included with LOCA and BTP5.4 transients. Constant value FPC loads need to be input for other evaluation conditions.

Include FPC transient loads for LOCA and BTP5.4 — $FP_{sw} :=$ On / Off (selected: On)

Constant FP loads (BTU/hr) — $FPC := 0 \cdot 10^6$

Essential Chillers

Essential Chillers heat load (BTU/hr) — $Q_{EC} := 5.1 \cdot 10^6$

Essential Chiller Flow (gpm) — $GPM_{chill} := 850$

Loop selection switch for EC loads, *select option* — $EC_{sw} :=$ ACCW Loop / CCW Loop (selected: ACCW Loop)

if ECsw = 0, ACCW
if ECsw = 1, CCW

Auxiliary Loads

Heat load from EDG, HPSI, LPSI, and Containment Spray (BTU/hr) — $Q_{aux} := (10) \cdot 10^6$

CCW Heat Exchanger

CCWHX Number of plugged tubes — $N_{plug} := 63$

CCWHX Fouling factor, shell side — $ff_o := 0.0012 \cdot (hr \cdot ft^2 \cdot F) \cdot BTU^{-1}$

CCWHX Fouling factor, tube side — $ff_i := 0.0 \cdot (hr \cdot ft^2 \cdot F) \cdot BTU^{-1}$

Options for Tornado Analysis

WCT Natural draft mode or normal operation — $WCT_{ND} :=$ Normal Operation / Natural Draft Mode (selected: Normal Operation)

Logical switch = 0 for normal, 1 for natural draft

Post-Tornado Analysis Heat Load (BTU/hr) — $Q_{Tor} := (0) \cdot 10^6$

Note: This heat load only used if EVAL=3.

Options for Normal Operation, Heat Load (BTU/Hr) — $Q_{Norm} := (0) \cdot 10^6$

Summary of Containment Heat Loads

$$Q_{cont}(Tm,T) := \frac{1}{N_{UHS}} \cdot \begin{cases} Q_{LOCA}(Tm,T,EVAL) + (1-FP_{sw})\cdot FPL(Tm) + FPC + Q_{aux} & \text{if } EVAL < 2 \\ Q_{BTP}(Tm) + (1-FP_{sw})\cdot FPL(Tm) + FPC + Q_{aux} & \text{if } EVAL = 2 \\ Q_{Tor} + FPC + Q_{aux} & \text{if } EVAL = 3 \\ Q_{Norm} + FPC + Q_{aux} & \text{if } EVAL = 4 \\ Q_{aux} & \text{otherwise} \end{cases}$$

Circuit Model

Determine time of maximum heat load.

$$TT := \begin{cases} Time(EVAL) & \text{if } EVAL < 2 \\ TTT & \text{if } EVAL = 2 \\ 0 & \text{otherwise} \end{cases}$$

$$time := \begin{cases} Time\_max(EVAL) & \text{if } EVAL < 2 \\ t_{BTPMAX} & \text{if } EVAL = 2 \\ 0 & \text{otherwise} \end{cases}$$

Check

$time = 3254.44$

$Q_{cont}(time, TCW) = 161.65 \times 10^6$

Note: This containment load is approximate based on selected TCW.

Initial seed values, over-written by calculated temperatures and flows

Tccw_out := TCW

Tcon_out := 165.01

Tdct_in := 165.02

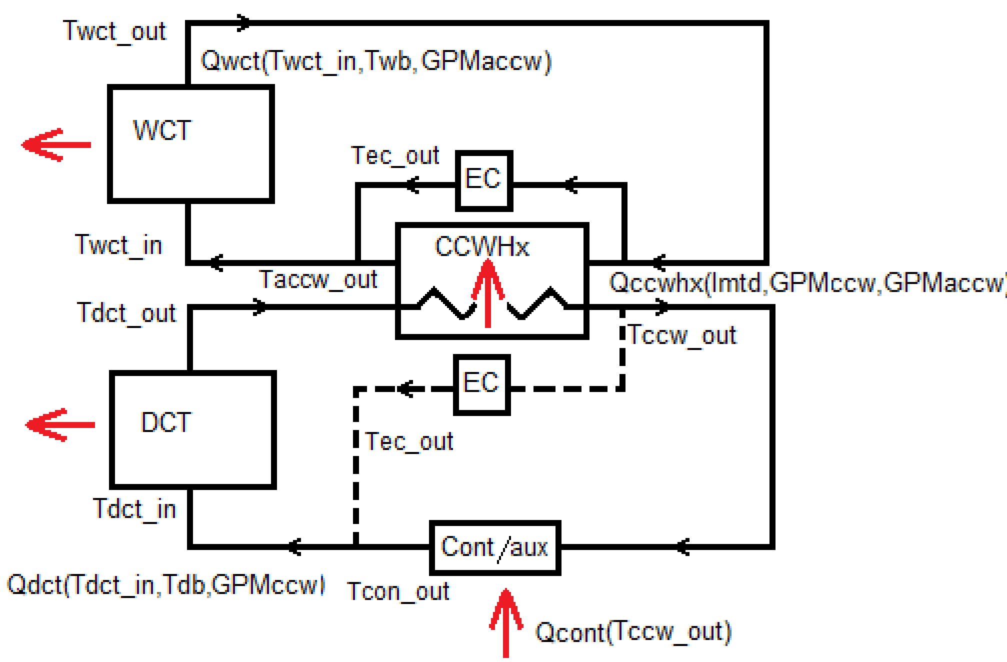
Tdct_out := 125.01

Taccw_out := 115.01

Tec_out := 100

Twct_in := 105.01

$$Twct\_out := \begin{cases} 110 & \text{if } EVAL = 3 \\ T_{wb} + .1 & \text{otherwise} \end{cases}$$



Title: Waterford3 UHS Model **Sheet No:** 5 of 9

Calculate Conditions based on fixed ACCW flow

Given

1) Heat in from Containment increases CCW temp

$$Q_{cont}(time, Tccw\_out) = Q_{wtr}\left(GPM_{ccw} - GPM_{chill} \cdot EC_{sw}, Tcon\_out, Tccw\_out\right)$$

2) DCT discharges heat and reduces CCW with added DCT recirc

$$Q_{dctx}\left(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF\left(Q_{cont}(time, Tccw\_out), EVAL\right), DCT_{fans}, AIR\right) = Q_{wtr}\left(GPM_{ccw}, Tdct\_in, Tdct\_out\right)$$

3) CCW Hx discharges from ccw

$$Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] = Q_{wtr}\left(GPM_{ccw}, Tdct\_out, Tccw\_out\right)$$

4) CCW Hx adds heat to accw

$$Q_{ccw}\left[Tdct\_out, Tccw\_out, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), ff_i, ff_o, N_{plug}\right] \ldots = 0$$
$$+ -Q_{wtr}\left[GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right), Taccw\_out, Twct\_out\right]$$

5-7) EC Heat is added to either wct_out or ccw_out based on ECsw = 0 (ACCW) or 1 (CCW)

$$\frac{Q_{EC}}{N_{UHS}} = Q_{wtr}\left(GPM_{chill}, Tec\_out, Twct\_out\right) \cdot \left(1 - EC_{sw}\right) + Q_{wtr}\left(GPM_{chill}, Tec\_out, Tccw\_out\right) \cdot \left(EC_{sw}\right)$$

$$GPM_{accw} \cdot Twct\_in = GPM_{chill} \cdot Tec\_out \cdot \left(1 - EC_{sw}\right) + \left[GPM_{accw} - GPM_{chill} \cdot \left(1 - EC_{sw}\right)\right] \cdot Taccw\_out$$

$$GPM_{ccw} \cdot Tdct\_in = GPM_{chill} \cdot Tec\_out \cdot EC_{sw} + \left[GPM_{ccw} - GPM_{chill} \cdot \left(EC_{sw}\right)\right] \cdot Tcon\_out$$

8) WCT discharges heat

$$Q_{wct}\left(GPM_{accw}, Twct\_in, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}\right) = Q_{wtr}\left(GPM_{accw}, Twct\_in, Twct\_out\right)$$

$$R1\left(time, EC_{sw}\right) := Find(Tccw\_out, Tdct\_in, Tdct\_out, Taccw\_out, Twct\_in, Twct\_out, Tec\_out, Tcon\_out)$$

$$A := R1\left(time, EC_{sw}\right)$$

Title: Waterford3 UHS Model

Calculate Conditions based on fixed CCW return temperature:

$TCW = 112.4$ $EVAL = 0$

Given

1) Heat in from Containment increases CCW temp

$$Q_{cont}(time, TCW) = Q_{wtr}(GPM_{ccw} - GPM_{chill} \cdot EC_{sw}, Tcon\_out, TCW)$$

2) DCT discharges heat and reduces CCW with added DCT recirc

$$Q_{dctx}(P_{dct}, GPM_{ccw}, Tdct\_in, T_{db} + DCT_R \cdot QRF(Q_{cont}(time, TCW), EVAL), DCT_{fans}, AIR) = Q_{wtr}(GPM_{ccw}, Tdct\_in, Tdct\_out)$$

3) CCW Hx discharges from ccw

$$Q_{ccw}\left[Tdct\_out, TCW, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}\right] = Q_{wtr}(GPM_{ccw}, Tdct\_out, TCW)$$

4) CCW Hx adds heat to accw

$$Q_{ccw}\left[Tdct\_out, TCW, Twct\_out, Taccw\_out, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}\right] \ldots = 0$$
$$+ -Q_{wtr}\left[GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), Taccw\_out, Twct\_out\right]$$

5-7) EC Heat is added to either wct_out or ccw_out based on ECsw = 0 (ACCW) or 1 (CCW)

$$\frac{Q_{EC}}{N_{UHS}} = Q_{wtr}(GPM_{chill}, Tec\_out, Twct\_out) \cdot (1 - EC_{sw}) + Q_{wtr}(GPM_{chill}, Tec\_out, TCW) \cdot (EC_{sw})$$

$$GPM_{accw} \cdot Twct\_in = GPM_{chill} \cdot Tec\_out \cdot (1 - EC_{sw}) + \left[GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw})\right] \cdot Taccw\_out$$

$$GPM_{ccw} \cdot Tdct\_in = GPM_{chill} \cdot Tec\_out \cdot EC_{sw} + \left[GPM_{ccw} - GPM_{chill} \cdot (EC_{sw})\right] \cdot Tcon\_out$$

8) WCT discharges heat

$$Q_{wct}(GPM_{accw}, Twct\_in, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}) = Q_{wtr}(GPM_{accw}, Twct\_in, Twct\_out)$$

$$R2(time, EC_{sw}) := Find(GPM_{accw}, Tdct\_in, Tdct\_out, Taccw\_out, Twct\_in, Twct\_out, Tec\_out, Tcon\_out)$$

Provide Result Sets for 2 Calculations (LOCA, BTP5.4 only)

$$B := \begin{cases} A & \text{if } EVAL > 2 \\ A & \text{if } A_0 > TCW \\ R2(time, EC_{sw}) & \text{otherwise} \end{cases}$$

$$X := \begin{cases} A & \text{if } B_0 \geq GPM_{accw} \\ B & \text{otherwise} \end{cases}$$

$$A = \begin{pmatrix} 114.49 \\ 161.2 \\ 128.63 \\ 115.15 \\ 113.63 \\ 93.52 \\ 105.61 \\ 161.2 \end{pmatrix} \qquad B = \begin{pmatrix} 114.49 \\ 161.2 \\ 128.63 \\ 115.15 \\ 113.63 \\ 93.52 \\ 105.61 \\ 161.2 \end{pmatrix}$$

Determine Tccw_out and GPMaccw from results

$$\text{Tccw\_out} := \begin{cases} X_0 & \text{if } X = A \\ \text{TCW} & \text{otherwise} \end{cases} \qquad GPM_{accw} := \begin{cases} \min(B_0, GPM_{accw}) & \text{if } (EVAL < 3) \wedge B_0 \neq A_0 \\ GPM_{accw} & \text{otherwise} \end{cases}$$

$\text{Tccw\_out} = 114.49$ $\quad GPM_{accw} = 5350$ $\quad T_{db} = 102$ $\quad T_{wb} = 86.8$

Final Result Set

$$X = \begin{pmatrix} 114.5 \\ 161.2 \\ 128.6 \\ 115.1 \\ 113.6 \\ 93.5 \\ 105.6 \\ 161.2 \end{pmatrix}$$

0 Tccw_out or GPM_accw
1 Tdct_in
2 Tdct_out
3 Taccw_out
4 Twct_in
5 Twct_out
6 Tec_out
7 Tcon_out

$\text{Tdct\_in} := X_1$
$\text{Tdct\_out} := X_2$
$\text{Taccw\_out} := X_3$
$\text{Twct\_in} := X_4$
$\text{Twct\_out} := X_5$
$\text{Tec\_out} := X_6$
$\text{Tcon\_out} := X_7$

Check heat flows

Heat Load $QC := Q_{cont}(\text{time}, \text{Tccw\_out})$ $\quad QC = 158.83 \times 10^6$

DCT $QD := Q_{dctx}(P_{dct}, GPM_{ccw}, \text{Tdct\_in}, T_{db} + DCT_R \cdot QRF(Q_{cont}(\text{time}, TCW), EVAL), DCT_{fans}, AIR)$ $\quad QD = 110.5 \times 10^6$

CCWHX $QCW := Q_{ccw}[\text{Tdct\_out}, \text{Tccw\_out}, \text{Twct\_out}, \text{Taccw\_out}, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}]$

$QCW = 48.29 \times 10^6$

EC Load $QE := Q_{wtr}[GPM_{chill}, \text{Tec\_out}, \text{Twct\_out} \cdot (1 - EC_{sw}) + \text{Tccw\_out} \cdot EC_{sw}]$ $\quad QE = 5.1 \times 10^6$

WCT $QW := Q_{wct}(GPM_{accw}, \text{Twct\_in}, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out})$ $\quad QW = 53.39 \times 10^6$

Error Check - CCW Loop

$$\frac{\begin{bmatrix} Q_{cont}(\text{time}, \text{Tccw\_out}) + Q_{EC} \cdot EC_{sw} \ldots \\ + -1 \cdot Q_{dctx}(P_{dct}, GPM_{ccw}, \text{Tdct\_in}, T_{db} + DCT_R \cdot QRF(Q_{cont}(\text{time}, \text{Tccw\_out}), EVAL), DCT_{fans}, AIR) \ldots \\ + -1 \cdot Q_{ccw}[\text{Tdct\_out}, \text{Tccw\_out}, \text{Twct\_out}, \text{Taccw\_out}, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}] \end{bmatrix}}{Q_{cont}(\text{time}, \text{Tccw\_out})} = 0.028 \cdot \%$$

Error Check - ACCW Loop

$$\frac{\begin{bmatrix} Q_{ccw}[\text{Tdct\_out}, \text{Tccw\_out}, \text{Twct\_out}, \text{Taccw\_out}, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}] \ldots \\ + Q_{EC} \cdot (1 - EC_{sw}) - Q_{wct}(GPM_{accw}, \text{Twct\_in}, T_{wb}, WCT_{ND}, WCT_{fans}, WCT_{cell\_out}) \end{bmatrix}}{Q_{ccw}[\text{Tdct\_out}, \text{Tccw\_out}, \text{Twct\_out}, \text{Taccw\_out}, GPM_{ccw}, GPM_{accw} - GPM_{chill} \cdot (1 - EC_{sw}), ff_i, ff_o, N_{plug}]} = -0.003 \cdot \%$$

Title: Waterford3 UHS Model

WCT water loss

Inlet enthalpy $h_i := h(T_{wb})$ $h_i = 51.67$ at $T_{wb} = 86.8$

Range $Range := Twct\_in - Twct\_out$ $Range = 20.11$

Outlet enthalpy $h_e := LG(GPM_{accw} \cdot gpm) \cdot Range + h_i$ $h_e = 79.5$ at $LG(GPM_{accw} \cdot gpm) = 1.384$

Evaporative loss (WCT fans on)

$EV(GPM_{accw}, h_e, T_{db}, T_{wb}) = 1.59 \cdot \frac{gal}{sec}$

Check air exit conditions

$W(Temp(h_e), 100\%) = 0.049$ $Temp(h_e) = 104.09$

Drift loss $DL(G) := .001 \cdot G$ $DL(GPM_{accw} \cdot gpm) = 0.09 \cdot \frac{gal}{sec}$

Hourly rate (WCT fans on or off)

$$WCT_{use} := \left[(1 - WCT_{ND}) \cdot EV(GPM_{accw}, h_e, T_{db}, T_{wb}) + WCT_{ND} \cdot EV_{wctND}(GPM_{accw}, T_{wb}, Range) \ldots \atop + DL(GPM_{accw} \cdot gpm) \right]$$

$$\boxed{WCT_{use} = 6058.6 \cdot \frac{gal}{hr}}$$

Repeat WCT water loss calculation for only EC loads, i.e. after ACCW isolation, using WCT pool temp

Given $Q_{EC} = Q_{wtr}(GPM_{chill}, Twct\_in, Twct\_out)$ $TWCT := Find(Twct\_in)$ $TWCT = 105.61$

Range $R_{EC} := TWCT - Twct\_out$ $R_{EC} = 12.09$

Outlet enthalpy $h_{e\_EC} := LG(GPM_{chill} \cdot gpm) \cdot R_{EC} + h_i$ $h_{e\_EC} = 54.33$ $h_i = 51.67$

Evaporative and Drift loss $EV_{chill\_1} := (EV(GPM_{chill}, h_{e\_EC}, T_{db}, T_{wb}) + DL(GPM_{chill} \cdot gpm))$ $EV_{chill\_1} = 1347.52 \cdot \frac{gal}{hr}$

Repeat WCT water loss calculation for only EC loads, i.e. after ACCW isolation, using WCT pool temp with **WCT fans off**

Given $Q_{EC} = Q_{wtr}(GPM_{chill}, Twct\_in, Twct\_out)$ $TWCT := Find(Twct\_in)$ $TWCT = 105.61$

Range $R_{EC} := TWCT - Twct\_out$ $R_{EC} = 12.09$

Evaporative and Drift loss $EV_{chill\_2} := (EV_{wctND}(GPM_{chill}, T_{wb}, R_{EC}) + DL(GPM_{chill} \cdot gpm))$ $EV_{chill\_2} = 603.03 \cdot \frac{gal}{hr}$

Title: Waterford3 UHS Model **Sheet No:** 9 of 9

Provide table of conditions/settings

$$SET1 := \begin{pmatrix} EVAL & \frac{t_{crit}}{hr} & T_{db} & DCT_R & T_{wb} & GPM_{ccw} & GPM_{accw} & TCW & N_{UHS} & DCT_{fans} \\ WCT_{fans} & P_{dct} & AIR & FP_{sw} & FPC & Q_{EC} & GPM_{chill} & EC_{sw} & Q_{aux} & N_{plug} \\ \frac{ff_o \cdot 1000BTU}{hr \cdot ft^2 \cdot R} & WCT_{ND} & Q_{Tor} & Q_{Norm} & Q_{cont}(time, TCW) & Tccw\_out & Tdct\_in & Tdct\_out & Taccw\_out & Twct\_in \\ Twct\_out & Tec\_out & Tcon\_out & QC & QD & QCW & QE & QW & WCT_{use} \cdot \frac{hr}{gal} & EV_{chill\_2} \cdot \frac{hr}{gal} \end{pmatrix}$$

SET1 =

	0	1	2	3	4	5	6	7	8	9
0	0	1	102	0.2	86.8	6900	5350	112.4	1	15
1	8	1	179.86	0	0	$5.1\cdot10^6$	850	0	$1\cdot10^7$	63
2	1.2	0	0	0	$1.62\cdot10^8$	114.49	161.2	128.63	115.15	113.63
3	93.52	105.61	161.2	$1.59\cdot10^8$	$1.1\cdot10^8$	$4.83\cdot10^7$	$5.1\cdot10^6$	$5.34\cdot10^7$	6058.57	603.03

▶ WCT Water Loss Model (LOCA-BTP5.4)

Attachment B: Benchmark Test Data

DCT Curve Data [8a]

Attachment 8: Letter from John Cooper, P.E., Dated May 3, 2012

TIME-AVERAGED AUGUST 19, 1982 DCT TEST DATA (10:00 – 10:30)

The time averaged test data acquired for the A-train DCT on August 19, 1982 are listed below:

DCT Water Flow Rate: Flow = 6,900 gpm
DCT Entering Water Temperature: HWT = 152.48°F
DCT Leaving Water Temperature: CWT = 115.94°F
DCT Range: HWT – CWT = 36.54°F
DCT Heat Rejection: Q = 125,417,000 Btu/hr
DCT Inlet Dry Bulb Temperature: DBT_{inlet} = 93.65°F
Ambient Dry Bulb Temperature: $DBT_{ambient}$ = 85.87°F
Recirculation Rate: $DBT_{inlet} - DBT_{ambient}$ = 93.65 – 85.87 = 7.78°F

DCT PERFORMANCE CURVE CROSS-PLOTS AT 6,000 GPM

With reference to Figure 1, the cross-plot values and associated regression equations are given below:

DBT	Range	CWT	
70	26.7	87.2	
80	26.7	97.0	
90	26.7	106.8	
85.87	26.7	102.75	CWT = 0.98(DBT) + 18.6

DBT	Range	CWT	
70	33.3	91.1	
80	33.3	101.0	
90	33.3	111.0	
85.87	33.3	106.87	CWT = 0.995(DBT) + 21.433

DBT	Range	CWT	
70	40.0	95.2	
80	40.0	105.2	
90	40.0	115.0	
85.87	40.0	110.94	CWT = 0.99(DBT) + 25.933

DCT PERFORMANCE CURVE CROSS-PLOTS AT 6,500 GPM

With reference to Figure 2, the cross-plot values and associated regression equations are given below:

DBT	Range	CWT	
70	30.8	93.0	
80	30.8	103.1	
90	30.8	113.0	
85.87	30.8	108.903	CWT = DBT + 23.033

DBT	Range	CWT	
70	36.9	98.0	
80	36.9	108.1	
90	36.9	118.1	
85.87	36.9	113.966	CWT = 1.005(DBT) + 27.666

DBT	Range	CWT	
70	43.1	102.3	
80	43.1	112.3	
90	43.1	122.3	
85.87	43.1	118.17	CWT = DBT + 32.3

DCT PERFORMANCE CURVE CROSS-PLOTS AT 7,500 GPM

With reference to Figure 3, the cross-plot values and associated regression equations are given below:

DBT	Range	CWT	
70	32.0	100.0	
80	32.0	110.1	
90	32.0	119.8	
85.87	32.0	115.78	CWT = 0.99(DBT) + 30.766

DBT	Range	CWT	
70	37.3	105.1	
80	37.3	115.5	
90	37.3	125.0	
85.87	37.3	121.04	CWT = 0.995(DBT) + 35.6

DBT	Range	CWT	
70	42.7	110.3	
80	42.7	120.8	
90	42.7	130.1	
85.87	42.7	126.21	CWT = 0.99(DBT) + 41.2

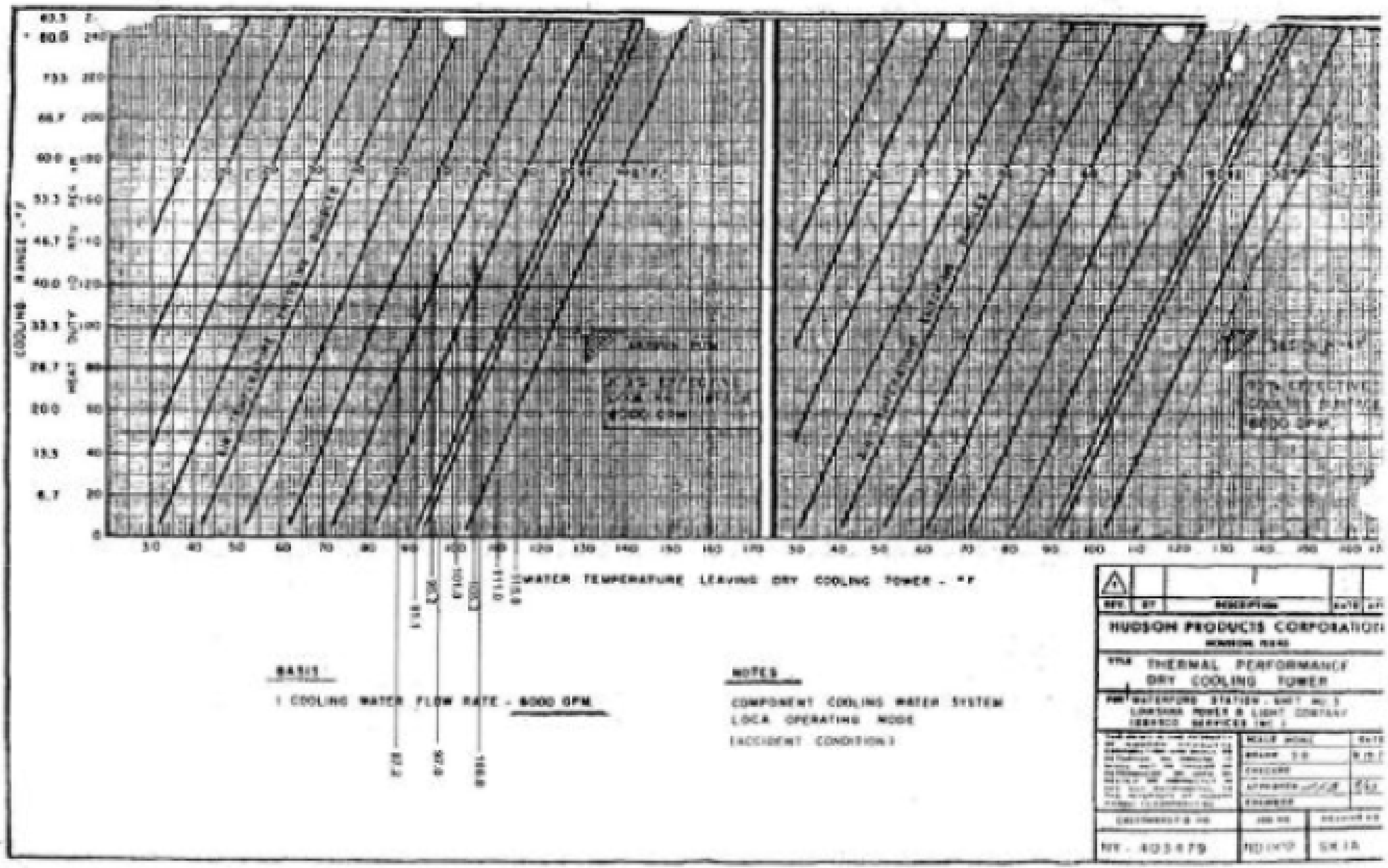


Figure 1 DCT Thermal Performance Curve Cross-Plot at 6,000 gpm

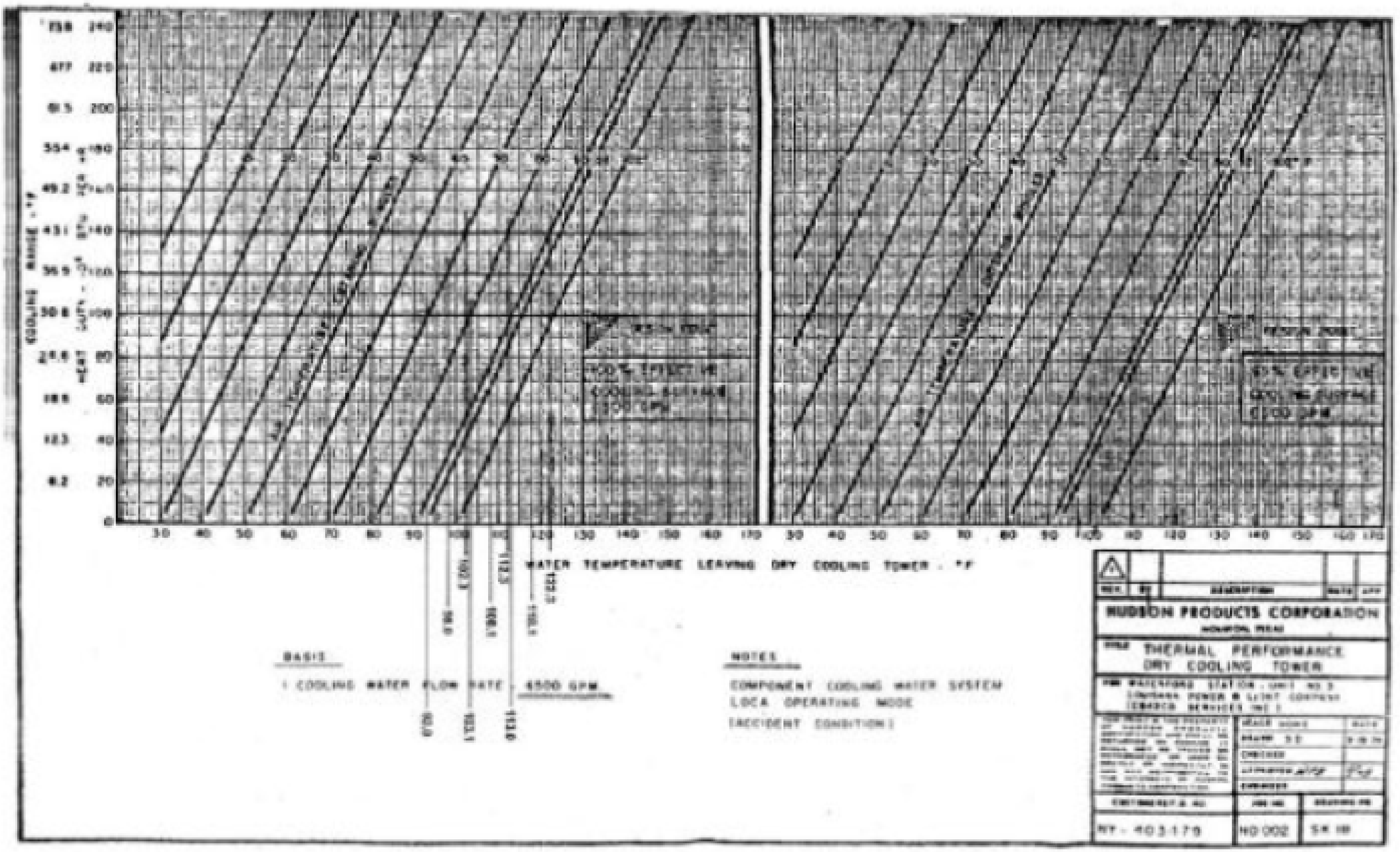


Figure 2 DCT Thermal Performance Curve Cross-Plot at 6,500 gpm

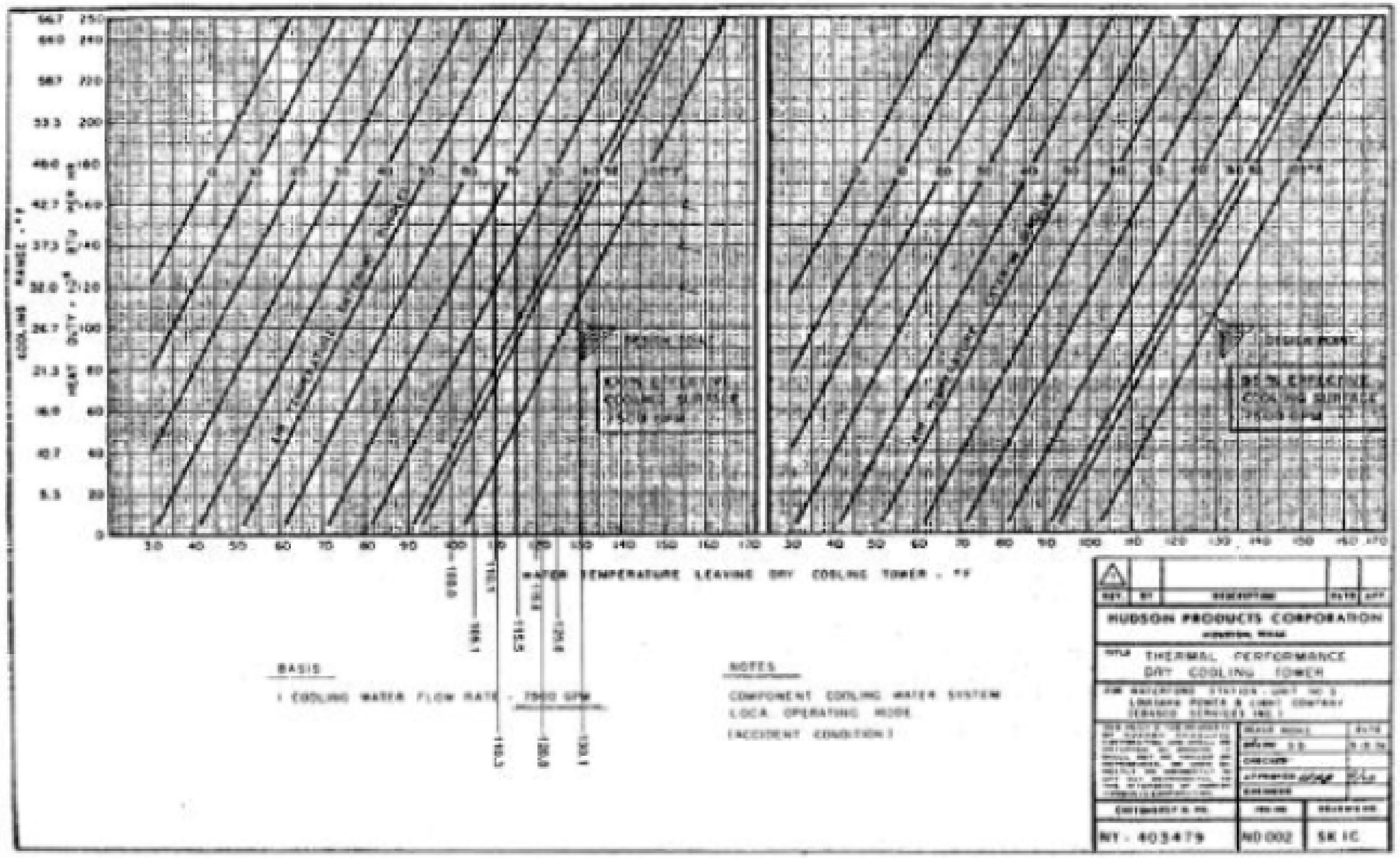


Figure 3 DCT Thermal Performance Curve Cross-Plot at 7,500 gpm

WCT Test Data

WCB 5/8/98 [7a]

TABLE 1.0 SUMMARY OF WCT "B" TEST DATA

THERMAL PERFORMANCE PARAMETER	THERMAL DESIGN CONDITIONS	MAY 8, 1998 TEST CONDITIONS
Water Flow Rate (gpm)	6500	6386.7
Hot Water Temperature	102.3°F	96.24°F
Cold Water Temperature	90.0°F	83.15°F
Cooling Range	12.3°F	13.09°F
Wet Bulb Temperature	83.0°F	71.10°
Approach Temperature	7.0°F	12.05°F
Motor Output Power	28.8 BHP	22.5 BHP

WCA 5/12/1998 [7b]

TABLE 1.0 SUMMARY OF WCT "A" TEST DATA

THERMAL PERFORMANCE PARAMETER	THERMAL DESIGN CONDITIONS	MAY 12, 1998 TEST CONDITIONS
Water Flow Rate (gpm)	6500	6019.82
Hot Water Temperature	102.3°F	92.95°F
Cold Water Temperature	90.0°F	81.77°F
Cooling Range	12.3°F	11.18°F
Wet Bulb Temperature	83.0°F	71.73°
Approach Temperature	7.0°F	10.04°F
Motor Output Power	28.8 BHP	15.5 BHP

WCA 4/10/2000 [7c]

WATERFORD 3 WET COOLING TOWER 'A' THERMAL PERFORMANCE TEST April 10, 2000

	DESIGN POINT	TEST CONDITIONS
WATER FLOW	6,500 gpm	6656.53 gpm
HWT	102.3°F	86.37°F
CWT	90°F	75.36 °F
WBT	83°F	62.34 °F
RANGE	12.3°F	11.01 °F
APPROACH	7.0°F	13.02 °F
FAN MOTOR OUTPUT	28.8 BHP	25.33 BHP

WCB 12/11/01 [7d]

B Wet Cooling Tower Test Date 12/11/01

Test Conditions Summary

	Design Conditions	Test Conditions
Flow	6500 gpm	6254 gpm
Hot water Temp	102.3 F	84.73 F
Cold Water Temp	90.0 F	72.46 F
Wet Bulb	83.0 F	56.0 F
Range	12.3 F	12.27 F
Approach	7.0 F	16.46 F
Fan HP	28.8 HP	26.86 HP
Heat load (million btu/hr)	40	38.4

WCB 12/10/08 [7e]

1.0 Test Conditions Summary

	Design	Test
Flow (gpm)	6,500	5976.39
Hot Water Temperature (F)	102.3	84.54
Cold Water Temperature (F)	90	70.44
Wet Bulb Temperature (F)	83	51.76
Cooling Range (F)	12.3	14.10
Approach (F)	7	18.68
Fan BHP (hp)	28.8	26.36
Heat Load ($x10^6$ BTU/hr)	40	42.03 (approximate)

3/31/09 PE-004-033 [7f]

1.0 Test Conditions Summary

	Design	Test
Flow (gpm)	6,500	6419.13
Hot Water Temperature (F)	102.3	86.96
Cold Water Temperature (F)	90	75.26
Wet Bulb Temperature (F)	83	62.18
Cooling Range (F)	12.3	11.70
Approach (F)	7	13.09
Fan BHP (hp)	28.8	25.0*
Heat Load ($x10^6$ BTU/hr)	40	37.5 (approximate)

CCW Test Data

1. ECM 95-008 Att. 7.2 (1 of 2) [5a]

ENTERGY	WATERFORD 3 DESIGN ENGINEERING	ECM95-008 Rev. 3 Attachment 7.2 Page 4 of 6

********** STER - 5.04 **********

Shell and Tube Heat Exchanger Rating Program

This computer code is validated under Holtec International's QA program.

File Name: WTFRDCCW.EQP
Unit Name: CCMHX0001A&B
Unit Description: CCW Heat Exchangers

This report was created Monday, November 07, 2005 at 1:03:03 PM

***** PERFORMANCE TEST MODE RESULTS *****

TEST ID: 102/78
DATE: 11-07-05
PROCEDURE: EC-M95-008
CONVERGENCE TOLERANCE: 0.05 %

PARAMETER	TUBE SIDE	SHELL SIDE
Mass Flow Rate [1000 lbm/hr]:	3396.78	2237.68
Volume Flow Rate [gpm]:	6882.58	4490.71
Inlet Temperature [degrees F]:	131.11	89.30
Outlet Temperature [degrees F]:	115.00	113.77
Fouling Factor [1/Btu/hr/sqft/F]:	0.00000	0.00159
Operating Pressure [psig]:	0.00	0.00
Heat Transfer Coeff [Btu/hr/sqft/F]:	1302.72	838.20
Pressure Drop [psi]:	3.07	3.24
Velocity [ft/sec]:	4.80	
Reynolds Number:	47325	14021

Total Heat Duty:	54,635,891 Btu/hr
Log Mean Temperature Difference:	21.25 F
Overall Heat Transfer Coefficient:	257.09 Btu/hr/sqft/F
Corrected LMTD:	21.25 F
Effective Surface Area per Shell:	10002.93 sq ft

Reference Temperature [F]:	123.055	101.535
Density [lbm/cu.ft]:	61.666	61.979
Specific Heat Capacity [Btu/lbm F]:	0.998	0.998
Thermal Conductivity [Btu/hr ft F]:	0.372	0.364
Absolute Viscosity [cP]:	0.539	0.689

WARNING 1: Central Baffle Spacing May Exceed TEMA Maximum.

2. ECM95-008 Att. 7.2 (2 of 2)

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********** STER - 5.04 **********

Shell and Tube Heat Exchanger Rating Program

This computer code is validated under Holtec International's QA program.

File Name: WTFRDCCW.EQP
Unit Name: CCMHX0001A&B
Unit Description: CCW Heat Exchangers

This report was created Monday, November 07, 2005 at 1:05:17 PM

***** PERFORMANCE TEST MODE RESULTS *****

TEST ID: 98/83
DATE: 11-07-05
PROCEDURE: EC-M95-008
CONVERGENCE TOLERANCE: 0.05 %

PARAMETER	TUBE SIDE	SHELL SIDE
Mass Flow Rate [1000 lbm/hr]:	3396.78	2237.68
Volume Flow Rate [gpm]:	6878.42	4492.12
Inlet Temperature [degrees F]:	128.90	91.03
Outlet Temperature [degrees F]:	115.00	112.14
Fouling Factor [1/Btu/hr/sqft/F]:	0.00000	0.00197
Operating Pressure [psig]:	0.00	0.00
Heat Transfer Coeff [Btu/hr/sqft/F]:	1296.93	837.64
Pressure Drop [psi]:	3.07	3.24
Velocity [ft/sec]:	4.80	
Reynolds Number:	46834	14029

Total Heat Duty: 47,139,080 Btu/hr
Log Mean Temperature Difference: 20.15 F
Overall Heat Transfer Coefficient: 233.90 Btu/hr/sqft/F
Corrected LMTD: 20.15 F
Effective Surface Area per Shell: 10002.93 sq ft

Reference Temperature [F]:	121.950	101.586
Density [lbm/cu.ft]:	61.684	61.978
Specific Heat Capacity [Btu/lbm F]:	0.998	0.998
Thermal Conductivity [Btu/hr ft F]:	0.372	0.364
Absolute Viscosity [cP]:	0.544	0.668

WARNING 1: Central Baffle Spacing May Exceed TEMA Maximum

CCWHX B Test 12/11/01 [7d]

***** PERFORMANCE PREDICTION MODE RESULTS *****

CASE ID: inletT
DATE: 12-17-01

PROCEDURE: inlet sensitivy

CONVERGENCE TOLERANCE: 0.50 %

PARAMETER	TUBE SIDE	SHELL SIDE
Mass Flow Rate [1000 lbm/hr]:	3227.48	2241.86
Volume Flow Rate [gpm]:	6545.00	4500.00
Inlet Temperature [degrees F]:	134.10	90.41
Outlet Temperature [degrees F]:	114.55 outlet temp	118.57
Fouling Factor [1/Btu/hr/sqft/F]:	0.00000	0.00080 fouling level
Operating Pressure [psig]:	0.00	0.00
Heat Transfer Coeff [Btu/hr/sqft/F]:	1262.33	849.79
Pressure Drop [psi]:	2.78	3.25
Velocity [ft/sec]:	4.57	
Reynolds Number:	45543	14497

Total Heat Duty:	62,704,220 Btu/hr
Log Mean Temperature Difference:	19.52 F
Overall Heat Transfer Coefficient:	321.41 Btu/hr/sqft/F
Corrected LMTD:	19.52 F
Effective Surface Area per Shell:	9994.69 sq ft

Reference Temperature [F]:	124.326	104.490
Density [lbm/cu.ft]:	61.646	61.940
Specific Heat Capacity [Btu/lbm F]:	0.999	0.998
Thermal Conductivity [Btu/hr ft F]:	0.372	0.365
Absolute Viscosity [cP]:	0.532	0.648

WARNING 1: Central Baffle Spacing May Exceed TEMA Maximum.

Calculation MNQ9-10

Att. 8.5
Page 4 of 4

ATT85.RPT

*********** STER - 5.04 ***********

Shell and Tube Heat Exchanger Rating Program

This computer code is validated under Holtec International's QA program.

File Name: CCWHX.EQP

Unit Name: CCWHX
Unit Description:

This report was created Tuesday, July 27, 2010 at 7:53:28 AM

***** PERFORMANCE TEST MODE RESULTS *****

TEST ID: case1
DATE: __-__-__

PROCEDURE:

CONVERGENCE TOLERANCE: 0.50 %

PARAMETER	TUBE SIDE	SHELL SIDE
Mass Flow Rate [1000 lbm/hr]:	3231.78	2243.21
Volume Flow Rate [gpm]:	6500.00	4500.00
Inlet Temperature [degrees F]:	100.65	87.00
Outlet Temperature [degrees F]:	95.00	95.17
Fouling Factor [1/Btu/hr/sqft/F]:	0.00000	0.00114
Operating Pressure [psig]:	0.00	0.00
Heat Transfer Coeff [Btu/hr/sqft/F]:	1113.33	797.63
Pressure Drop [psi]:	2.93	3.25
Velocity [ft/sec]:	4.56	
Reynolds Number:	34970	12515

Total Heat Duty:	18,286,560 Btu/hr
Log Mean Temperature Difference:	6.66 F
Overall Heat Transfer Coefficient:	274.47 Btu/hr/sqft/F
Corrected LMTD:	6.66 F
Effective Surface Area per Shell:	10002.93 sq ft

Reference Temperature [F]:	97.825	91.085
Density [lbm/cu.ft]:	62.026	62.106
Specific Heat Capacity [Btu/lbm F]:	0.998	0.998
Thermal Conductivity [Btu/hr ft F]:	0.362	0.359
Absolute Viscosity [cP]:	0.696	0.751

WARNING 1: Central Baffle Spacing May Exceed TEMA Maximum.

MNQ9-10 Att. 8.6 [5j]

Calculation MNQ9-10

Att 8.6
Page 1 of 1

ATT86.RPT

********** STER - 5.04 **********

Shell and Tube Heat Exchanger Rating Program

This computer code is validated under Holtec International's QA program.

File Name: CCWHX.EQP

Unit Name: CCWHX
Unit Description:

This report was created Tuesday, July 27, 2010 at 8:36:50 AM

***** PERFORMANCE TEST MODE RESULTS *****

TEST ID: case1
DATE: __-__-__

PROCEDURE:

CONVERGENCE TOLERANCE: 0.50 %

PARAMETER	TUBE SIDE	SHELL SIDE
Mass Flow Rate [1000 lbm/hr]:	3223.12	2242.82
Volume Flow Rate [gpm]:	6500.00	4500.00
Inlet Temperature [degrees F]:	112.73	88.00
Outlet Temperature [degrees F]:	105.00	99.19
Fouling Factor [1/Btu/hr/sqft/F]:	0.00000	0.00364
Operating Pressure [psig]:	0.00	0.00
Heat Transfer Coeff [Btu/hr/sqft/F]:	1174.43	810.84
Pressure Drop [psi]:	2.88	3.25
Velocity [ft/sec]:	4.58	
Reynolds Number:	39349	12876

Total Heat Duty:	25,041,571 Btu/hr
Log Mean Temperature Difference:	15.20 F
Overall Heat Transfer Coefficient:	164.66 Btu/hr/sqft/F
Corrected LMTD:	15.20 F
Effective Surface Area per Shell:	10002.93 sq ft

Reference Temperature [F]:	108.865	93.595
Density [lbm/cu.ft]:	61.879	62.077
Specific Heat Capacity [Btu/lbm F]:	0.998	0.998
Thermal Conductivity [Btu/hr ft F]:	0.367	0.361
Absolute Viscosity [cP]:	0.619	0.730

WARNING 1: Central Baffle Spacing May Exceed TEMA Maximum.

MNQ9-10 Att. 8.7 [5j]

Calculation MNQ9-10

Att. 8.7
Page 1 of 1

ATT87.RPT

********** STER - 5.04 **********

Shell and Tube Heat Exchanger Rating Program

This computer code is validated under Holtec International's QA program.

File Name: CCWHX.EQP

Unit Name: CCWHX
Unit Description:

This report was created Tuesday, July 27, 2010 at 8:39:18 AM

***** PERFORMANCE TEST MODE RESULTS *****

TEST ID: case1
DATE: __-__-__

PROCEDURE:

CONVERGENCE TOLERANCE: 0.50 %

PARAMETER	TUBE SIDE	SHELL SIDE
Mass Flow Rate [1000 lbm/hr]:	3232.11	2243.21
Volume Flow Rate [gpm]:	6500.00	4500.00
Inlet Temperature [degrees F]:	100.16	87.00
Outlet Temperature [degrees F]:	95.00	94.46
Fouling Factor [1/Btu/hr/sqft/F]:	0.00000	0.00156
Operating Pressure [psig]:	0.00	0.00
Heat Transfer Coeff [Btu/hr/sqft/F]:	1111.54	796.58
Pressure Drop [psi]:	2.93	3.25
Velocity [ft/sec]:	4.56	
Reynolds Number:	34869	12464

Total Heat Duty:	16,697,439 Btu/hr
Log Mean Temperature Difference:	6.79 F
Overall Heat Transfer Coefficient:	246.03 Btu/hr/sqft/F
Corrected LMTD:	6.79 F
Effective Surface Area per Shell:	10002.93 sq ft

Reference Temperature [F]:	97.580	90.730
Density [lbm/cu.ft]:	62.029	62.111
Specific Heat Capacity [Btu/lbm F]:	0.998	0.998
Thermal Conductivity [Btu/hr ft F]:	0.362	0.359
Absolute Viscosity [cP]:	0.698	0.754

WARNING 1: Central Baffle Spacing May Exceed TEMA Maximum.

CCW HX Inputs [5a]

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********** STER - 5.04 **********

Shell and Tube Heat Exchanger Rating Program

This computer code is validated under Holtec International's QA program.

File Name: WTFRDCCW.EQP
Unit Name: CCMHX0001A&B
Unit Description: CCW Heat Exchangers

This report was created Monday, November 07, 2005 at 1:03:03 PM

***** EQUIPMENT CONFIGURATION *****

PARAMETER	VALUE	QA REF
Number of Shells in Series/Parallel:	1/ 1	3/3
Shell Type:	TEMA E	1
Bundle Type:	FIXED	1
Shell Inside Diameter [inches]:	45.000	1
Number of Tube Passes:	1	1
Baffle Type:	NTIW	1
Baffle Cut [% of shell ID]:	21.11	5
Central Baffle Spacing [inches]:	92.000	2
Number of Tubes [holes in tubesheet]:	1276	1
Number of Tubes Plugged:	63	
Inlet Baffle Spacing [inches]:	114.000	
Outlet Baffle Spacing [inches]:	114.000	
Number of Pairs of Sealing Strips	0	
Tube Outside Diameter [inches]:	0.7500	1
Tube Wall Thickness [inches]:	0.0280	1
Tube Material:	304 Stainless	1
Thermal Conductivity [Btu/hr/ft/F]:	8.70	*
Tube Layout Angle [degrees]:	30	1
Tube Layout Pitch [inches]:	0.9375	1
Effective Tube Length [feet]:	42.000	2
Flow Orientation:	Counter-Current	
Tube Nozzle Inlet Diameter [inches]:	20.000	1
Tube Nozzle Outlet Diameter [inches]:	20.000	1
Shell Nozzle Inlet Diameter [inches]:	16.000	1
Shell Nozzle Outlet Diameter [inches]:	16.000	1
Integral Low Fin Tubes:	NO	

CCW HX Inputs [5a]

	WATERFORD 3 DESIGN ENGINEERING	ECM95-008 Rev. 3 Attachment 7.2 Page 2 of 6

********** STER - 5.04 **********

Shell and Tube Heat Exchanger Rating Program

This computer code is validated under Holtec International's QA program.

File Name: WTFRDCCW.EQP
Unit Name: CCMHX0001A&B
Unit Description: CCW Heat Exchangers

This report was created Monday, November 07, 2005 at 1:03:03 PM

PARAMETER	VALUE	QA REF
Shell to Bundle Clearance [inches]:	1.0000	4
Shell to Baffle Clearance [inches]:	0.3750	5
Tube to Baffle Clearance [inches]:	0.0156	2
Shell Inlet Annular Distributor:	NO	
Shell Outlet Annular Distributor:	NO	
Number of Baffles per Unit:	4	2
Impingement Plate Dist. [% nozzle dia]:	64.84	2
Omit Tubes at Inlet [% shell dia]:	23.05	
Omit Tubes at Outlet [% shell dia]:	0.00	*

Attachment C: Heat Exchanger Single Phase Shell-Side Heat Transfer Model

SUMMARY: The design method of Taborek (1983) for single-phase shell-side flows of shell-and-tube heat exchangers with *single segmental baffles* is presented here. The Taborek version of the Delaware method is thought to be the most accurate, reliable and complete method available in the open literature. The basic theory of single-phase shell-side flow in baffled heat exchangers is presented and then a complete treatment of the Taborek method for application to plain tubes and integral low finned tubes, such as the Wolverine Tube S/T Trufin tubes. The method predicts both heat transfer coefficients and pressure drops as a function of the tube bundle geometry and its dimensional description.

3.1 Introduction

Single-phase flow of liquids and gases over tube bundles is an important heat transfer process confronted in numerous types of heat exchanger applications. In contrast to single-phase heat transfer inside tubes, shell-side flows (i.e. those across the outside of the tubes in a baffled tube bundle confined by a heat exchanger shell) are particularly complex because of the many geometrical factors involved and the many possible fluid flow paths. Tinker (1951) was the first to give a physical description of this process, which was used in the development of what is often referred to as the *Delaware method*, proposed by Bell (1960, 1963) and republished in Bell (1986). Taborek (1983) proposed a new version of this design method for single-phase shell-side flows of shell-and-tube heat exchangers with single segmental baffles (essentially for what is called a TEMA E-shell) and described how to extended it to TEMA J-shells and F-shells and to E-shells with no-tubes-in-the-window. The basic theory of single-phase shell-side flow in baffled E-shell heat exchangers is presented here and then a more complete treatment of the Taborek method. This method is for flow over tube bundles with *single-segmental baffles*. Other types of baffles used in special applications include double-segmental baffles, triple-segmental baffles, disk-and-donut baffles, rod baffles and helical baffles; these alternative, less used geometries are not addressed here. In this chapter, first the method for *plain tubes* is described and then its extension to *integral low finned tubes*.

3.2 Stream Analysis of Flow Distribution in a Baffled Heat Exchanger

In a baffled shell-and-tube heat exchanger, only a fraction of the fluid flow through the shell-side of a heat exchanger actually flows across the tube bundle in the idealized path normal to the axis of the tubes. The remaining fraction of the fluid flows through "bypass" areas. As can be expected, the fluid seeks the flow path of less resistance from the inlet to the outlet of the exchanger. In a typical design, the *non-ideal* flows represent up to 40% of the total flow and hence it is imperative to account for their effects on heat transfer and pressure drop.

These flow paths in an actual heat exchanger with single-segmental baffles were first intuitively described by Tinker (1951) as depicted in his schematic diagram shown in Figure 3.1. The total flow is divided into individual streams designated by the letters shown in the diagram as follows:

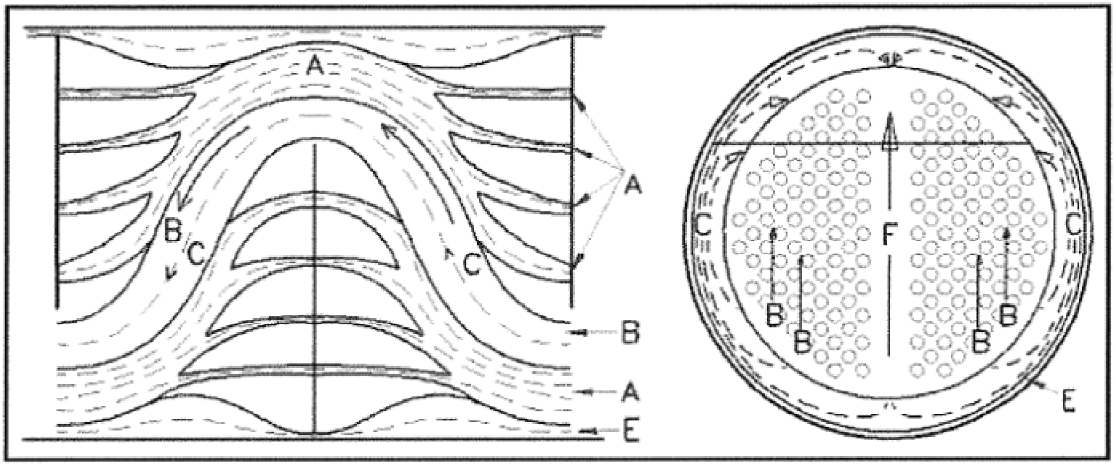


Figure 3.1. Shell-side flow paths in a baffled heat exchanger according to Tinker (1951).

The total flow is divided into individual streams designated by the letters shown in the diagram as follows:

- **Stream A**: The *tube hole leakage stream* represents the flow from one baffle compartment to the next that passes through the annular openings between the oversized holes for the tubes in the baffles and the outside of the tubes, as illustrated in Figure 3.2. The flow is driven by the pressure drop from one baffle compartment to the next. The leakage occurs through the diametral clearance between the diameter of the baffle hole minus the outside diameter of the tube. If the tubes are expanded into the baffles, then the diametral clearance is zero. This bypass stream is minimized by reducing the diametral clearance and completely eliminated if the clearance becomes zero.

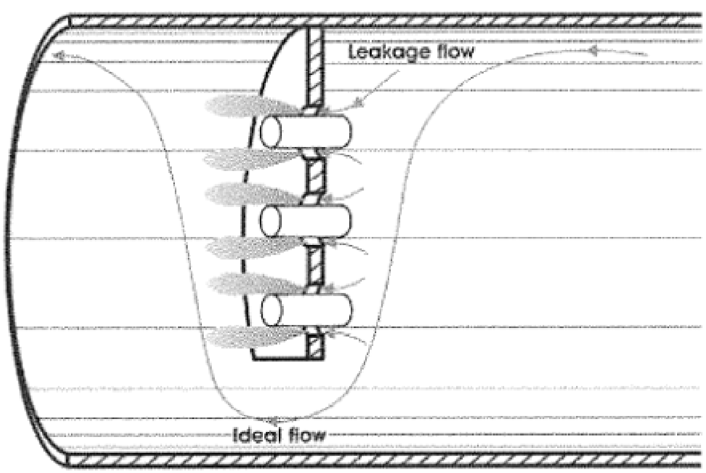


Figure 3.2. Diagram of tube hole leakage stream A.

- **Stream B**: The *crossflow stream* is the idealized cross flow over the tube bundle normal to the axis of the tubes. This is the preferred flow in a baffled shell-and-tube heat exchanger and is illustrated in Figure 3.1.

- **Stream C**: The *bundle bypass stream* flows through the annular opening between the outside of the tube bundle and the inner shell wall as illustrated in Figure 3.3. The diametral clearance for this flow to pass through is equal to the shell internal diameter minus the outer tube limit diameter of the tube bundle. The bundle bypass stream is reduced by minimizing the diametral clearance between the shell internal diameter and the outer tube limit diameter of the tube bundle and by installing pairs of sealing strips around the perimeter of the tube bundle to block this flow path and thereby force the fluid back into the tube bundle.

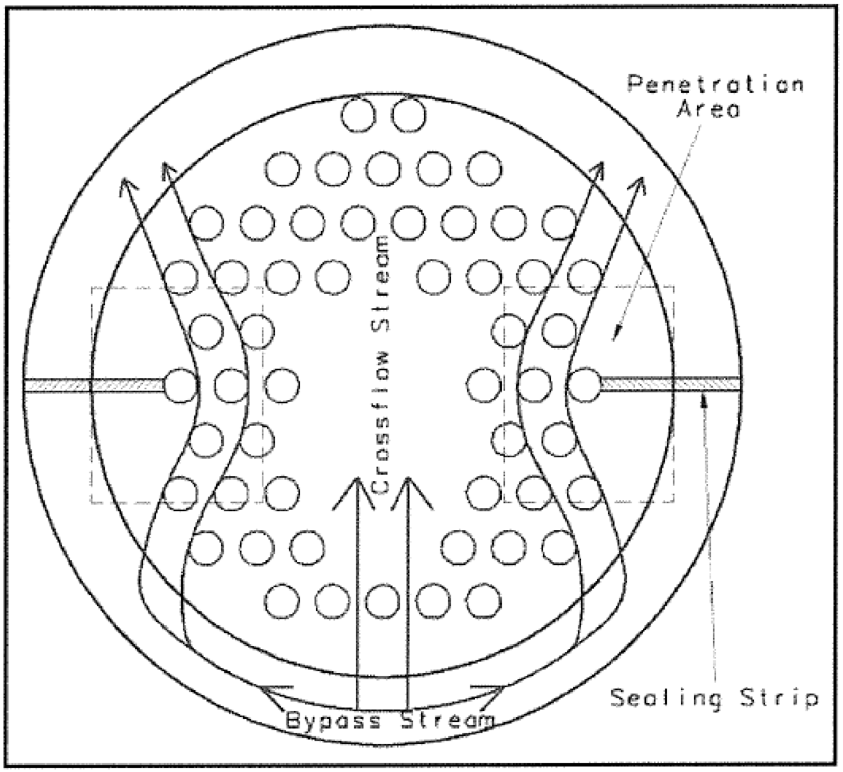


Figure 3.3. Schematic of bundle bypass stream C.

- **Stream E**: The *shell-to-baffle bypass stream* refers to the flow through the gap between the outer edge of the baffle and the inner shell wall as depicted in Figure 3.4. The diametral clearance is equal to the shell internal diameter minus the diameter of the baffle and is minimized by decreasing the construction clearance between the shell and the baffle to its feasible minimum.

- **Stream F**: The *pass partition bypass stream* refers to the flow through the open lanes in a tube bundle formed by omission of tubes in the bundle and tubesheet for placement of tubepass partition plates in the heads of multi-pass heat exchangers. It is illustrated in Figure 3.1. This stream only refers to those openings oriented in the *direction* of the fluid flow. Pass partition openings oriented *normal* to the flow path do *not* cause a bypass. This bypass stream thus only occurs in some multi-pass tube layouts and they can be eliminated by placement of several dummy tubes in each bypass lane to drive the fluid back into the tube bundle.

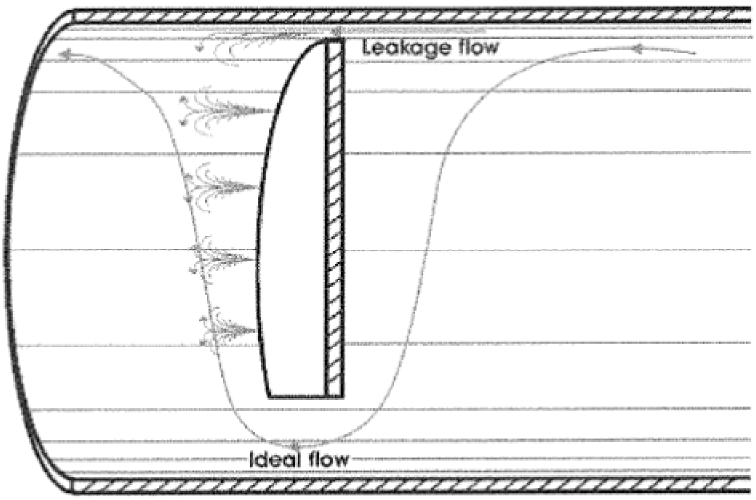


Figure 3.4. Schematic of shell-to-baffle bypass stream E.

3.3 Definition of Bundle and Shell Geometries

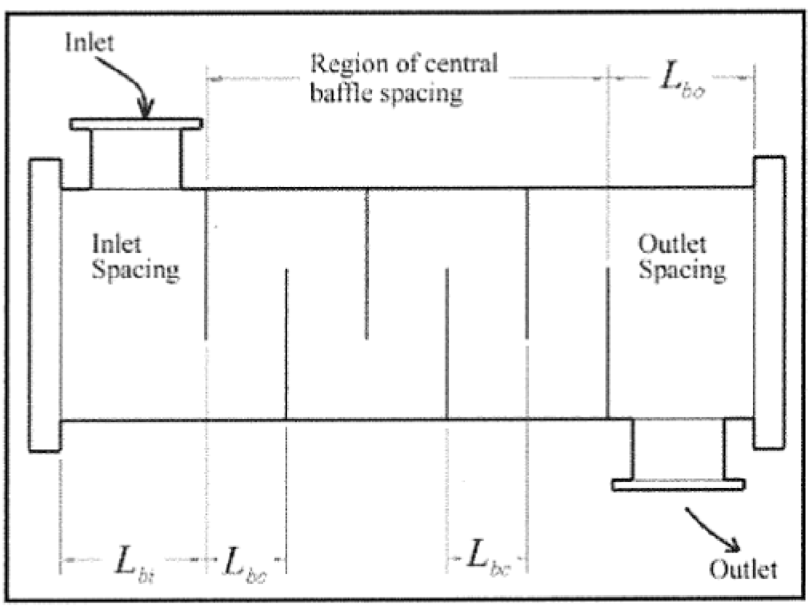


Figure 3.5. Single-segmental shell-and-tube heat exchanger showing baffle spacings.

Figure 3.5 depicts a single-segmental shell-and-tube bundle geometry with fixed tubesheets at both heads in which the shell-side flow makes one shell pass from one end of the tube bundle to the other with the flow directed across the tube bundle by the baffles. This is a common configuration used in refrigeration and petrochemical heat exchangers. The inlet, central and outlet baffle spacings are shown and are identified as L_{bi}, L_{bc} and L_{bo}, respectively. L_{bi} and L_{bo}, are often equal in length to L_{bc}, except when the first and last baffle compartments must be enlarged to allow for the placement of the respective shell-side

nozzles. The baffle layout is determined from the inlet, central, and outlet baffle spacings and the effective tube length. The effective tube length L_{ta} is equal to the total tube length less the combined thickness of the two tubesheets. The number of baffles (an integer) and baffle spacings can be determined from these values. The effective length for determining the baffle spacing for a U-tube exchanger includes the straight length of the tube plus $D_s/2$, where D_s is the shell internal diameter. Thus the baffle spacing at the U-bend should include the tube straight length in this compartment plus ($D_s/2$).

Figures 3.5, 3.6 and 3.7 reproduced from Taborek (1983) define the principal heat exchanger dimensions. D_{otl} is the *o*uter *t*ube *l*imit diameter and D_{ctl} is the *c*enter*l*ine *t*ube limit diameter (note: $D_{ctl} = D_{otl} - D_t$ where D_t is the outside diameter of the tubes). The *b*affle *c*ut *h*eight is shown as a height L_{bch}; the value of the baffle cut B_c is $(L_{bch}/D_s) \times 100\%$, i.e. given in terms of the *percent* of the shell internal diameter. The diametral clearance between the shell internal diameter D_s and outer tube limit diameter D_{otl} is L_{bb}. One-half of L_{bb} is the width of this bypass channel. A pass partition lane is shown with a width of L_p. The diametral clearance between the shell internal diameter D_s and the diameter of the baffle D_b is L_{sb}, where the gap is equal to $L_{sb}/2$.

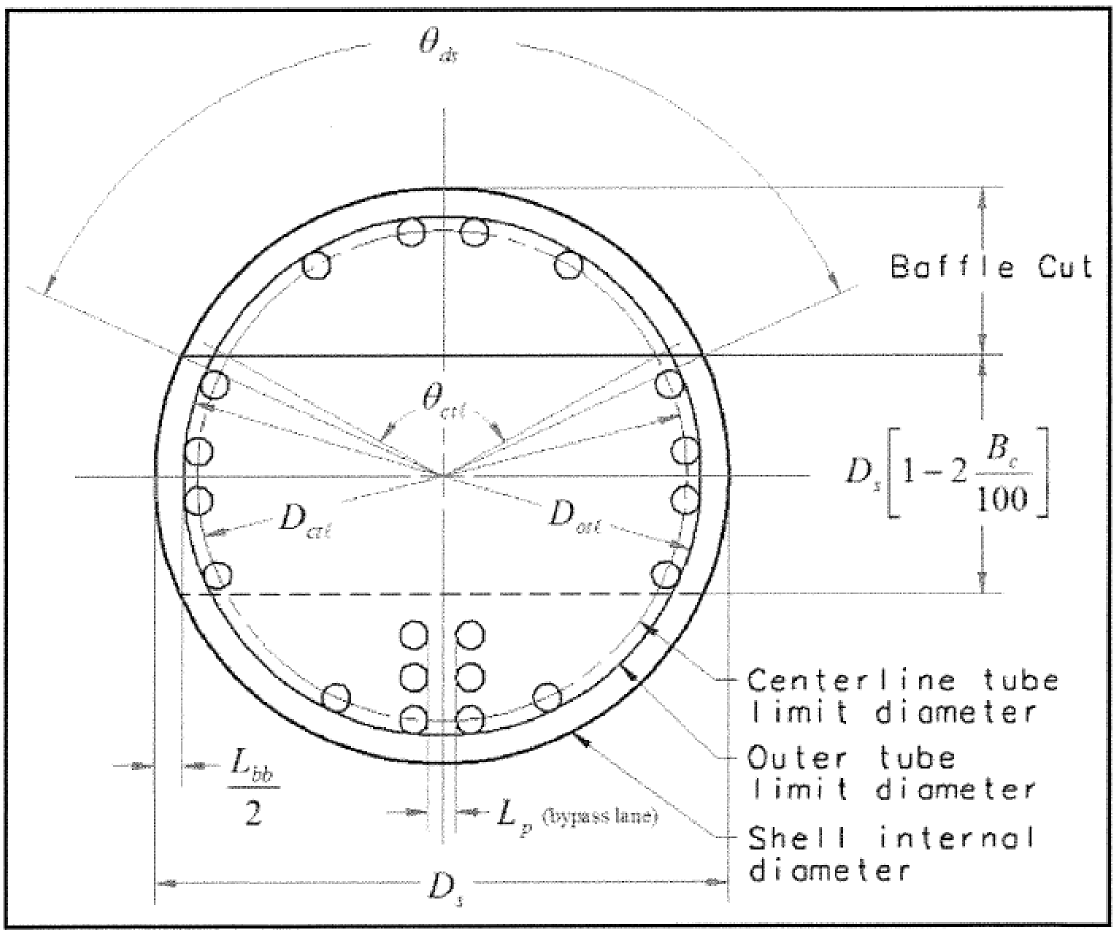


Figure 3.6. Baffle and tube bundle geometry.

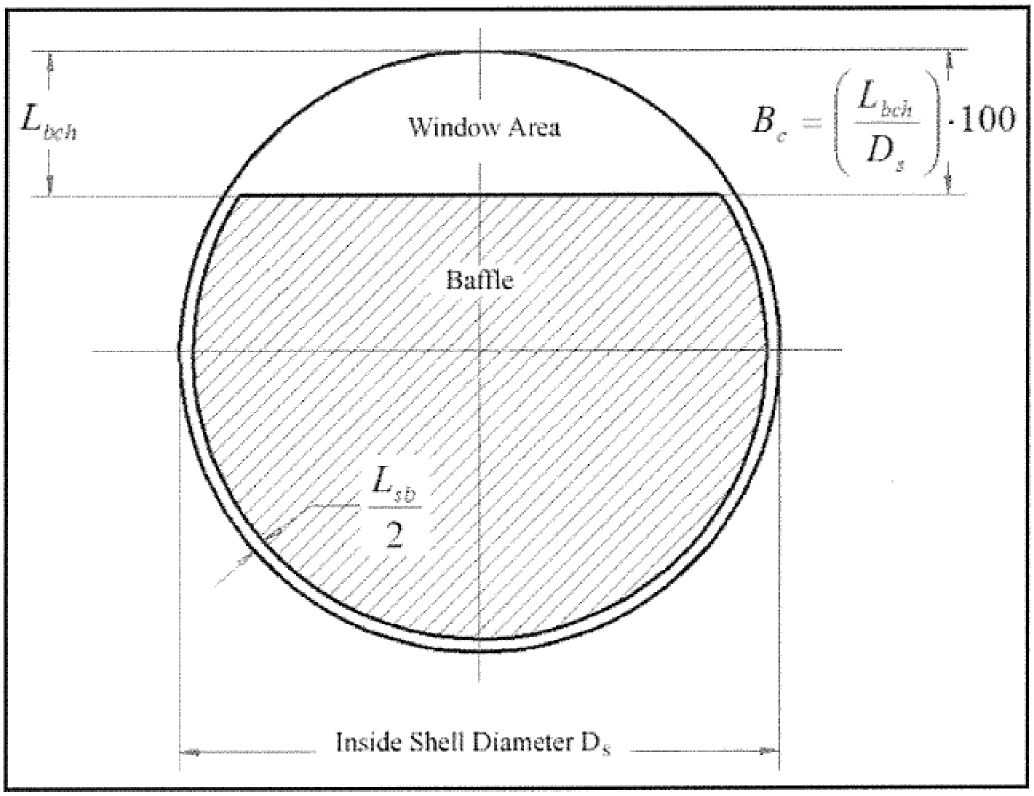


Figure 3.7. Baffle cut and clearance.

The above dimensions D_s, D_{otl}, baffle cut (% of D_s), L_{bb} and L_{sb} can be obtained from a tube layout drawing of the heat exchanger. If the value of D_{otl} is not known, L_{bb} can be assumed to be equal to 9.525 mm (3/8 in.) for $D_s < 300$ mm (11.81 in.) and L_{bb} can be assumed to be 15.875 mm (5/8 in.) for $D_s > 1000$ mm (39.37 in.). For D_s from 300 to 1000 mm inclusive, L_{bb} can be assumed to be 12.7 mm (1/2 in.). These values are typical of TEMA heat exchanger specifications but are often smaller for direct-expansion evaporators. If L_{sb} is not known, it can be assumed that $L_{sb} = 2.0$ mm for $D_s < 400$ mm (15.75 in.) while for larger shells $L_{sb} = 1.6 + 0.004D_S$ (mm). If the diametral clearance between the baffle holes and the outside of the tube is not known, the maximum TEMA value can be assumed 0.794 mm (1/32 in.) or a smaller value in the range from 0.397 mm (1/64 in.) to 0.794 mm. This clearance is equal to the baffle hole diameter minus D_t. Thermal performance is significantly improved by minimizing this clearance.

The three tube layouts addressed by the Taborek design method are shown in Figure 3.8: 30°, 45° and 90°. The 60° layout is not included. The *t*ube *p*itch is L_{tp} and is defined as the distance center-to-center between tubes in the bundle. The *p*itch *p*arallel to the direction of flow is L_{pp} while that *p*itch *n*ormal to the direction of the flow is L_{pn}.

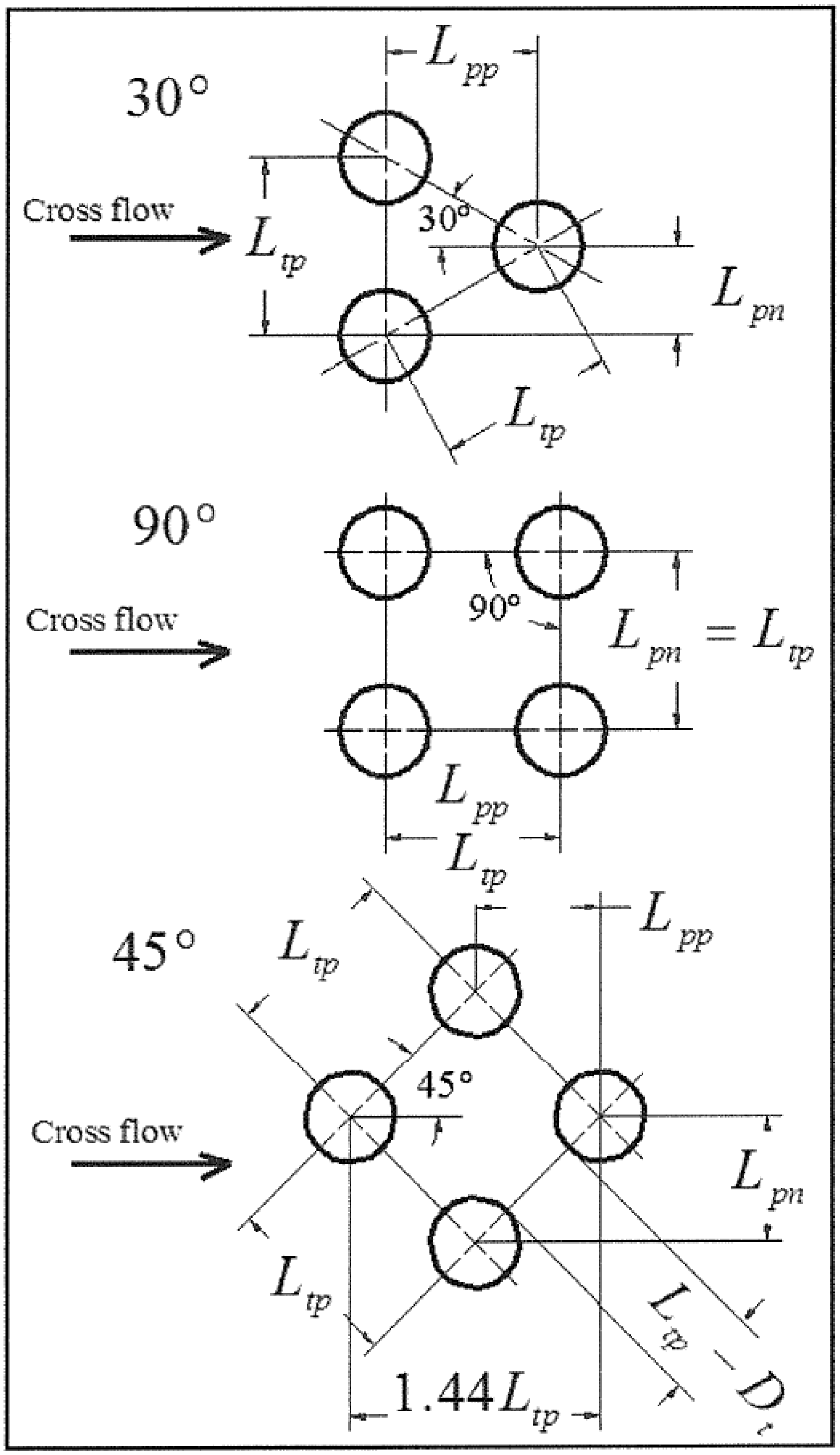


Figure 3.8. Tube layouts.

The number of tubes that fit within a shell depends on a number of geometrical factors, dimensions and clearances, principally the type of tube layout (triangular, square or rotated square) and the tube pitch.

The simple estimation method presented by Taborek (1983) for fixed tubesheets for single tubepass units without any tubes removed in the nozzle entrance and exit areas is:

$$N_{tt} = \frac{0.7854 D_{ctl}^2}{C_l L_{tp}^2} \quad [3.3.1]$$

where N_{tt} is the number of tubes, D_{ctl} is the centerline tube limit diameter and L_{tp} is the tube pitch. The constant C_l = 1.0 for square (90°) and rotated square tube (45°) layouts and C_l = 0.866 for triangular (30°) tube layouts. Designs with multiple tubepasses (2, 4, …) are commonly used and they will have fewer tubes than given by the above expression. Use of a tube count software program is highly recommended for an accurate estimate since tubes are often removed at the inlet nozzle to permit placement of an impingement plate and the number removed depends on the nozzle diameter. An accurate tube count improves the accuracy of the heat transfer and pressure drop calculations.

3.4 Stream Analysis of Heat Transfer in a Baffled Heat Exchanger

The stream analysis shell-side heat transfer coefficient for single-phase flow α_{ss} is

$$\alpha_{ss} = \left(J_C J_L J_B J_R J_S J_\mu\right)\alpha_I \quad [3.4.1]$$

where α_I is the ideal tube bank heat transfer coefficient calculated for all the flow across the tube bundle (that is all flow assumed to be in stream B). J_C, J_L, J_B, J_R and J_S are the correction factors for the leakage and bypass flow effects and J_μ is the wall viscosity correction factor. The corrections factors and ideal tube bank heat transfer correlations are described in the sections below. The value of α_{ss} is the mean value for the whole tube bundle applied to the outside heat transfer surface area of the tubes. Mean bulk physical properties are used for evaluating the correlations.

3.4.1 Baffle Cut Correction Factor (J_C)

The baffle cut correction factor J_C accounts for the non-ideal flow effects of window flow on heat transfer since the velocity through the window (that of the baffle cut) is not the same as that for cross-flow over the bundle. The window flow velocity can be larger or smaller than for cross-flow depending on the size of the cut and the baffle spacing. In addition, the window flow is partially longitudinal to the tubes, which is less effective than cross-flow. Therefore, J_C is a function of the baffle cut, the outer tube limit diameter and the window flow area and is calculated as follows:

$$J_C = 0.55 + 0.72 F_C \quad [3.4.2]$$

where F_C is

$$F_C = 1 - 2F_w \quad [3.4.3]$$

F_w is the fraction of the cross-sectional area occupied by the window:

$$F_w = \frac{\theta_{ctl}}{360} - \frac{\sin\theta_{ctl}}{2\pi} \quad [3.4.4]$$

The angle of the baffle cut relative to the *cen*ter*l*ine of the heat exchanger is θ_{ctl} (in degrees):

$$\theta_{ctl} = 2\cos^{-1}\left\{\frac{D_s}{D_{ctl}}\left[1-2\left(\frac{B_c}{100}\right)\right]\right\} \quad [3.4.5]$$

The above expression is valid for baffle cuts from 15% to 45% of the shell diameter. Use of baffle cuts outside this range is not normally recommended because of the ensuing maldistribution of the flow. J_C typically ranges in value from 0.65 to 1.175 in a well-designed unit.

3.4.2 Baffle Leakage Correction Factor (J_L)

The pressure difference between neighboring baffle compartments forces a fraction of the flow through the baffle-to-tubehole gaps in the baffles (Stream A) and through the annular gap between the shell and the baffle edge (Stream E). These streams reduce the part of the flow that passes over the tube bundle as cross-flow (Stream B), reducing both the heat transfer coefficient *and* the pressure drop. Stream E is very detrimental to thermal design because it is not effective for heat transfer. The baffle leakage correction factor is calculated from the following expression:

$$J_L = 0.44(1-r_s) + [1-0.44(1-r_s)]\exp(-2.2r_{lm}) \quad [3.4.6]$$

where r_s is

$$r_s = \frac{S_{sb}}{S_{sb}+S_{tb}} \quad [3.4.7]$$

and r_{lm} is

$$r_{lm} = \frac{S_{sb}+S_{tb}}{S_m} \quad [3.4.8]$$

The *s*hell-to-*b*affle leakage area S_{sb}, the *t*ube-to-*b*affle hole leakage area S_{tb} for $N_{tt}(1\text{-}F_w)$ tube holes and the cross-flow area at the bundle centerline S_m are determined as follows:

$$S_{sb} = 0.00436 D_s L_{sb}(360-\theta_{ds}) \quad [3.4.9]$$

$$S_{tb} = \left\{\frac{\pi}{4}\left[(D_t+L_{tb})^2 - D_t^2\right]\right\} N_{tt}(1-F_w) \quad [3.4.10]$$

$$S_m = L_{bc}\left[L_{bb} + \frac{D_{ctl}}{L_{tp,eff}}(L_{tp}-D_t)\right] \quad [3.4.11]$$

In the above expressions, L_{sb} is the diametral shell to baffle clearance and the baffle cut angle θ_{ds} in degrees is

$$\theta_{ds} = 2\cos^{-1}\left[1 - 2\left(\frac{B_c}{100}\right)\right] \qquad [3.4.12]$$

where L_{bc} is the central baffle spacing and L_{bb} is the bypass channel diametral gap, both described earlier. The *eff*ective *t*ube *p*itch is $L_{tp,eff}$, which is equal to L_{tp} for 30° and 90° tube layouts while for 45° staggered layouts $L_{tp,eff}$ is equal to $0.707L_{tp}$. For a well-proportioned heat exchanger, $J_L > 0.7$-0.9 while values of $J_L < 0.6$ should be avoided. The maximum value of J_L is 1.0. For refrigeration chillers and water-cooled condensers, a value of 0.85 to 0.90 is achievable because of their tighter construction tolerances and smaller clearances than TEMA standards.

3.4.3 Bundle Bypass Correction Factor (J_B)

The bundle bypass correction factor J_B accounts for the adverse effect of the flow between the inner shell wall and the tube bundle (Stream C) and the bypass lane created by any pass partition lanes (Stream F) in the direction of flow. Stream F is not always present and it can be eliminated completely by placing dummy tubes in the pass partition lanes. Stream C is reduced by a tighter fit of the tube bundle into the shell and also by placing sealing strips (in pairs) around the bundle perimeter, up to a maximum of one pair of strips for every two tube rows passed by the flow between the two baffle cuts. The bundle bypass correction factor J_B is

$$J_B = \exp\left[-C_{bh}F_{sbp}\left(1 - \sqrt[3]{2r_{ss}}\right)\right] \qquad [3.4.13]$$

The empirical factor $C_{bh} = 1.35$ for laminar flow ($100 \geq Re$) and $C_{bh} = 1.25$ for transition and turbulent flows ($Re > 100$). To evaluate this expression, one requires the ratio of the bypass to the crossflow area F_{sbp}, and the ratio r_{ss} of the number of sealing strips N_{ss} (number of pairs if any) passed by the flow to the number of tube rows crossed between baffle tips in one baffle section N_{tcc}. First of all, F_{sbp} is given by

$$F_{sbp} = \frac{S_b}{S_m} \qquad [3.4.14]$$

where S_m was given above and S_b is the bypass area:

$$S_b = L_{bc}\left[(D_s - D_{otl}) + L_{pl}\right] \qquad [3.4.15]$$

where L_{pl} represents the width of the bypass lane between tubes. For situations without a pass partition lane or for such a lane normal to the flow direction, set $L_{pl} = 0$ while for a pass partition lane parallel to the flow direction L_{pl} is equal to ½ the actual dimension of the lane or can be assumed to be equal to the tube diameter D_t. The ratio r_{ss} is

$$r_{ss} = \frac{N_{ss}}{N_{tcc}} \qquad [3.4.16]$$

The value of N_{tcc} is obtained from

$$N_{tcc} = \frac{D_s}{L_{pp}}\left[1 - 2\left(\frac{B_c}{100}\right)\right] \qquad [3.4.17]$$

where $L_{pp} = 0.866L_{tp}$ for a 30° layout, $L_{pp} = L_{tp}$ for a 90° layout and $L_{pp} = 0.707L_{tp}$ for a 45° layout. This expression has a maximum limit of $J_B = 1$ at $r_{ss} \geq ½$.

3.4.4 Unequal Baffle Spacing Correction Factor (J_S)

The unequal baffle spacing correction factor J_S accounts for the adverse effect of an inlet baffle spacing L_{bi} and/or outlet baffle spacing L_{bo} larger than the central baffle spacing L_{bc}. Some exchangers have a larger baffle spacing in the inlet and outlet nozzle compartments compared to the central baffle spacing, allowing placement of the shell-side nozzles without interference with the body flanges and without overlapping the first baffle. The flow velocity in these compartments is thus lowered and has an adverse influence on heat transfer. For larger inlet and outlet spacings than the central baffle spacing, the correction factor $J_S < 1.0$. For inlet and outlet baffle spacings equal to the central baffle spacing, no correction is required and $J_S = 1.0$. The value for J_S is determined directly from the effect on the flow velocity and is given by the following expression:

$$J_S = \frac{(N_b - 1) + (L_{bi}/L_{bc})^{1-n} + (L_{bo}/L_{bc})^{1-n}}{(N_b - 1) + (L_{bi}/L_{bc}) + (L_{bo}/L_{bc})} \qquad [3.4.18]$$

where n = 0.6 for turbulent flow and n = 1/3 for laminar flow. The number of baffle compartments N_b is determined from the effective tube length and the baffle spacings.

3.4.5 Laminar Flow Correction Factor (J_R)

In laminar flows, heat transfer is reduced by the adverse temperature gradient formed in the boundary layer as the flow thermally develops along the flow channel. The laminar flow correction factor J_R accounts for this effect. For laminar shell-side flow $J_R < 1.0$ (i.e. for $100 \geq Re$) while for $Re > 100$, no correction is needed and $J_R = 1.0$. For $20 \geq Re$, the value of J_R is given by

$$J_R = (J_R)_{20} = \left(\frac{10}{N_c}\right)^{0.18} \qquad [3.4.19]$$

where N_c is the total number of tube rows crossed by the flow in the entire heat exchanger:

$$N_c = (N_{tcc} + N_{tcw})(N_b + 1) \qquad [3.4.20]$$

The number of tuberows crossed N_{tcc} between baffle tips has been noted above while the number of tube rows crossed in the window area N_{tcw} is

$$N_{tcw} = \frac{0.8}{L_{pp}}\left[D_s\left(\frac{B_c}{100}\right) - \frac{D_s - D_{ctl}}{2}\right] \qquad [3.4.21]$$

For $Re > 20$ but $Re < 100$, the value is prorated as

$$J_R = (J_R)_{20} + \left(\frac{20 - Re}{80}\right)[(J_R)_{20} - 1] \quad [3.4.22]$$

The minimum value of J_R in all cases is 0.4.

3.4.6 Wall Viscosity Correction Factor (J_μ)

Heat transfer and pressure drop correlations are normally evaluated using bulk physical properties obtained at the mean of the inlet and outlet temperatures. For heating and cooling of liquids, the effect of variation in properties between the bulk fluid temperature and the wall temperature is corrected by the viscosity ratio J_μ, which is the ratio of the bulk viscosity μ to the wall viscosity μ_{wall}:

$$J_\mu = \left(\frac{\mu}{\mu_{wall}}\right)^m \quad [3.4.23]$$

The correction factor is greater than 1.0 for heating the shell-side fluid and vice-versa for cooling the shell-side fluid. The exponent for heating and cooling of liquids is usually set to m = 0.14. For gases, no correction is required for a gas being cooled while a correction based on temperature rather than viscosity is used for gases being heated as follows:

$$J_\mu = \left(\frac{T + 273}{T_{wall} + 273}\right)^{0.25} \quad [3.4.24]$$

where T is the bulk temperature and T_{wall} is the wall temperature. The wall temperature must be calculated from a preliminary heat transfer calculation to determine the viscosity at the wall.

3.4.7 Ideal Tube Bank Heat Transfer Coefficient (α_I)

The ideal tube bank heat transfer coefficient α_I is calculated for all the flow across the tube bundle (that is as if all the flow in the exchanger were in Stream B without any bypass flows) as:

$$\alpha_I = j_I c_p \dot{m} Pr^{-2/3} \quad [3.4.25]$$

The mass velocity of the fluid $\dot{m}$ is based on the total flow M through the minimum flow area normal to the flow and is in units of kg/m^{2}s. Pr is the Prandtl number. The heat transfer factor j_I is obtained as follows:

$$j_I = a_1 \left(\frac{1.33}{L_{tp}/D_t}\right)^a Re^{a_2} \quad [3.4.26]$$

$$a = \frac{a_3}{1 + 0.14 Re^{a_4}} \quad [3.4.27]$$

The values of a_1, a_2, a_3 and a_4 are listed in Table 3.1 given by Taborek (1983). For the above methods, the shell-side cross-flow mass velocity at the maxumum cross-section of the tube bundle is

$$\dot{m} = \frac{M}{S_m} \qquad [3.4.28]$$

where M is the shell-side flow rate in kg/s and S_m was defined earlier. The shell-side Reynolds number is then

$$Re = \frac{D_t \dot{m}}{\mu} \qquad [3.4.29]$$

The Prandtl number is defined as

$$Pr = \frac{c_p \mu}{k} \qquad [3.4.30]$$

The physical properties (viscosity μ, specific heat c_p and thermal conductivity k) are evaluated at the mean bulk fluid temperature. The effective tube length L_{ta} is used to calculate the actual heat transfer surface area A_o as

$$A_o = \pi D_t L_{ta} N_{tt} \qquad [3.4.31]$$

for the number of tubes in the bundle N_{tt}.

Table 3.1. Empirical coefficients for calculation of j_I and f_I.

Layout	Re	a_1	a_2	a_3	a_4	b_1	b_2	b_3	b_4
30°	10^5-10^4	0.321	-0.388	1.450	0.519	0.372	-0.123	7.00	0.500
	10^4-10^3	0.321	-0.388			0.486	-0.152		
	10^3-10^2	0.593	-0.477			4.570	-0.476		
	10^2-10	1.360	-0.657			45.10	-0.973		
	<10	1.400	-0.667			48.00	-1.000		
45°	10^5-10^4	0.370	-0.396	1.930	0.500	0.303	-0.126	6.59	0.520
	10^4-10^3	0.370	-0.396			0.333	-0.136		
	10^3-10^2	0.730	-0.500			3.500	-0.476		
	10^2-10	0.498	-0.656			26.20	-0.913		
	<10	1.550	-0.667			32.00	-1.000		
90°	10^5-10^4	0.370	-0.395	1.187	0.370	0.391	-0.148	6.30	0.378
	10^4-10^3	0.107	-0.266			0.0815	+0.022		
	10^3-10^2	0.408	-0.460			6.0900	-0.602		
	10^2-10	0.900	-0.631			32.100	-0.963		
	<10	0.970	-0.667			35.000	-1.000		

Attachment D: WCT Curves

This attachment contains plots of the curves used to characterize operation of the WCT, both with Fans In Service and Fans Out of Service [22].

Sets of curves are presented for operation with 8, 6, and 4 fans, with NO fans in service, i.e. natural draft operation, and for 4 fans out in 1 cell, i.e. half of the 8 fan tower is shut off.

The limited operation curves were developed using the assumption that out of service fans are covered to prevent short circuit flow from adjacent operating fans, and no restrictions were developed for numbers of fans out of service within a specific cell, i.e. 2 fans out in one cell was considered equivalent to 1 fan out in each of 2 cells.

Each of the following plots provides cold water temperature (Tc) vs. wet bulb temperature (Twb) for 4 difference ranges. For the limited fan operation, plots were developed for 8 fan, 6 fan, and 4 fan operation. General operating condition with 4, 5, 6, 7, or 8 fans operating was determined by 2 order regression curve fit from these points.

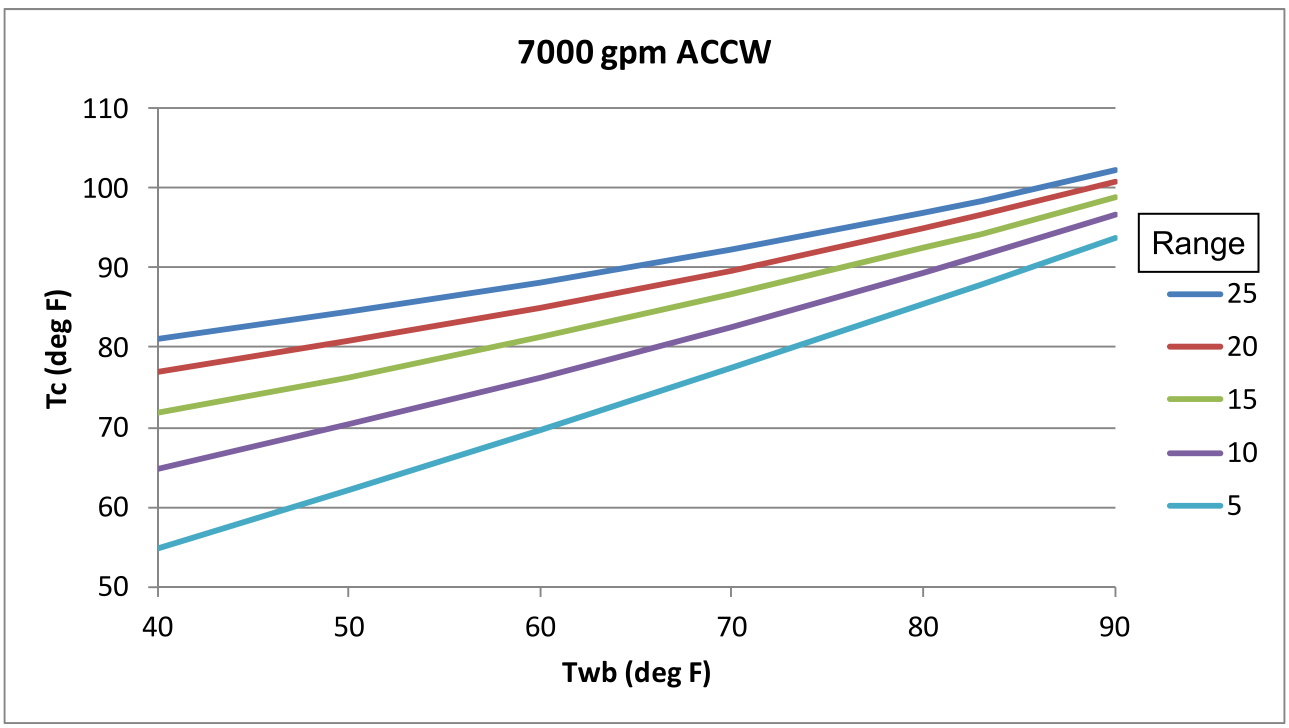


Figure D- 1: 8 Fan Operation, 7000 gpm ACCW

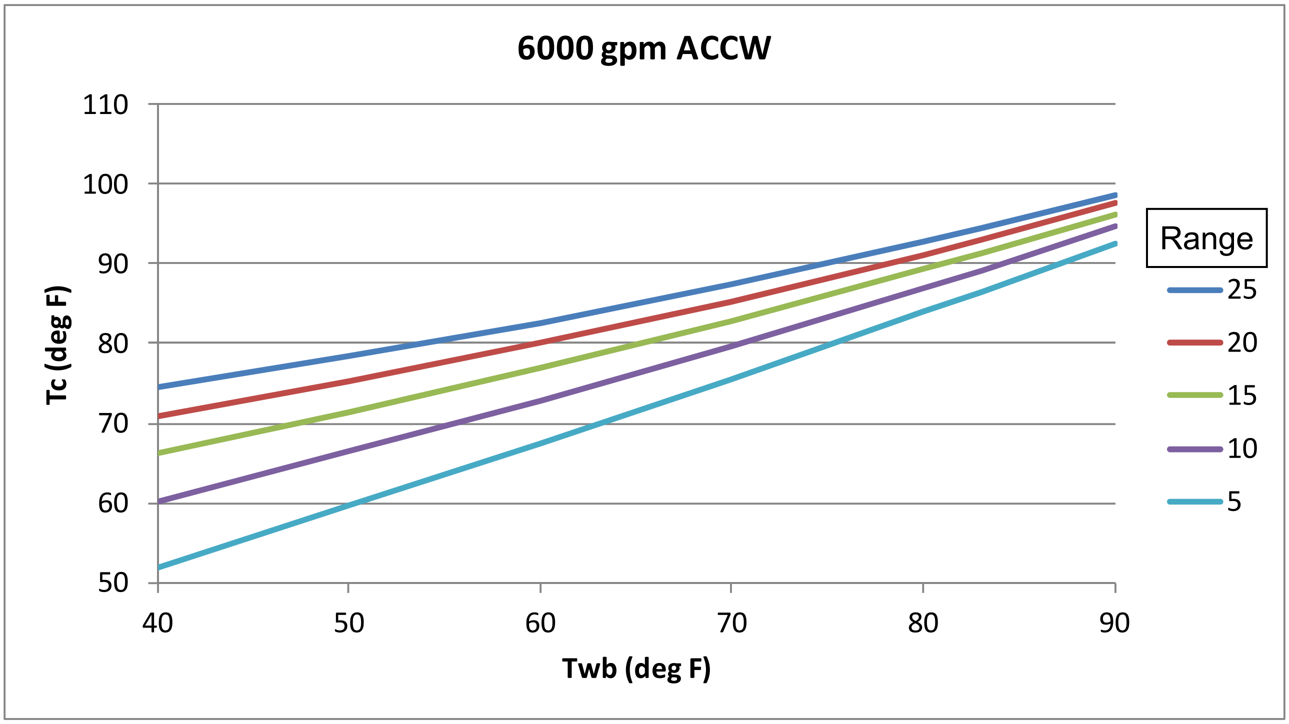


Figure D- 2: 8 Fan Operation, 6000 gpm ACCW

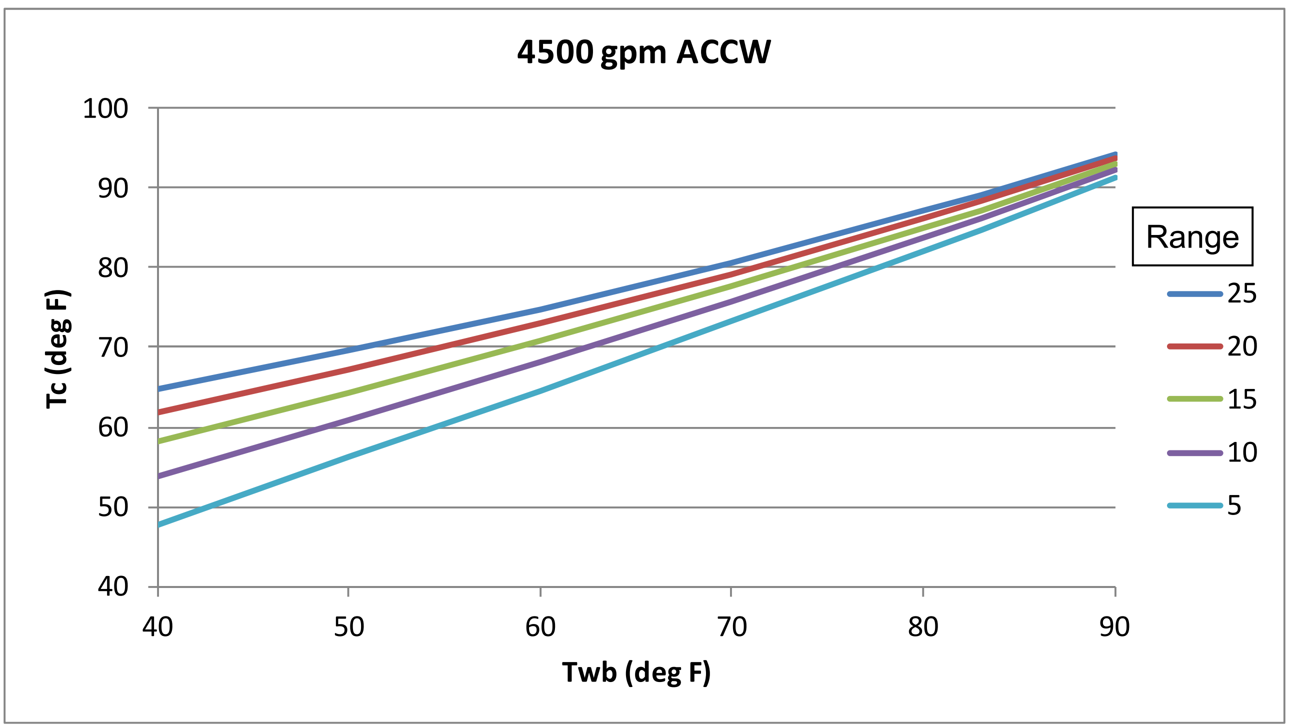


Figure D- 3: 8 Fan Operation, 4500 gpm ACCW

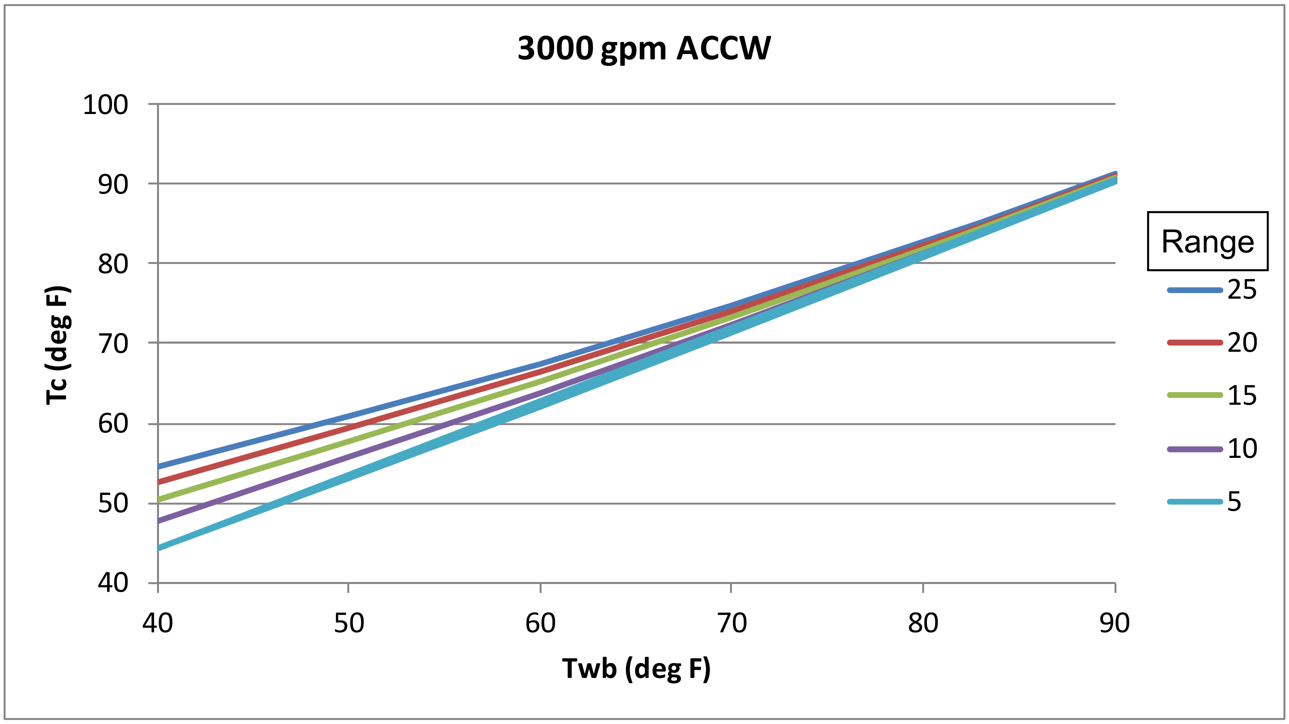


Figure D- 4: 8 Fan Operation, 3000 gpm ACCW

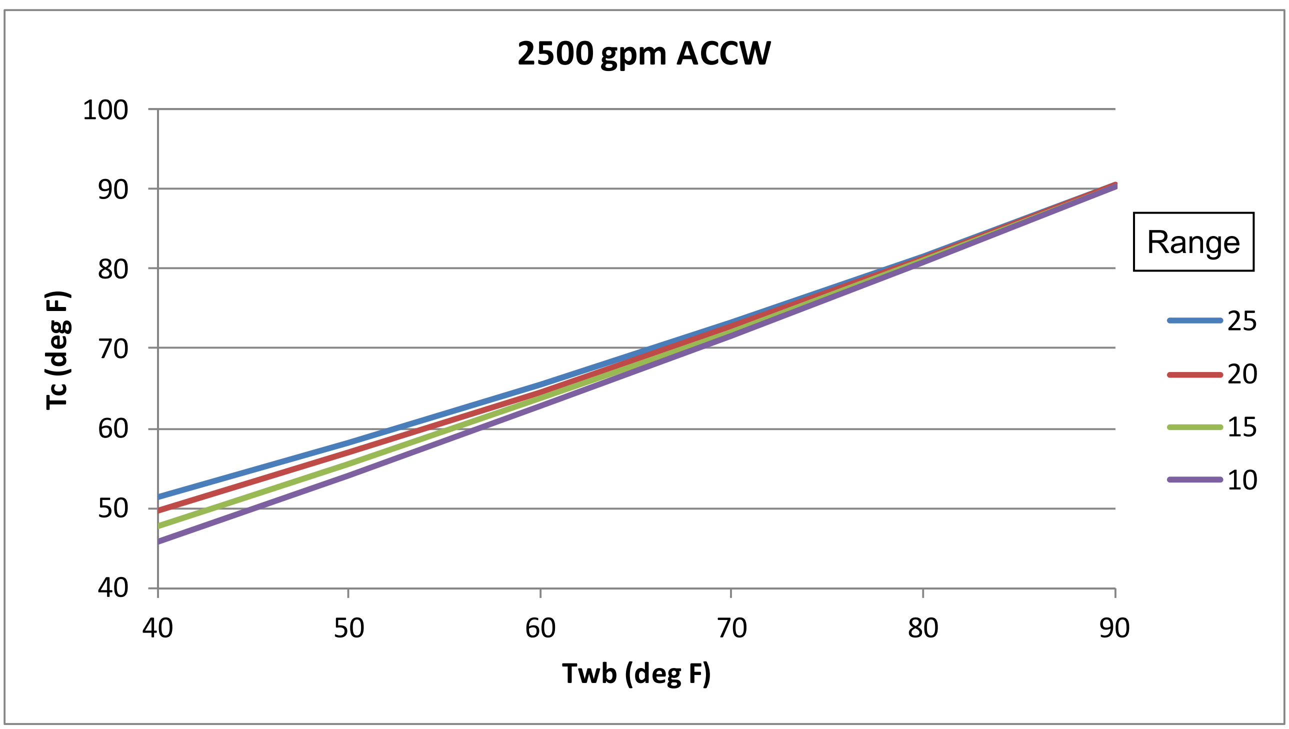


Figure D- 5: 8 Fan Operation, 2500 gpm ACCW

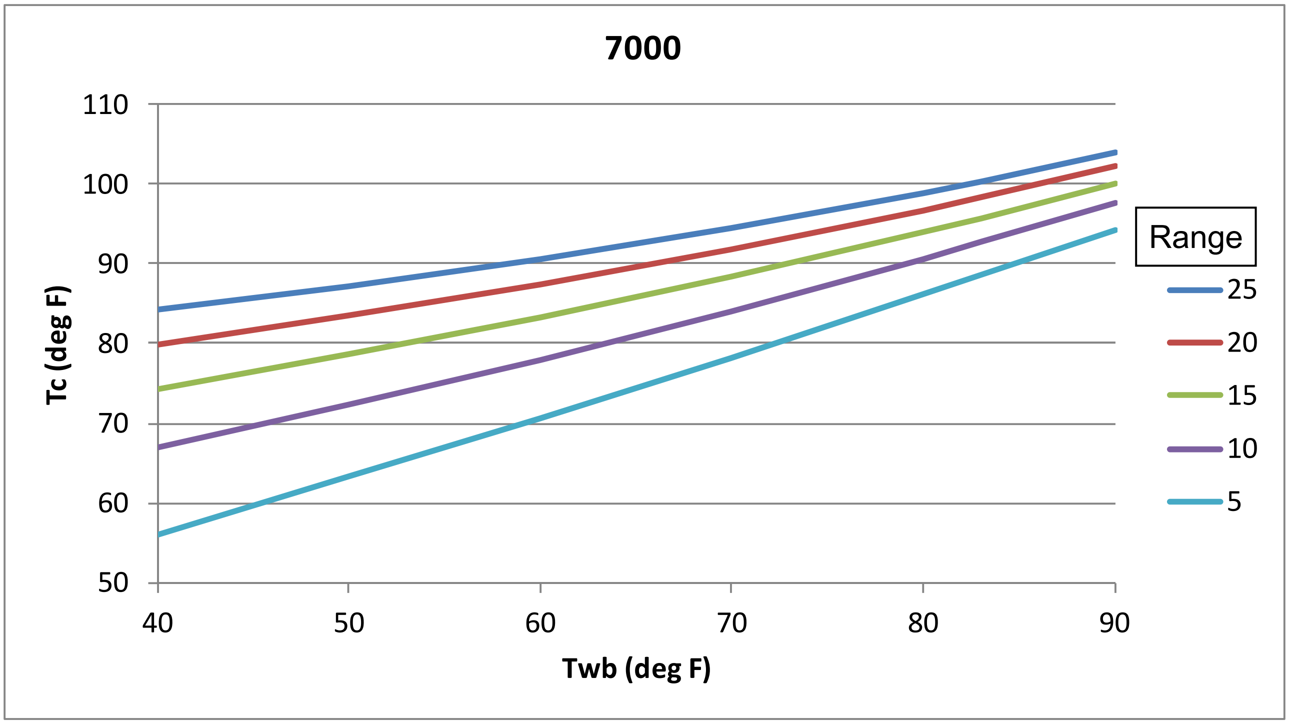


Figure D- 6: 6 Fan Operation, 7000 gpm ACCW

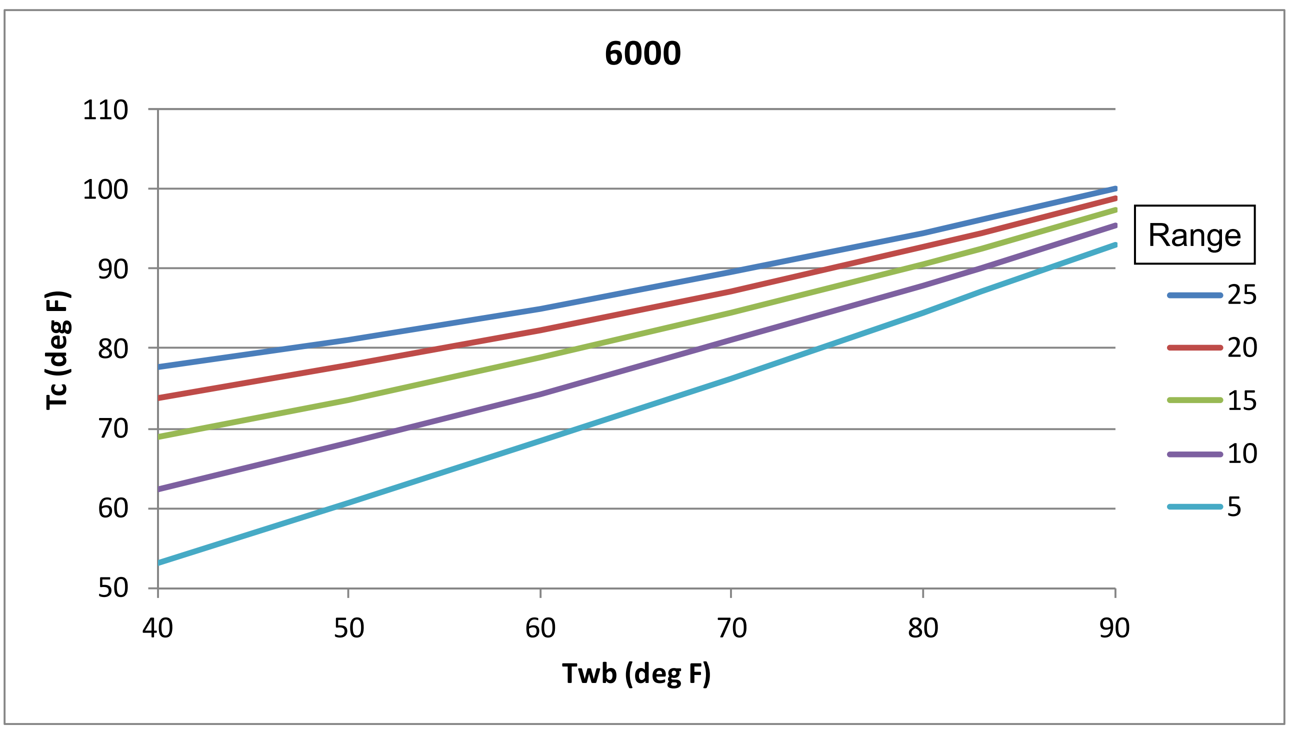


Figure D- 7: 6 Fan Operation, 6000 gpm ACCW

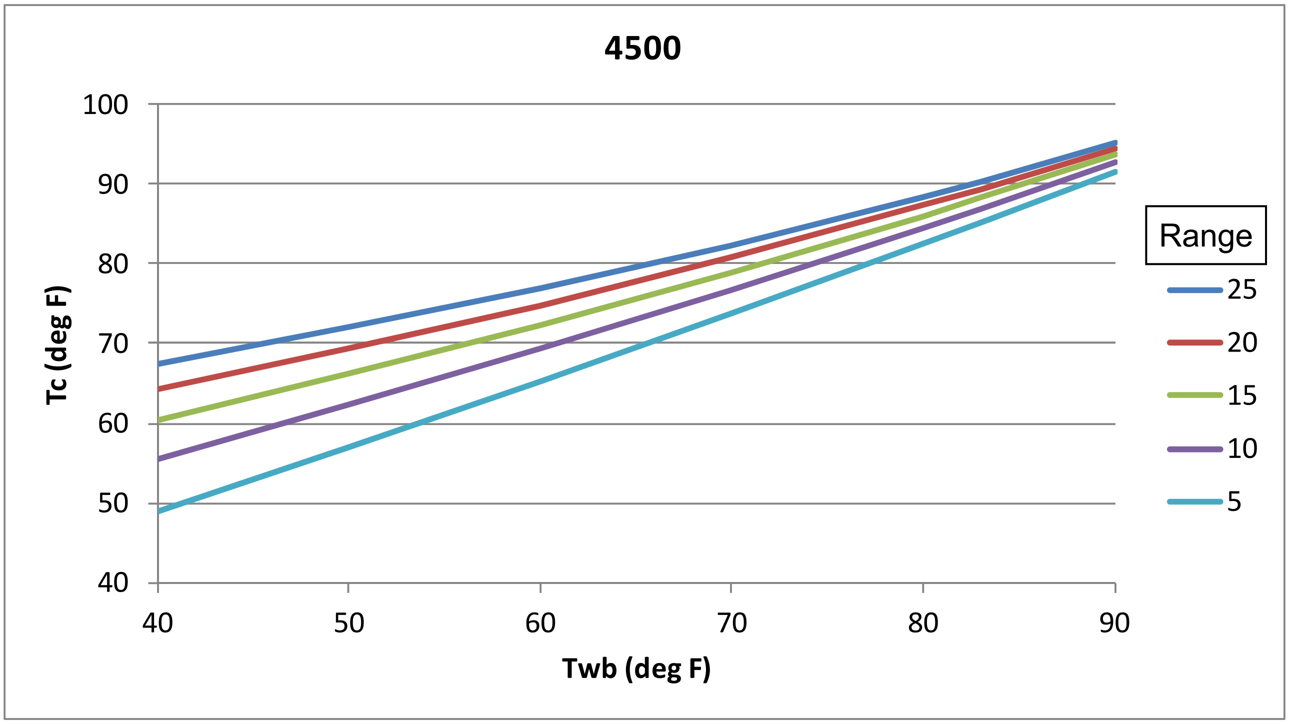


Figure D- 8: 6 Fan Operation, 4500 gpm ACCW

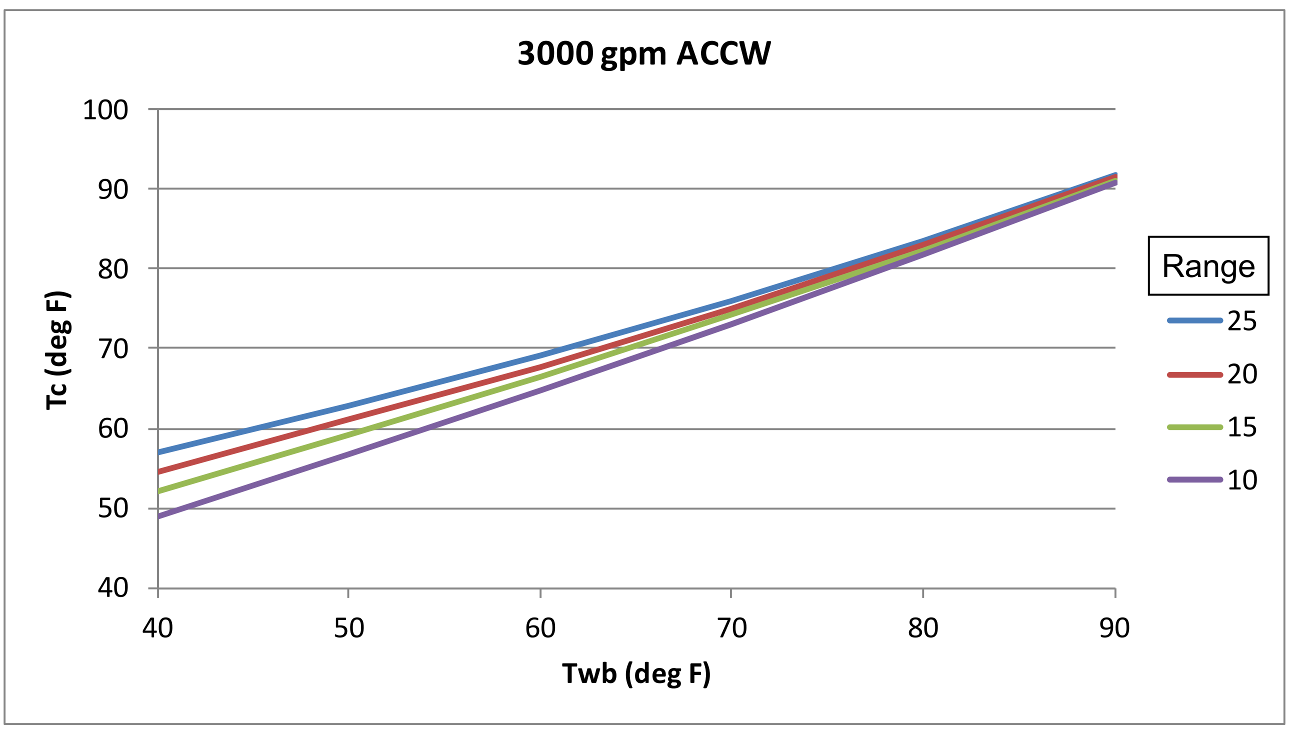


Figure D- 9: 6 Fan Operation, 3000 gpm ACCW

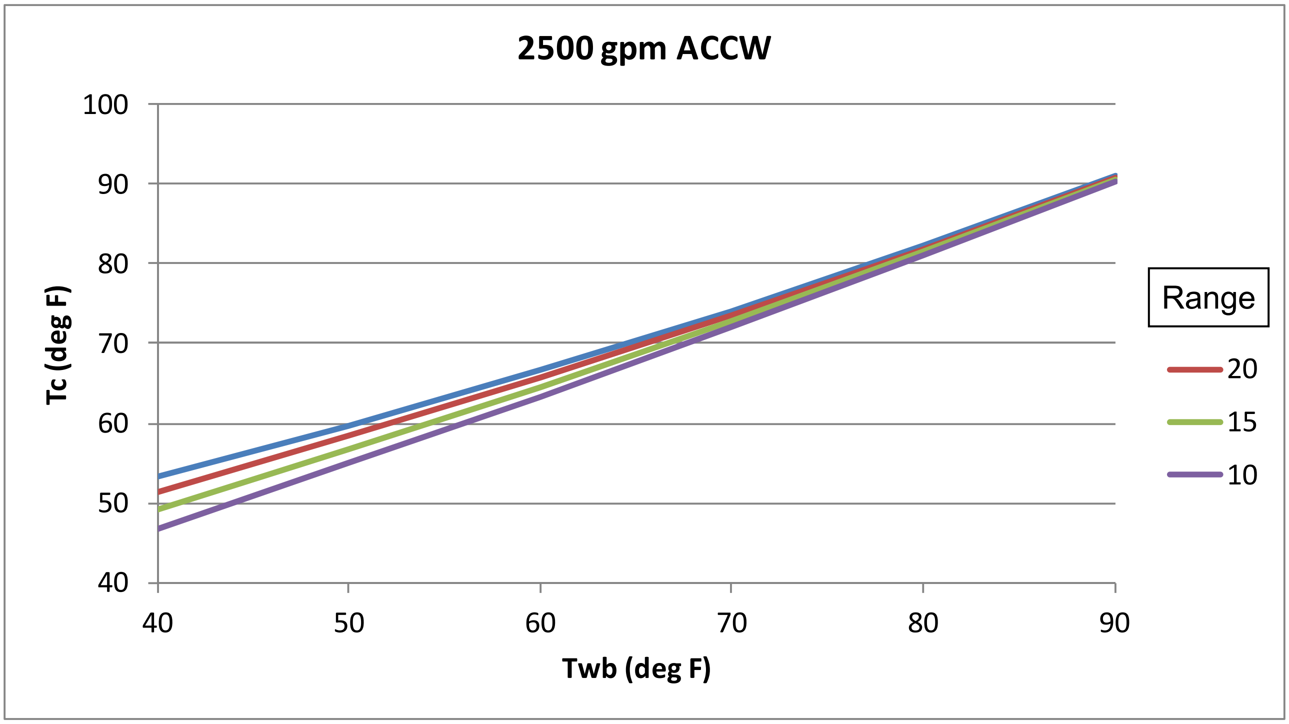


Figure D- 10: 6 Fan Operation, 2500 gpm ACCW

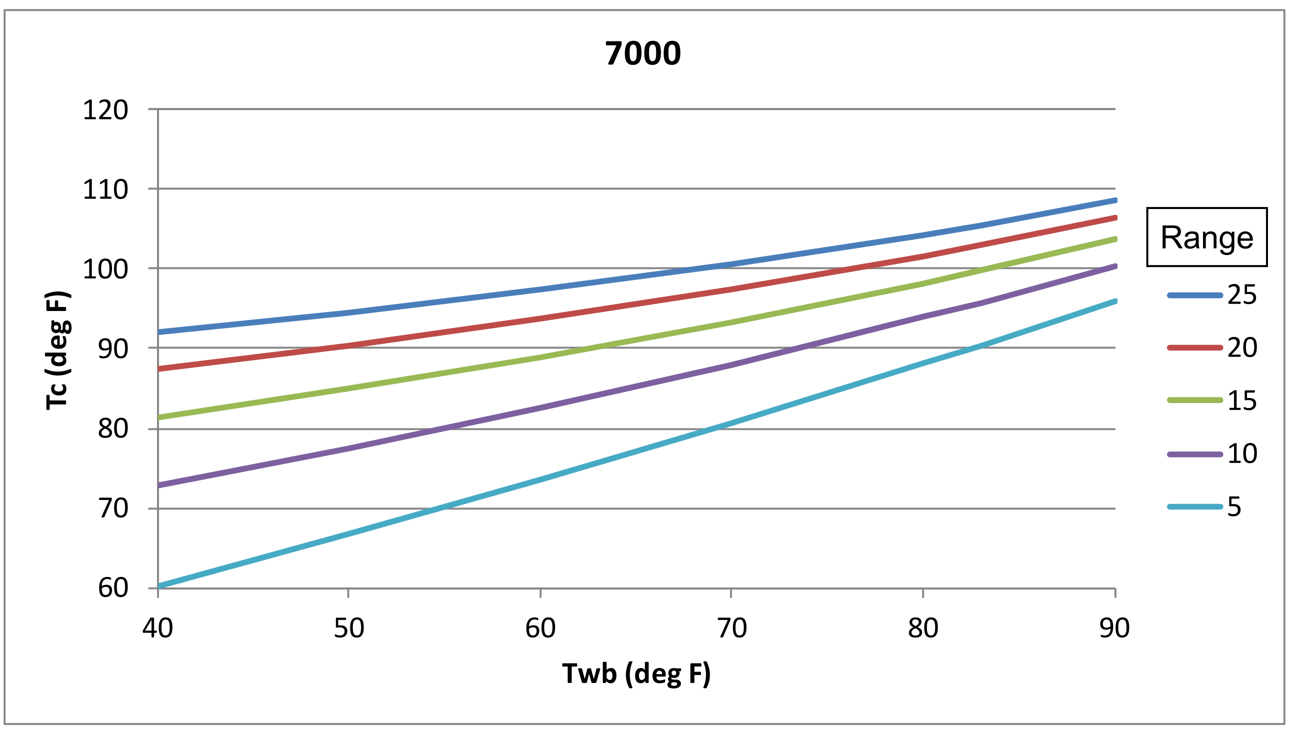


Figure D- 11: 4 Fan Operation, 7000 gpm ACCW

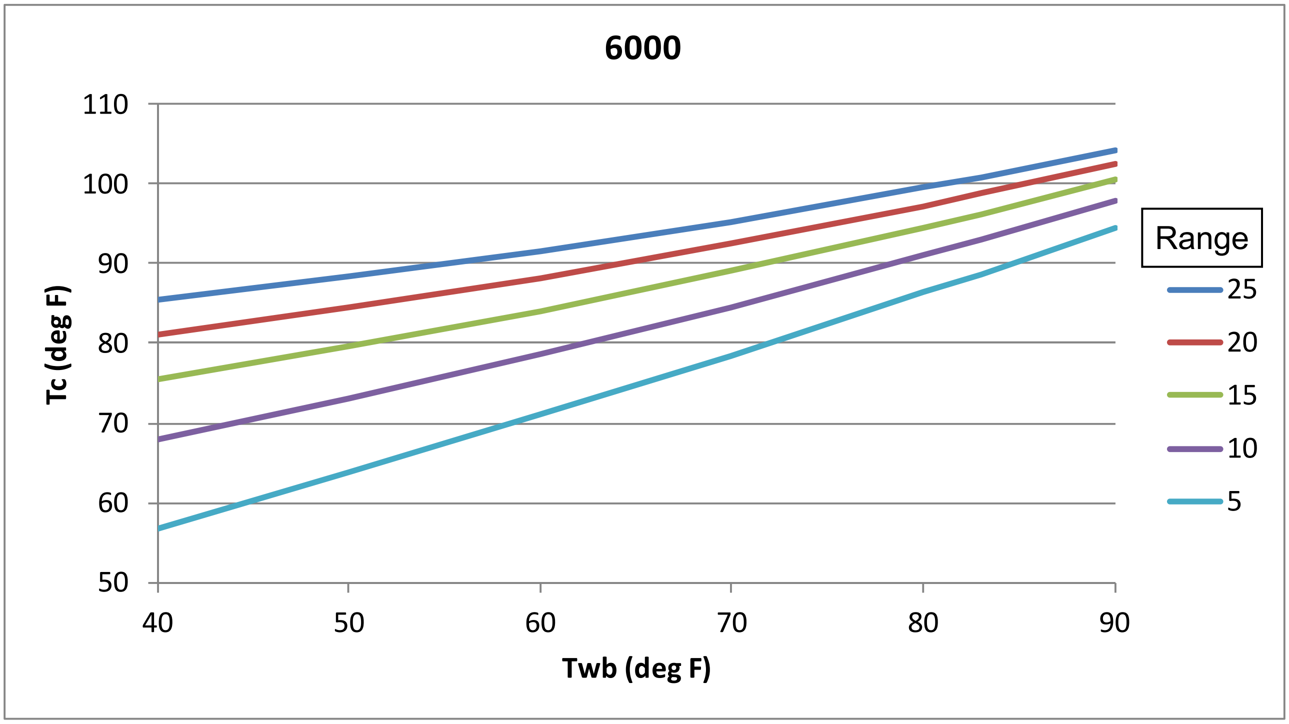


Figure D- 12: 4 Fan Operation, 6000 gpm ACCW

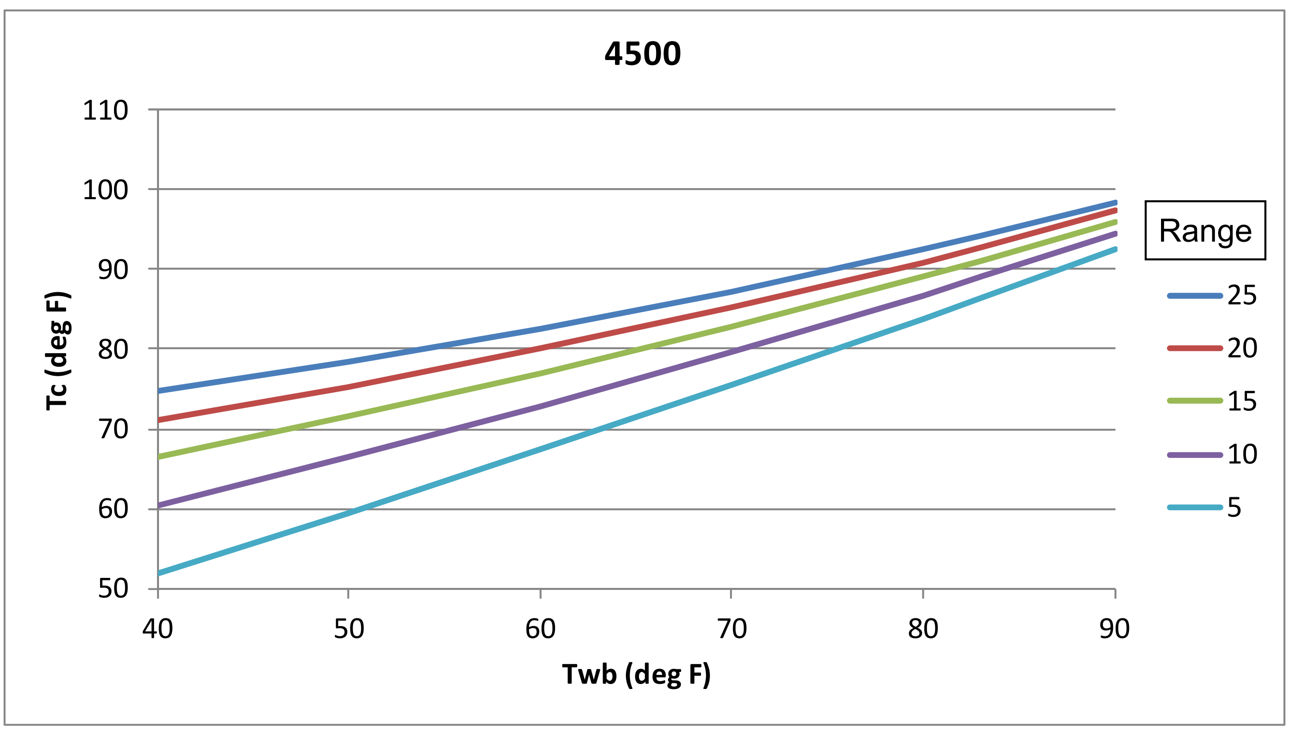


Figure D- 13: 4 Fan Operation, 4500 gpm ACCW

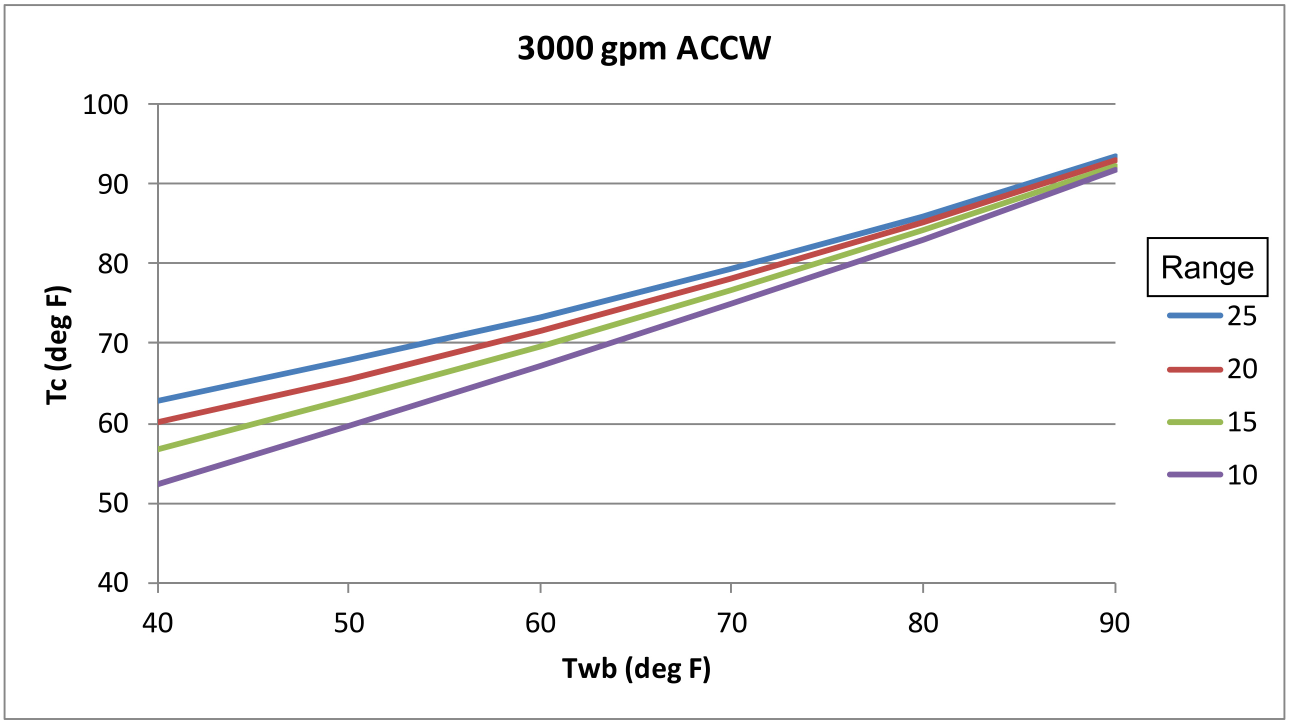


Figure D- 14: 4 Fan Operation, 3000 gpm ACCW

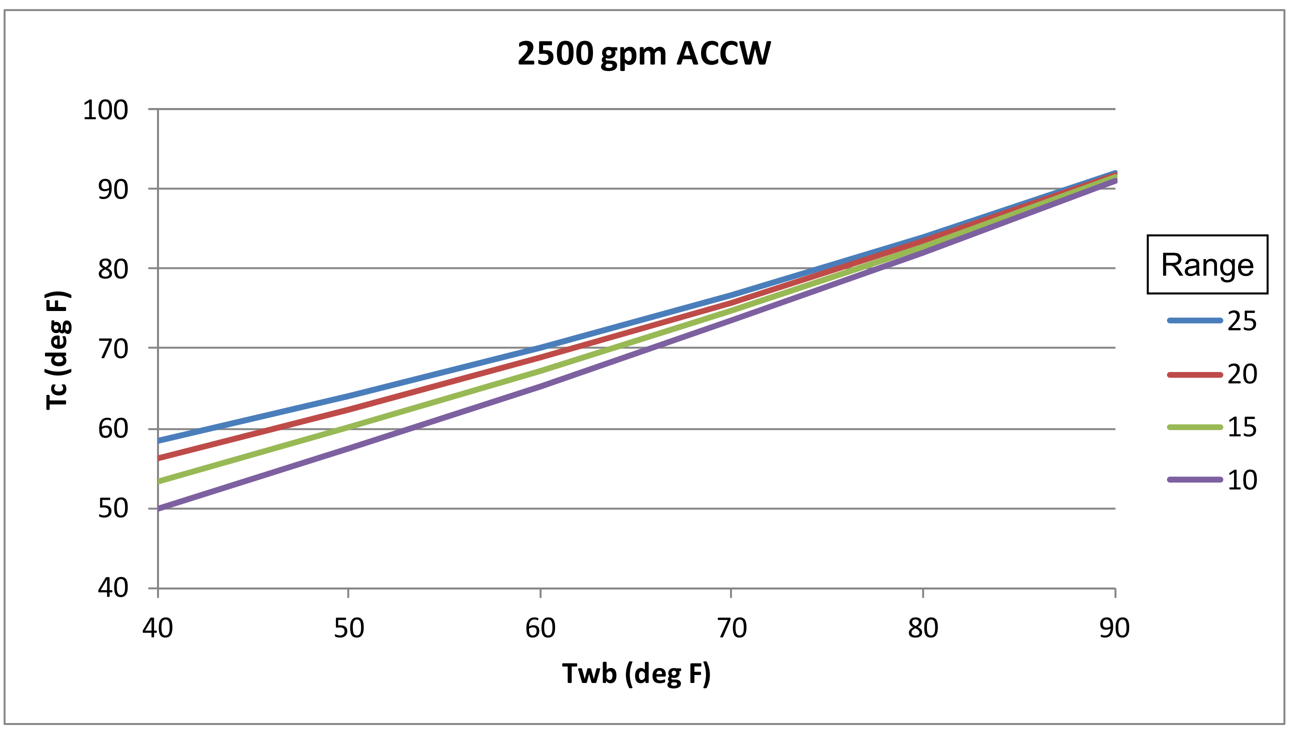


Figure D- 15: 4 Fan Operation, 2500 gpm ACCW

Waterford 3 Wet Cooling Tower Natural Draft Thermal Performance Curves
[Performance With All Fans Shut Down; ACCW Flow Rate = 6,500 gpm]

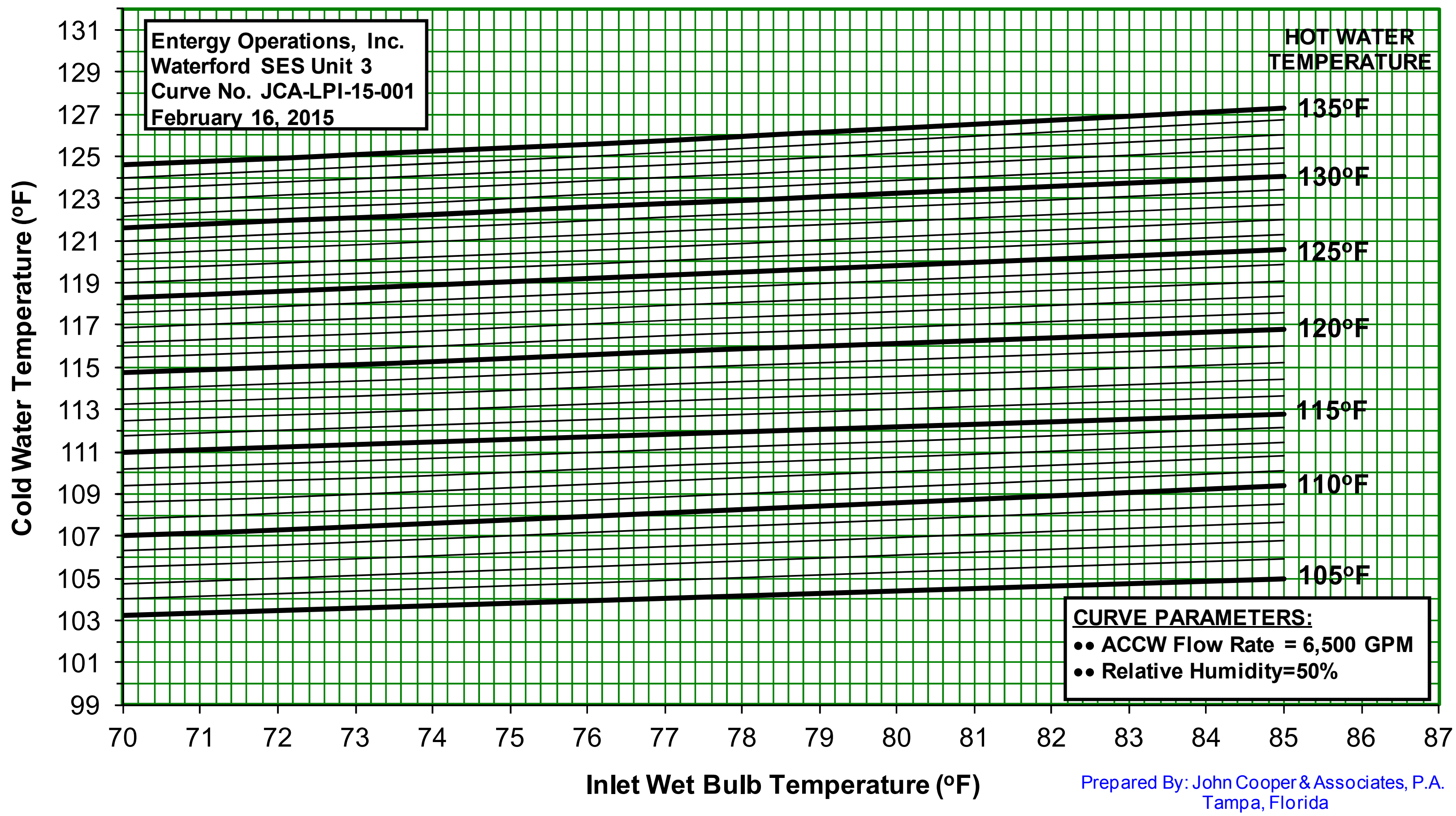
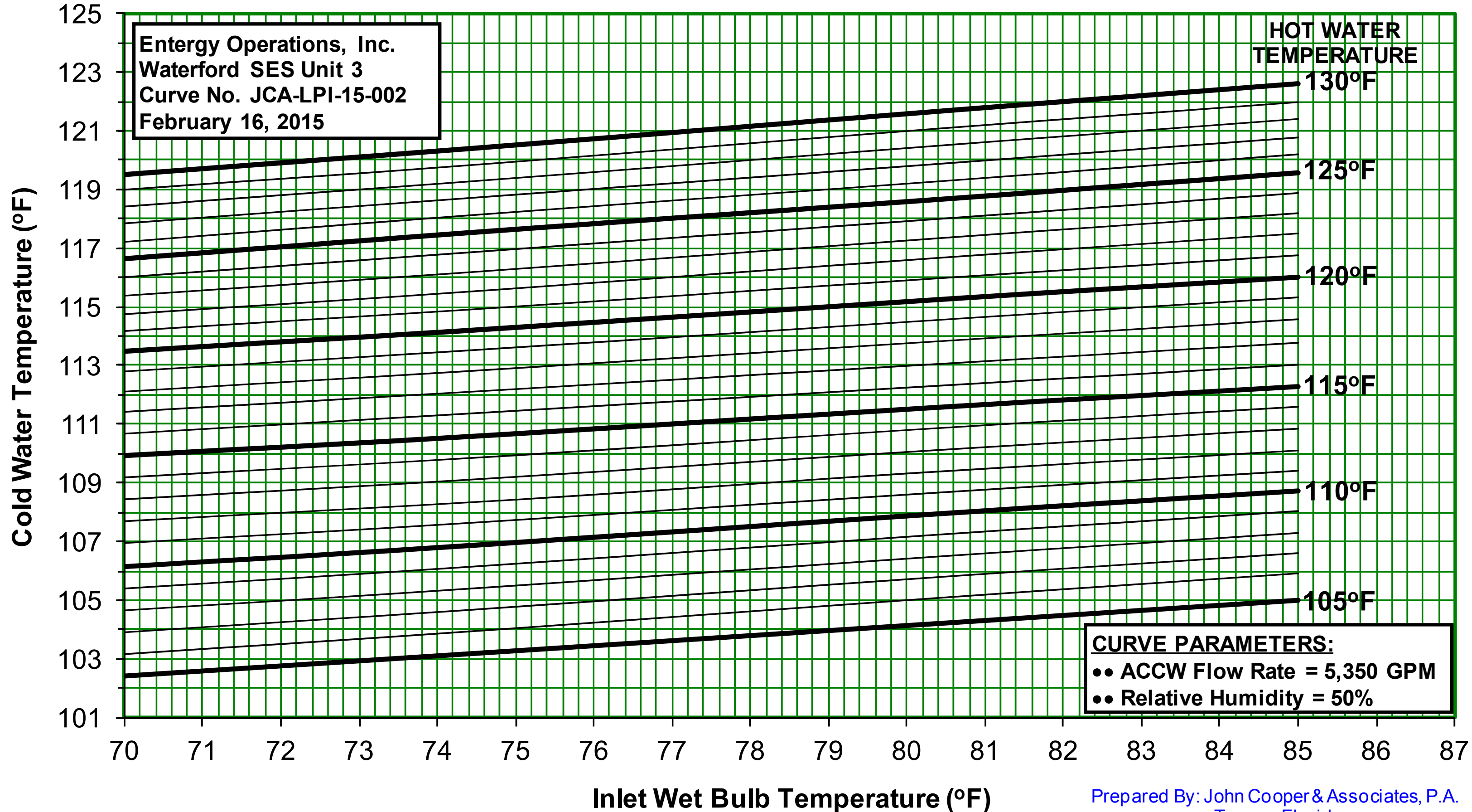


Figure D- 16: WCT Natural Draft Performance at 6500 gpm

Waterford 3 Wet Cooling Tower Natural Draft Thermal Performance Curves
[Performance With All Fans Shut Down; ACCW Flow Rate = 5,350 gpm]



Prepared By: John Cooper & Associates, P.A.
Tampa, Florida

Figure D- 17: WCT Natural Draft Performance at 5350 gpm

Waterford 3 Wet Cooling Tower Natural Draft Thermal Performance Curves
[Performance With All Fans Shut Down; ACCW Flow Rate = 4,200 gpm]

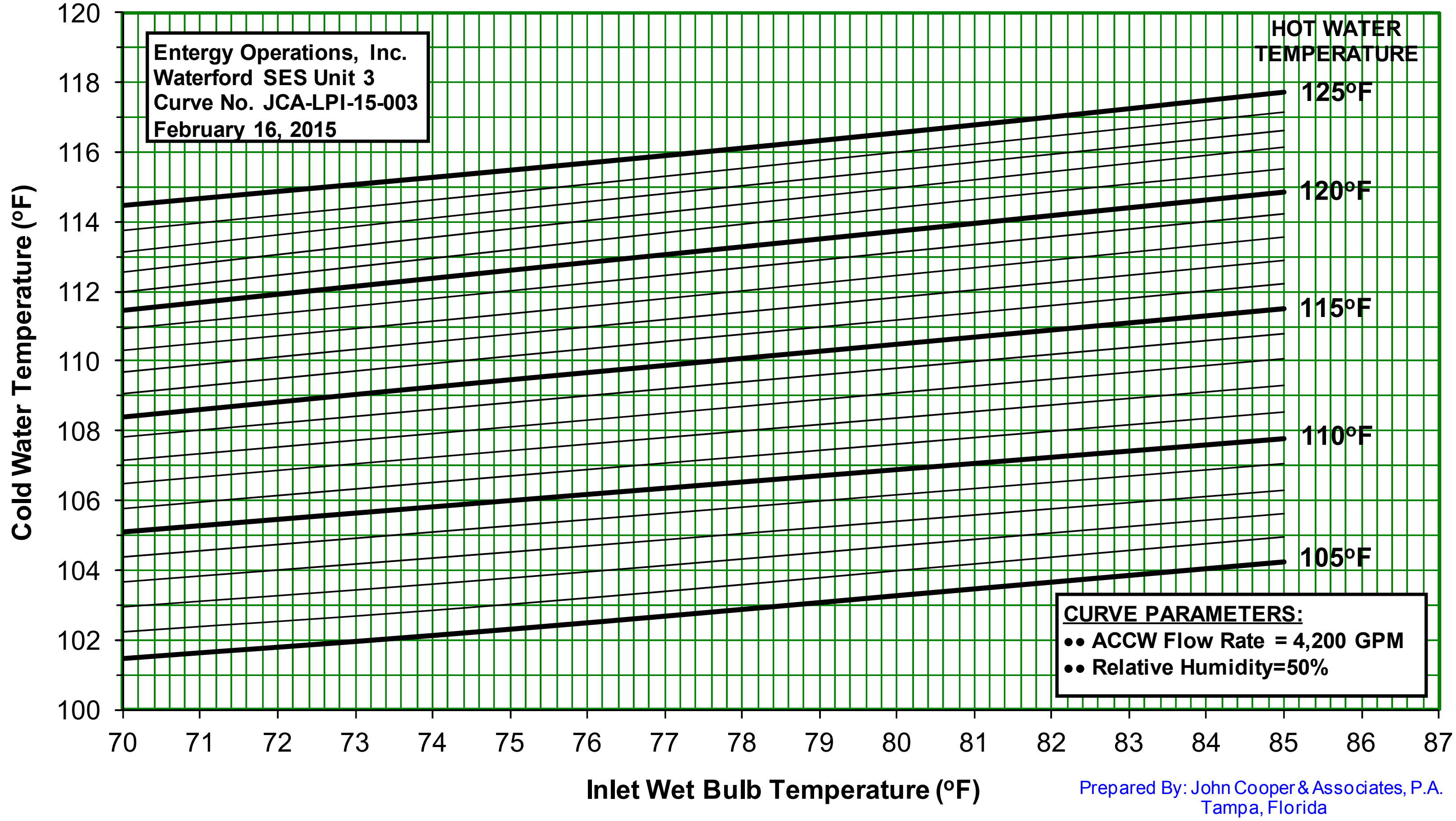
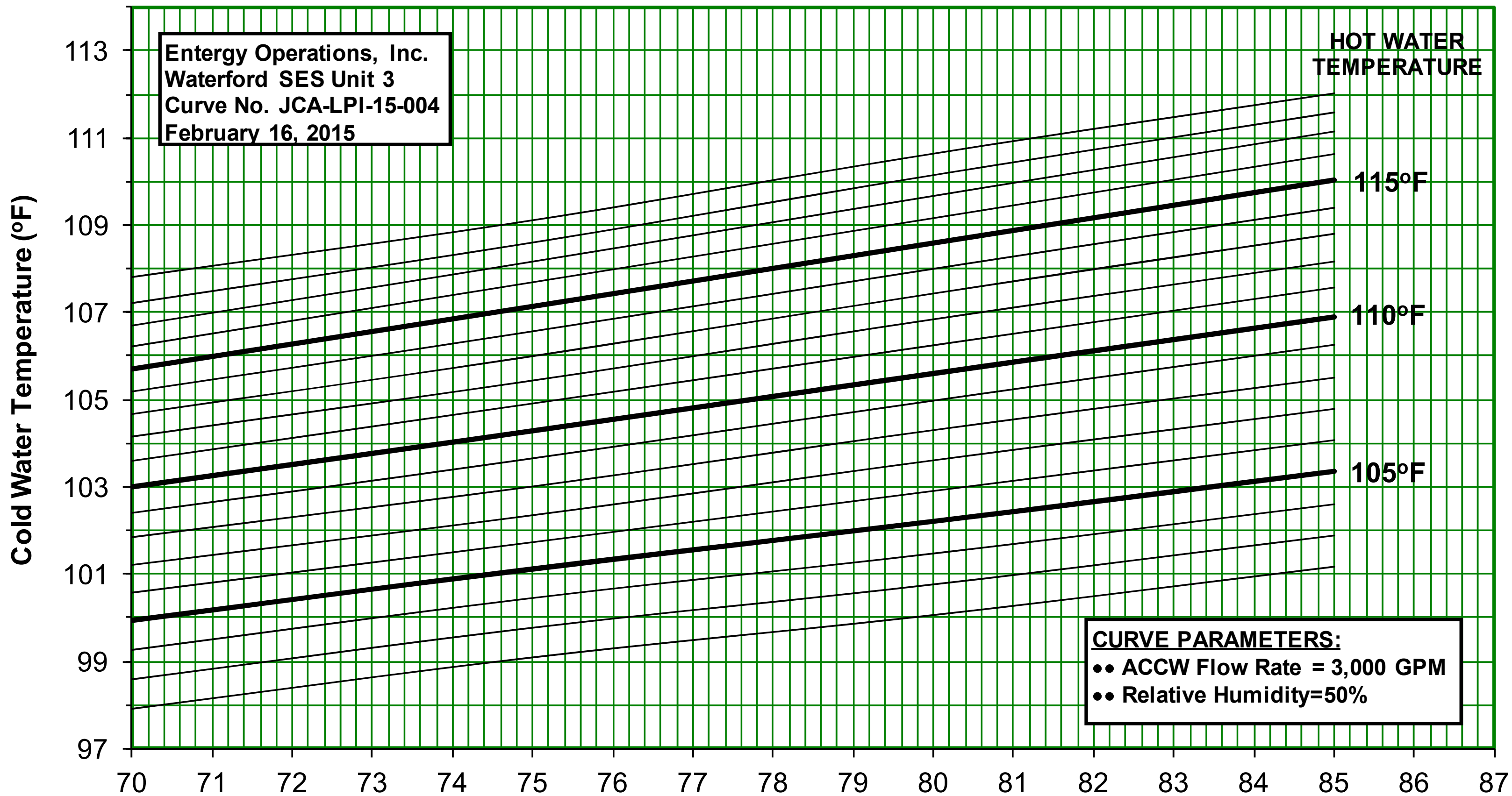


Figure D- 18: WCT Natural Draft Performance at 4200 gpm

Waterford 3 Wet Cooling Tower Natural Draft Thermal Performance Curves [Performance With All Fans Shut Down; ACCW Flow Rate = 3,000 gpm]



Prepared By: John Cooper & Associates, P.A.
Tampa, Florida

Figure D- 19: WCT Natural Draft Performance at 3000 gpm

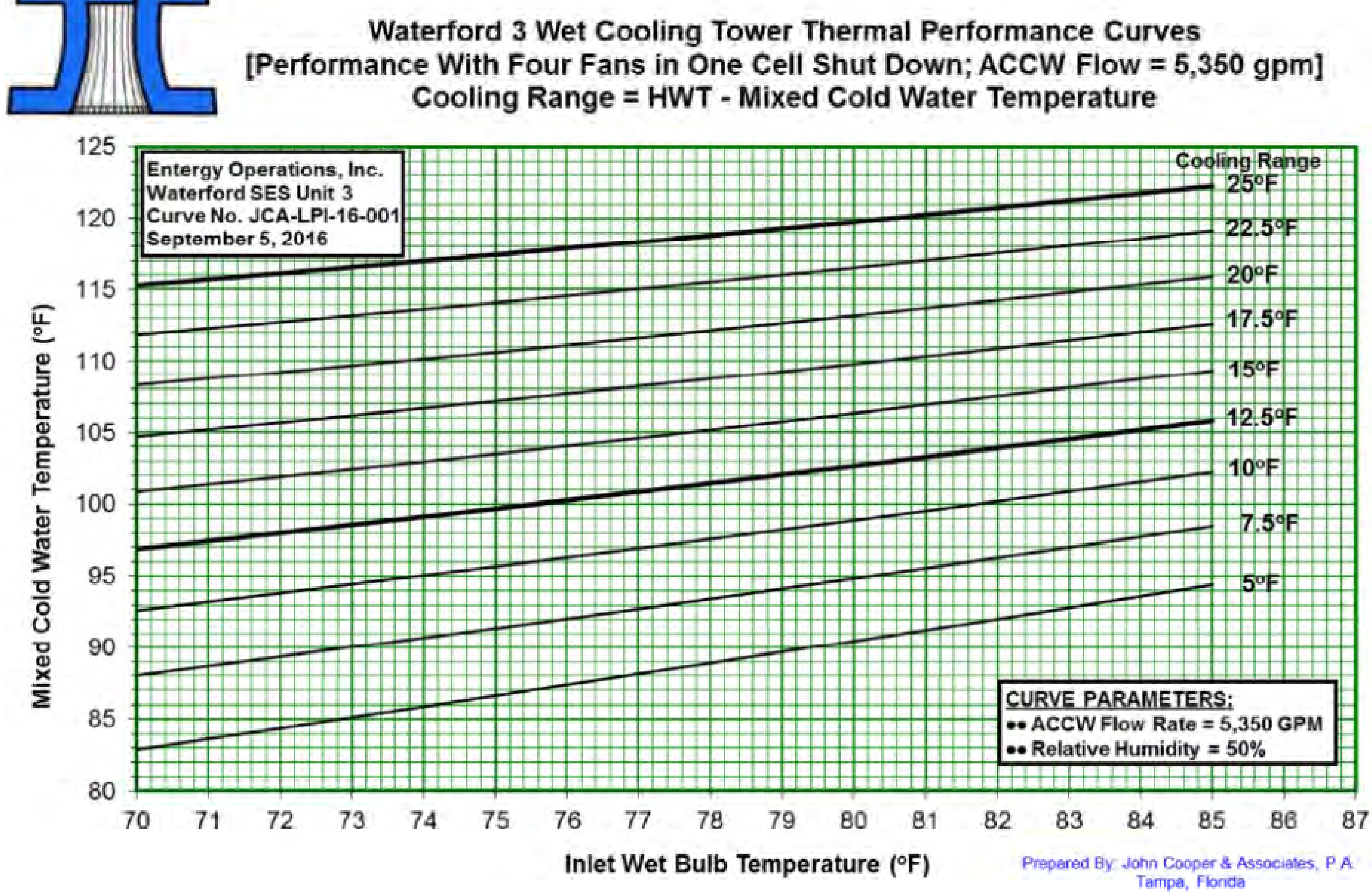


Figure D- 20: WCT 4 Fans in 1 Cell Out of Service at 5350 gpm

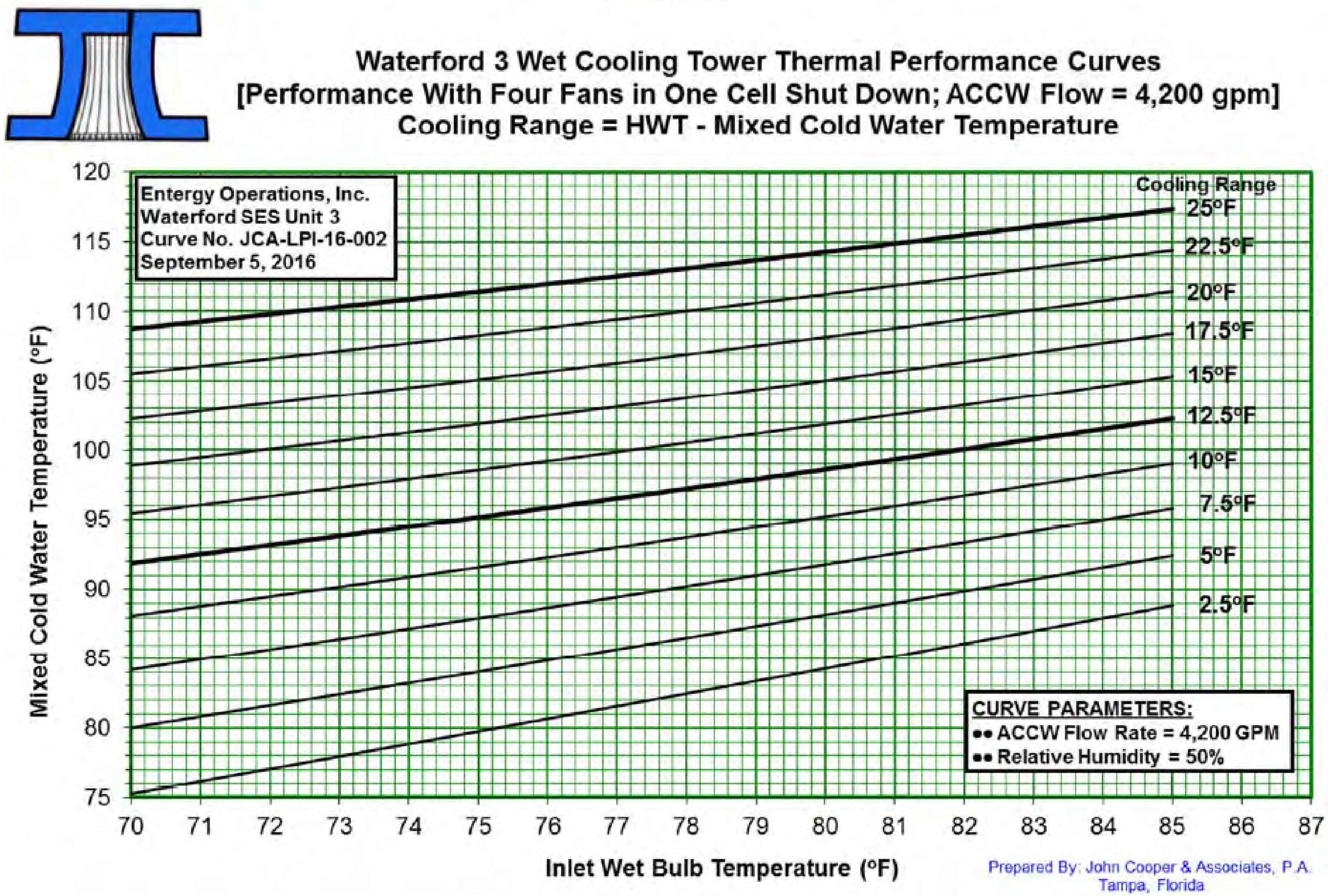


Figure D- 21: WCT 4 Fans in 1 Cell Out of Service at 4200 gpm

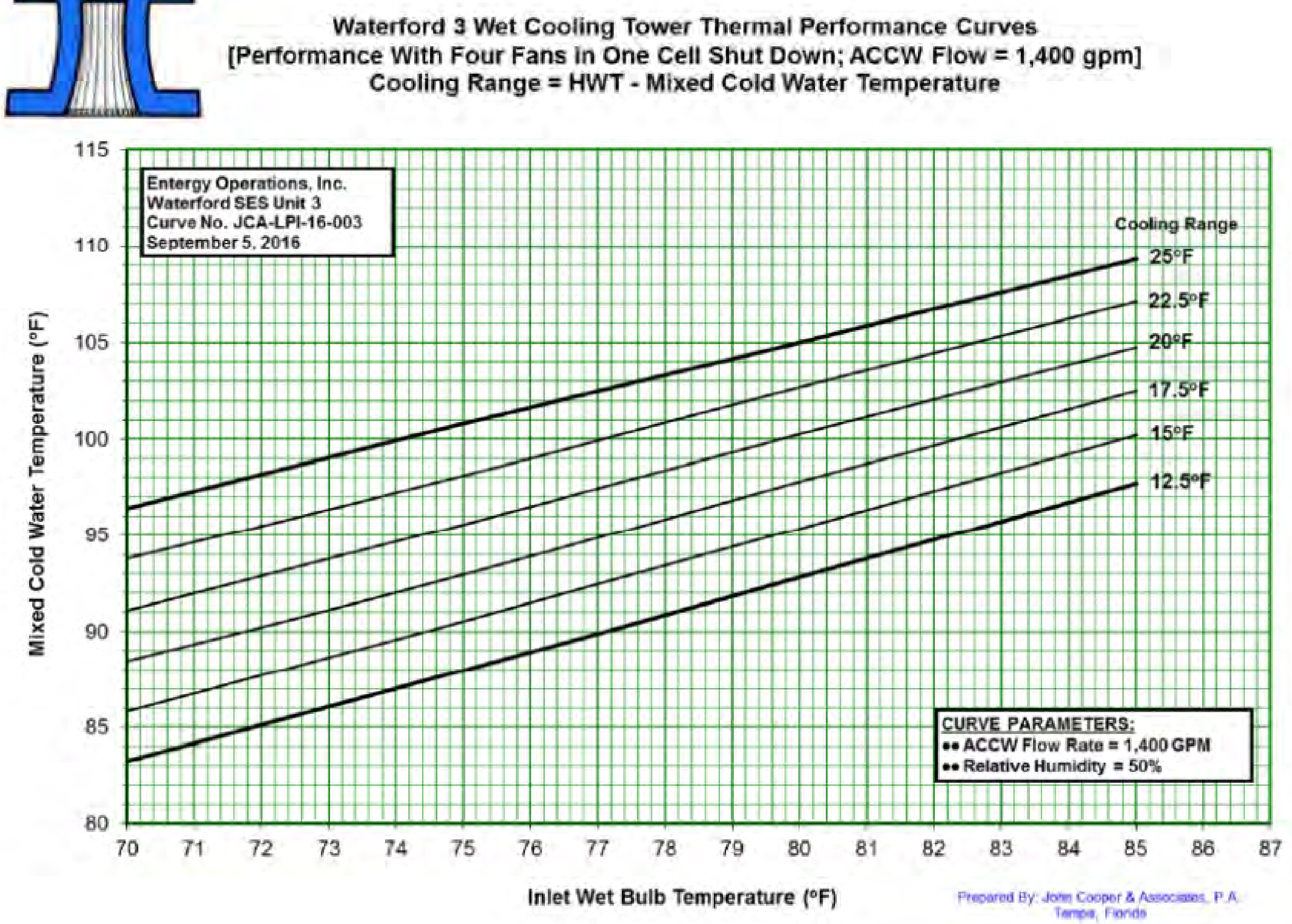


Figure D- 22: WCT 4 Fans in 1 Cell Out of Service at 1400 gpm

VENDOR DOCUMENT COMMENT RESOLUTION

Document No: A13326-R-003 (WF3-ME-15-00013) Rev. No: 3 EC No: 52043 (N/A for NP)

Document Title: WATERFORD 3 ULTIMATE HEAT SINK PROJECT UHS MODEL

Reviewer: Alex Tojeiro / See EC (Print Name/ Signature) 2/13/17 (Date) Ext. 504-739-6304

Comment No:	Page No:	Section No:	Comment:	Disposition I/O*	Resolution:
1.	20, 30, A-33	p.20: 3.2.2 p.30: 4.3 p.A-33: U_{tubeC}	DCT performance curves are described in paragraph 2 as discussing fouling not being considered. However, the design basis internal fouling is applied in the calculated U factor for the DCT Model in order to benchmark to the "service" U value in 1564-4983. The U value should be benchmarked to both the clean U value of 142 with all fouling set to zero and then to the service value of 119.5 with fouling applied.	I	As noted, the DCT curves are described as a non-fouled condition per Section 3.2.2. However, an overall heat transfer coefficient (U) developed in Att. A matches the "service" condition (119 BTU/hr-ft^2-F) and not a "clean" condition (142 BTU/hr-ft^2-F), and the DCT performance of 100 MBTU/hr is more closely matched by this U value. The statement under section 3.2.2 should be removed and the clean benchmark added to Att. A. The "service condition" U value will therefore continue to be used to modify the air flow effect using the Hudson curves.
2.	A-26	References	DCT-2 reference needs to be corrected to 1564-4983	I	OK.
3.	A-31	Extrapolation	What is the basis for extrapolating the model to 1 DCT coil isolated (90% area)? The linear extrapolation is non-conservative since the model predicts only about 20% loss of performance with all coils isolated, which does not make physical sense.	O	The area available is limited to 100-95% only, and 90% is not currently supported. Per page 15, "Pdct: The user may select the percentage of DCT area available to reflect plugging or other changes to available tube area. The Hudson Products heat transfer curves for 100% area and 95% area are interpolated to provide reduced heat transfer between these two area conditions. The user should exercise caution for values beyond this range (see also Section 4.3)." Per Section 4.3 "The user may select a percentage area between these two values, and the DCT heat transfer performance is

VENDOR DOCUMENT COMMENT RESOLUTION

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Reviewer: Alex Tojeiro / See EC 2/13/17 Ext. 504-739-6304
Print Name/ Signature Date

Comment No:	Page No:	Section No:	Comment:	Disposition I/O*	Resolution:
					interpolated”
4.	A-33	h_{air2}	This equation does not match (Nusselt number equivalent) equation 7.58 in editions 1, 2, 5, and 7 of the text. The equation appears to be the Grimison correlation for tube banks, where the correct reference is equation 7.50 (1st edition of Incropera).	I	The base equation is 7.58 from Incropera 2nd edition with modification per EQ 7.60, 7.61 Table 7-6. Note added to DCT worksheet.
5.	A-33	h_{air2}	The Grimison correlation used is missing a 1.13 multiplier. (see previous comment)	I	equation modified to form without Pradtl number and 1.13 factor
6.	A-33	h_{air2}	What is the basis for using the average diameter (fin vs. tube) when determining the S_T/d for the constants used in the Grimison correlation's convection coefficient?	O	This simplified method is used for determining an air flow correction to the provided Hudson curves. Since the DCT performance change is <3% for all expected air flows, this method is considered reasonable.
7.	A-33	U_{tubeC}	How is using only a fin-to-tube area ratio addressing fin efficiency? I would expect the resistance term to look similar to the following using the existing Mathcad terms: $R_{fin} = \frac{1}{h_{air2}\left(\frac{Q}{181}\right)^{m2}\left[1-\frac{A_{finC}}{A_{tubeOD}}(1-n_f)\right]}$ where n_f is the fin efficiency. (Ref. Incropera) Fin thickness is approximately 0.015 inches per field measurements of ten	I	DCT air correction term modified to include fin efficiency.

VENDOR DOCUMENT COMMENT RESOLUTION

Document No: A13326-R-003 (WF3-ME-15-00013) Rev. No: 3 EC No: 52043 (N/A for NP)

Document Title: WATERFORD 3 ULTIMATE HEAT SINK PROJECT UHS MODEL

Reviewer: Alex Tojeiro / See EC (Print Name/ Signature) 2/13/17 (Date) Ext. 504-739-6304

Comment No:	Page No:	Section No:	Comment:	Disposition I/O*	Resolution:
			fins using calipers (deviation ± 0.001 inches maximum between fins).		
8.	A-33	U_{tubeC}	Allow the provided internal fouling factor to be user-modified, and add a user-modifiable variable for external fouling. This model is intended to also be used potentially in support of operability evaluations and such flexibility would be extremely useful.	O	The current approach is to use the Hudson products curves as a basis for the DCT performance. The air flow modification changes these curves slightly (<3% for predicted air flow range) and is considered a small change. However, a fouling factor would affect the performance significantly (maybe 20%), and it appears (See #1 above) that the service condition already includes a fouling factor. This change would require a change in scope.
9.	A-33	U_{tubeC}	This value should be benchmarked against both the clean and in-service U values provided in the specification by adjusting fouling factor(s) between zero and maximum allowed.	I	Added to DCT worksheet. See also item 1 above
10.	A-27, A-30	Graphs	Bottom graphs on these pages do not have a legend.	I	Graphs modified to include legend.
11.	A-35 – A-37	M	All data tables after the first do not show N_Fans column. Based on the use of this M dataset, several values of N_Fans should exist.	I	Tables modified to include number of fans.
12.	A-39	T_{wct}	This function appears to also be based on the number of fans in service, where unavailable/inoperable fans are split between cells. Would the model allow for situations such as two fans out of service in one cell, with all available in the other cell? Clarify this in the	O	Please see the description of the curves provided in Att D. The limited operation curves were developed using the assumption that out of service fans are covered to prevent short circuit flow from adjacent operating fans, and no restrictions were developed for numbers of fans out of

VENDOR DOCUMENT COMMENT RESOLUTION

Document No: A13326-R-003 (WF3-ME-15-00013) Rev. No: 3 EC No: 52043 (N/A for NP)

Document Title: WATERFORD 3 ULTIMATE HEAT SINK PROJECT UHS MODEL

Reviewer: Alex Tojeiro / See EC (Print Name/ Signature) 2/13/17 (Date) Ext. 504-739-6304

Comment No:	Page No:	Section No:	Comment:	Disposition I/O*	Resolution:
			Mathcad worksheet.		service within a specific cell, i.e. 2 fans out in one cell was considered equivalent to 1 fan out in each of 2 cells.
13.	A-42	WCT_Test	Column for Q values has three blank cells, but based on Q2 value later these values appear to be entered. Adjust table so these values are visible.	O	As reported in the table, no Q data was recorded for these tests. This is described in the paragraph immediately following the table. "For comparison to tests, replace zero recorded heat removal (Q) from test with calculated values based on flow and temperature change." The data set is presented as Q2.
14.	A-43	p_{ws}, p_w	Clarify that these variable outputs are in units of psia.	I	OK, Added
15.	A-45	Q_{wct}	Variable CO is introduced yet undefined. This appears to be the number of cells out of service. Clarify or reuse variable WCTCO (see p.A-40).	O	CO is used as a test variable (on/off switch) within the WCT worksheet and does not represent a defined variable within the overall UHS1. This practice is used throughout to avoid conflicts with the main UHS1 worksheet.
16.	A-49	References & Input Data	Specification 1564.75 does not contain all the inputs provided. Several are found in 5817-10747 and 5817-10750. Include all references used.	I	OK. References added.
17.	A-52	Dittus-Boetler Eqn.	Prandtl number exponent should be 0.3, not 0.4. 0.3 is for T_s>T_m.	I	OK. Note added to describe better fit with given exponent.
18.	A-53	UERR	This error comparison should also benchmark the U value with specification 1564.75 values for clean tubes without plugging (U=429) and fouled with 5% plugging (U=292.61) using the provided inlet temperatures.	I	OK. Clean HX benchmark added.

VENDOR DOCUMENT COMMENT RESOLUTION

Document No: A13326-R-003 (WF3-ME-15-00013) Rev. No: 3 EC No: 52043 (N/A for NP)

Document Title: WATERFORD 3 ULTIMATE HEAT SINK PROJECT UHS MODEL

Reviewer: Alex Tojeiro / See EC 2/13/17 Ext. 504-739-6304
Print Name/ Signature Date

Comment No:	Page No:	Section No:	Comment:	Disposition I/O*	Resolution:
			As currently performed, there is no indication this model will be accurate at modeling with fewer than the design basis number of plugged tubes.		
19.	A-58	$T_{R\_A}(51)$	Test value of 51 is extrapolating. Why did this function not use a "otherwise" condition to bound it at a maximum recirculation of 5.6, similarly to how T_{R_B} was defined?	O	The extrapolation demonstrates that T_{R_A} remains < T_{B_B} through hurricane level winds (51 mph). Therefore, T_{R_B} is conservative and T_{R_A} is not used.
20.	A-7	Item 5-7	Equation starting with Q_{EC}/N_{UHS} incorrectly assumes two trains of UHS will equally split heat load from one chiller. Two trains of UHS will require two trains of chillers in operation due to the need to support room cooling for each train's CCW pump room. Remove the division by N_{UHS} and consider 2^*Q_{EC} in the event where two trains of UHS are available.	I	OK. EQ modified
21.	A-11	SET1	Displayed value of P_{dct} does not have enough precision. Value should display 0.9975.	I	OK. Display precision modified.

*I = Included, O = Omitted

RE: LPI – See Report A13326-R-003 Rev 4 See Report A13326-R-003 Rev 4
Print Name/ Signature Date

ENCLOSURE, ATTACHMENT 4

W3F1-2019-0005

Attachment 4: Engineering Report WF3-ME-15-00014

ENTERGY NUCLEAR
Engineering Report Cover Sheet

Engineering Report Title:
Waterford 3 Ultimate Heat Sink CFD Investigation of the Dry Cooling Tower Deflector Wall Modification

Engineering Report Type:

New ☒ Revision ☐ Cancelled ☐ Superseded ☐
Superseded by: ______

Applicable Site(s)

IP1	☐	IP2	☐	IP3	☐	JAF	☐	PNPS	☐	VY	☐	WPO	☐
ANO1	☐	ANO2	☐	ECH	☐	GGNS	☐	RBS	☐	WF3	☒	PLP	☐

EC No. 52043

Report Origin: ☐ Entergy ☒ Vendor
Vendor Document No.: A14386-R-001

Quality-Related: ☒ Yes ☐ No

Prepared by:	LPI, Inc. Responsible Engineer (Print Name/Sign)	Date:	See Vendor Report
Design Verified:	LPI, Inc. Design Verifier (if required) (Print Name/Sign)	Date:	See Vendor Report
Reviewed by:	Dale V. Gallodoro / See EC-52043 Reviewer (Print Name/Sign)	Date:	See EC-52043
Approved by:	Nicholas Petit / See EC-52043 Supervisor / Manager (Print Name/Sign)	Date:	See EC-52043

LPI, Inc. Consulting Engineers

Advanced Analysis & Fitness for Service
Failure & Materials Evaluation
Nondestructive Engineering
Est. 1885

WATERFORD3 ULTIMATE HEAT SINK: CFD INVESTIGATION OF THE DRY COOLING TOWER DEFLECTOR WALL

Report No.:
A14386-R-001
Revision No: *2*

August 2017

Prepared For
ENTERGY OPERATIONS, INC.
Waterford3 Steam/Electric Plant

Prepared By
LPI, Inc.

Lucius Pitkin – established 1885
36 Main Street • Amesbury, MA 01913 • 978.517.3100
New York • Boston • Richland • Sydney • www.lpiny.com

DOCUMENT RECORD					
Document Type:	☐ Calculation ☒ Report ☐ Procedure				
Document No:	**A14386-R-001**				
Document Title:	**WF3 UHS CFD Investigation of the DCT Deflector Wall**				
Client:	Entergy Nuclear Operations, Inc.				
Client Facility:	Waterford3 Steam/Electric Plant				
Client PO No:	10478555-01				
Quality Assurance:	**Nuclear Safety Related?** ☐ No ☒ Yes				
Computer Software Used:	☐ No[1] ☒ Yes[2]	1. Check NO when EXCEL, MathCAD and/or similar programs are used since algorithms are explicitly displayed. 2. Include Software Record for each computer program utilized			
Instrument Used	☒ No ☐ Yes[3]	3. Include Document Instrument Record.			

Revision	Approval Date	Preparer[5]	Checker[5]	Design Verification[5]	Approver[4,5]
0	4/18/16	L. K. Wong	Gregory Zysk	Alfred Chock	Paul Bruck
1	10/4/2016	L. K. Wong	Gregory Zysk	Alfred Chock	Paul Bruck
2	8/18/2017	Gregory Zysk	Alfred Chock	Alfred Chock	Paul Bruck

[4] The Approver of this document attests that all project examinations, inspections, tests and analysis (as applicable) have been conducted using approved LPI Procedures and are in conformance to the contract/purchase order.
[5] Electronic signatures may be used only with prior concurrence.

Page 2 of 425 Total Pages (include any Title Sheet and Attachments in page count. Document Back Cover, if utilized, not included in page count)

Form: LPI-3.1-Rev-8-Fig-5-2

	DESIGN VERIFICATION CHECKLIST						
	Document No(s)[1]:	A14386-R001			Rev.:	2	
	Review Method:		Document Review		Alternate Calculation		Test

	Criteria	DV[2]
1	Were the inputs correctly selected and incorporated into design?	AC
2	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed? If applicable, has an as built verification been performed and reconciled?	AC
3	Are the appropriate quality and quality assurance requirements specified?	AC
4	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?	AC
5	Have applicable construction and operating experience been considered, including operation procedures?	AC
6	Have the design interface requirements been satisfied?	n/a
7	Was an appropriate design method used?	n/a
8	Is the output reasonable compared to inputs?	AC
9	Are the specified parts, equipment, and processes suitable for the required application?	n/a
10	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	n/a
11	Have adequate maintenance features and requirements been specified?	n/a
12	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?	n/a
13	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?	n/a
14	Has the design properly considered radiation exposure to the public and plant personnel?	n/a
15	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	AC
16	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	n/a
17	Are adequate handling, storage, cleaning and shipping requirements specified?	n/a
18	If software was used, have the computer type and operating system been properly identified? Is use of the software, hardware and O/S appropriate for the conditions, components evaluated? Has a V&V been performed?	n/a
19	Are requirements for identification, record preparation review, approval, retention, etc., adequately specified?	n/a
20	Has an internal design review been performed for applicable design projects? Have comments from the Internal Design Review been appropriately considered/addressed?	AC

(1) Include any drawings developed from reviewed documents, or include separate checklist sheet for drawings
(2) Design Verifier shall initial indicating review and mark N/A where not applicable

DV Completed By:	Printed Name: Al Chock	Signature: [signature]	Date: 8/17/2017

Page	1	of	1	Total Pages	(include DV Checklist and Comment Resolution sheets in page count)

Form: LPI-3.1-Rev-8-Fig-5-5

Document Software Record[1]

(include separate sheet for each software package used)

1	**Computer Software Used** (Code/Version)	ANSYS CFX/Version 14.0
2	**Software Supplier**	ANSYS, Inc., Southpointe, 275 Technology Drive, Canonsburg, PA, 15317
3	**Software Update Review**	☒ Error notices; describe: Reviewed error report ☐ Other; describe:
4	**Nuclear Safety Related Software**	☐ NO ☒ YES[2] [2] If YES, complete the following: Computer type: DellT7500-4 Computer S/N: HC74VR1 Computer O/S: Windows XP x64 Edition V & V (include as ref): [14] See Attachment G
5	**Bases for Application**	Identify the bases that support use of this software for the application herein; may be separately discussed elsewhere in this document (indicate section) and/or may be addressed in the V&V (identify reference number): See section 1
6	**Input Listing/Summary**[3]	☐ Input listing and/or summary attached: ☒ Not attached: Inputs are listed in the output file
7	**Output Data/Identifier(s)**[3]	☐ Output results attached: See below** ☒ Not attached; identify File/Disc ID: **Selected Output information included in calculation
	[3]e.g., run date/time; use for reference, as appropriate, within body of calculation	
8	**Comments**	
9	**Keywords**[4]	Steady state, Buoyancy model, k Omega, SST, turbulence, thermal energy, total energy, ideal gas
	[4]For use in describing software features used in this calculation; use common terms based on software user manual and/or help files.	
10	**Project Manager Name:**	Gregory Zysk

[1] If computer software is used on project, complete form with required information.
Update the LPI Computer Software Use List per LPI Procedure 13.1 requirements.

Form: LPI-3.1-Rev-5-Fig-5-8

Record of Revision

Revision No.	Date	Description of Change	Reason
0	4/18/16	Original issue	
1	10/4/2016	Primary changes affect Sections 3.2, 3.4, 4.2, 4.4, 4.6, 4.7, 4.8, and Atts. A & B.	Add flat deflector wall design evaluation
2	See document record	Resolution of review comments. Changes highlighted throughout document.	Resolution of review comments.

Form: LPI-3.1-Rev-8-Fig-5-7

Table of Contents

ATTACHMENTS Total Pages

Table of Figures

1.0 Introduction

The Waterford3 (WF3) Ultimate Heat Sink (UHS) system provides a means to cool heat loads from the reactor and auxiliaries during normal and accident conditions. Heat is removed by the Component Cooling Water (CCW) system to the Dry Cooling Towers (DCT) and CCW heat exchanger. The CCW heat exchanger transfers heat to a second Auxiliary Component Cooling Water (ACCW) loop that discharges heat through the Wet Cooling Towers (WCT). Heat removed is dispersed to the atmosphere by the DCTs and WCTs. A simplified diagram of the UHS system is presented in Figure 1-1 [2][1].

Several issues have been raised with respect to the UHS system and its ability to maintain the design and license basis cooling water supply temperature and water inventory margin. These include questionable design basis assumptions and methodology regarding DCT and WCT recirculation effects, out-of-service fans, cooling water temperature control, and other performance issues. The recirculation effect refers to the potential for the DCT or WCT to draw hotter exhaust side air into the inlet side, increasing the effective ambient temperature and reducing heat removal performance (see also CR-WF3-2012-2332 [3]). As used herein, recirculation refers to the combination of recirculation of an individual cell and interference, which is a similar process of recirculation from a neighboring cells.

Computational Fluid Dynamics (CFD) has been used to predict air flows around structures and specifically for the evaluation of cooling tower recirculation in other industries. CFD has been used to accurately predict recirculation for Hudson fans [29] similar to those used at the Waterford3 DCT.

The potential for the DCT and WCT to experience recirculation under a range of wind conditions was studied using CFD as documented in [22]. As part of this study, modification concepts were evaluated to determine potential options for reducing recirculation. From these studies, modifications to divert DCT exit flow away from the inlet region (i.e. deflector walls) were the most successful. Included herein is a study of two modification concepts derived from the work contained in [22]. This report documents the CFD evaluation to determine the amount of recirculation for the DCT and WCT with a proposed modification concept in place.

The overall project is intended to revise the UHS design and licensing basis. This will be accomplished through a calculation methodology that considers the accurate modeling of components' heat removal performance and interaction with CCW/ACCW loop temperatures. Additionally, implementation of the proposed modification will restore

[1] Numbers in brackets [xx] identify numbered references provided in Section 6.0.

adequate design basis margin to accommodate degraded and nonconforming conditions that may potentially arise.

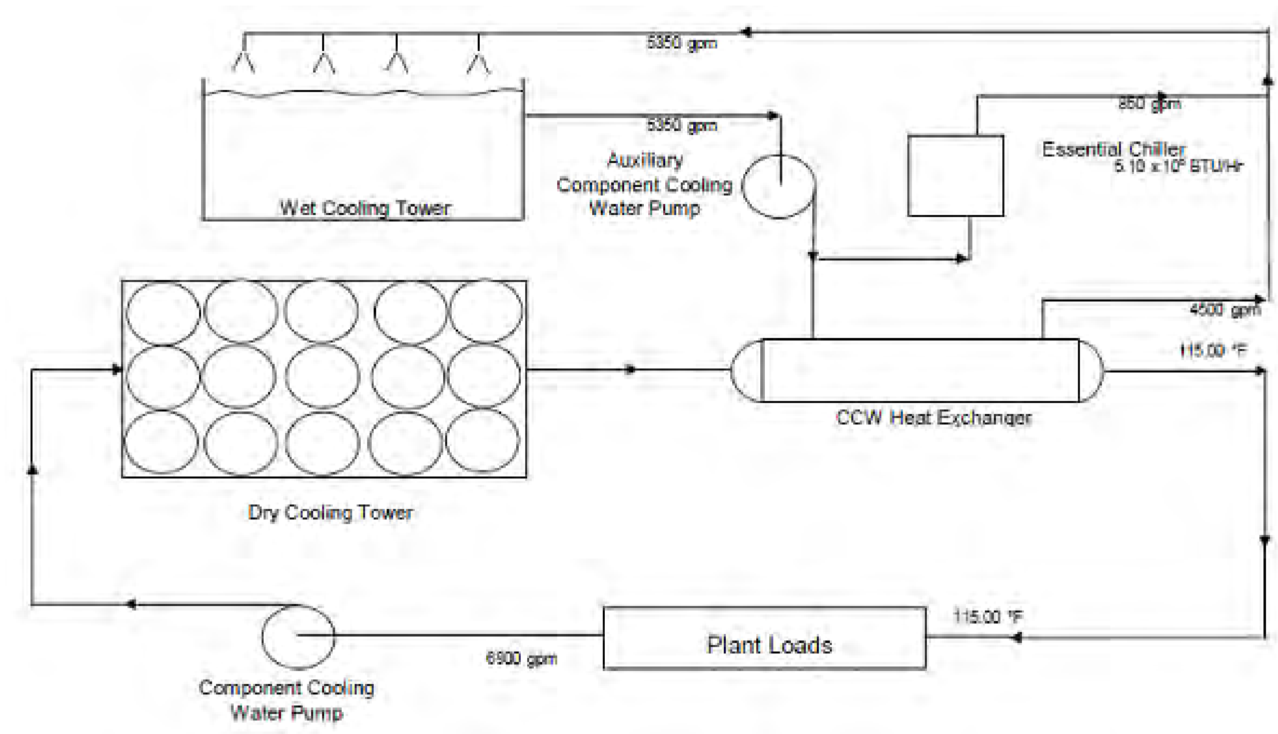


Figure 1-1: Simplified Diagram of the UHS

1.1 Scope

The scope of this report addresses a Computational Fluid Dynamics (CFD) investigation of recirculation flows for the Waterford3 Wet and Dry Cooling Towers with modification concepts in place. The recirculation effect refers to the potential for the DCT or WCT to draw hotter exhaust side air into the inlet side, increasing the effective ambient temperature and reducing heat removal performance. The recirculation of the WCT and DCT affects the heat removal for the UHS, which is investigated in a separate report [7]. The proposed modifications to the DCT structure include the addition of a deflector wall on the DCT outlet to maintain separation between the DCT inlet air and heated DCT exhaust air.

1.2 Description of the Proposed Modifications

Two separate concepts are proposed herein: an angle deflector wall and a horizontal deflector wall. The angle deflector modification consists of using an angled wall located at the top of the DCT missile shield and fan wall. The horizontal deflector consists of a wall covering a portion of the DCT outlet area and a second wall covering a portion of the DCT inlet area. Both modification concepts are designed to direct DCT exit air flow away from the inlet side and are described in detail below.

For the following descriptions and throughout this report, some basic terminology is used:

The five divided cells on the DCT inlet are numbered from the north and used to identify position. Cells 1-3 are associated with the missile shield cover on the DCT outlet, and Cells 4-5 are uncovered.

Deflector wall lengths are measured from the face of the wall at the fan inlet. This wall is referred to as the fan wall. All deflector walls extending to the DCT outlet include a portion that overlaps the fan wall, i.e. a 20ft deflector wall will extend approximately 16.5ft beyond the 3.5ft thick fan wall.

1.2.1 Angle Deflector Wall Modifications

Train A angle deflector wall is oriented at 30 degrees to the horizontal and cover the exit region of 5 DCT bays, extending approximately 100ft in width. The wall is 17ft in length measured along its face. A depiction of the deflector wall design for the A train is provided in Figure 1-2. Due to the relative height of the missile shield above the DCT fan wall (approximately 3ft) a vertical fan wall extension will be required above the south 2 cells. Additionally, an approximately 4in gap between the concrete wall and the missile shield will be blocked (see Figure 1-3).

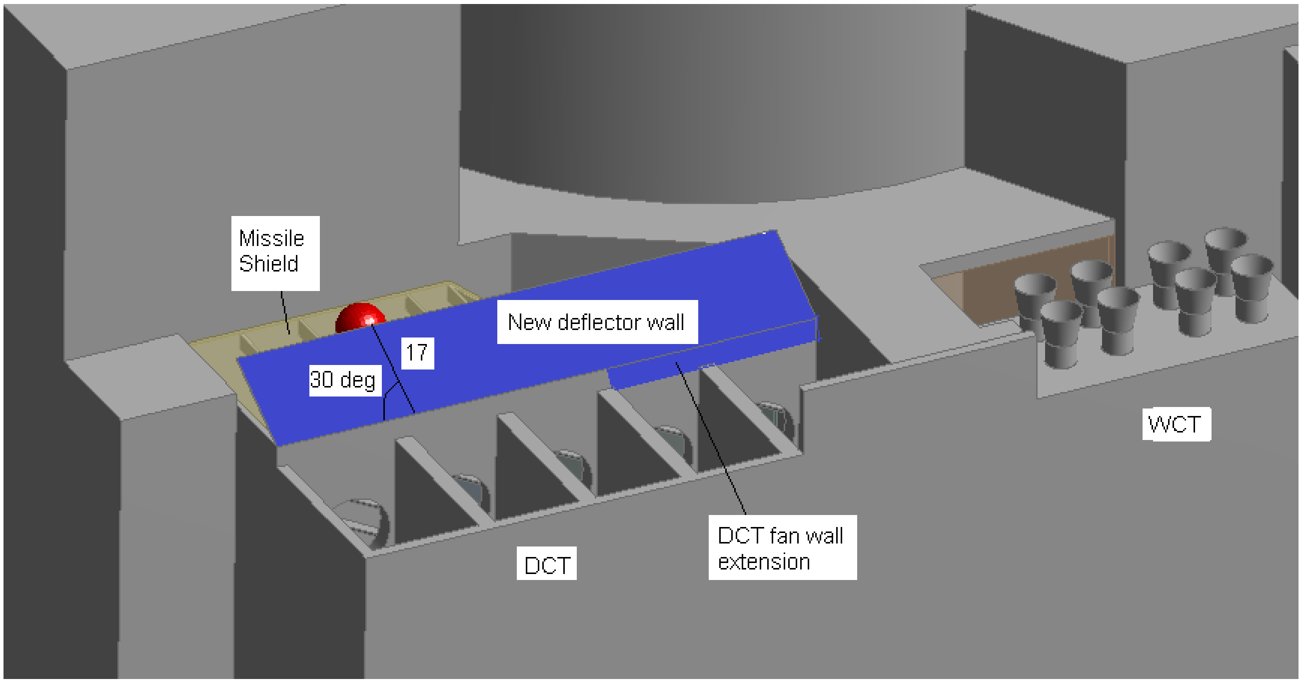


Figure 1-2: Depiction of A Train Deflector Wall Design

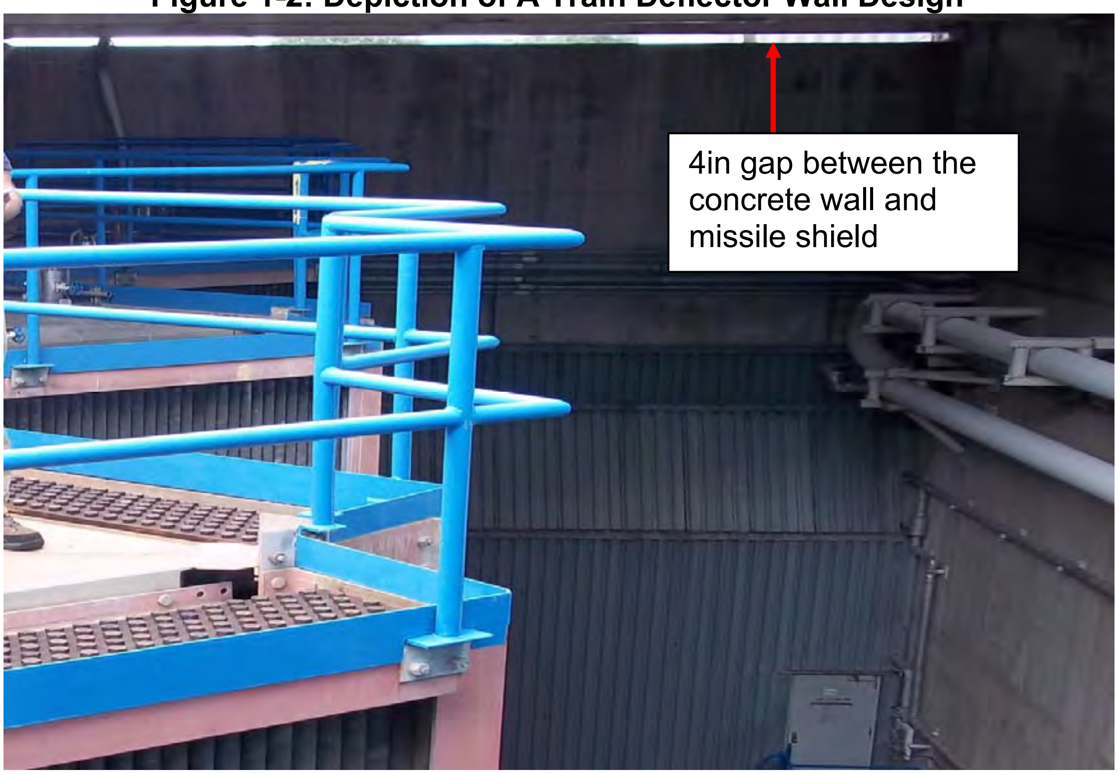


Figure 1-3: 4in gap between concrete wall and missile shield

Train B angle deflector wall covers the exit region of 6 bays (the north end bay does not contain DCT fans but is covered by the missile shield), extending approximately

120ft in width. The wall is 23ft in length measured along its face and is oriented at an angle of 20deg to the horizontal. A depiction of the deflector wall design for the B train is provided in Figure 1-4. Due to the relative height of the missile shield above the DCT fan wall (approximately 3ft) a vertical fan wall extension will be required above the south 2 cells.

In addition, the south end of the B Train deflector wall is enclosed by a vertical end wall, filling in the triangular region between the deflector wall and the existing vertical concrete wall. This end wall helps prevent air from flowing from the DCT exhaust into the adjacent WCT. This wall is not required on the A Train. As with train A, an approximately 4in gap between the concrete wall and the missile shield will be blocked (see Figure 1-3).

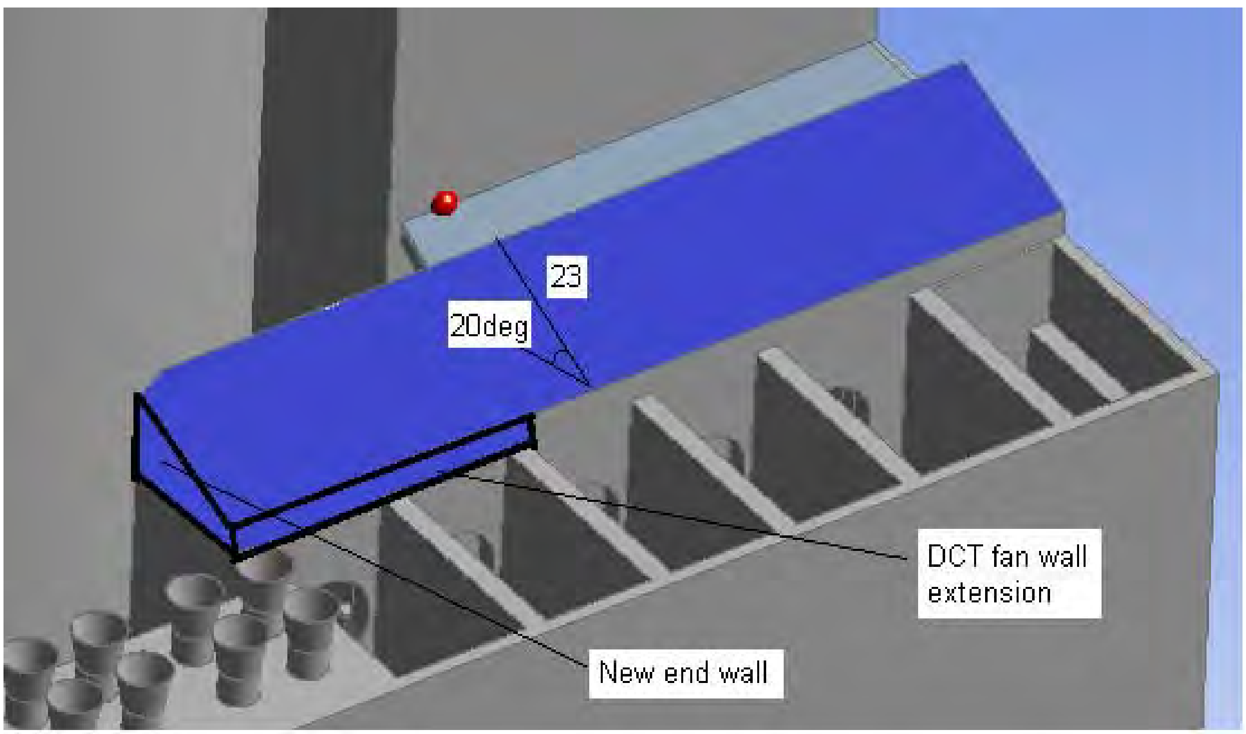


Figure 1-4: Depiction of B Train Deflector Wall Design

1.2.2 Horizontal Deflector Wall

Train A horizontal deflector wall is a 20ft long horizontal wall located on top of the missile shield (covering cell 1 to cell 3 discharge). A similar 15ft DCT wall extends over the discharge side of Cells 4 and 5 and is located on top of a 3ft tall beam to raise it to approximately the same height as the missle shield. The entire vertical missile shield at the DCT is blocked, and the fan wall extension is required above cell 4 and 5. The cell 4 and 5 wall is extended 10ft to the inlet side over the the DCT

fans. The inlet side wall is also supported by 3ft tall beams, which rest on the concrete cell partitions, An approximate 1ft gap between the 3ft beam and the partition wall between Cells 3 and 4 is covered (See Figure 1-5). Additionally, an approximately 4in gap between the concrete wall and the 3ft missile shield support beam will be blocked (see Figure 1-3). Smaller (1ft) beams span the Cell 4 and 5 inlet cells.

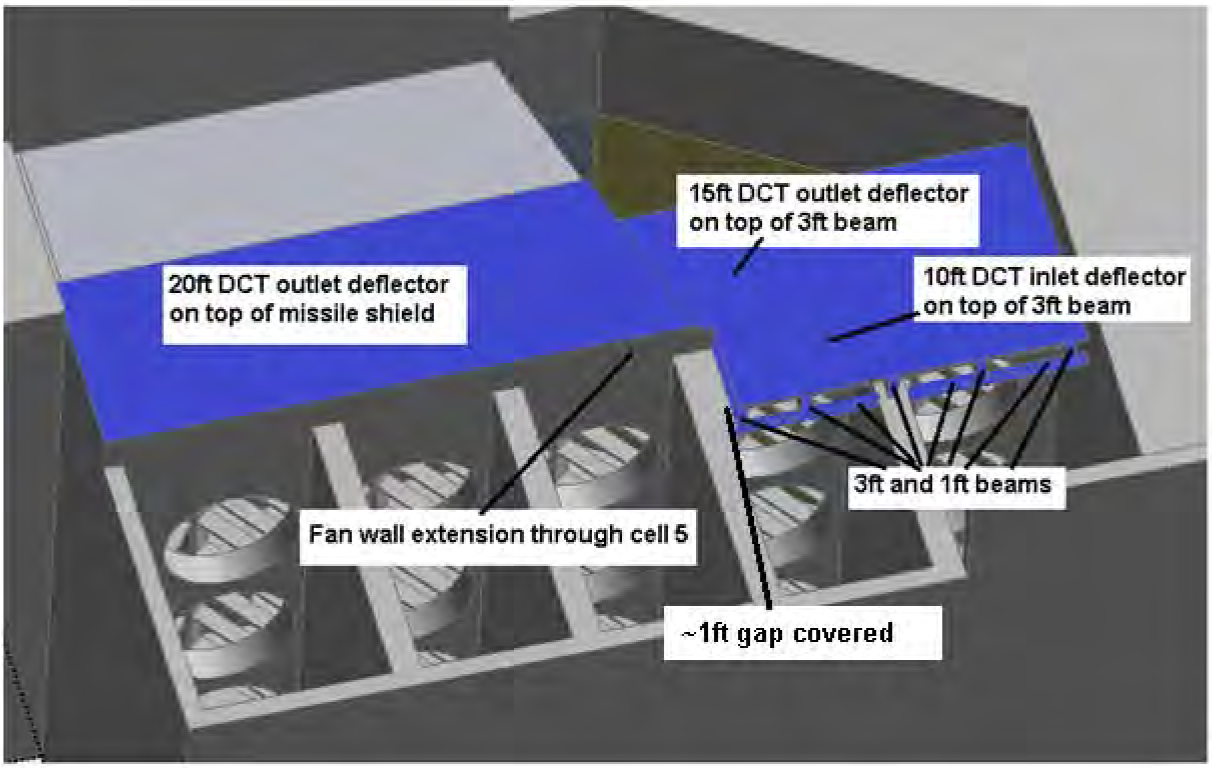


Figure 1-5: Train A horizontal deflector concept

Train B horizontal wall concept consists of 25ft horizontal wall located on top of the missile shield covering cell 1-3. A similar 20 ft DCT wall extends over the discharge side of Cells 4 and 5 and is located on top of a 3ft tall beam to raise it to approximately the same height as the missle shield. The entire vertical missile shield at the DCT is blocked, and the fan wall extension is required above cell 4 and 5. The cell 4 and 5 wall is extended 10ft to the inlet side over the the DCT fans. The inlet side wall is also supported by 3ft tall beams, which rest on the concrete cell partitions, An approximate 1ft gap between the 3ft beam and the partition wall between Cells 3 and 4 is also covered. Additionally, an approximately 4in gap between the concrete wall and the missile shield support beam will be blocked (see Figure 1-3). Smaller (1ft) beams span the Cell 4 and 5 inlet cells. (See Figure 1-6).

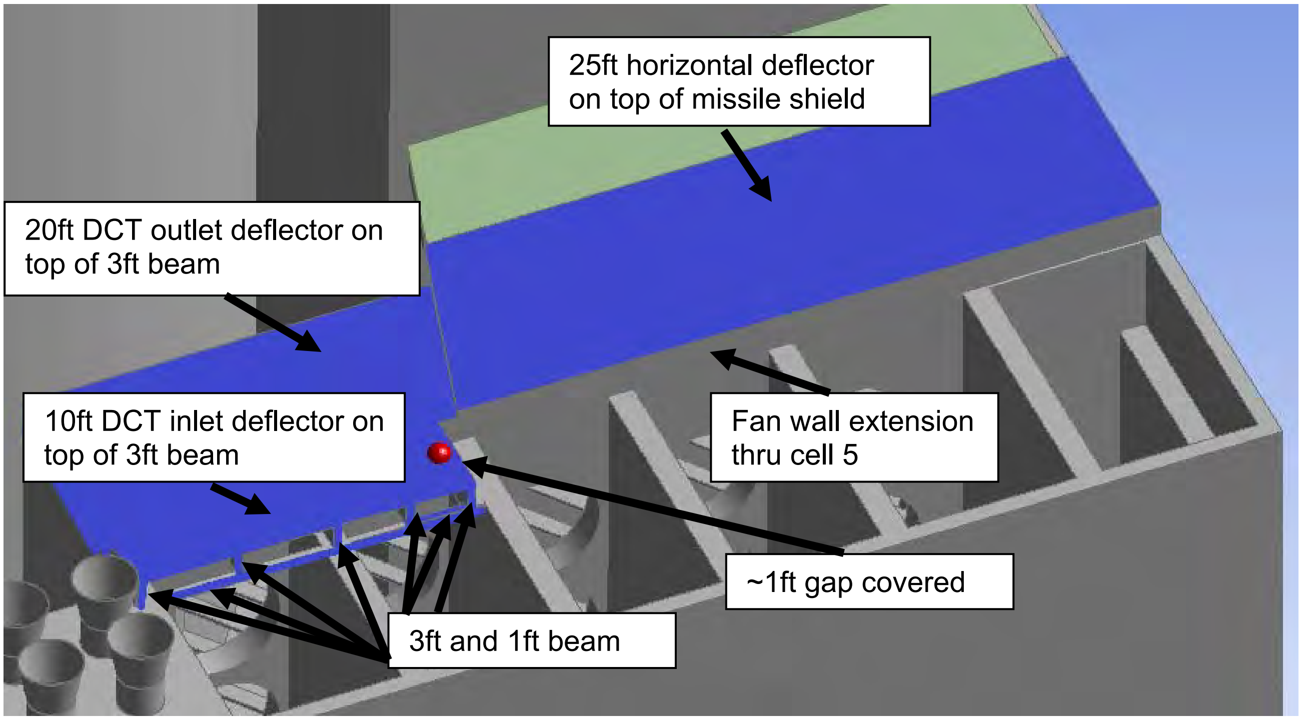


Figure 1-6: Train B horizontal deflector concept

2.0 Inputs and Assumptions

The UHS system elements addressed in this study include the wet and dry cooling towers and adjacent buildings affecting air flow to these components. The UHS includes two independent and nearly mirror image trains. The Dry Cooling Towers (DCT) consist of 15 fans, separated into 5 cells of 3 fans each, which force air over ten fin-tube heat exchangers (coils). The exit side is a single volume, covered approximately 60% by a missile shield. The Wet Cooling Towers (WCT) consist of 2 evaporative type mechanical draft towers with 4 fans each, which draw air over a liquid evaporator fill and discharge vertically into the air space above the tower. These cooling components are bordered by the Fuel Handling Building (FHB), Reactor Building, and Reactor Auxiliary Building.

2.1 Inputs

Key inputs are described below and shown from Table 2-2 to Table 2-5. The derivation of CFD model inputs from the design inputs is shown in detail in Attachment A.

1) The A Train angle wall modification geometry consists of a 30 degree angled deflector wall positioned on top of the missile shield and a 3ft extension of the fan wall separating the DCT inlet and outlet. The deflector wall is 17ft long (see Figure

2-1) and extends over the 5 DCT fan bays on the exit side. Additionally, a vertical fan wall extension is required above cell 4 and 5.

2) The A Train horizontal deflector wall consists of a 20ft horizontal wall covering the missile shield, a 15ft horizontal wall covering the outlet side of cell 4 and 5, and a 10ft horizontal wall covering the inlet side of cell 4 and 5. A vertical fan wall extension is required above cell 4 and 5.

3) The Train B angle deflector is a 20 degree angled wall, 23ft long, that extends over 6 bays on the exit side (5 DCT bays and 1 empty bay) as shown in Figure 2-3 and a 3ft extension of the fan wall separating the DCT inlet and outlet. A vertical fan wall extension is required above cell 4 and 5. The B train also features a roughly triangular vertical end wall separating the DCT and WCT.

4) The Train B horizontal deflector wall consists of a 25ft horizontal wall covering the missile shield, a 20ft horizontal wall covering the outlet side of cell 4 and 5, and a 10ft horizontal wall covering the inlet side of cell 4 and 5. A vertical fan wall extension is required above cell 4 and 5.

5) Model analysis cases were intended to address bounding ambient (wind and temperature) conditions as well as to develop a general relationship between wind and recirculation.The wind and temperature conditions are derived from [8]. From these analyses, bounding DCT recirculation values were determined.

    a. For the Train A angle deflector concept, seventeen analysis cases were run to evaluate recirculation air flows around the DCT and WCT. Cases addressing three cardinal directions (North, South, East) were augmented with Northeast and Southeast cases, which were found to produce the largest building wake effects. Additionally, a 102F/static wind condition was run to evaluate FSAR specified conditions.

    b. For the Train B angle deflector concept, eleven analysis cases were run to evaluate recirculation air flows around the DCT and WCT. Based on the results of the A Train analysis, five cases were run with Northwest wind to evaluate effects of the FHB wake. Southwest wind was also selected to study the wake effects in this direction. North, South and West wind directions were evaluated along with a 102F/static case to address FSAR conditions.

    c. For the horizontal deflector concept, eleven analysis cases were run for each Train (a total of twenty two cases for both Trains). 5 high wind (90F ambient 30mph wind) and 5 low wind (98F ambient 10mph wind) cases were run on different direction (N, NE, E, SE, S) on Train A, and (N, NW, W, SW, S) on Train B. These ambient temperatures and wind speeds are based on

enveloping the upper bound of the wind data based on [8]. An additional 102F/0 mph static case was run on both trains to address FSAR specified conditions.

6) For the East and West wind directions, the bounding conditions for Train A were applied from the East direction to provide flow over the FHB to push DCT exhaust air towards the inlet side. For Train B, the bounding direction was the West wind direction.

7) The DCT inputs for Train A angle wall and the horizontal wall concept are listed in Table 2-2 and Table 2-3 and include 0.8 ft/sec to account for a no slip wall boundary condition at the fan perimeter (see also Section 3.2). The Train B angle wall and horizontal wall inputs are listed in Table 2-4 and Table 2-5. The corresponding calculations to support these values are provided in Attachment A. The calculated values in Attachment A provide an estimate of the DCT outlet temperatures, which were increased to provide conservative (higher) temperatures provided in Table 2-2 through Table 2-5 and applied to the models.

8) WCT mass flow and temperatures were derived from design conditions with a correction based on tested WCT performance (See attachment A). The WCT inlet and outlet conditions were derived from a mass balance through the WCT as shown in Table 2-2 and Table 2-4 for the angle wall and Table 2-3, Table 2-5 for the horizontal wall with calculations for the conditions provided in Attachment A.

9) WCT outlet flow was defined over each of the 8 outlet fan areas. The vane-axial fans are designed to remove vortex (swirl) flow from exit flow stream. Thus, flow was defined perpendicular to the fan area.

10) The DCT missile shield (see Figure 2-1 and Figure 2-3) was represented by a porous region with a user defined loss coefficient and porosity. Porous regions use loss coefficients to establish pressure losses across permeable regions like screens or partial obstructions. The total loss coefficient across the missile shield was 0.49 (See Att. A). The loss coefficient per unit thickness was based on 0.49 / (7/12) = 0.83 per foot. The porosity value is based on the open area ratio of 0.67. Values are shown in Table 2-1.

11) For the train A, the region of complex steel support structures and pipes underneath the covered walkway adjacent to the DCT and WCT was also modeled as two porous regions, referred to as “DCT porous” and “WCT porous”, respectively (see Figure 2-1). Loss coefficients and porosity values for these porous regions were calculated as described in Attachment A. (See also Table 2-1).

12) Another porous domain, called WCT walkway (see Figure 2-1), was used to represent the steel grating walkway above the main inlet of the WCT. The loss coefficient and porosity values are shown in Table 2-1. Calculation of these values is based on 1in x 4in spacing of 0.25in bar, as shown in Attachment A.

13) A planned modification to install a Fuel Oil Storage Tank (FOST) with a covering missile shield structure was accounted for by including an additional porous domain. The porous domain labeled FOST (Figure 2-1 for Train A and Figure 2-3 for Train B), was applied to represent this change on Train A and Train B. The loss coefficient and porosity values are assumed to be the same as the DCT missile shield properties (shown in Table 2-1). The sensitivity to a potential change to a solid FOST barrier was also studied (see Section 4.5) and was found to provide negligible effects on the results.

14) The effect of inclusion of walkways and cable trays on the inlet side of the DCT fans was investigated through a sensitivity study as shown in Section 3.4.5. The DCT walkways were determined to negligibly affect the results and were thus not included in the model. This was considered to be conservative in that the walkways tended to reduce recirculation. Additionally, the walkways are non nuclear safety items, and therefore should not be credited in the analysis.

2.2 Assumptions

Assumptions that are made for the CFD cooling tower model include the following:

1) Steady state operation: This assumption is appropriate because the station reaches steady state relatively quickly. This assumption was verified in Att. C.

2) Air is treated as an ideal gas. This assumption is appropriate for the range of temperatures in the inlet and exhaust gases.

3) Small structural items such as the DCT fan motor cable trays, DCT inlet side walkways, and minor obstructions at the bottom of the DCT inlet structure were not included in the CFD model because they negligibly affect the flow. This assumption was verified in Section 3.4.5.

4) Based on first principles and cooling tower design [15], recirculation is maximized by increasing tower inlet velocity and decreasing tower outlet velocity. This increases the likelihood of drawing exhaust flow into the inlet side. The outlet velocity assumption is based on the consideration that the exit velocity pushes the DCT exhaust away from the fan wall and therefore decreases the amount drawn back into the suction, providing recirculation. The degree of conservatism for this assumption is negligible as shown in [22].

5) DCT inlet air at the fans and outlet air at the coils were applied as uniform flow fields, i.e. without local discontinuities due to fan blade induced swirl or uneven flow around the coil tubes. This assumption is justified based on two considerations. First, the pressure drop across the tube bundle is very large relative to the fan output head, approximately 0.6inwc (pressure drop based on data sheet) of 0.9inwc (based on fan curve from Hudson products). Thus, the barrier of the tube bundle will effectively spread approaching flows over the tube wall face in a relatively uniform manner. Second, the effects of discontinuities local to the tubes or fans, i.e. blade rotation swirl, eddies, vortex shedding, etc. constitute small scale effects not considered in the overall global scale of the model. Sensitivity studies relative to the inclusion of walkways and cable trays, support beams, etc. (see Input #14 and Sections 3.4.5, 3.4.7) showed negligible effects from these minor flow disturbances. It is expected that small scale flow discontinuities are resolved within a similar size scale, and thus the modeled uniform flow distribution will not affect results.

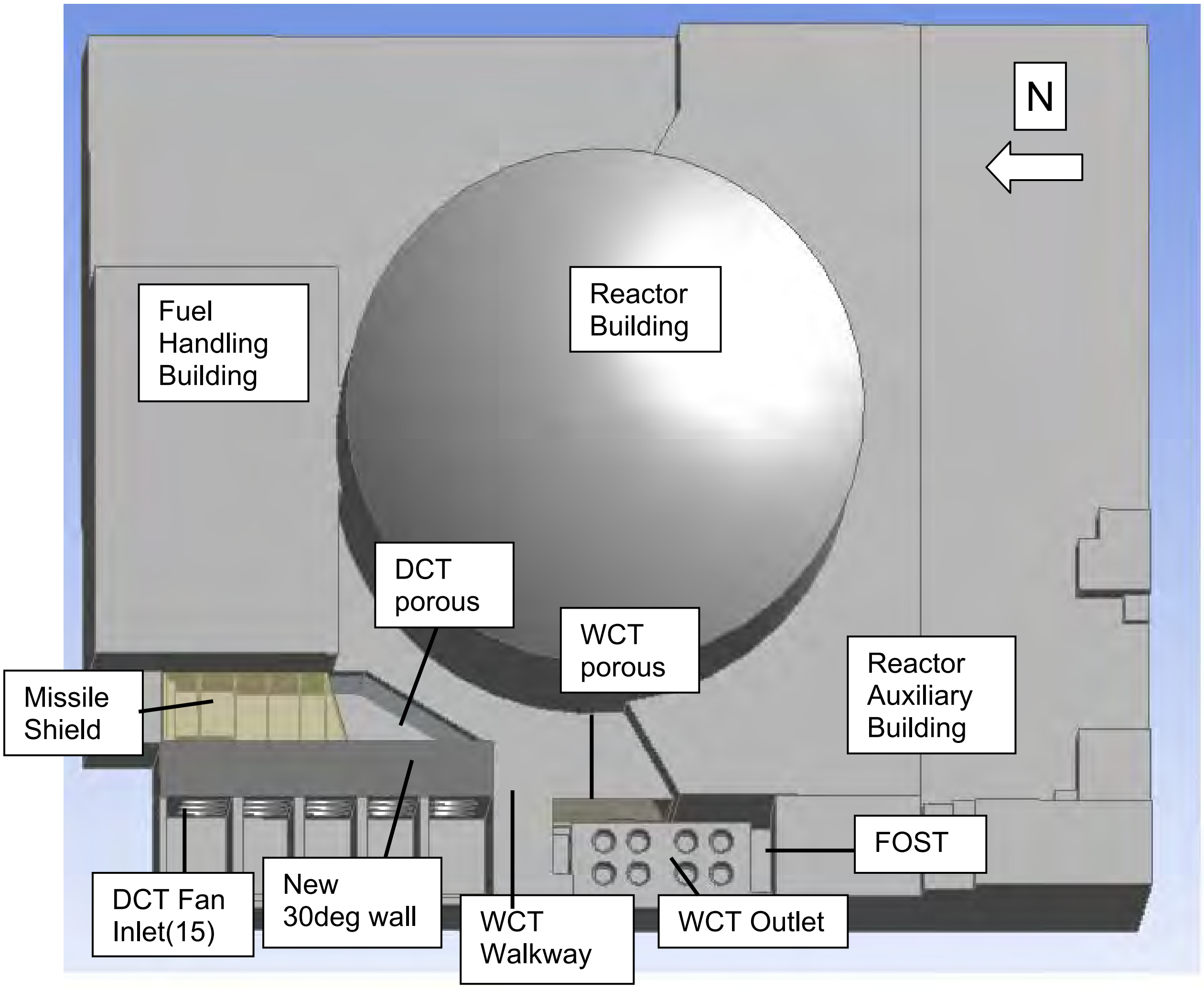
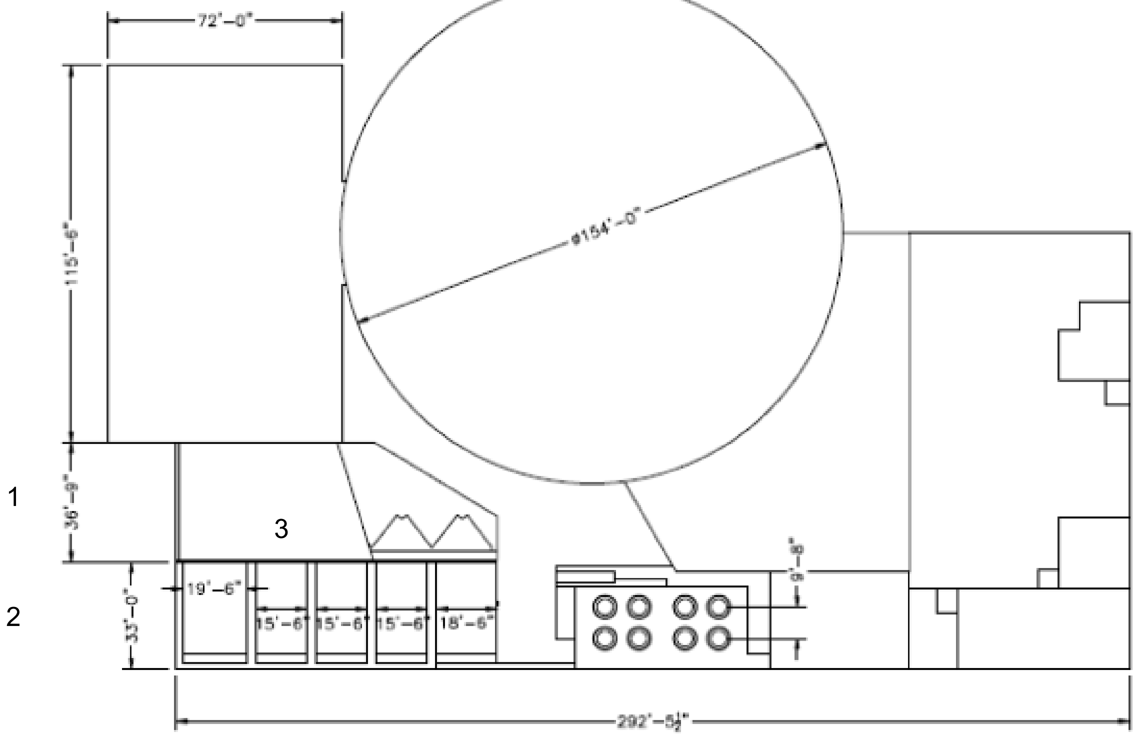


Figure 2-1: Train A plant geometry



1. Face of FHB to face of Fan wall
2. Fan wall to exterior wall
3. Inside walls of DCT inlet

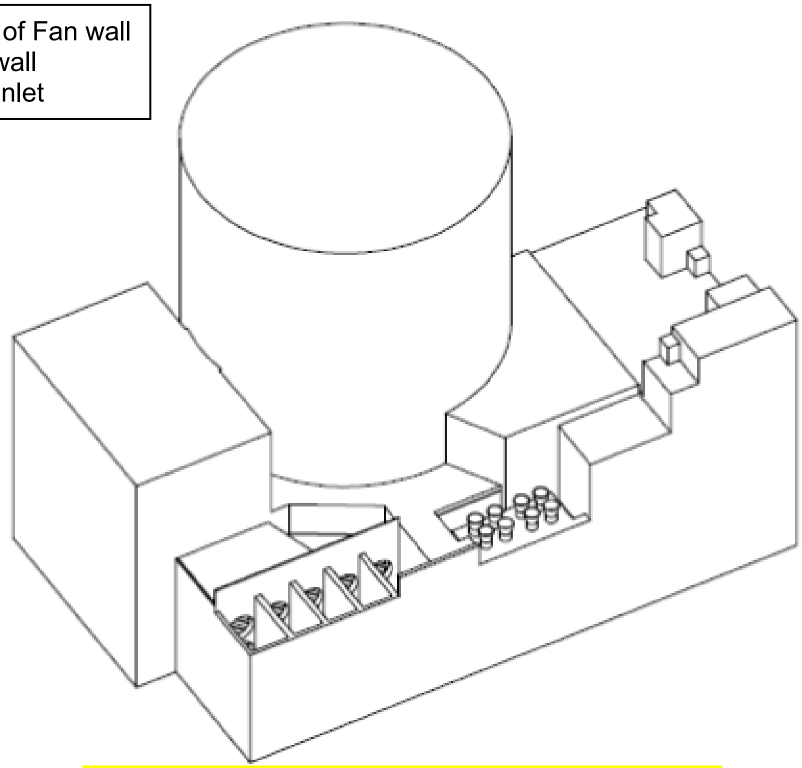


Figure 2-2: A Train AutoCad Layout Model

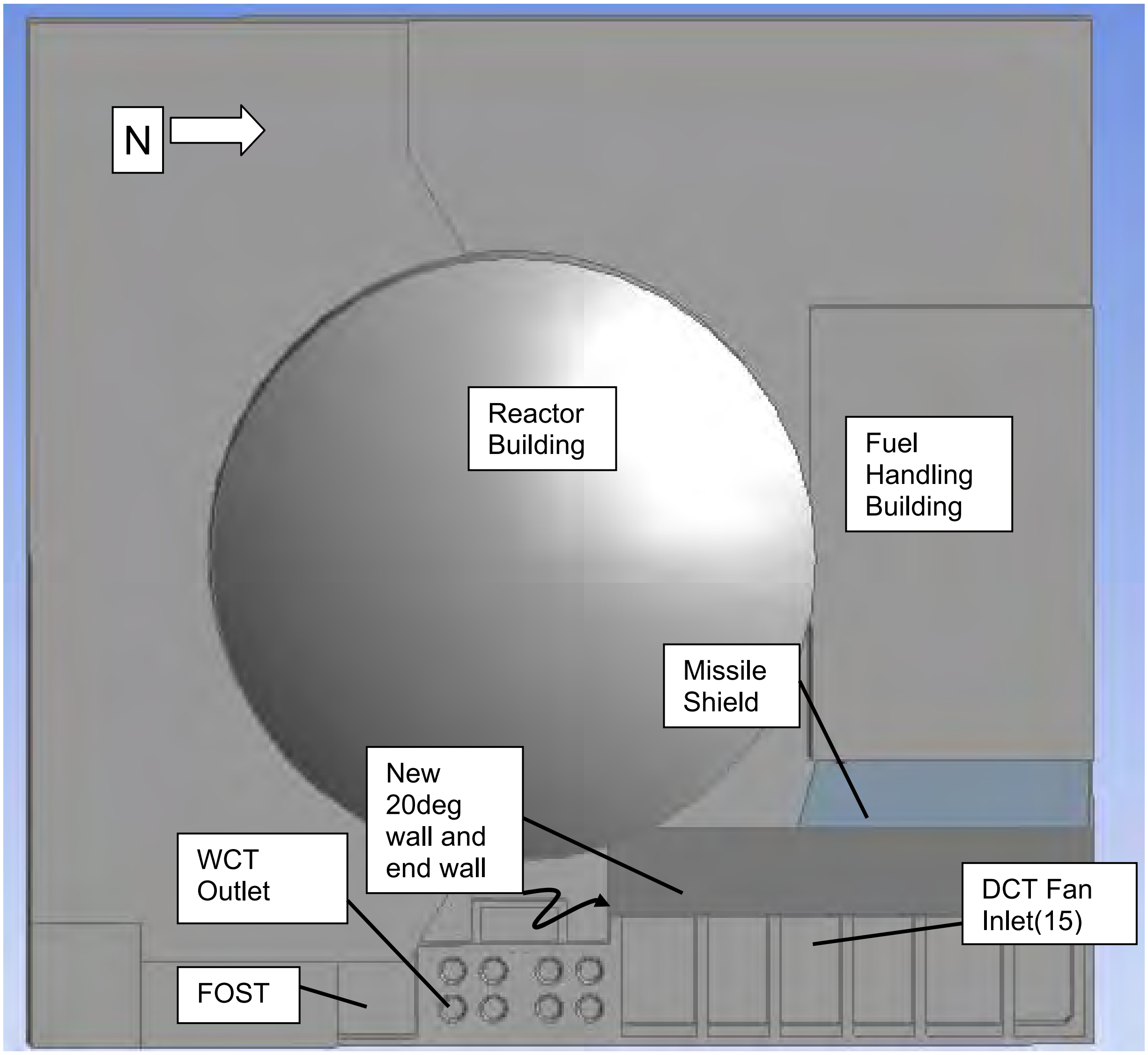
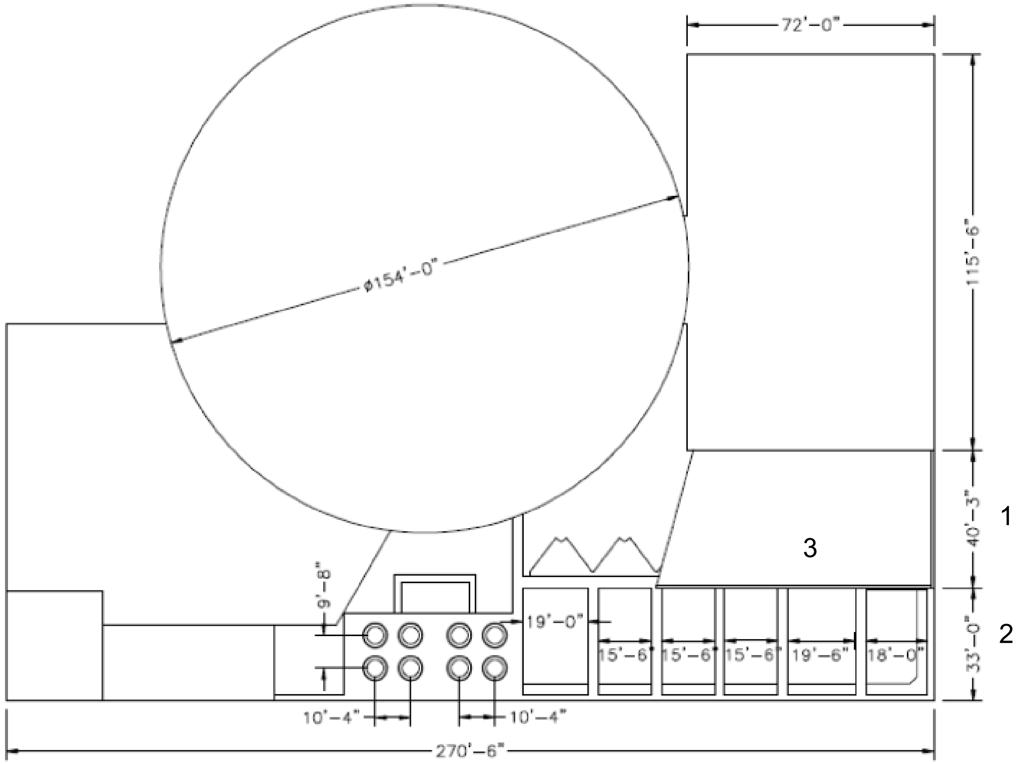


Figure 2-3: Train B plant geometry

Table 2-1: Porous Domain Input Summary

Boundary	CFD input	Reference
Missile shield, FOST	Porosity 0.67 Loss coeff. 0.83 ft^-1	See Att A
DCT and WCT porous	Porosity 0.805 Loss coeff. 0.08 ft^-1	See Att A Note that the porosity and loss coefficients (K) are applied to 1 ft thick (unit) section.
WCT walkway	Porosity 0.7 Loss coeff. 0.4 ft^-1	See Att A



1. Face of FHB to face of Fan wall
2. Fan wall to exterior wall
3. Inside wall of DCT inlets

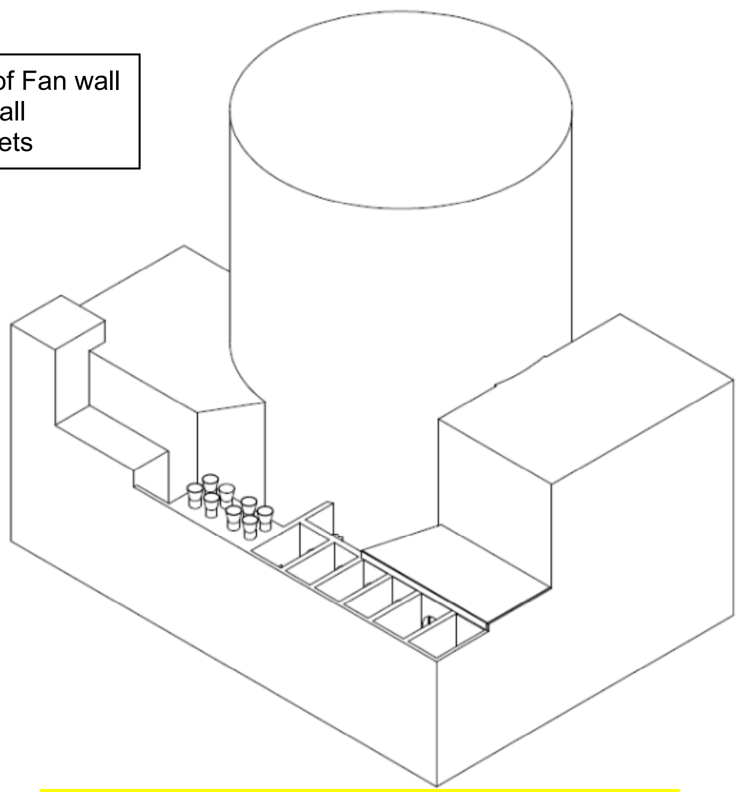


Figure 2-4: B Train AutoCad Layout Model

Table 2-2: Input Boundary Conditions for Train A Angle Wall Concept

<table>
<tr><th>Wind dir'n</th><th>Amb Temp (F)</th><th>Wind speed (mph)</th><th>DCT inlet vel (ft/s)</th><th>DCT outlet vel (ft/s)</th><th>DCT outlet temp (F)</th><th>DCT fan flow inputs (x1000 cfm)</th><th>WCT inlet vel (ft/s)</th><th>WCT outlet vel (ft/s)</th><th>WCT outlet temp (F)</th><th>WCT Design inputs</th><th>Ref</th></tr>
<tr><td rowspan="4">North</td><td>76</td><td>51</td><td>18.2</td><td>9</td><td>145</td><td>160</td><td>9.1</td><td rowspan="17">45.7</td><td>109</td><td rowspan="17">WCT flow: 53,500 cfm (per side)

ACCW flow: 5350 gpm

Water inlet/ outlet temp: 113F/ 89.3F</td><td rowspan="17">WCT Spec 1564.114 A [6] adjusted for tested motor power (see Att. A)

WCT Spec 1564.114 A EC 8465 [6]</td></tr>
<tr><td>86</td><td>29</td><td rowspan="9">20.3</td><td rowspan="9">9.75</td><td rowspan="9">150</td><td rowspan="12">180</td><td rowspan="9">9.35</td><td rowspan="9">109</td></tr>
<tr><td>92</td><td>26</td></tr>
<tr><td>97</td><td>8</td></tr>
<tr><td rowspan="3">East</td><td>85</td><td>22</td></tr>
<tr><td>91</td><td>21</td></tr>
<tr><td>96</td><td>10</td></tr>
<tr><td rowspan="3">South</td><td>89</td><td>22</td></tr>
<tr><td>92</td><td>21</td></tr>
<tr><td>96</td><td>10</td></tr>
<tr><td rowspan="5">NE</td><td>76</td><td>51</td><td>20.3</td><td>9.9</td><td>140</td><td>9.1</td><td>106</td></tr>
<tr><td>81</td><td>40</td><td>20.3</td><td>9.9</td><td>140</td><td>9.1</td><td rowspan="6">109</td></tr>
<tr><td>86</td><td>29</td><td>20.3</td><td>9.8</td><td>145</td><td>9.2</td></tr>
<tr><td>91</td><td>26</td><td>20.7</td><td>9.9</td><td>145</td><td>183</td><td>9.3</td></tr>
<tr><td>97</td><td>11</td><td>21.4</td><td>10.2</td><td>145</td><td rowspan="2">190</td><td>9.35</td></tr>
<tr><td>SE</td><td>89</td><td>22</td><td>21.4</td><td>10.2</td><td>145</td><td>9.2</td></tr>
<tr><td></td><td>102</td><td>0</td><td>20.3</td><td>9.75</td><td>150</td><td>180</td><td>9.35</td></tr>
</table>

Table 2-3: Input Boundary Conditions for Train A Horizontal Wall Concept

<table>
<tr><th>Wind dir'n</th><th>Amb Temp (F)</th><th>Wind speed (mph)</th><th>DCT inlet vel (ft/s)</th><th>DCT outlet vel (ft/s)</th><th>DCT outlet temp (F)</th><th>DCT fan flow inputs (x1000 cfm)</th><th>WCT inlet vel (ft/s)</th><th>WCT outlet vel (ft/s)</th><th>WCT outlet temp (F)</th><th>WCT Design inputs</th><th>Ref</th></tr>
<tr><td>All</td><td>90</td><td>30</td><td rowspan="3">18.5</td><td rowspan="3">8.7</td><td>147</td><td rowspan="3">160(1)</td><td>9.3</td><td rowspan="3">45.4</td><td rowspan="3">109</td><td colspan="2" rowspan="3">[6 and Att A]</td></tr>
<tr><td>All</td><td>98</td><td>10</td><td>148</td><td>9.3</td></tr>
<tr><td>N/A</td><td>102</td><td>0</td><td>149</td><td>9.4</td></tr>
</table>

Note: 1) Based on the fan flow results, the fan flow for the bounding case was approximately 160,000cfm. Therefore, the fan flow of 160,000cfm on Train A was conservatively applied to all cases.

Table 2-4: Input Boundary Conditions for Train B Angle Wall Concept

<table>
<tr><th>Wind dir'n</th><th>Amb Temp (F)</th><th>Wind speed (mph)</th><th>DCT inlet vel (ft/s)</th><th>DCT outlet vel (ft/s)</th><th>DCT outlet temp (F)</th><th>DCT fan flow inputs (x1000 cfm)</th><th>WCT inlet vel (ft/s)</th><th>WCT outlet vel (ft/s)</th><th>WCT outlet temp (F)</th><th>WCT Design inputs</th><th>Ref</th></tr>
<tr><td>North</td><td>76</td><td>51</td><td>20.3</td><td>9.95</td><td>135</td><td>180</td><td>9.1</td><td rowspan="11">45.7</td><td>107</td><td rowspan="11">WCT flow: 53,500cfm (per side)

ACCW flow: 5350gpm

Water inlet/ outlet temp: 113F/ 89.3F</td><td rowspan="11">WCT Spec 1564.114A [6] adjusted for tested motor power (see Att. A)

WCT Spec 1564.114A EC 8465 [6]</td></tr>
<tr><td>West</td><td>88</td><td>19</td><td rowspan="3">21.4</td><td>10.3</td><td>140</td><td rowspan="3">190</td><td>9.2</td><td>109</td></tr>
<tr><td>South</td><td>88</td><td>26.5</td><td>10.3</td><td>140</td><td>9.2</td><td>109</td></tr>
<tr><td rowspan="5">NW</td><td>76</td><td>51</td><td>10.4</td><td>135</td><td>9.1</td><td>107</td></tr>
<tr><td>82</td><td>40</td><td>20.9</td><td>10.1</td><td>140</td><td>185</td><td>9.2</td><td rowspan="7">109</td></tr>
<tr><td>88</td><td>29</td><td rowspan="6">21.4</td><td>10.3</td><td>140</td><td rowspan="6">190</td><td>9.2</td></tr>
<tr><td>92</td><td>26</td><td>10.2</td><td>145</td><td>9.2</td></tr>
<tr><td>97</td><td>10</td><td>10.2</td><td>145</td><td>9.35</td></tr>
<tr><td rowspan="2">SW</td><td>88</td><td>26.5</td><td>10.3</td><td>140</td><td>9.2</td></tr>
<tr><td>96</td><td>10</td><td>10.2</td><td>145</td><td>9.2</td></tr>
<tr><td></td><td>102</td><td>0</td><td>10.2</td><td>145</td><td>9.2</td></tr>
</table>

Table 2-5: Input Boundary Conditions for Train B Horizontal Wall Concept

<table>
<tr><th>Wind dir'n</th><th>Amb Temp (F)</th><th>Wind speed (mph)</th><th>DCT inlet vel (ft/s)</th><th>DCT outlet vel (ft/s)</th><th>DCT outlet temp (F)</th><th>DCT fan flow inputs (x1000 cfm)</th><th>WCT inlet vel (ft/s)</th><th>WCT outlet vel (ft/s)</th><th>WCT outlet temp (F)</th><th>WCT Design inputs</th><th>Ref</th></tr>
<tr><td>All</td><td>90</td><td>30</td><td rowspan="3">20.5</td><td rowspan="3">9.7</td><td>141.5</td><td rowspan="3">180(1)</td><td>9.3</td><td rowspan="3">45.4</td><td rowspan="3">109</td><td rowspan="3" colspan="2">See Table 2-4 [6 and Att A]</td></tr>
<tr><td>All</td><td>98</td><td>10</td><td>143</td><td>9.3</td></tr>
<tr><td>N/A</td><td>102</td><td>0</td><td>144</td><td>9.4</td></tr>
</table>

Note: 1) Based on the fan flow results, the fan flow for the bounding case was 180,000cfm. Therefore, the fan flow of 180,000cfm on Train B was conservatively applied to all cases.

3.0 Methodology

The complex flow field produced under accident condition DCT and WCT operation was evaluated using ANSYS CFX, a 3D Computational Fluid Dynamics (CFD) software package. ANSYS CFX is an appropriate method for evaluating the complex geometry and mix of buoyancy, wind, and fan driven flows. ANSYS CFX is qualified for use on safety related projects as documented in [13] per the requirements of [14]. An additional verification and validation case was documented in Attachment G. This verification and validation was run on the computer that performed this cooling tower CFD analysis. It showed that the results were the same if 1 or 8 processors were used.

The CFD model was created through multiple steps: geometry, meshing, problem definition, and results, which are described below. Results are discussed in Section 4.

To ensure model quality, the general guidance provided in NUREG-2152 [27] was followed. Studies of mesh density, turbulence models, and other parameters were performed and are discussed below.

3.1 CFD model Geometry and Meshing

The plant buildings and cooling tower geometry were created in AutoCAD 2009 [16]. This geometry file was imported to ANSYS Mechanical software for meshing. Figure 2-1 through Figure 2-4 show the geometry for Train A and Train B. The geometry includes buildings around DCT and WCT that would affect air flow including containment, the fuel handling building, and turbine building, and additional structures such as the FOST cover, missile shield, and porous domains that represent the pipes and steel beams.

Meshing involves the division of the air spaces into many small elements for CFD analysis, which was performed automatically within the ANSYS Mechanical software. The CFD solver evaluates the fluid variables, i.e. pressure, velocity, temperature, etc, in each element numerically.

The total number of elements on the angle wall concept was 20 million in Train A and 21 million in Train B. In the horizontal deflector concept, the number of elements was reduced to 16 million on Train A and 15 million on Train B. This reduction in mesh size was accomplished through the use of a “volume of influence” feature within ANSYS CFX. The volume of influence is shown as a green box in Figure 3-2 for Train A and Figure 3-5 for Train B. This feature allows the definition of a more precise (smaller) element spacing within the zone and courser spacing outside of the zone. The volume of influence was defined as roughly a box extending in height from the missle shield to ~15ft below the top of the Fuel Handling Building (FHB), extending in length from the

FHB vertical wall to the DCT inlet side exterior wall, and in width to cover all the DCT and WCT. Within the zone, elements were limited to 2 ft. Elements were limited to 5 ft outside of the zone and expanded to a maximum of 50 ft elements in the far field away from the plant. Additional cell volumes at the boundary were defined for each DCT inlet cell, with a maximum element size of 1 ft. This feature allowed more precise control of element density within the desired areas yet smaller overall element counts through the remainder of the mesh. Additional element size control at the boundary was done in the DCT outlet area for Train A, with a maximum of 0.5 ft element. Most of the elements are tetrahedral elements. Details from the Train A and B meshes for the angle wall are shown in Figure 3-1 and Figure 3-4, and mesh details for horizontal wall are shown in Figure 3-2 and Figure 3-3 for Train A, and Figure 3-5 and Figure 3-6 for Train B. Mesh sensitivity was studied during development studies as described in Section 3.4.3.

3.2 Problem Definition

Boundary conditions at the DCT and WCT inlet and outlet areas were defined in Table 2-2 and Table 2-4 for the A and B trains, respectively. The fans at the DCT and the bottom of the WCT fill section were modeled as outlet boundaries (i.e. out of the air-space) with defined velocities. The DCT coil and the WCT outlets were modeled as inlet boundaries (into the surrounding air-space) with defined velocities and temperatures.

Far field effects were addressed by extending the CFD model boundaries to include a “box” volume of approximately 2000 ft x 2000 ft x 1000 ft high. The box volume was used to ensure the local flow effect, i.e. the inflow and outflow of the DCT and WCT, do not affect the global domain, i.e. the ambient wind conditions leaving the box. This approach is appropriate as the effects of the perimeter boundaries are minimized. Boundary wind speeds were defined at the inlet boundary. Mass flows were defined at the outlet boundaries.

Outlying buildings within the box volume were not included for several reasons: First, these structures are non-safety related and could not be counted on to be in place post-accident. Second, the worst acting wind directions, relative to recirculation, were winds that passed around the FHB and created eddy patterns directly over the DCT, in the wind “shadow” of the FHB. The outlying structures, being further away and relatively short, would not induce eddies over the DCT but could slow the approaching wind. It was therefore judged that it was conservative to not include these structures and permit un-interrupted wind flow to the combined “containment-TB-FHB-cooling tower” structure included in the model.

For cases with no wind (102F, static conditions), the top and the side of the outer box are modeled as open boundaries. For wind cases, uniform wind across the plant was specified for inlet boundaries.

Flow through the DCT and WCT inlets were specified for the appropriate fan areas and coil or fill areas. To conservatively address the forced air flow through the DCTs and WCTs, the inlet and outlet area flows rates had to be adjusted to account for the no-slip wall condition. Without no-slip walls, the DCT fan inlet circular flow area would be expected to have uniform fan flow. However, the circle perimeter in contact with the wall has zero velocity (no-slip). Therefore, the flow rate over the remainder of the area must be increased to account for zero flow perimeter and small boundary layer. To ensure a conservative inlet velocity, DCT inlet velocity was increased by +0.8 ft/sec. The DCT outlet velocity and the WCT outlet were increased by +0.1 ft/sec to yield the desired average velocities over the total area.

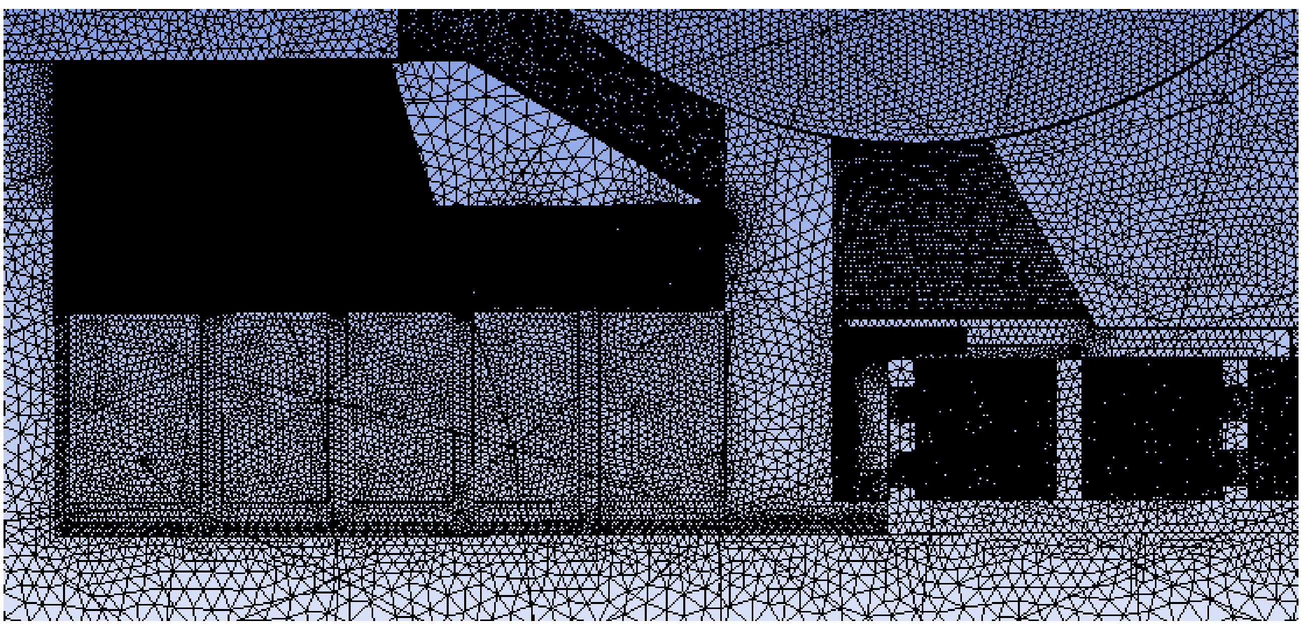


Figure 3-1: Train A mesh detail for the angle wall

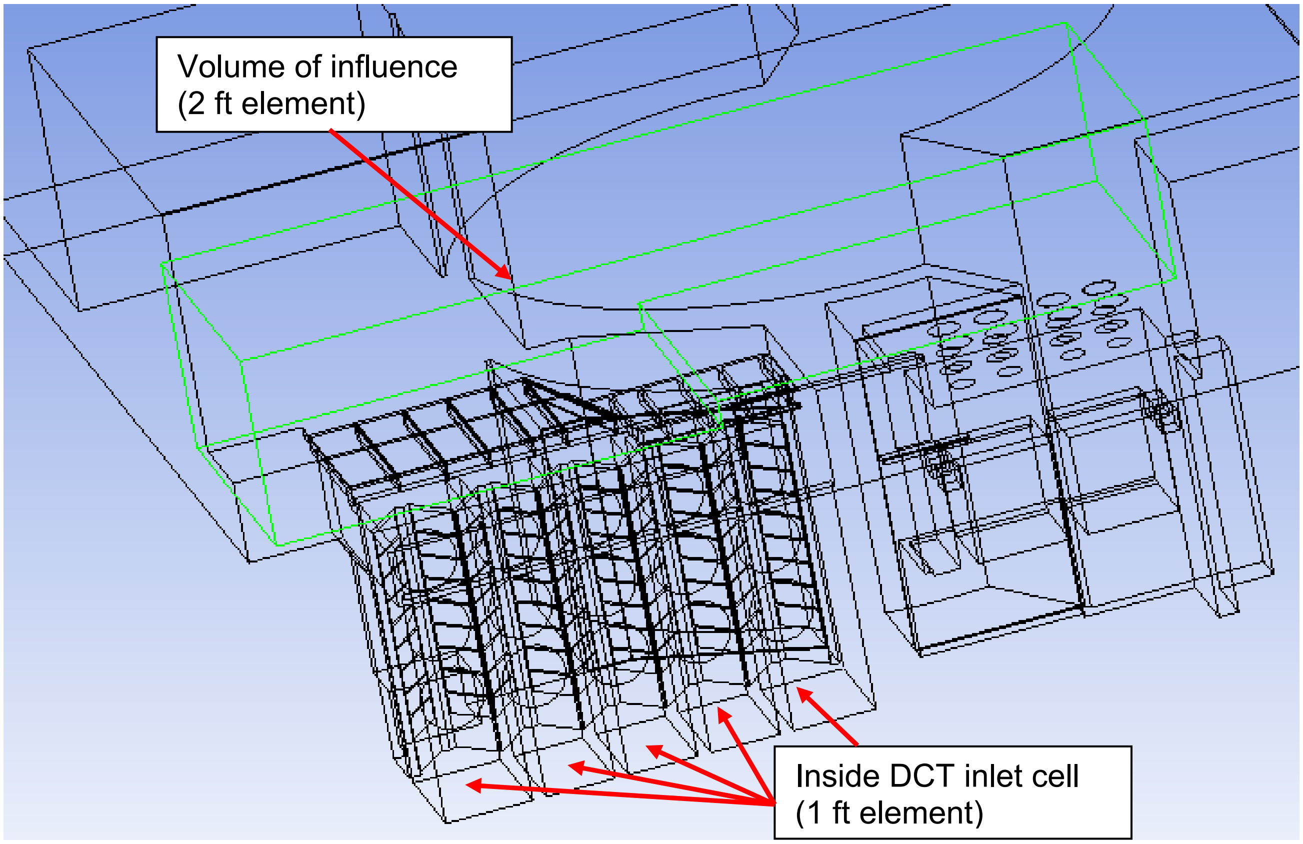


Figure 3-2: Train A volume of influence

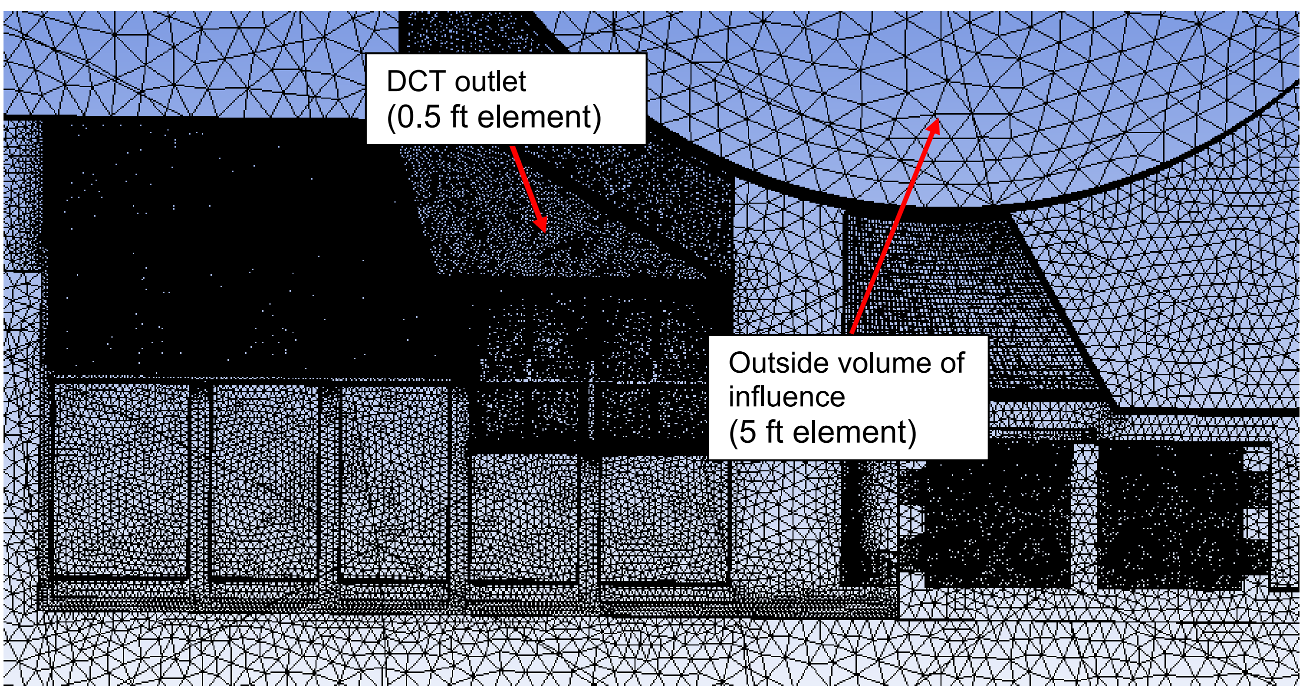


Figure 3-3: Train A mesh detail for the horizontal wall

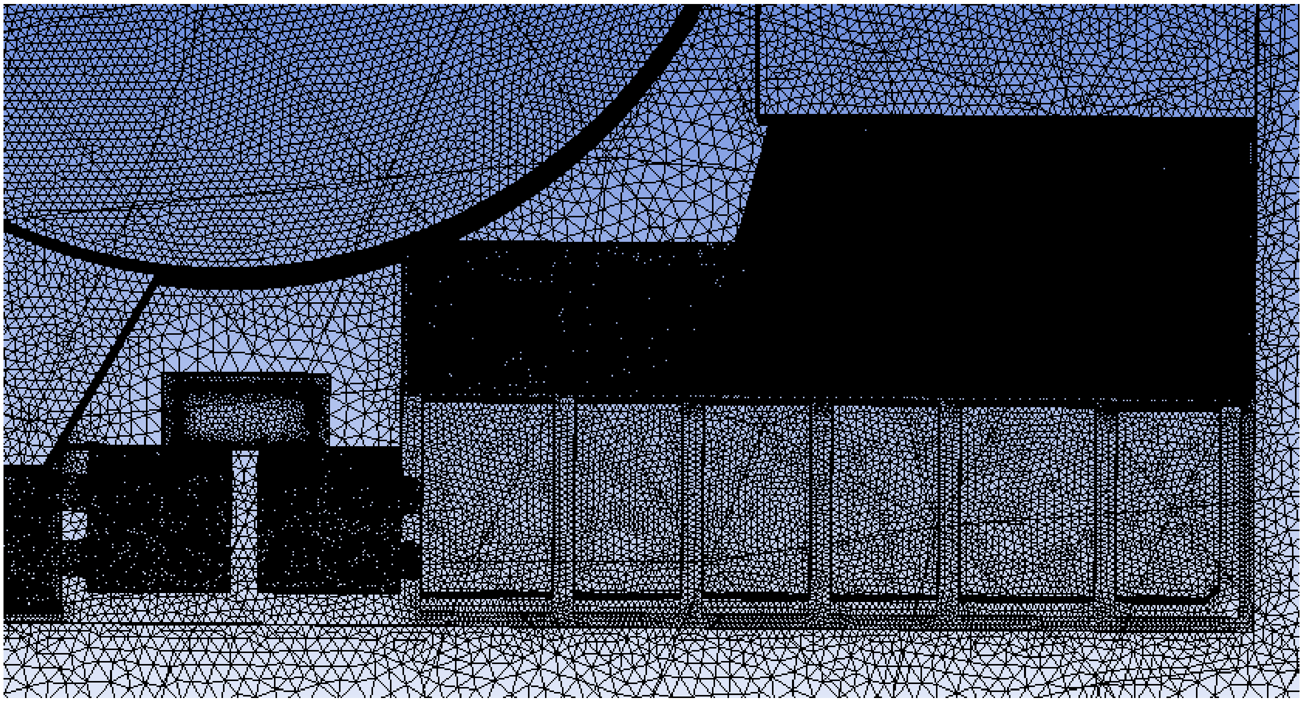


Figure 3-4: Train B mesh detail for the angle wall

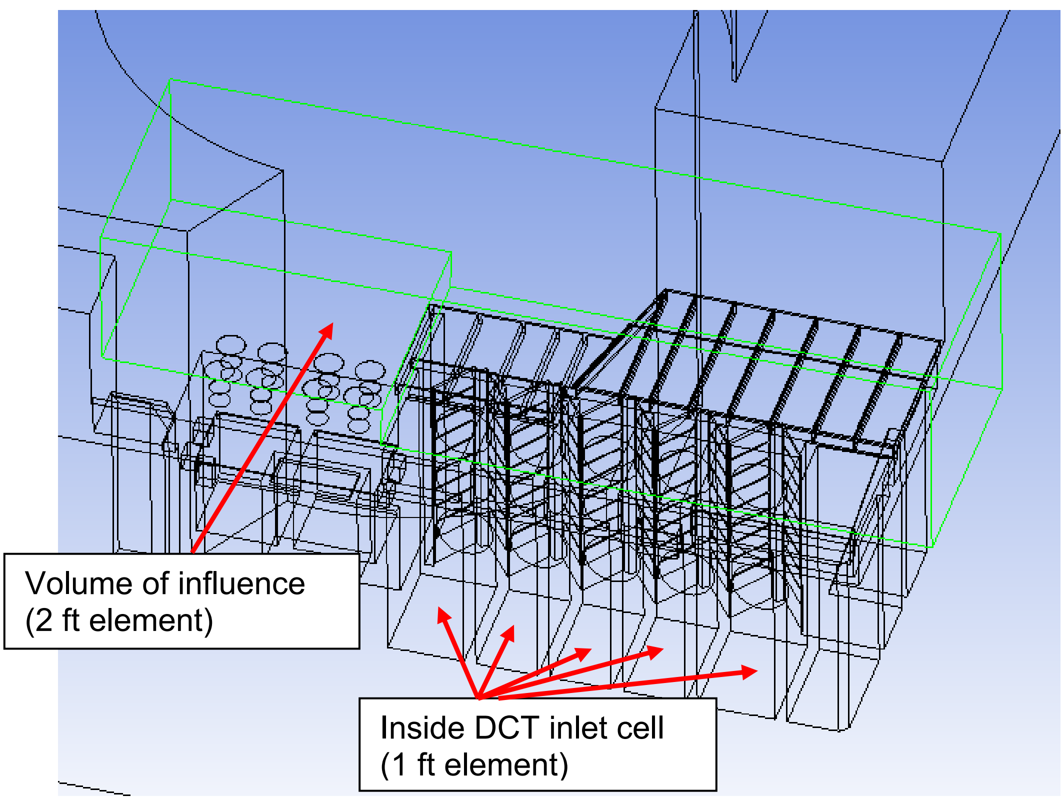


Figure 3-5: Train B volume of influence

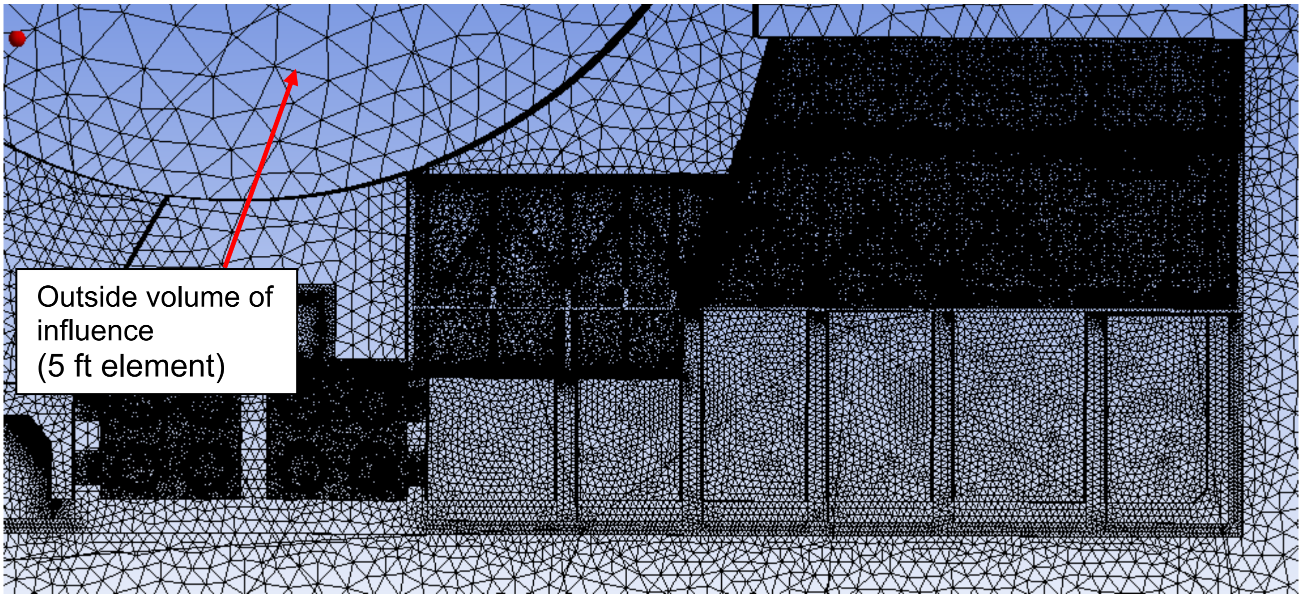


Figure 3-6: Train B mesh detail for the horizontal wall

3.3 Model Results Evaluation

3.3.1 Recirculation

The primary goal of the CFD study is to evaluate the recirculation effect at the DCT and WCT inlets. The DCT results were numerically evaluated to determine the degree of recirculation by querying the model for the area temperature for the 15 DCT fan inlet circular planes. The average of these 15 temperatures are reported as the fan temperature. The increased fan inlet temperature over the ambient shows the effect of recirculated discharge air. The temperature distribution over each fan area is presented as well as the numerical area average value.

The WCT recirculation was calculated using the recirculated mass flow, the average WCT inlet temperature, and the resulting inlet wet bulb temperature. From the CFD model, a mass tracking feature provided the WCT exit mass flow that recirculated to the WCT inlet. The CFD model also provided the increased WCT inlet temperature averaged across both bays. The recirculated mass of 100% humid air increased the moisture content of the incoming air and was used in combination with the higher WCT inlet temperature to calculate the increased wet bulb temperature at the WCT inlet. The increase above the ambient wet bulb was defined as WCT recirculation. Detailed calculations are provided in Att. A. It is noted that any cross communication between the towers is captured in the model temperatures. For the DCT, the wet bulb temperatures do not affect the DCT performance and moisture carry-over was not tracked.

The CFD models were run until approximately steady state average temperatures were achieved. DCT average temperatures with iteration are shown for each case. Due to minor fluctuations, temperature results were averaged over the last 50-100 iterations of each simulation.

3.3.2 Fan Flow Rate

A second consideration of the study was to ensure that the DCT fan flow rate would not be reduced to an unacceptable level by the addition of wall panels or other flow obstructions. Such items could increase pressure losses and therefore reduce fan flow, potentially reducing the ability to remove heat.

Since fan flows were defined as velocity boundary conditions directly in the model, a method of calculating the change in fan flow rate was derived from the available pressure measurements and the fan curve. First, a fan curve was derived from Hudson products data as shown in [19] for the 13 degree blade pitch angle and 205rpm rotational speed. Second, the model total pressures at the fan inlet and coil outlet provided the pressure required from the fan, with consideration of the loss across the coil. The design loss across the DCT coil at 181,044 cfm is between 0.385 inwg and 0.615 inwg per the coil data sheet [19]. Startup testing indicated that fan flows for the A tower averaged 186,000 cfm [21]. A comparable CFD simulation of the test was most closely matched by a pressure change across the DCT coil of 0.53-0.55 inwg, which was within the range. For conservatism, the upper bound loss of 0.615 inwg was used to calculate the pressure drop for each subsequent case by scaling using the square of the velocity relative to 186,000 cfm.

For each CFD analysis case, the area averages of the total pressure at fan inlet, missile shield, and coil boundary were sampled to calculate the pressure gain across the fan. The total pressure drop from the fan to ambient includes three terms: the pressure gain from the fan, buoyancy, and pressure drop across the coil. The buoyancy term is based on the change in air density over the average height between the coil exit and a reference plane (~30ft). This buoyancy term and the coil pressure drop are included with the total pressure acquired from CFX in order to determine flow from the Hudson fan curve. The buoyancy term is added based on the CFX manual description that a hydrostatic component is excluded from the reported pressure when buoyancy is activated (see CFX user's manual [32] Sections 1.1.3 and 1.2.9.3). However, this effect is negligible, adding approximately 0.03inwg compared to a fan output of approximately 0.9inwg.

The sampled pressures at the fan inlet and coil outlets used average pressures across all the fans. This is justified for three reasons: First, the goal was to

determine performance over the net operation of the entire DCT, so average performance is reasonable. Second, there are not significant pressure differences with elevation across the DCT inlet and outlet. Pressures across two sample planes bisecting the 3rd and 4th cells (Figure 3-7A) show that pressure change is within several thousandths of a psi (.001-.004psi) with fan position. Third, start-up testing [21] showed no regular pattern of fan flow variation with position, and instead showed a somewhat random variation across the 15 fans.

The lower limit for acceptable fan flow was established through discussion with Hudson Products personnel who utilized their in-house fan sizing software. From the Waterford3 fan speed and blade pitch angles, the fan curve shown in Figure 3-7 was produced (see also Att E). From this curve, the stall point was identified as 119,000 cfm. Based on discussion with Hudson products personnel, a margin of 20% provides sufficient conservatism relative to this stall point. The lower fan limit was therefore determined to be 120%x119,000 = 143,000 cfm.

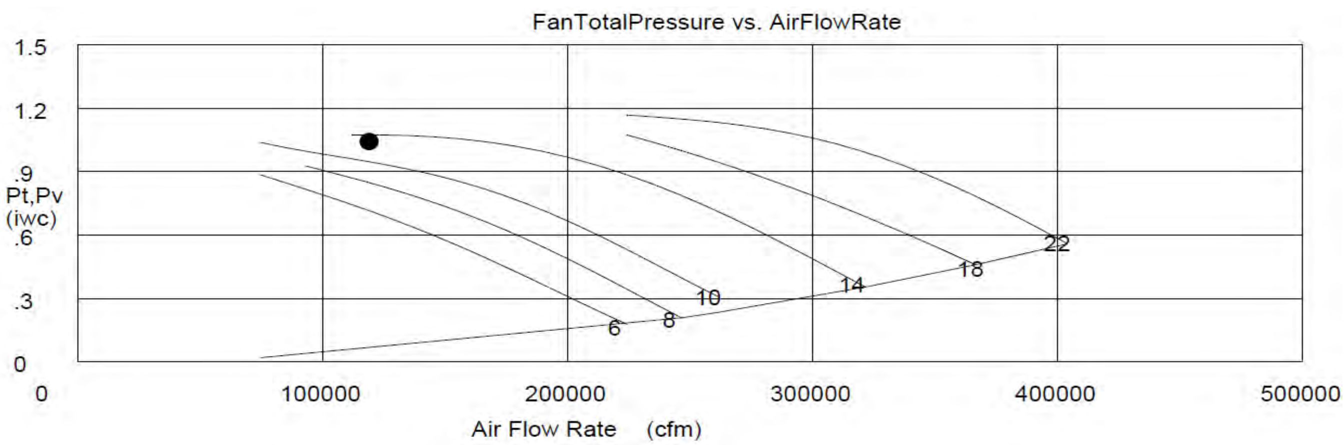
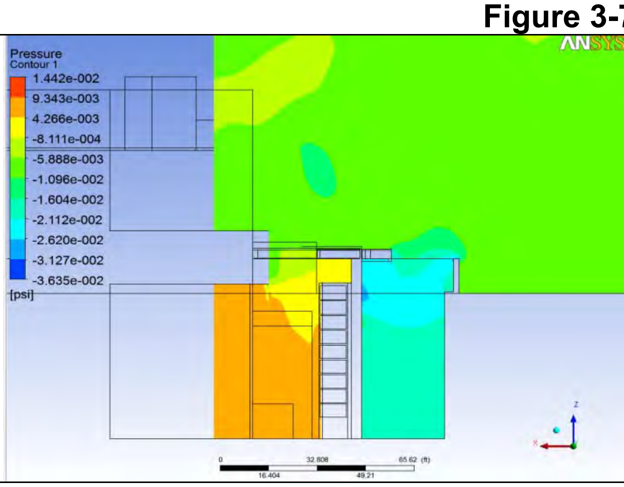
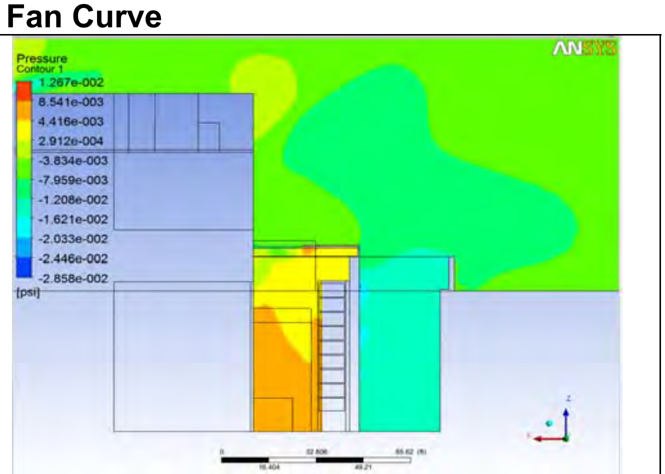


Figure 3-7: Fan Curve





Cell 3 Pressures	Cell 4 Pressures

Figure 3-7A: Pressure Variation with Fan Position

3.4 CFD Model Verification

To ensure model quality, the general guidance provided in NUREG-2152 [28] was followed. NUREG-2152 describes best practice guidelines for CFD, specifically for dry storage cask applications. However, the practices described in this NUREG are general in nature and are therefore applicable to a wide range of applications, including the evaluation described herein.

This section describes steps taken to verify the CFD results and ensure model quality. For tests of mesh density and turbulence models, verification tests of the angle wall geometry were evaluated using the A train geometry with a 30deg angled, 16.2ft deflector wall located on top of the missile shield and DCT wall. This wall was later extended to 17ft for the final design concept. This minor extension in length was not considered significant enough to affect the verification results. For the horizontal wall concept, the B Train geometry was used.

3.4.1 Convergence Criteria

Each evaluation model was run for several hundred iterations (typically 500-600) prior to termination. Solution outputs were obtained from averaging the last 50-100 steps as described in Section 4.0. Convergence on an acceptable solution set was determined based on two primary criteria:

1. Stable behavior of the average DCT inlet fan temperature. This is the average temperature of the 15 operating DCT fan inlets, and was judged acceptable if it oscillated within a small range. Copies of the DCT fan temperature with iteration are included in Attachment D.[2]
2. Reduction of the model residuals to a stable range.

Residuals are associated with difference between the solution and a conservation law such as mass, momentum, or energy. In ANSYS CFX, the residuals are normalized by a reference value based on the solution range.

A general criterion for residuals is 10^{-3} (1e-3) to 10^{-4} (1e-4) based on [27]. Figure 3-8 shows an example of residuals for an A Train angle wall evaluation. The values included in the plot are the residuals relative to conservation of mass, momentum in

[2] The DCT average fan temperature provides a reasonable measure of recirculation and overall performance of the DCT. The conditions at each individual fan will oscillate about a mean. Studies of time-dependent conditions (see Att. C) show that the average temperature oscillates +/-2F on a period of approximately 4 seconds. Individual fans can vary more than this, but fluctuations are largely self correcting, as one fan increase is balanced by an adjacent decrease. Additionally, oscillations at a period of 4 seconds are far faster than the thermal inertia of the large DCT coil mass.

3 directions, and energy. The RMS residuals for momentum and energy are steady at approximately 2e-4 while the mass residual is down to 3e-5. Based on the stable residual results in an appropriately low range and the steady DCT temperatures, these results were considered acceptable.

Figure 3-9 shows an example of residuals for B Train horizontal wall evaluation. The residuals were similar to Figure 3-8, which shows the mass equations were under 1e-4 in all cases, and the momentum, energy, and turbulence residuals were approximately 1e-3. Results were judged acceptable within the general criterion of 1e-3 to 1e-4 range.

The final modification residuals for the angle wall cases and the horizontal wall cases are provided in Attachment D and E respectively. All residuals were stable. The mass residuals were under 1e-4 in all cases. The momentum, energy, and turbulence residuals were around 1e-3 range. Results were judged acceptable within the general criterion of 1e-3 to 1e-4 range.

Stability of the WCT recirculation was not considered as important to the problem and results were accepted if the WCT mass results oscillated within a range. The effect of this was studied, and the driving parameter for WCT performance, the inlet wet bulb temperature, does not change significantly with the range of variation in recirculated air mass. For the results shown in Section 4, using the maximum recirculated WCT air mass over the last 100 iterations instead of the average would only change the calculated wet bulb by approximately 1F at 50% humidity.

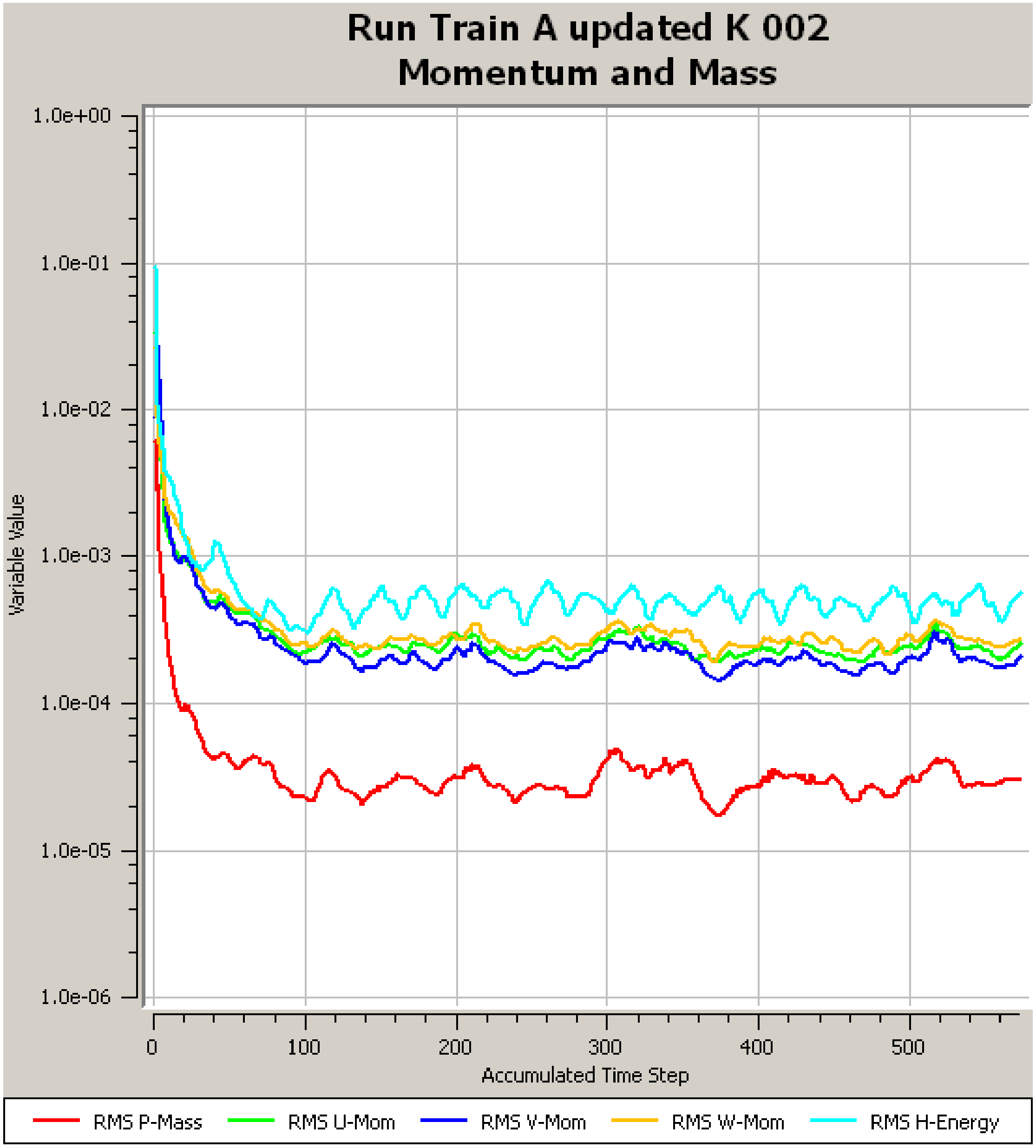


Figure 3-8: Example of Residuals for Train A Angle Wall Concept

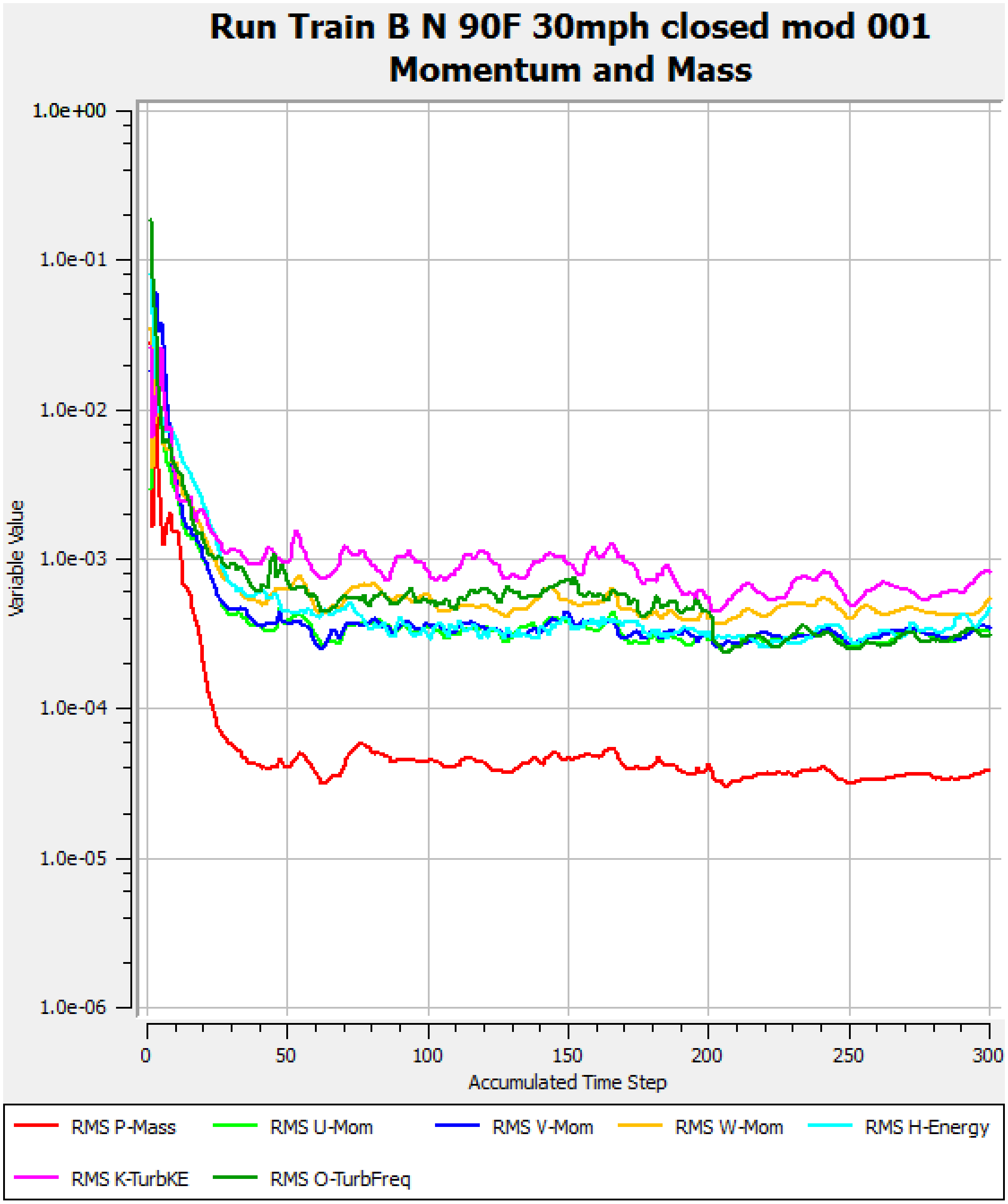


Figure 3-9: Example of Residuals for the Train B Horizontal Wall Concept

3.4.2 Mesh Quality

Mesh quality includes several parameters that help assure a numerically stable and accurate solution. This includes avoidance of the following:

- highly skewed elements with orthogonal angles <20 deg.
- large jumps in grid density
- large aspect ratios (>100)

The CFX output file shows these mesh quality metrics. Train A and B mesh statistics for the angle wall are shown in Figure 3-10 and Figure 3-11. In these figures, the minimum orthogonal angle, maximum expansion factor between grids, and the maximum aspect ratio for each domain are shown in the top half of the table. In the bottom half, the percentages of poor quality (indicated as "%!"), acceptable (%ok) and good (%OK). In the fluid domain, all these figures showed that less than 1% of the elements are shown as poor quality in terms of orthogonal angle and expansion factor. In a complicated model such as the cooling tower, this is considered insignificant. Figure 3-12 and Figure 3-13 shows the mesh statisitics for Train A and B horizontal wall concept. Less than 1% of the fluid mesh elements were shown as poor quality. This is considered insignificant.

Mesh Statistics

Domain Name	Orthog. Angle Minimum [deg]	Exp. Factor Maximum	Aspect Ratio Maximum
DCT porous 1	76.7 OK	1 OK	6 OK
DCT porous 2	60.8 OK	1 OK	7 OK
Fluid	15.6 !	1116 !	726 ok
WCT porous	62.5 OK	3 OK	6 OK
WCT walkway	89.5 OK	1 OK	1 OK
fost	75.4 OK	1 OK	5 OK
porous	43.6 ok	13 ok	6 OK
Global	15.6 !	1116 !	726 ok

Domain Name	Orthog. Angle %!	Orthog. Angle %ok	Orthog. Angle %OK	Exp. Factor %!	Exp. Factor %ok	Exp. Factor %OK	Aspect Ratio %!	Aspect Ratio %ok	Aspect Ratio %OK
DCT porous 1	0	0	100	0	0	100	0	0	100
DCT porous 2	0	0	100	0	0	100	0	0	100
Fluid	<1	3	97	<1	3	97	0	1	99
WCT porous	0	0	100	0	0	100	0	0	100
WCT walkway	0	0	100	0	0	100	0	0	100
fost	0	0	100	0	0	100	0	0	100
porous	0	<1	100	0	1	99	0	0	100
Global	<1	3	97	<1	2	98	0	1	99

Figure 3-10: Train A Angle Wall Mesh statistics

Mesh Statistics									
Domain Name	Orthog. Angle			Exp. Factor			Aspect Ratio		
	Minimum [deg]			Maximum			Maximum		
FOST	89.9 OK			1 OK			6 OK		
Fluid	9.9 !			351 !			900 ok		
porous	43.8 ok			11 ok			10 OK		
Global	9.9 !			351 !			900 ok		
	%!	%ok	%OK	%!	%ok	%OK	%!	%ok	%OK
FOST	0	0	100	0	0	100	0	0	100
Fluid	<1	3	97	<1	3	97	0	2	98
porous	0	<1	100	0	2	98	0	0	100
Global	<1	3	97	<1	3	97	0	2	98

Figure 3-11: Train B Angle Wall Mesh statistics

Mesh Statistics									
Domain Name	Orthog. Angle			Exp. Factor			Aspect Ratio		
	Minimum [deg]			Maximum			Maximum		
DCT porous 1	76.7 OK			1 OK			6 OK		
DCT porous 2	60.8 OK			1 OK			7 OK		
Fluid	11.2 !			398 !			1124 !		
WCT porous	62.5 OK			3 OK			6 OK		
WCT walkway	89.5 OK			1 OK			1 OK		
porous	25.2 ok			321 !			16 OK		
Global	11.2 !			398 !			1124 !		
	%!	%ok	%OK	%!	%ok	%OK	%!	%ok	%OK
DCT porous 1	0	0	100	0	0	100	0	0	100
DCT porous 2	0	0	100	0	0	100	0	0	100
Fluid	<1	4	96	<1	3	97	<1	1	99
WCT porous	0	0	100	0	0	100	0	0	100
WCT walkway	0	0	100	0	0	100	0	0	100
porous	0	4	96	2	5	93	0	0	100
Global	<1	4	96	<1	3	97	<1	1	99

Figure 3-12: Train A Horizontal Wall Mesh Statistics

Mesh Statistics						
Domain Name	Orthog. Angle		Exp. Factor		Aspect Ratio	
	Minimum [deg]		Maximum		Maximum	
Fluid	12.4	!	6393	!	1603	!
porous	8.1	!	2982	!	104	ok
Global	8.1	!	6393	!	1603	!

Domain Name	Orthog. Angle %!	Orthog. Angle %ok	Orthog. Angle %OK	Exp. Factor %!	Exp. Factor %ok	Exp. Factor %OK	Aspect Ratio %!	Aspect Ratio %ok	Aspect Ratio %OK
Fluid	<1	4	96	<1	3	97	<1	1	99
porous	<1	3	97	2	3	95	0	<1	100
Global	<1	4	96	<1	3	97	<1	1	99

Figure 3-13: Train B Horizontal Wall Mesh Statistics

3.4.3 Mesh Density Study

3.4.3.1 Angle Wall Concept

The mesh density study compared the results with a varied number of elements included to define the model fluid domain. In general CFD practice, more elements would provide a more accurate solution but require longer analysis times to resolve. To ensure that a sufficient but not excessive number of elements was included, the analysis results for three different mesh densities were compared. The tested mesh densities (number of elements) were 13 million, 18 million, and 24 million elements.

The cases in this study used the A Train geometry and simulated a south wind at 15mph with 95F ambient temperature. Table 3-1 shows the inlet and outlet values for this study.

To evaluate the results, both judgment and numerical criteria were used. First, flow patterns around the missile shield and fan inlets for the three models were reviewed. Flow patterns for each model were nearly identical. An example vector plot on a vertical plane through cell 3 is shown in Figure 3-14.

More accurate numerical evaluation showed subtle differences in fan inlet temperatures.

Table 3-2 shows the resulting fan inlet temperatures for the 15 fans using the 13M, 18M, and 24M element models. Using the 24M model as a basis, it can be seen that the 13M model fan temperatures differ between 0-1.1, with an average difference of 0.3 over all fans. The 18M model provides an average temperature within 0.1 and with the exception of 1 cell, all fan inlet temperatures are either identical or within

0.1. Based on these results, the 18M element model was determined to be sufficiently accurate for this study. In the final evaluation cases, 20M and 21M elements were used as described in Section 3.1.

Table 3-1: Input values for verification case

Variable	Value
DCT fan velocity	22.8 ft/s
DCT outlet velocity	10.6 ft/s
DCT outlet temperature	150 F
WCT inlet velocity	10.1 ft/s
WCT outlet velocity	44.2 ft/s
WCT outlet temperature	108.5 F

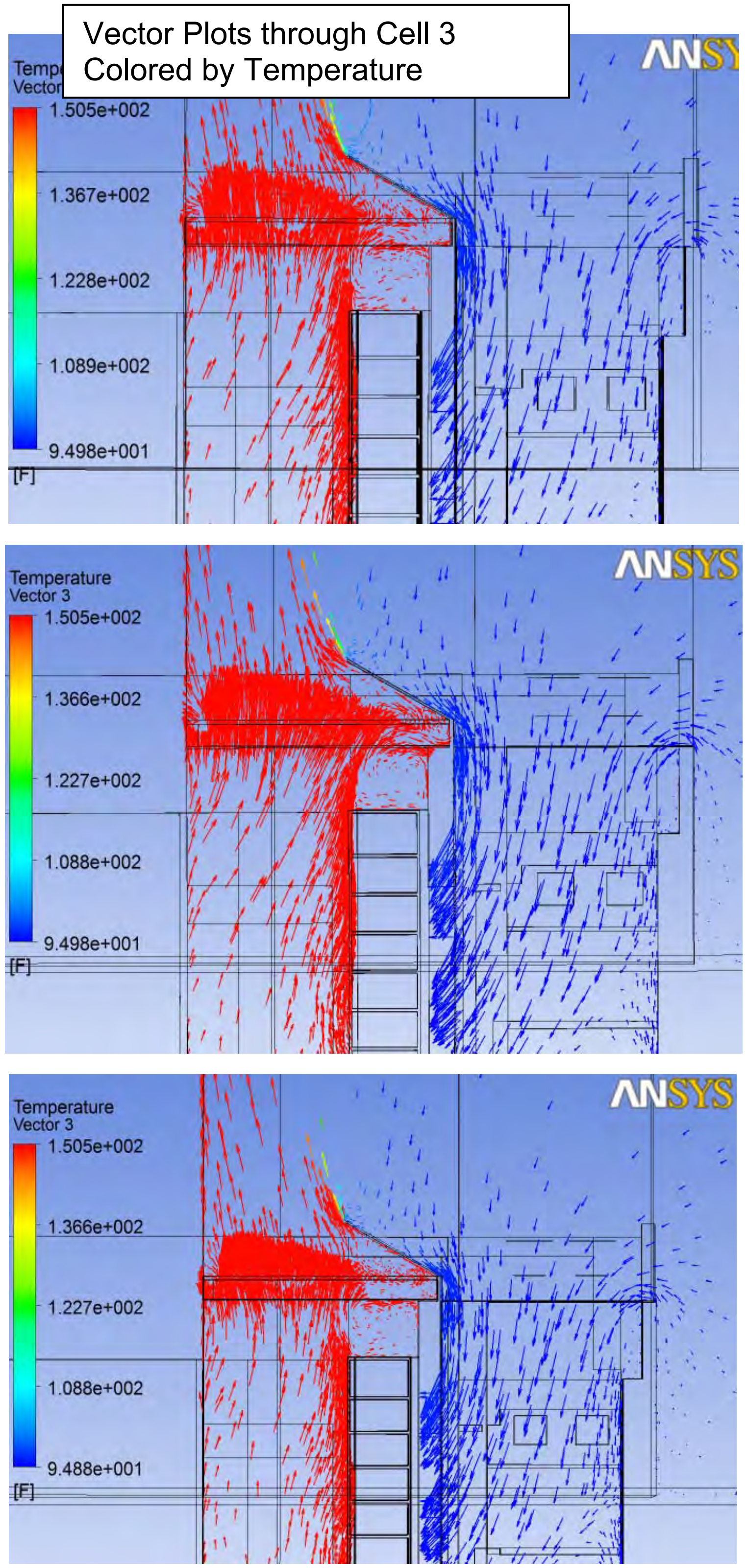


Figure 3-14: Comparison Plots of 13M, 18M, 24M Element Results

Table 3-2: Mesh Density Study: Comparison of Fan Temperatures for Angle Wall

13 Million Element Model					
Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	95.3	95.5	96.0	97.6	99.5
	95.2	95.2	95.5	96.6	98.6
	95.1	95.2	95.4	96.0	97.5
Average fan temperature:				96.3	

18 Million Element Model					
Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	95.2	95.4	96.7	97.2	100.0
	95.1	95.1	95.3	95.9	98.2
	95.1	95.1	95.2	95.5	96.4
Average fan temperature:				96.1	

24 Million Element Model					
Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	95.2	95.4	95.7	97.3	100.1
	95.1	95.1	95.3	95.9	98.2
	95.1	95.1	95.2	95.5	96.4
Average fan temperature:				96.0	

3.4.3.2 Horizontal Wall Concept

Similar to the angle wall concept, mesh sensitivity studies were conducted with changes in the mesh size. The mesh element size inside the volume of influence (see also Section 3.1) was varied to be 1ft (fine mesh), 2ft, and 4ft (coarse mesh).

The cases in this study used the B Train geometry and simulated a south wind at 30mph with 90F ambient temperature. This case was used because it produces the highest recirculation among all cases (see Section 4.0). Table 2-5 shows the inlet and outlet values for this study.

Flow patterns around the missile shield and the volume of influence region for the three models were reviewed. Flow patterns for each model were nearly identical. An example vector plot on a vertical plane through cell 3 is shown in Figure 3-15.

More accurate numerical evaluation showed subtle differences in fan inlet temperatures. Table 3-3 shows the resulting fan inlet temperatures for the 15 fans using the 4ft, 2ft, and 1ft element size models. It can be seen that the average fan temperature for the 1ft and 2ft element size model were the same. The 4ft model has a higher recirculation, which is due to the coarse mesh size. It can be seen that the maximum fan temperatures difference between the 4ft and 1 ft model was 7.7F, with an average difference of 1.5 over all fans. The 2ft model provides a maximum difference of 0.8F and average temperature within 0.1F. Based on these results, the 2ft element size model was determined to be sufficiently accurate for this study.

Table 3-3: Mesh Density Study: Comparison of Fan Temperatures for Horizontal Wall

4ft Element Model					
Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	105.1	102.8	101.8	102.1	100.0
	99.5	102.3	100.3	99.5	95.9
	97.2	97.6	97.2	93.9	93.6
Average fan temperature:				99.2	

2ft Element Model					
Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	97.3	103.0	105.3	104.0	100.7
	93.9	95.8	100.4	98.7	95.6
	97.0	92.1	94.1	93.3	94.0
Average fan temperature:				97.7	

1ft Element Model					
Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	97.4	102.2	105.0	104.0	101.2
	94.1	95.8	99.9	98.6	96.1
	96.5	92.5	94.3	93.7	94.6
Average fan temperature:				97.7	

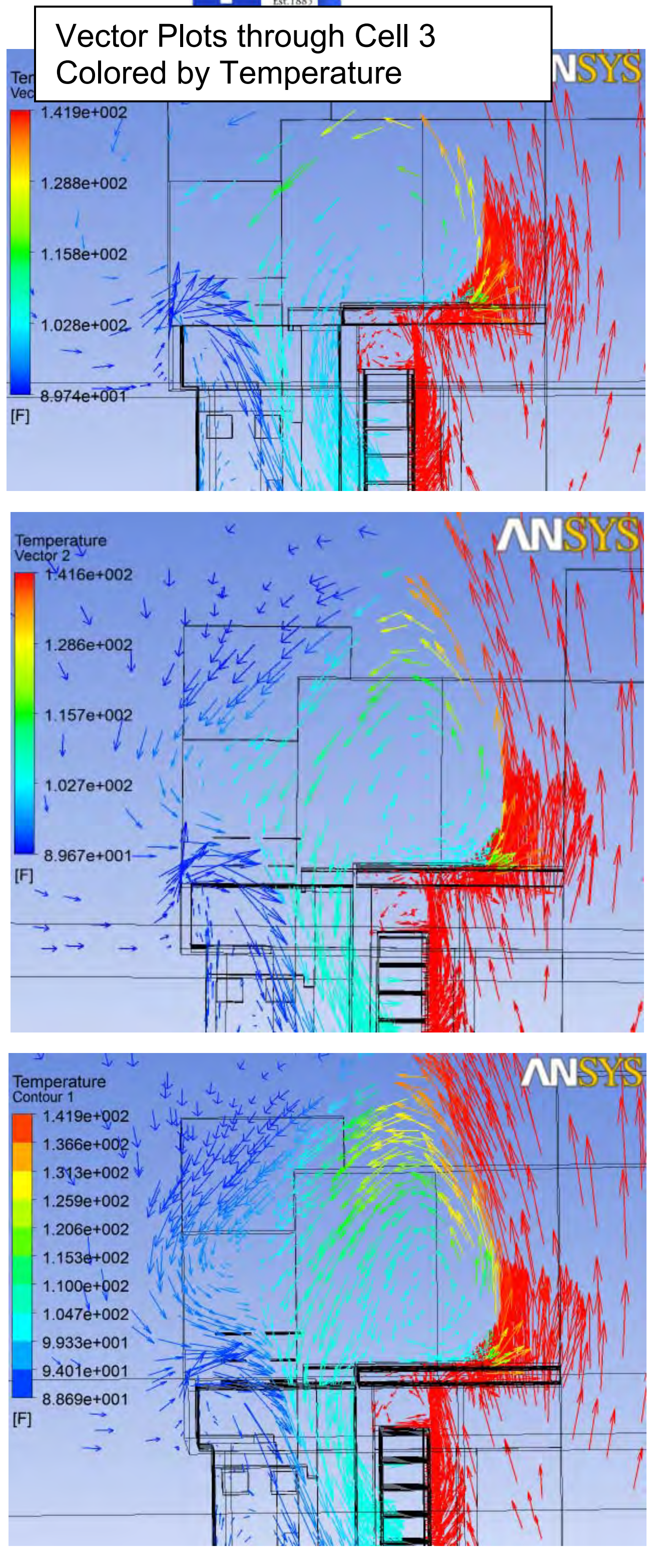


Figure 3-15: Comparison Plots of 4ft (top), 2ft (mid), and 1ft (bot) Element Results

3.4.4 Turbulence Modeling Study

There are several schemes to model turbulent flow available in ANSYS CFX. Three of the most common are the k-epsilon (k-ε) model, k-omega (k-ω) model, and the shear stress transport model (SST). A "standard" for CFD is the base k- ε model, while the k-ω model is considered an improvement in terms of the boundary layer and separated flow [27], The SST model combines many of the characteristics of the k-ω model near wall boundaries with the k-ε model further away from structures. Given the complex geometry and potential wake effects from the adjacent buildings, the SST model was chosen.

In this section, the k-ω turbulence model results are compared with other turbulence models, the k-ε and SST. The intent is to determine if there are significant differences in order to assure that error was not introduced through the choice of the SST scheme.

Much of the variation in turbulence models is captured in near wall boundary layer effects. Since these are relatively unimportant to the large scale flow patterns around the DCT, the variation in turbulence model results is not expected to be significant.

3.4.4.1 Angle Wall Concept

The boundary conditions for all inlets and outlets were the same as the conditions in the mesh density study. The mesh density used in this turbulence study was 18M elements.

Table 3-4 shows a comparison of the fan inlet temperatures for the 3 turbulence models. All three models provide the same average temperature for the 15 fans (96.1F). Modest differences are seen in the temperatures for cells 3-5, particularly in the top 2 rows, in which the flow separation and recirculation is highest.

As a second comparison, the table also provides the fan flow rate, calculated from the inlet and outlet pressures as described in Section 3.3.2. It can be seen that the SST model predicts a compromise between the two solutions. However, the difference is insignificant.

Table 3-4: Turbulence Study: Comparison of Fan Temperatures for Angle Wall

K-Omega Model					
Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	95.2	95.4	96.7	97.2	100.0
	95.1	95.1	95.3	95.9	98.2
	95.1	95.1	95.2	95.5	96.4
Average fan temperature:				96.1	
Fan Flow Rate (x1000cfm)				179	

K-Epsilon Model					
Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	95.2	95.4	96.1	98	99.2
	95.1	95.1	95.4	96.4	97.8
	95.1	95.1	95.2	95.4	96.3
Average fan temperature:				96.1	
Fan Flow Rate (x1000cfm)				181	

SST Model					
Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	95.2	95.4	95.8	98.1	99.9
	95.1	95.2	95.4	96.2	97.6
	95.1	95.1	95.2	95.4	96.5
Average fan temperature:				96.1	
Fan Flow Rate (x1000cfm)				180	

Based on the equivalent average temperatures, with only modest differences between models, and based on the prediction of the fan flow using the SST compared to the other turbulence models, the selected SST model is considered to provide an accurate representation of turbulent flow.

3.4.4.2 Horizontal Wall Concept

The boundary conditions for all inlets and outlets were the same the conditions as in the mesh density study. The mesh density used in this turbulence study was 2ft elements size.

Table 3-5 shows a comparison of the fan inlet temperatures for the 3 turbulence models. The k-omega and SST models provide the same average temperature for the 15 fans (97.7F). The k-epsilon model is considered less accurate for the prediction of separated flow, which is particularly important in the building wake region.

As a second comparison, the table also provides the fan flow rate, calculated from the inlet and outlet pressures as described in Section 3.3.2. It can be seen that the fan flows were between 177,000cfm and 180,000cfm. The differences are insignificant.

Table 3-5: Turbulence Study: Comparison of Fan Temperatures for Horizontal Wall

K-Omega Model					
Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	95.3	97.4	107.1	106.0	103.2
	95.3	94.2	98.8	98.2	96.8
	97.0	93.0	94.1	94.0	95.5
Average fan temperature:				97.7	
Fan Flow Rate (x1000cfm)				177	

K-Epsilon Model					
Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	99.3	102.7	105.3	103.7	101.1
	96.0	96.9	100.5	99.5	97.3
	97.7	94.0	95.6	94.8	95.5
Average fan temperature:				98.7	
Fan Flow Rate (x1000cfm)				178	

SST Model					
Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	97.3	103.0	105.3	104.0	100.7
	93.9	95.8	100.4	98.7	95.6
	97.0	92.1	94.1	93.3	94.0
Average fan temperature:				97.7	
Fan Flow Rate (x1000cfm)				180	

Based on the equivalent average temperatures, with only modest differences between the k-omega and the SST models, and based on the prediction of the fan

flow using the SST compared to the other turbulence models, the selected SST model is considered to provide an accurate representation of turbulent flow.

3.4.5 Sensitivity Study for DCT Fan Walkway

As with any model, some simplification of details is required. One of the details that was excluded from the model was the personnel walkway areas on each level of the DCT fan inlets. These walkways are steel grating structures that permit access to the motor and fan from the inlet side.

It was judged that these structures would reduce recirculation by impeding (hot) flows down the wall, causing (cool) air to be drawn from the area away from the wall, thereby reducing the recirculation temperature increase at the fan. Additionally, the walkways are non nuclear safety items, and therefore could not be credited in the analysis. To verify this judgment, a sensitivity study was conducted to understand the effect of the walkway.

For this study, a basic 12 million element model was used. The DCT and WCT fan walkways were added and defined as 0.5ft thick with a grating material porosity and loss coefficient of 0.7 and 0.79/ft respectively.

Figure 3-16 and Figure 3-17 show example vector plots on a vertical plane through cell 3 for the cases without and with the walkways in the model. While the porous walkways slightly impede flow, there is no significant effect on the overall patterns.

The effect on fan inlet temperature is shown in numerically in Table 3-6, which provides the individual fan inlet temperatures with and without the DCT fan walkway. The average fan temperature for both models were 96.3F, and the variation between models for the individual fans is within 0.2F.

Based on this study, it is concluded that the assumption that the walkways have negligible effect on the results is confirmed.

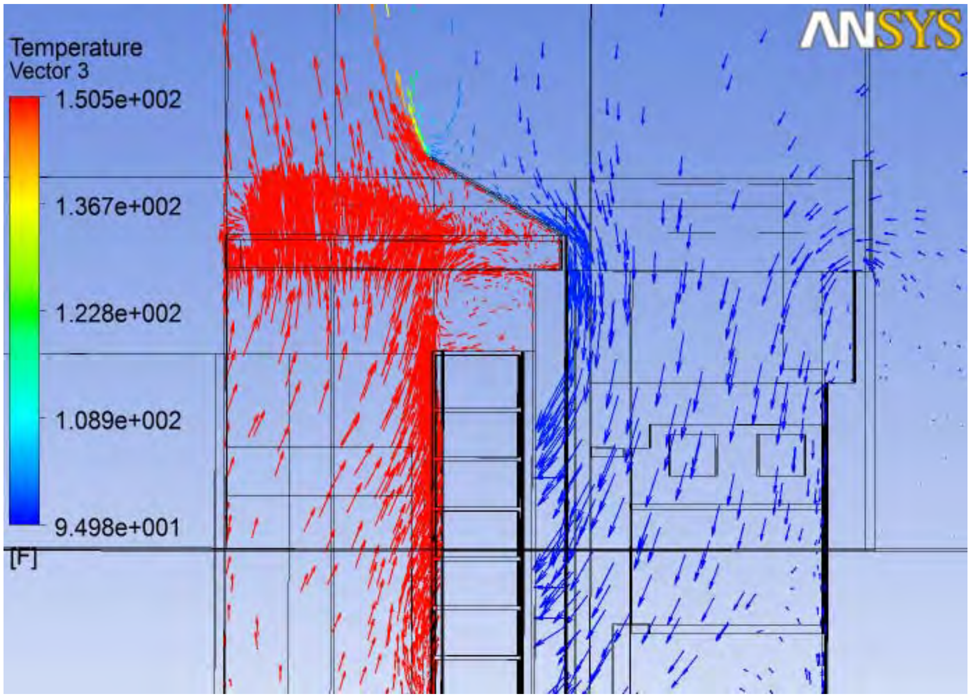


Figure 3-16: Velocity vectors through cell 3, without DCT fan walkway

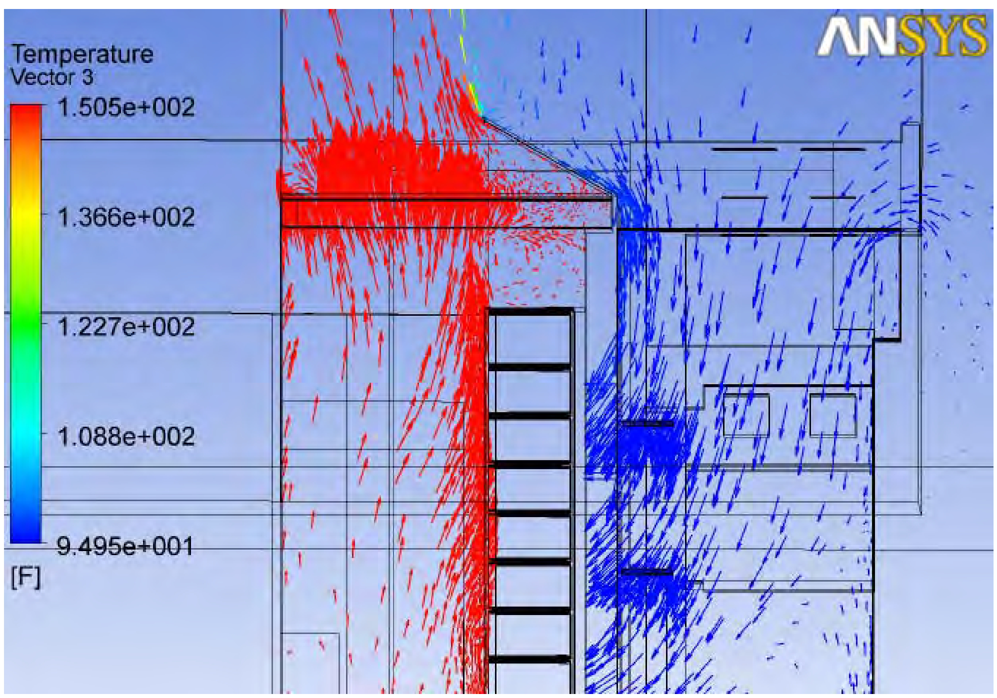


Figure 3-17: Velocity vectors through cell 3, with DCT fan walkway

Table 3-6: DCT Fan Walkway Study

Without Walkway					
Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	95.3	95.5	96.0	97.6	99.5
	95.2	95.2	95.5	96.6	98.6
	95.1	95.2	95.4	96.0	97.5
Average fan temperature:				96.3	

With Walkway					
Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	95.3	95.5	95.9	97.8	99.3
	95.2	95.2	95.4	96.6	98.6
	95.2	95.3	95.4	96.0	97.6
Average fan temperature:				96.3	

3.4.6 Horizontal Wall Length Sensitivity Study

The purpose of this study is to understand DCT recirculation and fan flow with various horizontal wall lengths. In general, a longer wall length produces less recirculation and lower fan flow. The study quantifies this relationship to optimize the wall length design.

The study evaluated the B train, because it produced limiting (higher) recirculation. Ambient conditions of 30mph wind speed and all 5 wind direction (NW, W, SW, S, N) were used.

The horizontal wall was varied in three different lengthes of 25ft, 28ft, and 30ft (see Figure 3-18). The length of 25ft was chosen based on initial studies (not included herein) to reduce recirculation to desired levels. A selection of initial studies addressing the A train are documented in [22]. However, numerous additional studies were also performed in the development of the final design concepts.

Figure 3-19 shows the recirculation results for the 25ft, 28ft, and the 30ft horizontal wall length model. It showed a downward trend as the length increases. The recirculation and fan flow reduced by 0.9F and 8000cfm as the plate increases from 25ft to 30ft (see Figure 3-19 and Figure 3-20).

Based on the results, recirculation decreased slightly as the horizontal wall length increased beyond 25ft. Because the change in recirculation was small relative to the greatly decreasing fan flow, the wall length was limited to 25ft.

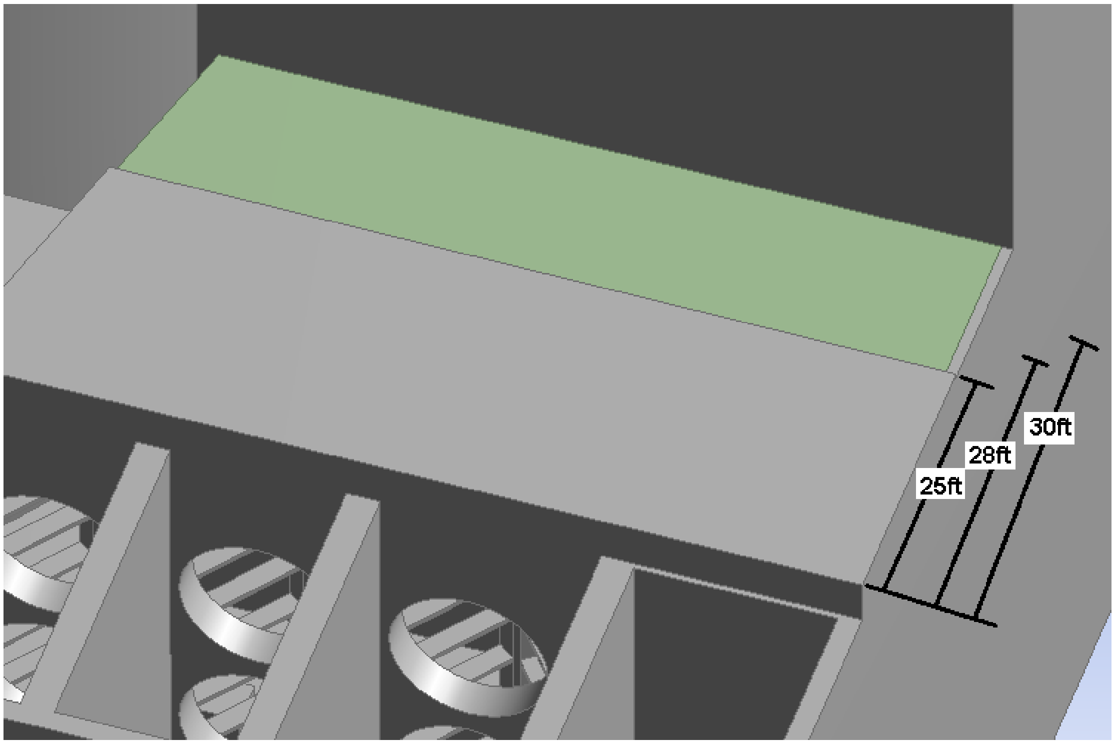


Figure 3-18: Horizontal Wall Length Sensitivity Study

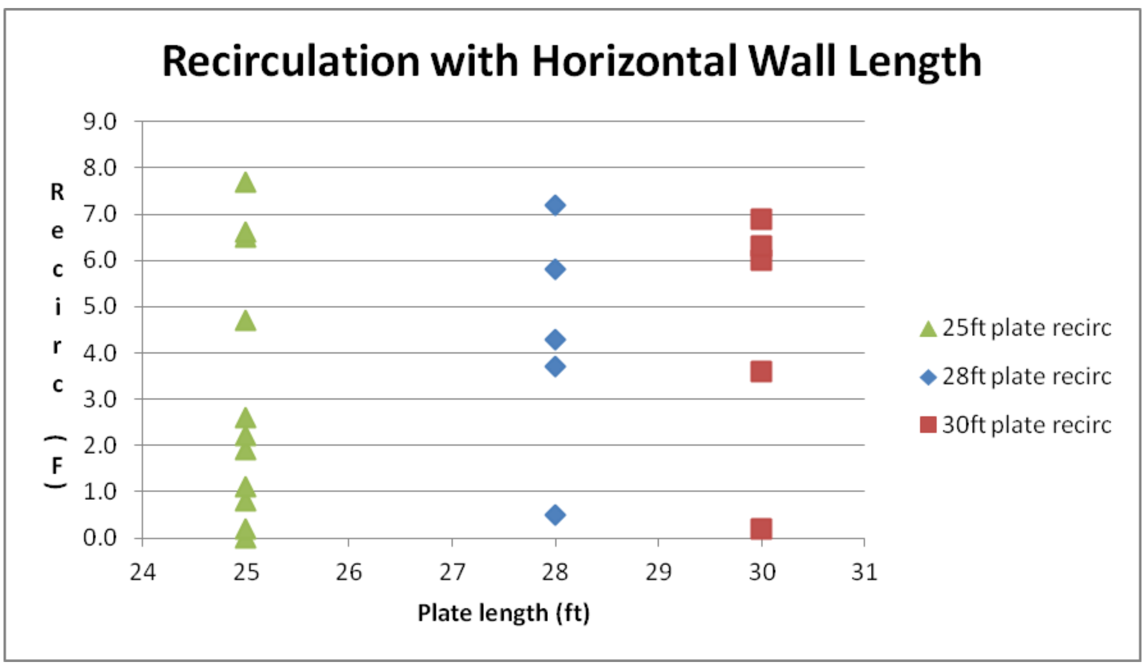


Figure 3-19: Recirculation Results for Wall Length Sensitivity study

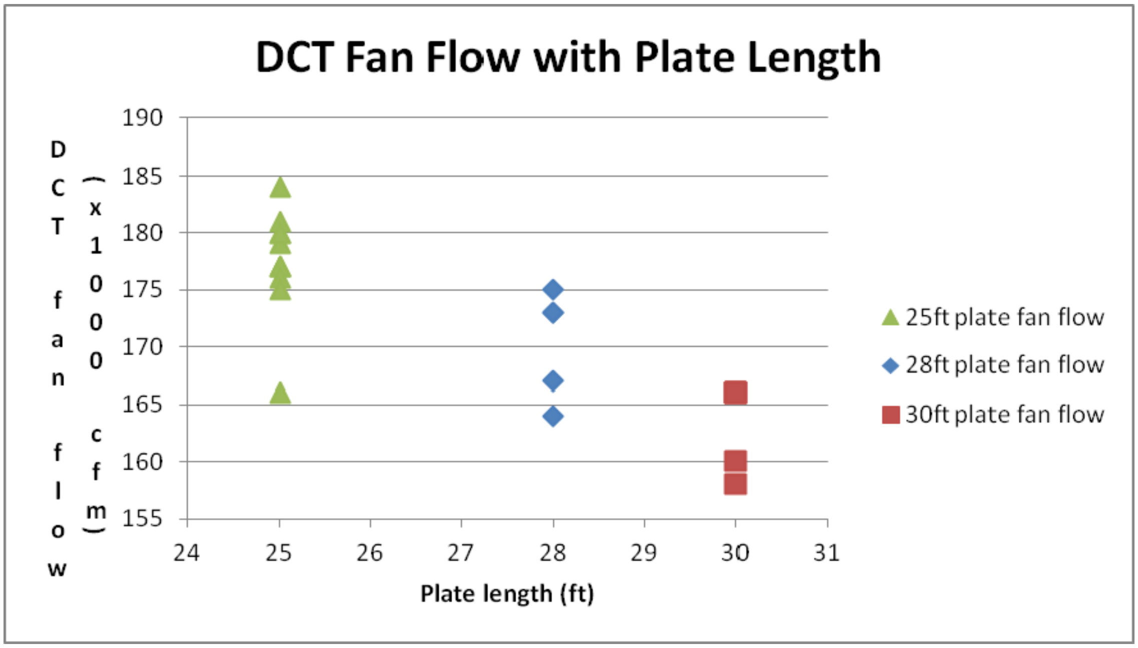


Figure 3-20: DCT Fan Flow Result for Wall Length Sensitivity Study

3.4.7 1 ft Beam Sensitivity Study for the Horizontal Wall

In all models, some details need to be omitted. As a general lower bound, beams and structural details that are less than approximately 1 ft were not included in the model. A sensitivity study was conducted to demonstrate the effect of this criterion.

Beams (W12x58) spanning the inlet over cells 4 and 5 are used to support the horizontal wall and a 10ft by 1ft horizontal plate is used to seal off the space between the concrete wall between cells 3&4 and the 3ft support beam (See Figure 3-21). To test the 1ft criterion, these elements were removed from the model to determine the change in recirculation and fan flow for the overall DCT tower and the individual cells (i.e. cell 4 and cell 5) in particular.

The B train South wind 90F/30mph case was used in this study because it yielded the bounding recirculation. Results are provided in Table 3-7. The individual fan temperature, overall DCT, and the average of the cell 4 and 5 fan temperature and fan flow are included in the table. The difference between with and without 1ft beam and plate change the overall recirculation by 0.1F and fan flow by 1000cfm. For cell 4 and 5, the recirculation with and without are the same, and the fan flow difference was 3000cfm. Figure 3-22 showed the flow pattern with and without the 1ft beam, and they are very similar.

Based on the results above, including or not including beam and plate less than 1ft have insignificant change in the recirculation and fan flow.

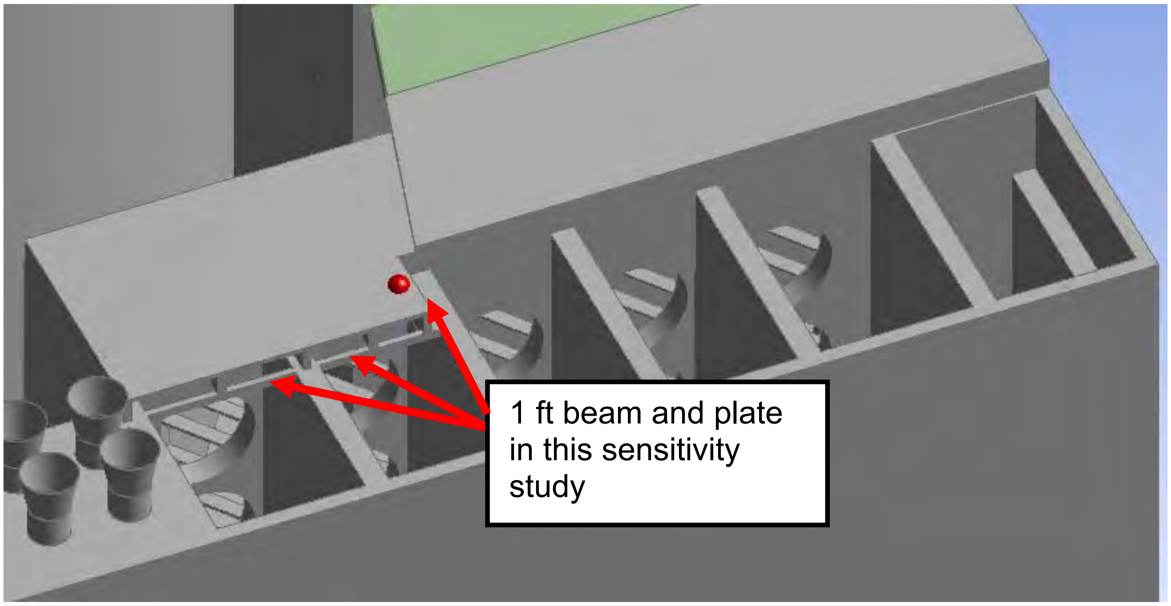
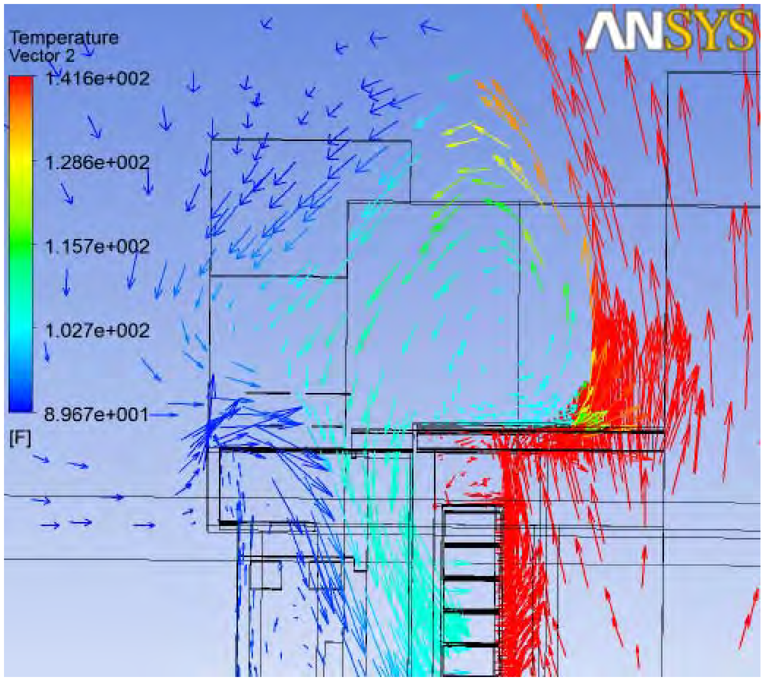


Figure 3-21: 1ft Beam Sensitivity Study

Table 3-7: Sensitivity Results Summary

With 1ft beam and plate					
Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	97.3	103.0	105.3	104.0	100.7
	93.9	95.8	100.4	98.7	95.6
	97.0	92.1	94.1	93.3	94.0
				Overall	Cell 4 and 5
Average fan temperature:				97.7	96.5
Fan Flow Rate (x1000cfm)				180	169

Without 1ft beam and plate					
Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	97.2	103.4	105.1	103.8	100.6
	94.0	95.8	99.9	98.5	95.5
	96.8	92.1	93.9	93.3	94.0
				Overall	Cell 4 and 5
Average fan temperature:				97.6	96.5
Fan Flow Rate (x1000cfm)				181	172



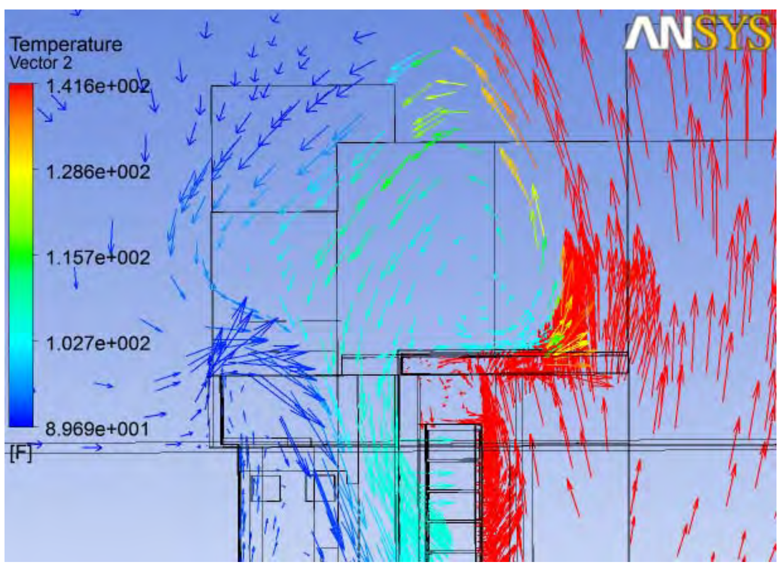


Figure 3-22: Cell 3 Vector with and without 1 ft beam

3.4.8 Study of Wind from the DCT Front Direction

Wind direction in the wake of the FHB was the primary concern relative to DCT recirculation, since the building wake affected inlet flow. Unimpeded flow to the front of the DCT (West on Train A and East on Train B) was assumed to have minimum recirculation because the wind pushes cool air into the DCT inlet and the hot outlet air away from the DCT, which reduces recirculation. This assumption is verified in this section.

The B train 90F 30mph was used to verify this assumption. Two cases were conducted on each train, (W and SW on Train A, E and SE on Train B). The SE and SW were included in the study because the wind passes the WCT before the DCT.

Train A and B, 90F/30mph results are tabulated in Table 3-8. The maximum recirculation in Train A and B were 1.2F, which is the lowest recirculation among the 30mph cases ran on Train A and Train B (See Section 4.2 and Section 4.4).

Figure 3-23 and Figure 3-24 showed the temperature contour and velocity vector of Train A West and Southwest wind. Figure 3-25 and Figure 3-26 show the same contour and vector on the B train. From those figures, the unimpeded wind to the DCT pushes the heated air away from the DCT tower, and therefore keeps the DCT fan inlet temperature cool.

Table 3-8: Recirculation and Fan Flow Results

Input Conditions			CFD Model Results		
Train A					
Wind direction	Ambient Temp (F)	Wind speed (mph)	Average fan temp (F)	Recirc (F)	Fan flowrate (x1000 cfm)
W	90	30	90	0	160
SW	90	30	91.2	1.2	153
Train B					
E	90	30	90.8	0.8	176
SE	90	30	91.2	1.2	170

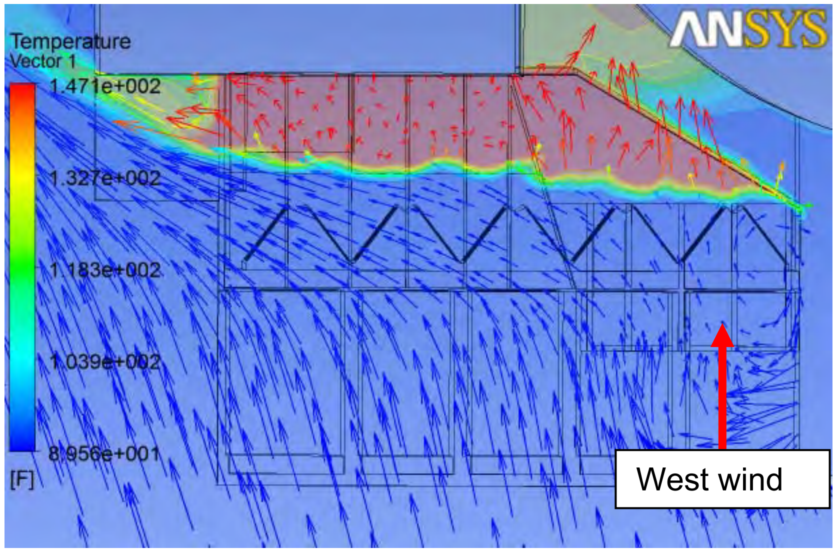


Figure 3-23: Temperature contour and Velocity vector for Train A W wind

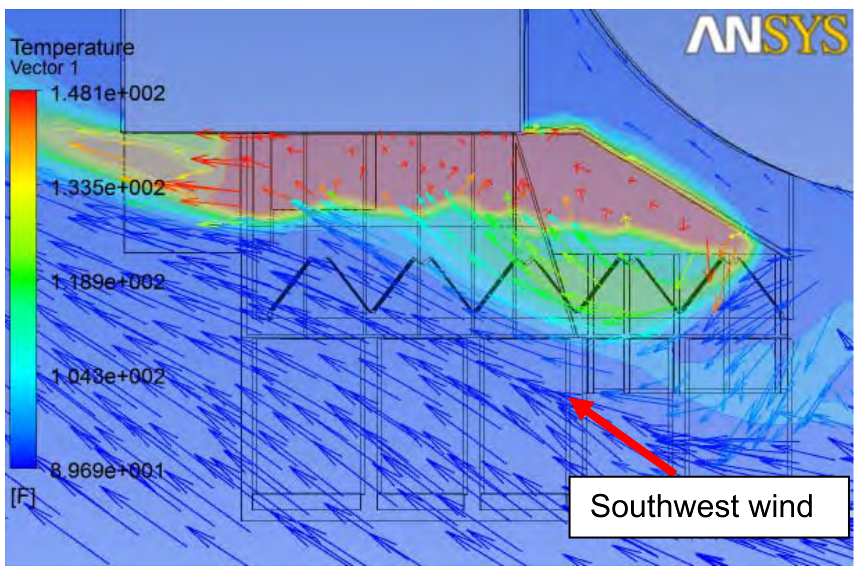


Figure 3-24: Temperature contour and Velocity vector for Train A SW wind

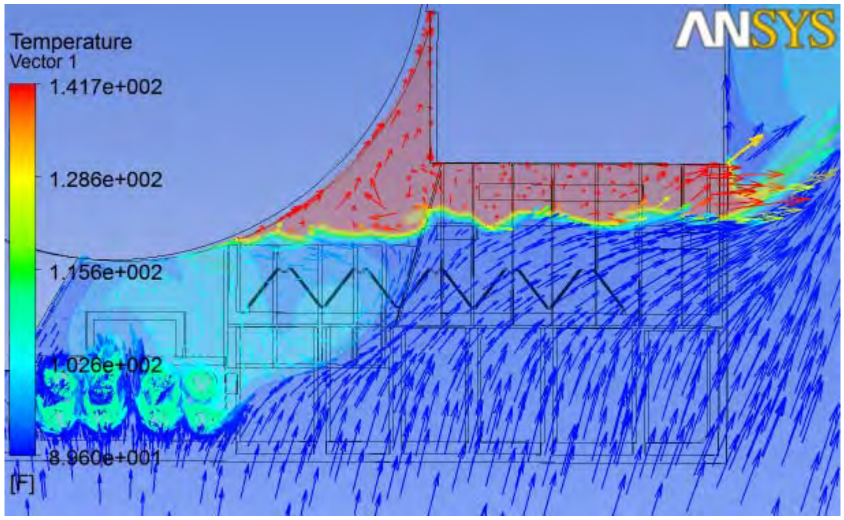


Figure 3-25: Temperature contour and Velocity vector for Train B E wind

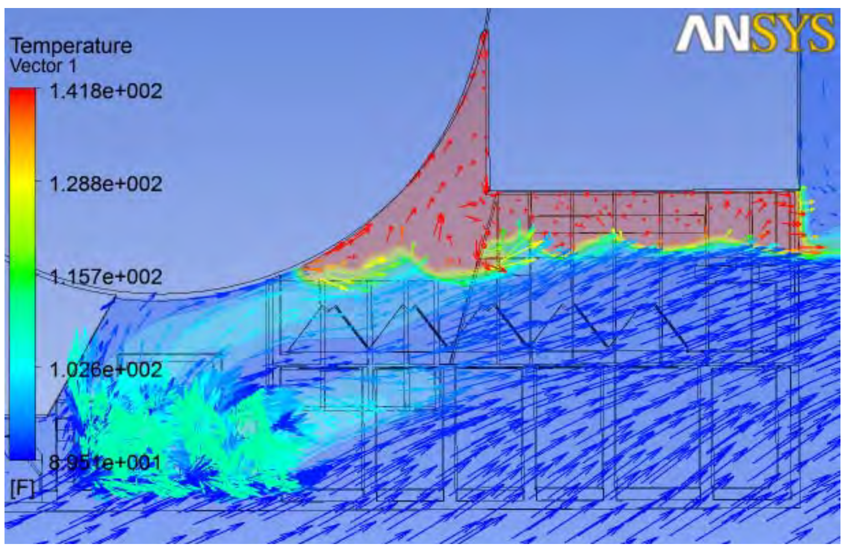


Figure 3-26: Temperature contour and Velocity vector for Train B SE wind

3.4.9 Independent Model Verification

ANSYS CFX is a software code approved for nuclear safety related projects per the LPI quality assurance program [13,14]. In addition to LPI verification requirements, two independent models using a separate CFD code (Fluent) were evaluated to verify the CFD model approach. This independent analysis verified the steady state assumption as well as the adequacy of the CFX software. The independent CFD model is documented in Attachment C.

3.4.10 Model Benchmark

A CFD model of the current configuration (i.e. no deflector walls) was benchmarked against the 1982 startup test measured data [22]. The predicted DCT recirculation from CFD result showed a good agreement with the measured data. Test data from MN(Q)9-52 [20] startup test case, from 8/19/82 from 10:00AM-10:30AM was evaluated. Wind was recorded for the A side test as northly at an average of 3.6 mph [20, Att.5 p 80,81]. The ambient temperature over this period averaged 85.87F. The inlet to the DCT averaged 93.65F for 3 temperature instruments, producing 7.8F recirculation. The CFD model relationship for recirculation produced 9.9F recirculation. The CFD model prediction was therefore comparable and conservative by approximately 2.1F.

3.5 Supporting Calculations

Supporting calculations were automated using the commercially available computer program, Mathcad [12]. All equations in Mathcad are presented and can be independently reviewed and verified. All units are converted within Mathcad with conversion terms generally not shown. The significant numbers of digits shown in results are rounded off values; Mathcad carries out all operations to 15 digits and such values are carried internally through a particular calculation.

4.0 Evaluation

4.1 Train A Evaluation for the Angle Wall Concept

The A train modification includes a 17ft long 30deg angle deflector on top of the DCT tower. Seventeen analysis cases, based on Waterford3 site ambient temperature and wind combinations [8], were run to evaluate recirculation around the DCT and WCT. Three cases addressed high wind speed (North, South, East) with low temperature, bounding the peak 1 hour maximum wind conditions [8]. Three cases addressed low wind speed with high temperature, bounding the peak 1 hour maximum temperature conditions [8]. Three cases addressed average temperature conditions [8]. A 102F/static wind condition was run to evaluate the FSAR defined conditions. Additional NE wind cases were run to evaluate the upper bound DCT recirculation in this train.

The DCT summary results are tabulated in Table 4-1 and include the DCT average fan temperatures, recirculation effects, and fan flows. The average fan temperature is calculated from the area average of the 15 inlet boundary (fan) planes as discussed in Section 3.3.1. The DCT recirculation represents the difference between the average fan inlet temperature and the ambient temperature. Fan flows are shown to be 163,000cfm or greater for all wind cases 29mph or less (non-hurricane conditions). The fan flow is also acceptable under North wind hurricane conditions (76F, 51mph) at 144,000cfm.

DCT recirculation data with wind velocity and direction are provided graphically in Figure 4-1. It can be seen that the deflector wall modification is effective in keeping DCT recirculation to minimal amounts (<2.2F) for all wind directions except the NE wind. This wind direction produces FHB wake effects that result in a low pressure region above the DCT and higher recirculation. The limiting case is approximately 6.5F based on NE 29mph wind. A bounding curve was created using the NE wind direction results with parabolic curve fit to the NE data from 0mph to 29mph.

WCT recirculation data are presented in Table 4-2 and Figure 4-2. WCT recirculation accounts for the mass of 100% humid air from the WCT outlet as well as the increase in WCT inlet temperature from the hot WCT and DCT exhaust. Table 4-2 shows WCT recirculation over a range of ambient relative humidity values and the resulting maximum values. For some cases, the WCT recirculation at 100% humidity was lower than 90% RH because air at 100% humidity was already saturated and more moisture could not be added. Figure 4-2 shows maximum WCT recirculation with wind speed for various wind directions. Bounding cases were produced by the South and SE wind directions. The highest WCT recirculation cases were 6.3F, produced by South wind at

21-22 mph. For all other directions under non-hurricane conditions (wind <30mph), WCT recirculation is limited to 4.3F.

Table 4-1: Train A Angle Wall DCT Result Summary

	Input Conditions			CFD Model Results		
Case number	Wind direction	Ambient Temp (F)	Wind Speed (mph)	Average DCT Fan Temp (F)	DCT Recirc. = Fan Temp-Ambient (F)	DCT fan flow rate (x1000cfm)
1	North	76	51	77.2	1.2	144
2		86	29	87.2	1.2	165
3		92	26	93	1	165
4		97	8	97.5	0.5	182
5	East	85	22	86.1	1.1	174
6		91	21	92	1	173
7		96	10	98	2	179
8	South	89	22	91.2	2.2	183
9		92	21	93.9	1.9	183
10		96	10	97	1	182
11	NE	76	51	81.9	5.9	177
12		81	40	85.5	4.5	176
13		86	29	92.5	6.5	179
14		91	26	96.5	5.5	177
15		97	11	101.1	4.1	179
16	SE	89	22	89.9	0.9	174
17	n/a	102	0	102.1	0.1	179

Table 4-2: Train A Angle Wall WCT Results Summary

	Input Conditions			CFD Results			Calculated Values						
Case	Wind dir'n	Dry bulb Temp.	Wind speed	Total mass flow	Mass Recirc	Average WCT temp	50% RH	60% RH	70% RH	80% RH	90% RH	100% RH	Max recirc
		(F)	(mph)	(lb/s)	(lb/s)	(F)	Twb increase (deg F)						
1	North	76	51	515	86.8	86.8	5.7	5.8	5.9	5.9	6	6	6
2		86	29	507	52.4	95.4	4.2	4.2	4.2	4.2	4.2	4.2	4.2
3		92	26	503	55.2	99.9	3.8	3.9	3.9	4	4	4	4
4		97	8	507	26.4	97.6	1.1	1.2	1.3	1.3	1.4	0.6	1.4
5	East	85	22	514	65.8	88.1	2.9	3.1	3.2	3.3	3.4	3.1	3.4
6		91	21	509	68.4	93.4	2.9	3.1	3.3	3.4	3.5	2.4	3.5
7		96	10	506	57.7	97.8	2.5	2.7	2.8	2.9	3	1.8	3
8	South	89	22	509	126	93.9	5.3	5.6	5.9	6.1	6.3	4.9	6.3
9		92	21	507	128	96.3	5.3	5.6	5.9	6.1	6.3	4.3	6.3
10		96	10	506	95.6	98.4	3.9	4.2	4.4	4.6	4.8	2.4	4.8
11	NE	76	51	507	72	81.3	3.7	3.8	3.9	4.1	4.1	4.2	4.2
12		81	40	509	37.8	84.6	2.2	2.3	2.3	2.4	2.4	2.5	2.5
13		86	29	504	55.5	91.0	3.1	3.2	3.3	3.4	3.5	3.5	3.5
14		91	26	505	44	94.5	2.4	2.5	2.6	2.6	2.7	2.7	2.7
15		97	11	504	51.0	99.9	2.5	2.7	2.8	2.8	2.9	2.9	2.9
16	SE	89	22	501	122	93.9	5.2	5.5	5.8	6	6.2	4.9	6.2
17	n/a	102	0	503	27	102.6	1.2	1.3	1.3	1.4	1.4	0.6	1.4

Table 4-3 shows the calculated Train A fan flow and the CFD results used to calculate these values. This data is also presented in Figure 4-3. The minimum fan flow cases were produced by the North direction wind, and a linear curve was fit to the North direction results.

As described in Section 2.1, fan inlet velocities were reduced from design values in an iterative manner. Calculated fan performance (see Section 3.3.2) is therefore reported to verify that input values remain bounding. For some cases, the fan input flow was less than the predicted fan flow, which would be non-conservative. However, these cases had minimal recirculation, and this non-conservatism does not impact the bounding cases.

Table 4-3: Train A Angle Wall Fan Flow Rate Summary

Case number	Description	Density (lb/ft^3)	Total pressure (fan)	Total pressure (coil)	Fan pressure gain (in.wg)	Fan flow rate x1000 (cfm)	DCT fan input flow x1000 (cfm)
1	North wind 76F 51mph	0.074	-0.025	-0.00057	0.997	144	160
2	North wind 86F 29mph	0.0727	-0.022	-0.0038	0.937	165	180
3	North wind 92F 26mph	0.0719	-0.021	-0.0031	0.940	165	180
4	North wind 97F 8mph	0.0712	-0.017	-0.0049	0.884	182	180
5	East wind 85F 22mph	0.0728	-0.022	-0.0066	0.914	174	180
6	East wind 91F 21mph	0.072	-0.021	-0.0057	0.912	173	180
7	East wind 96 10mph	0.0714	-0.018	-0.0046	0.900	179	180
8	South wind 89F 22mph	0.0723	-0.018	-0.0057	0.880	183	180
9	South wind 92F 21mph	0.0719	-0.017	-0.0051	0.885	183	180
10	South wind 96F 10mph	0.0714	-0.016	-0.0041	0.888	182	180
11	Northeast wind 76F 51mph	0.074	-0.039	-0.0252	0.904	177	180
12	Northeast wind 81F 40mph	0.0734	-0.031	-0.0166	0.907	176	180
13	Northeast wind 86F 29mph	0.0727	-0.025	-0.0113	0.894	179	180
14	Northeast wind 91F 26mph	0.072	-0.023	-0.0087	0.900	177	183
15	Northeast wind 97F 11mph	0.0712	-0.017	-0.0036	0.904	179	190
16	Southeast wind 89F 22mph	0.0723	-0.021	-0.0063	0.910	174	190
17	102F no wind	0.0706	-0.002	0.0111	0.896	179	180

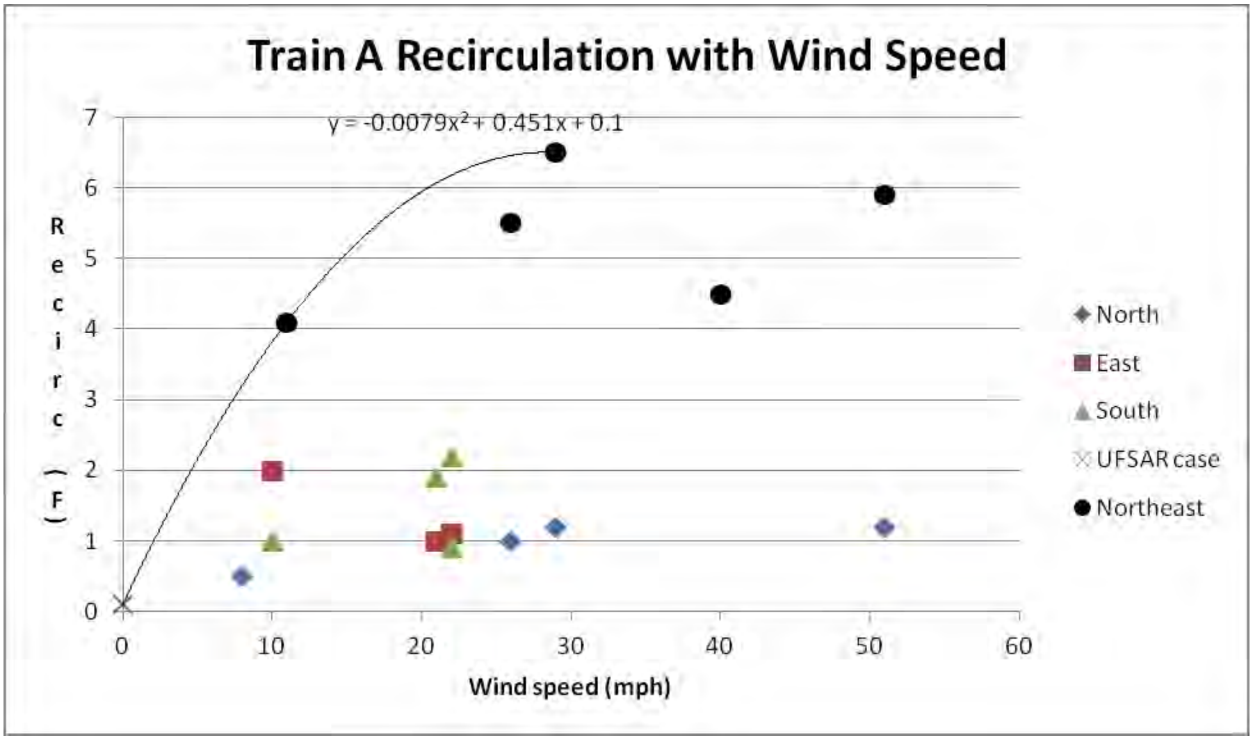


Figure 4-1: Train A angle wall DCT Recirculation with wind speed

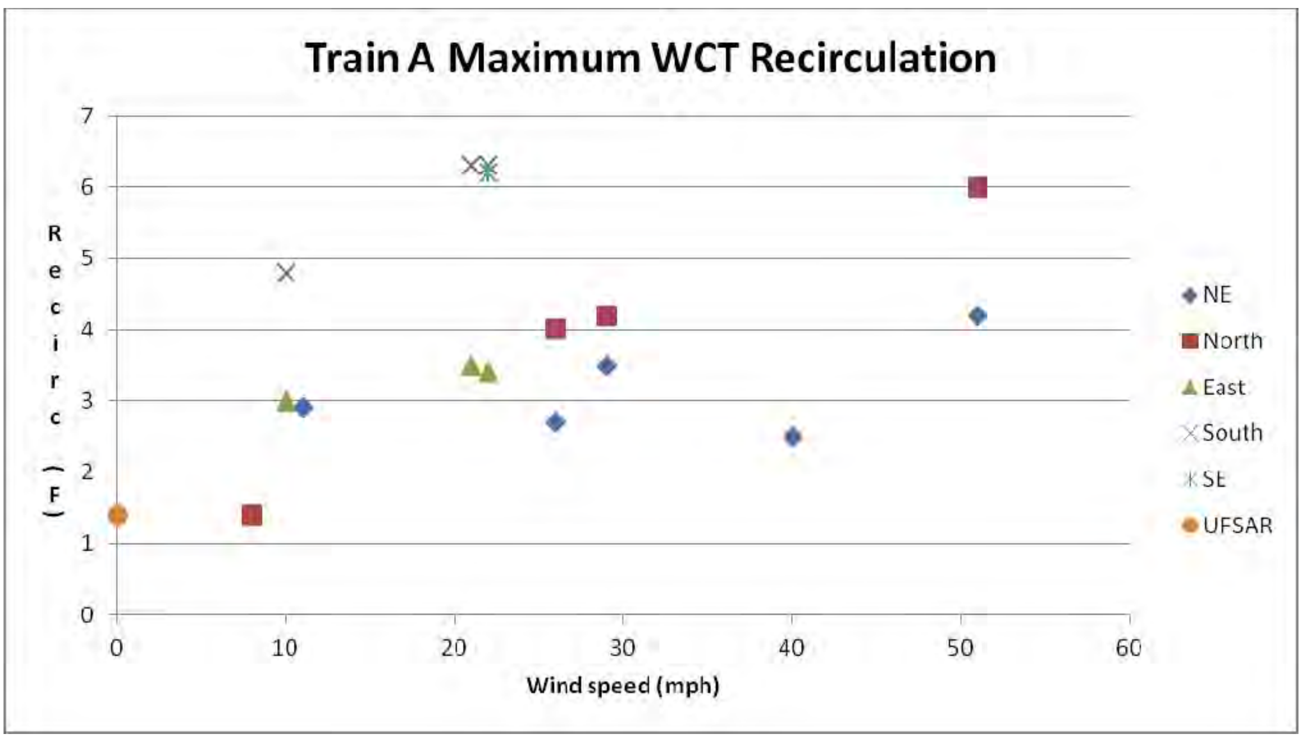


Figure 4-2: Train A angle wall WCT recirculation with wind speed

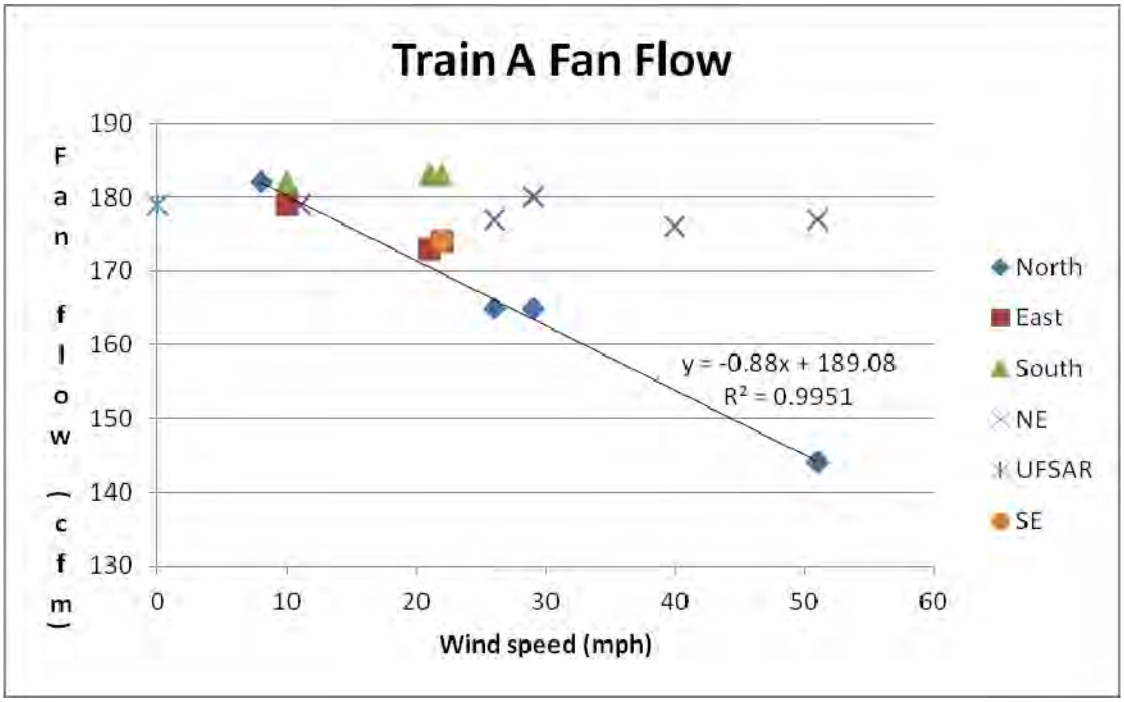


Figure 4-3: Train A angle wall DCT fan flow with wind direction

4.1.1 Train A Case 13: Northeast Wind with 29mph and 86F Ambient

All Train A analysis results are provided in Attachment D. Details for Case 13, which has the highest recirculation, are included herein as an example.

The residuals for this case are shown in Figure 4-4. All residuals were steady at 1e-3 to 1e-5 range.

Fan inlet temperatures are presented in Figure 4-5 as a contour plot showing the temperature distribution over the fan inlet faces and summarized numerically in the accompanying table. The numerical values are based on the average of the final 800 iterations. Higher temperatures are observed in cells 1 and 5, primarily due to a low pressure region in the building wake on cell 1 and influence from the DCT and WCT outlet flow on cell 5. The increased fan inlet temperature above ambient provides the recirculation wffect (92.5F – 86F = 6.5F).

The stability of the model is shown in Figure 4-6, which provides the average fan temperature with model iteration step from the ANSYS CFX analysis run. WCT mass flow is also presented in this figure. Based on the average of the last 800 iterations, the total recirculation for both WCT inlets is 55lb/s. This mass recirculation flow is divided by the total air mass flow at the inlet (~500lb/s), which yields 11% of mass

flow at WCT inlet. This recirculation raises the wet bulb temperature at WCT inlet by 3.5F (based on 100% relative humidity).

Figure 4-7 shows the velocity vectors and temperature contour immediately above the missile shield. The 30 degree separator wall is effective in separating most of the hot discharge air from fan suction side as seen by the sharp red/blue boundary. A small amount of heated air enters cell 1 was due to building wake effect, which creates separated flow and a low pressure region.

The streamlines leading into the the cell 5 fan inlet are shown in Figure 4-8, showing the source for the inlet air. A fraction of the DCT cell 5 inlet is provided from the hotter DCT and WCT outlets, which causes an increase in average fan temperature in this cell.

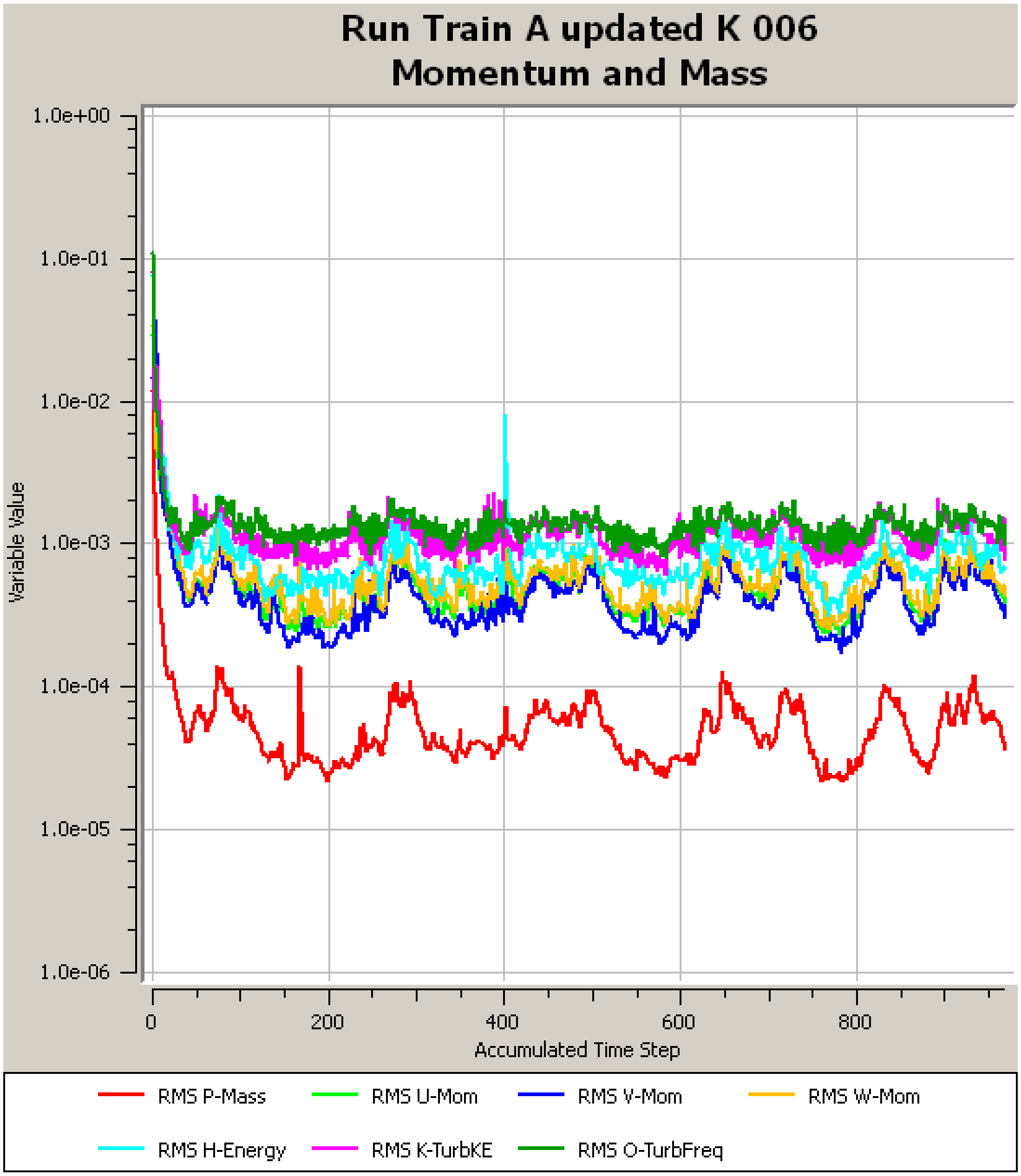


Figure 4-4: Residual plot for Train A Case 13

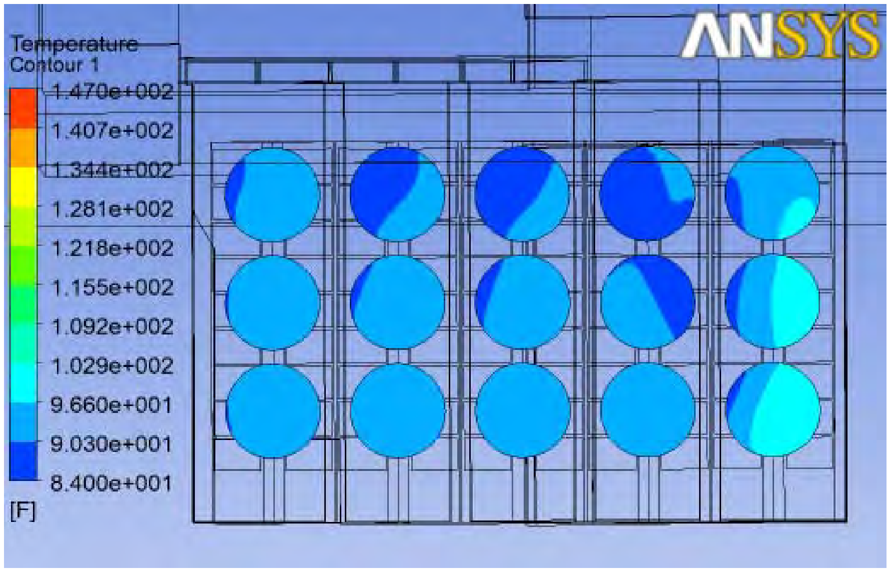


Figure 4-5: Fan temperature for case 13

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	93.4	91.5	90.9	92.0	97.9
	93.7	92.3	90.8	90.5	94.6
	93.3	92.7	91.1	90.3	92.7
Average fan temperature:				92.5	

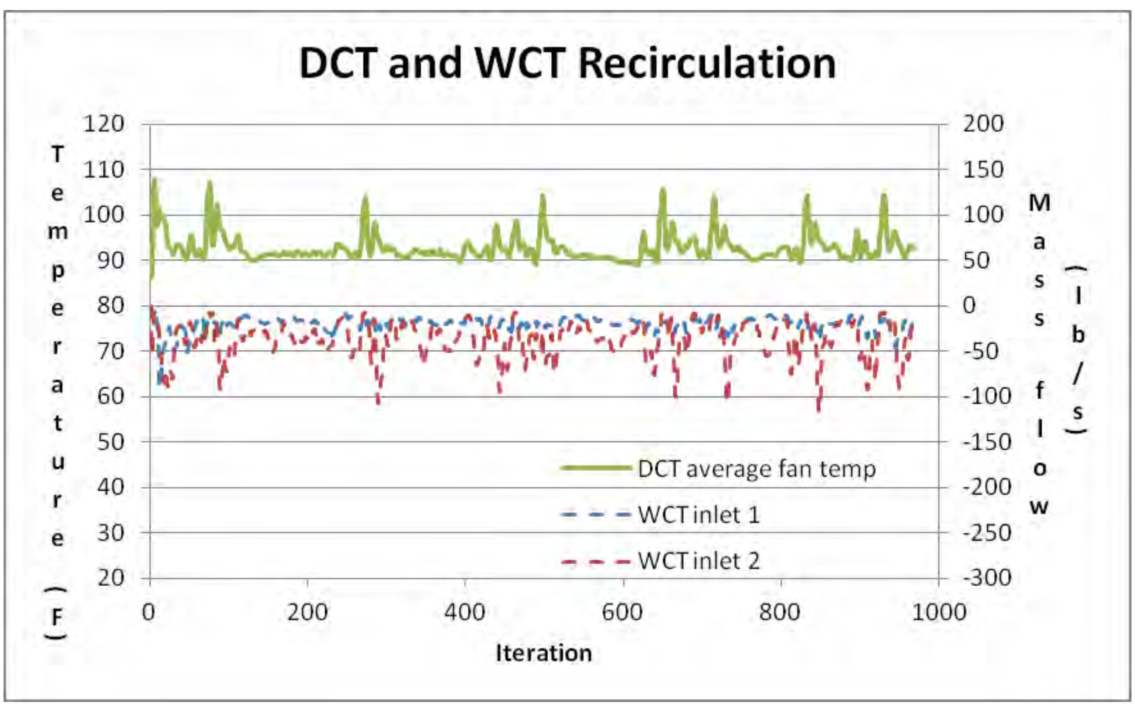


Figure 4-6: **DCT and WCT recirculation with iteration for case 13**

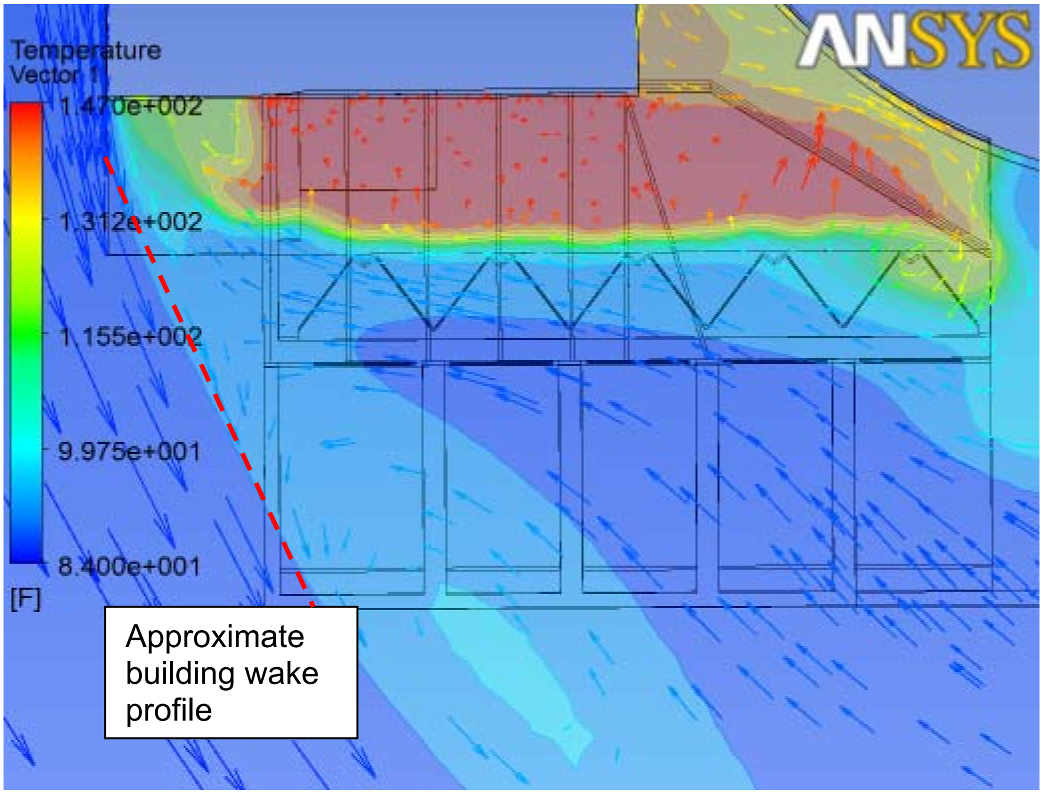


Figure 4-7: Velocity vector and temperature contour above the deflector wall

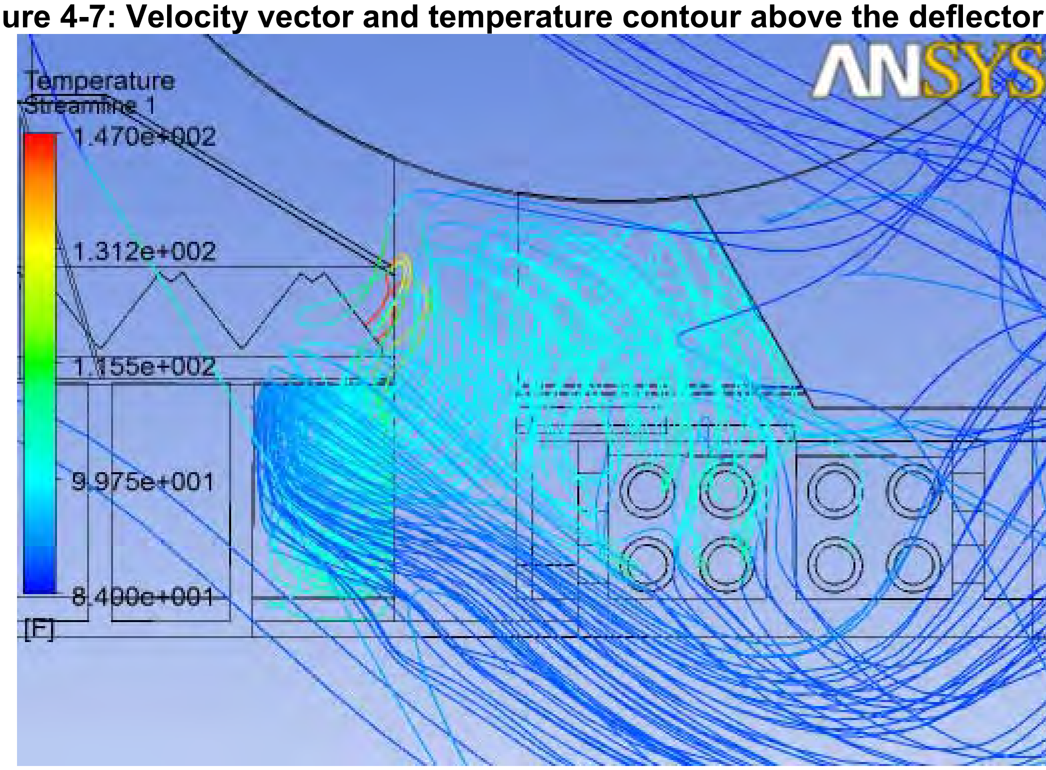


Figure 4-8: Streamline at cell 5 for case 13

4.2 Train A Evaluation for the Horizontal Wall Concept

The A train horizontal wall modification includes a 20ft long horizontal wall on top of the missile shield, 15ft wall on the discharge side of cell 4 and 5, and a 10ft inlet wall on the suction side of cell 4 and 5. Eleven analysis cases, based on the bounding Waterford3 site ambient temperature and wind combinations [8], were run to evaluate recirculation around the DCT and WCT. Wind direction included each 45 degree increment from North to South in the FHB wake, i.e. North, Northeast, East, Southeast, and South. Because recirculation is most significantly influenced by the FHB, wind from westerly directions does not produce significant recirculation. Five cases addressed high wind speed, i.e. 30mph with 90F ambient temperature. Five cases addressed low wind speed (10mph) with high temperature (98F). A 102F/static wind condition was run to evaluate the FSAR defined conditions.

The DCT summary results are tabulated in Table 4-4 and include the DCT average fan temperatures, recirculation effects, and fan flows. The average fan temperature is calculated from the area average of the 15 inlet boundary (fan) planes as discussed in Section 3.3.1. Fan flows are shown to be 160,000 cfm or greater for all wind cases except for the East wind case, which showed 151,000 cfm but small recirculation effects.

DCT recirculation data with wind velocity and direction are provided graphically in Figure 4-9. It can be seen that the deflector wall modification is effective in keeping DCT recirculation to minimal amounts (<3.1F) for all wind cases except the NE wind. The limiting case is approximately 5.6F based on NE 30mph wind. A bounding curve was created using the NE wind direction results with linear curve fit to the NE data from 0mph to 30mph.

WCT recirculation data are presented in Table 4-5 and Figure 4-10. Table 4-8 shows WCT recirculation over a range of ambient relative humidity values and the resulting maximum values. Figure 4-10 shows maximum WCT recirculation with wind speed for various wind directions. Bounding cases were produced by SE wind directions. The highest WCT recirculation cases were 8.3F, produced by South wind at 30 mph.

Figure 4-11 shows the calculated Train A fan flow and the CFD results used to calculate these values. This data is also presented in Table 4-6. The minimum fan flow cases were produced by the East direction wind, and a linear curve was fit to the minimum fan flow results.

Table 4-4: Train A Horizontal Wall DCT Result Summary

	Input Conditions			CFD Model Results		
Case	Wind direction	Ambient Temp (F)	Wind speed (mph)	Average fan temp (F)	Recirc (F)	Fan flowrate (x1000 cfm)
1	NE	90	30	95.6	5.6	163
2	SE	90	30	93.1	3.1	157
3	N	90	30	91.3	1.3	168
4	S	90	30	92.2	2.2	171
5	E	90	30	91.5	1.5	151
6	NE	98	10	100.2	2.2	163
7	SE	98	10	98.7	0.7	165
8	N	98	10	98	0	161
9	S	98	10	98.7	0.7	166
10	E	98	10	99.4	1.4	162
11		102	0	102	0	166

Table 4-5: Train A Horizontal Wall WCT Results Summary

	Input Conditions			CFD Results			Calculated Values						
Case	Wind dir'n	Dry bulb Temp.	Wind speed	Total mass flow	Mass Recirc	Average WCT temp	50% RH	60% RH	70% RH	80% RH	90% RH	100% RH	Max recirc
		(F)	(mph)	(lb/s)	(lb/s)	(F)	Twb increase (deg F)						
1	NE	90	30	507	71.6	94.4	3.5	3.7	3.8	3.9	4	4.1	4.1
2	SE	90	30	504	169	96.7	7.0	7.4	7.8	8.1	8.3	6.7	8.3
3	N	90	30	500	95.5	100.7	5.8	5.9	6	6.1	6.2	6.2	6.2
4	S	90	30	504	126	98.1	6.1	6.4	6.6	6.8	6.9	7.1	7.1
5	E	90	30	507	50	92	2.2	2.3	2.5	2.6	2.6	2.0	2.6
6	NE	98	10	504	42.2	99.9	2.0	2.1	2.2	2.3	2.4	1.9	2.4
7	SE	98	10	504	116	100.6	4.7	5.1	5.3	5.6	5.5	2.6	5.6
8	N	98	10	504	31.5	98.8	1.4	1.5	1.5	1.6	1.7	0.8	1.7
9	S	98	10	504	105	100.3	4.3	4.6	4.9	5.1	5.2	2.3	5.2
10	E	98	10	504	99.7	69.8	2.9	3.2	3.3	3.5	3.6	1.7	3.6
11		102	0	506	18	102.4	0.8	0.8	0.9	0.9	1.0	0.4	1.0

Table 4-6: Train A Horizontal Wall Fan Flow Rate Summary

Case number	Description	Density [lb/ft^3]	Total pressure (fan)	Total pressure (coil)	Fan pressure gain [in.wg]	Fan flow rate [x1000 cfm]	DCT fan input flow (x1000cfm
1	Northeast wind 90F 30mph	0.072	-0.012	0.006	0.945	163	160
1a	Northeast wind 90F 30mph	0.072	-0.012	0.008	0.957	158	165 [1]
2	Southeast wind 90F 30mph	0.072	-0.012	0.008	0.960	157	160
3	North wind 90F 30mph	0.072	-0.006	0.011	0.930	168	160
4	South wind 90F 30mph	0.072	-0.006	0.010	0.920	171	160
5	East wind 90F 30mph	0.072	-0.013	0.009	0.973	151	160
6	Northeast wind 98F 10mph	0.071	-0.005	0.013	0.942	163	160
7	Southeast wind 98F 10mph	0.071	-0.004	0.014	0.941	165	160
8	North wind 98F 10mph	0.071	-0.006	0.013	0.949	161	160
9	South wind 98F 10mph	0.071	-0.003	0.014	0.932	166	160
10	East wind 98F 10mph	0.071	-0.005	0.013	0.947	162	160
11	102F 0mph	0.071	-0.002	0.015	0.932	166	160

Note 1: This case (1a, 165,000 cfm) was run to confirm that the Case 1 input of 160,000 cfm provided conservative flow results. Since the 165,000 cfm input produced conditions corresponding to a fan flow of 158,000 cfm, the actual flow is expected to be approximately 160,000 cfm and this is not expected to significantly affect the results.

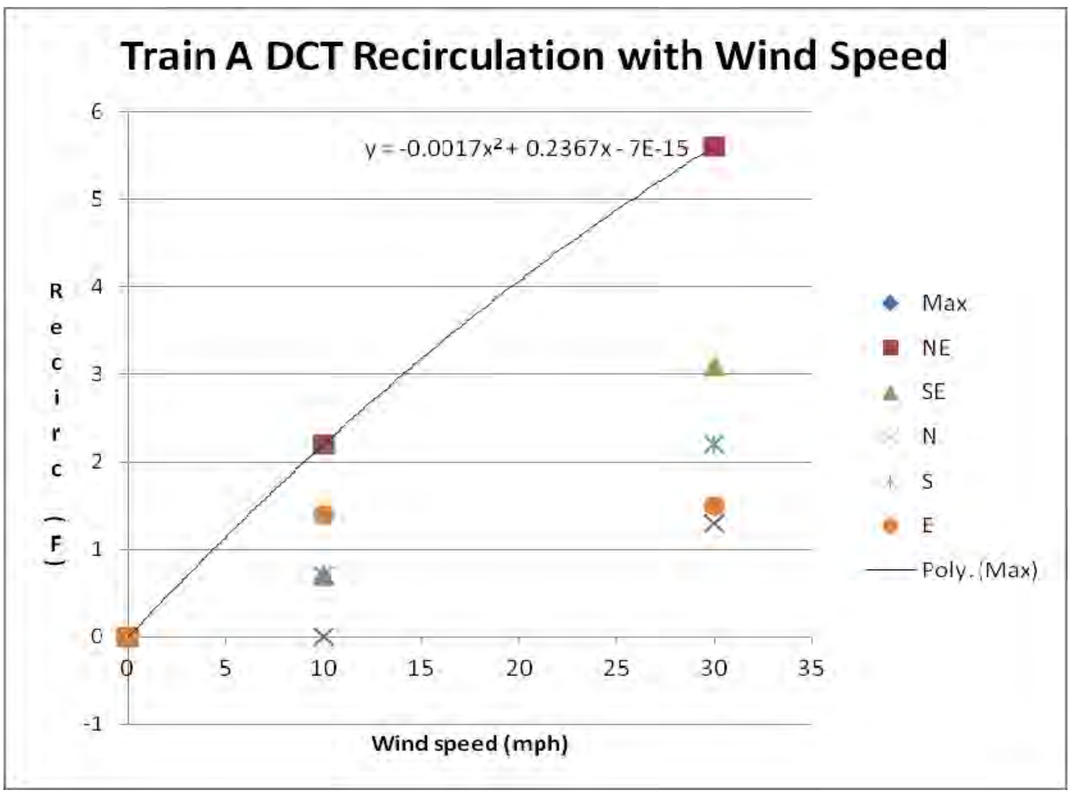


Figure 4-9: Train A horizontal wall DCT recirculation with wind speed

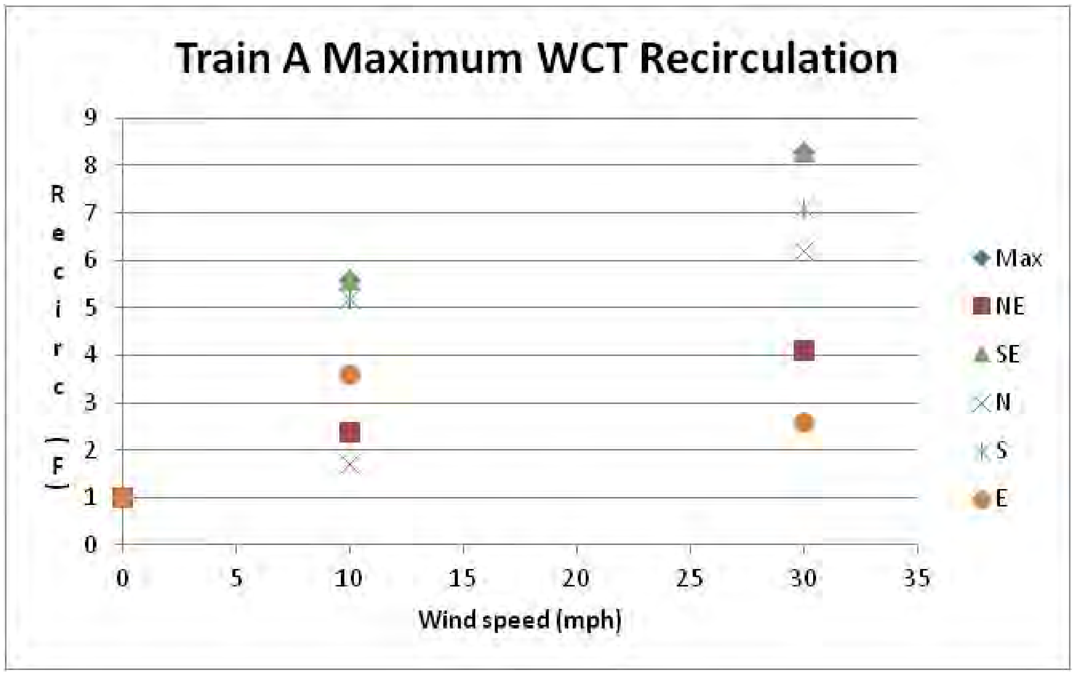


Figure 4-10: Train A horizontal wall WCT recirculation with wind speed

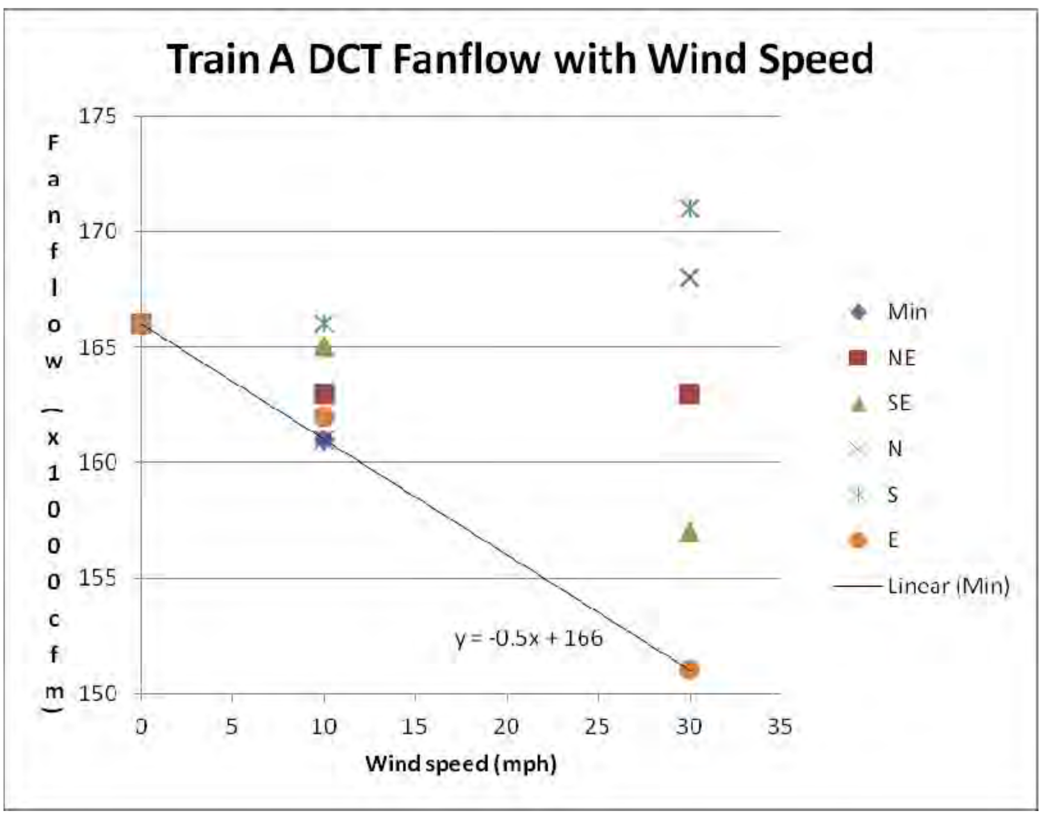


Figure 4-11: Train A horizontal wall DCT fan flow with wind direction

4.2.1 Train A Horizontal wall case 1: Northeast Wind with 30mph and 90F Ambient

All Train A analysis results are provided in Attachment E. Details for Case 1, which has the highest recirculation, are included herein as an example.

The residuals for this case are shown in Figure 4-12. All residuals were steady and below 1e-3.

Fan inlet temperatures are presented in Figure 4-13 as a contour plot showing the temperature distribution over the fan inlet faces and summarized numerically in the accompanying table. The numerical values are based on the average of the final 50 iterations. Higher temperatures are observed in cell 1, primarily due to a low pressure region in the building wake on cell 1. The increased fan inlet temperature above ambient provides the recirculation effect (95.6F – 90F = 5.6F).

The stability of the model is shown in Figure 4-14, which provides the average fan temperature with model iteration step from the ANSYS CFX analysis run. WCT mass flow is also presented in this figure. Based on the average of the last 50 iterations, the total recirculation for both WCT inlets is 72lb/s. This mass recirculation flow is divided by the total air mass flow at the inlet (~500lb/s), which yields 14% of mass flow at WCT inlet. This recirculation raises the wet bulb temperature at WCT inlet by 4.1F (based on 100% relative humidity).

Figure 4-15 shows the velocity vectors and temperature contour immediately above the missile shield. The horizontal separator wall is effective in separating most of the hot discharge air from fan suction side as seen by the sharp red/blue boundary. A small amount of heated air enters cell 1 was due to building wake effect, which creates separated flow and a low pressure region.

The streamlines leading into the the cell 1 fan inlet are shown in Figure 4-16, showing the source for the inlet air. Small fraction of the DCT cell 1 inlet is provided from the hotter DCT and WCT outlets, which causes an increase in average fan temperature in this cell.

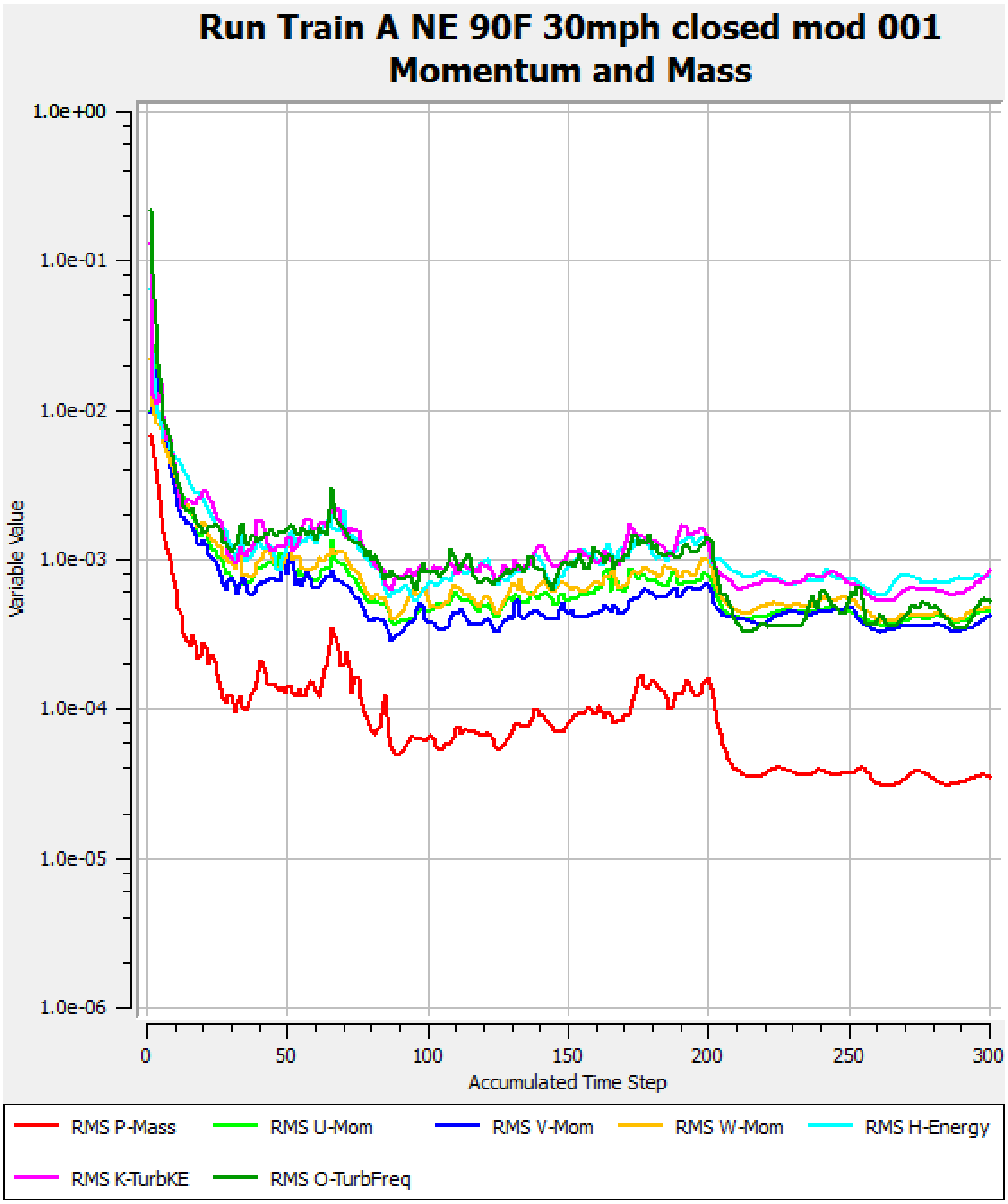


Figure 4-12: Residual plot for Train A horizontal wall case 1

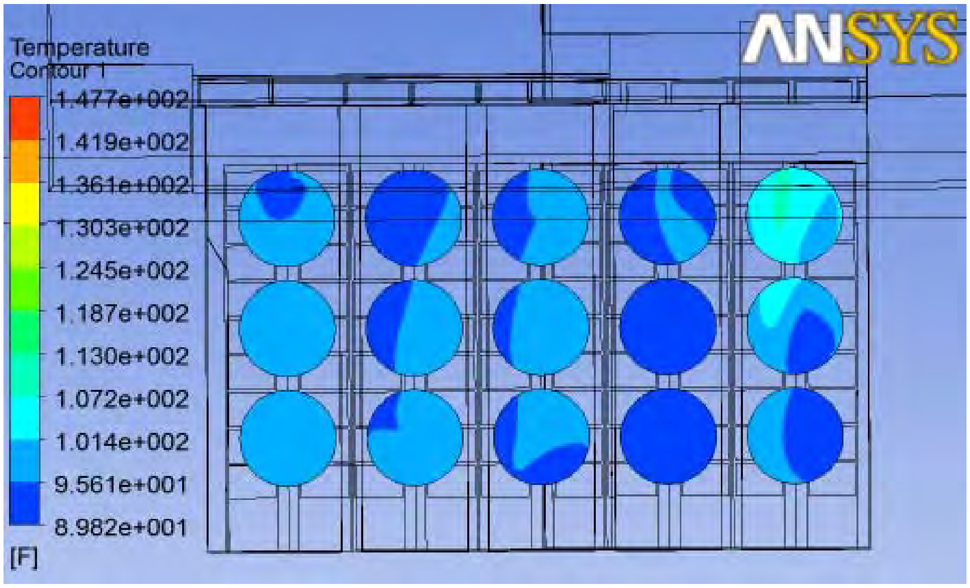


Figure 4-13: Fan temperature for horizontal wall case 1

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	97.6	96.7	95.5	94.6	96.5
	97.8	97.5	94.8	93.3	94.4
	97.6	97.0	94.8	93.0	93.5
Average fan temperature:				95.6	

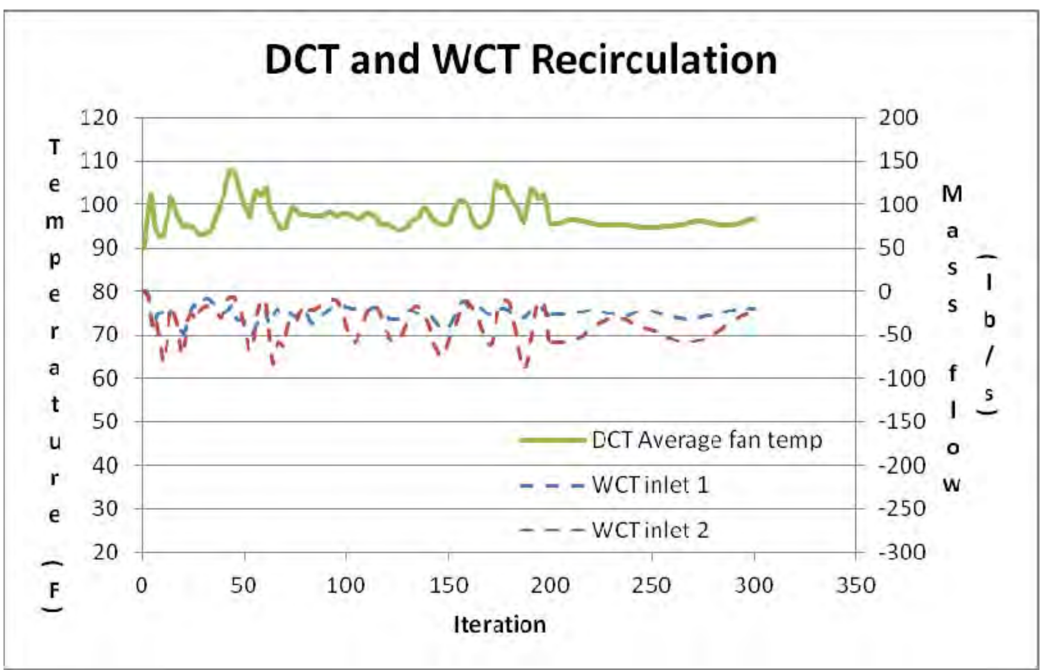


Figure 4-14: **DCT and WCT recirculation with iteration for case 1**

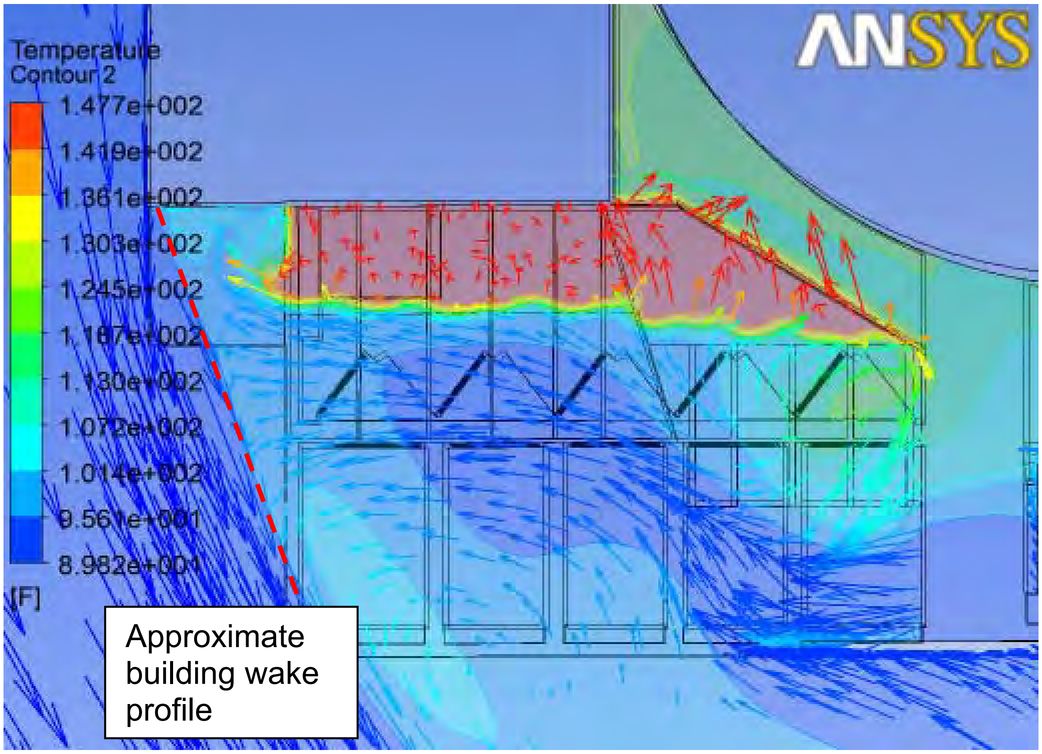


Figure 4-15: Velocity vector and temperature contour above the deflector wall

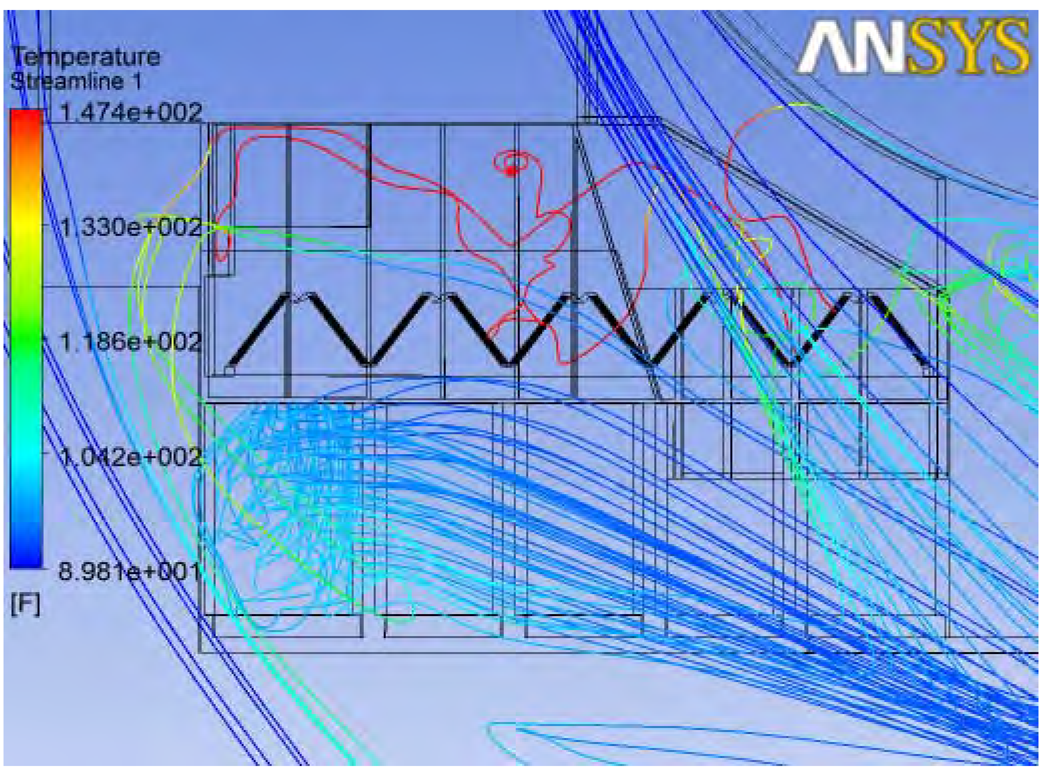


Figure 4-16: Streamline at cell 1 for horizontal wall case 1

4.3 Train B Evaluation for the Angle Wall Concept

The B train modification includes a 23ft long 20deg angle deflector on top of the DCT tower. Eleven cases based on Waterford3 site ambient temperature and wind combinations [8] were run, with emphasis on the Northwest wind direction. Five cases were run for this bounding wind direction. Five other analysis cases to confirm this condition. A 102F/static wind condition was run to evaluate the FSAR conditions.

The DCT summary results are tabulated in Table 4-7 and include the DCT average fan temperatures, recirculation effects, and fan flows. The average fan temperature is calculated from the area average of the 15 inlet boundary (fan) planes as discussed in Section 3.3.1. The DCT recirculation represents the difference between the average fan inlet temperature and the ambient temperature. Fan flows are shown to be greater than 176,000cfm for all cases.

DCT recirculation data with wind velocity and direction are provided graphically in Figure 4-17. It can be seen that the deflector wall modification is effective in keeping DCT recirculation to <3.9F for all wind directions except the NW wind. This wind direction produces FHB wake effects that result in a low pressure region above the DCT and higher recirculation. The limiting case is based on NW wind 29mph for non hurricane case and 40-51mph wind for hurricane wind, which produced DCT recirculation of 6.5F and 6.9F respectively. A bounding curve was created using the NW wind direction results with a bounding curve to the NW data from 0mph to 40mph.

WCT recirculation data are presented in Table 4-8 and Figure 4-18. WCT recirculation accounts for the recirculated mass of 100% humid air from the WCT outlet as well as the increase in WCT inlet temperature from the hot WCT and DCT exhaust. Table 4-8 shows WCT recirculation over a range of ambient relative humidity values and the resulting maximum values. For some cases, the WCT recirculation at 100% humidity was lower than 90% RH because air at 100% humidity was already saturated and more moisture could not be added. Figure 4-18 shows maximum WCT recirculation with wind speeds for various wind directions. The highest WCT recirculation case was 6.4F for the Southwest wind 89F 26.5mph. For all other directions under non-hurricane conditions (wind <30mph), WCT recirculation is limited to 4.6F

Table 4-9 shows the train B fan flow and model parameters for calculation as discussed in Section 3.3.2. The lowest fan flow on Train B is 176,000cfm on a NW 76F, 51mph case. Figure 4-19 shows that for all wind cases less than of equal to 29mph (non-hurricane conditions), fan flow is 181,000cfm or greater. A linear curve was fit to the bounding results.

Similar to Train A, calculated fan performance (see Section 3.3.2) is reported to verify that input values remain bounding. There are two cases with the fan input flow was less than predicted results. However, the recirculation for these cases were far less the bounding cases and any non-conservatism does not affect the results.

Table 4-7: Train B Angle Wall DCT Result Summary

	Input Conditions			CFD Model Results		
Case	Wind direction	Ambient Temp (F)	Wind Speed (mph)	Average DCT Fan Temp (F)	Recirc (F)	Fan flow rate (x1000cfm)
1	North	76	51	76.1	0.1	191
2	West	88	19	90.3	2.3	184
3	South	88	26.5	91.9	3.9	191
4	NW	76	51	82.9	6.9	176
5		82	40	88.9	6.9	182
6		88	29	94.5	6.5	182
7		92	26	97.4	5.4	184
8		97	10	101.7	4.7	188
9	SW	88	26.5	89.6	1.6	182
10		96	10	97.2	1.2	192
11	n/a	102	0	102.3	0.3	186

Table 4-8: Train B Angle Wall WCT Results Summary

	Input Conditions			CFD Results			Calculated Values						
Case	Wind dir'n	Dry bulb Temp.	Wind speed	Total mass flow	Mass Recirc	Avg WCT temp	50% RH	60% RH	70% RH	80% RH	90% RH	100% RH	Max recirc
		(F)	(mph)	(lb/s)	(Lb/s)	(F)	Twb increase (deg F)						
1	North	76	51	505	6.1	82.2	2.2	2.1	2.1	2.0	1.9	1.8	2.2
2	West	88	19	500	87.4	91.7	3.8	4	4.2	4.4	4.6	3.7	4.6
3	South	88	26.5	502	66.0	90.8	2.9	3.1	3.2	3.4	3.5	2.8	3.5
4	NW	76	51	505	92.4	82.8	4.7	4.9	5	5.2	5.3	5.4	5.4
5		82	40	506	79.4	87.6	4	4.2	4.3	4.4	4.5	4.6	4.6
6		88	29	502	69.2	92.3	3.4	3.6	3.7	3.8	3.9	4	4.0
7		92	26	499	73.4	95.8	3.5	3.7	3.8	3.9	4.0	3.8	4.0
8		97	10	503	67.2	101.4	3.4	3.6	3.7	3.8	3.9	4	4.0
9	SW	88	26.5	502	123	93.8	5.4	5.7	6	6.2	6.4	5.8	6.4
10		96	10	496	129	99.4	5.3	5.7	6	6.3	6.2	3.4	6.3
11	n/a	102	0	493	55.7	102.8	2.4	2.5	2.7	2.8	2.9	0.8	2.9

Table 4-9: Train B Angle Wall Fan Flow Rate Summary

Case number	Description	Density [lb/ft^3]	Total pressure (fan)	Total pressure (coil)	Fan pressure gain [in.wg]	Fan flow rate [x1000 cfm]	DCT fan flow rate (x1000cfm
1	North wind 76F 51mph	0.074	-0.020	-0.01041	0.862	191	180
2	West wind 88F 19mph	0.0724	-0.020	-0.0082	0.885	184	190
3	South wind 88F 26.5mph	0.0724	-0.019	-0.0100	0.861	191	190
4	Northwest wind 76F 51mph	0.074	-0.038	-0.0233	0.908	176	190
5	Northwest wind 82F 40mph	0.0732	-0.029	-0.0167	0.892	182	185
6	Northwest wind 88F 29mph	0.0724	-0.024	-0.0115	0.885	182	190
7	Northwest wind 92F 26mph	0.0719	-0.023	-0.0110	0.882	184	190
8	Northwest wind 97F 10mph	0.0712	-0.017	-0.0070	0.866	188	190
9	Southwest wind 88F 26.5mph	0.0724	-0.024	-0.0115	0.890	182	190
10	Southwest wind 96F 10mph	0.0712	-0.016	-0.0077	0.858	192	190
11	102F no wind	0.0706	-0.002	0.0088	0.871	186	190

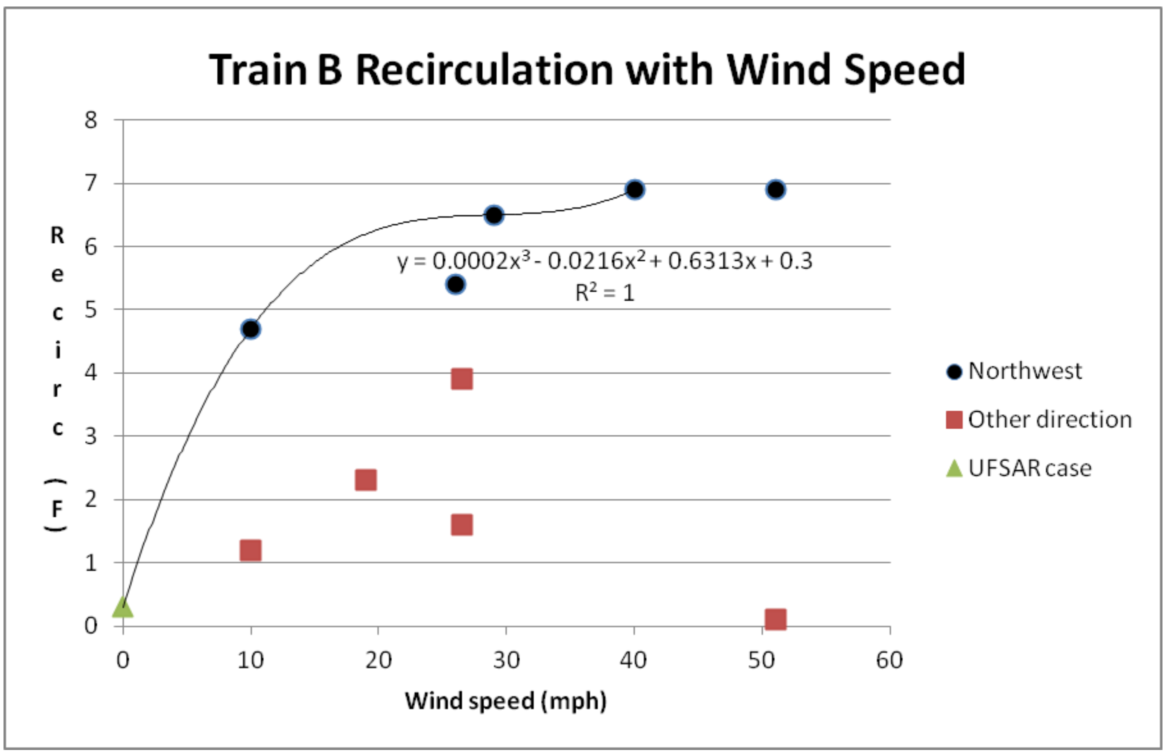


Figure 4-17: Train B angle wall DCT recirculation with wind speed

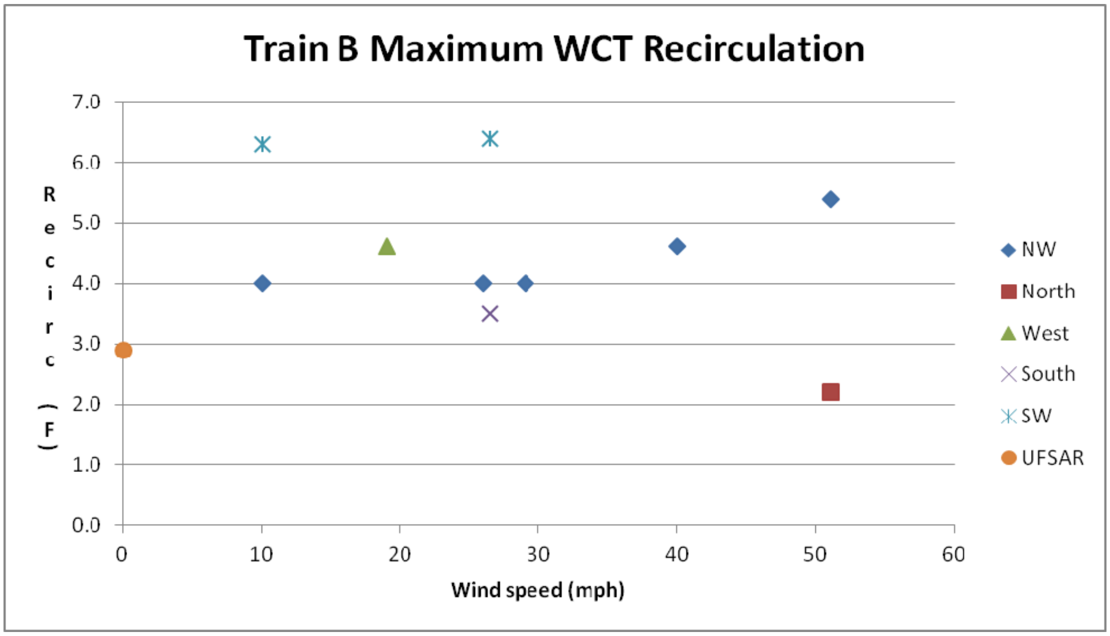


Figure 4-18: Train B angle wall WCT recirculation with relative humidity

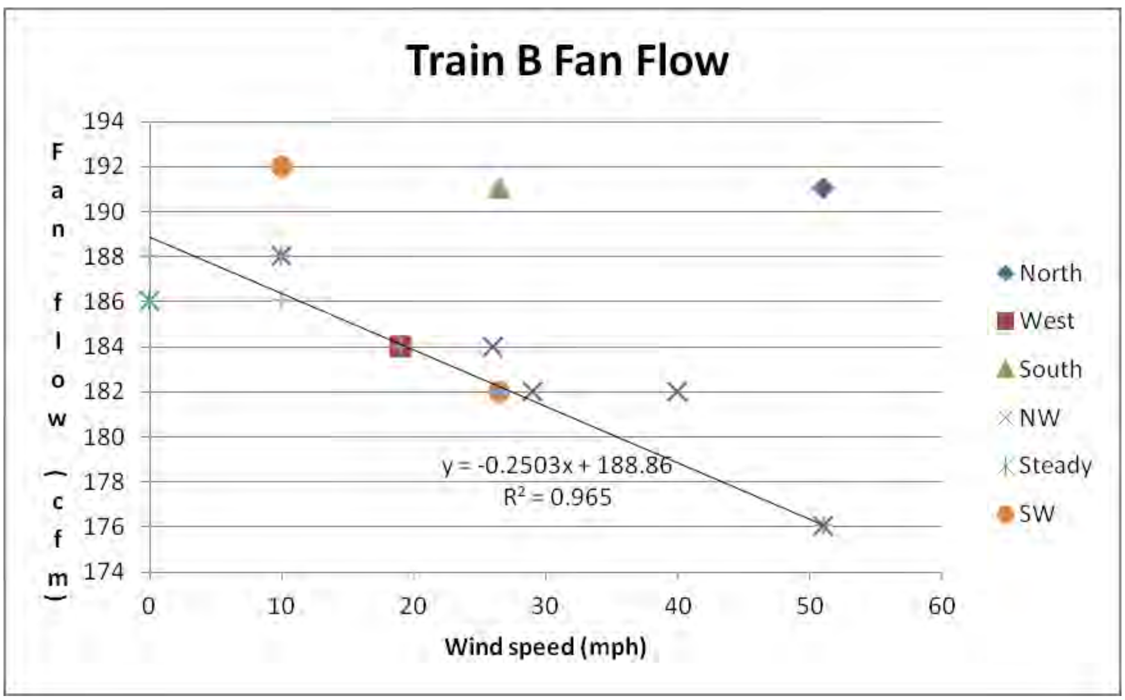


Figure 4-19: Train B angle wall DCT fan flow with wind direction

4.3.1 Train B Case 6: Northwest Wind with 29mph and 88F Ambient

All Train B analysis results are provided in Attachment D. Details for Case 6, which has the highest recirculation for a non-hurricane case, are included herein as an example.

The residuals for this case is shown in Figure 4-20. All residuals were steady at 1e-3 and 1e-5 range.

Fan inlet temperatures are presented in Figure 4-21 as a contour plot showing the temperature distribution over the fan inlet faces and summarized numerically in the accompanying table. The numerical values are based on the average of the final 50 iterations. Recirculation is spread throughout the fan inlets with a slightly higher temperature in cell 1 The increased fan inlet temperature above ambient provides the recirculation wffect (94.5F – 88F = 6.5F).

The stability of the model is shown in Figure 4-22, which provides the average fan temperature with model iteration step from the ANSYS CFX analysis run. The model is stable from the beginning of the run. WCT mass flow is also presented in this figure. Based on the average of the last 50 iterations, the total recirculation for both WCT inlets is 69lb/s. This mass recirculation flow is divided by the total air mass flow at the inlet (~500lb/s), which yields 14% of mass flow at WCT inlet. This recirculation raises the wet bulb temperature at WCT inlet by 4.0F (based on 100% relative humidity).

Figure 4-23 shows the velocity vectors and temperature contour above the deflector wall. The 20 degree separator wall is effective in separating most of the hot discharge air from fan suction side as seen by the sharp red/blue boundary. A small amount of heated air enters cell 1 was due to building wake effect, which creates separated flow and a low pressure region.

The streamlines leading into the the cell 4 fan inlet are shown in Figure 4-24, showing the source for the inlet air. A fraction of the DCT cell 4 inlet is provided from the hotter DCT and WCT outlets, which causes an increase in average fan temperature in this cell

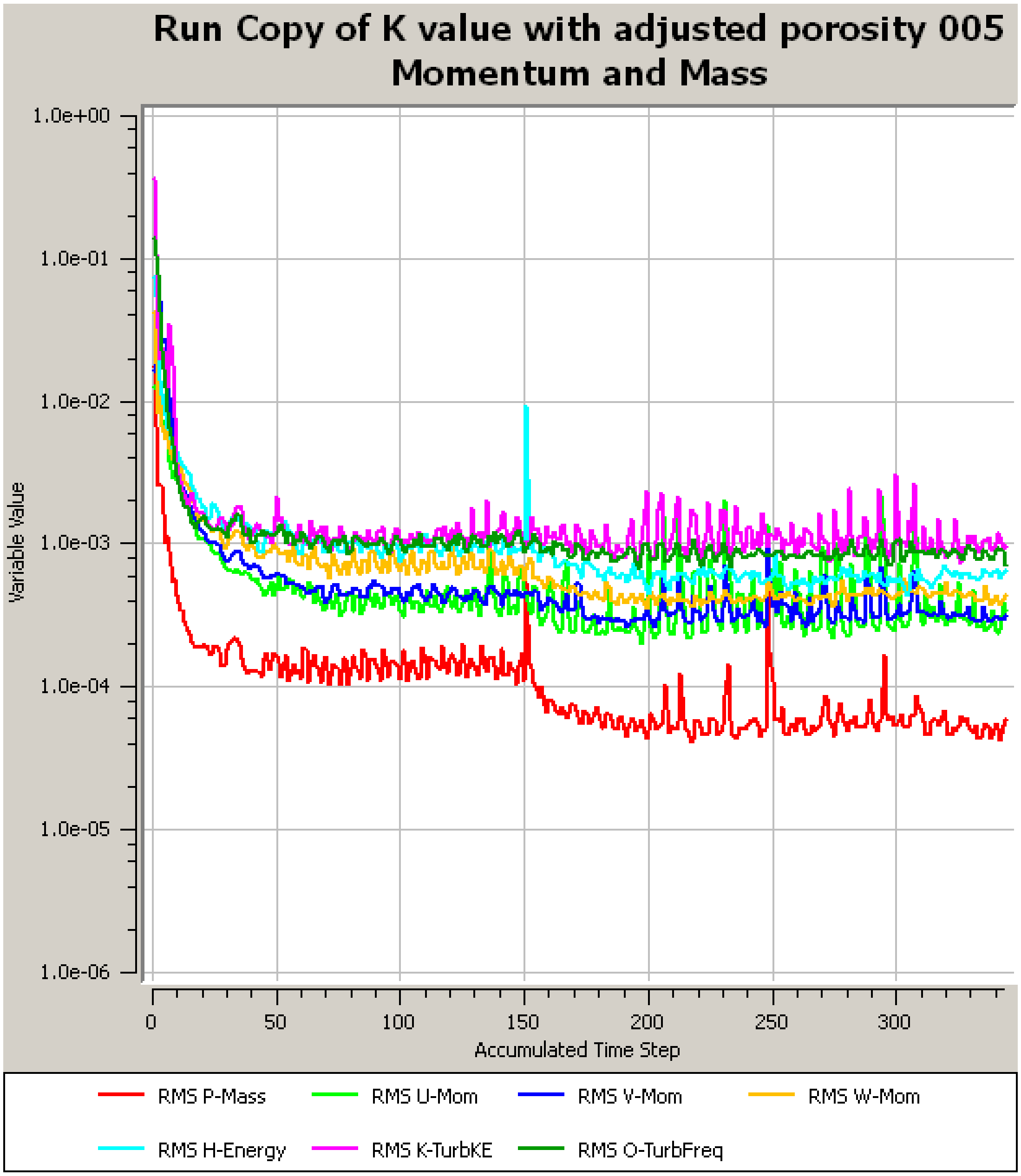


Figure 4-20: Residual plot for case 6

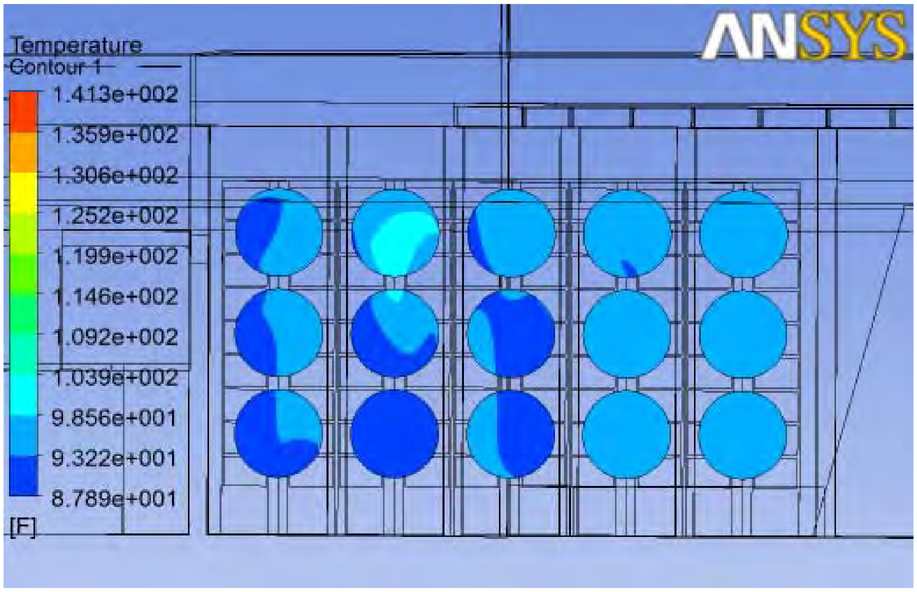


Figure 4-21: Fan temperature for case 6

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	93.6	96.5	94.7	94.2	95.7
	94.2	93.9	92.5	95.9	95.4
	93.4	92.5	93.5	97.0	94.8
Average fan temperature:				94.5	

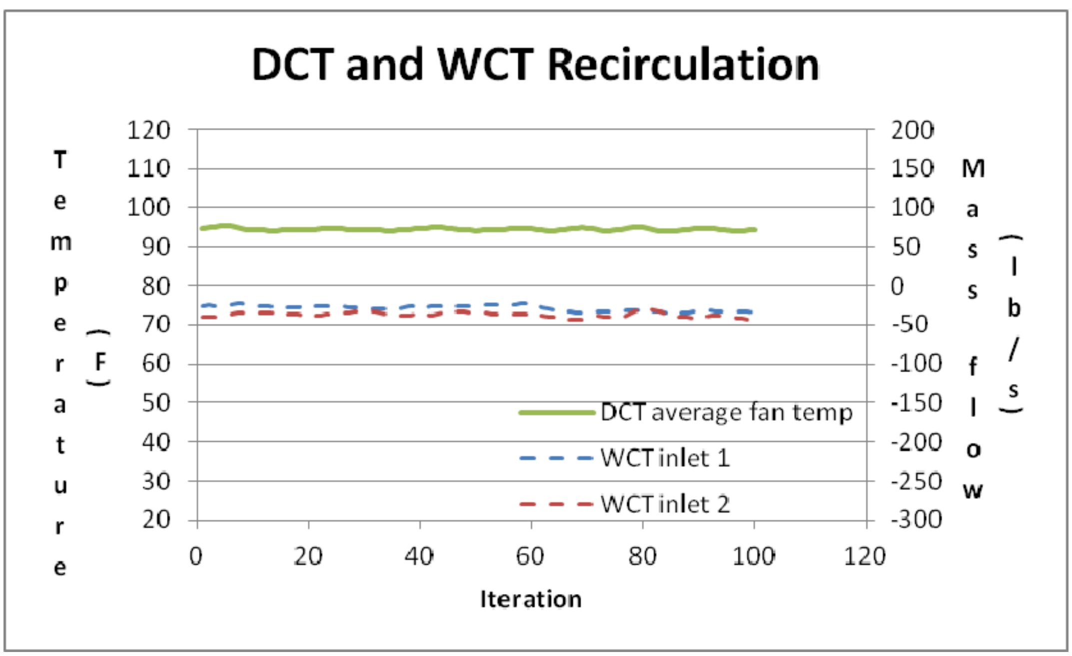


Figure 4-22: DCT and WCT recirculation with iteration for case 6

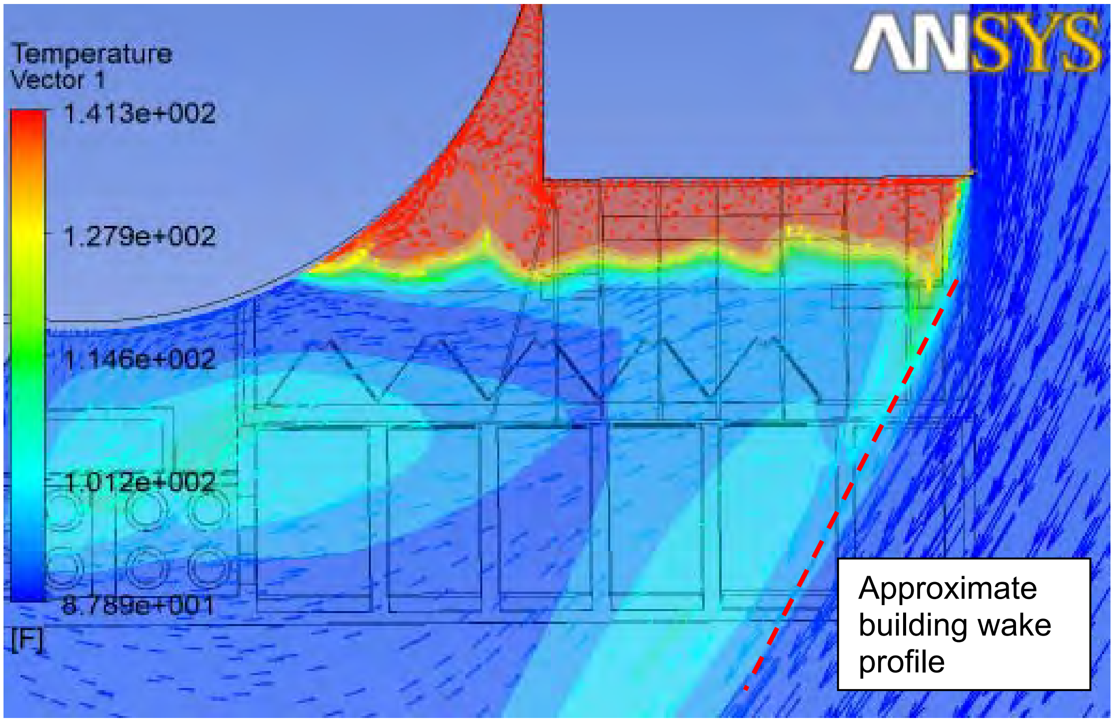


Figure 4-23: Case 6 velocity vector and temperature contour above the deflector wall

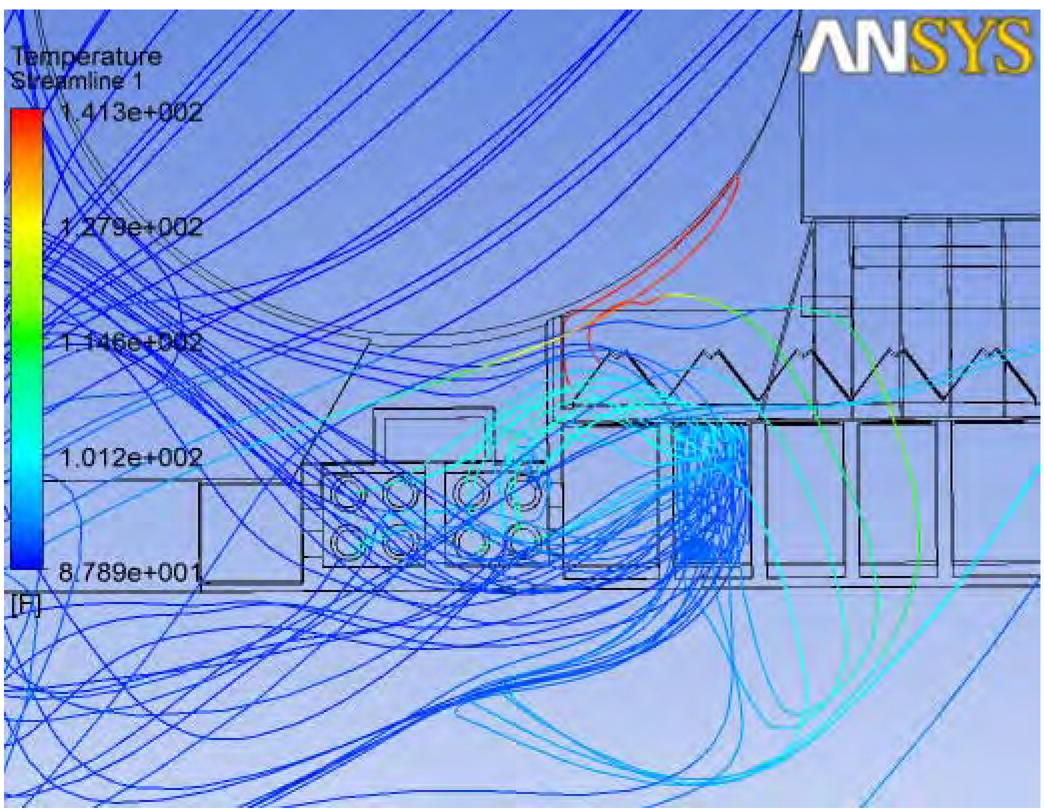


Figure 4-24: Streamline at cell 4 for case 6

4.4 Train B Horizontal Wall Evaluation

The B train modification includes a 25ft long horizontal wall on top of the missile shield, with 20ft horizontal wall on the discharge side of cell 4 and 5, and a 10ft wall on the suction side of cell 4 and 5. Eleven analysis cases, based on the bounding Waterford3 site ambient temperature and wind combinations [8] were run to evaluate recirculation around the DCT and WCT. Wind direction included each 45 degree increment from North to South in the FHB wake, i.e. North, Northwest, West, Southwest, and South. Because recirculation is most significantly influenced by the FHB, wind from easterly directions does not produce significant recirculation. Five cases addressed high wind speed, i.e. 30mph with 90F ambient temperature. Five cases addressed low wind speed (10mph) with high temperature (98F). A 102F/static wind condition was run to evaluate the FSAR defined conditions.

The DCT summary results are tabulated in Table 4-10 and include the DCT average fan temperatures, recirculation effects, and fan flows. The average fan temperature is calculated from the area average of the 15 inlet boundary (fan) planes as discussed in Section 3.3.1. Fan flows are shown to be greater than 165,000cfm for all cases.

DCT recirculation data with wind velocity and direction are provided graphically in Figure 4-25. The limiting case is based on S wind 30mph, which produced DCT recirculation of 7.7F respectively. A bounding curve was created using the maximum recirculation results.

WCT recirculation data are presented in Table 4-11 and Figure 4-26. Table 4-11 shows WCT recirculation over a range of ambient relative humidity values and the resulting maximum values. For some cases, the WCT recirculation at 100% humidity was lower than 90% RH because air at 100% humidity was already saturated and more moisture could not be added. Figure 4-26 shows maximum WCT recirculation with wind speeds for various wind directions. The bounding WCT recirculation was 8.8F for the South wind 90F 30mph case.

Table 4-12 shows the train B fan flow and model parameters for calculation as discussed in Section 3.3.2. The lowest fan flow on the horizontal wall is 166,000 cfm on a W 90F, 30mph case. Figure 4-27 shows that the fan flow for other cases is greater than 175,000cfm. A linear curve was fit to the bounding results. The fan flow for the South wind 90F/30mph case (bounding recirculation) was 180,000cfm. The higher fan flow also applies to the static wind case

Similar to Train A, calculated fan performance (see Section 3.3.2) is reported to verify that input values remain bounding. Cases for which the fan input flow was less than the

predicted results showed low recirculation and any non-conservatism in flow does not affect the bounding results.

Table 4-10: Train B Horizontal Wall DCT Result Summary

	Input Conditions			CFD Model Results		
Case	Wind direction	Ambient Temp (F)	Wind speed (mph)	Average fan temp (F)	Recirc (F)	Fan flowrate (x1000 cfm)
1	NW	90	30	96.5	6.5	177
2	SW	90	30	96.6	6.6	177
3	N	90	30	91.9	1.9	184
4	S	90	30	97.7	7.7	180
5	W	90	30	92.2	2.2	166
6	NW	98	10	102.7	4.7	177
7	SW	98	10	100.6	2.6	176
8	N	98	10	98	0.0	181
9	S	98	10	98.8	0.8	179
10	W	98	10	99.1	1.1	175
11		102	0	102.2	0.2	180

Table 4-11: Train B Horizontal Wall WCT Results Summary

	Input Conditions			CFD Results			Calculated Values						
Case	Wind dir'n	Dry bulb Temp.	Wind speed	Total mass flow	Mass Recirc	Average WCT temp	50% RH	60% RH	70% RH	80% RH	90% RH	100% RH	Max recirc
		(F)	(mph)	(lb/s)	(lb/s)	(F)	Twb increase (deg F)						
1	NW	90	30	506	102.0	94.6	4.5	4.8	5	5.2	5.3	4.6	5.3
2	SW	90	30	508	49.7	94	2.7	2.8	2.9	2.9	3	3.1	3.1
3	N	90	30	502	27.0	99	3.2	3.2	3.1	3	3	2.9	3.2
4	S	90	30	495	131.0	107.3	8.3	8.5	8.6	8.6	8.7	8.8	8.8
5	W	90	30	505	93.7	94.9	4.3	4.6	4.7	4.9	5	4.9	5
6	NW	98	10	503	66.3	100.8	3.1	3.2	3.4	3.5	3.6	2.8	3.6
7	SW	98	10	503	145.0	101.5	5.9	6.3	6.6	6.9	6.4	3.5	6.9
8	N	98	10	503	4.5	99.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4
9	S	98	10	503	96.5	100.4	4	4.3	4.5	4.7	4.9	2.4	4.9
10	W	98	10	503	103.0	100.8	4.4	4.7	4.9	5.1	5.3	2.8	5.3
11		102	0	505	54.0	103.4	2.4	2.5	2.7	2.8	2.9	1.4	2.9

Table 4-12: Train B Horizontal Wall Fan Flow Rate Summary

Case number	Description	Density [lb/ft^3]	Total pressure (fan)	Total pressure (coil)	Fan pressure gain [in.wg]	Fan flow rate [x1000 cfm]	DCT fan input flow (x1000cfm
1	Northwest wind 90F 30mph	0.072	-0.011	0.003	0.906	177	180
2	Southwest wind 90F 30mph	0.072	-0.012	0.001	0.895	177	180
3	North wind 90F 30mph	0.072	-0.006	0.005	0.883	184	180
4	South wind 90F 30mph	0.072	-0.010	0.002	0.893	180	180
5	West wind 90F 30mph	0.072	-0.011	0.006	0.935	166	180
6	Northwest wind 98F 10mph	0.0711	-0.006	0.008	0.904	177	180
7	Southwest wind 98F 10mph	0.0711	-0.006	0.008	0.908	176	180
8	North wind 98F 10mph	0.0711	-0.005	0.008	0.892	181	180
9	South wind 98F 10mph	0.0711	-0.004	0.009	0.898	179	180
10	West wind 98F 10mph	0.0711	-0.006	0.008	0.907	175	180
11	102F 0mph	0.0706	-0.002	0.010	0.891	180	180

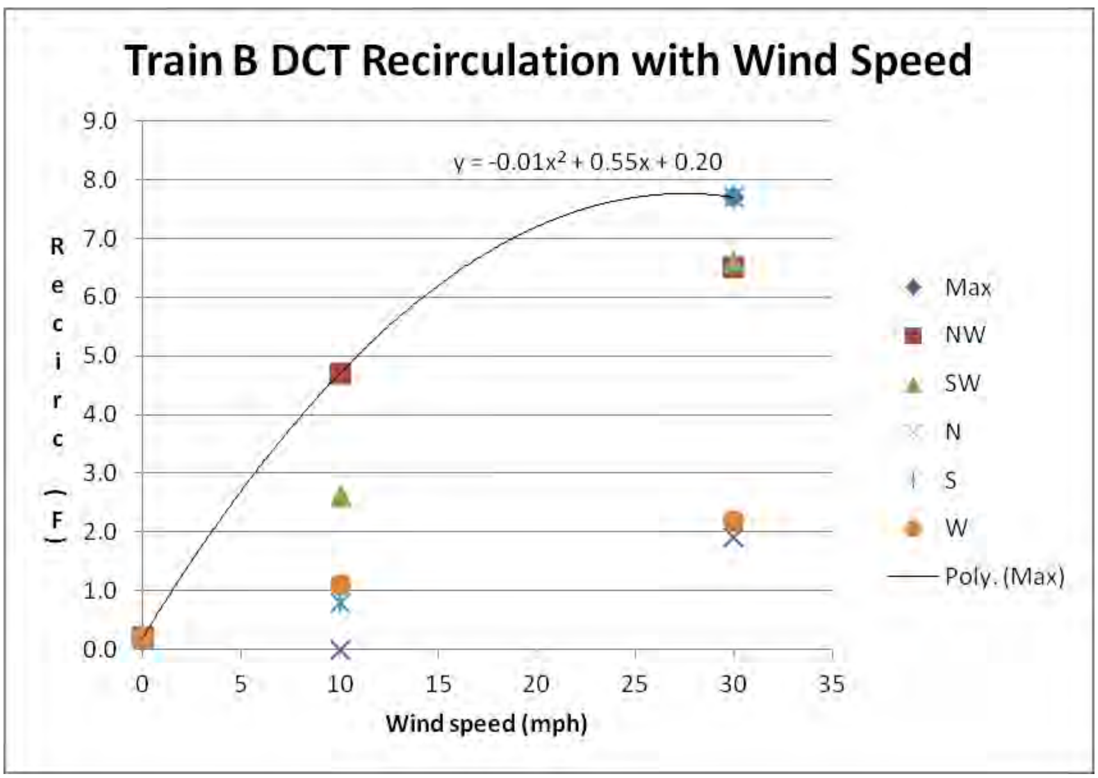


Figure 4-25: Train B horizontal wall DCT recirculation with wind speed

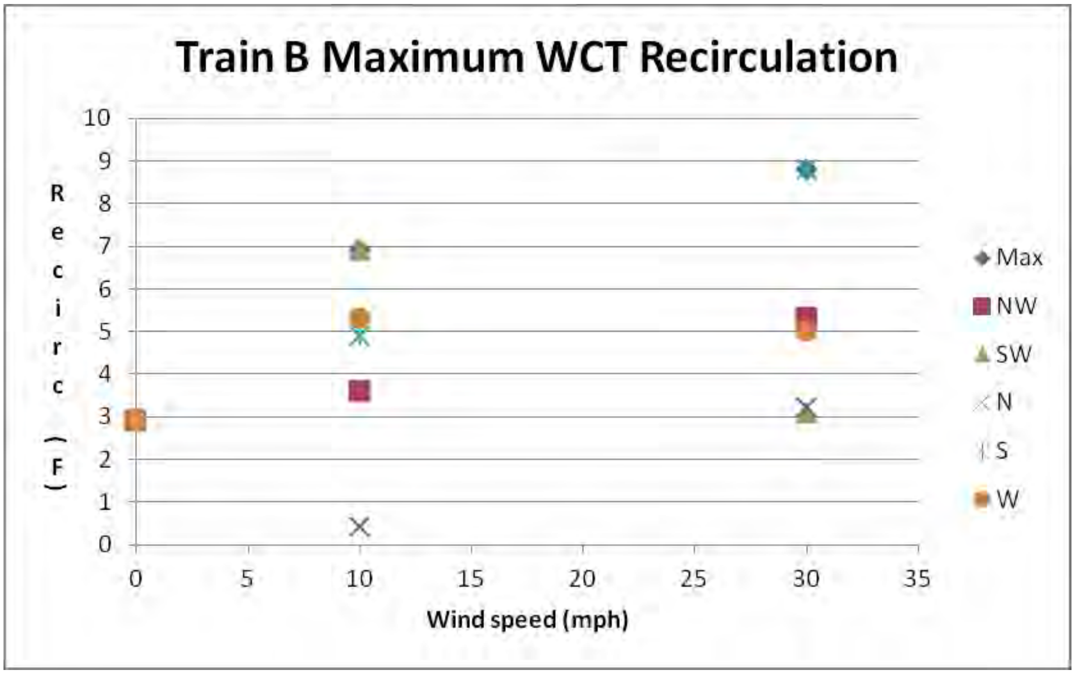


Figure 4-26: Train B horizontal wall WCT recirculation with relative humidity

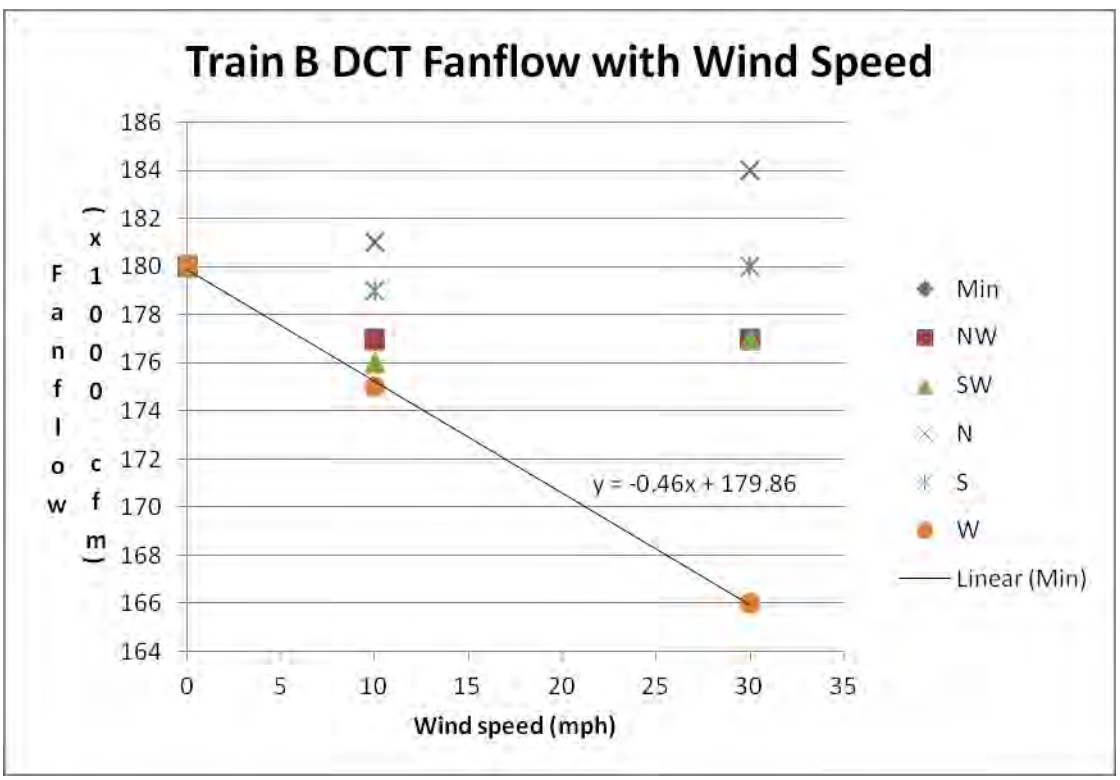


Figure 4-27: Train B horizontal wall DCT fan flow with wind direction

4.4.1 Train B Case 4: South Wind with 30mph and 90F Ambient

All Train B analysis results are provided in Attachment E. Details for Case 4, which has the highest recirculation, are included herein as an example.

The residuals for this case is shown in Figure 4-28. All residuals were steady and below 1e-3.

Fan inlet temperatures are presented in Figure 4-29 as a contour plot showing the temperature distribution over the fan inlet faces and summarized numerically in the accompanying table. The numerical values are based on the average of the final 50 iterations. Recirculation is spread throughout the fan inlets with a slightly higher temperature in cell 3 The increased fan inlet temperature above ambient provides the recirculation effect (97.7F – 90F = 7.7F).

The stability of the model is shown in Figure 4-30, which provides the average fan temperature with model iteration step from the ANSYS CFX analysis run. The model is stable after 50 steps. WCT mass flow is also presented in this figure. Based on the average of the last 50 iterations, the total recirculation for both WCT inlets is 131lb/s. This mass recirculation flow is divided by the total air mass flow at the inlet (~500lb/s), which yields 26% of mass flow at WCT inlet. This recirculation raises the wet bulb temperature at WCT inlet by 8.8F (based on 100% relative humidity).

Figure 4-31 shows the velocity vectors and temperature contour above the horizontal wall. The horizontal wall is effective in separating most of the hot discharge air from fan suction side as seen by the sharp red/blue boundary. A small amount of heated air enters cell 3 was due to a swirl developed on top of cell 3, which creates a low pressure region.

The streamline leading into the the cell 3 fan inlet are shown in Figure 4-32, showing the source for the inlet air. A fraction of the DCT cell 3 inlet is provided from the hotter DCT outlets, which causes an increase in average fan temperature in this cell

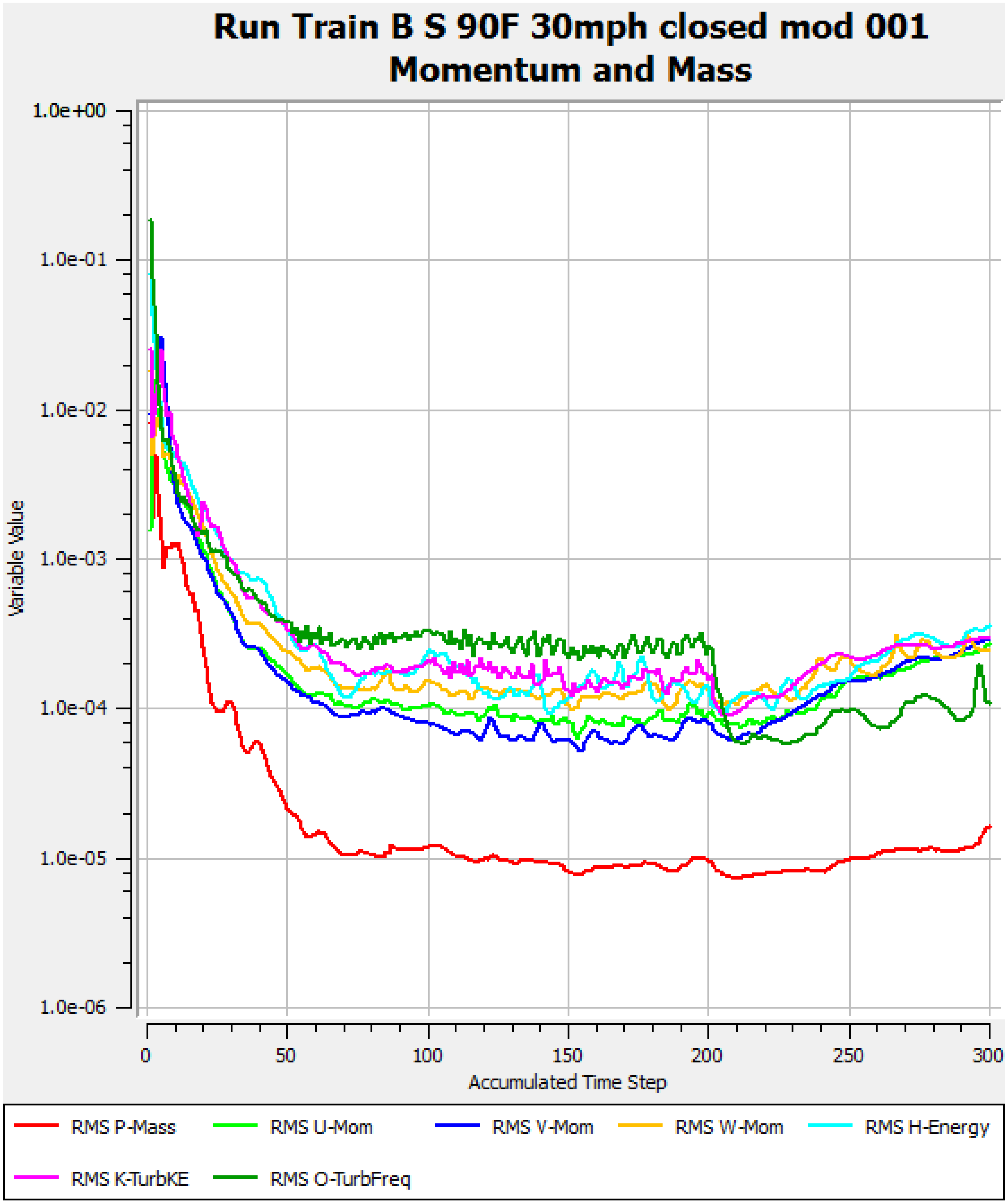


Figure 4-28: Residual plot for horizontal wall case 4

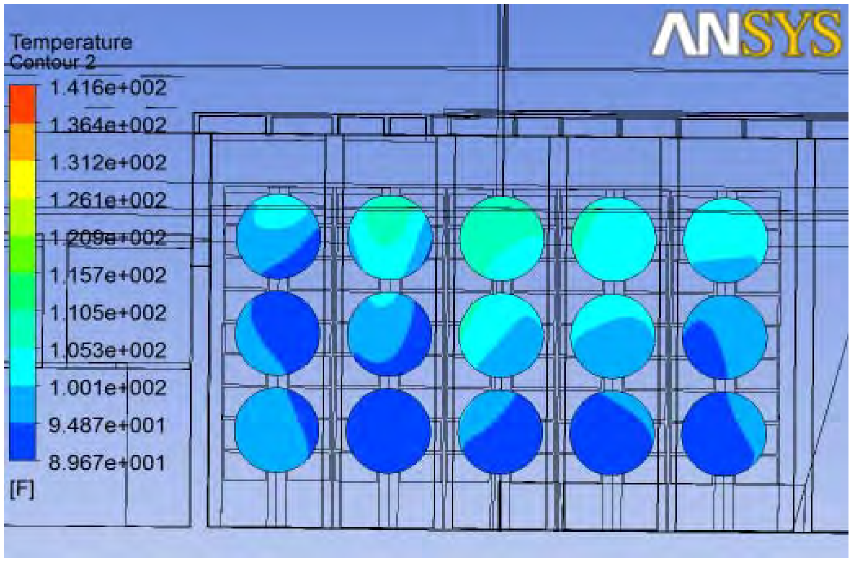


Figure 4-29: Fan temperature for horizontal wall case 4

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	97.3	103.0	105.3	104.0	100.7
	93.9	95.8	100.4	98.7	95.6
	97.0	92.1	94.1	93.3	94.0
Average fan temperature:				97.7	

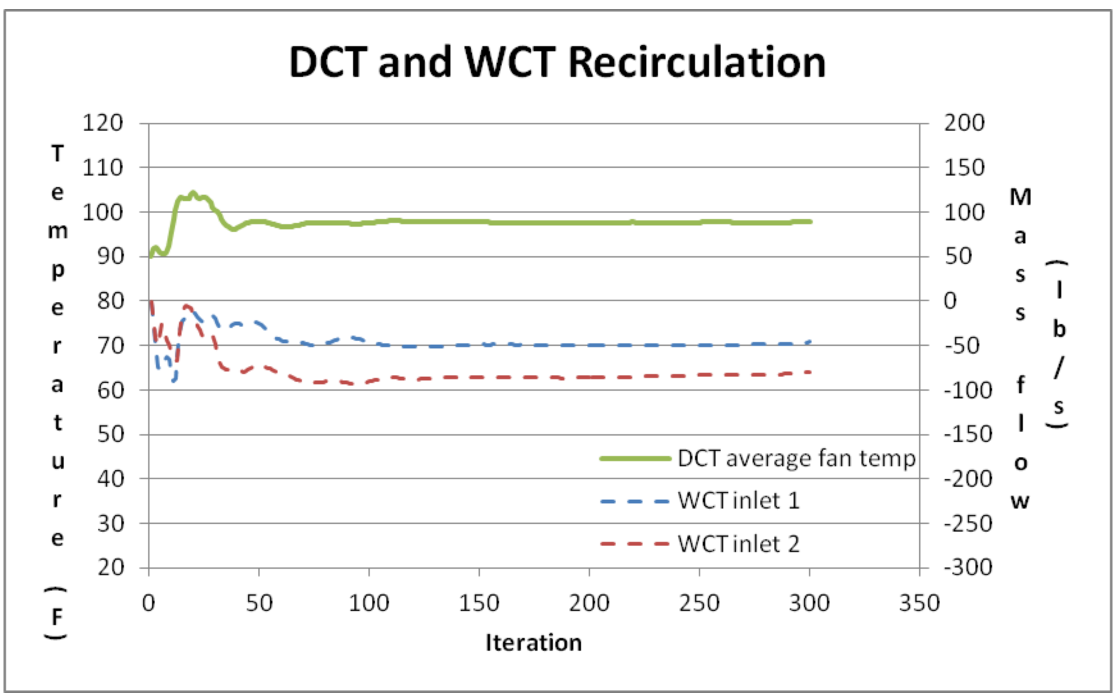


Figure 4-30: DCT and WCT recirculation with iteration for case 4

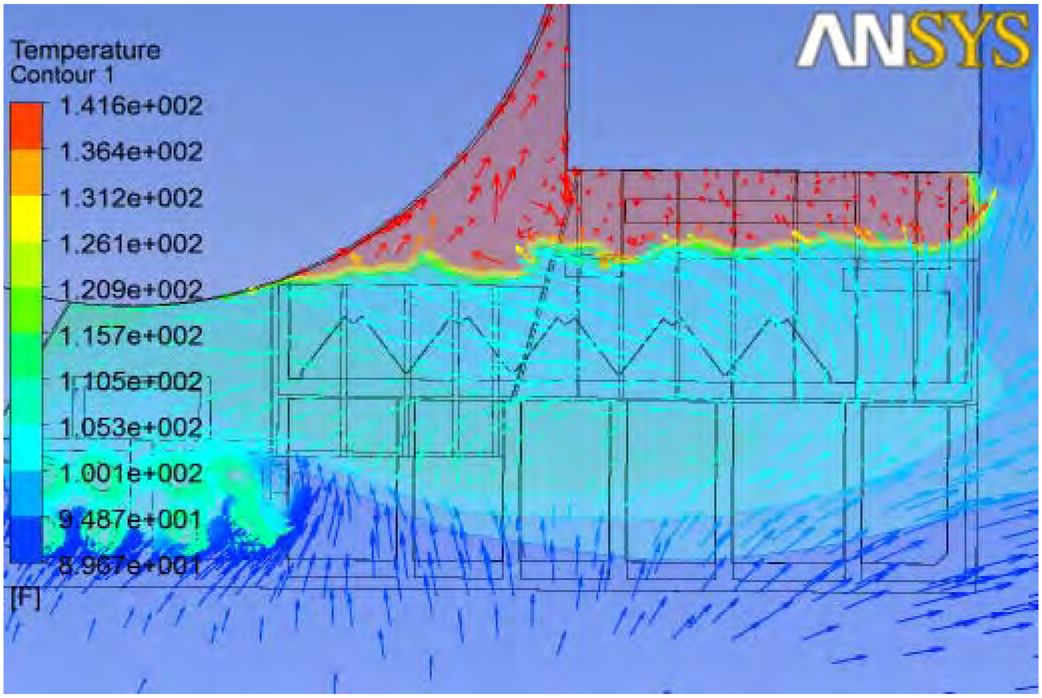


Figure 4-31: Case 4 velocity vector and temperature contour above the deflector wall

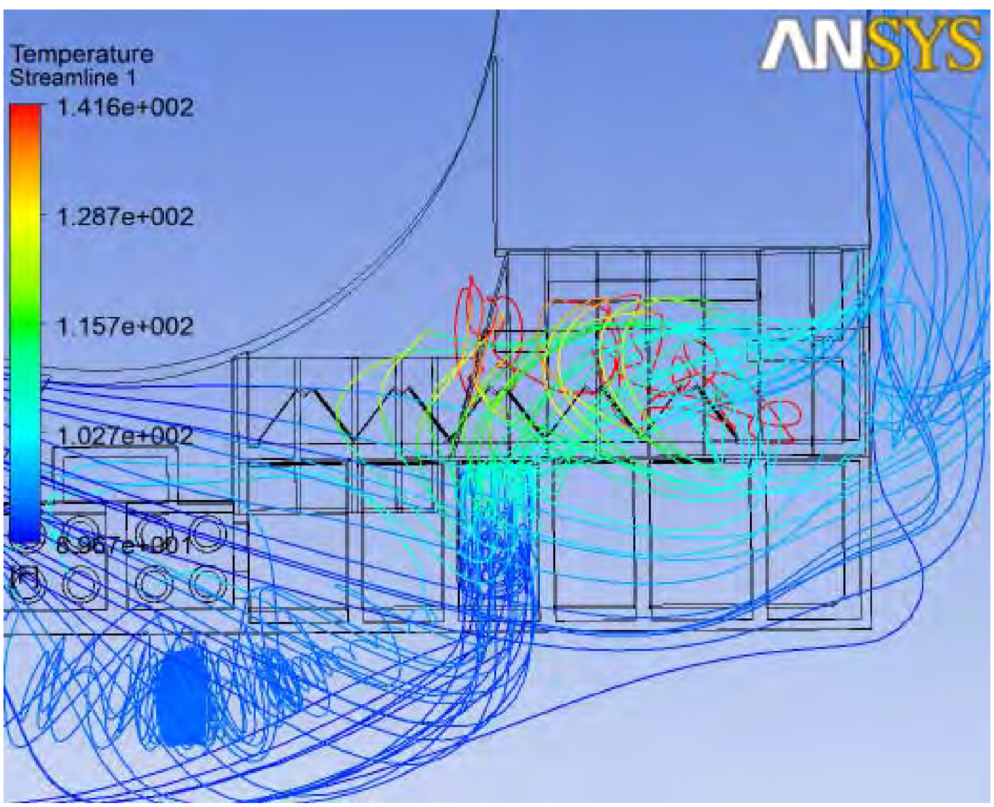


Figure 4-32: Streamline at cell 3 for horizontal wall case 4

4.5 Sensitivity Study of Solid FOST Wall

In the CFD model, the FOST was modeled as porous domain, which would restrict flow but would permit flow to pass. In a second design, shown in Figure 4-33, the FOST cover was modeled as a solid plate. Additionally, the FOST cover was raised to the height as the bottom of the WCT inlet window. A sensitivity study was conducted to understand the effect of the modified FOST design on DCT and WCT recirculation.

The NW 82F 40mph was used in this study because it has the bounding DCT recirculation. In this study, the WCT outlet temperature was defined as 111F, slightly higher than 109F that was used in the above section. The analysis demonstrated that the DCT recirculation was essentially unchanged at approximately 7.0F. The WCT recirculations for the porous and solid wall cases were 4.6F and 4.7F respectively. This change is insignificant.

Figure 4-34 and Figure 4-35 showed the average fan temperature difference between the FOST solid wall and porous cases were 0.1F. Figure 4-36 and Figure 4-37 showed that the DCT and WCT recirculation results for both cases were steady throughout the run. Figure 4-38 and Figure 4-39 showed the building wake from the FOST solid wall compared well with the FOST with porous case.

Therefore, the results of this sensitivity study showed that having a solid wall cover at the raised location over the FOST does not change the predicted DCT and WCT recirculation.

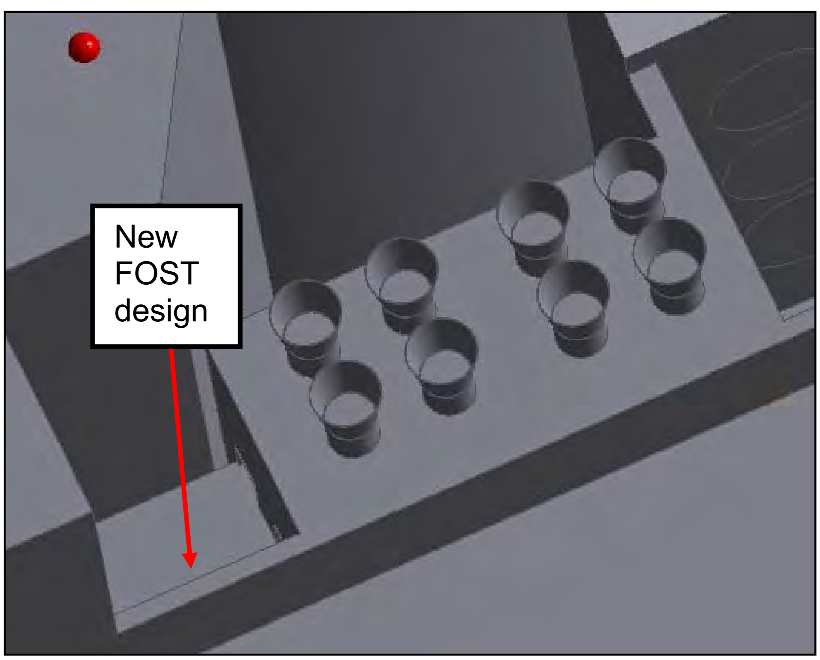


Figure 4-33: Geometry for the FOST solid wall

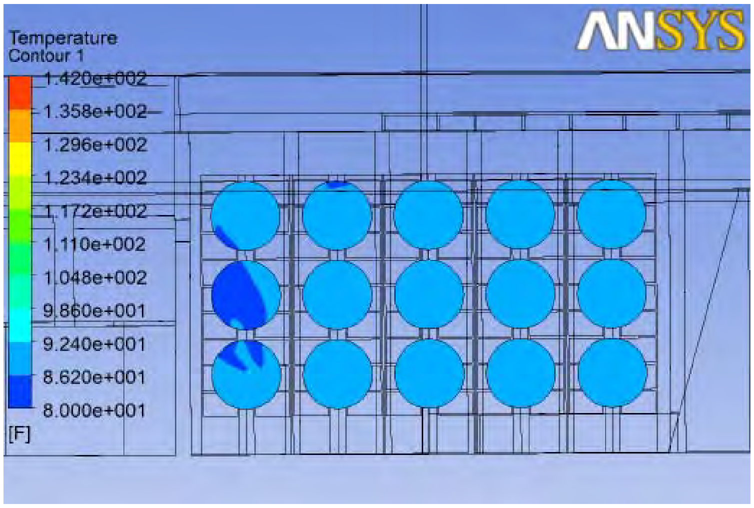


Figure 4-34: Fan temperature for FOST porous

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	89.6	90.4	90.4	89.4	90.7
	86.0	89.7	88.5	89.1	91.0
	85.5	88.7	87.7	89.5	90.7
Average fan temperature:				89.1	

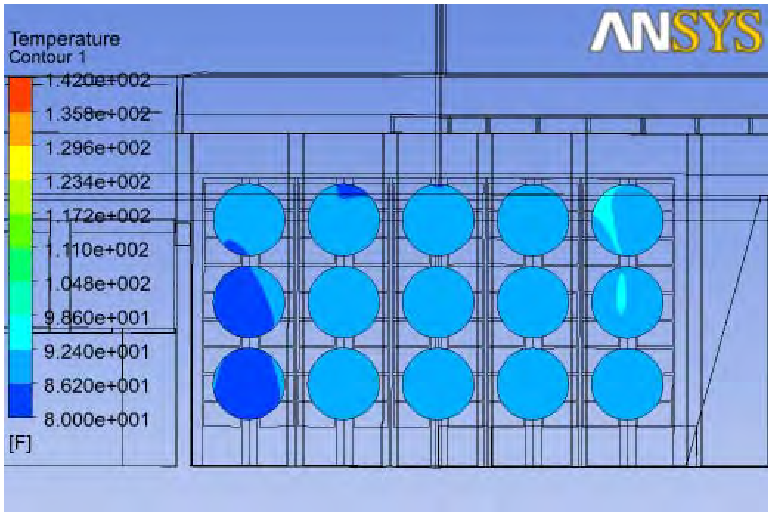


Figure 4-35: Fan temperature on the FOST solid wall

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	89.1	89.1	89.5	89.5	91.0
	86.0	89.5	88.7	88.6	91.3
	86.4	88.4	87.5	88.5	91.1
Average fan temperature:				89.0	

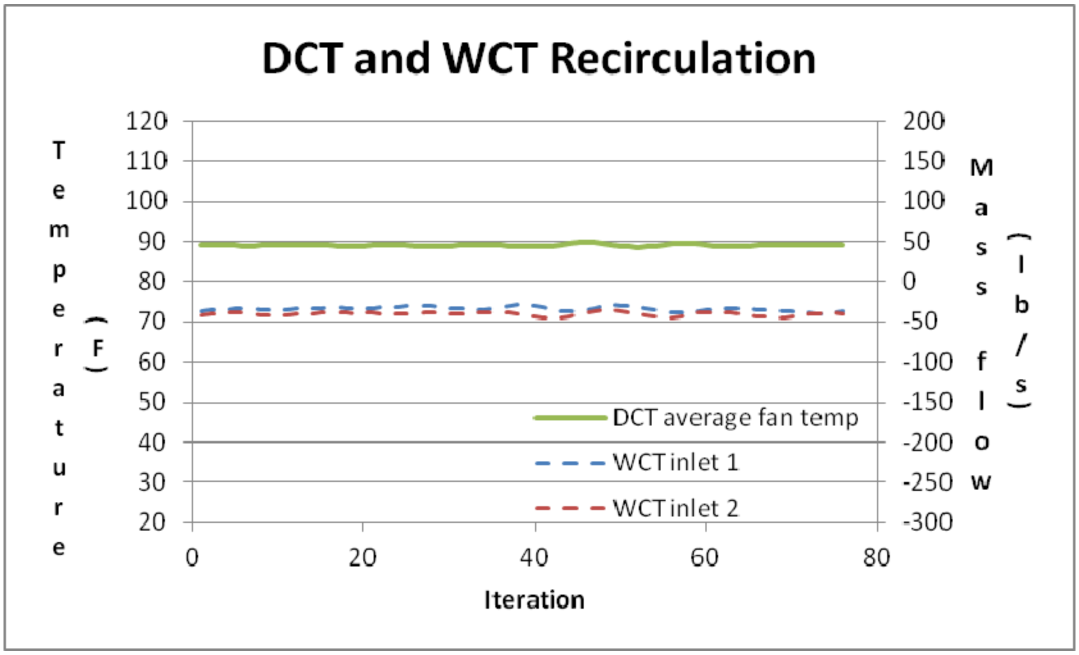


Figure 4-36: DCT and WCT recirculation with iteration for FOST porous

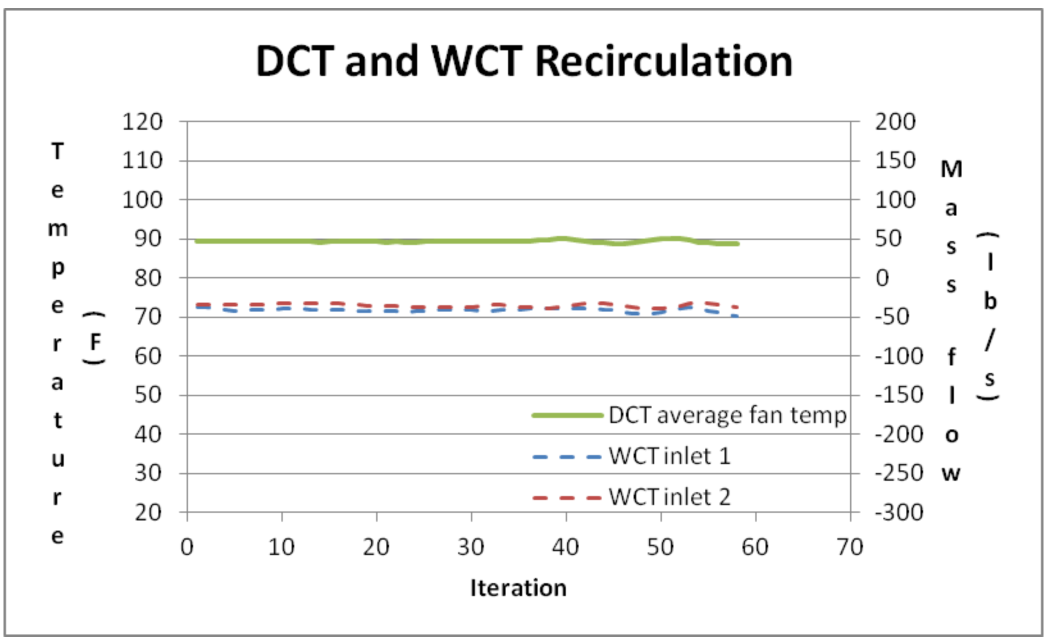


Figure 4-37: DCT and WCT recirculation with iteration for FOST solid wall

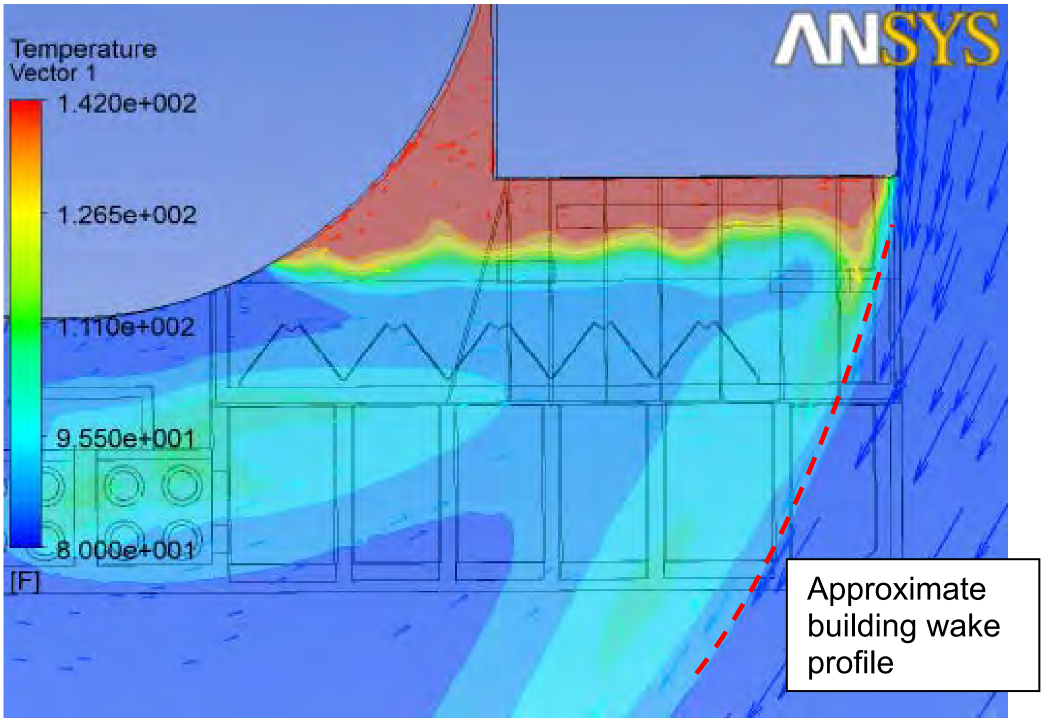


Figure 4-38: Velocity vector and temperature contour for FOST porous

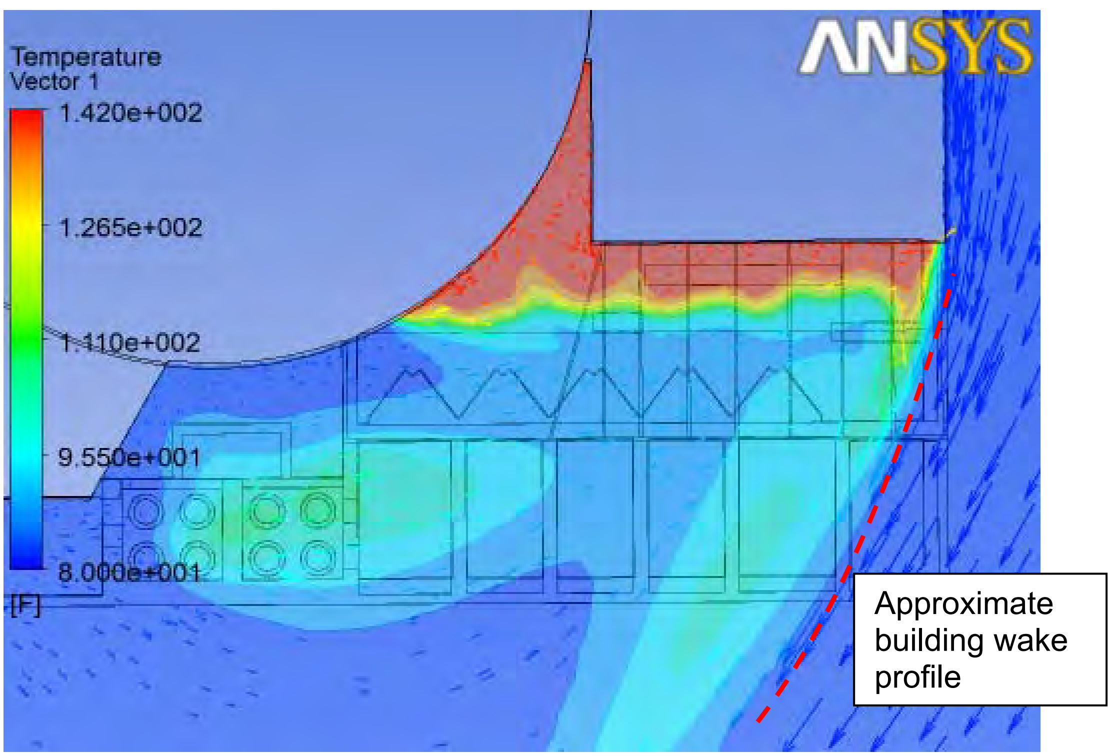


Figure 4-39: Velocity vector and temperature contour for FOST solid wall

4.6 Recirculation Change with Heat Load

The DCT air outlet temperatures for all 90F 30mph cases (See Table 2-3 and Table 2-5), 147F on Train A and 141.5F on Train B, are based on a component cooling water temperature of 161.5F, which corresponds to a peak containment heat load of approximately 161M BTU/hr [7] and DCT heat removal of approximately 120M BTU/hr. This heat load is conservative because the DCT outlet temperature decreases as the containment heat load decreases over the time period following a LOCA event. Lower DCT outlet air temperature affects the DCT recirculation. Therefore, this relationship was studied to understand the change in recirculation with DCT outlet temperature.

In the CFD model, the DCT outlet temperature was evaluated from its current level to 120F in 5F intervals, i.e. 120F, 125F, 130F, 135F, and 140F on Train A. Train B did not include 140F case because the current temperature is already close to 140F. The South wind on Train B and the Northeast wind 90F 30mph case on Train A were used because those two cases yields the highest recirculation among other cases. The recirculation was also evaluated with two additional wind direction, Train B NW and SW, at 120F outlet temperature only. These two wind direction were studied to confirm the maximum recirculation at 120F.

Train A results are shown graphically in Figure 4-40, which demonstrates that the recirculation decreased approximately by 1F for every 10F drop in DCT outlet temperature. Train B South wind results shown in Figure 4-41 yielded the same 1F recirculation change with 10F change in DCT outlet temperature. The non-bounding (lower recirculation) NW and SW wind direction cases showed slightly less reduction, producing only 0.5 degree change over the 120F to 140F outlet temperature range.

In application to a load range from 50MBTU/hr to 161MBTU/hr, the recirculation temperature decreases from 7.7F to 5.7F or 74% of the full recirculation. The linear reduction, expressed as a percentage, is Reduction = 0.00233%/MBTU/hr + 0.624% with a minimum of 50MBTU/hr = 74%.

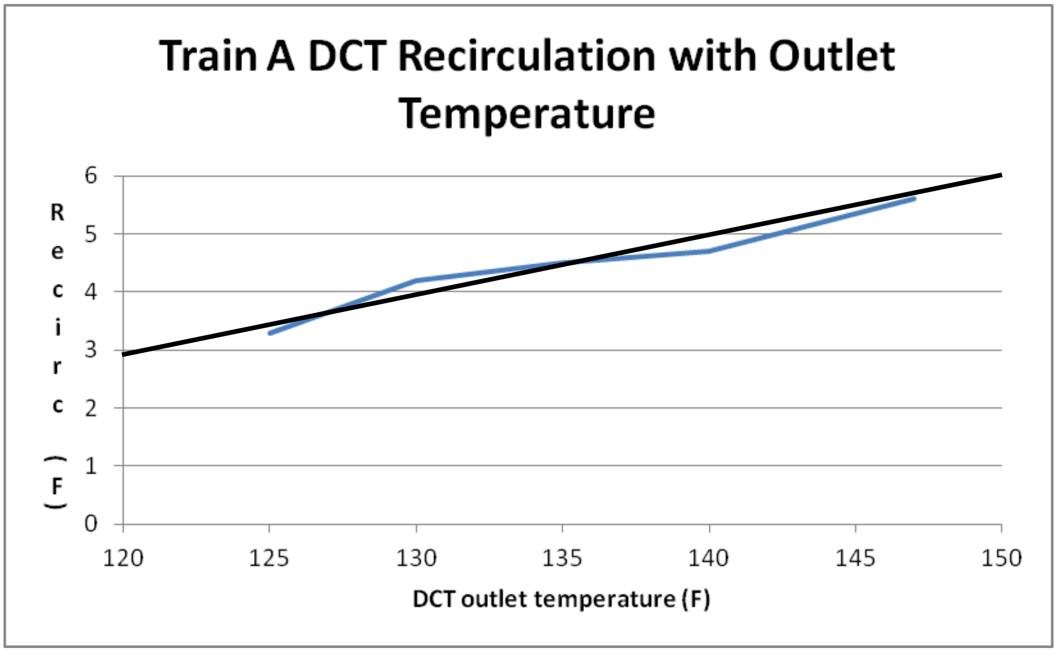


Figure 4-40: Train A Recirculation Results with Outlet Temperature

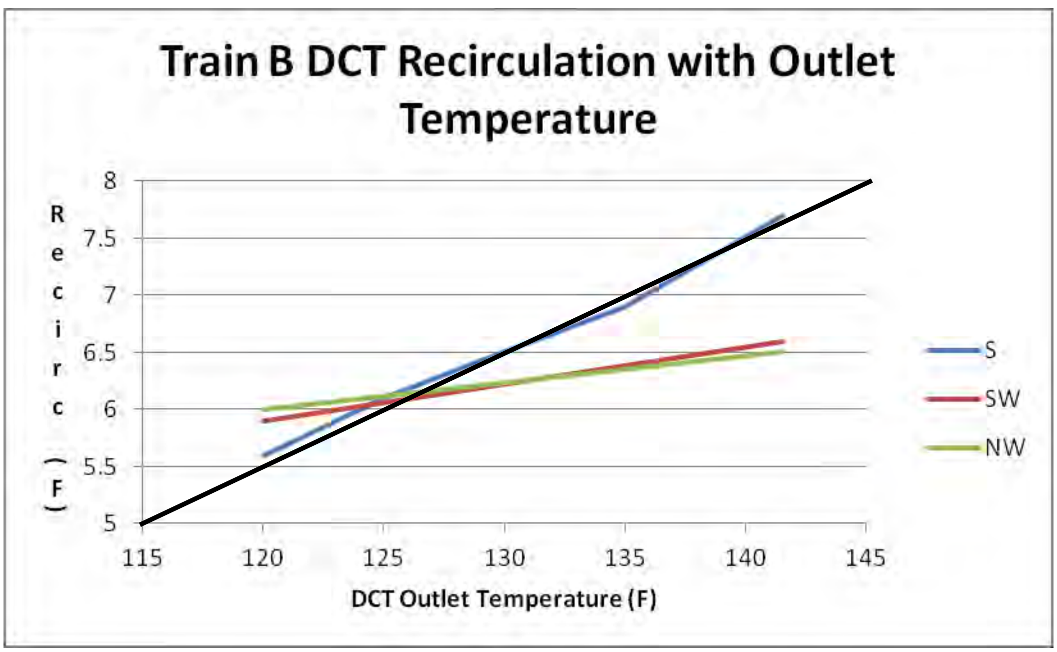


Figure 4-41: Train B Recirculation Results with Outlet Temperature

4.7 Horizontal and Vertical Missile Shield Partial Cover from Cell 1 through 3

The installation is expected to occur in three steps. The first step is to cover the ~3ft tall vertical missile shield portion, which is considered a minor change and was not evaluated. Second, 20ft plates on Train A and 25ft plates on Train B will be attached to the top of the horizontal missile shield. The last step will be to install the horizontal wall on both inlet and outlet side of the DCT at cell 4 and 5. Since the plant is expected to operate between installation, a study was conducted to demonstrate that no adverse conditions would arise during installation due to a potential restriction of fan air flow without a maintaining fan inlet temperature below the current operability limit of 111.5F (102F+9.5F recirculation) [31].

The CFD model geometry for Train A and B are shown in Figure 4-42 and Figure 4-43. It includes the vertical and 20ft (Train A) and 25ft (Train B) horizontal missile shield section from cell 1 to cell 3. Ambient conditions corresponding to an East wind at 90F/30mph (Train A), West wind at 90F/30mph (Train B), and a 102F/static case were evaluated, and the results compared with the similar cases in current configuration [22], i.e. without any cover on the vertical and horizontal missile shield. These wind directions were selected based on the greatest impact on fan flow.

Table 4-13 presents results for both the current configuration and partial installation. The A Train results show that the recirculation with the partial installation in place is less than or equal to the recirculation in the current condition. With the partial installation ("b" cases), fan flow for the East and static condition are 170,000 cfm and 176,000 cfm. Fan flow for the East wind case and static condition with no modification in place ("a" cases) are 157,000 cfm and 180,000 cfm. Fan flows above 143,000 cfm are considered acceptable based on Section 3.3.2. Train B recirculation with the partial installation is higher than the current condition. The fan flow with partial installation is 191,000cfm for both cases, which is much higher than the 143,00cfm limit.

Due to the fan flows remaining much higher than the lower limit of 143,000cfm and due to the fan inlet temperatures remaining below 111.5F, the partial installation does not introduce any adverse conditions.

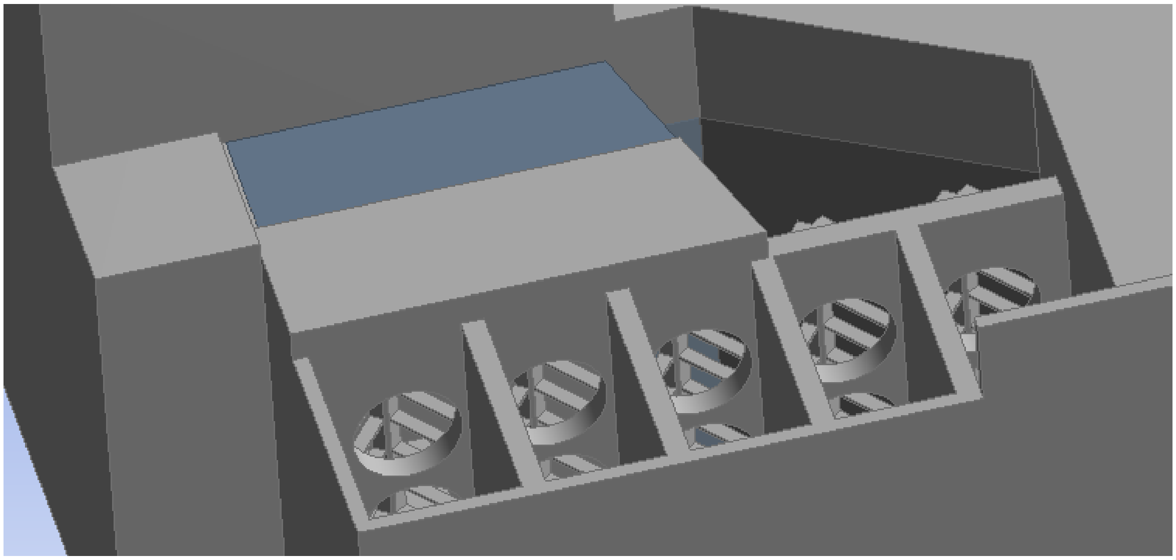


Figure 4-42: Train A with Horizontal and Vertical Missile Shield Covered

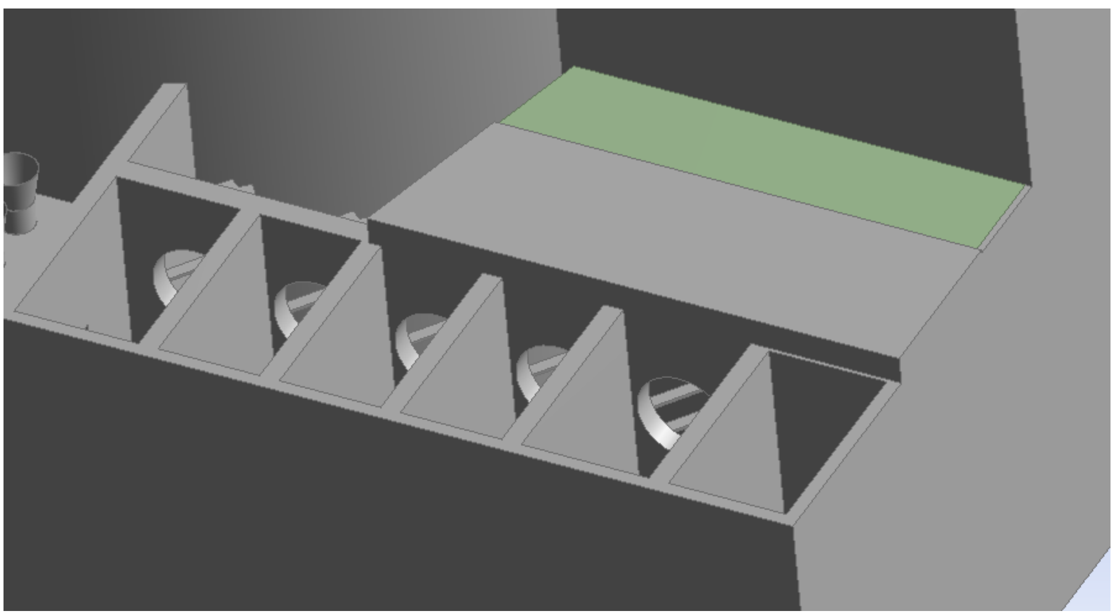


Figure 4-43: Train B with Horizontal and Vertical Missile Shield Covered

Table 4-13: Summary Results for Step 2 and Current Configuration

Train A case		Wind Direction	Ambient temp (F)	Wind speed (mph)	Average fan temp (F)	Recirc (F)	Fan flowrate x1000 (cfm)
1a	Current configuration [22]	East	89	33	98.9	9.9	157
1b	Partial Installation: Cover horizontal and vertical missile shield	East	90	30	95.5	5.5	170
2a	Current configuration [22]	N/A	102	0	106.2	4.2	180
2b	Partial Installation: Cover horizontal and vertical missile shield	N/A	102	0	106.2	4.2	176
Train B case							
3a	Current configuration [22]	West	90	30	96.1	6.1	194
3b	Partial Installation: Cover horizontal and vertical missile shield	West	90	30	103.5	13.5	191
4a	Current configuration [22]	N/A	102	0	105.4	3.4	198
4b	Partial Installation: Cover horizontal and vertical missile shield	N/A	102	0	106.0	4.0	191

4.8 Fan Out Of Service Analysis

The intent of the fan Out Of Service (OOS) study is to determine the recirculation effect of taking one, two, or three DCT fans out of service. As a fan is taken OOS, without a fan cover or louver, air reverse flow through the coil and non-operating fan can occur due to a relatively higher pressure on the discharge side and lower pressure on the suction side. Reverse flow through the non-operating fan acts in combination with any recirculation flow passing over the DCT wall, increasing the net inlet temperature at the remainder of the operating fans.

The reverse flow rate during fan OOS depends on the pressure differential and loss coefficient between the coil discharge side and the fan suction side. The upper bound pressure loss through the coil [19] of 0.615 in wg was used [22].

The fan OOS condition was evaluated in two steps. First, the inlet and outlet flows OOS fans were set to zero and the model was run to determine the pressure differential between the fan inlet and outlet bays. This provided a pressure drop used to determine back-flow rate. Second an air back flow velocity at DCT outlet temperature was applied to the inlet side of the fan out of service to determine the inlet temperature of the remaining fans and total DCT recirculation (see also Figure 4-44 and Figure 4-45). This method is very conservative because reverse flow through the OOS fan would limit pressure drop compared to the zero flow first step approximation and thus the back-

flow is conservatively over-estimated. This conservatism is large relative to any variation in fan differential pressure with position (see also Section 5)**Error! Reference source not found.** #5)

4.8.1 Angle Wall Concept

Train B Case 6 was used as a base case for this study (Northwest wind 88F/29mph). This case was used because it has the highest DCT recirculation without hurricane conditions. Based on the original case, the fan with the lowest inlet pressure would be taken out of service because this produced the highest differential pressure between the coil and the fan, which increased the backflow velocity.

Based on the first step, the pressure differential between the inlet and outlet sides was 0.0095 psi. With the pressure drop and loss coefficient, the reverse flow rate for 1 fan OOS per cell was 131lb/s, or 13ft/s coming out from the fan OOS inlet (~50-60% of the design forward flow rate of 230lb/s). This was conservatively defined as 13.5ft/sec in the CFD model, which is equivalent to approximately 150lb/s. With two fans OOS per cell, the air velocity entering the cell would be approximately half of the condition with one fan OOS. The estimated suction side pressure loss for the 2 fans OOS per cell would be proportional to the square root of this velocity ratio or $1/\sqrt{2}$ of the pressure with 1 fan OOS, i.e. 0.0095psi*0.707=0.0067psi. With this pressure drop, the reverse flow rate was 110lb/s, which yields 11ft/s for each fan. In the CFD model, 11.5ft/s was used to model 2 fan OOS in the same cell. These 130lb/s for one fan OOS and 110lb/s for two fan OOS per cell also bound the Train A fan OOS analyses. A detailed calculation is shown in Att. A. Confirmation of inlet and outlet side pressures were studied with and without flow through the DCT inlet and outlet.

From a weighted flow balance, adding approximately 150 lb/sec of 140F heated air to the remaining fans produces a net temperature of 2.4 to 3F for each fan OOS, as shown in Att A. This correlates with the CFD results as shown below.

Table 4-14 shows the Train B comparison between individual fan temperatures for zero, one, two, and three fans OOS cases. The combination of fans that were taken out of service for 1 fan OOS was the bottom fan from cell 4. The fan taken out of service for 2 and 3 fan OOS cases were the top 1 fan from cells 2, 3, and 5. The purpose of using a top and bottom fan for 1 and 2 fan OOS was to study the effect of recirculation by taking different fan out of service. The table provides the number of fans OOS within each cell. These results show the temperature increase that can be applied for each fan OOS is bounded by approximately 3F.

Plots of the flow vectors through the fan OOS cell are provided in Figure 4-44. This plot shows the base (no fans OOS), 1, 2, and 3 fans OOS (in separate cells) using the NW wind case. Figure 4-45 shows the vectors at cell 3, which is the cell with 2 fans OOS (Case 4).

Based on Train B fan OOS analysis, the bounding cases were 2 fan OOS with 2.35F recirc. Similar cases were run for Train A using case 13 (NE 86F 29mph). Table 4-15 shows the Train A comparison between 0, 2, and 3 fan OOS cases. The fans taken OOS were the top fan from cell 2, 3, 4. These results show that the temperature increase that can be applied for each fan OOS is bounded by approximately 3F per fan. Figure 4-46 and Figure 4-47 show the velocity vectors at the fan OOS cell and illustrate the back flow entering the adjacent fans.

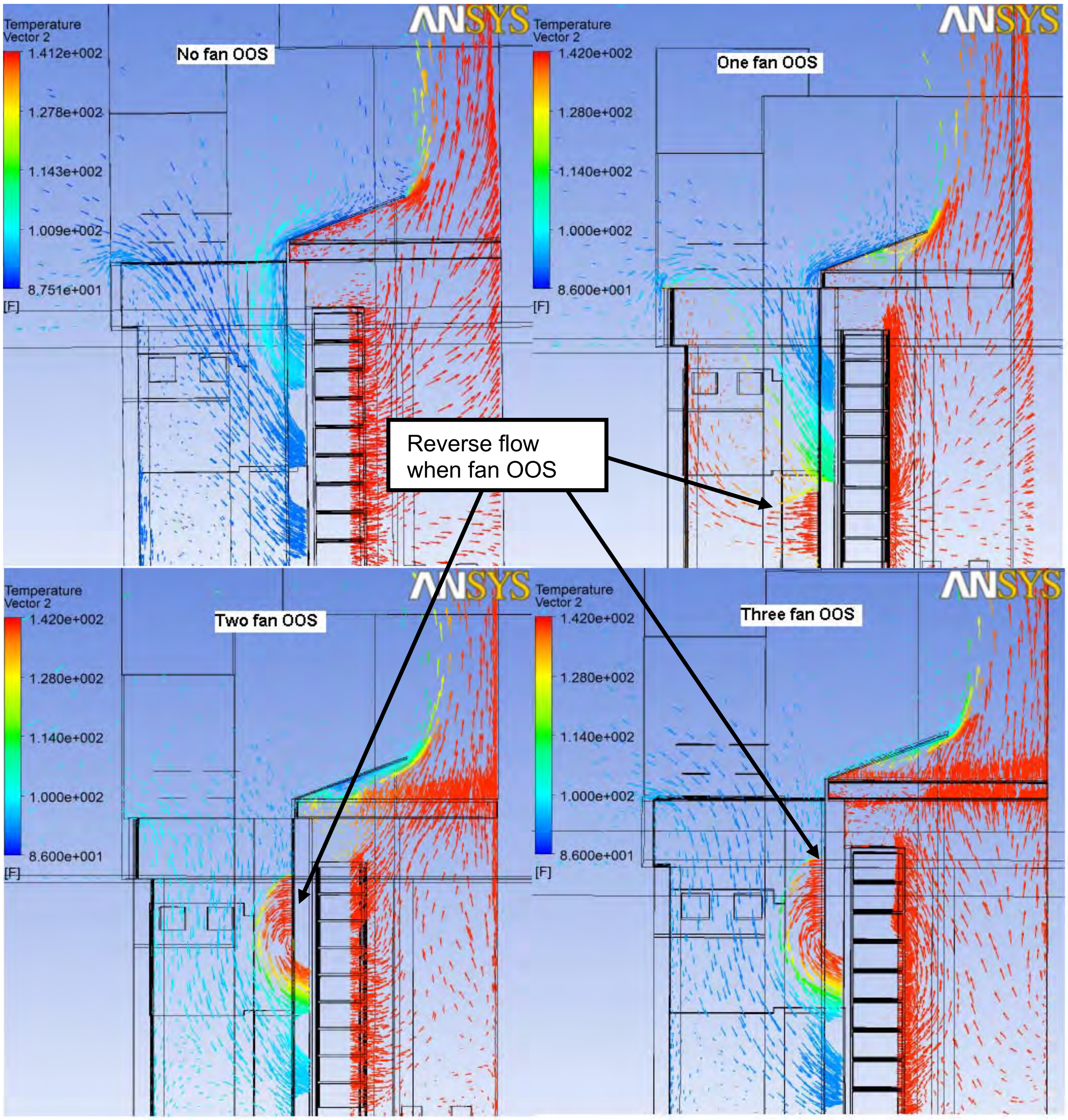


Figure 4-44: Cell 2 vectors for several fan OOS cases on Train B

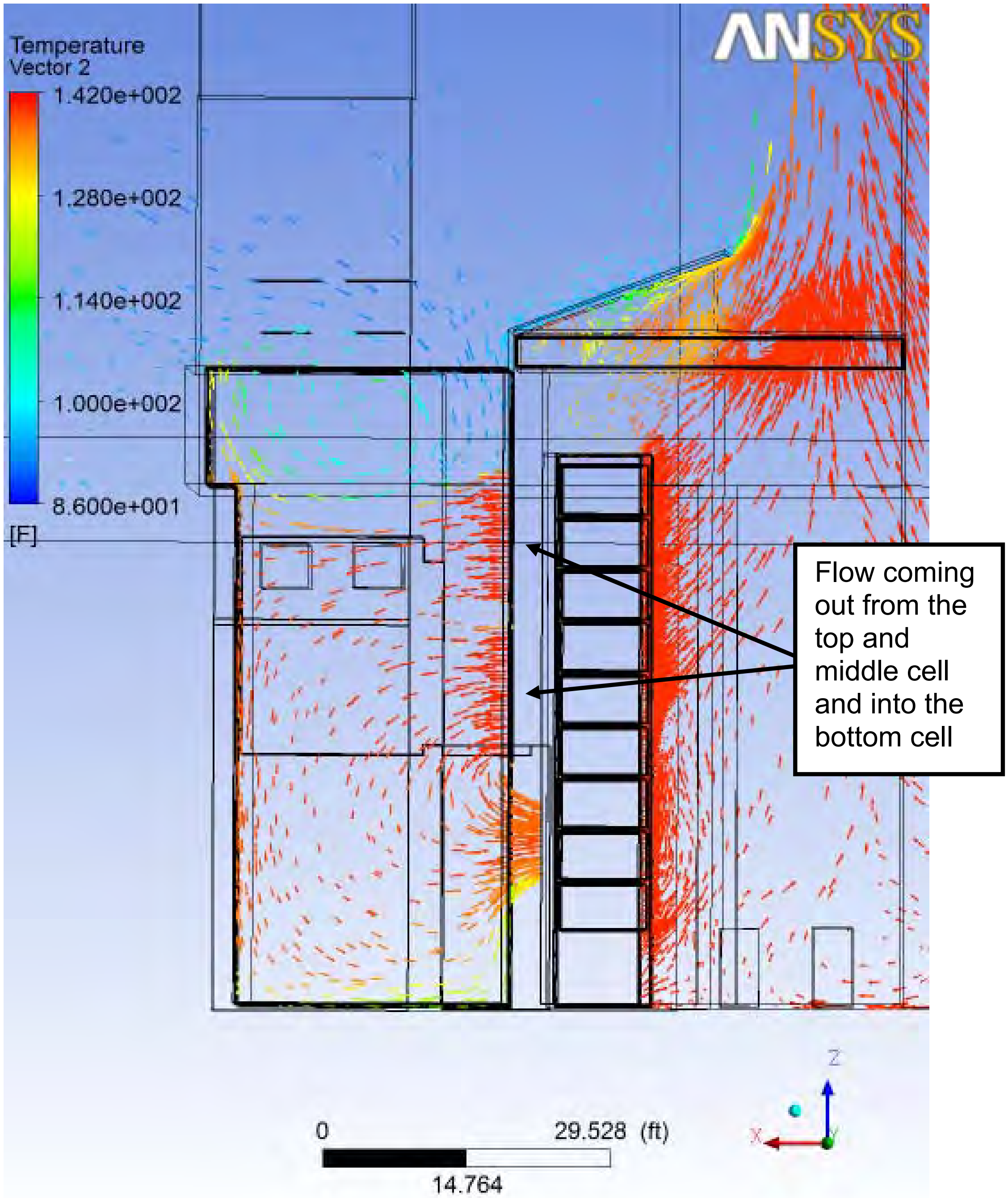


Figure 4-45: Cell 3 vectors for Case 4 (2 fan OOS in one cell) on Train B

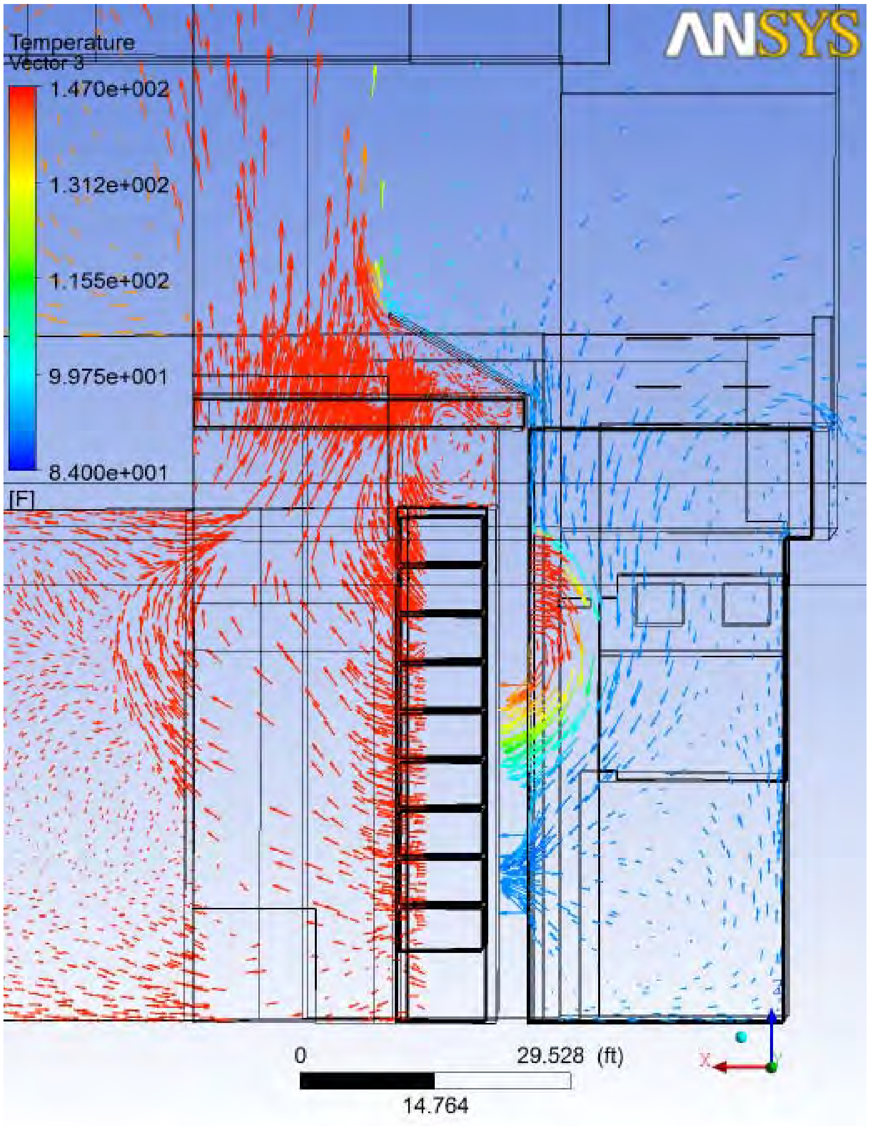


Figure 4-46: Cell 2 velocity vectors Case 1 (2 fan OOS) on Train A

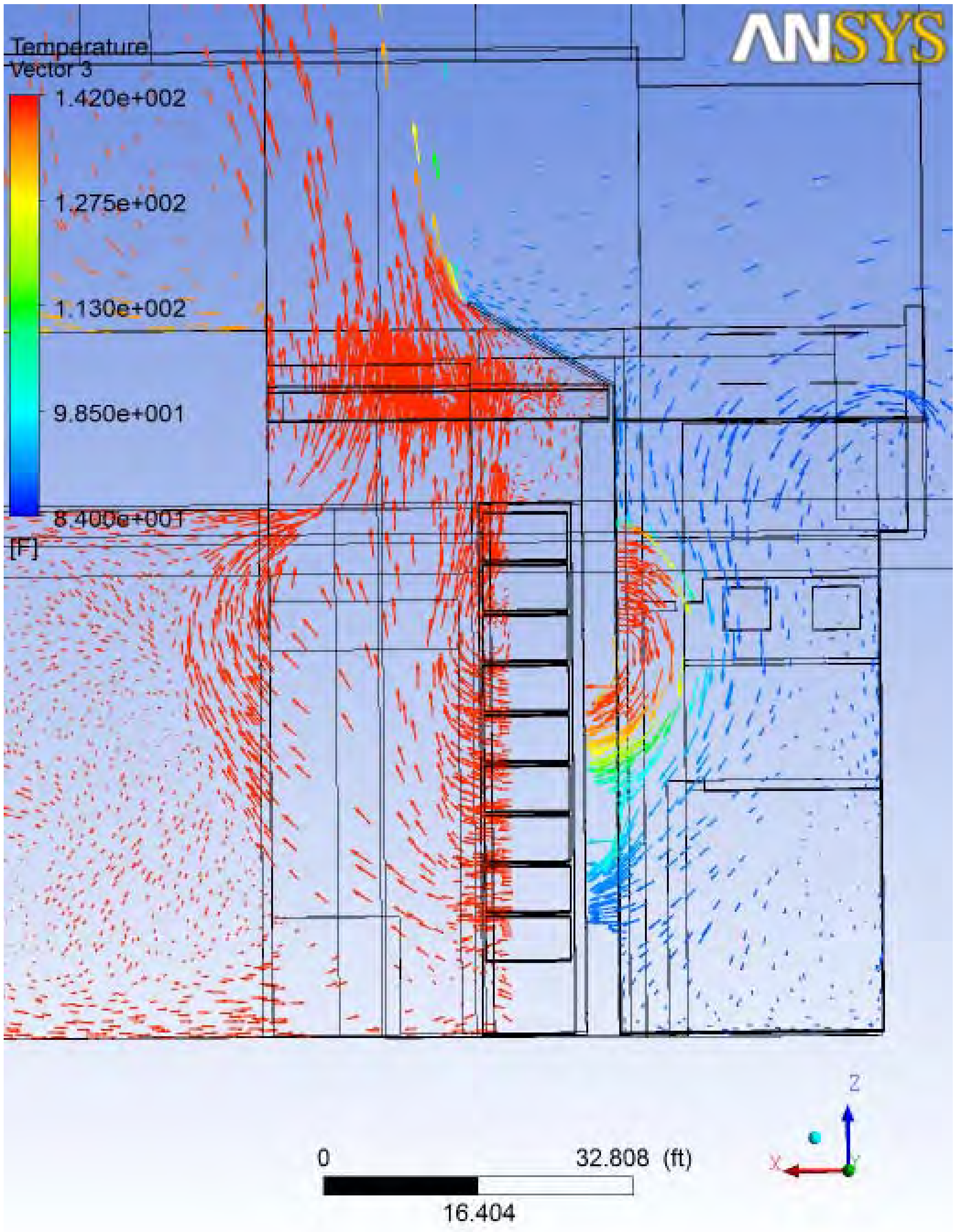


Figure 4-47: Cell 2 Velocity vectors for Case 2 (3 fan OOS) on Train A

Table 4-14: Train B Fan OOS Study: Comparison of Fan Temperature

Case	Wind	Total Fans OOS	No. of Fans OOS per Cell					Ambient	Fan Inlet	dT	dT per fan OOS (1)	Fan Flow
			Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	(F)	(F)	(F)	(F)	x1000 (cfm)
0	NW	0						88	94.5	6.5	n/a	183
1	NW	1				1		88	96.5	8.5	2	188
2	NW	2		1			1	88	99.2	11.2	2.35(1)	191
3	NW	3		1	1		1	88	101.5	13.5	2.33(1)	193
4	NW	3			2			88	98.1	10.1	1.8 (1)	193

Note: 1) Temperature change per fan removed from service is calculated by the increase in fan inlet temperature above the base case. For case 6, the recirc for the base case is 6.5F. (13.5-6.5)/3 fans = 2.3F

Table 4-15: Train A Fan OOS Study: Comparison of Fan Temperature

Case	Wind	Total Fans OOS	No. of Fans OOS per Cell					Ambient	Fan Inlet	dT	dT per fan OOS (1)	Fan Flow
			Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	(F)	(F)	(F)	(F)	x1000 (cfm)
0	NE	0						86	92.3	6.5	n/a	180
1	NE	2		1	1			86	98.1	12.1(1)	2.8	188
2	NE	3		1	1	1		86	98.3	12.3(1)	1.9	187

Note: 1) Temperature change per fan removed from service is calculated by the increase in fan inlet temperature above the base case. For case 13, the recirc for the base case is 6.5F. (12.1-6.5)/2 fans = 2.8F

4.8.2 Horizontal Wall Concept

Train B South Wind and Train A Northeast 90F/30mph were used as a base cases for this study. These cases were used because they produced the highest DCT recirculation for each Train.

The same two steps as described in Section 4.8.1 were used for this study. The first step determined the B Train pressure differential between the inlet and outlet sides to be 0.016 psi (See Att. A). With the pressure drop and loss coefficient, the reverse flow rate for 1 fan OOS per cell was 168lb/s, or 16.5ft/s coming out from the fan OOS inlet. This was conservatively defined as 16.7ft/sec in the CFD model, which is

equivalent to approximately 170lb/s. With two fans OOS per cell, the air velocity entering the cell would be approximately half of the condition with one fan OOS. The estimated suction side pressure loss for the 2 fans OOS per cell would be proportional to the square root of this velocity ratio or 1/√2 of the pressure with 1 fan OOS, i.e. 0.016psi*0.707 = 0.0111psi. With this pressure drop, the reverse flow rate was 141lb/s, which yields 13.9ft/s for each fan. In the CFD model, 14ft/s was used to model 2 fan OOS in the same cell. A detailed calculation is shown in Att. A. A similar analysis was performed on Train A one fan OOS. The reversed flow on Train A was 15.9ft/s, which conservatively defined as 16ft/s in the model.

Table 4-16 shows the Train B comparison between individual fan temperatures for zero, one, two, and three fans OOS cases. The combination of fans that were taken out of service for 1 fan OOS was the bottom fan from cell 4. The fan taken out of service for 2 and 3 fan OOS cases were the bottom 1 fan from cells 2, 4, and the top 1 fan from cell 5. The purpose of using a top and bottom fan for 2 and 3 fan OOS was to study the effect of recirculation by taking different fan out of service. The table provides the number of fans OOS within each cell. The bounding case was 3 fan OOS, producing 2.2F recirc. These results show the temperature increase that can be applied for each fan OOS is bounded by approximately 3F.

Plots of the flow vectors through the B Train fan OOS cell are provided in Figure 4-48. This plot shows the base (no fans OOS), 1, 2, and 3 fans OOS (in separate cells) using the NW wind case. Figure 4-49 shows the vectors at cell 4, which is the cell with 2 fans OOS in one cell (Case 4).

Similar cases were run for Train A using NE 90F/30mph. The first step determined the A Train pressure differential between the inlet and outlet sides to be 0.014 psi (See Att. A). With the pressure drop and loss coefficient, the reverse flow rate for 1 fan OOS per cell was 15.8ft/s coming out from the fan OOS inlet. This was conservatively defined as 16ft/sec. The fans taken OOS were the bottom fan from cell 4, 5, and the top fan from cell 3. Figure 4-50 and Figure 4-51 show the velocity vectors at the fan OOS cell and illustrate the back flow entering the adjacent fans. Table 4-17 shows the Train A comparison between 0, 2, and 3 fan OOS cases. The bounding case was 3 fan OOS, producing 2.8F recirc These results show that the temperature increase that can be applied for each fan OOS is bounded by approximately 3F per fan.

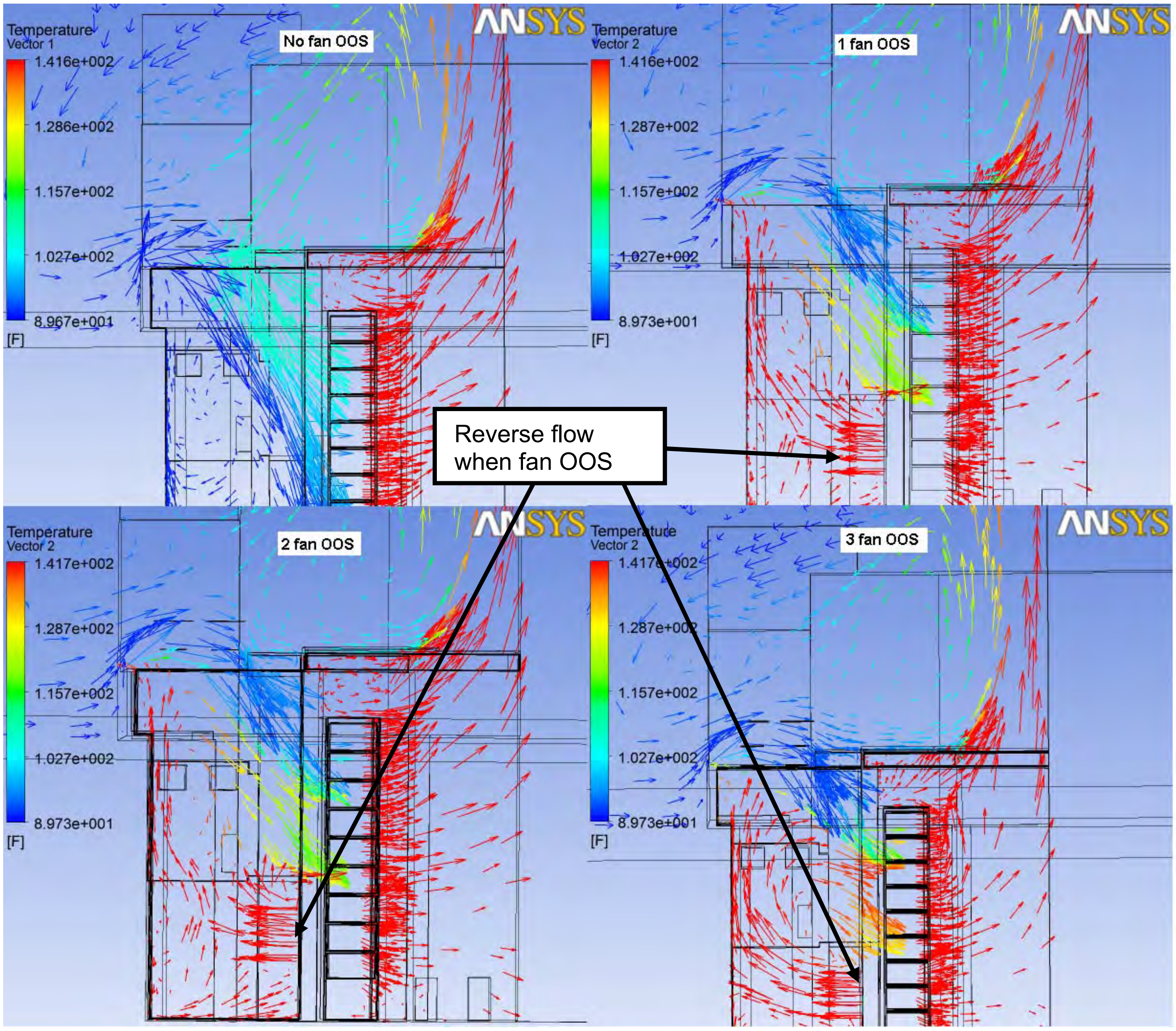


Figure 4-48: Cell 4 vectors for several fan OOS cases on Train B

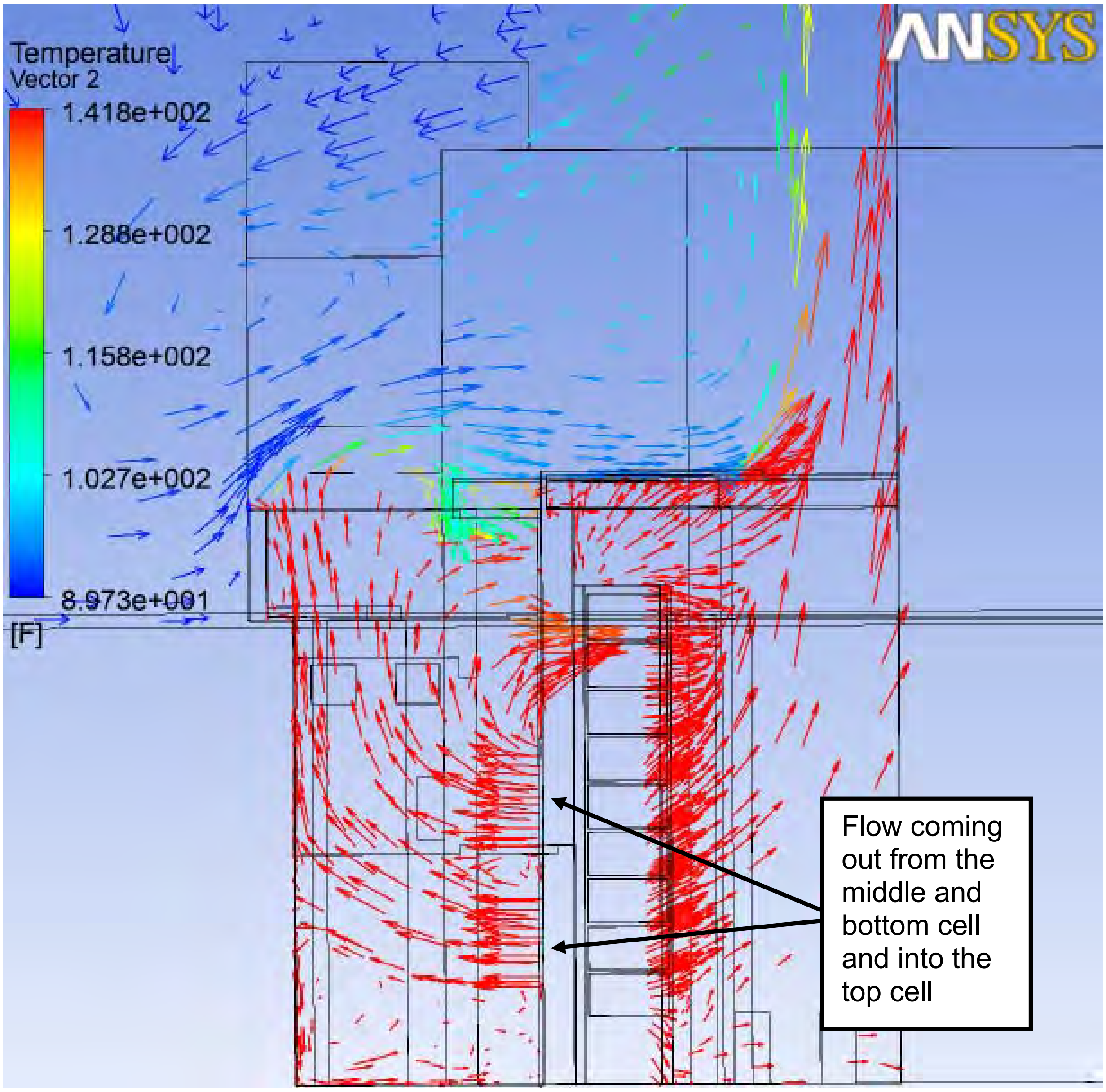


Figure 4-49: Cell 4 vectors case 4 (2 fan OOS in one cell) on Train B

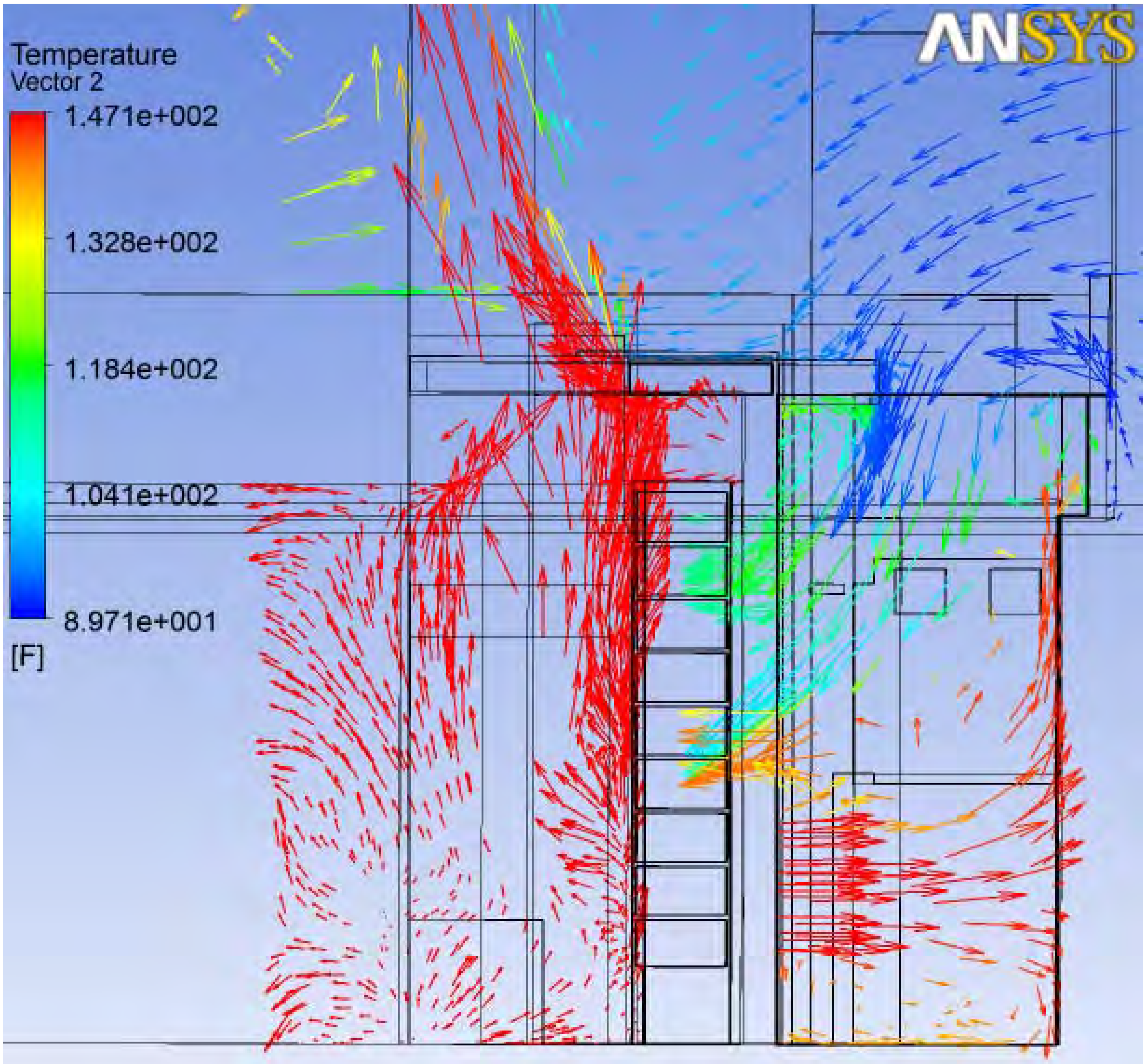


Figure 4-50: Cell 4 velocity vectors Case 1 (2 fan OOS) on Train A

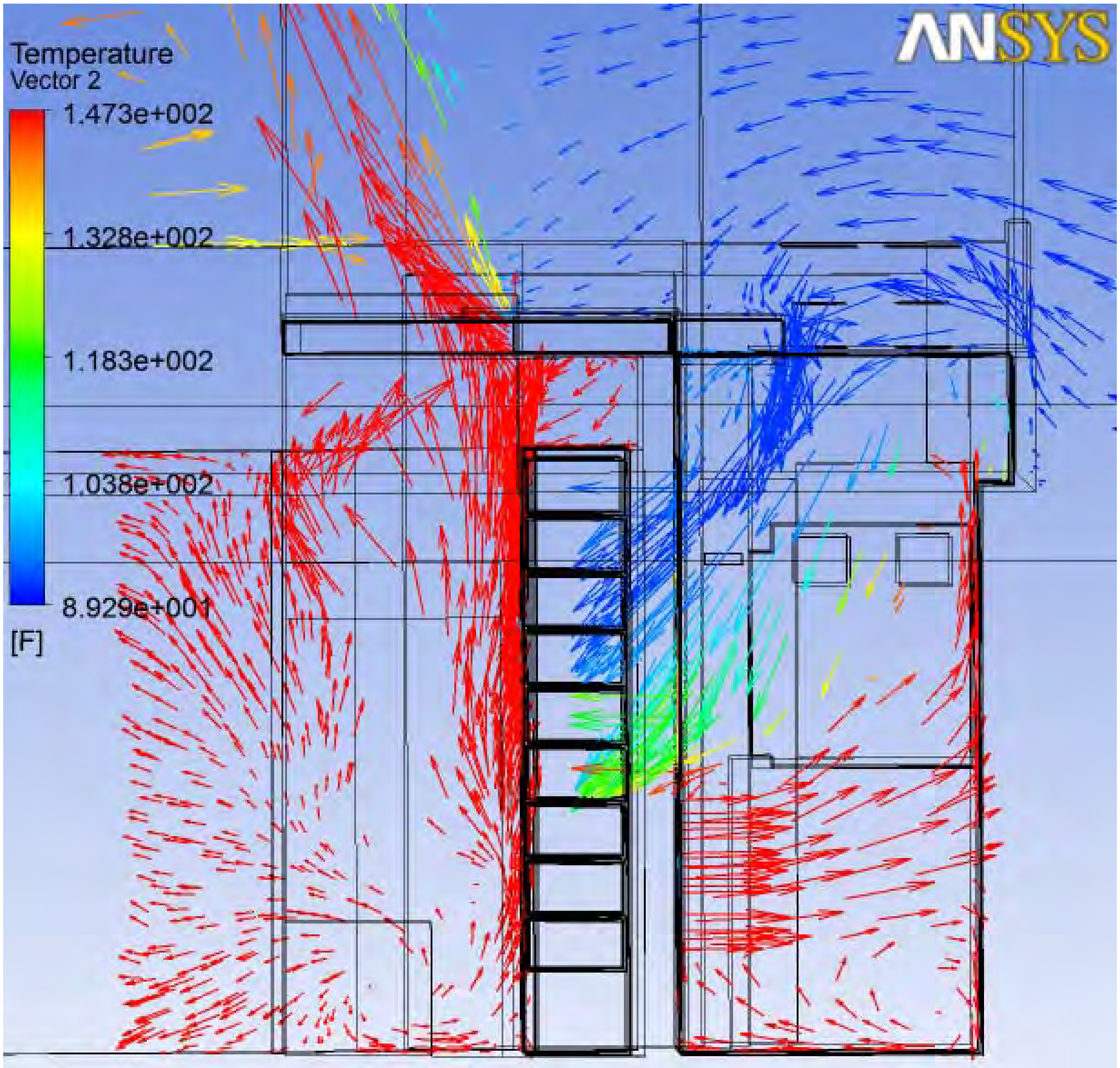


Figure 4-51: Cell 4 Velocity vectors for Case 2 (3 fan OOS) on Train A

Table 4-16: Train B Fan OOS Study: Comparison of Fan Temperature

Case	Wind	Total Fans OOS	No. of Fans OOS per Cell					Ambient	Fan Inlet	dT	dT per fan OOS (1)	Fan Flow
			Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	(F)	(F)	(F)	(F)	x1000 (cfm)
0	S	0						90	97.7	7.7	n/a	180
1	S	1				1		90	99.2	9.2	1.5 (1)	183
2	S	2		1		1		90	101.4	11.4	1.9 (1)	187
3	S	3		1		1	1	90	104.2	14.2	2.2 (1)	188
4	S	3				2	1	90	103.3	13.3	1.9 (1)	190

Note: 1) Temperature change per fan removed from service is calculated by the increase in fan inlet temperature above the base case. For 3 fan OOS case, the recirc for the base case is 7.7F. (14.2-7.7)/3 fans = 2.2F

Table 4-17: Train A Fan OOS Study: Comparison of Fan Temperature

Case	Wind	Total Fans OOS	No. of Fans OOS per Cell					Ambient	Fan Inlet	dT	dT per fan OOS (1)	Fan Flow
			Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	(F)	(F)	(F)	(F)	x1000 (cfm)
0	NE	0						90	95.6	5.6	n/a	163
1	NE	2				1	1	90	99.8	9.8	2.1	178
2	NE	3			1	1	1	90	103.9	13.9	2.8	183

Note: 1) Temperature change per fan removed from service is calculated by the increase in fan inlet temperature above the base case. For 3 fan OOS case, the recirc for the base case is 5.6F. (13.9-5.6)/3 fans = 2.8F

5.0 Conclusions

The scope of this report addresses a Computational Fluid Dynamics (CFD) investigation of recirculation flows for the Waterford3 Wet and Dry Cooling Towers under a range of temperature and wind conditions with a modification concept in place. The recirculation effect refers to the potential for the DCT or WCT to draw hotter exhaust side air into the inlet side, increasing the effective ambient temperature and reducing heat removal performance. The recirculation of the WCT and DCT affects the heat removal for the UHS. The proposed modification to the DCT structure consists of a deflector wall to maintain separation between the DCT inlet air and heated DCT exhaust air.

The complex flow field produced under accident condition DCT and WCT operation was evaluated using ANSYS CFX, a 3D CFD software package. ANSYS CFX is an appropriate method for evaluating the complex geometry and mix of buoyancy, wind, and fan driven flows. Model verification was accomplished through LPI software verification, two independent CFD calculations, as well as through sensitivity studies following the general guidelines of NUREG-2152. Model verification is described in Section 3.4.

The primary goal of the CFD study was to evaluate the recirculation effect at the DCT and WCT inlets. The DCT results were numerically evaluated to determine the degree of recirculation by querying the model for the area temperature for the 15 DCT fan inlet circular planes. The WCT recirculation was calculated by the recirculated mass flow with 100% humid air, the increase in WCT inlet temperature and the resulting increase in inlet wet bulb temperature. This study included a range of wind and temperature conditions and the effects of removing DCT fans from service. The results of this study are provided in Section 4.0.

In summary, a previous study of potential recirculation effects [22] for the current configuration showed that winds up to 19mph could produce recirculation effects of approximately 30F. Based on the results of this study, this would be reduced to a maximum of 6.9F for all wind conditions with the angle wall and 7.7F for the horizontal wall concept. Thus, both proposed deflector wall modification concepts will significantly improve performance and increase UHS margin.

6.0 References

1 Purchase Order 10478555-01.
2 Waterford 3 drawing 1564-G-160, Sheets 1-6, Flow Diagram, Component Closed Cooling Water System
3 CR-WF3-2012-2332, “Operability Evaluation”, 5/17/12
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   c. 1564-2947, Rev 6, “Tube Bundle Frame Detail Bank A”
   d. G138, Rev 20, “General Arrangement Reactor Auxiliary Bldg. Section-Sh1”
   e. G140, Rev 19, “General Arrangement Reactor Auxiliary Bldg. Section-Sh3”
   f. G142 Rev 19 , “General Arrangement Fuel Handling Building- Sections”
   g. G148 Rev 23, “General Arrangement Reactor Building – Section 3 – Sh 3”
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   i. G560 sht 2, Rev 11 Reactor Auxiliary Building Roof Slab at EL 69.00 Masonry Sh.2”
   j. G-707 sht 1 Rev 3, “Tornado Missile Protection Dry Cooling Towers SH1”
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   s. G499, sht4, Rev 10, “Common Foundation Structure Masonry”
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ATTACHMENT A

Derivation of CFD Model Inputs

Dry Cooling Towers

Discharge area through cooler tube assembly. Each coil features 2 banks of 9 panel areas 11.35ft wide by 4.7 to 5.06 ft tall per [9]

$$A_{exit} := 2\cdot\left[(11.35\cdot 5.06)ft^2 + 7(11.35\cdot 4.9)\,ft^2 + (11.35\cdot 4.71)ft^2\right] \qquad A_{exit} = 1000\,ft^2$$

DCT Parameters and Adjusted Velocity

gas constant [17] $R_{gas} := 287\cdot\frac{joule}{kg\cdot K}$ $R_{gas} = 2.06\times 10^4\cdot\frac{in\cdot lbf}{slug\cdot R}$

Define Fahrenheit scale $F := R$

Define in water gage pressure $inwg := \frac{1}{27.673}\cdot psi$

perfect gas density [17] $\rho(P,T) := \frac{P}{R_{gas}\cdot T}$ check $\rho[14.7\cdot psi,(96+460)\cdot R] = 0.0714\frac{lb}{ft^3}$

water properties (150F) $\rho_{wtr} := 61.2\cdot\frac{lb}{ft^3}$ $cp_{wtr} := 1\frac{BTU}{lb\cdot F}$

DCT Spec. Air flow $DCT_{air} := 196000\cdot\frac{ft^3}{min}$ Based on [5] Spec 1564.086, air flow at 103.9F

DCT mass flow $m_{air} := DCT_{air}\cdot\rho(14.7psi, 103.9F + 460R)$ $m_{air} = 229.88\frac{lb}{s}$

Air specific heat [17] $cp_{air} := 1007\frac{J}{kg\cdot K}$

The no slip boundary correction is determined through trial method from CFD results to ensure flow over region matches uniform area flow definition

Added no-slip boundary correction DCT outlet $SL_{out} := 0.1\frac{ft}{sec}$

Added no-slip boundary correction DCT inlet $SL_{in} := 0.8\frac{ft}{sec}$

Added no-slip boundary correction WCT inlet $WSL_{in} := .1\frac{ft}{sec}$

Four points are used to define 2 linear curves at 6500, 7500 gpm x 2 Tout values. Inputs in yellow areas only. Hudson products curves (lines) are parallel for a fixed flow at different Tdb, and they provide Q (10^6 BTU/hr) and R (range) vs. Tout. Tin and slopes are calculated within the spreadhseet.

DCT :=

Simplified DCT curve input				
GPM	6500	6500	7500	7500
Q	220	20	220	20
R	67.7	6.2	58.7	5.3
Tdb	80	80	80	80
Tout	131.5	84.5	136	85
Tin	199.2	90.7	194.7	90.3
Slope as a function of GPM			1.843	1.916
Y int as a function of GPM			-147.189	-152.989

Test values

$$Slope := \begin{pmatrix} DCT_{8,2} \\ DCT_{8,3} \end{pmatrix} \quad GPM := \begin{pmatrix} DCT_{0,0} \\ DCT_{0,2} \end{pmatrix} \quad T_{in1} := \begin{pmatrix} DCT_{6,0} \\ DCT_{6,2} \end{pmatrix} \quad Q := \begin{pmatrix} DCT_{1,0} \\ DCT_{1,2} \end{pmatrix}$$

$TDB1 := 102$

$G1 := 6900$

$i := 0..1$

Interpolate slope from gpm between 2 curves

$M(G) := linterp(GPM, Slope, G)$

Test functions

$M(G1) = 1.872$

Determine Y intercepts

$Y_i := Q_i - Slope_i \cdot T_{in1_i}$

$$Y = \begin{pmatrix} -147.19 \\ -152.99 \end{pmatrix}$$

Interpolate Y intercepts for gpm

$b(G) := linterp(GPM, Y, G)$

$b(G1) = -149.51$

Shift Y intercept for drybulb (slope constant)

$b1(G, Tdb) := b(G) + (80 - Tdb) \cdot M(G)$

$b1(G1, TDB1) = -190.7$

Write DCT heat function of Tin, Tdb, gpm

$Q_{dct}(G, Tin, Tdb) := (M(G) \cdot Tin + b1(G, Tdb)) \cdot 10^6$

$Q_{dct}(G1, 161, TDB1) = 110.74 \times 10^6$

Train A for all Horizontal Wall with 90F/30mph cases

Inlet conditions with recirculaiton $T_{in} := 90 + 8$ $T_{in} = 98$ deg F

DCT fan inlet volume flow $DCT_{air} := 160000 \cdot \frac{ft^3}{min}$

Determine heat removal by DCT using a maximum heat load of 148.14 MBTU/hr including fuel pool cooling plus 10 MBTU/hr axulairy loads [7] with 115F CCW. CCW temperature is provided by:

CCW Water temperature entering DCT $T_{CCW\_DCT} := 115F + \frac{158.2 \cdot 10^6 \cdot \frac{BTU}{hr}}{6900gpm \cdot \rho_{wtr} \cdot (cp_{wtr})}$ $T_{CCW\_DCT} = 161.71 \cdot F$ use 161.8F

DCT heat load $Q_{dct1} := Q_{dct}(6900, 161.8, T_{in}) \cdot 1 \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 48.61 \cdot F$

Outlet temperature $T_{out} := T_{in} F + dT$ $T_{out} = 146.61 \cdot F$ Use 147F for conservatism

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.065 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 8.79 \cdot \frac{ft}{s}$ Use 8.7ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0711 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 18.12 \cdot \frac{ft}{s}$ Use 18.5ft/s for conservatism

Wet Cooling Towers

Wet cooling tower flow conditions are based on the design fan performance [6]. Flow is factored down based on test data [7, Att B] showing current BHP ~26 compared to design BHP of 28.8. This is conservatively high compared to a similar study of fan curves and pressure losses through the inlet, fill, and drift eliminators showed flow of 52,000 cfm Ref. [JCA-WFD-031289], which includes a copy of the aerovent fan curves for 870 rpm 7 blade, 60" Vaneaxial fan, The blades set to 28degrees curve is interpolated between the 26 and 30 degree data. The "Vaneaxial" design includes flow straightening fins downstream of the fan to remove rotational velocity from the fan exit flow.

WCT Outlet Conditions

Design conditions
[6, spec 1564.114A]

$m' := 15494 \cdot \frac{lb}{min}$ $\rho_{in} := 0.07 \cdot \frac{lb}{ft^3}$

(each side, 4 fans)

Air flow based on tested motor BHP per fan power laws. The reduced flow rate is conservative.

$$WCT_{air} := \left[\frac{m'}{4\rho_{in}} \cdot \left(\frac{26}{28.8}\right)^{\frac{1}{3}}\right] \qquad WCT_{air} = 53.48 \times 10^3 \cdot \frac{ft^3}{min}$$

Outlet conditions

$HCW := 113.0F$ $CCW := 92.3F$ ACCW water temperature entering and leaving limit

$T_{in} := 98$ deg F — The UFSAR bounding case is used because it has the highest ambient temperature among all cases. For conservatism

$dT := 5$ — Assumed temperature gain

$T_{in} + dT = 103$

$Cp_{wtr} := 4178 \frac{J}{kg \cdot K}$ $\rho_{wtr} := 993 \frac{kg}{m^3}$ — Specific heat and density of water

$Q_{wtr} := 5350 \frac{gal}{min}$ — Accident ACCW flow rate [6]

$m_{airWCT} := 8WCT_{air} \cdot \rho[14.7psi, (103 + 460)R]$ $m_{airWCT} = 502.62 \cdot \frac{lb}{s}$

$m_{water} := Q_{wtr} \cdot \rho_{wtr} = 44335.38 \cdot \frac{lb}{min}$

$h_{in} := 43 \frac{BTU}{lb}$ — [Psychromatic chart, 24]
36%relative humidity is used based on CCW 89.3F [1564.114A]

$$h_{out} := h_{in} + \frac{m_{water} \cdot Cp_{wtr} \cdot (HCW - CCW)}{m_{airWCT}}$$

$h_{out} = 73.37 \cdot \frac{BTU}{lb}$ $T_{wct} := 105F$ — [Psychrometric chart, 24]

$T_{wct\_out} := 109F$ — Use 109F for conservatism

Fan area $A_{fan} := \frac{\pi}{4}\cdot(5ft)^2$ (each fan)

Exit velocity $V_{wct\_out} := \frac{WCT_{air}}{A_{fan}}$ $V_{wct\_out} = 45.4\cdot\frac{ft}{s}$

mass flow, total $m_{WCT\_air} := \rho(14.7psi, T_{wct\_out} + 460R)\cdot WCT_{air}$ $8m_{WCT\_air} = 497.32\cdot\frac{lb}{s}$

WCT Inlet Conditions

Fill area
[Ref 9: LOU1564 G499 S04]
$A_{main} := 18.67ft\cdot 20.5ft$ $A_{main} = 382.74\cdot ft^2$

Total WCT inlet area (2 towers) $A_{wct\_in} := 2\cdot(A_{main})$ $A_{wct\_in} = 765.47\cdot ft^2$

Inlet velocity $V_{wct\_in} := \frac{8\cdot m_{WCT\_air}}{\rho[14.7psi, (T_{in} + 1 + 460)R]\,A_{wct\_in}} + WSL_{in}$ $V_{wct\_in} = 9.25\cdot\frac{ft}{s}$

(use 9.3ft/s for conservatism)

Train A for all Horizontal Wall with 98F/10mph cases

Inlet conditions with recirculaiton $T_{in} := 98 + 4$ $T_{in} = 102$ deg F

DCT fan inlet volume flow $DCT_{air} := 160000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 161.8, T_{in}) \cdot 1 \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 45.89 \cdot F$

Outlet temperature $T_{out} := T_{in} F + dT$ $T_{out} = 147.89 \cdot F$ Use 148F for conservatism

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.065 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 8.75 \cdot \frac{ft}{s}$ Use 8.7ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0706 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 18.12 \cdot \frac{ft}{s}$ Use 18.5ft/s for conservatism

Train A for Horizontal Wall 102F/ no wind case

Inlet conditions with recirculaiton $T_{in} := 102 + 2$ $T_{in} = 104$ deg F

DCT fan inlet volume flow $DCT_{air} := 160000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 161.8, T_{in}) \cdot 1 \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in}F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 44.52 \cdot F$

Outlet temperature $T_{out} := T_{in}F + dT$ $T_{out} = 148.52 \cdot F$ Use 149F for conservatism

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.065 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 8.73 \cdot \frac{ft}{s}$ Use 8.7ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0704 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 18.12 \cdot \frac{ft}{s}$ Use 18.5ft/s for conservatism

Train B for all Horizontal Wall 90F/30mph Case

Inlet conditions with recirculaiton — $T_{in} := 90 + 8$ — $T_{in} = 98$ deg F

DCT fan inlet volume flow — $DCT_{air} := 180000 \cdot \frac{ft^3}{min}$

DCT heat load — $Q_{dct1} := Q_{dct}(6900, 161.8, T_{in}) \cdot 1 \frac{BTU}{hr}$

DCT fan mass flow — $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain — $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ — $dT = 43.21 \cdot F$

Outlet temperature — $T_{out} := T_{in} F + dT$ — $T_{out} = 141.21 \cdot F$ — Use 141.5F for conservatism

Exit density — $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ — $\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity — $V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ — $V_{out} = 9.79 \cdot \frac{ft}{s}$ — Use 9.7ft/s for conservatism

DCT Inlet Conditions

Fan inlet density — $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ — $\rho_{fan} = 0.0711 \cdot \frac{lb}{ft^3}$

Total fan area — $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ — $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity — $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ — $V_{in} = 20.29 \cdot \frac{ft}{s}$ — Use 20.5ft/s for conservatism

Train B for all Horizontal Wall 98F 10mph Case

Inlet conditions with recirculaiton $T_{in} := 98 + 4$ $T_{in} = 102$ deg F

DCT fan inlet volume flow $DCT_{air} := 180000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 161.8, T_{in}) \cdot 1 \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 40.79 \cdot F$

Outlet temperature $T_{out} := T_{in} F + dT$ $T_{out} = 142.79 \cdot F$ Use 143F for conservatism

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 9.75 \cdot \frac{ft}{s}$ Use 9.7ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0706 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 20.29 \cdot \frac{ft}{s}$ Use 20.5ft/s for conservatism

Train B for Horizontal Wall 102F 0mph case

Inlet conditions with recirculaiton $T_{in} := 102 + 2$ $T_{in} = 104$ deg F

DCT fan inlet volume flow $DCT_{air} := 180000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 161.8, T_{in}) \cdot 1 \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 39.57 \cdot F$

Outlet temperature $T_{out} := T_{in} F + dT$ $T_{out} = 143.57 \cdot F$ Use 144F for conservatism

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 9.73 \cdot \frac{ft}{s}$ Use 9.7ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0704 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 20.29 \cdot \frac{ft}{s}$ Use 20.5ft/s for conservatism

All Angle Wall Cases

Train A For North, South, East wind case and no wind case (case 2 to case 10)

Inlet conditions with recirculaiton $T_{in} := 97 + 5$ $T_{in} = 102$ deg F

DCT fan inlet volume flow $DCT_{air} := 180000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$

Note: angle wall cases were evaluated with a conservatively higher CCW inlet temperature of 163.5F

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in}F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 41.95 \cdot F$

Outlet temperature $T_{out} := T_{in}F + dT$ $T_{out} = 143.95 \cdot F$ Use 150F for conservatism

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 9.77 \cdot \frac{ft}{s}$ Use 9.75ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0706 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 20.29 \cdot \frac{ft}{s}$

Wet Cooling Towers

Wet cooling tower flow conditions are based on the design fan performance [6]. Flow is factored down based on test data [7, Att B] showing current BHP ~26 compared to design BHP of 28.8. This is conservatively high compared to a similar study of fan curves and pressure losses through the inlet, fill, and drift eliminators showed flow of 52,000 cfm Ref. [JCA-WFD-031289], which includes a copy of the aerovent fan curves for 870 rpm 7 blade, 60" Vaneaxial fan, The blades set to 28degrees curve is interpolated between the 26 and 30 degree data. The "Vaneaxial" design includes flow straightening fins downstream of the fan to remove rotational velocity from the fan exit flow.

WCT Outlet Conditions

Design conditions [6, spec 1564.114A] (each side, 4 fans)

$m' := 15494 \cdot \frac{lb}{min}$ $\rho_{in} := 0.07 \cdot \frac{lb}{ft^3}$

Air flow based on tested motor BHP per fan power laws

$WCT_{air} := \left[\frac{m'}{4\rho_{in}} \cdot \left(\frac{26}{28.8} \right)^{\frac{1}{3}} \right]$ $WCT_{air} = 53.48 \times 10^3 \cdot \frac{ft^3}{min}$

Outlet conditions

$HCW := 113.0F$ $CCW := 92.3F$ ACCW water temperature entering and leaving limit

$T_{in} := 102$ deg F — The UFSAR bounding case is used because it has the highest ambient temperature among all cases. For conservatism

$dT := 2$ — Assumed temperature gain

$T_{in} + dT = 104$

$Cp_{wtr} := 4178 \frac{J}{kg \cdot K}$ $\rho_{wtr} := 993 \frac{kg}{m^3}$ — Specific heat and density of water

$Q_{wtr} := 5350 \frac{gal}{min}$ — Accident ACCW flow rate [6]

$m_{airWCT} := 8WCT_{air} \cdot \rho[14.7psi, (104 + 460)R]$ $m_{airWCT} = 501.72 \cdot \frac{lb}{s}$

$m_{water} := Q_{wtr} \cdot \rho_{wtr} = 44335.38 \cdot \frac{lb}{min}$

$h_{in} := 43 \frac{BTU}{lb}$ — [Psychromatic chart, 24] 35%relative humidity is used based on CCW 89.3F [1564.114A]

$$h_{out} := h_{in} + \frac{m_{water} \cdot Cp_{wtr} \cdot (HCW - CCW)}{m_{airWCT}}$$

$h_{out} = 73.42 \cdot \frac{BTU}{lb}$ $T_{wct} := 104F$ — [Psychrometric chart, 24]

$T_{wct\_out} := 109F$ — Use 109F for conservatism

Fan area $A_{fan} := \frac{\pi}{4} \cdot (5ft)^2$ (each fan)

Exit velocity $V_{wct\_out} := \frac{WCT_{air}}{A_{fan}}$ $V_{wct\_out} = 45.4 \cdot \frac{ft}{s}$

45.7ft/s is used in the CFD model,which has a negligilble effect on the result.

mass flow, total $m_{WCT\_air} := \rho(14.7psi, T_{wct\_out} + 460R) \cdot WCT_{air}$ $8m_{WCT\_air} = 497.32 \cdot \frac{lb}{s}$

WCT Inlet Conditions

Fill area
[Ref 9: LOU1564 G499 S04]
$A_{main} := 18.67ft \cdot 20.5ft$ $A_{main} = 382.74 \cdot ft^2$

Total WCT inlet area (2 towers) $A_{wct\_in} := 2 \cdot (A_{main})$ $A_{wct\_in} = 765.47 \cdot ft^2$

Inlet velocity $V_{wct\_in} := \frac{8 \cdot m_{WCT\_air}}{\rho[14.7psi, (T_{in} + 1 + 460)R] A_{wct\_in}} + WSL_{in}$ $V_{wct\_in} = 9.32 \cdot \frac{ft}{s}$

(use 9.35ft/s for conservatism)

Train A case 1 (Angle Wall): North wind 76F 51mph

Inlet conditions with recirculaiton $T_{in} := 76 + 3$ $T_{in} = 79$ deg F

DCT fan inlet volume flow $DCT_{air} := 160000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in}F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 62.15 \cdot F$

Outlet temperature $T_{out} := T_{in}F + dT$ $T_{out} = 141.15 \cdot F$ Use 145F

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 9.02 \cdot \frac{ft}{s}$ Use 9ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0736 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 18.12 \cdot \frac{ft}{s}$

Train A case 11 (Angle Wall): Northeast wind 76F 51mph

Inlet conditions with recirculaiton $T_{in} := 76 + 8$ $T_{in} = 84$ deg F

DCT fan inlet volume flow $DCT_{air} := 180000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in}F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 52.46 \cdot F$

Outlet temperature $T_{out} := T_{in}F + dT$ $T_{out} = 136.46 \cdot F$ Use 140F for conservatism

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.067 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 9.96 \cdot \frac{ft}{s}$ Use 9.9ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0729 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 20.29 \frac{ft}{s}$

Train A case 12 (Angle Wall): Northeast wind 81F 40mph

Inlet conditions with recirculaiton $T_{in} := 81 + 8$ $T_{in} = 89$ deg F

DCT fan inlet volume flow $DCT_{air} := 180000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 49.62 \cdot F$

Outlet temperature $T_{out} := T_{in} F + dT$ $T_{out} = 138.62 \cdot F$ Use 140F

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 9.91 \cdot \frac{ft}{s}$ Use 9.9ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0723 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 20.29 \cdot \frac{ft}{s}$

Train A case 13 (Angle Wall): Northeast wind 86F 29mph

Inlet conditions with recirculaiton	$T_{in} := 86 + 8$	$T_{in} = 94$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 180000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in}F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 46.72 \cdot F$	
Outlet temperature	$T_{out} := T_{in}F + dT$	$T_{out} = 140.72 \cdot F$	Use 145F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 9.86 \cdot \frac{ft}{s}$	Use 9.8ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0716 \cdot \frac{lb}{ft^3}$
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 20.29 \cdot \frac{ft}{s}$

Train A case 14 (Angle Wall): Northeast wind 91F 26mph

Inlet conditions with recirculaiton $T_{in} := 91 + 8$ $T_{in} = 99$ deg F

DCT fan inlet volume flow $DCT_{air} := 183000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 43.04 \cdot F$

Outlet temperature $T_{out} := T_{in} F + dT$ $T_{out} = 142.04 \cdot F$ Use 145F

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 9.95 \cdot \frac{ft}{s}$ Use 9.9ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.071 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 20.613 \cdot \frac{ft}{s}$ Use 20.7ft/s

Train A case 15 (Angle Wall): Northeast wind 97F 11mph

Inlet conditions with recirculaiton	$T_{in} := 97 + 5$	$T_{in} = 102$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 190000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 39.74 \cdot F$	
Outlet temperature	$T_{out} := T_{in} F + dT$	$T_{out} = 141.74 \cdot F$	Use 145F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.27 \cdot \frac{ft}{s}$	Use 10.2ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0706 \cdot \frac{lb}{ft^3}$
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 21.37 \cdot \frac{ft}{s}$

Train A case 16 (Angle Wall): Southeast wind 89F 22mph

Inlet conditions with recirculaiton	$T_{in} := 89 + 8$	$T_{in} = 97$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 190000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 42.58 \cdot F$	
Outlet temperature	$T_{out} := T_{in} F + dT$	$T_{out} = 139.58 \cdot F$	Use 145F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.32 \cdot \frac{ft}{s}$	Use 10.2ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0712 \cdot \frac{lb}{ft^3}$
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 21.37 \cdot \frac{ft}{s}$

Train B case 1 (Angle Wall): North wind 76F 51mph

Inlet conditions with recirculaiton	$T_{in} := 76 + 3$	$T_{in} = 79$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 180000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 55.25 \cdot F$	
Outlet temperature	$T_{out} := T_{in} F + dT$	$T_{out} = 134.25 \cdot F$	Use 135F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.067 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.02 \cdot \frac{ft}{s}$	Use 9.95ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0736 \cdot \frac{lb}{ft^3}$
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 20.29 \cdot \frac{ft}{s}$

Train B case 2 (Angle Wall): West 88F 19mph

Inlet conditions with recirculaiton: $T_{in} := 88 + 8$ $\quad T_{in} = 96$ deg F

DCT fan inlet volume flow: $DCT_{air} := 190000 \cdot \frac{ft^3}{min}$

DCT heat load: $Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$

DCT fan mass flow: $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain: $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $\quad dT = 43.15 \cdot F$

Outlet temperature: $T_{out} := T_{in} F + dT$ $\quad T_{out} = 139.15 \cdot F$ $\quad$ Use 140F

Exit density: $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\quad \rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity: $V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $\quad V_{out} = 10.33 \cdot \frac{ft}{s}$ $\quad$ Use 10.3ft/s for conservatism

DCT Inlet Conditions

Fan inlet density: $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\quad \rho_{fan} = 0.0714 \cdot \frac{lb}{ft^3}$

Total fan area: $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $\quad A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity: $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $\quad V_{in} = 21.37 \cdot \frac{ft}{s}$

Train B case 3 (Angle Wall): South 88F 26.5mph

Inlet conditions with recirculaiton	$T_{in} := 88 + 8$	$T_{in} = 96$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 190000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in}F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 43.15 \cdot F$	
Outlet temperature	$T_{out} := T_{in}F + dT$	$T_{out} = 139.15 \cdot F$	Use 140F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.33 \cdot \frac{ft}{s}$	Use 10.3ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0714 \cdot \frac{lb}{ft^3}$
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 21.37 \cdot \frac{ft}{s}$

Train B case 4 (Angle Wall): Northwest wind 76F 51mph

Inlet conditions with recirculaiton	$T_{in} := 76 + 8$	$T_{in} = 84$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 190000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in}F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 49.7 \cdot F$	
Outlet temperature	$T_{out} := T_{in}F + dT$	$T_{out} = 133.7 \cdot F$	Use 135F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.067 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.46 \cdot \frac{ft}{s}$	Use 10.4ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0729 \cdot \frac{lb}{ft^3}$
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 21.37 \cdot \frac{ft}{s}$

Train B case 5 (Angle Wall): Northwest wind 82F 40mph

Inlet conditions with recirculaiton	$T_{in} := 82 + 8$	$T_{in} = 90$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 185000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 47.72 \cdot F$	
Outlet temperature	$T_{out} := T_{in} F + dT$	$T_{out} = 137.72 \cdot F$	Use 140F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.15 \cdot \frac{ft}{s}$	Use 10.1ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0722 \cdot \frac{lb}{ft^3}$	
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$	
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 20.83 \cdot \frac{ft}{s}$	Use 20.9ft/s

Train B case 6 (Angle Wall): Northwest wind 88F 29mph

Inlet conditions with recirculaiton	$T_{in} := 88 + 8$	$T_{in} = 96$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 190000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in}F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 43.15 \cdot F$	
Outlet temperature	$T_{out} := T_{in}F + dT$	$T_{out} = 139.15 \cdot F$	Use 140F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.33 \cdot \frac{ft}{s}$	Use 10.3ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0714 \cdot \frac{lb}{ft^3}$
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 21.37 \cdot \frac{ft}{s}$

Train B case 7 (Angle Wall): Northwest wind 92F 26mph

Inlet conditions with recirculaiton	$T_{in} := 92 + 8$	$T_{in} = 100$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 190000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 40.89 \cdot F$	
Outlet temperature	$T_{out} := T_{in} F + dT$	$T_{out} = 140.89 \cdot F$	Use 145F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.29 \cdot \frac{ft}{s}$	Use 10.2ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0709 \cdot \frac{lb}{ft^3}$	
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$	
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 21.37 \cdot \frac{ft}{s}$	

Train B case 8 (Angle Wall): Northwest wind 97F 10mph

Inlet conditions with recirculaiton $T_{in} := 97 + 5$ $T_{in} = 102$ deg F

DCT fan inlet volume flow $DCT_{air} := 190000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 39.74 \cdot F$

Outlet temperature $T_{out} := T_{in} F + dT$ $T_{out} = 141.74 \cdot F$ Use 145F

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 10.27 \cdot \frac{ft}{s}$ Use 10.2ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.0706 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 21.37 \cdot \frac{ft}{s}$

Train B case 9 (Angle Wall): Southwest wind 88F 26.5mph

Inlet conditions with recirculaiton	$T_{in} := 88 + 8$	$T_{in} = 96$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 190000 \cdot \frac{ft^3}{min}$		
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 43.15 \cdot F$	
Outlet temperature	$T_{out} := T_{in} F + dT$	$T_{out} = 139.15 \cdot F$	Use 140F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.33 \cdot \frac{ft}{s}$	Use 10.3ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0714 \cdot \frac{lb}{ft^3}$
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 21.37 \cdot \frac{ft}{s}$

Train B case 10 (Angle Wall): Southwest wind 96F 10mph

Inlet conditions with recirculaiton $T_{in} := 96 + 3$ $T_{in} = 99$ deg F

DCT fan inlet volume flow $DCT_{air} := 190000 \cdot \frac{ft^3}{min}$

DCT heat load $Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$

Temperature gain $dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$ $dT = 41.45 \cdot F$

Outlet temperature $T_{out} := T_{in} F + dT$ $T_{out} = 140.45 \cdot F$ Use 145F

Exit density $\rho_{out} := \rho(14.7psi, T_{out} + 460R)$ $\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$

Exit velocity $V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$ $V_{out} = 10.3 \cdot \frac{ft}{s}$ Use 10.2ft/s for conservatism

DCT Inlet Conditions

Fan inlet density $\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$ $\rho_{fan} = 0.071 \cdot \frac{lb}{ft^3}$

Total fan area $A_{in} := \frac{\pi}{4} \cdot (14ft)^2$ $A_{in} = 153.9 \cdot ft^2$

Fan inlet velocity $V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$ $V_{in} = 21.37 \cdot \frac{ft}{s}$

Train B case 11 (Angle Wall): 102F no wind case

Inlet conditions with recirculaiton	$T_{in} := 102 + 1$	$T_{in} = 103$ deg F	
DCT fan inlet volume flow	$DCT_{air} := 190000 \cdot \frac{ft^3}{min}$		Based on [5] Spec 1564.086, air flow at 103.9F
DCT heat load	$Q_{dct1} := Q_{dct}(6900, 163.5, T_{in}) \frac{BTU}{hr}$		
DCT fan mass flow	$m_{air} := DCT_{air} \cdot \rho(14.7psi, T_{in} F + 460R)$		
Temperature gain	$dT := \frac{Q_{dct1}}{m_{air} \cdot cp_{air} \cdot 15}$	$dT = 39.17 \cdot F$	
Outlet temperature	$T_{out} := T_{in} F + dT$	$T_{out} = 142.17 \cdot F$	Use 145F
Exit density	$\rho_{out} := \rho(14.7psi, T_{out} + 460R)$	$\rho_{out} = 0.066 \cdot \frac{lb}{ft^3}$	
Exit velocity	$V_{out} := \frac{3 m_{air}}{\rho_{out} \cdot A_{exit}} + SL_{out}$	$V_{out} = 10.26 \cdot \frac{ft}{s}$	Use 10.2ft/s for conservatism

DCT Inlet Conditions

Fan inlet density	$\rho_{fan} := \rho[14.7psi, (T_{in} + 460)R]$	$\rho_{fan} = 0.0705 \cdot \frac{lb}{ft^3}$
Total fan area	$A_{in} := \frac{\pi}{4} \cdot (14ft)^2$	$A_{in} = 153.9 \cdot ft^2$
Fan inlet velocity	$V_{in} := \frac{m_{air}}{\rho_{fan} \cdot A_{in}} + SL_{in}$	$V_{in} = 21.37 \cdot \frac{ft}{s}$

DCT Outlet Temperature Study With Changing Heat Load

This calculation supports the evaluation of DCT recirculation performance with changing heat load. The exit air temperature from the DCT is determined as follows. Containment and auxiliary heat loads over time are added to the CCW water at a nominal temperature of 115F to determine CCW inlet temperature to the DCT. The DCT performance curves are used to determine the heat removal to the air, and this is used to increase inlet air temperature.

All heat loads and DCT performance models are obtained from LPI A13326-R-003 [7].

Define index $last := 1000 \quad i := 0 .. last$

Define fluid properties $F := R \qquad \rho_{wtr} := 62 \frac{lb}{ft^3} \qquad cp_{wtr} := 1 \frac{BTU}{lb \cdot F}$

Define air properaties $\rho_{air} := .075 \frac{lb}{ft^3} \qquad cp_{air} := 1007 \frac{J}{kg \cdot K}$

Define cold leg break and Fuel Pool loads (from [7] LOCA Loads.xmcdz)

CLB :=

Index	Time (sec)	BTU/sec at 112F	BTU/sec at 115F	BTU/sec at 120F
0	1.0646E+01	3.9844E+04	3.9045E+04	3.7717E+04
1	1.0846E+01	3.9920E+04	3.9120E+04	3.7792E+04
2	1.1060E+01	3.9992E+04	3.9192E+04	3.7863E+04
3	1.1282E+01	4.0056E+04	3.9256E+04	3.7927E+04
4	1.1570E+01	4.0128E+04	3.9327E+04	3.7997E+04
5	1.1770E+01	4.0170E+04	3.9370E+04	3.8039E+04
6	1.1970E+01	4.0203E+04	3.9403E+04	3.8072E+04
7	1.2170E+01	4.0227E+04	3.9427E+04	3.8095E+04
8	1.2370E+01	4.0242E+04	3.9442E+04	3.8110E+04
9	1.2570E+01	4.0249E+04	3.9449E+04	3.8117E+04
10	1.2770E+01	4.0248E+04	3.9448E+04	3.8117E+04

FP :=

hours	Time (sec)	MBTU/hr
0	0.000	0
5.99	21564	0
6	21600	16.7
24	86400	16.5
48	172800	16.3
72	259200	16.1
96	345600	15.9
120	432000	15.7
144	518400	15.5
168	604800	15.4
192	691200	15.2

Define double interpolation function for containment heat loads (Time x Temperature) for CLB load.

$$Q_{LOCA}(Tm, T) := \begin{array}{|l} X \leftarrow CLB \\ Temp_0 \leftarrow 112 \\ Temp_1 \leftarrow 115 \\ Temp_2 \leftarrow 120 \\ Q_0 \leftarrow linterp\left(X^{\langle 1 \rangle}, X^{\langle 2 \rangle} \cdot 3600, Tm\right) \\ Q_1 \leftarrow linterp\left(X^{\langle 1 \rangle}, X^{\langle 3 \rangle} \cdot 3600, Tm\right) \\ Q_2 \leftarrow linterp\left(X^{\langle 1 \rangle}, X^{\langle 4 \rangle} \cdot 3600, Tm\right) \\ QC \leftarrow linterp(Temp, Q, max(T, 112)) \end{array}$$

Define curve fit function

$$FPL(Tm) := linterp\left(FP^{\langle 1 \rangle}, FP^{\langle 2 \rangle}, Tm\right) \cdot 10^6$$

Define time range for evaluation of transient conditions

Show selected values

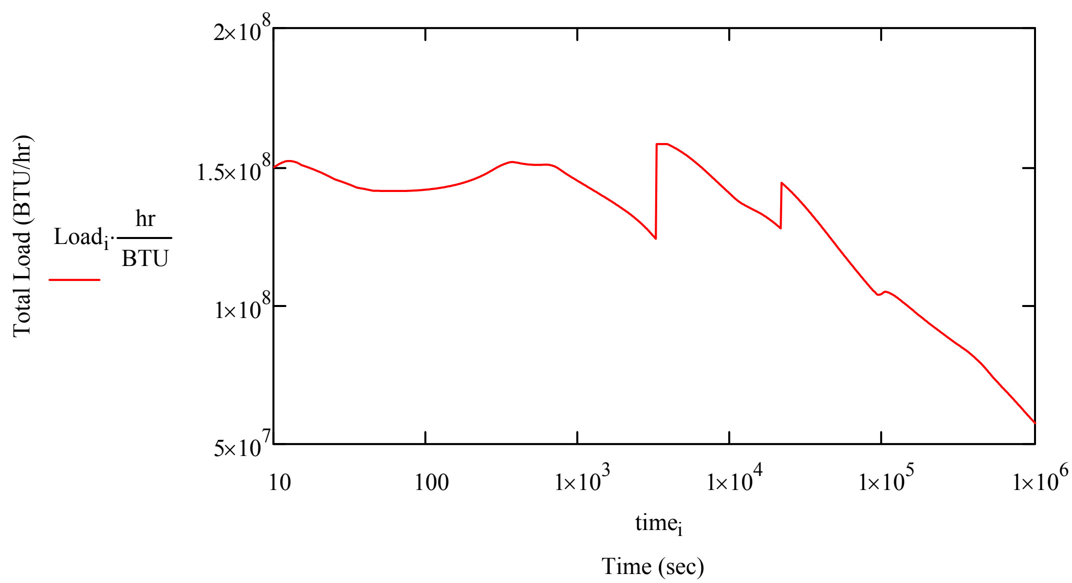
$$time_i := 10sec \cdot 10^{\frac{i}{200}}$$

$time_0 = 10\,s \quad time_1 = 10.12\,s \quad time_{last} = 1 \times 10^6\,s$

Add LOCA and Fuel pool heat loads and include 10MBTU/hr auxiliary loads

$$Load_i := 10 \cdot 10^6 \cdot \frac{BTU}{hr} + Q_{LOCA}\left(\frac{time_i}{sec}, 115\right) \cdot \frac{BTU}{hr} + FPL\left(\frac{time_i}{sec}\right) \cdot \frac{BTU}{hr}$$

Plot Load with time



Show selected values

$max(Load) = 158.12 \times 10^6 \cdot \frac{BTU}{hr}$ max heat load

$Load_{last} = 57.46 \times 10^6 \cdot \frac{BTU}{hr}$ final heat load

CCW Water temperature entering DCT

$$TDCT_i := 115F + \frac{Load_i}{6900gpm \cdot \rho_{wtr} \cdot (cp_{wtr})}$$

$max(TDCT) = 161.08 \cdot F$

$TDCT_{last} = 131.74 \cdot F$

Define DCT Outlet air temperature

Inlet conditions with recirculaiton $T_{in} := 102 + 0$ $T_{in} = 102$ deg F

DCT fan inlet volume flow $DCT_{air} := 180000 \cdot \frac{ft^3}{min}$

$$Q_{dct1_i} := Q_{dct}\left(6900, \frac{TDCT_i}{F}, T_{in}\right) \frac{BTU}{hr}$$

DCT fan mass flow $m_{air} := DCT_{air} \cdot \rho_{air}$

Temperature gain $dT_i := \frac{Q_{dct1_i}}{m_{air} \cdot cp_{air} \cdot 15}$

dT = (·F)

	0
0	36.4
1	36.4
2	36.4
3	36.5
4	36.5
5	...

Outlet temperature $T_{out} := T_{in} F + dT$

T_{out} = (·F)

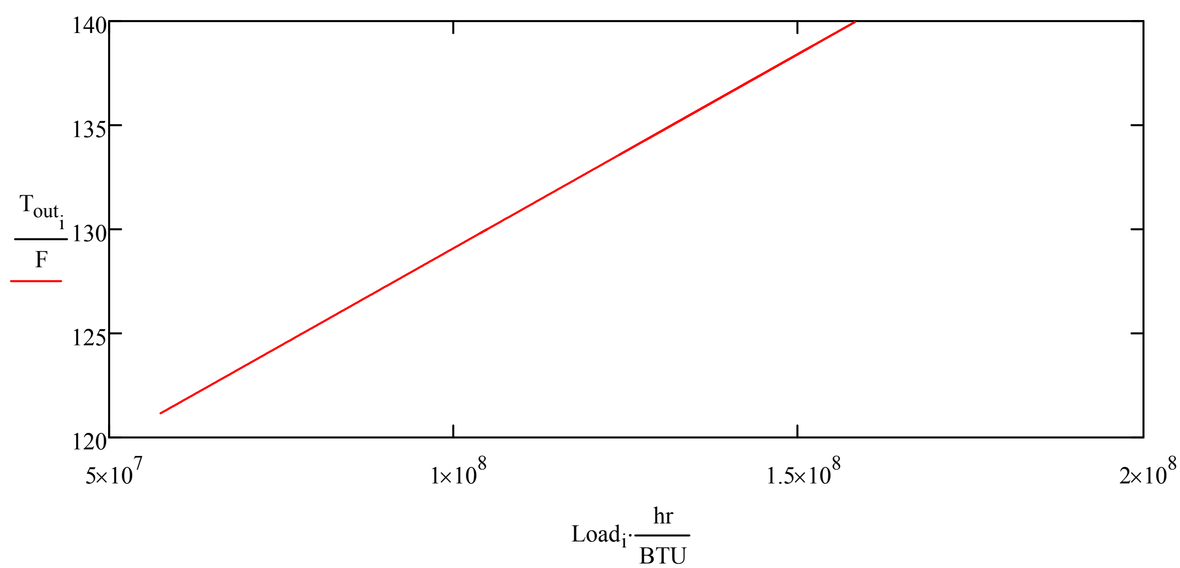
	0
0	138.4
1	138.4
2	138.4
3	138.5
4	138.5
5	...

Show selected results

$\max(T_{out}) = 139.95 \cdot F$ max

$T_{out_{last}} = 121.15 \cdot F$ min

Plot DCT outlet temperatures



Fan Out of Service (OOS) Calculation for Angle Wall Calculation

When a DCT fan is inoperable, hot exhaust air can back flow through the DCT fan opening due to higher pressure on the discharge side compared to the suction side. Below shows a calculation of how much backflow the DCT fan would experience during fan OOS. This calculation is based on the relationship between velocity and pressure drop.

The pressure drop and flow rate are based on test case [20, Att F]

$dP := 0.611\,\mathrm{inwg}$ $\quad dP = 0.0221\,\mathrm{psi}$

$m_{fan} := 181000\,\frac{ft^3}{min}$

Area of radiator OOS (6 openings)

$A_{radOOS} := 333.ft^2$

Back flow density and velocity at rad OOS

$V_{radOOS} := \frac{m_{fan}}{A_{radOOS}}$ $\quad V_{radOOS} = 9.06\,\frac{ft}{s}$

$\rho_{OOS} := \rho[14.7psi,(140+460)F]$ $\quad \rho_{OOS} = 0.0661\,\frac{lb}{ft^3}$

Loss coefficient with the corresponding dP

$k_{OOS} := \frac{dP}{0.5\cdot\rho_{OOS}\cdot V_{radOOS}^2}$ $\quad k_{OOS} = 37.69$

For NW wind fan OOS case

$P_{fan} := -0.025psi$ $\quad P_{rad} := -0.015psi$

The static pressure drop based on CFX model with one fan OOS in a cell

$P_{tot} := P_{rad} - P_{fan}$ $\quad P_{tot} = 0.01\,\mathrm{psi}$

$m_{radOOS} := \rho_{OOS}\cdot A_{radOOS}\sqrt{\frac{2P_{tot}}{k_{OOS}\cdot\rho_{OOS}}}$ $\quad m_{radOOS} = 134.27\,\frac{lb}{s}$

Backflow velocity when DCT fan is taken OOS

$V_{fanOOS} := \frac{m_{radOOS}}{\rho_{OOS}\cdot\frac{\pi}{4}\cdot(14ft)^2}$ $\quad V_{fanOOS} = 13.19\,\frac{ft}{s}$ (Use 13.5ft/s for conservatism)

In the case of 2 fan OOS on the same cell, 1 fan is operating while 2 fans are off within the cell. The flow rate in the cell is half of 1 fan OOS. Therefore, the total pressure drop would decrease.

The static pressure drop based on CFX model with two fan OOS in a cell

$P_{tot} := (P_{rad} - P_{fan})\cdot\sqrt{0.5}$ $\quad$ Half of the flow rate

$m_{radOOS} := \rho_{OOS}\cdot A_{radOOS}\sqrt{\frac{2P_{tot}}{k_{OOS}\cdot\rho_{OOS}}}$ $\quad m_{radOOS} = 112.91\,\frac{lb}{s}$

Backflow velocity when DCT fan is taken OOS

$V_{fanOOS} := \frac{m_{radOOS}}{\rho_{OOS}\cdot\frac{\pi}{4}\cdot(14ft)^2}$ $\quad V_{fanOOS} = 11.09\,\frac{ft}{s}$ (Use 11.5ft/s for conservatism)

Average Fan Temperature Approximation with Fan OOS for Angle Wall Concept

This section provides an estimation of temperature increase with 1, 2, 3 fan OOS. This estimation is developed for comparison (only) to the CFD results. No design information is developed in this section.

$$DCT_{air} := 190000 \frac{ft^3}{min}$$

Fan flowrate at 88F

$$m_{air} := DCT_{air} \cdot \rho[14.7psi, (88F + 460R)] \qquad m_{air} = 229.31 \frac{lb}{s}$$

Reverse flow based on 14ft/s

$$m_{reverse} := \rho[14.7psi, (88F + 460R)] \cdot \frac{\pi}{4} \cdot (14ft)^2 \cdot \left(13.5 \frac{ft}{s}\right) \qquad m_{reverse} = 150.49 \cdot \frac{lb}{s}$$

Fan temperature below fan OOS

$$fant := \frac{m_{reverse} \cdot 140F + \left(m_{air} - m_{reverse}\right) \cdot 88F}{m_{air}} \qquad fant = 122.13 \cdot F$$

Assuming no recirculation and fan OOS were taken at different cells

Overall average fan temperature with 1 fan OOS

$$DCT_{fantemp} := \frac{88F \cdot 13 + fant}{14} \qquad DCT_{fantemp} = 90.44 \cdot F$$

Overall average fan temperature with 2 fan OOS

$$DCT_{fantemp} := \frac{88F \cdot 11 + fant \cdot 2}{13} \qquad DCT_{fantemp} = 93.25 \cdot F$$

Overall average fan temperature with 3 fan OOS

$$DCT_{fantemp} := \frac{88F \cdot 9 + fant \cdot 3}{12} \qquad DCT_{fantemp} = 96.53 \cdot F$$

approximately 3F per fan OOS

The average fan temperature due to fan OOS with 2 fan OOS per cell

2 fan OOS per cell

Overall average fan temperature with 2 fan OOS

$$DCT_{fantemp} := \frac{88F \cdot 12 + 140F}{13} \qquad DCT_{fantemp} = 92 \cdot F$$

3 Fan OOS (2 fan OOS in one cell, 1 fan OOS was on different cell

Overall average fan temperature with 3 fan OOS

$$DCT_{fantemp} := \frac{88F \cdot 10 + fant + 140F}{12} \qquad DCT_{fantemp} = 95.18 \cdot F$$

approximately 3F per fan OOS

Train A Fan Out of Service (OOS) Calculation for Horizontal Wall Calculation

When a DCT fan is inoperable, hot exhaust air would back flow through the DCT fan opening due to higher pressure on the radiator side. Below shows a calculation of how much backflow the DCT fan would experience during fan OOS. This calculation is based on the relationship between velocity and pressure drop.

The pressure drop and flow rate are based on test case [20, Att A]

$dP := 0.611\,inwg$ $\quad dP = 0.0221\,psi$

$m_{fan} := 181000\,\frac{ft^3}{min}$

Area of radiator OOS (6 openings)

$A_{radOOS} := 333.ft^2$

Back flow density and velocity at rad OOS

$V_{radOOS} := \frac{m_{fan}}{A_{radOOS}}$ $\quad V_{radOOS} = 9.06\,\frac{ft}{s}$

$\rho_{OOS} := \rho[14.7psi, (140 + 460)F]$ $\quad \rho_{OOS} = 0.0661\,\frac{lb}{ft^3}$

Loss coefficient with the corresponding dP

$k_{OOS} := \frac{dP}{0.5 \cdot \rho_{OOS} \cdot V_{radOOS}^2}$ $\quad k_{OOS} = 37.69$

For S wind fan OOS case

$P_{fan} := -0.0119psi$ $\quad P_{rad} := 0.00249psi$ see Fan OOS results, Section 4.4

The static pressure drop based on CFX model with one fan OOS in a cell

$P_{tot} := P_{rad} - P_{fan}$ $\quad P_{tot} = 0.01439\,psi$

$m_{radOOS} := \rho_{OOS} \cdot A_{radOOS} \sqrt{\frac{2P_{tot}}{k_{OOS} \cdot \rho_{OOS}}}$ $\quad m_{radOOS} = 161.07\,\frac{lb}{s}$

Backflow velocity when DCT fan is taken OOS

$V_{fanOOS} := \frac{m_{radOOS}}{\rho_{OOS} \cdot \frac{\pi}{4} \cdot (14ft)^2}$ $\quad V_{fanOOS} = 15.82\,\frac{ft}{s}$ (Use 16.2ft/s for conservatism)

Train B Fan Out of Service (OOS) Calculation for Horizontal Wall Calculation

When a DCT fan is inoperable, hot exhaust air would back flow through the DCT fan opening due to higher pressure on the radiator side. Below shows a calculation of how much backflow the DCT fan would experience during fan OOS. This calculation is based on the relationship between velocity and pressure drop.

The pressure drop and flow rate are based on test case [20]

$dP := 0.611 \text{inwg}$ $\qquad dP = 0.0221 \text{ psi}$

$m_{fan} := 181000 \dfrac{ft^3}{min}$

Area of radiator OOS (6 openings)

$A_{radOOS} := 333.ft^2$

Back flow density and velocity at rad OOS

$V_{radOOS} := \dfrac{m_{fan}}{A_{radOOS}}$ $\qquad V_{radOOS} = 9.06 \dfrac{ft}{s}$

$\rho_{OOS} := \rho[14.7psi, (140 + 460)F]$ $\qquad \rho_{OOS} = 0.0661 \dfrac{lb}{ft^3}$

Loss coefficient with the corresponding dP

$k_{OOS} := \dfrac{dP}{0.5 \cdot \rho_{OOS} \cdot V_{radOOS}^2}$ $\qquad k_{OOS} = 37.69$

For S wind fan OOS case

$P_{fan} := -0.01726psi$ $\qquad P_{rad} := -0.00159psi$ see Fan OOS results, Section 4.4

The static pressure drop based on CFX model with one fan OOS in a cell

$P_{tot} := P_{rad} - P_{fan}$ $\qquad P_{tot} = 0.01567 \text{ psi}$

$m_{radOOS} := \rho_{OOS} \cdot A_{radOOS} \sqrt{\dfrac{2P_{tot}}{k_{OOS} \cdot \rho_{OOS}}}$ $\qquad m_{radOOS} = 168.08 \dfrac{lb}{s}$

Backflow velocity when DCT fan is taken OOS

$V_{fanOOS} := \dfrac{m_{radOOS}}{\rho_{OOS} \cdot \frac{\pi}{4} \cdot (14ft)^2}$ $\qquad V_{fanOOS} = 16.51 \dfrac{ft}{s}$ (Use 16.9ft/s for conservatism)

In the case of 2 fan OOS on the same cell, 1 fan is operating while 2 fans are off within the cell. The flow rate in the cell is half of 1 fan OOS. Therefore, the total pressure drop would decrease.

The static pressure drop based on CFX model with two fan OOS in a cell

$P_{tot} := (P_{rad} - P_{fan}) \cdot \sqrt{0.5}$ $\qquad$ Half of the flow rate

$m_{radOOS} := \rho_{OOS} \cdot A_{radOOS} \sqrt{\dfrac{2P_{tot}}{k_{OOS} \cdot \rho_{OOS}}}$ $\qquad m_{radOOS} = 141.34 \dfrac{lb}{s}$

Backflow velocity when DCT fan is taken OOS

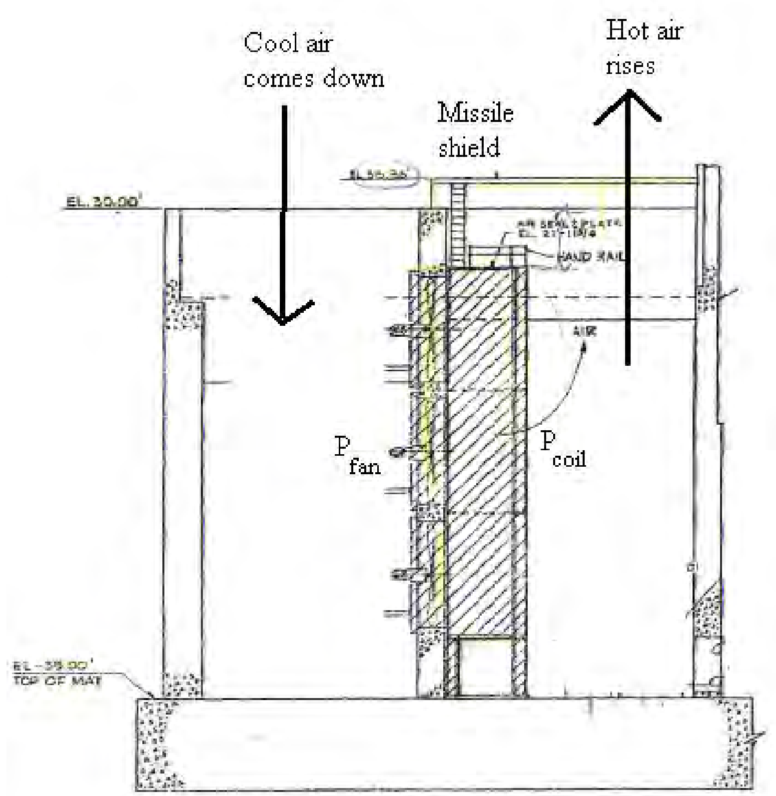
$V_{fanOOS} := \dfrac{m_{radOOS}}{\rho_{OOS} \cdot \frac{\pi}{4} \cdot (14ft)^2}$ $\qquad V_{fanOOS} = 13.88 \dfrac{ft}{s}$ (Use 14.3ft/s for conservatism)

Fan Flowrate Example Calculation

This section provides an example of the calculation of fan flowrate based on CFX pressure results and the fan curve. The fan pressure gain provides the pressure difference between the fan inlet and the coil outlet, which are sampled from CFX. A buoyancy term is also credited to reduce the pressure developed by the fan, i.e. increase flow.

This section is provided only to demonstrate the methodology.

Consider the 102F, Train A case 11



Model Inputs

Pressure at fan per CFX $P_{fan} := -0.00205\text{psi}$

Pressure at coil per CFX $P_{coil} := 0.01511\text{psi}$

Reference height (Height between MS and coil) $h_{ms} := 30\text{ft}$

Density at 149F outlet (see A-8) $\rho_{149} := \rho[14.695\text{psi}, (149 + 460)\text{R}]$ $\rho_{149} = 0.065\,\frac{\text{lb}}{\text{ft}^3}$

Density at 102F $\rho_{102} := \rho[14.695\text{psi}, (102 + 460)\text{R}]$ $\rho_{102} = 0.0706\,\frac{\text{lb}}{\text{ft}^3}$

Fan Flowrate Example Calculation: 102F and 0mph

Buoyancy term (Hydrostatic pressure) $P_{buo} := \left(\rho_{102} - \rho_{149}\right) \cdot g \cdot h_{ms}$ $P_{buo} = 0.03 \cdot inwg$

Pressure gain across fan without coil loss $P_{gain} := \left(P_{coil} - P_{fan} - P_{buo}\right)$ $P_{gain} = 0.44 \cdot inwg$

Coil Characteristics

Coil pressure drop [20] $P_{fs} := 0.615 inwg$

at fan flow of [20] based on startup testing $Q_{fs} := 186000$ in cfm

Seed values for solver $Q_{fan} := 160000$ in cfm

$P_{fanflow} := 1.2$ in wg

Given

Total pressure loss $$P_{fanflow} = \frac{P_{gain}}{inwg} + \frac{P_{fs}}{inwg} \cdot \left(\frac{Q_{fan}}{Q_{fs}}\right)^2$$

Fan curve $$P_{fanflow} = -7.381 \cdot 10^{-12} Q_{fan}^{2} - 3.2808 \cdot 10^{-7} \cdot Q_{fan} + 1.1966$$

$$X := Find\left(P_{fanflow}, Q_{fan}\right)$$

$$X = \begin{pmatrix} 937 \times 10^{-3} \\ 166.6 \times 10^{3} \end{pmatrix}$$

Fan pressure gain in wg

Fan flowrate in cfm

DCT and WCT porous properties

This section determines the loss coefficient and porosity of the pipe and steel structure. Those loss coefficient and porosity are input into the CFD analysis. Complex beam and pipe structure below walkway is approximated as a porous region with a loss coefficient as described below.

Beam drag coefficient [17] $C_d := 2.05$

Steel beam depth approximate, per walkdown $D_s := 1\,\text{ft}$

Open area for 3 bays between steel columns [9]. See also photo from walkdown

Length between walls

$$L_{open} := \sqrt{(22\text{ft} + 12\text{ft})^2 + (21.5\text{ft})^2} + 10\text{ft}$$

$$L_{open} = 50.23\ \text{ft}$$

Elevation from floor to walkway

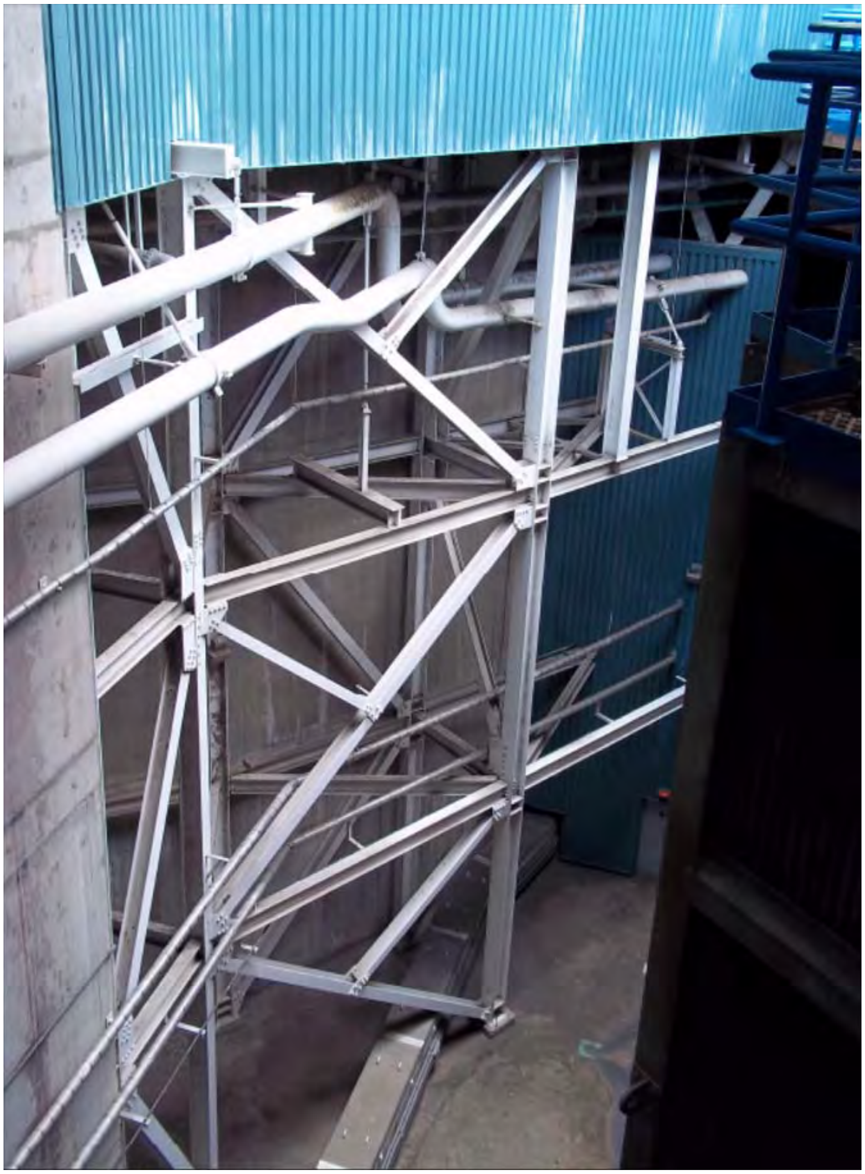
$$H_{open} := (21 - -35)\cdot\text{ft}$$

$$H_{open} = 56\ \text{ft}$$

Open area

$$A_{open} := L_{open}\cdot H_{open}$$

$$A_{open} = 2.81 \times 10^3\ \text{ft}^2$$



Beam areas obstructing flow [9]. See also walkdown photo

18x20 Angle braces $L_{ang} := 4.5 \cdot \sqrt{18.7^2 + 20^2}$

18x10 angle braces $L_{ang2} := 3 \cdot \sqrt{18.7^2 + 10^2}$

20 ft horizontals $L_{20h} := 4 \cdot 20$

10ft horz $L_{10h} := 3 \cdot 10$

columns $L_{col} := 2 \cdot 56 + 18.7$

Pipe $A_{pipe} := (2ft) \cdot 60ft$

Steel area $A_{steel} := \left(L_{ang} + L_{ang2} + L_{20h} + L_{10h} + L_{col}\right) \cdot ft \cdot D_s$

$$Poro := \frac{\left(A_{open} - A_{steel} - A_{pipe}\right)}{A_{open}} \qquad Poro = 0.805$$

$$K_{net} := C_d \cdot \left(\frac{A_{steel} + A_{pipe}}{A_{open}}\right)^2 \qquad K_{net} = 0.08$$

The loss coefficient scaling factor based on area^2 is intended to apply a local loss coefficient for a small flow area to a larger flow area (see Crane Eq 3-24), which would be based on (A1/A2)^2. However, since a conservative Cd value of 2.05 from a range of 1.6-2.05 (Blevins) was used, any variation in loss is expected to be bounded by this range.

Missile shield porous

This section determines the porosity and loss coefficient for the missile shield [10, Idelchick].

Grating geometry: .25" and .375" bars spaced 1.625" x 2" per [9] and walkdown

$W := 1.625\text{in}$ $\quad bar1 := 0.375\text{in}$ $\quad H := 7\text{in}$

$L := 2\text{in}$ $\quad bar2 := 0.25\text{in}$

Open area $\quad (L - bar2)\cdot(W - bar1) = 2.19\cdot\text{in}^2$

Total area $\quad L\cdot W = 3.25\cdot\text{in}^2$

Ratio $\quad fr := \dfrac{(L - bar2)\cdot(W - bar1)}{L\cdot W}$ $\quad fr = 0.67$ $\quad$ Open area ratio

Roughness $\quad \lambda := .034$ $\quad$ [Crane - rough walled duct]

$\tau := 0$ $\quad$ [Idelchik]

hydraulic diameter [Belvins, 17] $\quad d_h := \dfrac{4\cdot[(L - bar2)\cdot(W - bar1)]}{2\cdot[(L - bar2) + (W - bar1)]}$ $\quad d_h = 1.46\cdot\text{in}$

Grating loss coefficient [10]

$$K_{gr} := \left[.5\,(1 - fr)^{0.75} + \tau\cdot(1 - fr)^{1.375} + (1 - fr)^2 + \frac{\lambda\cdot H}{d_h}\right] \qquad K_{gr} = 0.49$$

Loss Coefficient per unit thickness $\quad K_{loss} := \dfrac{K_{gr}}{7\text{in}}$ $\quad K_{loss} = 0.83\cdot\dfrac{1}{\text{ft}}$

Test k value

$\lambda := .02$

$\tau := 1.22$

$H := 0.2in$ $\quad d_h := 1in$ $\quad fr := 0.5$

$\frac{H}{d_h} = 0.2$

$$K_{gr} := \frac{\left[.5(1-fr)^{0.75} + \tau\cdot(1-fr)^{1.375} + (1-fr)^2 + \frac{\lambda\cdot H}{d_h}\right]}{fr^2} \qquad K_{gr} = 4.09 \qquad \text{OK}$$

Train A WCT walkway

This section determine the loss coefficient and porosity at the WCT walkway

spacing = 1"x4" with .25" bars, 1" depth [5] $\quad l := 1in$

$\lambda := .034$ friction factor [Blevins, 17]

$A_{gr} := .75in\cdot 3.75in$ opening area

$A_{total} := 1in\cdot 4in$

$P_{gr} := 2\cdot(.75in + 3.75in)$ grid perimeter

$d_h := \frac{4\cdot A_{gr}}{P_{gr}}$ $\quad d_h = 1.25\cdot in$

$f := \frac{A_{gr}}{A_{total}}$ $\quad f = 0.7$ Porosity

$l_{eq} := \frac{l}{d_h}$ $\quad l_{eq} = 0.8$ $\quad \tau := 0.42$ Diagram 8-3 [10]

$$K_{gr} := \left[.5(1-f)^{0.75} + \tau\cdot(1-f)^{1.375} + (1-f)^2 + \frac{\lambda\cdot l}{d_h}\right] \qquad K_{gr} = 0.4$$

Loss coefficient [10]

$K_{wct} := \frac{K_{gr}}{0.5ft}$ $\quad K_{wct} = 0.79\frac{1}{ft}$

Wet Bulb Temperature Calculation

WCT recirculation is calculated by the increase in wet bulb temperature over the ambient condition. The wet bulb temperature is calulated from the temperature at the fill inlet and the increased moisture content due to the mass of air reccirculated from the WCT which is considered to be at 100% humidity. This calculation is as follows.

Example conditions to test functions, below. Inlet temperature and recirculated mass flow are obtained from CFD results, reported in Section 4. This calculation shows conditions for Train A, Case 11.

$T_{amb} := 102$ — Ambient drybulb temp (input Case 11)

$\phi_{amb} := 50\%$ — Ambient relative humidity (input Case 11)

$m_{air} := 506 \cdot \frac{lb}{sec}$ — Mass flow of air into WCT (input Case 11)

$T_{in} := 102.4$ — WCT inlet temperature (Table 4-6)

$m_{recirc} := 18 \cdot \frac{lb}{sec}$ — Recirc mass (Table 4-6)

$x := \frac{m_{recirc}}{m_{air}}$ $\quad x = 0.04$ — % recirculation

ASHRAE [23] equations for moist air, note T = abs

6.2 EQ6

$C_8 := -1.0440397 \cdot 10^{4}$ $\quad C_{10} := -2.7022355 \cdot 10^{-2}$ $\quad C_{12} := -2.4780681 \cdot 10^{-9}$

$C_9 := -1.1294650 \cdot 10^{1}$ $\quad C_{11} := 1.2890360 \cdot 10^{-5}$ $\quad C_{13} := 6.5459673 \cdot 1$

$$p_{ws}(T) := e^{\left[\frac{C_8}{(T+459.7)}+C_9+C_{10}\cdot(T+459.7)+C_{11}\cdot(T+459.7)^2+C_{12}\cdot(T+459.7)^3+C_{13}\cdot\ln(T+459.7)\right]}$$

$p_{ws}(T_{amb}) = 1.01$

6.2 EQ24 $\quad p_w(T,\phi) := p_{ws}(T)\cdot\phi$ $\quad p_w(T_{amb},\phi_{amb}) = 0.5$

6.2 EQ22 $\quad W(T,\phi) := 0.62198\cdot\left(\frac{p_w(T,\phi)}{14.7 - p_w(T,\phi)}\right)$ $\quad W(T_{amb},\phi_{amb}) = 0.022$

estimate $\quad T_{wb} := 77$

Given $\quad$ 6.2 EQ 35, humidity ratio based on Twb and Tdb

$$W(T_{amb},\phi_{amb}) = \frac{[1093 - .556(T_{wb})]\cdot W(T_{wb},100\%) - .240\cdot(T_{amb} - T_{wb})}{1093 + .444(T_{amb}) - (T_{wb})}$$

$TWB(T_{amb},\phi_{amb}) := Find(T_{wb})$ $\quad TWB(T_{amb},\phi_{amb}) = 84.871$ — Wet bulb temperature based on ambient

moisture increase with recirc

$W_{new}(T_{amb},\phi_{amb},x,T_{in}) := \min[W(T_{in},100\%),(1 + x)\cdot W(T_{amb},\phi_{amb})]$ $\quad W_{new}(T_{amb},\phi_{amb},x,T_{in}) = 0.023$

Given 6.2 EQ 35, humidity ratio based on Twb and Tin

$$W_{new}(T_{amb}, \phi_{amb}, x, T_{in}) = \frac{(1093 - .556T_{wb})\cdot W(T_{wb}, 100\%) - .240\cdot(T_{in} - T_{wb})}{1093 + .444(T_{in}) - (T_{wb})}$$

$TWBR(T_{amb}, \phi_{amb}, x, T_{in}) := Find(T_{wb})$ $TWBR(T_{amb}, \phi_{amb}, x, T_{in}) = 85.662$ Wet bulb temperature with recirc

Therefore, the recirculation is provided by: which matches Case 11, 50% RH condition $TWBR(T_{amb}, \phi_{amb}, x, T_{in}) - (TWB(T_{amb}, \phi_{amb})) = 0.8$

THis calculation is repeated for a range of RH conditions at one ambient temperature, using the data in the following table. In this case, the bounding B train (Case 4) results are shown.

Data :=

TDB	RH	M_rec	T_in	M_tot
90	50	131	107.3	495
90	60	131	107.3	495
90	70	131	107.3	495
90	80	131	107.3	495
90	90	131	107.3	495
90	100	131	107.3	495

RH is an independent variable. Recirc mass, inlet temperature and total mass flow are obtained fromthe CFD results, table 4-11

Define index $i := 0 .. 5$

$TDB := Data^{\langle 0 \rangle}$ Dry bulb temperature

$RH := Data^{\langle 1 \rangle}\cdot\%$ Relative humidity

$M_{rec} := Data^{\langle 2 \rangle}\cdot\frac{lb}{sec}$ WCT mass recirculation

$Tin := Data^{\langle 3 \rangle}$ WCT inlet temperature (average between tower 1 and 2)

$M_{air} := Data^{\langle 4 \rangle}\cdot\frac{lb}{sec}$ Air mass flow

$Twb_i := TWB(TDB_i, RH_i)$ Wet bulb temperature without recirc

$Twbr_i := TWBR\left(TDB_i, RH_i, \frac{M_{rec_i}}{M_{air_i}}, Tin_i\right)$ Wet bulb temperature with recirc

Results of calculation

$$\mathrm{Twb} = \begin{pmatrix} 74.9 \\ 78.34 \\ 81.54 \\ 84.54 \\ 87.35 \\ 90 \end{pmatrix}$$

Wet bulb temperature without recirc

$$\mathrm{Twbr} = \begin{pmatrix} 83.3 \\ 86.86 \\ 90.16 \\ 93.24 \\ 96.11 \\ 98.81 \end{pmatrix}$$

Wet bulb temperature with recirc

$$\mathrm{Twbr} - \mathrm{Twb} = \begin{pmatrix} 8.4 \\ 8.5 \\ 8.6 \\ 8.7 \\ 8.8 \\ 8.8 \end{pmatrix}$$

WCT wet bulb temperature recirc

Results proviced in Table 4-11

ATTACHMENT B

Example CFX Output File

Example input file (Train B S 90F 30mph Horizontal wall case)

```
This run of the CFX-14.0 Solver started at 08:25:07 on 18 Jul 2016 by
 user LWong on DELL-T7500-4 (intel_xeon64.sse2_winnt) using the command:

  "C:\Program Files\ANSYS Inc\v140\CFX\bin\perllib\cfx5solve.pl" -batch
    -def
    "C:\Users\lwong\Desktop\Waterford3 CFD\Batch run\Train B S 90F 30mph closed mod.def"
    -par-local -partition 5

 Setting up CFX Solver run ...


 +--------------------------------------------------------------------+
 |                                                                    |
 |                   CFX Command Language Upgrade                     |
 |                                                                    |
 +--------------------------------------------------------------------+

 Added /SIMULATION CONTROL/EXECUTION CONTROL/EXECUTABLE SELECTION/Double
 Precision = Off.


 +--------------------------------------------------------------------+
 |                                                                    |
 |                   CFX Command Language for Run                     |
 |                                                                    |
 +--------------------------------------------------------------------+

 LIBRARY:
   CEL:
     EXPRESSIONS:
       FT1 = areaAve(Temperature)@REGION:fan inlet 1
       FT10 = areaAve(Temperature)@REGION:fan inlet 10
       FT11 = areaAve(Temperature)@REGION:fan inlet 11
       FT12 = areaAve(Temperature)@REGION:fan inlet 12
       FT13 = areaAve(Temperature)@REGION:fan inlet 13
       FT14 = areaAve(Temperature)@REGION:fan inlet 14
       FT15 = areaAve(Temperature)@REGION:fan inlet 15
       FT2 = areaAve(Temperature)@REGION:fan inlet 2
       FT3 = areaAve(Temperature)@REGION:fan inlet 3
       FT4 = areaAve(Temperature)@REGION:fan inlet 4
       FT5 = areaAve(Temperature)@REGION:fan inlet 5
       FT6 = areaAve(Temperature)@REGION:fan inlet 6
       FT7 = areaAve(Temperature)@REGION:fan inlet 7
       FT8 = areaAve(Temperature)@REGION:fan inlet 8
       FT9 = areaAve(Temperature)@REGION:fan inlet 9
       FTAVG = areaAve(Temperature)@ fan inlet
       Pwct1 = areaAve(Total Pressure )@WCT inlet 1
       Pwct2 = areaAve(Total Pressure )@WCT inlet 2
       Pwctout = areaAve(Total Pressure )@WCT outlet
       WCT inlet vel = 9.3 [ft/s]
       WCT outlet temp = 109.0 [F]
       WCT outlet vel = 45.4 [ft/s]
       WCT temp1 = areaAve(Temperature )@REGION:WCT inlet 1
       WCT temp2 = areaAve(Temperature )@REGION:WCT inlet 2
       addvar1 = massFlowInt(dummy)@REGION:WCT inlet 1
       addvar2 = massFlowInt(dummy)@REGION:WCT inlet 2
       amb temp = 90.0 [F]
       fan inlet vel = 20.5 [ft/s]
       massinlet = massFlow()@South wind + massFlow()@Outlet
       pfan = areaAve(Total Pressure )@fan inlet
       pms = areaAve(Total Pressure )@intftop Side 1
       prad = areaAve(Total Pressure )@radiator
       radiator temp = 141.5 [F]
       radiator vel = 9.7 [ft/s]
       tscale = 15[s] * step(100 - citern) + 15[s]* step(200 - 100) - 14.5[s] \
         * step(citern - 200)
       windangle = 45.0 [deg]
       xwind = 30.0 [mile hr^-1]
       ywind = 30.0 [mile hr^-1]
     END
   END
   ADDITIONAL VARIABLE: dummy
     Option = Definition
     Tensor Type = SCALAR
     Units = [ ]
     Variable Type = Specific
   END
   MATERIAL: Air Ideal Gas
     Material Description = Air Ideal Gas (constant Cp)
     Material Group = Air Data, Calorically Perfect Ideal Gases
     Option = Pure Substance
     Thermodynamic State = Gas
     PROPERTIES:
       Option = General Material
       EQUATION OF STATE:
```

```
        Molar Mass = 28.96 [kg kmol^-1]
        Option = Ideal Gas
      END
      SPECIFIC HEAT CAPACITY:
        Option = Value
        Specific Heat Capacity = 1.0044E+03 [J kg^-1 K^-1]
        Specific Heat Type = Constant Pressure
      END
      REFERENCE STATE:
        Option = Specified Point
        Reference Pressure = 1 [atm]
        Reference Specific Enthalpy = 0. [J/kg]
        Reference Specific Entropy = 0. [J/kg/K]
        Reference Temperature = 25 [C]
      END
      DYNAMIC VISCOSITY:
        Dynamic Viscosity = 1.831E-05 [kg m^-1 s^-1]
        Option = Value
      END
      THERMAL CONDUCTIVITY:
        Option = Value
        Thermal Conductivity = 2.61E-2 [W m^-1 K^-1]
      END
      ABSORPTION COEFFICIENT:
        Absorption Coefficient = 0.01 [m^-1]
        Option = Value
      END
      SCATTERING COEFFICIENT:
        Option = Value
        Scattering Coefficient = 0.0 [m^-1]
      END
      REFRACTIVE INDEX:
        Option = Value
        Refractive Index = 1.0 [m m^-1]
      END
    END
  END
END
FLOW: Flow Analysis 1
  SOLUTION UNITS:
    Angle Units = [rad]
    Length Units = [m]
    Mass Units = [kg]
    Solid Angle Units = [sr]
    Temperature Units = [K]
    Time Units = [s]
  END
  ANALYSIS TYPE:
    Option = Steady State
    EXTERNAL SOLVER COUPLING:
      Option = None
    END
  END
  DOMAIN: Fluid
    Coord Frame = Coord 0
    Domain Type = Fluid
    Location = B6301
    BOUNDARY: Fluid Default
      Boundary Type = WALL
      Location = \
        F14401.6301,F14402.6301,F14403.6301,F14404.6301,F14405.6301,F14406.63\
        01,F14408.6301,F14410.6301,F14637.6301,F14643.6301,F14644.6301,F14645\
        .6301,F14648.6301,F14649.6301,F14650.6301,F14651.6301,F14653.6301,F14\
        654.6301,F14656.6301,F14657.6301,F14658.6301,F14660.6301,F14661.6301,\
        F14662.6301,F14664.6301,F14665.6301,F14666.6301,F14667.6301,F14668.63\
        01,F14669.6301,F14670.6301,F14671.6301,F14672.6301,F14673.6301,F14674\
        .6301,F14675.6301,F14676.6301,F14914.6301,F15067.6301,F15068.6301,F15\
        069.6301,F15070.6301,F15071.6301,F15072.6301,F15142.6301,F15182.6301,\
        F15534.6301,F15535.6301,F15536.6301,F15537.6301,F15539.6301,F15540.63\
        01,F15541.6301,F15625.6301,F15626.6301,F15627.6301,F15628.6301,F15629\
        .6301,F15630.6301,F15631.6301,F15632.6301,F15633.6301,F15846.6301,F15\
        848.6301,F15849.6301,F15897.6301,F15898.6301,F15899.6301,F15900.6301,\
        F15960.6301,F15961.6301,F15962.6301,F15963.6301,F15964.6301,F15965.63\
        01,F15966.6301,F16009.6301,F16010.6301,F16011.6301,F16344.6301,F16345\
        .6301,F16346.6301,F16347.6301,F16348.6301,F16356.6301,F16379.6301,F16\
        381.6301,F16382.6301,F16383.6301,F16584.6301,F16586.6301,F16623.6301,\
        F16624.6301,F16625.6301,F17823.6301,F17824.6301,F17825.6301,F17826.63\
        01,F17827.6301,F17828.6301,F17837.6301,F17838.6301,F17847.6301,F17848\
        .6301,F17850.6301,F17851.6301,F17854.6301,F17855.6301,F17856.6301,F17\
        857.6301,F17858.6301,F17859.6301,F17867.6301,F17870.6301,F17871.6301,\
        F17872.6301,F18289.6301,F18365.6301,F18366.6301,F18367.6301,F18368.63\
        01,F18373.6301,F18374.6301,F18375.6301,F18376.6301,F18377.6301,F18378\
        .6301,F18481.6301,F18483.6301,F18484.6301,F18485.6301,F18486.6301,F18\
        487.6301,F18488.6301,F18489.6301,F18490.6301,F18491.6301,F18492.6301,\
        F18493.6301,F6286.6301,F6287.6301,F6291.6301,F6297.6301,F6304.6301,F6\
        305.6301,F6306.6301,F6307.6301,F6308.6301,F6309.6301,F6310.6301,F6311\
        .6301,F6313.6301,F6315.6301,F6318.6301,F6319.6301,F6320.6301,F6321.63\
        01,F6322.6301,F6323.6301,F6324.6301,F6325.6301,F6326.6301,F6327.6301,\
```

```
    F6328.6301,F6329.6301,F6330.6301,F6331.6301,F6334.6301,F6335.6301,F63\
    36.6301,F6337.6301,F6338.6301,F6340.6301,F6342.6301,F6343.6301,F6344.\
    6301,F6345.6301,F6346.6301,F6347.6301,F6348.6301,F6349.6301,F6350.630\
    1,F6351.6301,F6352.6301,F6353.6301,F6354.6301,F6355.6301,F6356.6301,F\
    6358.6301,F6359.6301,F6360.6301,F6361.6301,F6362.6301,F6363.6301,F636\
    4.6301,F6365.6301,F6368.6301,F6369.6301,F6370.6301,F6371.6301,F6372.6\
    301,F6373.6301,F6374.6301,F6376.6301,F6377.6301,F6379.6301,F6381.6301\
    ,F6382.6301,F6383.6301,F6384.6301,F6385.6301,F6386.6301,F6387.6301,F6\
    388.6301,F6389.6301,F6390.6301,F6391.6301,F6393.6301,F6398.6301,F6399\
    .6301,F6400.6301,F6401.6301,F6402.6301,F6403.6301,F6404.6301,F6405.63\
    01,F6408.6301,F6410.6301,F6412.6301,F6413.6301,F6414.6301,F6415.6301,\
    F6416.6301,F6417.6301,F6418.6301,F6419.6301,F6420.6301,F6421.6301,F64\
    22.6301,F6423.6301,F6424.6301,F6425.6301,F6427.6301,F6428.6301,F6429.\
    6301,F6430.6301,F6431.6301,F6432.6301,F6433.6301,F6434.6301,F6435.630\
    1,F6437.6301,F6438.6301,F6439.6301,F6440.6301,F6441.6301,F6442.6301,F\
    6443.6301,F6444.6301,F6445.6301,F6446.6301,F6447.6301,F6448.6301,F644\
    9.6301,F6450.6301,F6451.6301,F6452.6301,F6453.6301,F6454.6301,F6455.6\
    301,F6456.6301,F6457.6301,F6458.6301,F6459.6301,F6460.6301,F6461.6301\
    ,F6462.6301,F6463.6301,F6464.6301,F6465.6301,F6466.6301,F6467.6301,F6\
    468.6301,F6470.6301,F7350.6301,F7351.6301,F7352.6301,F7353.6301
  BOUNDARY CONDITIONS:
    HEAT TRANSFER:
      Option = Adiabatic
    END
    MASS AND MOMENTUM:
      Option = No Slip Wall
    END
    WALL ROUGHNESS:
      Option = Smooth Wall
    END
  END
END
BOUNDARY: Outlet
  Boundary Type = OPENING
  Location = North
  BOUNDARY CONDITIONS:
    ADDITIONAL VARIABLE: dummy
      Additional Variable Value = 0 []
      Option = Value
    END
    FLOW DIRECTION:
      Option = Normal to Boundary Condition
    END
    FLOW REGIME:
      Option = Subsonic
    END
    HEAT TRANSFER:
      Option = Static Temperature
      Static Temperature = amb temp
    END
    MASS AND MOMENTUM:
      Option = Opening Pressure and Direction
      Relative Pressure = 0 [psi]
    END
    TURBULENCE:
      Option = Low Intensity and Eddy Viscosity Ratio
    END
  END
END
BOUNDARY: South wind
  Boundary Type = INLET
  Location = East,West,South
  BOUNDARY CONDITIONS:
    ADDITIONAL VARIABLE: dummy
      Additional Variable Value = 0 []
      Option = Value
    END
    FLOW REGIME:
      Option = Subsonic
    END
    HEAT TRANSFER:
      Option = Static Temperature
      Static Temperature = amb temp
    END
    MASS AND MOMENTUM:
      Option = Cartesian Velocity Components
      U = 0 [ft s^-1]
      V = ywind
      W = 0 [ft s^-1]
    END
    TURBULENCE:
      Option = Low Intensity and Eddy Viscosity Ratio
    END
  END
END
BOUNDARY: Top
  Boundary Type = OPENING
  Location = Top
```

```
  BOUNDARY CONDITIONS:
    ADDITIONAL VARIABLE: dummy
      Additional Variable Value = 0 []
      Option = Value
    END
    FLOW REGIME:
      Option = Subsonic
    END
    HEAT TRANSFER:
      Option = Static Temperature
      Static Temperature = amb temp
    END
    MASS AND MOMENTUM:
      Option = Entrainment
      Relative Pressure = 0 [psi]
    END
    TURBULENCE:
      Option = Zero Gradient
    END
  END
END
BOUNDARY: WCT inlet 1
  Boundary Type = OUTLET
  Location = WCT inlet 1
  BOUNDARY CONDITIONS:
    FLOW REGIME:
      Option = Subsonic
    END
    MASS AND MOMENTUM:
      Normal Speed = WCT inlet vel
      Option = Normal Speed
    END
  END
END
BOUNDARY: WCT inlet 2
  Boundary Type = OUTLET
  Location = WCT inlet 2
  BOUNDARY CONDITIONS:
    FLOW REGIME:
      Option = Subsonic
    END
    MASS AND MOMENTUM:
      Normal Speed = WCT inlet vel
      Option = Normal Speed
    END
  END
END
BOUNDARY: WCT outlet
  Boundary Type = INLET
  Location = WCT outlet 1,WCT outlet 2,WCT outlet 3,WCT outlet 4,WCT \
    outlet 5,WCT outlet 6,WCT outlet 7,WCT outlet 8
  BOUNDARY CONDITIONS:
    ADDITIONAL VARIABLE: dummy
      Additional Variable Value = 1 []
      Option = Value
    END
    FLOW REGIME:
      Option = Subsonic
    END
    HEAT TRANSFER:
      Option = Static Temperature
      Static Temperature = WCT outlet temp
    END
    MASS AND MOMENTUM:
      Normal Speed = WCT outlet vel
      Option = Normal Speed
    END
    TURBULENCE:
      Option = Medium Intensity and Eddy Viscosity Ratio
    END
  END
END
BOUNDARY: fan inlet
  Boundary Type = OUTLET
  Location = fan inlet 1,fan inlet 10,fan inlet 11,fan inlet 12,fan \
    inlet 13,fan inlet 14,fan inlet 15,fan inlet 2,fan inlet 3,fan inlet \
    4,fan inlet 5,fan inlet 6,fan inlet 7,fan inlet 8,fan inlet 9
  BOUNDARY CONDITIONS:
    FLOW REGIME:
      Option = Subsonic
    END
    MASS AND MOMENTUM:
      Normal Speed = fan inlet vel
      Option = Normal Speed
    END
  END
END
BOUNDARY: intfbtm Side 1
```

```
  Boundary Type = INTERFACE
  Location = fldbtm
  BOUNDARY CONDITIONS:
    ADDITIONAL VARIABLE: dummy
      Option = Conservative Interface Flux
    END
    HEAT TRANSFER:
      Option = Conservative Interface Flux
    END
    MASS AND MOMENTUM:
      Option = Conservative Interface Flux
    END
    TURBULENCE:
      Option = Conservative Interface Flux
    END
  END
END
BOUNDARY: intftop Side 1
  Boundary Type = INTERFACE
  Location = fldtop
  BOUNDARY CONDITIONS:
    ADDITIONAL VARIABLE: dummy
      Option = Conservative Interface Flux
    END
    HEAT TRANSFER:
      Option = Conservative Interface Flux
    END
    MASS AND MOMENTUM:
      Option = Conservative Interface Flux
    END
    TURBULENCE:
      Option = Conservative Interface Flux
    END
  END
END
BOUNDARY: radiator
  Boundary Type = INLET
  Location = radiator 1 1,radiator 1 2,radiator 1 3,radiator 1 \
    4,radiator 1 5,radiator 1 6,radiator 1 7,radiator 1 8,radiator 1 \
    9,radiator 2 1,radiator 2 2,radiator 2 3,radiator 2 4,radiator 2 \
    5,radiator 2 6,radiator 2 7,radiator 2 8,radiator 2 9,radiator \
    34,radiator 56,radiator 78,radiator 910
  BOUNDARY CONDITIONS:
    ADDITIONAL VARIABLE: dummy
      Additional Variable Value = 0 []
      Option = Value
    END
    FLOW REGIME:
      Option = Subsonic
    END
    HEAT TRANSFER:
      Option = Static Temperature
      Static Temperature = radiator temp
    END
    MASS AND MOMENTUM:
      Normal Speed = radiator vel
      Option = Normal Speed
    END
    TURBULENCE:
      Option = Medium Intensity and Eddy Viscosity Ratio
    END
  END
END
DOMAIN MODELS:
  BUOYANCY MODEL:
    Buoyancy Reference Density = 0.0711219 [lb ft^-3]
    Gravity X Component = 0 [ft s^-2]
    Gravity Y Component = 0 [ft s^-2]
    Gravity Z Component = -9.81 [m s^-2]
    Option = Buoyant
    BUOYANCY REFERENCE LOCATION:
      Option = Automatic
    END
  END
  DOMAIN MOTION:
    Option = Stationary
  END
  MESH DEFORMATION:
    Option = None
  END
  REFERENCE PRESSURE:
    Reference Pressure = 1 [atm]
  END
END
FLUID DEFINITION: Fluid 1
  Material = Air Ideal Gas
  Option = Material Library
  MORPHOLOGY:
```

```
      Option = Continuous Fluid
    END
  END
  FLUID MODELS:
    ADDITIONAL VARIABLE: dummy
      Option = Transport Equation
    END
    COMBUSTION MODEL:
      Option = None
    END
    HEAT TRANSFER MODEL:
      Option = Total Energy
    END
    THERMAL RADIATION MODEL:
      Option = None
    END
    TURBULENCE MODEL:
      Option = SST
      BUOYANCY TURBULENCE:
        Option = Production and Dissipation
      END
    END
    TURBULENT WALL FUNCTIONS:
      High Speed Model = Off
      Option = Automatic
    END
  END
  INITIALISATION:
    Option = Automatic
    INITIAL CONDITIONS:
      Velocity Type = Cartesian
      ADDITIONAL VARIABLE: dummy
        Option = Automatic
      END
      CARTESIAN VELOCITY COMPONENTS:
        Option = Automatic with Value
        U = 0 [ft s^-1]
        V = ywind
        W = 0 [ft s^-1]
      END
      STATIC PRESSURE:
        Option = Automatic
      END
      TEMPERATURE:
        Option = Automatic
      END
      TURBULENCE INITIAL CONDITIONS:
        Option = Low Intensity and Eddy Viscosity Ratio
      END
    END
  END
END
DOMAIN: porous
  Coord Frame = Coord 0
  Domain Type = Porous
  Location = \
    B17451,B17424,B17438,B17439,B17440,B17441,B17442,B17443,B17444,B17445,B\
    17446,B17447,B17448,B17449,B17450
  BOUNDARY: intfbtm Side 2
    Boundary Type = INTERFACE
    Location = prsbtm
    BOUNDARY CONDITIONS:
      ADDITIONAL VARIABLE: dummy
        Option = Conservative Interface Flux
      END
      HEAT TRANSFER:
        Option = Conservative Interface Flux
      END
      MASS AND MOMENTUM:
        Option = Conservative Interface Flux
      END
      TURBULENCE:
        Option = Conservative Interface Flux
      END
    END
  END
  BOUNDARY: intftop Side 2
    Boundary Type = INTERFACE
    Location = prstop
    BOUNDARY CONDITIONS:
      ADDITIONAL VARIABLE: dummy
        Option = Conservative Interface Flux
      END
      HEAT TRANSFER:
        Option = Conservative Interface Flux
      END
      MASS AND MOMENTUM:
        Option = Conservative Interface Flux
```

```
    END
    TURBULENCE:
      Option = Conservative Interface Flux
    END
  END
END
BOUNDARY: porous Default
  Boundary Type = WALL
  Location = \
    F17426.17424,F17427.17424,F17428.17444,F17429.17448,F17430.17446,F174\
    31.17424,F17432.17424,F17433.17448,F17434.17443,F17435.17438,F17436.1\
    7447,F17437.17445,F17452.17438,F17453.17438,F17454.17438,F17457.17444\
    ,F17458.17444,F17459.17444,F17461.17445,F17462.17445,F17463.17445,F17\
    464.17446,F17465.17446,F17466.17446,F17469.17447,F17470.17447,F17471.\
    17447,F17473.17448,F17474.17448,F17475.17448,F17476.17448,F17477.1744\
    8,F17478.17449,F17479.17449,F17480.17449,F17481.17450,F17482.17450,F1\
    7483.17450,F17484.17451,F17485.17451,F17486.17451,F17487.17439,F17488\
    .17439,F17489.17439,F17490.17440,F17491.17440,F17492.17440,F17493.174\
    41,F17494.17441,F17495.17441,F17496.17442,F17497.17442,F17498.17443,F\
    17499.17443,F17500.17443,F18410.17448
  BOUNDARY CONDITIONS:
    HEAT TRANSFER:
      Option = Adiabatic
    END
    MASS AND MOMENTUM:
      Option = No Slip Wall
    END
    WALL ROUGHNESS:
      Option = Smooth Wall
    END
  END
END
DOMAIN MODELS:
  BUOYANCY MODEL:
    Buoyancy Reference Density = 0.0711219 [lb ft^-3]
    Gravity X Component = 0 [ft s^-2]
    Gravity Y Component = 0 [ft s^-2]
    Gravity Z Component = -9.81 [m s^-2]
    Option = Buoyant
    BUOYANCY REFERENCE LOCATION:
      Option = Automatic
    END
  END
  DOMAIN MOTION:
    Option = Stationary
  END
  MESH DEFORMATION:
    Option = None
  END
  REFERENCE PRESSURE:
    Reference Pressure = 1 [atm]
  END
END
FLUID DEFINITION: Fluid 1
  Material = Air Ideal Gas
  Option = Material Library
  MORPHOLOGY:
    Option = Continuous Fluid
  END
END
FLUID MODELS:
  ADDITIONAL VARIABLE: dummy
    Option = Transport Equation
  END
  COMBUSTION MODEL:
    Option = None
  END
  HEAT TRANSFER MODEL:
    Option = Total Energy
  END
  THERMAL RADIATION MODEL:
    Option = None
  END
  TURBULENCE MODEL:
    Option = SST
    BUOYANCY TURBULENCE:
      Option = Production and Dissipation
    END
  END
  TURBULENT WALL FUNCTIONS:
    High Speed Model = Off
    Option = Automatic
  END
END
INITIALISATION:
  Option = Automatic
  INITIAL CONDITIONS:
    Velocity Type = Cartesian
```

```
      ADDITIONAL VARIABLE: dummy
        Option = Automatic
      END
      CARTESIAN VELOCITY COMPONENTS:
        Option = Automatic with Value
        U = 0 [ft s^-1]
        V = 0 [ft s^-1]
        W = 0 [ft s^-1]
      END
      STATIC PRESSURE:
        Option = Automatic
      END
      TEMPERATURE:
        Option = Automatic
      END
      TURBULENCE INITIAL CONDITIONS:
        Option = Low Intensity and Eddy Viscosity Ratio
      END
    END
  END
  POROSITY MODELS:
    AREA POROSITY:
      Option = Isotropic
    END
    LOSS MODEL:
      Loss Velocity Type = Superficial
      Option = Directional Loss
      DIRECTIONAL LOSS MODEL:
        STREAMWISE DIRECTION:
          Option = Cartesian Components
          Unit Vector X Component = 0
          Unit Vector Y Component = 0
          Unit Vector Z Component = 1
        END
        STREAMWISE LOSS:
          Option = Permeability and Loss Coefficient
          Resistance Loss Coefficient = 0.83 [ft^-1]
        END
        TRANSVERSE LOSS:
          Option = Streamwise Coefficient Multiplier
          Streamwise Coefficient Multiplier = 10.
        END
      END
    END
    VOLUME POROSITY:
      Option = Value
      Volume Porosity = 0.67
    END
  END
END
DOMAIN INTERFACE: intfbtm
  Boundary List1 = intfbtm Side 1
  Boundary List2 = intfbtm Side 2
  Interface Type = Fluid Porous
  INTERFACE MODELS:
    Option = General Connection
    FRAME CHANGE:
      Option = None
    END
    MASS AND MOMENTUM:
      Option = Conservative Interface Flux
      MOMENTUM INTERFACE MODEL:
        Option = None
      END
    END
    PITCH CHANGE:
      Option = None
    END
  END
  MESH CONNECTION:
    Option = GGI
  END
END
DOMAIN INTERFACE: intftop
  Boundary List1 = intftop Side 1
  Boundary List2 = intftop Side 2
  Interface Type = Fluid Porous
  INTERFACE MODELS:
    Option = General Connection
    FRAME CHANGE:
      Option = None
    END
    MASS AND MOMENTUM:
      Option = Conservative Interface Flux
      MOMENTUM INTERFACE MODEL:
        Option = None
      END
    END
```

```
    PITCH CHANGE:
      Option = None
    END
  END
  MESH CONNECTION:
    Option = GGI
  END
END
OUTPUT CONTROL:
  MONITOR OBJECTS:
    MONITOR BALANCES:
      Option = Full
    END
    MONITOR FORCES:
      Option = Full
    END
    MONITOR PARTICLES:
      Option = Full
    END
    MONITOR POINT: Fant1
      Expression Value = FT1
      Option = Expression
    END
    MONITOR POINT: Fant10
      Expression Value = FT10
      Option = Expression
    END
    MONITOR POINT: Fant11
      Expression Value = FT11
      Option = Expression
    END
    MONITOR POINT: Fant12
      Expression Value = FT12
      Option = Expression
    END
    MONITOR POINT: Fant13
      Expression Value = FT13
      Option = Expression
    END
    MONITOR POINT: Fant14
      Expression Value = FT14
      Option = Expression
    END
    MONITOR POINT: Fant15
      Expression Value = FT15
      Option = Expression
    END
    MONITOR POINT: Fant2
      Expression Value = FT2
      Option = Expression
    END
    MONITOR POINT: Fant3
      Expression Value = FT3
      Option = Expression
    END
    MONITOR POINT: Fant4
      Expression Value = FT4
      Option = Expression
    END
    MONITOR POINT: Fant5
      Expression Value = FT5
      Option = Expression
    END
    MONITOR POINT: Fant6
      Expression Value = FT6
      Option = Expression
    END
    MONITOR POINT: Fant7
      Expression Value = FT7
      Option = Expression
    END
    MONITOR POINT: Fant8
      Expression Value = FT8
      Option = Expression
    END
    MONITOR POINT: Fant9
      Expression Value = FT9
      Option = Expression
    END
    MONITOR POINT: Fantavg
      Expression Value = FTAVG
      Option = Expression
    END
    MONITOR POINT: Ptotwct1
      Expression Value = Pwct1
      Option = Expression
    END
    MONITOR POINT: Ptotwct2
```

```
      Expression Value = Pwct2
      Option = Expression
    END
    MONITOR POINT: Ptotwctout
      Expression Value = Pwctout
      Option = Expression
    END
    MONITOR POINT: WCT mass 1
      Expression Value = addvar1
      Option = Expression
    END
    MONITOR POINT: WCT mass 2
      Expression Value = addvar2
      Option = Expression
    END
    MONITOR POINT: WCT temp 1
      Expression Value = WCT temp1
      Option = Expression
    END
    MONITOR POINT: WCT temp 2
      Expression Value = WCT temp2
      Option = Expression
    END
    MONITOR POINT: fanpress
      Expression Value = pfan
      Option = Expression
    END
    MONITOR POINT: mspress
      Expression Value = pms
      Option = Expression
    END
    MONITOR POINT: radpress
      Expression Value = prad
      Option = Expression
    END
    MONITOR RESIDUALS:
      Option = Full
    END
    MONITOR TOTALS:
      Option = Full
    END
  END
  RESULTS:
    File Compression Level = Default
    Option = Standard
    Output Equation Residuals = All
  END
 END
 SOLVER CONTROL:
  Turbulence Numerics = First Order
  ADVECTION SCHEME:
    Option = High Resolution
  END
  CONVERGENCE CONTROL:
    Maximum Number of Iterations = 300
    Minimum Number of Iterations = 1
    Physical Timescale = tscale
    Timescale Control = Physical Timescale
  END
  CONVERGENCE CRITERIA:
    Residual Target = 0.00001
    Residual Type = RMS
  END
  DYNAMIC MODEL CONTROL:
    Global Dynamic Model Control = On
  END
 END
 EXPERT PARAMETERS:
  topology estimate factor zif = 1.2
 END
END
COMMAND FILE:
 Version = 14.0
 Results Version = 14.0
END
SIMULATION CONTROL:
 EXECUTION CONTROL:
  EXECUTABLE SELECTION:
    Double Precision = Off
  END
  PARALLEL HOST LIBRARY:
    HOST DEFINITION: dellt75004
      Remote Host Name = DELL-T7500-4
      Installation Root = C:\Program Files\ANSYS Inc\v%v\CFX
      Host Architecture String = winnt-amd64
    END
  END
  PARTITIONER STEP CONTROL:
```

```
    PARTITIONING TYPE:
      Option = MeTiS
      MeTiS Type = k-way
      Partition Size Rule = Automatic
      Partition Weight Factors = 0.20000, 0.20000, 0.20000, 0.20000, 0.20000
    END
  END
  RUN DEFINITION:
    Solver Input File = C:\Users\lwong\Desktop\Waterford3 CFD\Batch \
      run\Train B S 90F 30mph closed mod.def
    Run Mode = Full
  END
  SOLVER STEP CONTROL:
    PARALLEL ENVIRONMENT:
      Start Method = Platform MPI Local Parallel
      Number of Processes = 5
      Parallel Host List = dellt75004*5
    END
  END
 END
END

+--------------------------------------------------------------------+
|                                                                    |
|                            Partitioning                            |
|                                                                    |
+--------------------------------------------------------------------+



+--------------------------------------------------------------------+
|                                                                    |
|                ANSYS(R) CFX(R) Partitioner 14.0                    |
|                                                                    |
| Version 2011.10.10-23.01           Tue Oct 11 00:28:38 GMTDT 2011 |
|                                                                    |
|                       Executable Attributes                        |
|                                                                    |
| single-int32-64bit-novc8-noifort-novc6-optimised-supfort-noprof-nos|
|                                                                    |
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|                                                                    |
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+--------------------------------------------------------------------+



+--------------------------------------------------------------------+
|                          Job Information                           |
+--------------------------------------------------------------------+

Run mode:       partitioning run

Host computer:  DELL-T7500-4 (PID:5632)
Job started:    Mon Jul 18 08:25:09 2016

+--------------------------------------------------------------------+
|       Memory Allocated for Run  (Actual usage may be less)         |
+--------------------------------------------------------------------+

 Data Type      Kwords  Words/Node  Words/Elem      Kbytes Bytes/Node

 Real          25666.1       5.59        1.68    100258.2     22.36
 Integer      339064.6      73.86       22.13   1324470.9    295.44
 Character      3541.8       0.77        0.23      3458.8      0.77
 Logical          80.0       0.02        0.01       312.5      0.07
 Double         1200.5       0.26        0.08      9378.9      2.09

+--------------------------------------------------------------------+
|                          Mesh Statistics                           |
+--------------------------------------------------------------------+

Domain Name : Fluid

  Total Number of Nodes                    =     4562322

  Total Number of Elements                 =    15291578
    Total Number of Tetrahedrons           =     9871736
    Total Number of Prisms                 =     5382628
    Total Number of Pyramids               =       37214
```

Total Number of Faces = 831610

Domain Name : porous

Total Number of Nodes = 28378

Total Number of Elements = 28478
Total Number of Tetrahedrons = 8828
Total Number of Hexahedrons = 19170
Total Number of Pyramids = 480

Total Number of Faces = 20420

Global Statistics :

Global Number of Nodes = 4590700

Global Number of Elements = 15320056
Total Number of Tetrahedrons = 9880564
Total Number of Prisms = 5382628
Total Number of Hexahedrons = 19170
Total Number of Pyramids = 37694

Global Number of Faces = 852030

Domain Interface Name : intfbtm

Discretization type = GGI
Intersection type = Direct
Non-overlap area fraction on side 1 = 6.00E-07
Non-overlap area fraction on side 2 = 1.27E-07

Domain Interface Name : intftop

Discretization type = GGI
Intersection type = Direct
Non-overlap area fraction on side 1 = 4.32E-07
Non-overlap area fraction on side 2 = 6.03E-08

Vertex Based Partitioning

Partitioning of domain: Fluid

- Partitioning tool: MeTiS multilevel k-way algorithm
- Number of partitions: 5
- Number of graph-nodes: 4562322
- Number of graph-edges: 45959268

Partitioning of domain: porous

- Partitioning tool: MeTiS multilevel k-way algorithm
- Number of partitions: 5
- Number of graph-nodes: 28378
- Number of graph-edges: 168102

Partitioning Information

Partitioning information for domain: Fluid

	Elements		Vertices			Faces	
Part	Number	%	Number	%	%Ovlp	Number	%
Full	15291578		4562322			831610	
1	3036853	19.7	959574	20.6	1.8	191824	22.2
2	3552730	23.0	956279	20.5	1.9	154951	17.9
3	2879284	18.7	907718	19.5	2.1	171911	19.9
4	2984991	19.3	925440	19.9	2.4	176702	20.5
5	2972994	19.3	910748	19.5	2.2	167922	19.5
Sum	15426852	100.0	4659759	100.0	2.1	863310	100.0

Partitioning information for domain: porous

	Elements		Vertices			Faces	
Part	Number	%	Number	%	%Ovlp	Number	%
Full	28478		28378			20420	

```
|    1 |      4389   11.3 |      6216   13.3   8.1 |      4390   14.1 |
|    2 |     14124   36.4 |     10466   22.3  44.2 |      7441   23.9 |
|    3 |      4377   11.3 |      6196   13.2   8.4 |      4004   12.8 |
|    4 |     12055   31.1 |     18484   39.4  67.6 |     11718   37.6 |
|    5 |      3873   10.0 |      5536   11.8   6.9 |      3623   11.6 |
+------+-----------------+----------------------+-----------------+
| Sum  |     38818  100.0 |     46898  100.0  39.5 |     31176  100.0 |
+------+-----------------+----------------------+-----------------+

+--------------------------------------------------------------------+
|                 Partitioning CPU-Time Requirements                 |
+--------------------------------------------------------------------+

- Preparations                                  2.487E+01 seconds
- Low-level mesh partitioning                   6.173E+00 seconds
- Gather zone interface information             5.980E-01 seconds
- Global partitioning information               5.230E-01 seconds
- Element and face partitioning information     9.050E-01 seconds
- Vertex partitioning information               2.430E-01 seconds
- Partitioning information compression          4.400E-02 seconds
- Summed CPU-time for mesh partitioning         3.390E+01 seconds


+--------------------------------------------------------------------+
|                          Job Information                           |
+--------------------------------------------------------------------+

Host computer:  DELL-T7500-4 (PID:5632)
Job finished:   Mon Jul 18 08:25:48 2016
Total CPU time: 3.927E+01 seconds
         or: (          0:           0:           0:    39.272 )
             (       Days:      Hours:     Minutes:   Seconds )

Total wall clock time: 3.900E+01 seconds
         or: (          0:           0:           0:    39.000 )
             (       Days:      Hours:     Minutes:   Seconds )


+--------------------------------------------------------------------+
|                                                                    |
|                               Solver                               |
|                                                                    |
+--------------------------------------------------------------------+



+--------------------------------------------------------------------+
|                                                                    |
|                    ANSYS(R) CFX(R) Solver 14.0                     |
|                                                                    |
| Version 2011.10.10-23.01           Tue Oct 11 00:28:38 GMTDT 2011 |
|                                                                    |
|                       Executable Attributes                        |
|                                                                    |
| single-int32-64bit-novc8-noifort-novc6-optimised-supfort-noprof-nos|
|                                                                    |
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|                                                                    |
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+--------------------------------------------------------------------+



+--------------------------------------------------------------------+
|                          Job Information                           |
+--------------------------------------------------------------------+

Run mode:       parallel run (MPI)

Host computer:  DELL-T7500-4 (PID:7012)
Par. Process:   Master running on mesh partition:       1
Solver Build:   Tue Oct 11 00:28:38 GMTDT 2011
Attributes:     single-int32-64bit-novc8-noifort-novc6-optimised-su...
Job started:    Mon Jul 18 08:25:49 2016

Host computer:  DELL-T7500-4 (PID:6368)
Par. Process:   Slave  running on mesh partition:       2
Solver Build:   Tue Oct 11 00:28:38 GMTDT 2011
Attributes:     single-int32-64bit-novc8-noifort-novc6-optimised-su...
Job started:    Mon Jul 18 08:25:49 2016

Host computer:  DELL-T7500-4 (PID:5244)
Par. Process:   Slave  running on mesh partition:       3
```

Solver Build: Tue Oct 11 00:28:38 GMTDT 2011
Attributes: single-int32-64bit-novc8-noifort-novc6-optimised-su...
Job started: Mon Jul 18 08:25:49 2016

Host computer: DELL-T7500-4 (PID:3432)
Par. Process: Slave running on mesh partition: 4
Solver Build: Tue Oct 11 00:28:38 GMTDT 2011
Attributes: single-int32-64bit-novc8-noifort-novc6-optimised-su...
Job started: Mon Jul 18 08:25:49 2016

Host computer: DELL-T7500-4 (PID:6016)
Par. Process: Slave running on mesh partition: 5
Solver Build: Tue Oct 11 00:28:38 GMTDT 2011
Attributes: single-int32-64bit-novc8-noifort-novc6-optimised-su...
Job started: Mon Jul 18 08:25:49 2016
License Cap: ANSYS CFX Solver (> 512K Nodes)
License Cap: Parallel
License ID: LIC-SERVER2.luciuspitkin.com-SYSTEM-6840-656362

```
+--------------------------------------------------------------------+
|       Memory Allocated for Run  (Actual usage may be less)        |
+--------------------------------------------------------------------+
```

Allocated storage in: Kwords
Words/Node
Words/Elem
Kbytes
Bytes/Node

Partition	Real	Integer	Character	Logical	Double
1	386886.0	114285.0	3991.8	80.0	1208.0
	400.59	118.33	4.13	0.08	1.25
	127.21	37.58	1.31	0.03	0.40
	1511273.4	446425.6	3898.2	78.1	9437.9
	1602.36	473.33	4.13	0.08	10.01
2	400929.4	125967.0	3991.8	80.0	1208.0
	414.72	130.30	4.13	0.08	1.25
	112.40	35.32	1.12	0.02	0.34
	1566130.5	492058.6	3898.2	78.1	9437.9
	1658.88	521.20	4.13	0.08	10.00
3	365546.7	108354.0	3991.8	80.0	1208.0
	399.98	118.56	4.37	0.09	1.32
	126.76	37.58	1.38	0.03	0.42
	1427916.6	423257.8	3898.2	78.1	9437.9
	1599.92	474.24	4.37	0.09	10.57
4	404537.6	118238.6	3991.8	80.0	1208.0
	428.57	125.26	4.23	0.08	1.28
	134.98	39.45	1.33	0.03	0.40
	1580225.0	461869.6	3898.2	78.1	9437.9
	1714.28	501.05	4.23	0.08	10.24
5	368599.8	110316.6	3991.8	80.0	1208.0
	402.28	120.40	4.36	0.09	1.32
	123.82	37.06	1.34	0.03	0.41
	1439842.8	430924.1	3898.2	78.1	9437.9
	1609.11	481.58	4.36	0.09	10.55
Total	1926499.4	577161.1	19959.0	400.0	6040.2
	419.65	125.72	4.35	0.09	1.32
	125.75	37.67	1.30	0.03	0.39
	7525388.0	2254535.5	19491.2	390.6	47189.4
	1678.61	502.90	4.35	0.09	10.53

```
+--------------------------------------------------------------------+
|                      ****** Notice ******                         |
| The Wall Heat Transfer Coefficient written to the results file for |
|      Fluid 1                                                      |
| is based on the turbulent wall function coefficient. It is        |
| consistent with the Wall Heat Flux, the wall temperature, and the  |
| Wall Adjacent Temperature (near-wall temperature).  If you would   |
| like it to be based on a user-specified bulk temperature instead,  |
| please set the expert parameter "tbulk for htc = <value>".        |
+--------------------------------------------------------------------+
```

```
+--------------------------------------------------------------------+
|                      ****** Notice ******                         |
| The Wall Heat Transfer Coefficient written to the results file for |
|      Fluid 1                                                      |
| is based on the turbulent wall function coefficient. It is        |
| consistent with the Wall Heat Flux, the wall temperature, and the  |
```

```
| Wall Adjacent Temperature (near-wall temperature).  If you would   |
| like it to be based on a user-specified bulk temperature instead,  |
| please set the expert parameter "tbulk for htc = <value>".         |
+--------------------------------------------------------------------+


+--------------------------------------------------------------------+
|                    ****** Notice ******                            |
| Evaluation of quantitative CEL functions on mesh regions           |
| ignores any .Boundcon operator and uses conservative values.       |
+--------------------------------------------------------------------+

+--------------------------------------------------------------------+
|                         Mesh Statistics                            |
+--------------------------------------------------------------------+
| Domain Name          | Orthog. Angle | Exp. Factor  | Aspect Ratio |
+----------------------+---------------+--------------+--------------+
|                      | Minimum [deg] |   Maximum    |   Maximum    |
+----------------------+---------------+--------------+--------------+
| Fluid                |       12.4  ! |      6393  ! |      1603  ! |
| porous               |        8.1  ! |      2982  ! |       104 ok |
| Global               |        8.1  ! |      6393  ! |      1603  ! |
+----------------------+---------------+--------------+--------------+
|                      |  %!  %ok  %OK |  %!  %ok  %OK |  %!  %ok  %OK |
+----------------------+---------------+--------------+--------------+
| Fluid                |  <1    4   96 |  <1    3   97 |  <1    1   99 |
| porous               |  <1    3   97 |   2    3   95 |   0   <1  100 |
| Global               |  <1    4   96 |  <1    3   97 |  <1    1   99 |
+----------------------+---------------+--------------+--------------+

Domain Name : Fluid

    Total Number of Nodes                      =     4562322

    Total Number of Elements                   =    15291578
        Total Number of Tetrahedrons           =     9871736
        Total Number of Prisms                 =     5382628
        Total Number of Pyramids               =       37214

    Total Number of Faces                      =      831610

Domain Name : porous

    Total Number of Nodes                      =       28378

    Total Number of Elements                   =       28478
        Total Number of Tetrahedrons           =        8828
        Total Number of Hexahedrons            =       19170
        Total Number of Pyramids               =         480

    Total Number of Faces                      =       20420

Global Statistics :

    Global Number of Nodes                     =     4590700

    Global Number of Elements                  =    15320056
        Total Number of Tetrahedrons           =     9880564
        Total Number of Prisms                 =     5382628
        Total Number of Hexahedrons            =       19170
        Total Number of Pyramids               =       37694

    Global Number of Faces                     =      852030

Domain Interface Name : intfbtm

    Discretization type                        =         GGI
    Intersection type                          = Partitioner
    Non-overlap area fraction on side 1        =    6.00E-07
    Non-overlap area fraction on side 2        =    1.27E-07

Domain Interface Name : intftop

    Discretization type                        =         GGI
    Intersection type                          = Partitioner
    Non-overlap area fraction on side 1        =    4.32E-07
    Non-overlap area fraction on side 2        =    6.03E-08

+--------------------------------------------------------------------+
|                  User Defined Monitor Information                  |
+--------------------------------------------------------------------+

Monitor Point: radpress

Monitor Point: mspress

Monitor Point: fanpress
```

Monitor Point: WCT temp 2

Monitor Point: WCT temp 1

Monitor Point: WCT mass 2

Monitor Point: WCT mass 1

Monitor Point: Ptotwctout

Monitor Point: Ptotwct2

Monitor Point: Ptotwct1

Monitor Point: Fantavg

Monitor Point: Fant9

Monitor Point: Fant8

Monitor Point: Fant7

Monitor Point: Fant6

Monitor Point: Fant5

Monitor Point: Fant4

Monitor Point: Fant3

Monitor Point: Fant2

Monitor Point: Fant15

Monitor Point: Fant14

Monitor Point: Fant13

Monitor Point: Fant12

Monitor Point: Fant11

Monitor Point: Fant10

Monitor Point: Fant1

```
+--------------------------------------------------------------------+
|                 Buoyancy Reference Information                     |
+--------------------------------------------------------------------+
```

Domain Group: Fluid

Buoyancy has been activated. The absolute pressure will include hydrostatic pressure contribution, using the following reference coordinates: (8.00672E+01, 2.81627E+01,-2.22560E+01).

```
+--------------------------------------------------------------------+
|                   Average Scale Information                        |
+--------------------------------------------------------------------+
```

```
Domain Name : Fluid
   Global Length                                  = 4.8857E+02
   Minimum Extent                                 = 2.6076E+02
   Maximum Extent                                 = 6.9205E+02
   Density                                        = 1.1548E+00
   Dynamic Viscosity                              = 1.8310E-05
   Velocity                                       = 1.3411E+01
   Advection Time                                 = 3.6430E+01
   Reynolds Number                                = 4.1325E+08
   Speed of Sound                                 = 3.5038E+02
   Mach Number                                    = 3.8276E-02
   Thermal Conductivity                           = 2.6100E-02
   Specific Heat Capacity at Constant Pressure    = 1.0044E+03
   Specific Heat Capacity at Constant Volume      = 7.1730E+02
   Specific Heat Ratio                            = 1.4003E+00
   Prandtl Number                                 = 7.0462E-01

Domain Name : porous
   Global Length                                  = 3.6540E+00
   Minimum Extent                                 = 1.7770E-01
   Maximum Extent                                 = 2.4384E+01
   Density                                        = 1.1542E+00
   Dynamic Viscosity                              = 1.8310E-05
   Velocity                                       = 0.0000E+00
   Speed of Sound                                 = 3.5038E+02
   Mach Number                                    = 0.0000E+00
   Thermal Conductivity                           = 2.6100E-02
   Specific Heat Capacity at Constant Pressure    = 1.0044E+03
```

Specific Heat Capacity at Constant Volume = 7.1730E+02
Specific Heat Ratio = 1.4003E+00
Prandtl Number = 7.0462E-01

```
+--------------------------------------------------------------------+
|              Checking for Isolated Fluid Regions                   |
+--------------------------------------------------------------------+
```

No isolated fluid regions were found.

```
+--------------------------------------------------------------------+
|              The Equations Solved in This Calculation              |
+--------------------------------------------------------------------+
```

Equations are given two labels: the individual name and a combined name used for combining residuals together. Residuals for multidomain problems are combined provided the domains are connected together and have the same domain type (solid or fluid/porous). If there are multiple groups of the same domain type, then the group residual is identified by the name of the first domain in the connected group.

The individual and combined equation names are given below.

Subsystem : Wall Scale

```
 Wallscale-Fluid                --> Wallscale
 Wallscale-porous               --> Wallscale
```

Subsystem : Momentum and Mass

```
 U-Mom-Fluid                    --> U-Mom
 V-Mom-Fluid                    --> V-Mom
 W-Mom-Fluid                    --> W-Mom
 P-Mass-Fluid                   --> P-Mass
 U-Mom-porous                   --> U-Mom
 V-Mom-porous                   --> V-Mom
 W-Mom-porous                   --> W-Mom
 P-Mass-porous                  --> P-Mass
```

Subsystem : Additional Variables

```
 dummy-Fluid                    --> dummy
 dummy-porous                   --> dummy
```

Subsystem : Heat Transfer

```
 H-Energy-Fluid                 --> H-Energy
 H-Energy-porous                --> H-Energy
```

Subsystem : TurbKE and TurbFreq

```
 K-TurbKE-Fluid                 --> K-TurbKE
 O-TurbFreq-Fluid               --> O-TurbFreq
 K-TurbKE-porous                --> K-TurbKE
 O-TurbFreq-porous              --> O-TurbFreq
```

CFD Solver started: Mon Jul 18 08:26:29 2016

```
+--------------------------------------------------------------------+
|                     Convergence History                            |
+--------------------------------------------------------------------+

======================================================================
|                     Timescale Information                          |
----------------------------------------------------------------------
|   Equation      |        Type          |    Timescale     |
+-----------------+----------------------+------------------+
| U-Mom-Fluid     | Physical Timescale   |   3.00000E+01    |
| V-Mom-Fluid     | Physical Timescale   |   3.00000E+01    |
| W-Mom-Fluid     | Physical Timescale   |   3.00000E+01    |
| P-Mass-Fluid    | Physical Timescale   |   3.00000E+01    |
| U-Mom-porous    | Physical Timescale   |   3.00000E+01    |
| V-Mom-porous    | Physical Timescale   |   3.00000E+01    |
| W-Mom-porous    | Physical Timescale   |   3.00000E+01    |
| P-Mass-porous   | Physical Timescale   |   3.00000E+01    |
+-----------------+----------------------+------------------+
| dummy-Fluid     | Physical Timescale   |   3.00000E+01    |
| dummy-porous    | Physical Timescale   |   3.00000E+01    |
+-----------------+----------------------+------------------+
| H-Energy-Fluid  | Physical Timescale   |   3.00000E+01    |
| H-Energy-porous | Physical Timescale   |   3.00000E+01    |
+-----------------+----------------------+------------------+
| K-TurbKE-Fluid  | Physical Timescale   |   3.00000E+01    |
| K-TurbKE-porous | Physical Timescale   |   3.00000E+01    |
| O-TurbFreq-Fluid | Physical Timescale  |   3.00000E+01    |
| O-TurbFreq-porous | Physical Timescale |   3.00000E+01    |
+-----------------+----------------------+------------------+
```

```
======================================================================
OUTER LOOP ITERATION =    1                CPU SECONDS = 2.005E+02
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| Wallscale            | 0.00 | 1.5E-04 | 2.7E-03 | 44.0  1.8E-01  ok|
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.00 | 1.5E-03 | 1.9E-02 |       2.9E+00  ok|
| V-Mom                | 0.00 | 9.5E-03 | 1.1E-01 |       2.7E-01  ok|
| W-Mom                | 0.00 | 1.8E-02 | 6.9E-01 |       4.1E-03  OK|
| P-Mass               | 0.00 | 8.2E-03 | 6.1E-02 | 17.4  8.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.00 | 6.2E-03 | 8.2E-01 |  5.7  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.00 | 8.0E-02 | 8.4E-01 |  5.7  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.00 | 2.6E-02 | 1.6E+00 |  5.7  2.0E-08  OK|
| O-TurbFreq           | 0.00 | 1.9E-01 | 4.4E+00 | 12.5  2.1E-08  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =    2                CPU SECONDS = 1.140E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| Wallscale            | 1.99 | 2.9E-04 | 4.8E-02 | 20.1  9.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| U-Mom                |10.63 | 1.6E-02 | 9.1E-01 |       1.4E-02  OK|
| V-Mom                | 2.17 | 2.1E-02 | 2.9E-01 |       3.4E-02  OK|
| W-Mom                | 0.27 | 4.9E-03 | 4.7E-01 |       5.6E-02  OK|
| P-Mass               | 0.22 | 1.8E-03 | 4.8E-01 | 13.3  5.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.18 | 7.3E-03 | 1.7E+00 | 15.2  2.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.53 | 4.3E-02 | 7.7E-01 | 15.2  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.25 | 6.5E-03 | 3.7E-01 |  5.7  8.8E-07  OK|
| O-TurbFreq           | 0.41 | 7.7E-02 | 1.0E+00 | 12.5  2.1E-08  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =    3                CPU SECONDS = 1.929E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| Wallscale            | 0.45 | 1.3E-04 | 1.8E-02 | 29.7  9.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.57 | 9.3E-03 | 4.9E-01 |       8.6E-02  OK|
| V-Mom                | 1.47 | 3.0E-02 | 4.0E-01 |       1.7E-01  ok|
| W-Mom                | 1.82 | 9.0E-03 | 7.5E-01 |       1.0E-01  ok|
| P-Mass               | 2.71 | 5.0E-03 | 8.2E-01 |  5.1  4.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.65 | 4.7E-03 | 3.5E-01 | 10.5  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.44 | 1.9E-02 | 5.2E-01 | 10.5  9.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.97 | 1.3E-02 | 3.8E-01 |  5.7  3.6E-06  OK|
| O-TurbFreq           | 0.42 | 3.2E-02 | 6.0E-01 | 12.5  2.1E-08  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =    4                CPU SECONDS = 2.687E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| Wallscale            | 0.34 | 4.5E-05 | 8.5E-03 | 29.7  9.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.11 | 1.0E-02 | 4.7E-01 |       1.3E-01  ok|
| V-Mom                | 0.82 | 2.5E-02 | 4.6E+00 |       1.9E-01  ok|
| W-Mom                | 0.85 | 7.7E-03 | 4.2E-01 |       1.8E-01  ok|
| P-Mass               | 0.56 | 2.8E-03 | 4.3E-01 |  5.1  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.80 | 3.8E-03 | 3.4E-01 | 10.4  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.78 | 1.5E-02 | 6.0E-01 | 10.5  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.16 | 1.5E-02 | 6.6E-01 |  5.7  7.6E-06  OK|
| O-TurbFreq           | 0.46 | 1.5E-02 | 8.0E-01 | 12.6  2.2E-08  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =    5                CPU SECONDS = 3.447E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| Wallscale            | 0.70 | 3.1E-05 | 6.6E-03 | 29.7  8.9E-02  OK|
+----------------------+------+---------+---------+------------------+
```

```
| U-Mom                | 0.70 | 7.2E-03 | 3.0E-01 |       8.7E-02  OK|
| V-Mom                | 1.24 | 3.0E-02 | 8.7E-01 |       6.9E-02  OK|
| W-Mom                | 1.01 | 7.8E-03 | 8.3E-01 |       7.4E-02  OK|
| P-Mass               | 0.48 | 1.4E-03 | 4.3E-01 |  9.2  1.0E-01  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.86 | 3.2E-03 | 3.9E-01 | 10.5  6.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.63 | 9.2E-03 | 4.3E-01 | 10.5  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.70 | 2.5E-02 | 6.2E-01 |  5.7  2.7E-05  OK|
| O-TurbFreq           | 0.50 | 7.5E-03 | 3.4E-01 | 12.5  2.3E-08  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =    6                    CPU SECONDS = 4.221E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| Wallscale            | 0.72 | 2.2E-05 | 4.8E-03 | 29.7  8.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.73 | 5.3E-03 | 2.4E-01 |       6.7E-02  OK|
| V-Mom                | 0.71 | 2.2E-02 | 5.9E-01 |       4.6E-02  OK|
| W-Mom                | 0.63 | 4.9E-03 | 4.5E-01 |       6.5E-02  OK|
| P-Mass               | 0.64 | 8.7E-04 | 1.7E-01 |  9.2  7.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.93 | 3.0E-03 | 5.2E-01 | 10.5  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.68 | 6.3E-03 | 3.7E-01 | 10.4  2.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.56 | 1.4E-02 | 3.4E-01 |  5.7  7.2E-05  OK|
| O-TurbFreq           | 0.82 | 6.2E-03 | 3.7E-01 | 12.5  2.8E-08  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =    7                    CPU SECONDS = 4.990E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| Wallscale            | 0.68 | 1.5E-05 | 3.4E-03 | 29.7  8.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.78 | 4.1E-03 | 2.7E-01 |       2.2E-02  OK|
| V-Mom                | 0.49 | 1.1E-02 | 2.8E-01 |       1.3E-02  OK|
| W-Mom                | 1.03 | 5.1E-03 | 3.9E-01 |       2.3E-02  OK|
| P-Mass               | 1.38 | 1.2E-03 | 1.9E-01 | 13.3  8.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.93 | 2.8E-03 | 3.3E-01 | 10.5  2.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.88 | 5.6E-03 | 3.6E-01 | 10.5  1.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.64 | 9.1E-03 | 3.0E-01 |  5.7  2.1E-04  OK|
| O-TurbFreq           | 1.03 | 6.4E-03 | 3.5E-01 | 12.5  6.6E-08  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =    8                    CPU SECONDS = 5.774E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| Wallscale            | 0.66 | 1.0E-05 | 2.3E-03 | 29.7  8.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.81 | 3.3E-03 | 3.7E-01 |       2.3E-02  OK|
| V-Mom                | 0.54 | 5.7E-03 | 2.4E-01 |       1.2E-02  OK|
| W-Mom                | 0.92 | 4.6E-03 | 4.1E-01 |       2.3E-02  OK|
| P-Mass               | 0.98 | 1.2E-03 | 2.7E-01 | 13.3  8.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.08 | 3.0E-03 | 3.2E-01 | 10.4  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.95 | 5.3E-03 | 4.5E-01 |  5.7  8.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.06 | 9.6E-03 | 4.9E-01 |  5.7  1.3E-03  OK|
| O-TurbFreq           | 0.83 | 5.3E-03 | 2.9E-01 | 12.5  3.0E-07  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =    9                    CPU SECONDS = 6.553E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| Wallscale            | 0.64 | 6.5E-06 | 1.5E-03 | 29.7  8.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 3.3E-03 | 3.2E-01 |       1.9E-02  OK|
| V-Mom                | 0.65 | 3.7E-03 | 1.8E-01 |       1.1E-02  OK|
| W-Mom                | 0.87 | 4.0E-03 | 3.3E-01 |       1.8E-02  OK|
| P-Mass               | 1.09 | 1.3E-03 | 2.9E-01 | 13.3  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.13 | 3.4E-03 | 5.6E-01 | 10.4  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 5.2E-03 | 3.5E-01 | 10.4  2.1E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.71 | 6.8E-03 | 5.6E-01 |  5.7  4.1E-03  OK|
| O-TurbFreq           | 0.80 | 4.2E-03 | 4.0E-01 | 12.5  1.9E-06  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   10                CPU SECONDS = 7.339E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 3.1E-03 | 3.8E-01 |       1.8E-02  OK|
| V-Mom                | 0.74 | 2.8E-03 | 1.3E-01 |       1.3E-02  OK|
| W-Mom                | 0.90 | 3.6E-03 | 3.2E-01 |       2.0E-02  OK|
| P-Mass               | 0.95 | 1.2E-03 | 3.7E-01 | 13.3  9.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.06 | 3.6E-03 | 6.7E-01 | 10.4  4.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.92 | 4.8E-03 | 4.2E-01 |  5.7  9.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.87 | 5.9E-03 | 5.3E-01 |  5.7  6.7E-03  OK|
| O-TurbFreq           | 0.80 | 3.4E-03 | 4.4E-01 | 12.5  7.9E-06  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   11                CPU SECONDS = 8.047E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.89 | 2.8E-03 | 3.6E-01 |       9.1E-03  OK|
| V-Mom                | 0.86 | 2.4E-03 | 1.6E-01 |       5.3E-03  OK|
| W-Mom                | 1.00 | 3.6E-03 | 5.2E-01 |       1.2E-02  OK|
| P-Mass               | 1.06 | 1.3E-03 | 3.4E-01 | 17.4  6.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.04 | 3.8E-03 | 6.7E-01 | 10.4  4.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 4.7E-03 | 3.8E-01 |  5.7  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.81 | 4.8E-03 | 4.4E-01 |  5.7  8.1E-03  OK|
| O-TurbFreq           | 0.82 | 2.8E-03 | 4.2E-01 | 12.5  1.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   12                CPU SECONDS = 8.766E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.92 | 2.6E-03 | 3.0E-01 |       2.3E-02  OK|
| V-Mom                | 0.86 | 2.0E-03 | 1.2E-01 |       1.4E-02  OK|
| W-Mom                | 0.88 | 3.2E-03 | 3.1E-01 |       2.8E-02  OK|
| P-Mass               | 0.80 | 1.0E-03 | 3.3E-01 | 13.3  9.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.15 | 4.3E-03 | 5.3E-01 | 10.4  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.94 | 4.4E-03 | 2.9E-01 |  5.7  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.85 | 4.1E-03 | 4.2E-01 |  5.7  9.3E-03  OK|
| O-TurbFreq           | 0.86 | 2.4E-03 | 3.4E-01 | 12.5  2.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   13                CPU SECONDS = 9.473E+03
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.93 | 2.4E-03 | 2.5E-01 |       2.9E-02  OK|
| V-Mom                | 0.93 | 1.9E-03 | 1.4E-01 |       1.4E-02  OK|
| W-Mom                | 1.01 | 3.2E-03 | 3.4E-01 |       3.4E-02  OK|
| P-Mass               | 0.91 | 9.4E-04 | 3.7E-01 | 13.3  7.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 4.2E-03 | 5.7E-01 | 10.4  4.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 4.4E-03 | 3.0E-01 |  5.7  7.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.86 | 3.5E-03 | 4.8E-01 |  5.7  1.1E-02  OK|
| O-TurbFreq           | 1.11 | 2.7E-03 | 5.0E-01 | 12.5  1.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   14                CPU SECONDS = 1.017E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.93 | 2.2E-03 | 2.4E-01 |       2.9E-02  OK|
| V-Mom                | 0.92 | 1.7E-03 | 1.4E-01 |       1.6E-02  OK|
| W-Mom                | 0.91 | 3.0E-03 | 3.9E-01 |       3.3E-02  OK|
| P-Mass               | 0.71 | 6.6E-04 | 1.9E-01 | 13.3  7.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 4.3E-03 | 5.5E-01 | 10.4  3.8E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.90 | 4.0E-03 | 3.9E-01 |  5.7  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.83 | 2.9E-03 | 4.4E-01 |  5.7  1.3E-02  OK|
| O-TurbFreq           | 0.89 | 2.4E-03 | 3.4E-01 | 12.5  1.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   15                     CPU SECONDS = 1.088E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.91 | 2.0E-03 | 2.5E-01 |       2.3E-02  OK|
| V-Mom                | 0.93 | 1.6E-03 | 1.6E-01 |       1.7E-02  OK|
| W-Mom                | 0.90 | 2.6E-03 | 3.0E-01 |       2.6E-02  OK|
| P-Mass               | 0.86 | 5.7E-04 | 1.7E-01 | 13.3  8.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.89 | 3.8E-03 | 6.3E-01 | 10.4  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.84 | 3.4E-03 | 3.6E-01 |  5.7  8.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.81 | 2.4E-03 | 5.9E-01 |  5.7  1.7E-02  OK|
| O-TurbFreq           | 0.94 | 2.2E-03 | 4.3E-01 | 12.5  2.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   16                     CPU SECONDS = 1.158E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 1.9E-03 | 2.8E-01 |       1.7E-02  OK|
| V-Mom                | 0.95 | 1.5E-03 | 1.8E-01 |       1.5E-02  OK|
| W-Mom                | 0.95 | 2.5E-03 | 3.4E-01 |       1.9E-02  OK|
| P-Mass               | 1.05 | 6.0E-04 | 1.7E-01 | 13.3  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.86 | 3.3E-03 | 6.3E-01 | 10.4  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.92 | 3.1E-03 | 2.8E-01 |  5.7  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.83 | 2.0E-03 | 3.2E-01 |  5.7  1.7E-02  OK|
| O-TurbFreq           | 0.84 | 1.9E-03 | 3.1E-01 | 12.5  2.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   17                     CPU SECONDS = 1.228E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.82 | 1.6E-03 | 2.0E-01 |       1.3E-02  OK|
| V-Mom                | 0.87 | 1.3E-03 | 1.1E-01 |       1.1E-02  OK|
| W-Mom                | 0.87 | 2.2E-03 | 2.5E-01 |       1.5E-02  OK|
| P-Mass               | 0.74 | 4.5E-04 | 1.4E-01 | 13.3  6.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 3.0E-03 | 8.0E-01 | 10.4  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.91 | 2.8E-03 | 3.9E-01 |  5.7  6.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.81 | 1.6E-03 | 2.9E-01 |  5.7  1.9E-02  OK|
| O-TurbFreq           | 0.88 | 1.7E-03 | 2.9E-01 | 12.5  2.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   18                     CPU SECONDS = 1.299E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.90 | 1.4E-03 | 1.6E-01 |       8.2E-03  OK|
| V-Mom                | 0.92 | 1.2E-03 | 1.2E-01 |       8.4E-03  OK|
| W-Mom                | 0.91 | 2.0E-03 | 3.0E-01 |       1.2E-02  OK|
| P-Mass               | 1.02 | 4.6E-04 | 1.5E-01 | 13.3  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.86 | 2.6E-03 | 6.9E-01 | 10.4  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.90 | 2.5E-03 | 3.6E-01 |  5.7  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.90 | 1.4E-03 | 1.7E-01 |  5.7  2.0E-02  OK|
| O-TurbFreq           | 0.93 | 1.5E-03 | 1.7E-01 | 12.5  2.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   19                     CPU SECONDS = 1.369E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.89 | 1.3E-03 | 1.9E-01 |       2.9E-02  OK|
| V-Mom                | 0.88 | 1.1E-03 | 8.8E-02 |       2.9E-02  OK|
| W-Mom                | 0.88 | 1.8E-03 | 1.9E-01 |       3.4E-02  OK|
| P-Mass               | 0.70 | 3.2E-04 | 8.3E-02 |  9.2  9.9E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 2.4E-03 | 6.8E-01 | 10.4  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.85 | 2.2E-03 | 3.2E-01 |  5.7  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.22 | 1.7E-03 | 2.1E-01 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 1.01 | 1.6E-03 | 1.7E-01 | 12.5  2.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   20                    CPU SECONDS = 1.438E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.91 | 1.2E-03 | 1.4E-01 |       6.5E-03  OK|
| V-Mom                | 0.94 | 1.0E-03 | 6.8E-02 |       7.8E-03  OK|
| W-Mom                | 0.93 | 1.6E-03 | 2.1E-01 |       1.1E-02  OK|
| P-Mass               | 0.81 | 2.6E-04 | 6.9E-02 | 13.3  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 2.5E-03 | 5.9E-01 | 10.4  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 2.1E-03 | 2.8E-01 |  5.7  6.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.40 | 2.4E-03 | 2.8E-01 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 0.95 | 1.5E-03 | 1.3E-01 | 12.5  2.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   21                    CPU SECONDS = 1.509E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.93 | 1.1E-03 | 1.2E-01 |       2.5E-02  OK|
| V-Mom                | 0.94 | 9.7E-04 | 6.6E-02 |       2.8E-02  OK|
| W-Mom                | 0.88 | 1.5E-03 | 1.6E-01 |       3.6E-02  OK|
| P-Mass               | 0.74 | 1.9E-04 | 4.8E-02 |  9.2  8.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 2.5E-03 | 3.2E-01 | 10.4  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 2.1E-03 | 3.6E-01 |  5.7  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.90 | 2.2E-03 | 1.4E-01 |  5.7  3.6E-02  OK|
| O-TurbFreq           | 1.06 | 1.6E-03 | 1.5E-01 | 12.5  2.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   22                    CPU SECONDS = 1.578E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.86 | 9.2E-04 | 1.0E-01 |       2.9E-02  OK|
| V-Mom                | 0.87 | 8.4E-04 | 6.9E-02 |       3.0E-02  OK|
| W-Mom                | 0.88 | 1.3E-03 | 1.6E-01 |       4.0E-02  OK|
| P-Mass               | 0.78 | 1.5E-04 | 4.8E-02 |  9.2  8.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.84 | 2.1E-03 | 3.9E-01 | 10.4  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.87 | 1.8E-03 | 3.1E-01 |  5.7  8.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.86 | 1.9E-03 | 1.4E-01 |  5.7  3.9E-02  OK|
| O-TurbFreq           | 0.82 | 1.3E-03 | 1.2E-01 | 12.5  2.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   23                    CPU SECONDS = 1.647E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.88 | 8.2E-04 | 9.3E-02 |       3.4E-02  OK|
| V-Mom                | 0.89 | 7.5E-04 | 6.8E-02 |       2.9E-02  OK|
| W-Mom                | 0.86 | 1.1E-03 | 1.1E-01 |       4.5E-02  OK|
| P-Mass               | 0.75 | 1.1E-04 | 2.6E-02 |  9.2  8.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 1.9E-03 | 3.5E-01 | 10.4  2.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.91 | 1.7E-03 | 3.3E-01 |  5.7  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.88 | 1.7E-03 | 1.3E-01 |  5.7  3.6E-02  OK|
| O-TurbFreq           | 0.87 | 1.1E-03 | 7.5E-02 | 12.5  2.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   24                    CPU SECONDS = 1.716E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.87 | 7.1E-04 | 7.3E-02 |       3.4E-02  OK|
| V-Mom                | 0.88 | 6.6E-04 | 6.1E-02 |       2.7E-02  OK|
```

```
| W-Mom                | 0.87 | 9.6E-04 | 1.0E-01 |       4.7E-02  OK|
| P-Mass               | 0.90 | 1.0E-04 | 2.0E-02 |  9.2  8.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 1.7E-03 | 2.2E-01 | 10.4  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.93 | 1.6E-03 | 3.7E-01 |  5.7  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 1.7E-03 | 1.4E-01 |  5.7  3.3E-02  OK|
| O-TurbFreq           | 1.02 | 1.1E-03 | 7.2E-02 | 12.5  2.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   25              CPU SECONDS = 1.785E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.88 | 6.2E-04 | 6.0E-02 |       3.1E-02  OK|
| V-Mom                | 0.90 | 6.0E-04 | 4.3E-02 |       2.5E-02  OK|
| W-Mom                | 0.89 | 8.5E-04 | 7.7E-02 |       4.8E-02  OK|
| P-Mass               | 0.97 | 9.7E-05 | 1.4E-02 |  9.2  9.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 1.7E-03 | 1.8E-01 | 10.4  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.93 | 1.5E-03 | 2.2E-01 |  5.7  7.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 1.6E-03 | 1.3E-01 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 1.02 | 1.2E-03 | 6.0E-02 | 12.5  1.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   26              CPU SECONDS = 1.854E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.94 | 5.8E-04 | 4.9E-02 |       2.9E-02  OK|
| V-Mom                | 0.95 | 5.7E-04 | 3.4E-02 |       2.5E-02  OK|
| W-Mom                | 0.91 | 7.7E-04 | 6.6E-02 |       4.8E-02  OK|
| P-Mass               | 0.98 | 9.5E-05 | 1.1E-02 |  9.2  8.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.89 | 1.5E-03 | 1.7E-01 | 10.4  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.94 | 1.4E-03 | 3.0E-01 |  5.7  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.87 | 1.4E-03 | 9.2E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq           | 0.95 | 1.1E-03 | 7.9E-02 | 12.5  1.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   27              CPU SECONDS = 1.923E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.94 | 5.5E-04 | 5.2E-02 |       3.0E-02  OK|
| V-Mom                | 0.96 | 5.4E-04 | 2.8E-02 |       2.7E-02  OK|
| W-Mom                | 0.93 | 7.2E-04 | 5.6E-02 |       4.8E-02  OK|
| P-Mass               | 1.00 | 9.4E-05 | 8.9E-03 |  9.2  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.89 | 1.3E-03 | 1.2E-01 | 10.4  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.89 | 1.2E-03 | 3.5E-01 |  5.7  7.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.88 | 1.2E-03 | 7.5E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq           | 0.97 | 1.1E-03 | 8.8E-02 | 12.5  1.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   28              CPU SECONDS = 1.992E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.93 | 5.1E-04 | 4.4E-02 |       3.7E-02  OK|
| V-Mom                | 0.93 | 5.0E-04 | 3.1E-02 |       3.2E-02  OK|
| W-Mom                | 0.96 | 6.9E-04 | 6.2E-02 |       5.0E-02  OK|
| P-Mass               | 1.13 | 1.1E-04 | 1.1E-02 |  9.2  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.86 | 1.1E-03 | 1.0E-01 | 10.4  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.86 | 1.1E-03 | 2.3E-01 |  5.7  9.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.91 | 1.1E-03 | 8.8E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 0.95 | 1.0E-03 | 8.1E-02 | 12.5  9.3E-06  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   29              CPU SECONDS = 2.061E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
```

```
| U-Mom | 0.93 | 4.8E-04 | 5.4E-02 | 4.8E-02 OK|
| V-Mom | 0.93 | 4.7E-04 | 4.3E-02 | 4.0E-02 OK|
| W-Mom | 0.93 | 6.4E-04 | 6.5E-02 | 5.3E-02 OK|
| P-Mass | 1.06 | 1.1E-04 | 1.7E-02 | 9.2 5.4E-02 OK|
+----------------------+------+---------+---------+------------------+
| dummy | 0.90 | 1.0E-03 | 9.8E-02 | 10.4 5.8E-02 OK|
+----------------------+------+---------+---------+------------------+
| H-Energy | 0.95 | 9.9E-04 | 1.2E-01 | 10.4 2.2E-02 OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE | 0.92 | 1.0E-03 | 9.6E-02 | 5.7 2.5E-02 OK|
| O-TurbFreq | 0.87 | 8.8E-04 | 8.0E-02 | 12.5 8.3E-06 OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION = 30 CPU SECONDS = 2.131E+04
----------------------------------------------------------------------
| Equation | Rate | RMS Res | Max Res | Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom | 0.90 | 4.3E-04 | 3.6E-02 | 5.4E-02 OK|
| V-Mom | 0.93 | 4.4E-04 | 6.6E-02 | 4.6E-02 OK|
| W-Mom | 0.94 | 6.0E-04 | 7.0E-02 | 5.7E-02 OK|
| P-Mass | 0.96 | 1.1E-04 | 2.1E-02 | 9.2 5.5E-02 OK|
+----------------------+------+---------+---------+------------------+
| dummy | 0.97 | 9.9E-04 | 1.0E-01 | 10.4 4.1E-02 OK|
+----------------------+------+---------+---------+------------------+
| H-Energy | 1.00 | 1.0E-03 | 1.3E-01 | 5.7 9.9E-02 OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE | 0.94 | 9.7E-04 | 1.3E-01 | 5.7 3.1E-02 OK|
| O-TurbFreq | 0.94 | 8.3E-04 | 7.1E-02 | 12.5 8.0E-06 OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION = 31 CPU SECONDS = 2.200E+04
----------------------------------------------------------------------
| Equation | Rate | RMS Res | Max Res | Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom | 0.88 | 3.8E-04 | 4.3E-02 | 5.0E-02 OK|
| V-Mom | 0.89 | 3.9E-04 | 7.2E-02 | 4.3E-02 OK|
| W-Mom | 0.94 | 5.6E-04 | 9.5E-02 | 5.6E-02 OK|
| P-Mass | 0.90 | 9.8E-05 | 1.9E-02 | 9.2 5.9E-02 OK|
+----------------------+------+---------+---------+------------------+
| dummy | 0.94 | 9.3E-04 | 9.5E-02 | 10.4 3.4E-02 OK|
+----------------------+------+---------+---------+------------------+
| H-Energy | 0.92 | 9.2E-04 | 1.6E-01 | 5.7 9.2E-02 OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE | 0.94 | 9.1E-04 | 1.5E-01 | 5.7 3.8E-02 OK|
| O-TurbFreq | 0.94 | 7.7E-04 | 7.2E-02 | 12.5 8.9E-06 OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION = 32 CPU SECONDS = 2.268E+04
----------------------------------------------------------------------
| Equation | Rate | RMS Res | Max Res | Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom | 0.90 | 3.4E-04 | 5.4E-02 | 4.1E-02 OK|
| V-Mom | 0.88 | 3.4E-04 | 5.6E-02 | 3.6E-02 OK|
| W-Mom | 0.92 | 5.2E-04 | 8.2E-02 | 5.1E-02 OK|
| P-Mass | 0.80 | 7.9E-05 | 1.5E-02 | 9.2 6.0E-02 OK|
+----------------------+------+---------+---------+------------------+
| dummy | 0.91 | 8.4E-04 | 1.3E-01 | 10.5 3.9E-02 OK|
+----------------------+------+---------+---------+------------------+
| H-Energy | 0.92 | 8.4E-04 | 1.2E-01 | 5.7 7.9E-02 OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE | 0.90 | 8.2E-04 | 1.2E-01 | 5.7 3.7E-02 OK|
| O-TurbFreq | 1.01 | 7.8E-04 | 8.7E-02 | 12.5 1.1E-05 OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION = 33 CPU SECONDS = 2.337E+04
----------------------------------------------------------------------
| Equation | Rate | RMS Res | Max Res | Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom | 0.91 | 3.1E-04 | 3.9E-02 | 3.2E-02 OK|
| V-Mom | 0.89 | 3.0E-04 | 4.1E-02 | 2.9E-02 OK|
| W-Mom | 0.90 | 4.6E-04 | 6.3E-02 | 4.7E-02 OK|
| P-Mass | 0.82 | 6.4E-05 | 1.2E-02 | 9.2 5.8E-02 OK|
+----------------------+------+---------+---------+------------------+
| dummy | 0.86 | 7.2E-04 | 1.3E-01 | 10.5 3.7E-02 OK|
+----------------------+------+---------+---------+------------------+
| H-Energy | 0.96 | 8.1E-04 | 1.2E-01 | 5.7 7.0E-02 OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE | 0.87 | 7.2E-04 | 8.5E-02 | 5.7 3.4E-02 OK|
| O-TurbFreq | 0.90 | 7.0E-04 | 8.5E-02 | 12.5 1.3E-05 OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION = 34 CPU SECONDS = 2.406E+04
----------------------------------------------------------------------
```

```
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.93 | 2.9E-04 | 3.8E-02 |       2.7E-02  OK|
| V-Mom                | 0.92 | 2.8E-04 | 3.5E-02 |       2.4E-02  OK|
| W-Mom                | 0.91 | 4.2E-04 | 6.9E-02 |       4.6E-02  OK|
| P-Mass               | 0.88 | 5.6E-05 | 9.1E-03 |  9.2  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.84 | 6.1E-04 | 9.6E-02 |  5.7  9.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 8.0E-04 | 9.8E-02 |  5.7  6.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.87 | 6.2E-04 | 7.0E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 0.91 | 6.4E-04 | 5.7E-02 | 12.5  1.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   35                    CPU SECONDS = 2.474E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.93 | 2.7E-04 | 4.2E-02 |       2.5E-02  OK|
| V-Mom                | 0.94 | 2.6E-04 | 2.2E-02 |       1.9E-02  OK|
| W-Mom                | 0.93 | 3.9E-04 | 8.6E-02 |       4.5E-02  OK|
| P-Mass               | 0.92 | 5.2E-05 | 8.3E-03 |  9.2  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 5.6E-04 | 1.0E-01 | 10.5  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 8.1E-04 | 1.1E-01 |  5.7  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.91 | 5.7E-04 | 6.8E-02 |  5.7  3.9E-02  OK|
| O-TurbFreq           | 0.95 | 6.1E-04 | 1.0E-01 | 12.5  1.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   36                    CPU SECONDS = 2.543E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 2.6E-04 | 5.4E-02 |       2.7E-02  OK|
| V-Mom                | 0.98 | 2.6E-04 | 2.0E-02 |       1.8E-02  OK|
| W-Mom                | 0.95 | 3.7E-04 | 5.8E-02 |       4.3E-02  OK|
| P-Mass               | 0.99 | 5.1E-05 | 9.5E-03 |  9.2  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 5.2E-04 | 7.1E-02 | 10.5  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 7.8E-04 | 8.9E-02 |  5.7  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 5.5E-04 | 8.7E-02 |  5.7  4.8E-02  OK|
| O-TurbFreq           | 1.01 | 6.2E-04 | 1.6E-01 | 12.5  2.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   37                    CPU SECONDS = 2.612E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 2.5E-04 | 2.6E-02 |       3.0E-02  OK|
| V-Mom                | 1.01 | 2.6E-04 | 2.3E-02 |       1.9E-02  OK|
| W-Mom                | 0.98 | 3.7E-04 | 5.8E-02 |       4.3E-02  OK|
| P-Mass               | 1.07 | 5.4E-05 | 1.4E-02 |  9.2  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.90 | 4.6E-04 | 5.4E-02 | 10.5  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.92 | 7.2E-04 | 7.7E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 5.5E-04 | 1.0E-01 |  5.7  4.5E-02  OK|
| O-TurbFreq           | 1.00 | 6.2E-04 | 1.8E-01 | 12.5  2.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   38                    CPU SECONDS = 2.681E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 2.5E-04 | 4.9E-02 |       3.4E-02  OK|
| V-Mom                | 1.01 | 2.6E-04 | 1.9E-02 |       2.4E-02  OK|
| W-Mom                | 1.00 | 3.7E-04 | 5.3E-02 |       4.6E-02  OK|
| P-Mass               | 1.10 | 6.0E-05 | 2.0E-02 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.88 | 4.1E-04 | 3.7E-02 | 10.5  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 7.1E-04 | 5.2E-02 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 5.5E-04 | 9.0E-02 |  5.7  4.1E-02  OK|
| O-TurbFreq           | 0.93 | 5.7E-04 | 1.5E-01 | 12.5  3.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
```

```
OUTER LOOP ITERATION =   39             CPU SECONDS = 2.750E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 2.5E-04 | 3.7E-02 |       3.7E-02  OK|
| V-Mom                | 0.99 | 2.6E-04 | 2.3E-02 |       2.8E-02  OK|
| W-Mom                | 1.02 | 3.8E-04 | 6.2E-02 |       5.6E-02  OK|
| P-Mass               | 1.03 | 6.2E-05 | 2.2E-02 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.86 | 3.5E-04 | 3.2E-02 | 10.5  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 7.4E-04 | 4.9E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 5.5E-04 | 9.6E-02 |  5.7  3.6E-02  OK|
| O-TurbFreq           | 0.94 | 5.4E-04 | 9.3E-02 | 12.5  4.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   40             CPU SECONDS = 2.818E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 2.5E-04 | 4.3E-02 |       4.0E-02  OK|
| V-Mom                | 0.96 | 2.5E-04 | 2.6E-02 |       2.9E-02  OK|
| W-Mom                | 0.99 | 3.7E-04 | 6.7E-02 |       6.7E-02  OK|
| P-Mass               | 0.95 | 5.9E-05 | 2.0E-02 |  9.2  7.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.90 | 3.1E-04 | 3.1E-02 | 10.5  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 7.5E-04 | 9.7E-02 |  5.7  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.94 | 5.2E-04 | 1.0E-01 |  5.7  3.2E-02  OK|
| O-TurbFreq           | 0.94 | 5.1E-04 | 7.0E-02 | 12.5  5.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   41             CPU SECONDS = 2.888E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 2.5E-04 | 5.0E-02 |       4.2E-02  OK|
| V-Mom                | 0.94 | 2.3E-04 | 3.5E-02 |       2.7E-02  OK|
| W-Mom                | 0.96 | 3.6E-04 | 8.6E-02 |       7.7E-02  OK|
| P-Mass               | 0.90 | 5.3E-05 | 1.8E-02 |  9.2  8.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 3.0E-04 | 4.2E-02 | 10.5  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.95 | 7.1E-04 | 7.6E-02 |  5.7  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.92 | 4.7E-04 | 8.1E-02 |  5.7  3.2E-02  OK|
| O-TurbFreq           | 1.01 | 5.2E-04 | 6.9E-02 | 12.5  6.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   42             CPU SECONDS = 2.956E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 2.4E-04 | 5.9E-02 |       4.3E-02  OK|
| V-Mom                | 0.92 | 2.1E-04 | 1.9E-02 |       2.4E-02  OK|
| W-Mom                | 0.95 | 3.4E-04 | 7.5E-02 |       8.4E-02  OK|
| P-Mass               | 0.88 | 4.7E-05 | 1.4E-02 |  9.2  8.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 2.9E-04 | 5.6E-02 |  5.7  9.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.95 | 6.7E-04 | 8.3E-02 |  5.7  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.94 | 4.5E-04 | 6.7E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 0.98 | 5.0E-04 | 6.0E-02 | 12.5  7.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   43             CPU SECONDS = 3.024E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.94 | 2.3E-04 | 6.1E-02 |       4.2E-02  OK|
| V-Mom                | 0.93 | 2.0E-04 | 1.7E-02 |       2.1E-02  OK|
| W-Mom                | 0.94 | 3.2E-04 | 5.8E-02 |       8.6E-02  OK|
| P-Mass               | 0.88 | 4.1E-05 | 1.1E-02 |  9.2  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 2.9E-04 | 7.8E-02 |  5.7  9.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.90 | 6.1E-04 | 9.1E-02 |  5.7  6.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.97 | 4.3E-04 | 5.7E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 0.90 | 4.6E-04 | 1.1E-01 | 12.5  8.2E-05  OK|
+----------------------+------+---------+---------+------------------+
```

```
=====================================================================
OUTER LOOP ITERATION =   44                   CPU SECONDS = 3.092E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom               | 0.94 | 2.1E-04 | 3.4E-02 |       3.8E-02  OK|
| V-Mom               | 0.95 | 1.9E-04 | 1.5E-02 |       1.8E-02  OK|
| W-Mom               | 0.96 | 3.1E-04 | 6.6E-02 |       7.7E-02  OK|
| P-Mass              | 0.87 | 3.6E-05 | 8.4E-03 |  9.2  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 0.99 | 2.8E-04 | 7.7E-02 | 10.5  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 0.92 | 5.5E-04 | 8.9E-02 |  5.7  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 0.98 | 4.2E-04 | 5.5E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq          | 0.93 | 4.2E-04 | 7.4E-02 | 12.5  9.5E-05  OK|
+----------------------+------+---------+---------+------------------+

=====================================================================
OUTER LOOP ITERATION =   45                   CPU SECONDS = 3.161E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom               | 0.96 | 2.1E-04 | 5.2E-02 |       3.3E-02  OK|
| V-Mom               | 0.95 | 1.8E-04 | 2.0E-02 |       1.5E-02  OK|
| W-Mom               | 0.95 | 2.9E-04 | 3.7E-02 |       6.7E-02  OK|
| P-Mass              | 0.90 | 3.2E-05 | 7.8E-03 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 0.99 | 2.8E-04 | 7.8E-02 | 10.5  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 0.88 | 4.9E-04 | 8.6E-02 |  5.7  5.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 0.98 | 4.1E-04 | 4.1E-02 |  5.7  3.2E-02  OK|
| O-TurbFreq          | 0.98 | 4.2E-04 | 4.2E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

=====================================================================
OUTER LOOP ITERATION =   46                   CPU SECONDS = 3.230E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom               | 0.97 | 2.0E-04 | 5.8E-02 |       3.1E-02  OK|
| V-Mom               | 0.95 | 1.7E-04 | 2.4E-02 |       1.4E-02  OK|
| W-Mom               | 0.95 | 2.8E-04 | 3.6E-02 |       5.9E-02  OK|
| P-Mass              | 0.94 | 3.0E-05 | 7.7E-03 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 1.03 | 2.9E-04 | 7.0E-02 | 10.5  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 0.91 | 4.4E-04 | 7.6E-02 |  5.7  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 0.96 | 4.0E-04 | 3.7E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq          | 0.93 | 3.9E-04 | 4.2E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

=====================================================================
OUTER LOOP ITERATION =   47                   CPU SECONDS = 3.298E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom               | 0.95 | 1.9E-04 | 2.9E-02 |       3.4E-02  OK|
| V-Mom               | 0.96 | 1.6E-04 | 3.1E-02 |       1.5E-02  OK|
| W-Mom               | 0.95 | 2.6E-04 | 3.6E-02 |       5.3E-02  OK|
| P-Mass              | 0.94 | 2.8E-05 | 7.2E-03 |  9.2  4.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 1.04 | 3.0E-04 | 5.5E-02 | 10.5  2.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 0.93 | 4.1E-04 | 5.9E-02 |  5.7  4.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 0.97 | 3.8E-04 | 3.4E-02 |  5.7  3.5E-02  OK|
| O-TurbFreq          | 1.01 | 3.9E-04 | 3.9E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

=====================================================================
OUTER LOOP ITERATION =   48                   CPU SECONDS = 3.367E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom               | 0.97 | 1.8E-04 | 6.0E-02 |       3.7E-02  OK|
| V-Mom               | 0.98 | 1.6E-04 | 3.1E-02 |       1.7E-02  OK|
| W-Mom               | 0.95 | 2.5E-04 | 3.6E-02 |       4.8E-02  OK|
| P-Mass              | 0.91 | 2.6E-05 | 5.3E-03 |  9.2  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 1.08 | 3.3E-04 | 5.9E-02 | 10.5  3.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 0.95 | 3.9E-04 | 7.6E-02 |  5.7  4.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 0.98 | 3.8E-04 | 4.4E-02 |  5.7  3.1E-02  OK|
```

```
| O-TurbFreq          | 1.02 | 4.0E-04 | 3.3E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   49              CPU SECONDS = 3.436E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 1.7E-04 | 3.4E-02 |       3.8E-02  OK|
| V-Mom                | 0.98 | 1.6E-04 | 1.9E-02 |       1.8E-02  OK|
| W-Mom                | 0.98 | 2.5E-04 | 4.0E-02 |       4.5E-02  OK|
| P-Mass               | 0.90 | 2.3E-05 | 3.9E-03 |  9.2  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 3.3E-04 | 6.5E-02 | 10.5  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.94 | 3.6E-04 | 5.5E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.97 | 3.7E-04 | 4.7E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 0.96 | 3.8E-04 | 3.0E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   50              CPU SECONDS = 3.505E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 1.7E-04 | 6.1E-02 |       3.5E-02  OK|
| V-Mom                | 0.97 | 1.5E-04 | 1.7E-02 |       1.6E-02  OK|
| W-Mom                | 0.98 | 2.4E-04 | 3.6E-02 |       4.7E-02  OK|
| P-Mass               | 0.93 | 2.2E-05 | 3.4E-03 |  9.2  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.95 | 3.1E-04 | 4.9E-02 | 10.5  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.93 | 3.4E-04 | 5.9E-02 |  5.7  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.93 | 3.4E-04 | 4.1E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 1.00 | 3.8E-04 | 4.3E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   51              CPU SECONDS = 3.574E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.94 | 1.6E-04 | 4.5E-02 |       3.1E-02  OK|
| V-Mom                | 0.94 | 1.4E-04 | 1.6E-02 |       1.4E-02  OK|
| W-Mom                | 0.99 | 2.4E-04 | 7.0E-02 |       5.3E-02  OK|
| P-Mass               | 0.95 | 2.1E-05 | 3.7E-03 |  9.2  5.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.95 | 3.0E-04 | 3.5E-02 | 10.5  3.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.92 | 3.1E-04 | 4.9E-02 |  5.7  4.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 3.3E-04 | 3.3E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 1.00 | 3.8E-04 | 6.0E-02 | 12.5  1.8E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   52              CPU SECONDS = 3.643E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 1.5E-04 | 3.6E-02 |       3.0E-02  OK|
| V-Mom                | 0.96 | 1.4E-04 | 1.6E-02 |       1.3E-02  OK|
| W-Mom                | 0.97 | 2.3E-04 | 4.3E-02 |       5.6E-02  OK|
| P-Mass               | 0.96 | 2.0E-05 | 4.3E-03 |  9.2  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.94 | 2.8E-04 | 3.8E-02 | 10.5  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.91 | 2.9E-04 | 4.3E-02 |  5.7  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 3.2E-04 | 2.9E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 0.85 | 3.3E-04 | 2.7E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   53              CPU SECONDS = 3.711E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 1.5E-04 | 3.3E-02 |       3.3E-02  OK|
| V-Mom                | 0.97 | 1.3E-04 | 2.6E-02 |       1.3E-02  OK|
| W-Mom                | 0.95 | 2.2E-04 | 3.9E-02 |       5.8E-02  OK|
| P-Mass               | 0.97 | 1.9E-05 | 4.5E-03 |  9.2  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 2.7E-04 | 4.6E-02 | 10.5  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.93 | 2.7E-04 | 3.3E-02 |  5.7  6.1E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.91 | 2.9E-04 | 2.4E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 1.06 | 3.5E-04 | 4.3E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   54                CPU SECONDS = 3.780E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 1.4E-04 | 3.1E-02 |       4.1E-02  OK|
| V-Mom                | 0.96 | 1.3E-04 | 1.9E-02 |       1.6E-02  OK|
| W-Mom                | 0.97 | 2.2E-04 | 4.4E-02 |       5.6E-02  OK|
| P-Mass               | 0.93 | 1.8E-05 | 4.3E-03 |  9.2  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 2.7E-04 | 7.1E-02 | 10.5  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.96 | 2.5E-04 | 3.7E-02 |  5.7  7.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.93 | 2.6E-04 | 2.7E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 0.81 | 2.8E-04 | 2.4E-02 | 12.5  1.8E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   55                CPU SECONDS = 3.849E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 1.3E-04 | 4.4E-02 |       5.2E-02  OK|
| V-Mom                | 0.97 | 1.2E-04 | 3.8E-02 |       2.3E-02  OK|
| W-Mom                | 0.93 | 2.0E-04 | 3.9E-02 |       5.6E-02  OK|
| P-Mass               | 0.90 | 1.6E-05 | 3.9E-03 |  9.2  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 2.8E-04 | 8.3E-02 | 10.5  5.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 2.5E-04 | 4.6E-02 |  5.7  7.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.95 | 2.5E-04 | 2.9E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 1.18 | 3.3E-04 | 2.9E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   56                CPU SECONDS = 3.918E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 1.3E-04 | 4.1E-02 |       6.3E-02  OK|
| V-Mom                | 0.98 | 1.2E-04 | 3.1E-02 |       3.0E-02  OK|
| W-Mom                | 0.94 | 1.9E-04 | 4.1E-02 |       6.4E-02  OK|
| P-Mass               | 0.92 | 1.5E-05 | 3.4E-03 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 3.0E-04 | 6.9E-02 | 10.5  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 2.4E-04 | 6.9E-02 |  5.7  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 2.6E-04 | 2.3E-02 |  5.7  3.4E-02  OK|
| O-TurbFreq           | 0.90 | 3.0E-04 | 3.7E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   57                CPU SECONDS = 3.986E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 1.2E-04 | 4.9E-02 |       6.4E-02  OK|
| V-Mom                | 1.00 | 1.2E-04 | 1.5E-02 |       3.2E-02  OK|
| W-Mom                | 0.96 | 1.8E-04 | 3.0E-02 |       7.1E-02  OK|
| P-Mass               | 0.95 | 1.4E-05 | 2.7E-03 |  9.2  6.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 3.0E-04 | 5.2E-02 | 10.5  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.06 | 2.6E-04 | 9.1E-02 |  5.7  7.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.99 | 2.5E-04 | 2.7E-02 |  5.7  3.2E-02  OK|
| O-TurbFreq           | 1.19 | 3.6E-04 | 3.1E-02 | 12.5  1.9E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   58                CPU SECONDS = 4.055E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 1.3E-04 | 6.3E-02 |       5.6E-02  OK|
| V-Mom                | 0.98 | 1.2E-04 | 1.3E-02 |       2.8E-02  OK|
| W-Mom                | 1.02 | 1.8E-04 | 6.3E-02 |       7.6E-02  OK|
| P-Mass               | 1.00 | 1.4E-05 | 1.7E-03 |  9.2  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 2.9E-04 | 2.9E-02 | 10.5  3.5E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 2.7E-04 | 9.9E-02 |  5.7  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 2.6E-04 | 3.3E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 0.76 | 2.7E-04 | 4.0E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   59                    CPU SECONDS = 4.124E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 1.2E-04 | 2.1E-02 |       4.7E-02  OK|
| V-Mom                | 0.95 | 1.1E-04 | 1.7E-02 |       2.4E-02  OK|
| W-Mom                | 1.02 | 1.9E-04 | 4.2E-02 |       8.5E-02  OK|
| P-Mass               | 1.03 | 1.4E-05 | 1.9E-03 |  9.2  7.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 2.8E-04 | 4.7E-02 |  5.7  9.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 2.7E-04 | 1.1E-01 |  5.7  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 4.2E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 1.19 | 3.2E-04 | 3.6E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   60                    CPU SECONDS = 4.192E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.2E-04 | 3.6E-02 |       4.2E-02  OK|
| V-Mom                | 0.97 | 1.1E-04 | 2.3E-02 |       2.2E-02  OK|
| W-Mom                | 1.01 | 1.9E-04 | 5.4E-02 |       8.8E-02  OK|
| P-Mass               | 1.03 | 1.5E-05 | 2.1E-03 |  9.2  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 2.7E-04 | 4.1E-02 | 10.5  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 2.6E-04 | 8.1E-02 |  5.7  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 2.7E-04 | 4.7E-02 |  5.7  3.3E-02  OK|
| O-TurbFreq           | 0.92 | 3.0E-04 | 4.0E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   61                    CPU SECONDS = 4.261E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.3E-04 | 3.7E-02 |       4.1E-02  OK|
| V-Mom                | 0.98 | 1.1E-04 | 2.3E-02 |       2.4E-02  OK|
| W-Mom                | 1.02 | 1.9E-04 | 5.7E-02 |       7.6E-02  OK|
| P-Mass               | 1.02 | 1.5E-05 | 2.0E-03 |  9.2  6.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 2.7E-04 | 3.8E-02 |  5.7  9.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.94 | 2.5E-04 | 4.9E-02 |  5.7  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.95 | 2.5E-04 | 4.7E-02 |  5.7  3.6E-02  OK|
| O-TurbFreq           | 1.17 | 3.5E-04 | 3.8E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   62                    CPU SECONDS = 4.329E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.3E-04 | 4.5E-02 |       4.3E-02  OK|
| V-Mom                | 0.98 | 1.1E-04 | 1.8E-02 |       2.9E-02  OK|
| W-Mom                | 0.96 | 1.8E-04 | 3.4E-02 |       7.0E-02  OK|
| P-Mass               | 1.00 | 1.5E-05 | 2.0E-03 |  9.2  6.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 2.6E-04 | 3.2E-02 | 10.5  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.90 | 2.2E-04 | 4.0E-02 |  5.7  5.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.97 | 2.5E-04 | 4.5E-02 |  5.7  3.8E-02  OK|
| O-TurbFreq           | 0.78 | 2.7E-04 | 3.3E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   63                    CPU SECONDS = 4.398E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 1.2E-04 | 6.0E-02 |       4.8E-02  OK|
| V-Mom                | 0.99 | 1.1E-04 | 2.5E-02 |       3.5E-02  OK|
| W-Mom                | 0.99 | 1.8E-04 | 4.5E-02 |       6.7E-02  OK|
| P-Mass               | 0.98 | 1.5E-05 | 2.1E-03 |  9.2  5.9E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 2.6E-04 | 2.9E-02 |  5.7  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.91 | 2.1E-04 | 2.6E-02 |  5.7  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 2.4E-04 | 4.9E-02 |  5.7  4.1E-02  OK|
| O-TurbFreq           | 1.12 | 3.0E-04 | 2.5E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   64              CPU SECONDS = 4.466E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 1.2E-04 | 4.0E-02 |       5.3E-02  OK|
| V-Mom                | 0.98 | 1.0E-04 | 2.6E-02 |       3.8E-02  OK|
| W-Mom                | 0.96 | 1.7E-04 | 3.3E-02 |       6.9E-02  OK|
| P-Mass               | 0.94 | 1.4E-05 | 2.2E-03 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 2.7E-04 | 3.2E-02 |  5.7  8.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.91 | 1.9E-04 | 2.7E-02 |  5.7  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 2.4E-04 | 4.7E-02 |  5.7  3.7E-02  OK|
| O-TurbFreq           | 0.96 | 2.9E-04 | 3.3E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   65              CPU SECONDS = 4.534E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 1.2E-04 | 7.5E-02 |       5.4E-02  OK|
| V-Mom                | 0.96 | 9.9E-05 | 1.5E-02 |       3.6E-02  OK|
| W-Mom                | 0.95 | 1.7E-04 | 4.8E-02 |       7.0E-02  OK|
| P-Mass               | 0.93 | 1.3E-05 | 2.2E-03 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 2.6E-04 | 3.6E-02 |  5.7  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.91 | 1.7E-04 | 2.7E-02 |  5.7  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.91 | 2.2E-04 | 3.4E-02 |  5.7  3.4E-02  OK|
| O-TurbFreq           | 1.10 | 3.2E-04 | 4.6E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   66              CPU SECONDS = 4.602E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.94 | 1.2E-04 | 5.7E-02 |       5.2E-02  OK|
| V-Mom                | 0.96 | 9.5E-05 | 1.6E-02 |       3.1E-02  OK|
| W-Mom                | 0.95 | 1.6E-04 | 4.0E-02 |       7.1E-02  OK|
| P-Mass               | 0.96 | 1.2E-05 | 2.8E-03 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 2.6E-04 | 3.8E-02 |  5.7  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.95 | 1.6E-04 | 3.1E-02 |  5.7  5.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.94 | 2.0E-04 | 3.1E-02 |  5.7  3.3E-02  OK|
| O-TurbFreq           | 0.83 | 2.6E-04 | 2.6E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   67              CPU SECONDS = 4.670E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.92 | 1.1E-04 | 3.3E-02 |       5.1E-02  OK|
| V-Mom                | 0.96 | 9.1E-05 | 1.7E-02 |       2.8E-02  OK|
| W-Mom                | 0.93 | 1.5E-04 | 5.4E-02 |       7.4E-02  OK|
| P-Mass               | 0.96 | 1.2E-05 | 2.9E-03 |  9.2  6.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 2.5E-04 | 4.0E-02 |  5.7  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.92 | 1.5E-04 | 2.9E-02 |  5.7  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.99 | 2.0E-04 | 2.5E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 1.02 | 2.7E-04 | 2.9E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   68              CPU SECONDS = 4.739E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 1.1E-04 | 6.5E-02 |       4.7E-02  OK|
| V-Mom                | 0.99 | 9.0E-05 | 2.4E-02 |       2.5E-02  OK|
```

```
| W-Mom               | 0.99 | 1.4E-04 | 5.3E-02 |       7.7E-02  OK|
| P-Mass              | 0.96 | 1.1E-05 | 3.5E-03 |  9.2  6.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 0.95 | 2.4E-04 | 3.7E-02 |  5.7  8.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 0.90 | 1.3E-04 | 2.7E-02 |  5.7  4.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 1.03 | 2.1E-04 | 3.3E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq          | 1.04 | 2.8E-04 | 3.9E-02 | 12.5  1.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   69               CPU SECONDS = 4.807E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom               | 0.95 | 1.1E-04 | 4.9E-02 |       4.1E-02  OK|
| V-Mom               | 0.99 | 8.9E-05 | 2.2E-02 |       2.3E-02  OK|
| W-Mom               | 0.96 | 1.4E-04 | 4.4E-02 |       7.2E-02  OK|
| P-Mass              | 0.97 | 1.1E-05 | 4.5E-03 |  9.2  6.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 0.96 | 2.3E-04 | 3.4E-02 |  5.7  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 0.93 | 1.2E-04 | 2.6E-02 |  5.7  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 0.98 | 2.0E-04 | 3.0E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq          | 1.02 | 2.9E-04 | 3.1E-02 | 12.5  9.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   70               CPU SECONDS = 4.875E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom               | 1.02 | 1.1E-04 | 6.5E-02 |       3.4E-02  OK|
| V-Mom               | 0.99 | 8.8E-05 | 1.7E-02 |       2.1E-02  OK|
| W-Mom               | 0.99 | 1.4E-04 | 5.1E-02 |       6.4E-02  OK|
| P-Mass              | 0.97 | 1.1E-05 | 4.7E-03 |  9.2  5.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 0.96 | 2.2E-04 | 3.4E-02 |  5.7  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 0.97 | 1.2E-04 | 2.3E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 0.96 | 1.9E-04 | 3.4E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq          | 1.00 | 2.9E-04 | 5.0E-02 | 12.5  7.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   71               CPU SECONDS = 4.944E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom               | 0.96 | 1.0E-04 | 3.1E-02 |       3.2E-02  OK|
| V-Mom               | 1.00 | 8.8E-05 | 2.3E-02 |       1.9E-02  OK|
| W-Mom               | 1.00 | 1.4E-04 | 3.6E-02 |       5.8E-02  OK|
| P-Mass              | 1.00 | 1.1E-05 | 5.5E-03 |  9.2  5.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 0.96 | 2.1E-04 | 3.3E-02 |  5.7  8.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 0.98 | 1.2E-04 | 1.9E-02 |  5.7  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 0.94 | 1.8E-04 | 3.6E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq          | 0.90 | 2.6E-04 | 3.1E-02 | 12.5  8.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   72               CPU SECONDS = 5.012E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom               | 1.05 | 1.1E-04 | 5.7E-02 |       3.1E-02  OK|
| V-Mom               | 1.02 | 8.9E-05 | 2.2E-02 |       1.8E-02  OK|
| W-Mom               | 0.99 | 1.4E-04 | 3.2E-02 |       5.8E-02  OK|
| P-Mass              | 0.99 | 1.0E-05 | 3.5E-03 |  9.2  5.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy               | 0.98 | 2.1E-04 | 3.1E-02 |  5.7  8.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy            | 1.01 | 1.2E-04 | 1.9E-02 |  5.7  4.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE            | 0.98 | 1.8E-04 | 2.8E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq          | 1.08 | 2.8E-04 | 3.9E-02 | 12.5  8.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   73               CPU SECONDS = 5.080E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
```

```
| U-Mom             | 0.97 | 1.0E-04 | 3.7E-02 |       3.2E-02  OK|
| V-Mom             | 1.00 | 9.0E-05 | 1.6E-02 |       1.7E-02  OK|
| W-Mom             | 1.00 | 1.4E-04 | 4.0E-02 |       5.7E-02  OK|
| P-Mass            | 1.02 | 1.1E-05 | 3.7E-03 |  9.2  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy             | 0.98 | 2.0E-04 | 2.9E-02 |  5.7  9.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy          | 1.04 | 1.2E-04 | 1.9E-02 |  5.7  5.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE          | 1.00 | 1.8E-04 | 2.0E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq        | 1.03 | 2.9E-04 | 3.1E-02 | 12.5  8.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   74                 CPU SECONDS = 5.149E+04
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom             | 0.98 | 1.0E-04 | 2.8E-02 |       3.4E-02  OK|
| V-Mom             | 1.01 | 9.1E-05 | 1.7E-02 |       1.7E-02  OK|
| W-Mom             | 0.99 | 1.4E-04 | 4.8E-02 |       5.7E-02  OK|
| P-Mass            | 1.00 | 1.1E-05 | 3.5E-03 |  9.2  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy             | 1.01 | 2.0E-04 | 2.8E-02 |  5.7  9.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy          | 1.07 | 1.3E-04 | 2.2E-02 |  5.7  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE          | 0.96 | 1.7E-04 | 2.6E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq        | 1.04 | 3.0E-04 | 4.7E-02 | 12.5  8.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   75                 CPU SECONDS = 5.217E+04
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom             | 1.03 | 1.1E-04 | 3.9E-02 |       3.8E-02  OK|
| V-Mom             | 1.02 | 9.2E-05 | 1.8E-02 |       1.8E-02  OK|
| W-Mom             | 0.99 | 1.4E-04 | 4.7E-02 |       6.0E-02  OK|
| P-Mass            | 1.04 | 1.1E-05 | 4.8E-03 |  9.2  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy             | 1.04 | 2.1E-04 | 2.6E-02 |  5.7  9.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy          | 1.10 | 1.5E-04 | 2.6E-02 |  5.7  5.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE          | 0.97 | 1.7E-04 | 2.6E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq        | 0.85 | 2.5E-04 | 2.2E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   76                 CPU SECONDS = 5.285E+04
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom             | 0.99 | 1.0E-04 | 2.7E-02 |       4.5E-02  OK|
| V-Mom             | 1.03 | 9.5E-05 | 2.5E-02 |       1.9E-02  OK|
| W-Mom             | 0.99 | 1.3E-04 | 4.5E-02 |       7.0E-02  OK|
| P-Mass            | 1.00 | 1.1E-05 | 3.6E-03 |  9.2  7.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy             | 1.07 | 2.3E-04 | 3.2E-02 |  5.7  8.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy          | 1.07 | 1.6E-04 | 2.8E-02 |  5.7  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE          | 1.02 | 1.7E-04 | 2.5E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq        | 1.02 | 2.6E-04 | 2.9E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   77                 CPU SECONDS = 5.354E+04
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom             | 1.07 | 1.1E-04 | 6.6E-02 |       4.9E-02  OK|
| V-Mom             | 1.00 | 9.5E-05 | 2.3E-02 |       2.0E-02  OK|
| W-Mom             | 1.02 | 1.4E-04 | 5.2E-02 |       7.6E-02  OK|
| P-Mass            | 1.01 | 1.1E-05 | 4.3E-03 |  9.2  8.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy             | 1.05 | 2.4E-04 | 3.6E-02 |  5.7  8.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy          | 1.04 | 1.6E-04 | 2.7E-02 |  5.7  6.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE          | 1.01 | 1.7E-04 | 2.8E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq        | 1.17 | 3.0E-04 | 3.1E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   78                 CPU SECONDS = 5.422E+04
----------------------------------------------------------------------
```

```
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 1.1E-04 | 5.7E-02 |       5.2E-02  OK|
| V-Mom                | 1.00 | 9.5E-05 | 2.0E-02 |       2.0E-02  OK|
| W-Mom                | 1.00 | 1.4E-04 | 3.9E-02 |       7.8E-02  OK|
| P-Mass               | 0.98 | 1.1E-05 | 3.7E-03 |  9.2  8.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 2.4E-04 | 3.5E-02 |  5.7  8.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.7E-04 | 2.9E-02 |  5.7  6.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 1.7E-04 | 2.5E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq           | 0.95 | 2.9E-04 | 3.6E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   79                    CPU SECONDS = 5.490E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 1.1E-04 | 3.8E-02 |       5.4E-02  OK|
| V-Mom                | 0.99 | 9.4E-05 | 2.2E-02 |       2.0E-02  OK|
| W-Mom                | 0.97 | 1.3E-04 | 1.8E-02 |       8.2E-02  OK|
| P-Mass               | 0.99 | 1.1E-05 | 4.0E-03 |  9.2  9.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 2.4E-04 | 3.5E-02 |  5.7  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 1.8E-04 | 3.7E-02 |  5.7  6.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 1.7E-04 | 2.1E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq           | 0.94 | 2.7E-04 | 3.1E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   80                    CPU SECONDS = 5.559E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.05 | 1.2E-04 | 6.3E-02 |       5.5E-02  OK|
| V-Mom                | 1.01 | 9.5E-05 | 2.3E-02 |       2.0E-02  OK|
| W-Mom                | 1.02 | 1.4E-04 | 4.0E-02 |       8.8E-02  OK|
| P-Mass               | 0.97 | 1.0E-05 | 3.9E-03 |  9.2  8.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 2.3E-04 | 4.1E-02 |  5.7  7.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 1.7E-04 | 4.3E-02 |  5.7  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.05 | 1.8E-04 | 2.2E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq           | 0.94 | 2.5E-04 | 3.3E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   81                    CPU SECONDS = 5.627E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 1.2E-04 | 5.1E-02 |       5.3E-02  OK|
| V-Mom                | 1.00 | 9.6E-05 | 2.1E-02 |       1.9E-02  OK|
| W-Mom                | 1.00 | 1.4E-04 | 3.0E-02 |       8.6E-02  OK|
| P-Mass               | 1.01 | 1.0E-05 | 4.2E-03 |  9.2  8.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 2.3E-04 | 4.6E-02 |  5.7  7.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 1.7E-04 | 4.8E-02 |  5.7  5.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 1.8E-04 | 1.9E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 1.22 | 3.1E-04 | 3.8E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   82                    CPU SECONDS = 5.695E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 1.1E-04 | 4.9E-02 |       4.8E-02  OK|
| V-Mom                | 1.03 | 9.8E-05 | 2.3E-02 |       1.8E-02  OK|
| W-Mom                | 1.03 | 1.4E-04 | 4.1E-02 |       7.9E-02  OK|
| P-Mass               | 0.98 | 1.0E-05 | 4.1E-03 |  9.2  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 2.3E-04 | 3.7E-02 |  5.7  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 1.7E-04 | 3.9E-02 |  5.7  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.07 | 1.9E-04 | 1.8E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 0.89 | 2.7E-04 | 3.4E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
```

```
OUTER LOOP ITERATION =   83              CPU SECONDS = 5.764E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 1.1E-04 | 6.2E-02 |       4.3E-02  OK|
| V-Mom                | 1.01 | 1.0E-04 | 2.3E-02 |       1.7E-02  OK|
| W-Mom                | 1.09 | 1.5E-04 | 6.0E-02 |       7.4E-02  OK|
| P-Mass               | 1.03 | 1.1E-05 | 4.9E-03 |  9.2  7.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 2.3E-04 | 3.6E-02 |  5.7  7.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.7E-04 | 3.8E-02 |  5.7  5.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.97 | 1.9E-04 | 1.7E-02 |  5.7  2.2E-02  OK|
| O-TurbFreq           | 1.17 | 3.2E-04 | 3.4E-02 | 12.5  9.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   84              CPU SECONDS = 5.832E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 1.1E-04 | 4.3E-02 |       3.9E-02  OK|
| V-Mom                | 1.02 | 1.0E-04 | 2.5E-02 |       1.5E-02  OK|
| W-Mom                | 1.09 | 1.7E-04 | 5.7E-02 |       7.5E-02  OK|
| P-Mass               | 0.97 | 1.0E-05 | 4.7E-03 |  9.2  6.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 2.3E-04 | 3.8E-02 |  5.7  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.7E-04 | 4.0E-02 |  5.7  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 1.9E-04 | 1.8E-02 |  5.7  1.9E-02  OK|
| O-TurbFreq           | 0.84 | 2.7E-04 | 2.1E-02 | 12.5  8.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   85              CPU SECONDS = 5.900E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.08 | 1.2E-04 | 7.4E-02 |       3.3E-02  OK|
| V-Mom                | 1.00 | 1.0E-04 | 2.3E-02 |       1.4E-02  OK|
| W-Mom                | 1.11 | 1.9E-04 | 1.0E-01 |       6.8E-02  OK|
| P-Mass               | 1.07 | 1.1E-05 | 6.8E-03 |  9.2  6.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 2.3E-04 | 7.4E-02 |  5.7  7.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 1.8E-04 | 7.2E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.9E-04 | 1.9E-02 |  5.7  1.8E-02  OK|
| O-TurbFreq           | 1.16 | 3.1E-04 | 3.4E-02 | 12.5  9.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   86              CPU SECONDS = 5.968E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 1.1E-04 | 3.2E-02 |       2.8E-02  OK|
| V-Mom                | 0.98 | 9.9E-05 | 2.1E-02 |       1.2E-02  OK|
| W-Mom                | 0.92 | 1.7E-04 | 7.5E-02 |       5.8E-02  OK|
| P-Mass               | 0.99 | 1.1E-05 | 7.9E-03 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 2.2E-04 | 4.8E-02 |  5.7  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 1.8E-04 | 4.7E-02 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 2.0E-04 | 1.7E-02 |  5.7  1.9E-02  OK|
| O-TurbFreq           | 0.96 | 3.0E-04 | 3.6E-02 | 12.5  9.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   87              CPU SECONDS = 6.037E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 1.1E-04 | 4.5E-02 |       2.5E-02  OK|
| V-Mom                | 0.96 | 9.5E-05 | 2.3E-02 |       1.1E-02  OK|
| W-Mom                | 0.87 | 1.5E-04 | 3.9E-02 |       5.2E-02  OK|
| P-Mass               | 1.14 | 1.2E-05 | 1.4E-02 |  9.2  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 2.2E-04 | 5.3E-02 |  5.7  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.8E-04 | 5.2E-02 |  5.7  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.97 | 1.9E-04 | 2.9E-02 |  5.7  2.1E-02  OK|
| O-TurbFreq           | 1.08 | 3.2E-04 | 4.0E-02 | 12.5  9.2E-05  OK|
+----------------------+------+---------+---------+------------------+
```

```
======================================================================
OUTER LOOP ITERATION =   88                 CPU SECONDS = 6.105E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 0.97 | 1.1E-04 | 3.5E-02 |       2.4E-02  OK|
| V-Mom              | 0.97 | 9.2E-05 | 2.2E-02 |       1.0E-02  OK|
| W-Mom              | 0.91 | 1.4E-04 | 2.5E-02 |       4.9E-02  OK|
| P-Mass             | 0.93 | 1.2E-05 | 1.2E-02 |  9.2  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 0.97 | 2.1E-04 | 4.9E-02 |  5.7  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 1.01 | 1.8E-04 | 5.0E-02 |  5.7  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 0.92 | 1.8E-04 | 1.4E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq         | 0.87 | 2.8E-04 | 2.6E-02 | 12.5  8.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   89                 CPU SECONDS = 6.173E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 0.98 | 1.1E-04 | 4.3E-02 |       2.4E-02  OK|
| V-Mom              | 0.97 | 9.0E-05 | 2.2E-02 |       1.1E-02  OK|
| W-Mom              | 0.98 | 1.3E-04 | 3.6E-02 |       4.5E-02  OK|
| P-Mass             | 1.01 | 1.2E-05 | 1.2E-02 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 0.95 | 2.0E-04 | 4.3E-02 |  5.7  8.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 1.00 | 1.8E-04 | 4.9E-02 |  5.7  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.00 | 1.8E-04 | 2.5E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq         | 1.07 | 3.0E-04 | 3.4E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   90                 CPU SECONDS = 6.242E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 1.00 | 1.1E-04 | 7.5E-02 |       2.7E-02  OK|
| V-Mom              | 1.00 | 9.0E-05 | 2.4E-02 |       1.3E-02  OK|
| W-Mom              | 1.01 | 1.3E-04 | 4.6E-02 |       4.3E-02  OK|
| P-Mass             | 0.98 | 1.1E-05 | 1.2E-02 |  9.2  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 0.95 | 1.9E-04 | 4.2E-02 | 10.5  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 1.00 | 1.8E-04 | 4.4E-02 |  5.7  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.01 | 1.8E-04 | 1.8E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq         | 0.98 | 3.0E-04 | 4.1E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   91                 CPU SECONDS = 6.310E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 0.92 | 9.8E-05 | 4.1E-02 |       3.1E-02  OK|
| V-Mom              | 0.97 | 8.7E-05 | 2.0E-02 |       1.6E-02  OK|
| W-Mom              | 1.02 | 1.4E-04 | 5.6E-02 |       4.4E-02  OK|
| P-Mass             | 1.00 | 1.1E-05 | 1.1E-02 |  9.2  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 0.94 | 1.8E-04 | 4.6E-02 |  5.7  9.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 0.97 | 1.7E-04 | 4.3E-02 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.05 | 1.9E-04 | 2.0E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq         | 1.05 | 3.1E-04 | 3.9E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   92                 CPU SECONDS = 6.379E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 1.00 | 9.8E-05 | 4.7E-02 |       3.5E-02  OK|
| V-Mom              | 0.98 | 8.6E-05 | 2.4E-02 |       2.1E-02  OK|
| W-Mom              | 1.05 | 1.4E-04 | 8.2E-02 |       4.8E-02  OK|
| P-Mass             | 1.00 | 1.1E-05 | 1.1E-02 |  9.2  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 0.93 | 1.7E-04 | 5.0E-02 | 10.5  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 0.98 | 1.7E-04 | 5.1E-02 |  5.7  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 0.95 | 1.8E-04 | 2.0E-02 |  5.7  2.9E-02  OK|
```

```
| O-TurbFreq          | 1.03 | 3.2E-04 | 3.2E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   93              CPU SECONDS = 6.448E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 9.9E-05 | 3.2E-02 |       4.0E-02  OK|
| V-Mom                | 0.99 | 8.5E-05 | 2.3E-02 |       2.4E-02  OK|
| W-Mom                | 0.96 | 1.4E-04 | 7.9E-02 |       5.6E-02  OK|
| P-Mass               | 0.99 | 1.1E-05 | 1.1E-02 |  9.2  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 1.6E-04 | 1.0E-01 | 10.5  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 1.7E-04 | 1.0E-01 |  5.7  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.05 | 1.9E-04 | 1.9E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 0.90 | 2.9E-04 | 2.5E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   94              CPU SECONDS = 6.516E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 1.0E-04 | 5.2E-02 |       4.3E-02  OK|
| V-Mom                | 0.99 | 8.4E-05 | 1.9E-02 |       2.7E-02  OK|
| W-Mom                | 0.94 | 1.3E-04 | 3.5E-02 |       6.0E-02  OK|
| P-Mass               | 1.02 | 1.1E-05 | 1.1E-02 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.91 | 1.5E-04 | 6.6E-02 | 10.5  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 1.7E-04 | 6.6E-02 |  5.7  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.99 | 1.8E-04 | 1.8E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 1.10 | 3.1E-04 | 3.9E-02 | 12.5  1.9E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   95              CPU SECONDS = 6.585E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 1.0E-04 | 4.8E-02 |       4.5E-02  OK|
| V-Mom                | 0.99 | 8.3E-05 | 2.2E-02 |       2.7E-02  OK|
| W-Mom                | 0.99 | 1.3E-04 | 2.4E-02 |       6.4E-02  OK|
| P-Mass               | 0.99 | 1.1E-05 | 1.0E-02 |  9.2  6.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 1.4E-04 | 7.1E-02 | 10.5  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.8E-04 | 7.0E-02 |  5.7  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.9E-04 | 1.7E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 0.97 | 3.1E-04 | 3.0E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   96              CPU SECONDS = 6.654E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 1.0E-04 | 6.8E-02 |       4.4E-02  OK|
| V-Mom                | 0.99 | 8.3E-05 | 2.2E-02 |       2.6E-02  OK|
| W-Mom                | 1.01 | 1.3E-04 | 2.5E-02 |       6.7E-02  OK|
| P-Mass               | 1.00 | 1.1E-05 | 1.1E-02 |  9.2  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 1.4E-04 | 7.0E-02 |  5.7  1.0E-01  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.06 | 1.9E-04 | 6.8E-02 |  5.7  5.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 1.9E-04 | 1.9E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 1.07 | 3.3E-04 | 4.7E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   97              CPU SECONDS = 6.722E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 1.0E-04 | 3.2E-02 |       4.2E-02  OK|
| V-Mom                | 0.98 | 8.1E-05 | 1.9E-02 |       2.4E-02  OK|
| W-Mom                | 1.05 | 1.4E-04 | 4.5E-02 |       6.6E-02  OK|
| P-Mass               | 1.00 | 1.1E-05 | 1.1E-02 |  9.2  7.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 1.3E-04 | 4.2E-02 | 10.5  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.06 | 2.0E-04 | 7.0E-02 |  5.7  5.7E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 1.9E-04 | 1.7E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq           | 0.93 | 3.0E-04 | 2.6E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   98                   CPU SECONDS = 6.791E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.07 | 1.1E-04 | 6.5E-02 |       3.9E-02  OK|
| V-Mom                | 1.00 | 8.1E-05 | 1.7E-02 |       2.2E-02  OK|
| W-Mom                | 1.05 | 1.4E-04 | 5.3E-02 |       6.3E-02  OK|
| P-Mass               | 1.02 | 1.2E-05 | 1.1E-02 |  9.2  7.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 1.4E-04 | 6.3E-02 |  5.7  9.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.07 | 2.1E-04 | 8.0E-02 |  5.7  5.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 2.0E-04 | 2.2E-02 |  5.7  2.1E-02  OK|
| O-TurbFreq           | 1.09 | 3.3E-04 | 3.2E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =   99                   CPU SECONDS = 6.859E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 1.0E-04 | 3.4E-02 |       3.6E-02  OK|
| V-Mom                | 1.00 | 8.1E-05 | 1.8E-02 |       2.0E-02  OK|
| W-Mom                | 1.08 | 1.5E-04 | 7.4E-02 |       5.9E-02  OK|
| P-Mass               | 1.02 | 1.2E-05 | 1.1E-02 |  9.2  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 1.4E-04 | 6.3E-02 |  5.7  9.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.06 | 2.2E-04 | 6.2E-02 |  5.7  5.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 2.0E-04 | 2.2E-02 |  5.7  2.1E-02  OK|
| O-TurbFreq           | 0.99 | 3.3E-04 | 4.4E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  100                   CPU SECONDS = 6.928E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 1.0E-04 | 3.3E-02 |       3.0E-02  OK|
| V-Mom                | 0.99 | 8.0E-05 | 2.3E-02 |       1.5E-02  OK|
| W-Mom                | 1.00 | 1.6E-04 | 6.4E-02 |       5.3E-02  OK|
| P-Mass               | 1.02 | 1.2E-05 | 1.1E-02 |  9.2  6.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.11 | 1.5E-04 | 1.1E-01 |  5.7  9.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.11 | 2.5E-04 | 1.1E-01 |  5.7  5.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.05 | 2.1E-04 | 2.2E-02 |  5.7  2.0E-02  OK|
| O-TurbFreq           | 1.02 | 3.3E-04 | 3.9E-02 | 12.5  1.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  101                   CPU SECONDS = 6.996E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 1.1E-04 | 4.2E-02 |       2.2E-02  OK|
| V-Mom                | 0.99 | 7.9E-05 | 2.2E-02 |       9.4E-03  OK|
| W-Mom                | 0.97 | 1.5E-04 | 4.2E-02 |       4.3E-02  OK|
| P-Mass               | 1.00 | 1.2E-05 | 1.1E-02 |  9.2  5.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.04 | 1.6E-04 | 1.4E-01 |  5.7  8.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 2.5E-04 | 1.4E-01 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 2.0E-04 | 1.7E-02 |  5.7  1.6E-02  OK|
| O-TurbFreq           | 0.98 | 3.3E-04 | 3.0E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  102                   CPU SECONDS = 7.064E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 1.1E-04 | 3.1E-02 |       2.2E-02  OK|
| V-Mom                | 1.00 | 7.9E-05 | 1.8E-02 |       8.7E-03  OK|
| W-Mom                | 0.99 | 1.5E-04 | 2.8E-02 |       3.9E-02  OK|
| P-Mass               | 1.01 | 1.2E-05 | 1.1E-02 |  9.2  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 1.6E-04 | 1.2E-01 |  5.7  7.9E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.95 | 2.4E-04 | 1.1E-01 |  5.7  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.06 | 2.2E-04 | 1.7E-02 |  5.7  1.4E-02  OK|
| O-TurbFreq           | 0.95 | 3.1E-04 | 2.9E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  103                    CPU SECONDS = 7.133E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.1E-04 | 5.7E-02 |       2.2E-02  OK|
| V-Mom                | 0.99 | 7.8E-05 | 2.2E-02 |       8.3E-03  OK|
| W-Mom                | 0.99 | 1.5E-04 | 2.9E-02 |       3.8E-02  OK|
| P-Mass               | 0.99 | 1.2E-05 | 1.1E-02 |  9.2  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 1.5E-04 | 9.6E-02 |  5.7  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.95 | 2.2E-04 | 9.4E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.91 | 2.0E-04 | 1.6E-02 |  5.7  1.5E-02  OK|
| O-TurbFreq           | 1.04 | 3.2E-04 | 4.6E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  104                    CPU SECONDS = 7.201E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 1.0E-04 | 6.8E-02 |       2.0E-02  OK|
| V-Mom                | 0.98 | 7.7E-05 | 2.3E-02 |       8.1E-03  OK|
| W-Mom                | 0.98 | 1.4E-04 | 4.7E-02 |       3.5E-02  OK|
| P-Mass               | 1.01 | 1.2E-05 | 1.1E-02 |  9.2  5.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.07 | 1.6E-04 | 1.2E-01 |  5.7  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 2.3E-04 | 1.2E-01 |  5.7  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.99 | 2.0E-04 | 2.6E-02 |  5.7  1.7E-02  OK|
| O-TurbFreq           | 1.00 | 3.2E-04 | 4.1E-02 | 12.5  9.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  105                    CPU SECONDS = 7.269E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.94 | 9.8E-05 | 3.2E-02 |       2.0E-02  OK|
| V-Mom                | 0.97 | 7.5E-05 | 1.7E-02 |       7.7E-03  OK|
| W-Mom                | 0.91 | 1.3E-04 | 3.9E-02 |       3.3E-02  OK|
| P-Mass               | 0.97 | 1.2E-05 | 1.0E-02 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.03 | 1.7E-04 | 1.4E-01 |  5.7  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 2.3E-04 | 1.4E-01 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.93 | 1.8E-04 | 1.7E-02 |  5.7  1.9E-02  OK|
| O-TurbFreq           | 0.98 | 3.2E-04 | 5.2E-02 | 12.5  1.8E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  106                    CPU SECONDS = 7.338E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 9.3E-05 | 2.4E-02 |       2.1E-02  OK|
| V-Mom                | 0.98 | 7.3E-05 | 1.3E-02 |       7.6E-03  OK|
| W-Mom                | 1.02 | 1.3E-04 | 7.5E-02 |       3.0E-02  OK|
| P-Mass               | 0.99 | 1.2E-05 | 1.0E-02 |  9.2  6.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.03 | 1.7E-04 | 1.4E-01 |  5.7  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 2.4E-04 | 1.4E-01 |  5.7  4.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.93 | 1.7E-04 | 1.7E-02 |  5.7  1.7E-02  OK|
| O-TurbFreq           | 0.92 | 2.9E-04 | 2.7E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  107                    CPU SECONDS = 7.406E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 9.4E-05 | 3.1E-02 |       1.9E-02  OK|
| V-Mom                | 0.99 | 7.3E-05 | 1.7E-02 |       7.3E-03  OK|
| W-Mom                | 0.96 | 1.3E-04 | 5.4E-02 |       3.0E-02  OK|
| P-Mass               | 0.95 | 1.1E-05 | 9.5E-03 |  9.2  6.2E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| dummy                | 0.78 | 1.4E-04 | 7.5E-02 |  5.7  7.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.89 | 2.1E-04 | 7.5E-02 |  5.7  4.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.11 | 1.9E-04 | 2.0E-02 |  5.7  1.6E-02  OK|
| O-TurbFreq           | 0.95 | 2.8E-04 | 3.4E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  108                    CPU SECONDS = 7.474E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 9.5E-05 | 4.4E-02 |       1.7E-02  OK|
| V-Mom                | 0.98 | 7.1E-05 | 2.4E-02 |       6.8E-03  OK|
| W-Mom                | 0.94 | 1.2E-04 | 2.8E-02 |       3.0E-02  OK|
| P-Mass               | 0.99 | 1.1E-05 | 9.9E-03 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.95 | 1.3E-04 | 8.1E-02 |  5.7  7.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.95 | 2.0E-04 | 8.1E-02 |  5.7  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.85 | 1.6E-04 | 1.7E-02 |  5.7  1.8E-02  OK|
| O-TurbFreq           | 1.22 | 3.4E-04 | 6.6E-02 | 12.5  8.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  109                    CPU SECONDS = 7.543E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 9.6E-05 | 7.0E-02 |       1.6E-02  OK|
| V-Mom                | 0.95 | 6.8E-05 | 2.2E-02 |       6.3E-03  OK|
| W-Mom                | 1.00 | 1.2E-04 | 2.8E-02 |       2.7E-02  OK|
| P-Mass               | 0.94 | 1.0E-05 | 9.1E-03 |  9.2  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.15 | 1.5E-04 | 1.4E-01 |  5.7  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 2.1E-04 | 1.4E-01 |  5.7  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.28 | 2.1E-04 | 4.2E-02 |  5.7  2.0E-02  OK|
| O-TurbFreq           | 0.83 | 2.8E-04 | 3.5E-02 | 12.5  1.8E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  110                    CPU SECONDS = 7.611E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 9.2E-05 | 4.2E-02 |       1.5E-02  OK|
| V-Mom                | 0.99 | 6.7E-05 | 1.9E-02 |       6.0E-03  OK|
| W-Mom                | 1.02 | 1.3E-04 | 3.3E-02 |       2.5E-02  OK|
| P-Mass               | 1.00 | 1.0E-05 | 9.6E-03 |  9.2  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 1.4E-04 | 1.4E-01 |  5.7  9.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.94 | 2.0E-04 | 1.4E-01 |  5.7  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.85 | 1.8E-04 | 1.9E-02 |  5.7  2.0E-02  OK|
| O-TurbFreq           | 1.06 | 2.9E-04 | 4.4E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  111                    CPU SECONDS = 7.679E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 8.9E-05 | 2.8E-02 |       1.7E-02  OK|
| V-Mom                | 1.02 | 6.8E-05 | 2.2E-02 |       6.0E-03  OK|
| W-Mom                | 1.03 | 1.3E-04 | 4.4E-02 |       2.5E-02  OK|
| P-Mass               | 0.98 | 1.0E-05 | 9.1E-03 |  9.2  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 1.3E-04 | 1.4E-01 | 10.5  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 1.9E-04 | 1.4E-01 |  5.7  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.8E-04 | 2.1E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 0.96 | 2.8E-04 | 3.3E-02 | 12.5  1.8E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  112                    CPU SECONDS = 7.748E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 9.1E-05 | 2.9E-02 |       1.6E-02  OK|
| V-Mom                | 1.04 | 7.1E-05 | 2.2E-02 |       6.6E-03  OK|
```

```
| W-Mom                | 0.99 | 1.3E-04 | 4.3E-02 |       2.3E-02  OK|
| P-Mass               | 1.01 | 1.0E-05 | 9.5E-03 |  9.2  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 1.3E-04 | 1.3E-01 |  5.7  9.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 2.0E-04 | 1.4E-01 |  5.7  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.13 | 2.0E-04 | 2.2E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 0.89 | 2.5E-04 | 3.8E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  113                    CPU SECONDS = 7.816E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 9.2E-05 | 3.1E-02 |       1.7E-02  OK|
| V-Mom                | 1.00 | 7.1E-05 | 1.6E-02 |       7.7E-03  OK|
| W-Mom                | 1.03 | 1.3E-04 | 7.1E-02 |       1.8E-02  OK|
| P-Mass               | 0.98 | 1.0E-05 | 9.3E-03 |  9.2  4.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 1.3E-04 | 1.3E-01 |  5.7  9.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 1.9E-04 | 1.3E-01 |  5.7  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.84 | 1.7E-04 | 2.0E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 1.35 | 3.4E-04 | 7.7E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  114                    CPU SECONDS = 7.885E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 9.4E-05 | 3.9E-02 |       1.9E-02  OK|
| V-Mom                | 1.01 | 7.2E-05 | 1.4E-02 |       1.0E-02  OK|
| W-Mom                | 0.95 | 1.3E-04 | 6.6E-02 |       2.0E-02  OK|
| P-Mass               | 0.98 | 1.0E-05 | 9.6E-03 |  9.2  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.80 | 1.1E-04 | 9.2E-02 |  5.7  9.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.86 | 1.7E-04 | 9.0E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.26 | 2.1E-04 | 4.0E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 0.78 | 2.6E-04 | 4.2E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  115                    CPU SECONDS = 7.953E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 9.5E-05 | 4.4E-02 |       1.7E-02  OK|
| V-Mom                | 0.98 | 7.1E-05 | 1.7E-02 |       1.2E-02  OK|
| W-Mom                | 0.92 | 1.1E-04 | 3.0E-02 |       2.3E-02  OK|
| P-Mass               | 0.98 | 9.7E-06 | 9.7E-03 |  9.2  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.20 | 1.3E-04 | 1.6E-01 |  5.7  9.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.7E-04 | 1.6E-01 |  5.7  4.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.77 | 1.6E-04 | 1.8E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 1.18 | 3.1E-04 | 5.3E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  116                    CPU SECONDS = 8.021E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 9.3E-05 | 6.0E-02 |       2.0E-02  OK|
| V-Mom                | 0.98 | 6.9E-05 | 2.5E-02 |       1.3E-02  OK|
| W-Mom                | 1.04 | 1.2E-04 | 2.8E-02 |       2.5E-02  OK|
| P-Mass               | 0.98 | 9.5E-06 | 9.9E-03 |  9.2  6.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.74 | 9.6E-05 | 1.0E-01 |  5.7  9.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.84 | 1.5E-04 | 1.0E-01 |  5.7  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.08 | 1.8E-04 | 1.8E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq           | 0.73 | 2.3E-04 | 3.3E-02 | 12.5  2.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  117                    CPU SECONDS = 8.090E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
```

```
| U-Mom                | 0.99 | 9.2E-05 | 6.8E-02 |       2.2E-02  OK|
| V-Mom                | 0.95 | 6.6E-05 | 2.3E-02 |       1.2E-02  OK|
| W-Mom                | 1.08 | 1.3E-04 | 3.7E-02 |       2.5E-02  OK|
| P-Mass               | 0.99 | 9.5E-06 | 1.0E-02 |  9.2  6.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.20 | 1.2E-04 | 1.4E-01 |  5.7  9.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.10 | 1.6E-04 | 1.4E-01 |  5.7  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.09 | 1.9E-04 | 2.0E-02 |  5.7  3.3E-02  OK|
| O-TurbFreq           | 1.20 | 2.7E-04 | 4.6E-02 | 12.5  2.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  118                   CPU SECONDS = 8.158E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.89 | 8.2E-05 | 1.9E-02 |       1.8E-02  OK|
| V-Mom                | 0.95 | 6.3E-05 | 2.0E-02 |       1.2E-02  OK|
| W-Mom                | 1.06 | 1.4E-04 | 4.5E-02 |       2.1E-02  OK|
| P-Mass               | 1.01 | 9.5E-06 | 1.0E-02 |  9.2  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.76 | 8.8E-05 | 1.1E-01 |  5.7  9.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.85 | 1.4E-04 | 1.1E-01 |  5.7  2.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 1.9E-04 | 2.2E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 1.10 | 3.0E-04 | 6.5E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  119                   CPU SECONDS = 8.226E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.06 | 8.7E-05 | 2.8E-02 |       1.7E-02  OK|
| V-Mom                | 0.98 | 6.2E-05 | 2.2E-02 |       1.1E-02  OK|
| W-Mom                | 1.01 | 1.4E-04 | 3.9E-02 |       2.0E-02  OK|
| P-Mass               | 1.02 | 9.7E-06 | 1.0E-02 |  9.2  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 9.0E-05 | 7.2E-02 |  5.7  9.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.4E-04 | 7.2E-02 |  5.7  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.15 | 2.2E-04 | 4.0E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 1.00 | 3.0E-04 | 3.6E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  120                   CPU SECONDS = 8.294E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 9.1E-05 | 3.1E-02 |       2.0E-02  OK|
| V-Mom                | 1.12 | 6.9E-05 | 2.2E-02 |       1.1E-02  OK|
| W-Mom                | 1.02 | 1.4E-04 | 6.4E-02 |       2.0E-02  OK|
| P-Mass               | 1.01 | 9.8E-06 | 1.1E-02 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.91 | 8.2E-05 | 6.7E-02 |  5.7  9.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.92 | 1.3E-04 | 6.7E-02 |  5.7  4.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.86 | 1.9E-04 | 2.0E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 0.93 | 2.8E-04 | 5.2E-02 | 12.5  3.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  121                   CPU SECONDS = 8.363E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.08 | 9.8E-05 | 4.8E-02 |       2.4E-02  OK|
| V-Mom                | 1.14 | 7.9E-05 | 1.8E-02 |       1.3E-02  OK|
| W-Mom                | 0.98 | 1.4E-04 | 6.0E-02 |       2.1E-02  OK|
| P-Mass               | 1.02 | 1.0E-05 | 1.1E-02 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.10 | 9.0E-05 | 8.3E-02 |  5.7  9.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 1.3E-04 | 8.3E-02 |  5.7  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.9E-04 | 3.1E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 0.98 | 2.7E-04 | 3.0E-02 | 12.5  2.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  122                   CPU SECONDS = 8.431E+04
----------------------------------------------------------------------
```

```
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.05 | 1.0E-04 | 6.2E-02 |       2.6E-02  OK|
| V-Mom                | 1.11 | 8.8E-05 | 1.7E-02 |       1.5E-02  OK|
| W-Mom                | 0.95 | 1.3E-04 | 2.9E-02 |       2.9E-02  OK|
| P-Mass               | 1.03 | 1.0E-05 | 1.1E-02 |  9.2  5.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.89 | 8.1E-05 | 6.1E-02 |  5.7  9.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.91 | 1.2E-04 | 6.1E-02 |  5.7  4.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.10 | 2.1E-04 | 2.6E-02 |  5.7  2.2E-02  OK|
| O-TurbFreq           | 0.94 | 2.5E-04 | 3.5E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  123                    CPU SECONDS = 8.500E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 9.9E-05 | 4.5E-02 |       2.2E-02  OK|
| V-Mom                | 0.95 | 8.3E-05 | 1.7E-02 |       1.7E-02  OK|
| W-Mom                | 1.01 | 1.3E-04 | 2.9E-02 |       2.5E-02  OK|
| P-Mass               | 1.02 | 1.0E-05 | 1.1E-02 |  9.2  5.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 8.5E-05 | 6.6E-02 | 10.5  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.2E-04 | 6.6E-02 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.86 | 1.8E-04 | 1.7E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq           | 1.27 | 3.2E-04 | 5.6E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  124                    CPU SECONDS = 8.568E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.07 | 1.1E-04 | 8.2E-02 |       2.6E-02  OK|
| V-Mom                | 0.92 | 7.6E-05 | 2.6E-02 |       1.6E-02  OK|
| W-Mom                | 0.97 | 1.3E-04 | 3.9E-02 |       2.5E-02  OK|
| P-Mass               | 0.99 | 1.0E-05 | 1.1E-02 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 8.1E-05 | 5.3E-02 |  5.7  9.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.96 | 1.1E-04 | 5.3E-02 |  5.7  4.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.06 | 1.9E-04 | 3.0E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq           | 0.84 | 2.7E-04 | 3.8E-02 | 12.5  2.9E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  125                    CPU SECONDS = 8.637E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.85 | 9.0E-05 | 3.6E-02 |       3.5E-02  OK|
| V-Mom                | 0.90 | 6.8E-05 | 2.3E-02 |       1.6E-02  OK|
| W-Mom                | 1.00 | 1.3E-04 | 4.9E-02 |       2.7E-02  OK|
| P-Mass               | 0.96 | 1.0E-05 | 1.0E-02 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 7.9E-05 | 5.3E-02 | 10.5  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.2E-04 | 5.3E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.85 | 1.6E-04 | 1.7E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq           | 1.00 | 2.7E-04 | 3.9E-02 | 12.5  2.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  126                    CPU SECONDS = 8.705E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 8.9E-05 | 3.0E-02 |       2.7E-02  OK|
| V-Mom                | 0.94 | 6.4E-05 | 2.1E-02 |       1.9E-02  OK|
| W-Mom                | 0.97 | 1.2E-04 | 4.7E-02 |       2.5E-02  OK|
| P-Mass               | 0.97 | 9.7E-06 | 1.1E-02 |  9.2  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 7.6E-05 | 5.0E-02 | 10.5  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 1.2E-04 | 4.8E-02 |  5.7  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.6E-04 | 2.3E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 0.95 | 2.6E-04 | 3.8E-02 | 12.5  2.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
```

```
OUTER LOOP ITERATION =  127               CPU SECONDS = 8.774E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 8.9E-05 | 3.0E-02 |       2.7E-02  OK|
| V-Mom                | 1.01 | 6.5E-05 | 2.1E-02 |       1.8E-02  OK|
| W-Mom                | 1.06 | 1.3E-04 | 7.3E-02 |       1.9E-02  OK|
| P-Mass               | 0.98 | 9.5E-06 | 1.1E-02 |  9.2  6.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.93 | 7.1E-05 | 3.8E-02 | 10.5  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.2E-04 | 3.8E-02 |  5.7  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.17 | 1.9E-04 | 4.5E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq           | 1.06 | 2.7E-04 | 4.6E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  128               CPU SECONDS = 8.843E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 8.9E-05 | 4.7E-02 |       2.6E-02  OK|
| V-Mom                | 1.02 | 6.7E-05 | 2.2E-02 |       2.1E-02  OK|
| W-Mom                | 1.05 | 1.4E-04 | 7.0E-02 |       1.8E-02  OK|
| P-Mass               | 1.01 | 9.6E-06 | 1.1E-02 |  9.2  6.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.94 | 6.7E-05 | 3.5E-02 |  5.7  9.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.07 | 1.3E-04 | 3.6E-02 |  5.7  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.94 | 1.8E-04 | 3.2E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq           | 1.11 | 3.0E-04 | 4.1E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  129               CPU SECONDS = 8.911E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 9.0E-05 | 6.3E-02 |       2.3E-02  OK|
| V-Mom                | 0.95 | 6.4E-05 | 1.8E-02 |       2.3E-02  OK|
| W-Mom                | 0.93 | 1.3E-04 | 3.2E-02 |       2.3E-02  OK|
| P-Mass               | 0.99 | 9.5E-06 | 1.1E-02 |  9.2  6.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.95 | 6.4E-05 | 2.9E-02 | 10.5  3.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.4E-04 | 2.9E-02 |  5.7  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 1.7E-04 | 1.9E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 0.86 | 2.6E-04 | 4.1E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  130               CPU SECONDS = 8.980E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.94 | 8.4E-05 | 4.9E-02 |       2.6E-02  OK|
| V-Mom                | 0.96 | 6.1E-05 | 1.6E-02 |       2.0E-02  OK|
| W-Mom                | 1.01 | 1.3E-04 | 2.6E-02 |       2.5E-02  OK|
| P-Mass               | 0.98 | 9.3E-06 | 1.1E-02 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 6.3E-05 | 4.3E-02 |  5.7  8.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 1.4E-04 | 4.6E-02 |  5.7  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.93 | 1.6E-04 | 1.8E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 0.92 | 2.4E-04 | 2.8E-02 | 12.5  2.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  131               CPU SECONDS = 9.049E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.11 | 9.3E-05 | 7.8E-02 |       2.7E-02  OK|
| V-Mom                | 1.00 | 6.1E-05 | 1.7E-02 |       2.0E-02  OK|
| W-Mom                | 1.01 | 1.3E-04 | 4.4E-02 |       2.4E-02  OK|
| P-Mass               | 0.99 | 9.2E-06 | 1.1E-02 |  9.2  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 5.8E-05 | 2.6E-02 | 10.5  3.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.91 | 1.2E-04 | 3.4E-02 |  5.7  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.6E-04 | 1.9E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 1.08 | 2.6E-04 | 3.8E-02 | 12.5  2.1E-04  OK|
+----------------------+------+---------+---------+------------------+
```

```
======================================================================
OUTER LOOP ITERATION =  132                    CPU SECONDS = 9.117E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
| U-Mom              | 0.94 | 8.7E-05 | 4.5E-02 |       3.8E-02  OK|
| V-Mom              | 1.05 | 6.4E-05 | 2.6E-02 |       2.2E-02  OK|
| W-Mom              | 1.03 | 1.4E-04 | 5.3E-02 |       2.8E-02  OK|
| P-Mass             | 1.01 | 9.4E-06 | 1.1E-02 |  9.2  7.2E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 0.98 | 5.7E-05 | 2.0E-02 | 10.5  3.1E-02  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 1.00 | 1.2E-04 | 3.7E-02 |  5.7  4.2E-02  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.16 | 1.9E-04 | 2.3E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq         | 1.13 | 2.9E-04 | 4.5E-02 | 12.5  1.7E-04  OK|
+--------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  133                    CPU SECONDS = 9.186E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
| U-Mom              | 0.99 | 8.7E-05 | 2.9E-02 |       4.0E-02  OK|
| V-Mom              | 1.01 | 6.5E-05 | 2.3E-02 |       2.7E-02  OK|
| W-Mom              | 0.99 | 1.3E-04 | 4.7E-02 |       3.1E-02  OK|
| P-Mass             | 1.02 | 9.6E-06 | 1.1E-02 |  9.2  7.1E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 0.99 | 5.7E-05 | 2.4E-02 | 10.5  3.4E-02  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 1.05 | 1.3E-04 | 3.2E-02 |  5.7  5.1E-02  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 0.91 | 1.7E-04 | 2.7E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq         | 1.05 | 3.1E-04 | 5.9E-02 | 12.5  1.8E-04  OK|
+--------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  134                    CPU SECONDS = 9.255E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
| U-Mom              | 0.98 | 8.5E-05 | 2.6E-02 |       3.6E-02  OK|
| V-Mom              | 0.99 | 6.4E-05 | 2.2E-02 |       2.9E-02  OK|
| W-Mom              | 0.98 | 1.3E-04 | 6.7E-02 |       2.8E-02  OK|
| P-Mass             | 1.02 | 9.8E-06 | 1.1E-02 |  9.2  6.7E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 0.96 | 5.5E-05 | 2.1E-02 | 10.5  3.4E-02  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 0.99 | 1.3E-04 | 3.3E-02 |  5.7  5.3E-02  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 0.94 | 1.6E-04 | 1.9E-02 |  5.7  3.2E-02  OK|
| O-TurbFreq         | 0.83 | 2.5E-04 | 3.2E-02 | 12.5  2.4E-04  OK|
+--------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  135                    CPU SECONDS = 9.324E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
| U-Mom              | 1.01 | 8.6E-05 | 3.4E-02 |       3.9E-02  OK|
| V-Mom              | 0.96 | 6.2E-05 | 2.1E-02 |       2.8E-02  OK|
| W-Mom              | 1.02 | 1.3E-04 | 6.2E-02 |       2.5E-02  OK|
| P-Mass             | 0.99 | 9.7E-06 | 1.1E-02 |  9.2  7.4E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 0.92 | 5.0E-05 | 2.5E-02 | 10.5  3.3E-02  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 0.96 | 1.2E-04 | 4.0E-02 |  5.7  4.7E-02  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.02 | 1.6E-04 | 1.9E-02 |  5.7  3.4E-02  OK|
| O-TurbFreq         | 0.88 | 2.2E-04 | 3.2E-02 | 12.5  2.9E-04  OK|
+--------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  136                    CPU SECONDS = 9.393E+04
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
| U-Mom              | 1.04 | 9.0E-05 | 6.9E-02 |       3.8E-02  OK|
| V-Mom              | 0.99 | 6.1E-05 | 2.3E-02 |       3.0E-02  OK|
| W-Mom              | 0.93 | 1.2E-04 | 2.9E-02 |       3.0E-02  OK|
| P-Mass             | 1.00 | 9.6E-06 | 1.1E-02 |  9.2  8.3E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 1.00 | 5.0E-05 | 1.8E-02 | 10.5  3.1E-02  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 1.05 | 1.3E-04 | 4.1E-02 |  5.7  3.7E-02  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 0.99 | 1.6E-04 | 2.1E-02 |  5.7  3.2E-02  OK|
```

```
| O-TurbFreq          | 1.30 | 2.9E-04 | 6.8E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  137                    CPU SECONDS = 9.461E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 8.5E-05 | 4.7E-02 |       2.8E-02  OK|
| V-Mom                | 1.01 | 6.2E-05 | 1.6E-02 |       2.8E-02  OK|
| W-Mom                | 0.98 | 1.2E-04 | 2.2E-02 |       2.9E-02  OK|
| P-Mass               | 0.99 | 9.5E-06 | 1.1E-02 |  9.2  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 4.9E-05 | 2.2E-02 |  5.7  9.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.09 | 1.4E-04 | 3.6E-02 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.23 | 2.0E-04 | 3.7E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq           | 1.04 | 3.0E-04 | 3.9E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  138                    CPU SECONDS = 9.530E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 8.4E-05 | 4.5E-02 |       2.4E-02  OK|
| V-Mom                | 1.08 | 6.7E-05 | 1.5E-02 |       2.4E-02  OK|
| W-Mom                | 1.00 | 1.2E-04 | 4.6E-02 |       2.6E-02  OK|
| P-Mass               | 1.01 | 9.6E-06 | 1.1E-02 |  9.2  7.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 4.9E-05 | 2.0E-02 |  5.7  9.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.17 | 1.6E-04 | 6.1E-02 |  5.7  4.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.73 | 1.5E-04 | 2.1E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 1.11 | 3.3E-04 | 6.1E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  139                    CPU SECONDS = 9.598E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 8.0E-05 | 2.8E-02 |       2.5E-02  OK|
| V-Mom                | 1.13 | 7.5E-05 | 1.7E-02 |       2.2E-02  OK|
| W-Mom                | 0.96 | 1.2E-04 | 5.5E-02 |       2.8E-02  OK|
| P-Mass               | 0.98 | 9.4E-06 | 1.1E-02 |  9.2  7.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 4.8E-05 | 2.2E-02 |  5.7  8.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 1.7E-04 | 6.1E-02 |  5.7  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 1.5E-04 | 1.8E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 0.67 | 2.2E-04 | 3.2E-02 | 12.5  3.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  140                    CPU SECONDS = 9.666E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 8.3E-05 | 3.8E-02 |       2.6E-02  OK|
| V-Mom                | 1.09 | 8.2E-05 | 2.6E-02 |       2.1E-02  OK|
| W-Mom                | 1.03 | 1.2E-04 | 6.5E-02 |       2.4E-02  OK|
| P-Mass               | 1.00 | 9.4E-06 | 1.1E-02 |  9.2  6.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 4.6E-05 | 1.8E-02 |  5.7  8.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.91 | 1.5E-04 | 5.7E-02 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 1.5E-04 | 1.8E-02 |  5.7  3.2E-02  OK|
| O-TurbFreq           | 1.04 | 2.3E-04 | 3.6E-02 | 12.5  1.8E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  141                    CPU SECONDS = 9.735E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 8.3E-05 | 4.9E-02 |       3.0E-02  OK|
| V-Mom                | 0.96 | 7.9E-05 | 2.3E-02 |       2.1E-02  OK|
| W-Mom                | 0.99 | 1.2E-04 | 6.4E-02 |       2.8E-02  OK|
| P-Mass               | 0.99 | 9.3E-06 | 1.1E-02 |  9.2  6.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.95 | 4.4E-05 | 2.1E-02 |  5.7  8.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.79 | 1.2E-04 | 3.6E-02 |  5.7  4.1E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.05 | 1.6E-04 | 1.8E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 1.28 | 3.0E-04 | 6.9E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  142                    CPU SECONDS = 9.803E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 8.4E-05 | 6.0E-02 |       3.8E-02  OK|
| V-Mom                | 0.93 | 7.3E-05 | 2.3E-02 |       2.4E-02  OK|
| W-Mom                | 1.03 | 1.2E-04 | 4.4E-02 |       3.0E-02  OK|
| P-Mass               | 1.02 | 9.4E-06 | 1.1E-02 |  9.2  7.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 4.2E-05 | 1.8E-02 |  5.7  8.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.81 | 1.0E-04 | 2.5E-02 |  5.7  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.37 | 2.2E-04 | 3.9E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 0.94 | 2.8E-04 | 3.9E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  143                    CPU SECONDS = 9.871E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 8.3E-05 | 4.3E-02 |       4.5E-02  OK|
| V-Mom                | 0.90 | 6.6E-05 | 2.0E-02 |       2.6E-02  OK|
| W-Mom                | 1.00 | 1.2E-04 | 2.9E-02 |       3.6E-02  OK|
| P-Mass               | 0.98 | 9.3E-06 | 1.1E-02 |  9.2  7.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 4.1E-05 | 1.9E-02 |  5.7  7.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.94 | 9.3E-05 | 1.9E-02 |  5.7  4.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.77 | 1.7E-04 | 2.1E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq           | 1.12 | 3.1E-04 | 7.1E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  144                    CPU SECONDS = 9.939E+04
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.08 | 8.9E-05 | 6.8E-02 |       3.6E-02  OK|
| V-Mom                | 0.94 | 6.2E-05 | 2.3E-02 |       2.8E-02  OK|
| W-Mom                | 1.06 | 1.3E-04 | 4.9E-02 |       3.6E-02  OK|
| P-Mass               | 0.99 | 9.2E-06 | 1.1E-02 |  9.2  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 4.0E-05 | 1.7E-02 |  5.7  7.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 9.6E-05 | 1.8E-02 |  5.7  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 1.7E-04 | 2.7E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 0.74 | 2.3E-04 | 3.4E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  145                    CPU SECONDS = 1.001E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.92 | 8.2E-05 | 4.3E-02 |       2.8E-02  OK|
| V-Mom                | 0.98 | 6.0E-05 | 1.6E-02 |       2.7E-02  OK|
| W-Mom                | 1.06 | 1.4E-04 | 4.6E-02 |       2.7E-02  OK|
| P-Mass               | 0.99 | 9.1E-06 | 1.1E-02 |  9.2  6.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 4.1E-05 | 1.9E-02 |  5.7  9.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.0E-04 | 2.3E-02 |  5.7  4.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.7E-04 | 2.2E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq           | 1.06 | 2.5E-04 | 3.9E-02 | 12.5  1.9E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  146                    CPU SECONDS = 1.008E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 7.9E-05 | 3.0E-02 |       3.4E-02  OK|
| V-Mom                | 1.03 | 6.2E-05 | 1.5E-02 |       2.4E-02  OK|
| W-Mom                | 0.99 | 1.3E-04 | 3.8E-02 |       2.9E-02  OK|
| P-Mass               | 1.03 | 9.4E-06 | 1.1E-02 |  9.2  6.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 4.2E-05 | 1.9E-02 | 10.5  3.4E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.1E-04 | 2.8E-02 |  5.7  4.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 1.7E-04 | 1.9E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 1.18 | 2.9E-04 | 6.6E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  147                    CPU SECONDS = 1.014E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 8.2E-05 | 3.5E-02 |       3.5E-02  OK|
| V-Mom                | 0.98 | 6.1E-05 | 1.7E-02 |       2.4E-02  OK|
| W-Mom                | 1.02 | 1.4E-04 | 7.6E-02 |       2.5E-02  OK|
| P-Mass               | 0.97 | 9.1E-06 | 1.0E-02 |  9.2  7.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 4.2E-05 | 1.8E-02 | 10.5  3.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.1E-04 | 4.0E-02 |  5.7  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.13 | 1.9E-04 | 3.1E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 1.01 | 2.9E-04 | 4.7E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  148                    CPU SECONDS = 1.021E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 8.3E-05 | 4.2E-02 |       3.2E-02  OK|
| V-Mom                | 1.01 | 6.2E-05 | 2.7E-02 |       2.5E-02  OK|
| W-Mom                | 0.93 | 1.3E-04 | 5.8E-02 |       2.5E-02  OK|
| P-Mass               | 0.98 | 8.9E-06 | 1.0E-02 |  9.2  6.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 4.1E-05 | 1.9E-02 |  5.7  9.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.1E-04 | 2.8E-02 |  5.7  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.79 | 1.5E-04 | 1.9E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 1.00 | 2.9E-04 | 7.6E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  149                    CPU SECONDS = 1.028E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.07 | 8.8E-05 | 8.1E-02 |       3.2E-02  OK|
| V-Mom                | 1.00 | 6.2E-05 | 2.3E-02 |       2.4E-02  OK|
| W-Mom                | 0.86 | 1.1E-04 | 2.9E-02 |       3.2E-02  OK|
| P-Mass               | 0.94 | 8.4E-06 | 9.9E-03 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 4.1E-05 | 2.0E-02 |  5.7  9.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 1.1E-04 | 3.0E-02 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.89 | 1.3E-04 | 2.0E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 0.82 | 2.4E-04 | 3.4E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  150                    CPU SECONDS = 1.035E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.92 | 8.1E-05 | 4.6E-02 |       3.3E-02  OK|
| V-Mom                | 1.01 | 6.3E-05 | 2.4E-02 |       2.6E-02  OK|
| W-Mom                | 0.98 | 1.1E-04 | 5.4E-02 |       2.9E-02  OK|
| P-Mass               | 0.98 | 8.2E-06 | 1.0E-02 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 4.2E-05 | 2.0E-02 |  5.7  9.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.2E-04 | 3.4E-02 |  5.7  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 1.3E-04 | 1.9E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq           | 0.92 | 2.2E-04 | 3.4E-02 | 12.5  2.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  151                    CPU SECONDS = 1.042E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 8.1E-05 | 4.9E-02 |       3.0E-02  OK|
| V-Mom                | 0.96 | 6.0E-05 | 2.0E-02 |       2.7E-02  OK|
| W-Mom                | 0.92 | 9.8E-05 | 3.8E-02 |       2.7E-02  OK|
| P-Mass               | 0.96 | 7.9E-06 | 9.9E-03 |  9.2  6.0E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 4.0E-05 | 1.8E-02 | 10.5  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.2E-04 | 3.0E-02 |  5.7  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.94 | 1.2E-04 | 1.7E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq           | 1.16 | 2.6E-04 | 6.7E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  152                   CPU SECONDS = 1.049E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.87 | 7.1E-05 | 4.2E-02 |       3.2E-02  OK|
| V-Mom                | 0.96 | 5.8E-05 | 2.4E-02 |       2.5E-02  OK|
| W-Mom                | 1.03 | 1.0E-04 | 5.0E-02 |       2.6E-02  OK|
| P-Mass               | 0.99 | 7.8E-06 | 1.0E-02 |  9.2  6.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 4.0E-05 | 1.7E-02 | 10.5  3.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.3E-04 | 3.0E-02 |  5.7  4.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.21 | 1.5E-04 | 2.1E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 0.90 | 2.3E-04 | 3.5E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  153                   CPU SECONDS = 1.056E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.89 | 6.3E-05 | 3.7E-02 |       4.6E-02  OK|
| V-Mom                | 0.94 | 5.5E-05 | 1.5E-02 |       2.3E-02  OK|
| W-Mom                | 1.01 | 1.0E-04 | 4.5E-02 |       2.8E-02  OK|
| P-Mass               | 0.98 | 7.7E-06 | 1.0E-02 |  9.2  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 3.7E-05 | 1.8E-02 |  5.7  9.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.4E-04 | 2.8E-02 |  5.7  5.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.87 | 1.3E-04 | 1.6E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq           | 1.08 | 2.5E-04 | 5.6E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  154                   CPU SECONDS = 1.062E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.08 | 6.8E-05 | 4.9E-02 |       5.2E-02  OK|
| V-Mom                | 0.96 | 5.2E-05 | 1.5E-02 |       2.6E-02  OK|
| W-Mom                | 1.09 | 1.1E-04 | 5.5E-02 |       3.2E-02  OK|
| P-Mass               | 1.01 | 7.8E-06 | 1.0E-02 |  9.2  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.11 | 4.1E-05 | 1.8E-02 |  5.7  9.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.4E-04 | 2.3E-02 |  5.7  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 1.3E-04 | 1.8E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 0.85 | 2.1E-04 | 3.5E-02 | 12.5  2.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  155                   CPU SECONDS = 1.069E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.10 | 7.5E-05 | 6.4E-02 |       4.2E-02  OK|
| V-Mom                | 1.02 | 5.3E-05 | 1.6E-02 |       2.8E-02  OK|
| W-Mom                | 1.09 | 1.2E-04 | 4.6E-02 |       3.3E-02  OK|
| P-Mass               | 1.02 | 7.9E-06 | 1.0E-02 |  9.2  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 4.2E-05 | 1.8E-02 |  5.7  9.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 1.4E-04 | 2.1E-02 |  5.7  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.4E-04 | 2.0E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 1.06 | 2.2E-04 | 3.3E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  156                   CPU SECONDS = 1.076E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 7.7E-05 | 4.0E-02 |       3.3E-02  OK|
| V-Mom                | 1.10 | 5.9E-05 | 2.7E-02 |       2.7E-02  OK|
```

```
| W-Mom                | 0.99 | 1.2E-04 | 3.5E-02 |       3.4E-02  OK|
| P-Mass               | 1.03 | 8.2E-06 | 1.1E-02 |  9.2  6.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.09 | 4.6E-05 | 2.2E-02 |  5.7  8.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.5E-04 | 3.0E-02 |  5.7  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 1.4E-04 | 1.8E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 1.17 | 2.6E-04 | 5.7E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  157                    CPU SECONDS = 1.083E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.18 | 9.0E-05 | 7.3E-02 |       3.2E-02  OK|
| V-Mom                | 1.10 | 6.5E-05 | 2.3E-02 |       2.6E-02  OK|
| W-Mom                | 0.99 | 1.2E-04 | 4.6E-02 |       3.0E-02  OK|
| P-Mass               | 1.01 | 8.3E-06 | 1.1E-02 |  9.2  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 4.5E-05 | 1.8E-02 |  5.7  9.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.10 | 1.7E-04 | 3.8E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.16 | 1.6E-04 | 2.1E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 0.91 | 2.4E-04 | 3.6E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  158                    CPU SECONDS = 1.090E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 8.6E-05 | 4.7E-02 |       3.4E-02  OK|
| V-Mom                | 1.08 | 7.0E-05 | 2.5E-02 |       2.7E-02  OK|
| W-Mom                | 1.00 | 1.2E-04 | 5.2E-02 |       2.8E-02  OK|
| P-Mass               | 1.02 | 8.4E-06 | 1.1E-02 |  9.2  7.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.06 | 4.8E-05 | 2.5E-02 |  5.7  9.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.10 | 1.8E-04 | 6.1E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.87 | 1.4E-04 | 2.0E-02 |  5.7  3.2E-02  OK|
| O-TurbFreq           | 1.11 | 2.7E-04 | 3.5E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  159                    CPU SECONDS = 1.097E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 8.3E-05 | 4.1E-02 |       3.5E-02  OK|
| V-Mom                | 1.01 | 7.1E-05 | 1.9E-02 |       2.6E-02  OK|
| W-Mom                | 1.02 | 1.2E-04 | 5.8E-02 |       3.0E-02  OK|
| P-Mass               | 1.02 | 8.6E-06 | 1.1E-02 |  9.2  7.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.94 | 4.5E-05 | 2.5E-02 |  5.7  8.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 1.8E-04 | 5.2E-02 |  5.7  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 1.4E-04 | 1.8E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq           | 0.88 | 2.4E-04 | 3.2E-02 | 12.5  2.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  160                    CPU SECONDS = 1.104E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 8.0E-05 | 2.6E-02 |       3.5E-02  OK|
| V-Mom                | 0.99 | 7.0E-05 | 2.4E-02 |       2.4E-02  OK|
| W-Mom                | 1.02 | 1.2E-04 | 5.3E-02 |       3.3E-02  OK|
| P-Mass               | 1.02 | 8.7E-06 | 1.1E-02 |  9.2  8.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 4.7E-05 | 3.4E-02 |  5.7  7.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.93 | 1.7E-04 | 4.3E-02 |  5.7  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.94 | 1.3E-04 | 1.8E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 1.09 | 2.6E-04 | 4.6E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  161                    CPU SECONDS = 1.110E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
```

```
| U-Mom          | 1.01 | 8.1E-05 | 4.0E-02 |       3.6E-02  OK|
| V-Mom          | 0.93 | 6.5E-05 | 1.5E-02 |       2.3E-02  OK|
| W-Mom          | 0.97 | 1.2E-04 | 3.3E-02 |       4.0E-02  OK|
| P-Mass         | 0.99 | 8.6E-06 | 1.1E-02 |  9.2  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 0.90 | 4.3E-05 | 2.3E-02 |  5.7  8.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 0.88 | 1.5E-04 | 4.2E-02 |  5.7  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 1.08 | 1.4E-04 | 1.7E-02 |  5.7  2.2E-02  OK|
| O-TurbFreq     | 0.87 | 2.2E-04 | 3.9E-02 | 12.5  2.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  162                    CPU SECONDS = 1.117E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom          | 1.04 | 8.5E-05 | 6.9E-02 |       3.4E-02  OK|
| V-Mom          | 0.98 | 6.3E-05 | 1.5E-02 |       2.3E-02  OK|
| W-Mom          | 1.04 | 1.2E-04 | 3.8E-02 |       3.6E-02  OK|
| P-Mass         | 0.99 | 8.5E-06 | 1.1E-02 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 1.08 | 4.6E-05 | 3.3E-02 | 10.5  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 0.94 | 1.4E-04 | 3.3E-02 |  5.7  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 1.11 | 1.6E-04 | 2.2E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq     | 1.18 | 2.6E-04 | 4.6E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  163                    CPU SECONDS = 1.124E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom          | 0.97 | 8.2E-05 | 5.4E-02 |       3.4E-02  OK|
| V-Mom          | 0.99 | 6.2E-05 | 1.6E-02 |       2.1E-02  OK|
| W-Mom          | 1.03 | 1.3E-04 | 5.2E-02 |       3.1E-02  OK|
| P-Mass         | 1.01 | 8.6E-06 | 1.1E-02 |  9.2  6.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 0.94 | 4.3E-05 | 2.9E-02 | 10.5  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 0.99 | 1.4E-04 | 2.9E-02 |  5.7  5.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 1.03 | 1.6E-04 | 1.8E-02 |  5.7  3.2E-02  OK|
| O-TurbFreq     | 0.95 | 2.5E-04 | 3.2E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  164                    CPU SECONDS = 1.131E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom          | 0.96 | 7.9E-05 | 4.1E-02 |       4.4E-02  OK|
| V-Mom          | 0.99 | 6.2E-05 | 2.7E-02 |       2.1E-02  OK|
| W-Mom          | 0.99 | 1.3E-04 | 5.7E-02 |       3.2E-02  OK|
| P-Mass         | 1.01 | 8.7E-06 | 1.1E-02 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 1.07 | 4.6E-05 | 3.1E-02 | 10.5  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 1.05 | 1.4E-04 | 3.1E-02 |  5.7  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 0.94 | 1.5E-04 | 1.8E-02 |  5.7  3.2E-02  OK|
| O-TurbFreq     | 0.98 | 2.5E-04 | 3.4E-02 | 12.5  1.8E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  165                    CPU SECONDS = 1.138E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom          | 1.02 | 8.0E-05 | 5.5E-02 |       5.1E-02  OK|
| V-Mom          | 0.95 | 5.8E-05 | 2.3E-02 |       2.5E-02  OK|
| W-Mom          | 0.98 | 1.2E-04 | 5.0E-02 |       3.5E-02  OK|
| P-Mass         | 1.00 | 8.7E-06 | 1.1E-02 |  9.2  7.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 0.93 | 4.3E-05 | 2.5E-02 |  5.7  9.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 1.02 | 1.5E-04 | 3.6E-02 |  5.7  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 0.97 | 1.5E-04 | 1.9E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq     | 0.93 | 2.3E-04 | 3.6E-02 | 12.5  2.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  166                    CPU SECONDS = 1.145E+05
----------------------------------------------------------------------
```

```
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 7.6E-05 | 4.0E-02 |       4.5E-02  OK|
| V-Mom                | 1.01 | 5.9E-05 | 2.7E-02 |       2.8E-02  OK|
| W-Mom                | 0.97 | 1.2E-04 | 5.7E-02 |       3.7E-02  OK|
| P-Mass               | 1.00 | 8.8E-06 | 1.1E-02 |  9.2  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.14 | 4.9E-05 | 3.4E-02 |  5.7  9.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.5E-04 | 4.3E-02 |  5.7  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.5E-04 | 2.6E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 0.95 | 2.2E-04 | 4.7E-02 | 12.5  1.9E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  167                   CPU SECONDS = 1.152E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 7.6E-05 | 4.1E-02 |       3.4E-02  OK|
| V-Mom                | 1.02 | 6.0E-05 | 1.8E-02 |       2.8E-02  OK|
| W-Mom                | 1.02 | 1.2E-04 | 7.6E-02 |       3.1E-02  OK|
| P-Mass               | 1.00 | 8.8E-06 | 1.1E-02 |  9.2  7.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.08 | 5.3E-05 | 3.2E-02 |  5.7  8.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.14 | 1.8E-04 | 3.9E-02 |  5.7  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 1.5E-04 | 2.3E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 1.13 | 2.5E-04 | 3.3E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  168                   CPU SECONDS = 1.158E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.06 | 8.1E-05 | 6.6E-02 |       3.2E-02  OK|
| V-Mom                | 1.00 | 6.0E-05 | 2.4E-02 |       2.6E-02  OK|
| W-Mom                | 0.97 | 1.2E-04 | 4.5E-02 |       3.4E-02  OK|
| P-Mass               | 1.01 | 8.9E-06 | 1.1E-02 |  9.2  6.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.08 | 5.7E-05 | 3.6E-02 |  5.7  8.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.17 | 2.1E-04 | 5.7E-02 |  5.7  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.97 | 1.5E-04 | 1.8E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 1.07 | 2.6E-04 | 3.0E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  169                   CPU SECONDS = 1.165E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 7.8E-05 | 2.9E-02 |       3.4E-02  OK|
| V-Mom                | 0.97 | 5.9E-05 | 1.5E-02 |       2.5E-02  OK|
| W-Mom                | 0.96 | 1.2E-04 | 4.1E-02 |       3.5E-02  OK|
| P-Mass               | 0.98 | 8.8E-06 | 1.1E-02 |  9.2  6.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 5.3E-05 | 3.7E-02 |  5.7  9.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.92 | 1.9E-04 | 7.0E-02 |  5.7  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.92 | 1.4E-04 | 1.8E-02 |  5.7  2.8E-02  OK|
| O-TurbFreq           | 1.03 | 2.7E-04 | 5.2E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  170                   CPU SECONDS = 1.172E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.13 | 8.8E-05 | 6.1E-02 |       3.5E-02  OK|
| V-Mom                | 1.02 | 6.0E-05 | 1.6E-02 |       2.4E-02  OK|
| W-Mom                | 1.05 | 1.2E-04 | 7.0E-02 |       3.0E-02  OK|
| P-Mass               | 1.00 | 8.8E-06 | 1.1E-02 |  9.2  7.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 5.2E-05 | 3.9E-02 |  5.7  1.0E-01  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.80 | 1.5E-04 | 3.9E-02 |  5.7  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.06 | 1.4E-04 | 1.8E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 0.81 | 2.2E-04 | 4.1E-02 | 12.5  2.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
```

```
OUTER LOOP ITERATION =  171              CPU SECONDS = 1.179E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 8.8E-05 | 4.2E-02 |       3.9E-02  OK|
| V-Mom                | 1.04 | 6.2E-05 | 1.6E-02 |       2.4E-02  OK|
| W-Mom                | 1.05 | 1.3E-04 | 6.9E-02 |       3.3E-02  OK|
| P-Mass               | 0.99 | 8.7E-06 | 1.1E-02 |  9.2  7.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.84 | 4.3E-05 | 3.3E-02 |  5.7  8.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.94 | 1.4E-04 | 3.6E-02 |  5.7  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 1.4E-04 | 2.2E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 1.13 | 2.5E-04 | 4.1E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  172              CPU SECONDS = 1.186E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 8.6E-05 | 4.1E-02 |       4.5E-02  OK|
| V-Mom                | 1.09 | 6.8E-05 | 2.7E-02 |       2.6E-02  OK|
| W-Mom                | 1.01 | 1.3E-04 | 4.2E-02 |       3.8E-02  OK|
| P-Mass               | 1.02 | 8.9E-06 | 1.1E-02 |  9.2  7.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.15 | 5.0E-05 | 3.8E-02 |  5.7  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.07 | 1.5E-04 | 3.8E-02 |  5.7  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.18 | 1.7E-04 | 2.3E-02 |  5.7  2.2E-02  OK|
| O-TurbFreq           | 1.08 | 2.7E-04 | 3.1E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  173              CPU SECONDS = 1.192E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 8.5E-05 | 3.9E-02 |       4.2E-02  OK|
| V-Mom                | 1.06 | 7.2E-05 | 2.3E-02 |       2.9E-02  OK|
| W-Mom                | 0.97 | 1.3E-04 | 4.2E-02 |       4.2E-02  OK|
| P-Mass               | 0.98 | 8.8E-06 | 1.0E-02 |  9.2  7.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.24 | 6.2E-05 | 3.7E-02 |  5.7  8.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.09 | 1.7E-04 | 3.7E-02 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 1.6E-04 | 2.0E-02 |  5.7  2.5E-02  OK|
| O-TurbFreq           | 1.14 | 3.1E-04 | 5.1E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  174              CPU SECONDS = 1.199E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 8.1E-05 | 4.2E-02 |       3.8E-02  OK|
| V-Mom                | 1.06 | 7.7E-05 | 2.9E-02 |       2.8E-02  OK|
| W-Mom                | 1.04 | 1.3E-04 | 7.4E-02 |       3.4E-02  OK|
| P-Mass               | 1.01 | 8.9E-06 | 1.1E-02 |  9.2  6.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.13 | 7.0E-05 | 4.0E-02 | 10.5  3.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.7E-04 | 4.1E-02 |  5.7  4.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 1.6E-04 | 1.9E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 0.86 | 2.7E-04 | 3.6E-02 | 12.5  2.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  175              CPU SECONDS = 1.206E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.07 | 8.6E-05 | 7.4E-02 |       4.5E-02  OK|
| V-Mom                | 1.03 | 7.9E-05 | 1.9E-02 |       2.7E-02  OK|
| W-Mom                | 1.00 | 1.3E-04 | 5.3E-02 |       3.5E-02  OK|
| P-Mass               | 1.00 | 8.9E-06 | 1.1E-02 |  9.2  7.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.12 | 7.8E-05 | 4.3E-02 | 10.5  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.17 | 2.0E-04 | 6.1E-02 |  5.7  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.97 | 1.6E-04 | 1.8E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 0.89 | 2.4E-04 | 5.9E-02 | 12.5  2.1E-04  OK|
+----------------------+------+---------+---------+------------------+
```

```
======================================================================
OUTER LOOP ITERATION =  176                CPU SECONDS = 1.213E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.92 | 7.9E-05 | 5.1E-02 |       5.5E-02  OK|
| V-Mom                | 0.97 | 7.7E-05 | 2.3E-02 |       2.8E-02  OK|
| W-Mom                | 1.03 | 1.3E-04 | 5.1E-02 |       4.5E-02  OK|
| P-Mass               | 1.03 | 9.2E-06 | 1.1E-02 |  9.2  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 7.8E-05 | 3.7E-02 | 10.5  3.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.09 | 2.2E-04 | 8.2E-02 |  5.7  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.6E-04 | 1.8E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 1.01 | 2.4E-04 | 3.0E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  177                CPU SECONDS = 1.220E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 7.8E-05 | 3.2E-02 |       4.8E-02  OK|
| V-Mom                | 0.95 | 7.3E-05 | 1.5E-02 |       2.9E-02  OK|
| W-Mom                | 1.09 | 1.5E-04 | 6.7E-02 |       4.0E-02  OK|
| P-Mass               | 1.01 | 9.3E-06 | 1.1E-02 |  9.2  8.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.85 | 6.6E-05 | 2.4E-02 |  5.7  8.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.93 | 2.1E-04 | 6.8E-02 |  5.7  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.16 | 1.9E-04 | 2.0E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 1.11 | 2.7E-04 | 3.2E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  178                CPU SECONDS = 1.227E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.06 | 8.2E-05 | 3.8E-02 |       3.7E-02  OK|
| V-Mom                | 0.94 | 6.8E-05 | 1.7E-02 |       2.7E-02  OK|
| W-Mom                | 1.04 | 1.5E-04 | 5.4E-02 |       3.9E-02  OK|
| P-Mass               | 1.01 | 9.3E-06 | 1.1E-02 |  9.2  7.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 6.4E-05 | 5.3E-02 |  5.7  7.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.87 | 1.8E-04 | 7.5E-02 |  5.7  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 1.8E-04 | 2.4E-02 |  5.7  2.2E-02  OK|
| O-TurbFreq           | 1.14 | 3.0E-04 | 6.1E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  179                CPU SECONDS = 1.234E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 8.5E-05 | 4.7E-02 |       3.6E-02  OK|
| V-Mom                | 0.96 | 6.6E-05 | 1.5E-02 |       2.6E-02  OK|
| W-Mom                | 0.99 | 1.5E-04 | 4.1E-02 |       4.1E-02  OK|
| P-Mass               | 0.99 | 9.2E-06 | 1.1E-02 |  9.2  7.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.82 | 5.2E-05 | 4.0E-02 |  5.7  8.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.82 | 1.5E-04 | 4.0E-02 |  5.7  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.99 | 1.8E-04 | 2.0E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 0.90 | 2.7E-04 | 5.1E-02 | 12.5  2.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  180                CPU SECONDS = 1.240E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 8.8E-05 | 3.9E-02 |       3.6E-02  OK|
| V-Mom                | 1.03 | 6.7E-05 | 2.6E-02 |       2.5E-02  OK|
| W-Mom                | 0.97 | 1.5E-04 | 3.7E-02 |       3.8E-02  OK|
| P-Mass               | 1.01 | 9.3E-06 | 1.1E-02 |  9.2  6.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.87 | 4.6E-05 | 3.5E-02 |  5.7  9.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.81 | 1.2E-04 | 3.5E-02 |  5.7  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.8E-04 | 2.5E-02 |  5.7  3.1E-02  OK|
```

```
| O-TurbFreq           | 0.86 | 2.4E-04 | 3.5E-02 | 12.5  2.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  181                  CPU SECONDS = 1.247E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 9.0E-05 | 4.0E-02 |       3.8E-02  OK|
| V-Mom                | 0.99 | 6.7E-05 | 2.2E-02 |       2.4E-02  OK|
| W-Mom                | 1.00 | 1.5E-04 | 5.6E-02 |       3.4E-02  OK|
| P-Mass               | 0.99 | 9.2E-06 | 1.1E-02 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 4.8E-05 | 5.4E-02 |  5.7  1.0E-01  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.95 | 1.1E-04 | 5.4E-02 |  5.7  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.95 | 1.7E-04 | 2.1E-02 |  5.7  3.1E-02  OK|
| O-TurbFreq           | 1.13 | 2.6E-04 | 3.2E-02 | 12.5  1.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  182                  CPU SECONDS = 1.254E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.06 | 9.5E-05 | 6.5E-02 |       4.4E-02  OK|
| V-Mom                | 0.99 | 6.6E-05 | 3.0E-02 |       2.4E-02  OK|
| W-Mom                | 0.93 | 1.4E-04 | 4.2E-02 |       3.6E-02  OK|
| P-Mass               | 0.99 | 9.1E-06 | 1.1E-02 |  9.2  7.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 4.7E-05 | 4.2E-02 |  5.7  9.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.1E-04 | 4.2E-02 |  5.7  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.08 | 1.8E-04 | 2.1E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 1.11 | 2.9E-04 | 5.8E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  183                  CPU SECONDS = 1.261E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 9.7E-05 | 7.4E-02 |       5.0E-02  OK|
| V-Mom                | 0.98 | 6.5E-05 | 2.1E-02 |       2.7E-02  OK|
| W-Mom                | 0.88 | 1.2E-04 | 5.7E-02 |       4.6E-02  OK|
| P-Mass               | 0.96 | 8.7E-06 | 1.0E-02 |  9.2  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.82 | 3.8E-05 | 2.9E-02 |  5.7  8.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.2E-04 | 3.2E-02 |  5.7  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.83 | 1.5E-04 | 2.0E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 0.98 | 2.9E-04 | 3.9E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  184                  CPU SECONDS = 1.268E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.89 | 8.6E-05 | 3.9E-02 |       4.9E-02  OK|
| V-Mom                | 1.00 | 6.5E-05 | 2.3E-02 |       2.9E-02  OK|
| W-Mom                | 0.93 | 1.1E-04 | 6.6E-02 |       4.7E-02  OK|
| P-Mass               | 0.98 | 8.6E-06 | 1.1E-02 |  9.2  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.25 | 4.8E-05 | 6.0E-02 |  5.7  7.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.12 | 1.3E-04 | 6.0E-02 |  5.7  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.87 | 1.3E-04 | 1.8E-02 |  5.7  2.2E-02  OK|
| O-TurbFreq           | 0.83 | 2.4E-04 | 5.9E-02 | 12.5  2.0E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  185                  CPU SECONDS = 1.275E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 8.4E-05 | 3.8E-02 |       4.0E-02  OK|
| V-Mom                | 0.98 | 6.4E-05 | 1.4E-02 |       2.8E-02  OK|
| W-Mom                | 0.94 | 1.0E-04 | 4.3E-02 |       4.4E-02  OK|
| P-Mass               | 0.97 | 8.3E-06 | 1.1E-02 |  9.2  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.93 | 4.5E-05 | 4.3E-02 |  5.7  9.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 1.4E-04 | 4.3E-02 |  5.7  4.8E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| K-TurbKE        | 0.94 | 1.2E-04 | 1.7E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq      | 0.91 | 2.2E-04 | 3.3E-02 | 12.5  1.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  186                CPU SECONDS = 1.281E+05
----------------------------------------------------------------------
|      Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom           | 1.00 | 8.4E-05 | 4.5E-02 |       4.2E-02  OK|
| V-Mom           | 0.98 | 6.3E-05 | 1.8E-02 |       2.6E-02  OK|
| W-Mom           | 0.96 | 9.9E-05 | 5.4E-02 |       4.3E-02  OK|
| P-Mass          | 0.99 | 8.2E-06 | 1.1E-02 |  9.2  7.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy           | 0.92 | 4.1E-05 | 3.3E-02 | 10.5  3.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy        | 1.04 | 1.4E-04 | 3.7E-02 |  5.7  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE        | 1.14 | 1.4E-04 | 2.2E-02 |  5.7  3.3E-02  OK|
| O-TurbFreq      | 1.11 | 2.4E-04 | 4.7E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  187                CPU SECONDS = 1.288E+05
----------------------------------------------------------------------
|      Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom           | 0.99 | 8.3E-05 | 4.9E-02 |       4.8E-02  OK|
| V-Mom           | 0.99 | 6.2E-05 | 1.4E-02 |       2.6E-02  OK|
| W-Mom           | 1.03 | 1.0E-04 | 4.5E-02 |       4.4E-02  OK|
| P-Mass          | 0.98 | 8.1E-06 | 1.1E-02 |  9.2  7.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy           | 1.19 | 4.9E-05 | 5.9E-02 |  5.7  9.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy        | 1.04 | 1.5E-04 | 5.9E-02 |  5.7  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE        | 1.14 | 1.6E-04 | 1.9E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq      | 1.13 | 2.7E-04 | 5.5E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  188                CPU SECONDS = 1.295E+05
----------------------------------------------------------------------
|      Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom           | 0.99 | 8.2E-05 | 5.9E-02 |       4.3E-02  OK|
| V-Mom           | 1.05 | 6.5E-05 | 2.5E-02 |       2.6E-02  OK|
| W-Mom           | 1.07 | 1.1E-04 | 3.2E-02 |       4.4E-02  OK|
| P-Mass          | 1.03 | 8.3E-06 | 1.1E-02 |  9.2  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy           | 0.99 | 4.8E-05 | 3.8E-02 |  5.7  8.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy        | 0.98 | 1.5E-04 | 3.9E-02 |  5.7  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE        | 0.95 | 1.5E-04 | 2.8E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq      | 1.01 | 2.8E-04 | 6.1E-02 | 12.5  1.9E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  189                CPU SECONDS = 1.302E+05
----------------------------------------------------------------------
|      Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom           | 0.98 | 8.1E-05 | 4.9E-02 |       3.8E-02  OK|
| V-Mom           | 1.04 | 6.8E-05 | 2.1E-02 |       2.6E-02  OK|
| W-Mom           | 1.13 | 1.3E-04 | 3.6E-02 |       4.1E-02  OK|
| P-Mass          | 1.03 | 8.5E-06 | 1.1E-02 |  9.2  7.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy           | 0.98 | 4.7E-05 | 4.0E-02 |  5.7  6.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy        | 0.97 | 1.4E-04 | 4.0E-02 |  5.7  3.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE        | 1.00 | 1.5E-04 | 2.7E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq      | 0.84 | 2.3E-04 | 3.0E-02 | 12.5  2.7E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  190                CPU SECONDS = 1.309E+05
----------------------------------------------------------------------
|      Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom           | 1.15 | 9.3E-05 | 8.0E-02 |       3.6E-02  OK|
| V-Mom           | 1.10 | 7.5E-05 | 3.2E-02 |       2.5E-02  OK|
| W-Mom           | 1.09 | 1.4E-04 | 6.1E-02 |       4.1E-02  OK|
| P-Mass          | 1.04 | 8.8E-06 | 1.1E-02 |  9.2  7.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy           | 1.16 | 5.5E-05 | 5.0E-02 |  5.7  7.1E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.4E-04 | 5.0E-02 |  5.7  3.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.6E-04 | 2.3E-02 |  5.7  2.4E-02  OK|
| O-TurbFreq           | 1.02 | 2.4E-04 | 3.3E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  191                    CPU SECONDS = 1.316E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 8.8E-05 | 2.9E-02 |       3.9E-02  OK|
| V-Mom                | 1.08 | 8.0E-05 | 2.5E-02 |       2.5E-02  OK|
| W-Mom                | 1.00 | 1.4E-04 | 6.3E-02 |       4.2E-02  OK|
| P-Mass               | 1.01 | 9.0E-06 | 1.1E-02 |  9.2  6.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.93 | 5.1E-05 | 3.4E-02 |  5.7  9.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 1.4E-04 | 3.4E-02 |  5.7  3.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.14 | 1.8E-04 | 2.4E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 1.22 | 2.9E-04 | 6.9E-02 | 12.5  1.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  192                    CPU SECONDS = 1.322E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.09 | 9.6E-05 | 3.7E-02 |       4.1E-02  OK|
| V-Mom                | 1.06 | 8.5E-05 | 2.2E-02 |       2.5E-02  OK|
| W-Mom                | 1.09 | 1.5E-04 | 4.5E-02 |       4.0E-02  OK|
| P-Mass               | 1.03 | 9.2E-06 | 1.1E-02 |  9.2  6.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 4.9E-05 | 3.2E-02 | 10.5  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.93 | 1.3E-04 | 3.3E-02 |  5.7  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.06 | 1.9E-04 | 2.1E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 1.08 | 3.1E-04 | 4.8E-02 | 12.5  1.6E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  193                    CPU SECONDS = 1.329E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.09 | 1.1E-04 | 3.1E-02 |       5.0E-02  OK|
| V-Mom                | 1.04 | 8.8E-05 | 1.4E-02 |       2.5E-02  OK|
| W-Mom                | 1.03 | 1.5E-04 | 5.1E-02 |       4.4E-02  OK|
| P-Mass               | 1.03 | 9.4E-06 | 1.0E-02 |  9.2  7.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 5.2E-05 | 4.7E-02 | 10.5  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.93 | 1.2E-04 | 4.7E-02 |  5.7  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.92 | 1.7E-04 | 2.1E-02 |  5.7  2.9E-02  OK|
| O-TurbFreq           | 0.96 | 3.0E-04 | 4.9E-02 | 12.5  2.4E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  194                    CPU SECONDS = 1.336E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 1.1E-04 | 4.8E-02 |       5.4E-02  OK|
| V-Mom                | 0.97 | 8.6E-05 | 1.8E-02 |       2.7E-02  OK|
| W-Mom                | 1.01 | 1.5E-04 | 7.7E-02 |       4.8E-02  OK|
| P-Mass               | 1.05 | 1.0E-05 | 1.0E-02 |  9.2  8.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 4.9E-05 | 3.7E-02 |  5.7  9.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.93 | 1.1E-04 | 3.7E-02 |  5.7  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.97 | 1.7E-04 | 1.8E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq           | 0.87 | 2.6E-04 | 3.4E-02 | 12.5  4.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  195                    CPU SECONDS = 1.343E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 1.0E-04 | 6.0E-02 |       5.0E-02  OK|
| V-Mom                | 0.96 | 8.2E-05 | 1.4E-02 |       2.9E-02  OK|
| W-Mom                | 0.94 | 1.4E-04 | 4.0E-02 |       5.6E-02  OK|
| P-Mass               | 0.99 | 9.9E-06 | 1.0E-02 |  9.2  8.0E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| dummy                | 0.87 | 4.3E-05 | 2.9E-02 |  5.7  8.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 1.1E-04 | 2.9E-02 |  5.7  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.7E-04 | 1.7E-02 |  5.7  2.3E-02  OK|
| O-TurbFreq           | 1.12 | 2.9E-04 | 5.5E-02 | 12.5  1.3E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  196                   CPU SECONDS = 1.350E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.90 | 9.2E-05 | 4.6E-02 |       4.0E-02  OK|
| V-Mom                | 0.98 | 8.1E-05 | 2.4E-02 |       2.9E-02  OK|
| W-Mom                | 0.99 | 1.4E-04 | 2.4E-02 |       5.5E-02  OK|
| P-Mass               | 1.00 | 9.8E-06 | 1.0E-02 |  9.2  7.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.04 | 4.5E-05 | 3.4E-02 |  5.7  8.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.06 | 1.2E-04 | 3.4E-02 |  5.7  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.24 | 2.1E-04 | 3.3E-02 |  5.7  2.6E-02  OK|
| O-TurbFreq           | 0.99 | 2.9E-04 | 6.1E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  197                   CPU SECONDS = 1.357E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.06 | 9.8E-05 | 8.1E-02 |       3.9E-02  OK|
| V-Mom                | 1.02 | 8.2E-05 | 2.0E-02 |       2.6E-02  OK|
| W-Mom                | 1.04 | 1.5E-04 | 5.8E-02 |       4.5E-02  OK|
| P-Mass               | 1.00 | 9.8E-06 | 1.0E-02 |  9.2  7.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.93 | 4.2E-05 | 2.9E-02 |  5.7  9.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.08 | 1.3E-04 | 3.0E-02 |  5.7  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.90 | 1.9E-04 | 2.1E-02 |  5.7  3.0E-02  OK|
| O-TurbFreq           | 1.12 | 3.3E-04 | 5.9E-02 | 12.5  1.5E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  198                   CPU SECONDS = 1.363E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.91 | 8.9E-05 | 4.6E-02 |       4.6E-02  OK|
| V-Mom                | 1.04 | 8.6E-05 | 3.4E-02 |       2.5E-02  OK|
| W-Mom                | 0.96 | 1.4E-04 | 4.0E-02 |       4.4E-02  OK|
| P-Mass               | 1.02 | 1.0E-05 | 1.1E-02 |  9.2  7.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.95 | 4.0E-05 | 2.3E-02 |  5.7  9.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.08 | 1.4E-04 | 3.6E-02 |  5.7  3.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.93 | 1.8E-04 | 1.9E-02 |  5.7  3.2E-02  OK|
| O-TurbFreq           | 0.87 | 2.8E-04 | 3.2E-02 | 12.5  3.2E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  199                   CPU SECONDS = 1.370E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 8.7E-05 | 3.2E-02 |       4.5E-02  OK|
| V-Mom                | 0.98 | 8.4E-05 | 2.9E-02 |       2.6E-02  OK|
| W-Mom                | 0.95 | 1.4E-04 | 4.2E-02 |       4.3E-02  OK|
| P-Mass               | 0.99 | 9.9E-06 | 1.1E-02 |  9.2  7.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.14 | 4.5E-05 | 4.0E-02 |  5.7  8.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.4E-04 | 6.8E-02 |  5.7  3.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 1.7E-04 | 1.8E-02 |  5.7  2.7E-02  OK|
| O-TurbFreq           | 0.81 | 2.3E-04 | 3.4E-02 | 12.5  2.9E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  200                   CPU SECONDS = 1.377E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.06 | 9.3E-05 | 3.9E-02 |       2.7E-02  OK|
| V-Mom                | 0.96 | 8.1E-05 | 2.0E-02 |       1.7E-02  OK|
```

```
| W-Mom                | 0.98 | 1.3E-04 | 3.9E-02 |       3.1E-02  OK|
| P-Mass               | 0.98 | 9.6E-06 | 1.1E-02 |  9.2  6.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 4.5E-05 | 3.2E-02 |  5.7  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 1.4E-04 | 6.4E-02 |  5.7  2.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.94 | 1.6E-04 | 2.1E-02 |  5.7  1.7E-02  OK|
| O-TurbFreq           | 1.14 | 2.6E-04 | 6.0E-02 | 12.5  9.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  201                    CPU SECONDS = 1.384E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 9.6E-05 | 4.4E-02 |       3.7E-03  OK|
| V-Mom                | 0.97 | 7.9E-05 | 1.6E-02 |       2.8E-03  OK|
| W-Mom                | 0.97 | 1.3E-04 | 7.0E-02 |       5.8E-03  OK|
| P-Mass               | 0.97 | 9.4E-06 | 1.1E-02 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.82 | 3.7E-05 | 2.2E-02 |  5.7  9.3E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.76 | 1.1E-04 | 4.9E-02 |  5.7  2.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.06 | 1.7E-04 | 3.1E-02 |  5.7  1.1E-03  OK|
| O-TurbFreq           | 0.96 | 2.5E-04 | 3.7E-02 | 12.5  4.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  202                    CPU SECONDS = 1.391E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 9.1E-05 | 7.6E-02 |       2.1E-03  OK|
| V-Mom                | 0.92 | 7.3E-05 | 1.9E-02 |       1.6E-03  OK|
| W-Mom                | 0.93 | 1.2E-04 | 4.4E-02 |       3.1E-03  OK|
| P-Mass               | 0.95 | 8.9E-06 | 1.2E-02 |  9.2  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 3.9E-05 | 2.6E-02 |  5.7  8.2E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 1.0E-04 | 4.1E-02 |  5.7  1.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.70 | 1.2E-04 | 1.6E-02 |  5.7  9.6E-04  OK|
| O-TurbFreq           | 0.78 | 2.0E-04 | 4.0E-02 | 12.5  9.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  203                    CPU SECONDS = 1.398E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.91 | 8.3E-05 | 3.2E-02 |       7.4E-03  OK|
| V-Mom                | 0.94 | 6.8E-05 | 1.6E-02 |       5.5E-03  OK|
| W-Mom                | 0.92 | 1.1E-04 | 3.6E-02 |       9.9E-03  OK|
| P-Mass               | 0.91 | 8.1E-06 | 1.1E-02 |  5.1  9.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.95 | 3.7E-05 | 2.7E-02 |  5.7  8.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 1.0E-04 | 3.2E-02 |  5.7  1.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.89 | 1.0E-04 | 1.6E-02 |  5.7  8.8E-04  OK|
| O-TurbFreq           | 0.70 | 1.4E-04 | 1.9E-02 | 12.5  6.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  204                    CPU SECONDS = 1.404E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 8.6E-05 | 6.6E-02 |       1.4E-03  OK|
| V-Mom                | 0.98 | 6.7E-05 | 2.2E-02 |       1.1E-03  OK|
| W-Mom                | 0.99 | 1.1E-04 | 4.0E-02 |       2.1E-03  OK|
| P-Mass               | 1.00 | 8.1E-06 | 1.1E-02 |  9.2  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 3.5E-05 | 2.1E-02 |  5.7  8.0E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.92 | 9.3E-05 | 3.1E-02 |  5.7  1.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.92 | 9.5E-05 | 1.5E-02 |  5.7  9.0E-04  OK|
| O-TurbFreq           | 0.87 | 1.2E-04 | 2.2E-02 | 12.5  1.1E-04  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  205                    CPU SECONDS = 1.411E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
```

```
| U-Mom                | 0.92 | 7.8E-05 | 3.4E-02 |       1.3E-03  OK|
| V-Mom                | 0.96 | 6.4E-05 | 1.9E-02 |       1.1E-03  OK|
| W-Mom                | 0.97 | 1.1E-04 | 3.9E-02 |       2.0E-03  OK|
| P-Mass               | 0.97 | 7.8E-06 | 1.1E-02 |  9.2  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 3.6E-05 | 2.6E-02 |  5.7  8.0E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 9.1E-05 | 2.8E-02 |  5.7  1.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.96 | 9.1E-05 | 1.7E-02 |  5.7  9.0E-04  OK|
| O-TurbFreq           | 0.85 | 1.0E-04 | 2.6E-02 | 12.5  5.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  206                    CPU SECONDS = 1.418E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.98 | 7.7E-05 | 3.4E-02 |       1.5E-03  OK|
| V-Mom                | 1.01 | 6.5E-05 | 3.0E-02 |       1.2E-03  OK|
| W-Mom                | 1.03 | 1.1E-04 | 5.4E-02 |       2.0E-03  OK|
| P-Mass               | 0.99 | 7.7E-06 | 1.1E-02 |  9.2  4.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 3.4E-05 | 1.9E-02 |  5.7  8.0E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.06 | 9.6E-05 | 3.4E-02 |  5.7  1.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 9.0E-05 | 1.6E-02 |  5.7  9.1E-04  OK|
| O-TurbFreq           | 0.81 | 8.2E-05 | 1.8E-02 | 12.5  8.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  207                    CPU SECONDS = 1.425E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.05 | 8.1E-05 | 4.4E-02 |       1.5E-03  OK|
| V-Mom                | 0.99 | 6.4E-05 | 2.6E-02 |       1.4E-03  OK|
| W-Mom                | 1.01 | 1.1E-04 | 5.9E-02 |       2.2E-03  OK|
| P-Mass               | 0.96 | 7.5E-06 | 1.1E-02 |  9.2  5.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.08 | 3.7E-05 | 3.5E-02 |  5.7  7.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.07 | 1.0E-04 | 3.5E-02 |  5.7  1.4E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 9.0E-05 | 1.5E-02 |  5.7  9.2E-04  OK|
| O-TurbFreq           | 0.90 | 7.4E-05 | 1.4E-02 | 12.5  5.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  208                    CPU SECONDS = 1.432E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 7.8E-05 | 4.3E-02 |       1.6E-03  OK|
| V-Mom                | 0.97 | 6.2E-05 | 2.0E-02 |       1.5E-03  OK|
| W-Mom                | 0.98 | 1.1E-04 | 5.1E-02 |       2.3E-03  OK|
| P-Mass               | 1.02 | 7.6E-06 | 1.1E-02 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 3.6E-05 | 3.1E-02 |  5.7  7.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.09 | 1.1E-04 | 3.8E-02 |  5.7  1.3E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 9.1E-05 | 1.6E-02 |  5.7  9.0E-04  OK|
| O-TurbFreq           | 0.87 | 6.4E-05 | 1.5E-02 | 12.5  6.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  209                    CPU SECONDS = 1.438E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 7.8E-05 | 5.5E-02 |       1.6E-03  OK|
| V-Mom                | 1.00 | 6.1E-05 | 1.3E-02 |       1.5E-03  OK|
| W-Mom                | 1.04 | 1.1E-04 | 5.3E-02 |       2.4E-03  OK|
| P-Mass               | 0.97 | 7.4E-06 | 1.1E-02 |  9.2  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.91 | 3.3E-05 | 1.5E-02 |  5.7  7.3E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.1E-04 | 3.6E-02 |  5.7  1.2E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 9.3E-05 | 1.5E-02 |  5.7  8.9E-04  OK|
| O-TurbFreq           | 0.99 | 6.3E-05 | 1.4E-02 | 12.5  5.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  210                    CPU SECONDS = 1.445E+05
----------------------------------------------------------------------
```

```
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 8.1E-05 | 6.2E-02 |       1.7E-03  OK|
| V-Mom                | 1.02 | 6.3E-05 | 1.9E-02 |       1.6E-03  OK|
| W-Mom                | 0.94 | 1.1E-04 | 3.0E-02 |       2.4E-03  OK|
| P-Mass               | 1.01 | 7.5E-06 | 1.1E-02 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 3.3E-05 | 1.7E-02 |  5.7  6.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.2E-04 | 3.9E-02 |  5.7  1.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 9.5E-05 | 1.7E-02 |  5.7  8.6E-04  OK|
| O-TurbFreq           | 0.94 | 6.0E-05 | 1.4E-02 | 12.5  6.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  211                    CPU SECONDS = 1.452E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.91 | 7.4E-05 | 3.8E-02 |       1.6E-03  OK|
| V-Mom                | 1.02 | 6.4E-05 | 1.5E-02 |       1.6E-03  OK|
| W-Mom                | 1.07 | 1.1E-04 | 5.3E-02 |       2.4E-03  OK|
| P-Mass               | 0.99 | 7.4E-06 | 1.1E-02 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.24 | 4.1E-05 | 4.0E-02 |  5.7  6.4E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.06 | 1.3E-04 | 4.0E-02 |  5.7  1.0E-03  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 9.8E-05 | 1.5E-02 |  5.7  8.3E-04  OK|
| O-TurbFreq           | 0.99 | 5.9E-05 | 1.4E-02 | 12.5  5.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  212                    CPU SECONDS = 1.459E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 7.7E-05 | 4.0E-02 |       1.6E-03  OK|
| V-Mom                | 1.04 | 6.6E-05 | 2.3E-02 |       1.6E-03  OK|
| W-Mom                | 1.04 | 1.2E-04 | 4.5E-02 |       2.4E-03  OK|
| P-Mass               | 1.02 | 7.5E-06 | 1.1E-02 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.89 | 3.6E-05 | 3.0E-02 |  5.7  5.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.3E-04 | 4.8E-02 |  5.7  9.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.0E-04 | 1.7E-02 |  5.7  7.9E-04  OK|
| O-TurbFreq           | 0.98 | 5.8E-05 | 1.4E-02 | 12.5  4.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  213                    CPU SECONDS = 1.466E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 7.8E-05 | 4.0E-02 |       1.6E-03  OK|
| V-Mom                | 1.00 | 6.6E-05 | 1.9E-02 |       1.7E-03  OK|
| W-Mom                | 1.05 | 1.2E-04 | 6.9E-02 |       2.3E-03  OK|
| P-Mass               | 0.99 | 7.5E-06 | 1.1E-02 |  9.2  5.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.91 | 3.3E-05 | 1.3E-02 |  5.7  5.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.3E-04 | 4.5E-02 |  5.7  8.3E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 1.0E-04 | 1.5E-02 |  5.7  7.5E-04  OK|
| O-TurbFreq           | 1.01 | 5.9E-05 | 1.4E-02 | 12.5  4.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  214                    CPU SECONDS = 1.473E+05
----------------------------------------------------------------------
|      Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.08 | 8.4E-05 | 5.1E-02 |       1.6E-03  OK|
| V-Mom                | 1.04 | 6.9E-05 | 3.3E-02 |       1.7E-03  OK|
| W-Mom                | 1.03 | 1.3E-04 | 6.9E-02 |       2.4E-03  OK|
| P-Mass               | 1.01 | 7.6E-06 | 1.1E-02 |  9.2  5.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 3.4E-05 | 1.3E-02 |  5.7  5.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 1.3E-04 | 5.1E-02 |  5.7  7.6E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.1E-04 | 1.7E-02 |  5.7  7.1E-04  OK|
| O-TurbFreq           | 1.02 | 6.0E-05 | 1.4E-02 | 12.5  4.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
```

```
OUTER LOOP ITERATION =  215              CPU SECONDS = 1.479E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 8.5E-05 | 7.4E-02 |       1.6E-03  OK|
| V-Mom                | 0.99 | 6.9E-05 | 3.0E-02 |       1.7E-03  OK|
| W-Mom                | 0.99 | 1.3E-04 | 3.0E-02 |       2.4E-03  OK|
| P-Mass               | 1.01 | 7.6E-06 | 1.1E-02 |  9.2  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 3.5E-05 | 2.0E-02 |  5.7  4.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.3E-04 | 4.3E-02 |  5.7  6.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 1.1E-04 | 1.6E-02 |  5.7  6.7E-04  OK|
| O-TurbFreq           | 1.08 | 6.5E-05 | 1.5E-02 | 12.5  4.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  216              CPU SECONDS = 1.486E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.94 | 7.9E-05 | 3.6E-02 |       1.5E-03  OK|
| V-Mom                | 0.98 | 6.7E-05 | 2.0E-02 |       1.7E-03  OK|
| W-Mom                | 1.03 | 1.3E-04 | 4.1E-02 |       2.3E-03  OK|
| P-Mass               | 1.01 | 7.7E-06 | 1.1E-02 |  9.2  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 3.2E-05 | 1.4E-02 |  5.7  4.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.3E-04 | 4.1E-02 |  5.7  6.5E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 1.2E-04 | 1.7E-02 |  5.7  6.3E-04  OK|
| O-TurbFreq           | 1.06 | 6.9E-05 | 2.1E-02 | 12.5  4.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  217              CPU SECONDS = 1.493E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 8.2E-05 | 5.2E-02 |       1.5E-03  OK|
| V-Mom                | 1.01 | 6.8E-05 | 1.3E-02 |       1.7E-03  OK|
| W-Mom                | 1.03 | 1.3E-04 | 5.1E-02 |       2.3E-03  OK|
| P-Mass               | 1.00 | 7.7E-06 | 1.1E-02 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.03 | 3.3E-05 | 1.5E-02 |  5.7  4.3E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.3E-04 | 3.0E-02 |  5.7  6.2E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 1.2E-04 | 1.6E-02 |  5.7  5.7E-04  OK|
| O-TurbFreq           | 0.95 | 6.6E-05 | 1.5E-02 | 12.5  4.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  218              CPU SECONDS = 1.500E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 7.9E-05 | 3.1E-02 |       1.4E-03  OK|
| V-Mom                | 1.04 | 7.1E-05 | 1.9E-02 |       1.6E-03  OK|
| W-Mom                | 1.00 | 1.3E-04 | 3.7E-02 |       2.2E-03  OK|
| P-Mass               | 1.01 | 7.8E-06 | 1.1E-02 |  9.2  5.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 3.4E-05 | 1.9E-02 |  5.7  4.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 1.3E-04 | 3.2E-02 |  5.7  6.0E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.2E-04 | 1.7E-02 |  5.7  5.2E-04  OK|
| O-TurbFreq           | 0.97 | 6.4E-05 | 1.5E-02 | 12.5  4.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  219              CPU SECONDS = 1.507E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 8.0E-05 | 2.9E-02 |       1.4E-03  OK|
| V-Mom                | 1.03 | 7.4E-05 | 1.5E-02 |       1.6E-03  OK|
| W-Mom                | 1.04 | 1.4E-04 | 4.9E-02 |       2.2E-03  OK|
| P-Mass               | 1.00 | 7.8E-06 | 1.1E-02 |  9.2  5.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.92 | 3.1E-05 | 1.6E-02 |  5.7  4.0E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.96 | 1.2E-04 | 3.2E-02 |  5.7  6.0E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.2E-04 | 1.7E-02 |  5.7  4.7E-04  OK|
| O-TurbFreq           | 1.01 | 6.5E-05 | 1.5E-02 | 12.5  3.4E-05  OK|
+----------------------+------+---------+---------+------------------+
```

```
======================================================================
OUTER LOOP ITERATION =  220                CPU SECONDS = 1.514E+05
----------------------------------------------------------------------
|     Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+-------------------+------+---------+---------+------------------+
| U-Mom             | 1.02 | 8.2E-05 | 3.8E-02 |       1.3E-03  OK|
| V-Mom             | 1.04 | 7.7E-05 | 2.2E-02 |       1.6E-03  OK|
| W-Mom             | 1.04 | 1.5E-04 | 7.0E-02 |       2.1E-03  OK|
| P-Mass            | 1.01 | 7.8E-06 | 1.2E-02 |  9.2  5.5E-02  OK|
+-------------------+------+---------+---------+------------------+
| dummy             | 0.95 | 2.9E-05 | 1.3E-02 |  5.7  3.8E-03  OK|
+-------------------+------+---------+---------+------------------+
| H-Energy          | 0.94 | 1.1E-04 | 2.6E-02 |  5.7  6.1E-04  OK|
+-------------------+------+---------+---------+------------------+
| K-TurbKE          | 1.00 | 1.2E-04 | 1.7E-02 |  5.7  4.8E-04  OK|
| O-TurbFreq        | 1.01 | 6.5E-05 | 1.5E-02 | 12.5  3.5E-05  OK|
+-------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  221                CPU SECONDS = 1.520E+05
----------------------------------------------------------------------
|     Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+-------------------+------+---------+---------+------------------+
| U-Mom             | 1.03 | 8.4E-05 | 4.0E-02 |       1.2E-03  OK|
| V-Mom             | 1.01 | 7.8E-05 | 1.9E-02 |       1.5E-03  OK|
| W-Mom             | 0.99 | 1.4E-04 | 6.1E-02 |       2.1E-03  OK|
| P-Mass            | 1.01 | 7.9E-06 | 1.2E-02 |  9.2  5.5E-02  OK|
+-------------------+------+---------+---------+------------------+
| dummy             | 1.21 | 3.6E-05 | 4.4E-02 |  5.7  3.8E-03  OK|
+-------------------+------+---------+---------+------------------+
| H-Energy          | 0.94 | 1.1E-04 | 4.4E-02 |  5.7  6.4E-04  OK|
+-------------------+------+---------+---------+------------------+
| K-TurbKE          | 0.99 | 1.2E-04 | 1.8E-02 |  5.7  4.2E-04  OK|
| O-TurbFreq        | 1.00 | 6.5E-05 | 1.5E-02 | 12.5  3.4E-05  OK|
+-------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  222                CPU SECONDS = 1.527E+05
----------------------------------------------------------------------
|     Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+-------------------+------+---------+---------+------------------+
| U-Mom             | 1.01 | 8.5E-05 | 5.6E-02 |       1.2E-03  OK|
| V-Mom             | 1.04 | 8.1E-05 | 3.0E-02 |       1.5E-03  OK|
| W-Mom             | 0.92 | 1.3E-04 | 2.4E-02 |       2.0E-03  OK|
| P-Mass            | 1.01 | 8.0E-06 | 1.2E-02 |  9.2  5.5E-02  OK|
+-------------------+------+---------+---------+------------------+
| dummy             | 0.89 | 3.2E-05 | 3.2E-02 |  5.7  3.7E-03  OK|
+-------------------+------+---------+---------+------------------+
| H-Energy          | 0.94 | 1.0E-04 | 3.2E-02 |  5.7  6.6E-04  OK|
+-------------------+------+---------+---------+------------------+
| K-TurbKE          | 0.99 | 1.2E-04 | 1.6E-02 |  5.7  4.2E-04  OK|
| O-TurbFreq        | 0.98 | 6.4E-05 | 1.5E-02 | 12.5  3.8E-05  OK|
+-------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  223                CPU SECONDS = 1.534E+05
----------------------------------------------------------------------
|     Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+-------------------+------+---------+---------+------------------+
| U-Mom             | 1.07 | 9.1E-05 | 7.4E-02 |       1.1E-03  OK|
| V-Mom             | 1.01 | 8.2E-05 | 2.6E-02 |       1.4E-03  OK|
| W-Mom             | 0.99 | 1.3E-04 | 3.9E-02 |       2.0E-03  OK|
| P-Mass            | 0.99 | 7.9E-06 | 1.2E-02 |  9.2  5.5E-02  OK|
+-------------------+------+---------+---------+------------------+
| dummy             | 0.88 | 2.8E-05 | 9.8E-03 |  5.7  3.7E-03  OK|
+-------------------+------+---------+---------+------------------+
| H-Energy          | 0.99 | 9.9E-05 | 1.7E-02 |  5.7  6.9E-04  OK|
+-------------------+------+---------+---------+------------------+
| K-TurbKE          | 1.00 | 1.2E-04 | 1.8E-02 |  5.7  4.3E-04  OK|
| O-TurbFreq        | 0.97 | 6.2E-05 | 1.6E-02 | 12.5  3.9E-05  OK|
+-------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  224                CPU SECONDS = 1.541E+05
----------------------------------------------------------------------
|     Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+-------------------+------+---------+---------+------------------+
| U-Mom             | 0.94 | 8.6E-05 | 3.5E-02 |       1.1E-03  OK|
| V-Mom             | 1.00 | 8.2E-05 | 2.0E-02 |       1.4E-03  OK|
| W-Mom             | 0.98 | 1.3E-04 | 2.9E-02 |       1.9E-03  OK|
| P-Mass            | 1.01 | 8.0E-06 | 1.2E-02 |  9.2  5.4E-02  OK|
+-------------------+------+---------+---------+------------------+
| dummy             | 1.06 | 3.0E-05 | 1.2E-02 |  5.7  3.6E-03  OK|
+-------------------+------+---------+---------+------------------+
| H-Energy          | 1.11 | 1.1E-04 | 2.7E-02 |  5.7  7.0E-04  OK|
+-------------------+------+---------+---------+------------------+
| K-TurbKE          | 1.00 | 1.2E-04 | 1.9E-02 |  5.7  4.2E-04  OK|
```

```
| O-TurbFreq         | 0.99 | 6.1E-05 | 1.5E-02 | 12.5  4.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  225                    CPU SECONDS = 1.548E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 8.3E-05 | 3.1E-02 |       1.0E-03  OK|
| V-Mom                | 1.02 | 8.4E-05 | 1.5E-02 |       1.4E-03  OK|
| W-Mom                | 0.97 | 1.2E-04 | 4.5E-02 |       1.9E-03  OK|
| P-Mass               | 1.00 | 8.0E-06 | 1.2E-02 |  9.2  5.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.03 | 3.1E-05 | 1.5E-02 |  5.7  3.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.15 | 1.3E-04 | 3.1E-02 |  5.7  7.3E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 1.2E-04 | 2.0E-02 |  5.7  4.3E-04  OK|
| O-TurbFreq           | 1.00 | 6.1E-05 | 1.6E-02 | 12.5  3.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  226                    CPU SECONDS = 1.555E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.06 | 8.8E-05 | 4.9E-02 |       1.0E-03  OK|
| V-Mom                | 1.02 | 8.6E-05 | 1.9E-02 |       1.4E-03  OK|
| W-Mom                | 1.02 | 1.3E-04 | 5.5E-02 |       1.8E-03  OK|
| P-Mass               | 1.01 | 8.1E-06 | 1.2E-02 |  9.2  5.2E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 3.0E-05 | 1.3E-02 |  5.7  3.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.10 | 1.4E-04 | 3.9E-02 |  5.7  7.5E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 1.2E-04 | 2.0E-02 |  5.7  4.5E-04  OK|
| O-TurbFreq           | 0.99 | 6.0E-05 | 1.5E-02 | 12.5  4.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  227                    CPU SECONDS = 1.561E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 8.7E-05 | 4.5E-02 |       1.0E-03  OK|
| V-Mom                | 1.03 | 8.8E-05 | 1.5E-02 |       1.4E-03  OK|
| W-Mom                | 0.97 | 1.2E-04 | 5.9E-02 |       1.8E-03  OK|
| P-Mass               | 0.99 | 8.1E-06 | 1.2E-02 |  9.2  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 2.9E-05 | 1.3E-02 |  5.7  3.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.06 | 1.5E-04 | 5.3E-02 |  5.7  7.5E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.3E-04 | 2.1E-02 |  5.7  4.8E-04  OK|
| O-TurbFreq           | 0.98 | 5.9E-05 | 1.5E-02 | 12.5  4.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  228                    CPU SECONDS = 1.568E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.11 | 9.7E-05 | 6.4E-02 |       1.0E-03  OK|
| V-Mom                | 1.03 | 9.1E-05 | 2.3E-02 |       1.4E-03  OK|
| W-Mom                | 0.98 | 1.2E-04 | 7.6E-02 |       1.8E-03  OK|
| P-Mass               | 1.02 | 8.2E-06 | 1.2E-02 |  9.2  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.04 | 3.0E-05 | 2.3E-02 |  5.7  3.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 1.6E-04 | 5.1E-02 |  5.7  7.5E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.3E-04 | 2.1E-02 |  5.7  5.2E-04  OK|
| O-TurbFreq           | 1.00 | 5.9E-05 | 1.5E-02 | 12.5  4.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  229                    CPU SECONDS = 1.575E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.93 | 9.1E-05 | 3.2E-02 |       1.0E-03  OK|
| V-Mom                | 1.02 | 9.3E-05 | 1.9E-02 |       1.5E-03  OK|
| W-Mom                | 0.94 | 1.1E-04 | 3.5E-02 |       1.8E-03  OK|
| P-Mass               | 0.99 | 8.1E-06 | 1.2E-02 |  9.2  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 3.1E-05 | 1.9E-02 |  5.7  3.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.6E-04 | 5.7E-02 |  5.7  7.5E-04  OK|
```

```
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.4E-04 | 2.5E-02 |  5.7  5.3E-04  OK|
| O-TurbFreq           | 1.02 | 6.0E-05 | 1.5E-02 | 12.5  4.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  230                    CPU SECONDS = 1.582E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.06 | 9.6E-05 | 4.5E-02 |       1.0E-03  OK|
| V-Mom                | 1.04 | 9.7E-05 | 3.4E-02 |       1.5E-03  OK|
| W-Mom                | 1.01 | 1.2E-04 | 2.5E-02 |       1.8E-03  OK|
| P-Mass               | 1.02 | 8.3E-06 | 1.2E-02 |  9.2  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 3.1E-05 | 1.4E-02 |  5.7  3.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.94 | 1.5E-04 | 4.2E-02 |  5.7  7.3E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.4E-04 | 2.8E-02 |  5.7  5.4E-04  OK|
| O-TurbFreq           | 1.00 | 6.0E-05 | 1.5E-02 | 12.5  4.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  231                    CPU SECONDS = 1.589E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 9.6E-05 | 3.5E-02 |       1.0E-03  OK|
| V-Mom                | 1.03 | 9.9E-05 | 3.0E-02 |       1.5E-03  OK|
| W-Mom                | 1.05 | 1.2E-04 | 3.2E-02 |       1.8E-03  OK|
| P-Mass               | 0.99 | 8.2E-06 | 1.1E-02 |  9.2  5.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 2.9E-05 | 1.5E-02 |  5.7  3.4E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.90 | 1.3E-04 | 3.3E-02 |  5.7  6.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.5E-04 | 2.8E-02 |  5.7  5.7E-04  OK|
| O-TurbFreq           | 1.00 | 6.0E-05 | 1.5E-02 | 12.5  4.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  232                    CPU SECONDS = 1.596E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.97 | 9.3E-05 | 3.5E-02 |       1.0E-03  OK|
| V-Mom                | 1.02 | 1.0E-04 | 2.0E-02 |       1.5E-03  OK|
| W-Mom                | 1.05 | 1.3E-04 | 4.1E-02 |       1.8E-03  OK|
| P-Mass               | 1.03 | 8.4E-06 | 1.2E-02 |  9.2  5.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 3.0E-05 | 1.4E-02 |  5.7  3.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.92 | 1.2E-04 | 3.0E-02 |  5.7  6.7E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.6E-04 | 2.9E-02 |  5.7  5.8E-04  OK|
| O-TurbFreq           | 1.02 | 6.1E-05 | 1.5E-02 | 12.5  3.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  233                    CPU SECONDS = 1.602E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 9.4E-05 | 3.2E-02 |       1.0E-03  OK|
| V-Mom                | 1.03 | 1.0E-04 | 1.9E-02 |       1.6E-03  OK|
| W-Mom                | 1.07 | 1.4E-04 | 6.3E-02 |       1.8E-03  OK|
| P-Mass               | 0.99 | 8.3E-06 | 1.1E-02 |  9.2  4.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.08 | 3.2E-05 | 2.9E-02 |  5.7  3.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.96 | 1.2E-04 | 2.9E-02 |  5.7  6.4E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.6E-04 | 3.2E-02 |  5.7  5.9E-04  OK|
| O-TurbFreq           | 1.04 | 6.3E-05 | 1.5E-02 | 12.5  4.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  234                    CPU SECONDS = 1.609E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 9.5E-05 | 3.5E-02 |       1.0E-03  OK|
| V-Mom                | 1.03 | 1.1E-04 | 2.3E-02 |       1.6E-03  OK|
| W-Mom                | 1.03 | 1.4E-04 | 4.7E-02 |       1.8E-03  OK|
| P-Mass               | 1.03 | 8.5E-06 | 1.1E-02 |  9.2  4.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.96 | 3.1E-05 | 1.5E-02 |  5.7  3.6E-03  OK|
```

```
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 1.2E-04 | 2.9E-02 |  5.7  5.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.7E-04 | 3.6E-02 |  5.7  6.0E-04  OK|
| O-TurbFreq           | 1.07 | 6.7E-05 | 1.9E-02 | 12.5  3.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  235                    CPU SECONDS = 1.616E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 9.9E-05 | 6.7E-02 |       1.0E-03  OK|
| V-Mom                | 1.03 | 1.1E-04 | 2.4E-02 |       1.5E-03  OK|
| W-Mom                | 1.07 | 1.5E-04 | 7.9E-02 |       1.8E-03  OK|
| P-Mass               | 0.98 | 8.3E-06 | 1.1E-02 |  9.2  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 3.2E-05 | 2.0E-02 |  5.7  3.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 1.2E-04 | 3.3E-02 |  5.7  5.5E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.04 | 1.7E-04 | 3.5E-02 |  5.7  6.0E-04  OK|
| O-TurbFreq           | 1.01 | 6.8E-05 | 2.0E-02 | 12.5  3.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  236                    CPU SECONDS = 1.623E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 1.0E-04 | 6.7E-02 |       9.9E-04  OK|
| V-Mom                | 1.03 | 1.1E-04 | 2.3E-02 |       1.5E-03  OK|
| W-Mom                | 1.05 | 1.6E-04 | 5.3E-02 |       1.8E-03  OK|
| P-Mass               | 1.01 | 8.4E-06 | 1.1E-02 |  9.2  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 3.2E-05 | 1.8E-02 |  5.7  3.4E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.06 | 1.3E-04 | 4.1E-02 |  5.7  5.2E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 1.8E-04 | 3.5E-02 |  5.7  5.7E-04  OK|
| O-TurbFreq           | 0.98 | 6.7E-05 | 1.5E-02 | 12.5  3.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  237                    CPU SECONDS = 1.630E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.96 | 9.8E-05 | 4.3E-02 |       9.7E-04  OK|
| V-Mom                | 1.02 | 1.2E-04 | 2.1E-02 |       1.5E-03  OK|
| W-Mom                | 1.03 | 1.6E-04 | 2.4E-02 |       1.8E-03  OK|
| P-Mass               | 0.97 | 8.2E-06 | 1.1E-02 |  9.2  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.95 | 3.0E-05 | 1.4E-02 |  5.7  3.4E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.3E-04 | 3.6E-02 |  5.7  5.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 1.8E-04 | 3.6E-02 |  5.7  5.3E-04  OK|
| O-TurbFreq           | 1.01 | 6.7E-05 | 1.4E-02 | 12.5  3.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  238                    CPU SECONDS = 1.637E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 1.0E-04 | 2.8E-02 |       9.5E-04  OK|
| V-Mom                | 1.03 | 1.2E-04 | 3.0E-02 |       1.5E-03  OK|
| W-Mom                | 1.12 | 1.8E-04 | 3.2E-02 |       1.7E-03  OK|
| P-Mass               | 1.01 | 8.3E-06 | 1.1E-02 |  9.2  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.07 | 3.2E-05 | 1.7E-02 |  5.7  3.2E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 1.4E-04 | 3.7E-02 |  5.7  5.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 1.9E-04 | 3.9E-02 |  5.7  5.1E-04  OK|
| O-TurbFreq           | 1.03 | 6.9E-05 | 1.5E-02 | 12.5  3.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  239                    CPU SECONDS = 1.643E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.07 | 1.1E-04 | 3.4E-02 |       9.2E-04  OK|
| V-Mom                | 1.02 | 1.2E-04 | 2.5E-02 |       1.4E-03  OK|
| W-Mom                | 1.19 | 2.1E-04 | 4.1E-02 |       1.7E-03  OK|
| P-Mass               | 0.98 | 8.1E-06 | 1.0E-02 |  9.2  4.5E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 3.3E-05 | 2.9E-02 |  5.7  3.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.4E-04 | 3.2E-02 |  5.7  5.3E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 2.0E-04 | 4.7E-02 |  5.7  4.7E-04  OK|
| O-TurbFreq           | 1.07 | 7.4E-05 | 1.6E-02 | 12.5  3.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  240                   CPU SECONDS = 1.650E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.10 | 1.2E-04 | 4.6E-02 |       9.0E-04  OK|
| V-Mom                | 1.02 | 1.2E-04 | 2.2E-02 |       1.4E-03  OK|
| W-Mom                | 1.02 | 2.2E-04 | 4.2E-02 |       1.7E-03  OK|
| P-Mass               | 1.02 | 8.3E-06 | 1.1E-02 |  9.2  4.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.97 | 3.2E-05 | 2.4E-02 |  5.7  3.0E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.4E-04 | 3.6E-02 |  5.7  5.6E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 2.0E-04 | 4.8E-02 |  5.7  4.5E-04  OK|
| O-TurbFreq           | 1.05 | 7.7E-05 | 1.4E-02 | 12.5  4.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  241                   CPU SECONDS = 1.657E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.2E-04 | 5.9E-02 |       8.8E-04  OK|
| V-Mom                | 1.02 | 1.3E-04 | 2.1E-02 |       1.4E-03  OK|
| W-Mom                | 0.90 | 2.0E-04 | 3.8E-02 |       1.7E-03  OK|
| P-Mass               | 0.99 | 8.2E-06 | 1.0E-02 |  9.2  4.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.98 | 3.1E-05 | 1.4E-02 |  5.7  2.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 1.4E-04 | 4.9E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 2.1E-04 | 4.6E-02 |  5.7  4.7E-04  OK|
| O-TurbFreq           | 1.04 | 8.0E-05 | 1.3E-02 | 12.5  4.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  242                   CPU SECONDS = 1.664E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 1.2E-04 | 4.9E-02 |       8.7E-04  OK|
| V-Mom                | 1.03 | 1.3E-04 | 2.1E-02 |       1.4E-03  OK|
| W-Mom                | 0.96 | 1.9E-04 | 6.1E-02 |       1.6E-03  OK|
| P-Mass               | 1.04 | 8.5E-06 | 1.0E-02 |  9.2  4.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 3.1E-05 | 1.7E-02 |  5.7  2.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 1.5E-04 | 4.3E-02 |  5.7  6.6E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 2.2E-04 | 4.4E-02 |  5.7  5.0E-04  OK|
| O-TurbFreq           | 1.06 | 8.5E-05 | 1.4E-02 | 12.5  5.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  243                   CPU SECONDS = 1.671E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.07 | 1.3E-04 | 8.3E-02 |       8.7E-04  OK|
| V-Mom                | 1.03 | 1.3E-04 | 2.2E-02 |       1.4E-03  OK|
| W-Mom                | 0.97 | 1.8E-04 | 6.2E-02 |       1.6E-03  OK|
| P-Mass               | 1.01 | 8.6E-06 | 1.0E-02 |  9.2  4.3E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.03 | 3.2E-05 | 1.9E-02 |  5.7  2.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 1.5E-04 | 4.6E-02 |  5.7  7.0E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 2.2E-04 | 5.0E-02 |  5.7  5.3E-04  OK|
| O-TurbFreq           | 1.07 | 9.1E-05 | 1.3E-02 | 12.5  5.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  244                   CPU SECONDS = 1.678E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.95 | 1.2E-04 | 3.4E-02 |       8.9E-04  OK|
| V-Mom                | 1.03 | 1.4E-04 | 2.5E-02 |       1.4E-03  OK|
```

```
| W-Mom              | 0.98 | 1.8E-04 | 2.9E-02 |       1.6E-03  OK|
| P-Mass             | 1.05 | 9.0E-06 | 1.0E-02 |  9.2  4.3E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 0.94 | 3.0E-05 | 1.2E-02 |  5.7  2.9E-03  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 1.01 | 1.5E-04 | 4.8E-02 |  5.7  7.4E-04  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.02 | 2.3E-04 | 5.2E-02 |  5.7  6.1E-04  OK|
| O-TurbFreq         | 1.04 | 9.5E-05 | 1.4E-02 | 12.5  6.1E-05  OK|
+--------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  245                    CPU SECONDS = 1.684E+05
----------------------------------------------------------------------
|       Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
| U-Mom              | 1.03 | 1.2E-04 | 2.8E-02 |       9.0E-04  OK|
| V-Mom              | 1.03 | 1.4E-04 | 2.4E-02 |       1.5E-03  OK|
| W-Mom              | 1.04 | 1.9E-04 | 3.1E-02 |       1.6E-03  OK|
| P-Mass             | 1.02 | 9.1E-06 | 1.0E-02 |  9.2  4.3E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 1.08 | 3.2E-05 | 2.3E-02 |  5.7  3.0E-03  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 1.02 | 1.5E-04 | 5.0E-02 |  5.7  7.8E-04  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.01 | 2.3E-04 | 4.3E-02 |  5.7  6.6E-04  OK|
| O-TurbFreq         | 1.01 | 9.6E-05 | 1.3E-02 | 12.5  6.1E-05  OK|
+--------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  246                    CPU SECONDS = 1.691E+05
----------------------------------------------------------------------
|       Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
| U-Mom              | 1.06 | 1.3E-04 | 3.1E-02 |       9.2E-04  OK|
| V-Mom              | 1.03 | 1.5E-04 | 3.4E-02 |       1.5E-03  OK|
| W-Mom              | 1.08 | 2.0E-04 | 5.0E-02 |       1.6E-03  OK|
| P-Mass             | 1.03 | 9.4E-06 | 1.0E-02 |  9.2  4.3E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 1.03 | 3.3E-05 | 2.7E-02 |  5.7  3.0E-03  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 1.00 | 1.5E-04 | 5.2E-02 |  5.7  7.7E-04  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.01 | 2.3E-04 | 4.2E-02 |  5.7  7.8E-04  OK|
| O-TurbFreq         | 1.00 | 9.6E-05 | 1.4E-02 | 12.5  5.5E-05  OK|
+--------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  247                    CPU SECONDS = 1.698E+05
----------------------------------------------------------------------
|       Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
| U-Mom              | 1.07 | 1.4E-04 | 4.8E-02 |       9.3E-04  OK|
| V-Mom              | 1.02 | 1.5E-04 | 3.1E-02 |       1.5E-03  OK|
| W-Mom              | 1.10 | 2.2E-04 | 5.1E-02 |       1.6E-03  OK|
| P-Mass             | 1.01 | 9.5E-06 | 1.0E-02 |  9.2  4.3E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 0.93 | 3.1E-05 | 1.3E-02 |  5.7  3.0E-03  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 1.00 | 1.5E-04 | 6.1E-02 |  5.7  7.6E-04  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.00 | 2.3E-04 | 4.2E-02 |  5.7  8.5E-04  OK|
| O-TurbFreq         | 1.02 | 9.7E-05 | 1.7E-02 | 12.5  5.5E-05  OK|
+--------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  248                    CPU SECONDS = 1.705E+05
----------------------------------------------------------------------
|       Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
| U-Mom              | 1.07 | 1.5E-04 | 5.7E-02 |       9.3E-04  OK|
| V-Mom              | 1.01 | 1.5E-04 | 2.7E-02 |       1.6E-03  OK|
| W-Mom              | 1.04 | 2.3E-04 | 4.4E-02 |       1.6E-03  OK|
| P-Mass             | 1.02 | 9.7E-06 | 1.0E-02 |  9.2  4.1E-02  OK|
+--------------------+------+---------+---------+------------------+
| dummy              | 0.94 | 2.9E-05 | 1.3E-02 |  5.7  3.0E-03  OK|
+--------------------+------+---------+---------+------------------+
| H-Energy           | 1.01 | 1.5E-04 | 6.6E-02 |  5.7  7.5E-04  OK|
+--------------------+------+---------+---------+------------------+
| K-TurbKE           | 0.99 | 2.3E-04 | 4.7E-02 |  5.7  9.3E-04  OK|
| O-TurbFreq         | 1.02 | 9.9E-05 | 2.0E-02 | 12.5  5.0E-05  OK|
+--------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  249                    CPU SECONDS = 1.712E+05
----------------------------------------------------------------------
|       Equation     | Rate | RMS Res | Max Res |  Linear Solution |
+--------------------+------+---------+---------+------------------+
```

```
| U-Mom          | 1.02 | 1.5E-04 | 4.7E-02 |       9.2E-04  OK|
| V-Mom          | 1.01 | 1.5E-04 | 2.7E-02 |       1.6E-03  OK|
| W-Mom          | 0.96 | 2.2E-04 | 6.6E-02 |       1.6E-03  OK|
| P-Mass         | 1.01 | 9.8E-06 | 1.0E-02 |  9.2  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 1.07 | 3.1E-05 | 1.8E-02 |  5.7  2.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 1.02 | 1.6E-04 | 6.6E-02 |  5.7  7.3E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 0.99 | 2.3E-04 | 4.7E-02 |  5.7  9.8E-04  OK|
| O-TurbFreq     | 0.98 | 9.7E-05 | 1.4E-02 | 12.5  5.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  250                  CPU SECONDS = 1.719E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom          | 1.05 | 1.6E-04 | 7.9E-02 |       9.0E-04  OK|
| V-Mom          | 1.01 | 1.5E-04 | 2.7E-02 |       1.5E-03  OK|
| W-Mom          | 0.97 | 2.2E-04 | 6.8E-02 |       1.6E-03  OK|
| P-Mass         | 1.00 | 9.8E-06 | 1.1E-02 |  9.2  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 0.94 | 2.9E-05 | 1.3E-02 |  5.7  2.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 1.03 | 1.6E-04 | 6.2E-02 |  5.7  6.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 0.99 | 2.2E-04 | 4.1E-02 |  5.7  1.0E-03  OK|
| O-TurbFreq     | 1.01 | 9.7E-05 | 1.4E-02 | 12.5  4.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  251                  CPU SECONDS = 1.725E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom          | 0.97 | 1.6E-04 | 3.3E-02 |       8.6E-04  OK|
| V-Mom          | 1.00 | 1.5E-04 | 2.4E-02 |       1.5E-03  OK|
| W-Mom          | 0.93 | 2.0E-04 | 2.9E-02 |       1.5E-03  OK|
| P-Mass         | 1.00 | 9.9E-06 | 1.1E-02 |  9.2  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 1.08 | 3.2E-05 | 2.0E-02 |  5.7  2.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 1.05 | 1.7E-04 | 5.2E-02 |  5.7  6.6E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 0.98 | 2.2E-04 | 3.8E-02 |  5.7  1.1E-03  OK|
| O-TurbFreq     | 1.00 | 9.8E-05 | 1.5E-02 | 12.5  4.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  252                  CPU SECONDS = 1.732E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom          | 1.02 | 1.6E-04 | 3.3E-02 |       8.2E-04  OK|
| V-Mom          | 1.00 | 1.5E-04 | 2.4E-02 |       1.5E-03  OK|
| W-Mom          | 0.96 | 1.9E-04 | 2.9E-02 |       1.5E-03  OK|
| P-Mass         | 0.99 | 9.8E-06 | 1.1E-02 |  9.2  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 0.99 | 3.1E-05 | 2.5E-02 |  5.7  2.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 1.05 | 1.8E-04 | 4.7E-02 |  5.7  6.3E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 0.98 | 2.2E-04 | 3.7E-02 |  5.7  1.0E-03  OK|
| O-TurbFreq     | 1.01 | 9.9E-05 | 1.4E-02 | 12.5  4.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  253                  CPU SECONDS = 1.739E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom          | 1.01 | 1.6E-04 | 3.3E-02 |       7.8E-04  OK|
| V-Mom          | 0.99 | 1.5E-04 | 2.3E-02 |       1.4E-03  OK|
| W-Mom          | 0.96 | 1.9E-04 | 4.4E-02 |       1.5E-03  OK|
| P-Mass         | 1.01 | 9.9E-06 | 1.1E-02 |  9.2  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy          | 0.99 | 3.1E-05 | 1.2E-02 |  5.7  2.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy       | 1.04 | 1.9E-04 | 4.3E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE       | 0.98 | 2.1E-04 | 3.4E-02 |  5.7  1.0E-03  OK|
| O-TurbFreq     | 0.99 | 9.8E-05 | 1.6E-02 | 12.5  3.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  254                  CPU SECONDS = 1.746E+05
----------------------------------------------------------------------
```

```
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 1.01 | 1.6E-04 | 4.8E-02 |       7.3E-04  OK|
| V-Mom              | 1.01 | 1.5E-04 | 2.9E-02 |       1.3E-03  OK|
| W-Mom              | 0.98 | 1.8E-04 | 5.6E-02 |       1.4E-03  OK|
| P-Mass             | 0.99 | 9.8E-06 | 1.1E-02 |  9.2  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 0.93 | 2.9E-05 | 1.0E-02 |  5.7  2.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 1.03 | 2.0E-04 | 4.8E-02 |  5.7  6.0E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.00 | 2.1E-04 | 4.3E-02 |  5.7  9.6E-04  OK|
| O-TurbFreq         | 0.96 | 9.4E-05 | 1.5E-02 | 12.5  4.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  255                CPU SECONDS = 1.753E+05
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 1.01 | 1.6E-04 | 6.8E-02 |       7.0E-04  OK|
| V-Mom              | 1.01 | 1.5E-04 | 2.8E-02 |       1.3E-03  OK|
| W-Mom              | 0.97 | 1.8E-04 | 5.7E-02 |       1.4E-03  OK|
| P-Mass             | 1.01 | 9.9E-06 | 1.2E-02 |  9.2  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 1.01 | 2.9E-05 | 1.7E-02 |  5.7  2.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 1.02 | 2.0E-04 | 5.6E-02 |  5.7  5.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.01 | 2.1E-04 | 4.5E-02 |  5.7  8.8E-04  OK|
| O-TurbFreq         | 0.96 | 9.0E-05 | 1.6E-02 | 12.5  3.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  256                CPU SECONDS = 1.760E+05
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 1.00 | 1.6E-04 | 6.0E-02 |       6.8E-04  OK|
| V-Mom              | 1.01 | 1.6E-04 | 2.9E-02 |       1.2E-03  OK|
| W-Mom              | 0.99 | 1.7E-04 | 8.0E-02 |       1.3E-03  OK|
| P-Mass             | 1.01 | 9.9E-06 | 1.2E-02 |  9.2  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 0.94 | 2.7E-05 | 9.3E-03 |  5.7  3.0E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 1.02 | 2.0E-04 | 6.2E-02 |  5.7  5.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.02 | 2.2E-04 | 5.5E-02 |  5.7  8.3E-04  OK|
| O-TurbFreq         | 0.95 | 8.6E-05 | 1.5E-02 | 12.5  4.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  257                CPU SECONDS = 1.766E+05
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 1.02 | 1.6E-04 | 8.0E-02 |       6.7E-04  OK|
| V-Mom              | 1.01 | 1.6E-04 | 2.9E-02 |       1.2E-03  OK|
| W-Mom              | 0.98 | 1.7E-04 | 5.7E-02 |       1.3E-03  OK|
| P-Mass             | 1.03 | 1.0E-05 | 1.2E-02 |  9.2  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 1.07 | 2.9E-05 | 1.5E-02 |  5.7  3.0E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 1.01 | 2.1E-04 | 6.2E-02 |  5.7  5.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.02 | 2.2E-04 | 4.9E-02 |  5.7  7.3E-04  OK|
| O-TurbFreq         | 0.95 | 8.2E-05 | 1.7E-02 | 12.5  4.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  258                CPU SECONDS = 1.773E+05
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom              | 0.97 | 1.6E-04 | 3.5E-02 |       6.7E-04  OK|
| V-Mom              | 1.01 | 1.6E-04 | 2.7E-02 |       1.2E-03  OK|
| W-Mom              | 0.97 | 1.7E-04 | 2.4E-02 |       1.3E-03  OK|
| P-Mass             | 1.01 | 1.0E-05 | 1.3E-02 |  9.2  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy              | 1.07 | 3.1E-05 | 2.3E-02 |  5.7  3.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy           | 1.00 | 2.0E-04 | 5.7E-02 |  5.7  5.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE           | 1.01 | 2.2E-04 | 5.6E-02 |  5.7  6.7E-04  OK|
| O-TurbFreq         | 0.97 | 7.9E-05 | 1.6E-02 | 12.5  4.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
```

```
OUTER LOOP ITERATION =  259              CPU SECONDS = 1.780E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 1.6E-04 | 3.7E-02 |       6.9E-04  OK|
| V-Mom                | 1.01 | 1.6E-04 | 3.2E-02 |       1.2E-03  OK|
| W-Mom                | 1.01 | 1.7E-04 | 2.3E-02 |       1.3E-03  OK|
| P-Mass               | 1.03 | 1.1E-05 | 1.3E-02 |  9.2  3.4E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 3.1E-05 | 1.1E-02 |  5.7  3.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 2.1E-04 | 6.5E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 2.3E-04 | 5.2E-02 |  5.7  6.3E-04  OK|
| O-TurbFreq           | 0.98 | 7.7E-05 | 1.8E-02 | 12.5  5.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  260              CPU SECONDS = 1.787E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.6E-04 | 3.4E-02 |       7.0E-04  OK|
| V-Mom                | 1.02 | 1.6E-04 | 3.2E-02 |       1.2E-03  OK|
| W-Mom                | 1.05 | 1.8E-04 | 4.6E-02 |       1.3E-03  OK|
| P-Mass               | 1.01 | 1.1E-05 | 1.3E-02 |  9.2  3.5E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.08 | 3.3E-05 | 1.0E-02 |  5.7  3.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 2.1E-04 | 7.1E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 2.3E-04 | 5.0E-02 |  5.7  6.5E-04  OK|
| O-TurbFreq           | 0.98 | 7.6E-05 | 1.6E-02 | 12.5  5.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  261              CPU SECONDS = 1.794E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 1.6E-04 | 3.2E-02 |       7.3E-04  OK|
| V-Mom                | 1.01 | 1.7E-04 | 3.2E-02 |       1.3E-03  OK|
| W-Mom                | 1.02 | 1.8E-04 | 5.7E-02 |       1.3E-03  OK|
| P-Mass               | 1.02 | 1.1E-05 | 1.3E-02 |  9.2  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.14 | 3.8E-05 | 2.2E-02 |  5.7  3.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 2.2E-04 | 6.9E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 2.4E-04 | 5.1E-02 |  5.7  7.1E-04  OK|
| O-TurbFreq           | 0.99 | 7.5E-05 | 1.8E-02 | 12.5  6.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  262              CPU SECONDS = 1.801E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 1.6E-04 | 6.7E-02 |       7.5E-04  OK|
| V-Mom                | 1.02 | 1.7E-04 | 3.4E-02 |       1.3E-03  OK|
| W-Mom                | 1.07 | 1.9E-04 | 7.3E-02 |       1.3E-03  OK|
| P-Mass               | 1.01 | 1.1E-05 | 1.3E-02 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.09 | 4.2E-05 | 1.3E-02 |  5.7  3.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 2.2E-04 | 6.2E-02 |  5.7  6.2E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 2.4E-04 | 6.2E-02 |  5.7  7.9E-04  OK|
| O-TurbFreq           | 0.99 | 7.4E-05 | 1.6E-02 | 12.5  6.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  263              CPU SECONDS = 1.807E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 1.6E-04 | 4.9E-02 |       7.7E-04  OK|
| V-Mom                | 1.02 | 1.7E-04 | 3.7E-02 |       1.4E-03  OK|
| W-Mom                | 1.02 | 2.0E-04 | 4.2E-02 |       1.3E-03  OK|
| P-Mass               | 1.01 | 1.1E-05 | 1.3E-02 |  9.2  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.11 | 4.6E-05 | 1.5E-02 |  5.7  3.2E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 2.3E-04 | 5.6E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.03 | 2.5E-04 | 6.4E-02 |  5.7  8.9E-04  OK|
| O-TurbFreq           | 1.00 | 7.5E-05 | 1.8E-02 | 12.5  6.9E-05  OK|
+----------------------+------+---------+---------+------------------+
```

```
======================================================================
OUTER LOOP ITERATION =  264                    CPU SECONDS = 1.814E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.7E-04 | 3.8E-02 |       7.8E-04  OK|
| V-Mom                | 1.02 | 1.8E-04 | 3.5E-02 |       1.4E-03  OK|
| W-Mom                | 1.04 | 2.0E-04 | 3.1E-02 |       1.3E-03  OK|
| P-Mass               | 1.01 | 1.1E-05 | 1.3E-02 |  9.2  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.13 | 5.2E-05 | 2.8E-02 |  5.7  3.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.05 | 2.4E-04 | 5.2E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 2.5E-04 | 4.5E-02 |  5.7  9.6E-04  OK|
| O-TurbFreq           | 1.03 | 7.7E-05 | 1.7E-02 | 12.5  6.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  265                    CPU SECONDS = 1.821E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.7E-04 | 3.7E-02 |       7.8E-04  OK|
| V-Mom                | 1.03 | 1.8E-04 | 2.9E-02 |       1.4E-03  OK|
| W-Mom                | 1.08 | 2.2E-04 | 2.9E-02 |       1.3E-03  OK|
| P-Mass               | 1.00 | 1.1E-05 | 1.3E-02 |  9.2  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 5.5E-05 | 1.7E-02 |  5.7  3.7E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 2.5E-04 | 6.0E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 2.6E-04 | 5.5E-02 |  5.7  1.0E-03  OK|
| O-TurbFreq           | 1.04 | 8.0E-05 | 1.7E-02 | 12.5  7.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  266                    CPU SECONDS = 1.828E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 1.7E-04 | 4.6E-02 |       7.8E-04  OK|
| V-Mom                | 1.03 | 1.9E-04 | 3.0E-02 |       1.4E-03  OK|
| W-Mom                | 1.16 | 2.6E-04 | 2.6E-02 |       1.3E-03  OK|
| P-Mass               | 1.02 | 1.1E-05 | 1.3E-02 |  9.2  4.0E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.09 | 6.0E-05 | 1.8E-02 |  5.7  4.0E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.04 | 2.6E-04 | 6.2E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 2.6E-04 | 5.8E-02 |  5.7  1.1E-03  OK|
| O-TurbFreq           | 1.05 | 8.4E-05 | 1.7E-02 | 12.5  7.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  267                    CPU SECONDS = 1.835E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 1.8E-04 | 5.0E-02 |       7.7E-04  OK|
| V-Mom                | 1.03 | 1.9E-04 | 3.4E-02 |       1.4E-03  OK|
| W-Mom                | 1.22 | 3.2E-04 | 4.5E-02 |       1.3E-03  OK|
| P-Mass               | 0.99 | 1.1E-05 | 1.3E-02 |  9.2  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.06 | 6.3E-05 | 2.0E-02 |  5.7  4.2E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 2.7E-04 | 7.5E-02 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 2.7E-04 | 5.5E-02 |  5.7  1.1E-03  OK|
| O-TurbFreq           | 1.01 | 8.5E-05 | 1.6E-02 | 12.5  6.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  268                    CPU SECONDS = 1.842E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.8E-04 | 6.4E-02 |       7.5E-04  OK|
| V-Mom                | 1.03 | 2.0E-04 | 3.6E-02 |       1.3E-03  OK|
| W-Mom                | 0.83 | 2.6E-04 | 4.9E-02 |       1.3E-03  OK|
| P-Mass               | 1.02 | 1.2E-05 | 1.3E-02 |  9.2  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.06 | 6.7E-05 | 2.4E-02 |  5.7  4.4E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 2.8E-04 | 1.0E-01 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.7E-04 | 5.6E-02 |  5.7  1.1E-03  OK|
```

```
| O-TurbFreq          | 1.07 | 9.1E-05 | 1.7E-02 | 12.5  6.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  269                    CPU SECONDS = 1.848E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 1.8E-04 | 3.6E-02 |       7.4E-04  OK|
| V-Mom                | 1.02 | 2.0E-04 | 3.6E-02 |       1.3E-03  OK|
| W-Mom                | 0.93 | 2.4E-04 | 7.7E-02 |       1.3E-03  OK|
| P-Mass               | 0.98 | 1.1E-05 | 1.2E-02 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.03 | 6.9E-05 | 1.8E-02 |  5.7  4.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 2.9E-04 | 1.5E-01 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.7E-04 | 5.2E-02 |  5.7  1.1E-03  OK|
| O-TurbFreq           | 1.10 | 1.0E-04 | 1.5E-02 | 12.5  6.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  270                    CPU SECONDS = 1.855E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 1.9E-04 | 6.7E-02 |       7.3E-04  OK|
| V-Mom                | 1.02 | 2.0E-04 | 3.4E-02 |       1.3E-03  OK|
| W-Mom                | 0.94 | 2.3E-04 | 5.5E-02 |       1.3E-03  OK|
| P-Mass               | 1.02 | 1.2E-05 | 1.2E-02 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.04 | 7.1E-05 | 2.6E-02 |  5.7  4.7E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 2.9E-04 | 1.7E-01 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 5.1E-02 |  5.7  1.0E-03  OK|
| O-TurbFreq           | 1.10 | 1.1E-04 | 1.6E-02 | 12.5  5.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  271                    CPU SECONDS = 1.862E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 1.9E-04 | 3.2E-02 |       7.3E-04  OK|
| V-Mom                | 1.02 | 2.1E-04 | 3.6E-02 |       1.3E-03  OK|
| W-Mom                | 0.97 | 2.2E-04 | 5.3E-02 |       1.3E-03  OK|
| P-Mass               | 0.98 | 1.1E-05 | 1.1E-02 |  9.2  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 7.2E-05 | 1.8E-02 |  5.7  4.7E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 3.0E-04 | 1.6E-01 |  5.7  6.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 4.8E-02 |  5.7  9.2E-04  OK|
| O-TurbFreq           | 1.00 | 1.1E-04 | 1.4E-02 | 12.5  4.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  272                    CPU SECONDS = 1.869E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.03 | 1.9E-04 | 3.6E-02 |       7.4E-04  OK|
| V-Mom                | 1.02 | 2.1E-04 | 3.9E-02 |       1.3E-03  OK|
| W-Mom                | 0.99 | 2.2E-04 | 4.9E-02 |       1.3E-03  OK|
| P-Mass               | 1.03 | 1.2E-05 | 1.1E-02 |  9.2  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.03 | 7.4E-05 | 1.8E-02 |  5.7  4.7E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 3.1E-04 | 1.8E-01 |  5.7  6.2E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 4.5E-02 |  5.7  8.9E-04  OK|
| O-TurbFreq           | 0.98 | 1.1E-04 | 1.5E-02 | 12.5  4.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  273                    CPU SECONDS = 1.876E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 2.0E-04 | 3.4E-02 |       7.6E-04  OK|
| V-Mom                | 1.01 | 2.2E-04 | 3.7E-02 |       1.3E-03  OK|
| W-Mom                | 1.02 | 2.2E-04 | 3.2E-02 |       1.3E-03  OK|
| P-Mass               | 0.98 | 1.1E-05 | 1.0E-02 |  9.2  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 7.4E-05 | 2.3E-02 |  5.7  4.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 3.1E-04 | 1.9E-01 |  5.7  6.4E-04  OK|
```

```
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 4.4E-02 |  5.7  8.4E-04  OK|
| O-TurbFreq           | 1.04 | 1.1E-04 | 1.8E-02 | 12.5  3.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  274                    CPU SECONDS = 1.883E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 2.0E-04 | 3.7E-02 |       7.9E-04  OK|
| V-Mom                | 1.01 | 2.2E-04 | 3.4E-02 |       1.3E-03  OK|
| W-Mom                | 1.10 | 2.5E-04 | 7.1E-02 |       1.3E-03  OK|
| P-Mass               | 1.01 | 1.2E-05 | 1.1E-02 |  9.2  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.04 | 7.7E-05 | 2.7E-02 |  5.7  4.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.01 | 3.2E-04 | 1.5E-01 |  5.7  6.4E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 3.7E-02 |  5.7  8.2E-04  OK|
| O-TurbFreq           | 1.05 | 1.2E-04 | 2.6E-02 | 12.5  3.8E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  275                    CPU SECONDS = 1.889E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.04 | 2.1E-04 | 6.8E-02 |       8.2E-04  OK|
| V-Mom                | 1.01 | 2.2E-04 | 3.5E-02 |       1.3E-03  OK|
| W-Mom                | 1.12 | 2.8E-04 | 1.1E-01 |       1.3E-03  OK|
| P-Mass               | 0.96 | 1.1E-05 | 9.5E-03 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 0.99 | 7.6E-05 | 1.8E-02 |  5.7  4.7E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 3.2E-04 | 1.5E-01 |  5.7  6.7E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 3.3E-02 |  5.7  7.9E-04  OK|
| O-TurbFreq           | 1.01 | 1.2E-04 | 2.3E-02 | 12.5  4.1E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  276                    CPU SECONDS = 1.896E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 2.1E-04 | 7.1E-02 |       8.5E-04  OK|
| V-Mom                | 1.01 | 2.2E-04 | 3.7E-02 |       1.4E-03  OK|
| W-Mom                | 1.05 | 2.9E-04 | 1.1E-01 |       1.3E-03  OK|
| P-Mass               | 1.03 | 1.1E-05 | 9.8E-03 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 7.7E-05 | 1.8E-02 |  5.7  4.7E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.00 | 3.1E-04 | 1.4E-01 |  5.7  6.8E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 4.0E-02 |  5.7  8.2E-04  OK|
| O-TurbFreq           | 1.01 | 1.2E-04 | 1.8E-02 | 12.5  4.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  277                    CPU SECONDS = 1.903E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 2.1E-04 | 6.1E-02 |       8.7E-04  OK|
| V-Mom                | 1.00 | 2.2E-04 | 3.5E-02 |       1.4E-03  OK|
| W-Mom                | 0.99 | 2.9E-04 | 7.8E-02 |       1.3E-03  OK|
| P-Mass               | 1.00 | 1.1E-05 | 8.8E-03 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 8.1E-05 | 3.1E-02 |  5.7  4.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 3.1E-04 | 1.6E-01 |  5.7  7.0E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 4.2E-02 |  5.7  8.6E-04  OK|
| O-TurbFreq           | 1.02 | 1.2E-04 | 1.7E-02 | 12.5  5.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  278                    CPU SECONDS = 1.910E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 2.1E-04 | 4.1E-02 |       8.7E-04  OK|
| V-Mom                | 0.99 | 2.2E-04 | 3.5E-02 |       1.4E-03  OK|
| W-Mom                | 0.97 | 2.8E-04 | 6.1E-02 |       1.3E-03  OK|
| P-Mass               | 1.03 | 1.2E-05 | 9.0E-03 |  9.2  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 8.2E-05 | 3.4E-02 |  5.7  4.9E-03  OK|
```

```
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 3.1E-04 | 1.6E-01 |  5.7  6.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.99 | 2.6E-04 | 4.4E-02 |  5.7  9.4E-04  OK|
| O-TurbFreq           | 1.00 | 1.2E-04 | 1.3E-02 | 12.5  5.7E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  279                    CPU SECONDS = 1.917E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 2.1E-04 | 3.8E-02 |       8.7E-04  OK|
| V-Mom                | 0.99 | 2.2E-04 | 3.8E-02 |       1.4E-03  OK|
| W-Mom                | 0.96 | 2.7E-04 | 6.5E-02 |       1.3E-03  OK|
| P-Mass               | 0.98 | 1.2E-05 | 8.4E-03 |  9.2  3.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.01 | 8.2E-05 | 2.2E-02 |  5.7  4.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 3.1E-04 | 1.4E-01 |  5.7  7.0E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 2.6E-04 | 4.9E-02 |  5.7  1.1E-03  OK|
| O-TurbFreq           | 0.98 | 1.2E-04 | 1.4E-02 | 12.5  6.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  280                    CPU SECONDS = 1.924E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 2.2E-04 | 4.6E-02 |       8.6E-04  OK|
| V-Mom                | 0.99 | 2.1E-04 | 3.4E-02 |       1.4E-03  OK|
| W-Mom                | 0.95 | 2.5E-04 | 4.1E-02 |       1.3E-03  OK|
| P-Mass               | 0.99 | 1.2E-05 | 8.5E-03 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.04 | 8.5E-05 | 2.7E-02 |  5.7  4.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 3.0E-04 | 1.2E-01 |  5.7  7.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.98 | 2.5E-04 | 4.7E-02 |  5.7  1.2E-03  OK|
| O-TurbFreq           | 0.97 | 1.2E-04 | 1.3E-02 | 12.5  6.5E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  281                    CPU SECONDS = 1.930E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 2.2E-04 | 7.0E-02 |       8.4E-04  OK|
| V-Mom                | 1.00 | 2.1E-04 | 3.9E-02 |       1.4E-03  OK|
| W-Mom                | 0.95 | 2.4E-04 | 4.4E-02 |       1.3E-03  OK|
| P-Mass               | 0.98 | 1.1E-05 | 8.3E-03 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 8.7E-05 | 2.3E-02 |  5.7  4.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 2.9E-04 | 1.1E-01 |  5.7  7.2E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 0.99 | 2.5E-04 | 5.1E-02 |  5.7  1.3E-03  OK|
| O-TurbFreq           | 0.98 | 1.1E-04 | 1.4E-02 | 12.5  7.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  282                    CPU SECONDS = 1.937E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 0.99 | 2.2E-04 | 4.5E-02 |       8.3E-04  OK|
| V-Mom                | 1.00 | 2.2E-04 | 4.4E-02 |       1.3E-03  OK|
| W-Mom                | 0.96 | 2.3E-04 | 4.0E-02 |       1.3E-03  OK|
| P-Mass               | 0.99 | 1.1E-05 | 8.5E-03 |  9.2  3.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 8.9E-05 | 2.7E-02 |  5.7  4.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.97 | 2.8E-04 | 1.0E-01 |  5.7  7.1E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 2.5E-04 | 5.2E-02 |  5.7  1.4E-03  OK|
| O-TurbFreq           | 0.99 | 1.1E-04 | 2.1E-02 | 12.5  6.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  283                    CPU SECONDS = 1.944E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 2.2E-04 | 5.5E-02 |       8.3E-04  OK|
| V-Mom                | 1.00 | 2.2E-04 | 4.6E-02 |       1.3E-03  OK|
| W-Mom                | 0.98 | 2.3E-04 | 6.1E-02 |       1.3E-03  OK|
| P-Mass               | 0.99 | 1.1E-05 | 8.7E-03 |  9.2  3.6E-02  OK|
```

```
+----------------------+------+---------+---------+------------------+
| dummy                | 1.03 | 9.2E-05 | 2.1E-02 |  5.7  4.9E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 2.8E-04 | 8.7E-02 |  5.7  7.2E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 2.6E-04 | 6.5E-02 |  5.7  1.5E-03  OK|
| O-TurbFreq           | 0.96 | 1.1E-04 | 1.8E-02 | 12.5  6.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  284                    CPU SECONDS = 1.951E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 2.2E-04 | 3.8E-02 |       8.5E-04  OK|
| V-Mom                | 1.01 | 2.2E-04 | 4.2E-02 |       1.3E-03  OK|
| W-Mom                | 0.98 | 2.2E-04 | 5.2E-02 |       1.3E-03  OK|
| P-Mass               | 0.99 | 1.1E-05 | 8.8E-03 |  9.2  3.8E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 9.3E-05 | 1.9E-02 |  5.7  5.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 2.7E-04 | 8.1E-02 |  5.7  7.3E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 2.6E-04 | 6.9E-02 |  5.7  1.6E-03  OK|
| O-TurbFreq           | 0.94 | 1.0E-04 | 1.2E-02 | 12.5  6.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  285                    CPU SECONDS = 1.958E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 2.2E-04 | 3.6E-02 |       8.8E-04  OK|
| V-Mom                | 1.01 | 2.2E-04 | 4.3E-02 |       1.3E-03  OK|
| W-Mom                | 0.99 | 2.2E-04 | 8.3E-02 |       1.3E-03  OK|
| P-Mass               | 1.01 | 1.1E-05 | 9.4E-03 |  9.2  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.05 | 9.8E-05 | 3.9E-02 |  5.7  5.3E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.99 | 2.7E-04 | 7.6E-02 |  5.7  7.4E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.6E-04 | 6.8E-02 |  5.7  1.7E-03  OK|
| O-TurbFreq           | 0.98 | 1.0E-04 | 1.3E-02 | 12.5  5.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  286                    CPU SECONDS = 1.965E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.01 | 2.2E-04 | 3.2E-02 |       9.2E-04  OK|
| V-Mom                | 1.02 | 2.2E-04 | 4.7E-02 |       1.4E-03  OK|
| W-Mom                | 1.00 | 2.2E-04 | 7.1E-02 |       1.3E-03  OK|
| P-Mass               | 0.99 | 1.1E-05 | 9.6E-03 |  9.2  3.9E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.00 | 9.8E-05 | 2.0E-02 |  5.7  5.5E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 2.6E-04 | 7.0E-02 |  5.7  7.3E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 2.6E-04 | 7.3E-02 |  5.7  1.7E-03  OK|
| O-TurbFreq           | 0.96 | 9.7E-05 | 1.3E-02 | 12.5  5.3E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  287                    CPU SECONDS = 1.971E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.00 | 2.2E-04 | 3.5E-02 |       9.7E-04  OK|
| V-Mom                | 1.02 | 2.3E-04 | 5.1E-02 |       1.4E-03  OK|
| W-Mom                | 1.00 | 2.2E-04 | 4.3E-02 |       1.4E-03  OK|
| P-Mass               | 1.01 | 1.1E-05 | 1.0E-02 |  9.2  4.1E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 9.9E-05 | 1.6E-02 |  5.7  5.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 0.98 | 2.6E-04 | 8.4E-02 |  5.7  7.5E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.02 | 2.6E-04 | 6.7E-02 |  5.7  1.7E-03  OK|
| O-TurbFreq           | 0.94 | 9.1E-05 | 1.4E-02 | 12.5  4.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  288                    CPU SECONDS = 1.978E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 2.3E-04 | 6.9E-02 |       1.0E-03  OK|
| V-Mom                | 1.02 | 2.3E-04 | 4.5E-02 |       1.4E-03  OK|
```

```
| W-Mom               | 1.02 | 2.2E-04 | 5.1E-02 |       1.5E-03  OK|
| P-Mass              | 0.99 | 1.1E-05 | 1.0E-02 |  9.2  4.3E-02  OK|
+---------------------+------+---------+---------+------------------+
| dummy               | 1.02 | 1.0E-04 | 2.5E-02 |  5.7  5.6E-03  OK|
+---------------------+------+---------+---------+------------------+
| H-Energy            | 1.00 | 2.6E-04 | 8.8E-02 |  5.7  7.6E-04  OK|
+---------------------+------+---------+---------+------------------+
| K-TurbKE            | 1.02 | 2.7E-04 | 6.9E-02 |  5.7  1.6E-03  OK|
| O-TurbFreq          | 0.94 | 8.5E-05 | 1.3E-02 | 12.5  4.2E-05  OK|
+---------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  289                    CPU SECONDS = 1.985E+05
----------------------------------------------------------------------
|       Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+---------------------+------+---------+---------+------------------+
| U-Mom               | 1.01 | 2.3E-04 | 6.0E-02 |       1.1E-03  OK|
| V-Mom               | 1.02 | 2.4E-04 | 5.0E-02 |       1.5E-03  OK|
| W-Mom               | 1.03 | 2.3E-04 | 4.0E-02 |       1.6E-03  OK|
| P-Mass              | 1.02 | 1.1E-05 | 1.1E-02 |  9.2  4.4E-02  OK|
+---------------------+------+---------+---------+------------------+
| dummy               | 1.02 | 1.0E-04 | 2.1E-02 |  5.7  5.6E-03  OK|
+---------------------+------+---------+---------+------------------+
| H-Energy            | 1.03 | 2.7E-04 | 8.0E-02 |  5.7  7.5E-04  OK|
+---------------------+------+---------+---------+------------------+
| K-TurbKE            | 1.01 | 2.7E-04 | 7.0E-02 |  5.7  1.6E-03  OK|
| O-TurbFreq          | 0.97 | 8.3E-05 | 1.5E-02 | 12.5  3.6E-05  OK|
+---------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  290                    CPU SECONDS = 1.992E+05
----------------------------------------------------------------------
|       Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+---------------------+------+---------+---------+------------------+
| U-Mom               | 1.00 | 2.3E-04 | 6.0E-02 |       1.1E-03  OK|
| V-Mom               | 1.02 | 2.4E-04 | 5.4E-02 |       1.5E-03  OK|
| W-Mom               | 1.04 | 2.4E-04 | 3.9E-02 |       1.6E-03  OK|
| P-Mass              | 1.00 | 1.1E-05 | 1.1E-02 |  9.2  4.6E-02  OK|
+---------------------+------+---------+---------+------------------+
| dummy               | 0.99 | 1.0E-04 | 1.9E-02 |  5.7  5.5E-03  OK|
+---------------------+------+---------+---------+------------------+
| H-Energy            | 1.06 | 2.8E-04 | 1.0E-01 |  5.7  7.4E-04  OK|
+---------------------+------+---------+---------+------------------+
| K-TurbKE            | 1.01 | 2.8E-04 | 6.1E-02 |  5.7  1.5E-03  OK|
| O-TurbFreq          | 0.99 | 8.3E-05 | 1.6E-02 | 12.5  3.1E-05  OK|
+---------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  291                    CPU SECONDS = 1.999E+05
----------------------------------------------------------------------
|       Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+---------------------+------+---------+---------+------------------+
| U-Mom               | 1.01 | 2.3E-04 | 5.2E-02 |       1.1E-03  OK|
| V-Mom               | 1.02 | 2.5E-04 | 5.0E-02 |       1.5E-03  OK|
| W-Mom               | 1.09 | 2.6E-04 | 5.0E-02 |       1.7E-03  OK|
| P-Mass              | 1.02 | 1.2E-05 | 1.1E-02 |  9.2  4.7E-02  OK|
+---------------------+------+---------+---------+------------------+
| dummy               | 1.01 | 1.0E-04 | 1.8E-02 |  5.7  5.6E-03  OK|
+---------------------+------+---------+---------+------------------+
| H-Energy            | 1.08 | 3.0E-04 | 1.2E-01 |  5.7  7.4E-04  OK|
+---------------------+------+---------+---------+------------------+
| K-TurbKE            | 1.01 | 2.8E-04 | 6.9E-02 |  5.7  1.4E-03  OK|
| O-TurbFreq          | 1.03 | 8.5E-05 | 2.6E-02 | 12.5  3.0E-05  OK|
+---------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  292                    CPU SECONDS = 2.006E+05
----------------------------------------------------------------------
|       Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+---------------------+------+---------+---------+------------------+
| U-Mom               | 1.01 | 2.3E-04 | 4.9E-02 |       1.1E-03  OK|
| V-Mom               | 1.02 | 2.5E-04 | 5.3E-02 |       1.6E-03  OK|
| W-Mom               | 1.18 | 3.1E-04 | 4.8E-02 |       1.8E-03  OK|
| P-Mass              | 1.01 | 1.2E-05 | 1.1E-02 |  9.2  4.7E-02  OK|
+---------------------+------+---------+---------+------------------+
| dummy               | 1.01 | 1.0E-04 | 1.8E-02 |  5.7  5.8E-03  OK|
+---------------------+------+---------+---------+------------------+
| H-Energy            | 1.06 | 3.2E-04 | 1.3E-01 |  5.7  7.4E-04  OK|
+---------------------+------+---------+---------+------------------+
| K-TurbKE            | 1.01 | 2.8E-04 | 7.0E-02 |  5.7  1.3E-03  OK|
| O-TurbFreq          | 1.02 | 8.7E-05 | 3.1E-02 | 12.5  2.9E-05  OK|
+---------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  293                    CPU SECONDS = 2.012E+05
----------------------------------------------------------------------
|       Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+---------------------+------+---------+---------+------------------+
```

```
| U-Mom            | 1.01 | 2.3E-04 | 5.2E-02 |       1.1E-03  OK|
| V-Mom            | 1.03 | 2.6E-04 | 5.2E-02 |       1.5E-03  OK|
| W-Mom            | 0.95 | 3.0E-04 | 3.2E-02 |       1.8E-03  OK|
| P-Mass           | 1.01 | 1.2E-05 | 1.2E-02 |  9.2  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy            | 1.01 | 1.0E-04 | 1.7E-02 |  5.7  6.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy         | 1.03 | 3.3E-04 | 1.2E-01 |  5.7  7.4E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE         | 1.01 | 2.9E-04 | 5.7E-02 |  5.7  1.3E-03  OK|
| O-TurbFreq       | 1.04 | 9.0E-05 | 2.6E-02 | 12.5  3.0E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  294                 CPU SECONDS = 2.019E+05
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom            | 1.01 | 2.3E-04 | 6.0E-02 |       1.1E-03  OK|
| V-Mom            | 1.03 | 2.7E-04 | 5.2E-02 |       1.5E-03  OK|
| W-Mom            | 0.92 | 2.7E-04 | 4.7E-02 |       1.8E-03  OK|
| P-Mass           | 1.01 | 1.2E-05 | 1.2E-02 |  9.2  4.7E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy            | 1.00 | 1.0E-04 | 2.0E-02 |  5.7  6.4E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy         | 1.01 | 3.4E-04 | 9.6E-02 |  5.7  7.4E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE         | 1.01 | 2.9E-04 | 5.6E-02 |  5.7  1.3E-03  OK|
| O-TurbFreq       | 1.12 | 1.0E-04 | 2.4E-02 | 12.5  3.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  295                 CPU SECONDS = 2.026E+05
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom            | 1.01 | 2.4E-04 | 5.3E-02 |       1.0E-03  OK|
| V-Mom            | 1.02 | 2.7E-04 | 5.0E-02 |       1.5E-03  OK|
| W-Mom            | 0.95 | 2.6E-04 | 6.0E-02 |       1.7E-03  OK|
| P-Mass           | 1.03 | 1.2E-05 | 1.2E-02 |  9.2  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy            | 1.02 | 1.1E-04 | 1.7E-02 |  5.7  6.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy         | 1.00 | 3.4E-04 | 1.0E-01 |  5.7  7.6E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE         | 1.01 | 2.9E-04 | 5.1E-02 |  5.7  1.2E-03  OK|
| O-TurbFreq       | 1.37 | 1.4E-04 | 2.2E-02 | 12.5  3.6E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  296                 CPU SECONDS = 2.033E+05
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom            | 1.03 | 2.4E-04 | 8.3E-02 |       1.0E-03  OK|
| V-Mom            | 1.01 | 2.8E-04 | 5.3E-02 |       1.5E-03  OK|
| W-Mom            | 0.97 | 2.5E-04 | 6.5E-02 |       1.7E-03  OK|
| P-Mass           | 1.03 | 1.3E-05 | 1.2E-02 |  9.2  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy            | 1.00 | 1.1E-04 | 1.6E-02 |  5.7  6.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy         | 0.99 | 3.4E-04 | 1.0E-01 |  5.7  7.6E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE         | 1.01 | 3.0E-04 | 5.0E-02 |  5.7  1.2E-03  OK|
| O-TurbFreq       | 1.41 | 1.9E-04 | 2.9E-02 | 12.5  3.9E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  297                 CPU SECONDS = 2.040E+05
----------------------------------------------------------------------
|      Equation      | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom            | 1.00 | 2.5E-04 | 4.6E-02 |       9.6E-04  OK|
| V-Mom            | 1.01 | 2.8E-04 | 5.3E-02 |       1.5E-03  OK|
| W-Mom            | 0.97 | 2.4E-04 | 4.5E-02 |       1.7E-03  OK|
| P-Mass           | 1.07 | 1.4E-05 | 1.2E-02 |  9.2  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy            | 1.01 | 1.1E-04 | 1.7E-02 |  5.7  7.1E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy         | 0.99 | 3.4E-04 | 1.1E-01 |  5.7  7.5E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE         | 1.01 | 3.0E-04 | 4.9E-02 |  5.7  1.1E-03  OK|
| O-TurbFreq       | 1.00 | 1.9E-04 | 2.6E-02 | 12.5  4.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  298                 CPU SECONDS = 2.047E+05
----------------------------------------------------------------------
```

```
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.02 | 2.5E-04 | 5.0E-02 |       9.2E-04  OK|
| V-Mom                | 1.01 | 2.9E-04 | 5.2E-02 |       1.4E-03  OK|
| W-Mom                | 1.00 | 2.4E-04 | 5.8E-02 |       1.7E-03  OK|
| P-Mass               | 1.08 | 1.5E-05 | 1.2E-02 |  9.2  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 1.1E-04 | 1.9E-02 |  5.7  7.3E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 3.4E-04 | 1.8E-01 |  5.7  7.6E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 3.0E-04 | 5.1E-02 |  5.7  1.1E-03  OK|
| O-TurbFreq           | 0.73 | 1.4E-04 | 1.6E-02 | 12.5  4.2E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  299                    CPU SECONDS = 2.053E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.05 | 2.6E-04 | 6.5E-02 |       9.0E-04  OK|
| V-Mom                | 1.01 | 2.9E-04 | 6.2E-02 |       1.4E-03  OK|
| W-Mom                | 0.99 | 2.4E-04 | 3.8E-02 |       1.7E-03  OK|
| P-Mass               | 1.07 | 1.6E-05 | 1.2E-02 |  9.2  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.02 | 1.1E-04 | 1.9E-02 |  5.7  7.6E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.03 | 3.5E-04 | 2.3E-01 |  5.7  7.8E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.00 | 2.9E-04 | 4.7E-02 |  5.7  1.0E-03  OK|
| O-TurbFreq           | 0.79 | 1.1E-04 | 1.7E-02 | 12.5  4.4E-05  OK|
+----------------------+------+---------+---------+------------------+

======================================================================
OUTER LOOP ITERATION =  300                    CPU SECONDS = 2.060E+05
----------------------------------------------------------------------
|       Equation       | Rate | RMS Res | Max Res |  Linear Solution |
+----------------------+------+---------+---------+------------------+
| U-Mom                | 1.05 | 2.8E-04 | 6.1E-02 |       8.9E-04  OK|
| V-Mom                | 1.00 | 2.9E-04 | 6.0E-02 |       1.5E-03  OK|
| W-Mom                | 1.01 | 2.4E-04 | 3.3E-02 |       1.7E-03  OK|
| P-Mass               | 1.02 | 1.6E-05 | 1.3E-02 |  9.2  4.6E-02  OK|
+----------------------+------+---------+---------+------------------+
| dummy                | 1.03 | 1.1E-04 | 2.4E-02 |  5.7  7.8E-03  OK|
+----------------------+------+---------+---------+------------------+
| H-Energy             | 1.02 | 3.6E-04 | 1.8E-01 |  5.7  7.9E-04  OK|
+----------------------+------+---------+---------+------------------+
| K-TurbKE             | 1.01 | 3.0E-04 | 3.9E-02 |  5.7  1.0E-03  OK|
| O-TurbFreq           | 0.99 | 1.1E-04 | 1.6E-02 | 12.5  4.6E-05  OK|
+----------------------+------+---------+---------+------------------+

CFD Solver finished: Mon Jul 18 19:54:51 2016
CFD Solver wall clock seconds: 4.1302E+04

======================================================================
              Termination and Interrupt Condition Summary
======================================================================

CFD Solver: Run duration reached
  (Maximum number of outer iterations)

======================================================================
              Boundary Flow and Total Source Term Summary
======================================================================

+--------------------------------------------------------------------+
|                            U-Mom-Fluid                             |
+--------------------------------------------------------------------+
Boundary             : Fluid Default                     9.4886E+03
Boundary             : Outlet                            2.2463E+04
Boundary             : South wind                        8.3731E+03
Boundary             : Top                              -3.7210E+01
Boundary             : WCT inlet 1                       2.1935E+01
Boundary             : WCT inlet 2                       1.4638E+02
Boundary             : WCT outlet                       -2.8536E-05
Boundary             : fan inlet                        -1.8513E+04
Boundary             : radiator                         -5.9726E+03
Domain Interface     : intfbtm (Side 1)                  1.3743E+03
Domain Interface     : intftop (Side 1)                 -2.8210E+02
                                                        -----------
Domain Imbalance :                                       1.7062E+04

Domain Imbalance, in %:                                    0.0507 %

+--------------------------------------------------------------------+
|                            V-Mom-Fluid                             |
+--------------------------------------------------------------------+
Boundary             : Fluid Default                    -2.4214E+05
```

```
Boundary        : Outlet                         -3.2182E+07
Boundary        : South wind                      3.3678E+07
Boundary        : Top                            -1.2563E+06
Boundary        : WCT inlet 1                     9.6780E+01
Boundary        : WCT inlet 2                    -4.2168E+01
Boundary        : WCT outlet                     -3.1372E-05
Boundary        : fan inlet                       9.1374E+02
Boundary        : radiator                       -2.6742E+02
Domain Interface : intfbtm (Side 1)               1.1821E+02
Domain Interface : intftop (Side 1)              -3.5252E+01
                                              -----------
Domain Imbalance :                               -1.4160E+03

Domain Imbalance, in %:                          -0.0042 %

+--------------------------------------------------------------------+
|                        W-Mom-Fluid                                 |
+--------------------------------------------------------------------+
Boundary        : Fluid Default                   4.7087E+05
Boundary        : Outlet                         -5.6884E+05
Boundary        : South wind                     -9.6244E-02
Boundary        : Top                            -3.0957E+04
Boundary        : WCT inlet 1                     3.1518E+03
Boundary        : WCT inlet 2                     2.3287E+03
Boundary        : WCT outlet                      1.2239E+03
Boundary        : fan inlet                       1.0762E+04
Boundary        : radiator                       -6.3597E-03
Domain Src (Neg) : Fluid                         -4.3582E+06
Domain Src (Pos) : Fluid                          4.4915E+06
Domain Interface : intfbtm (Side 1)              -3.7959E+03
Domain Interface : intftop (Side 1)               2.5439E+02
                                              -----------
Domain Imbalance :                                1.8235E+04

Domain Imbalance, in %:                           0.0541 %

+--------------------------------------------------------------------+
|                        P-Mass-Fluid                                |
+--------------------------------------------------------------------+
Boundary        : Outlet                         -2.4841E+06
Boundary        : South wind                      2.5779E+06
Boundary        : Top                            -9.3773E+04
Boundary        : WCT inlet 1                    -1.1261E+02
Boundary        : WCT inlet 2                    -1.1278E+02
Boundary        : WCT outlet                      2.2503E+02
Boundary        : fan inlet                      -1.5242E+03
Boundary        : radiator                        1.4515E+03
Domain Interface : intfbtm (Side 1)              -6.4048E+02
Domain Interface : intftop (Side 1)               6.3980E+02
                                              -----------
Domain Imbalance :                               -2.2849E+00

Domain Imbalance, in %:                          -0.0001 %

+--------------------------------------------------------------------+
|                        U-Mom-porous                                |
+--------------------------------------------------------------------+
Boundary        : porous Default                 -2.2010E+02
Domain Src (Neg) : porous                        -1.4760E+02
Domain Src (Pos) : porous                         1.9914E+03
Domain Interface : intfbtm (Side 2)              -2.0404E+03
Domain Interface : intftop (Side 2)               4.1869E+02
                                              -----------
Domain Imbalance :                                1.9059E+00

Domain Imbalance, in %:                           0.0000 %

+--------------------------------------------------------------------+
|                        V-Mom-porous                                |
+--------------------------------------------------------------------+
Boundary        : porous Default                 -3.5870E+01
Domain Src (Neg) : porous                        -4.0270E+02
Domain Src (Pos) : porous                         5.6697E+02
Domain Interface : intfbtm (Side 2)              -1.8105E+02
Domain Interface : intftop (Side 2)               5.2716E+01
                                              -----------
Domain Imbalance :                                6.7768E-02

Domain Imbalance, in %:                           0.0000 %

+--------------------------------------------------------------------+
|                        W-Mom-porous                                |
+--------------------------------------------------------------------+
Boundary        : porous Default                 -9.2211E+02
Domain Src (Neg) : porous                        -7.4697E+02
Domain Src (Pos) : porous                         2.7952E+01
Domain Interface : intfbtm (Side 2)               3.6073E+03
Domain Interface : intftop (Side 2)              -1.9674E+03
```

```
                                        -----------
Domain Imbalance :                               -1.1733E+00

Domain Imbalance, in %:                           0.0000 %

+--------------------------------------------------------------------+
|                    P-Mass-porous                                   |
+--------------------------------------------------------------------+
Domain Interface : intfbtm (Side 2)               6.4048E+02
Domain Interface : intftop (Side 2)              -6.3980E+02
                                        -----------
Domain Imbalance :                                6.7834E-01

Domain Imbalance, in %:                           0.0000 %

+--------------------------------------------------------------------+
|                    dummy-Fluid                                     |
+--------------------------------------------------------------------+
Boundary        : Outlet                         -5.3494E+01
Boundary        : Top                            -1.4861E-07
Boundary        : WCT inlet 1                    -2.0992E+01
Boundary        : WCT inlet 2                    -3.6221E+01
Boundary        : WCT outlet                      2.2503E+02
Boundary        : fan inlet                      -1.0796E+02
Domain Interface : intfbtm (Side 1)               4.2111E-08
Domain Interface : intftop (Side 1)              -2.3073E-06
                                        -----------
Domain Imbalance :                                6.3600E+00

Domain Imbalance, in %:                           2.8263 %

+--------------------------------------------------------------------+
|                    dummy-porous                                    |
+--------------------------------------------------------------------+
Domain Interface : intfbtm (Side 2)              -4.2111E-08
Domain Interface : intftop (Side 2)               2.3074E-06
                                        -----------
Domain Imbalance :                                2.2652E-06

Domain Imbalance, in %:                           0.0000 %

+--------------------------------------------------------------------+
|                    H-Energy-Fluid                                  |
+--------------------------------------------------------------------+
Boundary        : Outlet                         -1.8279E+10
Boundary        : South wind                      1.8932E+10
Boundary        : Top                            -6.8866E+08
Boundary        : WCT inlet 1                    -1.9454E+06
Boundary        : WCT inlet 2                    -1.9029E+06
Boundary        : WCT outlet                      4.0397E+06
Boundary        : fan inlet                      -1.7767E+07
Boundary        : radiator                        5.2248E+07
Domain Interface : intfbtm (Side 1)              -2.3054E+07
Domain Interface : intftop (Side 1)               2.3030E+07
                                        -----------
Domain Imbalance :                               -3.9147E+05

Domain Imbalance, in %:                          -0.0021 %

+--------------------------------------------------------------------+
|                    H-Energy-porous                                 |
+--------------------------------------------------------------------+
Domain Interface : intfbtm (Side 2)               2.3054E+07
Domain Interface : intftop (Side 2)              -2.3030E+07
                                        -----------
Domain Imbalance :                                2.4420E+04

Domain Imbalance, in %:                           0.0001 %

======================================================================
                Wall Force and Moment Summary
======================================================================

Notes:
1. Pressure integrals exclude the reference pressure.  To include
   it, set the expert parameter 'include pref in forces = t'.


+--------------------------------------------------------------------+
|                Pressure Force On Walls                             |
+--------------------------------------------------------------------+
                          X-Comp.     Y-Comp.     Z-Comp.

Domain Group: Fluid

Fluid Default            -8.7806E+03  1.5823E+05  3.5206E+07
porous Default            2.2089E+02  3.5860E+01 -1.2629E+04
                         -----------  -----------  -----------
```

Domain Group Totals : -8.5597E+03 1.5827E+05 3.5194E+07

```
+--------------------------------------------------------------------+
|                    Viscous Force On Walls                          |
+--------------------------------------------------------------------+
                          X-Comp.      Y-Comp.      Z-Comp.

Domain Group: Fluid

Fluid Default           -1.1170E+03   8.3908E+04   2.5364E+02
porous Default          -7.9511E-01   9.8733E-03   3.4496E-01
                        -----------  -----------  -----------
Domain Group Totals :   -1.1178E+03   8.3908E+04   2.5398E+02


+--------------------------------------------------------------------+
|                    Pressure Moment On Walls                        |
+--------------------------------------------------------------------+
                          X-Comp.      Y-Comp.      Z-Comp.

Domain Group: Fluid

Fluid Default            2.8680E+08  -1.8739E+09   9.7559E+06
porous Default          -4.7999E+05   1.0011E+06  -5.6416E+03
                        -----------  -----------  -----------
Domain Group Totals :    2.8632E+08  -1.8729E+09   9.7503E+06


+--------------------------------------------------------------------+
|                    Viscous Moment On Walls                         |
+--------------------------------------------------------------------+
                          X-Comp.      Y-Comp.      Z-Comp.

Domain Group: Fluid

Fluid Default            1.2727E+06   3.3760E+03   4.7043E+06
porous Default           1.4119E+01  -1.5721E+01   3.0307E+01
                        -----------  -----------  -----------
Domain Group Totals :    1.2727E+06   3.3603E+03   4.7043E+06


+--------------------------------------------------------------------+
|                 Locations of Maximum Residuals                     |
+--------------------------------------------------------------------+
|      Equation      | Node # |     X     |     Y     |     Z     |
+--------------------------------------------------------------------+
| U-Mom-Fluid        | 1324299 | 3.781E+01 | 2.490E+01 | 1.463E+01 |
| V-Mom-Fluid        | 1324299 | 3.781E+01 | 2.490E+01 | 1.463E+01 |
| W-Mom-Fluid        |  926261 | 5.970E+01 | 2.924E+01 | 2.423E+01 |
| P-Mass-Fluid       |  272359 | 4.984E+01 | 2.801E+01 | 6.462E+00 |
| U-Mom-porous       |   16392 | 7.249E+01 | 3.395E+01 |-1.108E+01 |
| V-Mom-porous       |   16389 | 7.249E+01 | 3.395E+01 |-1.090E+01 |
| W-Mom-porous       |   16392 | 7.249E+01 | 3.395E+01 |-1.108E+01 |
| P-Mass-porous      |   16392 | 7.249E+01 | 3.395E+01 |-1.108E+01 |
| dummy-Fluid        |  150707 | 8.534E+01 |-2.394E+00 |-1.884E+01 |
| dummy-porous       |   18612 | 7.397E+01 | 2.780E+01 |-1.090E+01 |
| H-Energy-Fluid     | 1347689 | 6.004E+01 | 3.035E+01 | 2.564E+01 |
| H-Energy-porous    |   18612 | 7.397E+01 | 2.780E+01 |-1.090E+01 |
| K-TurbKE-Fluid     | 1673392 | 1.467E+01 | 1.466E+01 |-2.587E+00 |
| O-TurbFreq-Fluid   |  276052 | 4.719E+01 | 2.809E+01 | 5.815E+00 |
| K-TurbKE-porous    |   16754 | 7.249E+01 | 3.406E+01 |-1.102E+01 |
| O-TurbFreq-porous  |   16754 | 7.249E+01 | 3.406E+01 |-1.102E+01 |
+--------------------------------------------------------------------+


+--------------------------------------------------------------------+
|                    Peak Values of Residuals                        |
+--------------------------------------------------------------------+
|      Equation      | Loop # | Peak Residual | Final Residual |
+--------------------------------------------------------------------+
| U-Mom-Fluid        |      2 |  1.37467E-02  |  2.75733E-04   |
| V-Mom-Fluid        |      5 |  3.05654E-02  |  2.88332E-04   |
| W-Mom-Fluid        |      1 |  1.73705E-02  |  2.43628E-04   |
| P-Mass-Fluid       |      1 |  8.22134E-03  |  1.42195E-05   |
| U-Mom-porous       |      2 |  1.13614E-01  |  1.72443E-04   |
| V-Mom-porous       |      2 |  4.34456E-02  |  5.60769E-05   |
| W-Mom-porous       |      3 |  8.40725E-02  |  2.66550E-04   |
| P-Mass-porous      |      3 |  5.89933E-02  |  1.01616E-04   |
| dummy-Fluid        |      2 |  6.81891E-03  |  1.13941E-04   |
| dummy-porous       |      2 |  3.46656E-02  |  1.81722E-04   |
| H-Energy-Fluid     |      1 |  8.00883E-02  |  3.59860E-04   |
| H-Energy-porous    |      3 |  7.45991E-02  |  1.90022E-04   |
| K-TurbKE-Fluid     |      1 |  2.54963E-02  |  2.97012E-04   |
| O-TurbFreq-Fluid   |      1 |  1.88416E-01  |  1.08962E-04   |
| K-TurbKE-porous    |      1 |  3.17336E-02  |  2.28827E-04   |
| O-TurbFreq-porous  |      3 |  8.65126E-02  |  2.89009E-04   |
+--------------------------------------------------------------------+
```

False Transient Information		
Equation	Type	Elapsed Pseudo-Time
U-Mom-Fluid	Physical	4.53525E+03
V-Mom-Fluid	Physical	4.53525E+03
W-Mom-Fluid	Physical	4.53525E+03
P-Mass-Fluid	Physical	4.53525E+03
U-Mom-porous	Physical	4.53525E+03
V-Mom-porous	Physical	4.53525E+03
W-Mom-porous	Physical	4.53525E+03
P-Mass-porous	Physical	4.53525E+03
dummy-Fluid	Physical	4.53525E+03
dummy-porous	Physical	4.53525E+03
H-Energy-Fluid	Physical	4.53525E+03
H-Energy-porous	Physical	4.53525E+03
K-TurbKE-Fluid	Physical	4.53525E+03
O-TurbFreq-Fluid	Physical	4.53525E+03
K-TurbKE-porous	Physical	4.53525E+03
O-TurbFreq-porous	Physical	4.53525E+03

Average Scale Information

Domain Name : Fluid

Global Length	= 4.8857E+02
Minimum Extent	= 2.6076E+02
Maximum Extent	= 6.9205E+02
Density	= 1.0884E+00
Dynamic Viscosity	= 1.8310E-05
Velocity	= 5.0188E+00
Advection Time	= 9.7348E+01
Reynolds Number	= 1.4576E+08
Speed of Sound	= 3.6085E+02
Mach Number	= 1.3908E-02
Thermal Conductivity	= 2.6100E-02
Specific Heat Capacity at Constant Pressure	= 1.0044E+03
Specific Heat Capacity at Constant Volume	= 7.1730E+02
Specific Heat Ratio	= 1.4003E+00
Prandtl Number	= 7.0462E-01
Temperature Range	= 2.8878E+01

Domain Name : porous

Global Length	= 3.6540E+00
Minimum Extent	= 1.7770E-01
Maximum Extent	= 2.4384E+01
Density	= 1.0553E+00
Dynamic Viscosity	= 1.8310E-05
Velocity	= 5.7498E+00
Advection Time	= 6.3549E-01
Reynolds Number	= 1.2109E+06
Speed of Sound	= 3.6641E+02
Mach Number	= 1.5692E-02
Thermal Conductivity	= 2.6100E-02
Specific Heat Capacity at Constant Pressure	= 1.0044E+03
Specific Heat Capacity at Constant Volume	= 7.1730E+02
Specific Heat Ratio	= 1.4003E+00
Prandtl Number	= 7.0462E-01
Temperature Range	= 7.0749E+00

Variable Range Information

Domain Name : Fluid

Variable Name	min	max
dummy	-1.18E-04	1.00E+00
Density	1.05E+00	1.16E+00
Specific Heat Capacity at Constant Pressure	1.00E+03	1.00E+03
Dynamic Viscosity	1.83E-05	1.83E-05
Thermal Conductivity	2.61E-02	2.61E-02
Isothermal Compressibility	9.86E-06	1.02E-05
Static Entropy	2.42E+01	1.15E+02
Velocity u	-1.59E+01	1.72E+01
Velocity v	-1.65E+01	2.17E+01
Velocity w	-1.73E+01	1.57E+01
Pressure	-3.11E+02	1.05E+02
Turbulence Kinetic Energy	2.47E-06	1.80E+01
Turbulence Eddy Frequency	2.76E-01	3.64E+03
Eddy Viscosity	9.74E-06	3.00E+00
Temperature	3.05E+02	3.34E+02

```
| Static Enthalpy                    |  7.07E+03 |  3.61E+04 |
| Total Enthalpy                     |  7.22E+03 |  3.61E+04 |
| Wall Scale                         | -8.44E-01 |  2.94E+04 |
| Wall Distance                      |  0.00E+00 |  2.37E+02 |
+--------------------------------------------------------------------+

Domain Name : porous
+--------------------------------------------------------------------+
|       Variable Name                         |    min    |    max    |
+--------------------------------------------------------------------+
| dummy                              | -1.66E-07 |  4.87E-03 |
| Density                            |  1.05E+00 |  1.08E+00 |
| Specific Heat Capacity at Constant Pressure|  1.00E+03 |  1.00E+03 |
| Dynamic Viscosity                  |  1.83E-05 |  1.83E-05 |
| Thermal Conductivity               |  2.61E-02 |  2.61E-02 |
| Isothermal Compressibility         |  9.88E-06 |  9.90E-06 |
| Static Entropy                     |  9.31E+01 |  1.15E+02 |
| Velocity u                         | -7.91E+00 |  3.29E+00 |
| Velocity v                         | -5.03E+00 |  5.71E+00 |
| Velocity w                         | -8.31E+00 |  1.52E+01 |
| Pressure                           | -1.50E+02 |  1.91E+01 |
| Turbulence Kinetic Energy          |  1.70E-03 |  1.42E+01 |
| Turbulence Eddy Frequency          |  1.35E+00 |  4.84E+02 |
| Eddy Viscosity                     |  3.15E-05 |  5.28E-02 |
| Temperature                        |  3.27E+02 |  3.34E+02 |
| Static Enthalpy                    |  2.89E+04 |  3.60E+04 |
| Total Enthalpy                     |  2.89E+04 |  3.60E+04 |
| Wall Scale                         |  7.04E-05 |  4.43E+01 |
| Wall Distance                      |  2.05E-04 |  9.00E-01 |
+--------------------------------------------------------------------+

+--------------------------------------------------------------------+
|        CPU Requirements of Numerical Solution - Total          |
+--------------------------------------------------------------------+

Subsystem Name              Discretization      Linear Solution
                          (secs.   %total)    (secs.   %total)
----------------------------------------------------------------------
Wall Scale                 2.53E+02   0.1 %    4.06E+02   0.2 %
Momentum and Mass          7.07E+04  34.2 %    2.12E+04  10.3 %
Additional Variables       1.37E+04   6.6 %    6.99E+03   3.4 %
Heat Transfer              1.97E+04   9.5 %    7.49E+03   3.6 %
TurbKE and TurbFreq        2.07E+04  10.0 %    1.53E+04   7.4 %
                           -------- -------    -------- ------
Subsystem Summary          1.25E+05  60.4 %    5.15E+04  24.9 %

Variable Updates           2.93E+04  14.1 %
GGI Intersection           6.26E-01   0.0 %
Search Calculations        1.98E+00   0.0 %
File Reading               2.47E+01   0.0 %
File Writing               1.13E+02   0.1 %
Miscellaneous              1.05E+03   0.5 %
                           --------
Total                      2.07E+05


+--------------------------------------------------------------------+
|                      Job Information                       |
+--------------------------------------------------------------------+

Host computer:  DELL-T7500-4 (PID:7012)
Par. Process:   Master running on mesh partition:       1
Job finished:   Mon Jul 18 19:55:28 2016
Total CPU time: 4.138E+04 seconds
         or: (        0:        11:        29:    39.848 )
            (      Days:     Hours:   Minutes:   Seconds )


Host computer:  DELL-T7500-4 (PID:6368)
Par. Process:   Slave  running on mesh partition:       2
Job finished:   Mon Jul 18 19:55:28 2016
Total CPU time: 4.138E+04 seconds
         or: (        0:        11:        29:    39.848 )
            (      Days:     Hours:   Minutes:   Seconds )


Host computer:  DELL-T7500-4 (PID:5244)
Par. Process:   Slave  running on mesh partition:       3
Job finished:   Mon Jul 18 19:55:28 2016
Total CPU time: 4.138E+04 seconds
         or: (        0:        11:        29:    39.848 )
            (      Days:     Hours:   Minutes:   Seconds )


Host computer:  DELL-T7500-4 (PID:3432)
Par. Process:   Slave  running on mesh partition:       4
Job finished:   Mon Jul 18 19:55:28 2016
Total CPU time: 4.138E+04 seconds
```

```
        or: (         0:        11:        29:    39.848 )
            (       Days:     Hours:   Minutes:   Seconds )


 Host computer:  DELL-T7500-4 (PID:6016)
 Par. Process:   Slave  running on mesh partition:       5
 Job finished:   Mon Jul 18 19:55:28 2016
 Total CPU time: 4.138E+04 seconds
        or: (         0:        11:        29:    39.949 )
            (       Days:     Hours:   Minutes:   Seconds )

 Total wall clock time: 4.138E+04 seconds
        or: (         0:        11:        29:    39.000 )
            (       Days:     Hours:   Minutes:   Seconds )



 --> Master-Partition Nr.    1 reaches final synchronization point!
 --> Slave-Partition  Nr.    2 reaches final synchronization point!
 --> Slave-Partition  Nr.    3 reaches final synchronization point!
 --> Slave-Partition  Nr.    4 reaches final synchronization point!
 --> Slave-Partition  Nr.    5 reaches final synchronization point!
End of solution stage.

 +--------------------------------------------------------------------+
 | The results from this run of the ANSYS CFX Solver have been        |
 | written to C:\Users\lwong\Desktop\Waterford3 CFD\Batch run\Train B |
 | S 90F 30mph closed mod_001.res                                     |
 +--------------------------------------------------------------------+


This run of the ANSYS CFX Solver has finished.
```

ATTACHMENT C

CFD Model Verification

Verification of the ANSYS CFX code is performed through the verification and validation (V&V) program conducted under the LPI quality assurance program. Results of this V&V effort are documented in [14]. This program assures code acceptability for use on nuclear safety related projects.

Additional verification steps, beyond the QA software verification requirements, were conducted in several areas. First, as described in Section 3.4, model verification per the general guidelines of NUREG-2152 was conducted. Second, verification by independent calculation was performed.

This attachment describes two independent model studies, conducted using the Fluent CFD code [18]. These two models were developed to evaluate the A Train and B Train geometry. Identical geometry files were used for both CFX and Fluent simulations, although the actual geometry differs slightly from the final design evaluated in this report. These models were used to evaluate a single analysis case for each Train. The models are intended to provide confirmation of the modeling approach, including software accuracy, mesh quality, etc. In particular, they provide a full transient solution and therefore verify that the steady state model used for the majority of the analysis is sufficiently accurate to capture the behavior of the DCT and WCT recirculation.

The independent verification models provide an alternate calculation, and as such have no quantitative acceptance requirements. However, the results are compared to ensure the CFX model captures appropriate flow behavior.

The conditions considered in the Fluent and ANSYS CFX models are summarized in Table C-1. Analysis conditions are for Train A and Train B, with some minor differences between the DCT and WCT inlet and outlet conditions as shown.

Table C-1: Design and CFD Model Inputs

	Train A		Train B	
	CFX	Fluent	CFX	Fluent
Ambient Temperature	86F	86F	85F	85F
Ambient Wind	North, 29 mph	North, 29 mph	North, 19mph	North, 19mph
DCT flow rate (lb/sec) total	3213 (in) 3570 (out)	3213 (in) 3570 (out)	3218 (in) 3581 (out)	3218 (in) 3581 (out)
DCT Coil outlet temperature	151F	151F	151F (1)	151F
WCT flow rate (lb/sec) total	541.8 (in) 477.1 (out)	541.8 (in) 477.1 (out)	540.7 (in) 477.8 (out)	540.7 (in) 477.8 (out)
WCT outlet temperature	109F	109F	109F	109F

Notes:

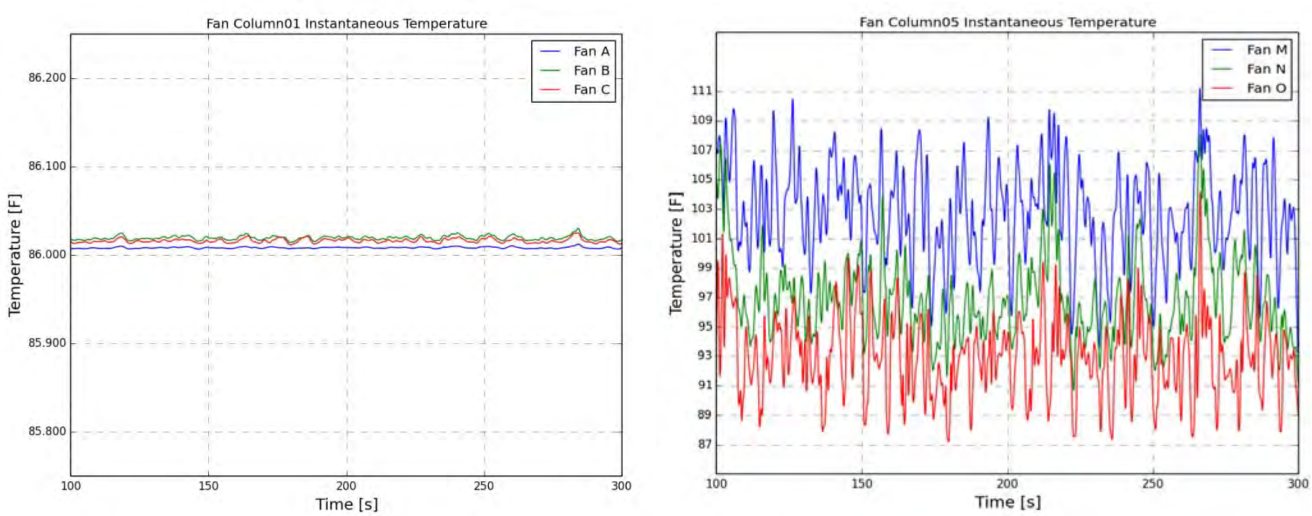
1. It in noted that the DCT flow rates and discharge temperatures reflect design values that were overly conservative relative the values evaluated in the body of the report. These input values were used for comparison of the two CFD codes.

The primary difference between the CFX and Fluent models is the full transient analysis performed using Fluent compared to a steady state model in CFX. This transient analysis was performed to verify the steady state assumption used for all CFX models reported herein.

A comparison of the analysis results of the two models are provided below.

Train A Comparison

The Fluent model results show temperature oscillation indicative of swirling, vortex type flows as would be expected in regions affected by a building wake. Fans at the North end (cell 1) of the DCT were out of the wake region and at relatively constant temperature. Fans at the south end (cell 5) had more temperature variation. However, the average values across 15 fans did not vary widely. A plot of the north and south fan temperatures is provided in Figure C- 1.



North Fans South Fans

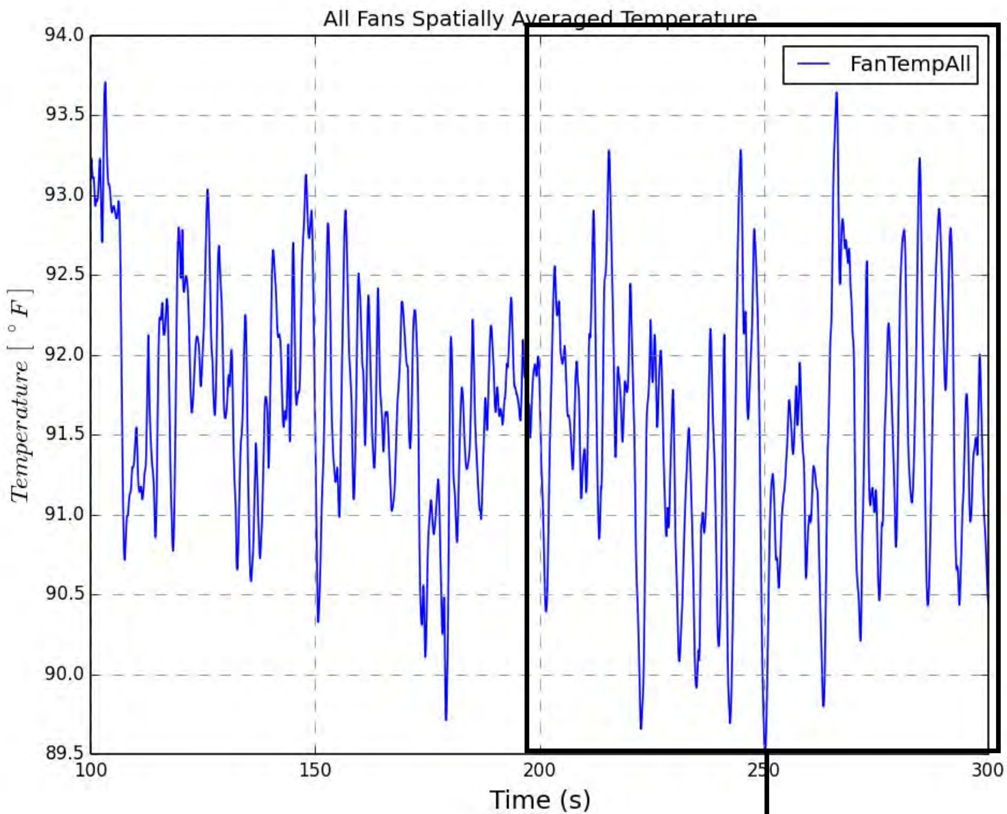
Figure C- 1: Comparison of North and South Fan Temperatures

The north Cell 1 is identified as “Column 1” and the south Cell 5 as “Column 5”. Individual Fans are identified as A, B, C and M, N, O in top to bottom order.

A plot of the average temperature with time is provided in Figure C- 2. The resulting mean, minimum and maximum temperatures were obtained from the period from 200-300 seconds in the transient. A comparison table of results from the CFX model is provided and shows that the model results are within 1F with approximately 5F recirculation (91F-86F ambient).

The average temperature oscillates over a range of approximately +/-2F. The time period of the oscillations is on the order of 13/50 seconds or 0.25Hz, based on a visual inspection of the plot. Given the large mass of the DCT cooling coils and contained water, this time period will have an insignificant effect on heat transfer to the CCW. Thus, the steady state behavior is a reasonable model for the DCT air flow.

Additional comparison plots of the Train A results are provided in Figure C- 3 through Figure C- 6, and show good correlation between the two models.



Fluent Results	
Variable	T [F]
T_{mean}	91.43
T_{min}	89.52
T_{max}	93.64

CFX Results					
Average fan temperature (deg F) for the last 100 iterations					
Cell:	1	2	3	4	5
	86.2	86.4	90.1	97.9	99.1
	86.3	86.2	90.2	98.4	95.0
	86.2	86.2	89.4	93.3	90.5
Average fan temperature:				90.8	

Figure C- 2: Fluent and CFX Average Fan Temperature with Time

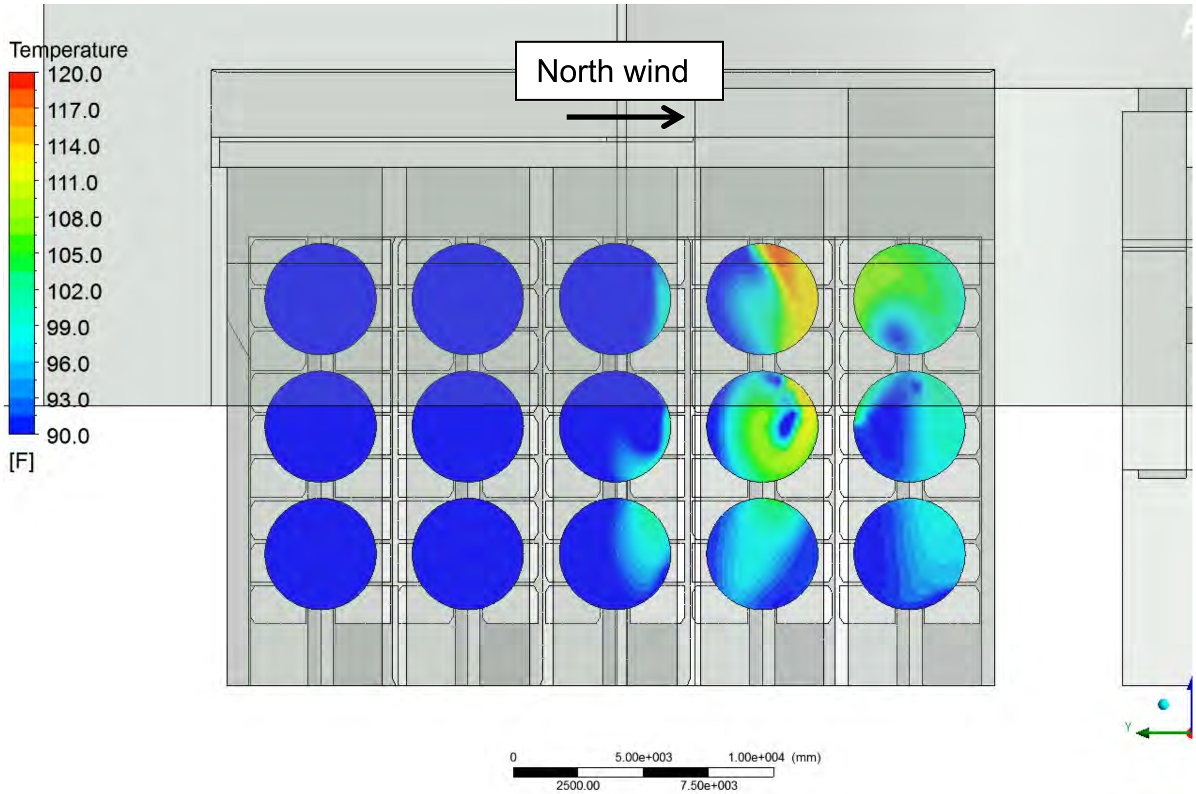


Figure C- 3: Fluent Train A Fan Temperatures

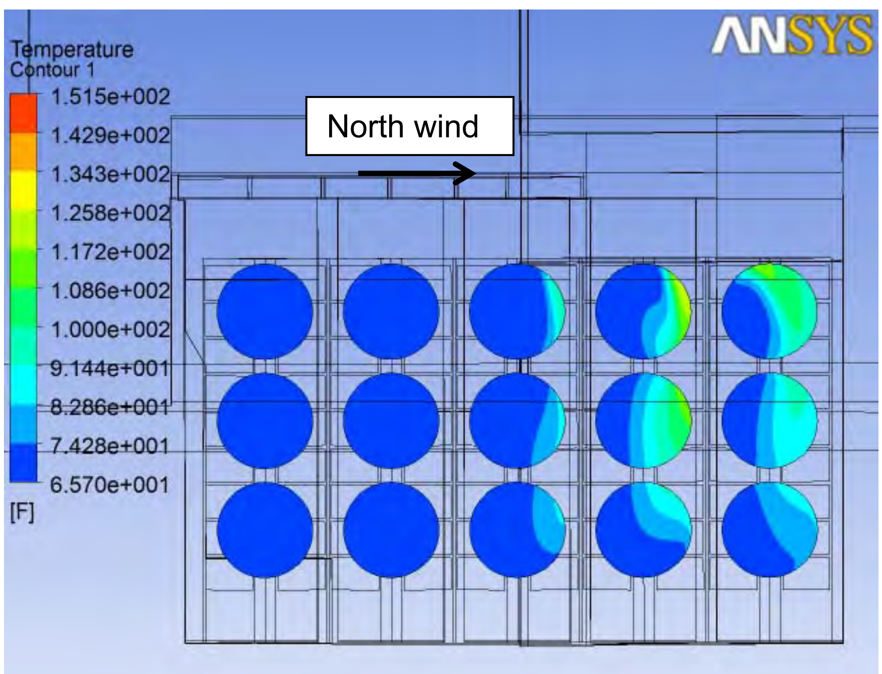


Figure C- 4: CFX Train A Fan Temperatures

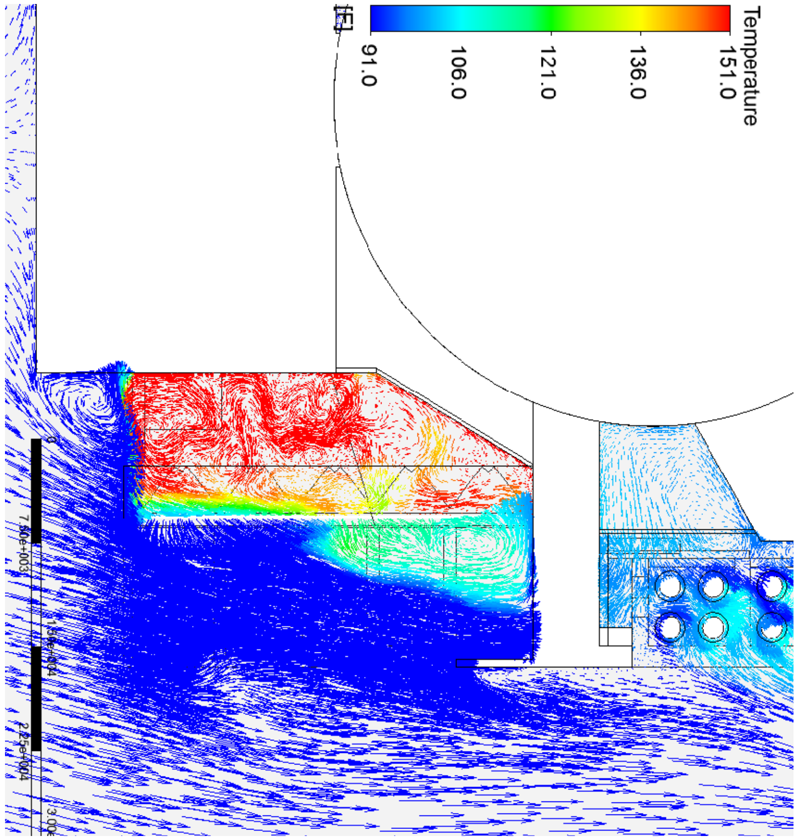


Figure C- 5: Fluent Train A Flow Pattern

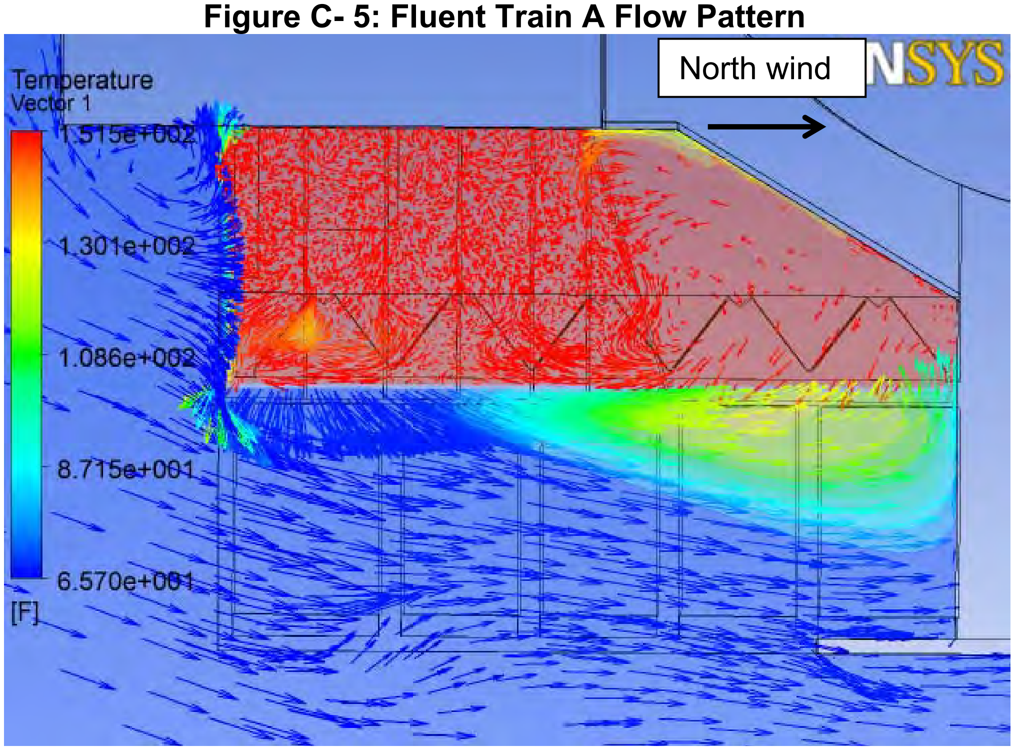
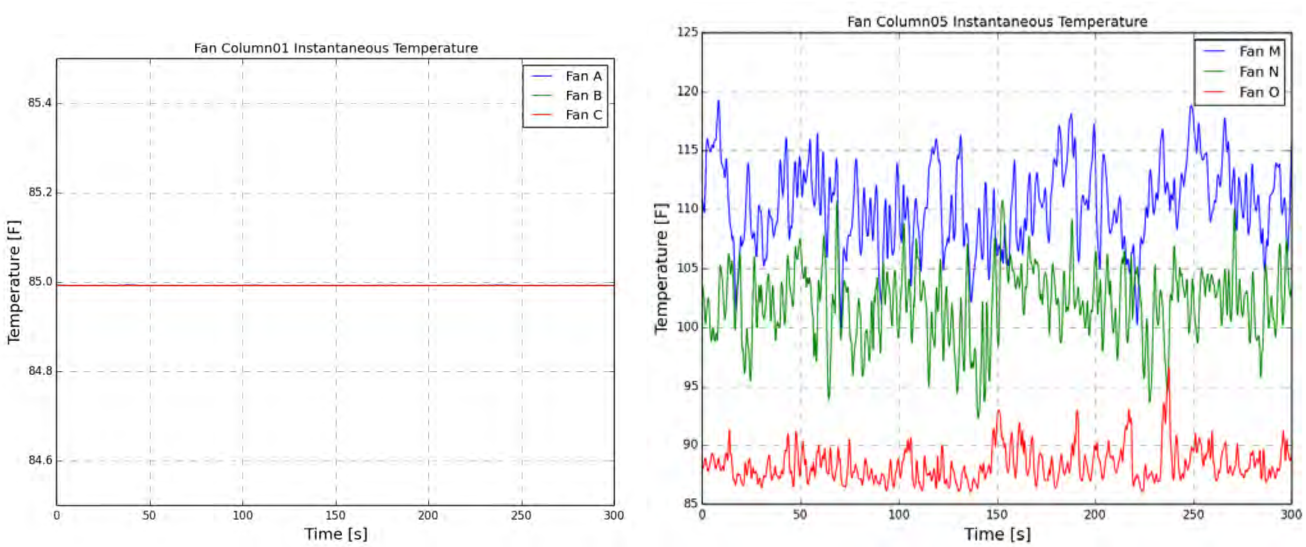


Figure C- 6: CFX Train A Flow Pattern

Train B Comparison

The Fluent model results show temperature oscillation indicative of swirling, vortex type flows as would be expected in regions affected by a building wake. As with the A train, fans at the North end of the DCT were out of the wake region and at constant temperature. Fans at the south end had more temperature variation. The average values across 15 fans did not vary widely. A plot of the north and south fan temperatures is provided in Figure C- 7.



North Fans South Fans

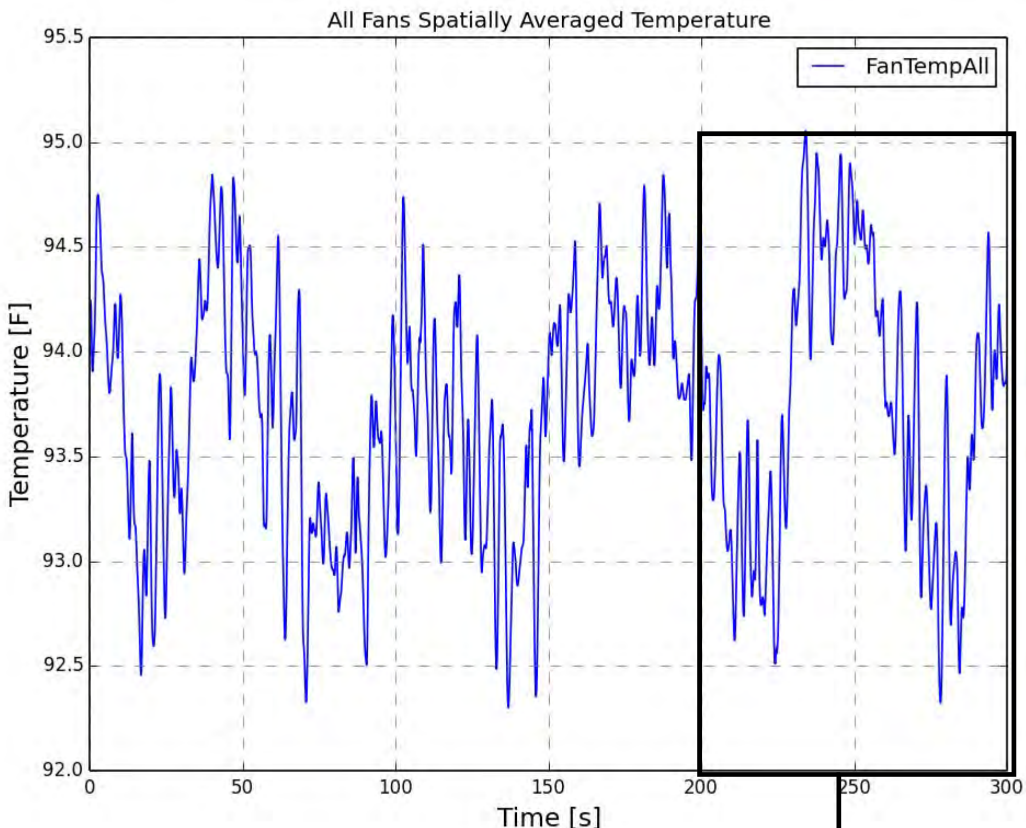
Figure C- 7: Comparison of North and South Fan Temperatures

The north Cell 1 is identified as “Column 1” and the south Cell 5 as “Column 5”. Individual Fans are identified as A, B, C and M, N, O in top to bottom order.

A plot of the average temperature with time is provided in Figure C- 8. The resulting mean, minimum and maximum temperatures were obtained from the period from 200-300 seconds in the transient. A comparison table of results from the CFX model shows that the CFX over-predicts the Fluent model by 3.5F with approximately 12.3F recirculation. As noted above, these results are for comparison only. As noted previously, these recirculation results are based on overly conservative inputs and are for comparison purposes only.

The average temperature oscillates over a range of approximately +/-1.5F. The time period of the oscillations is on the order of 13/50 seconds or 0.25Hz with a longer ~70 second sine wave pattern. Given the large mass of the DCT cooling coils and contained water, this time period will have an insignificant effect on heat transfer to the CCW. Thus, the steady state behavior is a reasonable model for the DCT air flow.

Additional comparison plots of the Train B results are provided in Figure C- 9 through Figure C- 12 and show good correlation between the two models with the CFX results slightly higher.



Fluent Results	
Variable	FanTempAll [F]
T_{mean}	93.75
T_{min}	92.33
T_{max}	95.05

CFX Results					
Average fan temperature (deg F) for the last 100 iterations					
Cell:	1	2	3	4	5
	85.1	86.3	96.4	107.9	112.5
	85	90.9	112.2	115.1	110.4
	85.1	87.4	91.1	99.2	95.1
Average fan temperature:				97.3	

Figure C- 8: Fluent and CFX Average Fan Temperature with Time

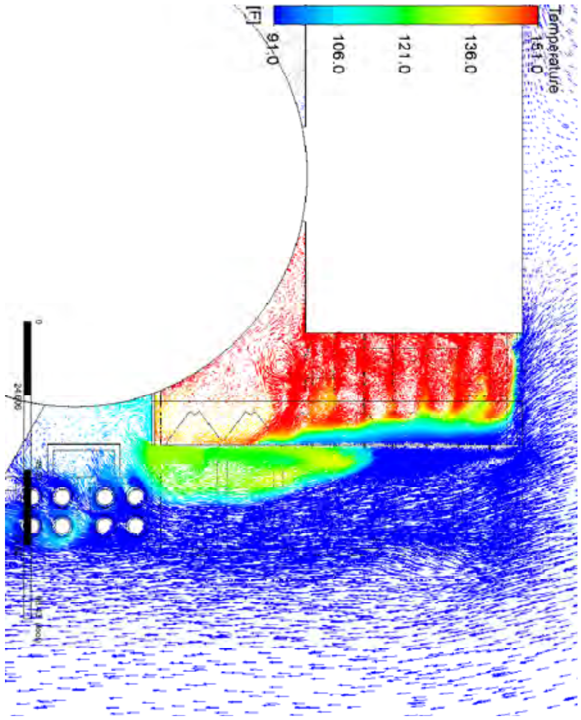


Figure C- 9: Fluent Train B Flow Pattern

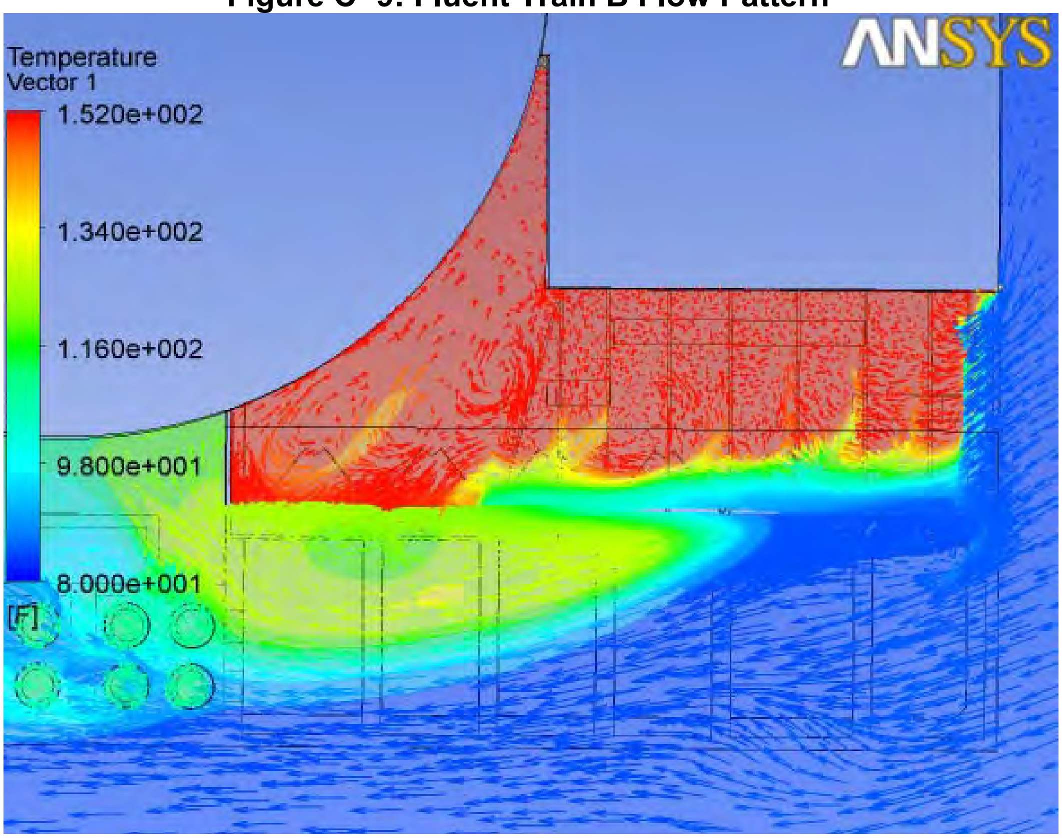


Figure C- 10: CFX Train B Flow Pattern

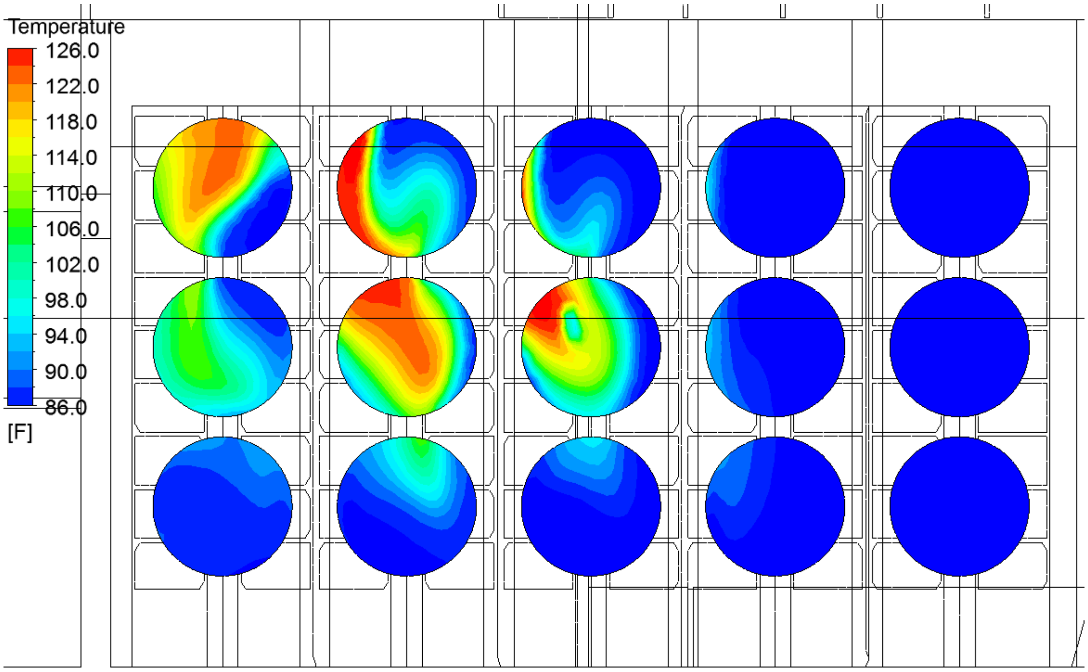


Figure C- 11: Fluent Fan Temperature Plot

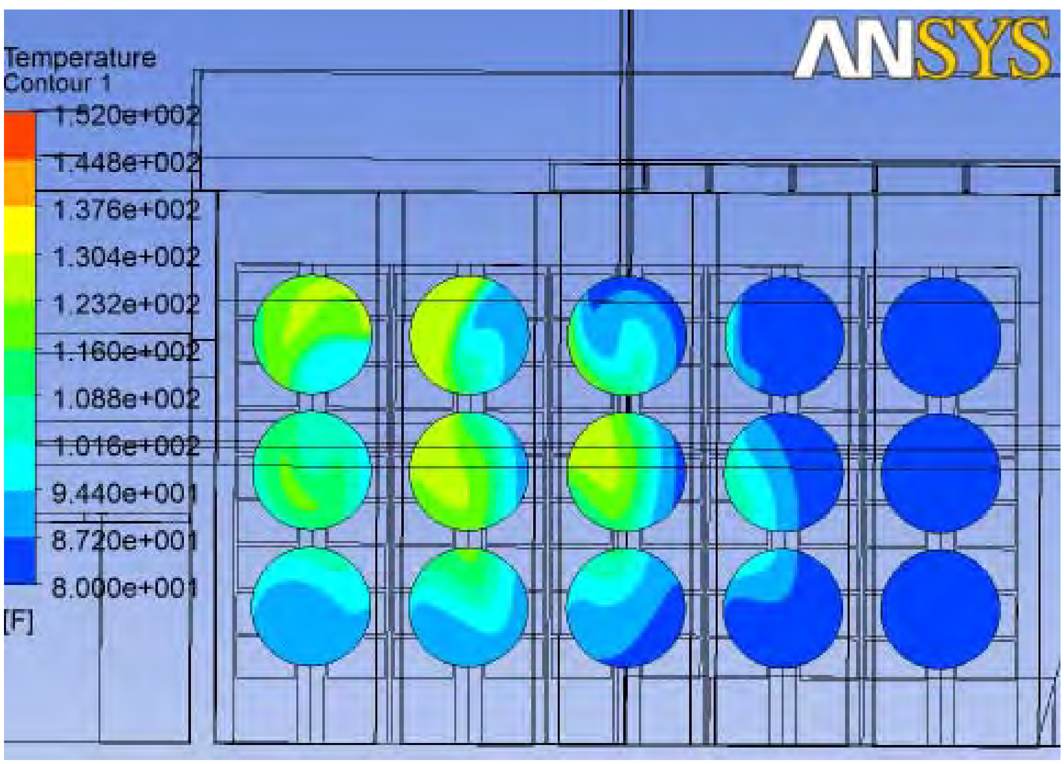


Figure C- 12: CFX Fan Temperature Plot

ATTACHMENT D

Angle Wall Modification Studies

Note: Train A Case 13 and Train B Case 6 are included in the report body and not reproduced in this Attachment

D-1: Train A Case 1: North wind with 51mph wind and 76F Ambient

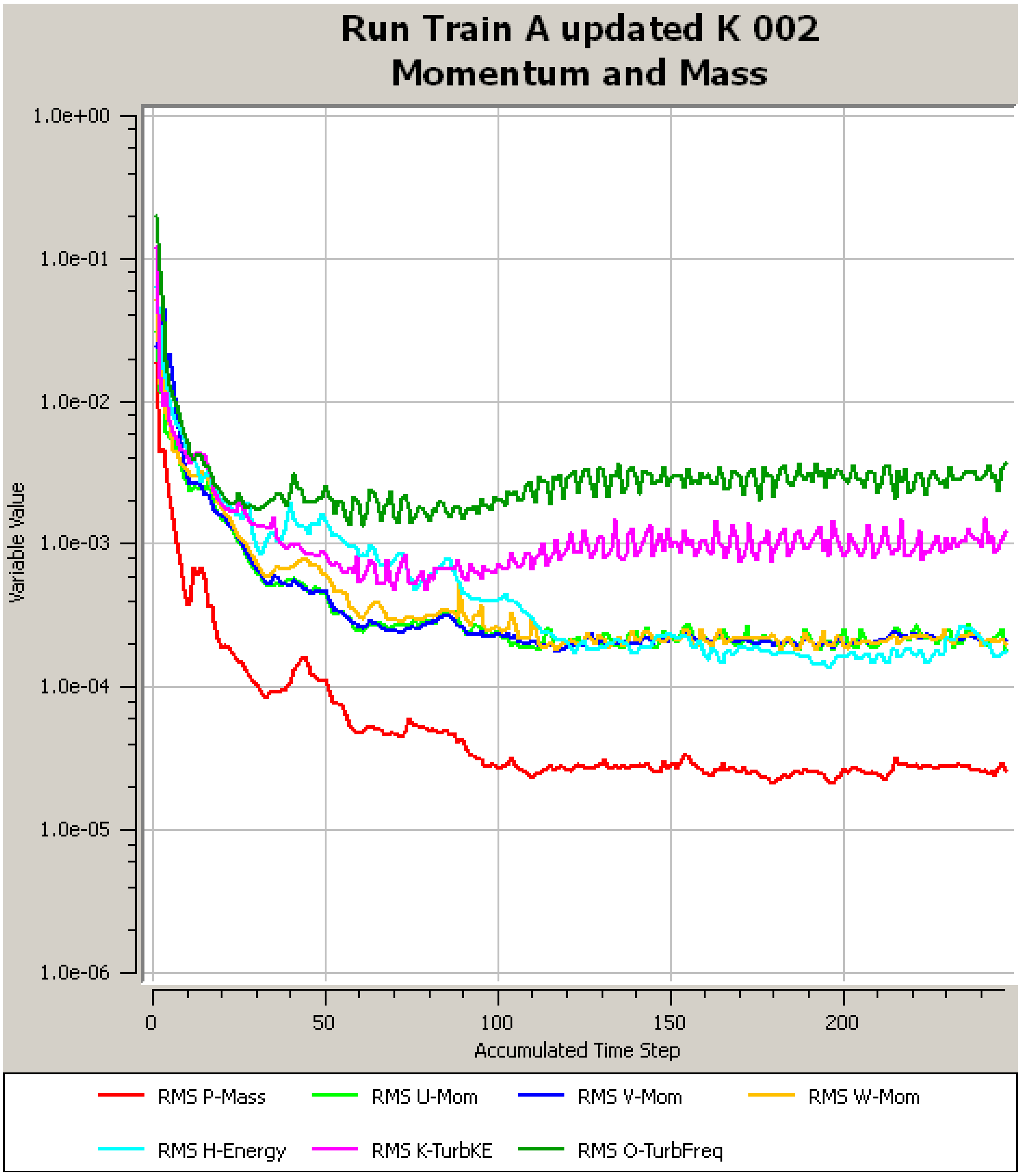


Figure D-1 Residual plot for case 1

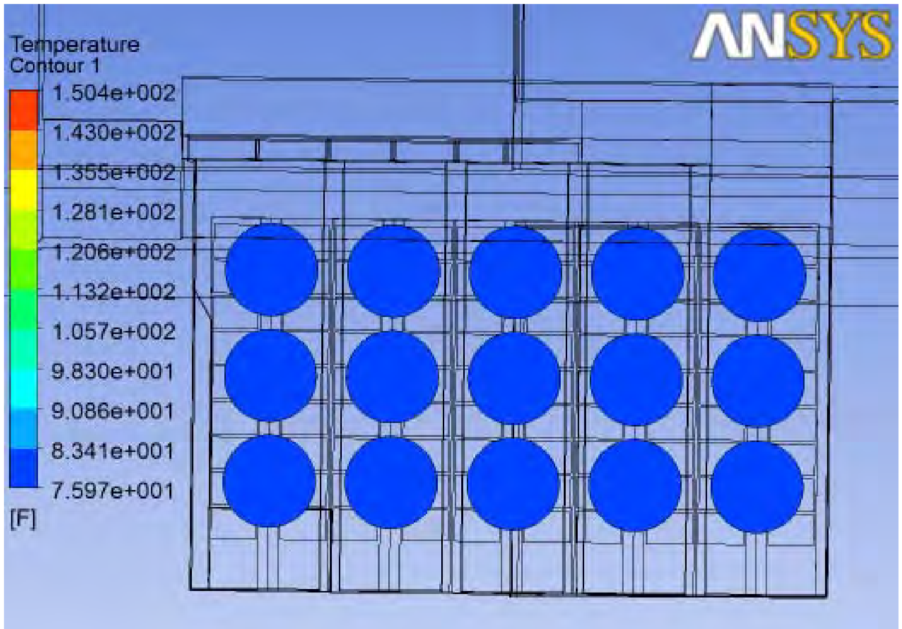


Figure D-2: Fan temperature for case 1

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	78.5	76.8	76.3	78.1	78.0
	78.3	77.0	76.2	76.5	77.4
	77.8	77.1	76.2	76.3	76.9
Average fan temperature:				77.2	

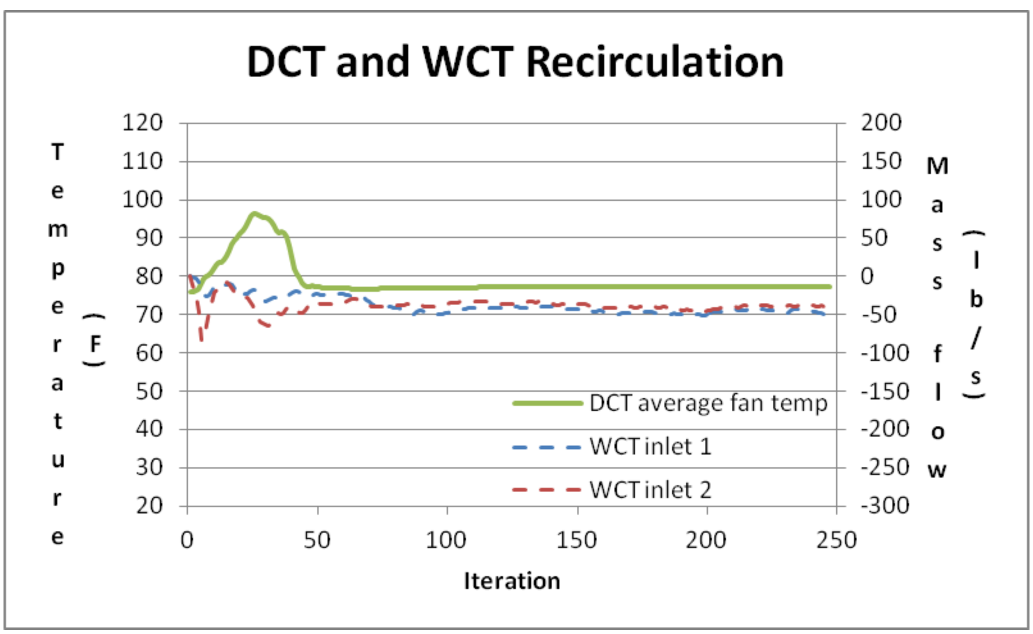


Figure D-3: DCT and WCT recirculation with iteration for case 1

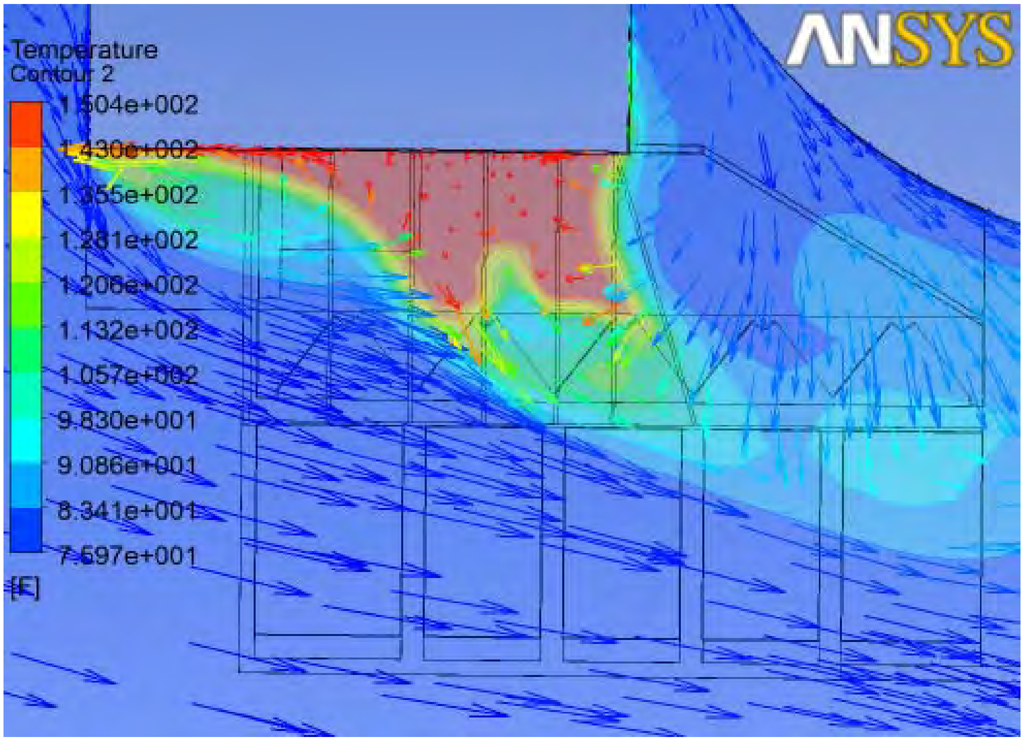


Figure D-4: Velocity vector and temperature contour above the deflector wall

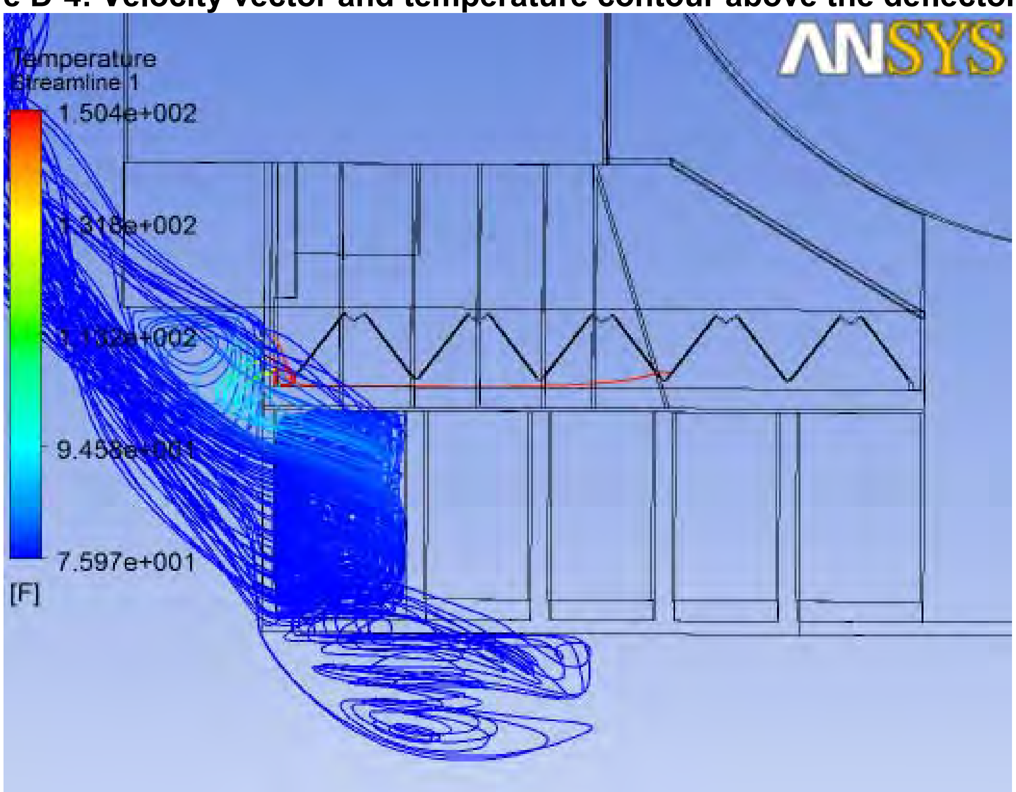


Figure D-5: Streamline at cell 1 for case 1

D-2: Train A Case 2: North wind with 29mph wind and 86F Ambient

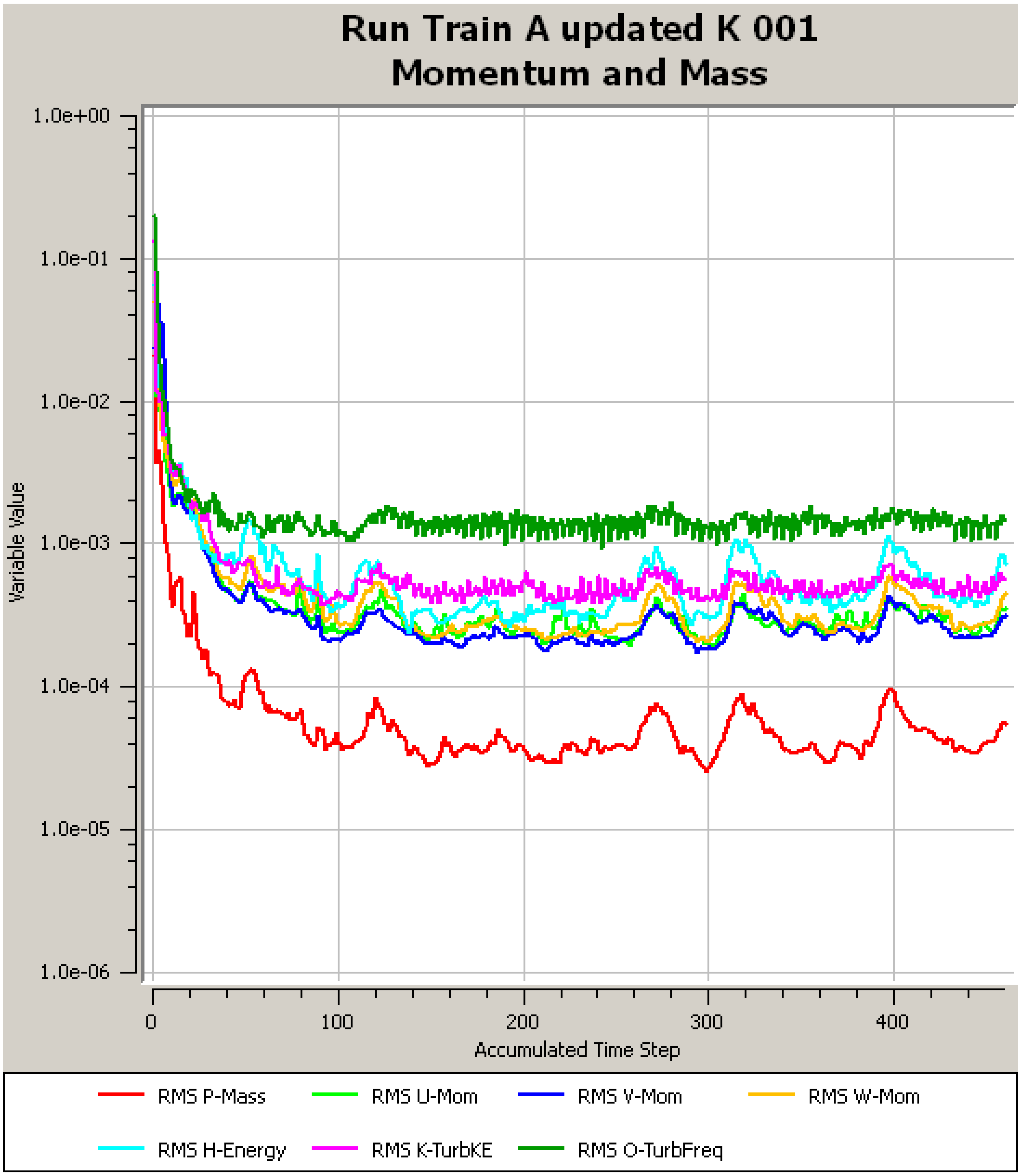


Figure D-6: Residual plot for case 2

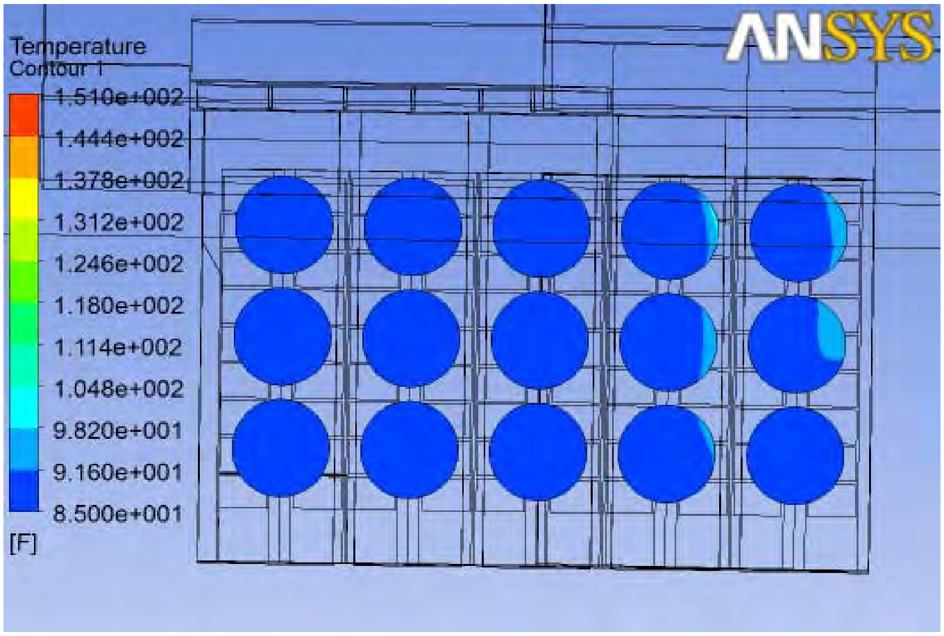


Figure D-7: Fan temperature for case 2

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	87.4	86.2	86.3	87.3	87.8
	88.2	86.3	86.3	87.7	88.6
	88.3	86.3	86.3	87.3	87.4
Average fan temperature:				87.2	

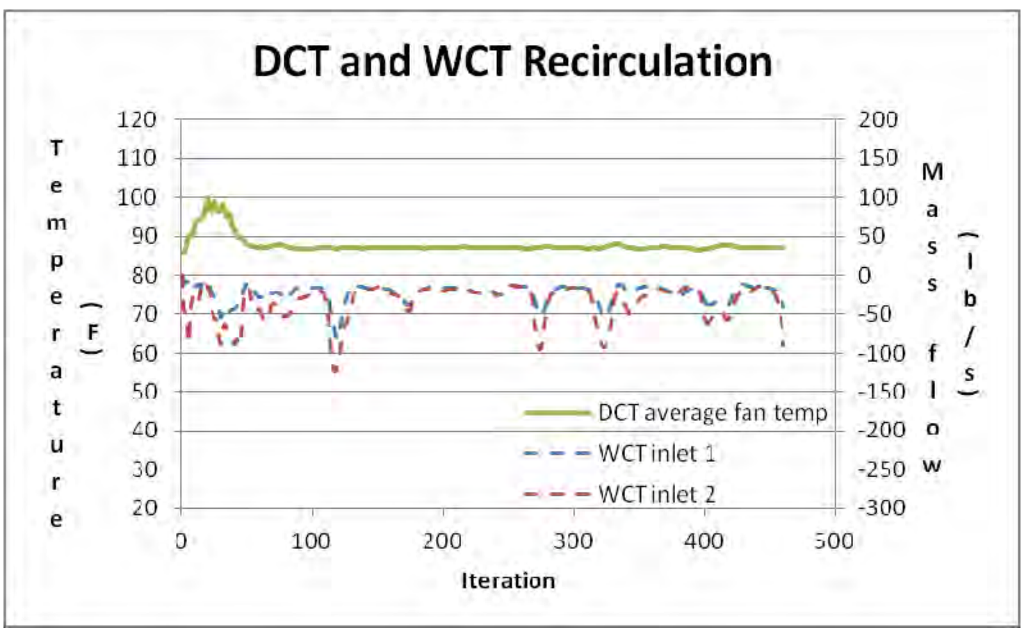


Figure D-8: DCT and WCT recirculation with iteration for case 2

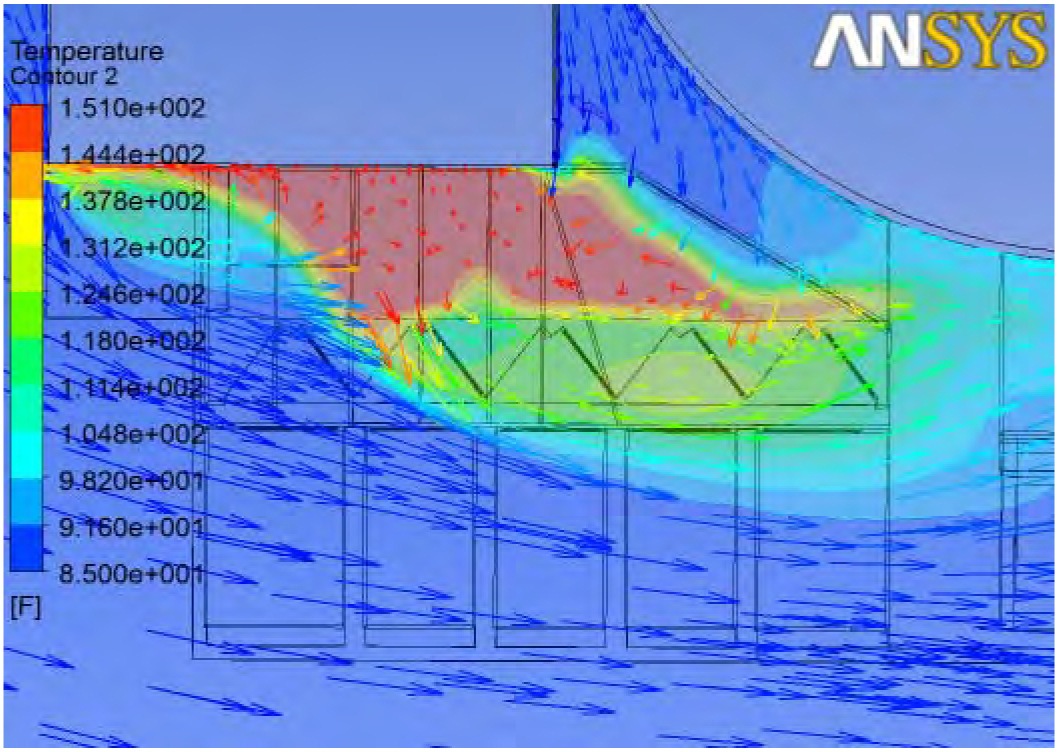


Figure D-9: Velocity vector and temperature contour above the deflector wall

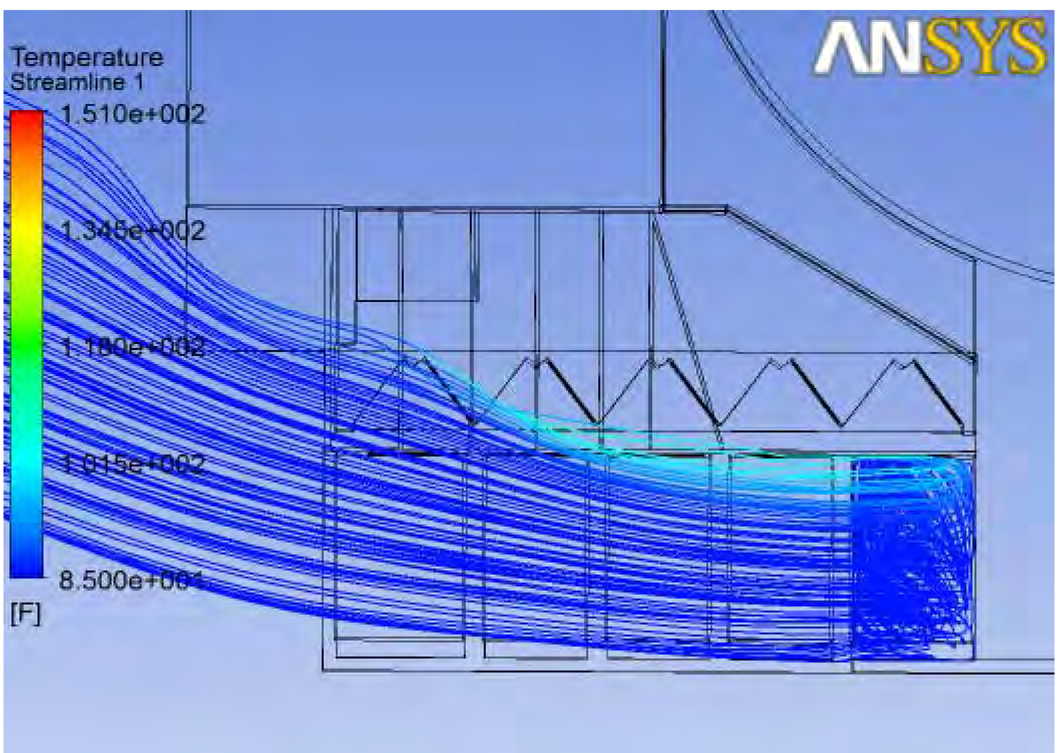


Figure D-10: Streamline at cell 1 for case 2

D-3: Train A Case 3: North wind with 26mph wind and 92F Ambient

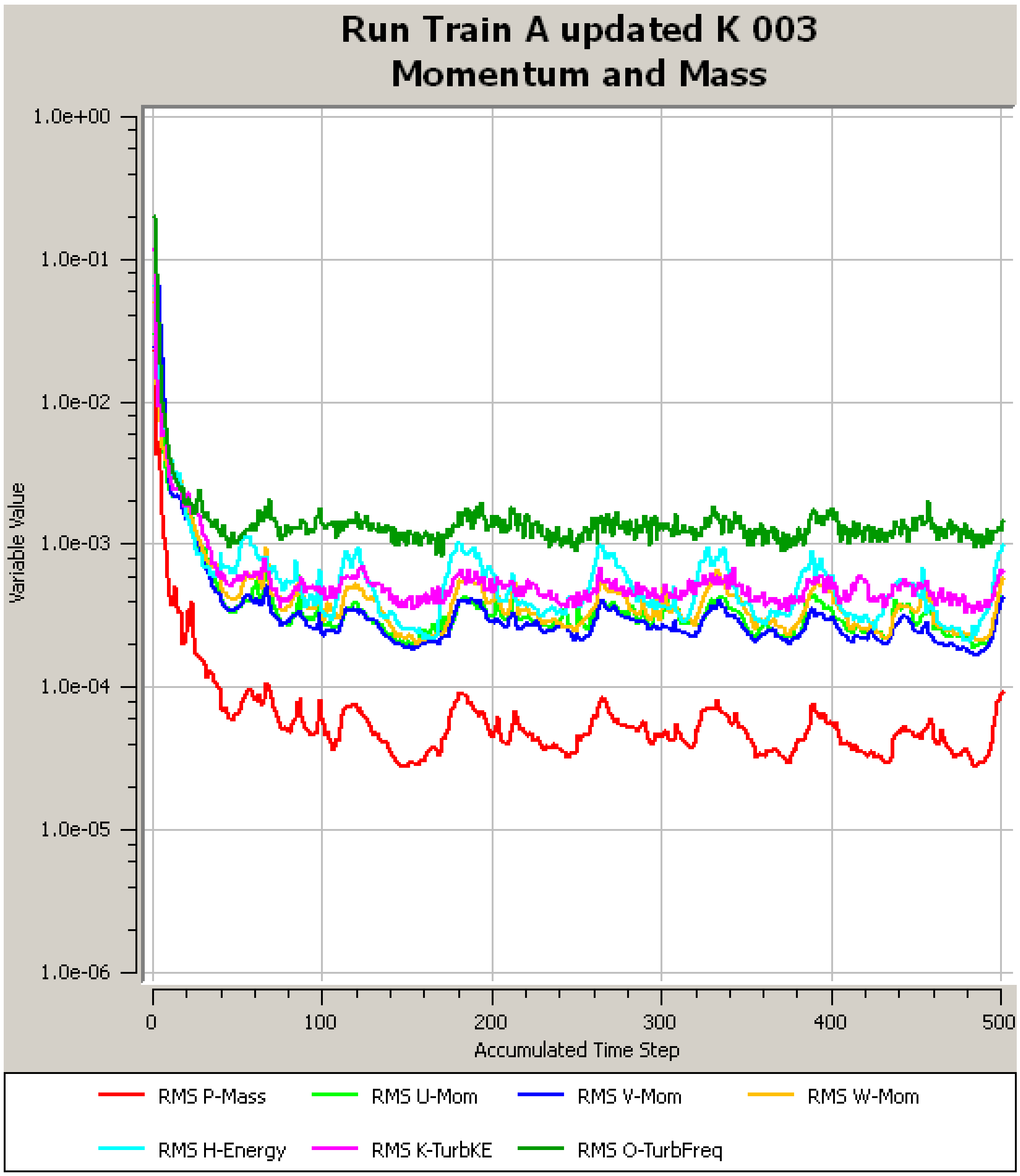


Figure D-11 Residual plot for case 3

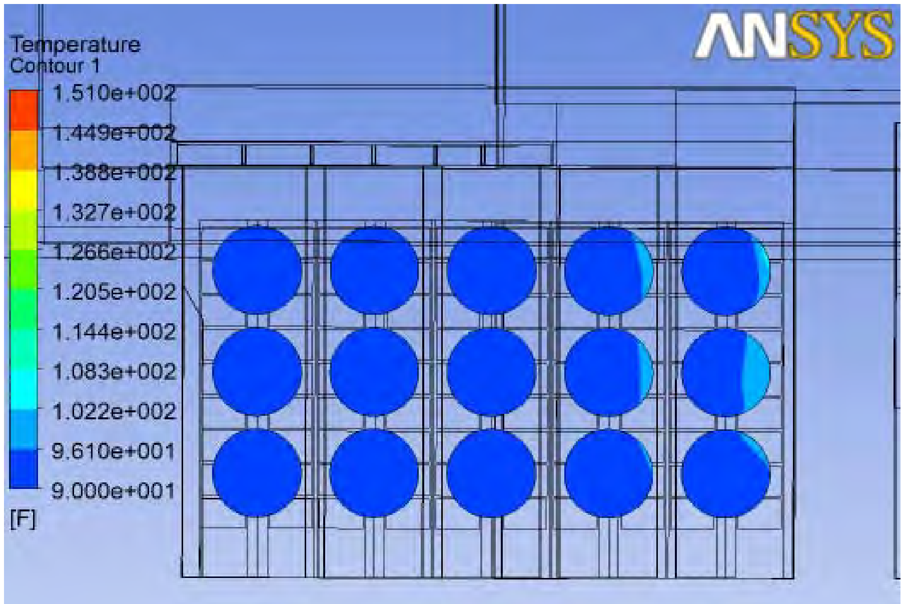


Figure D-12: Fan temperature for case 3

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	93.5	92.2	92.3	93.0	93.1
	94.2	92.3	92.2	93.2	93.9
	94.4	92.3	92.2	92.8	93.1
Average fan temperature:			93.0		

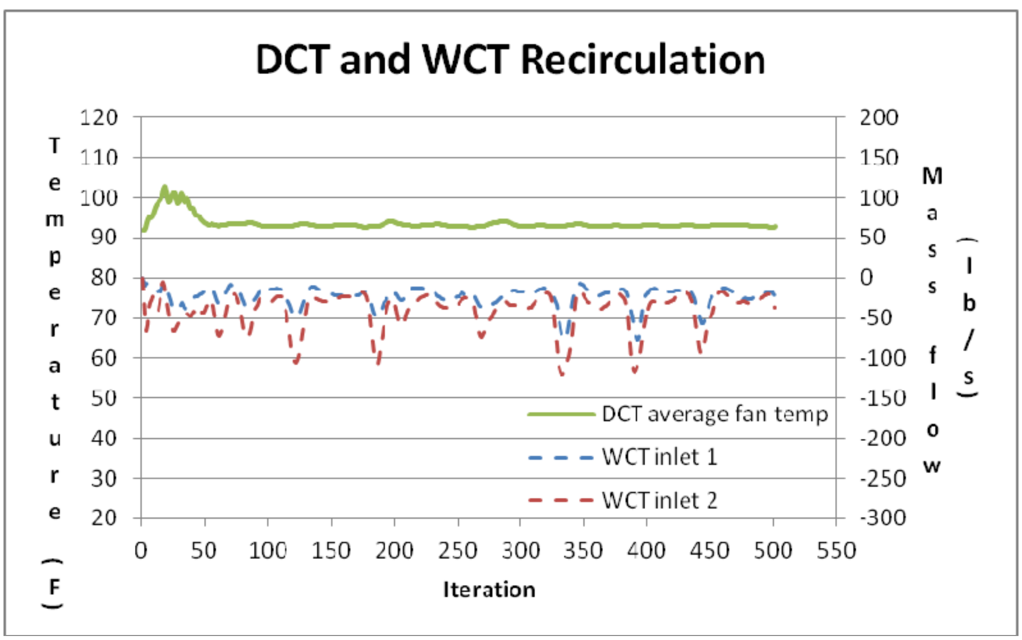


Figure D-13: DCT and WCT recirculation with iteration for case 3

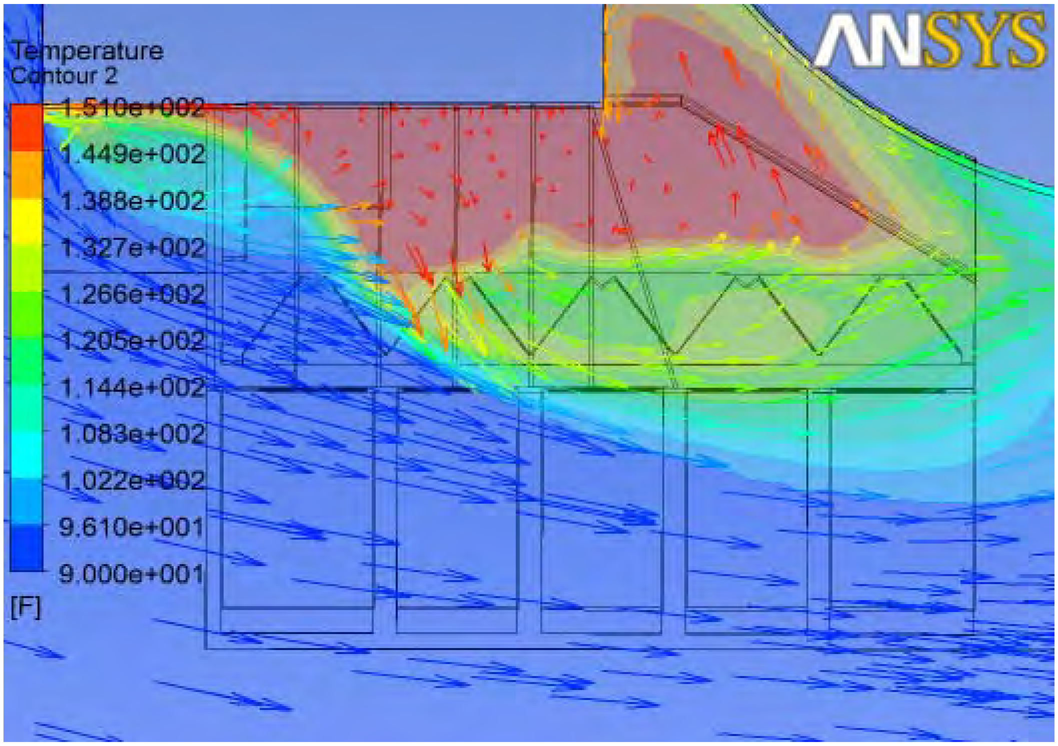


Figure D-14: Velocity vector and temperature contour above the missile shield

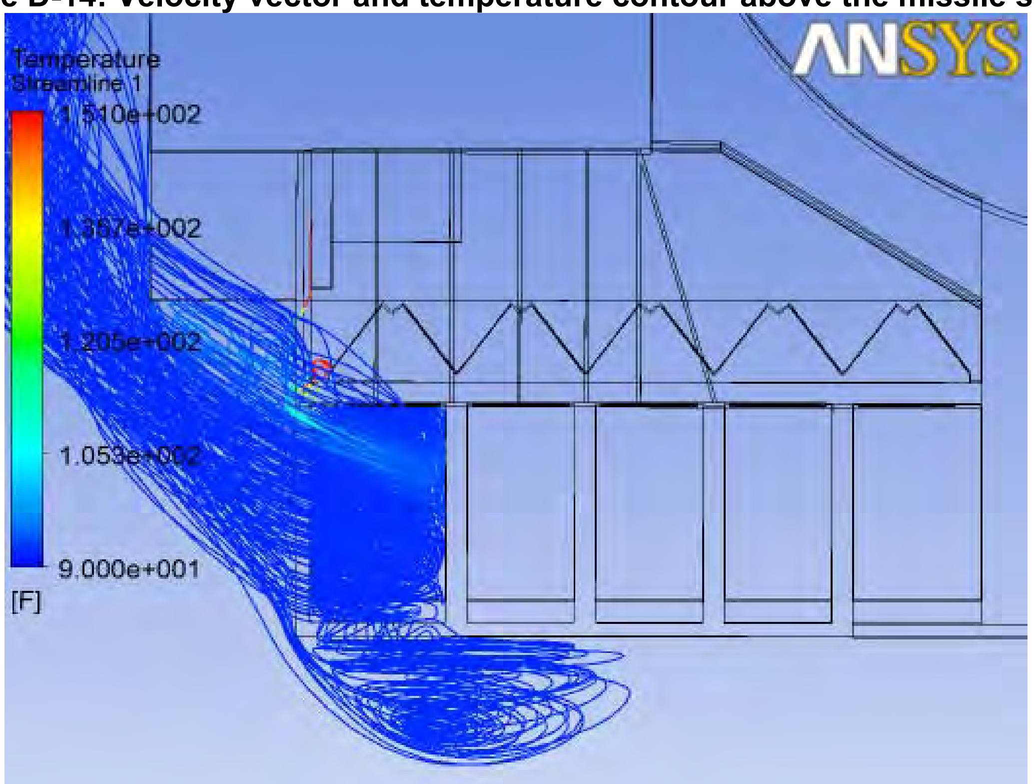


Figure D-15: Streamline at cell 1 for case 3

D-4: Train A Case 4: North wind with 8mph wind and 97F Ambient

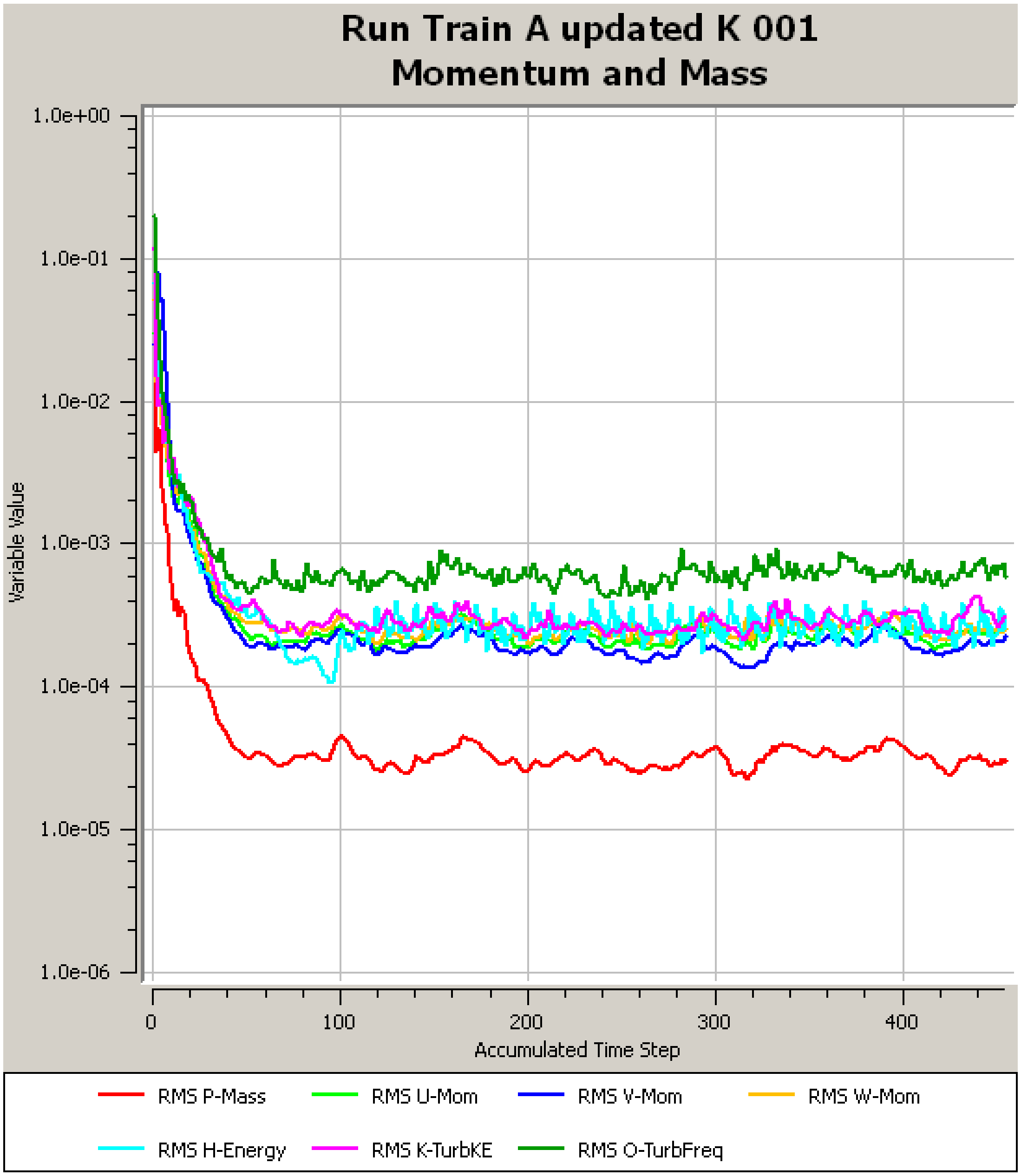


Figure D-16 Residual plot for case 4

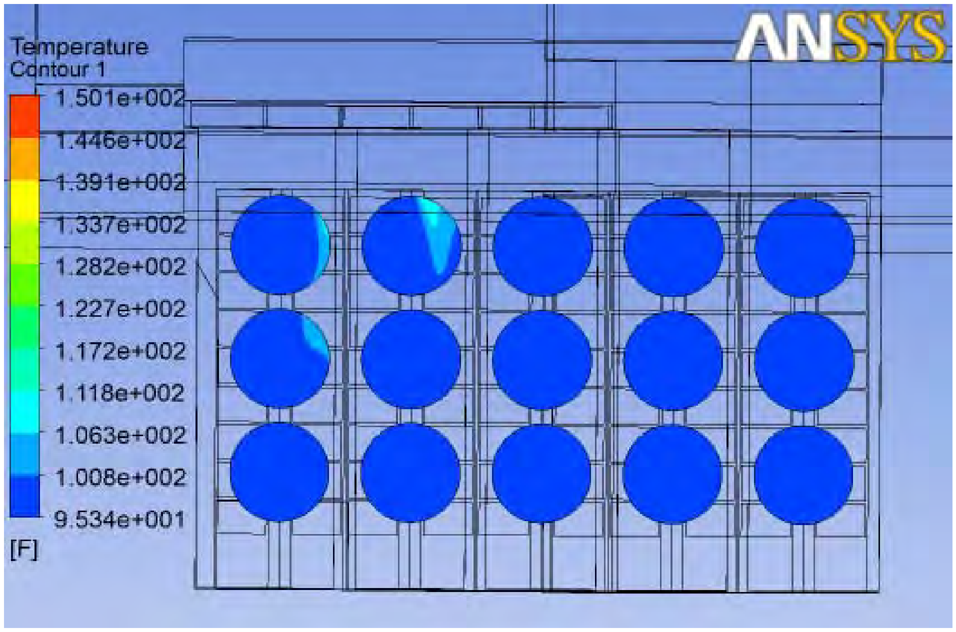


Figure D-17: Fan temperature for case 4

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	98.5	98.9	97.3	97.1	97.1
	99.2	97.3	97.0	97.0	97.0
	97.4	97.0	97.0	97.0	97.0
Average fan temperature:				97.5	

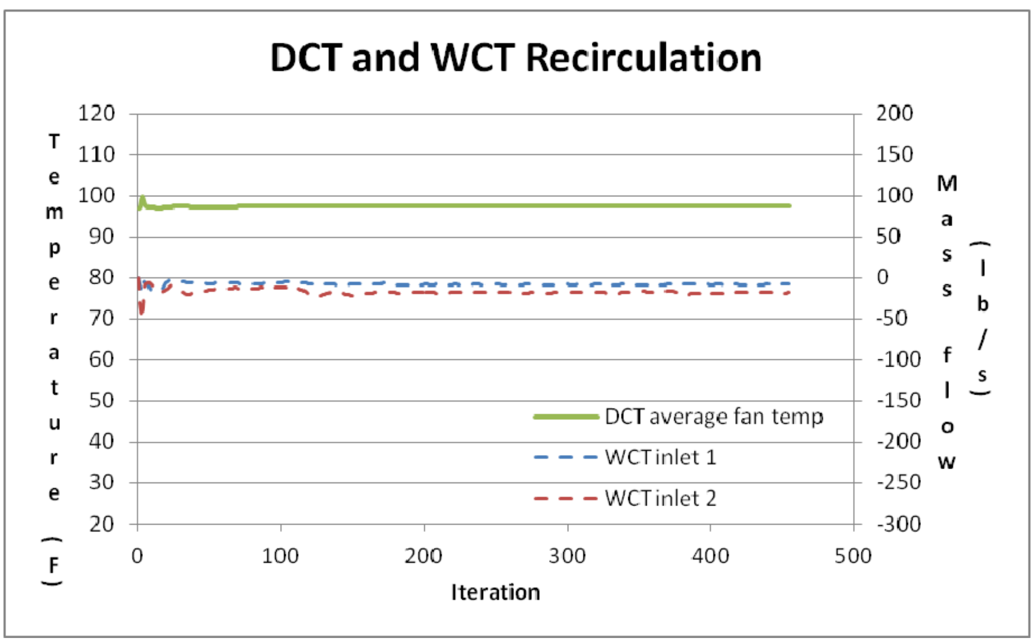


Figure D-18: DCT and WCT recirculation with iteration for case 4

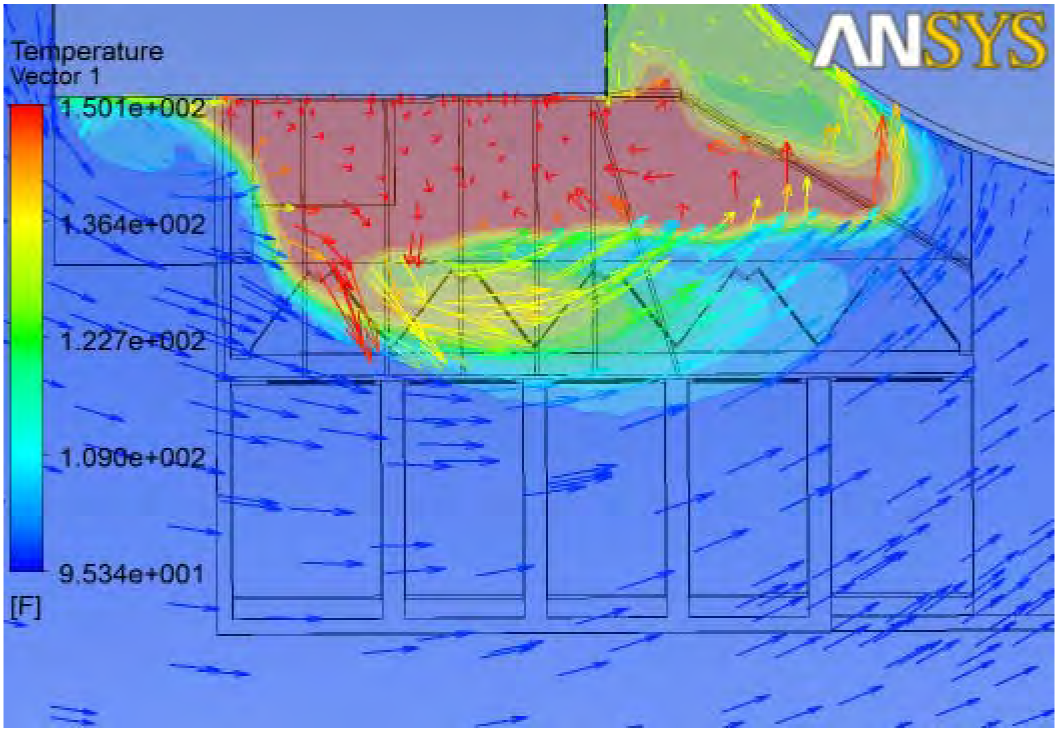


Figure D-19: Velocity vector and temperature contour above the deflector wall

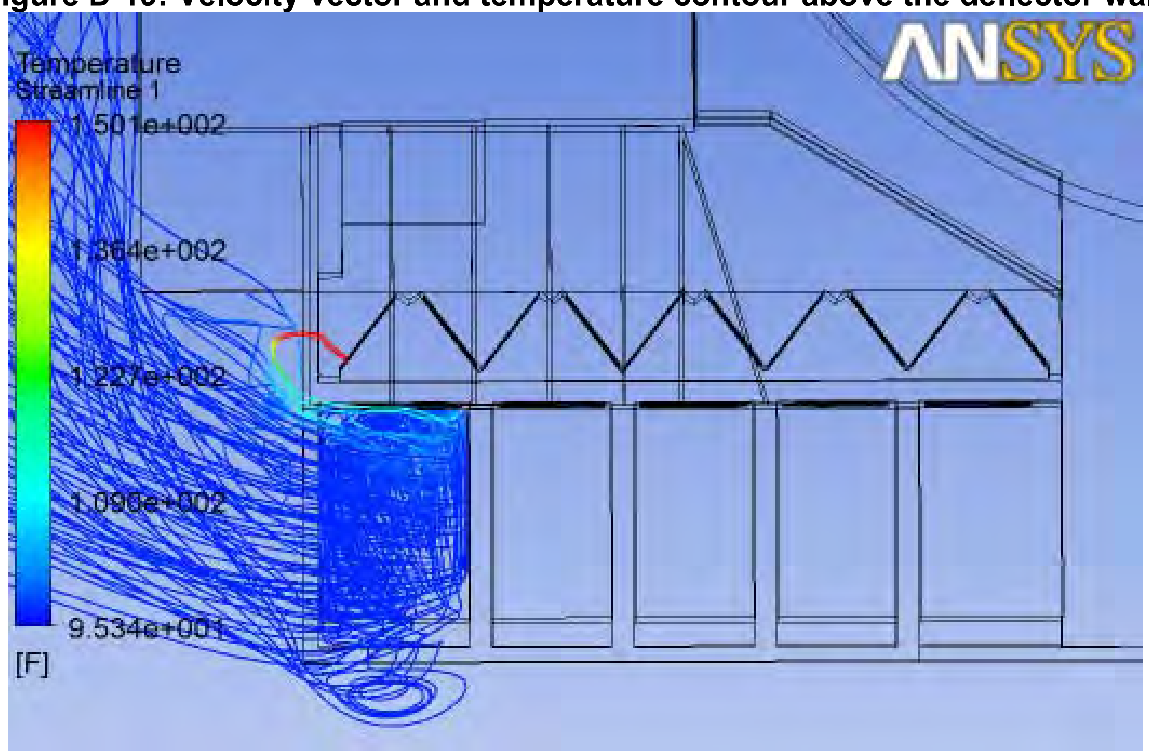


Figure D-20: Streamline at cell 1 for case 4

D-5: Train A Case 5: East wind with 22mph wind and 85F Ambient

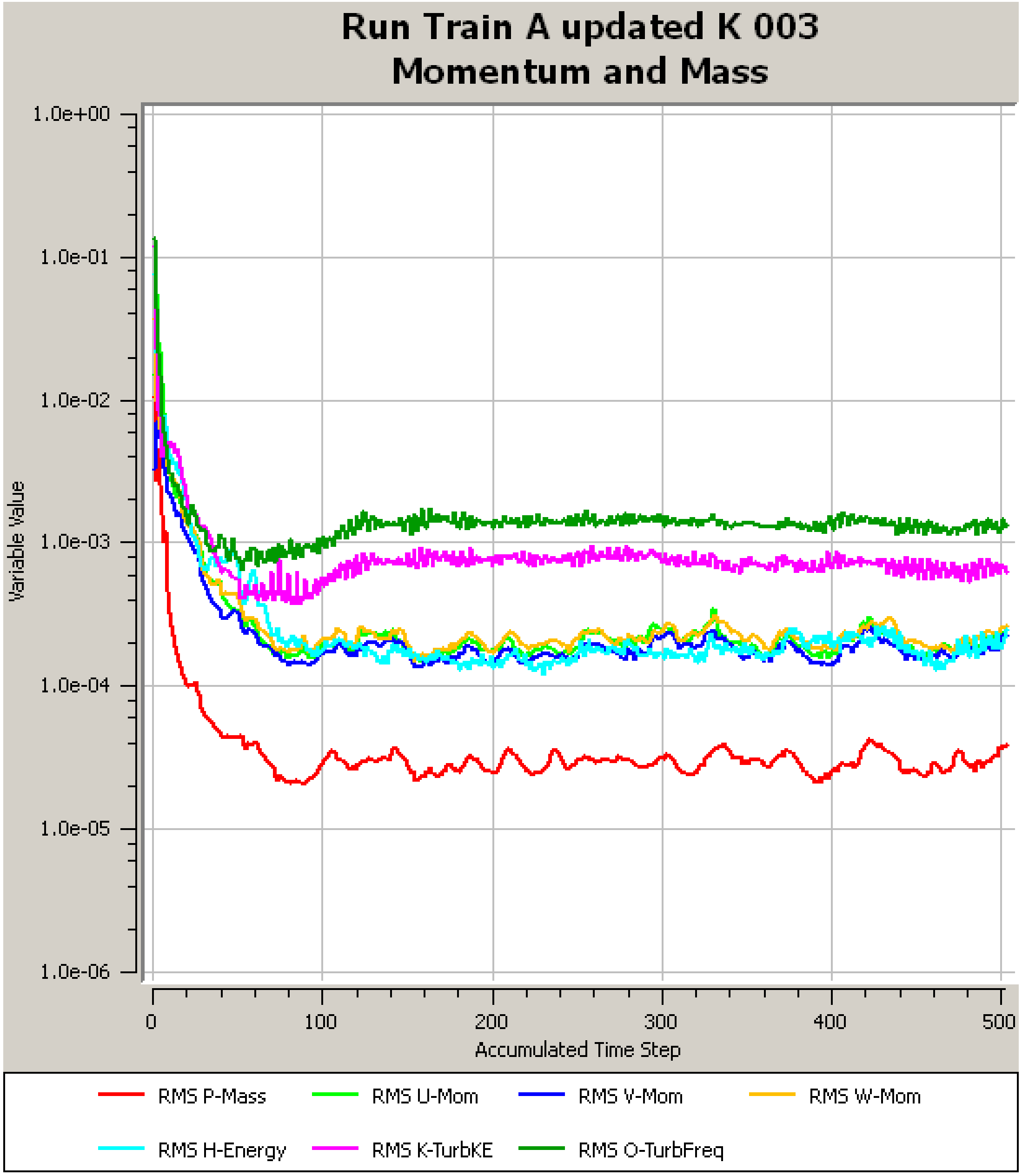


Figure D-21 Residual plot for case 5

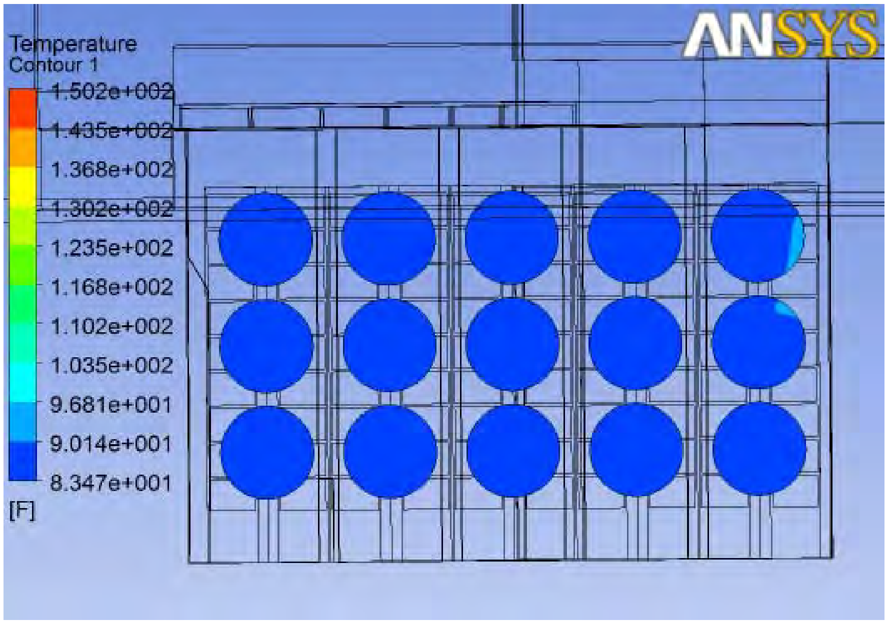


Figure D-22: Fan temperature for case 5

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	86.6	85.8	85.6	85.1	87.2
	87.0	85.9	85.8	85.1	86.8
	87.1	86.0	85.7	85.0	86.4
Average fan temperature:				86.1	

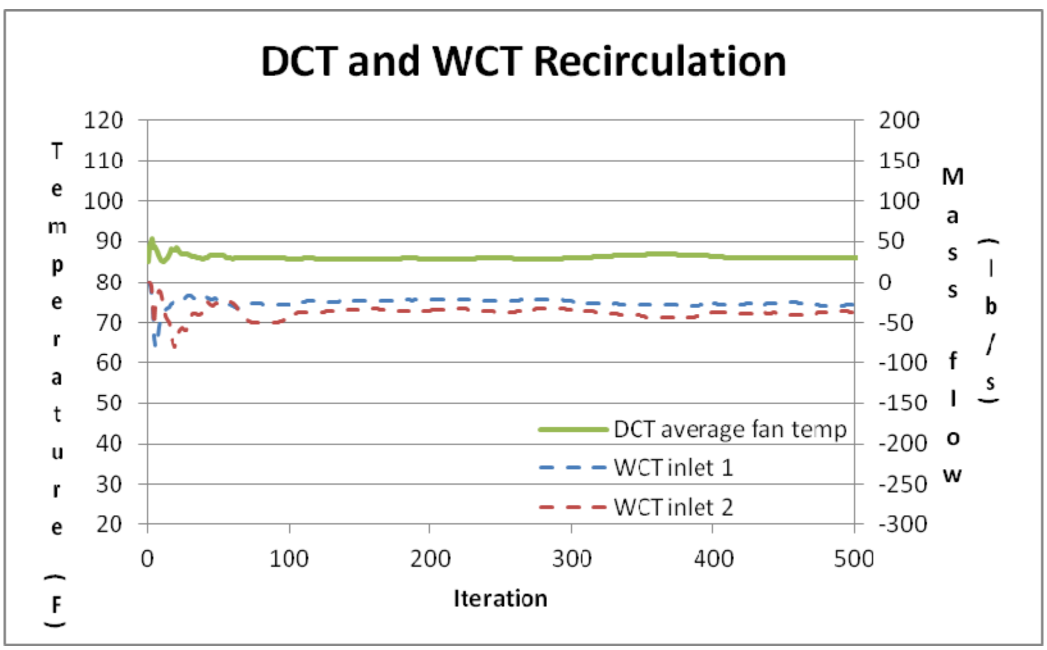


Figure D-23: DCT and WCT recirculation with iteration for case 5

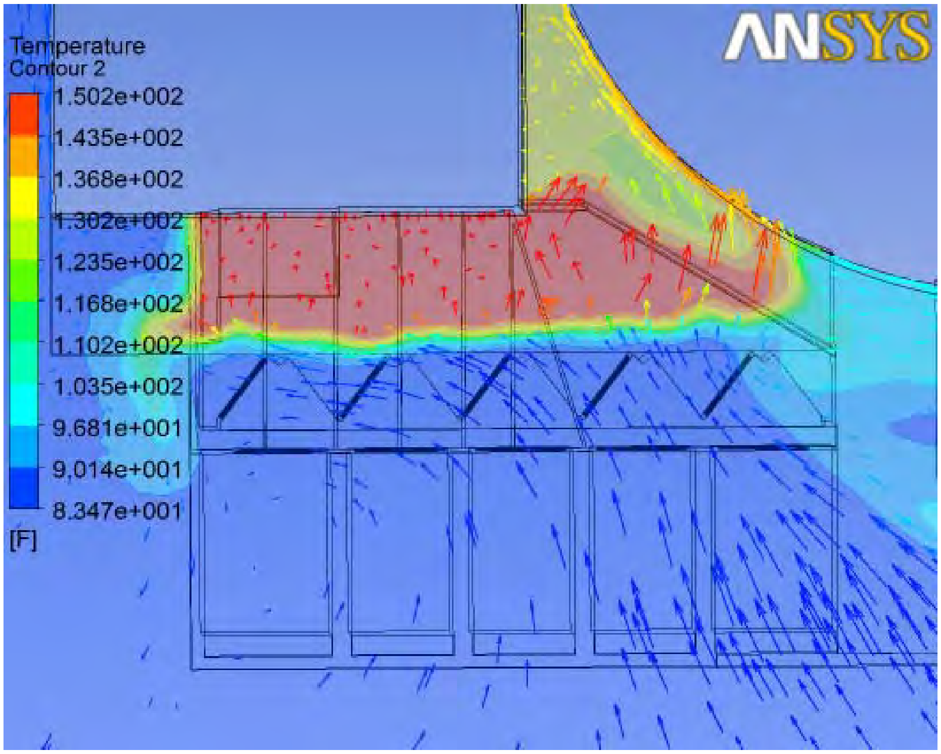


Figure D-24: Velocity vector and temperature contour above the deflector wall

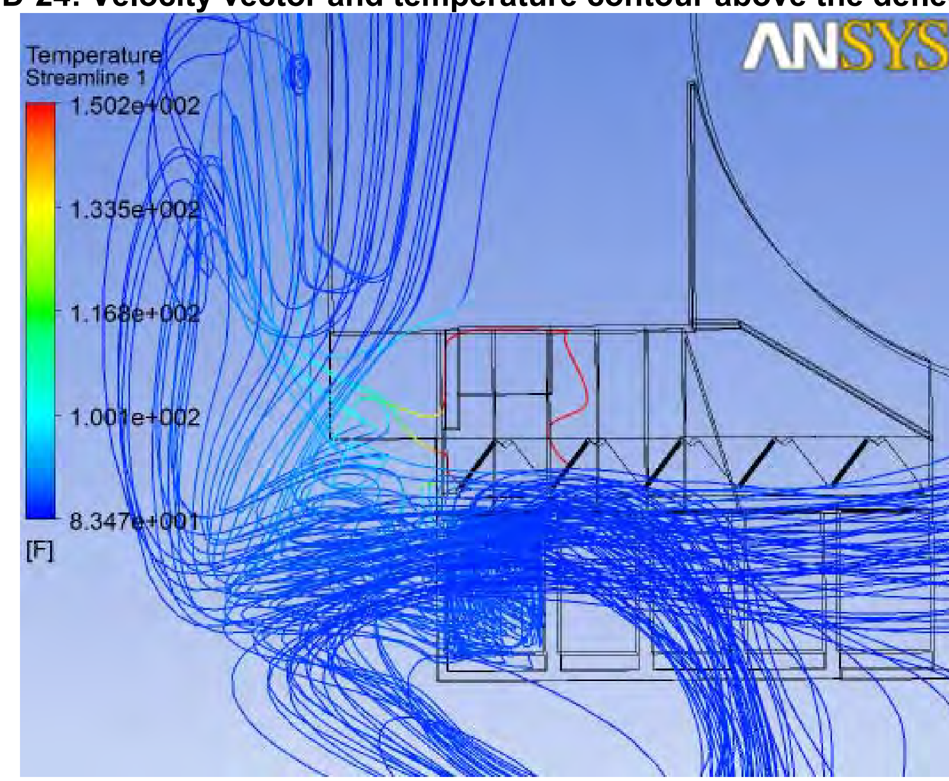


Figure D-25: Streamline at cell 1 for case 5

D-6: Train A Case 6: East wind with 21mph wind and 91F Ambient

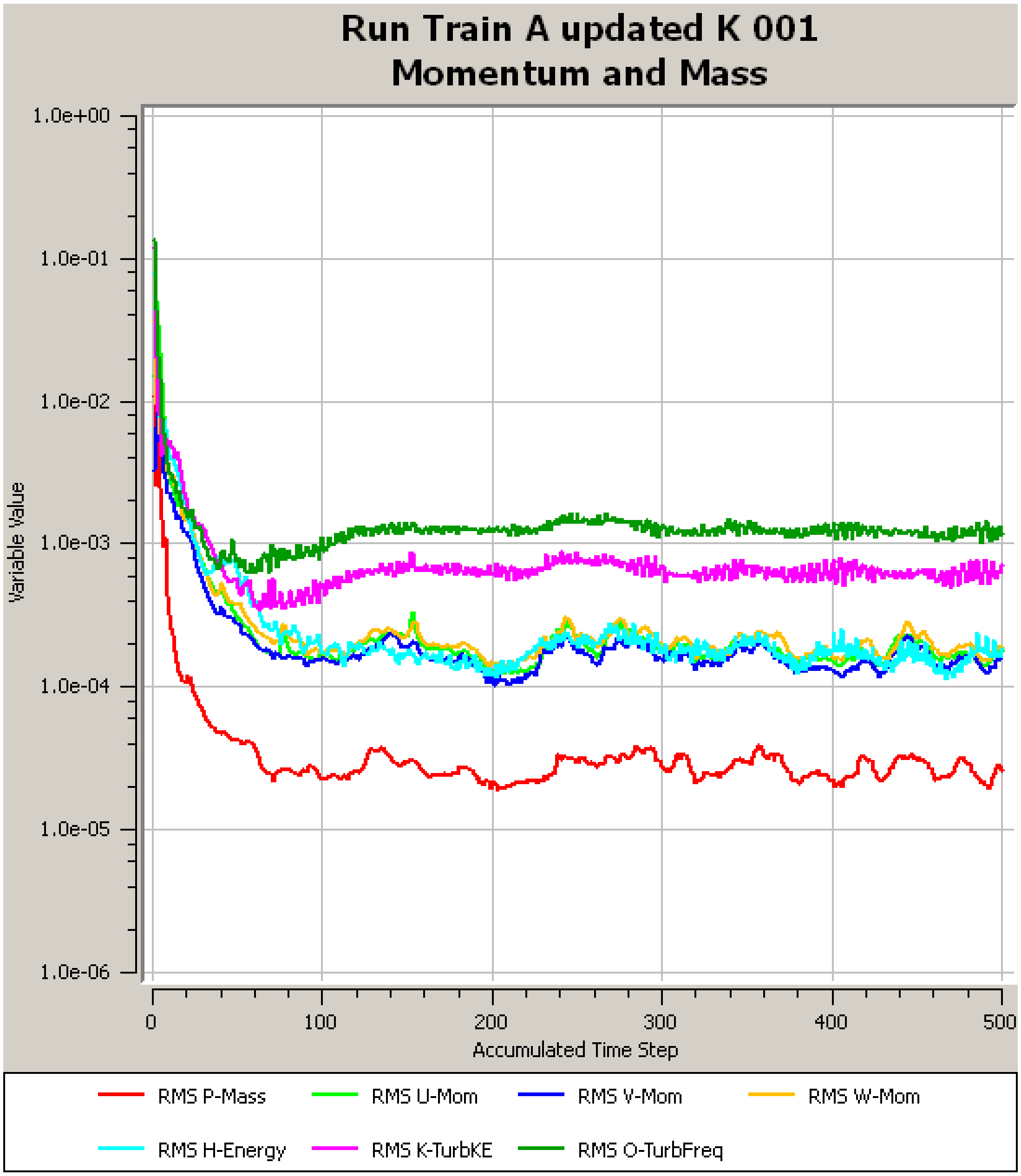


Figure D-26 Residual plot for case 6

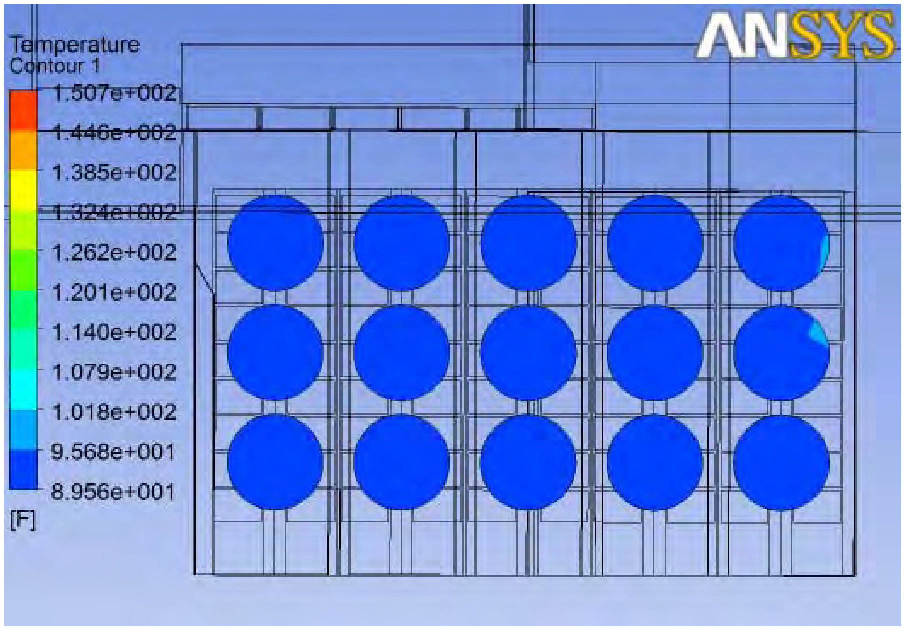


Figure D-27: Fan temperature for case 6

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	92.4	91.7	91.6	91.1	92.8
	92.9	91.8	91.7	91.0	92.6
	93.0	92.0	91.7	91.0	92.2
Average fan temperature:			92.0		

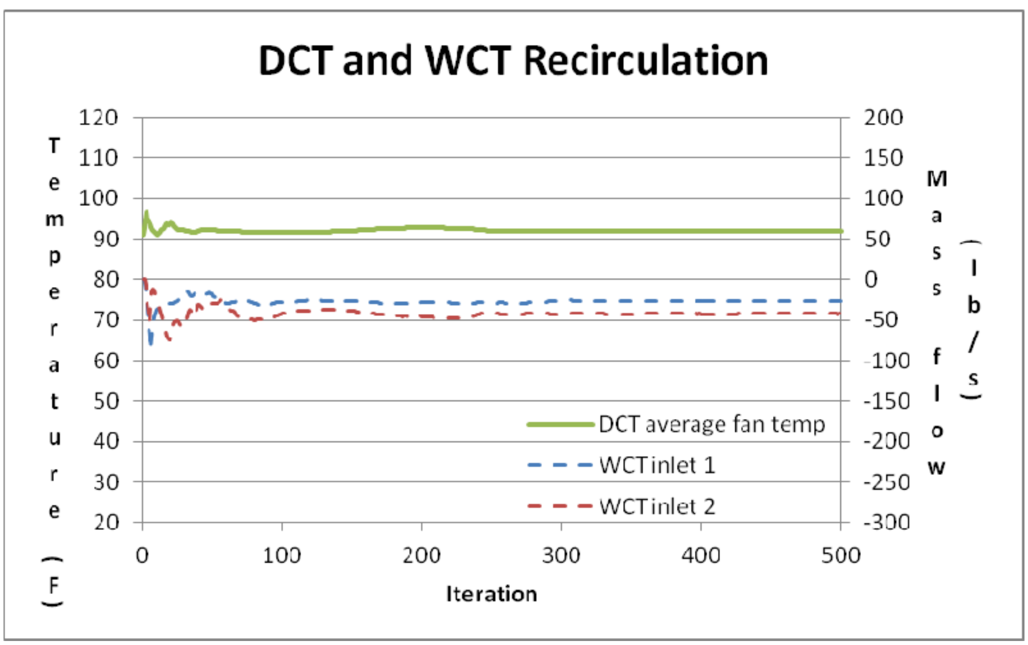


Figure D-28: DCT and WCT recirculation with iteration for case 6

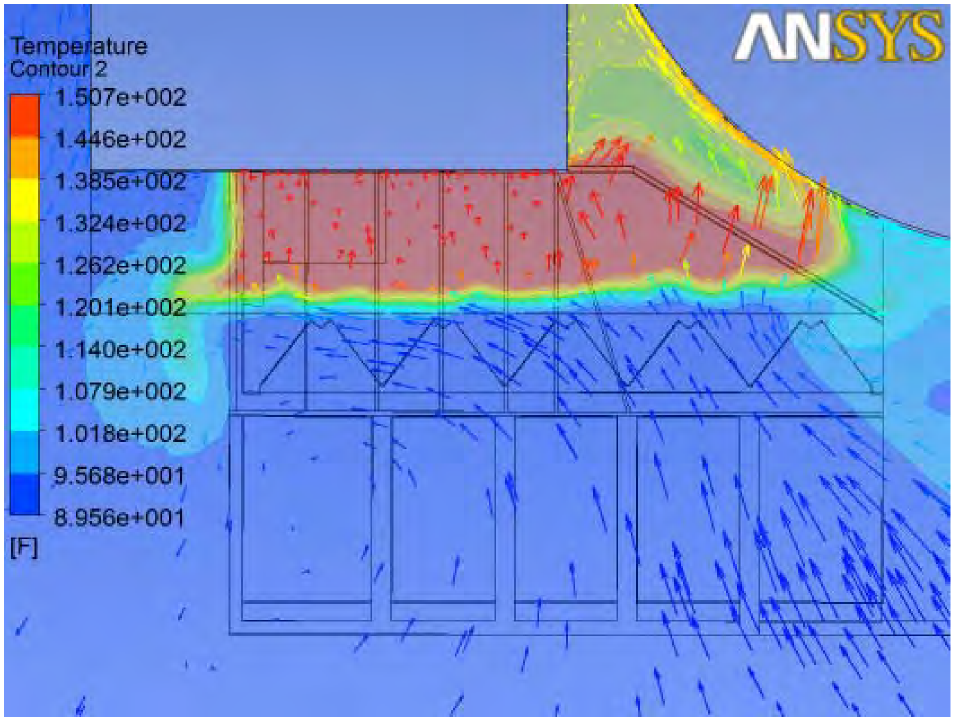


Figure D-29: Velocity vector and temperature contour above the missile shield

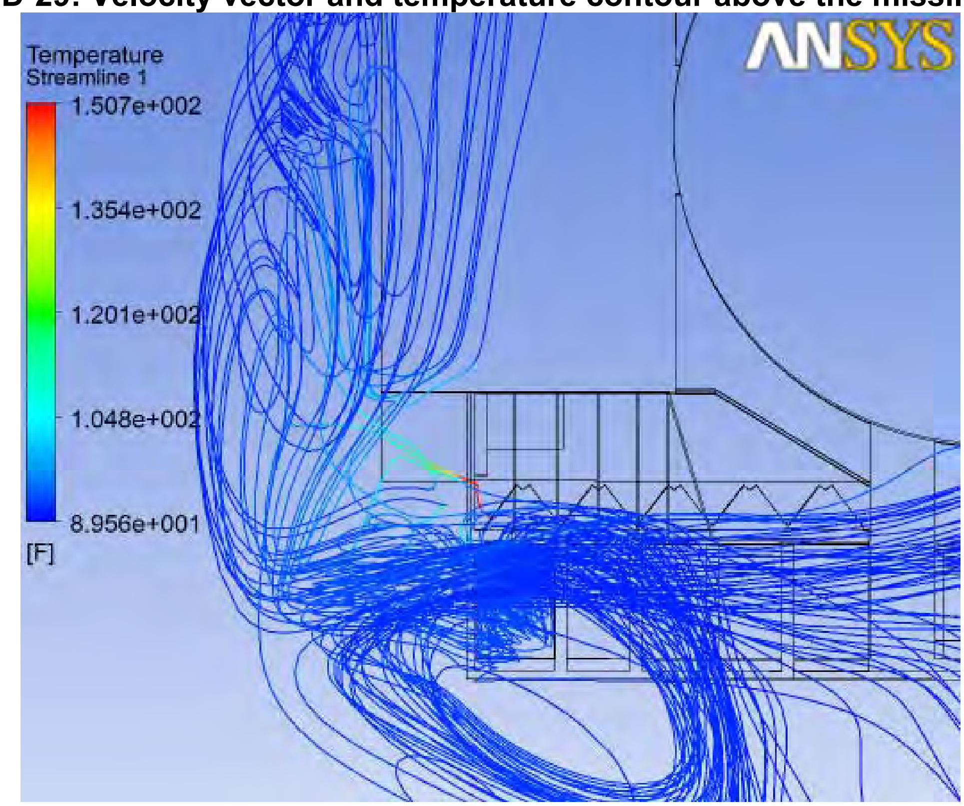


Figure D-30: Streamline at cell 1 for case 6

D-7: Train A Case 7: East wind with 10mph wind and 96F Ambient

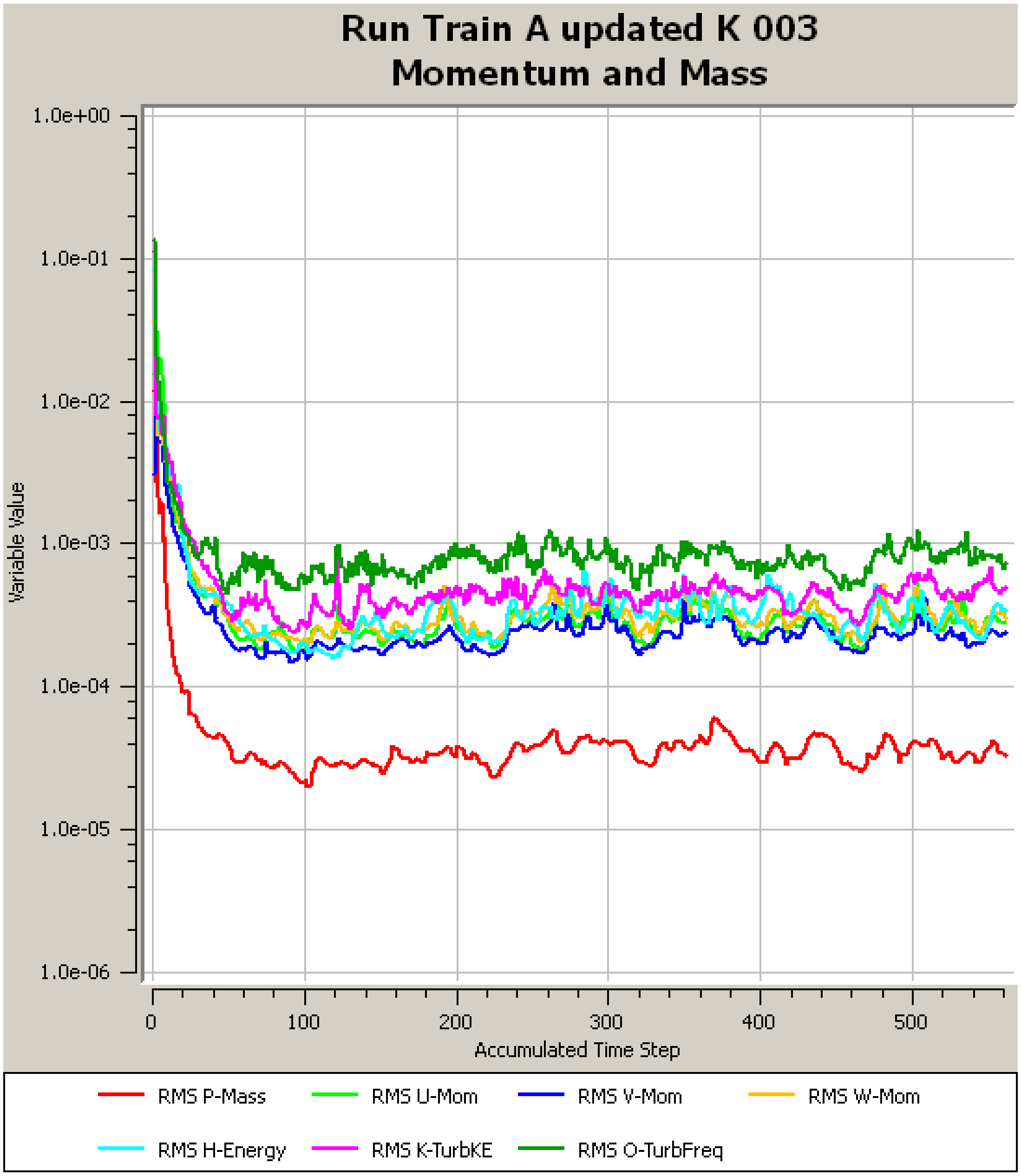


Figure D-31 Residual plot for case 7

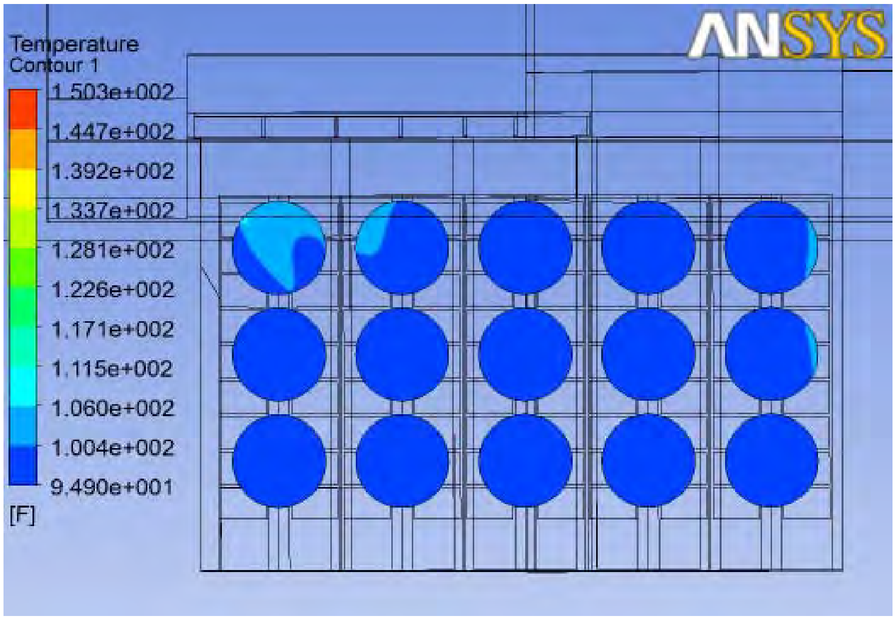


Figure D-32: Fan temperature for case 7

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	101.3	99.6	98.0	97.3	98.9
	98.5	98.5	97.3	96.6	97.7
	97.4	97.9	97.0	96.6	97.8
Average fan temperature:			98.0		

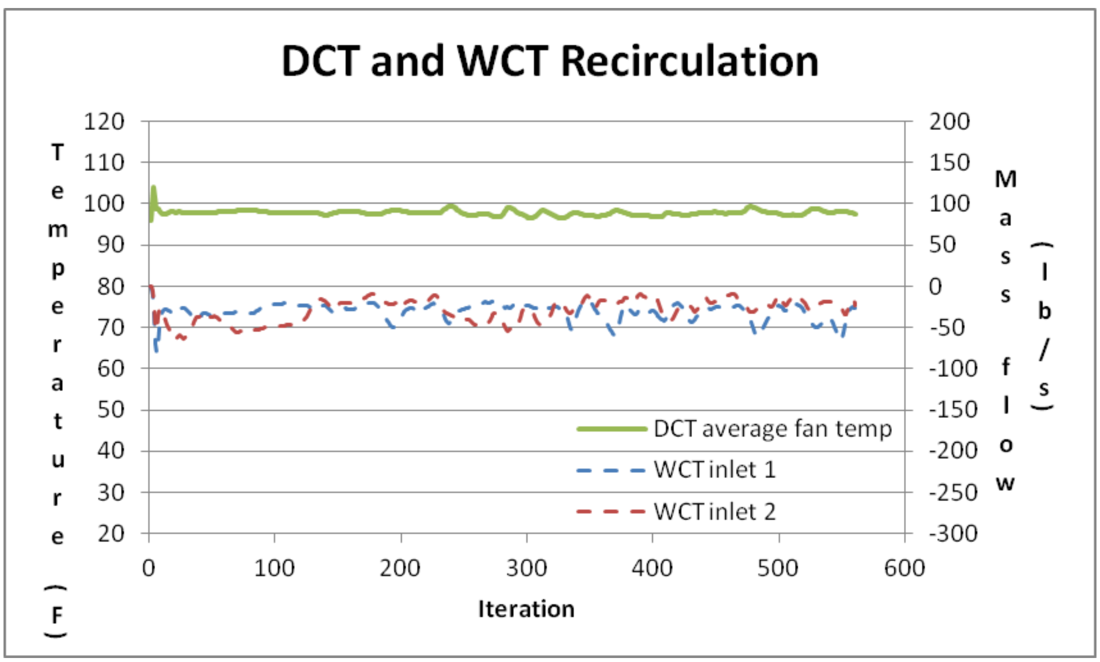


Figure D-33: DCT and WCT recirculation with iteration for case 7

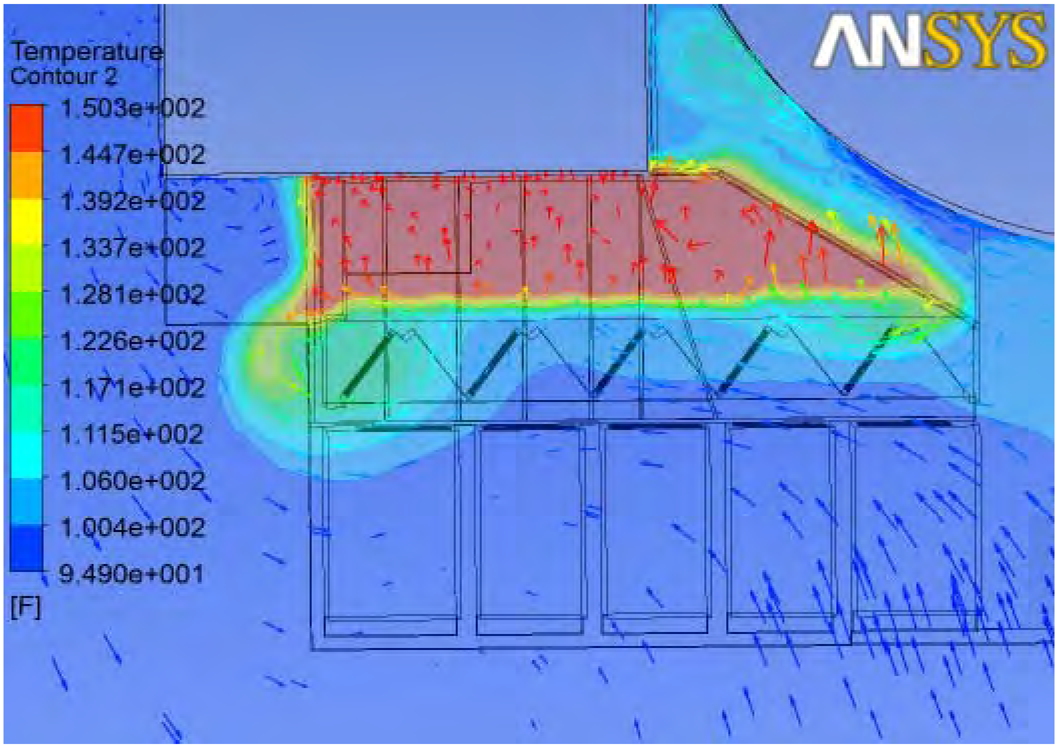


Figure D-34: Velocity vector and temperature contour above the deflector wall

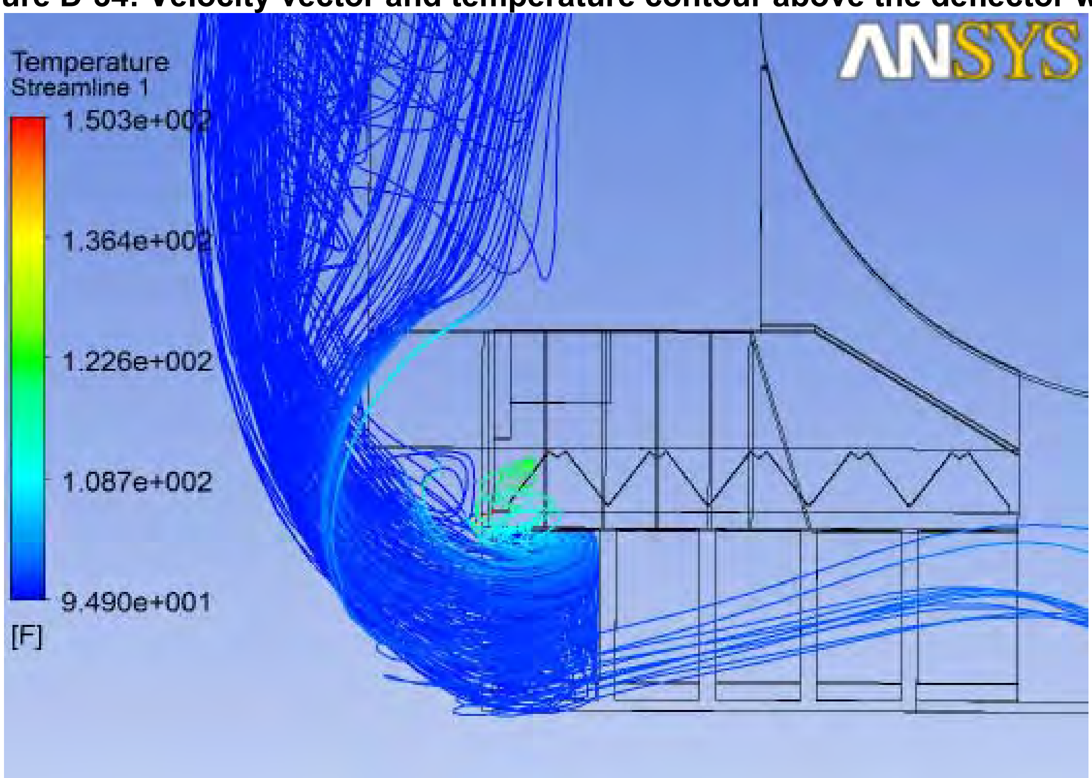


Figure D-35: Streamline at cell 1 for case 7

D-8: Train A Case 8 South wind with 22mph wind and 89F Ambient

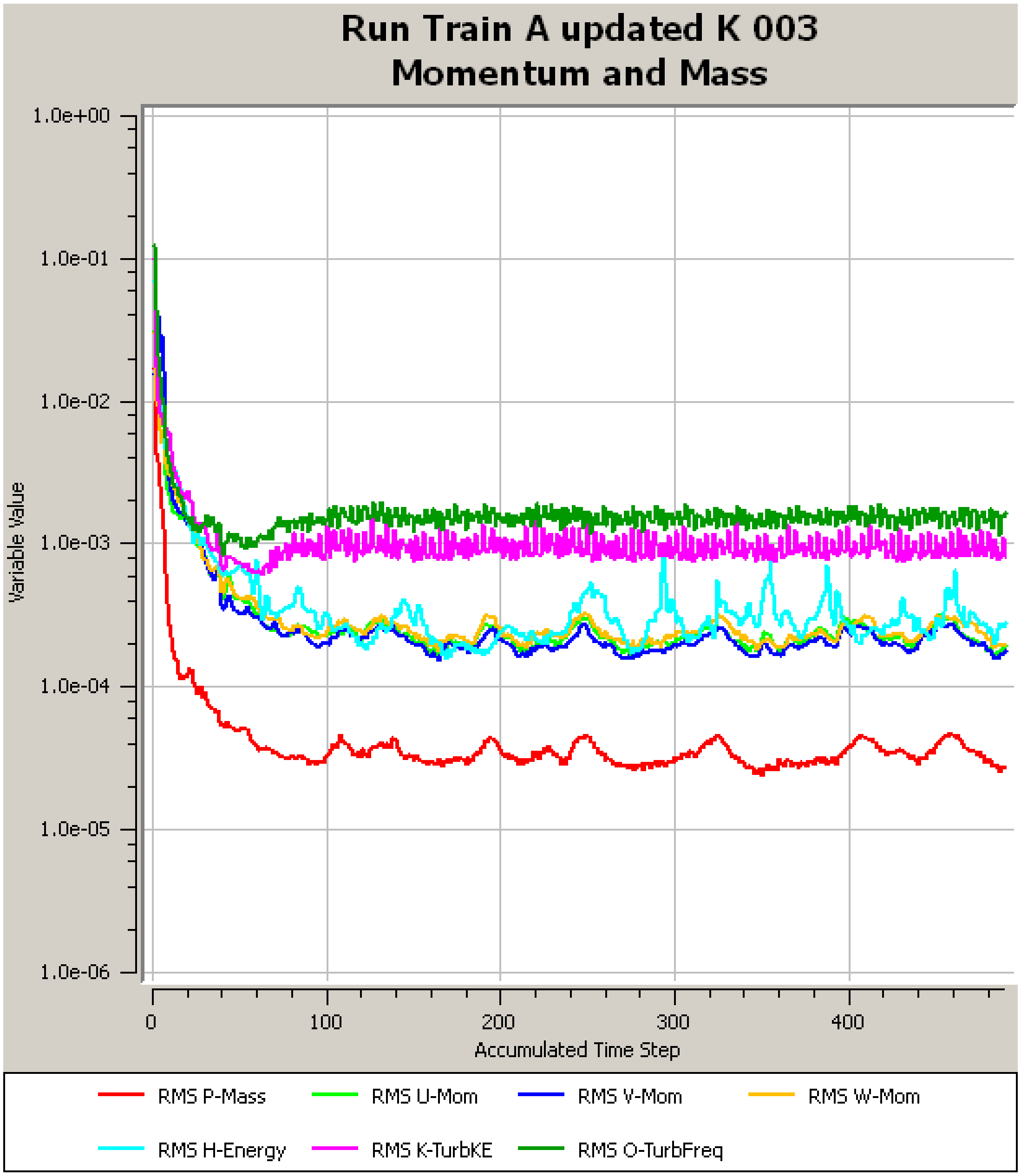


Figure D-36 Residual plot for case 8

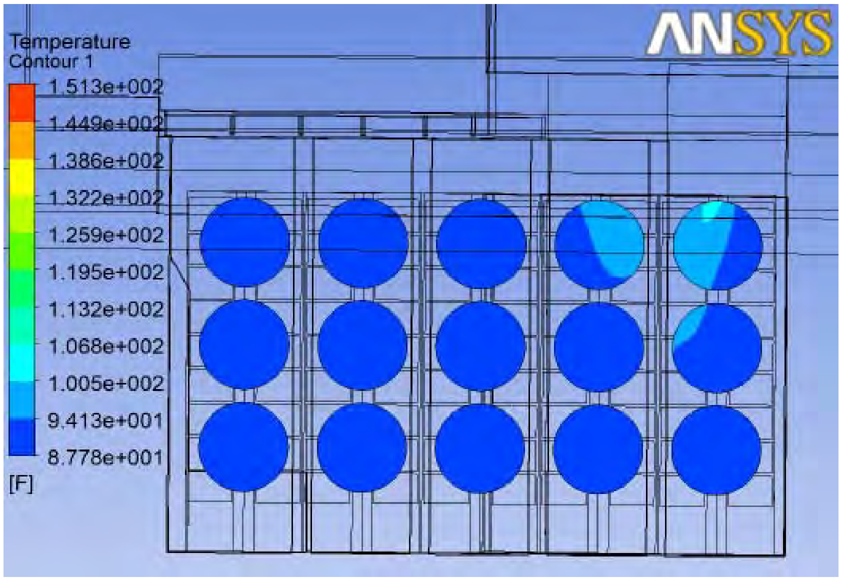


Figure D-37: Fan temperature for case 8

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	90.0	90.4	91.3	94.9	95.7
	89.8	89.9	90.2	91.6	92.5
	89.8	89.9	90.0	90.3	91.0
Average fan temperature:			91.2		

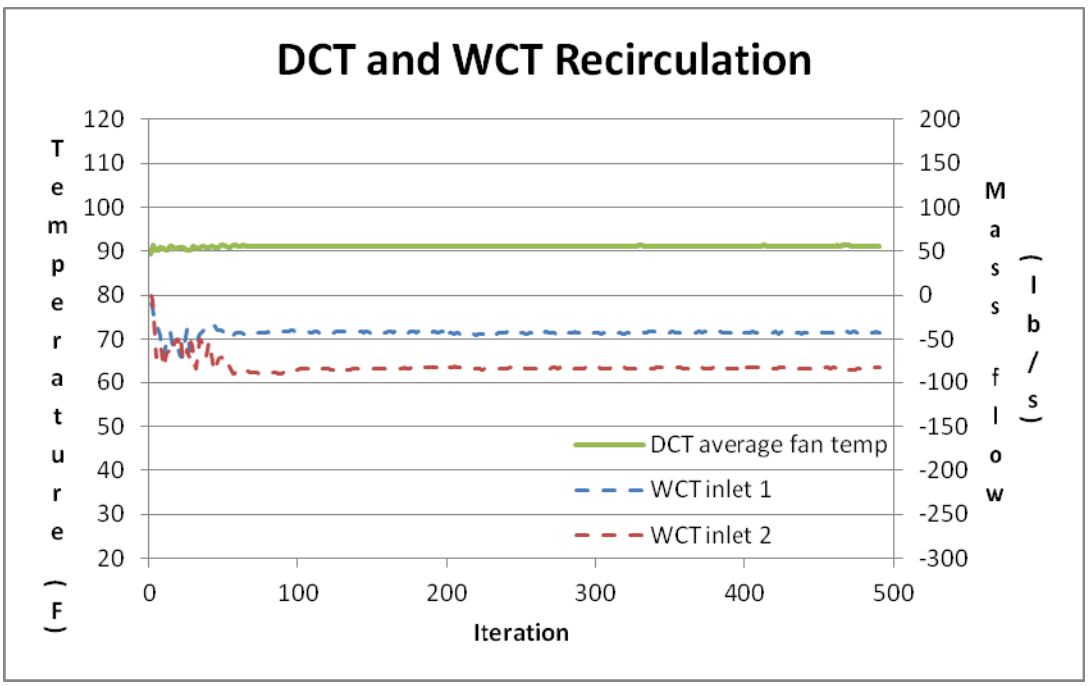


Figure D-38: DCT and WCT recirculation with iteration for case 8

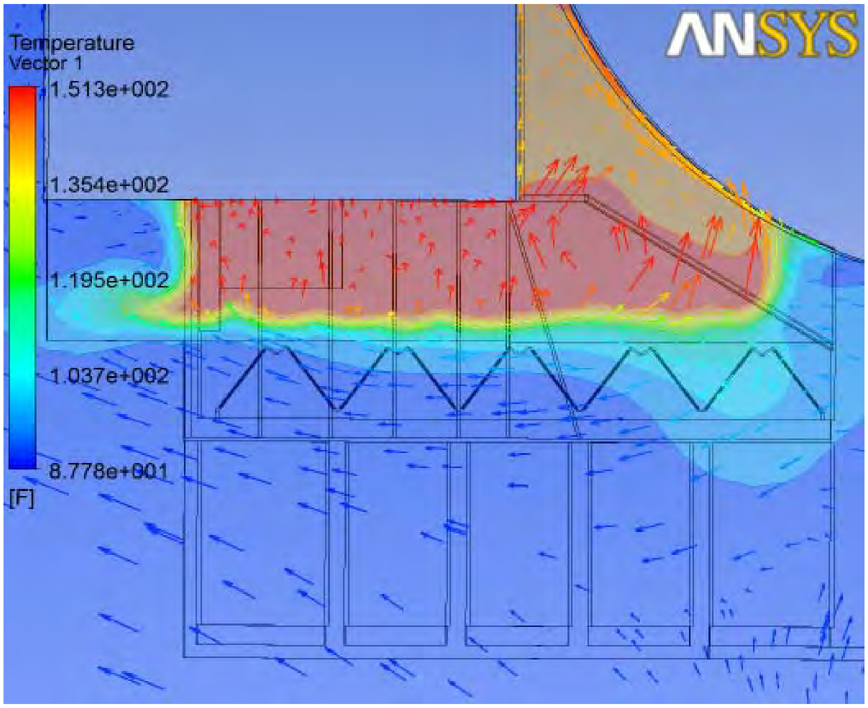


Figure D-39: Velocity vector and temperature contour above the deflector wall

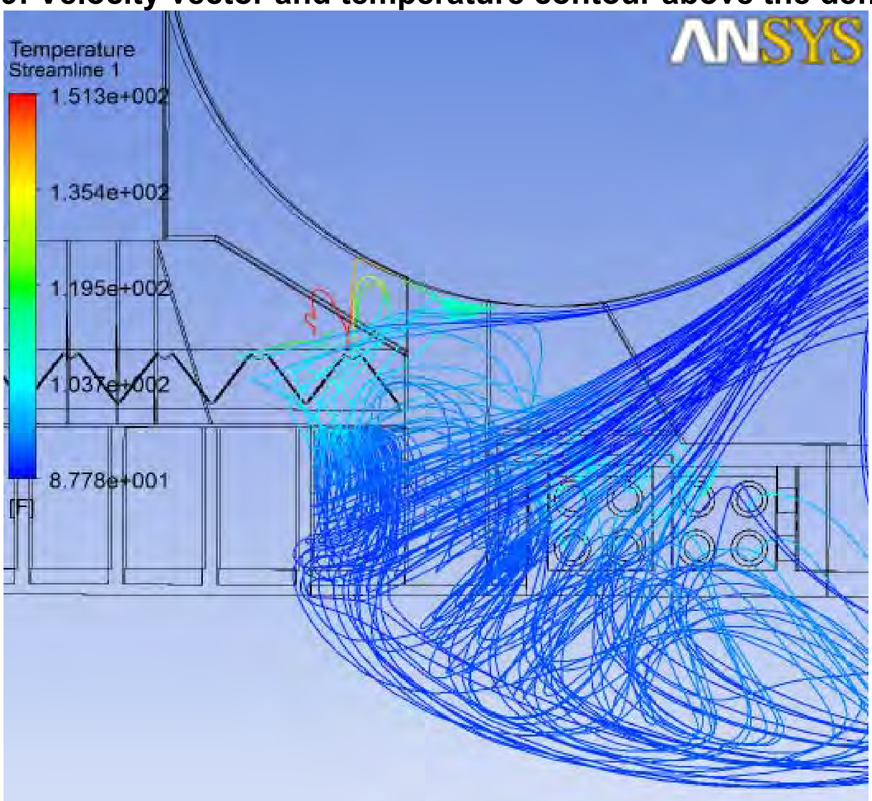


Figure D-40: Streamline at cell 5 for case 8

D-9: Train A Case 9: South wind with 21mph wind and 92F Ambient

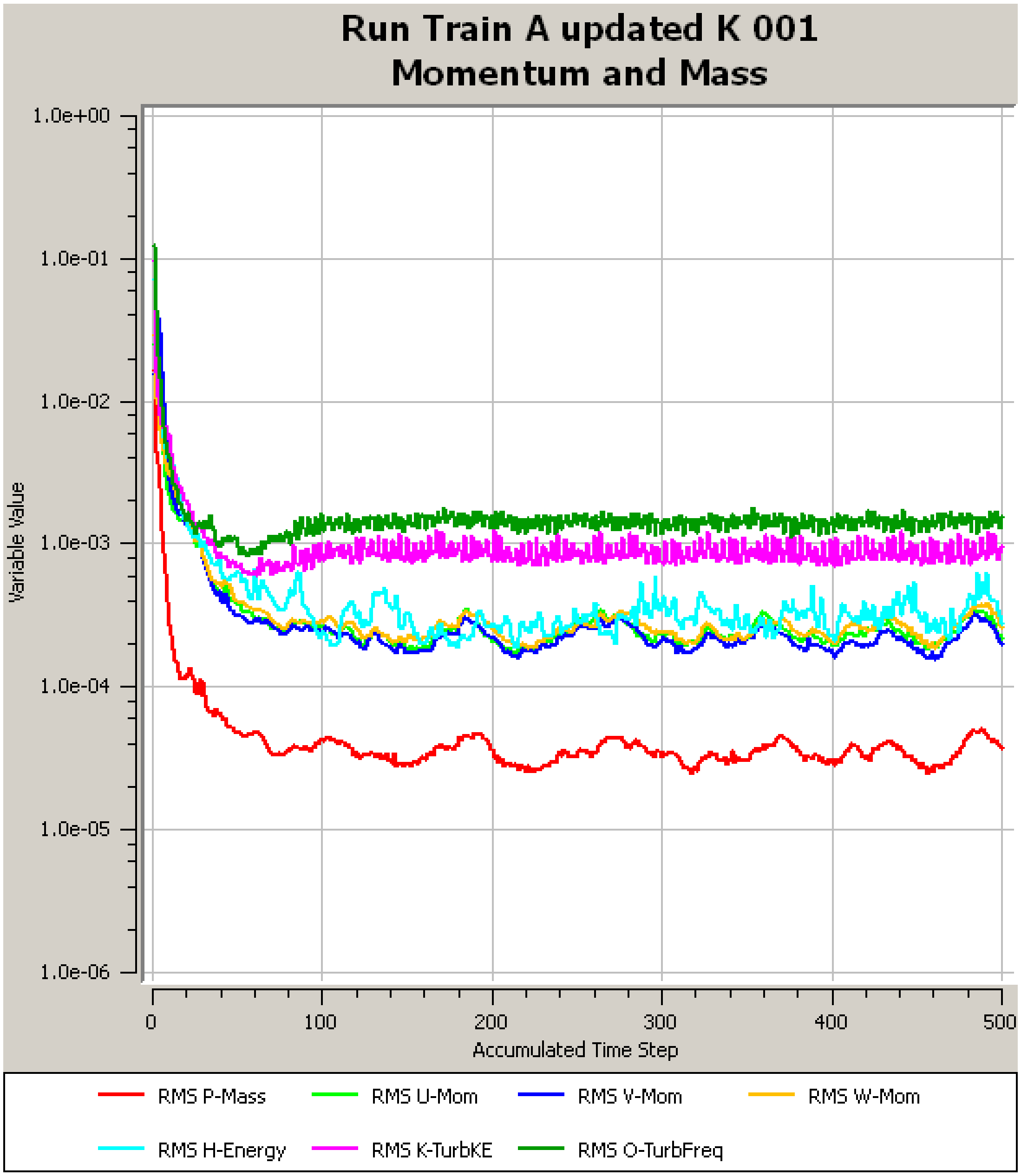


Figure D-41: Residual plot for case 9

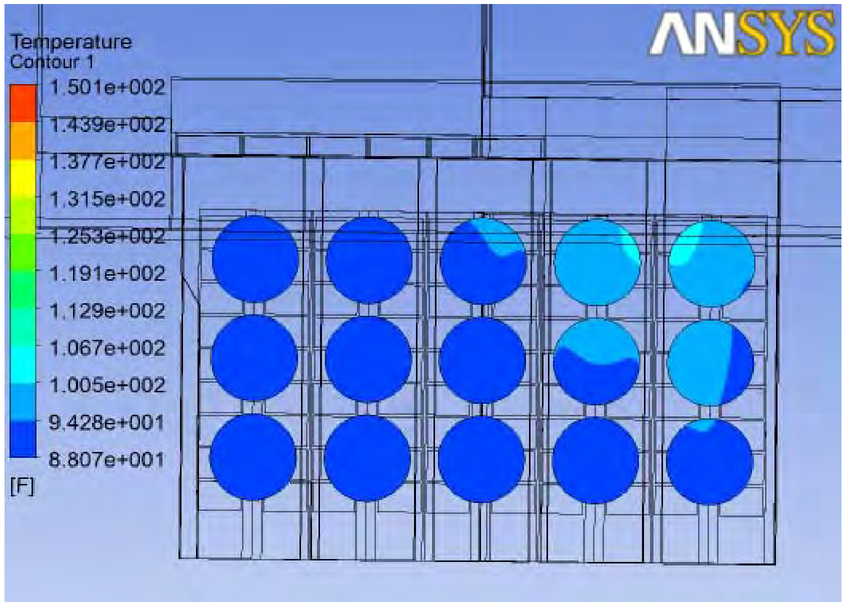


Figure D-42: Fan temperature for case 9

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	92.8	93.2	94.0	97.4	97.3
	92.6	92.8	93.0	94.4	95.1
	92.6	92.7	92.9	93.2	93.8
Average fan temperature:				93.9	

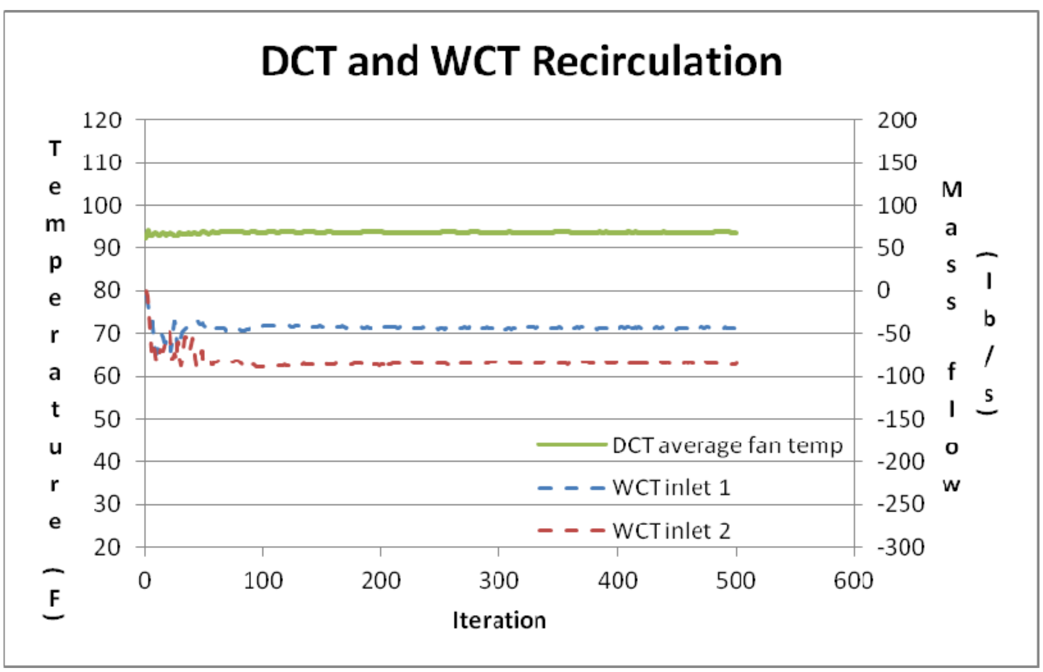


Figure D-43: DCT and WCT recirculation with iteration for case 9

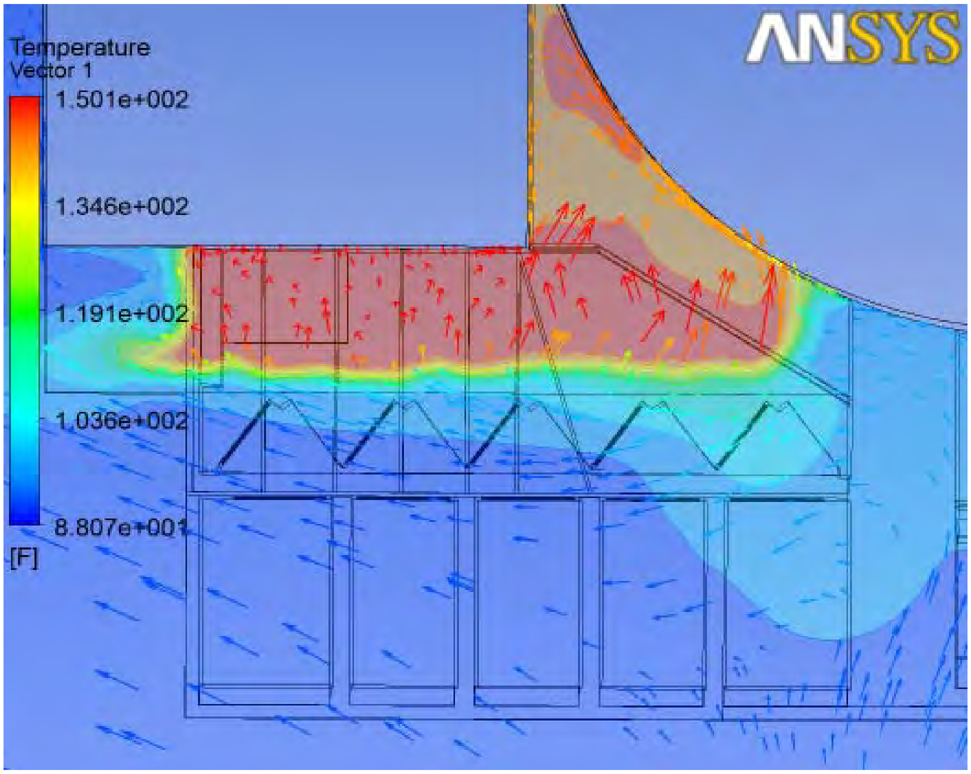


Figure D-44: Velocity vector and temperature contour above the deflector wall

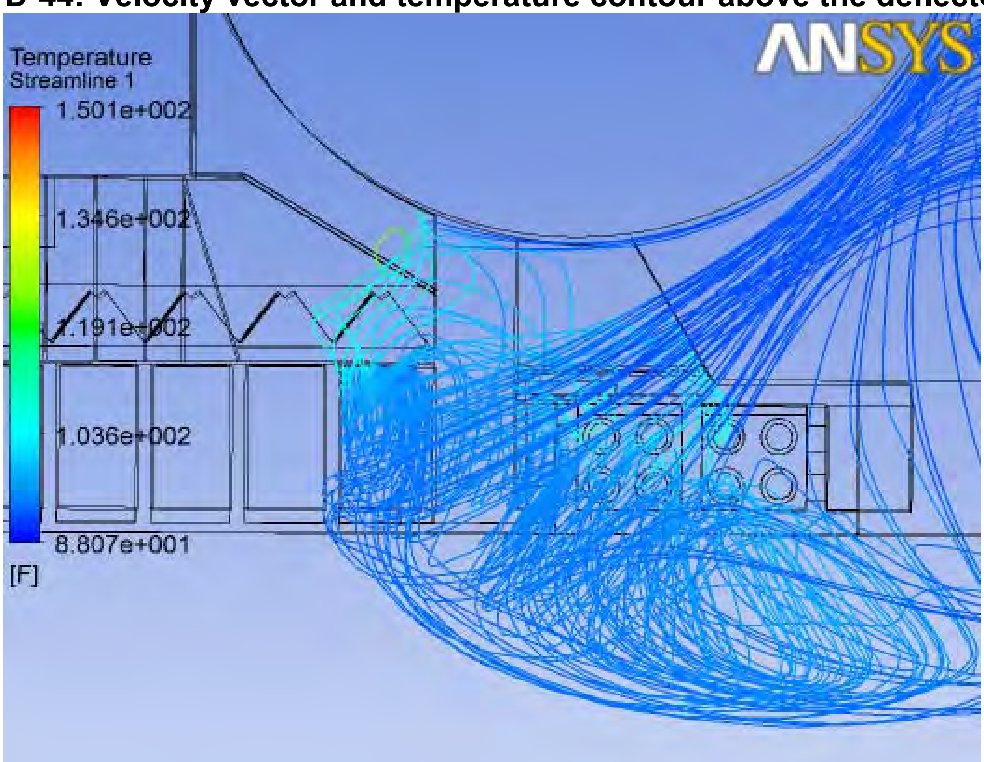


Figure D-45: Streamline at cell 5 for case 9

D-10: Train A Case 10: South wind with 10mph wind and 96F Ambient

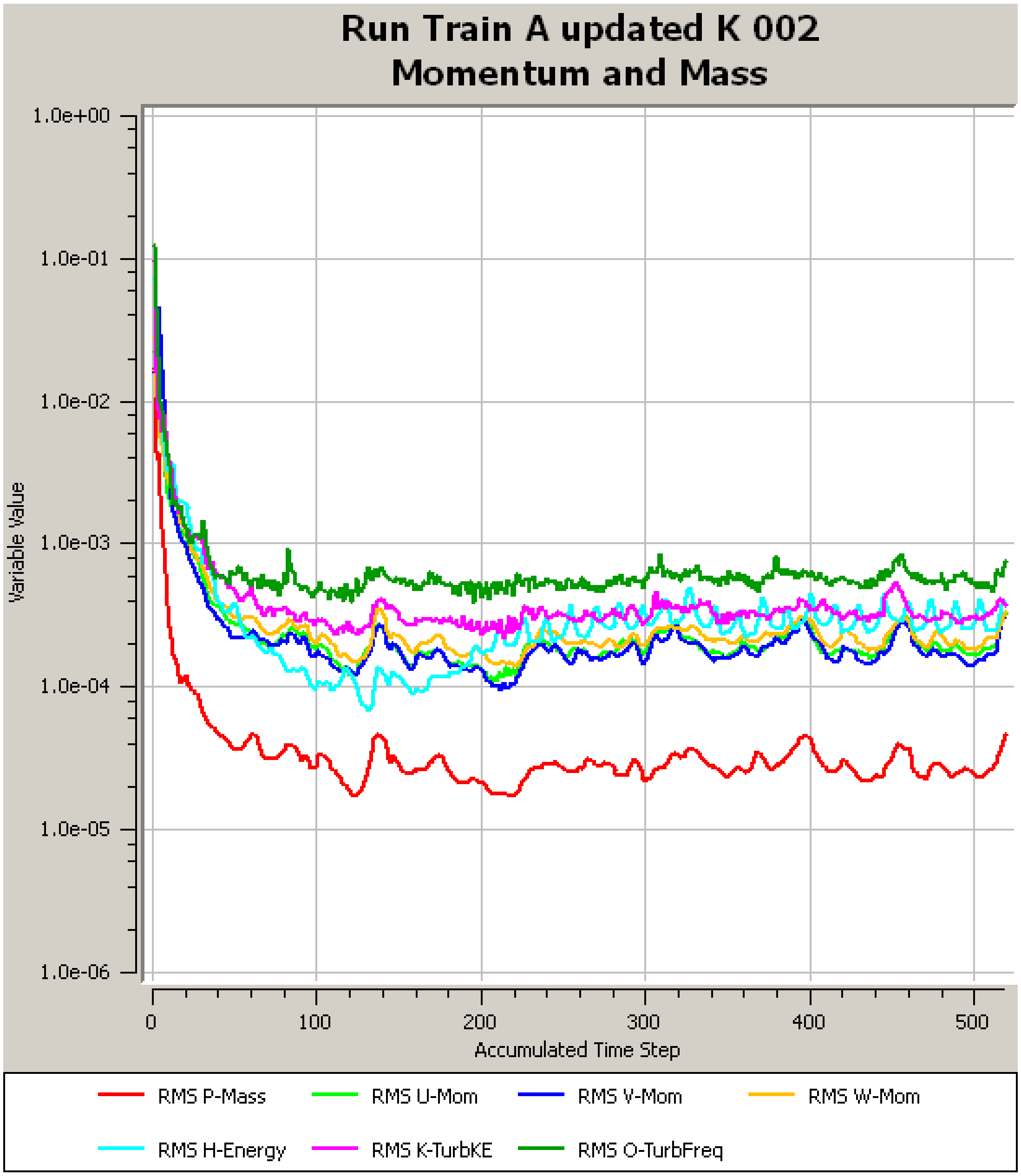


Figure D-46: Residual plot for case 10

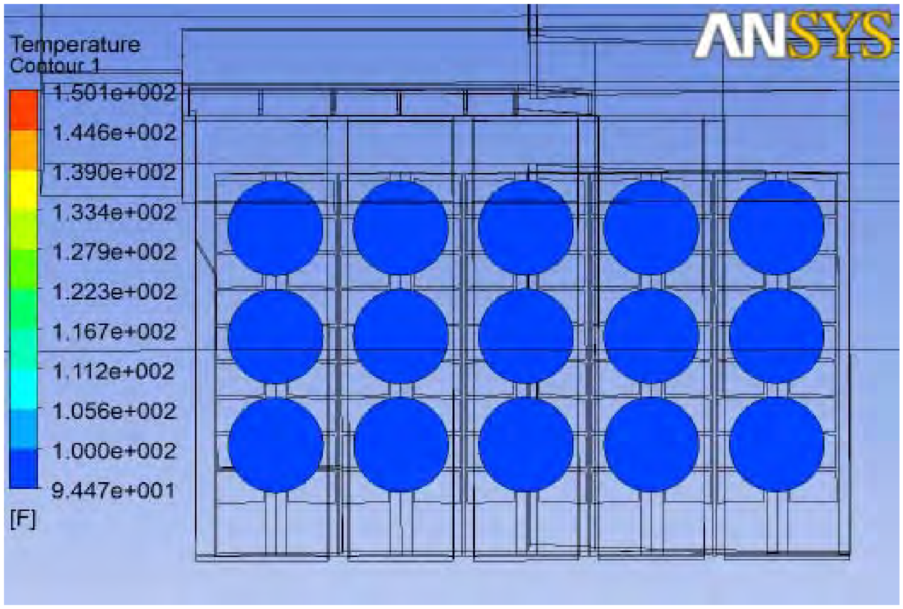


Figure D-47: Fan temperature for case 10

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	96.8	97.5	97.8	98.2	98.5
	96.2	96.4	96.6	97.3	97.8
	96.1	96.1	96.2	96.3	96.9
Average fan temperature:			97.0		

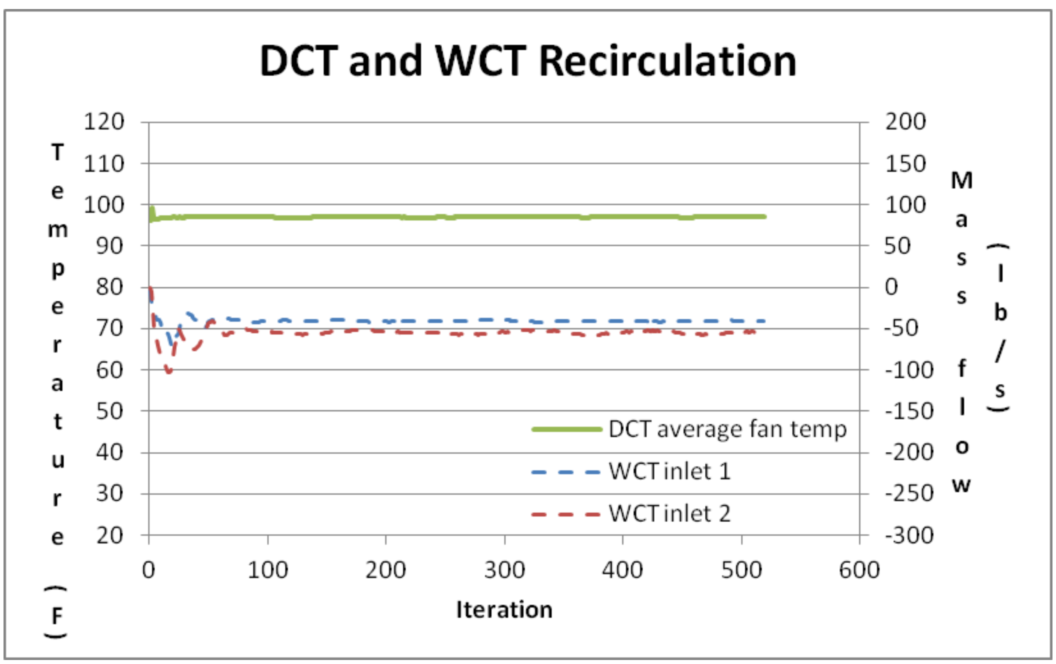


Figure D-48: DCT and WCT recirculation with iteration for case 10

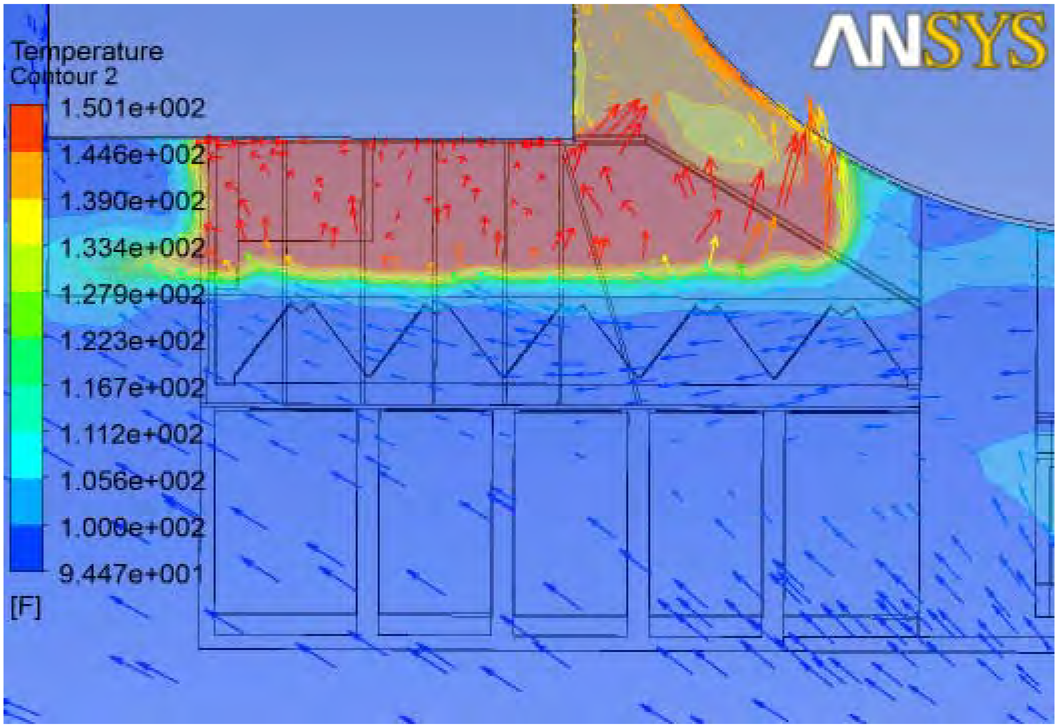


Figure D-49: Velocity vector and temperature contour above the deflector wall

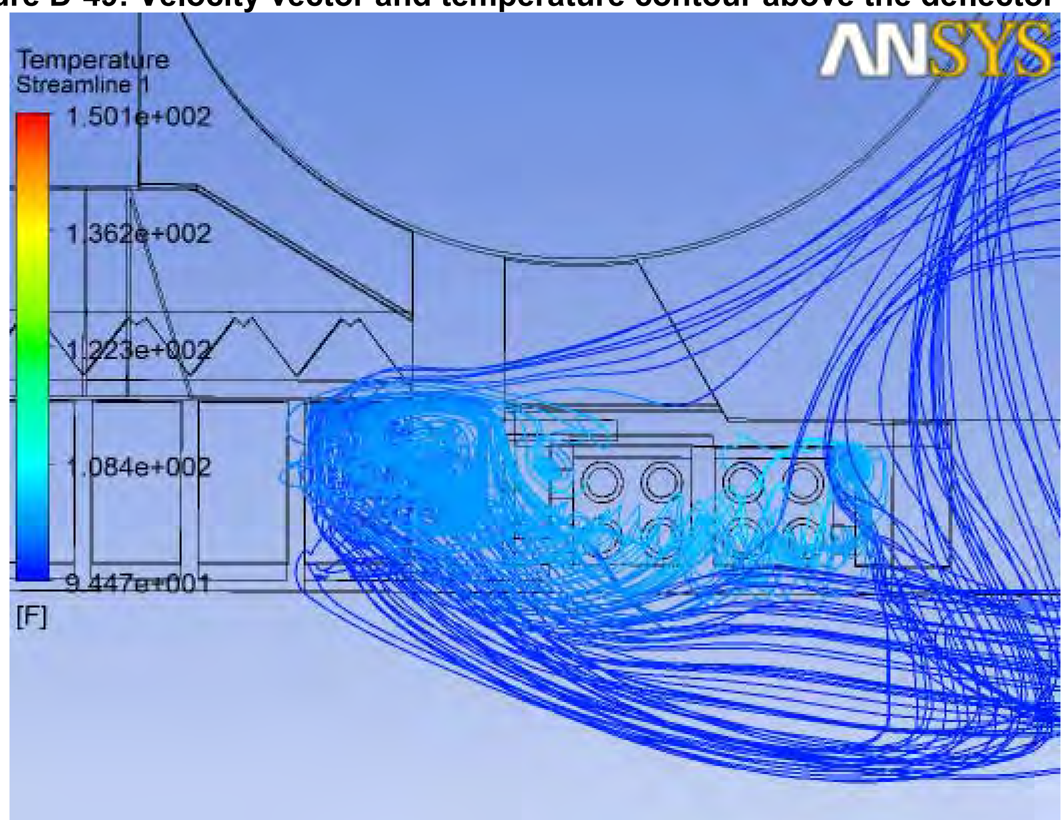


Figure D-50: Streamline at cell 5 for case 10

D-11: Train A Case 11: Northeast wind with 51mph wind and 76F Ambient

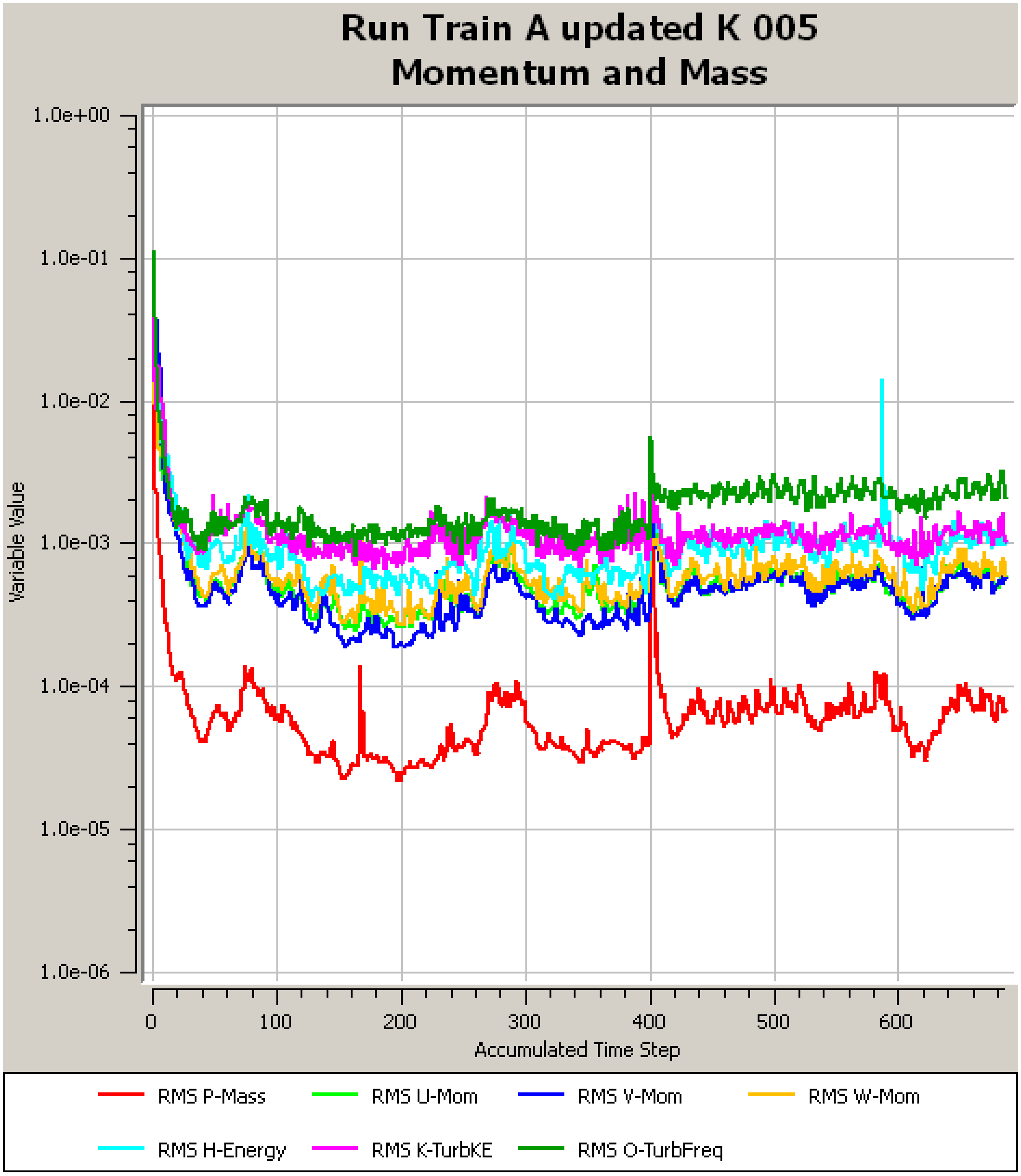


Figure D-51: Residual plot for case 11

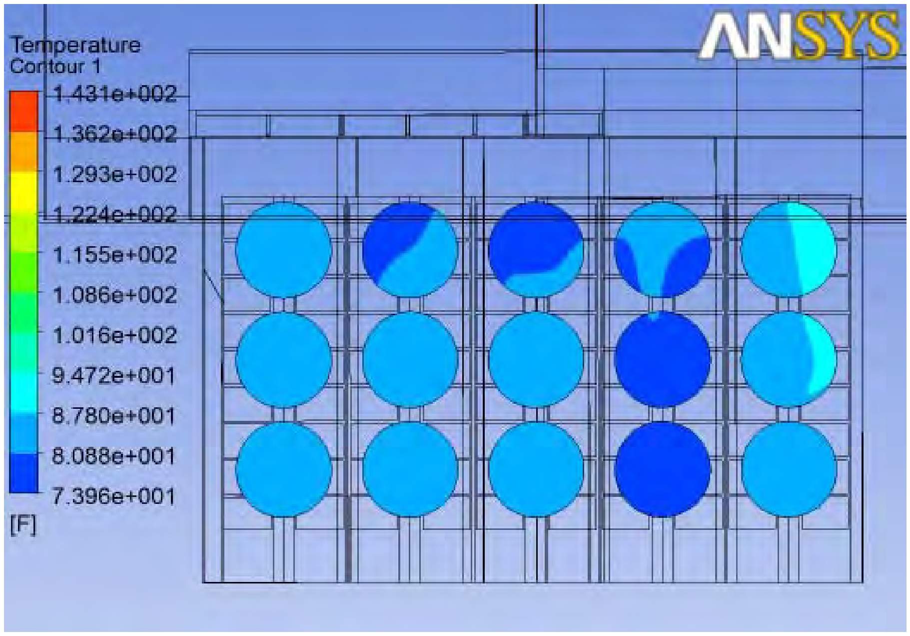


Figure D-52: Fan temperature for case 11

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	82.3	81.1	80.6	81.5	87.0
	82.6	81.4	80.5	80.1	85.0
	82.5	81.5	80.7	79.4	82.8
Average fan temperature:				81.9	

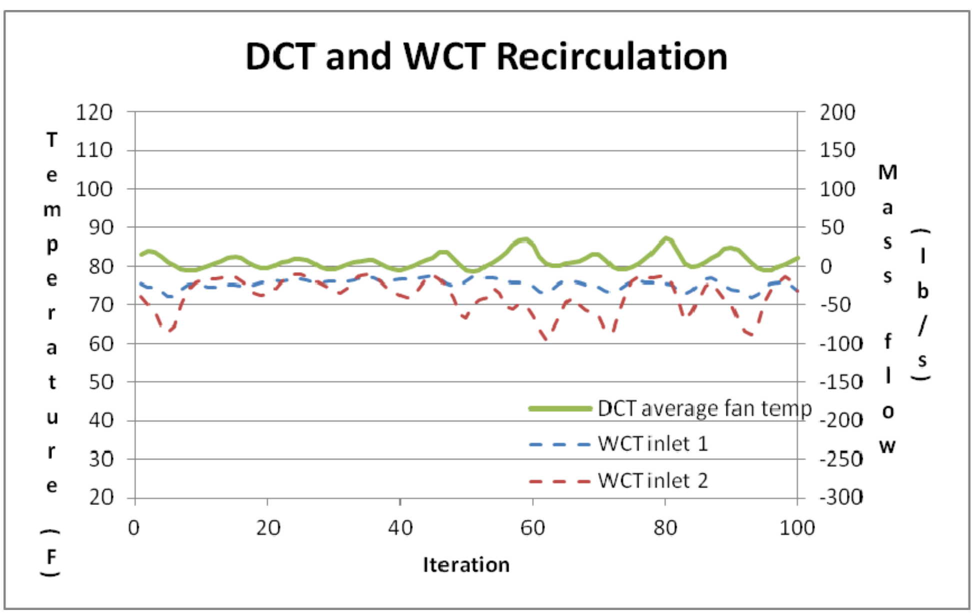


Figure D-53: DCT and WCT recirculation with iteration for case 11

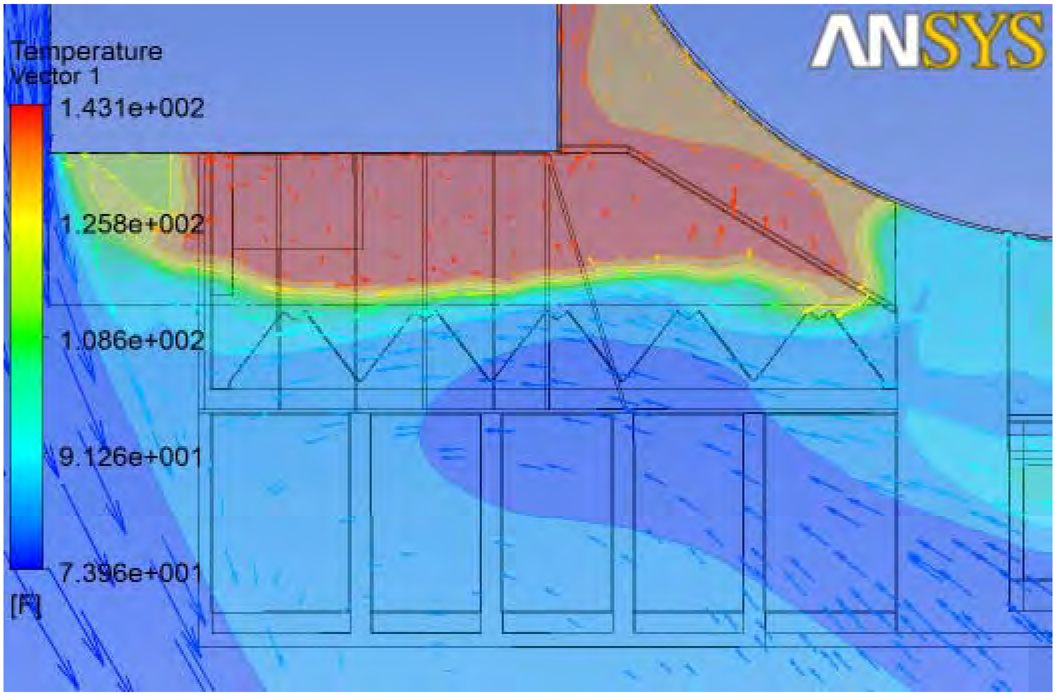


Figure D-54: Velocity vector and temperature contour above the deflector wall

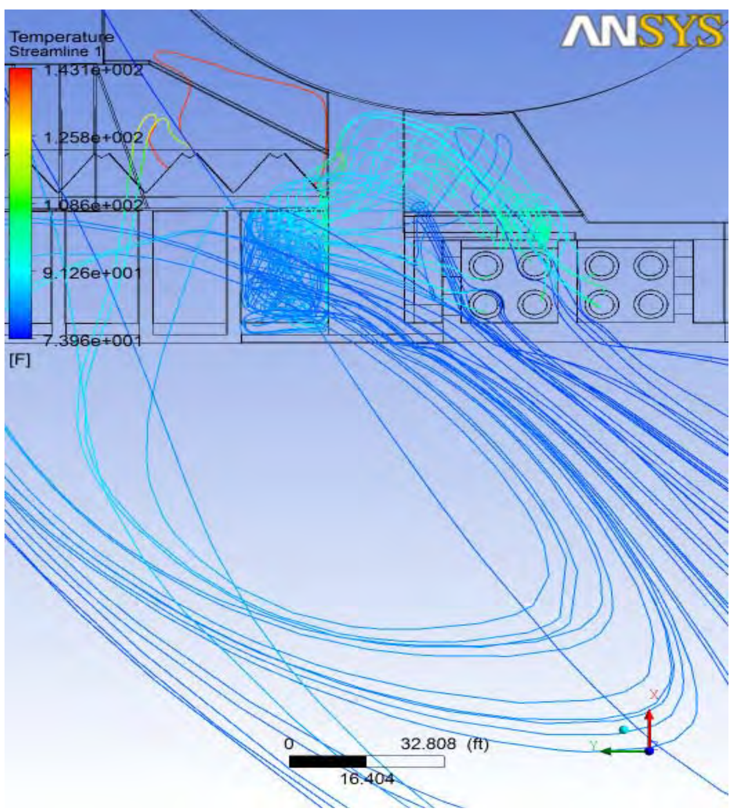


Figure D-55: Streamline at cell 5 for case 11

D-12: Train A Case 12: Northeast wind with 40mph wind and 81F Ambient

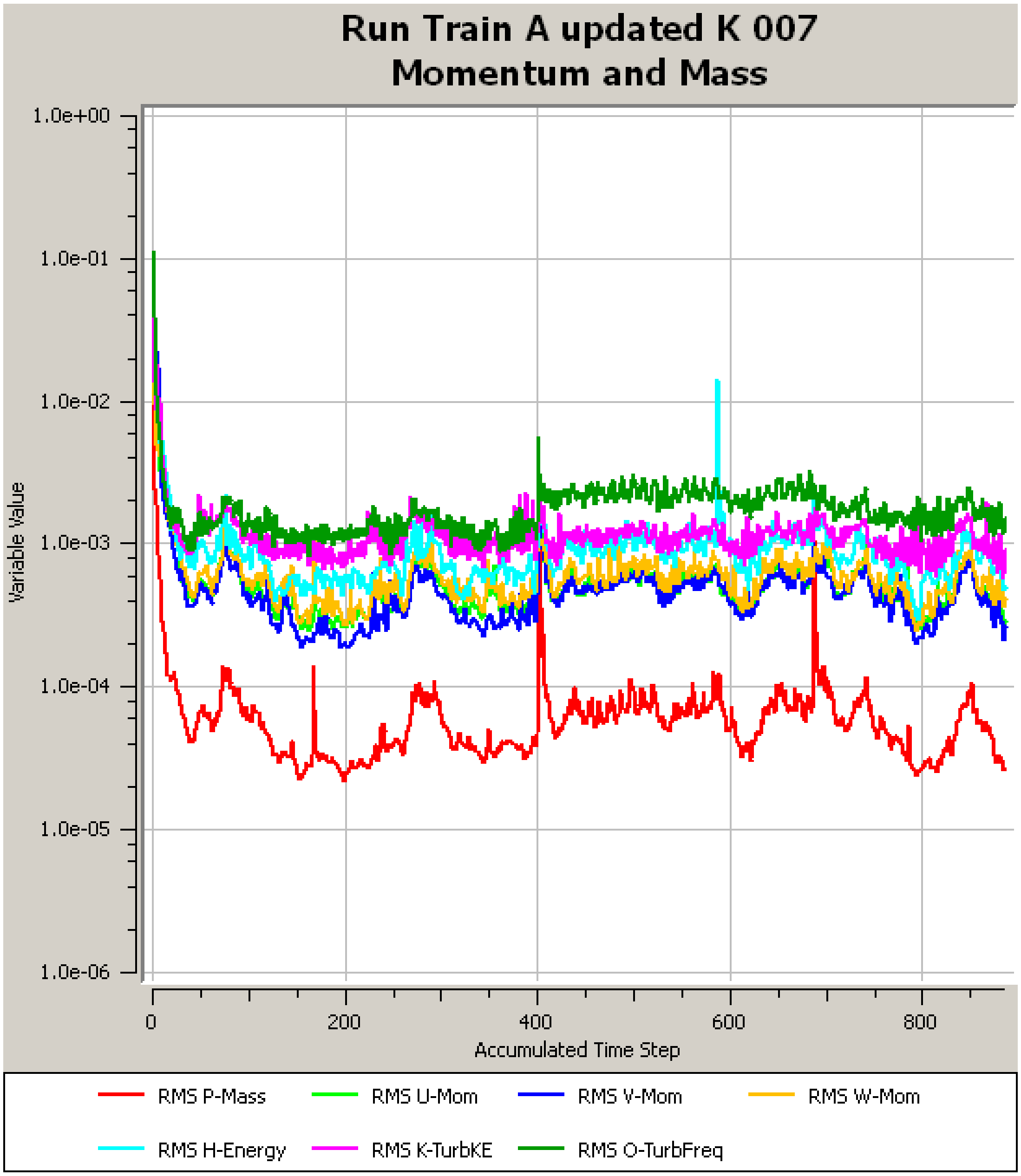


Figure D-56: Residual plot for case 12

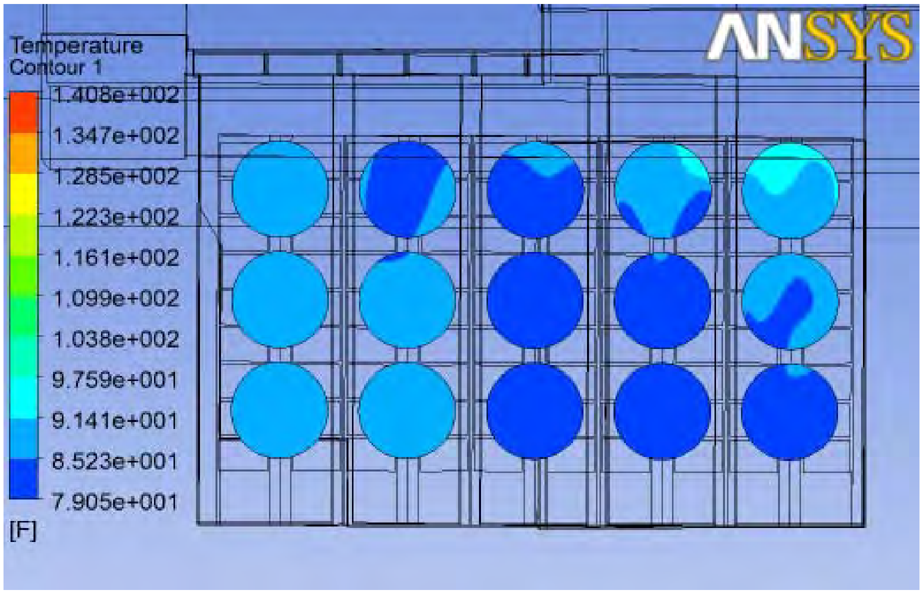


Figure D-57: Fan temperature for case 12

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	85.6	84.1	83.8	85.4	91.9
	85.8	84.3	83.4	83.7	89.8
	85.5	84.5	83.3	83.3	87.9
Average fan temperature:				85.5	

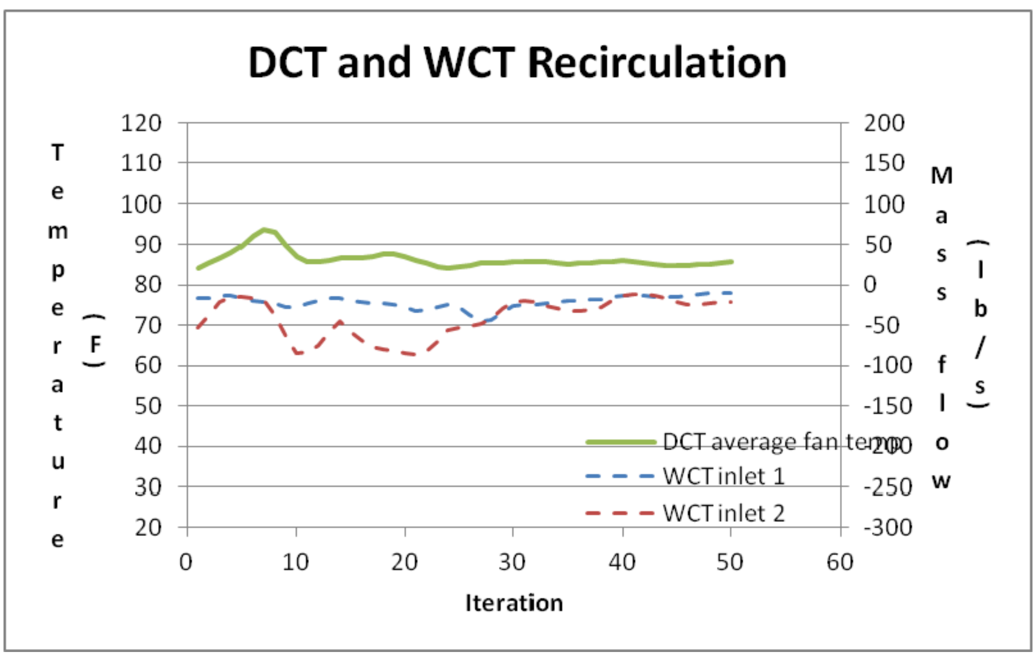


Figure D-58: DCT and WCT recirculation with iteration for case 12

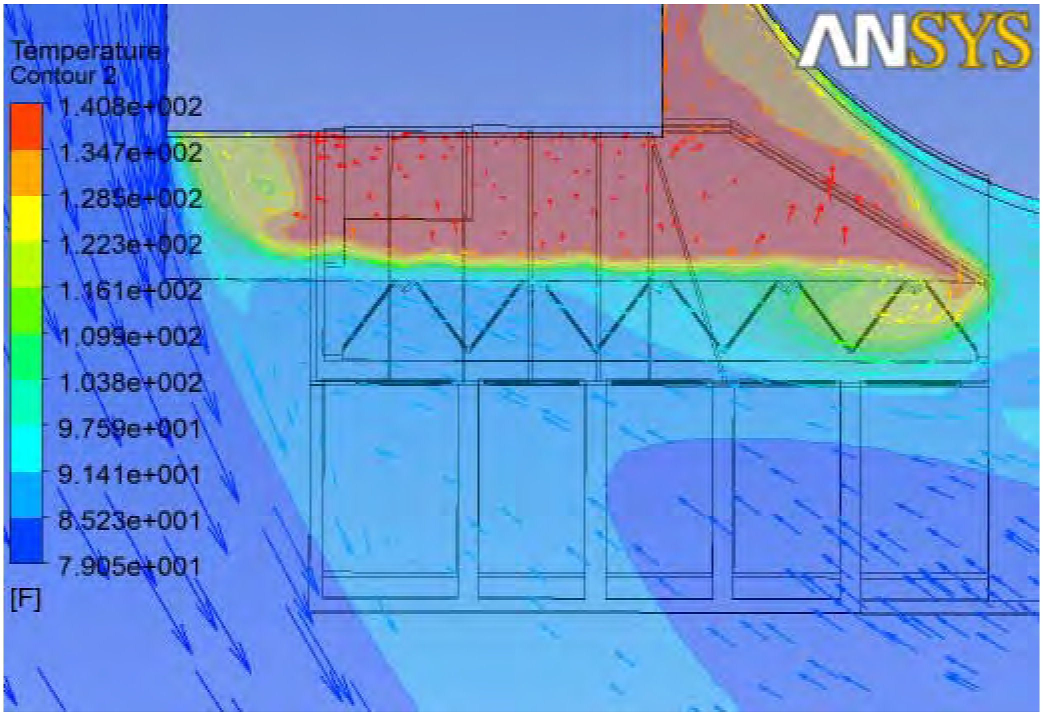


Figure D-59: Velocity vector and temperature contour above the deflector wall

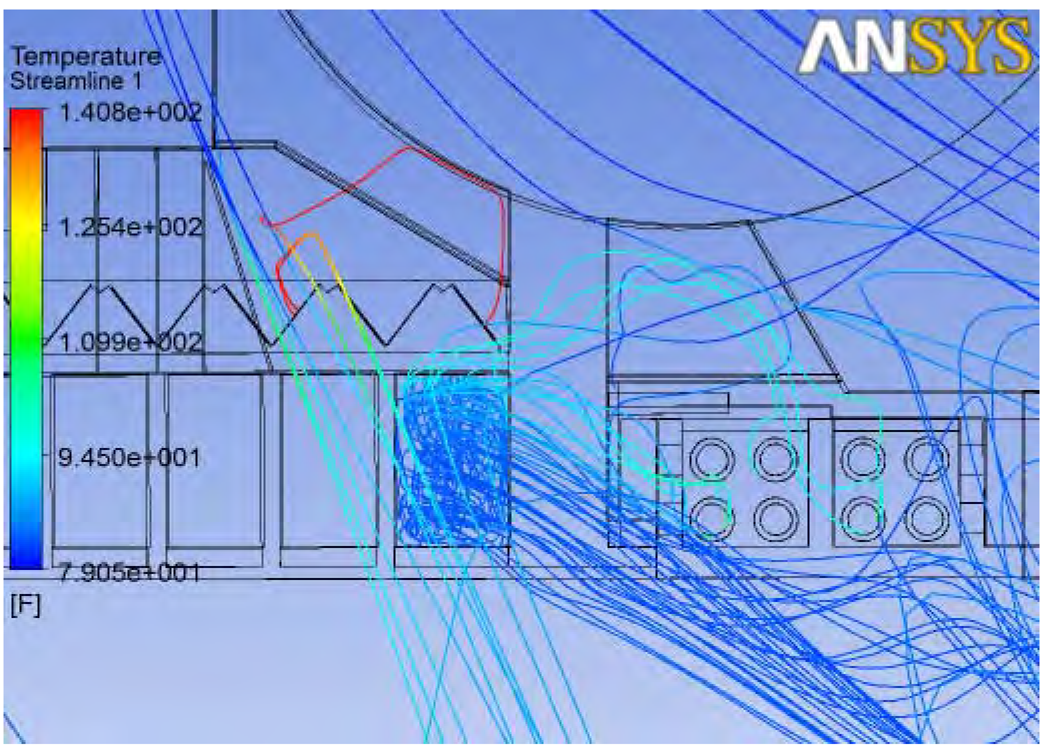


Figure D-60: Streamline at cell 5 for case 12

D-14: Train A Case 14: Northeast wind with 26mph wind and 91F Ambient

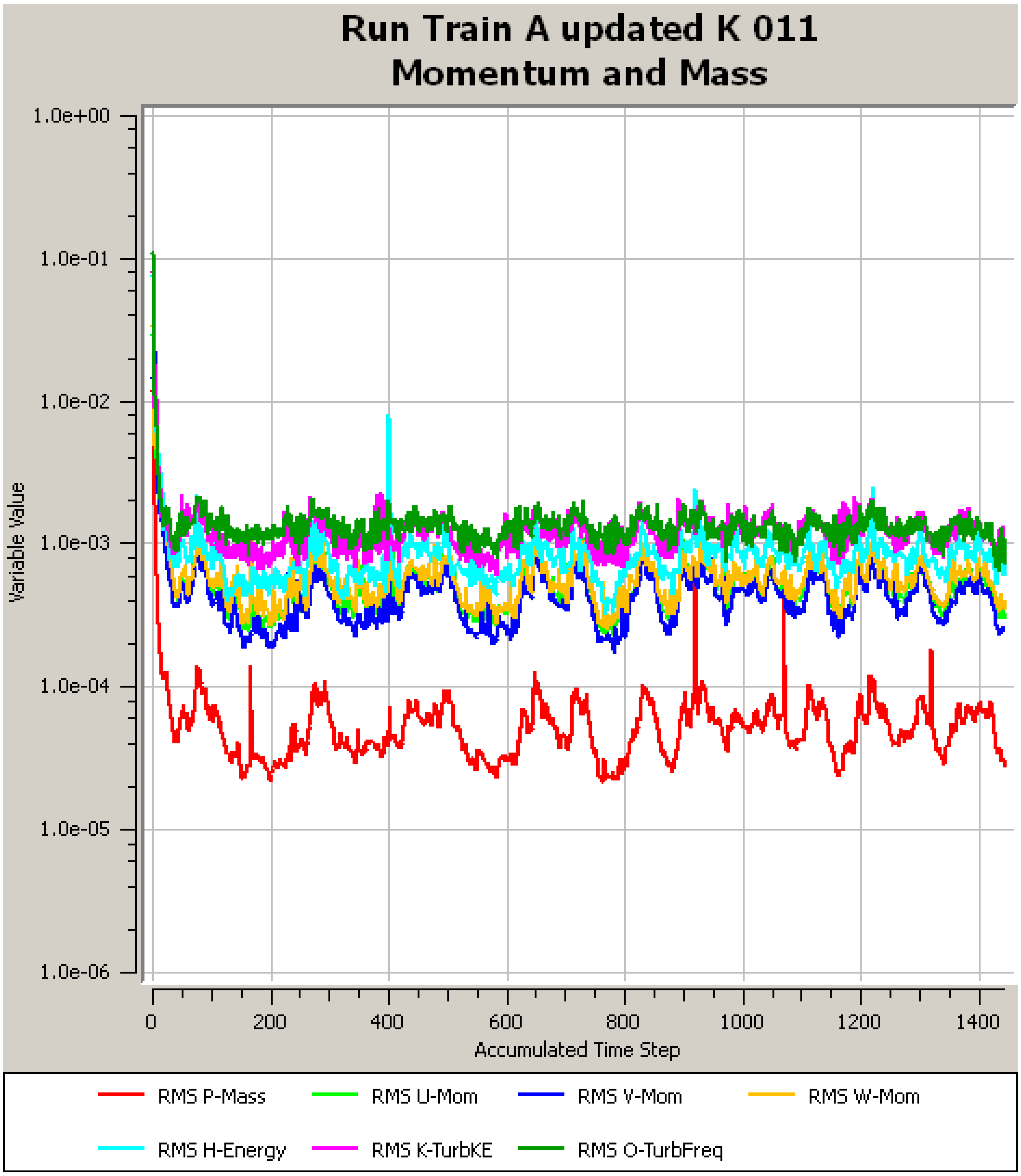


Figure D-61: Residual plot for case 14

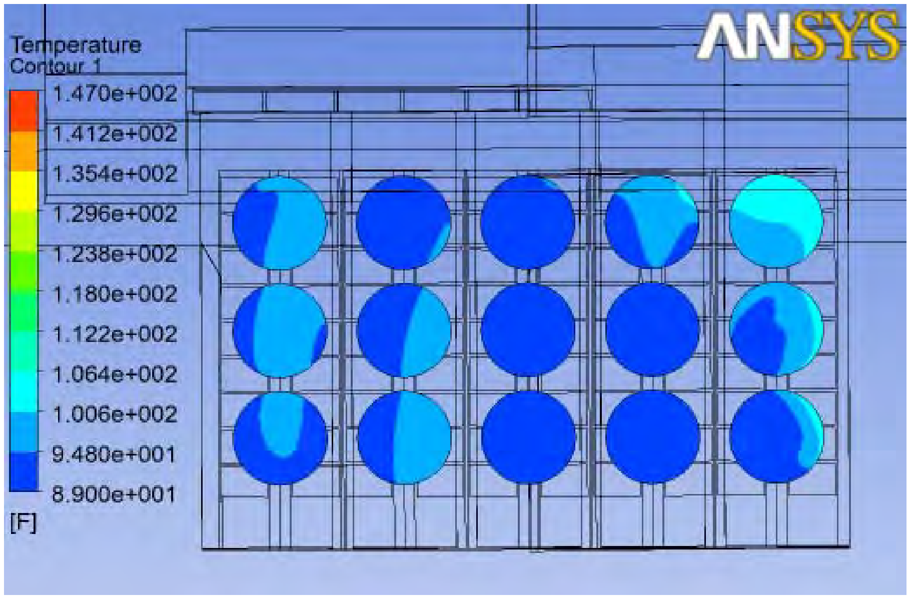


Figure D-62: Fan temperature for case 14

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	97.1	95.0	94.6	95.7	99.9
	97.6	96.7	95.0	94.3	99.0
	97.4	97.4	95.6	94.3	97.9
Average fan temperature:				96.5	

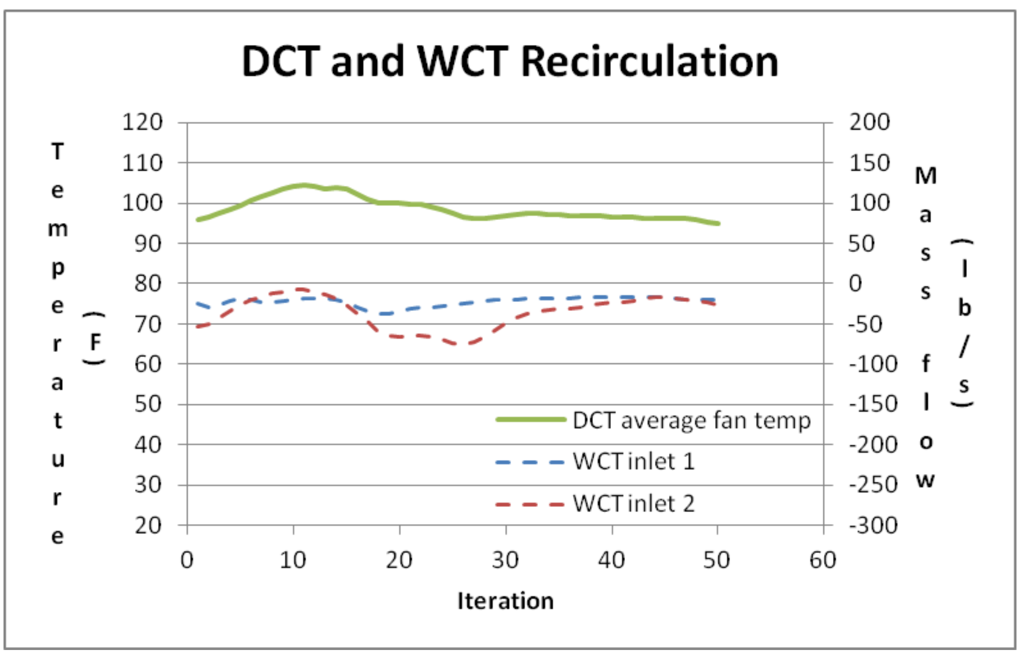


Figure D-63: DCT and WCT recirculation with iteration for case 14

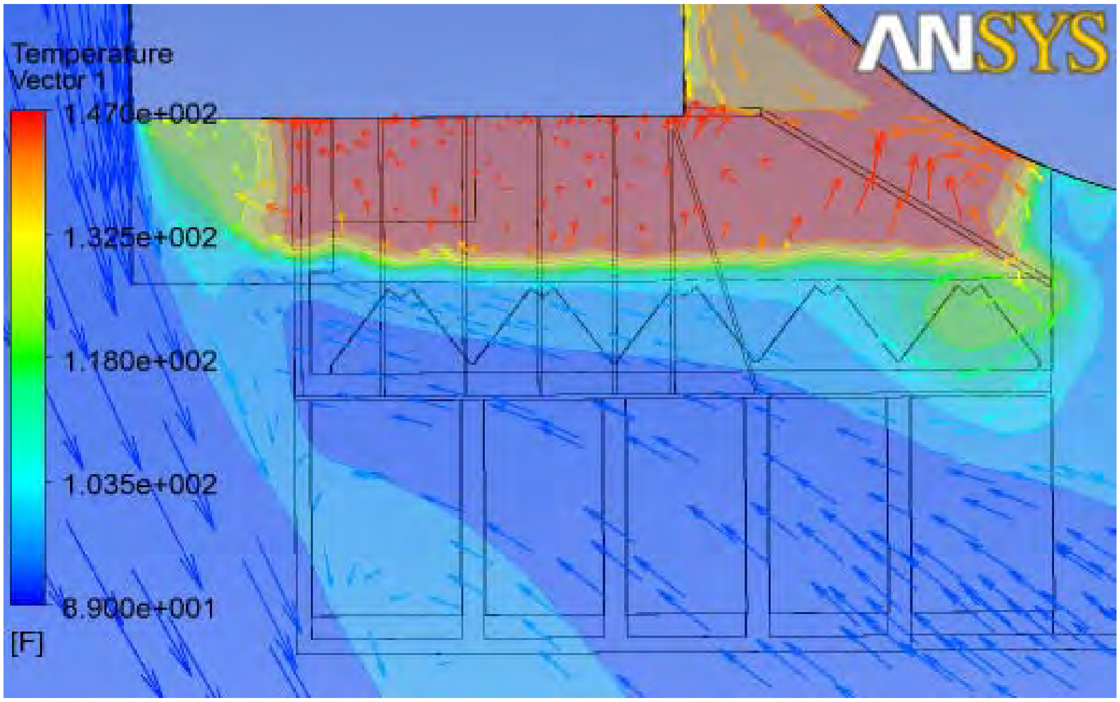


Figure D-64: Velocity vector and temperature contour above the deflector wall

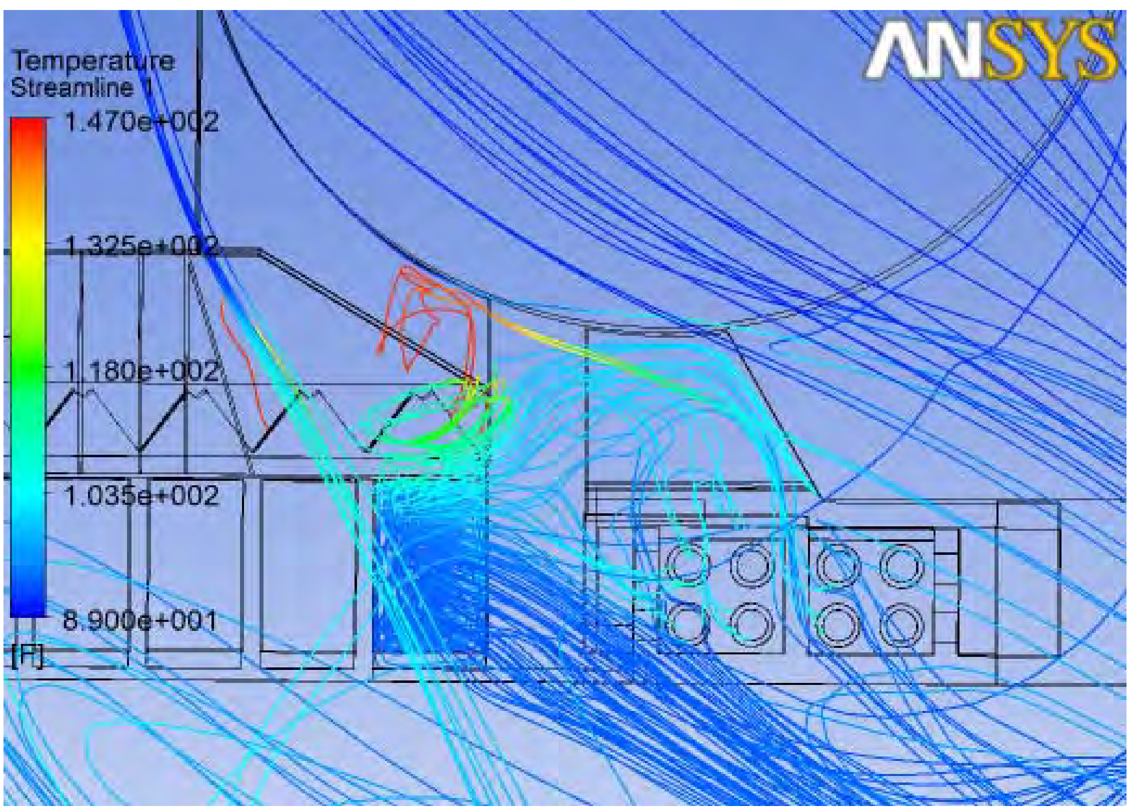


Figure D-65: Streamline at cell 1 for case 14

D-15: Train A Case 15: Northeast wind with 11mph wind and 97F Ambient

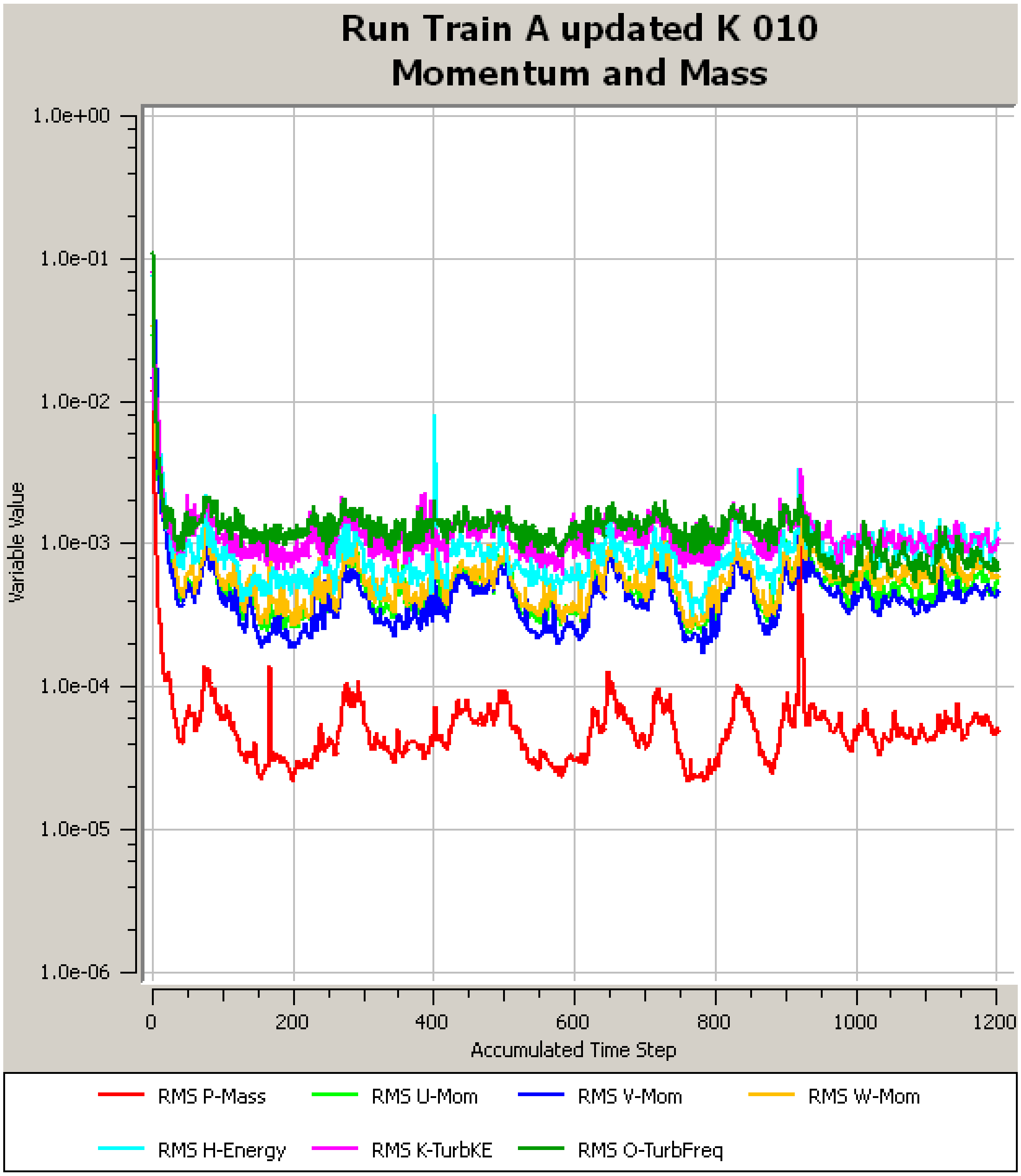


Figure D-66: Residual plot for case 15

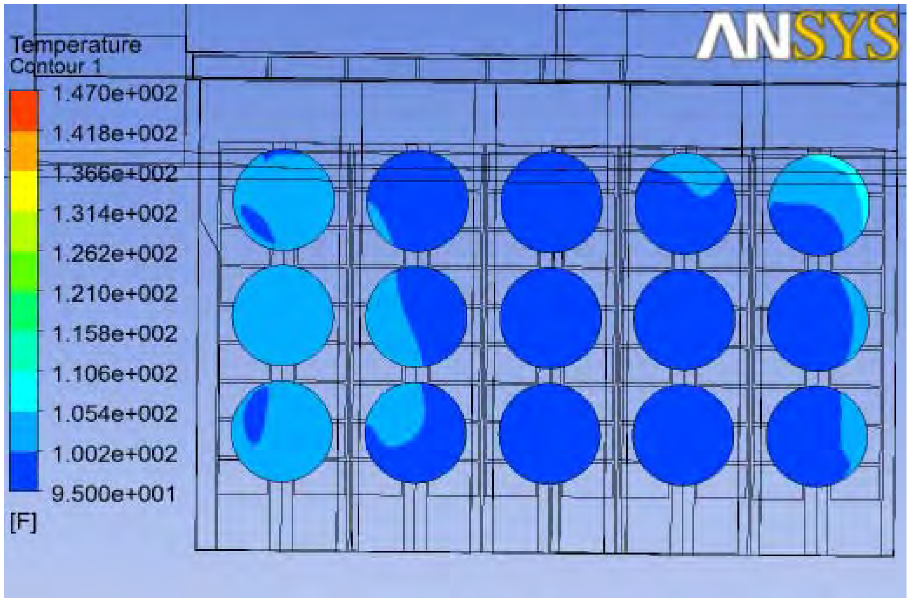


Figure D-67: Fan temperature for case 15

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	102.5	100.9	100.2	100.5	100.0
	104.0	101.1	100.5	100.0	102.1
	102.6	100.7	100.6	100.0	100.1
Average fan temperature:			101.1		

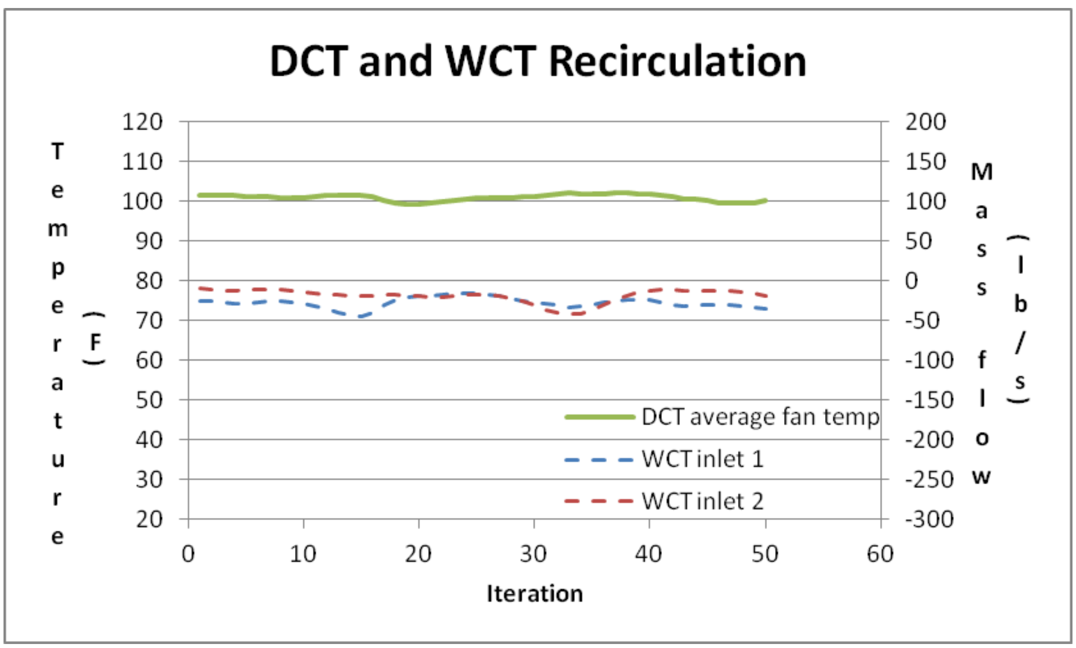


Figure D-68: DCT and WCT recirculation with iteration for case 15

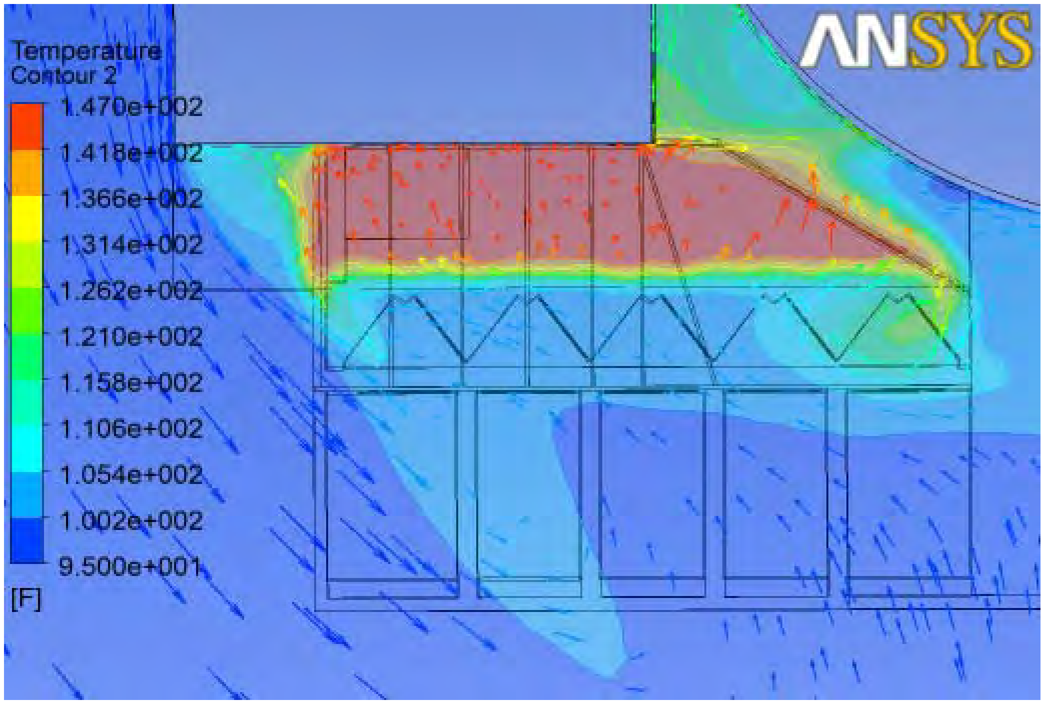


Figure D-69: Velocity vector and temperature contour above the deflector wall

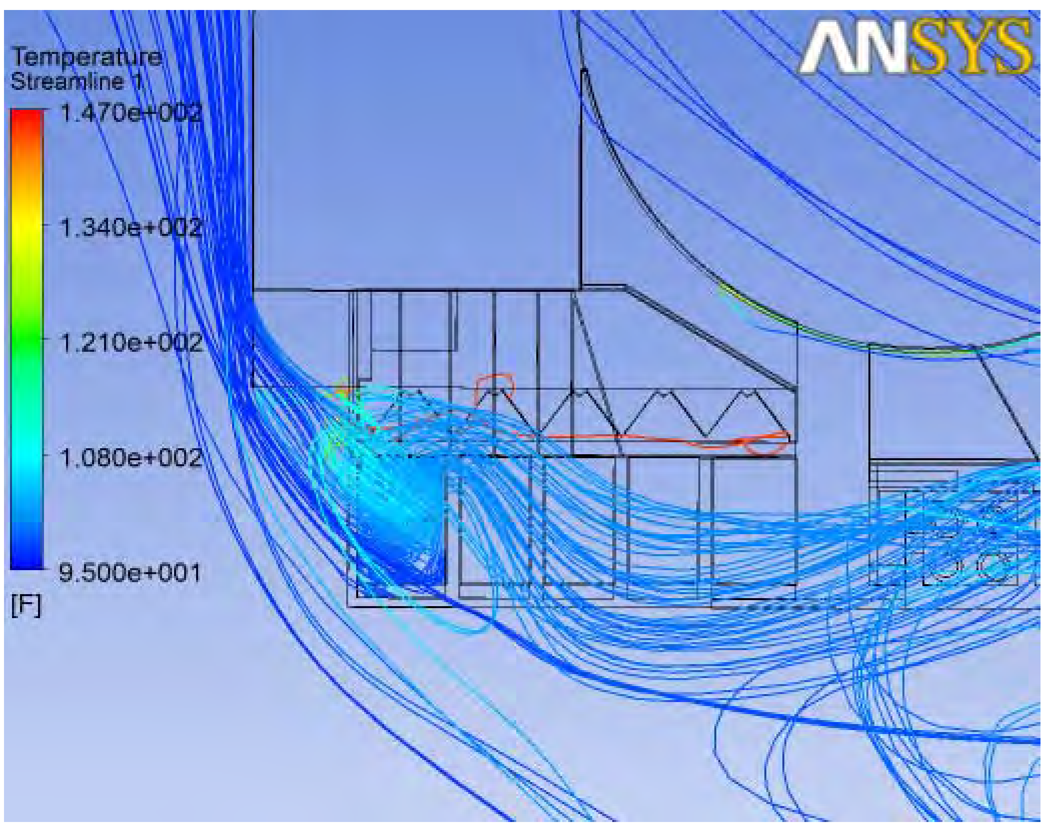


Figure D-70: Streamline at cell 1 for case 15

D-16: Train A Case 16: Southeast wind with 22mph wind and 89F Ambient

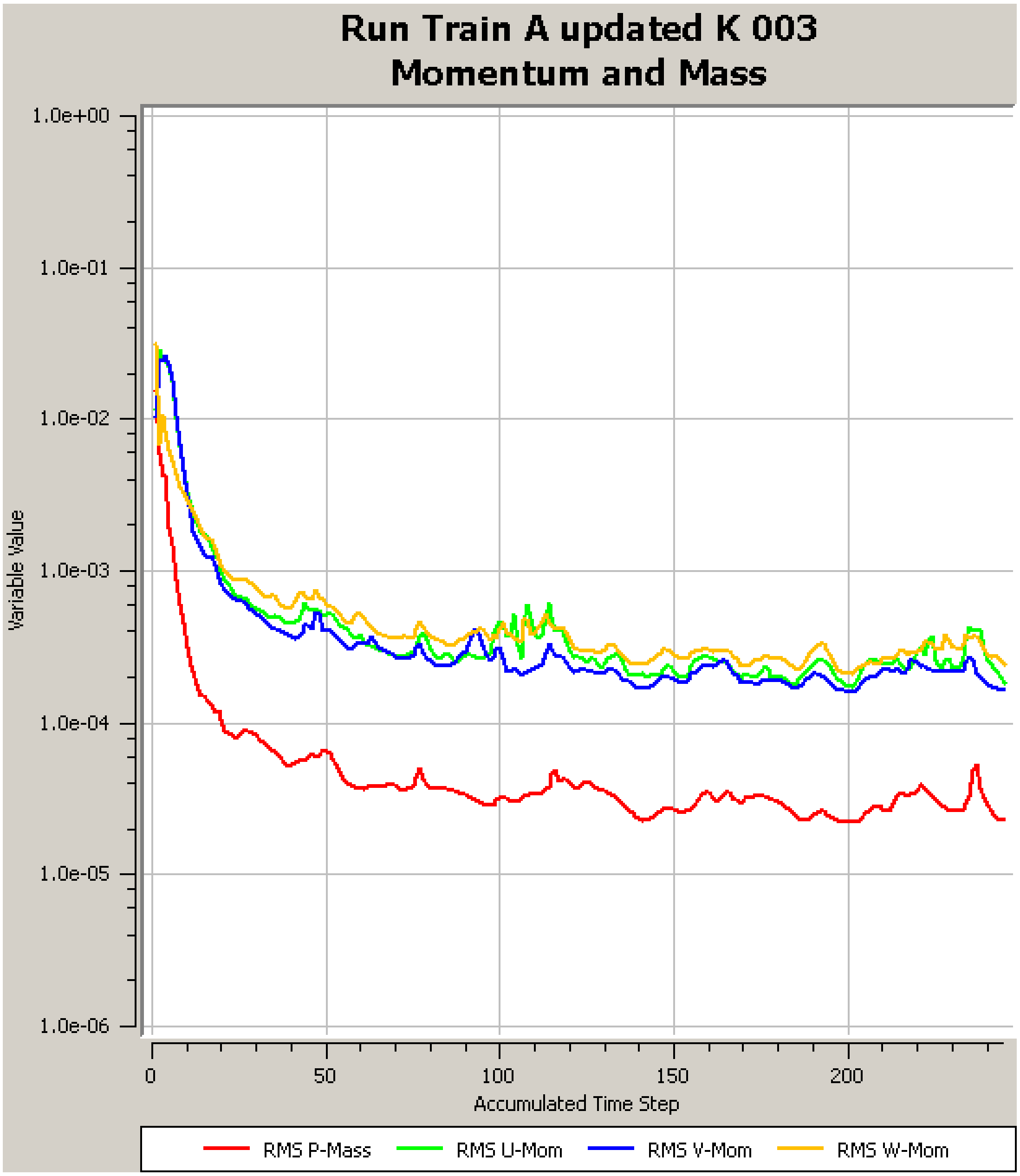


Figure D-71: Residual plot for case 16

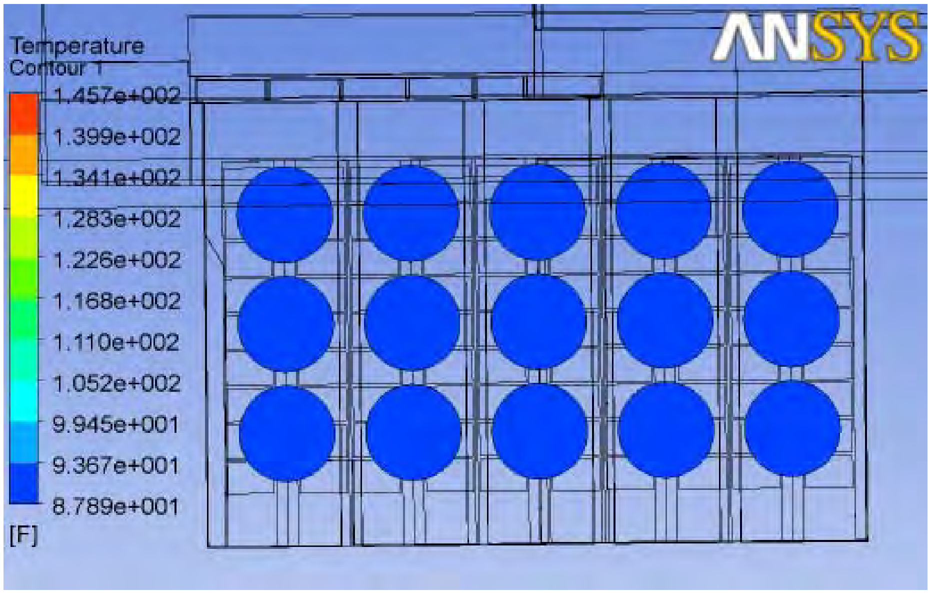


Figure D-72: Fan temperature for case 16

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	90.5	90.9	89.4	89.4	90.6
	90.0	89.9	89.2	89.7	90.4
	89.5	89.2	89.2	90.1	89.8
Average fan temperature:				89.9	

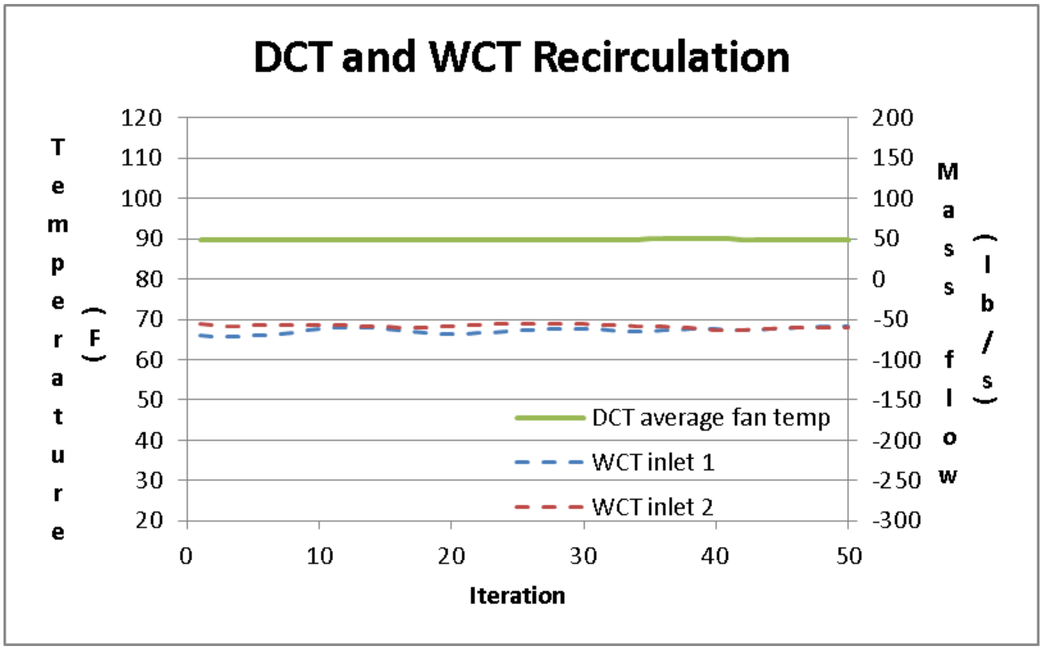


Figure D-73: DCT and WCT recirculation with iteration for case 16

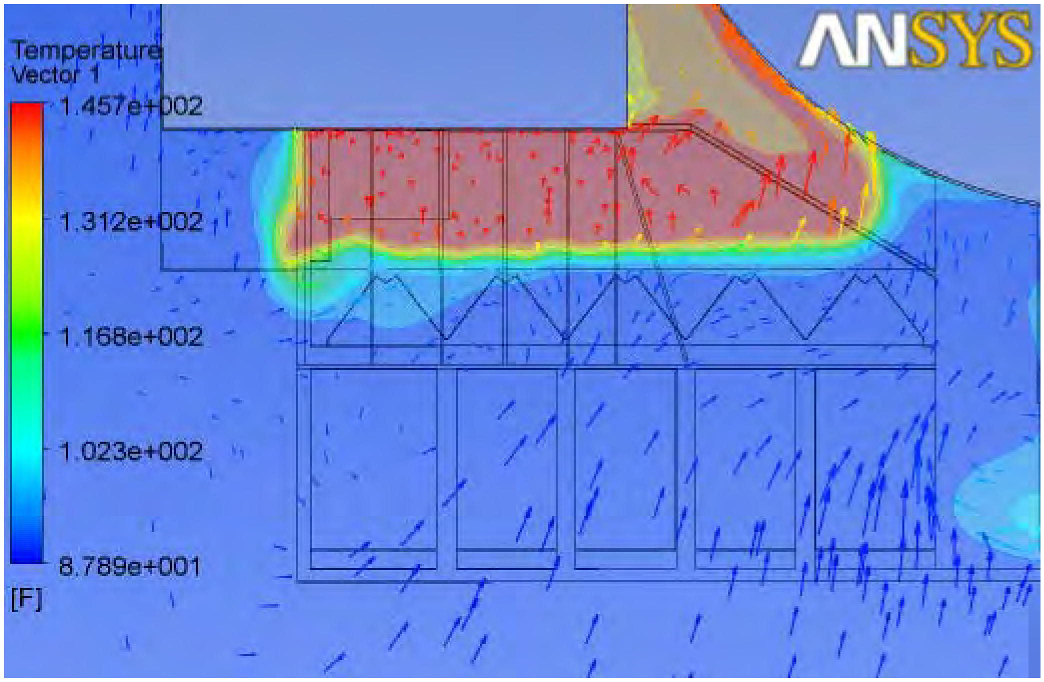


Figure D-74: Velocity vector and temperature contour above the deflector wall

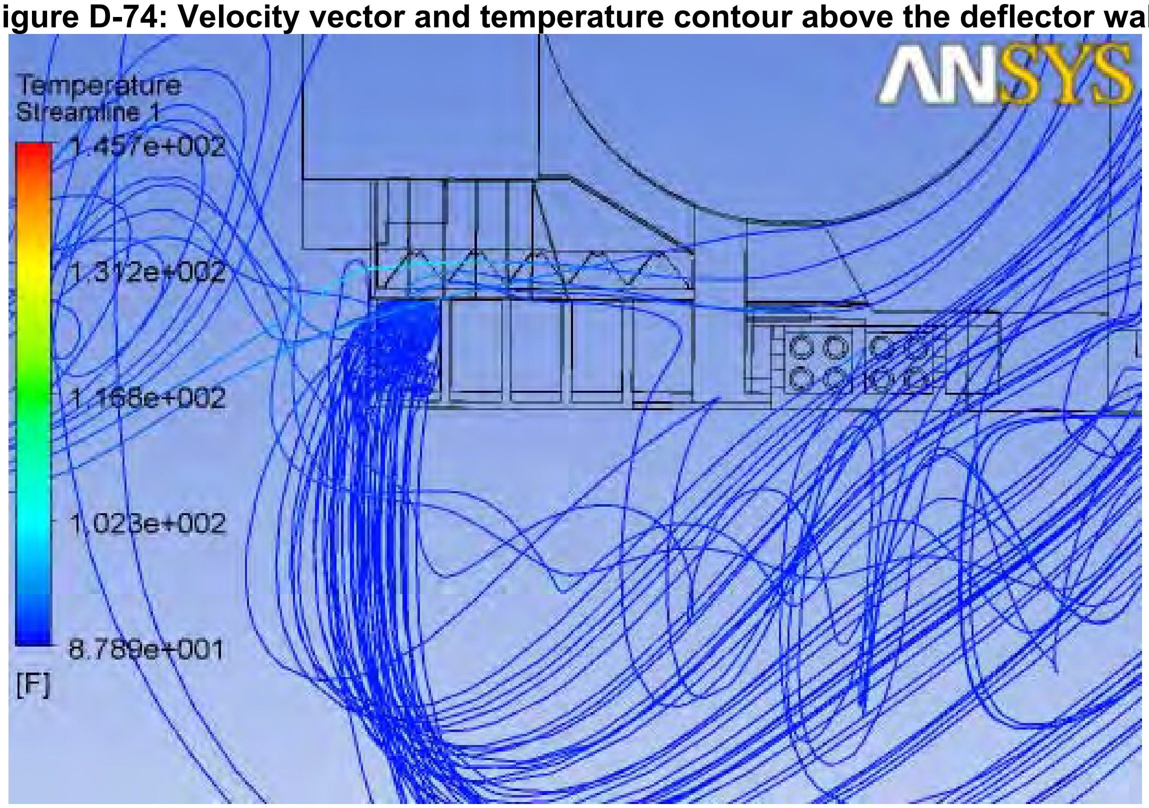


Figure D-75: Streamline at cell 1 for case 16

D-17: Train A Case 17: 102F no wind case

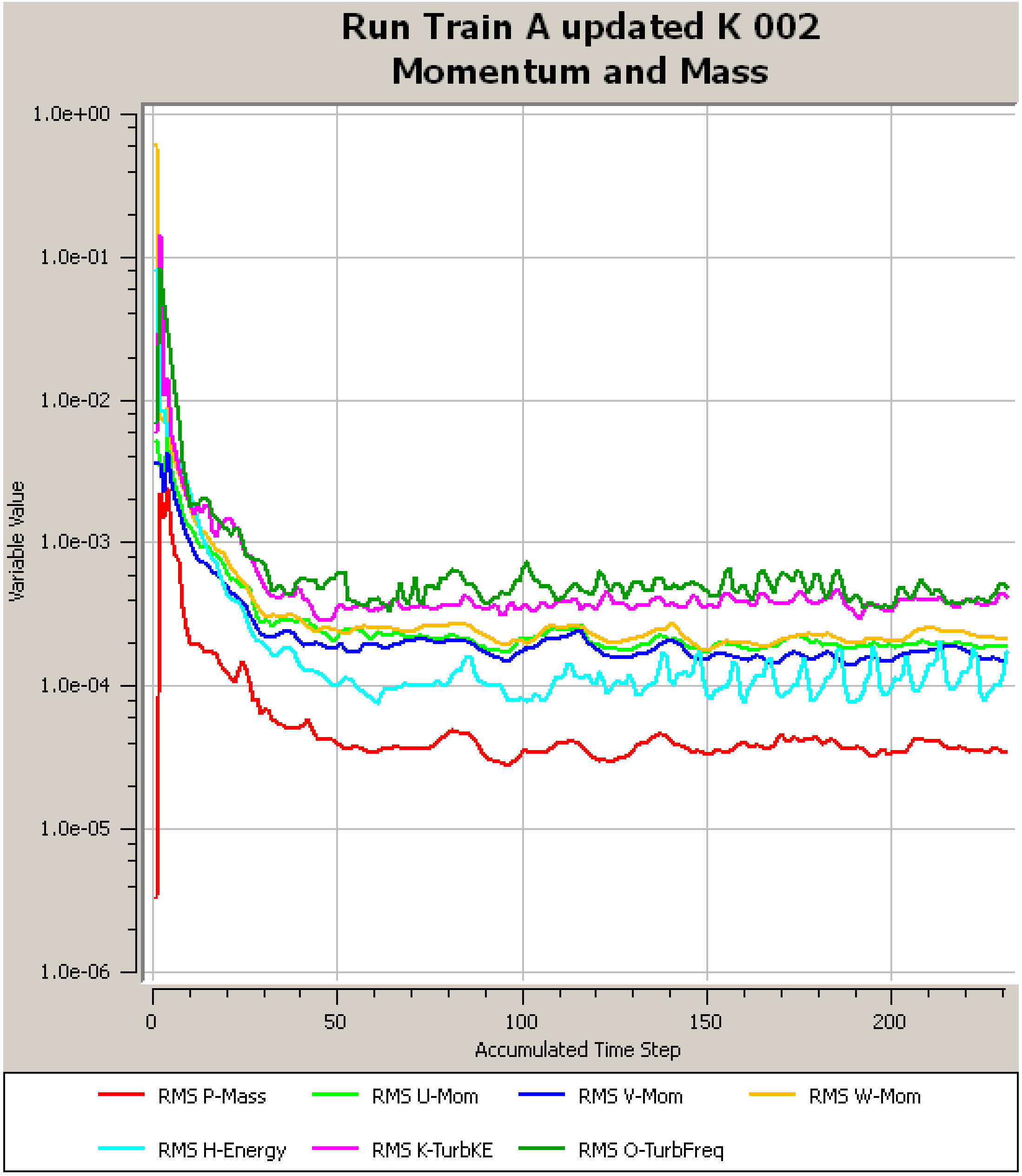


Figure D-76: Residual plot for case 17

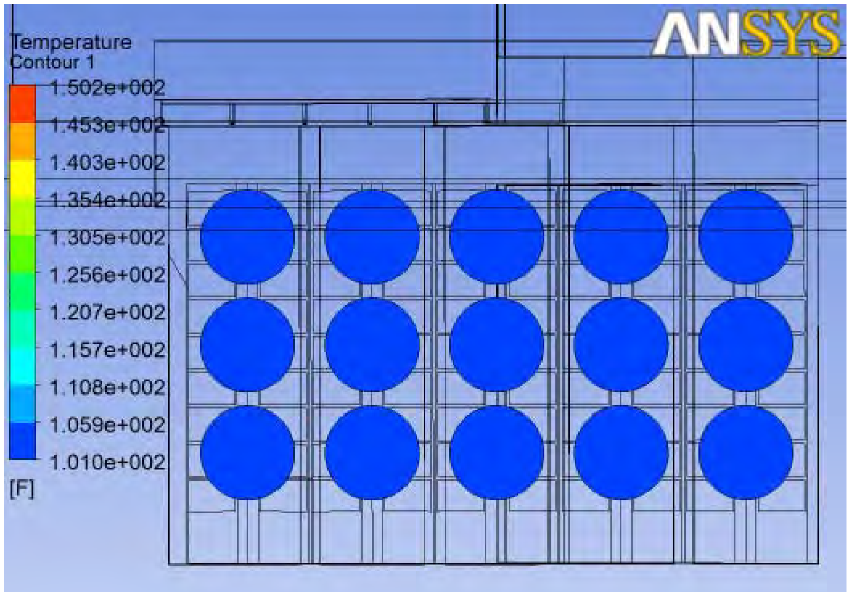


Figure D-77: Fan temperature for case 17

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	102.2	102.1	102.2	102.1	102.1
	102.0	102.0	102.0	102.0	102.0
	102.0	102.0	102.0	102.0	102.0
Average fan temperature:			102.1		

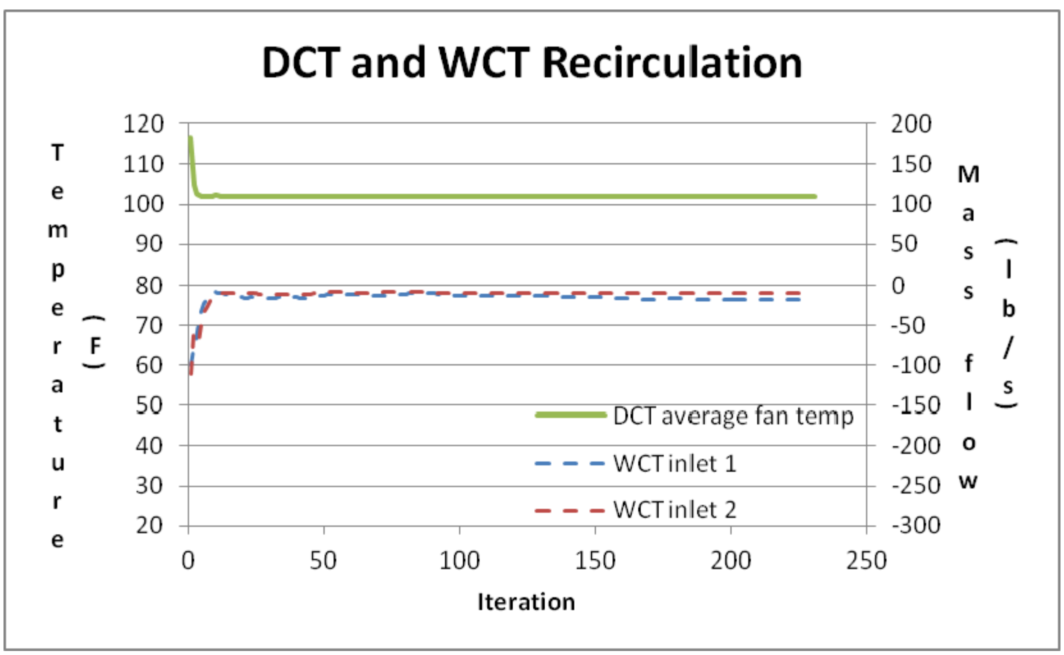


Figure D-78: DCT and WCT recirculation with iteration for case 17

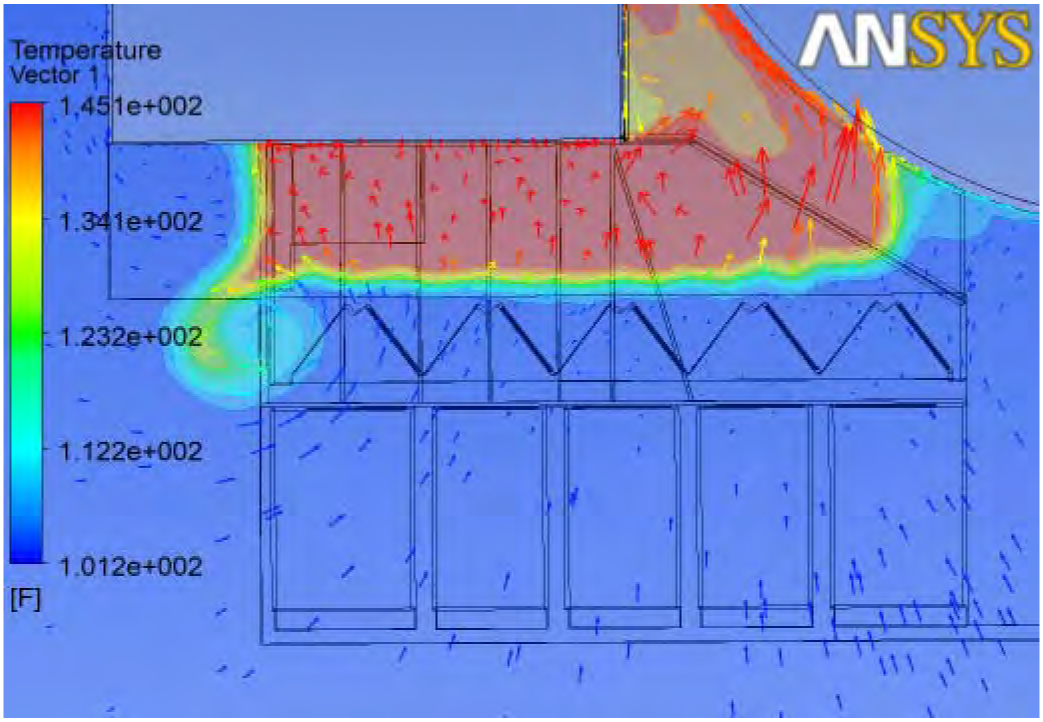


Figure D-79 Velocity vector and temperature contour above the deflector wall

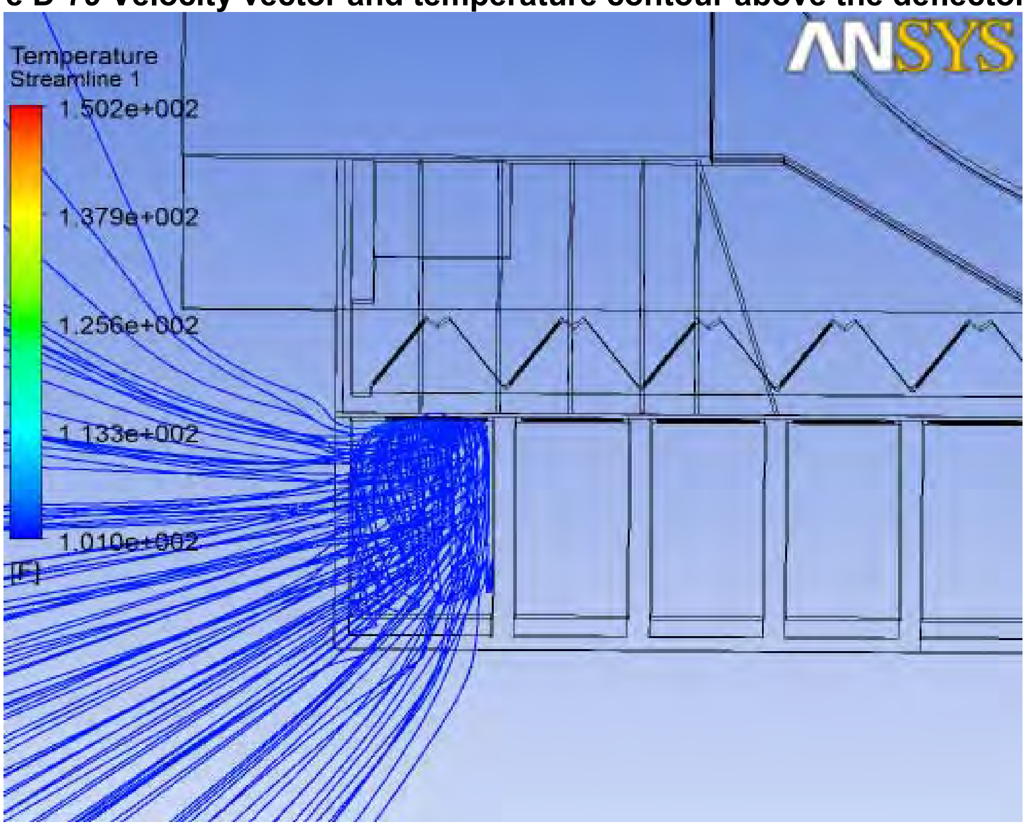


Figure D-80: Streamline at cell 1 for case 17

D-18: Train B Case 1: North wind with 51mph wind and 76F Ambient

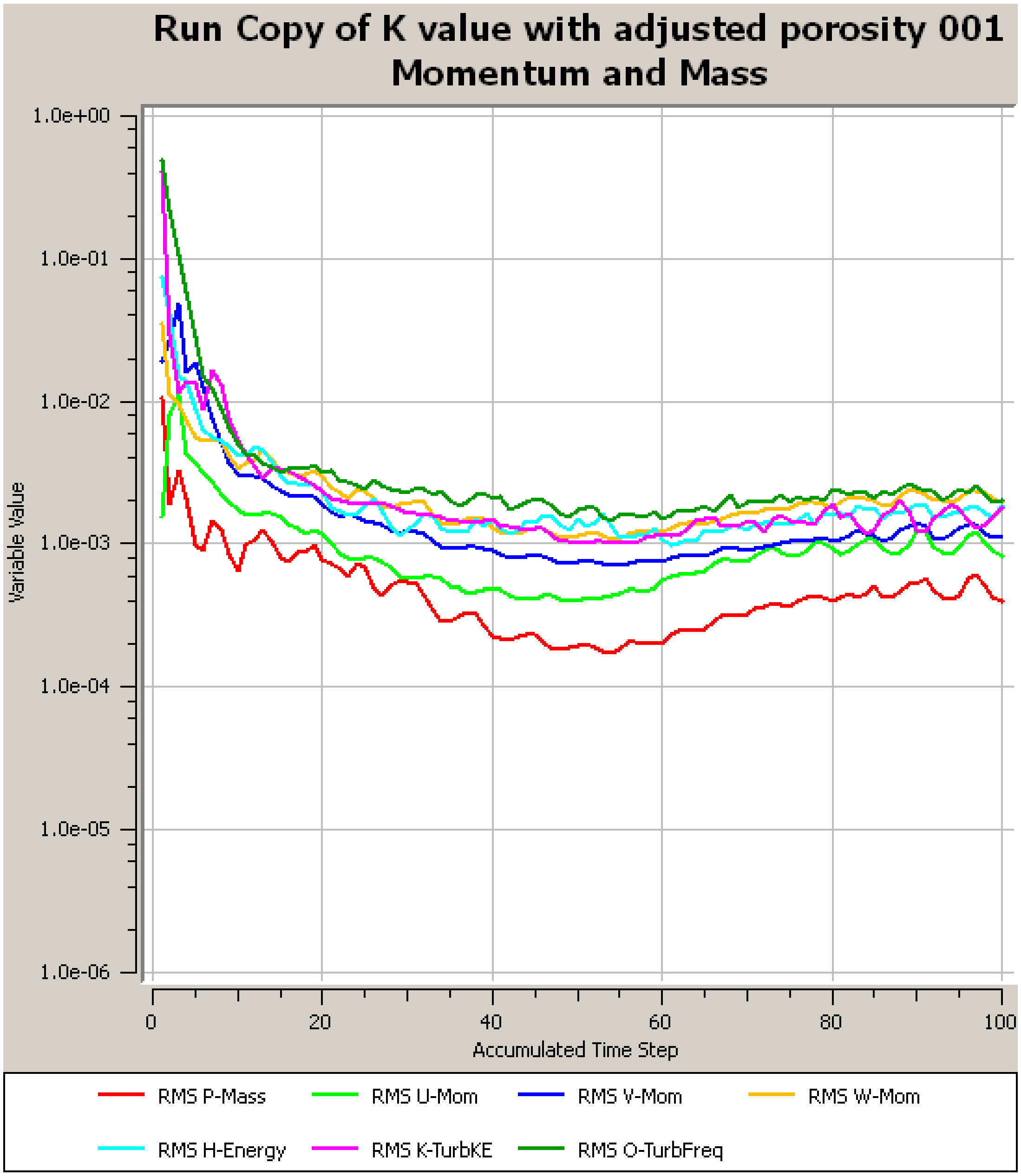


Figure D-81: Residual plot for case 1

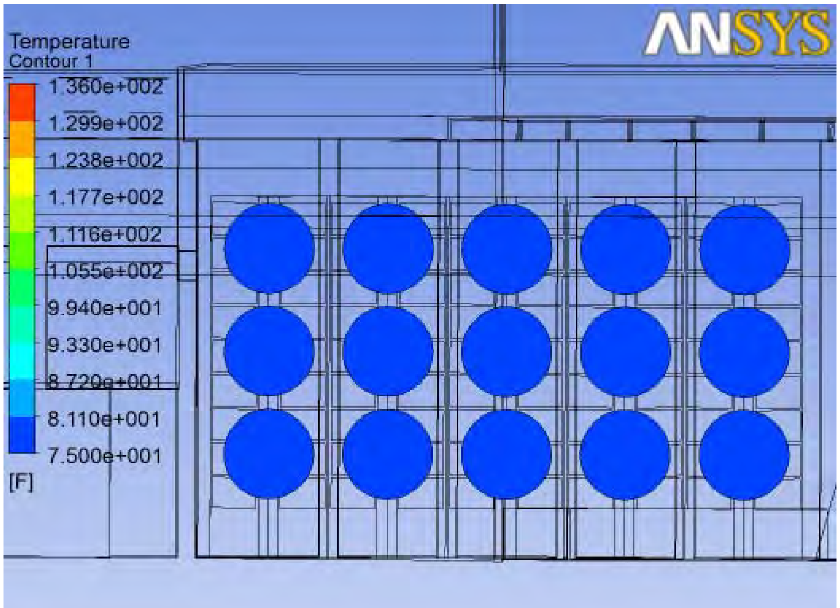


Figure D-82: Fan temperature for case 1

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	76.6	76.2	76.0	76.0	76.0
	76.7	76.1	76.0	76.0	76.0
	76.5	76.0	76.0	76.0	76.0
Average fan temperature:				76.1	

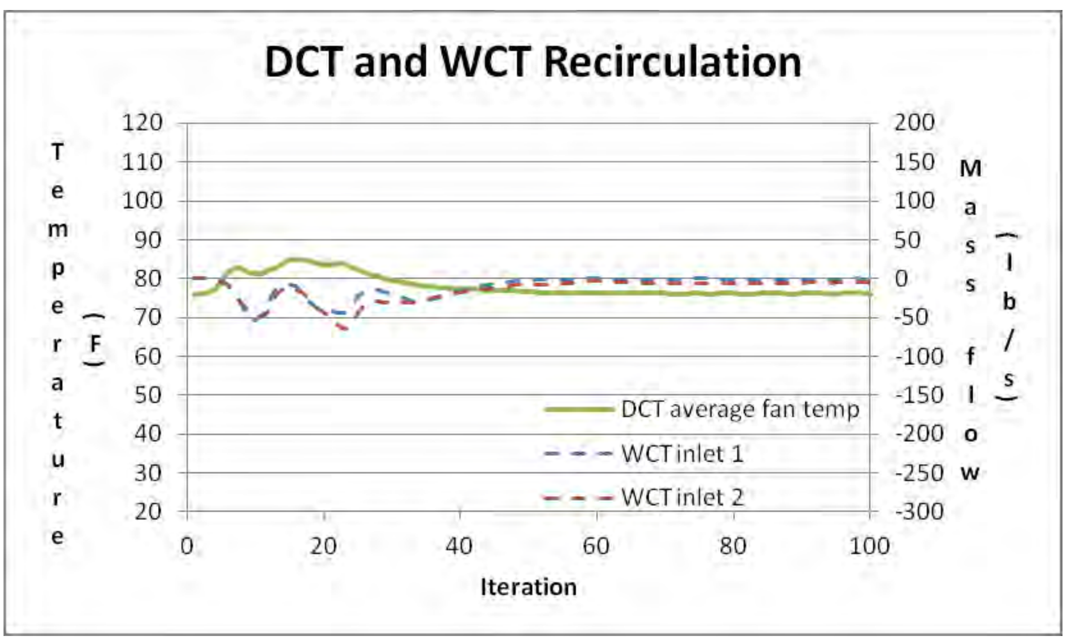


Figure D-83: DCT and WCT recirculation with iteration for case 1

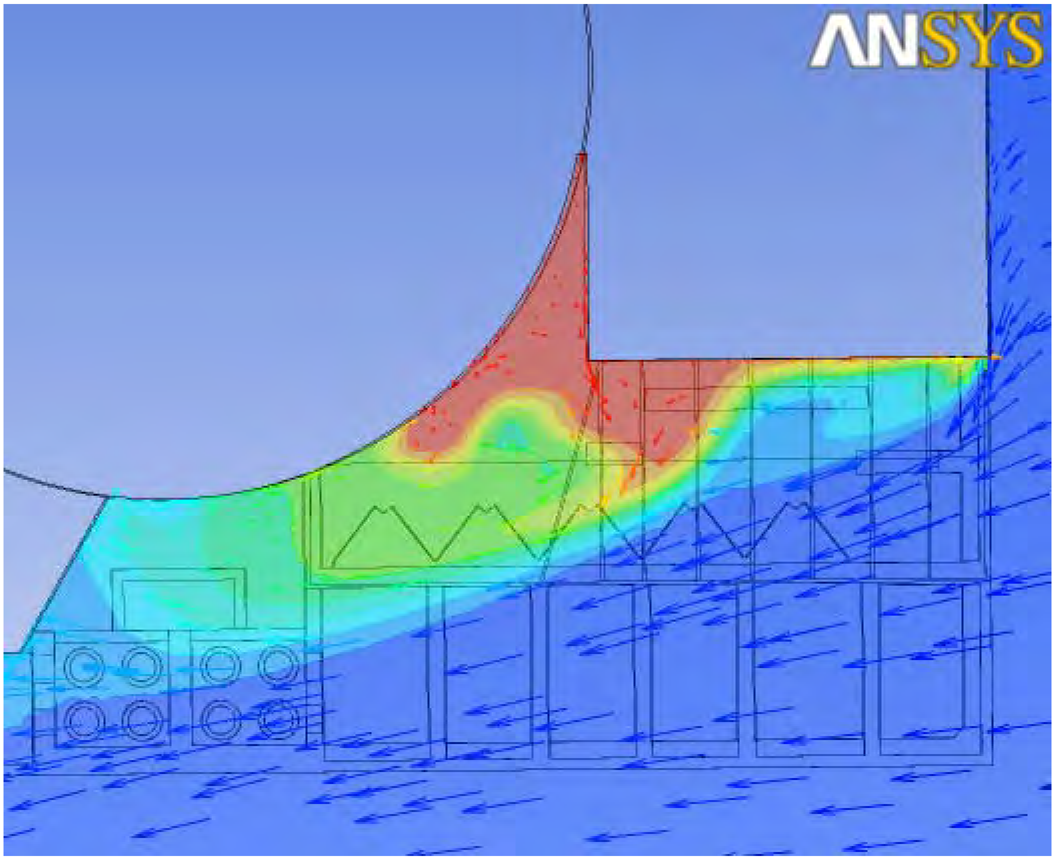


Figure D-84: Velocity vector and temperature contour above the deflector wall

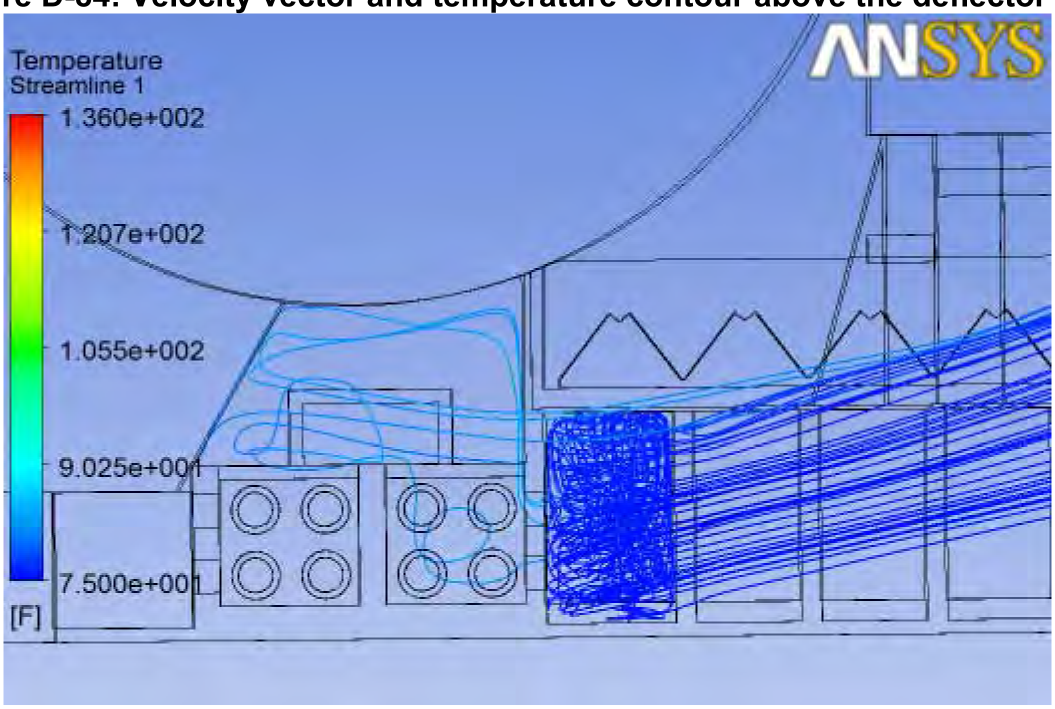


Figure D-85: Streamline at cell 5 for case 1

D-19: Train B Case 2: West wind with 19mph wind and 88F Ambient

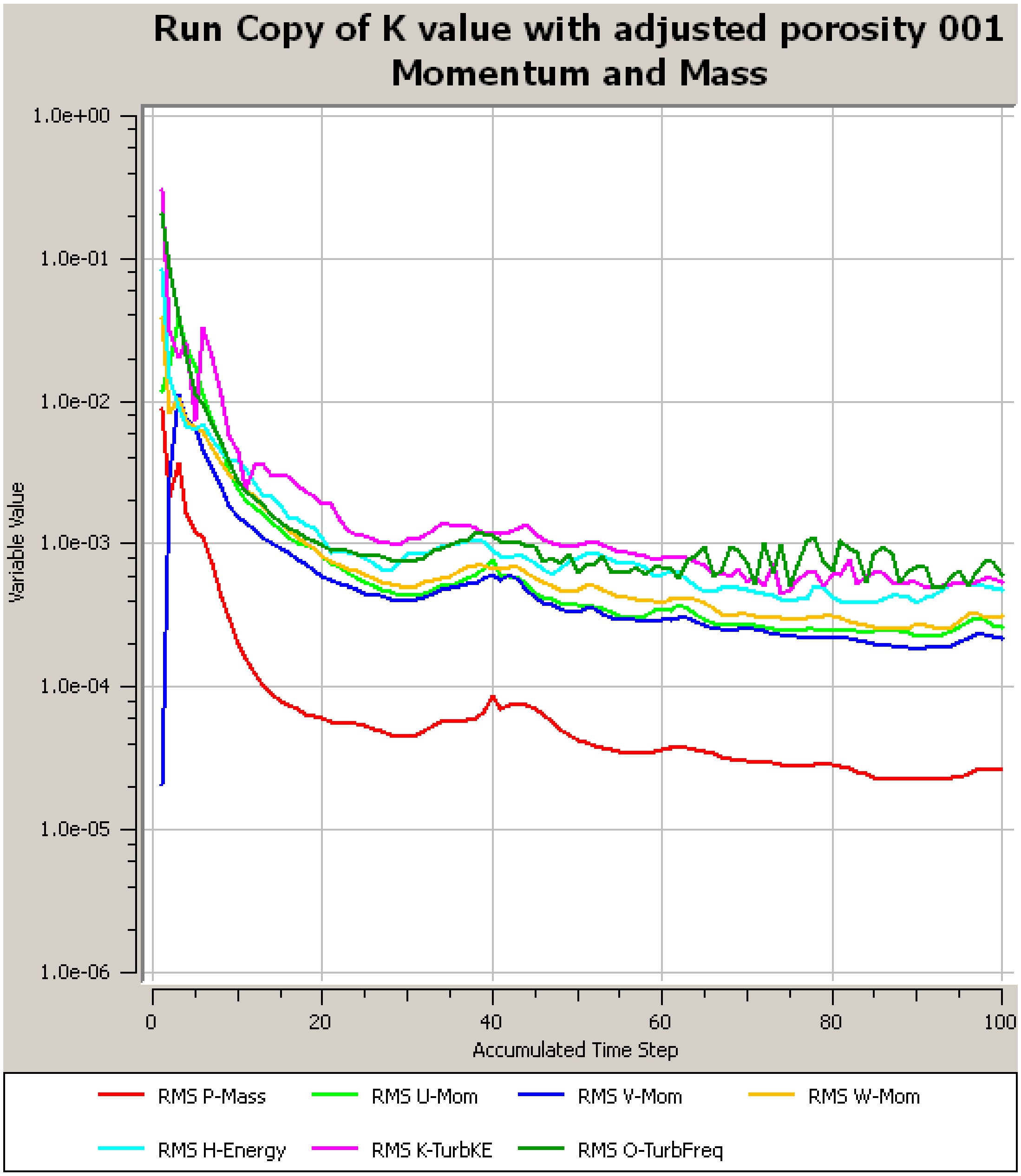


Figure D-86: Residual plot for case 2

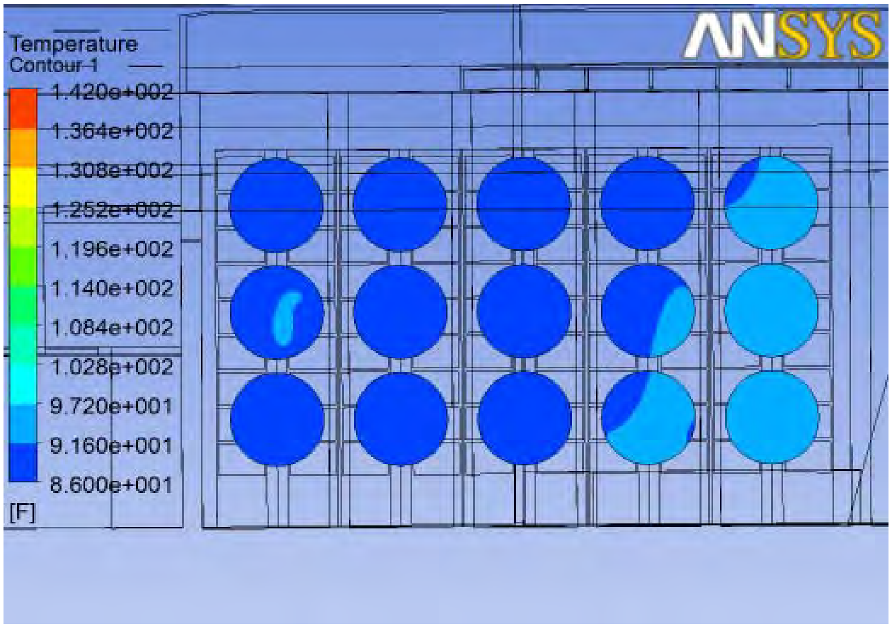


Figure D-87: Fan temperature for case 2

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	90.3	89.7	89.7	90.4	91.7
	90.1	89.3	89.3	90.2	91.9
	91.1	89.3	89.2	90.0	91.7
Average fan temperature:				90.3	

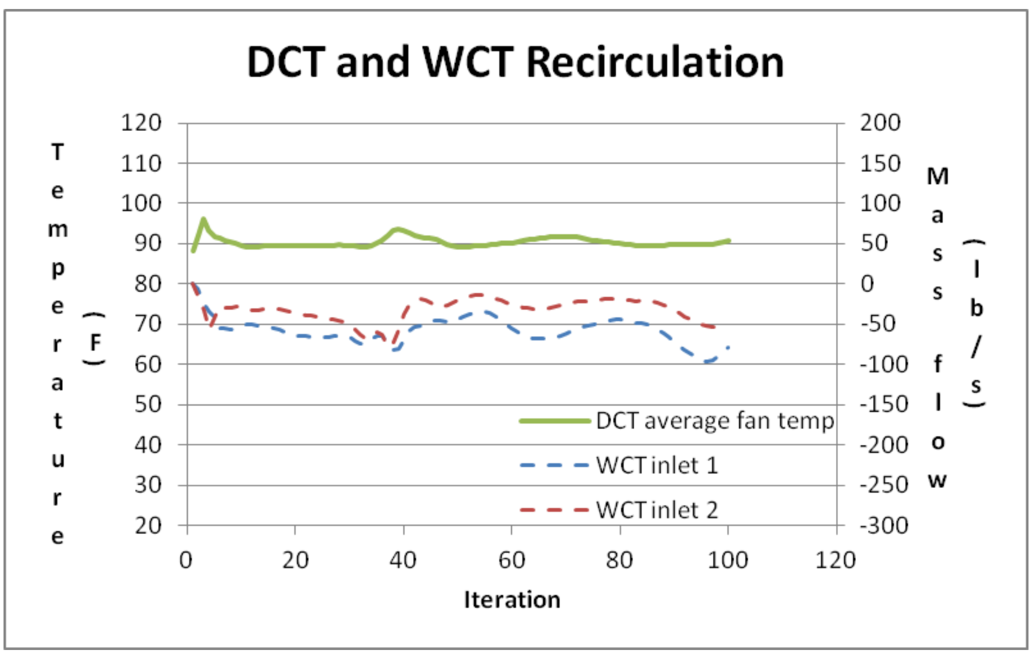


Figure D-88: DCT and WCT recirculation with iteration for case 2

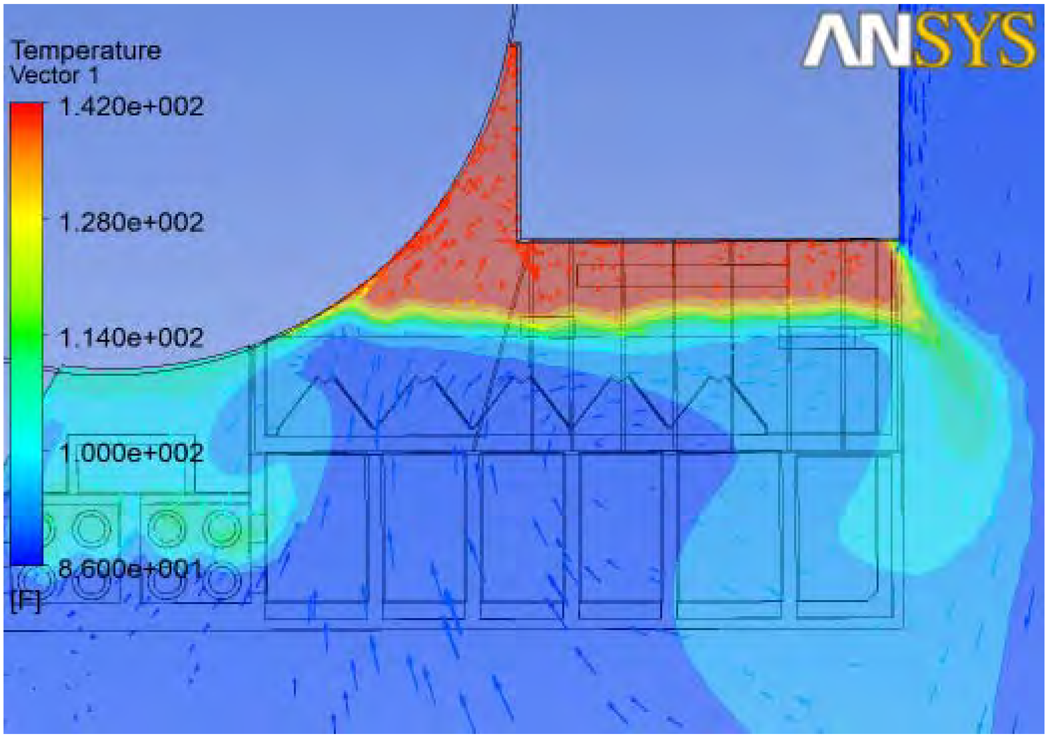


Figure D-89: Velocity vector and temperature contour above the deflector wall

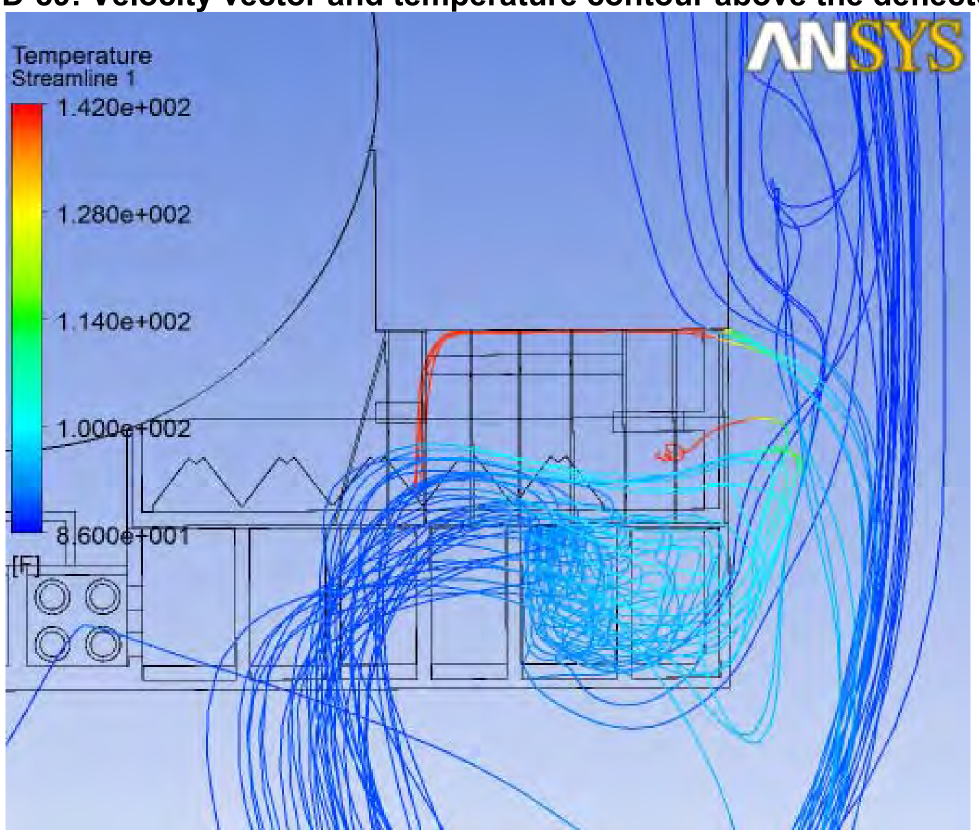


Figure D-90: Streamline at cell 1 for case 2

D-20: Train B Case 3: South wind with 26.5mph wind and 88F Ambient

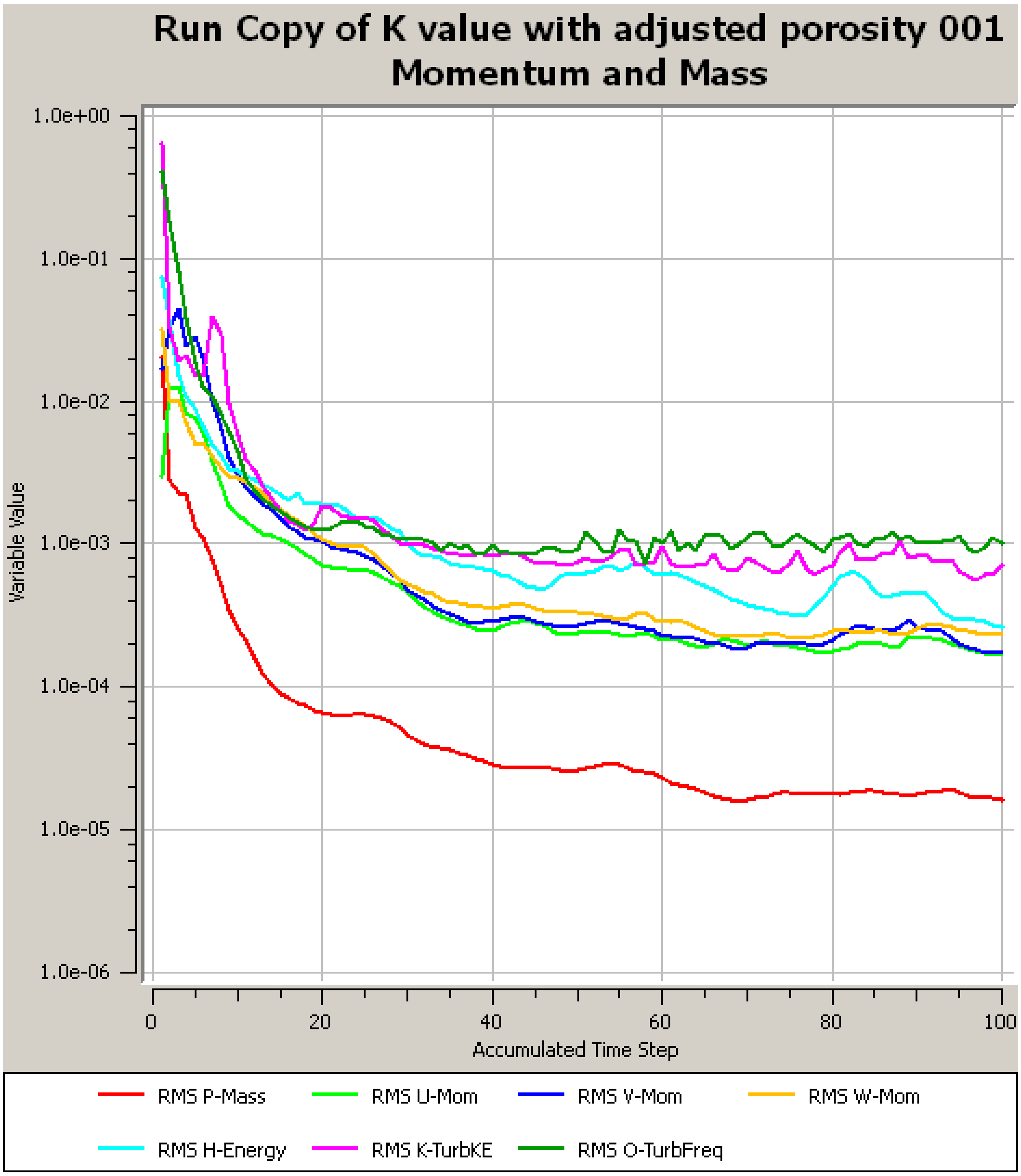


Figure D-91: Residual plot for case 3

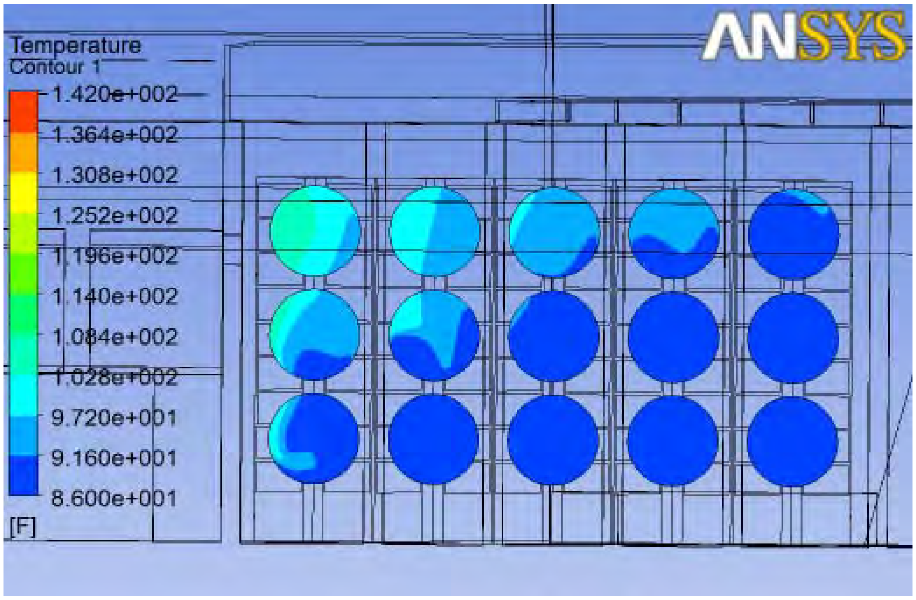


Figure D-92: Fan temperature for case 3

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	101.1	97.8	95.1	92.8	89.5
	94.9	92.7	89.9	89.1	89.0
	92.2	89.1	88.5	88.5	88.5
Average fan temperature:				91.9	

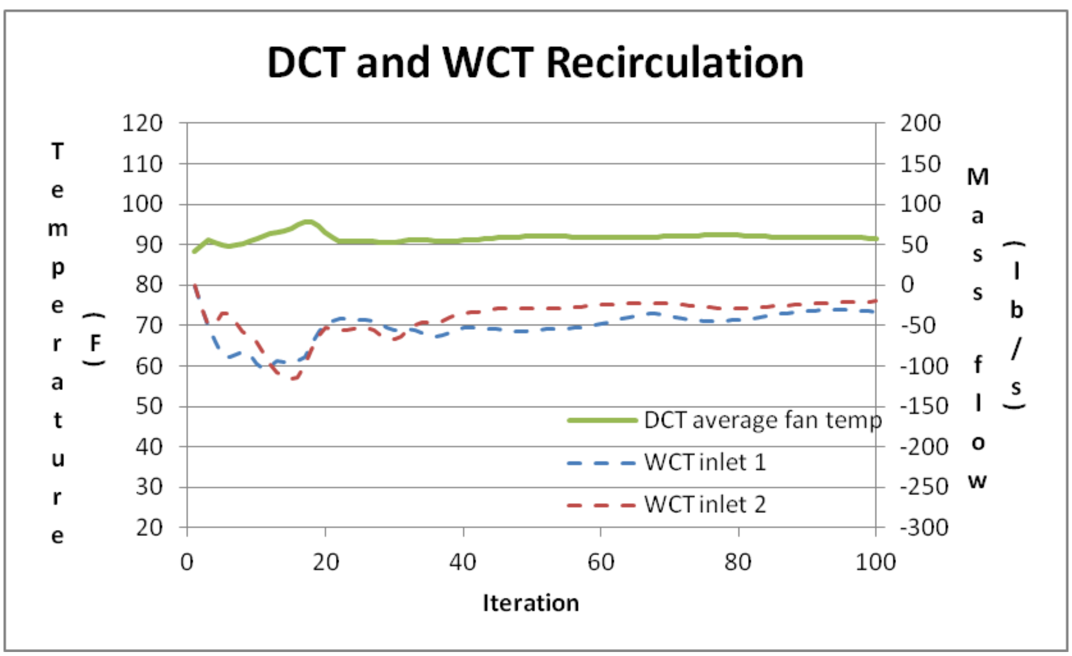


Figure D-93: DCT and WCT recirculation with iteration for case 3

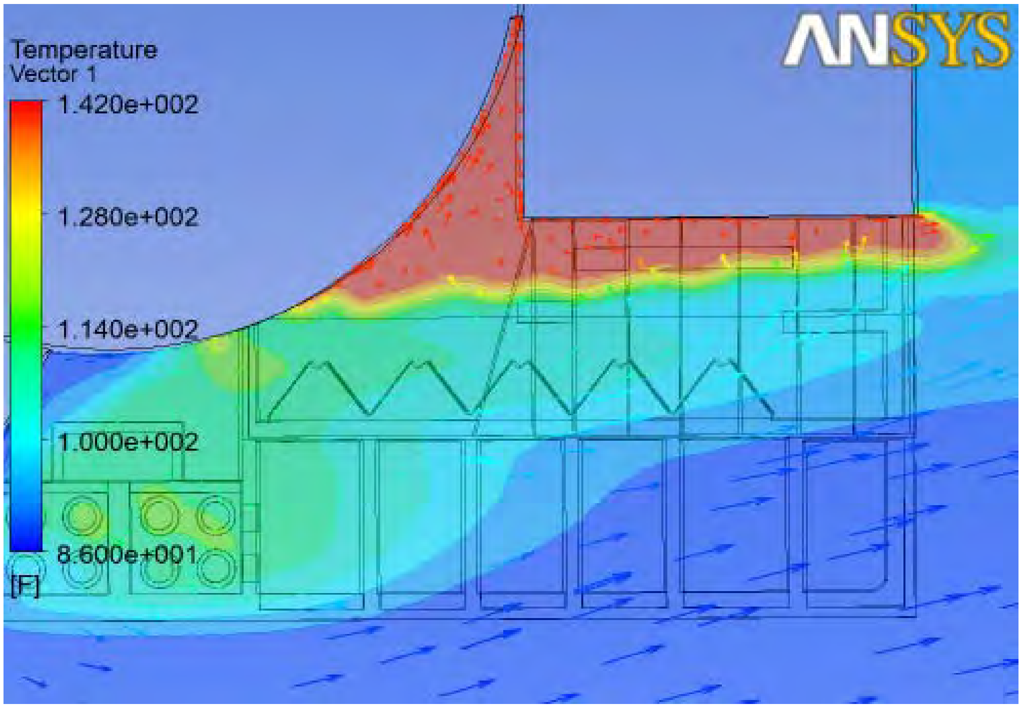


Figure D-94: Velocity vector and temperature contour above the deflector wall

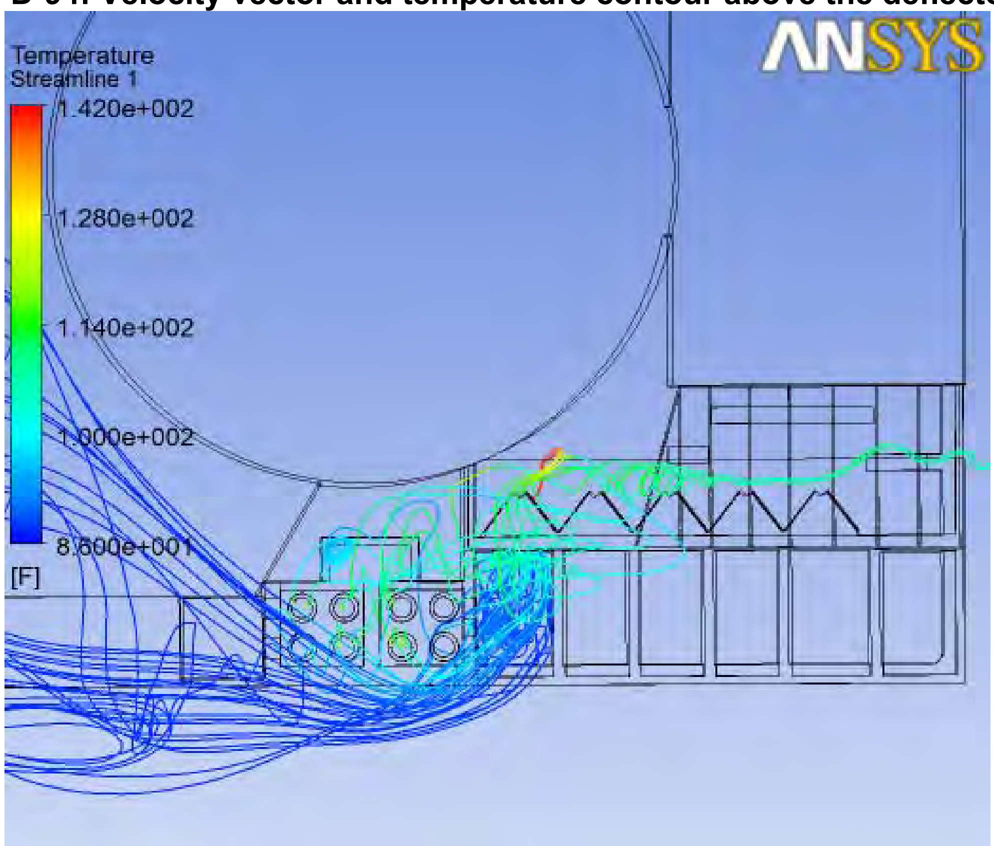


Figure D-95: Streamline at cell 5 for case 3

D-21: Train B Case 4: Northwest wind with 51mph wind and 76F Ambient

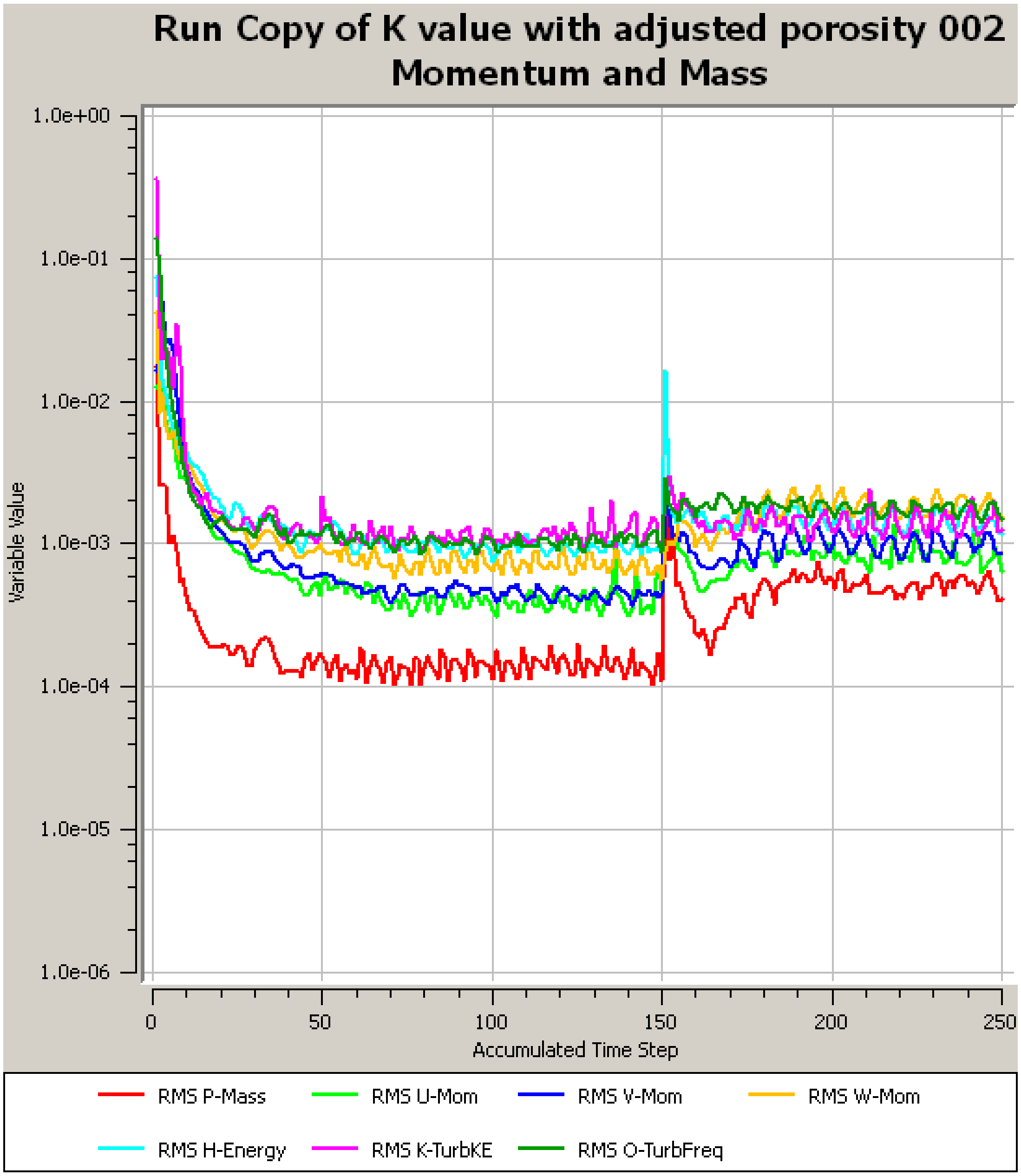


Figure D-96: Residual plot for case 4

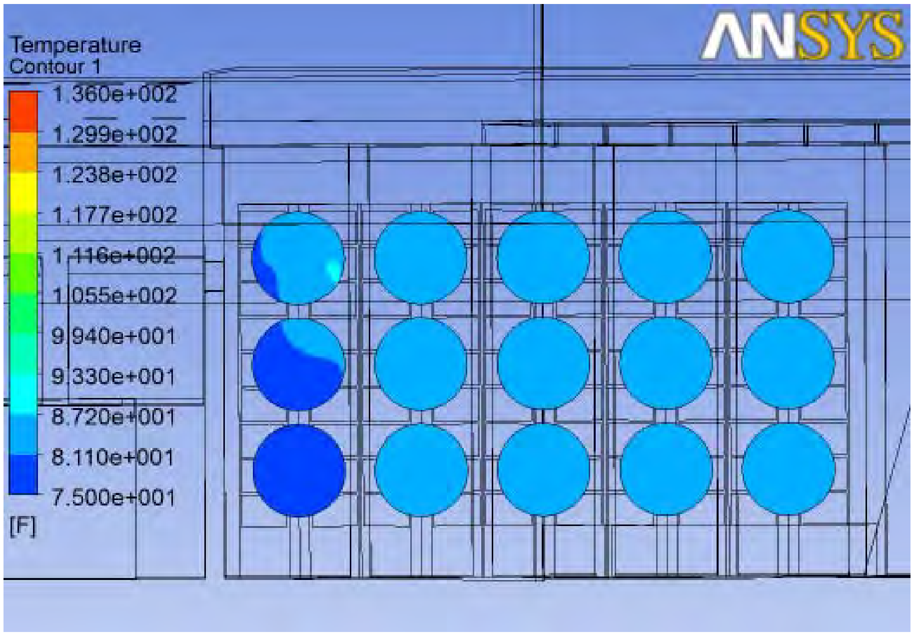


Figure D-97: Fan temperature for case 4

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	83.9	84.1	83.7	83.1	84.2
	80.0	83.7	83.1	82.3	84.4
	79.4	82.7	82.0	82.1	84.5
Average fan temperature:				82.9	

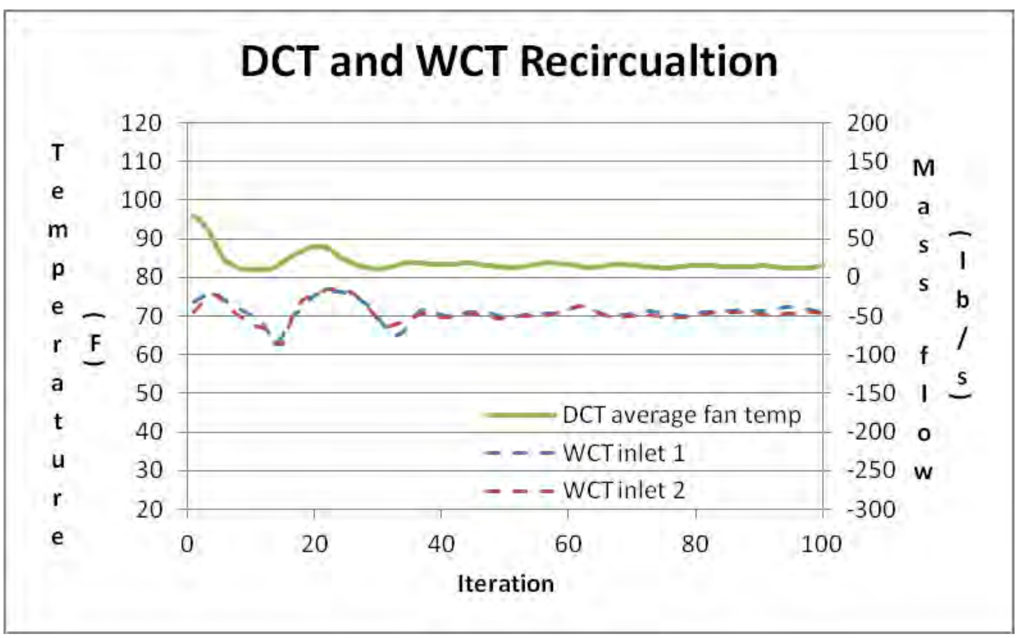


Figure D-98: DCT and WCT recirculation with iteration for case 4

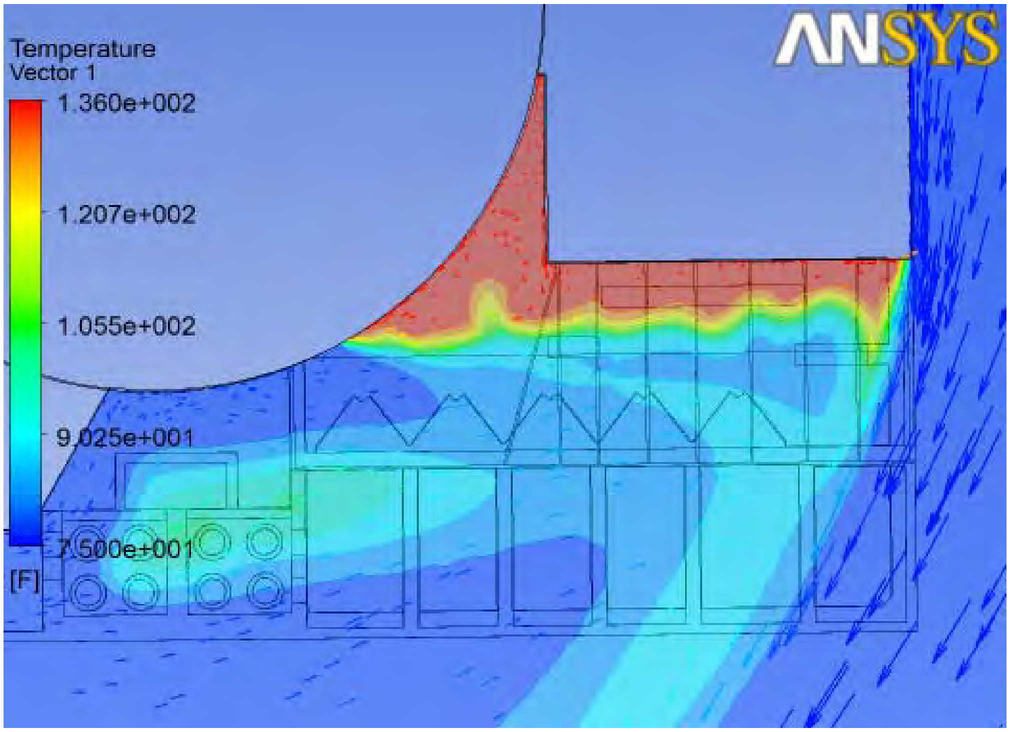


Figure D-99: Velocity vector and temperature contour above the deflector wall

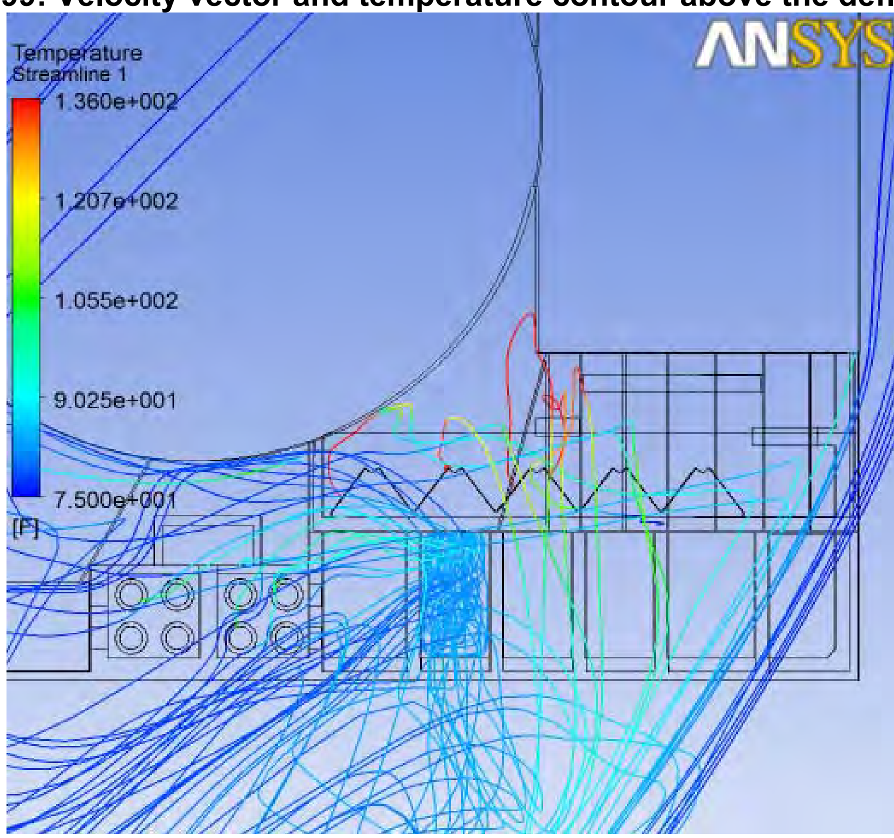


Figure D-100: Streamline at cell 4 for case 4

D-22: Train B Case 5: Northwest wind with 40mph wind and 82F Ambient

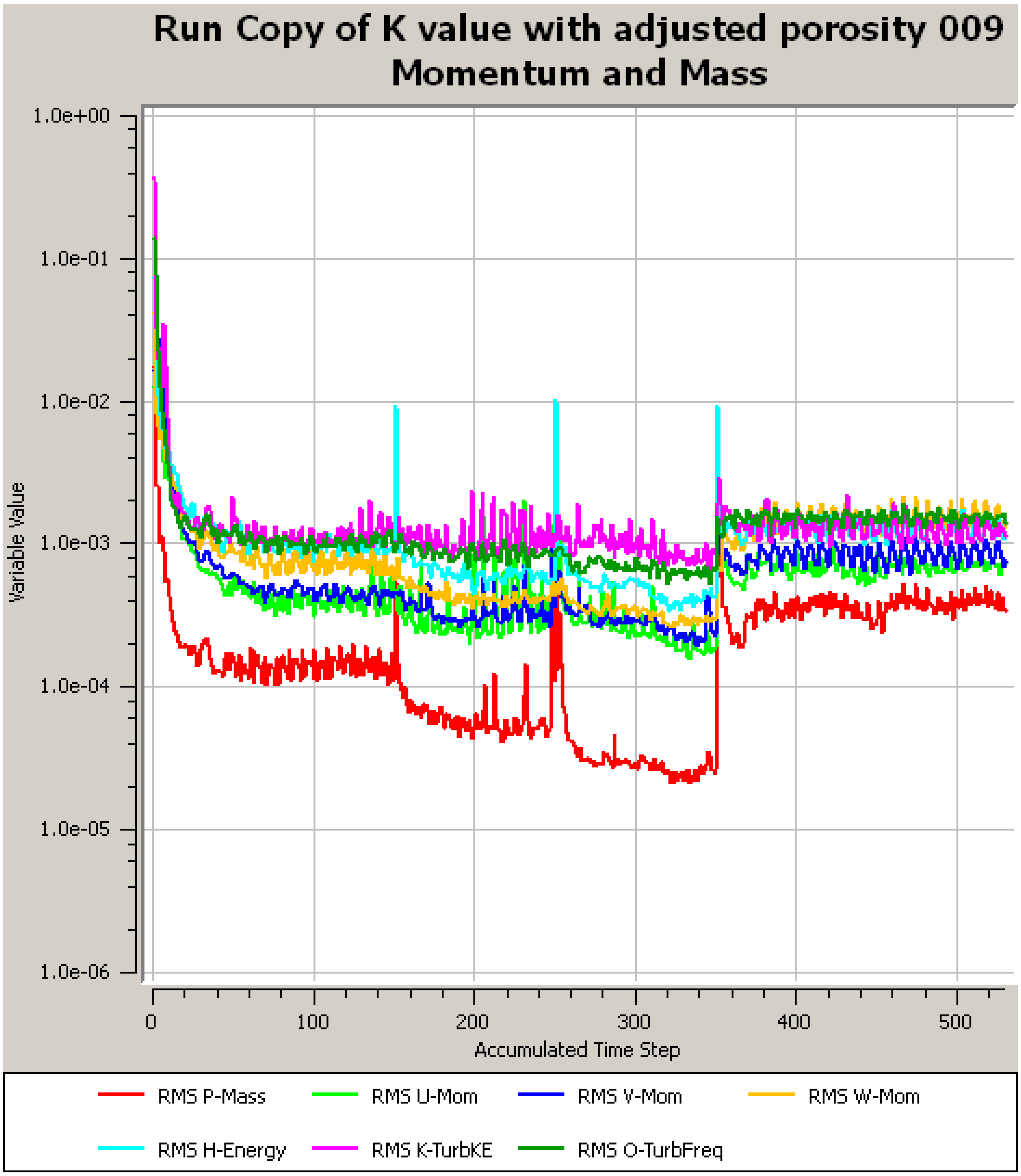


Figure D-101: Residual plot for case 5

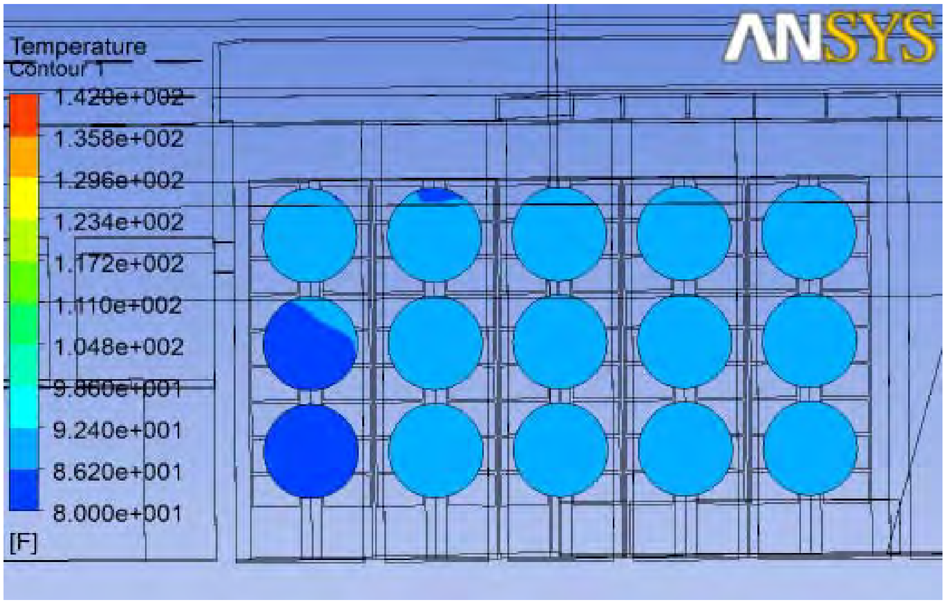


Figure D-102: Fan temperature for case 5

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	89.6	89.7	89.8	89.2	90.8
	85.8	89.2	88.2	88.9	91.0
	85.4	88.4	87.4	89.4	90.7
Average fan temperature:				88.9	

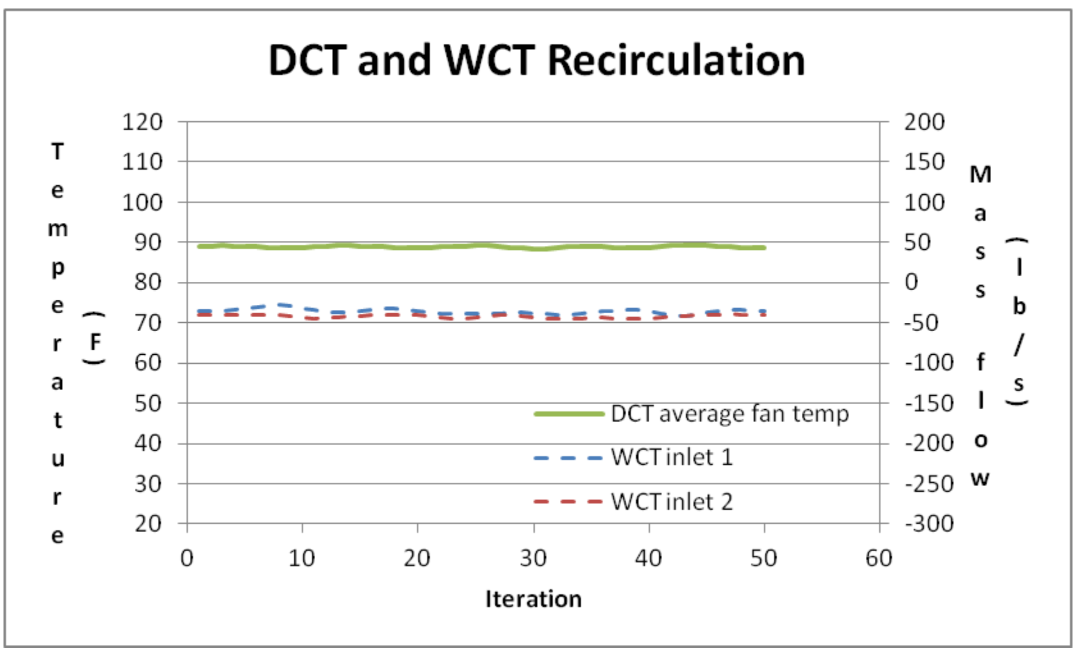


Figure D-103: DCT and WCT recirculation with iteration for case 5

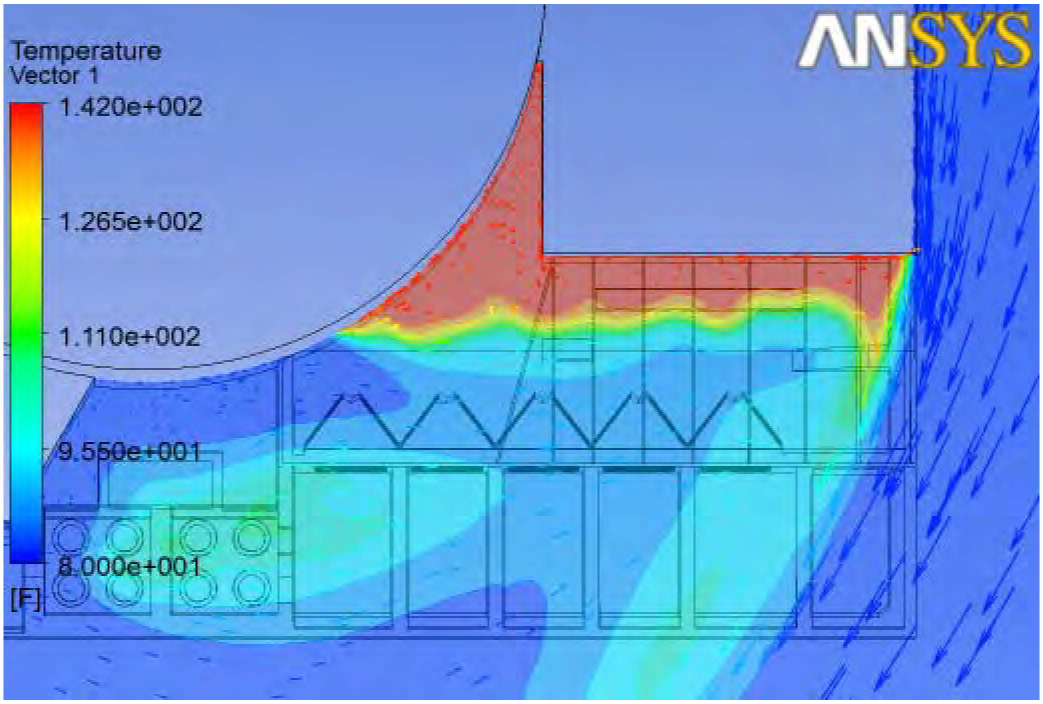


Figure D-104: Velocity vector and temperature contour above the deflector wall

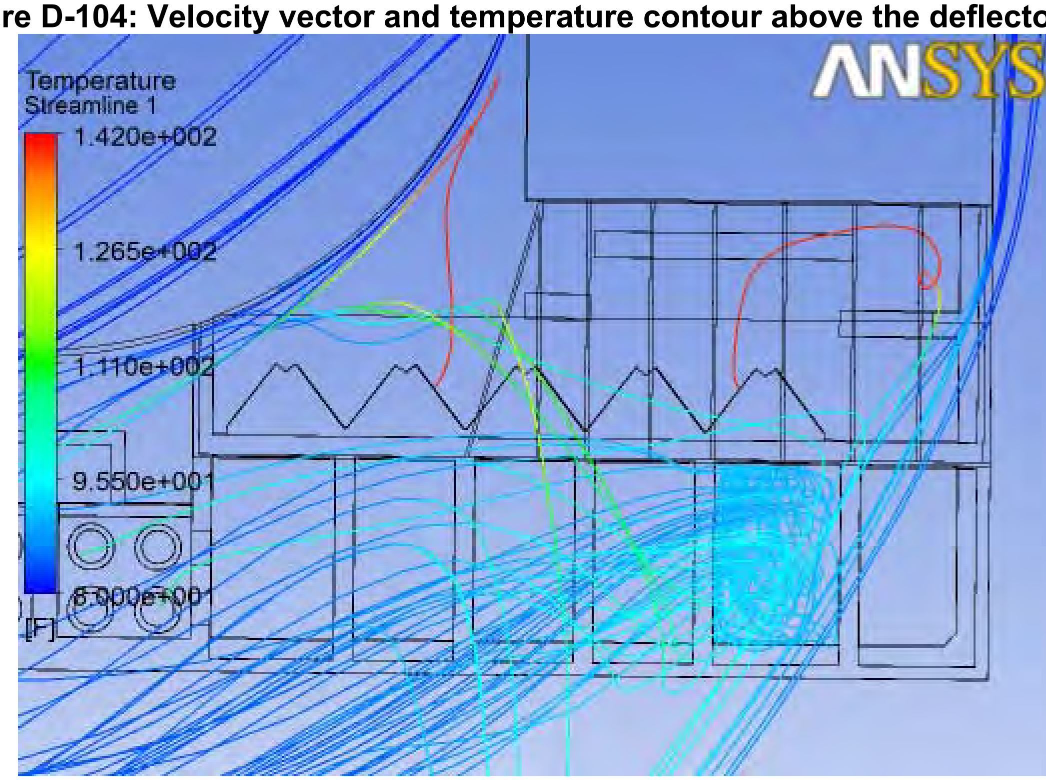


Figure D-105: Streamline at cell 1 for case 5

D-23: Train B Case 7: Northwest wind with 26mph wind and 92F Ambient

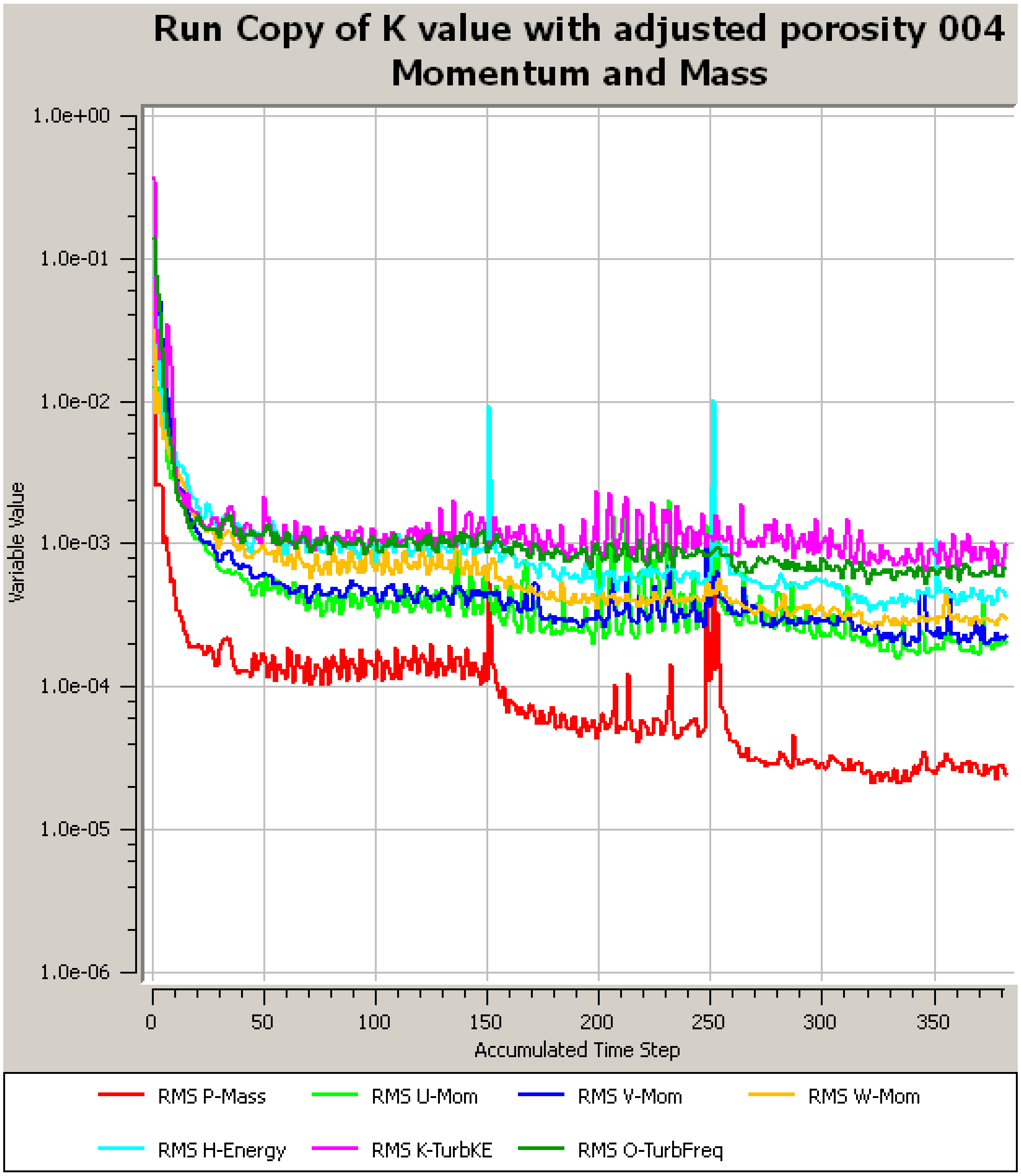


Figure D-106: Residual plot for case 7

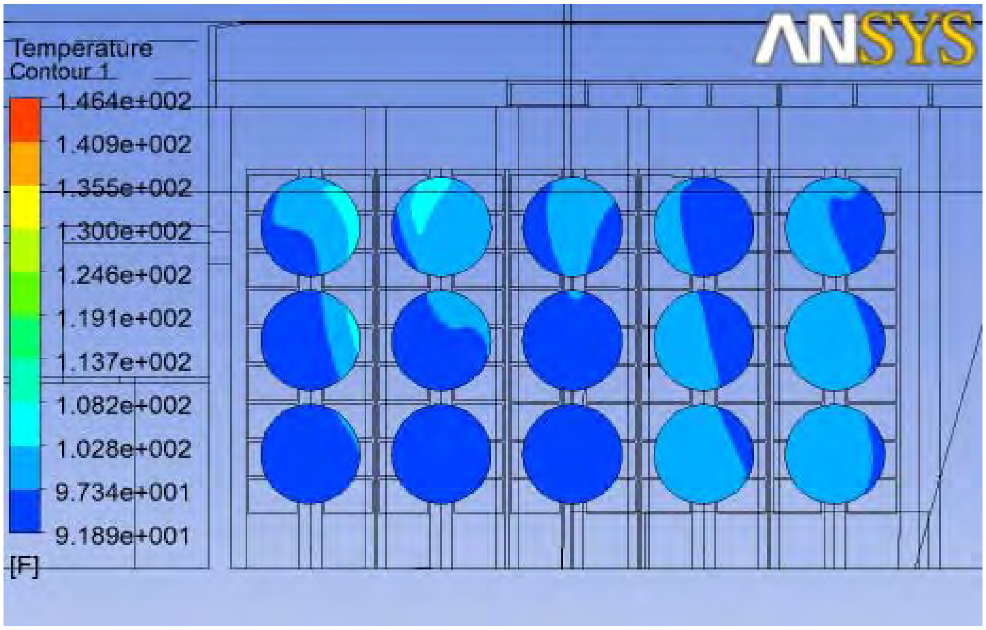


Figure D-107: Fan temperature for case 7

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	99.2	101.1	97.9	96.6	97.4
	97.5	96.5	96.3	97.8	97.8
	95.8	95.3	96.0	98.4	97.9
Average fan temperature:				97.4	

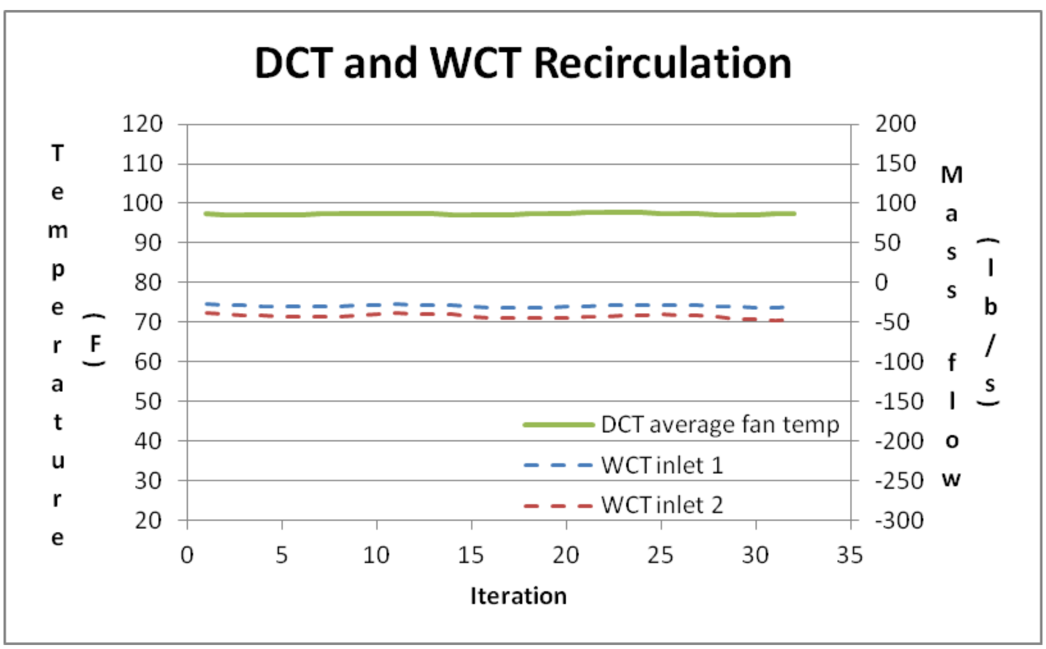


Figure D-108: DCT and WCT recirculation with iteration for case 7

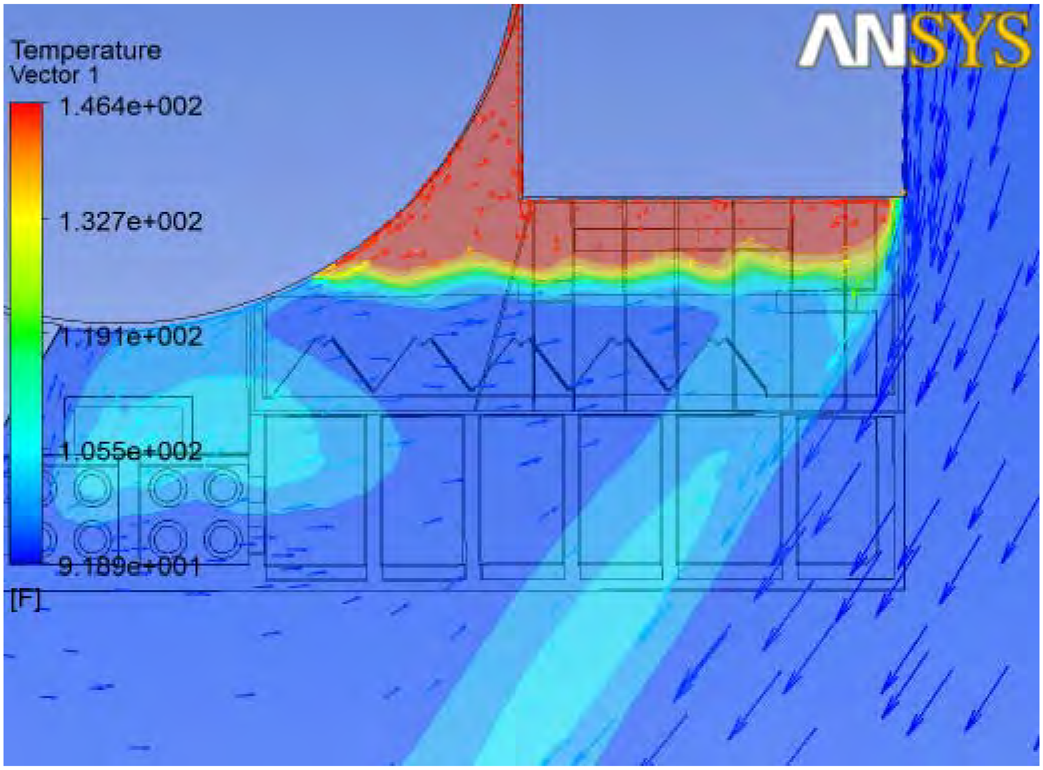


Figure D-109: Velocity vector and temperature contour above the deflector wall

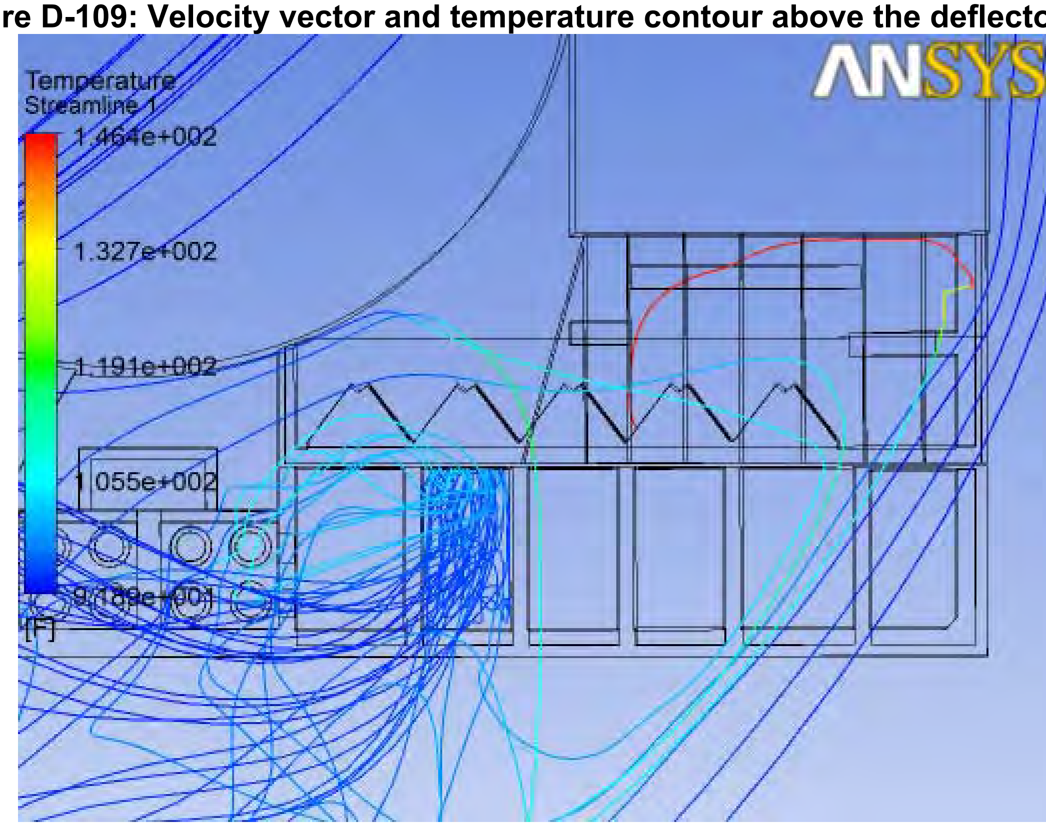


Figure D-110: Streamline at cell 4 for case 7

D-24: Train B Case 8: Northwest wind with 10mph wind and 97F Ambient

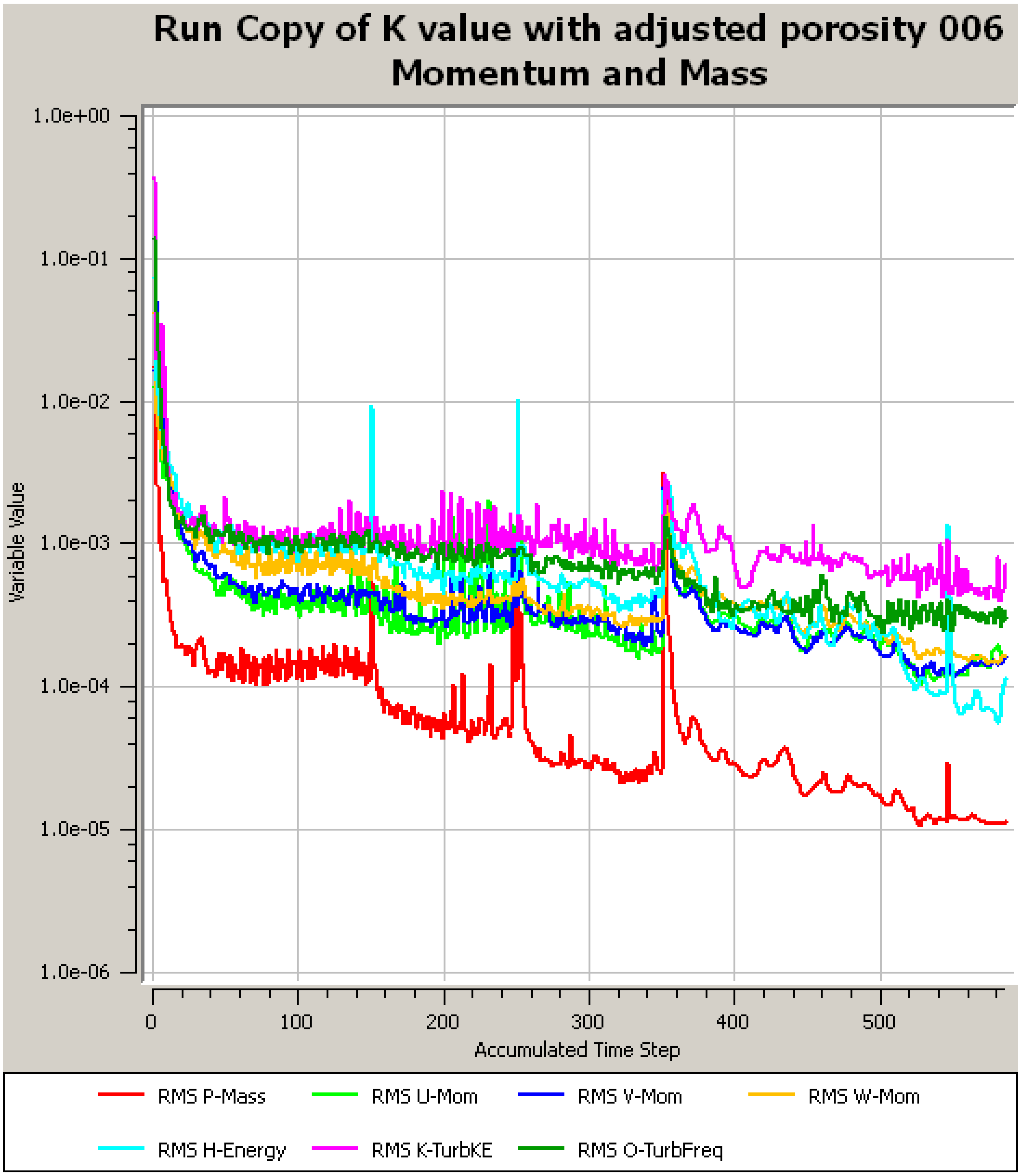


Figure D-111: Residual plot for case 8

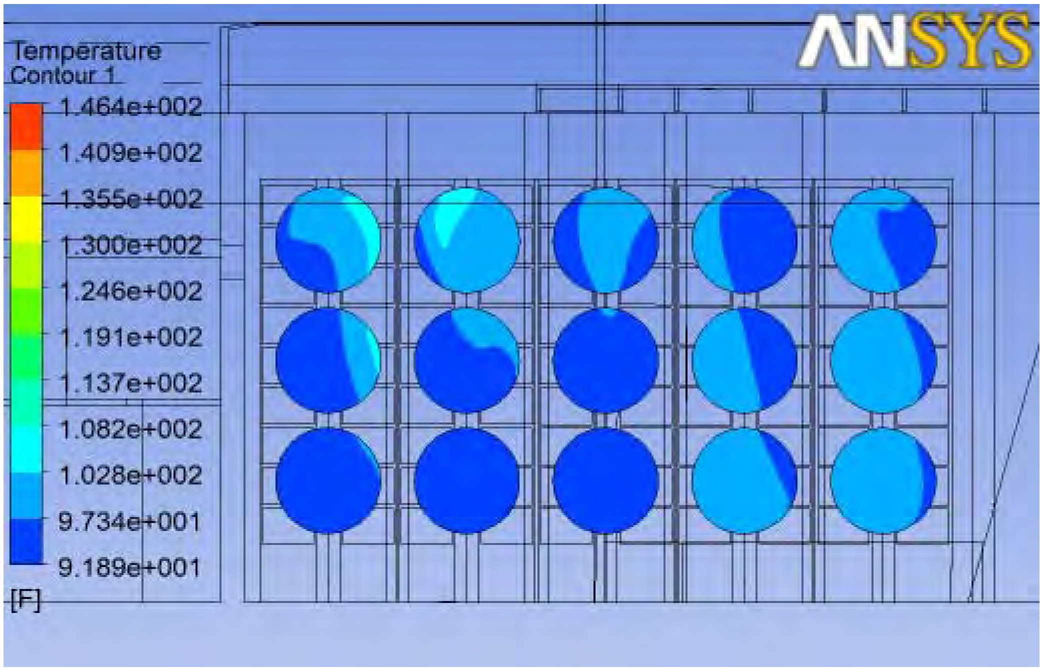


Figure D-112: Fan temperature for case 8

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	103.1	100.8	99.7	100.1	101.7
	101.7	100.3	100.6	101.6	104.2
	101.4	101.0	102.1	104.4	103.0
Average fan temperature:				101.7	

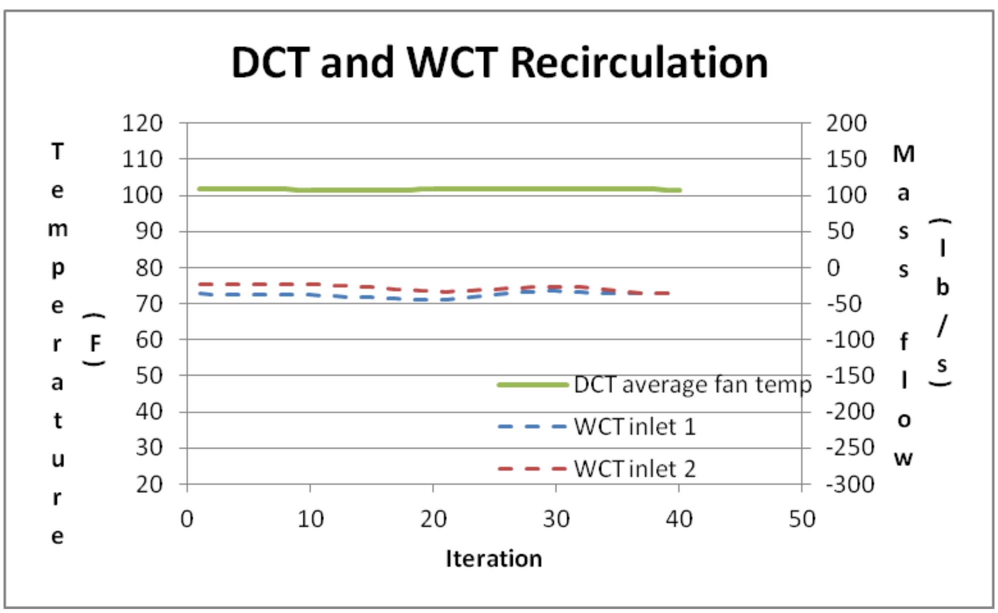


Figure D-113: DCT and WCT recirculation with iteration for case 8

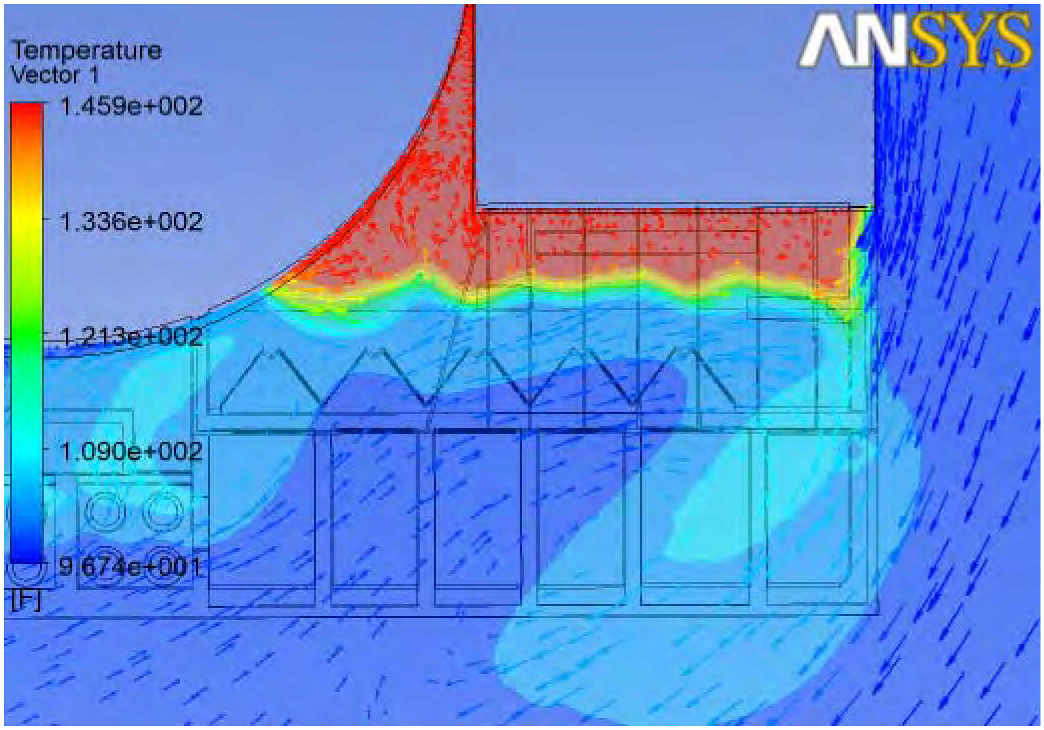


Figure D-114: Velocity vector and temperature contour above the deflector wall

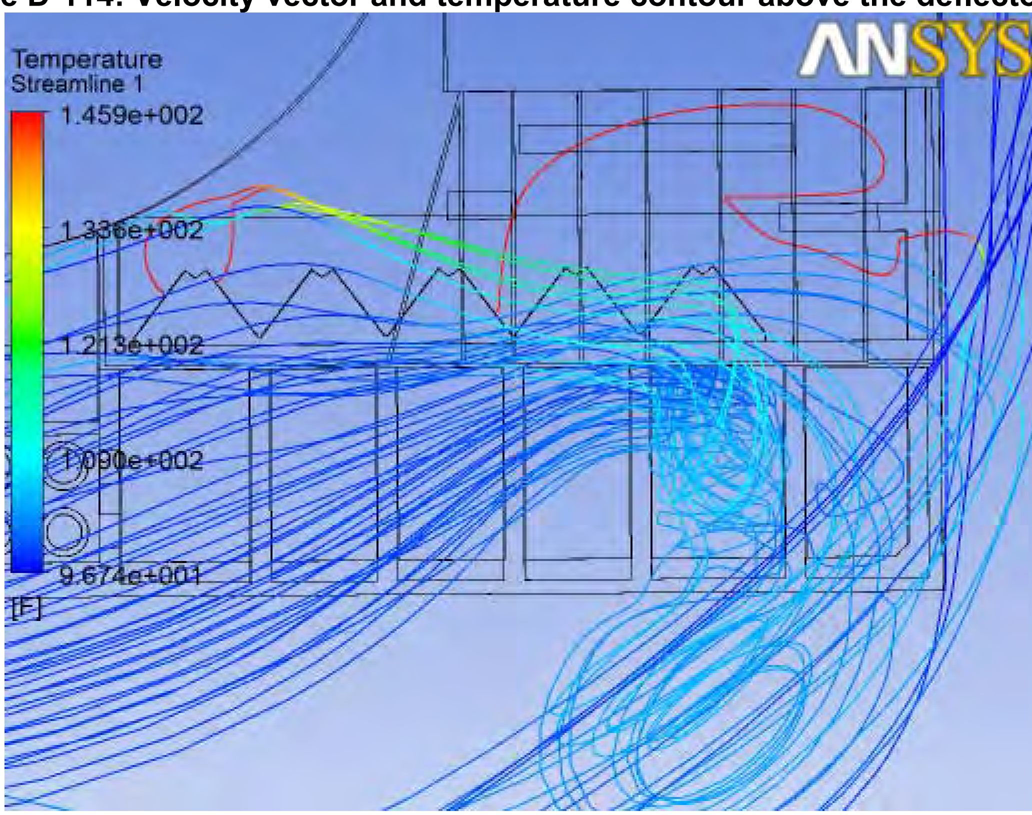


Figure D-115: Streamline at cell 1 for case 8

D-25: Train B Case 9: Southwest wind with 26.5mph wind and 88F Ambient

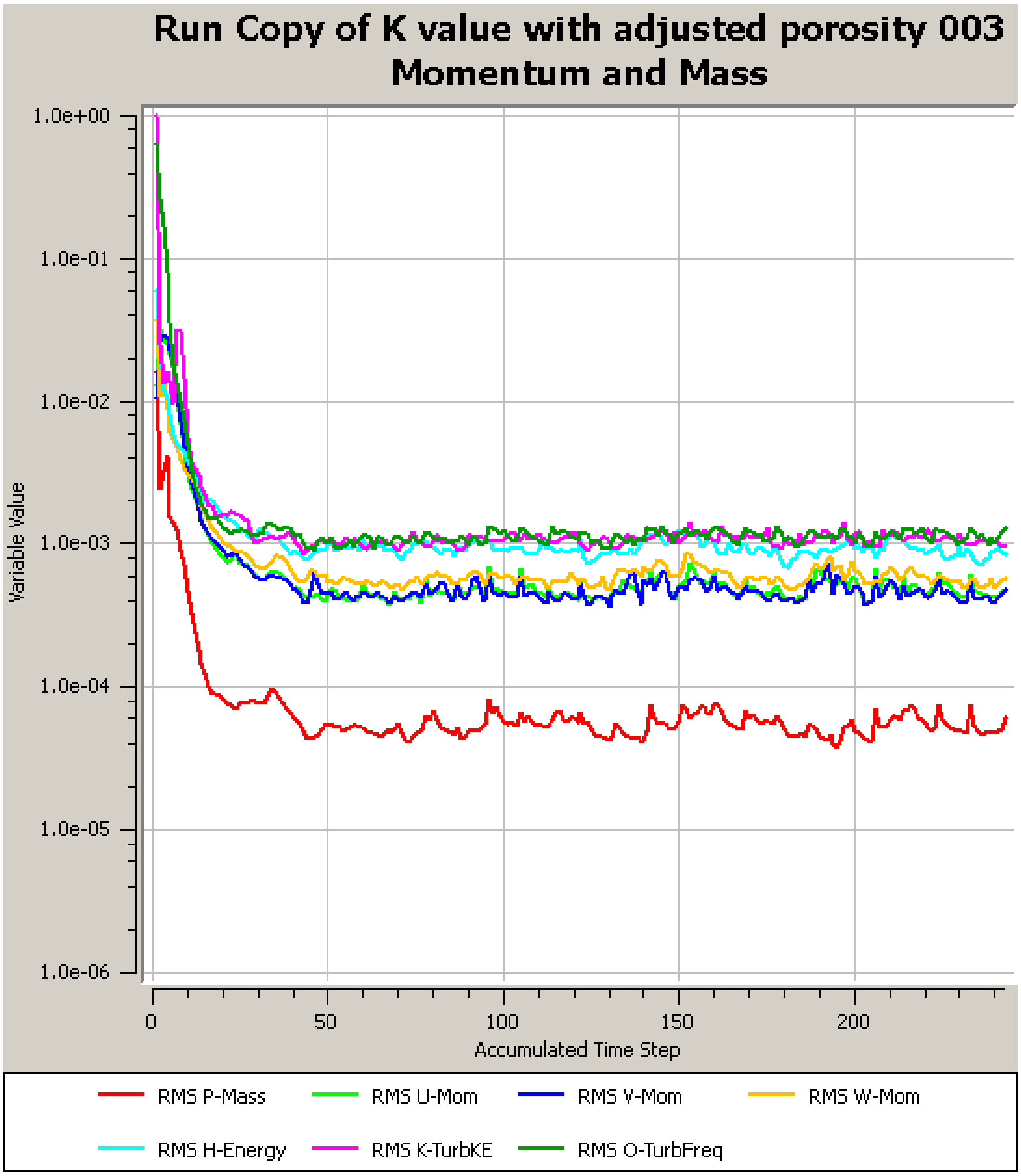


Figure D-116: Residual plot for case 9

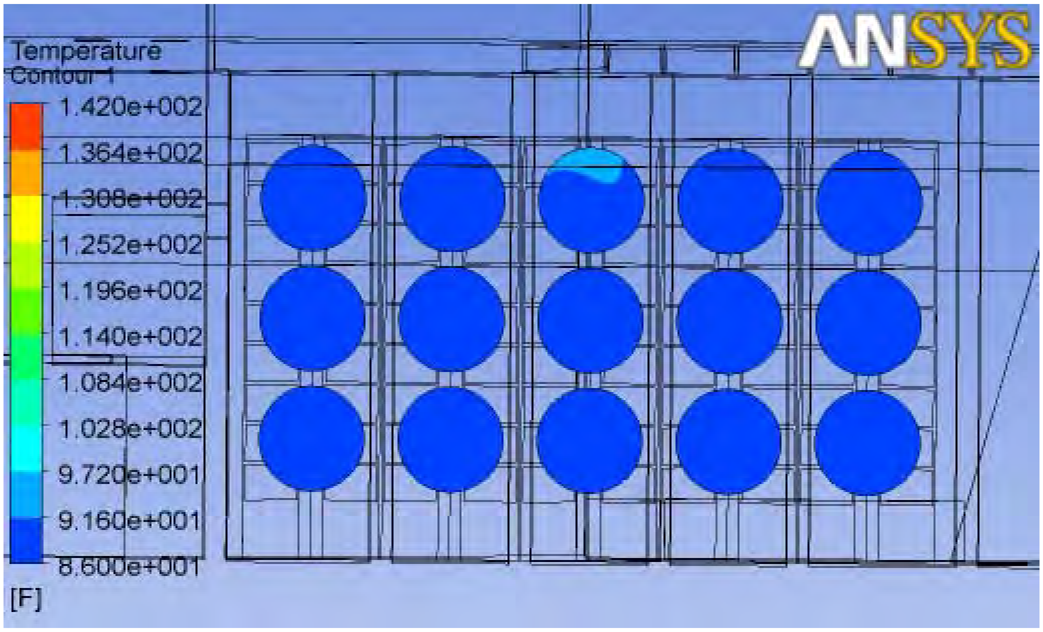


Figure D-117: Fan temperature for case 9

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	89.7	91.1	91.5	90.3	89.6
	89.1	89.4	89.9	89.6	89.1
	89.1	88.7	88.9	89.0	89.0
Average fan temperature:				89.6	

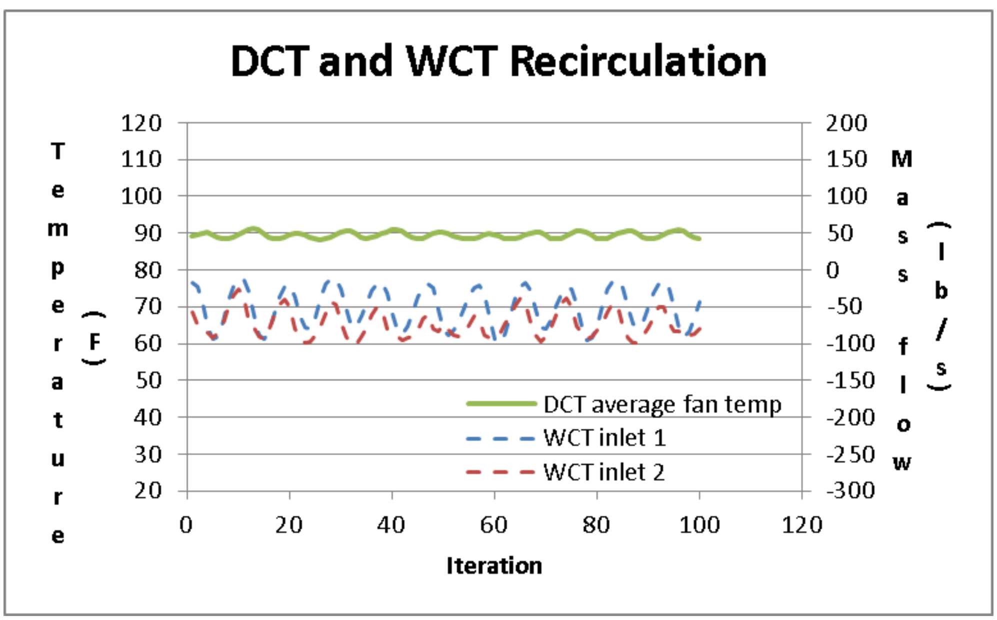


Figure D-118: DCT and WCT recirculation with iteration for case 9

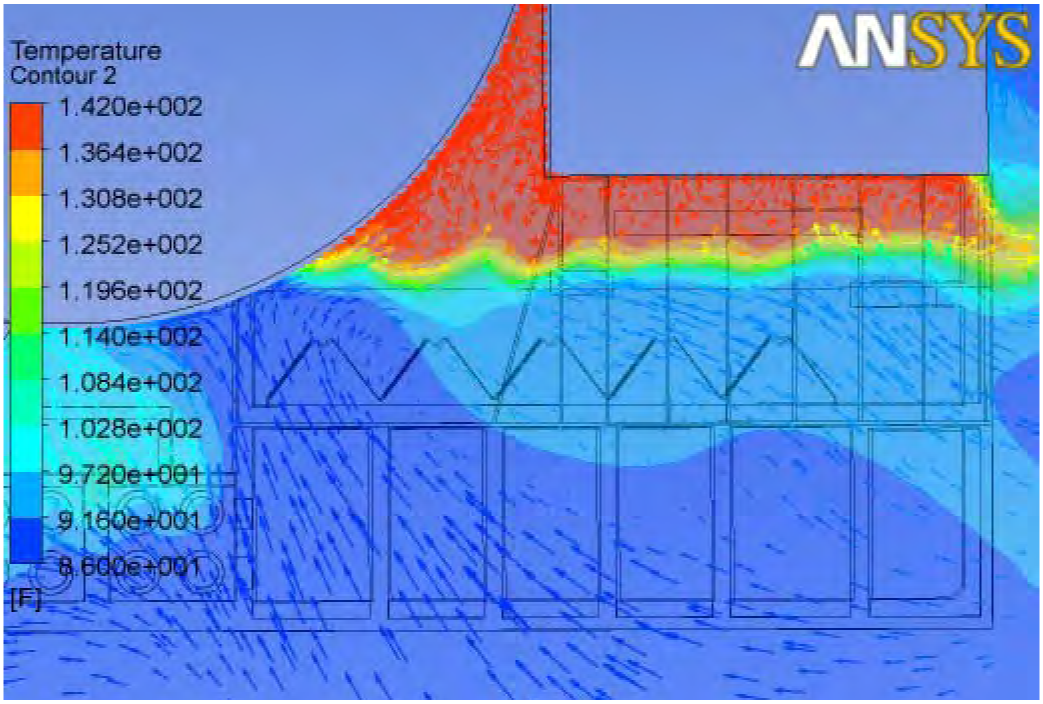


Figure D-119: Velocity vector and temperature contour above the deflector wall

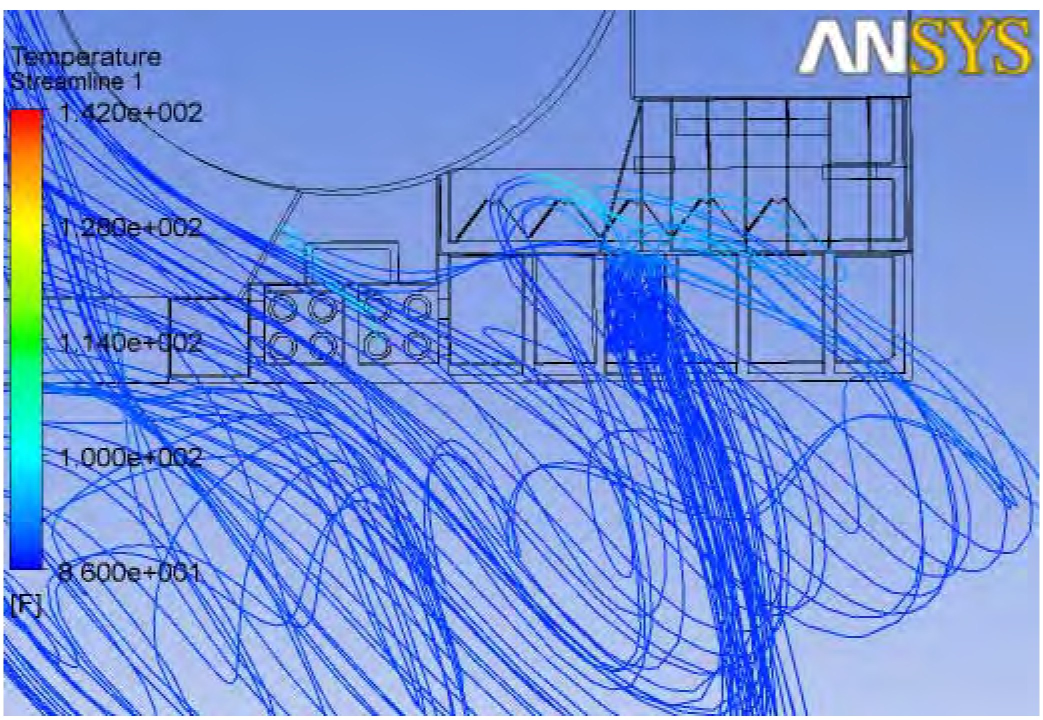


Figure D-120: Streamline at cell 3 for case 9

D-26: Train B Case 10: Southwest wind with 10mph wind and 96F Ambient

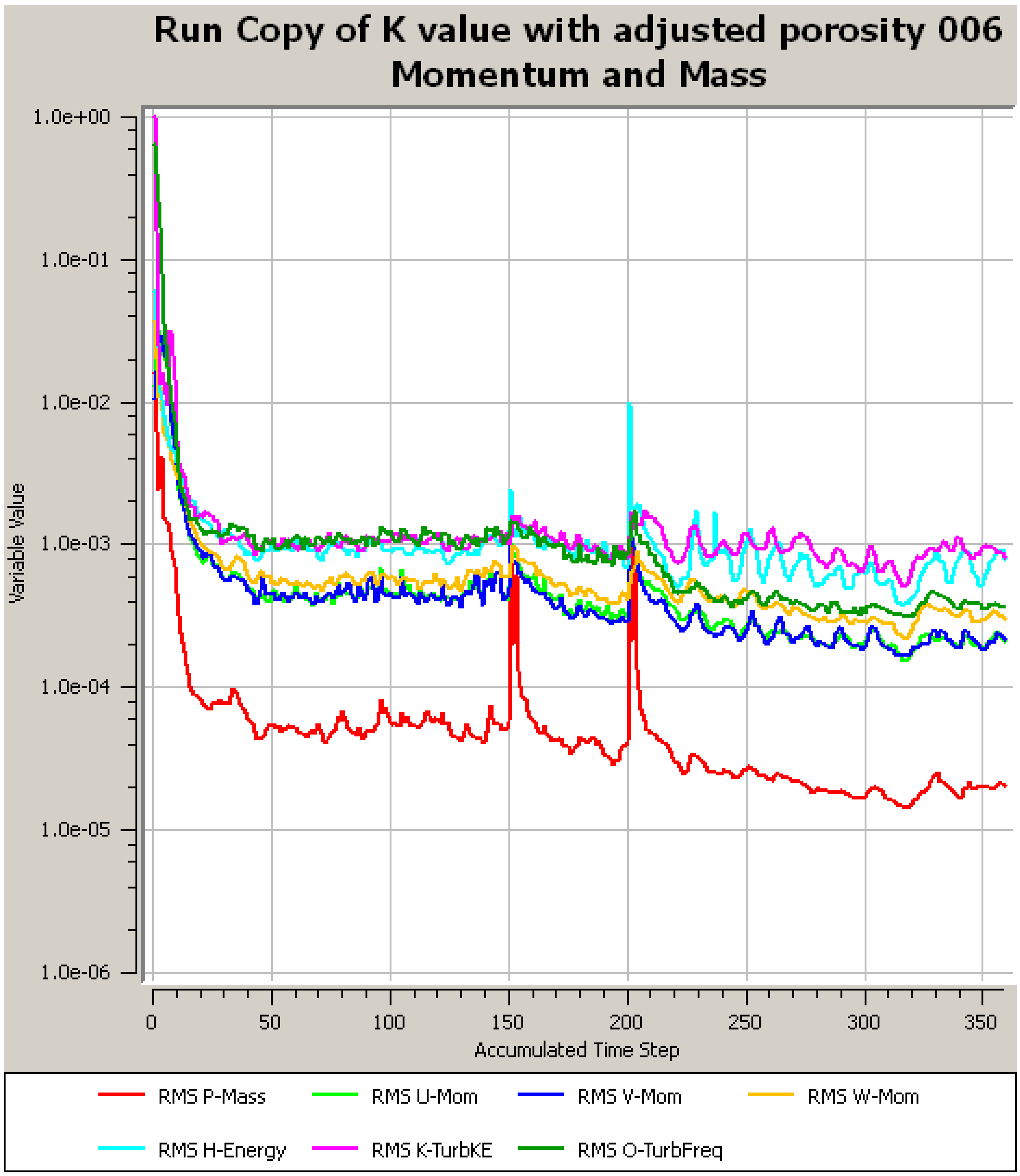


Figure D-121: Residual plot for case 10

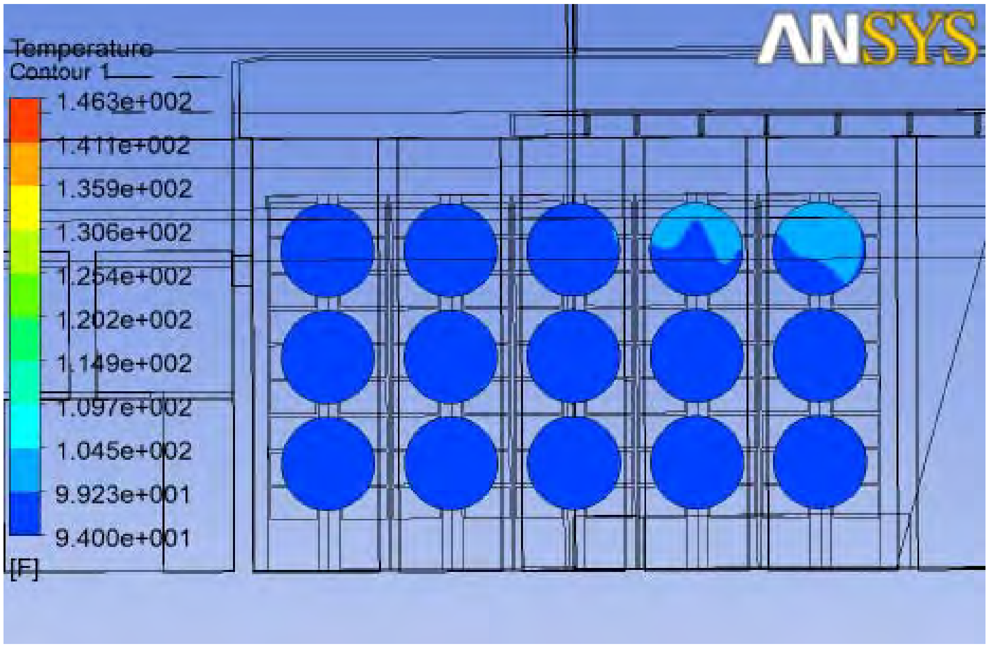


Figure D-122: Fan temperature for case 10

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	96.3	96.8	98.1	100.0	101.3
	96.3	96.1	97.0	97.6	97.4
	97.0	96.0	96.0	96.2	96.5
Average fan temperature:				97.2	

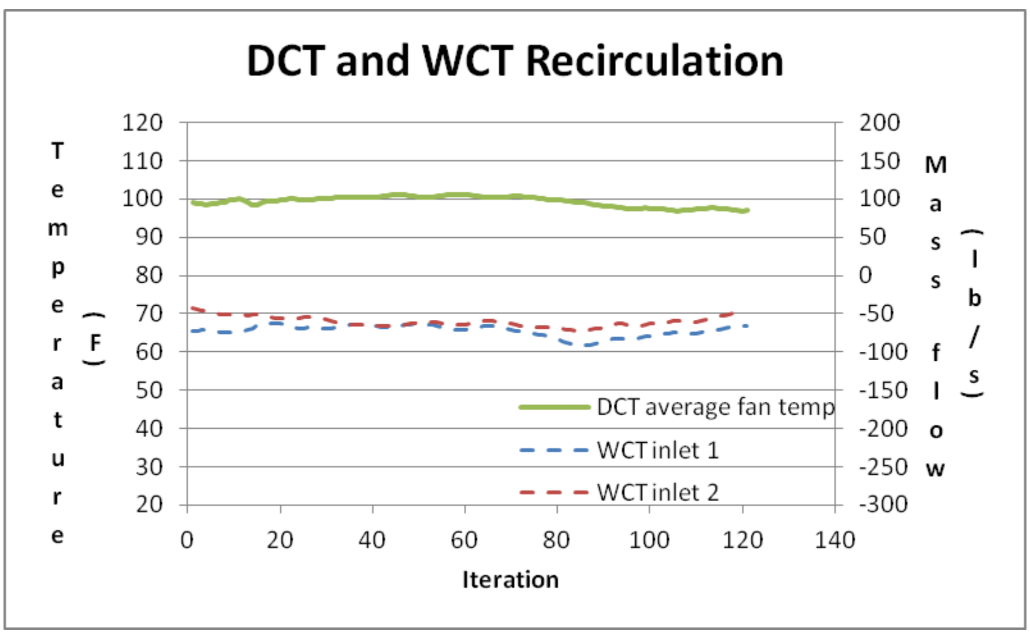


Figure D-123: DCT and WCT recirculation with iteration for case 10

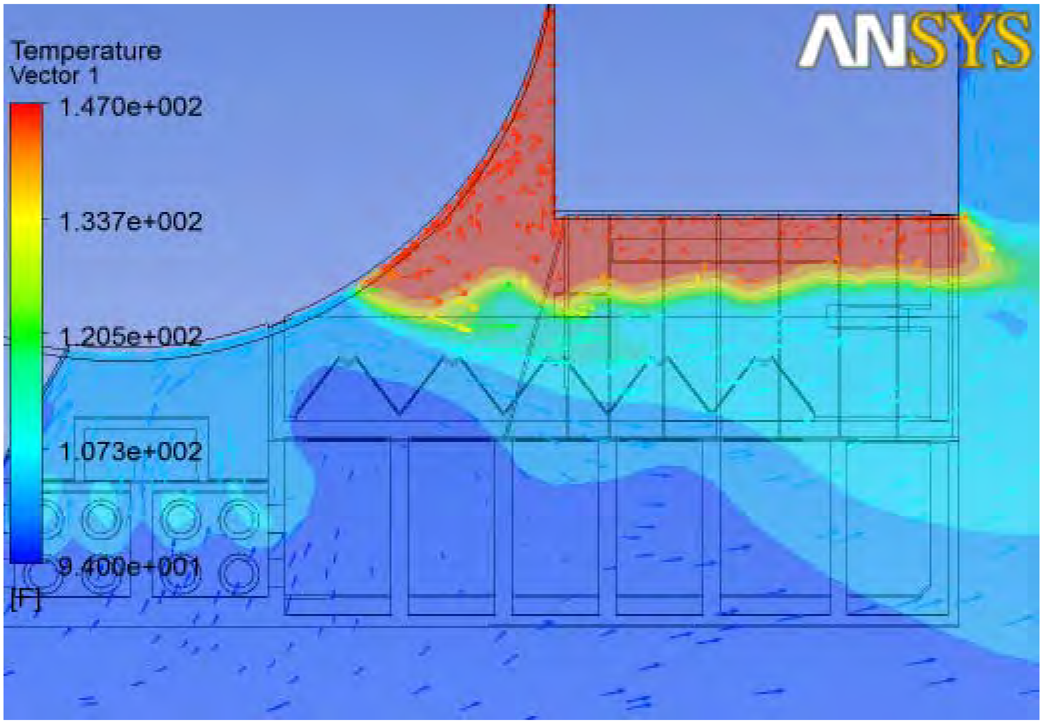


Figure D-124: Velocity vector and temperature contour above the deflector wall

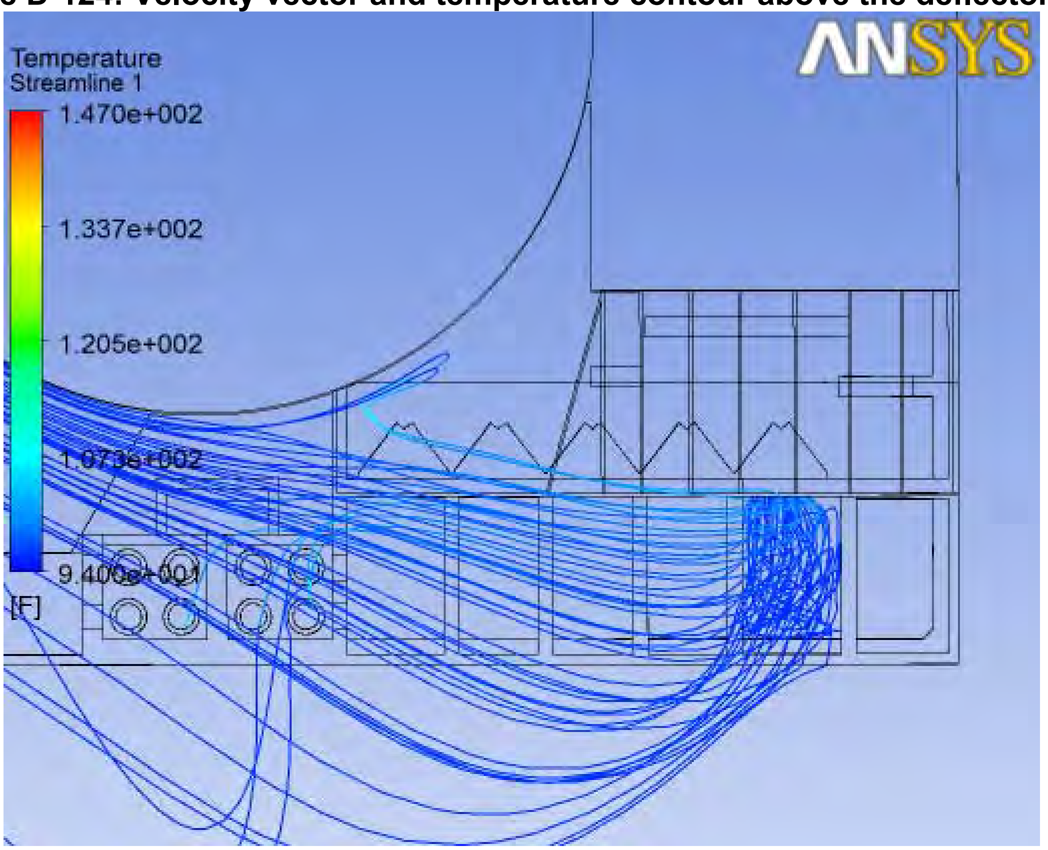


Figure D-125: Streamline at cell 1 for case 10

D-27: Train B Case 11: 102F no wind case

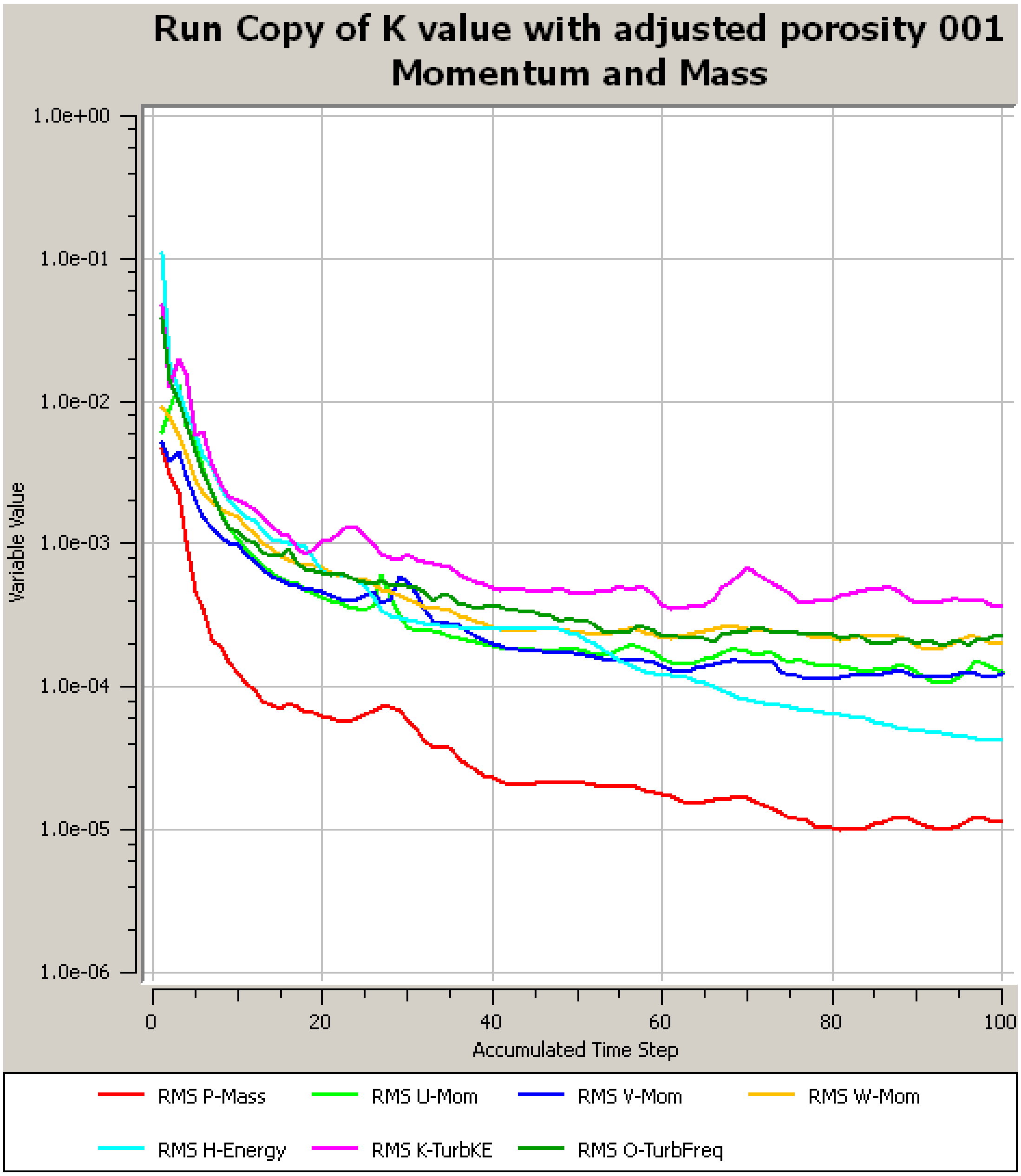


Figure D-126: Residual plot for case 11

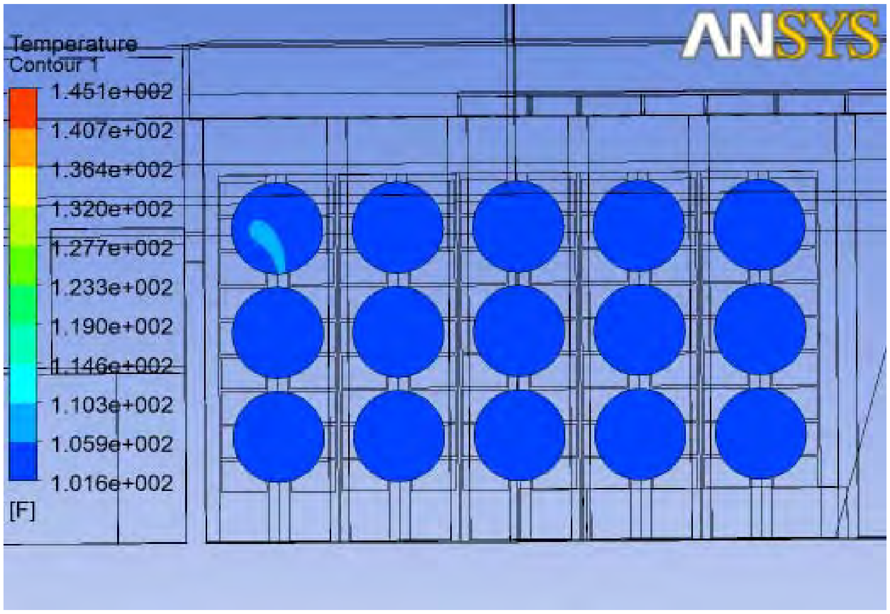


Figure D-127: Fan temperature for case 11

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	104.3	102.1	102.0	102.0	102.0
	103.3	102.0	102.0	102.0	102.0
	102.4	102.0	102.0	102.0	102.0
Average fan temperature:			102.3		

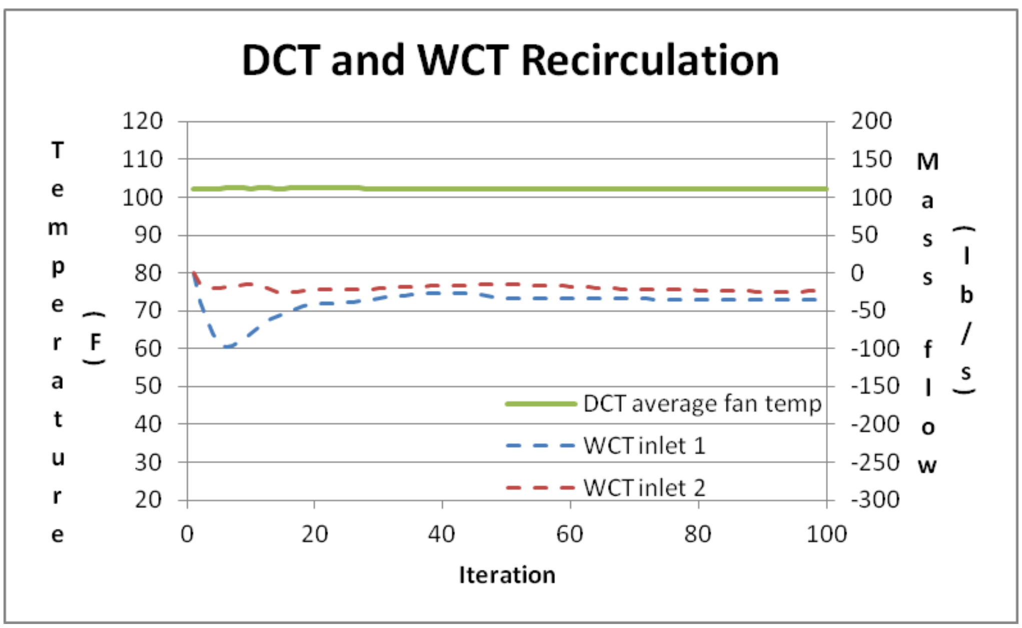


Figure D-128: DCT and WCT recirculation with iteration for case 11

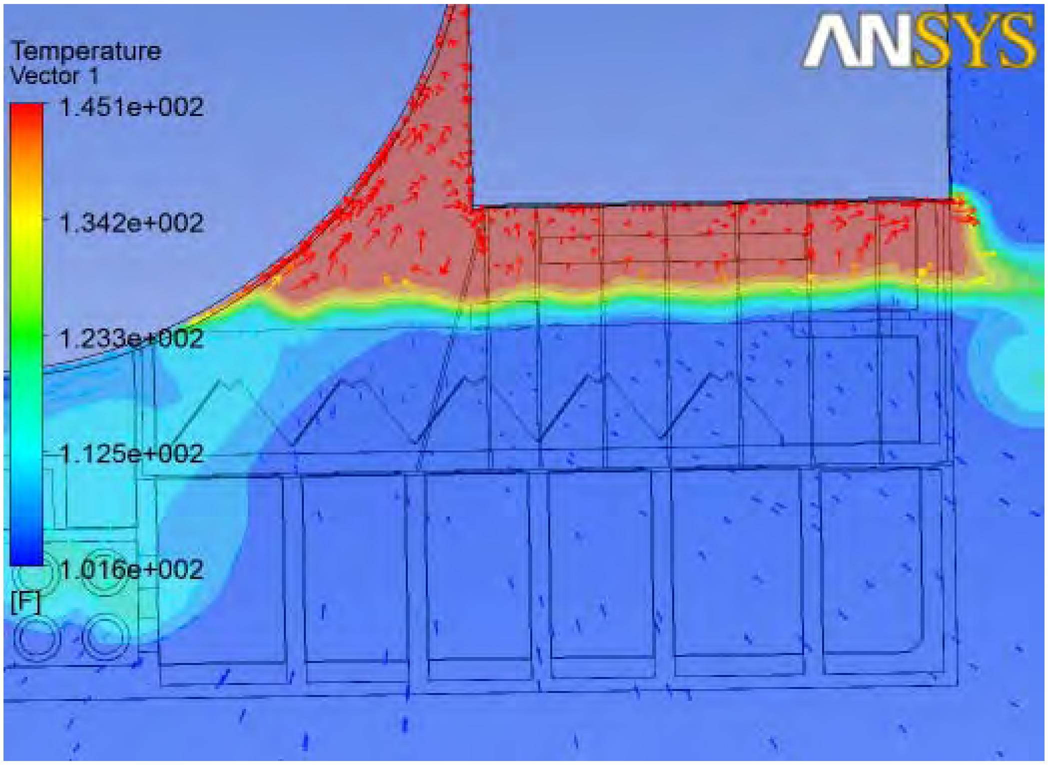


Figure D-129: Velocity vector and temperature contour above the deflector wall

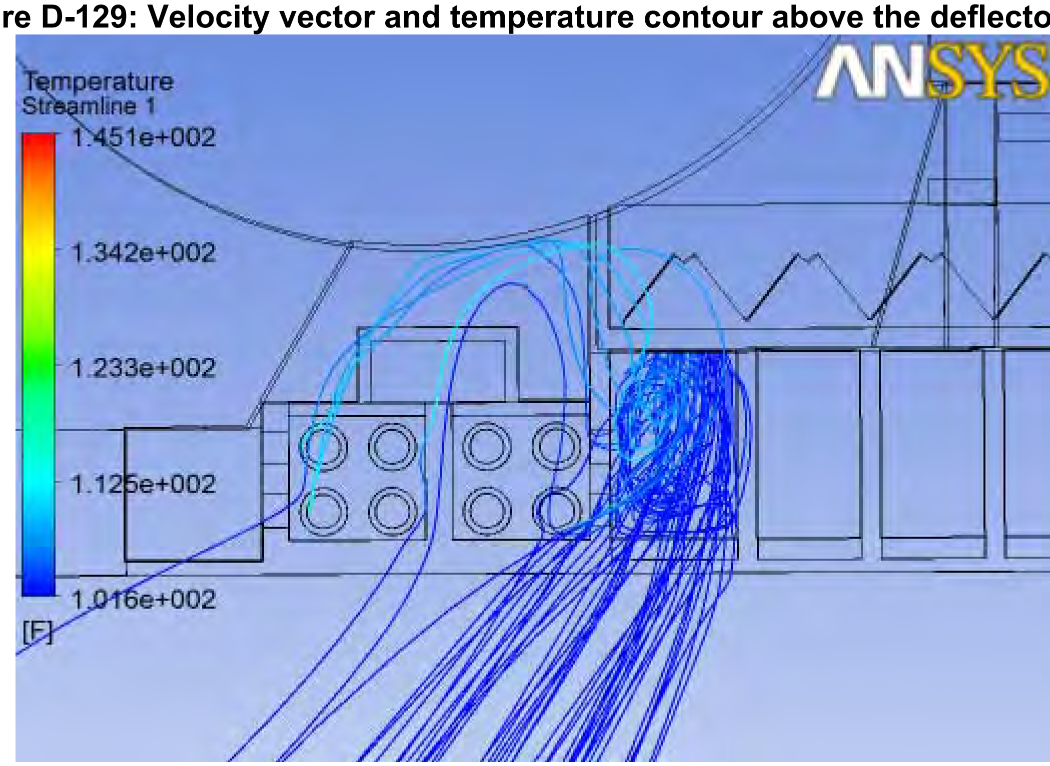


Figure D-130: Streamline at cell 5 for case 11

Attachment E

Horizontal Wall Modification Studies

E-1: Train A Case 2: Southeast wind with 30mph wind and 90F Ambient

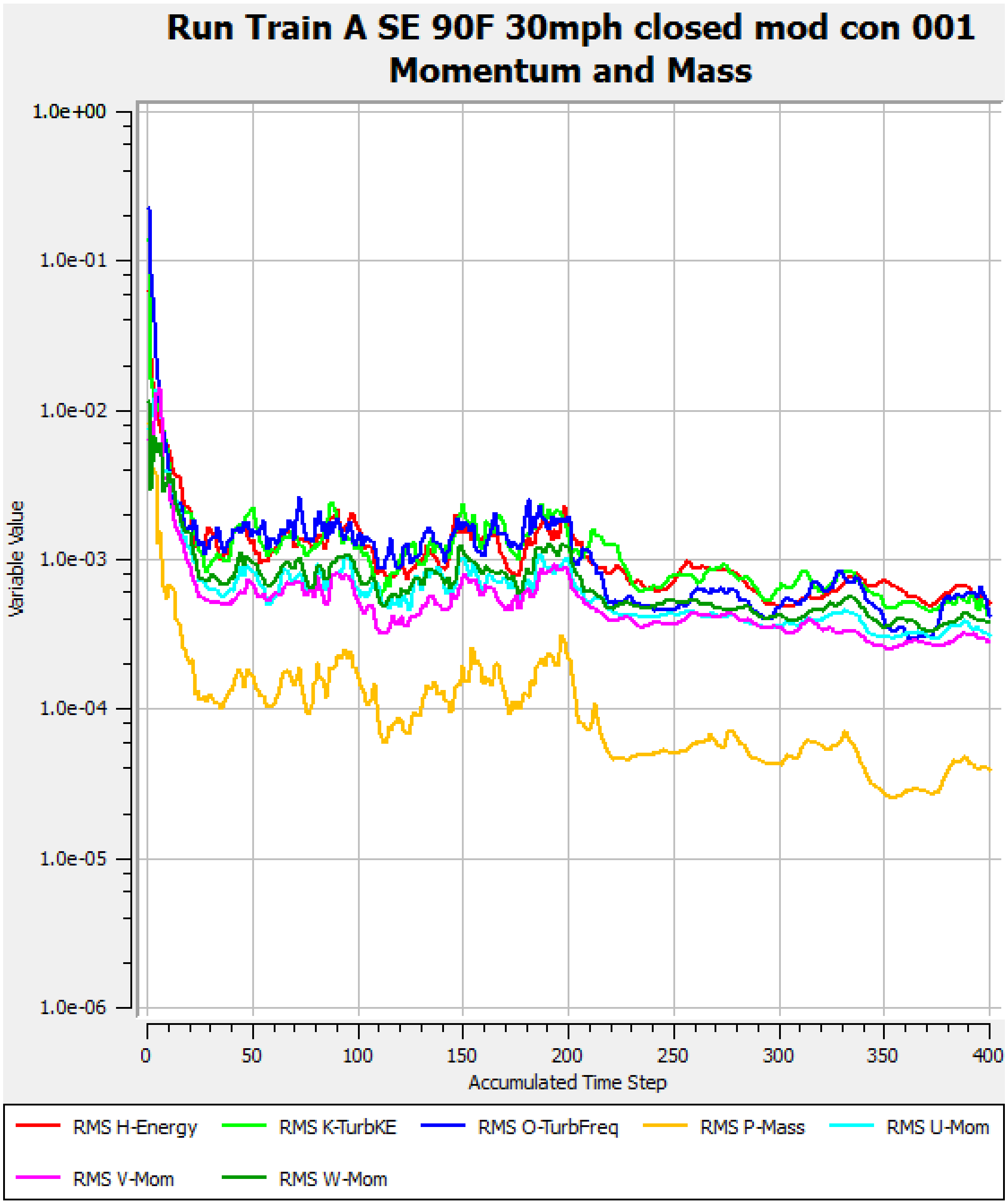


Figure E-1: Residual plot for case 2

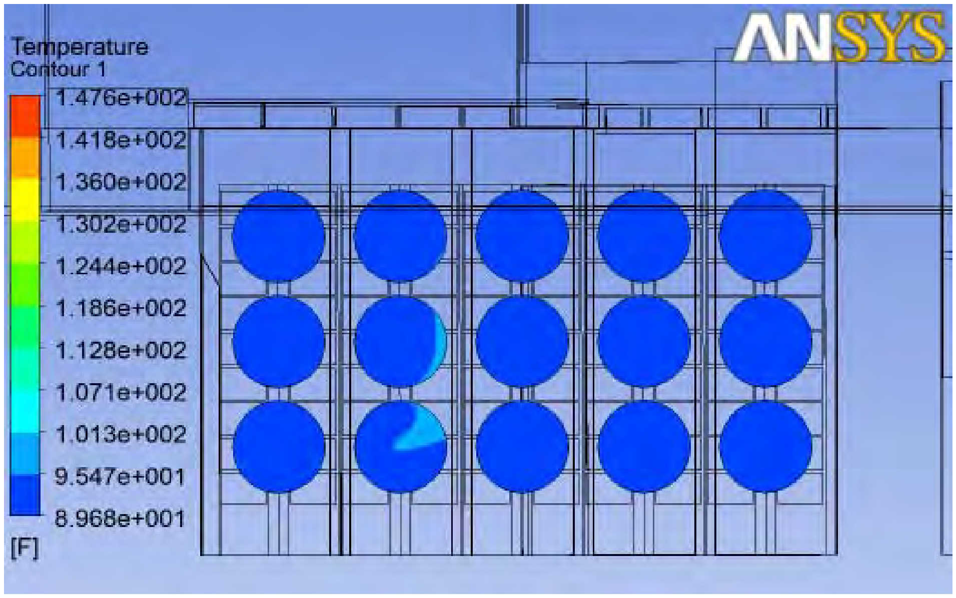


Figure E-2: Fan temperature for case 2

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	93.0	95.7	93.2	91.9	91.8
	93.6	94.8	93.2	91.8	92.0
	94.2	94.8	93.1	91.8	91.9
Average fan temperature:				93.1	

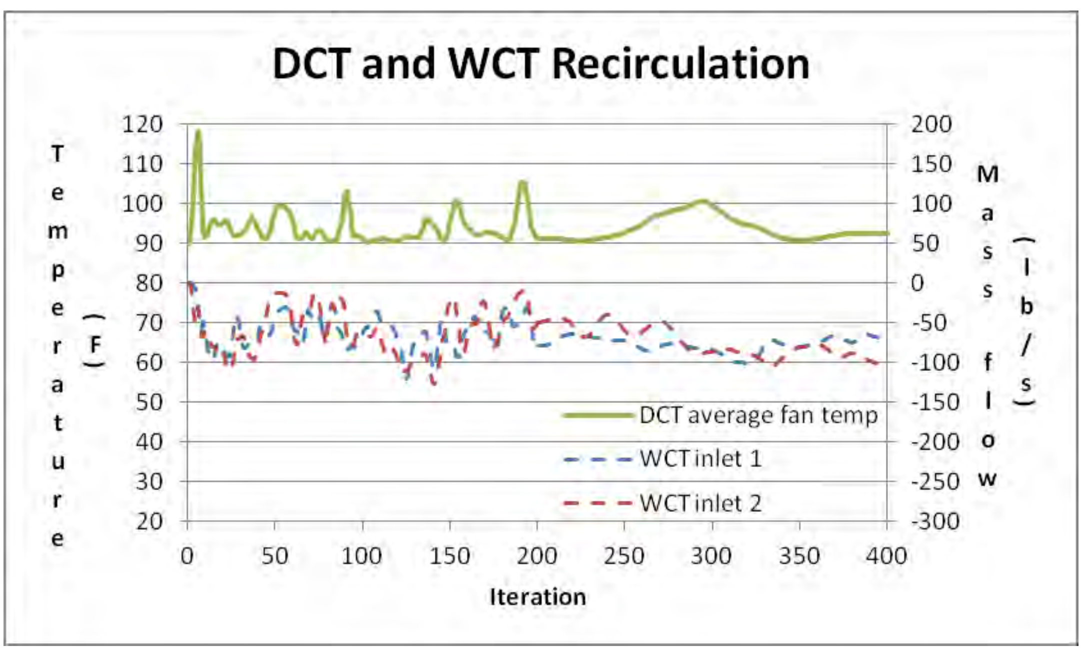


Figure E-3: DCT and WCT recirculation with iteration for case 2

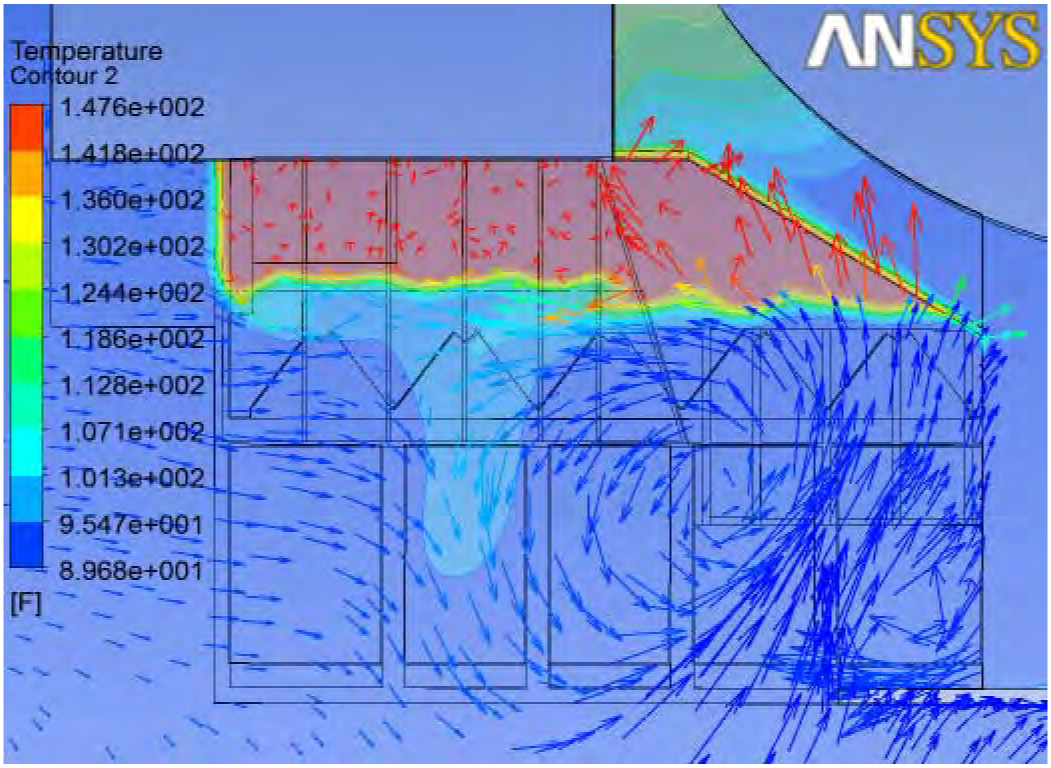


Figure E-4: Velocity vector and temperature contour above the deflector wall

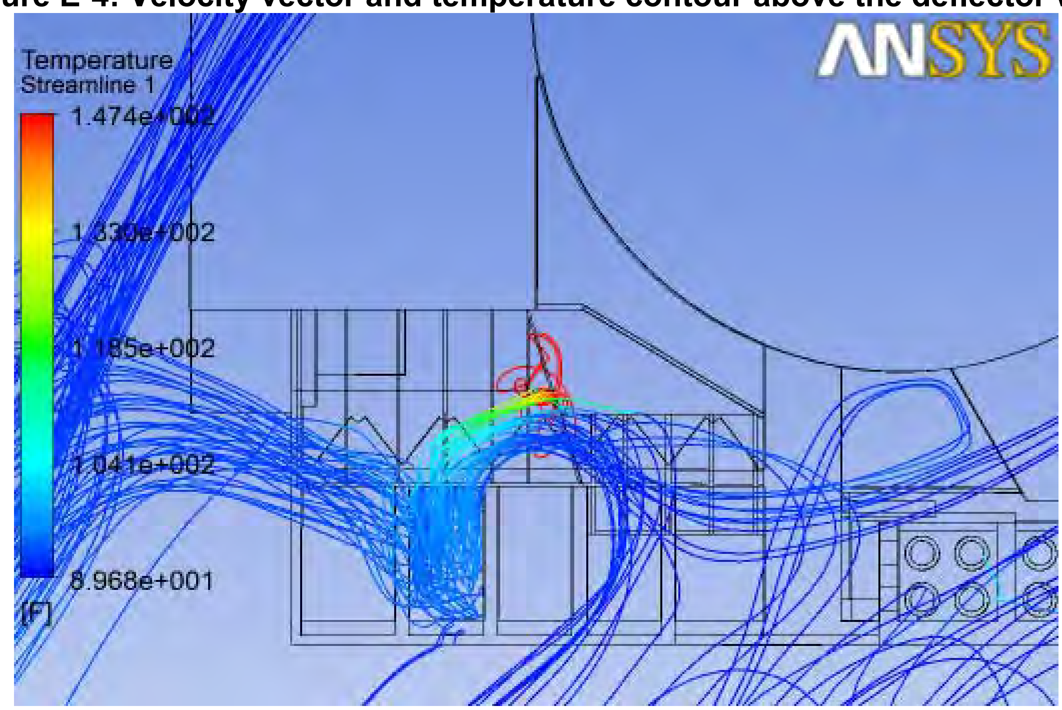


Figure E-5: Streamline at cell 5 for case 2

E-2: Train A Case 3: North wind with 30mph wind and 90F Ambient

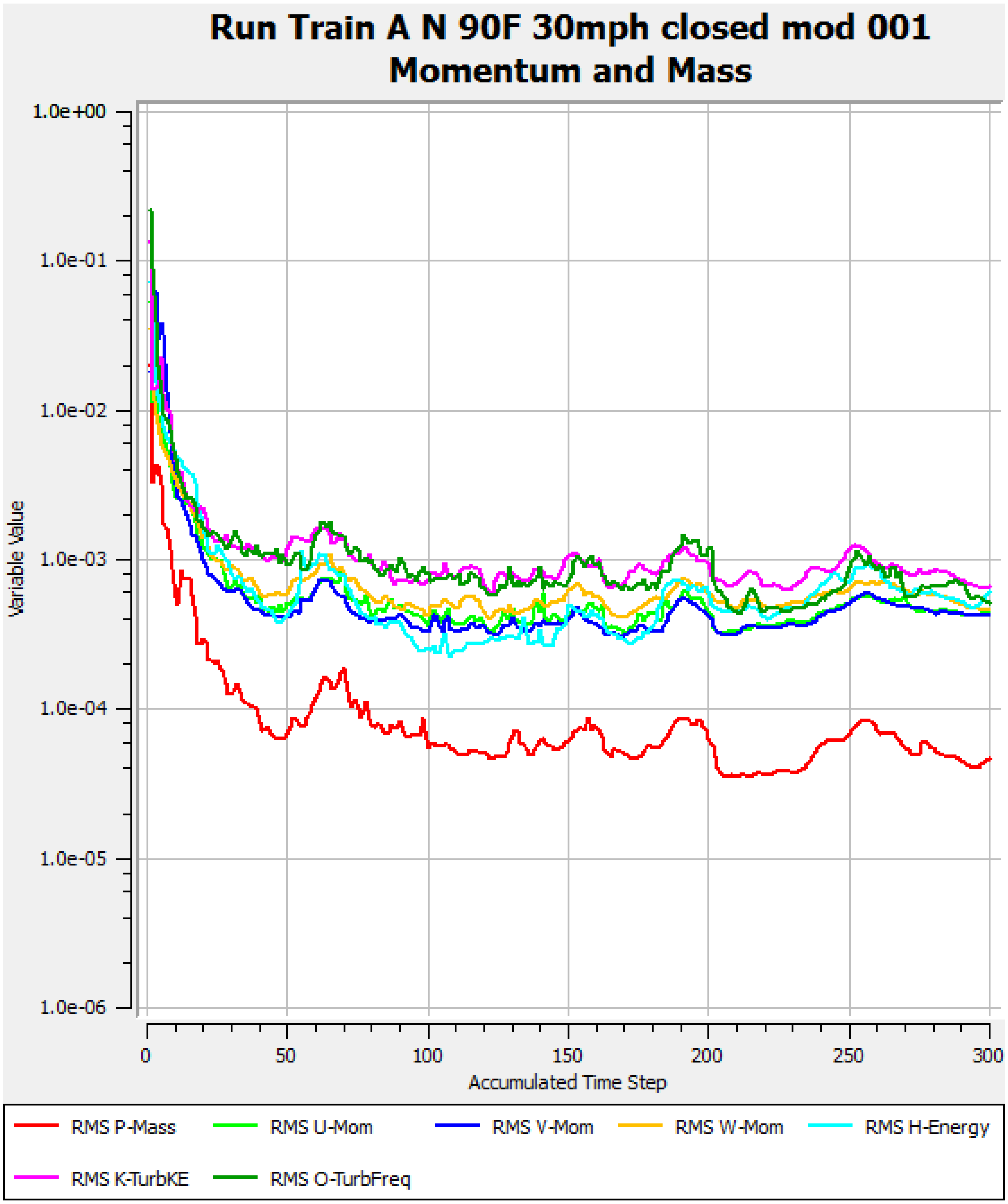


Figure E-6: Residual plot for case 3

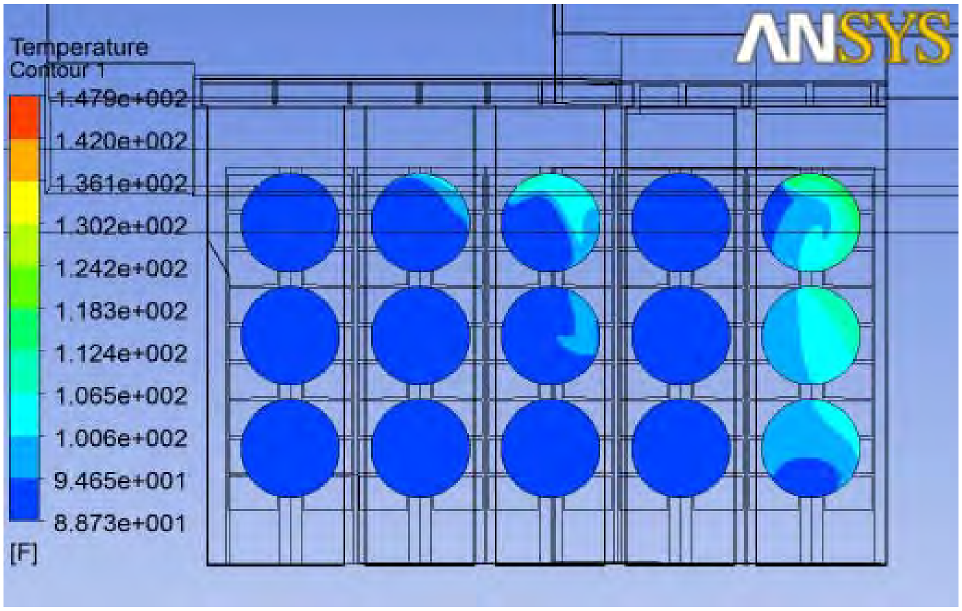


Figure E-7: Fan temperature for case 3

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	90.4	91.1	95.3	90.4	92.8
	90.2	90.4	92.9	90.5	92.6
	90.1	90.1	91.0	90.2	91.7
Average fan temperature:				91.3	

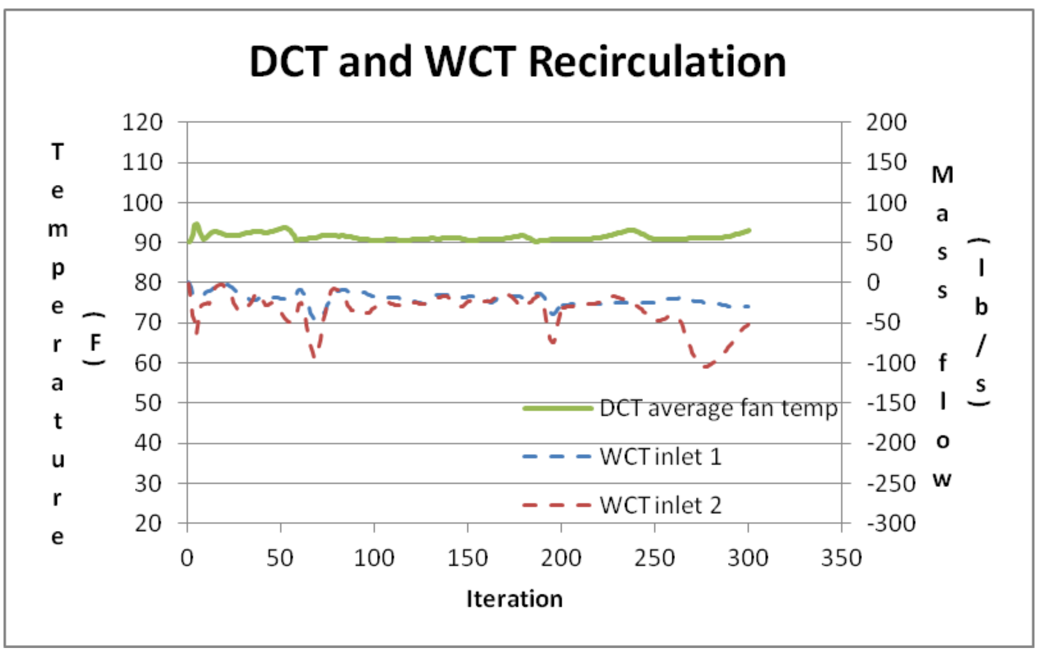


Figure E-8: DCT and WCT recirculation with iteration for case 3

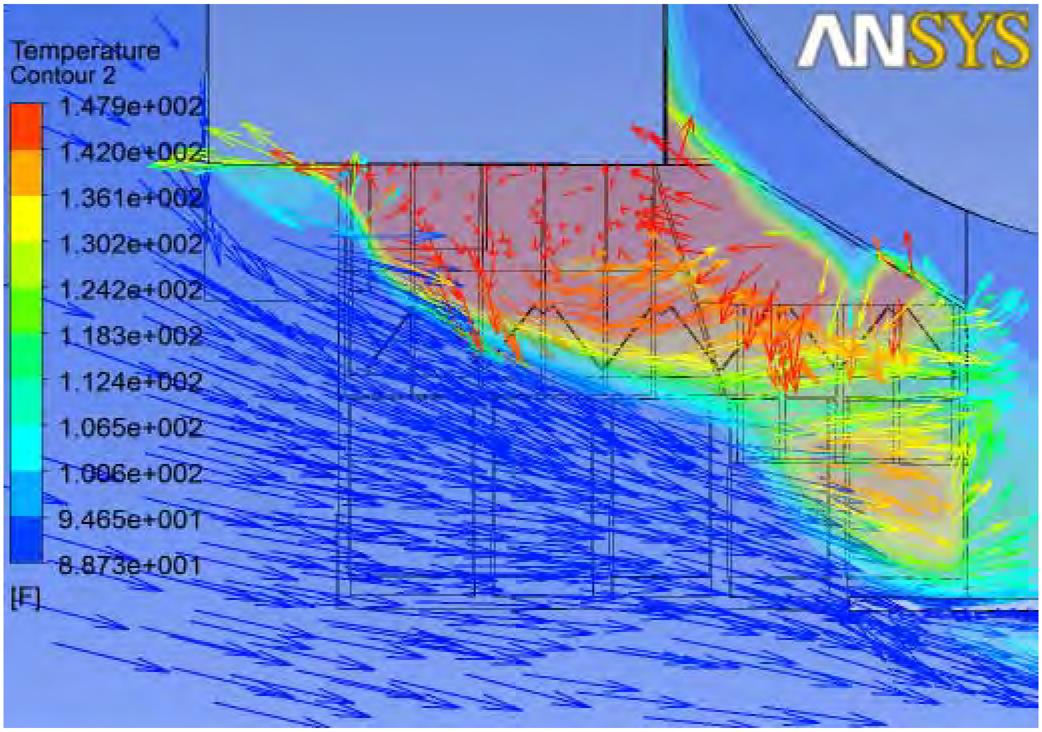


Figure E-9: Velocity vector and temperature contour above the deflector wall

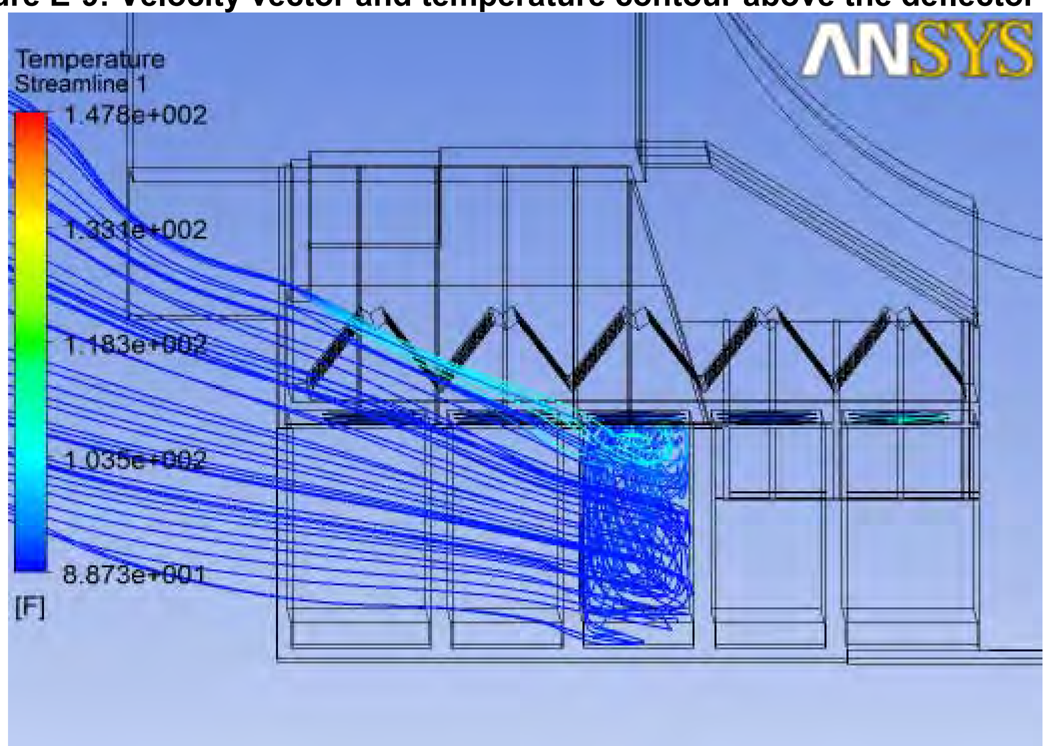


Figure E-10: Streamline at cell 3 for case 3

E-3: Train A Case 4: South wind with 30mph wind and 90F Ambient

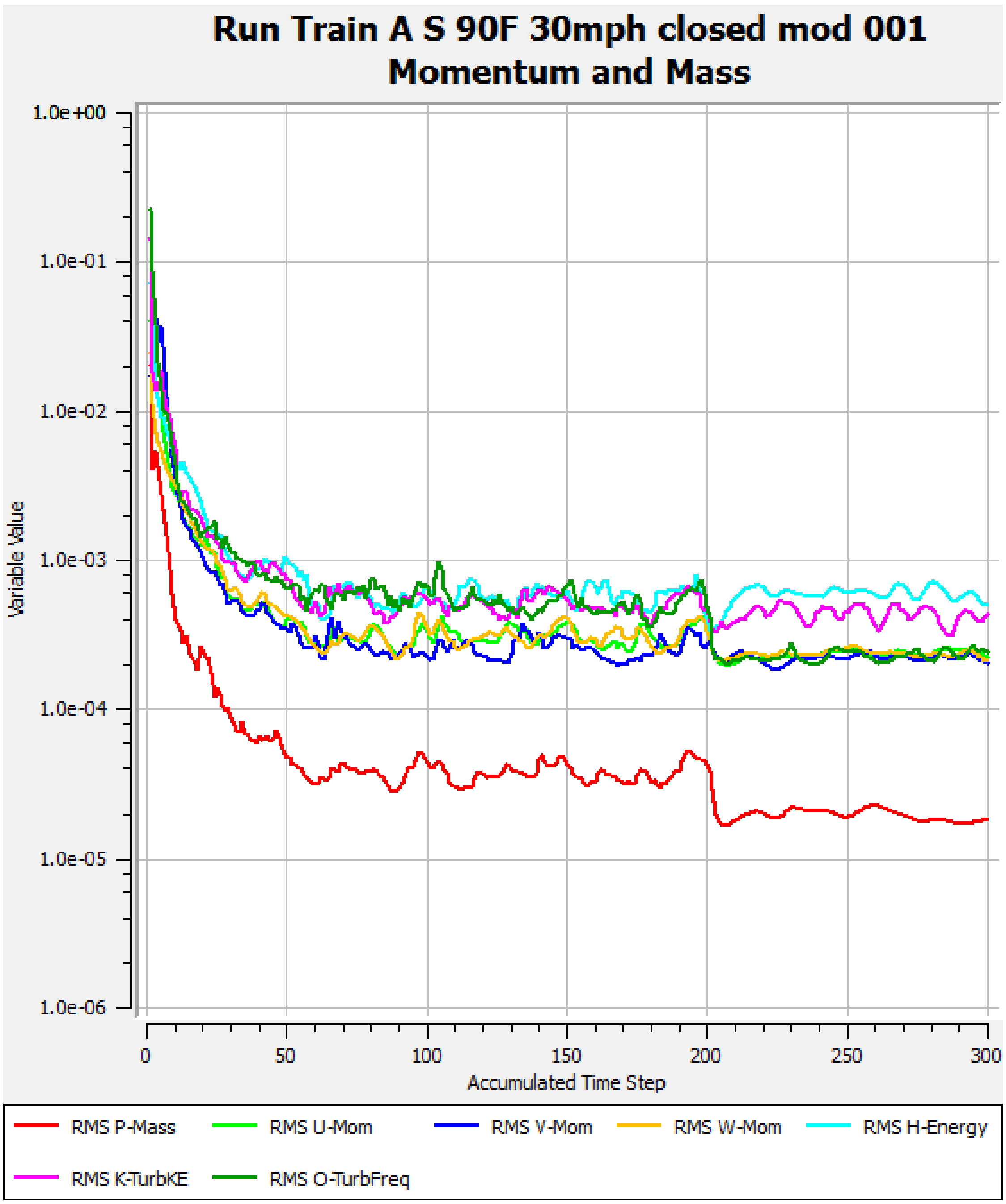


Figure E-11: Residual plot for case 4

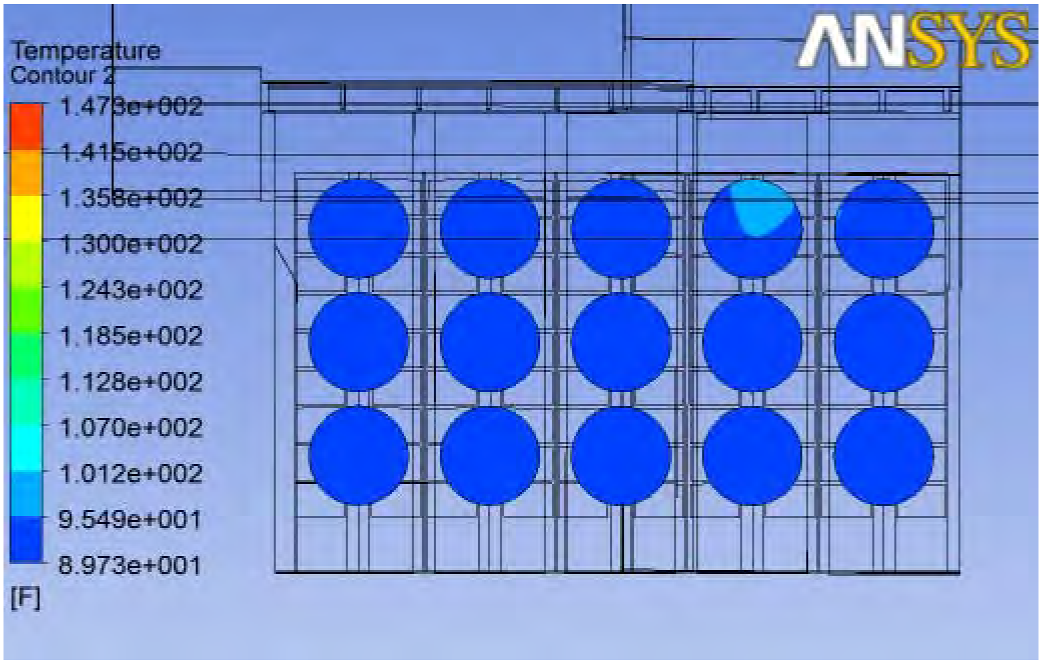


Figure E-12: Fan temperature for case 4

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	90.8	91.6	93.7	94.9	93.5
	90.7	91.1	92.2	92.9	93.3
	90.7	90.9	91.7	92.1	92.9
Average fan temperature:				92.2	

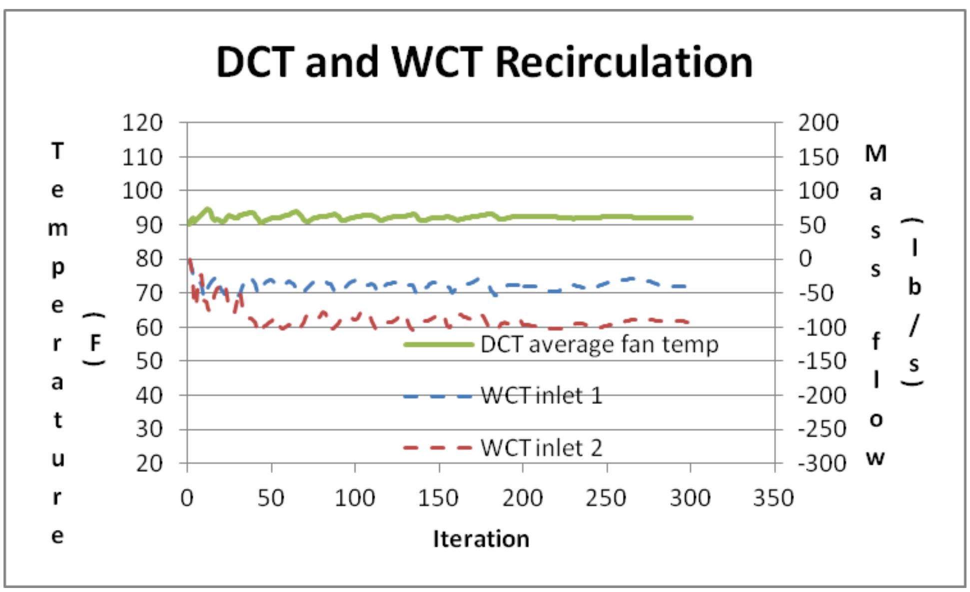


Figure E-13: DCT and WCT recirculation with iteration for case 4

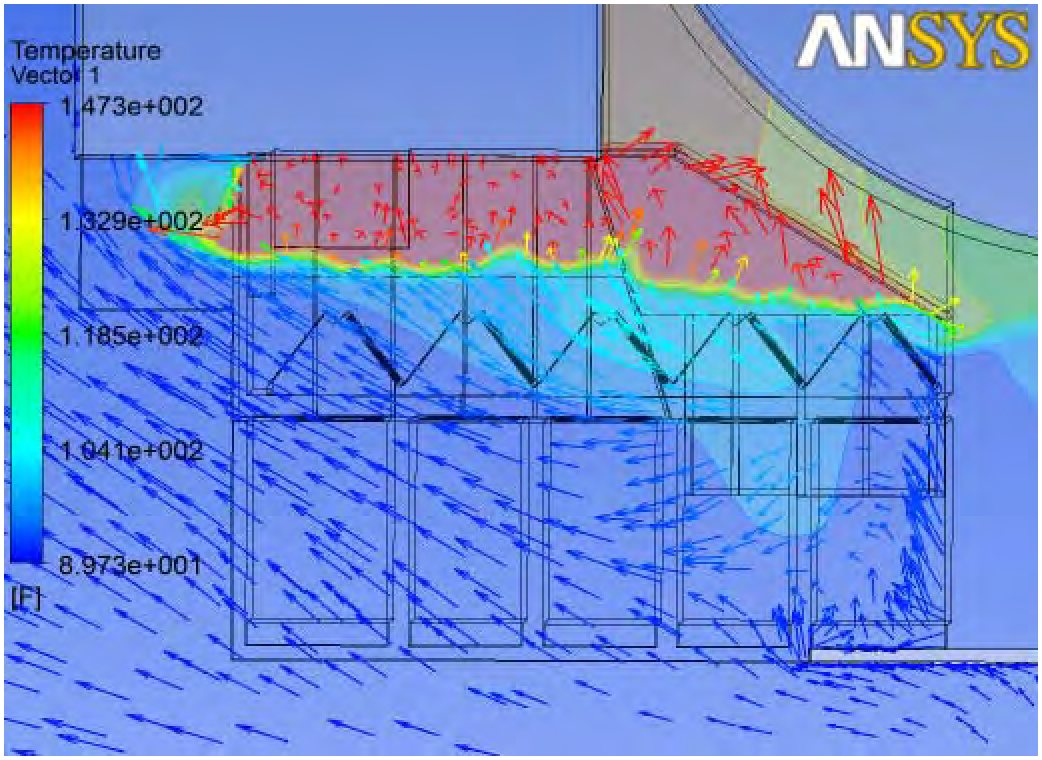


Figure E-14: Velocity vector and temperature contour above the deflector wall

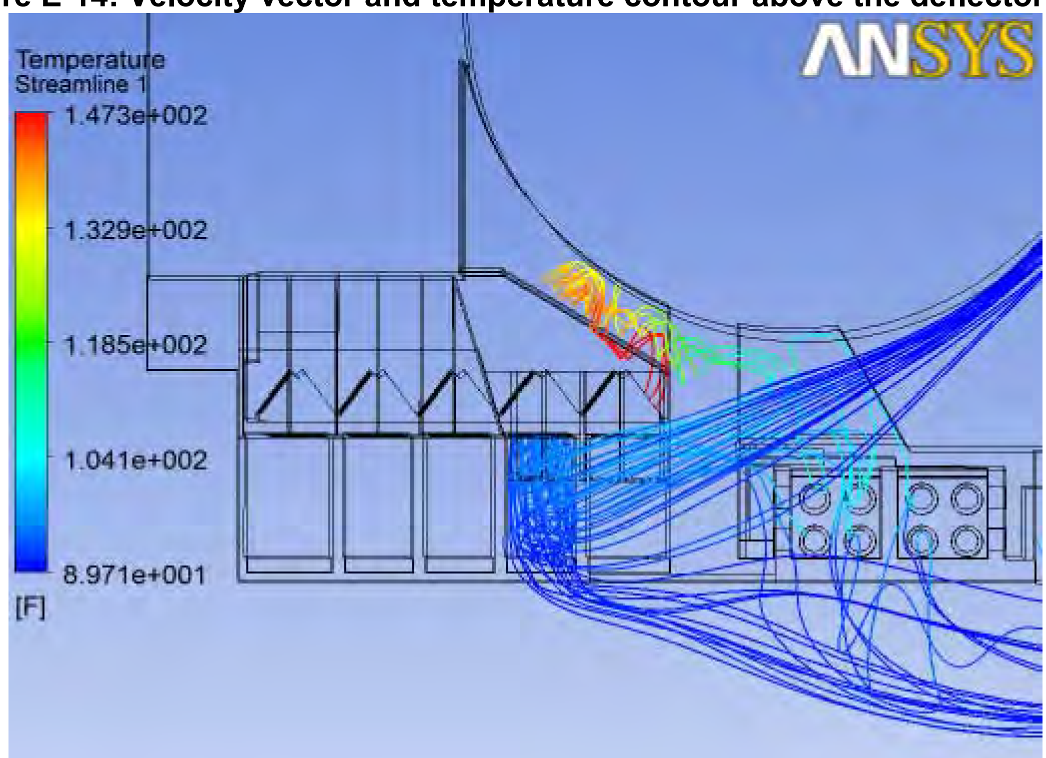


Figure E-15: Streamline at cell 4 for case 4

E-4: Train A Case 5: East wind with 30mph wind and 90F Ambient

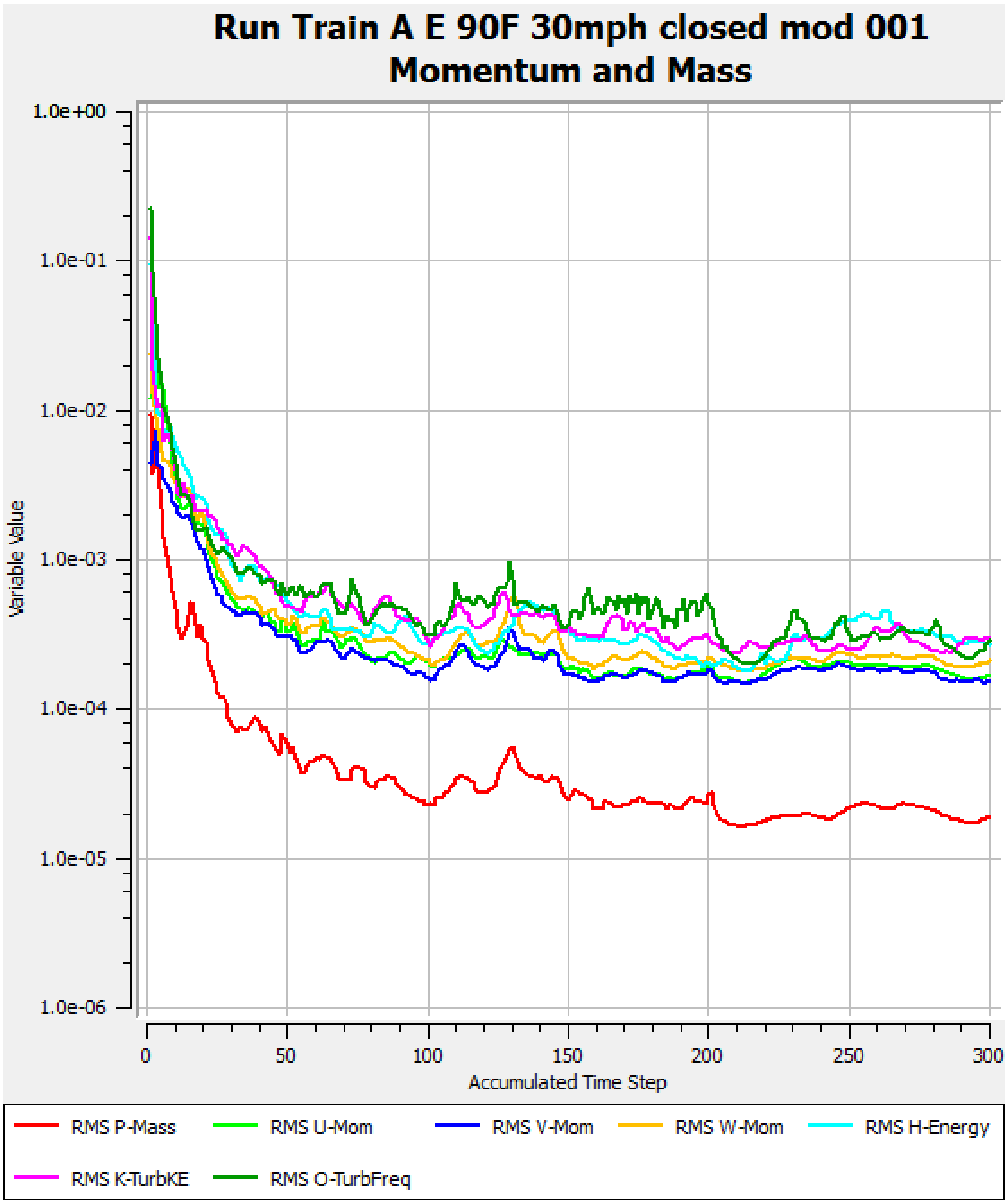


Figure E-16: Residual plot for case 5

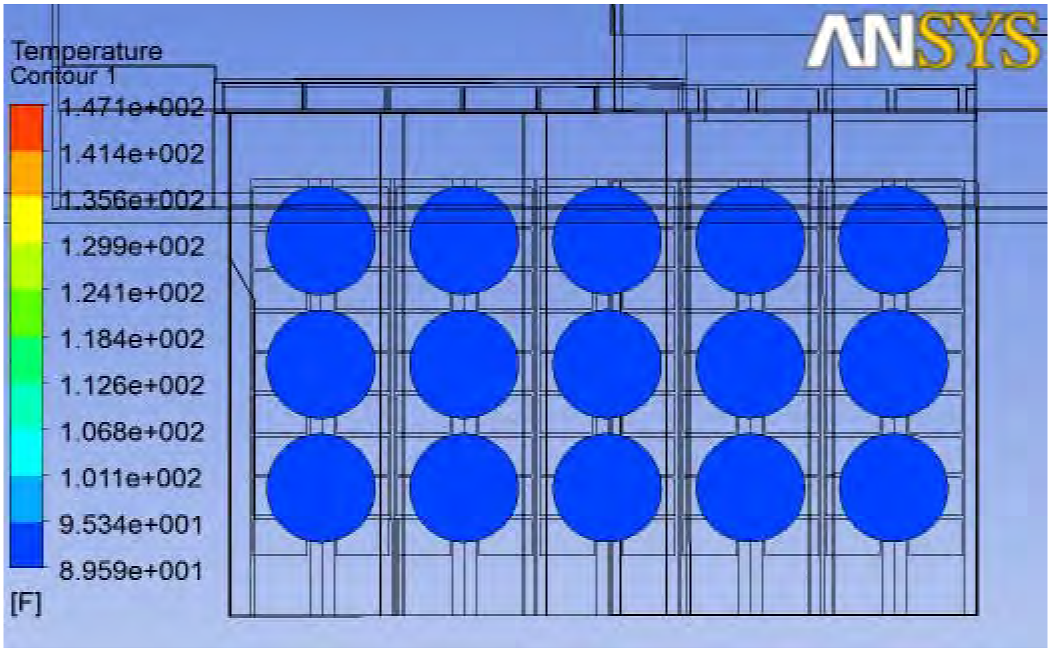


Figure E-17: Fan temperature for case 5

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	92.8	92.8	91.4	90.9	90.3
	92.3	92.7	91.5	90.5	90.3
	92.0	92.4	91.5	90.3	90.3
Average fan temperature:				91.5	

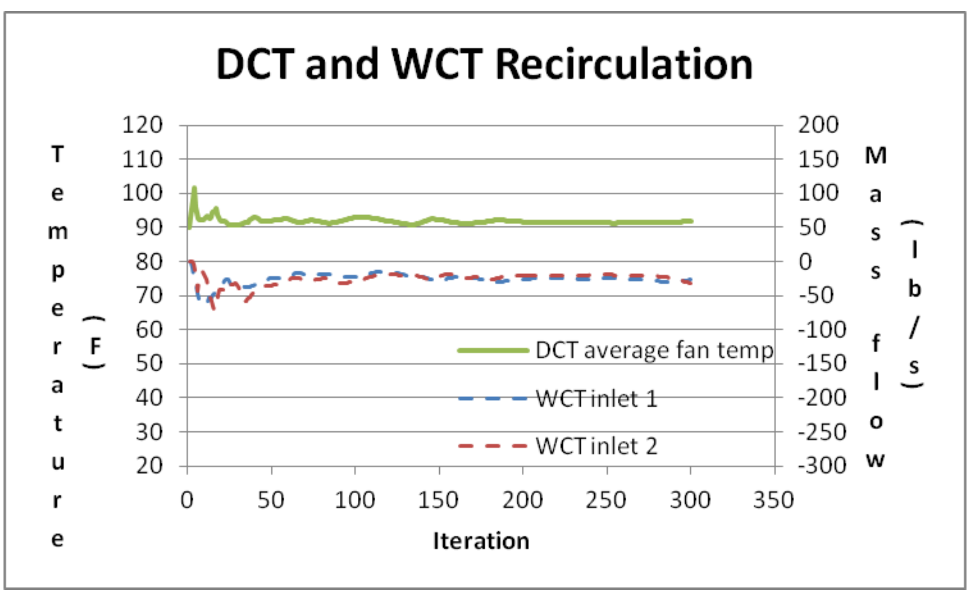


Figure E-18: DCT and WCT recirculation with iteration for case 5

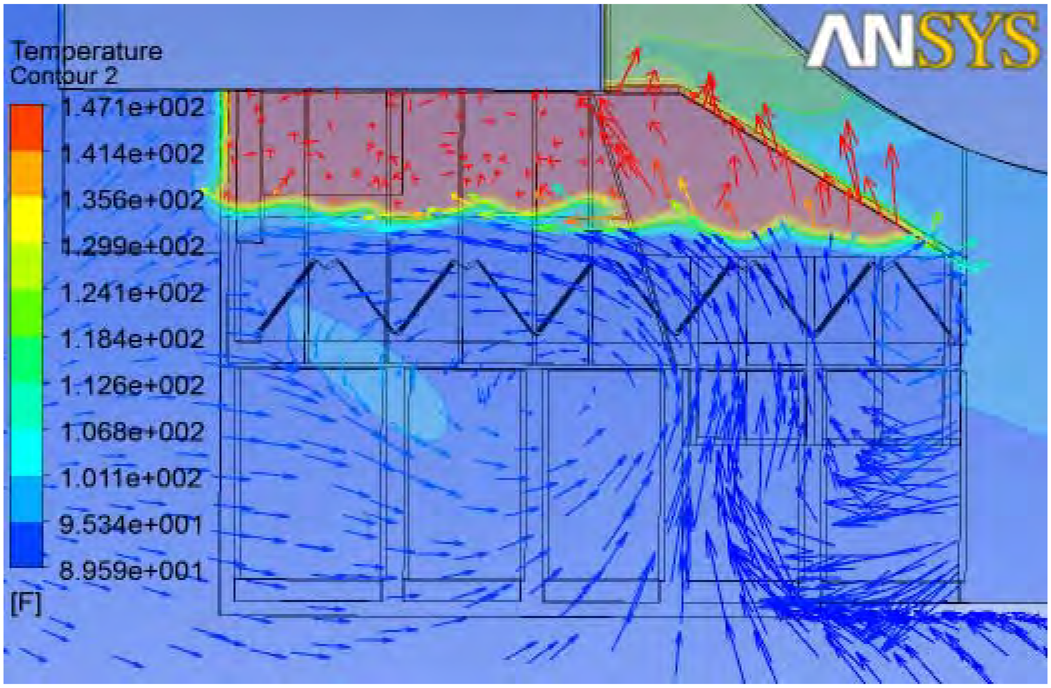


Figure E-19: Velocity vector and temperature contour above the deflector wall

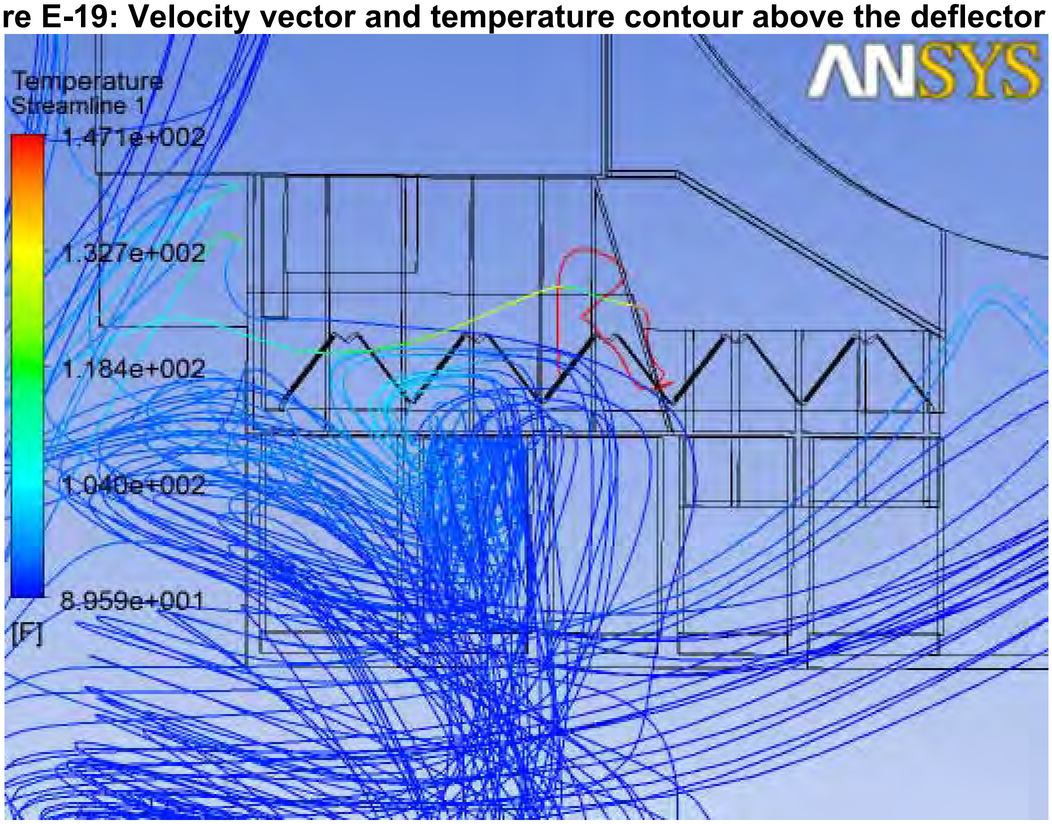


Figure E-20: Streamline at cell 2 for case 5

E-5: Train A Case 6: Northeast wind with 10mph wind and 98F Ambient

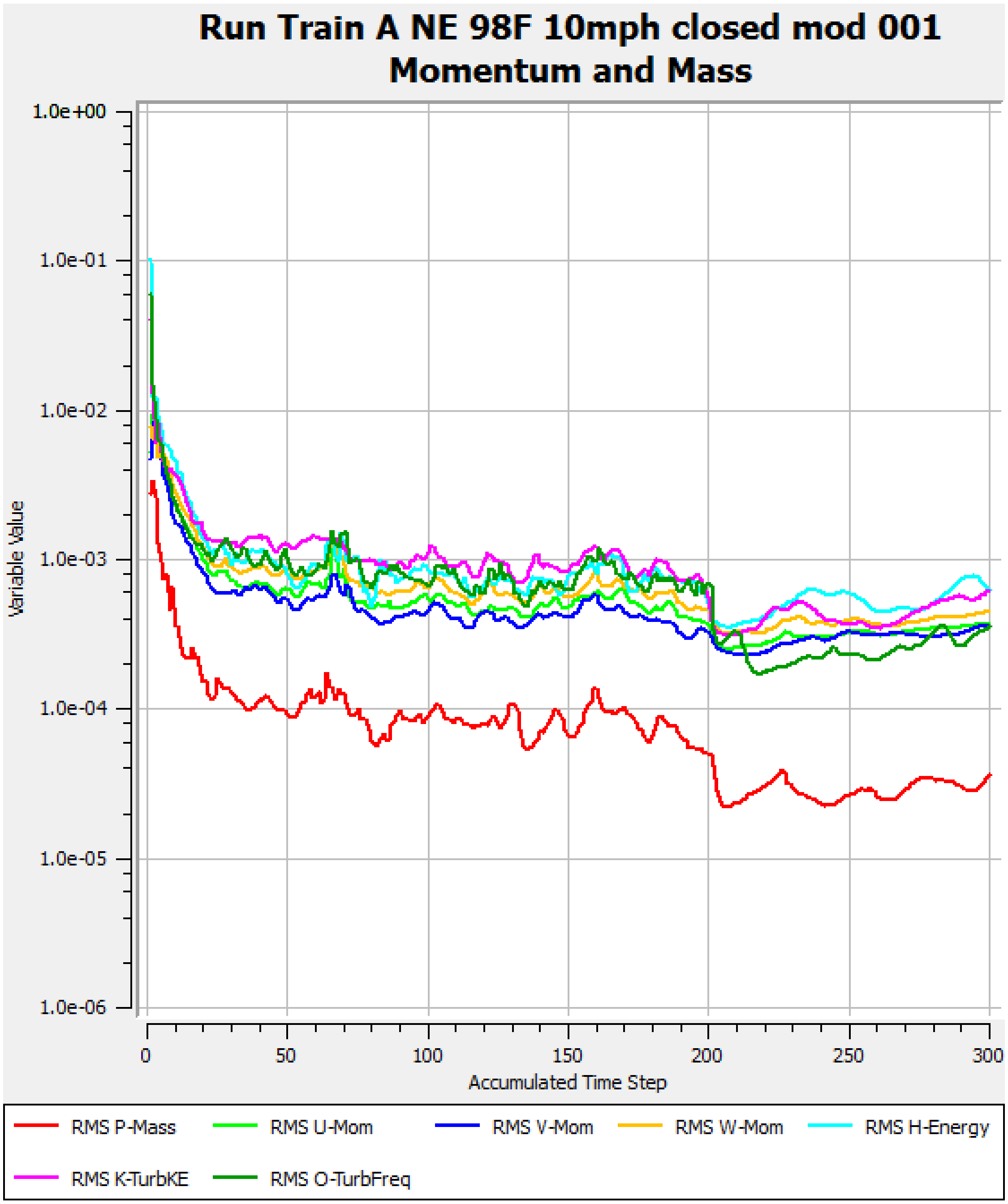


Figure E-21: Residual plot for case 6

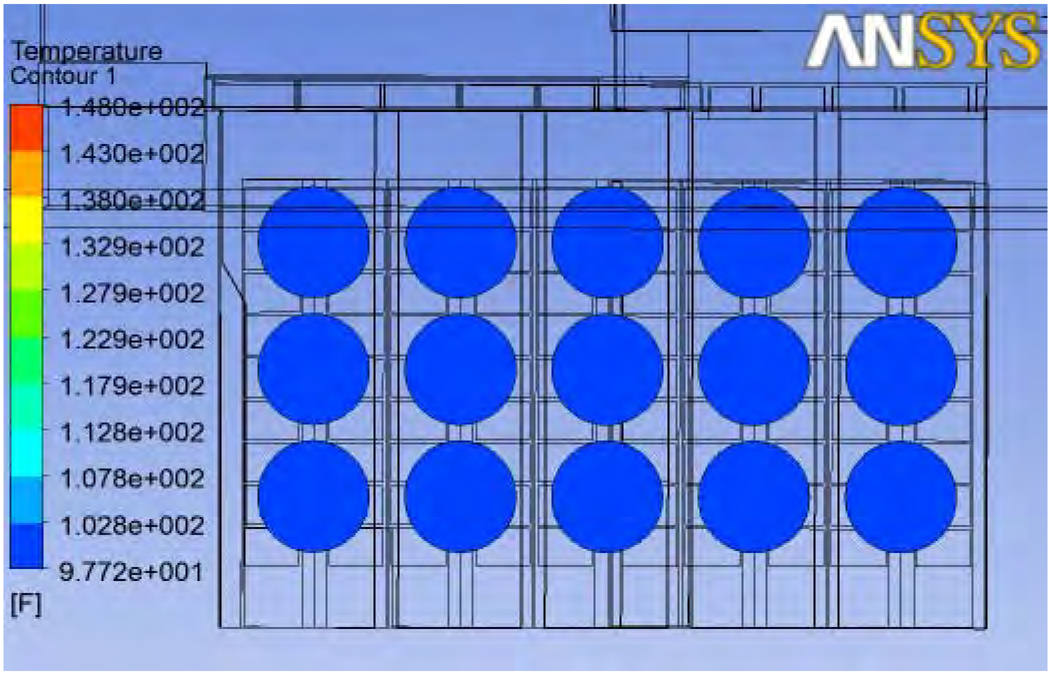


Figure E-22: Fan temperature for case 6

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	99.9	100.3	100.5	100.2	100.5
	100.2	100.8	100.1	99.7	100.0
	99.7	100.9	100.3	99.8	100.3
Average fan temperature:				100.2	

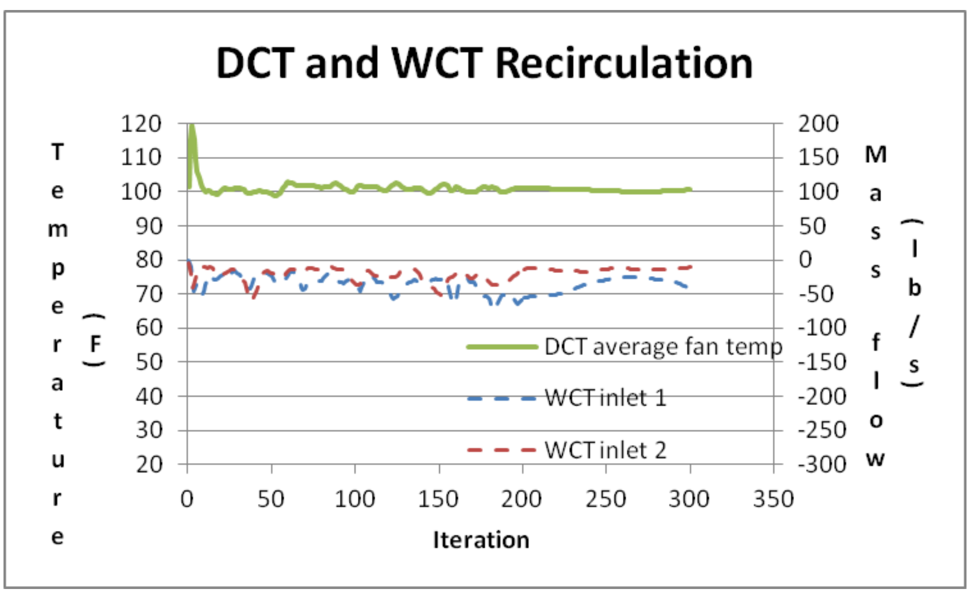


Figure E-23: DCT and WCT recirculation with iteration for case 6

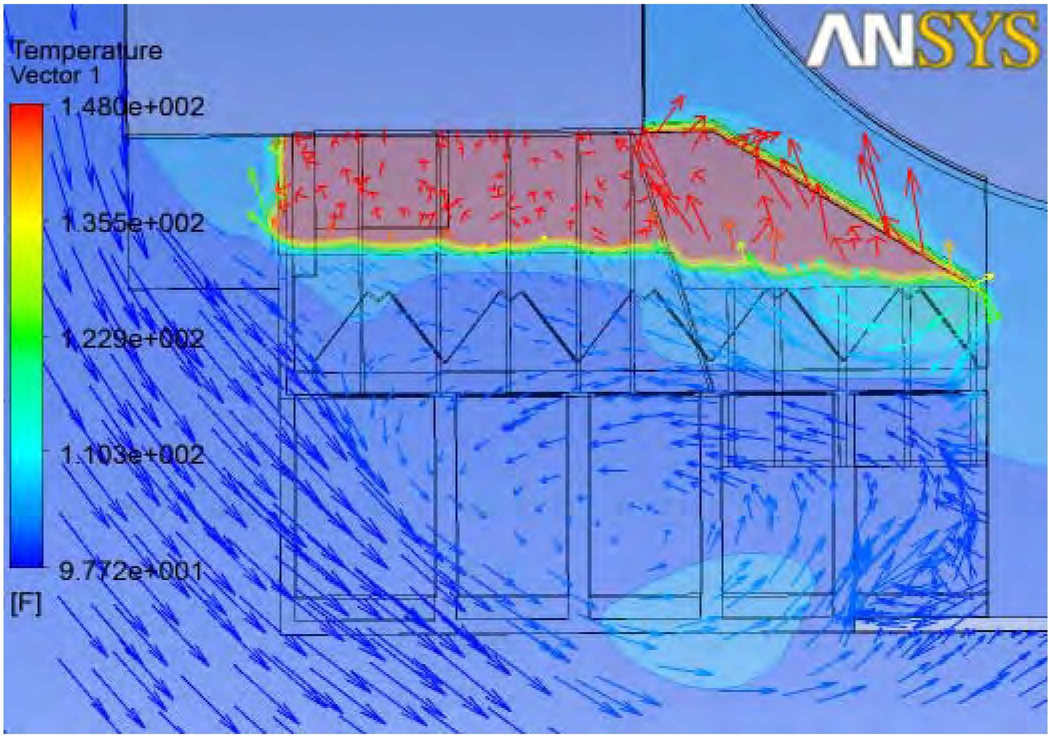


Figure E-24: Velocity vector and temperature contour above the deflector wall

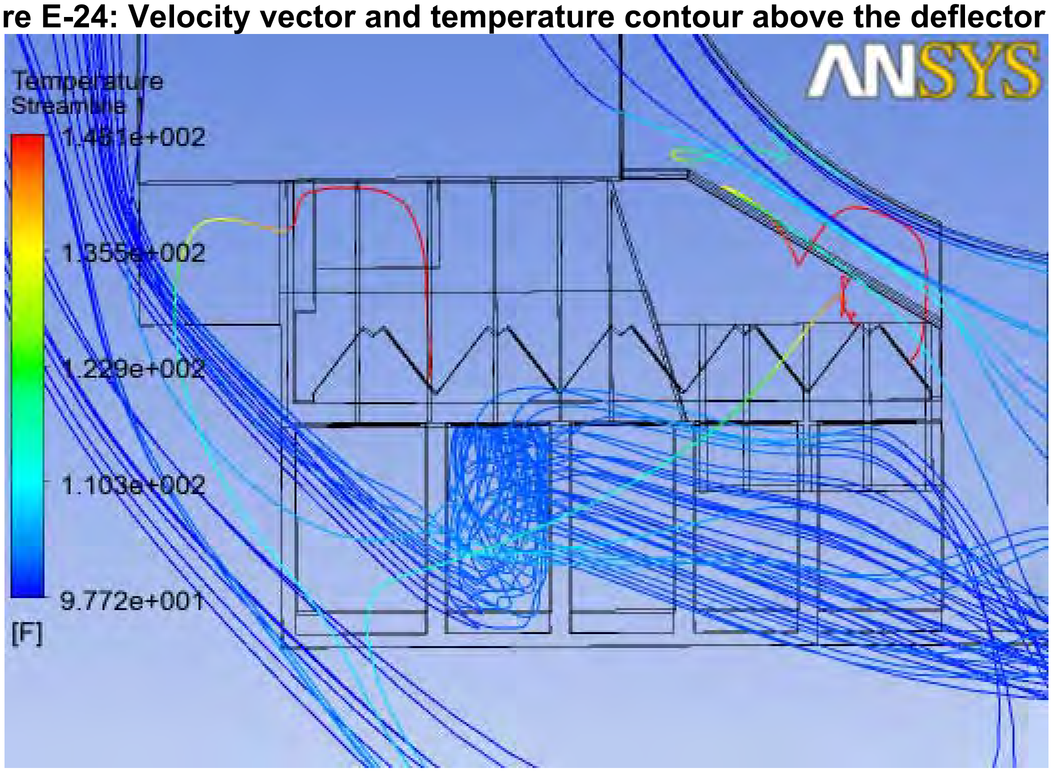


Figure E-25: Streamline at cell 2 for case 6

E-6: Train A Case 7: Southeast wind with 10mph wind and 98F Ambient

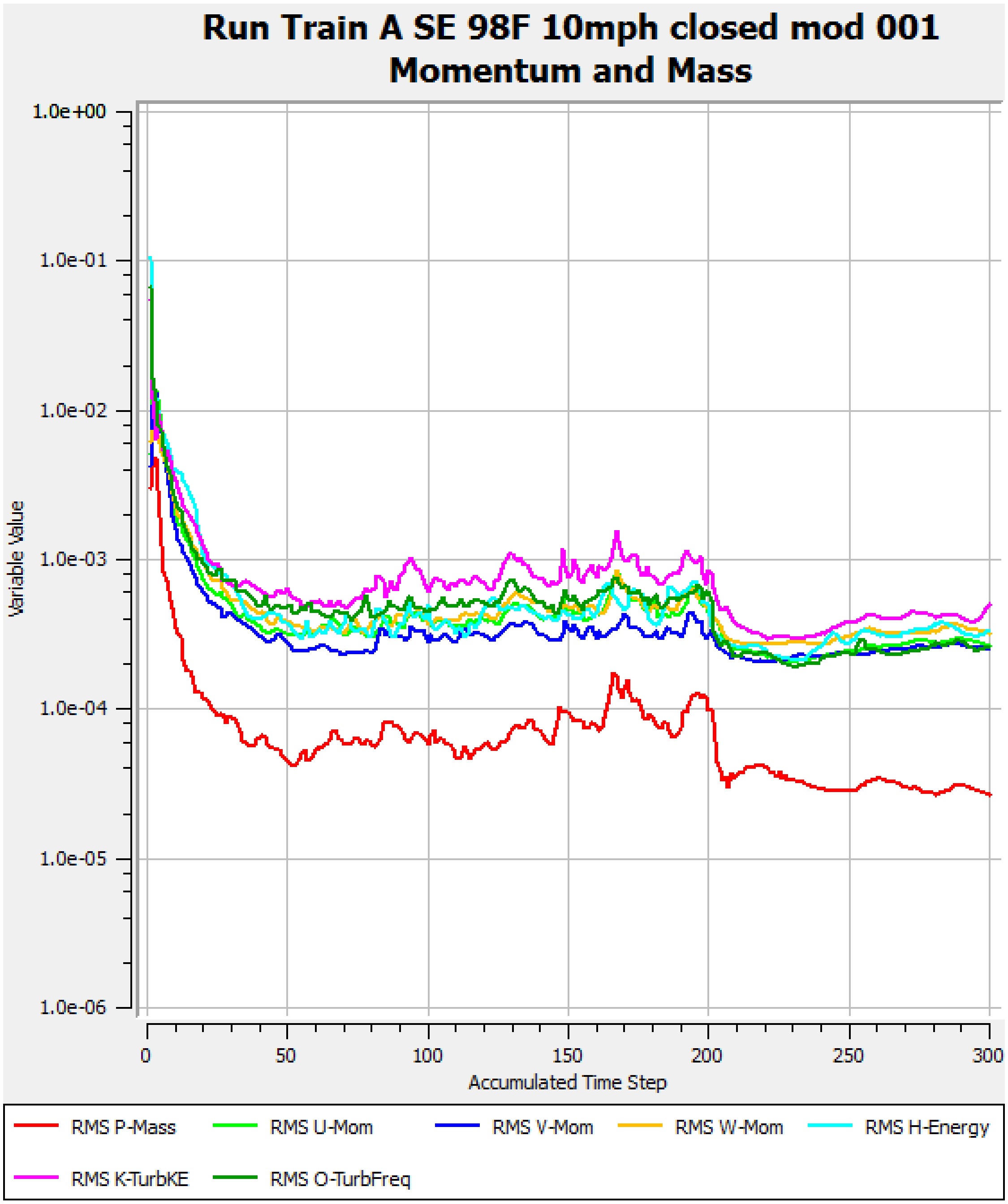


Figure E-26: Residual plot for case 7

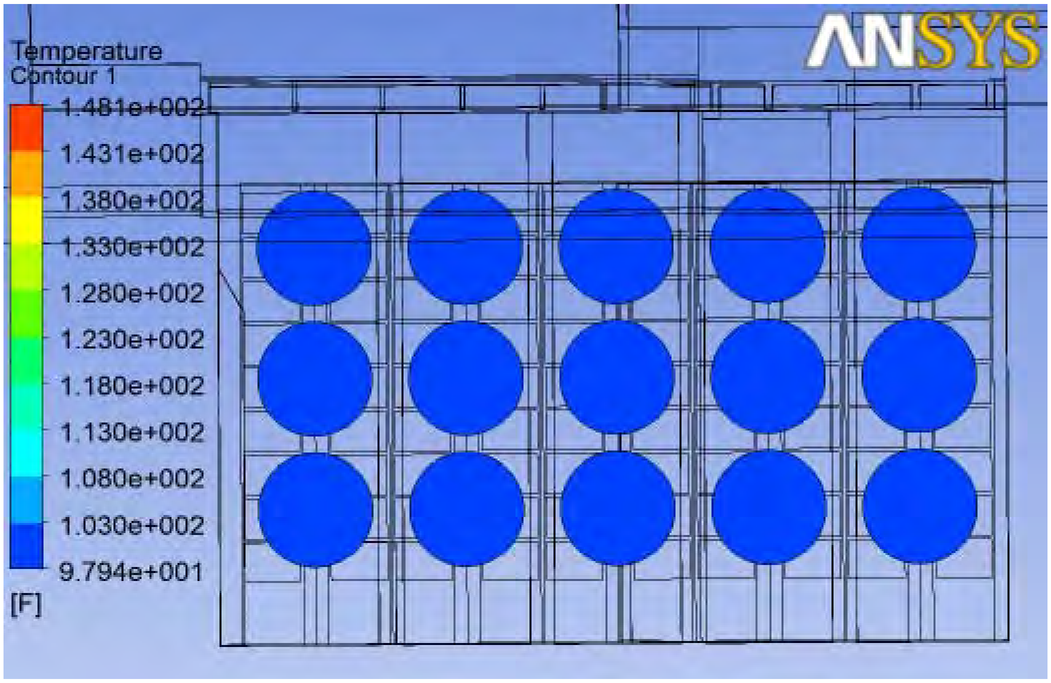


Figure E-27: Fan temperature for case 7

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	98.4	98.9	100.0	99.4	98.9
	98.4	98.6	99.2	98.4	99.0
	98.2	98.1	98.3	98.2	99.0
Average fan temperature:			98.7		

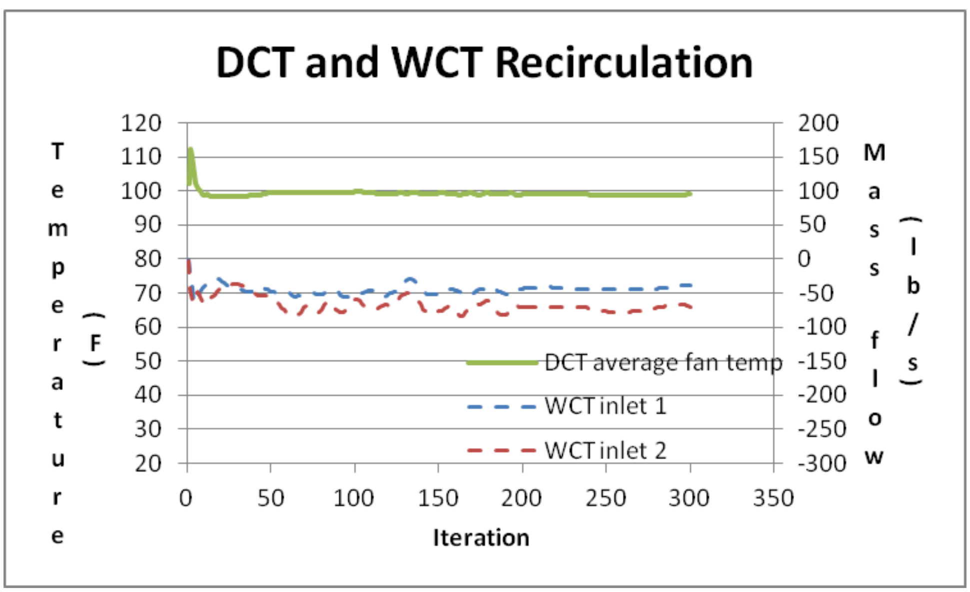


Figure E-28: DCT and WCT recirculation with iteration for case 7

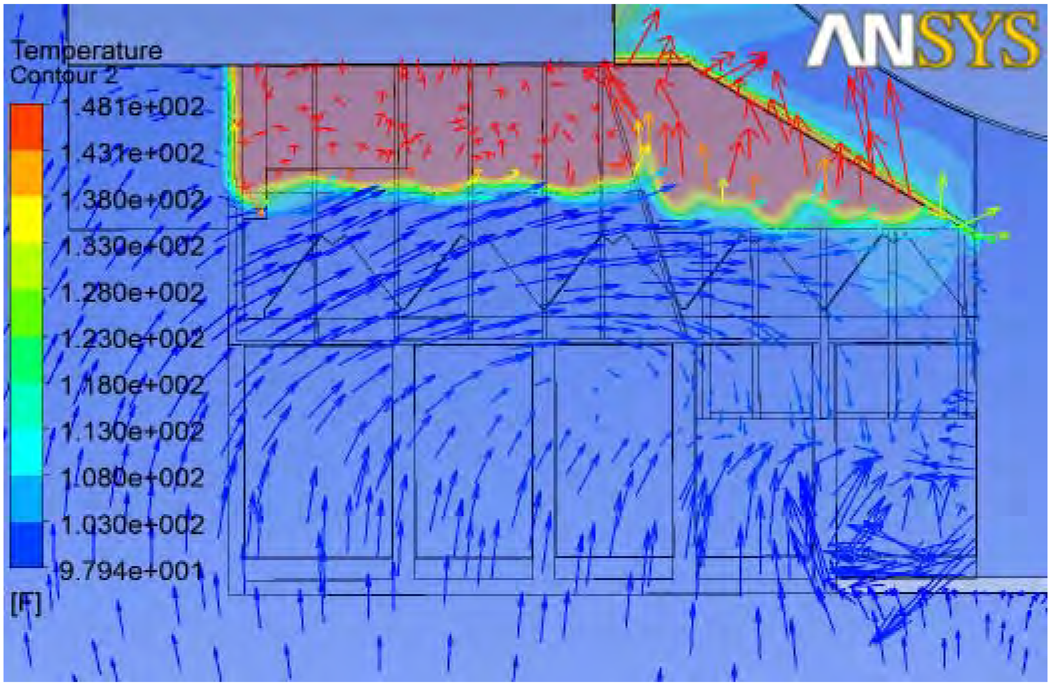


Figure E-29: Velocity vector and temperature contour above the deflector wall

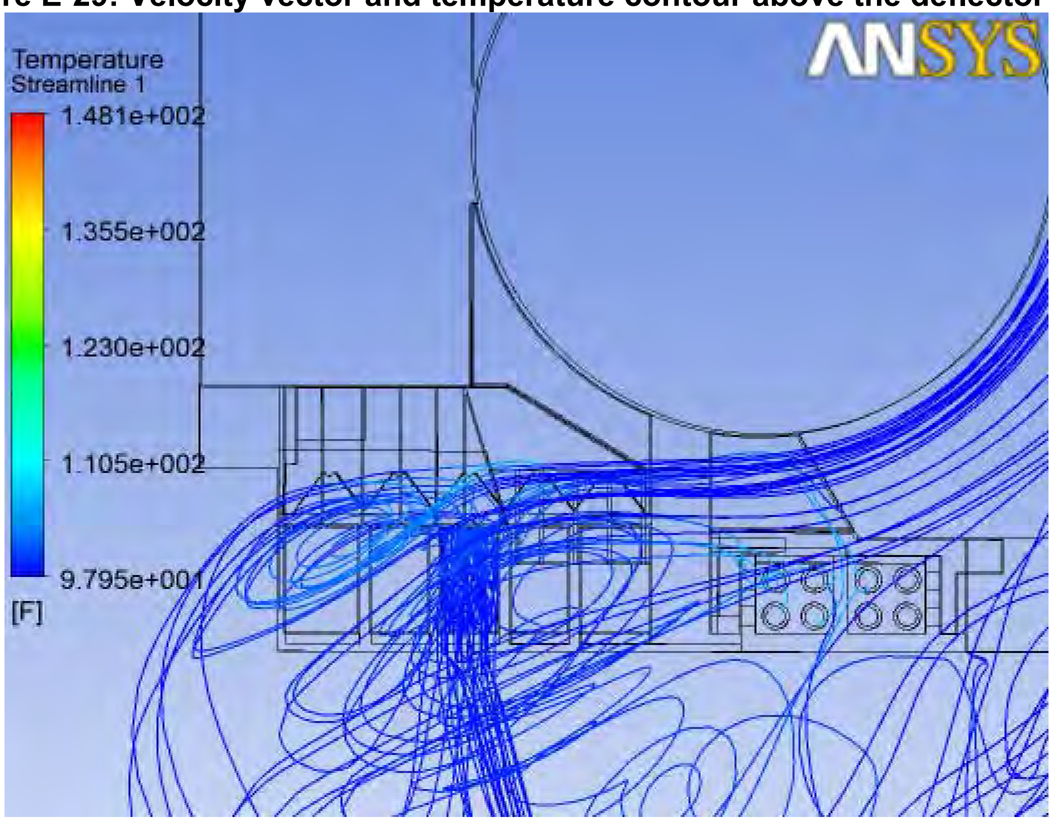


Figure E-30: Streamline at cell 3 for case 7

E-7: Train A Case 8: North wind with 10mph wind and 98F Ambient

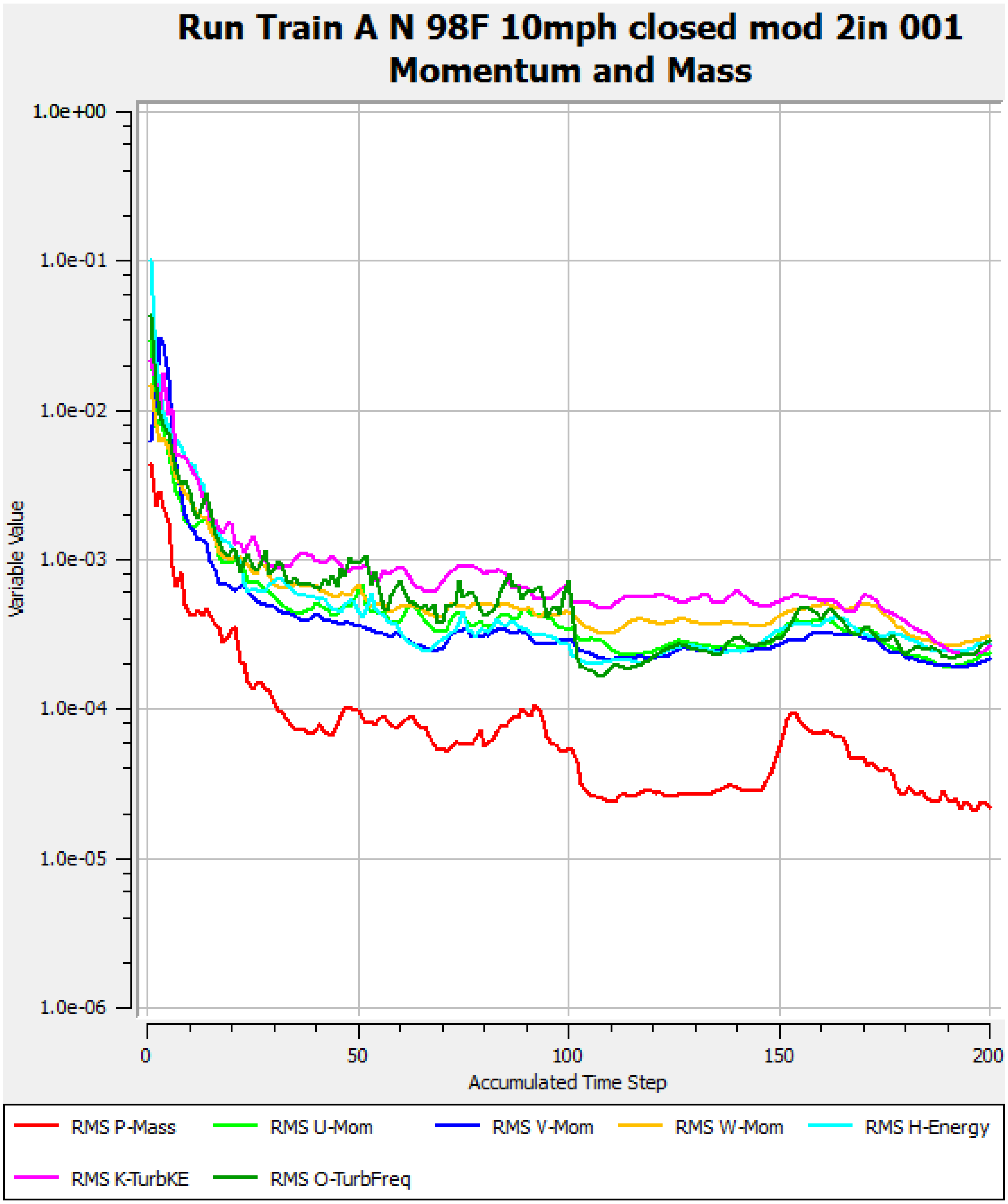


Figure E-31: Residual plot for case 8

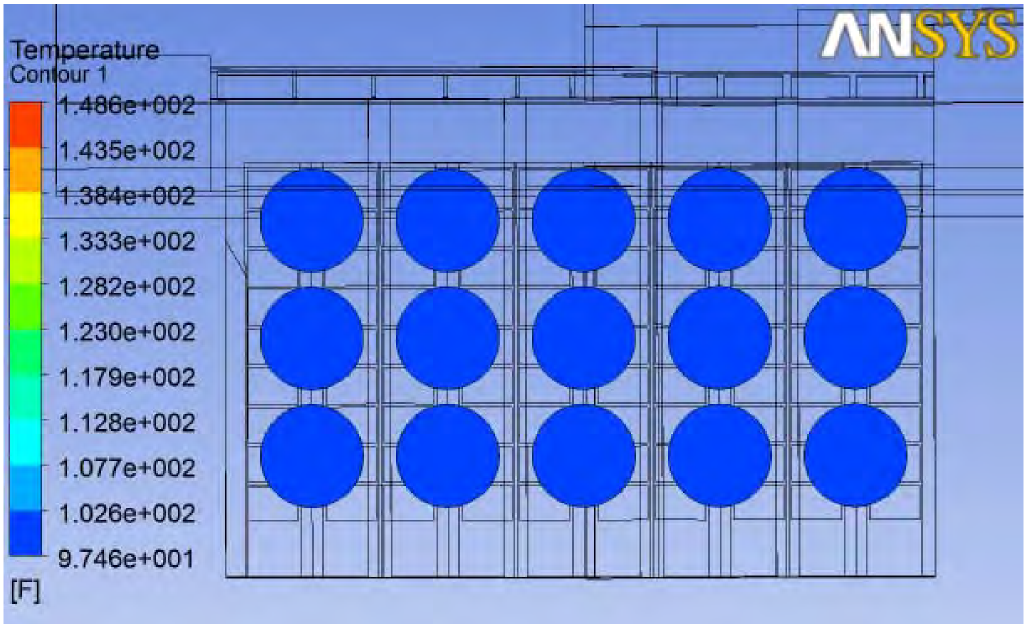


Figure E-32: Fan temperature for case 8

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	98	98	98	98	98
	98	98	98	98	98
	98	98	98	98	98
Average fan temperature:				98	

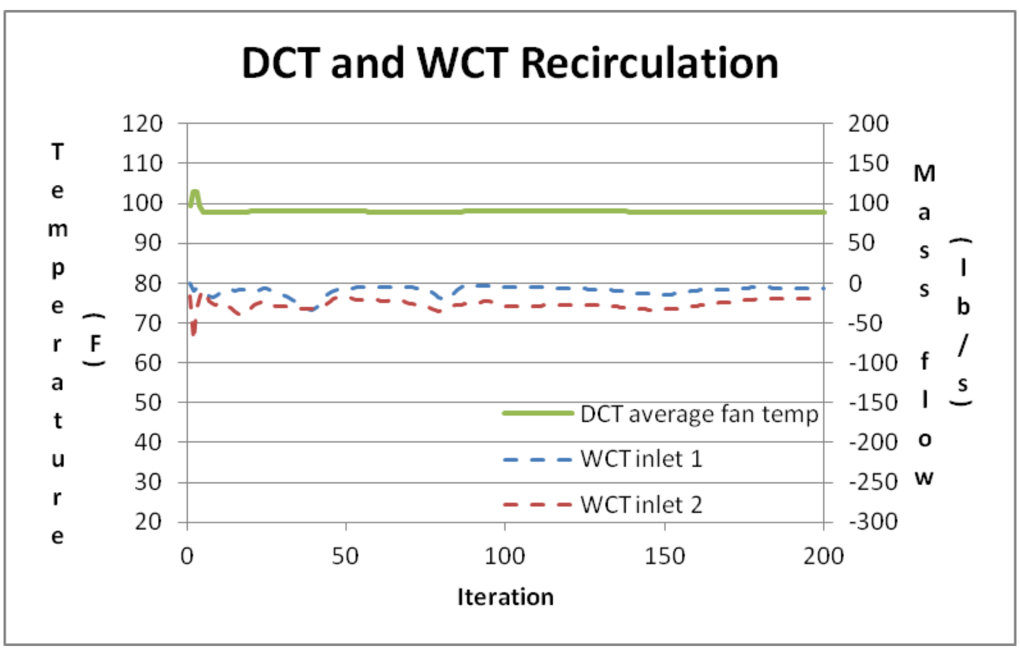


Figure E-33: DCT and WCT recirculation with iteration for case 8

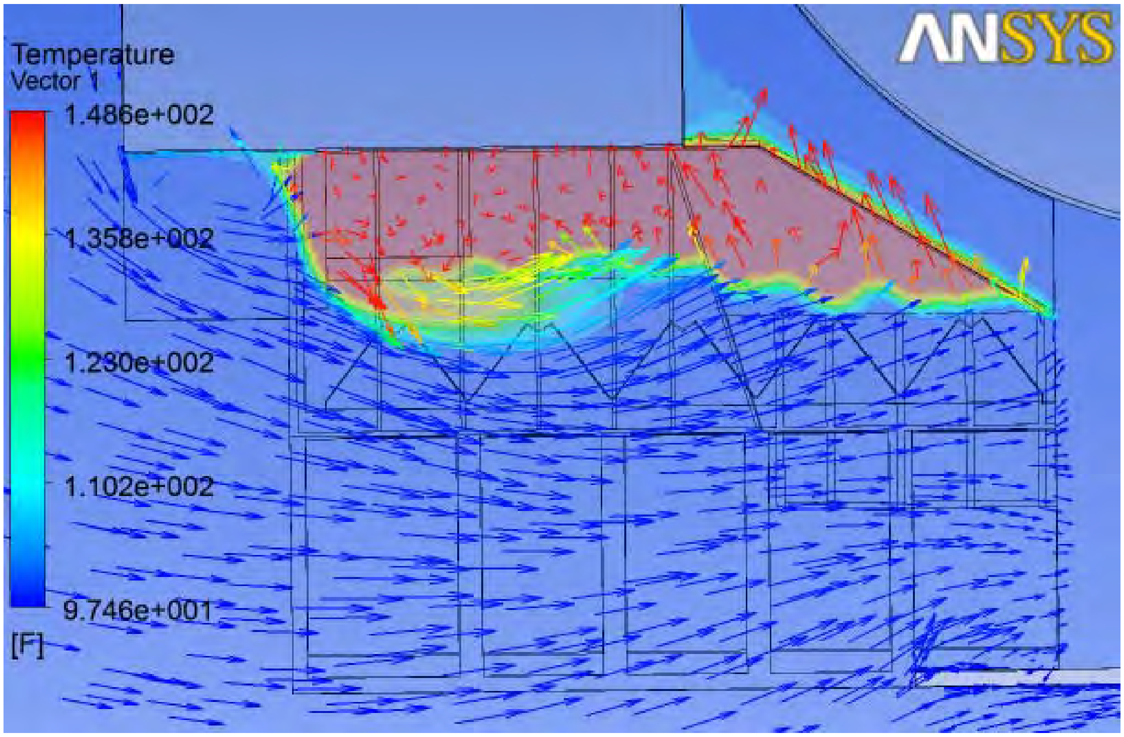


Figure E-34: Velocity vector and temperature contour above the deflector wall

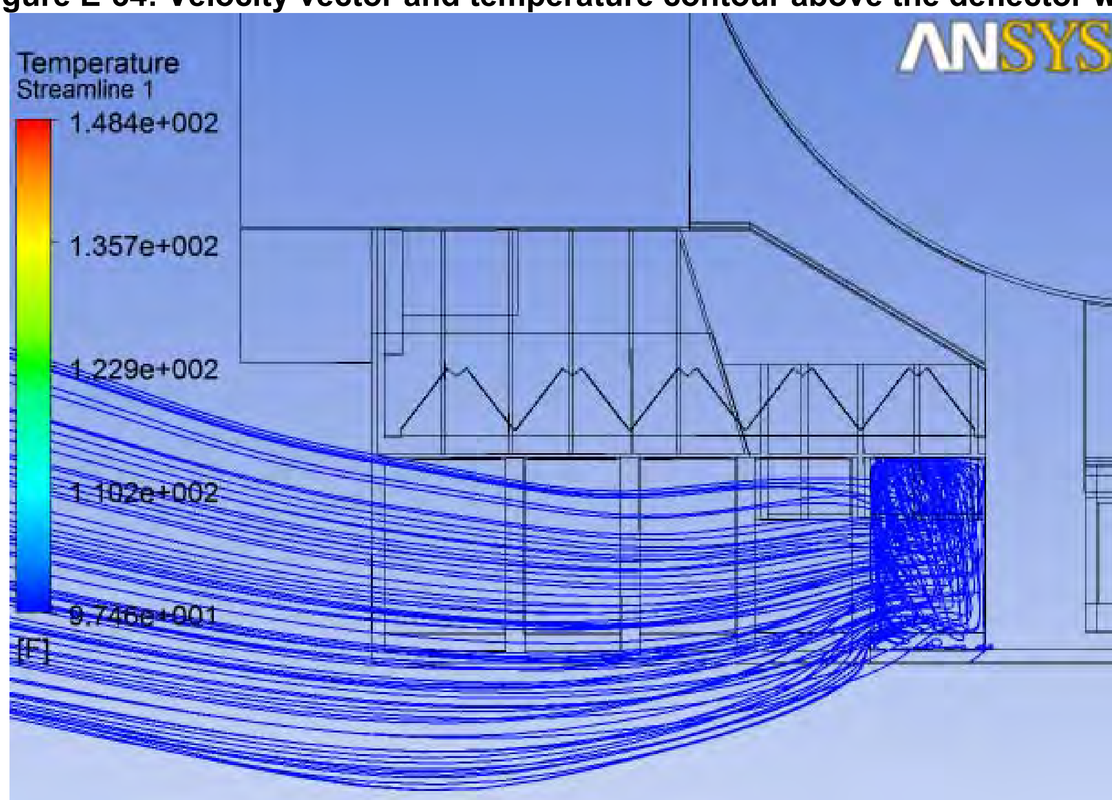


Figure E-35: Streamline at cell 5 for case 8

E-8: Train A Case 9: South wind with 10mph wind and 98F Ambient

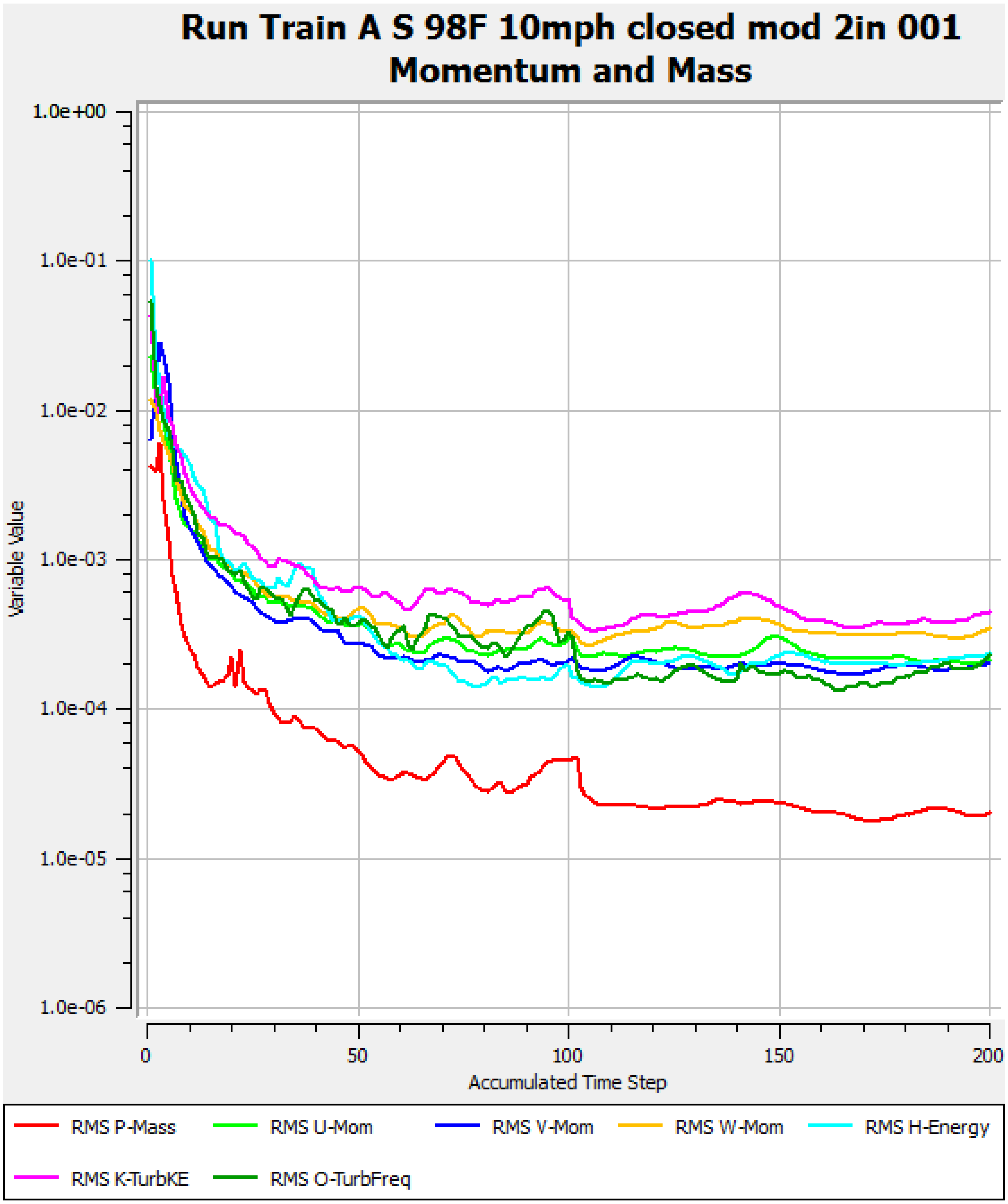


Figure E-36: Residual plot for case 9

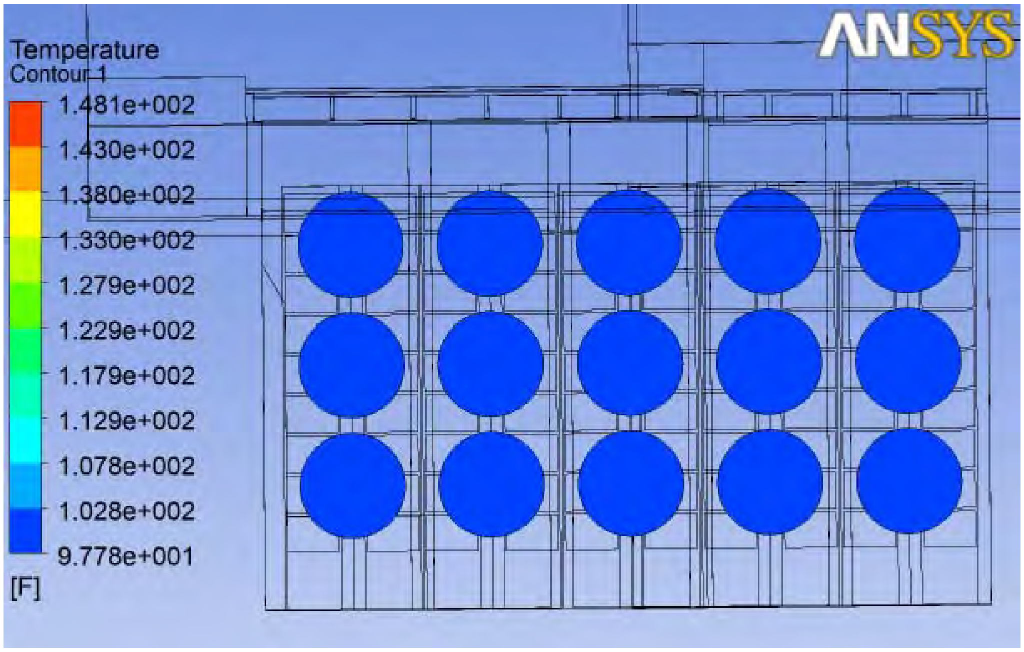


Figure E-37: Fan temperature for case 9

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	98.4	99.2	100.0	99.8	100.2
	98.0	98.1	98.6	98.6	99.2
	98.0	98.0	98.0	98.0	98.5
Average fan temperature:			98.7		

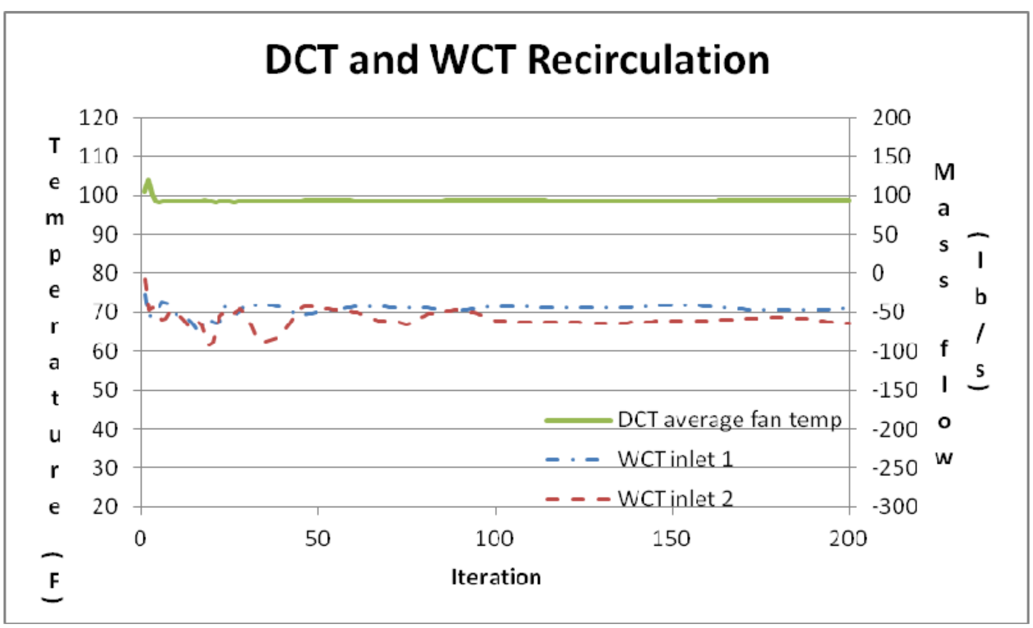


Figure E-38: DCT and WCT recirculation with iteration for case 9

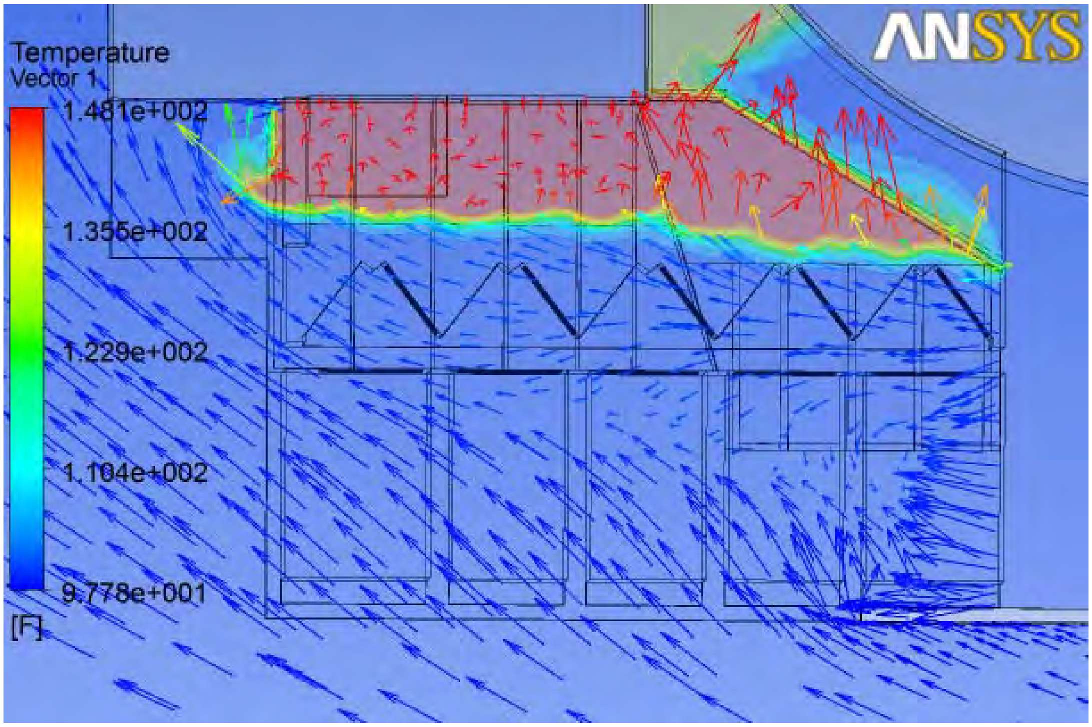


Figure E-39: Velocity vector and temperature contour above the deflector wall

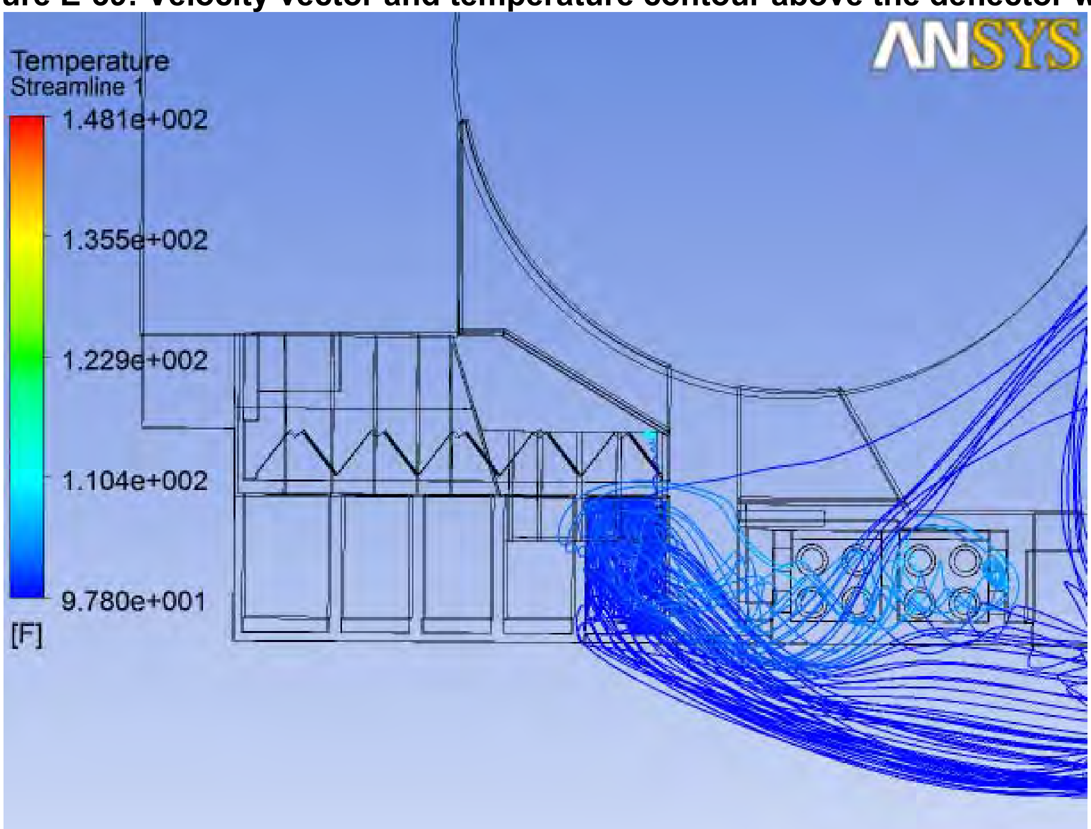


Figure E-40: Streamline at cell 5 for case 9

E-9: Train A Case 10: East wind with 10mph wind and 98F Ambient

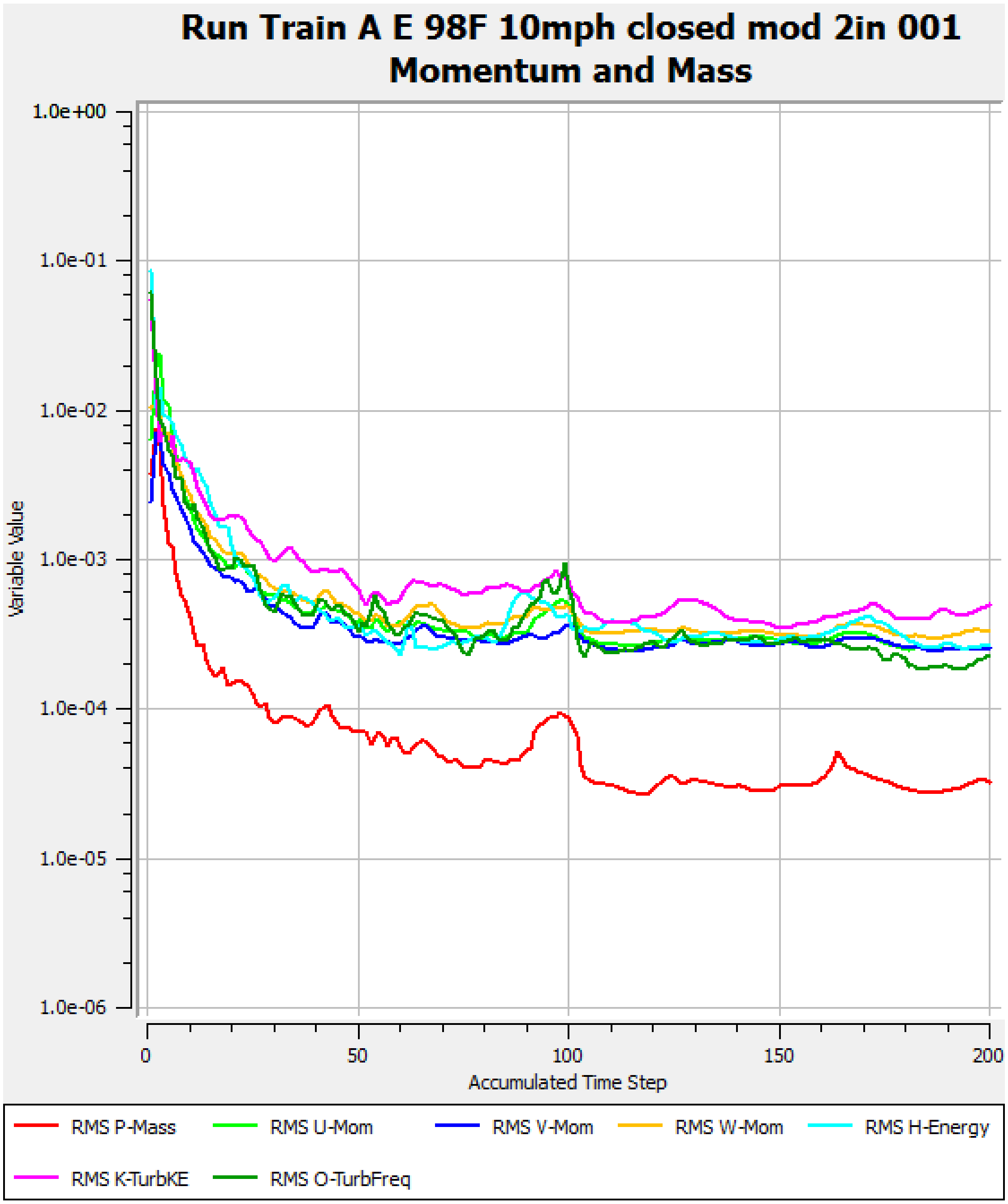


Figure E-41: Residual plot for case 10

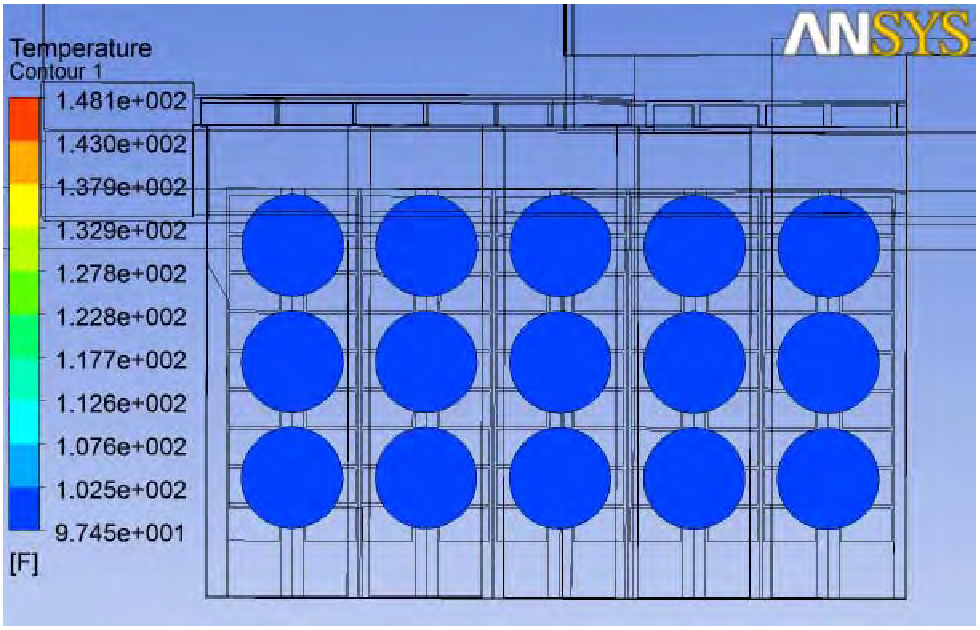


Figure E-42: Fan temperature for case 10

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	98.0	99.5	99.3	99.3	99.5
	99.0	100.1	99.6	99.4	99.3
	98.8	100.6	100.0	99.7	99.3
Average fan temperature:				99.4	

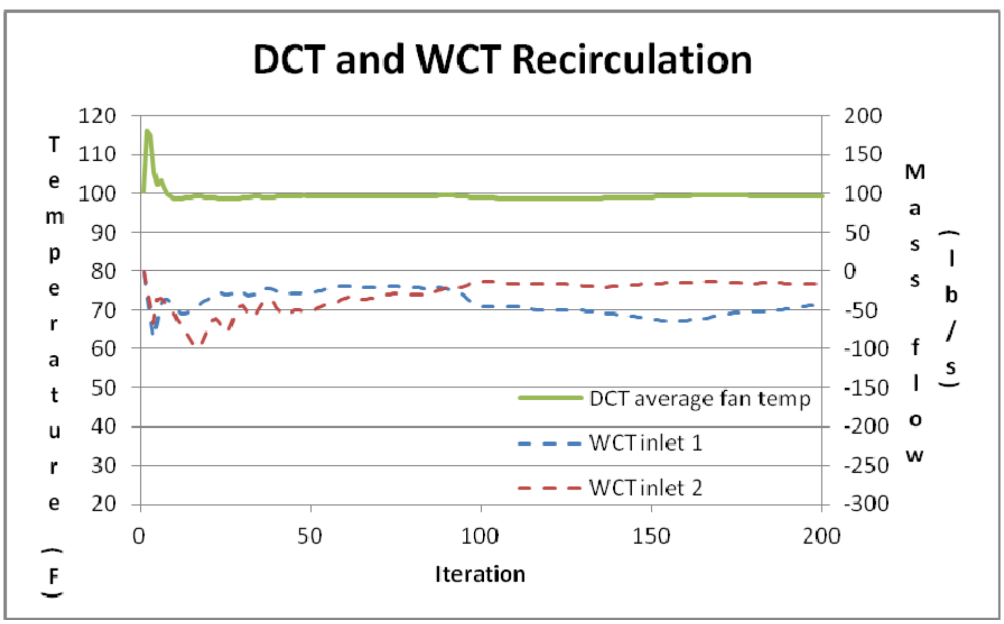


Figure E-43: DCT and WCT recirculation with iteration for case 10

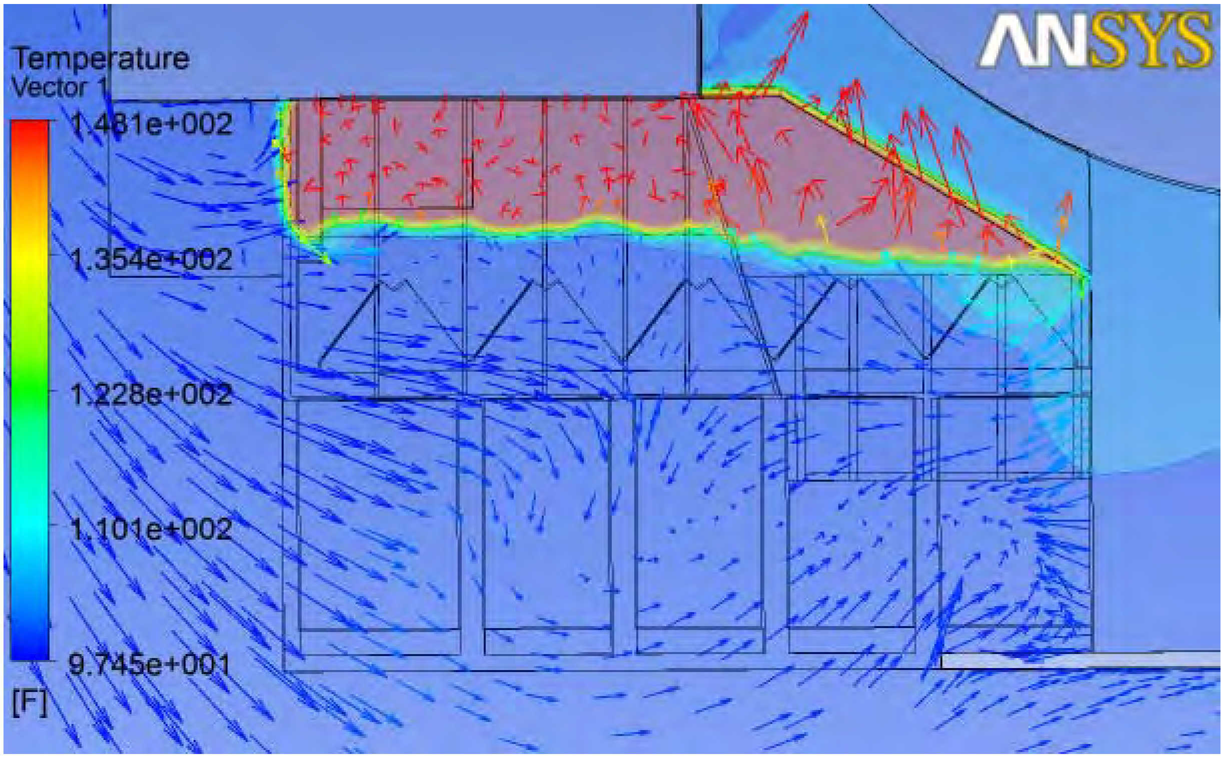


Figure E-44: Velocity vector and temperature contour above the deflector wall

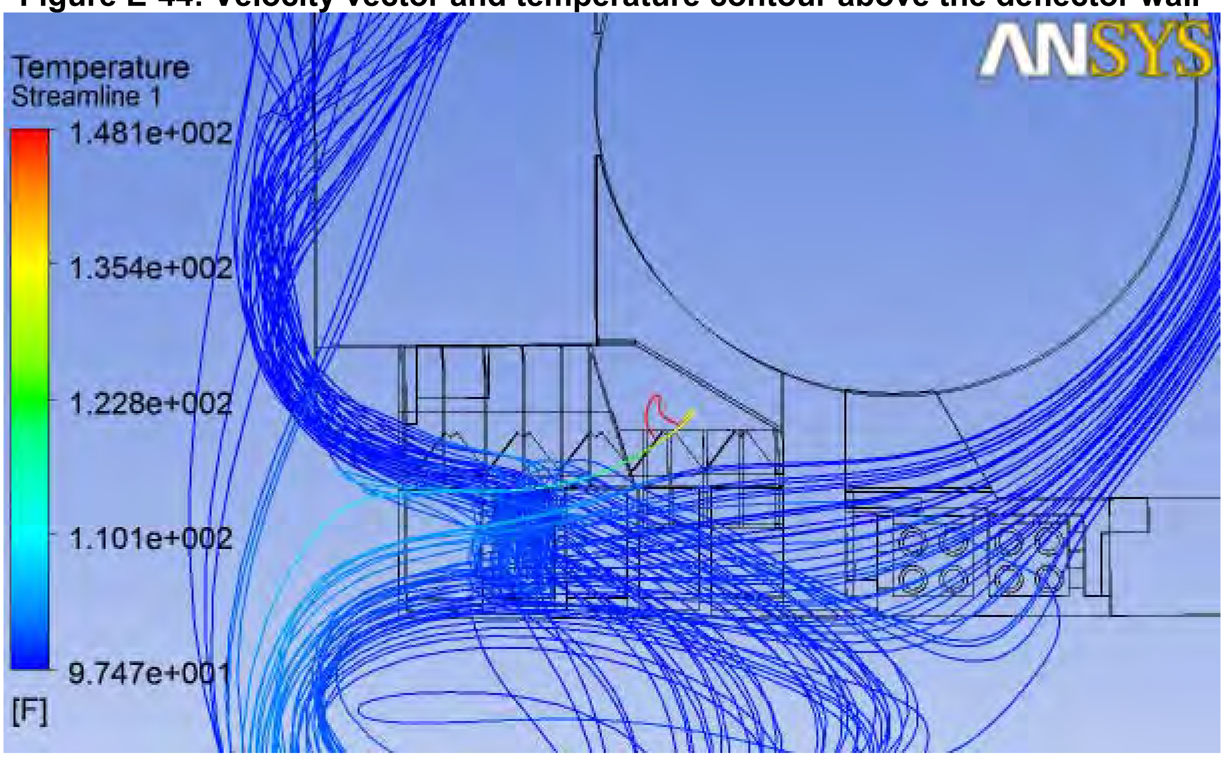


Figure E-45: Streamline at cell 2 for case 10

E-10: Train A Case 11: 102F Ambient with no wind

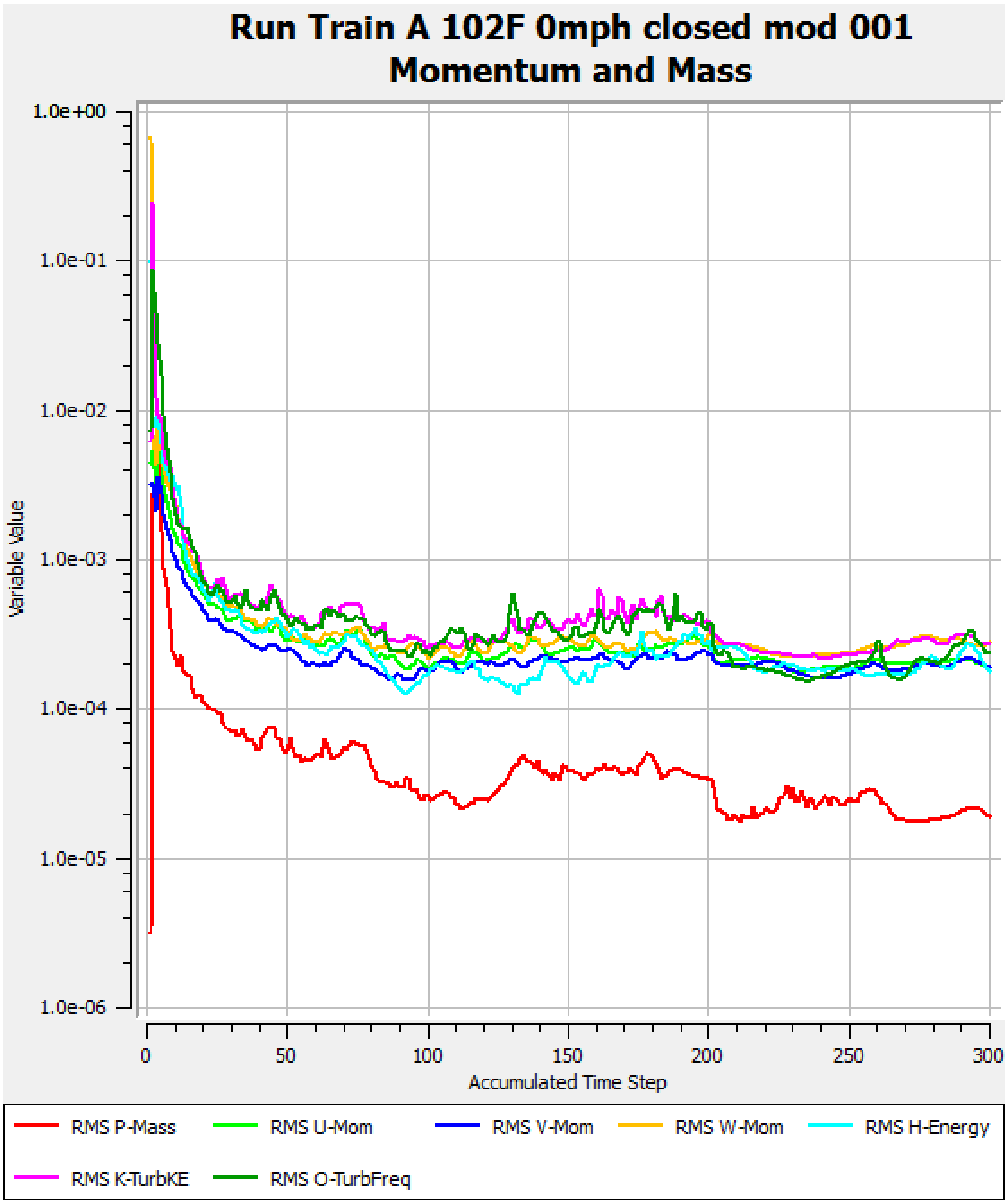


Figure E-46: Residual plot for case 11

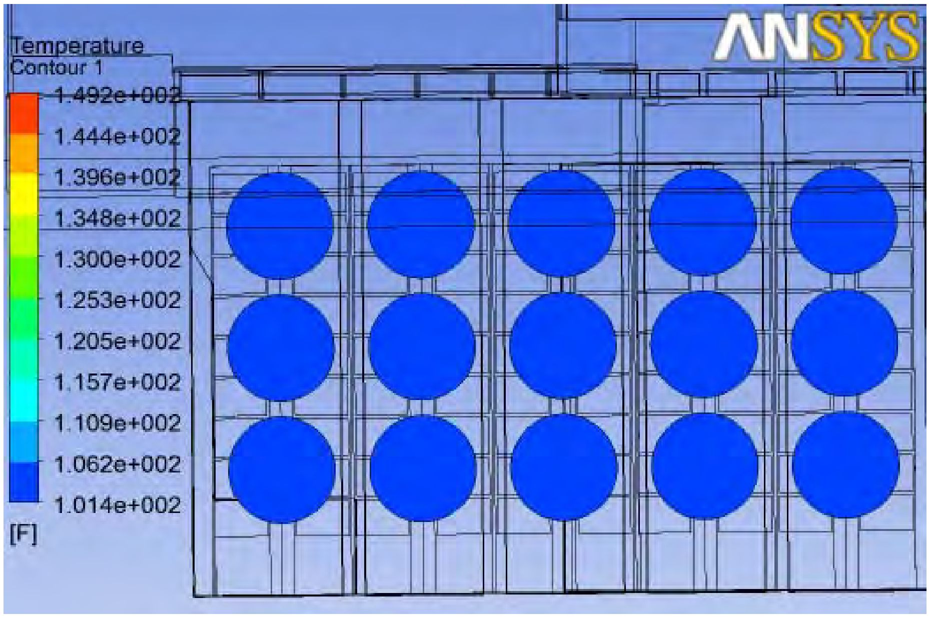


Figure E-47: Fan temperature for case 11

Individual fan temperature (deg F)					
Cell:	1	2	3	4	5
	102	102	102	102	102
	102	102	102	102	102
	102	102	102	102	102
Average fan temperature:			102		

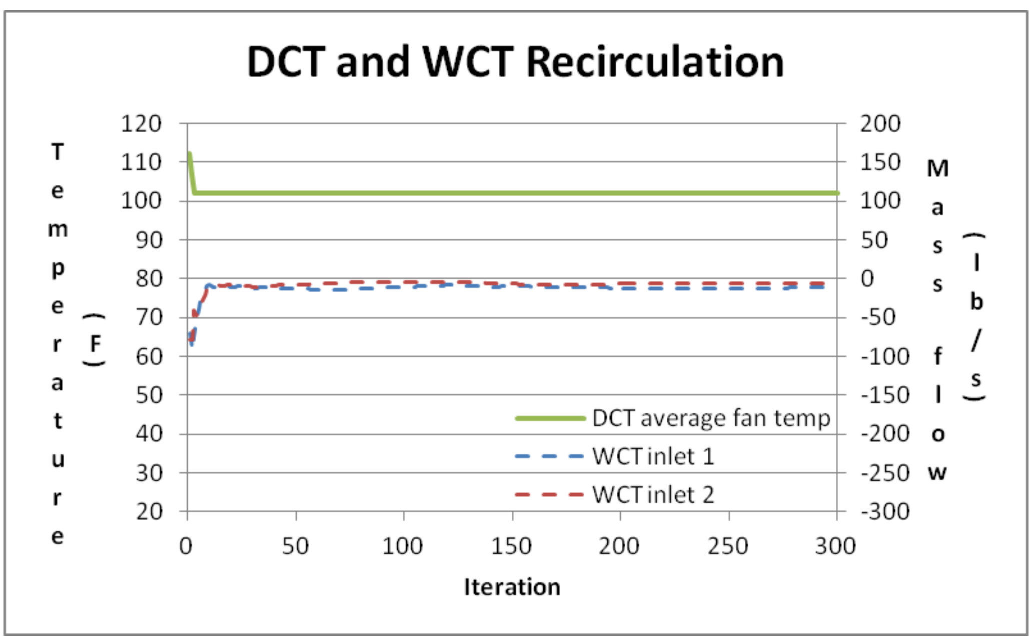


Figure E-48: DCT and WCT recirculation with iteration for case 11

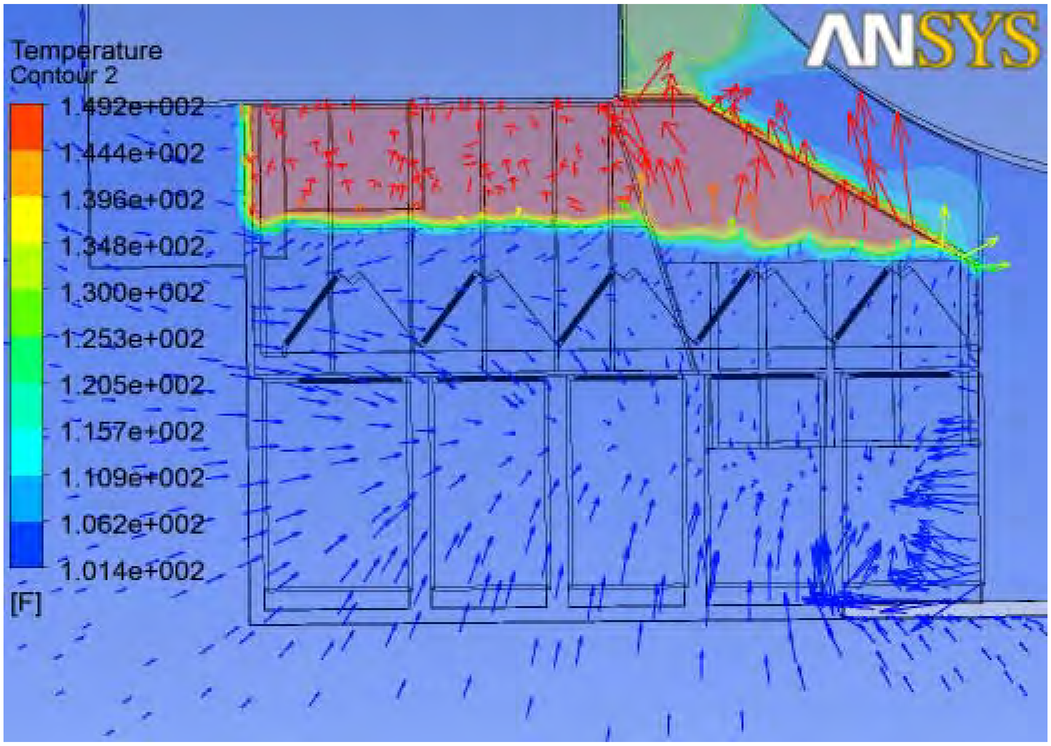


Figure E-49: Velocity vector and temperature contour above the deflector wall

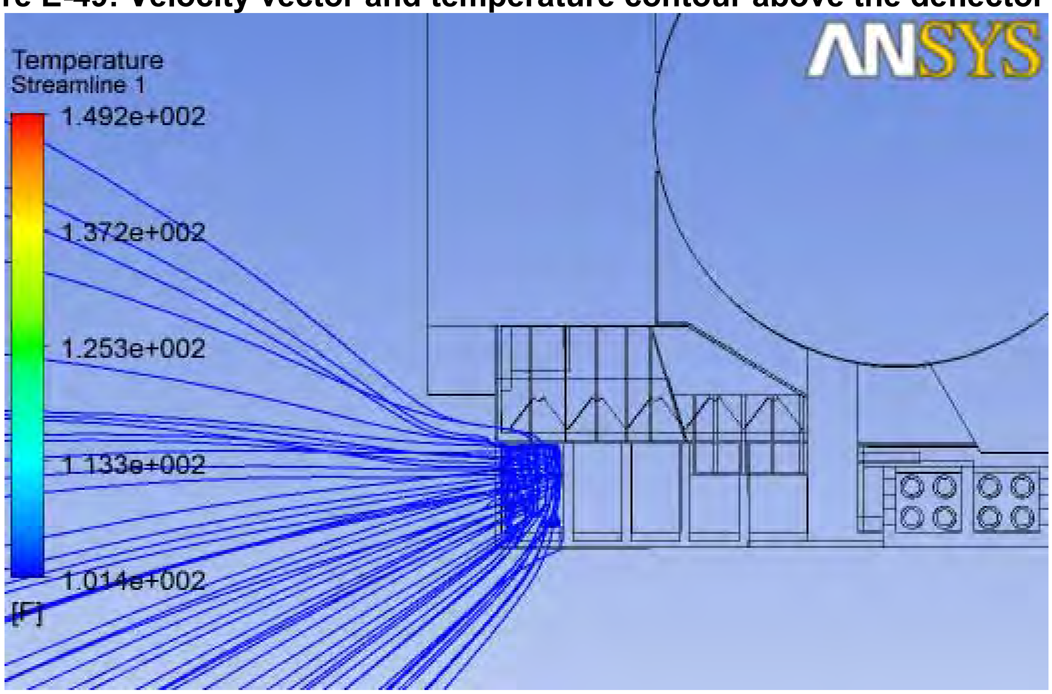


Figure E-50: Streamline at cell 1 for case 11

E-11: Train B Case 1: Northwest wind with 30mph wind and 90F Ambient

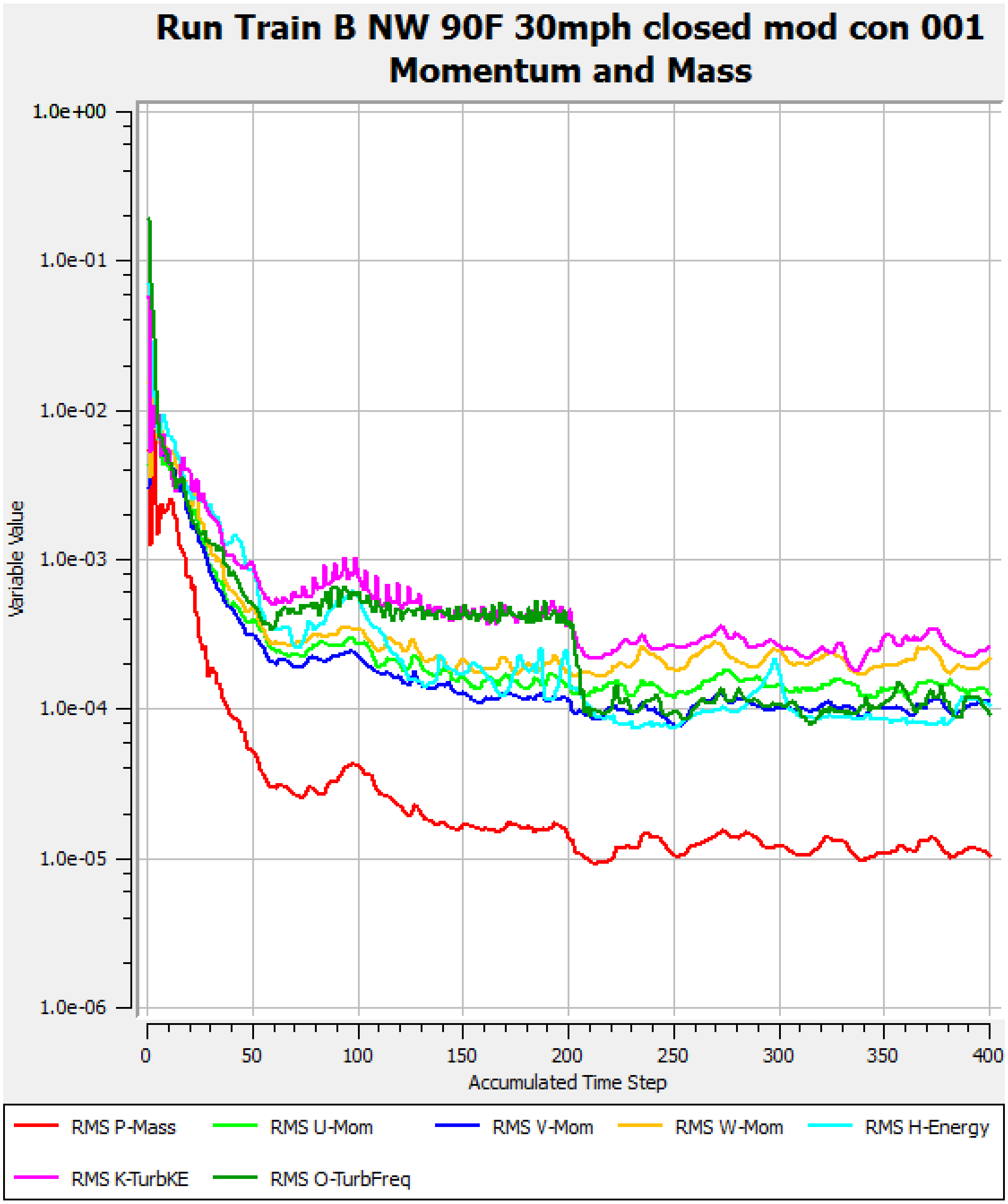


Figure E-51: Residual plot for case 1

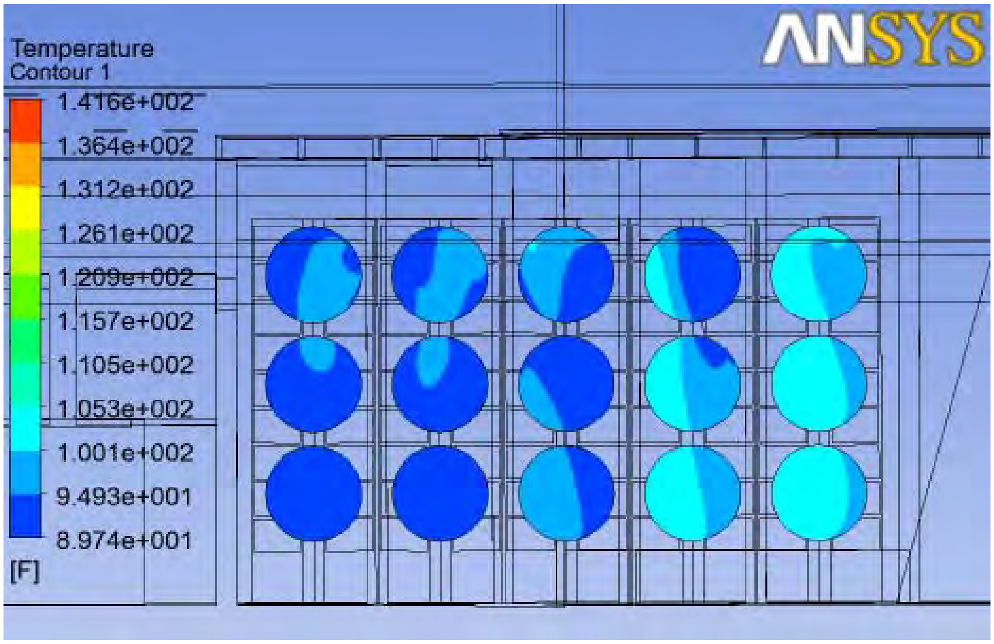


Figure E-52: Fan temperature for case 1

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	95.8	95.8	96.5	96.1	100.3
	94.0	94.5	94.3	98.4	101.8
	92.1	92.7	95.0	99.4	101.1
Average fan temperature:			96.5		

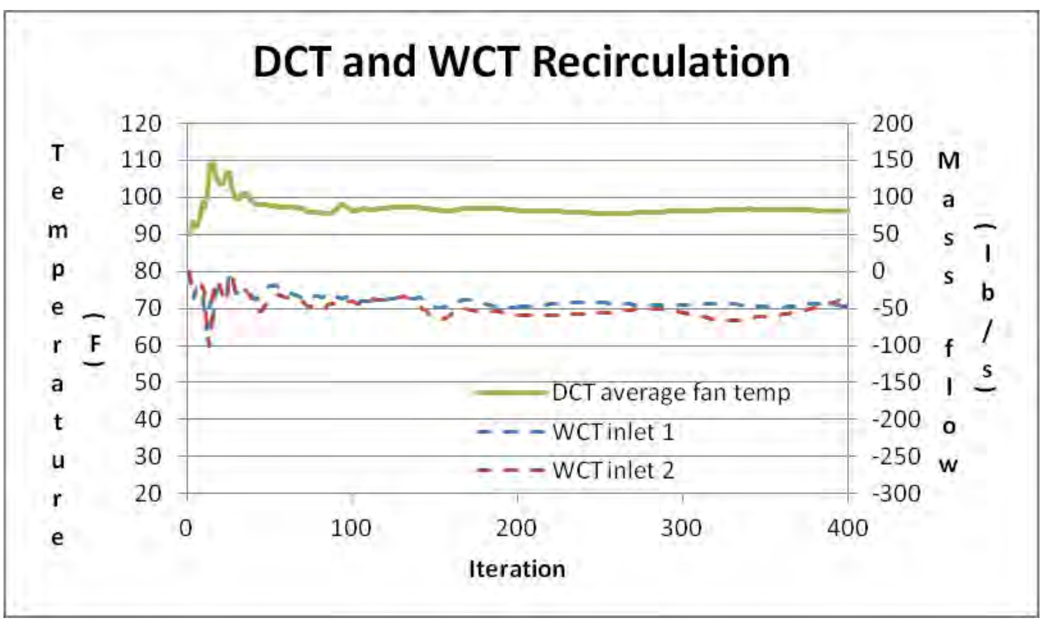


Figure E-53: DCT and WCT recirculation with iteration for case 1

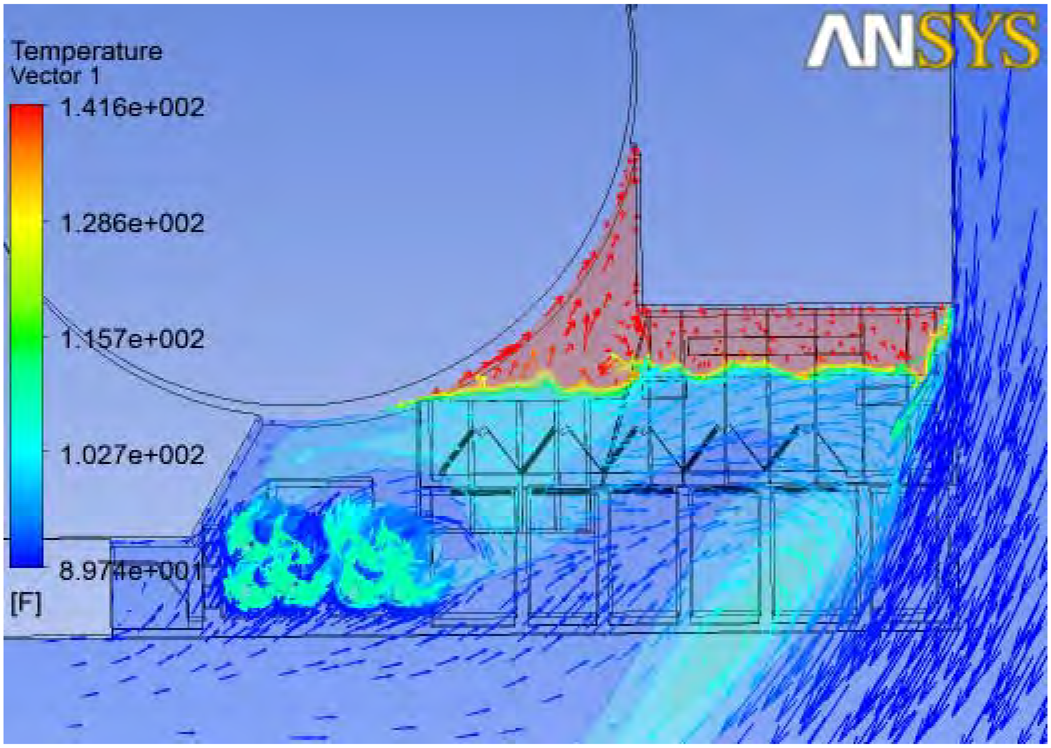


Figure E-54: Velocity vector and temperature contour above the deflector wall

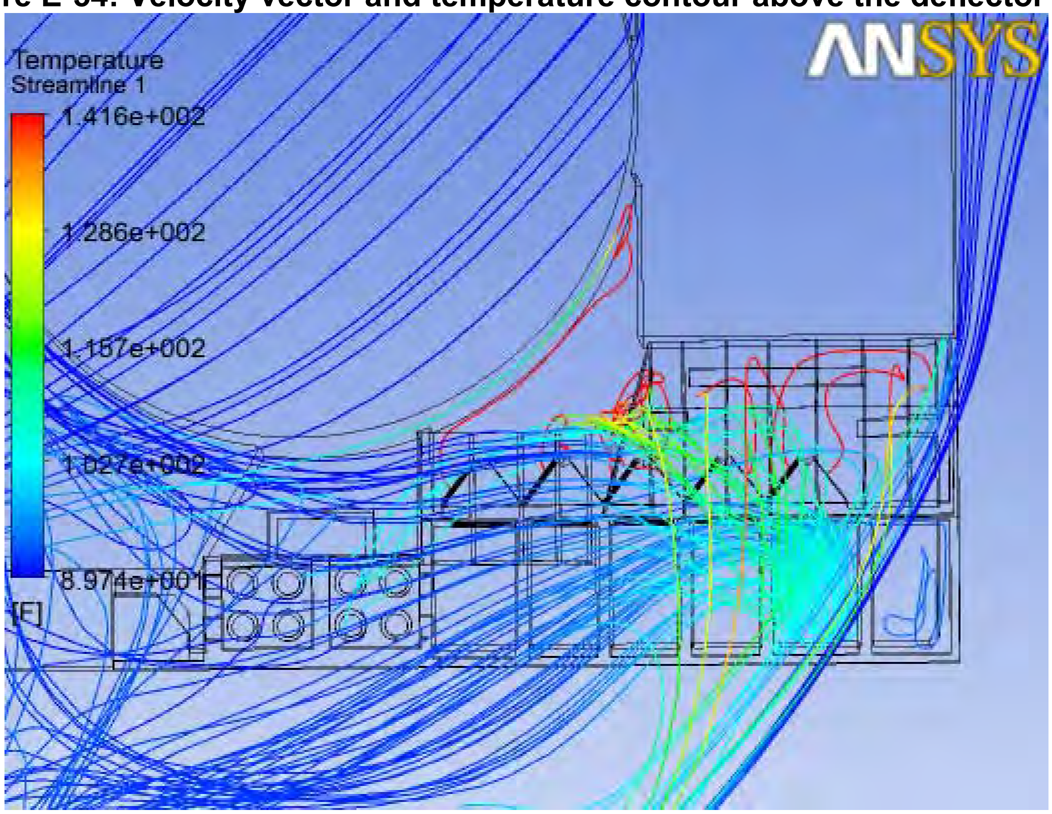


Figure E-55: Streamline at cell 1 for case 1

E-12: Train B Case 2: Southwest wind with 30mph wind and 90F Ambient

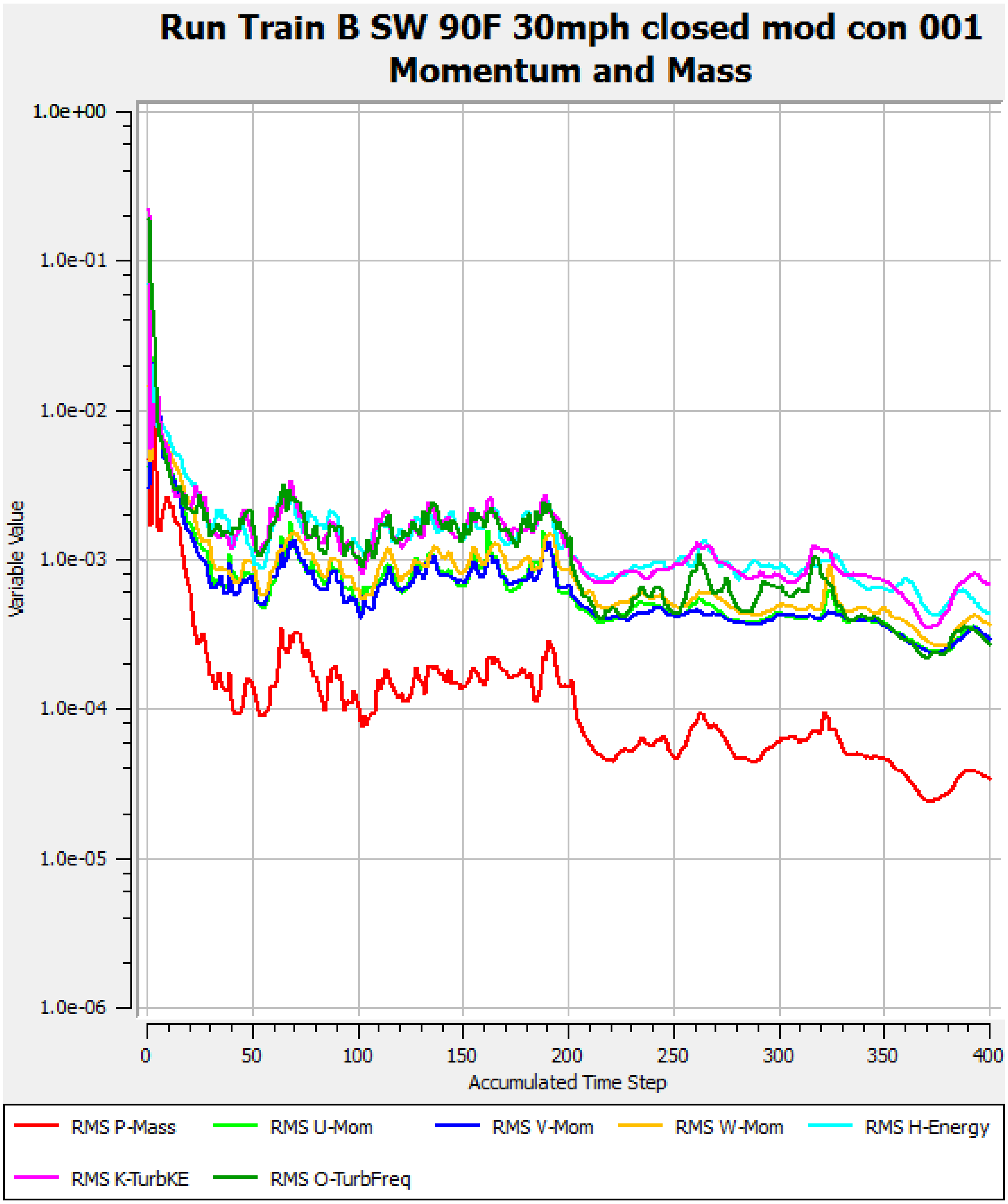


Figure E-56: Residual plot for case 2

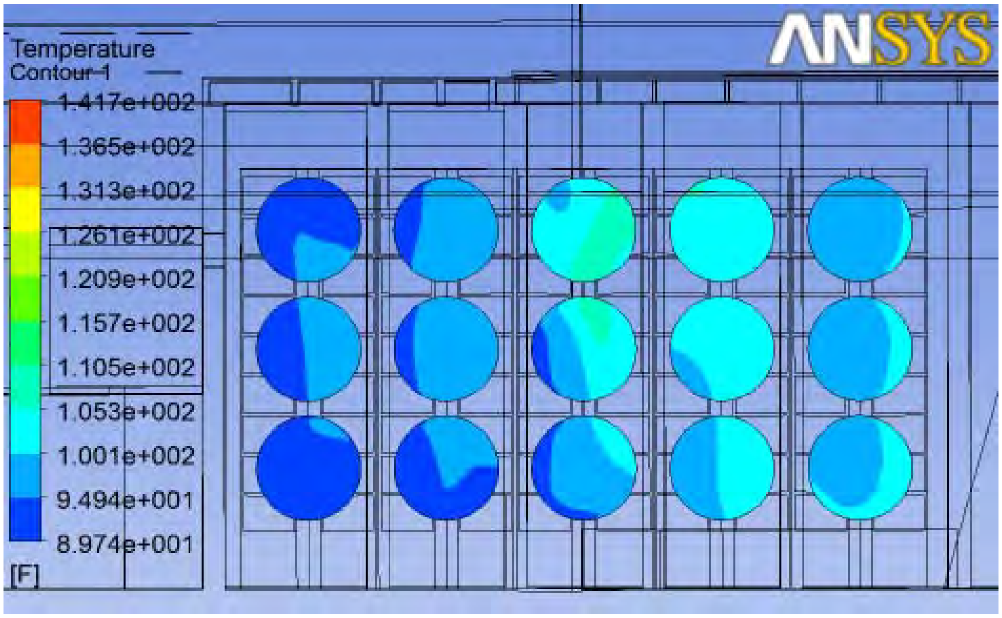


Figure E-57: Fan temperature for case 2

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	94.0	94.8	97.7	99.7	100.1
	93.6	94.5	96.1	97.9	99.7
	93.8	94.6	95.6	97.3	99.7
Average fan temperature:				96.6	

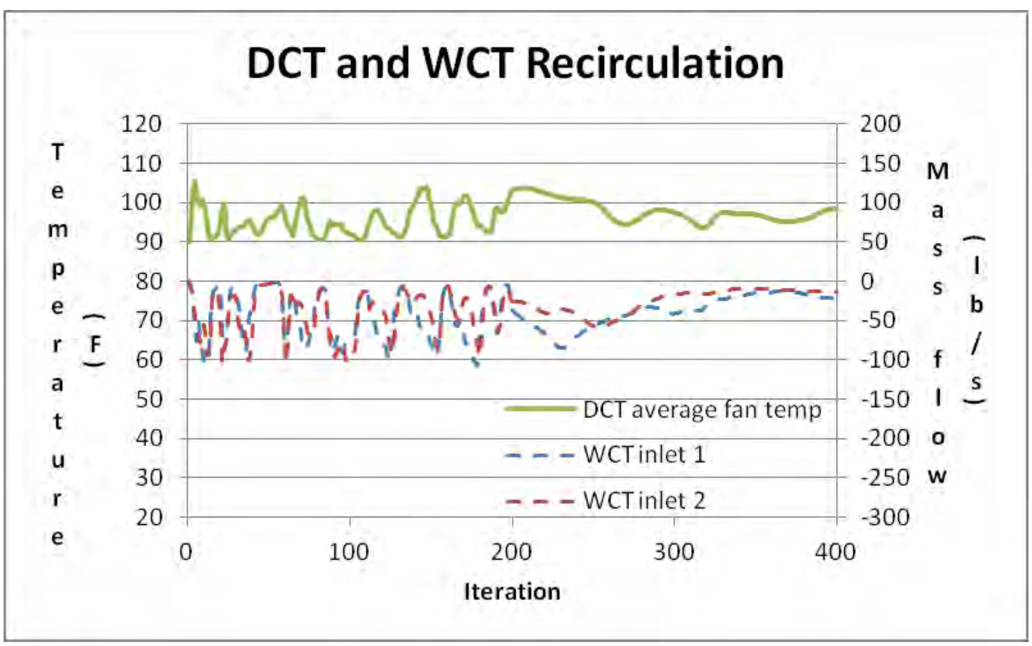


Figure E-58: DCT and WCT recirculation with iteration for case 2

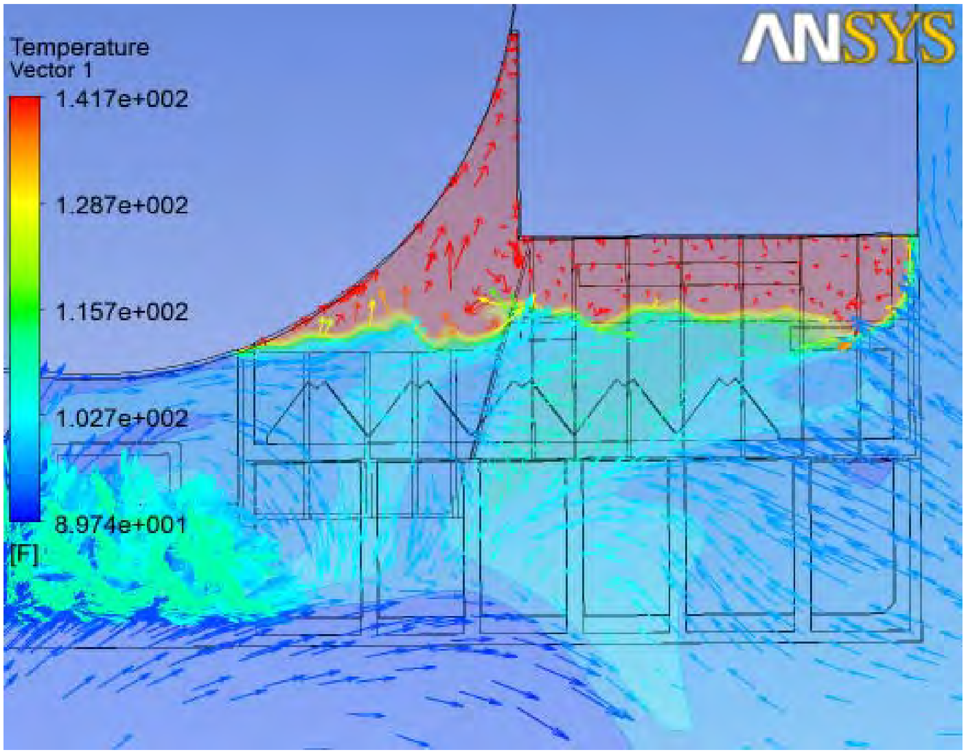


Figure E-59: Velocity vector and temperature contour above the deflector wall

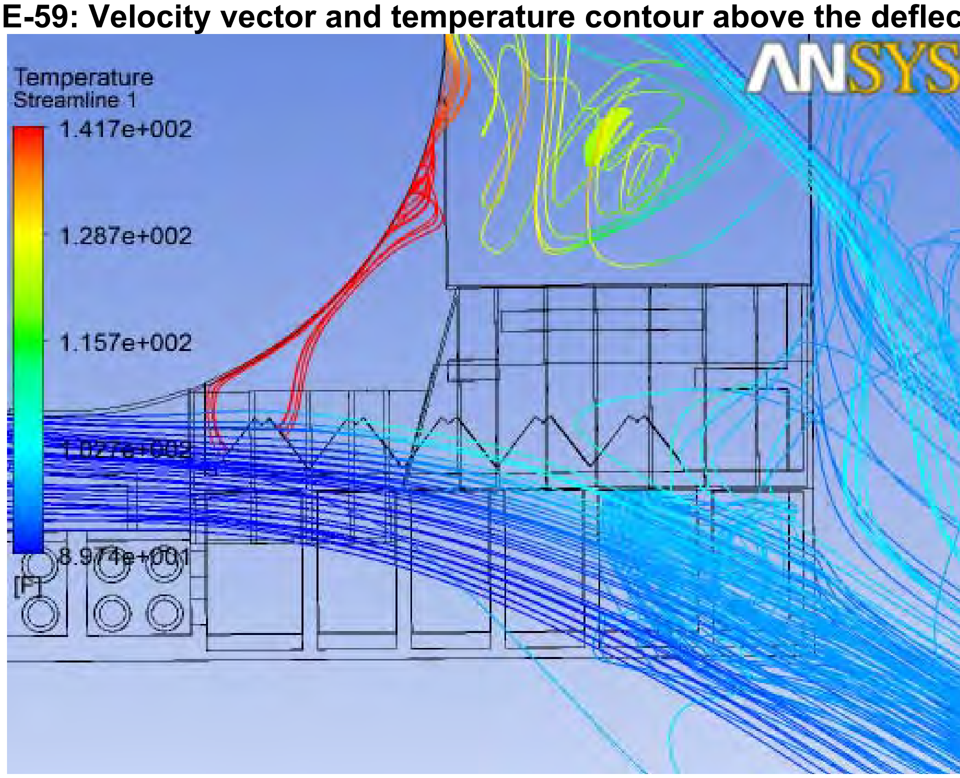


Figure E-60: Streamline at cell 1 for case 2

E-13: Train B Case 3: North wind with 30mph wind and 90F Ambient

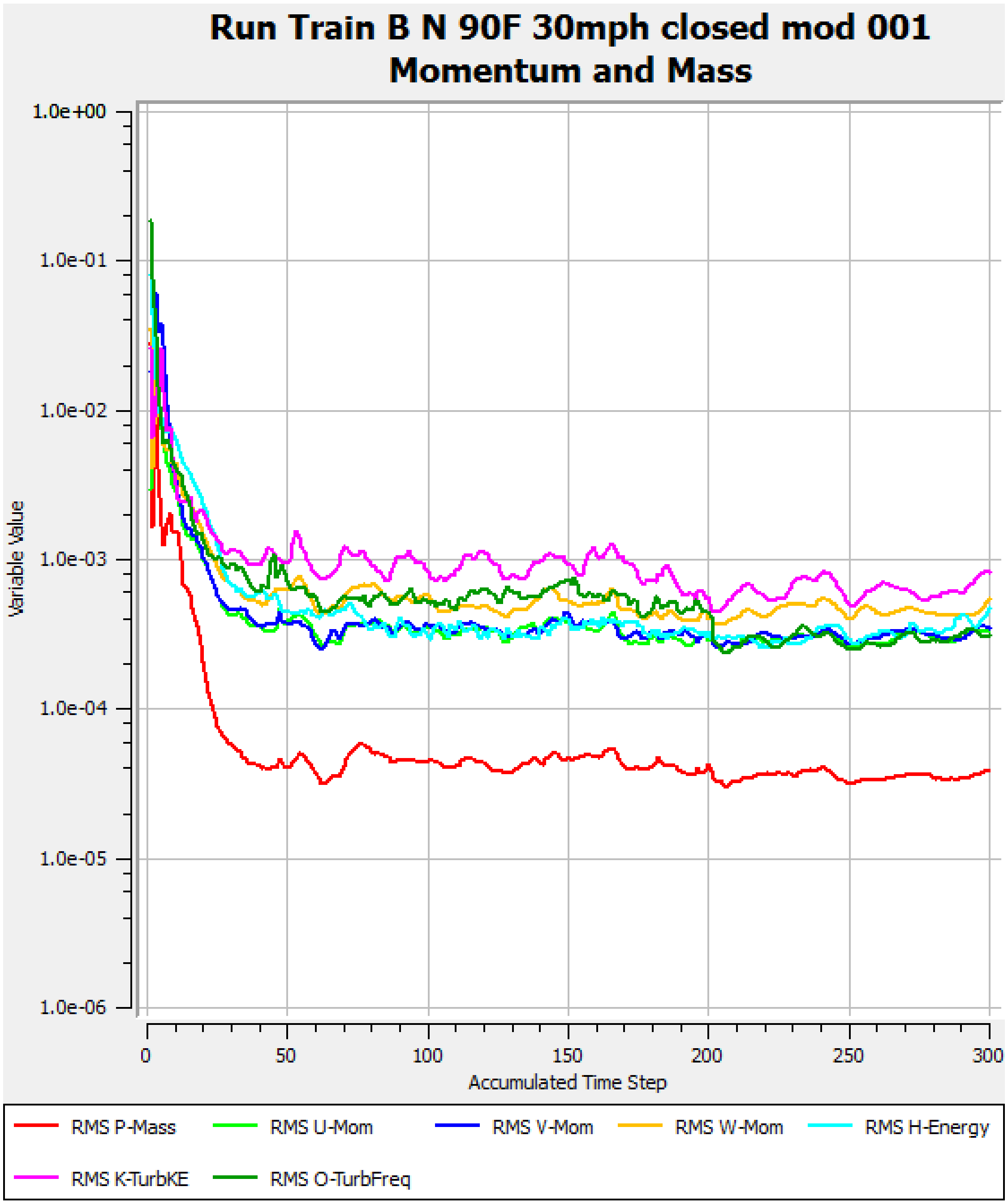


Figure E-61: Residual plot for case 3

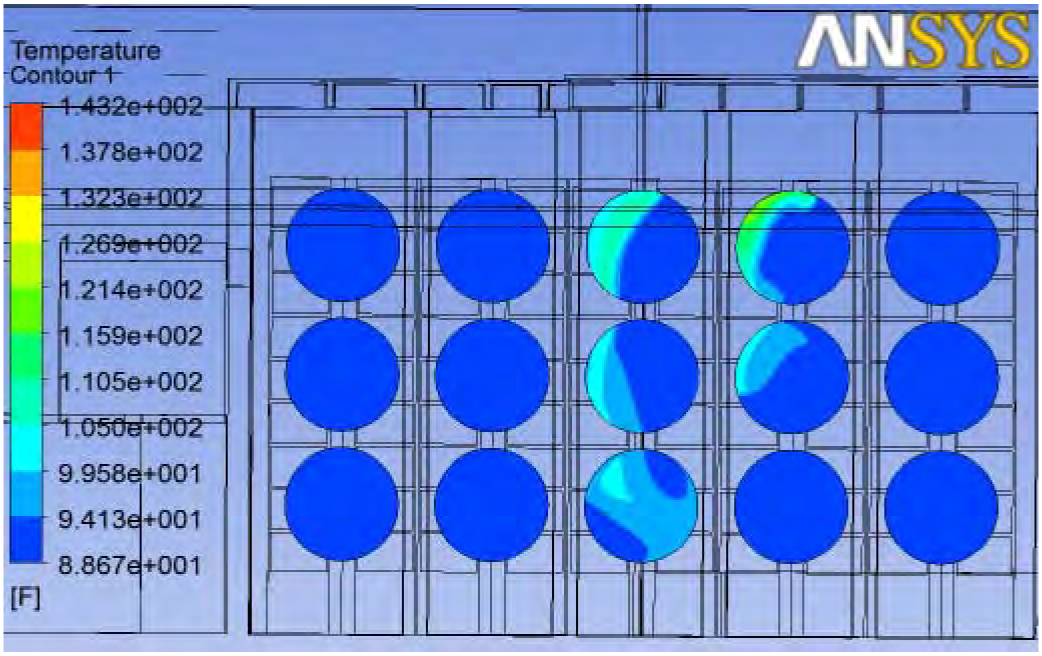


Figure E-62: Fan temperature for case 3

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	90.8	90.2	96.4	95.6	90.1
	90.7	90.3	95.3	93.5	90.1
	90.8	90.1	92.7	91.5	90.1
Average fan temperature:				91.9	

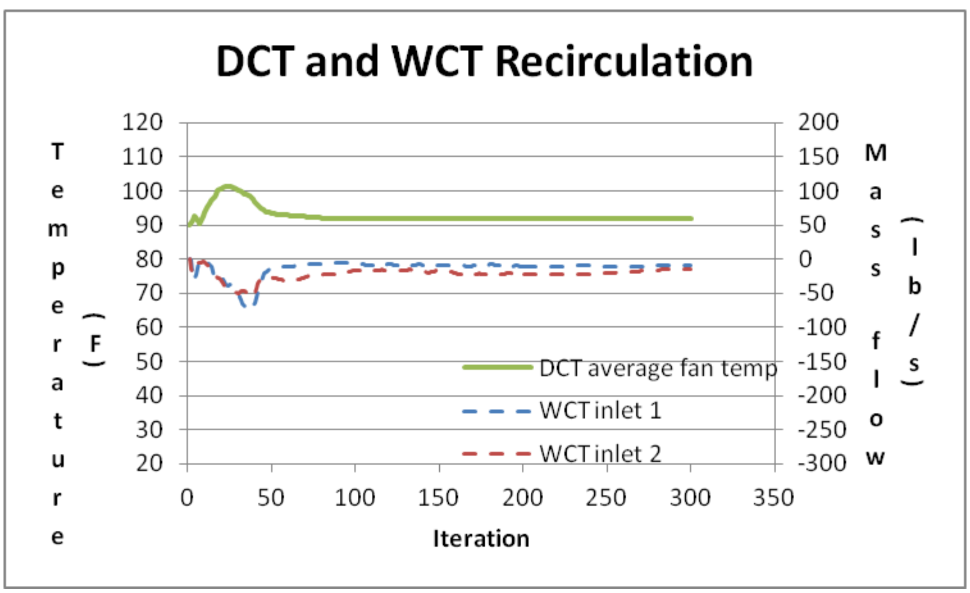


Figure E-63: DCT and WCT recirculation with iteration for case 3

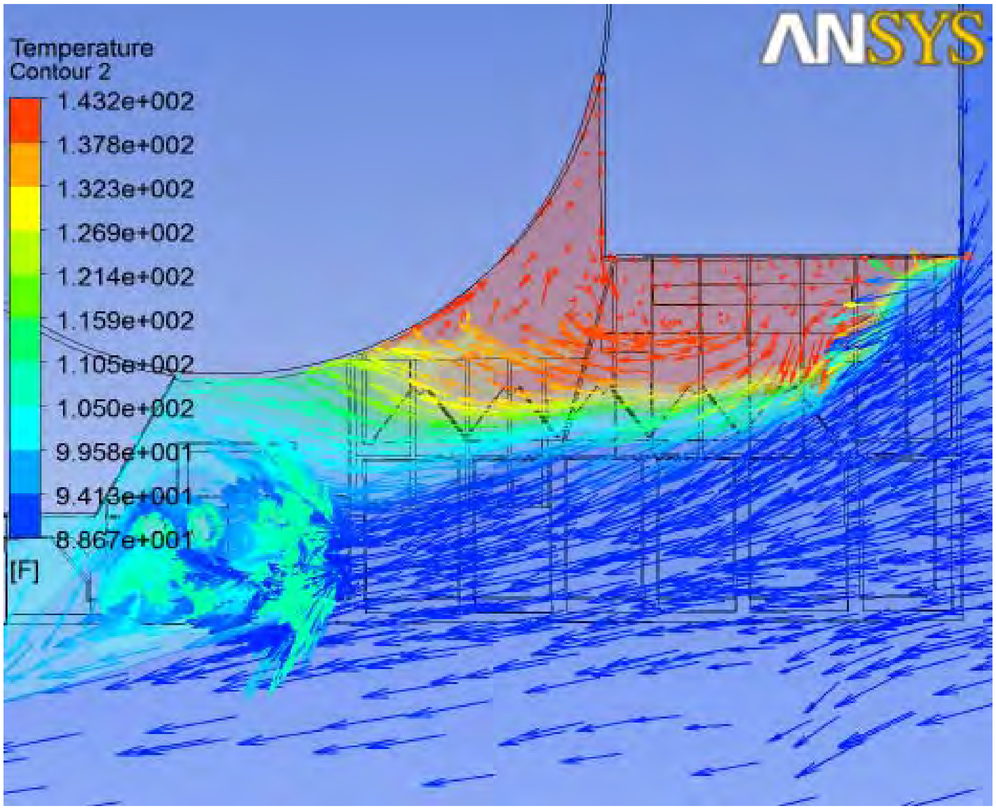


Figure E-64: Velocity vector and temperature contour above the deflector wall

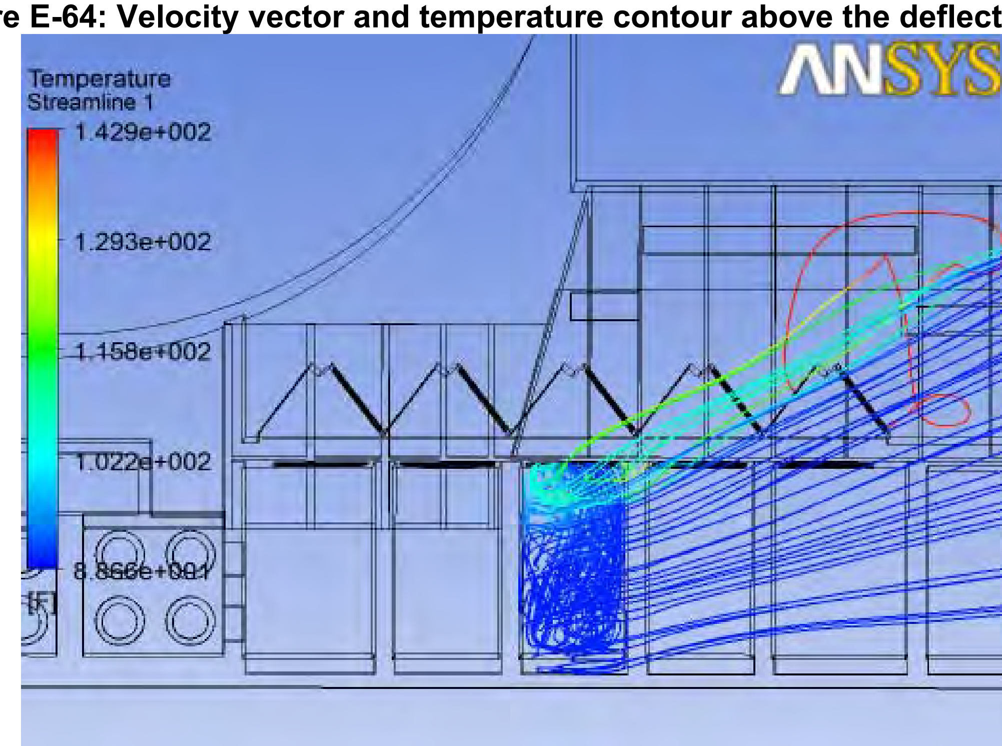


Figure E-65: Streamline at cell 3 for case 3

E-14: Train B Case 5: West wind with 30mph wind and 90F Ambient

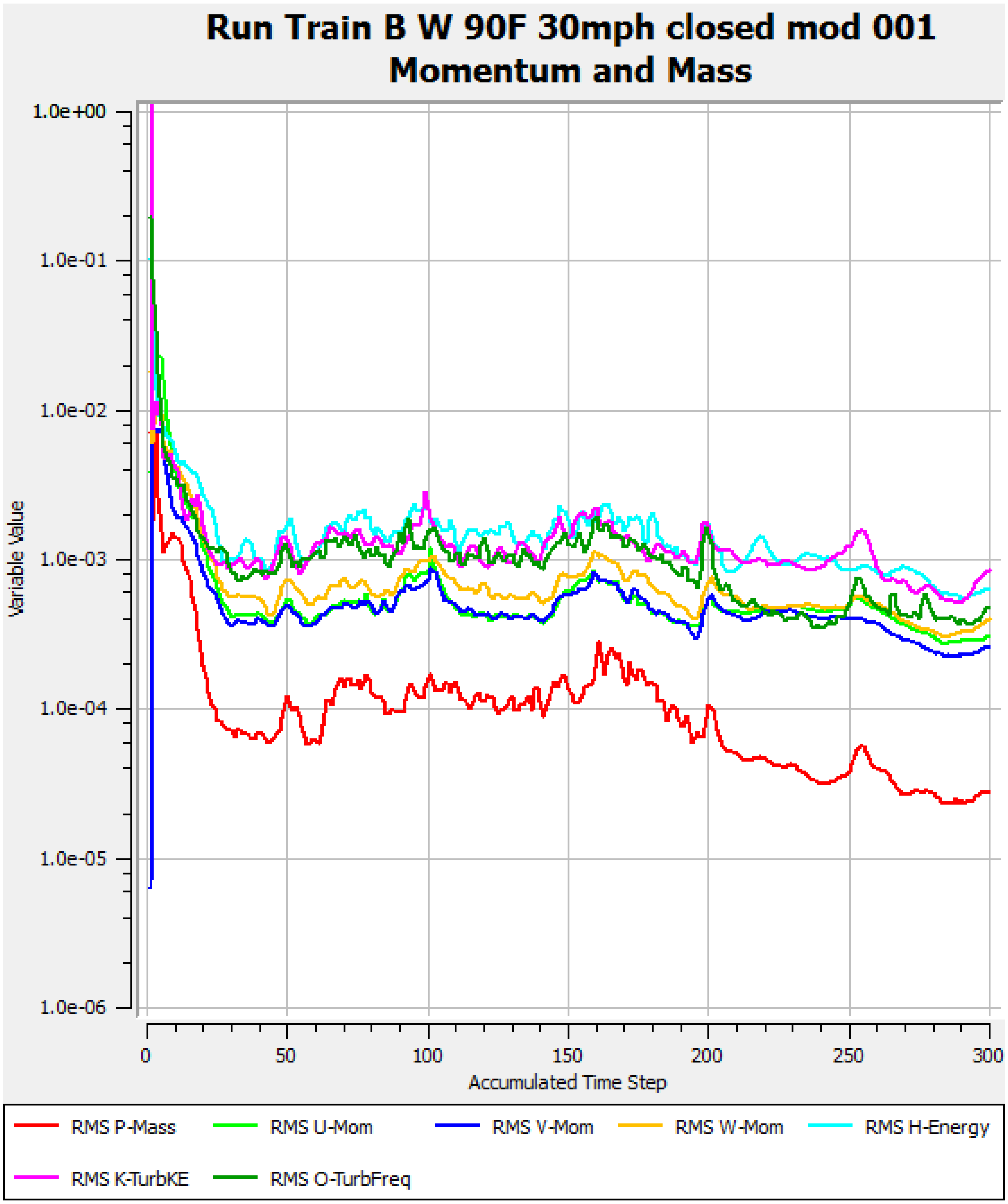


Figure E-66: Residual plot for case 5

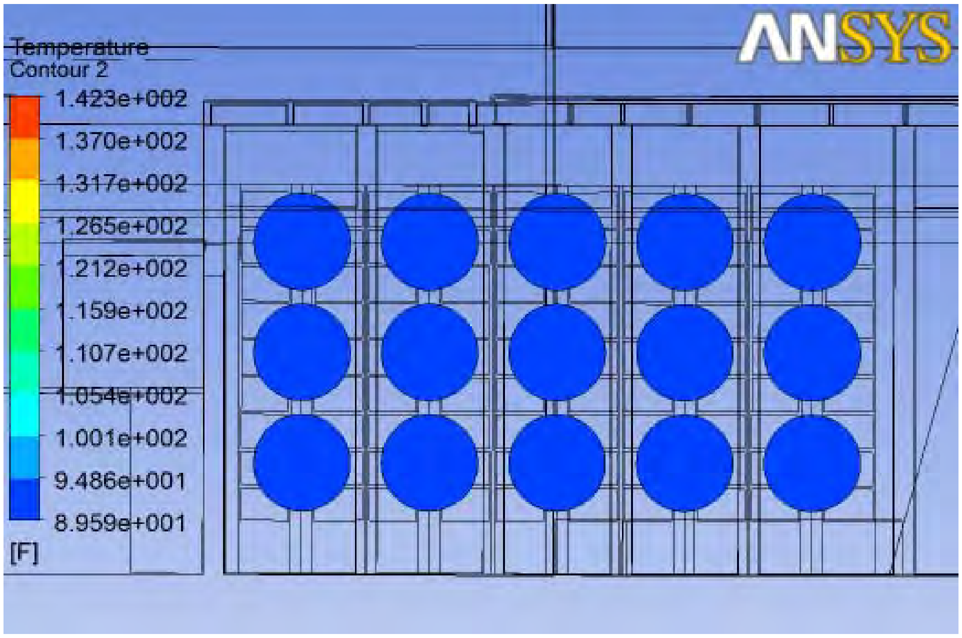


Figure E-67: Fan temperature for case 5

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	91.3	91.3	91.8	92.8	93.2
	91.4	91.0	91.8	92.8	93.3
	92.4	91.3	92.0	93.0	93.4
Average fan temperature:				92.2	

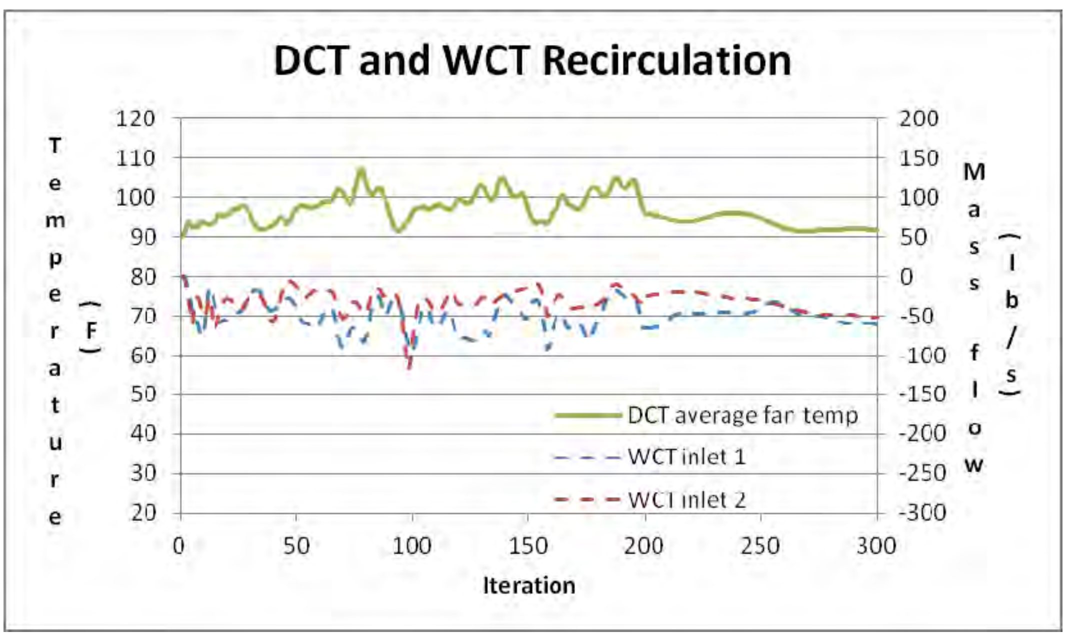


Figure E-68: DCT and WCT recirculation with iteration for case 5

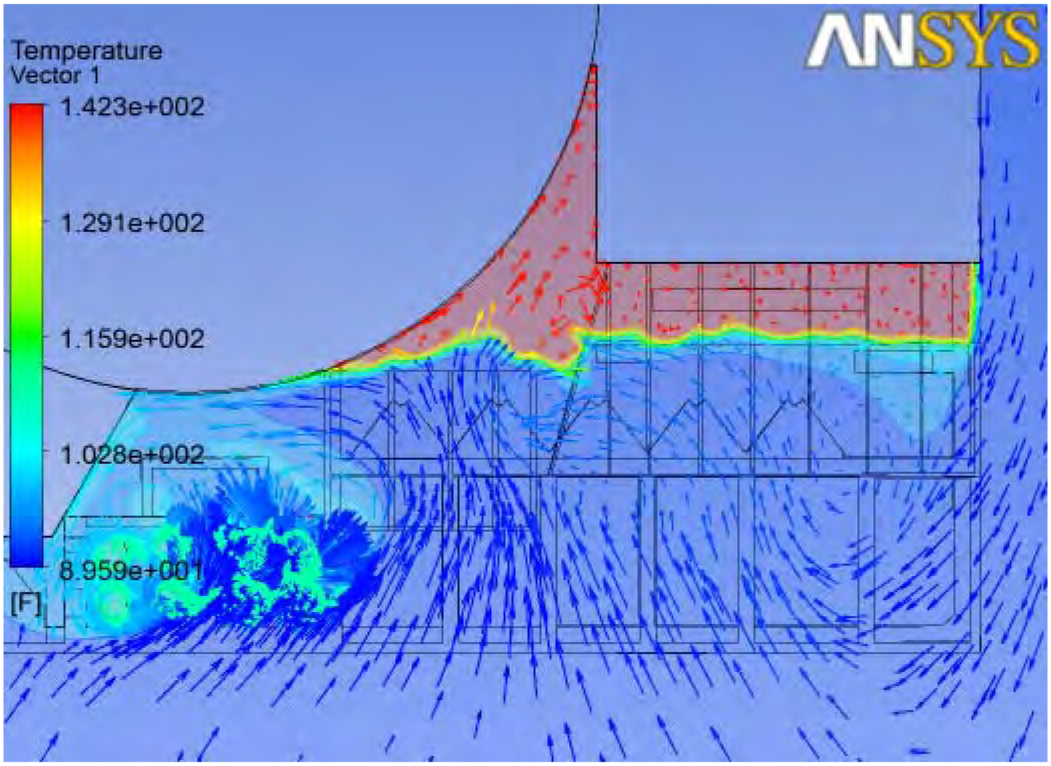


Figure E-69: Velocity vector and temperature contour above the deflector wall

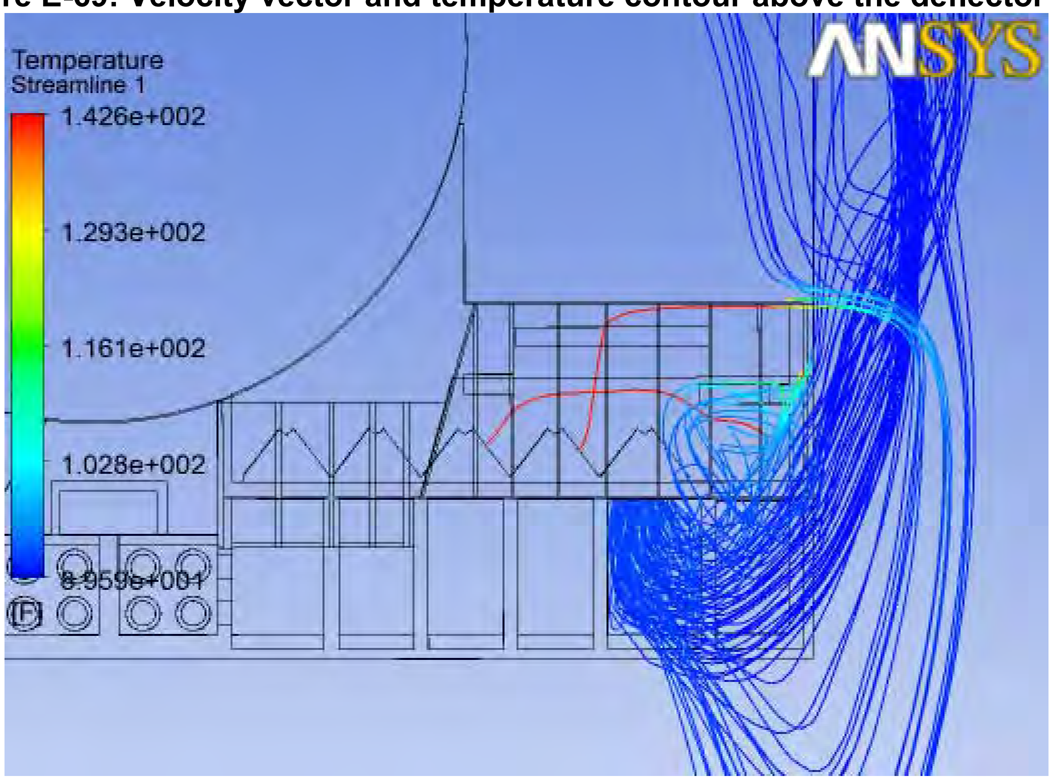


Figure E-70: Streamline at cell 1 for case 5

E-15: Train B Case 6: Northwest wind with 10mph wind and 98F Ambient

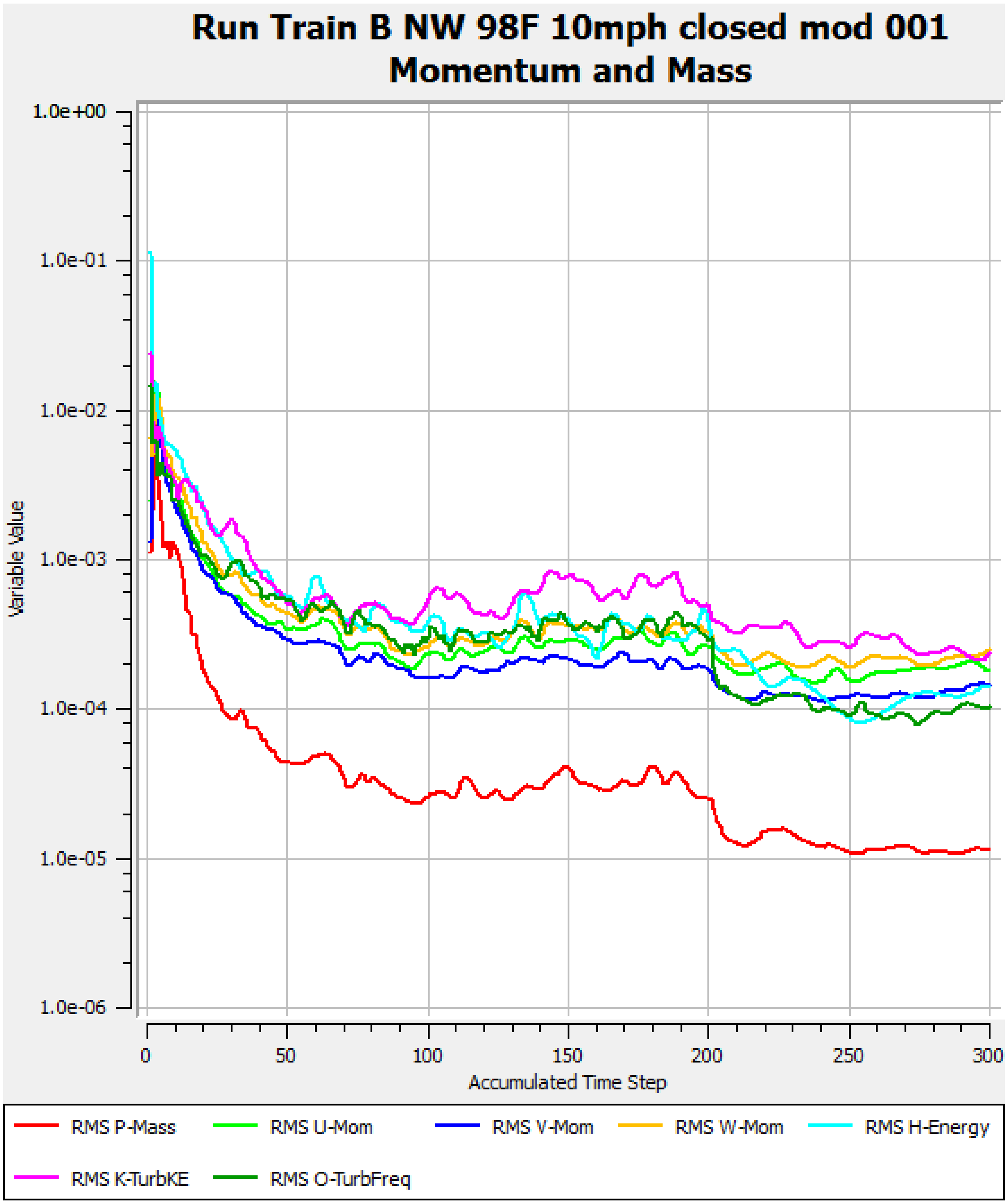


Figure E-71: Residual plot for case 6

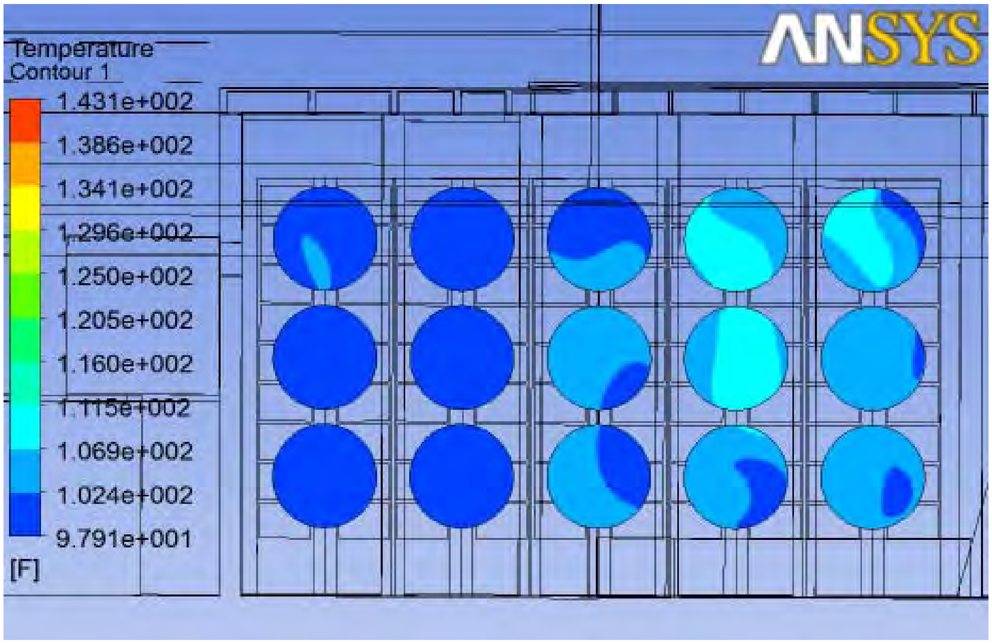


Figure E-72: Fan temperature for case 6

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	101.6	100.2	101.6	105.6	104.4
	101.1	100.7	103.9	106.1	103.6
	100.5	101.4	102.8	104.3	102.4
Average fan temperature:				102.7	

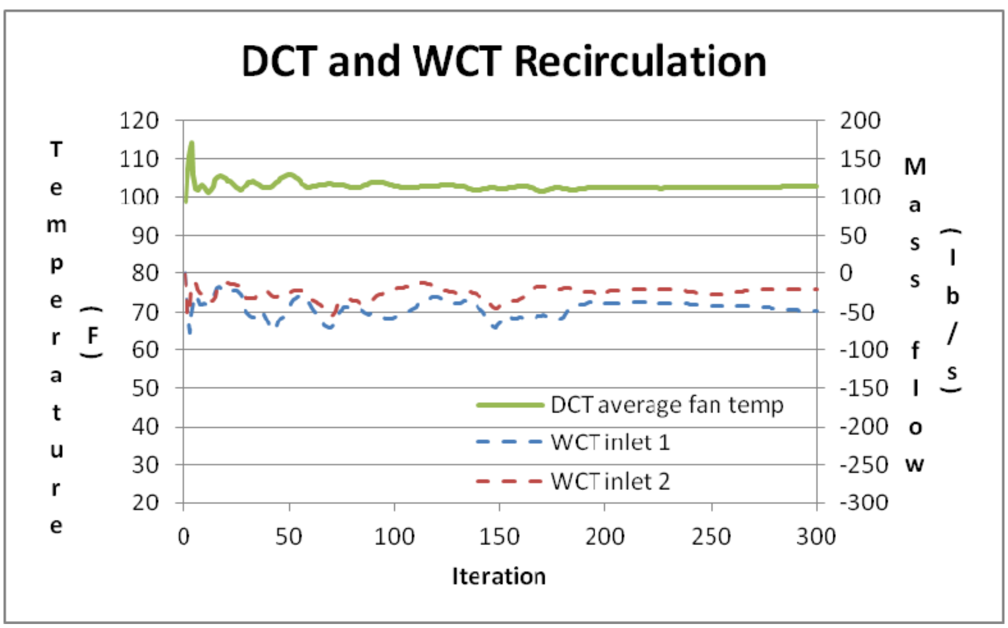


Figure E-73: DCT and WCT recirculation with iteration for case 6

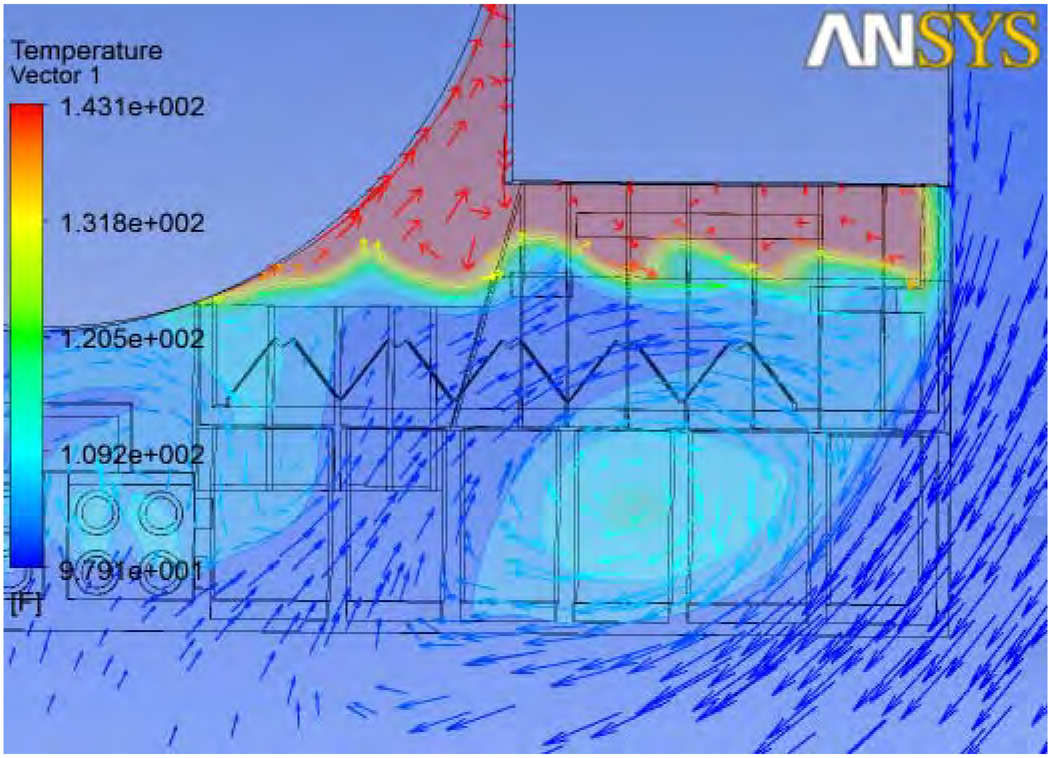


Figure E-74: Velocity vector and temperature contour above the deflector wall

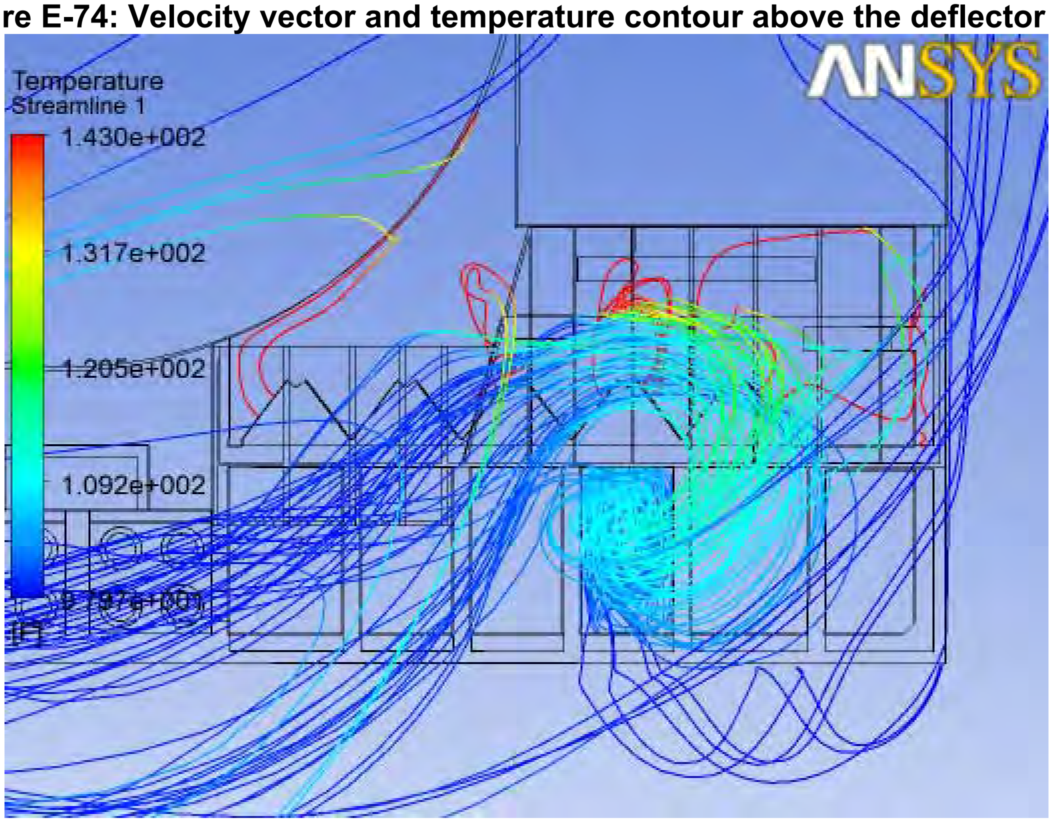


Figure E-75: Streamline at cell 2 for case 6

E-16: Train B Case 7: Southwest wind with 10mph wind and 98F Ambient

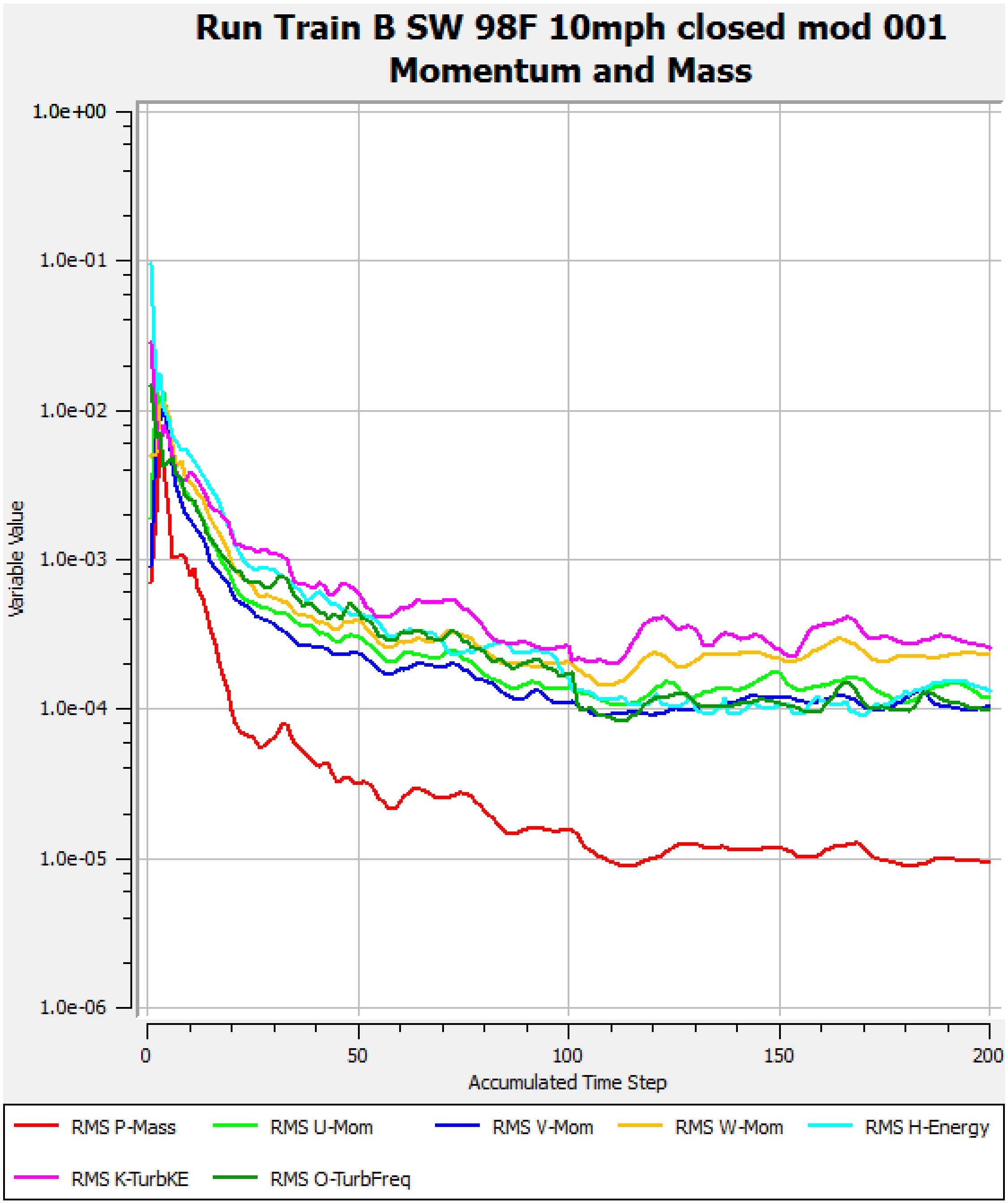


Figure E-76: Residual plot for case 7

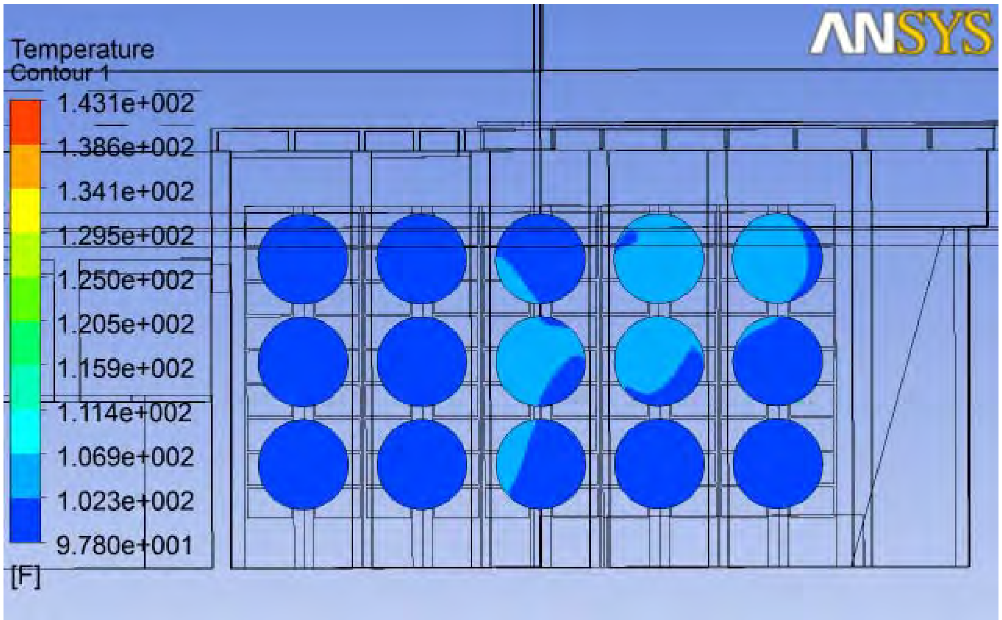


Figure E-77: Fan temperature for case 7

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	98.6	99.9	101.1	104.0	103.0
	98.4	99.8	103.5	103.3	100.7
	98.8	98.9	100.9	99.7	99.1
Average fan temperature:				100.6	

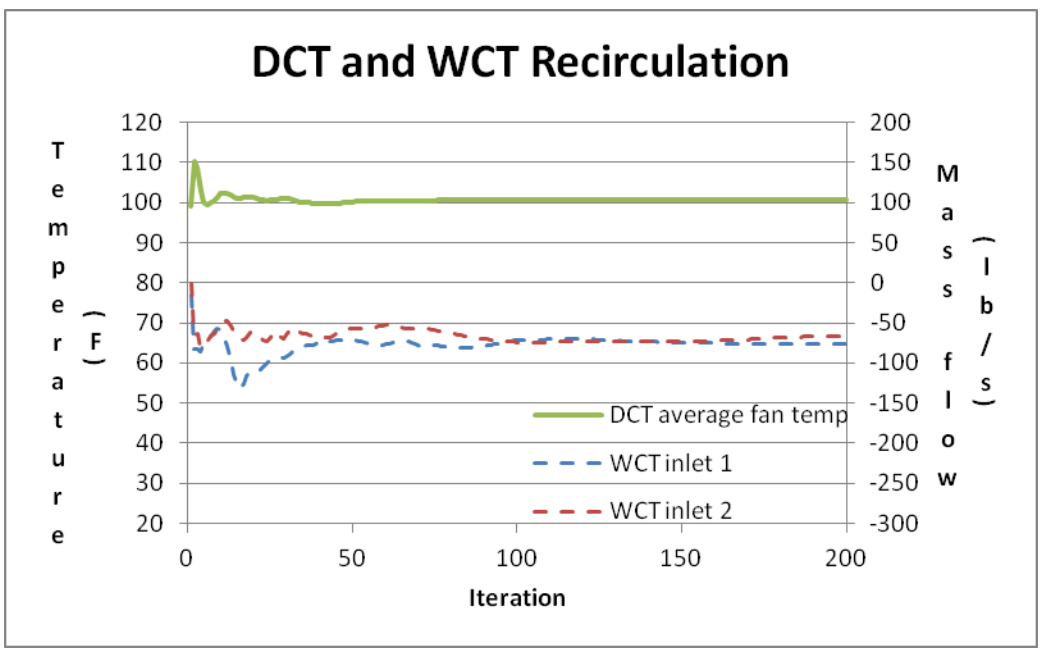


Figure E-78: DCT and WCT recirculation with iteration for case 7

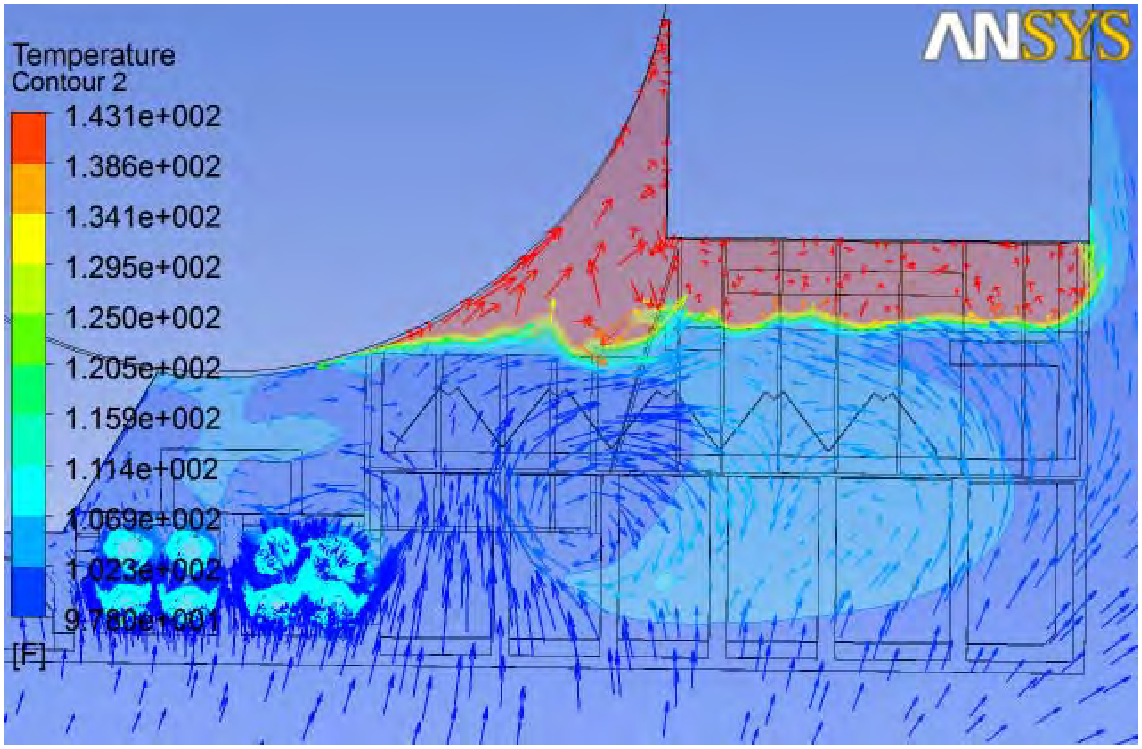


Figure E-79: Velocity vector and temperature contour above the deflector wall

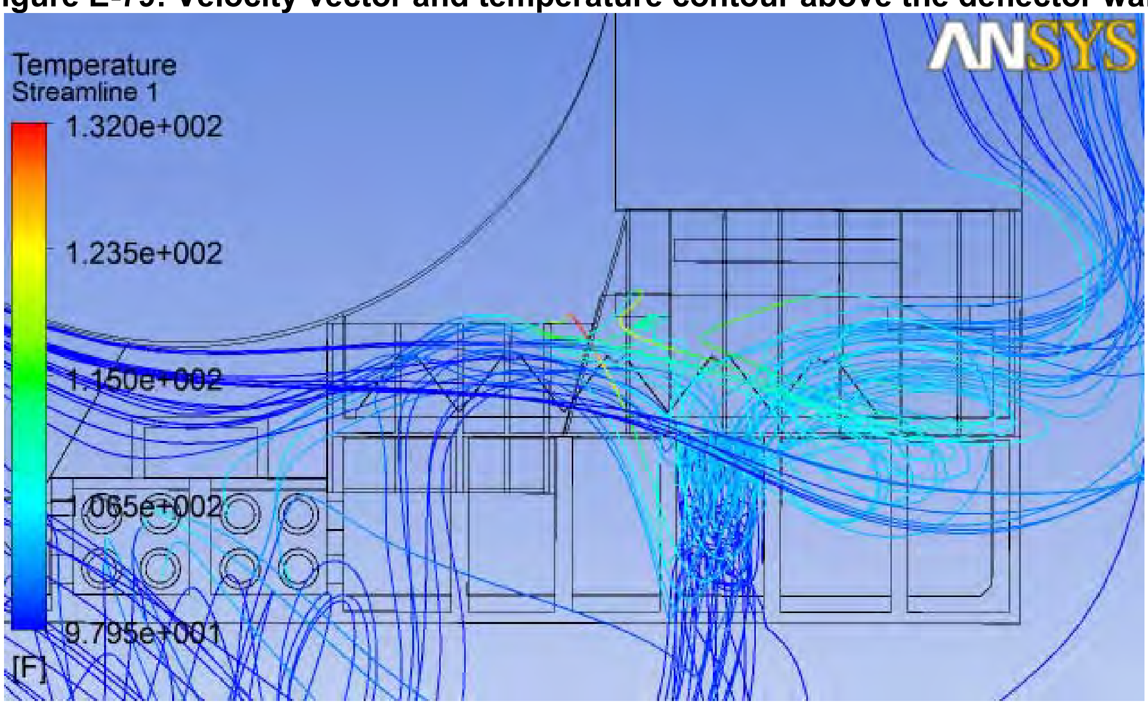


Figure E-80: Streamline at cell 2 for case 7

E-17: Train B Case 8: North wind with 10mph wind and 98F Ambient

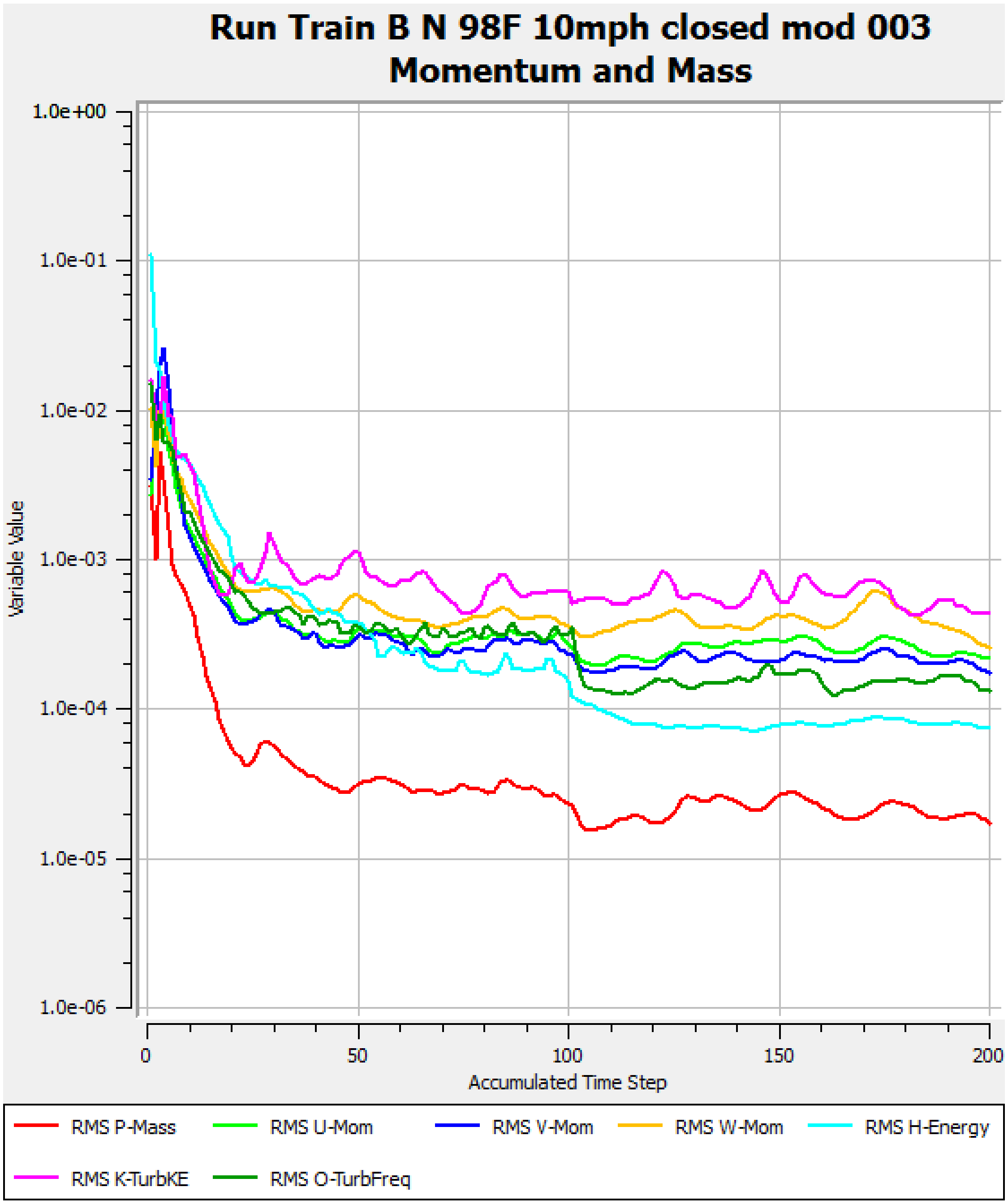


Figure E-81: Residual plot for case 8

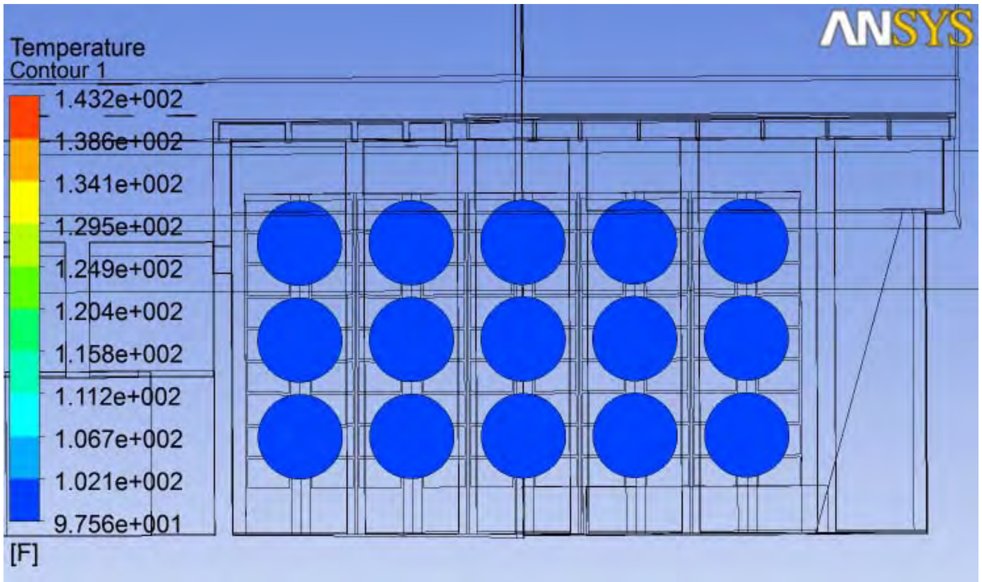


Figure E-82: Fan temperature for case 8

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	98	98	98	98	98
	98	98	98	98	98
	98	98	98	98	98
Average fan temperature:				98	

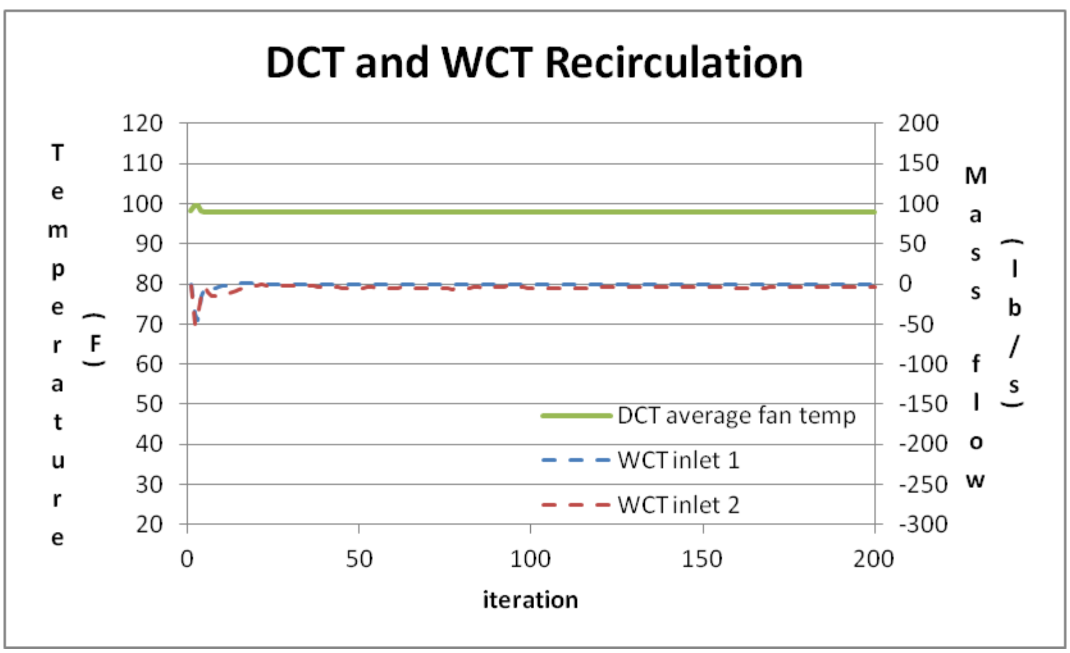


Figure E-83: DCT and WCT recirculation with iteration for case 8

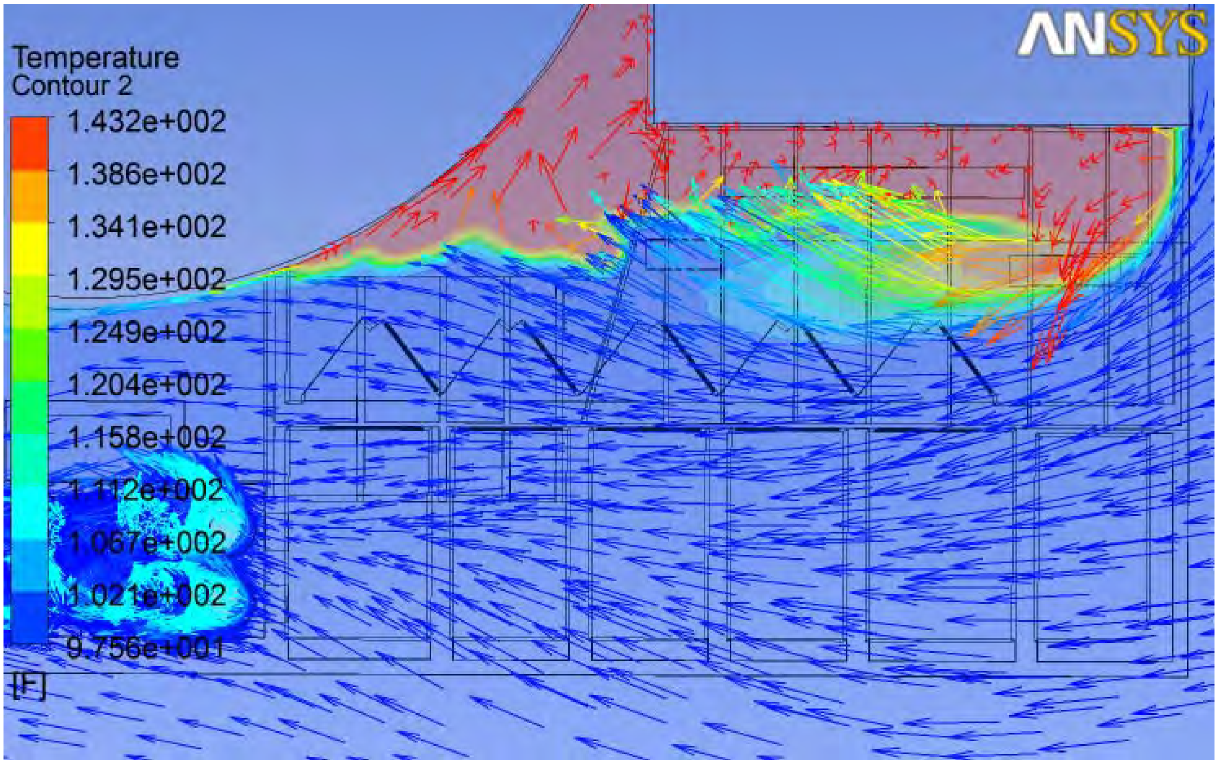


Figure E-84: Velocity vector and temperature contour above the deflector wall

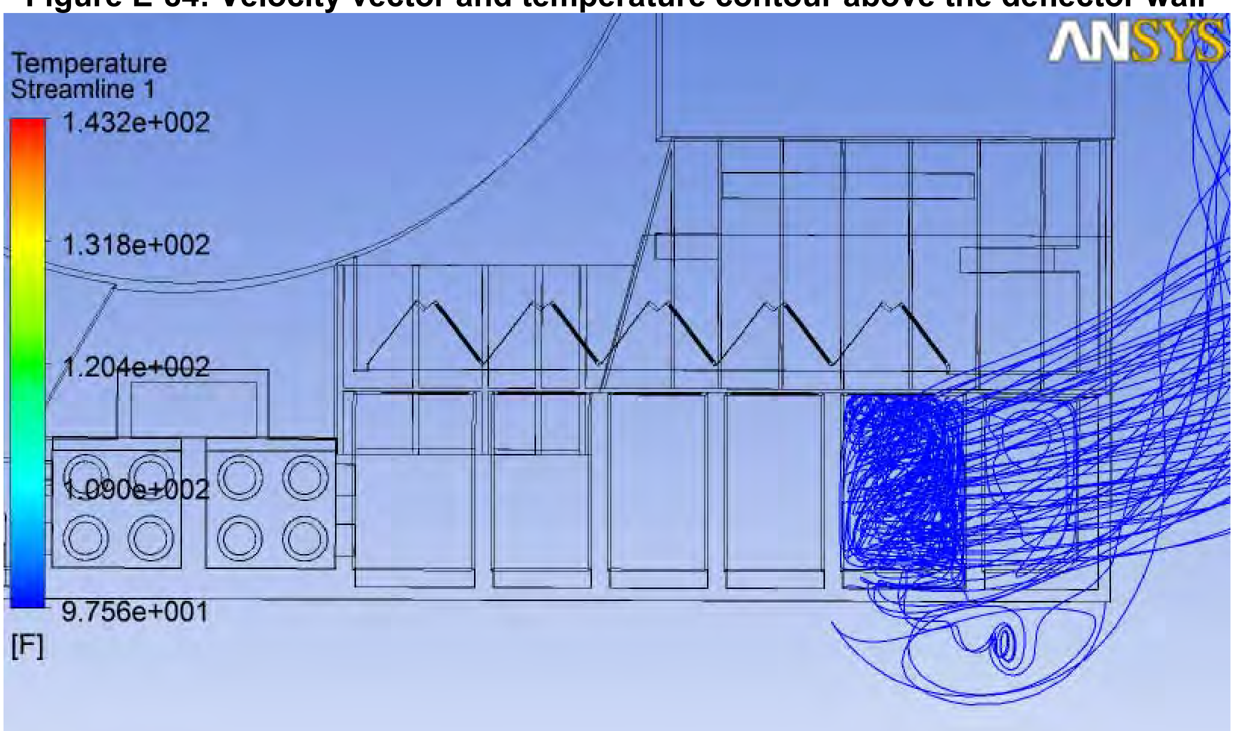


Figure E-85: Streamline at cell 1 for case 8

E-18: Train B Case 9: South wind with 10mph wind and 98F Ambient

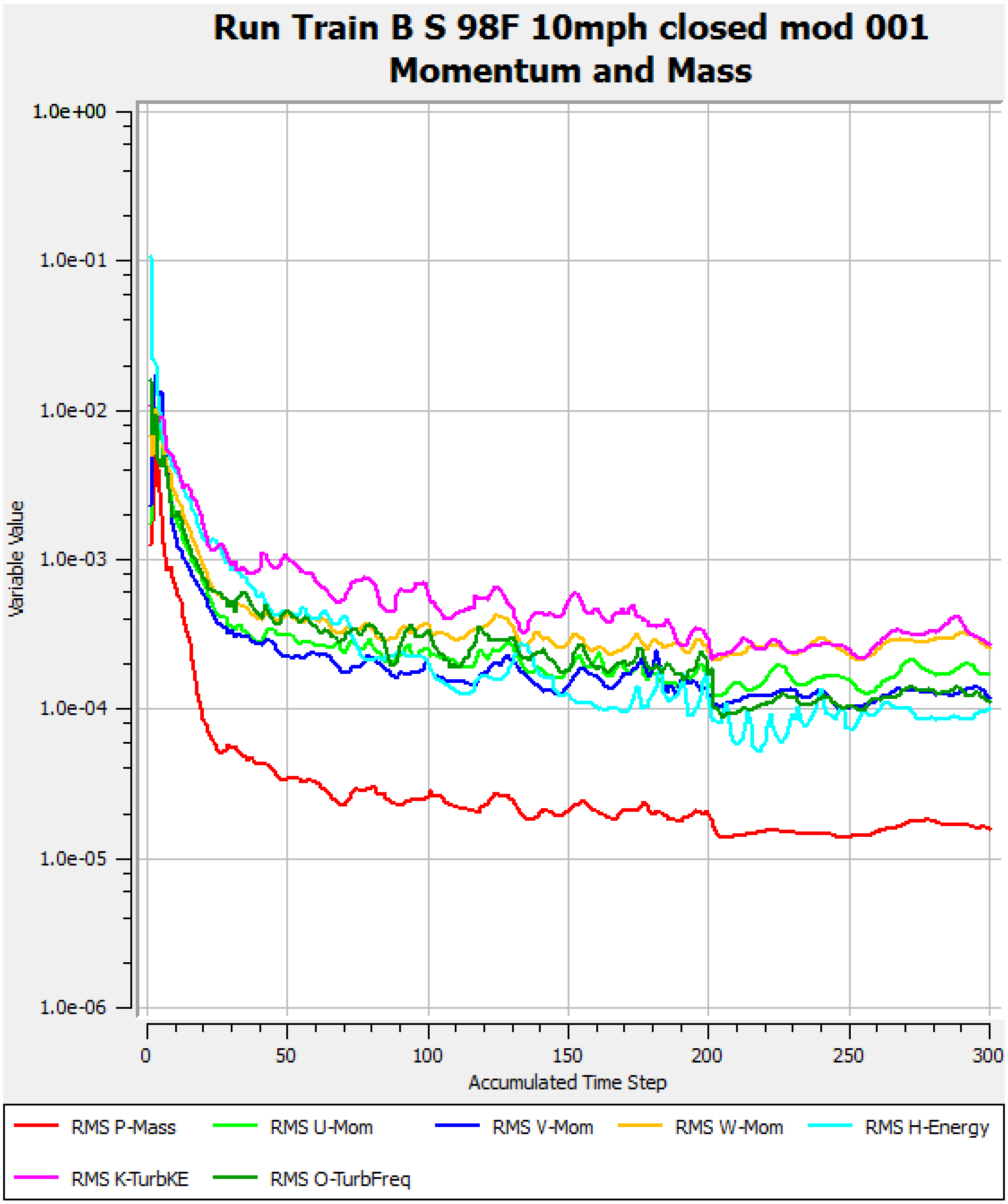


Figure E-86: Residual plot for case 9

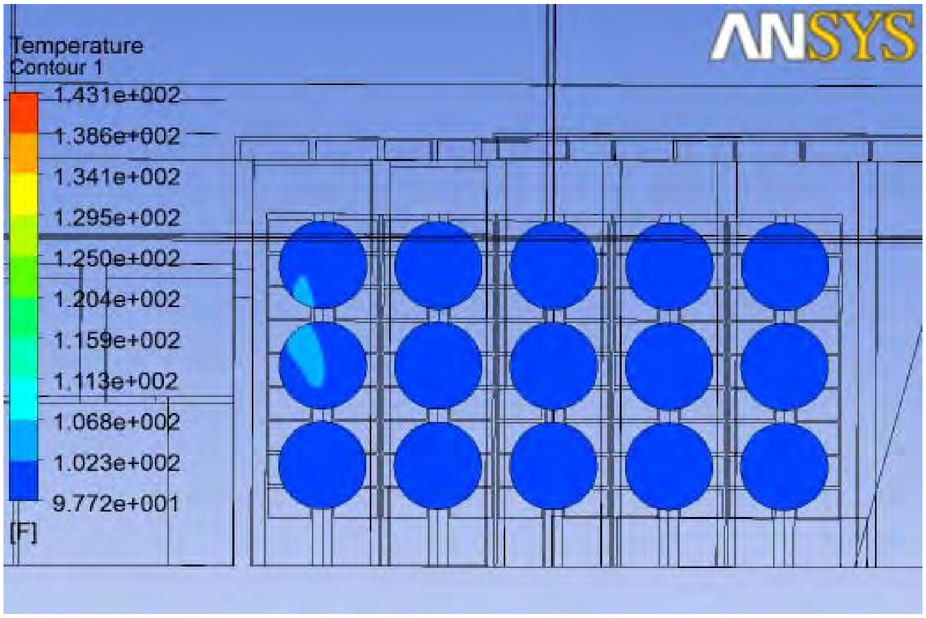


Figure E-87: Fan temperature for case 9

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	101.3	99.2	100.0	99.2	98.2
	100.8	98.2	98.1	98.0	98.0
	99.3	97.9	97.9	98.0	98.0
Average fan temperature:				98.8	

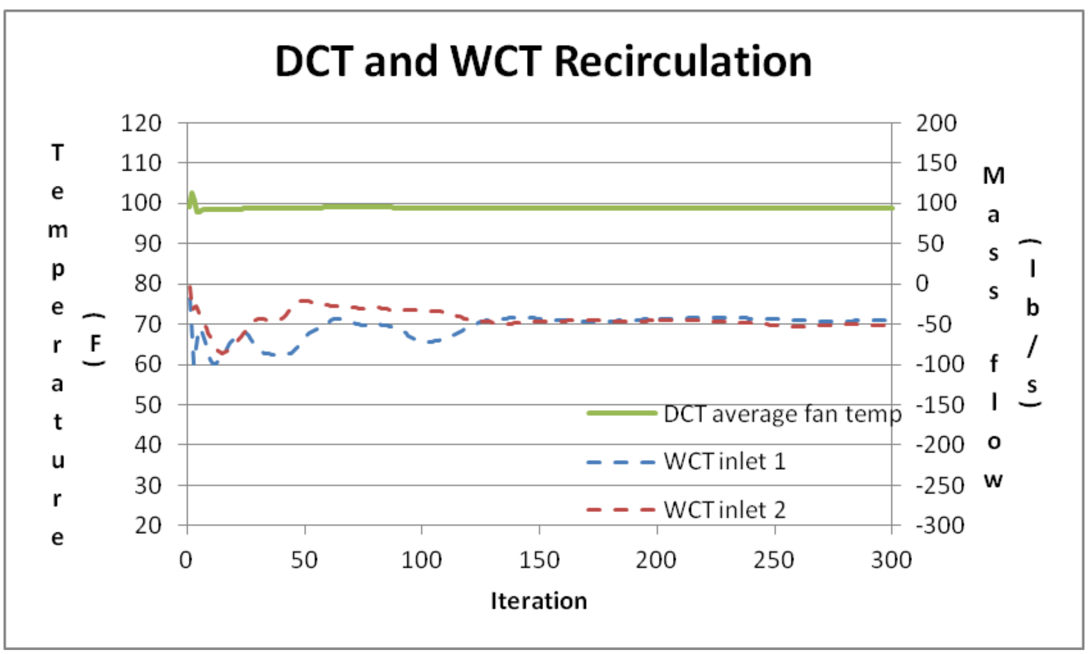


Figure E-88: DCT and WCT recirculation with iteration for case 9

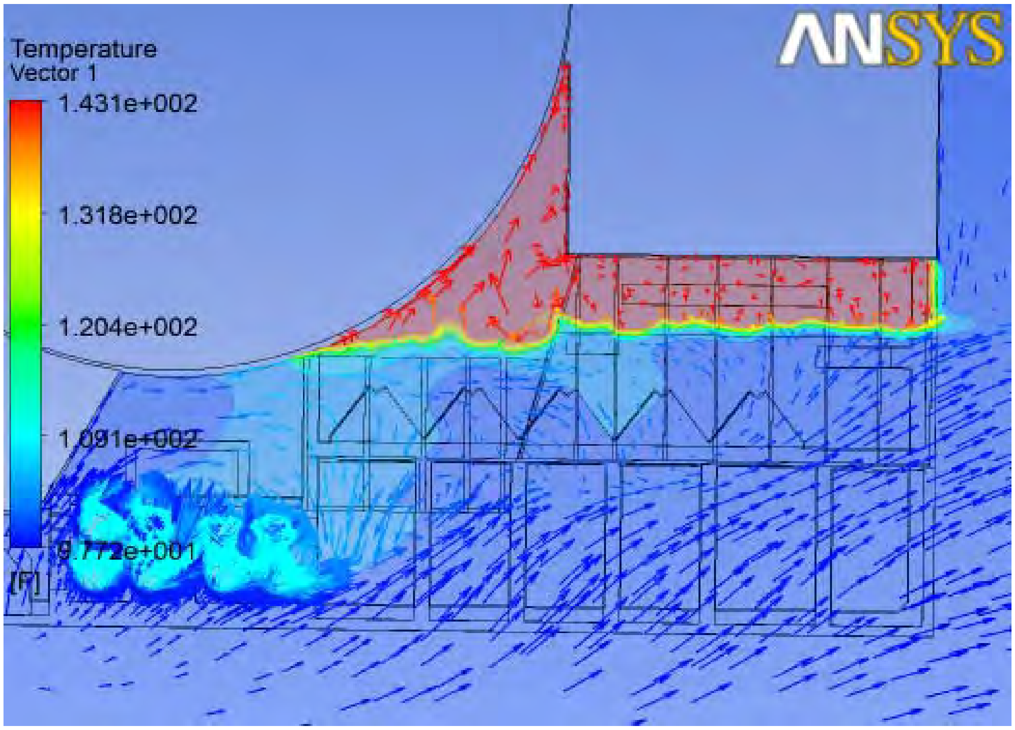


Figure E-89: Velocity vector and temperature contour above the deflector wall

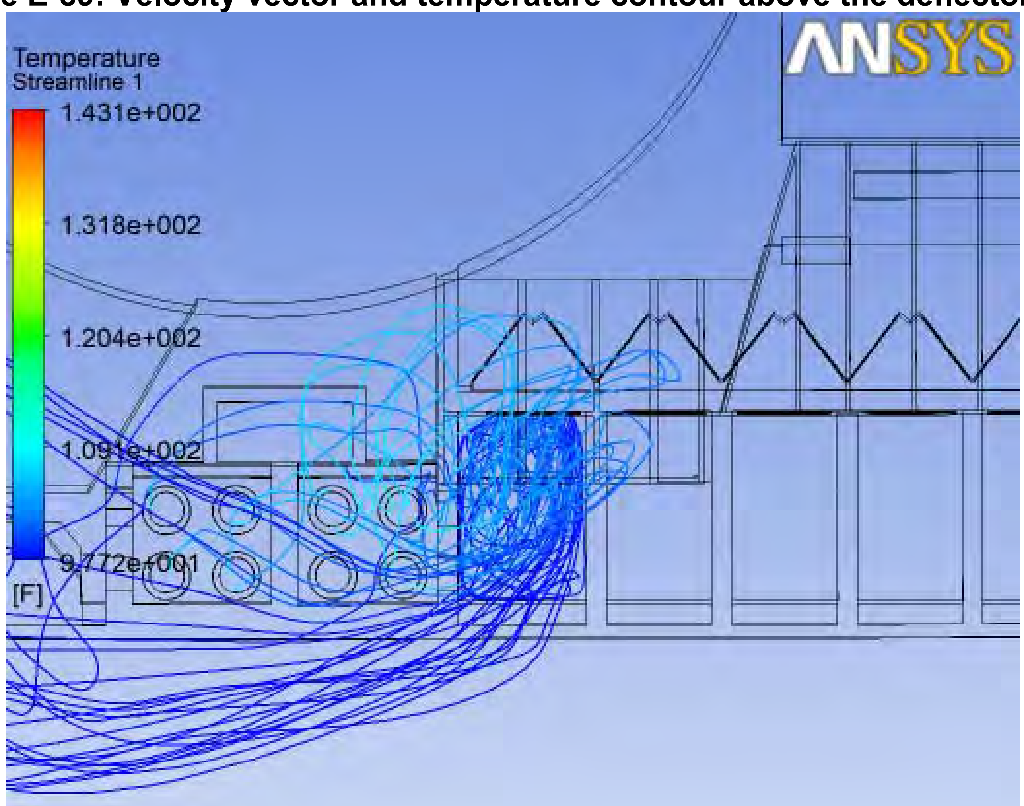


Figure E-90: Streamline at cell 5 for case 9

E-19: Train B Case 10: West wind with 10mph wind and 98F Ambient

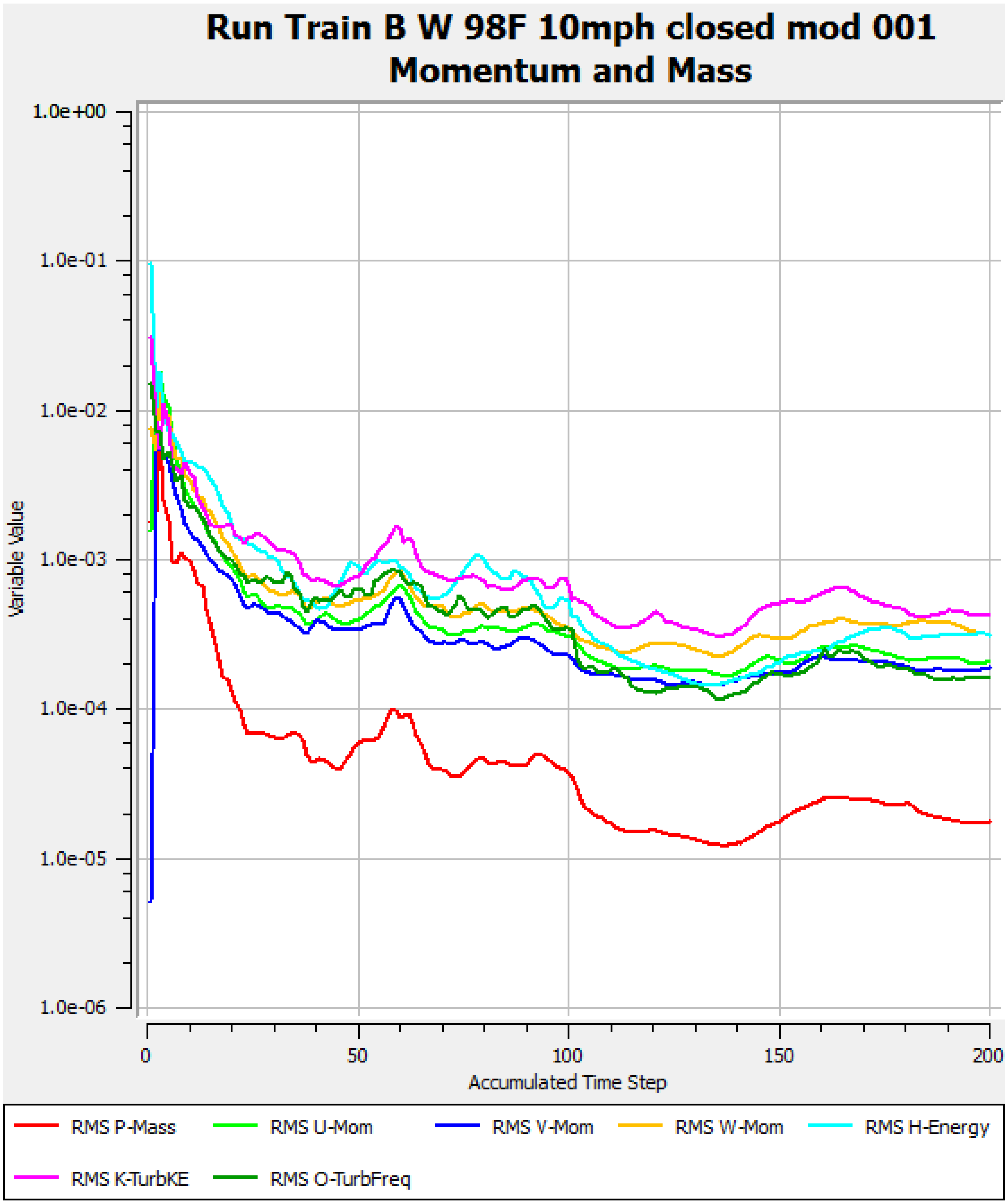


Figure E-91: Residual plot for case 10

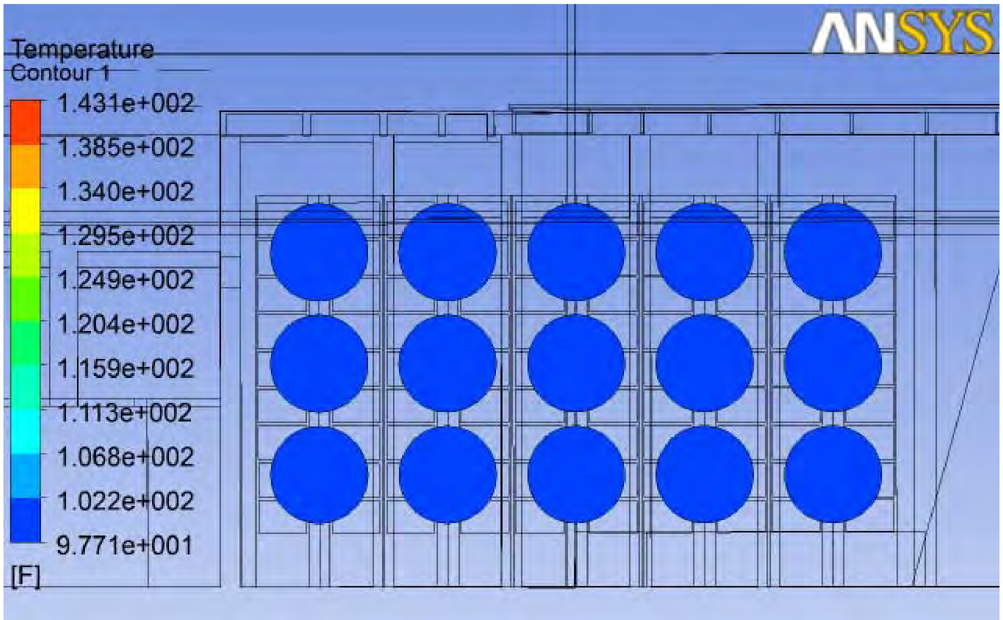


Figure E-92: Fan temperature for case 10

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	98.9	98.7	99.8	100.1	99.8
	98.8	98.3	99.0	99.2	100.4
	98.8	98.1	98.2	98.6	99.2
Average fan temperature:				99.1	

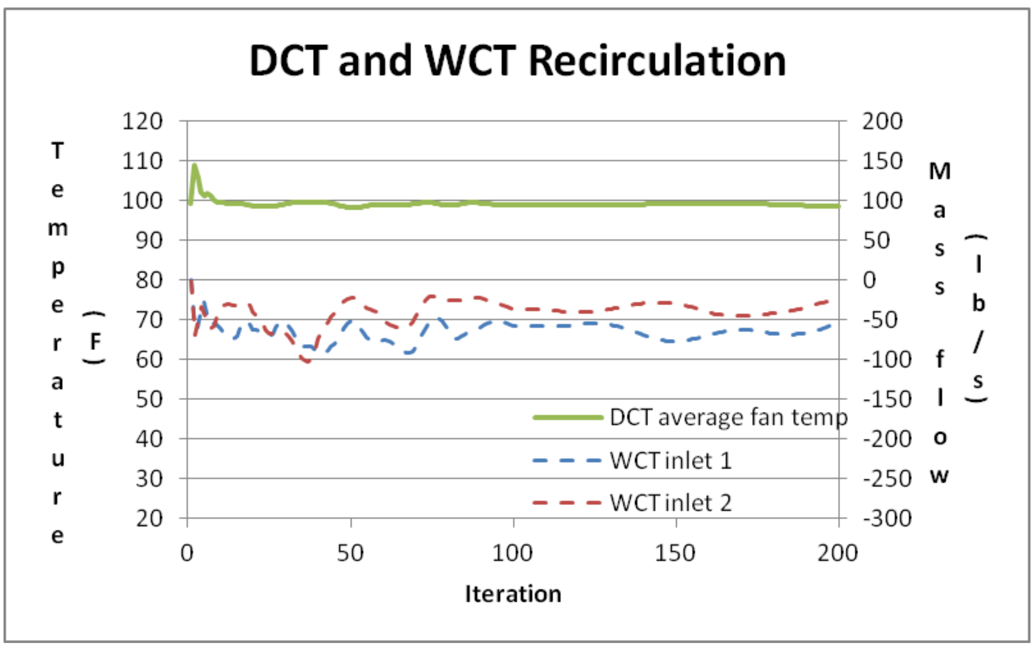


Figure E-93: DCT and WCT recirculation with iteration for case 10

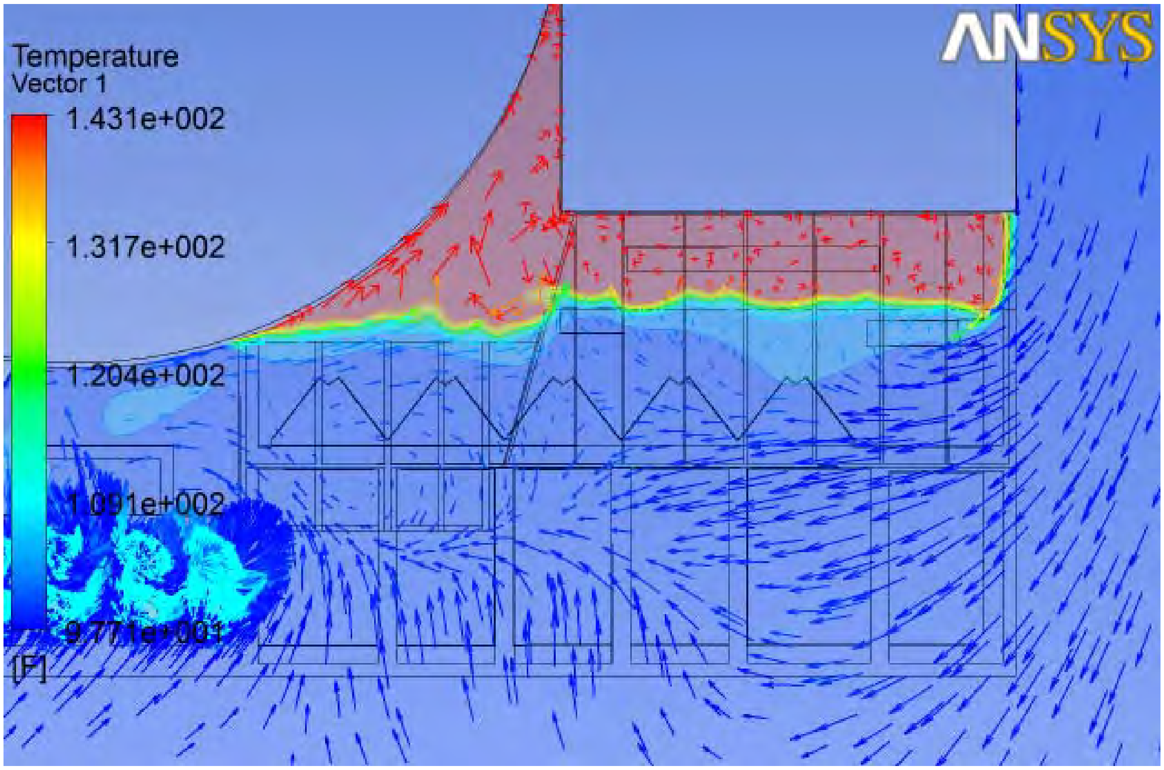


Figure E-94: Velocity vector and temperature contour above the deflector wall

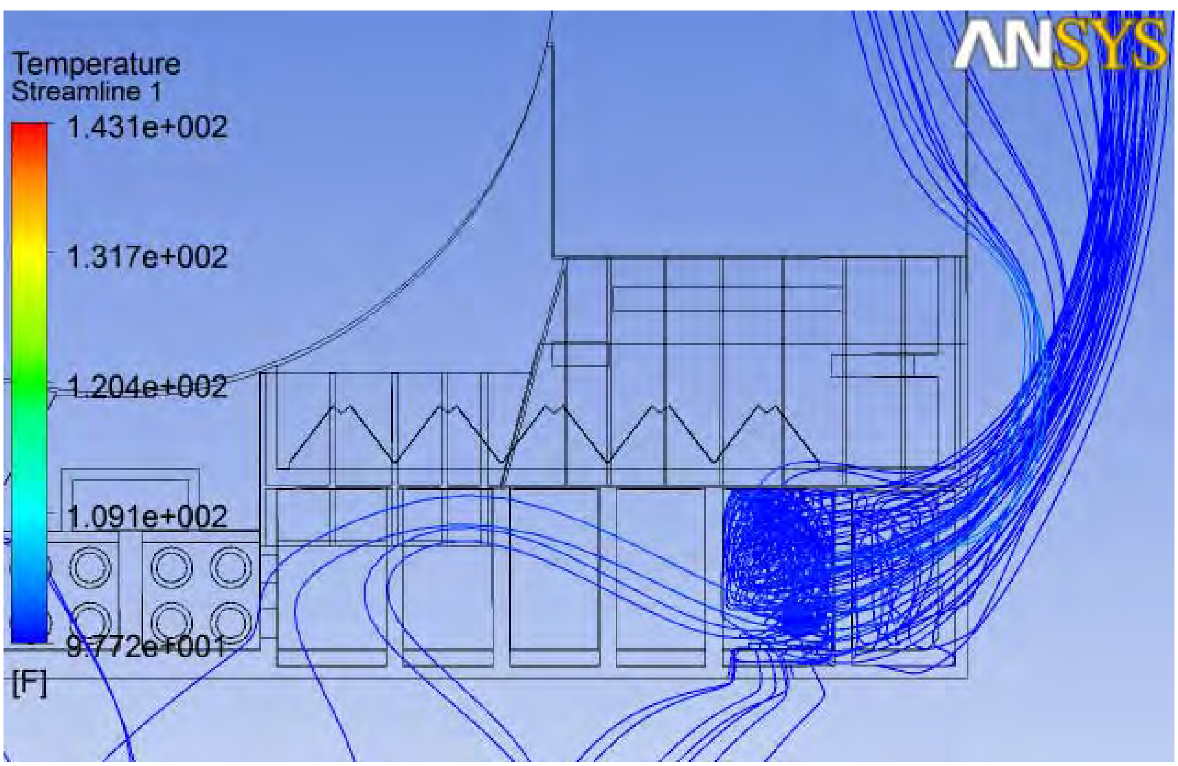


Figure E-95: Streamline at cell 1 for case 10

E-20: Train B Case 11: 102F Ambient with no wind

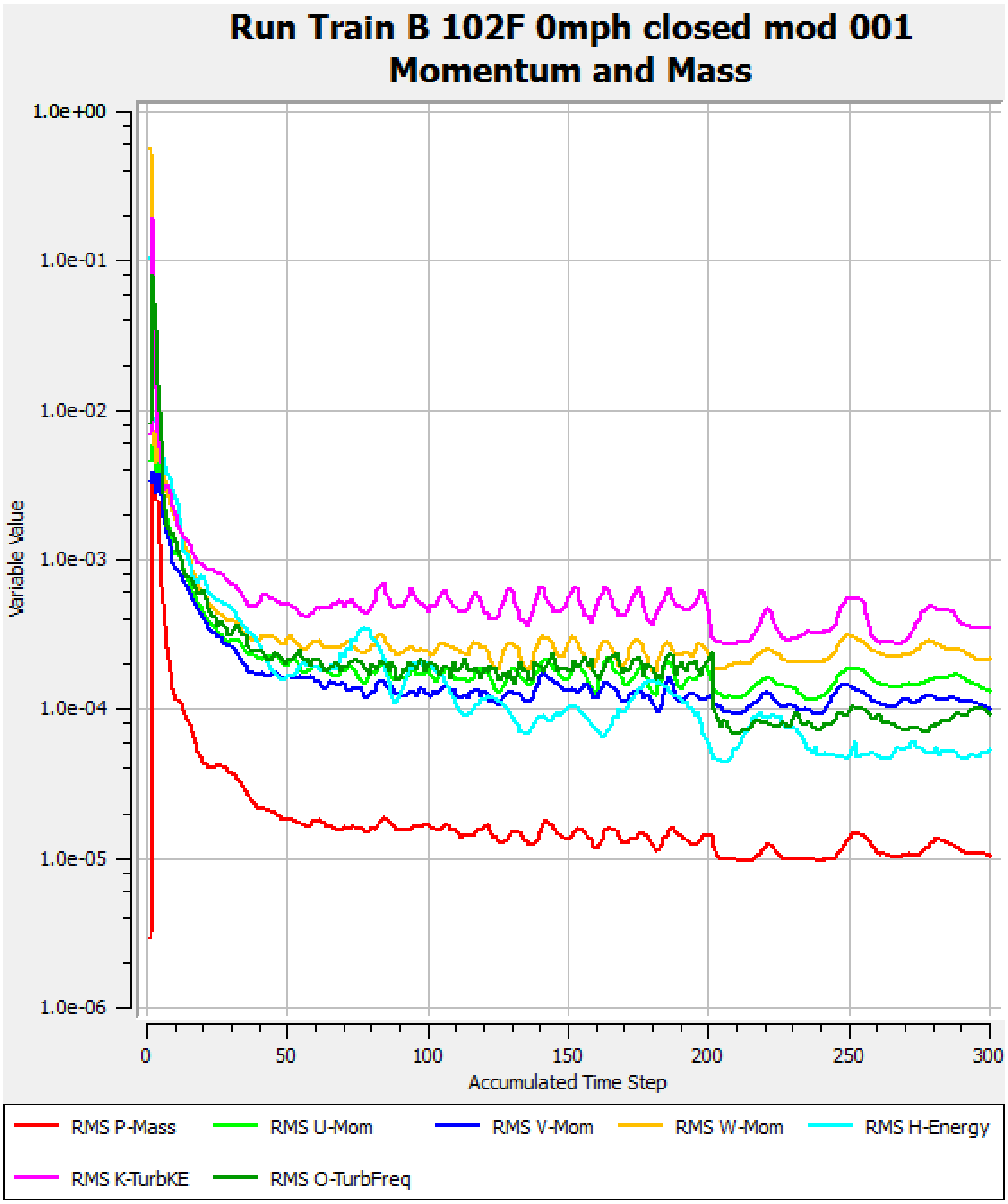


Figure E-96: Residual plot for case 11

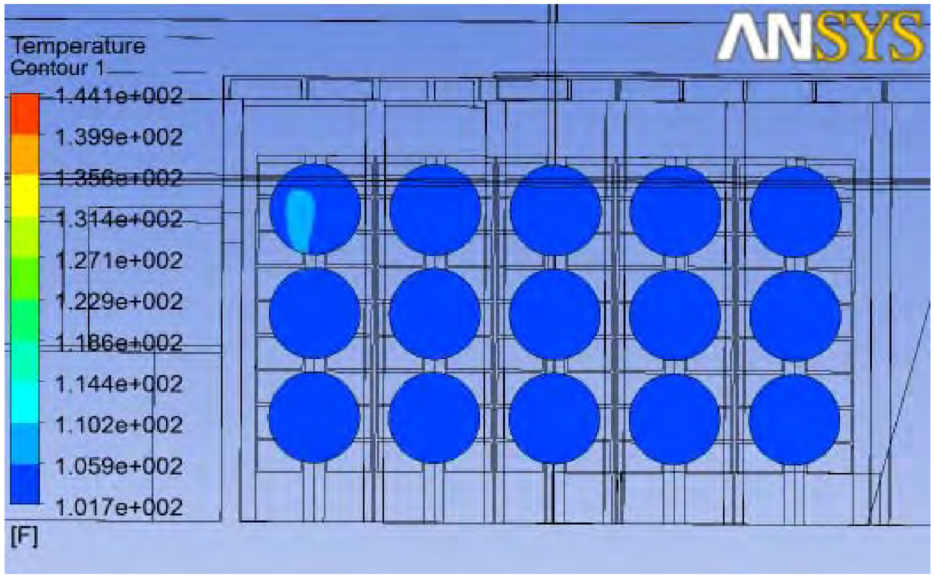


Figure E-97: Fan temperature for case 11

Individual fan temperature (deg F)					
Cell:	5	4	3	2	1
	105	102	102	102	102
	103	102	102	102	102
	102	102	102	102	102
Average fan temperature:			102.2		

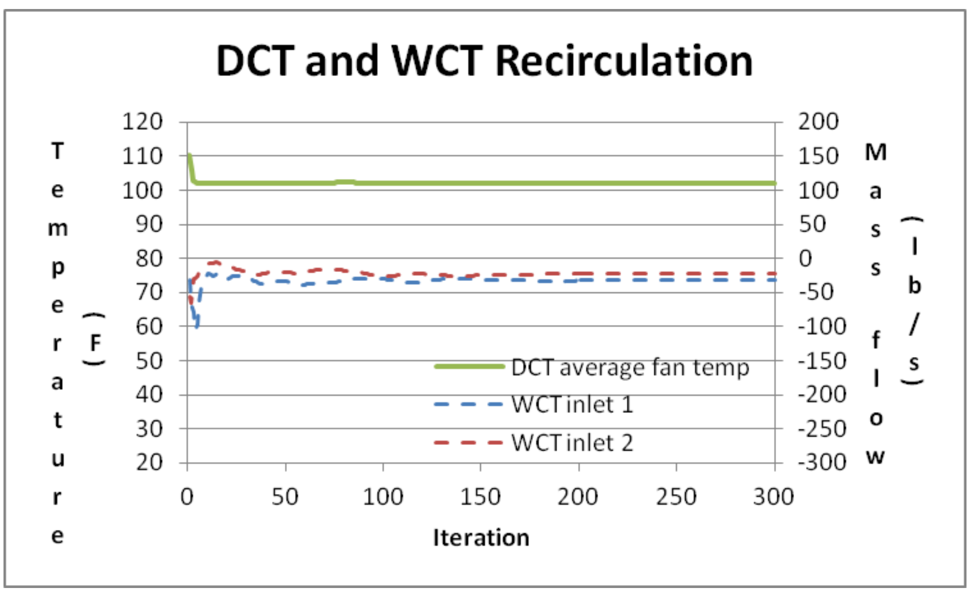


Figure E-98: DCT and WCT recirculation with iteration for case 11

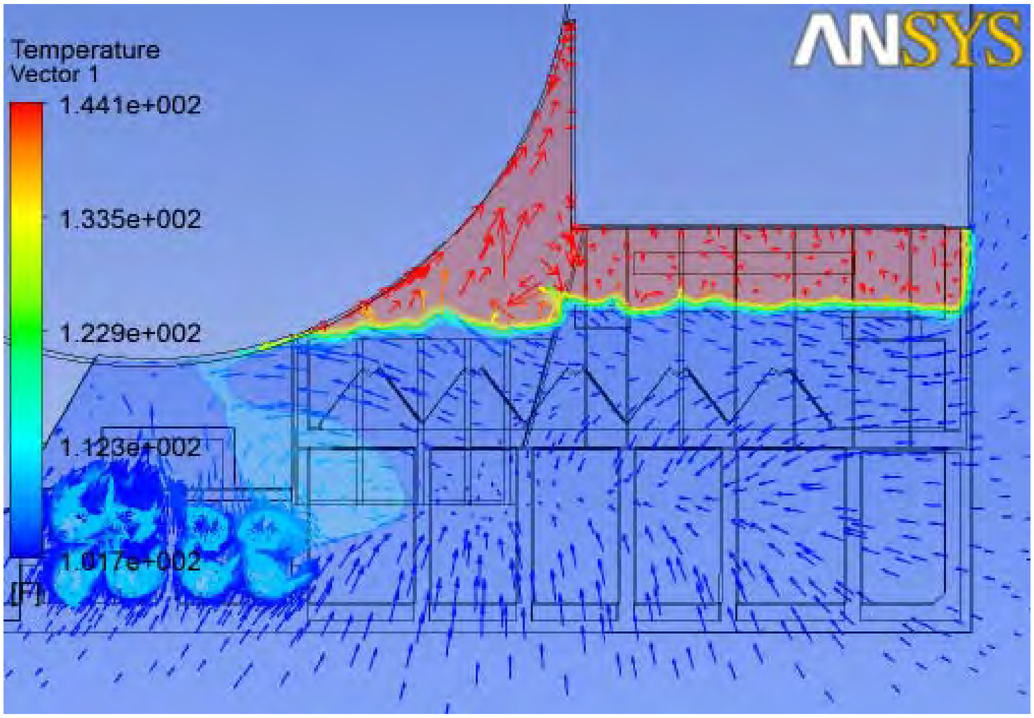


Figure E-99: Velocity vector and temperature contour above the deflector wall

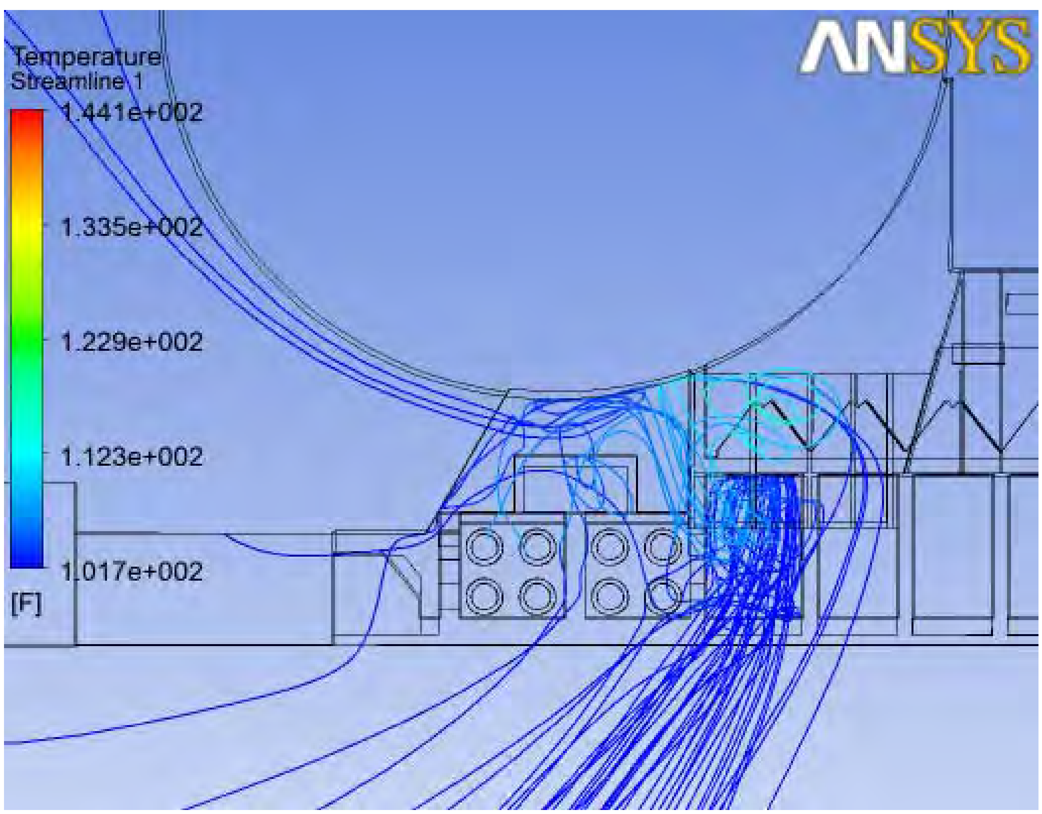


Figure E-100: Streamline at cell 5 for case 11

ATTACHMENT F

Input Data

Hudson Products Heat Transfer Data [20]

MNQ9-52 Rev 2 Attch 2 2 of 5

HUDSON PRODUCTS

Date	By
8-29-74	DVG
11-10-76	BRF
1-19-79	BRF

Fin-Fan *Trademark

JOB NO. ND002

Customer	EBASCO FOR LOUISIANA POWER & LIGHT COMPANY	Item No.	1
		Date	June 15, 1973
		Proposal No.	PN73-104-LA
Address	New York, New York; Plant Location Taft, Louisiana	Cust. Ref. No.	LOU-1675
		Sheet	1 of 1
Service	WATER COOLER	No. of Units	5 per Item
Size	24-686-P; Type 3FPGA; Forced Draft		
Surface/Item — External	895,813; Bare Tube 42,255		Sq. Ft.
Heat Exchange — BTU/Hr	100,000,000 (LOCA)	Effective MTD	19.8 °F
Transfer Rate — External Surface	5.64; Bare Tube Surface — Service 119.5 — Clean 142		BTU/Hr. Sq. Ft. °F

(2) ITEMS REQUIRED — PERFORMANCE DATA

TUBE SIDE

Fluid Circulated	WATER	Temperature In	161.4 °F
Total Fluid Entering Lbs/Hr	6500 GPM	Temperature Out	130.7 °F
Vapor		Inlet Pressure	PSIG
Liquid	3,250,000 lbs/hr.	Gravity—Liquid	
Steam		Viscosity (V) (L)	@ °F
Non-Condensables		Viscosity (V) (L)	@ °F
Vapor Condensed		Molecular Weight (V) (L)	
Steam Condensed		Specific Heat (V) (L)	BTU/Lb °F
Density Vapor Lbs/Cu. Ft.		Latent Heat	BTU/Lb
Conductivity BTU Ft/Hr. Sq. Ft. °F		Allowable Press. Drop	15 PSI
Fouling Resistance I.S. Hr. Sq. Ft. °F/BTU	.00132 (842 Uc)	Design Pressure Drop	12.5 PSI

AIR SIDE 2 334; 102° AMB.

Air Quantity/Item SCFM	2,538,000; Face Velocity 450 SFM	Temperature In	107.9 °F
Air Quantity/Fan ACFM	181,044	Temperature Out	144.4 °F
Actual Static Pressure In. Water	.385 / .23 , .45	Altitude	17.5 Ft.

CONSTRUCTION

Design Pressure	125 PSI	Test Pressure 304 PSI	Design Temperature 300 °F

SECTION	HEADER (c)	TUBE (a)
Size 12 Ft. 0 In. X 48 Ft. X 6 Rows	Type — Plug	Material Stl.
No./Item 10	Material Stl. ASME-SA-516, Gr.70	ASME-SA-178,C Welded
Arrangement: Stack	No. Passes/Section 4; Slope - In./Ft.	OD 1.0 In. .085 Min. Wall
Sections in Parallel 10 in Series	Plug/Design Shoulder ASME-SA-105	No./Section 336; Length 48 Ft.
Units in Parallel 5 in Series	Gasket Material Steel / A-366	Pitch 2¼ In. △
Section Side Frames G. Steel	Corrosion Allowance ⅛ In.	FIN
MISC. Mtg. Grade —	Size Inlet Nozzle 8 In.	Material Aluminum
Structure G Steel; Ladder -	Size Outlet Nozzle 8 In.	OD 2¼ In.
Plenum G Steel; Walkway -	Rating & Facing 150# RF	No./In. 10
Louvers; Vibrat. Switch (d) YES	Code — ASME — Stamp — Yes "N"	Type Extruded

MECHANICAL EQUIPMENT

FAN 9000 FPM TIP SPEED (b)	DRIVER w/Space Heater	SPEED REDUCER
Mfr. Hudson; Pitch Angle 11°	Type Electric Motor	Type In-Line Reducer
No./Unit 3; HP/Fan 30.8	No./Unit 3	No./Unit 3
Diameter 14 Ft.; RPM 205	RPM 1750/850; Nominal HP/Driver 40	Model 8HL2 for 326 T Motor
No. Blades 6W; Pitch—Adjust.—	Enclosure TEFC - MAC	AGMA Hp Rating 40 HP @ 3.0SF
Blade Material *TUF-LITE	Specials 460 / 3 / 60	Ratio = 8.55 /1
Hub Material Cast Iron	Mfr. Westinghouse (MAC)	Mfr. Philadelphia Gear

CONTROLS

WINTERIZATION	STEAM COIL	
External Air Recirculation	Inlet Press. PSI; Design Press. PSI	Tube Material Steel—Seamless—Welded
Panel Walls	Design Temp. °F; Test Press. PSI	1 Row; Length Ft.; ASME—SA—
ACTUATOR AIR: SIGNAL / SUPPLY	Total Steam Quantity Lbs/Hr	No. OD In. BWG Avg. Min. Wall
Steam Coil to PSI / PSI	Size Inlet Nozzle 3 In.; Rating RF	Fin Material Aluminum
AV Fan to PSI / PSI	Size Outlet Nozzle 3 In.; Rating RF	OD 2¼ In.; No. Fins/in. 10
Louvers to PSI / PSI	Code — ASME — No Stamp; No Corrosion Allow	Type

NOTES. The Following Items are Located in One Unit: Bank No.

(a) Epoxy Tube End Protection. (b) w/Inlet Bells.

(c) Carbozinc #11 - 1.5 mils DFT. (d) Metrix

Plot Area — Proposal Drawing No. P-3104-A — Shipping Weight 1,080,000 Lbs.

Tuf-Lite V5.9 Axial Flow Fans

Hudson Products

User System: jrborges

Project References

Project/Job	Waterford3	InquiryNo.		RunTime	7/9/2015 8:24:17 AM
CustomerName	Gregory Zysk	ItemNo.		Preparer	Juan Borges

Fan Input Specifications

Units	English	
Blade Type:	W	
Fan Diameter	14	ft
Blade Count	6	
Fan Rpm	204	
Max Tip Spd	12000	fpm
VRS Hgt (eff)	0	ft
Inptd Pch(Rtg)	13	
MinFloMarg(%)	0	

Flow Units	Vol Flow (cfm)
AirFlow	119000
Press Units	in wg
Static Press	0
Max PWL (db)	0
Min RF Marg (%)	10
No. Spt Beams	0
Hydr Exponent	0

Application Type	Heat Exchanger	
Draft Type	Forced Draft	
Inlet Bell Type	Ellip, R/D.10x.15	
Drive Type	Synch Belt	
Calculation Type	Rate Performance	
Air Temperature	40	F
Site Elevation	0	ft
Air Density	0	lb/f3
Mot Effy (%/100)	0.95	
Drv Effy (%/100)	0.95	

Hudson Products Corporation

Tuf-Lite V5.9 Axial Flow Fans

Hudson Products

User System: jrborges

Project References

Project/Job	Waterford3	InquiryNo.		RunTime	7/9/2015 8:24:17 AM
CustomerName	Gregory Zysk	ItemNo.		Preparer	Juan Borges

Overall Selection Rationale		Hudson Blade Type
Rating	***Fan Output Results***	***Tuf-Lite***

Basic Fan Data			Conditions of Service			Basic Requirements			Dynamics		
Appln	Heat Exchanger		DraftType	Forced Draft		DriveType	Synch Belt		1st RFqy	14.4	hz
BldType:	W		AirFlo	119,000.	cfm	Model	APT-14W-6		RfMarg	29.41	%
FanDiam	14	ft	MasFlo	564,777.7	lb/h	Calc	Rate Performance		BldPassFqy	20.4	hz
	4267.	mm	TotPres	1.042	iwc	Inlet	Ellip, R/D.10x.15		BmPassFqy	0	hz
BldCount	6		StaPres	.995	iwc	VrsHgt	0	ft	1xRpmFqy	3.4	hz
BldPitch	13.	deg	VelPres	.048	iwc	AirTemp	40	F	2xRpmFqy	6.8	hz
Fan Rpm	204.		InLoss	-.002	iwc	SiteElev	0	ft	3xRpmFqy	10.2	hz
TipSpd	8972.4	fpm	VelRecy	0	iwc	AirDens	.0791	lb/f3	4xRpmFqy	13.6	hz
MxTpSpd	12000	fpm	MnRFMarg	10	%	MaxPwl	0	db			
MotShfPwr	34.3	hp	ActHp/Bld	5.4	hp/b	NoSptBms	0		**Physicals**		
FanShfPwr	32.5	hp	MxHp/Bld	10.	hp/b	MotEffy	0.95	%	WR2Inertia	4285	lb-f2
Totl Effy	59.9	%/100				DrvEffy	0.95	%	FanAssyWgt	415	lb
Stat Effy	57.3	%/100				MinFloMrg	0		FanAeroLoad	750	lb
ElectPwr	26.9	kw				HydrExp	0		TotAxialLoad	1165	lb
									UBFrce@G6.3	12.6	lb

Noise			Noise Spectrum								
PWL	92.1	dba	**hz**	31.5	63	125	250	500	1K	2K	4K	8K
			db	94.1	97.2	96.1	93.	87.5	87.1	82.	79.4	72.2

Informational Messages

Hudson Products fan ratings/selections are the result of tests run under ideal conditions. Since actual conditions will vary and are beyond Hudson Products' control, Hudson Products makes no warranties or guarantees concerning fan performance and all such warranties or guarantees, including merchantability and fitness for a particular purpose, are disclaimed.

Hudson Products Corporation

Tuf-Lite V5.9 Axial Flow Fans

Hudson Products

User System: jrborges

Project References

Project/Job Waterford3

FanModel APT-14W-6

RunTime 7/9/2015 8:24:17 AM

CustomerName Gregory Zysk

InquiryNo.

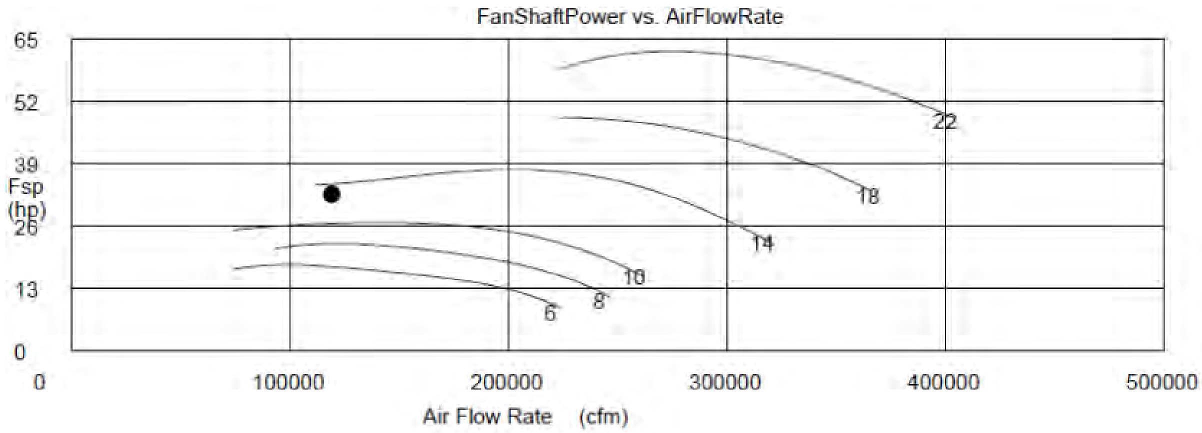
ItemNo.

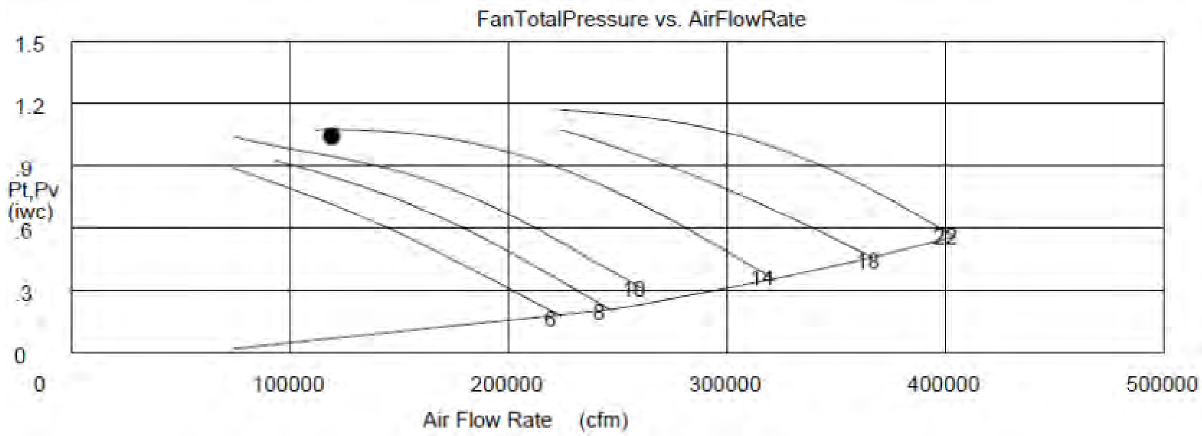
Preparer Juan Borges

AirDens .0791 lb/f3

TipSpd 8972.4 fpm

Fan Characteristic Curves





Fan power shown represents the fan operating under ideal conditions - be sure to allow for extra power for drive losses

Hudson Products Corporation

ATTACHMENT G

Verification and Validation

This attachment documents a verification and validation case performed on the computer used herein. This case was required to demonstrate the effect of using multiple processors for the CFD analysis, in this case 8 processors, would yield the same results as obtained using 1 processor. Based on this evaluation, the results were determined to be unaffected regardless of the number of processors used.

The verification and validation case considered the turbulent mixing of two streams with different densities. This case was used because it used a buoyancy model, which is similar to the cooling tower exit flows that consider buoyancy effects. Figure G-1 and Figure G-2 show the summary and the results of the test case. This test case is documented in [27].

Table G-1 shows the verification and validation results differences for 1 and 8 processors used. The 1 processor and 8 processors results were the same, and therefore, the CFD results were the same regardless of how many processors used. Figure G-3 showed the graphical results for single core and 8 core processors. Those two results are identical to each other since the single core result curve overlaps with the 8 core result curve. The input file is provided at the end of the attachment.

Table G-1: Verification and Validation Results

Processors used	Variable	Verification ratio 0.9 to 1.1	Validation ratio 0.995 to 1.005
1	Mass fraction	0.936	1.000
8	Mass fraction	0.936	1.000
	Difference	0	0

VMFL042: Turbulent Mixing of Two Streams with Different Density

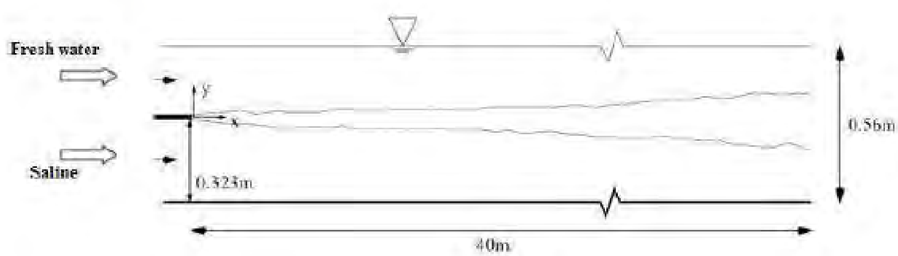
Overview

Reference	1. Uittenbogaard, R.E. (1989) Stably Stratified Mixing Layer. Data Report for the 14th meeting of the IAHR Working Group on Refined Flow Modeling 2. Uittenbogaard, R.E. (1995) The Importance of Internal Waves for Mixing in a Stratified Estaur-ine Tidal Flow
Solver	CFX
Physics/Models	SST model, mixing layer, density difference, buoyancy
Input File	`saline-mixing_layer.def`

Test Case

Mixing of two turbulent streams of fresh water and saline water is modeled. The two streams are parallel at the inlet and mixing proceeds downstream.

Figure 1 Flow Domain



Material Properties	Geometry	Boundary Conditions
Density of fresh water: 1015 kg/m^3 Density of saline water: 1030 kg/m^3 Mixture kinematic diffusivity: 1 X 10^{-9} m^2/s	Length of the mixing duct = 40 m	Fresh water inlet velocity = 0.52 m/s Salt water inlet velocity = 0.32 m/s

Figure G-1: Summary of the Verification and Validation Test Case [27]

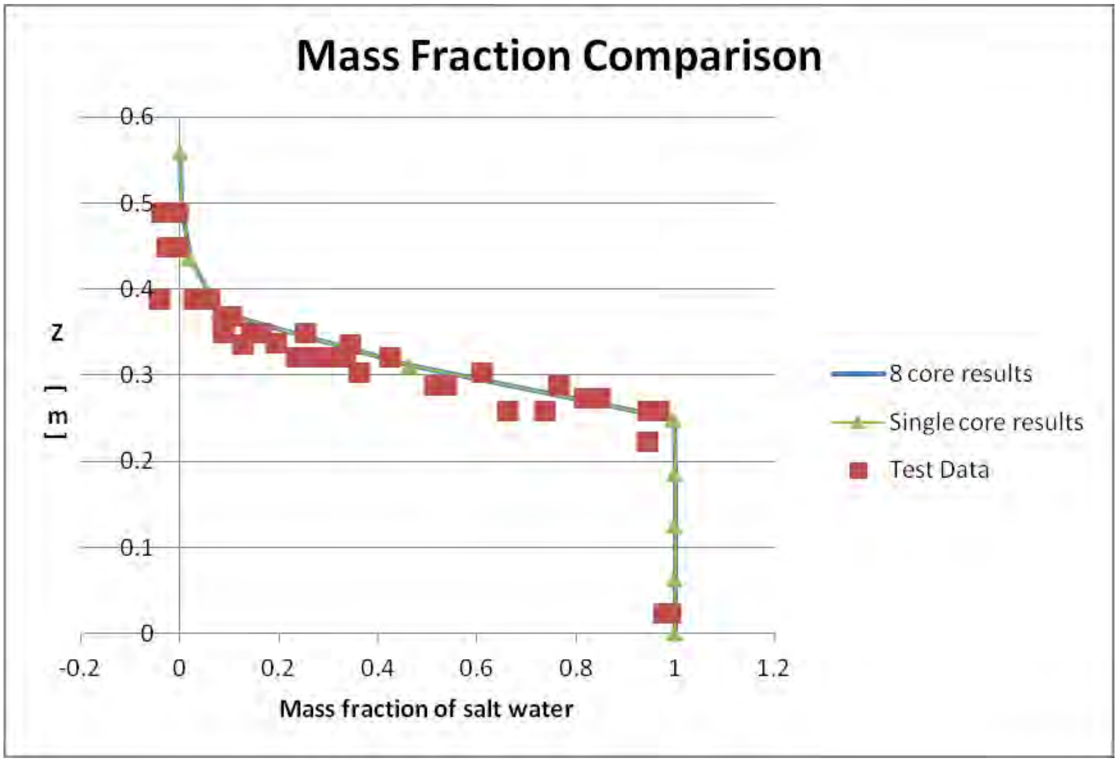


Figure G-3: Graphical Results for Single Core Processor Used

This run of the CFX-14.0 Solver started at 09:57:59 on 24 Aug 2016 by
user LWong on DELL-T7500-4 (intel_xeon64.sse2_winnt) using the command:

```
 "C:\Program Files\ANSYS Inc\v140\CFX\bin\perllib\cfx5solve.pl" -batch
   -ccl runInput.ccl -fullname VMFL042___saline-mixing_layer_001

 Setting up CFX Solver run ...


 +--------------------------------------------------------------------+
 |                                                                    |
 |                    CFX Command Language for Run                    |
 |                                                                    |
 +--------------------------------------------------------------------+

 LIBRARY:
   CEL:
     EXPRESSIONS:
       BottomFlow = step((z - 0.001[m])/1[m]) * step((0.322[m]-z)/1[m])
       Dzplate = 4 [mm]
       Dzwall = 7 [mm]
       EpsBottom = ((Uwall^3/(z+1e-20[m]))+(Uplate^3/(0.323[m]- \
         z+1e-20[m]))))/Kap
       EpsPlate = 5*(Uplate^3)/(Kap*Dzplate)
       EpsTop = ((Uplate^3)/(Kap*(1e-7[m]+z-0.323[m])))
       Epsilon = \
         Wall*Epswall+BottomFlow*EpsBottom+Plate*EpsPlate+TopFlow*EpsTop
       Epswall = 5*((Uwall^3)/(Kap*Dzwall))
       Kap = 0.41
       Plate = step((z - 0.322 [m])/1[m]) * step((0.324[m]-z)/1[m])
       TopFlow = step((z - 0.324[m])/1[m])
       Uplate = 9.11 [mm s^-1]
       Uwall = 11.44 [mm s^-1]
       Wall = step((0.001[m] - z)/1[m])
       fresh water density = 1015 [ kg m^-3]
       infreshmassfrac = step((z - 0.323[m])/1[m])
       insaltmassfrac = 1 - infreshmassfrac
       salt water density = 1030 [kg m^-3]
     END
     FUNCTION: InletTKE
       Argument Units = [m]
       Extend Max = true
       Extend Min = true
       File Name = C:\Users\lwong\Desktop\CFX V&V\Verification \
         Results_pending_tasks\dp0_CFX 37_Solution_37\VMFL042___Tkeprofile.csv
       Option = Profile Data
       Spatial Fields = z
       DATA FIELD: Turbulence Kinectic Energy
         Field Name = Turbulence Kinectic Energy
         Result Units = [m^2 s^-2]
       END
     END
     FUNCTION: InletVelocityU
       Argument Units = [mm]
       Extend Max = true
       Extend Min = true
       File Name = C:\Users\lwong\Desktop\CFX V&V\Verification \
         Results_pending_tasks\dp0_CFX 37_Solution_37\VMFL042___VelUprofile.csv
       Option = Profile Data
       Spatial Fields = z
       DATA FIELD: Velocity u
         Field Name = Velocity u
         Parameter List = U,Velocity r Component,Wall U,Wall Velocity r \
           Component
         Result Units = [mm s^-1]
       END
```

```
  END
END
MATERIAL: Salt Water
  Material Description = Water (liquid)
  Material Group = Water Data,Constant Property Liquids
  Option = Pure Substance
  Thermodynamic State = Liquid
  PROPERTIES:
    Option = General Material
    EQUATION OF STATE:
      Density = salt water density
      Molar Mass = 18.02 [kg kmol^-1]
      Option = Value
    END
    SPECIFIC HEAT CAPACITY:
      Option = Value
      Specific Heat Capacity = 4181.7 [J kg^-1 K^-1]
      Specific Heat Type = Constant Pressure
    END
    REFERENCE STATE:
      Option = Specified Point
      Reference Pressure = 1 [atm]
      Reference Specific Enthalpy = 0.0 [J/kg]
      Reference Specific Entropy = 0.0 [J/kg/K]
      Reference Temperature = 25 [C]
    END
    DYNAMIC VISCOSITY:
      Dynamic Viscosity = 8.899E-4 [kg m^-1 s^-1]
      Option = Value
    END
    THERMAL CONDUCTIVITY:
      Option = Value
      Thermal Conductivity = 0.6069 [W m^-1 K^-1]
    END
    ABSORPTION COEFFICIENT:
      Absorption Coefficient = 1.0 [m^-1]
      Option = Value
    END
    SCATTERING COEFFICIENT:
      Option = Value
      Scattering Coefficient = 0.0 [m^-1]
    END
    REFRACTIVE INDEX:
      Option = Value
      Refractive Index = 1.0 [m m^-1]
    END
    THERMAL EXPANSIVITY:
      Option = Value
      Thermal Expansivity = 2.57E-04 [K^-1]
    END
  END
END
MATERIAL: Water
  Material Description = Water (liquid)
  Material Group = Water Data,Constant Property Liquids
  Option = Pure Substance
  Thermodynamic State = Liquid
  PROPERTIES:
    Option = General Material
    EQUATION OF STATE:
      Density = fresh water density
      Molar Mass = 18.02 [kg kmol^-1]
      Option = Value
    END
    SPECIFIC HEAT CAPACITY:
      Option = Value
```

```
      Specific Heat Capacity = 4181.7 [J kg^-1 K^-1]
      Specific Heat Type = Constant Pressure
    END
    REFERENCE STATE:
      Option = Specified Point
      Reference Pressure = 1 [atm]
      Reference Specific Enthalpy = 0.0 [J/kg]
      Reference Specific Entropy = 0.0 [J/kg/K]
      Reference Temperature = 25 [C]
    END
    DYNAMIC VISCOSITY:
      Dynamic Viscosity = 8.899E-4 [kg m^-1 s^-1]
      Option = Value
    END
    THERMAL CONDUCTIVITY:
      Option = Value
      Thermal Conductivity = 0.6069 [W m^-1 K^-1]
    END
    ABSORPTION COEFFICIENT:
      Absorption Coefficient = 1.0 [m^-1]
      Option = Value
    END
    SCATTERING COEFFICIENT:
      Option = Value
      Scattering Coefficient = 0.0 [m^-1]
    END
    REFRACTIVE INDEX:
      Option = Value
      Refractive Index = 1.0 [m m^-1]
    END
    THERMAL EXPANSIVITY:
      Option = Value
      Thermal Expansivity = 2.57E-04 [K^-1]
    END
   END
  END
  MATERIAL: WaterMixture
   Material Group = User
   Materials List = Salt Water,Water
   Option = Variable Composition Mixture
   Thermodynamic State = Liquid
  END
END
FLOW: Flow Analysis 1
  SOLUTION UNITS:
   Angle Units = [rad]
   Length Units = [m]
   Mass Units = [kg]
   Solid Angle Units = [sr]
   Temperature Units = [K]
   Time Units = [s]
  END
  ANALYSIS TYPE:
   Option = Steady State
   EXTERNAL SOLVER COUPLING:
    Option = None
   END
  END
  DOMAIN: channel
   Coord Frame = Coord 0
   Domain Type = Fluid
   Location = Primitive 3D
   BOUNDARY: Inlet
    Boundary Type = INLET
    Location = IN
    BOUNDARY CONDITIONS:
```

```
      COMPONENT: Salt Water
        Mass Fraction = 1-infreshmassfrac
        Option = Mass Fraction
      END
      FLOW REGIME:
        Option = Subsonic
      END
      MASS AND MOMENTUM:
        Option = Cartesian Velocity Components
        U = InletVelocityU.Velocity u(z)
        V = 0 [m s^-1]
        W = 0 [m s^-1]
      END
      TURBULENCE:
        Epsilon = Epsilon
        Option = k and Epsilon
        k = InletTKE.Turbulence Kinectic Energy(z)
      END
    END
  END
  BOUNDARY: bottomwall
    Boundary Type = WALL
    Location = Bottom
    BOUNDARY CONDITIONS:
      MASS AND MOMENTUM:
        Option = No Slip Wall
      END
      WALL ROUGHNESS:
        Option = Smooth Wall
      END
    END
  END
  BOUNDARY: freesurface
    Boundary Type = WALL
    Location = Top
    BOUNDARY CONDITIONS:
      MASS AND MOMENTUM:
        Option = Free Slip Wall
      END
    END
  END
  BOUNDARY: out
    Boundary Type = OUTLET
    Location = OUT
    BOUNDARY CONDITIONS:
      FLOW REGIME:
        Option = Subsonic
      END
      MASS AND MOMENTUM:
        Option = Average Static Pressure
        Pressure Profile Blend = 0.05
        Relative Pressure = 0 [Pa]
      END
      PRESSURE AVERAGING:
        Option = Average Over Whole Outlet
      END
    END
  END
  BOUNDARY: symm1
    Boundary Type = SYMMETRY
    Location = symm1
  END
  BOUNDARY: symm2
    Boundary Type = SYMMETRY
    Location = symm2
  END
```

```
    DOMAIN MODELS:
      BUOYANCY MODEL:
        Buoyancy Reference Density = salt water density
        Gravity X Component = 0 [m s^-2]
        Gravity Y Component = 0 [m s^-2]
        Gravity Z Component = -g
        Option = Buoyant
        BUOYANCY REFERENCE LOCATION:
          Option = Automatic
        END
      END
      DOMAIN MOTION:
        Option = Stationary
      END
      MESH DEFORMATION:
        Option = None
      END
      REFERENCE PRESSURE:
        Reference Pressure = 1 [atm]
      END
    END
    FLUID DEFINITION: WaterMixture
      Material = WaterMixture
      Option = Material Library
      MORPHOLOGY:
        Option = Continuous Fluid
      END
    END
    FLUID MODELS:
      COMBUSTION MODEL:
        Option = None
      END
      COMPONENT: Salt Water
        Kinematic Diffusivity = 1e-9 [m^2 s^-1]
        Option = Transport Equation
      END
      COMPONENT: Water
        Option = Constraint
      END
      HEAT TRANSFER MODEL:
        Fluid Temperature = 25 [C]
        Option = Isothermal
      END
      THERMAL RADIATION MODEL:
        Option = None
      END
      TURBULENCE MODEL:
        Option = SST
        BUOYANCY TURBULENCE:
          Option = Production
        END
      END
      TURBULENT WALL FUNCTIONS:
        Option = Automatic
      END
    END
  END
  OUTPUT CONTROL:
    MONITOR OBJECTS:
      MONITOR BALANCES:
        Option = Full
      END
      MONITOR FORCES:
        Option = Full
      END
      MONITOR PARTICLES:
```

```
    Option = Full
  END
  MONITOR POINT: X10Z161
    Cartesian Coordinates = 10 [m], 0.05 [m], 0.161 [m]
    Option = Cartesian Coordinates
    Output Variables List = Density,Salt Water.Mass Fraction,Velocity u
  END
  MONITOR POINT: X10Z450
    Cartesian Coordinates = 10 [m], 0.05 [m], 0.45 [m]
    Option = Cartesian Coordinates
    Output Variables List = Density,Salt Water.Mass Fraction,Velocity u
  END
  MONITOR POINT: X40Z161
    Cartesian Coordinates = 40 [m], 0.05 [m], 0.161 [m]
    Option = Cartesian Coordinates
    Output Variables List = Density,Salt Water.Mass Fraction,Velocity u
  END
  MONITOR POINT: X40Z450
    Cartesian Coordinates = 40 [m], 0.05 [m], 0.45 [m]
    Option = Cartesian Coordinates
    Output Variables List = Density,Salt Water.Mass Fraction,Velocity u
  END
  MONITOR POINT: X5Z161
    Cartesian Coordinates = 5 [m], 0.05 [m], 0.161 [m]
    Option = Cartesian Coordinates
    Output Variables List = Density,Salt Water.Mass Fraction,Velocity u
  END
  MONITOR POINT: X5Z450
    Cartesian Coordinates = 5 [m], 0.05 [m], 0.45 [m]
    Option = Cartesian Coordinates
    Output Variables List = Density,Salt Water.Mass Fraction,Velocity u
  END
  MONITOR RESIDUALS:
    Option = Full
  END
  MONITOR TOTALS:
    Option = Full
  END
 END
 RESULTS:
  File Compression Level = Default
  Option = Standard
 END
END
SOLVER CONTROL:
 Turbulence Numerics = First Order
 ADVECTION SCHEME:
  Option = High Resolution
 END
 CONVERGENCE CONTROL:
  Length Scale Option = Conservative
  Maximum Number of Iterations = 500
  Minimum Number of Iterations = 1
  Timescale Control = Auto Timescale
  Timescale Factor = 1.0
 END
 CONVERGENCE CRITERIA:
  Residual Target = 0.00001
  Residual Type = RMS
 END
 DYNAMIC MODEL CONTROL:
  Global Dynamic Model Control = On
 END
END
END
COMMAND FILE:
```

```
  Version = 14.0
  Results Version = 14.0
END
SIMULATION CONTROL:
  EXECUTION CONTROL:
    EXECUTABLE SELECTION:
      Double Precision = Off
    END
    INTERPOLATOR STEP CONTROL:
      Runtime Priority = Standard
      MEMORY CONTROL:
        Memory Allocation Factor = 1.0
      END
    END
    PARALLEL HOST LIBRARY:
      HOST DEFINITION: dellt75004
        Remote Host Name = DELL-T7500-4
        Host Architecture String = winnt-amd64
        Installation Root = C:\Program Files\ANSYS Inc\v%v\CFX
      END
    END
    PARTITIONER STEP CONTROL:
      Multidomain Option = Independent Partitioning
      Runtime Priority = Standard
      EXECUTABLE SELECTION:
        Use Large Problem Partitioner = Off
      END
      MEMORY CONTROL:
        Memory Allocation Factor = 1.0
      END
      PARTITIONING TYPE:
        MeTiS Type = k-way
        Option = MeTiS
        Partition Size Rule = Automatic
      END
    END
    RUN DEFINITION:
      Run Mode = Full
      Solver Input File = VMFL042___saline-mixing_layer.def
    END
    SOLVER STEP CONTROL:
      Runtime Priority = Standard
      MEMORY CONTROL:
        Memory Allocation Factor = 1.0
      END
      PARALLEL ENVIRONMENT:
        Number of Processes = 1
        Start Method = Serial
      END
    END
  END
END


+--------------------------------------------------------------------+
|                                                                    |
|                            Profile Data                            |
|                                                                    |
+--------------------------------------------------------------------+


+--------------------------------------------------------------------+
|  Profile Data File: C:\Users\lwong\Desktop\CFX V&V\Verification    |
|                Results_pending_tasks\dp0_CFX                        |
|           37_Solution_37\VMFL042___VelUprofile.csv                 |
|                                                                    |
```

| File size: 5.3 kB. Summary shown. |
+--+

[Name]
InletVelocityU

[Spatial Fields]
z

[Data]
z [mm], Velocity u [mm s^-1]
0,0
2.8,176.917568
5.6,202.07062208
8.4,214.7277602
11.2,222.5063114
14,227.512325
16.8,231.5634266
19.6,236.13856636
22.4,241.17841684
25.2,246.083878264
28,250.362161
30.8,253.776899096
33.6,256.148042248
...
...

+--+
| Profile Data File: C:\Users\lwong\Desktop\CFX V&V\Verification |
| Results_pending_tasks\dp0_CFX |
| 37_Solution_37\VMFL042___Tkeprofile.csv |
| |
| File size: 212 bytes. Summary shown. |
+--+

[Name]
InletTKE

[Spatial Fields]
z

[Data]
z [m], Turbulence Kinectic Energy [m^2 s^-2]
0.00176056,4.9409e-4
0.110915,0.612925e-4
0.220951,0.606434e-4
0.325704,2.7389e-4
0.419014,0.742241e-4
0.56162,0.733828e-4

ATTACHMENT H

Independent Review Comments

No.	Comment	Resolution
1.1	The calculations in Attachment A utilize the ambient temperature along with an increase due to recirculation to define the effective inlet air temperature to the dry cooling tower. There are discrepancies between the temperature increase due to recirculation reported as a result from the CFD runs.	Explanation added to Input 2.1. 7) that Att A calculated valued were increased to determine conservative boundary conditions
1.2.1	The report makes the assumption that a lower DCT exit flow velocity is conservative for the analysis.	Explanation added to Assumption 2.2.4) to address conservatism of the exit velocity.
1.2.2	The model has a uniform flow velocity assumed over the entire height of the DCT exit plane representing each tube bundle. There are a number of implicit assumptions in this method which need to be justified given the actual design of the tower	Assumption 2.2.5) added to address DCT flow condition.
1.3.1	The methodology for estimating the fan flowrate in relies on results from CFX to evaluate the inlet and discharge pressures for use in the balance equations that govern the fan's performance (developed head vs. flow rate and coil resistance). The report should describe whether those pressures are constant over the entire height of the DCT, and if specifying three levels of pressure zones corresponding to each fan elevation would produce different results	Discussion added to Section 3.3.2 and Figure 3.7A regarding the appropriate use of average fan pressures.
1.3.2	Given that the CFX pressure results inherently account for buoyancy effects from the use of the ideal gas relationship for the density of air, the report should further explain the use of the explicit buoyancy term in the equation for 'Pgain'	Clarification added to Section 3.3.2 regarding hydrostatic term in buoyancy solution.
1.3.3	Rotation of fan blades vs. assumption of perpendicular flow	Assumption 2.2.5) added to address DCT flow condition.
1.3.4	The report states "Using the upper bound loss of 0.615inwg, the pressure drop for each subsequent case was scaled by the square of the velocity relative to 186,000cfm", but there is no reference for the source which supports the 186,000 cfm flow rate. The report should provide the basis for this value.	Clarification added to Section 3.3.2 for the basis of the coil pressure drop calculation
1.4.1	Drag coefficient to K-factor: The equation used to calculate the hydraulic resistance	The loss coefficient scaling factor based on area^2 is intended to apply a local loss coefficient for a small

	coefficient for the beam and pipe structure uses an equation to convert from a drag coefficient to a flow loss coefficient that has a ratio of areas squared	flow area to a larger flow area (see Crane Eq 3-24), which would be based on $(A1/A2)^2$. However, since a conservative Cd value of 2.05 from a range of 1.6-2.05 (Blevins) was used, any variation in loss is expected to be bounded by this range. Note added to Att. A.
1.4.2	Porous domain loss coefficient. The Knet = 0.08 value on page A43 (Reference 2) is unitless, but it appears to have been inputted to the model on a per foot basis (also reported as 0.08 ft-1 in Table 2-1).	Note added to Table 2-1 to clarify
1.4.3	Extent of porous domain	**No response required. Comment is resolved by ITPR.**
1.4.4	Porosity calculation	Note added to Table 2-1 to clarify
1.4.5	Grating loss coefficient: Idelchik correlations are used which include an expansion term (1-fr)2 and then another expansion term was added to the equation to represent the exit loss coefficient from the grating. This additional loss increases resistance and decreases the fan flow rate	The equation used to determine the grating loss coefficient is per Idelchik diagram 8-3. The note indicating an addional expansion term is in error and is removed from Att. A.
2.1	Verification of model dimensions	Figure 2-2 and Figure 2-4 added to show basic dimensions in AUtocad model used for CFX development.
2.2	Description of wind box: provide rationale for box selection and reasoning behind modeled structures	Discussion added to Section 3.2 to address structures within the boundary volume.
3.0	WCT and wet bulb temperature	Discussion added to Section 3.3.1 to clarify.
4.0	Model convergence: Fluctuation of individual fan temperatures.	Footnote added to Section 3.4.1 to address individual fan variation
5.0	Turbulence model study	Discussion added to Section 3.4.4 to address expectation of turbulence model similarity.
6.0	Deflector wall lengths	Discussion added to Section 3.4.6 to address other studies of wall lengths not included herein.
7.0	Heat exchanger calculation	**No response required. Comment is resolved by ITPR.**

LPI, Inc. Consulting Engineers

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Failure & Materials Evaluation
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ENCLOSURE, ATTACHMENT 5

W3F1-2019-0005

Attachment 5: Engineering Report WF3-ME-15-00011

ENTERGY NUCLEAR
Engineering Report Cover Sheet

Engineering Report Title:
Waterford 3 Ultimate Heat Sink Project Weather Investigation

Engineering Report Type:

New ☒ Revision ☐ Cancelled ☐ Superseded ☐
Superseded by: ______

Applicable Site(s)

IP1	☐	IP2	☐	IP3	☐	JAF	☐	PNPS	☐	VY	☐	WPO	☐
ANO1	☐	ANO2	☐	ECH	☐	GGNS	☐	RBS	☐	WF3	☒	PLP	☐

EC No. 52043

Report Origin: ☐ Entergy ☒ Vendor
Vendor Document No.: A13326-R-001

Quality-Related: ☒ Yes ☐ No

Prepared by: LPI, Inc. — Responsible Engineer (Print Name/Sign) — Date: See Vendor Report

Design Verified: LPI, Inc. — Design Verifier (if required) (Print Name/Sign) — Date: See Vendor Report

Reviewed by: Dale V. Gallodoro / See EC-52043 — Reviewer (Print Name/Sign) — Date: See EC-52043

Approved by: Nicholas Petit / See EC-52043 — Supervisor / Manager (Print Name/Sign) — Date: See EC-52043

LPI, Inc. Consulting Engineers

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Nondestructive Engineering

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WATERFORD 3 ULTIMATE HEAT SINK PROJECT WEATHER INVESTIGATION

Report No.:
A13326-R-001
Rev. No: 1

April 2016

Prepared For
ENTERGY OPERATIONS, INC.
Waterford 3 Steam Electric Station

Prepared By
LPI, Inc.

Lucius Pitkin – established 1885
36 Main Street • Amesbury, MA 01913 • 978.517.3100
New York • Boston • Richland • Sydney • www.lpiny.com

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DOCUMENT RECORD

Document Type:	☐ **Calculation** ☒ **Report** ☐ **Procedure**				
Document No:	**A13326-R-001**				
Document Title:	**Waterford 3 UHS Project Weather Investigation**				
Client:	Entergy Operations, Inc.				
Client Facility:	Waterford 3 Steam Electric Station				
Client PO No:	10387412				
Quality Assurance:	**Nuclear Safety Related?** ☐ **No** ☒ **Yes**				
Computer Software Used:	☒ **No**[1] ☐ **Yes**[2]	1. Check NO when EXCEL, MathCAD and/or similar programs are used since algorithms are explicitly displayed. 2. Include Software Record for each computer program utilized			
Instrument Used	☒ **No** ☐ **Yes**[3]	3. Include Document Instrument Record.			
Revision	**Approval Date**	**Preparer**	**Checker**	**Design Verification**	**Approver**[4]
0	5/8/14	Gregory Zysk	Frank Mulcahy	Alfred Chock	Paul Bruck
1	4/18/16	Joseph Cluever Gregory Zysk	John Mills	Alfred Chock	Paul Bruck

[4] The Approver of this document attests that all project examinations, inspections, tests and analysis (as applicable) have been conducted using approved LPI Procedures and are in conformance to the contract/purchase order.

Page	1	of	103	Total Pages	(include any Title Sheet and Attachments in page count. Document Back Cover, if utilized, not included in page count)

*Form: LPI-3.1-Rev-**5**-Fig-5-2*

	DESIGN VERIFICATION CHECKLIST							
	Document No(s)[1]:		A13326-R-001			Rev.:		1
	Review Method:	X	Document Review		Alternate Calculation		Test	

	Criteria	DV[2]
1	Were the inputs correctly selected and incorporated into design?	AC
2	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed? If applicable, has an as built verification been performed and reconciled?	AC
3	Are the appropriate quality and quality assurance requirements specified?	AC
4	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?	AC
5	Have applicable construction and operating experience been considered, including operation procedures?	AC
6	Have the design interface requirements been satisfied?	AC
7	Was an appropriate design method used?	AC
8	Is the output reasonable compared to inputs?	AC
9	Are the specified parts, equipment, and processes suitable for the required application?	n/a
10	Are the specified materials compatible with each other and the design environmental conditions to which the material were exposed?	n/a
11	Have adequate maintenance features and requirements been specified?	n/a
12	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?	n/a
13	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?	n/a
14	Has the design properly considered radiation exposure to the public and plant personnel?	n/a
15	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	AC
16	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	n/a
17	Are adequate handling, storage, cleaning and shipping requirements specified?	n/a
18	If software was used, have the computer type and operating system been properly identified? Is use of the software, hardware and O/S appropriate for the conditions, components evaluated? Has a V&V been performed?	n/a
19	Are requirements for identification, record preparation review, approval, retention, etc., adequately specified?	AC
20	Has an internal design review been performed for applicable design projects? Have comments from the Internal Design Review been appropriately considered/addressed?	n/a

(1) Include any drawings developed from reviewed documents, or include separate checklist sheet for drawings
(2) Design Verifier shall initial indicating review and mark N/A where not applicable

DV Completed By:	Printed Name: Alfred Chock	Signature [signature]	Date: 4/13/16

Page	1	of	1	Total Pages	(include DV Checklist and Comment Resolution sheets in page count)

Form: LPI-3.1-Rev-5-Fig-5-5

Record of Revision

Revision No.	Date	Description of Change	Reason
0	5/8/2014	n/a	Original issue
1	See Document Record	Section 1: Added description of revision. Section 2.1: Revised description of the NOAA data. Section 3.1: Revision to address confidence interval basis. Section 3.2: Revised discussion of data screening method and NOAA data. Section 4: Section revised in its entirety. Section 6: Modified ref 17. Removed ref 18. Added refs 19-22. Att. A: Attachment revised in its entirety. Att. B: New Attachment. Att. C: New Attachment. Minor editorial corrections, page renumbering, and figure renumbering made throughout.	Updated evaluation to consider seasonal data, revised NOAA data, and revised confidence interval.

Form: LPI-3.1-Rev-5-Fig-5-7

Table of Contents

Table of Figures

1 Introduction

The Waterford 3 (WF3) Ultimate Heat Sink (UHS) system provides a means to cool heat loads from the reactor and auxiliaries during normal and accident conditions. Heat is removed by the Component Cooling Water (CCW) system to the Dry Cooling Towers (DCT) and CCW heat exchanger. The CCW heat exchanger transfers heat to a second Auxiliary Component Cooling Water (ACCW) loop that discharges heat through the Wet Cooling Towers (WCT). Heat removed is dispersed to the atmosphere by the DCT and WCT. A simplified diagram of the UHS system is presented in Figure 1-1 [5][1].

Several issues have been raised with respect to the UHS system and its ability to meet design basis heat loads. These include WCT and DCT recirculation effects, depletion of WCT inventory, and other performance issues. The recirculation effect refers to the potential for the DCT or WCT to draw hotter exhaust side air into the inlet side, increasing the effective ambient temperature and reducing heat removal performance (see also CR-WF3-2012-2332 [6]).

The overall project is intended to revise the UHS design and licensing basis. This will be accomplished through a calculation methodology that considers the accurate modeling of DCT and WCT heat removal performance and interaction with CCW/ACCW loop temperatures. Additionally, modifications will be implemented as necessary to restore adequate design basis margin to accommodate degraded and nonconforming conditions that may potentially arise.

This report is revised to ensure that the modification considers the appropriate climatological data and confidence factors to meet the intent of Regulatory Guide 1.27, Revision 2 and to provide bounding climatological conditions for quarter.

[1] Numbers in brackets [xx] identify numbered references provided in Section 6.

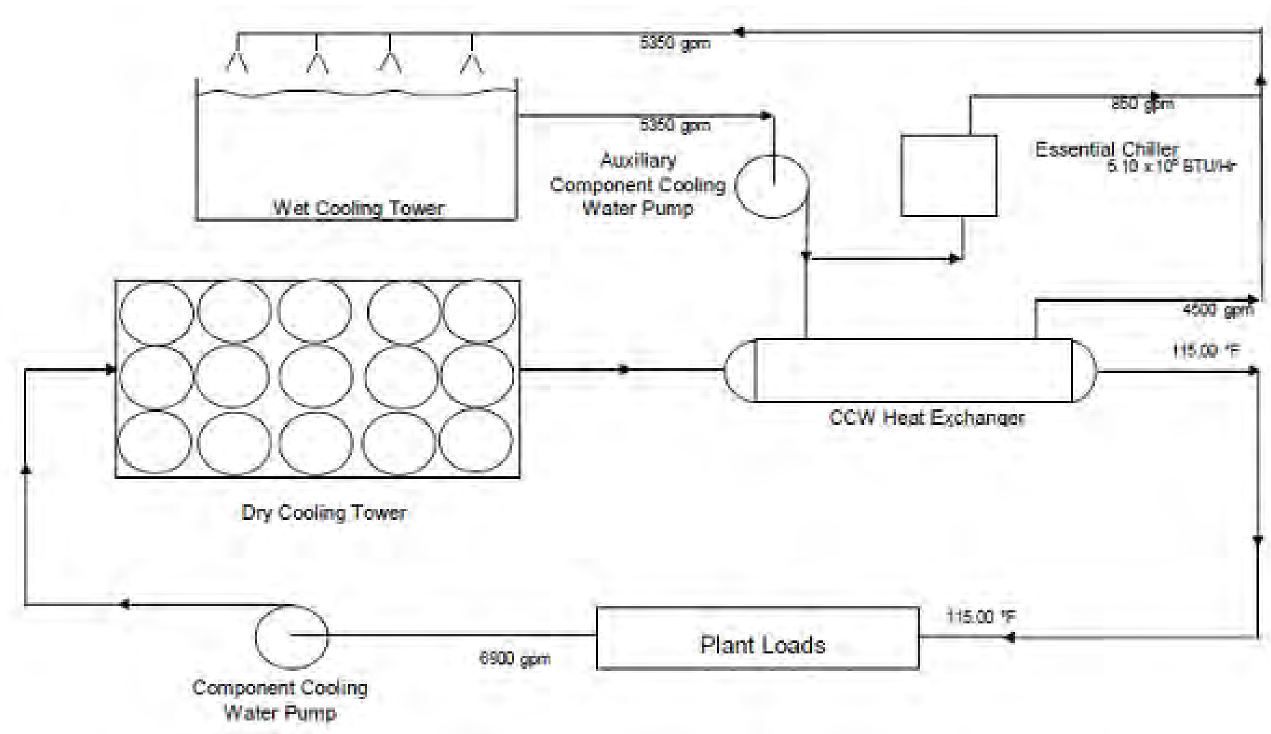


Figure 1-1: Simplified Diagram of the UHS

1.1 Scope

The scope of this report addresses an investigation of the Waterford 3 site meteorology, specifically the combination of wind speed, wind direction, and ambient temperature. These parameters affect the performance of the DCT and WCT, particularly with respect to recirculation effects, which are investigated separately in another report [14]. This report develops limiting ambient wind and temperature combinations in order to conservatively address recirculation.

The work included herein is performed in accordance with the requirements of Entergy Contract Number 10387412 [1].

2 Inputs and Assumptions

2.1 Inputs

Inputs to this investigation are identified as References in Section 6 of this report. The primary input to this report is historical meteorological (MET) tower data obtained for a period from 2000 to 2013 [2].

A second set of data was obtained by query of NOAA data [9] for the New Orleans airport to determine peak daily temperatures and daily average wind speed for the period from 1984-2014.

Additionally, the results of an external survey of temperature data [16] prior to 1977 was reviewed.

Data included in the evaluation are provided in Attachment B. The combined set of data produced over 100,000 data points of wind direction, speed, and temperature. Data is stored electronically [17] and presented in chart form.

2.2 Assumptions

There are no assumptions that affect the conclusions drawn in this report.

3 Methodology

This section of the report outlines the methodology for the review of weather data to determine bounding site wind and temperature combination conditions. These bounding conditions are used in a separate analysis to evaluate DCT and WCT recirculation effects.

This evaluation meets the climatological review criteria of Regulatory Guide 1.27 Rev. 2 [15] for Ultimate Heat Sink design. Specifically, MET tower weather data (temperature and wind) for 1 hour, 1 day, and 3 day averages for a 14 year period are statistically evaluated. NOAA one day maximum temperature data and daily average winds were obtained for the period from 1984-2014 and compared to the MET tower data. In combination, these efforts meet the 30 year period specified in Regulatory Guide 1.27.

3.1 Bounding Conditions

Air temperatures elevated above ambient have been observed at the DCT and WCT inlets during testing [7]. The elevated temperatures have been attributed to recirculation.

The location of the DCT exhaust regions relative to the inlet areas makes recirculation dependent on wind direction. The magnitude of recirculation as a function of temperature and wind is studied separately in another report. This report determines bounding combinations of wind and temperature data measured at the site.

A diagram illustrating potential wind and temperature combinations is presented in Figure 3-1. In this diagram, the wind speed is on the Y-axis and the temperature on the X-axis. Data pairs form a “cloud” that can be enveloped by a curve relating wind speed and temperature. Separate curves can be generated to fit the data distribution for each cardinal wind direction.

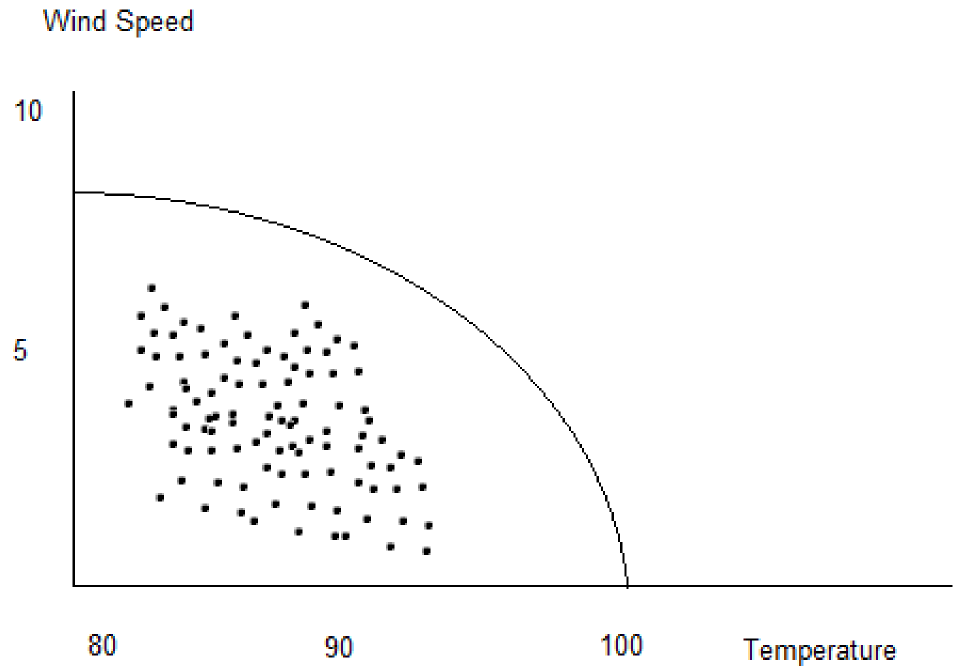


Figure 3-1: Diagram of Wind vs. Temperature Bounding Limits

This combination of two variables is mathematically represented by a bivariate distribution. Figure 3-2 shows a diagram of two variables X and Y with normal probability distributions p(X) and p(Y) as shown by the blue and red curves, respectively. When plotted Y vs. X, the “cloud” of data can be enveloped by an ellipse as shown in green. This ellipse represents a confidence interval that provides the probability that random data will fall inside the elliptical boundary.

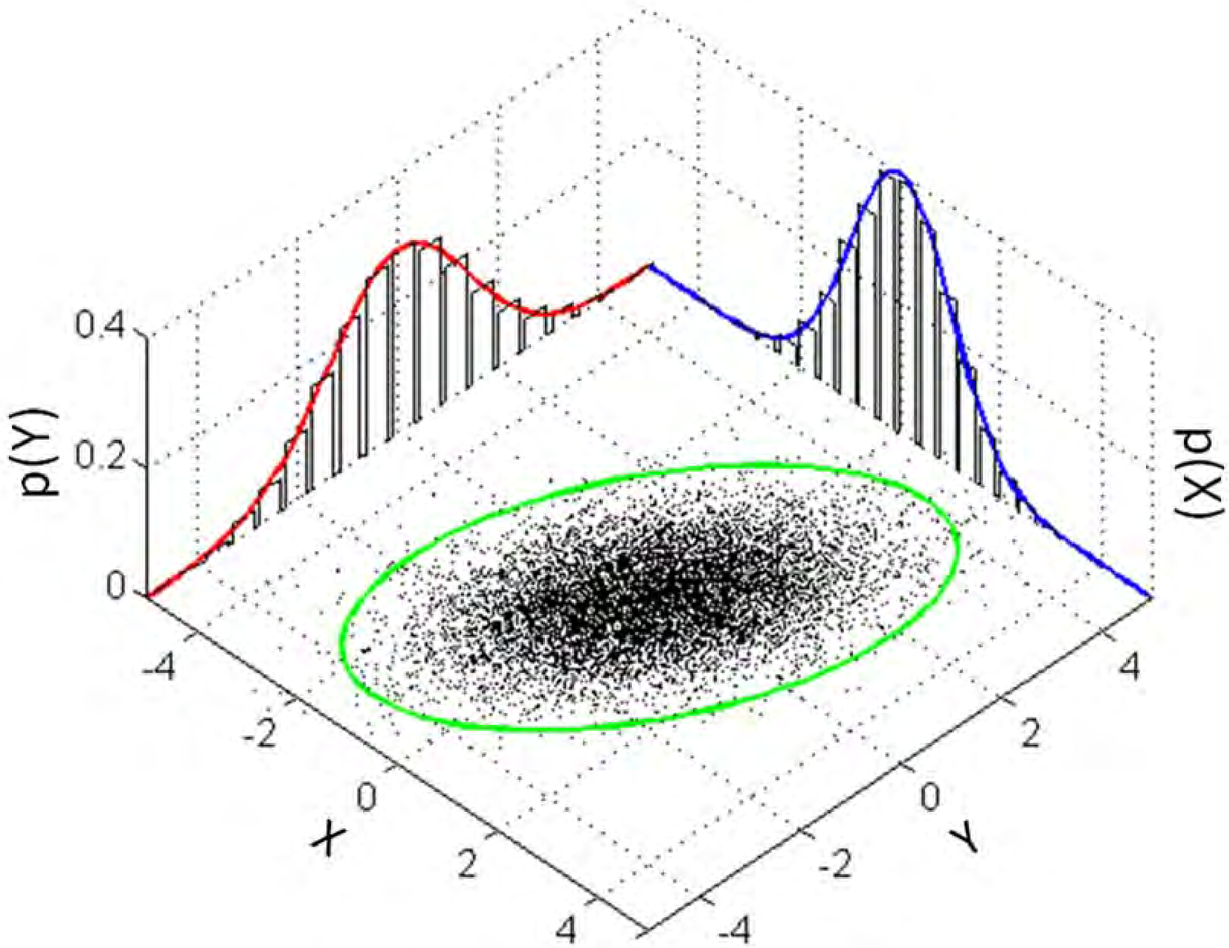


Figure 3-2: Representation of Bivariate Distribution

Comparing Figure 3-1 and Figure 3-2, it can be seen that only temperatures and wind speeds that are both above the limiting curve, i.e. one quarter of the ellipse, are important. Thus, a 99% confidence interval is achieved using a 96% confidence bound of the data. The probability of exceeding this value over the quarter ellipse is ¼ x 4% = 1%, producing a confidence of 99% or 1E-2 chance that a point will exceed the curve bounds for both temperature and wind.

No explicit guidance exists for upper bound ambient wind and temperature for DCT and WCT performance. For this investigation, both 1E-2 (99%) and 1E-3 (99.9%) data are presented. These represent a conservative upper bound of the data relative to several industry standards:

First, evaluation of Ultimate Heat Sink components, specifically Cooling Ponds per NUREG-0693 [19], and Spray Ponds per NUREG-0733 [20] are shown to utilize a

confidence interval of 95% to determine the upper bound ambient wind and temperature effects on the heat sink capacities. Both the 99% and 99.9% criteria selected herein are conservative relative to this value.

Second, site meteorological wind data is typically used to evaluate radioactive plume dispersion. Per Regulatory Guide Document 1.145 and its technical basis document NUREG/CR-2260 [8, 21], upper bound site winds are developed from the MET tower data using a confidence interval of 95%. Both the 99% and 99.9% criteria selected herein are conservative relative to this value.

Third, the NRC publication "Applying Statistics" NUREG-1475 [22], indicates that the 95% bound and 95% confidence interval (95/95) has precedence for data analysis. Both the 99% and 99.9% criteria selected herein are conservative relative to this value. Per NUREG-1475 (p 184):

> *The 95/95 specification is the most common specification for tolerance intervals at the NRC. It is usually regarded as the default tolerance interval specification.*

Additionally, the site wind data used herein is based on 1 hour averages. These results are conservatively applied to determine recirculation effects that will be statically applied to evaluate transients which could extend for multiple days. Per Regulatory Guide 1.27 [15], accident analyses typically require 1 day, 5 day, and 30 day averages for wind and temperature. Higher values are associated with shorter time intervals; thus, the intervals used in this analysis (1 hour, 1 day and 3 day averages) conservative compared to the Regulatory Guide 1.27 values.

Therefore, the 99% and 99.9% confidence intervals combined with the shorter time intervals provides a conservative assessment of wind and temperature combinations at the site.

As a comparison, similar work for the Department of Energy references DOE-STD-3009-94 [13], which describes 1E-2 to 1E-4 probability as a threshold for evaluation of maximum wind speed gusts as shown in Figure 3-3. This standard indicates that 1E-2 is in the appropriate range for evaluating maximum wind gusts.

Table 3-4. Qualitative likelihood classification table.

Descriptive word	Estimated annual likelihood of occurrence	Description
Anticipated	$10^{-1} > p > 10^{-2}$	Incidents that may occur several times during the lifetime of the facility. (Incidents that commonly occur)
Unlikely	$10^{-2} > p > 10^{-4}$	Accidents that are not anticipated to occur during the lifetime of the facility. Natural phenomena of this probability class include: Uniform Building Code-level earthquake, 100-year flood, maximum wind gust, etc.
Extremely Unlikely	$10^{-4} > p > 10^{-6}$	Accidents that will probably not occur during the life cycle of the facility. This class includes the design basis accidents.
Beyond Extremely Unlikely	$10^{-6} > p$	All other accidents.

Figure 3-3: DOE-STD-3009-94 Classification Table

The mathematical expression of the confidence interval of a bivariate normal distribution is [10]:

$$(T-\mu_T)^2\, \Sigma_{1,1}^{-1} + 2(T-\mu_T)(\ln W - \mu_{\ln W})\, \Sigma_{1,2}^{-1} + (\ln W - \mu_{\ln W})^2\, \Sigma_{2,2}^{-1} = X^2(p)$$

Where T is temperature, W is the logarithm of wind speed, μ are mean values, and $\Sigma_{i,j}^{-1}$ are the (i,j) elements of the inverse of the covariance matrix. The right side of the equation is the chi-squared value for percentage p at 2 degrees of freedom. As described above, p was set to 96%, corresponding to a 99% confidence. In this expression, the wind data was fit with a log-normal distribution, while the temperature provides a normal distribution, based on a review of the data (see also Section 4.1).

3.2 Meteorological Data

The primary consideration with respect to UHS performance is the heat removal capacity of the DCT and WCT at the bounding high temperature limits. Heat removal is proportional to the temperature difference between the CCW fluid and drybulb temperature in the DCT and between the ACCW and wetbulb temperature in the WCT. Highest ambient

temperatures, corresponding to smallest temperature differences, occur during the summer months of June, July and August. This summer period forms the primary basis of this study. However, in order to assure applicability to plant operation throughout the year, data for all 4 seasons was also reviewed.

Data was obtained from the plant Meteorological Tower (MET) [2] over a period from June, 2000 through August, 2013. The MET data used in this analysis consisted of 1 hour average (obtained at 15 minute increments) temperature (deg F), wind speed (mph), and wind direction (degrees) at the 33 ft elevation, including both primary and backup measurements.

The collected MET data was filtered to omit data that appeared inaccurate, based on the following criteria:

- Negative or non-numerical values
- Values repeated three or more times successively[2]
- Wind speeds below 0.31 mph or above 100 mph.
- Wind speeds differing by more than 15 mph between the primary and backup measurements
- Linearly interpolated wind speed versus time data ($R \geq 0.9999$)[3]

Where primary temperature, wind speed, or wind direction data was omitted or absent, backup data was utilized.

Outlier temperature data, specified as points 3.5 standard deviations from the monthly mean, were considered inaccurate and omitted. The filtered MET data set used in analyses is included in Attachment A.

Data was categorized into four cardinal source directions (North, South, East, West) to determine bounding limits for each direction. The following definitions were used based on degrees of a compass:

North: < 45 or ≥ 315

East: 45 to < 135 deg

South: 135 to < 225 deg

[2] A review of the MET data showed identical repeated values of 0.31 mph wind for extended time periods, indicating a non-functioning instrument. Based on the data review, the threshold for identifying these conditions was set to 3 identical readings at 0.31mph or less.

[3] A review of the MET data showed periods of data linearly interpolated between adjacent readings. These were judged to be approximated data and were not included as real data in this study.

West: 225 to < 315 deg

Data was also categorized into four seasons, as follows:

Winter: December, January, February

Spring: March, April, May

Summer: June, July, August

Fall: September, October, November

Bounding limits were calculated for each combination of cardinal direction and season.

Per the requirements of Regulatory Guide 1.27 [15], a 30 year period of data was examined. NOAA data [9] for the New Orleans airport was obtained for the period from 1984 through 2014 The most comparable NOAA data to the available MET data consisted of peak daily temperatures and average daily wind speeds.

Negative or absent temperature and wind speed data were culled from the NOAA data set before categorizing into the 4 seasonal groups as defined above. The NOAA data was compared to the MET tower data to ensure that the MET data provided a conservative representation of the ambient wind conditions.

The NOAA data set produced approximately 12,000 data points of wind speed and temperature. Data is stored electronically [18] and presented in chart form below.

Lastly, bounding temperature data from [16], which covered the period from 1946 through 1977, was also reviewed. Although no wind data was included, this reference provided further evidence of the 102°F limiting drybulb temperature.

4 Data Evaluation

This section includes a review of the temperature and wind distribution and development of bounding temperature/wind combinations based on probability limits discussed above.

4.1 Review of Data Distribution

Plots of the temperature and wind speed data distribution are contained in Att. A for each cardinal direction (North, South, East, West). The model used to evaluate the confidence interval is based on a normal and log-normal distribution for the temperature and wind, respectively. The plots provide a comparison of the data distribution and the model of the data distribution.

Two example plots are provided in Figure 4-1 and Figure 4-2. The X-axis of each plot provides the temperature or wind speed, and the Y-axis provides the cumulative probability of occurrence at or below each value. The close agreement between the two curves demonstrates the accuracy of the data distribution model.

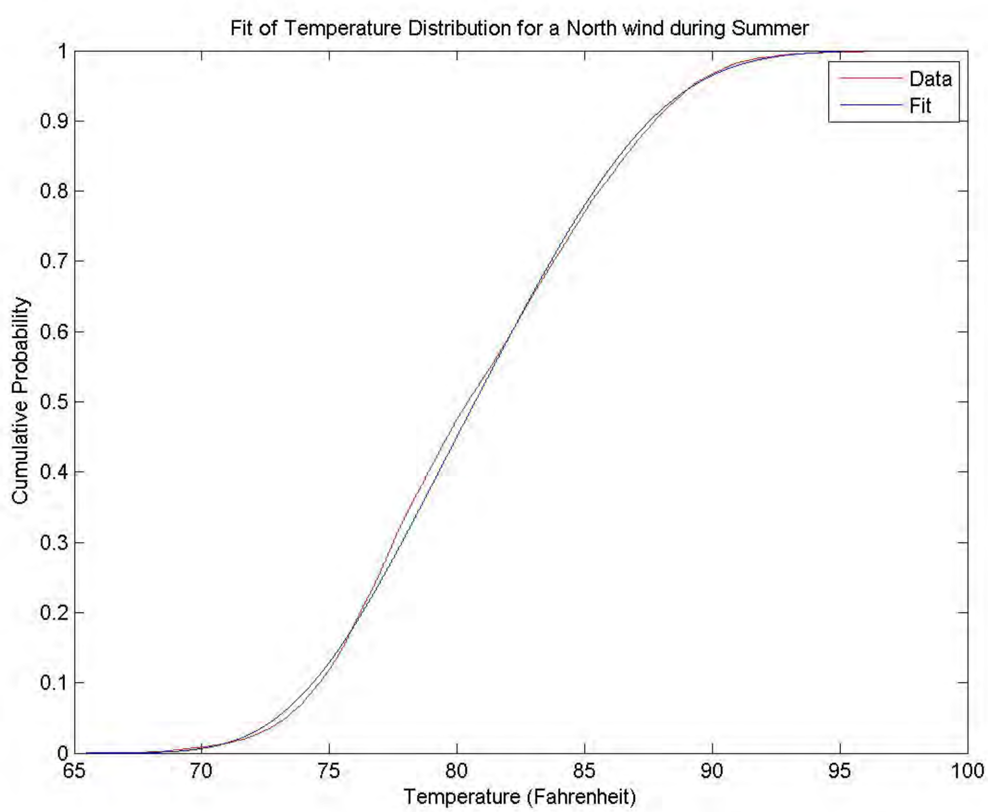


Figure 4-1: Temperature Cumulative Distribution, North Wind

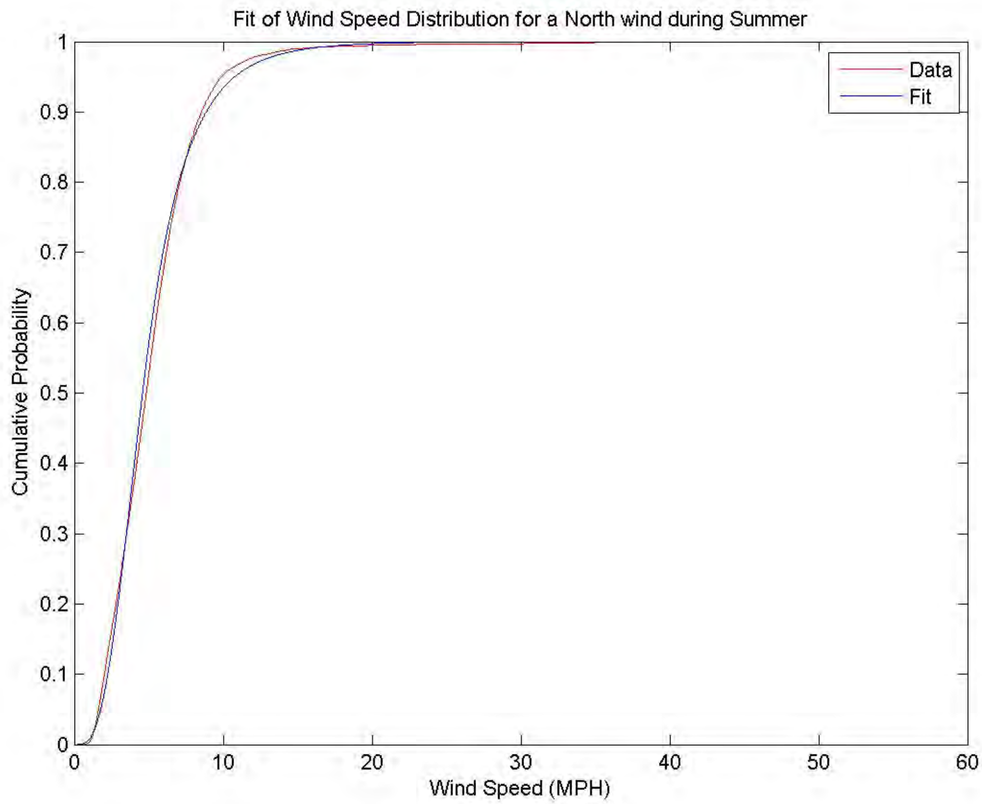


Figure 4-2: Wind Speed Cumulative Distribution, North Wind

4.2 MET Wind-Temperature Data

Selected data prediction interval plots are included and discussed below. The complete set of 99% and 99.9% prediction interval plots are presented in Att. B and Att. C.

In the prediction interval plots, MET data is presented in red and the confidence interval curve is presented in blue. The plots are presented with a linear Y-axis scale. It should be noted that an ellipse in a log-linear scale, which defines the bounding curve, changes shape when converted to a linear-linear scale.

From each bounding curve, three bounding points were selected to represent the limits of the curve. These three points are the wind and temperature pairs corresponding to: (A) the peak temperature, (B) the peak wind speed, and the (C) the average temperature between the peak wind and peak temperature.

Two example plots of the data, confidence interval, and bounding points are shown in Figure 4-3 and Figure 4-4.

Combining the seasonal variation with bounding curve points resulted in the summary plots provided in Figure 4-5, Figure 4-6, and Figure 4-7 for the North, East-West, and South Wind directions, respectively. The east and west winds were combined to address the mirror image layout of the A and B trains for the DCT/WCT, i.e. an east wind approaching the A train is equivalent to a west wind approaching the B train. Therefore, the selected analysis points represent the bounding values of the analysis points for the two data sets.

For the plots in Figure 4-5, Figure 4-6, and Figure 4-7, the 99% data is presented as dashed lines and the 99.9% data is presented as solid lines.

The 1-hour data is provided in tabular form in Table 4-1 and Table 4-2 for the 99.9% and 99% data, respectively. Table 4-3 and Table 4-4 present the 99%, 1 day and 3 day averages, respectively. No 1 day or 3 day data was developed for the 99.9% data.

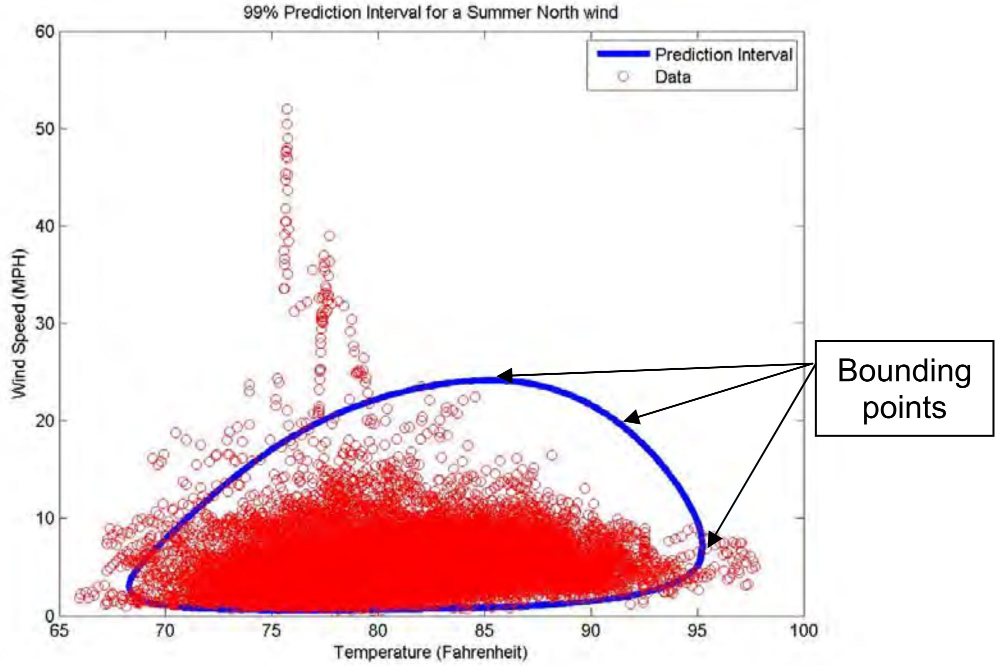


Figure 4-3: Prediction Interval, Summer North Wind

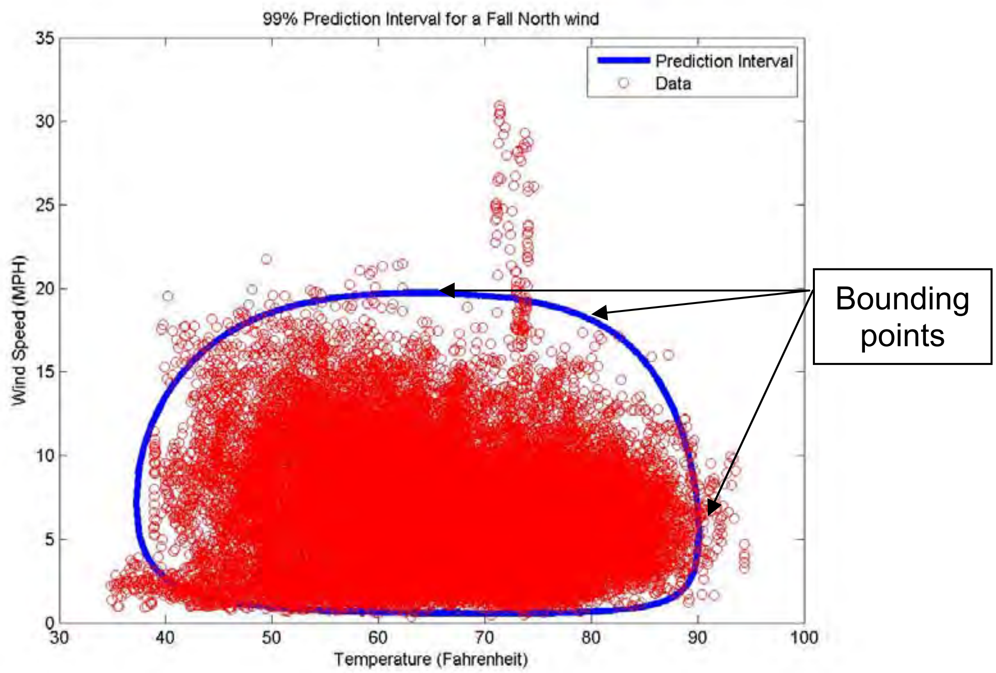


Figure 4-4: Prediction Interval, Fall North Wind

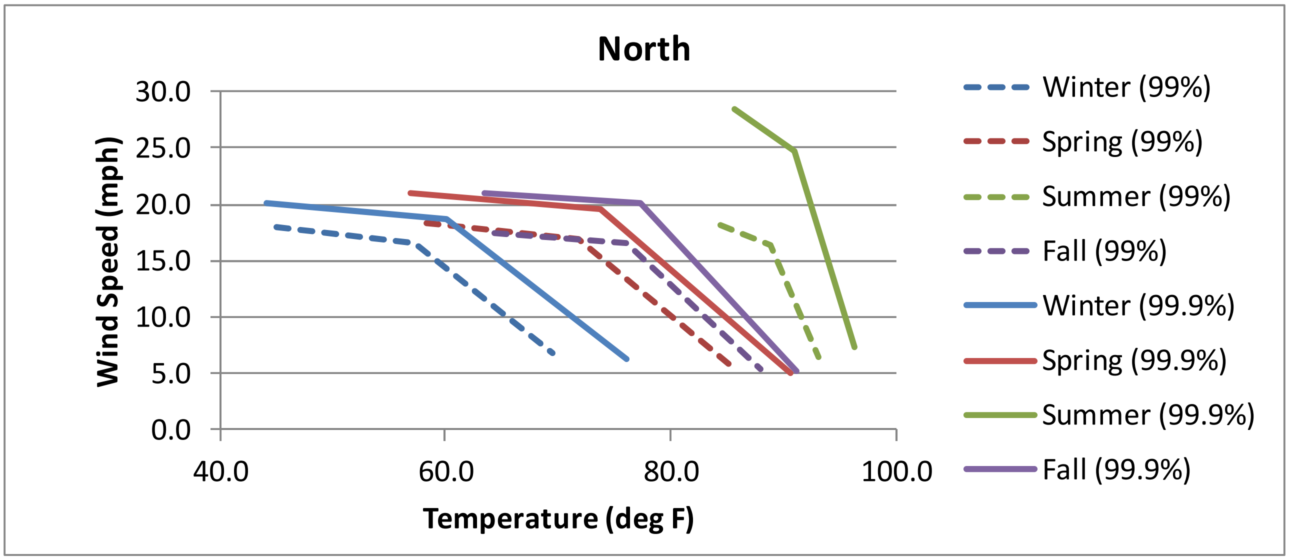


Figure 4-5: Summary Plot for 1 Hour North Wind

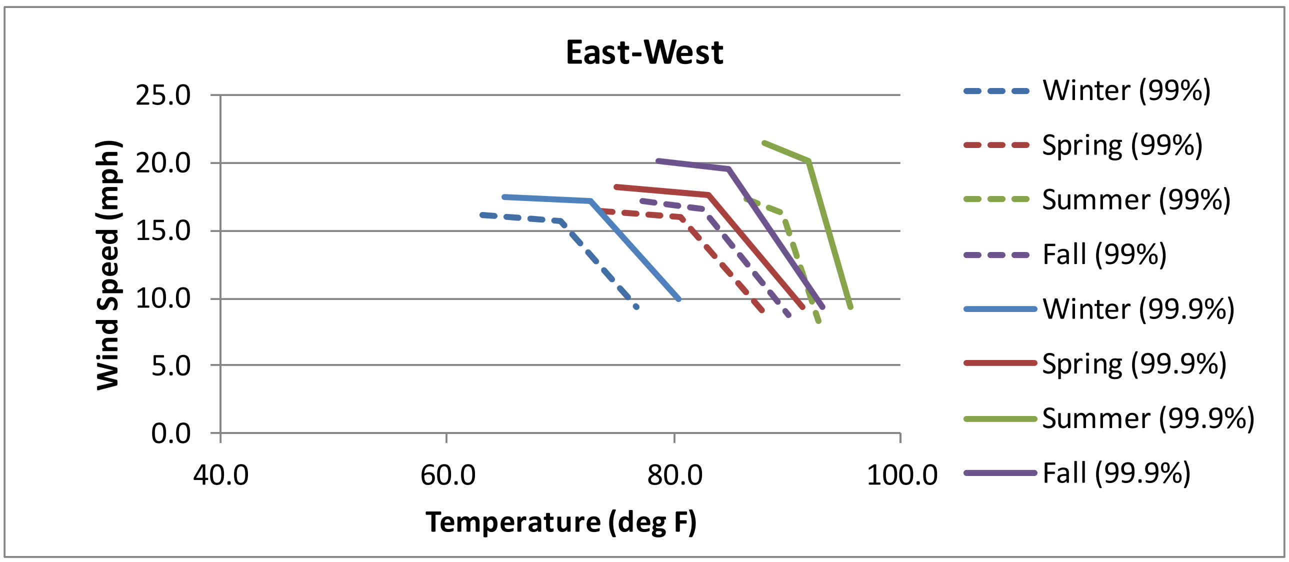


Figure 4-6: Summary Plot for 1 Hour East-West Wind

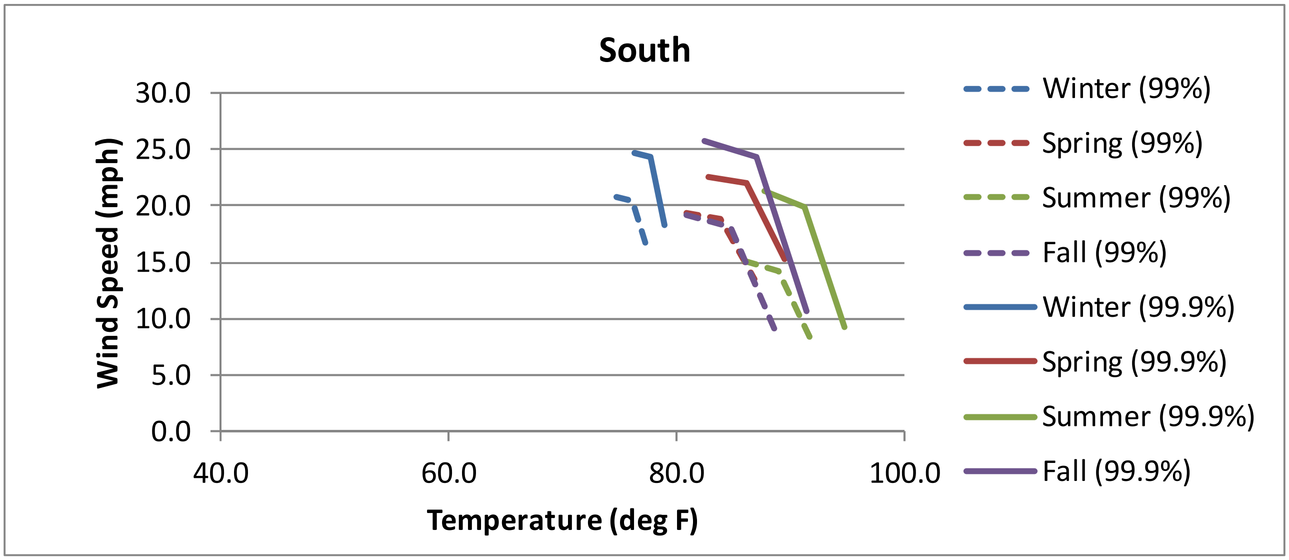


Figure 4-7: Summary Plot for 1 Hour South Wind

Table 4-1: One Hour Wind, 99.9% Data Summary

		Max Wind		Average of Temps		Max Temperature	
		Temp	Wind	Temp	Wind	Temp	Wind
Winter	North	44.1	20.0	60.1	18.6	76.0	6.3
	East	58.4	17.5	67.4	17.1	76.4	9.9
	South	76.4	24.7	77.7	24.3	79.1	18.4
	West	65.0	17.5	72.7	17.0	80.3	9.3
Spring	North	56.9	21.1	73.8	19.6	90.6	5.0
	East	70.9	18.2	79.8	17.6	88.6	9.4
	South	82.8	22.5	86.2	21.9	89.6	15.3
	West	74.9	17.7	83.1	17.1	91.3	7.6
Summer	North	85.6	28.4	91.0	24.8	96.4	7.3
	East	84.6	21.5	89.8	20.1	94.9	9.3
	South	87.7	21.4	91.3	19.9	94.9	9.3
	West	88.0	18.7	91.8	17.1	95.6	7.1
Fall	North	63.5	21.1	77.3	20.2	91.2	5.2
	East	78.6	20.1	84.0	19.5	89.5	9.4
	South	82.6	25.8	87.1	24.3	91.5	10.7
	West	76.4	16.1	84.8	15.4	93.1	5.3

Table 4-2: One Hour Wind, 99% Data Summary

		Max Wind		Average of Temps		Max Temperature	
		Temp	Wind	Temp	Wind	Temp	Wind
Winter	North	45.0	17.9	57.3	16.6	69.5	6.8
	East	57.5	16.1	65.0	15.7	72.5	9.4
	South	74.8	20.8	76.1	20.4	77.5	15.7
	West	63.1	15.3	69.9	14.9	76.7	8.5
Spring	North	58.4	18.3	71.9	17.0	85.4	5.5
	East	70.2	16.5	77.4	15.9	84.7	9.0
	South	80.9	19.4	83.9	18.9	86.9	13.5
	West	73.5	15.1	80.6	14.5	87.7	7.0
Summer	North	84.5	18.2	88.9	16.4	93.2	6.5
	East	83.6	17.3	87.7	16.3	91.7	8.4
	South	86.0	15.1	89.0	14.3	92.0	7.8
	West	86.4	12.5	89.6	11.7	92.8	6.0
Fall	North	64.4	17.4	76.2	16.5	88.0	5.5
	East	77.3	17.1	82.3	16.6	87.4	8.7
	South	80.9	19.1	84.8	18.1	88.7	9.2
	West	75.1	12.7	82.6	12.1	90.1	4.9

Table 4-3: One Day Wind, 99% Data Summary

		Max Wind		Average of Temps		Max Temperature	
		Temp	Wind	Temp	Wind	Temp	Wind
Winter	North	46.9	16.0	58.9	14.9	71.0	6.0
	East	55.7	14.9	64.0	14.3	72.2	7.6
	South	72.1	17.2	73.1	16.9	74.2	13.7
	West	64.5	13.1	70.2	12.7	75.8	7.9
Spring	North	62.1	16.1	73.6	14.7	85.1	5.4
	East	67.6	14.2	76.3	13.5	85.0	6.8
	South	76.6	16.6	79.3	16.1	82.0	9.3
	West	73.5	13.1	79.3	12.6	85.1	6.6
Summer	North	81.2	17.5	86.4	13.7	91.6	4.8
	East	82.0	15.4	87.7	13.2	93.3	5.5
	South	82.3	11.8	86.4	10.2	90.6	5.2
	West	82.1	11.3	85.5	9.8	88.8	4.5
Fall	North	68.3	15.8	77.3	15.1	86.2	5.4
	East	72.8	17.5	80.3	16.2	87.8	5.9
	South	79.6	16.1	82.3	15.3	85.1	6.9
	West	75.8	12.0	81.0	11.4	86.1	4.3

Table 4-4: Three Day Wind, 99% Data Summary

		Max Wind		Average of Temps		Max Temperature	
		Temp	Wind	Temp	Wind	Temp	Wind
Winter	**North**	44.6	15.1	58.0	13.5	71.4	5.7
	East	54.9	14.2	62.6	13.6	70.3	7.5
	South	71.5	15.5	72.7	15.3	74.0	12.9
	West	62.9	12.6	69.3	12.2	75.7	7.2
Spring	**North**	60.1	14.6	72.4	13.4	84.6	5.3
	East	65.8	12.5	74.7	12.0	83.6	6.6
	South	75.0	15.7	78.0	15.1	81.1	8.4
	West	72.6	11.8	78.6	11.3	84.6	6.3
Summer	**North**	80.7	15.2	85.7	11.1	90.8	4.7
	East	81.4	14.9	86.8	12.2	92.1	5.3
	South	81.5	13.3	85.0	10.3	88.6	4.8
	West	81.3	13.8	83.9	11.1	86.5	4.2
Fall	**North**	62.8	15.7	74.0	14.7	85.2	5.1
	East	73.2	17.1	80.0	15.6	86.9	6.1
	South	78.2	16.7	81.2	15.8	84.1	6.1
	West	73.7	12.0	79.7	11.3	85.8	4.1

4.3 NOAA Wind-Temperature Data

NOAA data from 1984 to 2014 was used for a comparison to the 2000-2013 MET data set. The available NOAA data types were not identical to the MET data, and thus a manner of direct comparison was developed.

The NOAA data provided the following:

- Peak daily temperature
- Average daily wind speed (without direction)

The MET tower data provided the following:

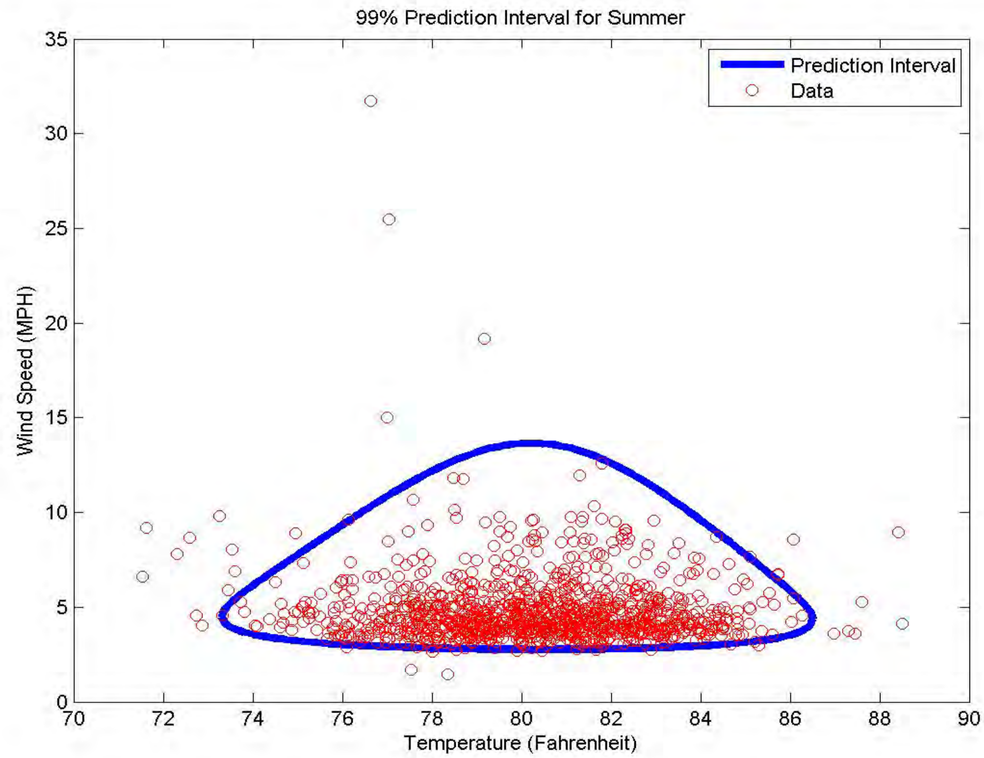
- Average daily temperature
- Average daily wind speed (with direction, all directions combined for this study)

To compare the data sets, the NOAA data and MET data for the same period (2000-2013) were evaluated. Since the peak temperature for the NOAA data was recorded, it is expected that the NOAA data is shifted higher compared to the average temperature recorded for the MET data. A comparison of the data sets demonstrates this shift.

Focusing on the hottest, summer months, the NOAA peak daily temperature and average daily wind were combined and bounding curves developed in the same manner as the MET tower data (see Section 4.2). The NOAA data and MET tower data plots for daily average conditions were then compared. Plots of these data sets are provided in Figure 4-8 below. Key parameters of the 99% bounding points for these curves are provided in Table 4-2. In the comparison of NOAA 30 year data and MET 13 year data, it can be seen that the NOAA max temperature is 13.3 deg F greater than the MET max temperature and the NOAA max wind is approximately equal (-0.1mph) to the MET max wind.

Table 4-5: Comparison of MET and NOAA 2000-2013 Data

	Max Wind		Average of Temps		Max Temperature	
	Temp	Wind	Temp	Wind	Temp	Wind
NOAA summer	90.4	13.6	95.1	12.0	99.8	5.4
MET summer	80.2	13.7	83.4	10.7	86.5	4.4
Difference	10.1	-0.1	11.7	1.4	13.3	1.1



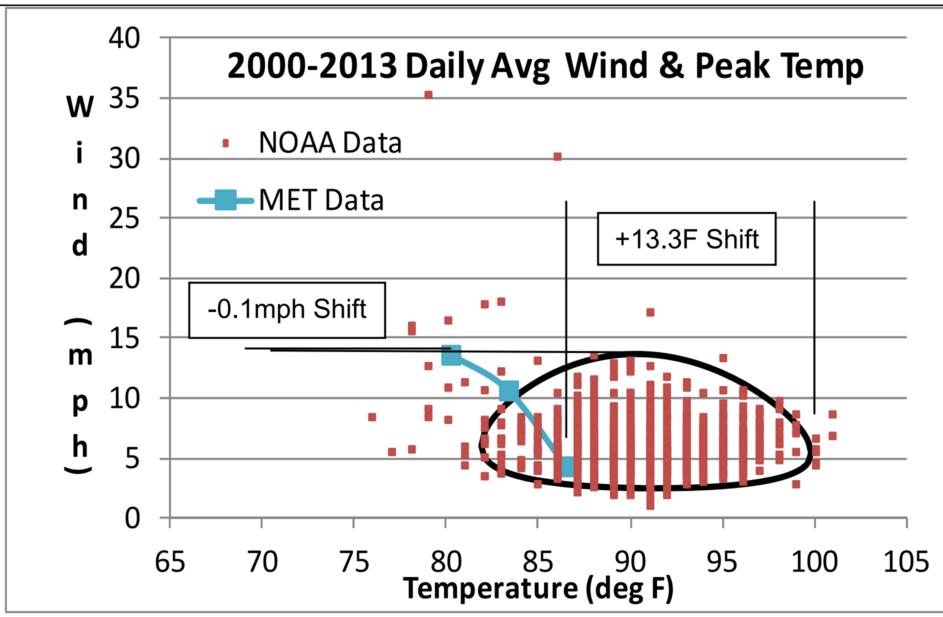


Figure 4-8: MET– NOAA 2000-2013 Data Comparison

Expanding the comparison to account for the larger, 30 year data set, the NOAA data is adjusted (-13.3 deg F/+0.1mph) to provide an equivalent comparison and to show how this additional 30 year data would modify the MET tower data set. A plot of the shifted NOAA data and the MET tower data is presented in Figure 4-9, and key parameters of the 99% bounding points for these curves are provided in Table 4-6 .

In general, the shape of the curves is similar. The equivalent (shifted) NOAA data produces max wind and temperature points that are slightly higher than the MET data (+0.4mph/+0.1 deg F). Therefore, the bounding MET data will be increased to account for the difference to the 30 year expanded data set.

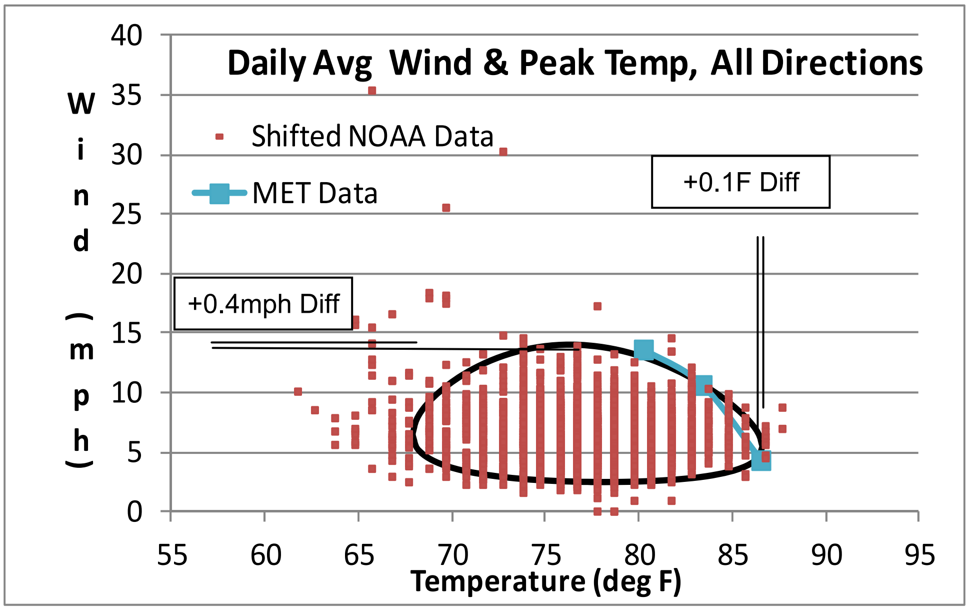


Figure 4-9: NOAA 30 Year Set

Table 4-6: Comparison of 30 Year NOAA and MET data

	Max Wind		Average of Temps		Max Temperature	
	Temp	Wind	Temp	Wind	Temp	Wind
NOAA 30 year summer	76.3	14.1	81.5	12.4	86.6	5.5
MET summer	80.2	13.7	83.4	10.7	86.5	4.4
Difference	-3.9	0.4	-1.9	1.7	0.1	1.1

4.4 Bounding Points

Recirculation behavior of the DCT is a primarily a function of wind speed [14]. Therefore, the maximum wind speed points are selected for analysis of modifications to the DCT design. The points defining the maximum wind and temperature at the maximum wind across the four seasons are presented in Table 4-7 for each of the time averaged periods. These points are shifted +0.4mph/+0.1F to account for the 30 year expanded data set and rounded to the nearest mile per hour. It can be seen that the bounding wind conditions is 29mph based on the 99.9% data.

Table 4-7: Bounding Temperature-Wind Points

	99.9% (1 hour)		99% (1 hour)		99% (1 day)		99% (3 day)	
	Temp	**Wind**	**Temp**	**Wind**	**Temp**	**Wind**	**Temp**	**Wind**
North	86	29	85	19	81	18	81	16
East	85	22	84	18	82	18	82	17
South	88	26	86	21	82	18	82	17
West	88	19	86	16	82	14	81	14

4.5 Confirmation with MET Tower Data

In order to ensure that the derived bounding site conditions were conservative relative to all observed MET tower data, a final comparison plot is developed showing the bounding curve data (99.9% Data from Table 4-1 and shown in Figure 4-5 through Figure 4-7) with all temperature and wind data on a single plot, Figure 4-10. In this plot, the 3 point curve is extended to include a the 102F, no wind case to meet FSAR criteria, and to a 76F/51mph wind case to envelop extreme winds as observed during Hurricane Katrina. It can be seen that the derived site conditions bound all observed data.

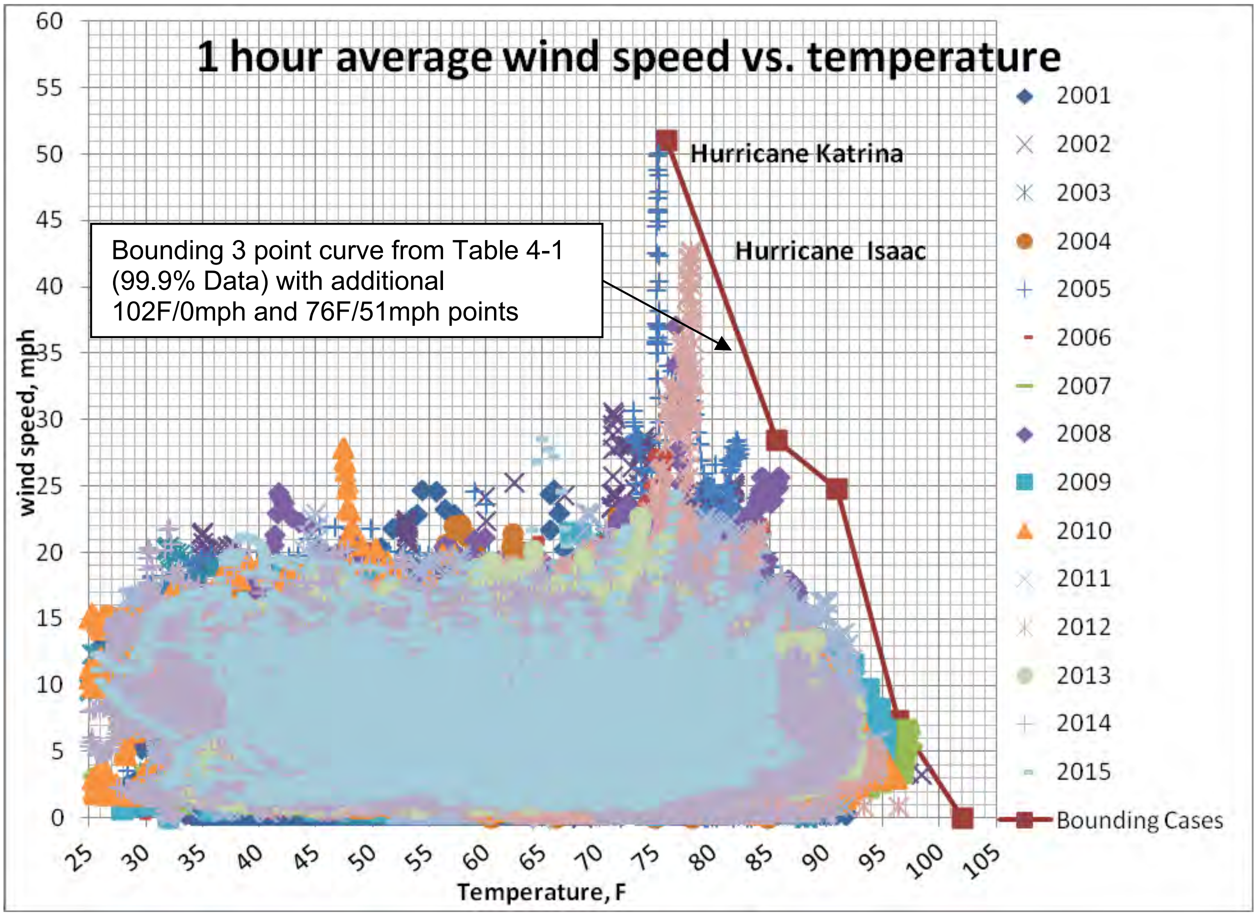


Figure 4-10: Comparison plot of MET Tower Data and Analysis Cases

5 Conclusions

This report addresses an investigation of the Waterford 3 site meteorology. The site meteorology affects the performance of the DCT and WCT, particularly with respect to recirculation effects, which are investigated separately. This report develops bounding ambient wind and temperature combinations in order to ensure recirculation is addressed in a conservative manner.

From the review of data, a set of bounding points for the hourly at 99.9% and 99% confidence interval, as well as 99% 1 day and 3 day average temperature and wind speeds were obtained and are provided in Section 4.4. A final comparison with all observed MET tower data is provided in Section 4.5. This comparison demonstrates the conservative position of all bounding cases compared to observed data.

6 References

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22. NUREG-1475, “Applying Statistics”

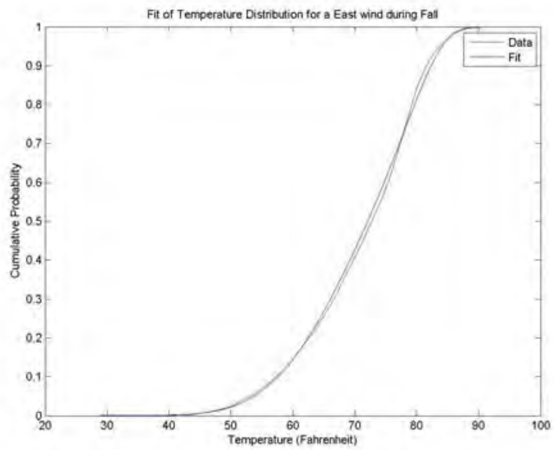
Attachment A:

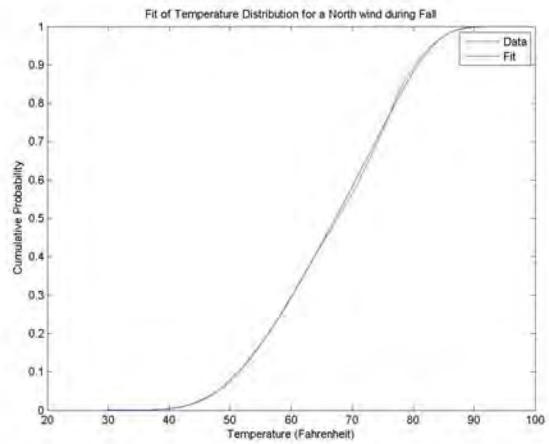
MET Tower Data Distribution

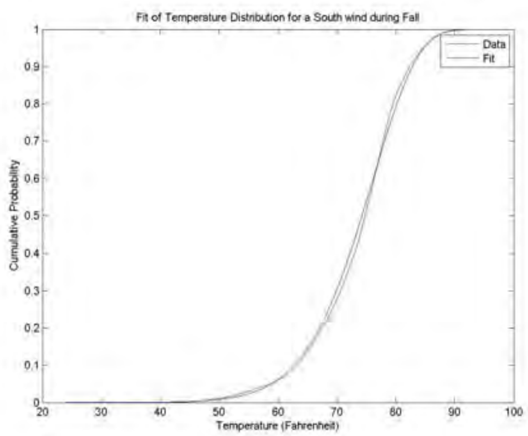
The following plots provide wind speed (mph) or temperature (deg F) on the X axis and probability of occurrence on the Y axis. One hour, one day and 3 day average plots are included.

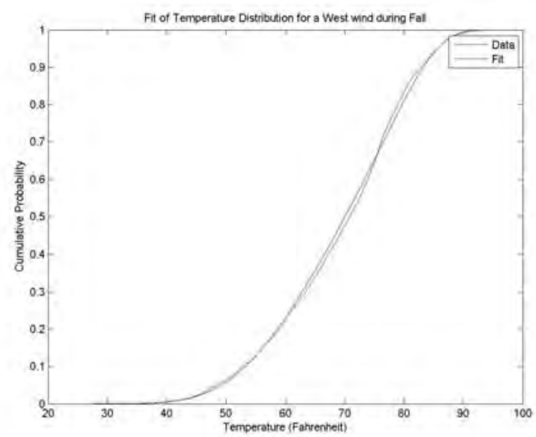
1 Hour Data

Fall Temperature Distribution (1 hr), 4 Directions



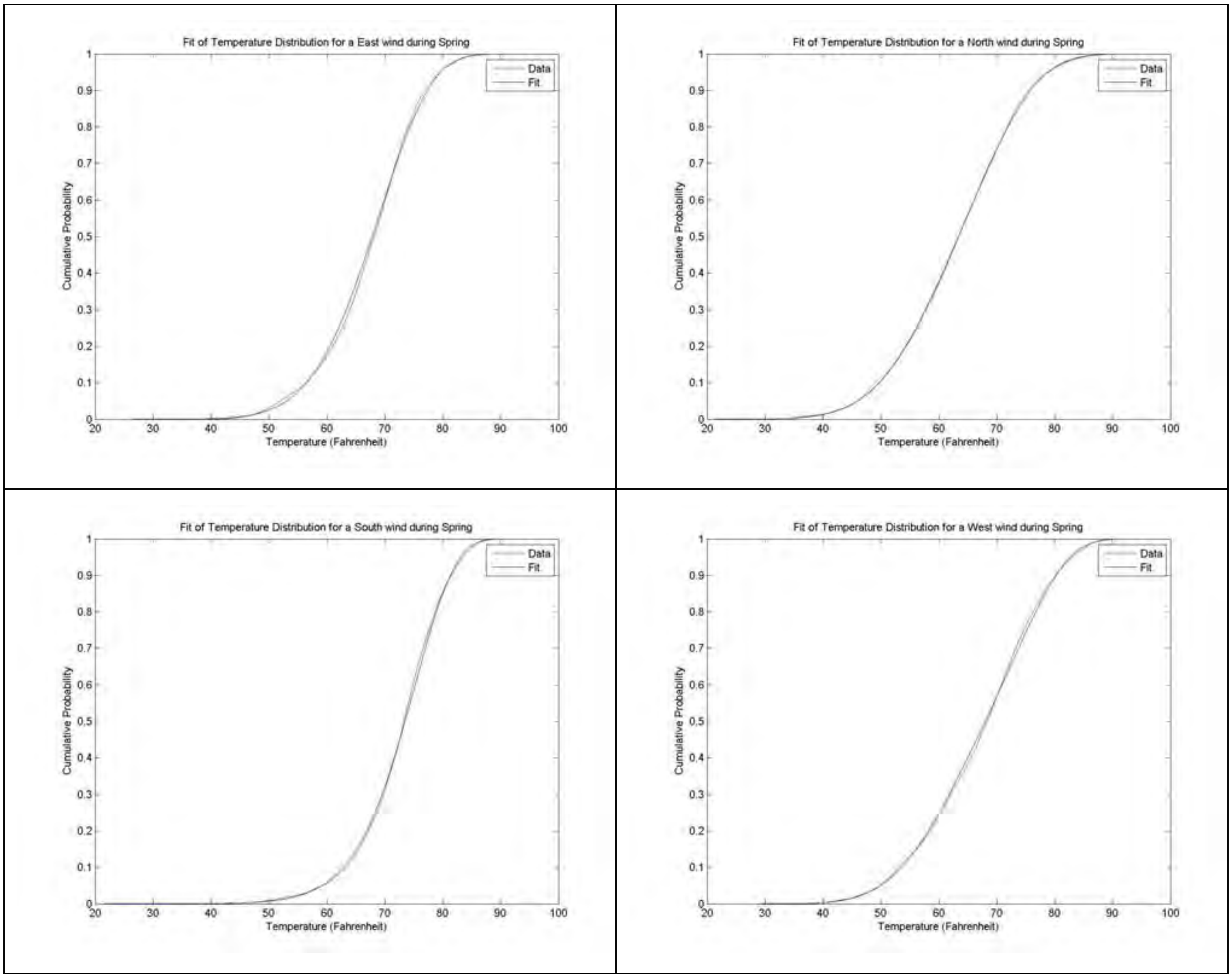






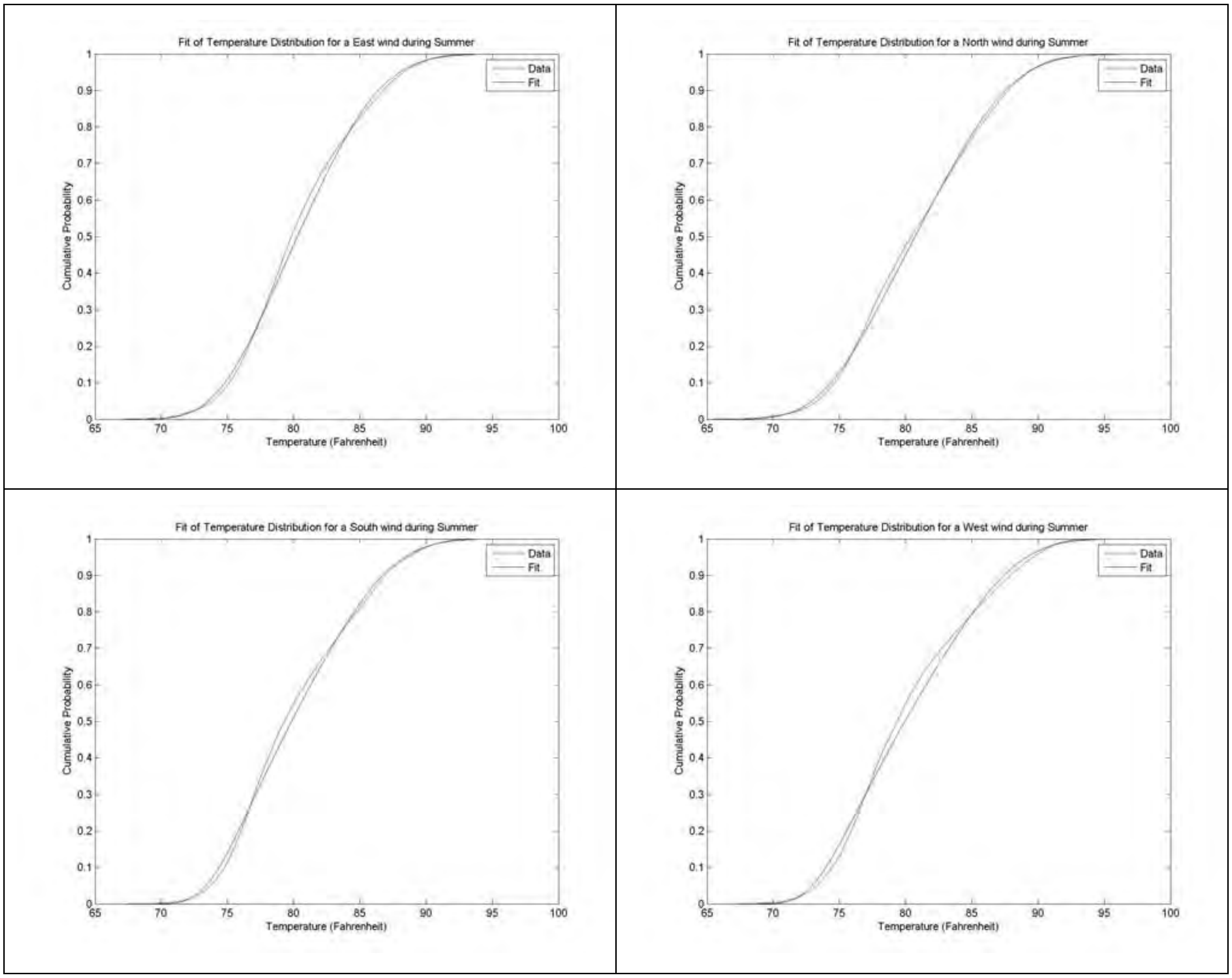
1 Hour Data

Spring Temperature Distribution (1 hr), 4 Directions



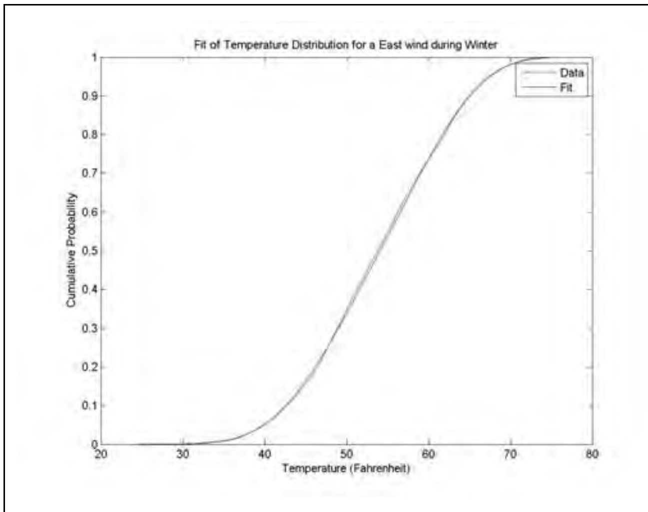
1 Hour Data

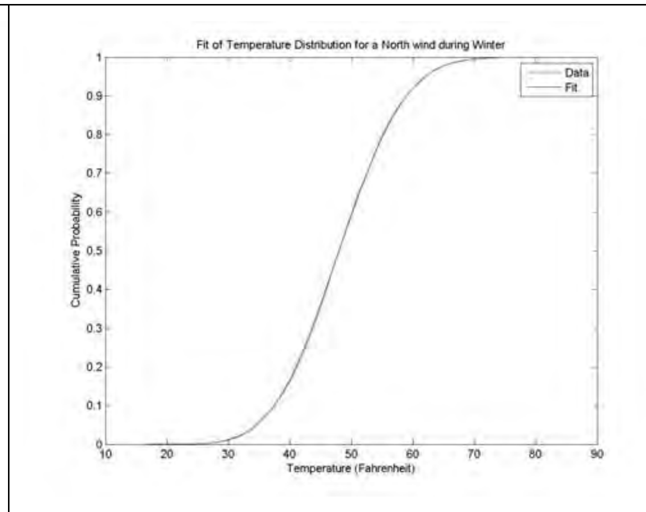
Summer Temperature Distribution (1 hr), 4 Directions

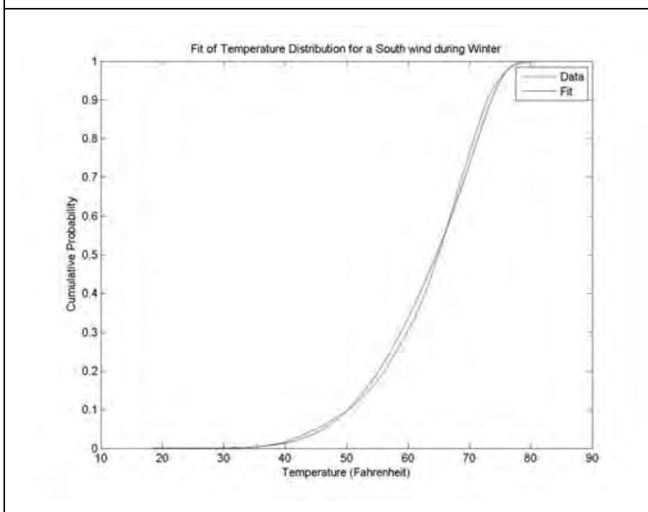


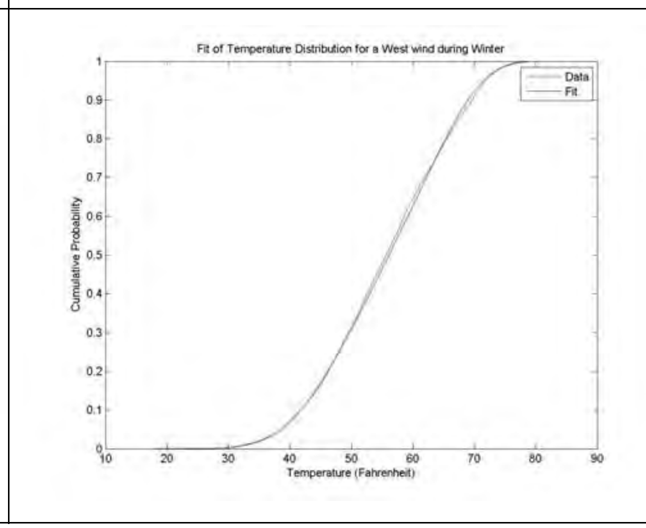
1 Hour Data

Winter Temperature Distribution (1 hr), 4 Directions



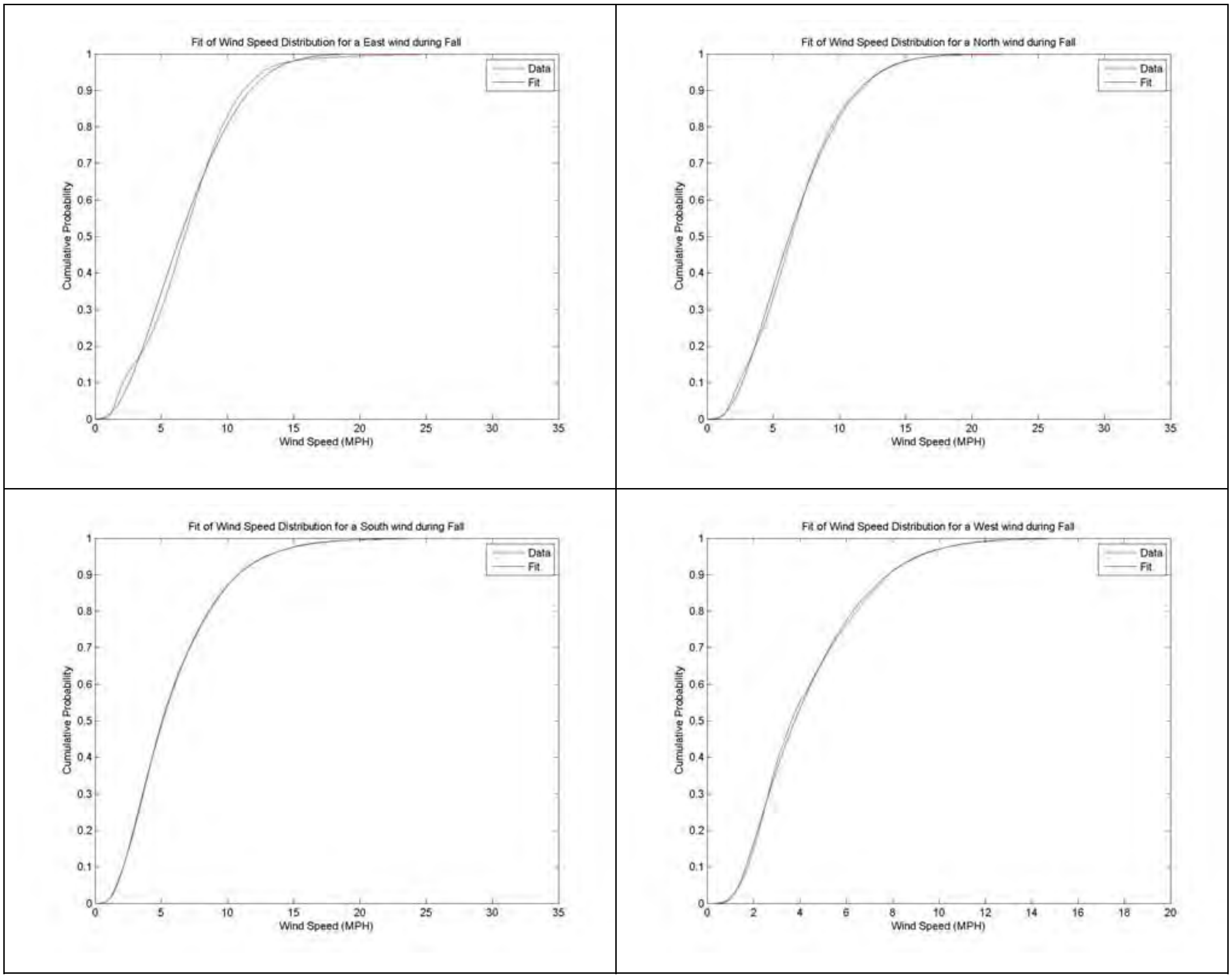






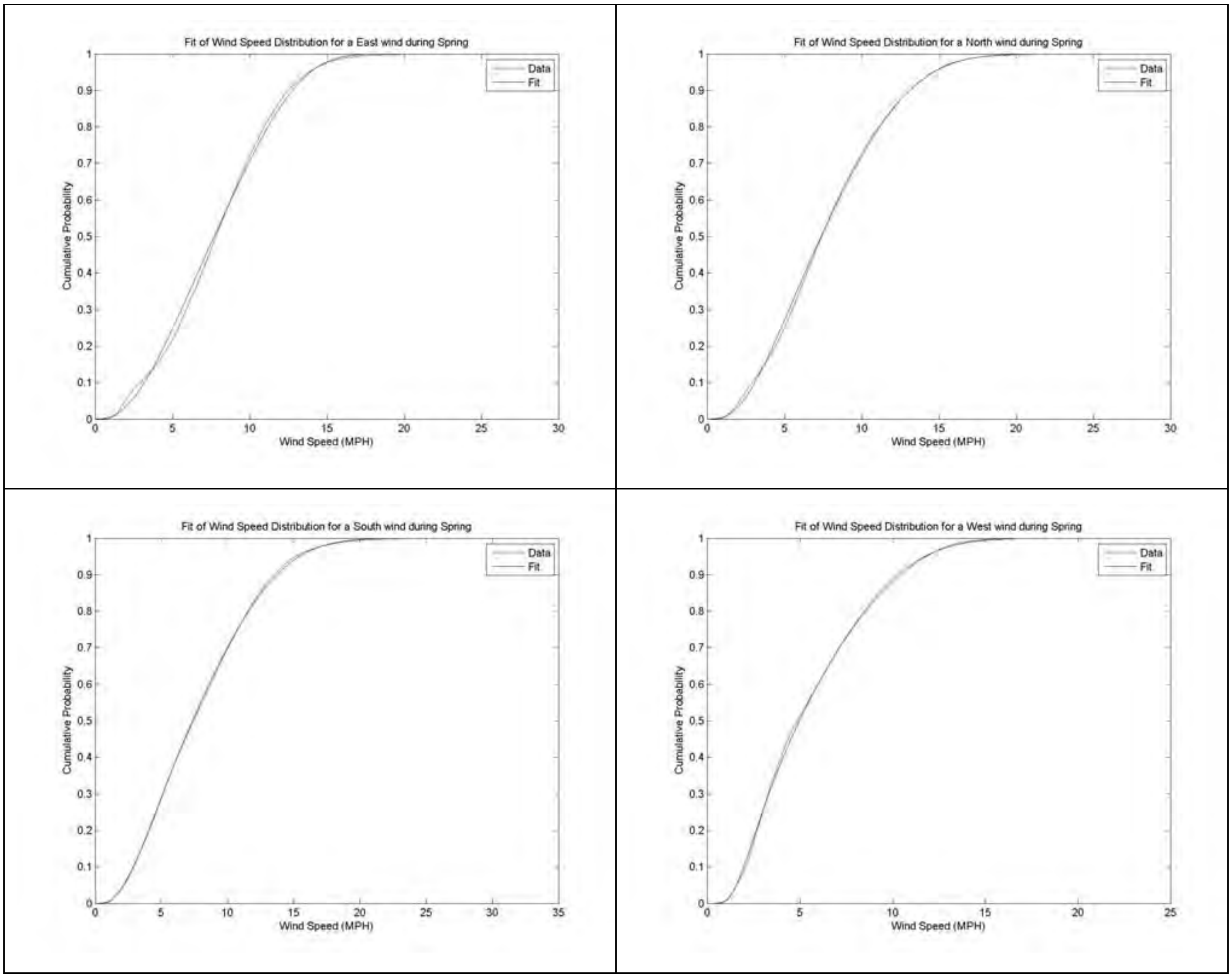
1 Hour Data

Fall Wind Distribution (1 hr), 4 Directions



1 Hour Data

Spring Wind Distribution (1 hr), 4 Directions



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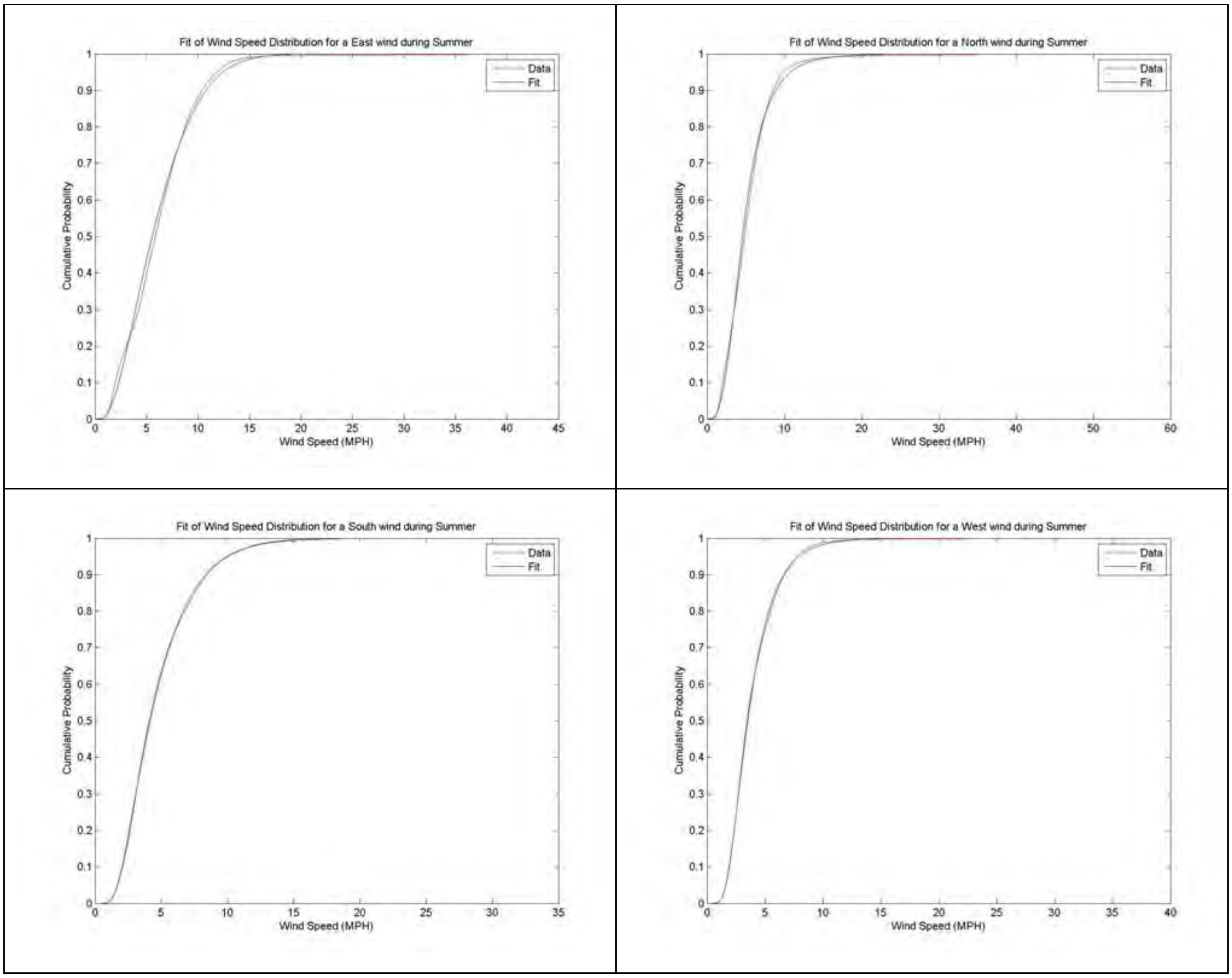
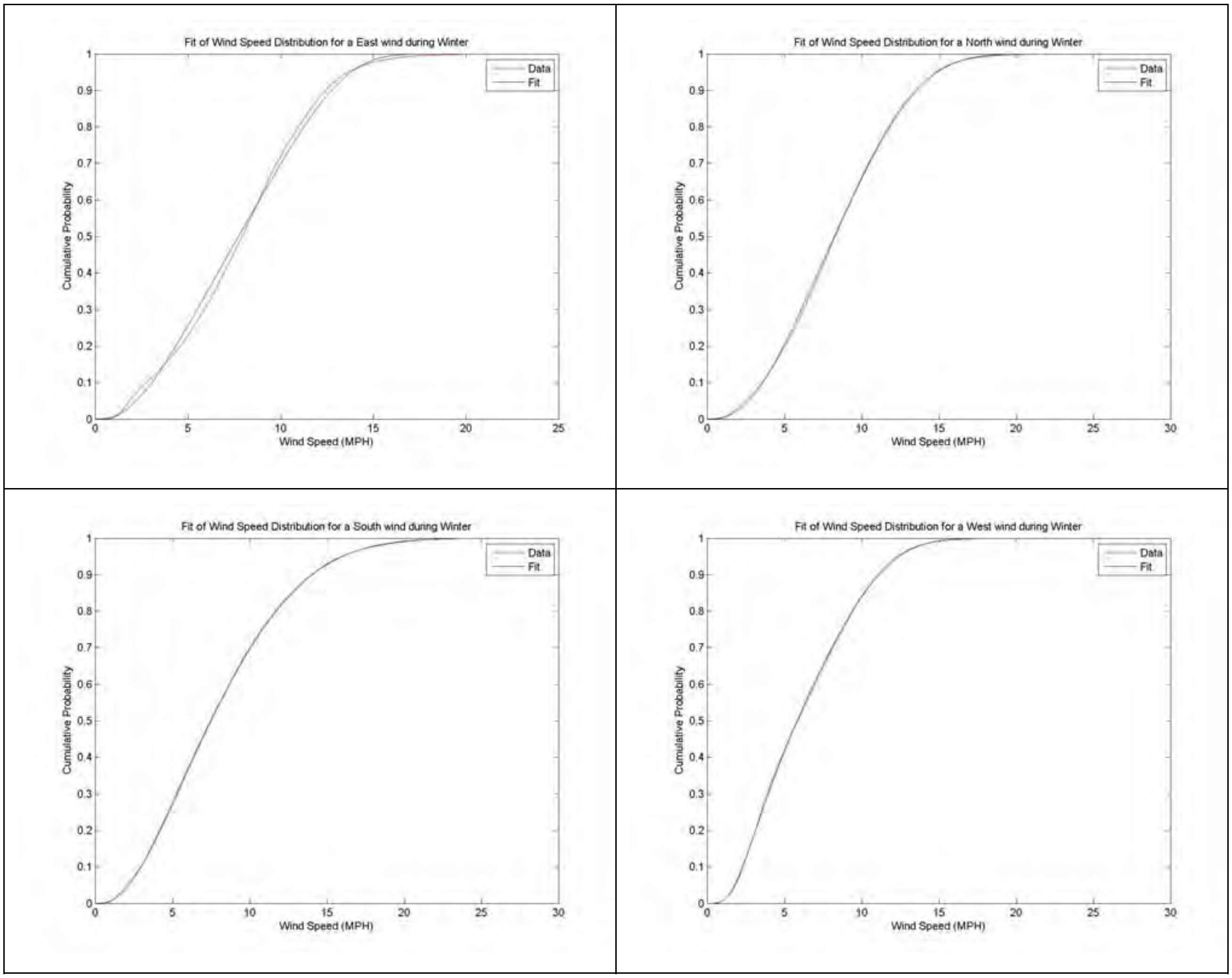
Summer Wind Distribution (1 hr), 4 Directions



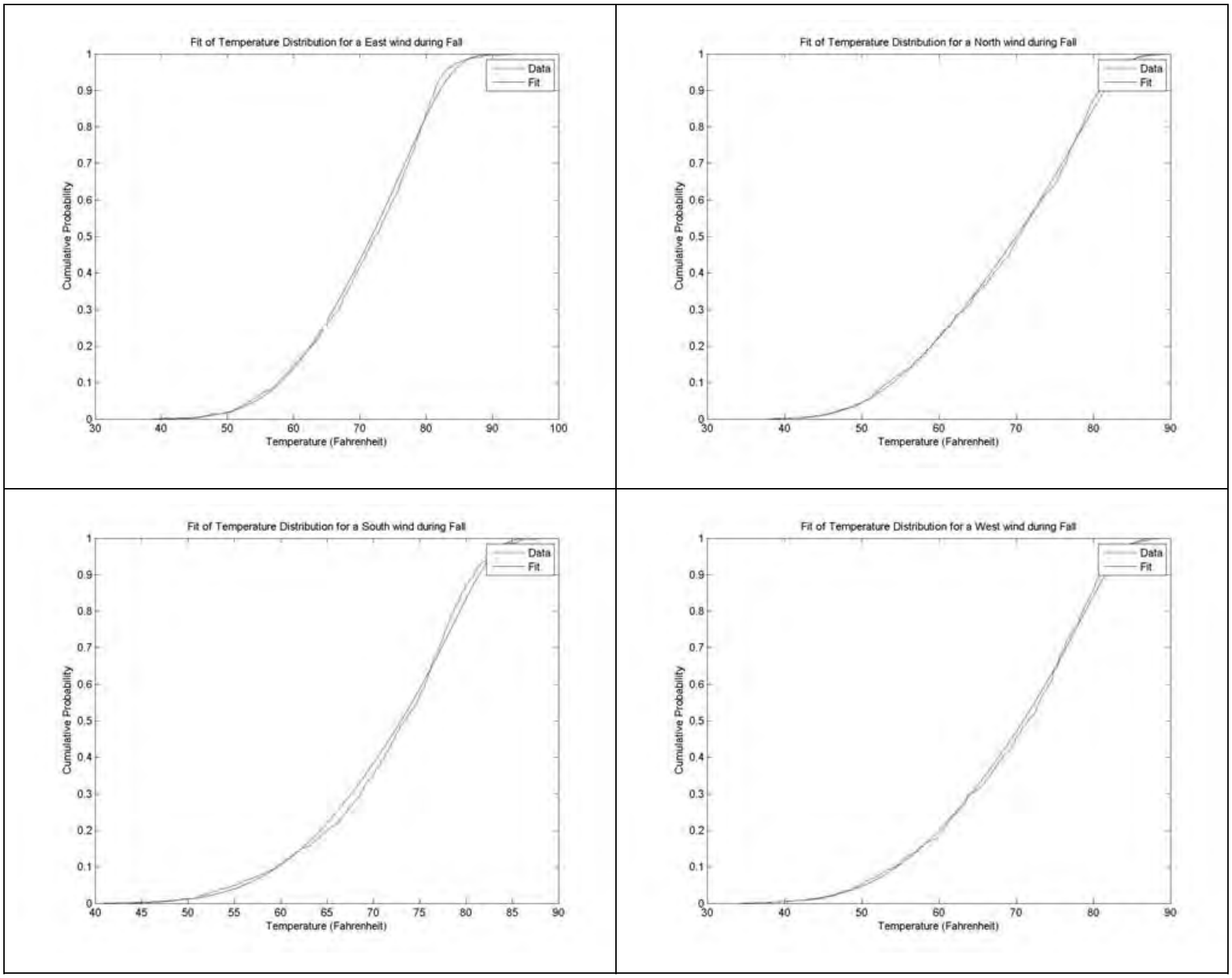
1 Hour Data

Winter Wind Distribution (1 hr), 4 Directions



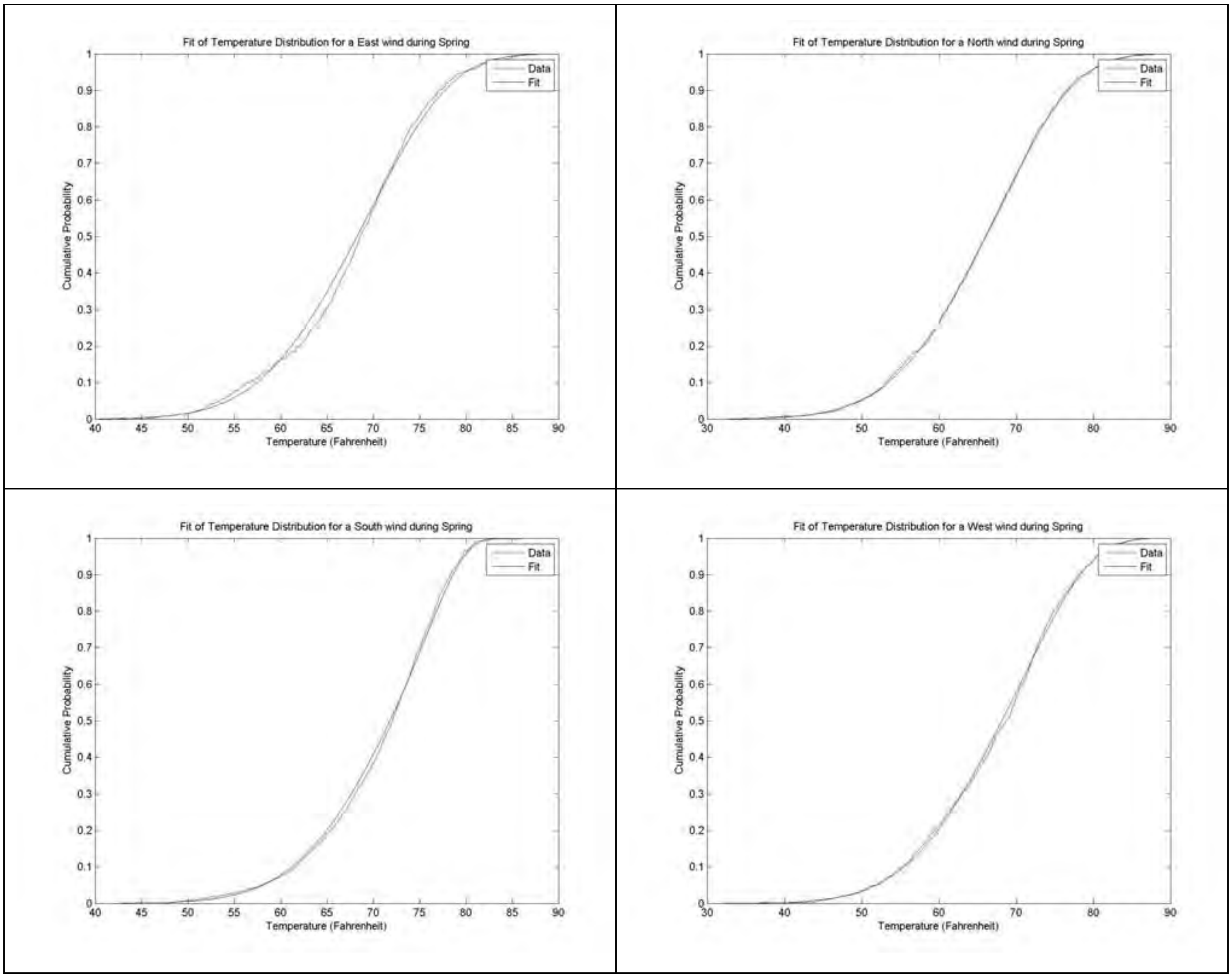
<u>**1 Day Data**</u>

Fall Temperature Distribution, 4 Directions



1 Day Data

Spring Temperature Distribution, 4 Directions



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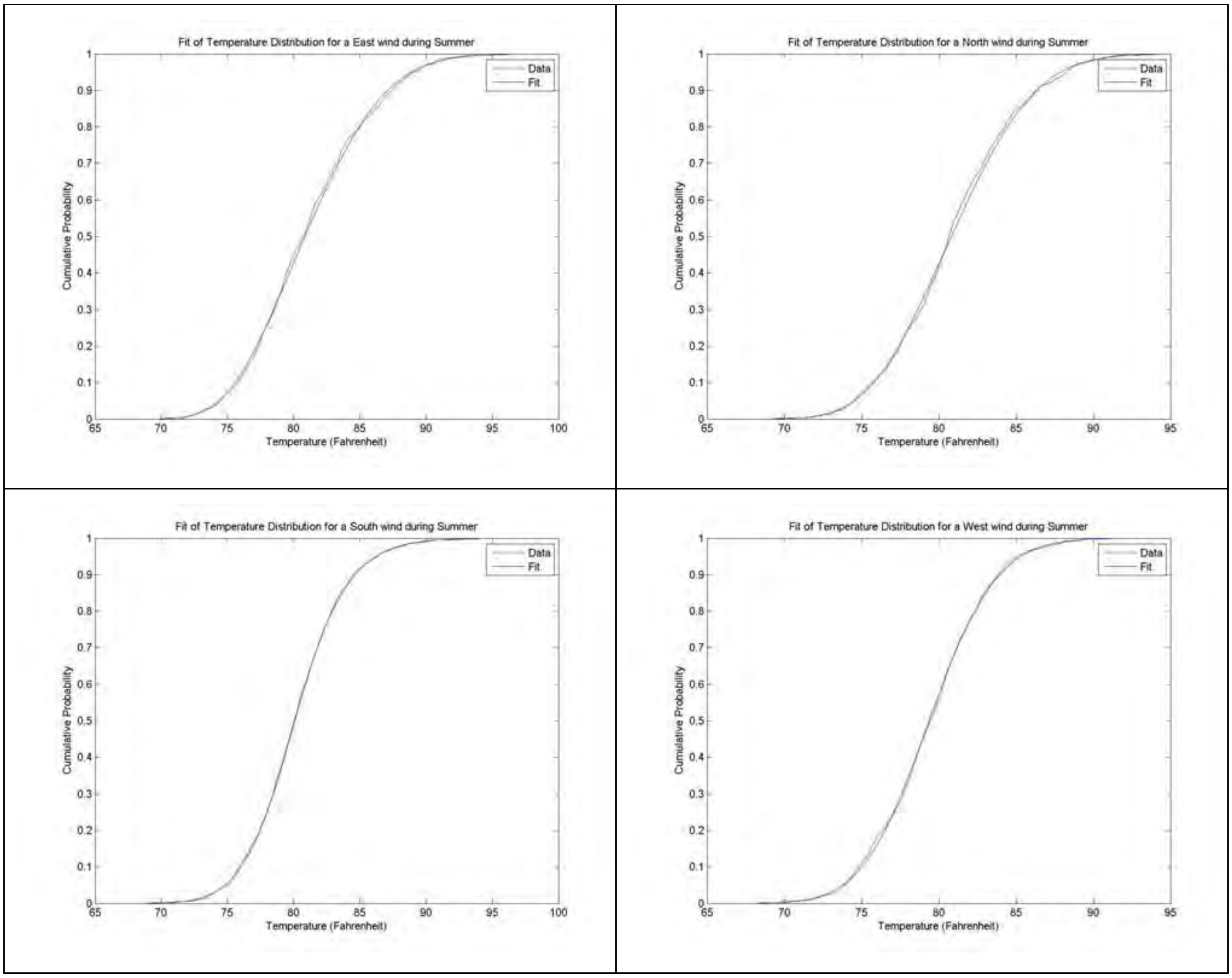
Summer Temperature Distribution, 4 Directions



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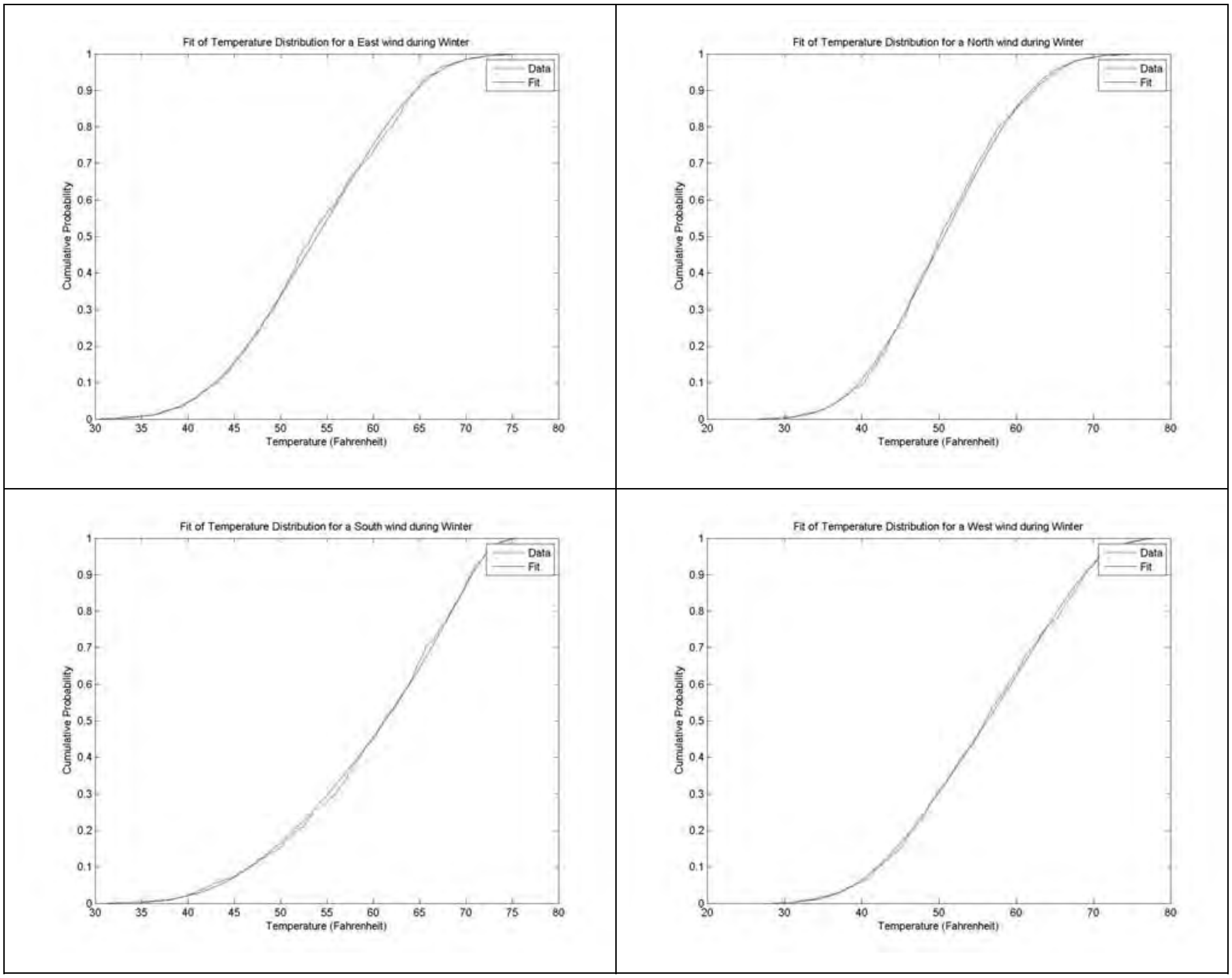
Winter Temperature Distribution, 4 Directions



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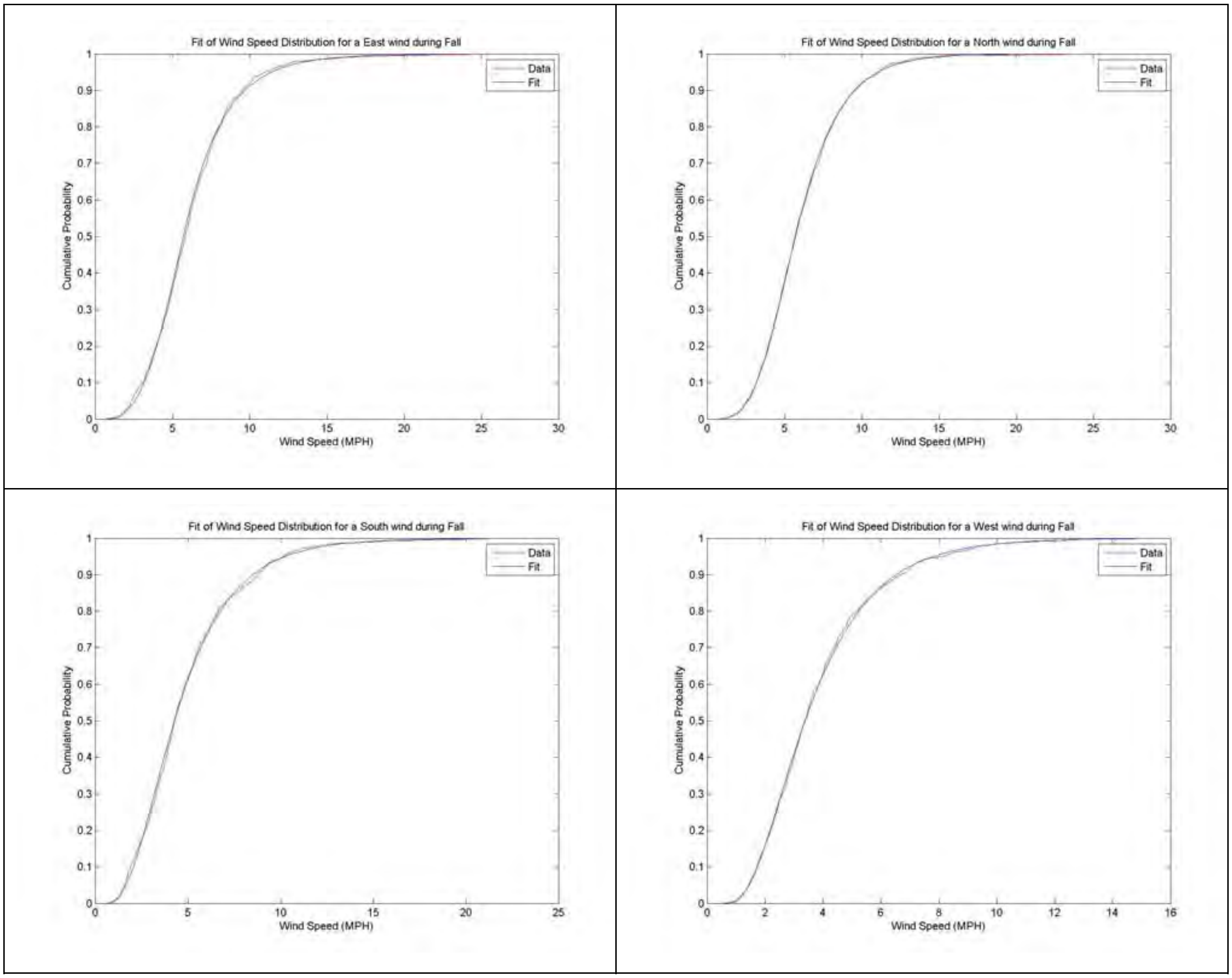
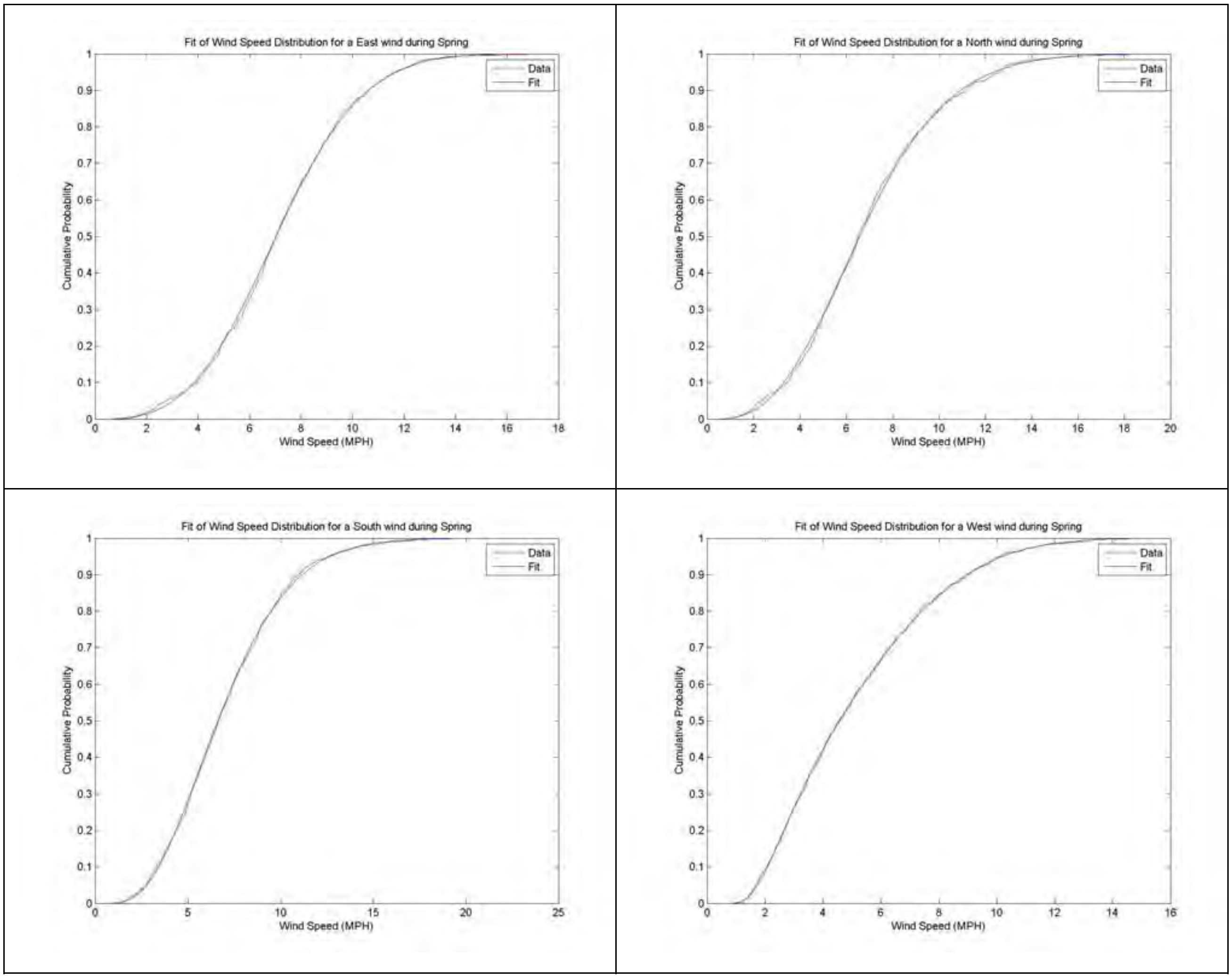
Fall Wind Distribution, 4 Directions



1 Day Data

Spring Wind Distribution, 4 Directions



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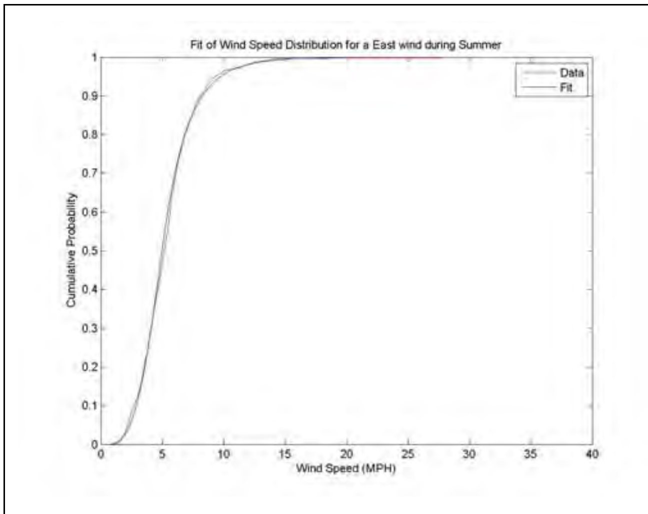

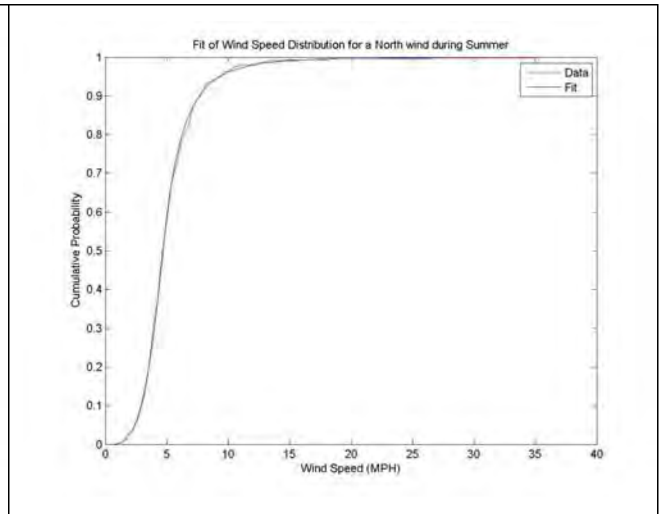

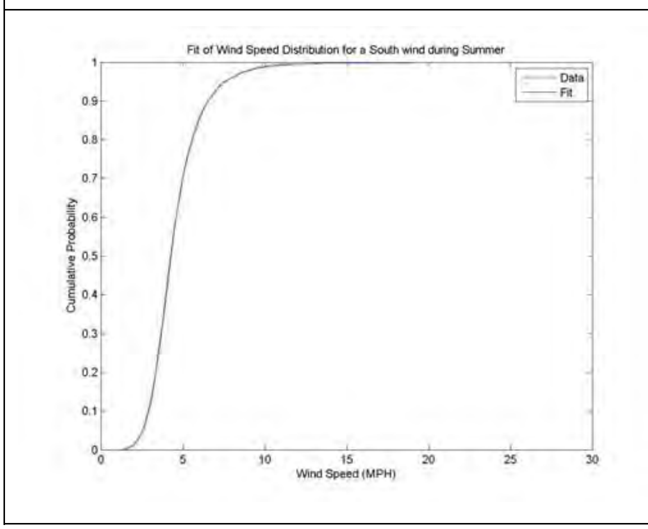

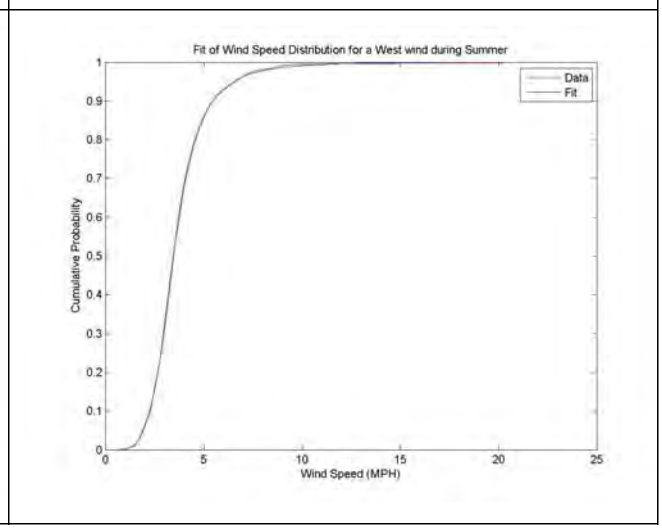

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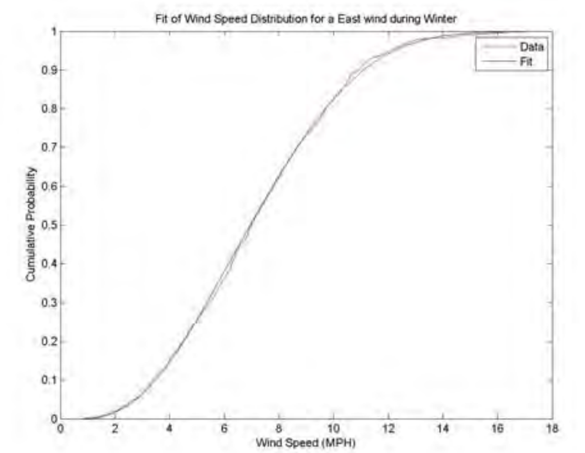
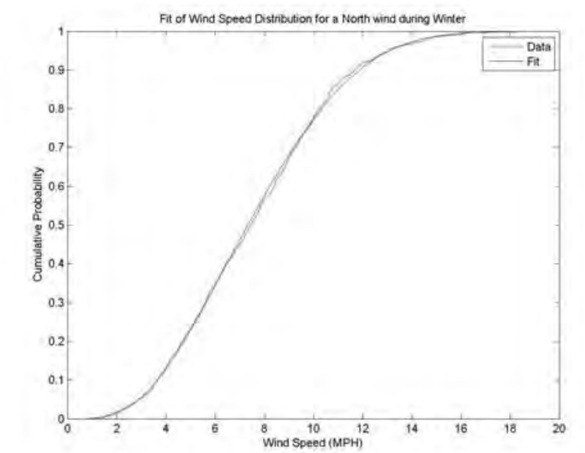
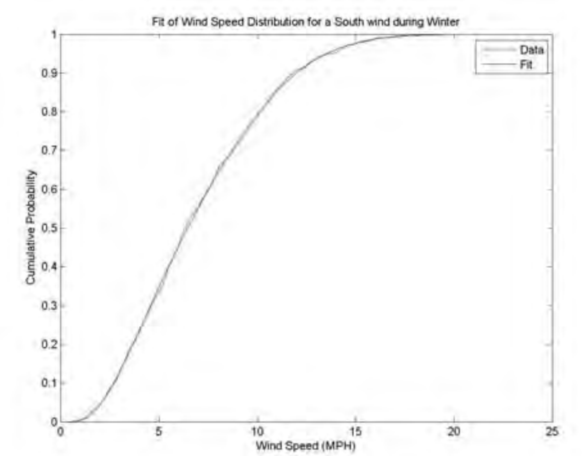
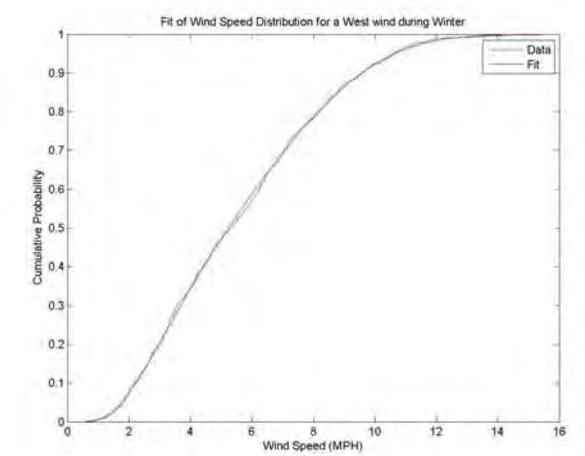
Winter Wind Distribution, 4 Directions



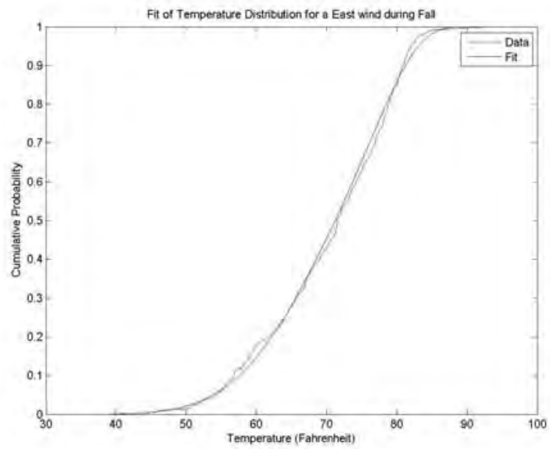


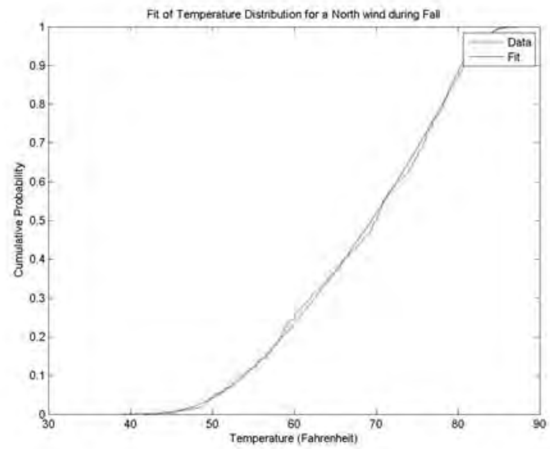


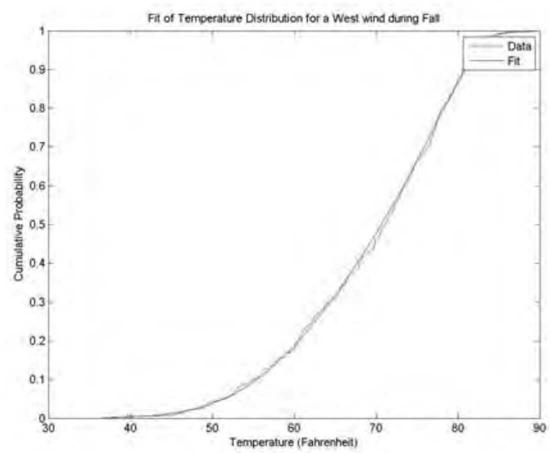


3 Day Data

Fall Temperature Distribution, 4 Directions

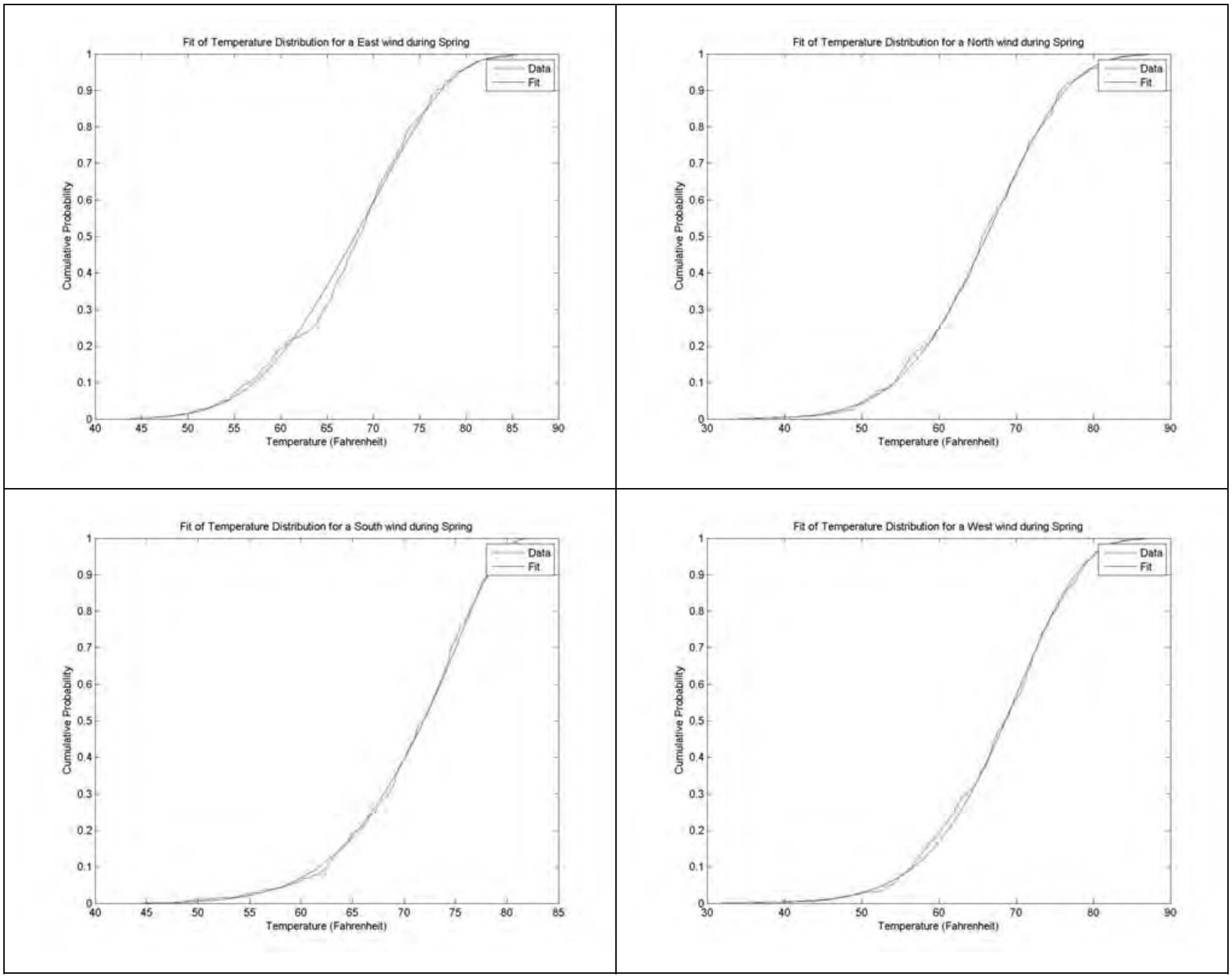






3 Day Data

Spring Temperature Distribution, 4 Directions



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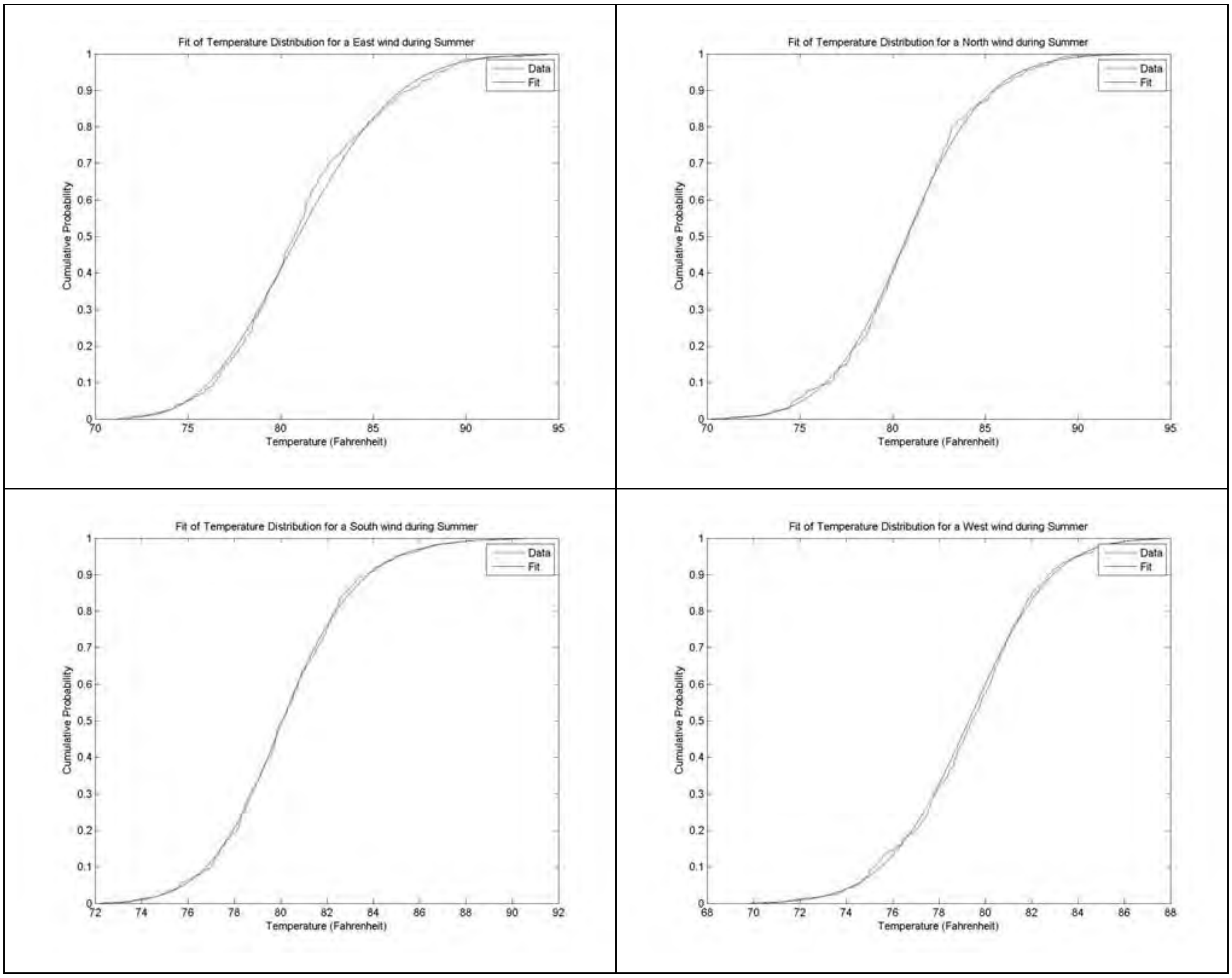
Fall Temperature Distribution, 4 Directions



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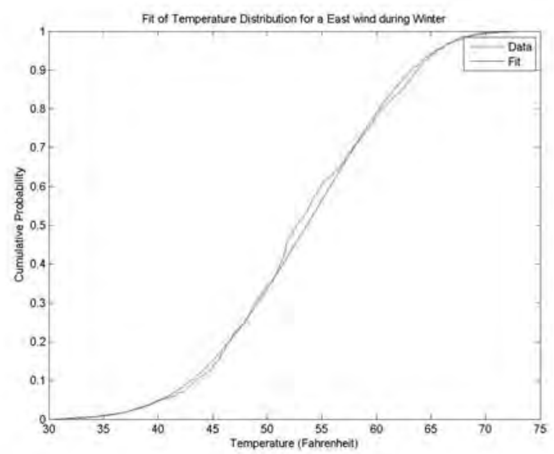
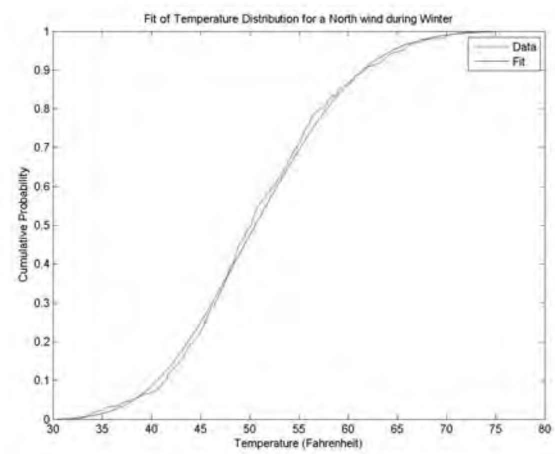
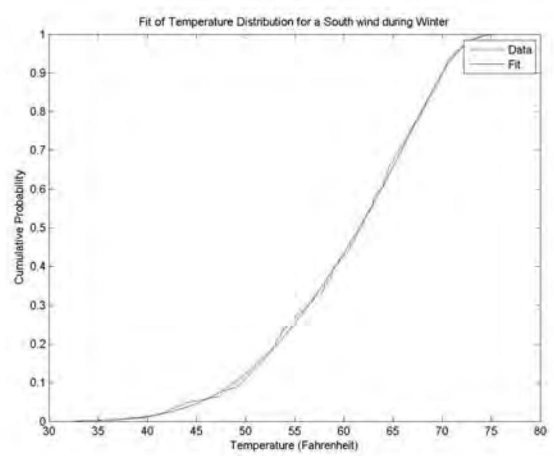
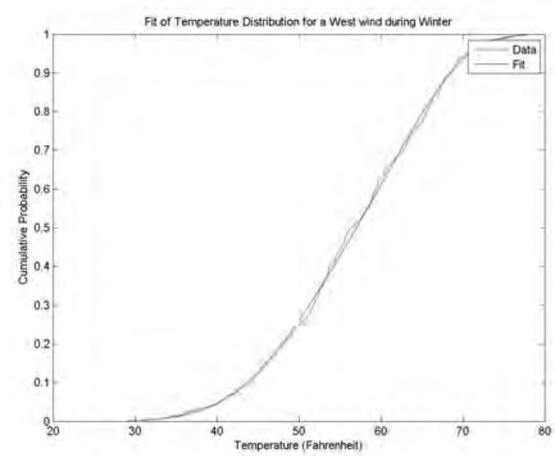
Winter Temperature Distribution, 4 Directions



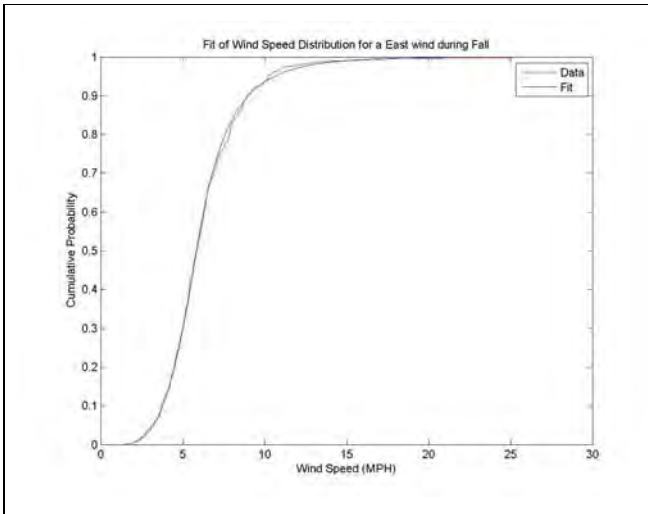


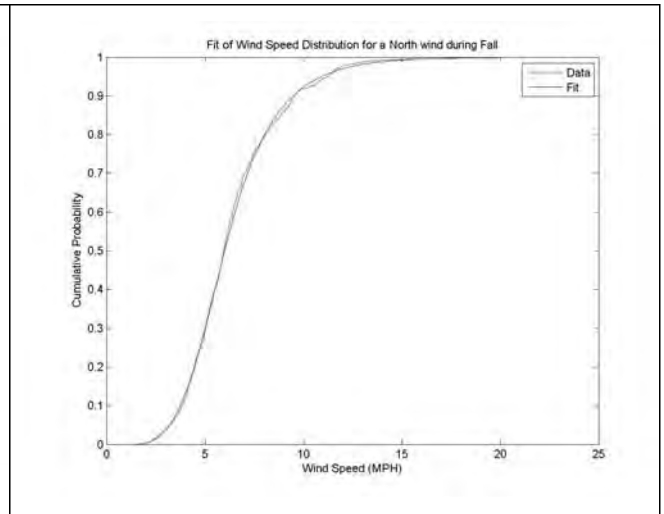


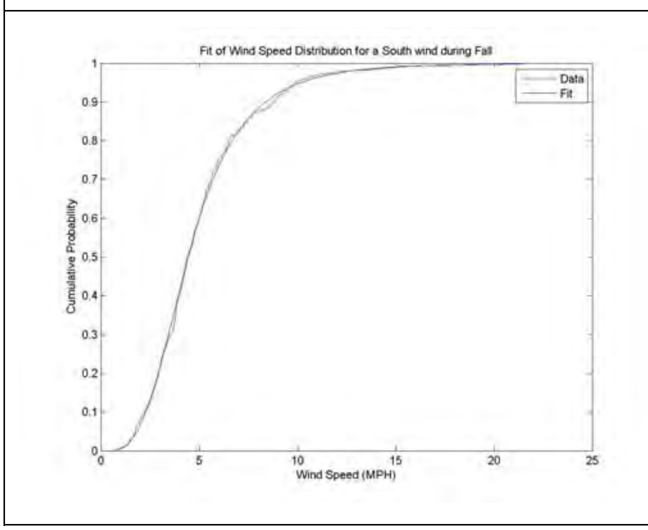


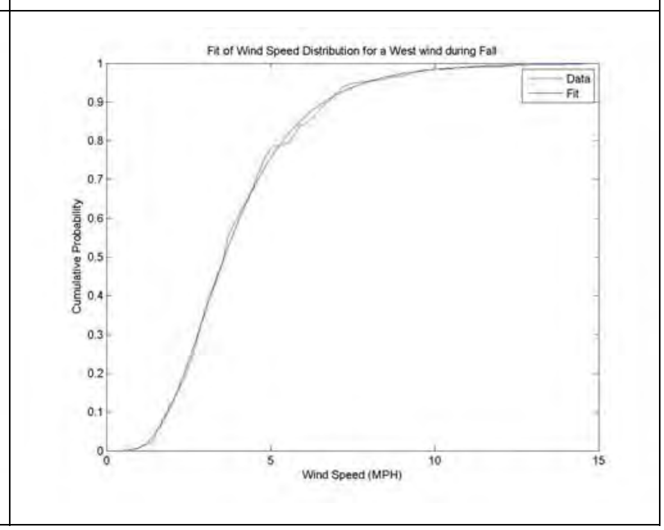
3 Day Data

Fall Wind Distribution, 4 Directions



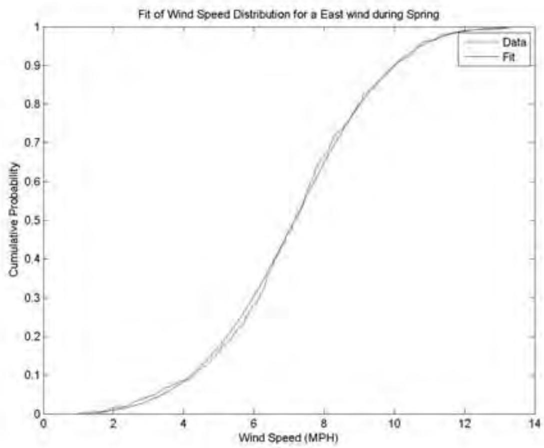


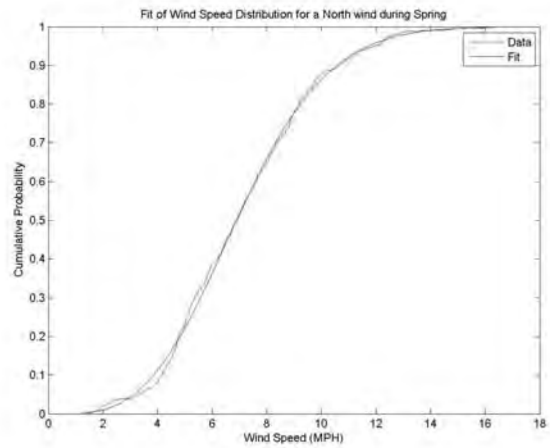


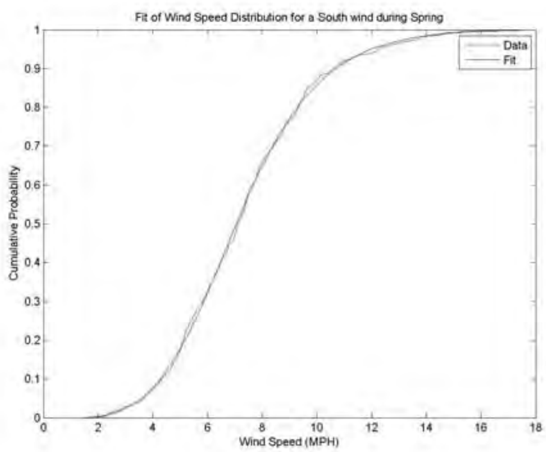


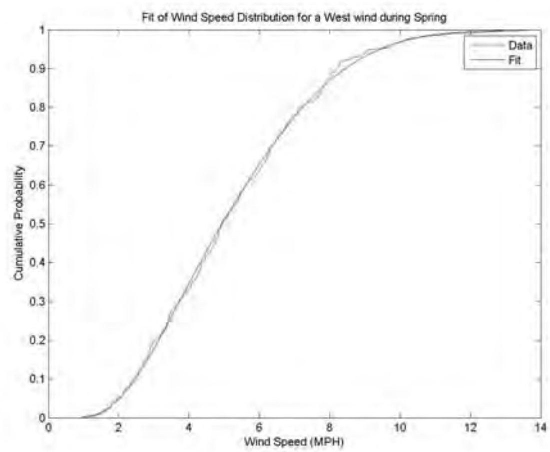
3 Day Data

Spring Wind Distribution, 4 Directions



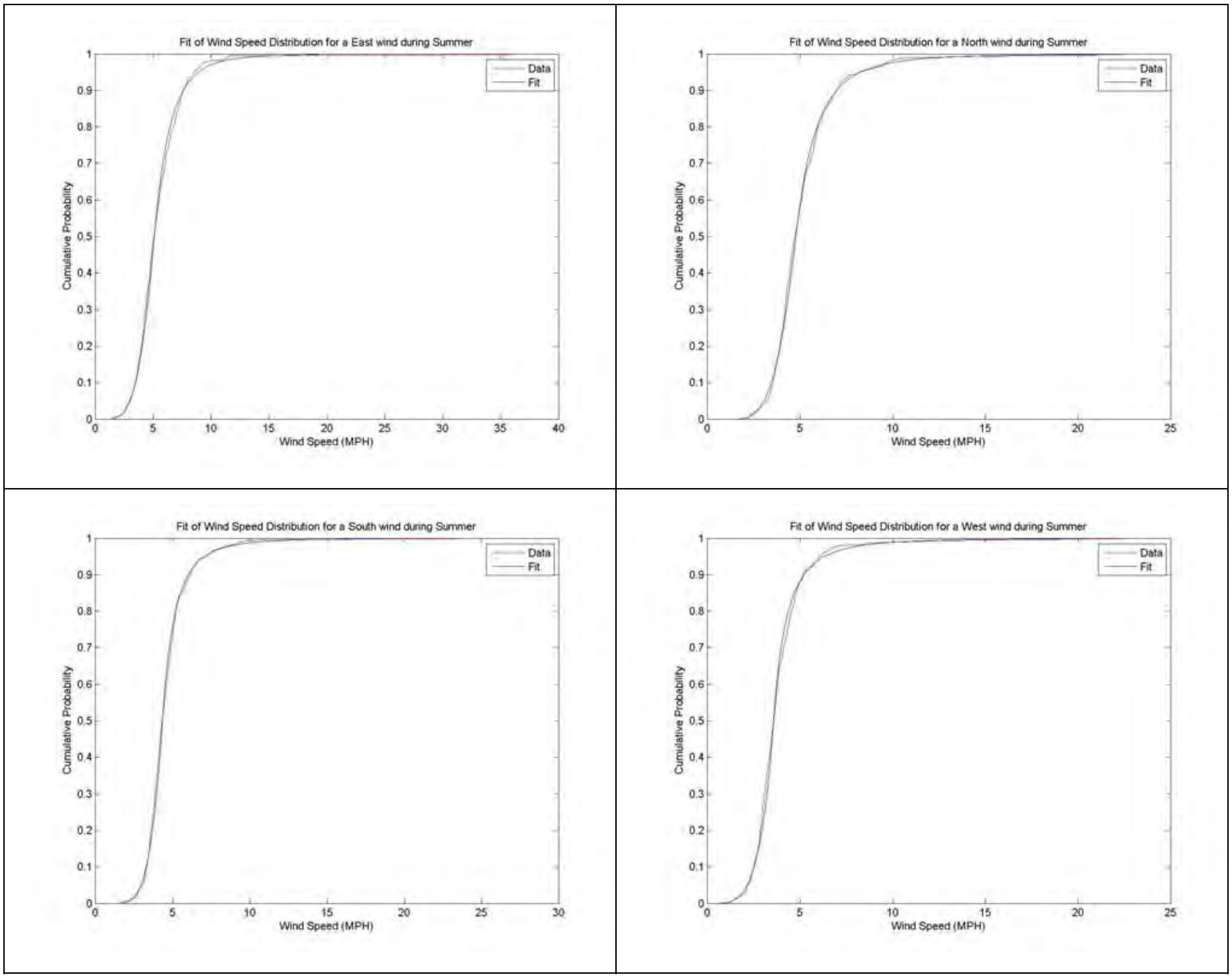






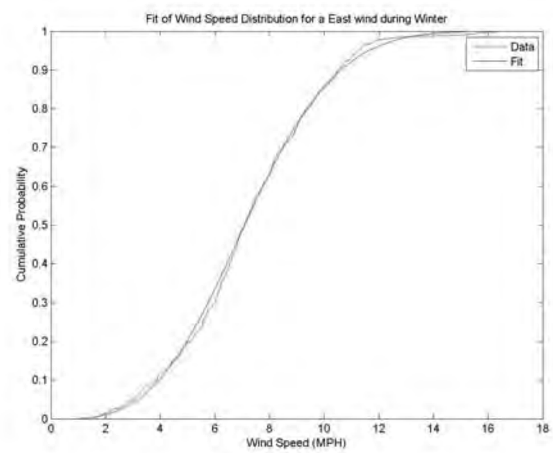
3 Day Data

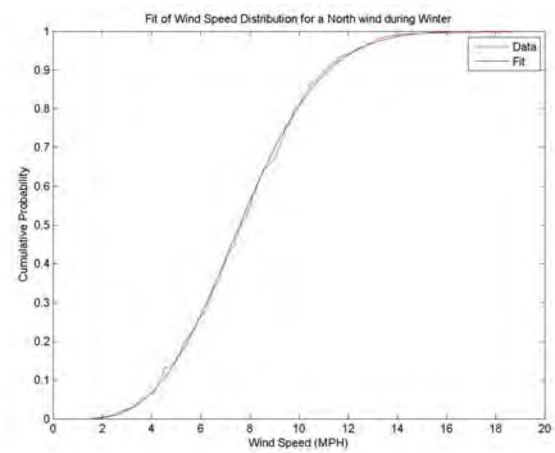
Summer Wind Distribution, 4 Directions

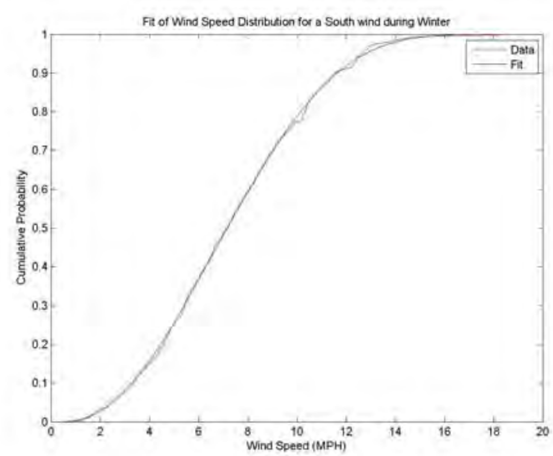


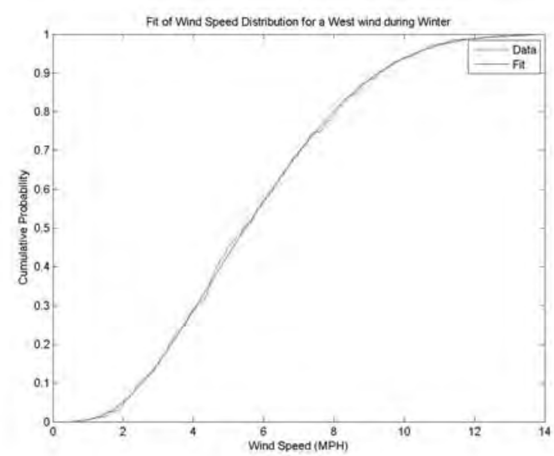
3 Day Data

Winter Wind Distribution, 4 Directions







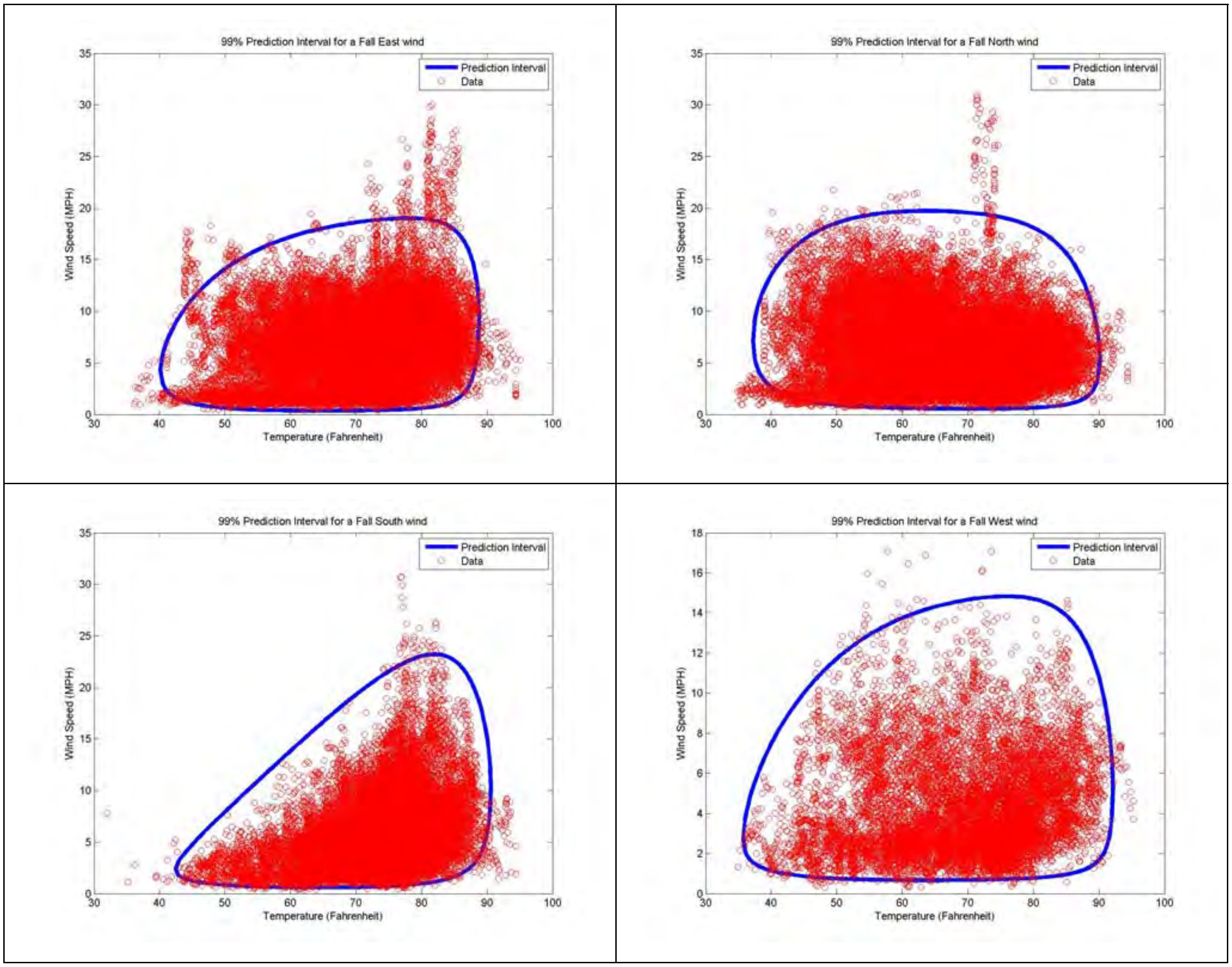


Attachment B:

MET Tower Data 99% Prediction Intervals

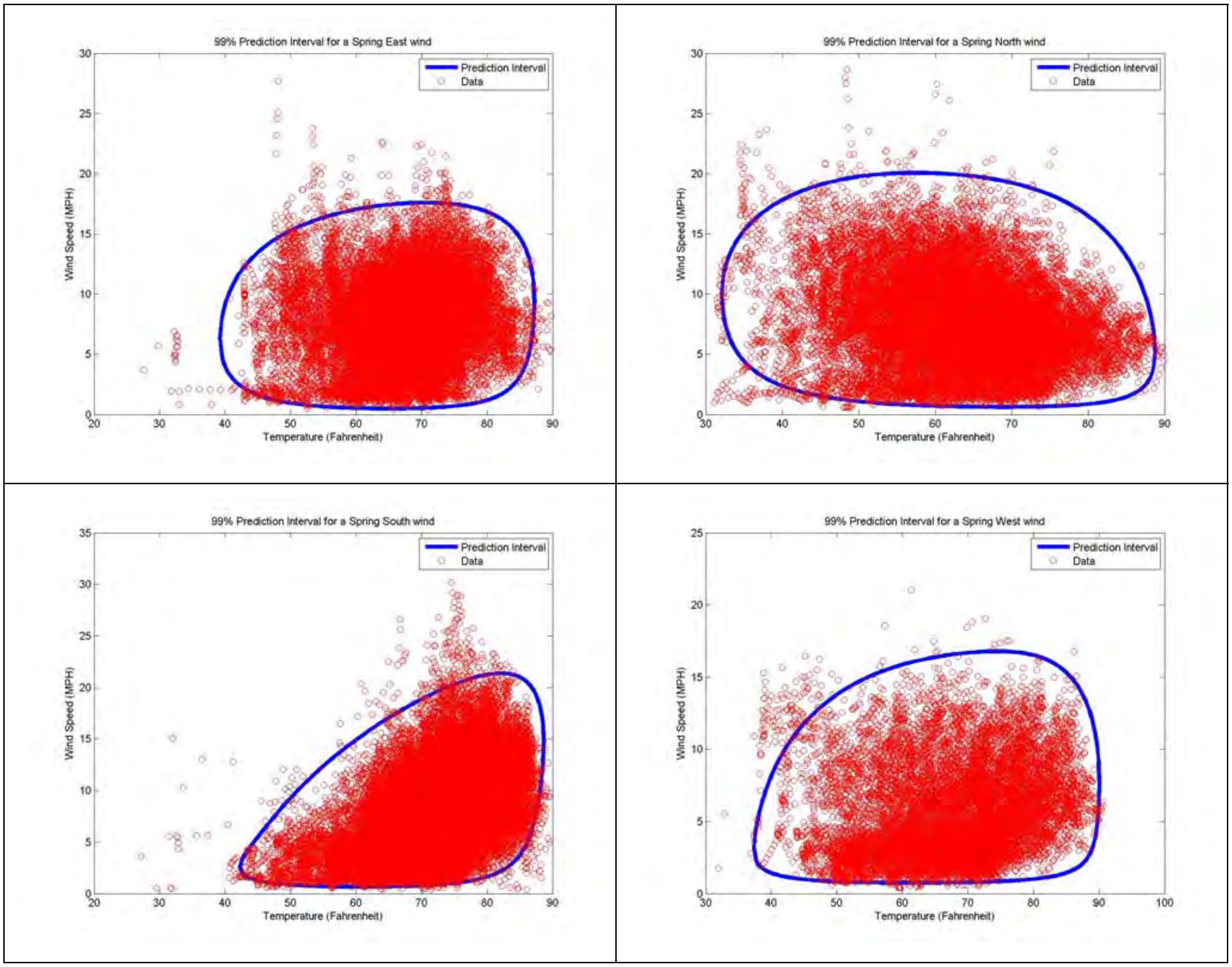
1 Hour Data

Fall Prediction Interval, 4 Directions



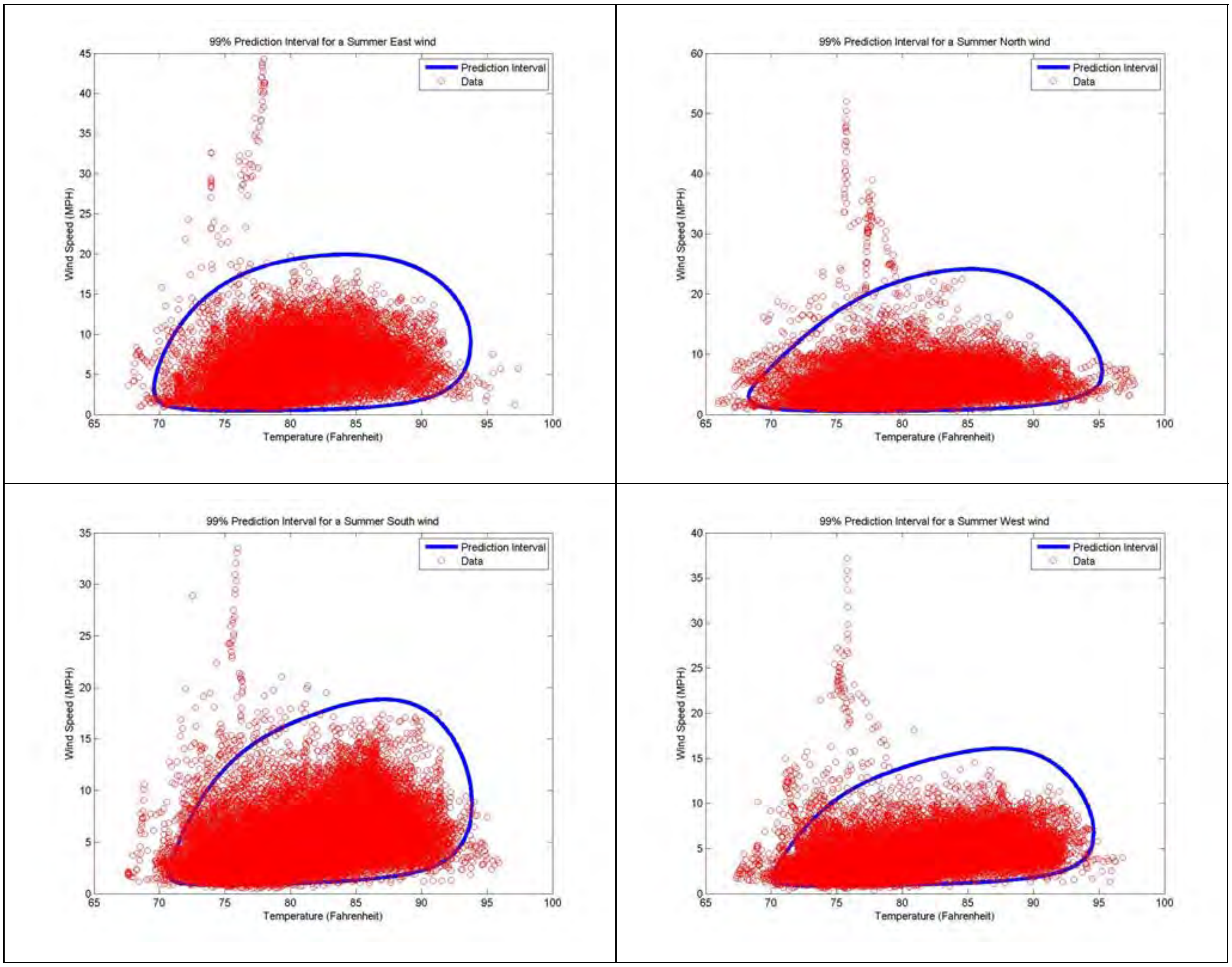
1 Hour Data

Spring Prediction Interval, 4 Directions



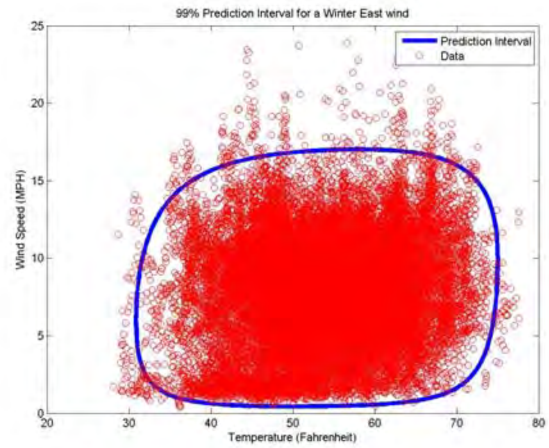
1 Hour Data

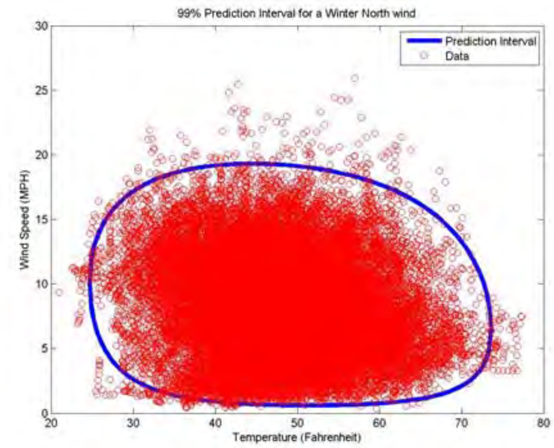
Summer Prediction Interval, 4 Directions

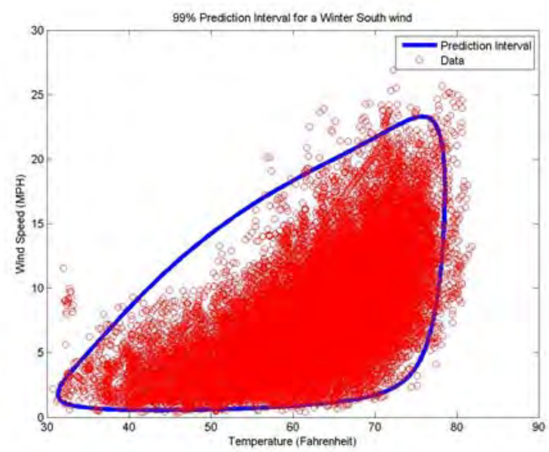


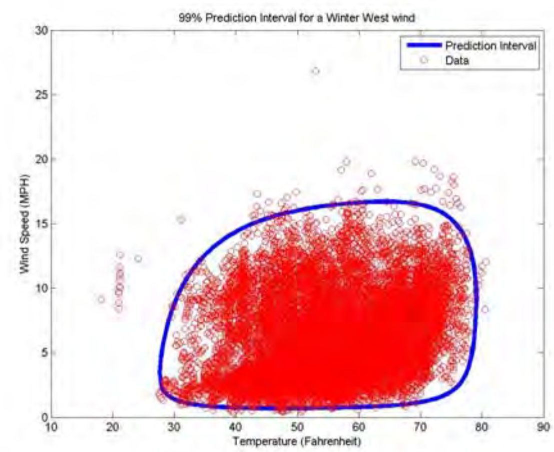
1 Hour Data

Winter Prediction Interval, 4 Directions



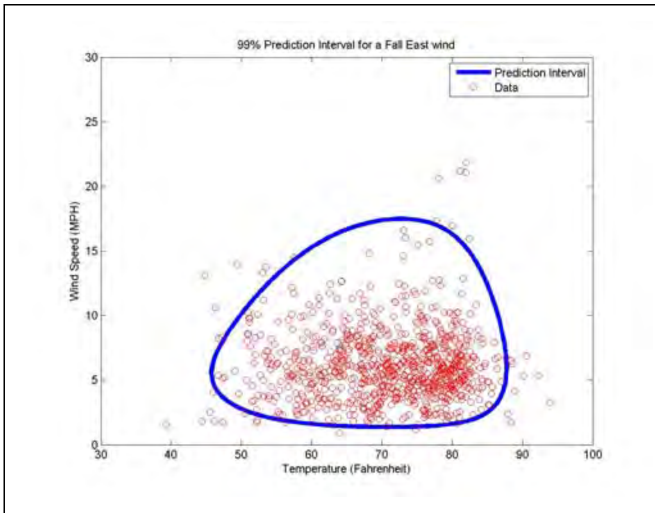


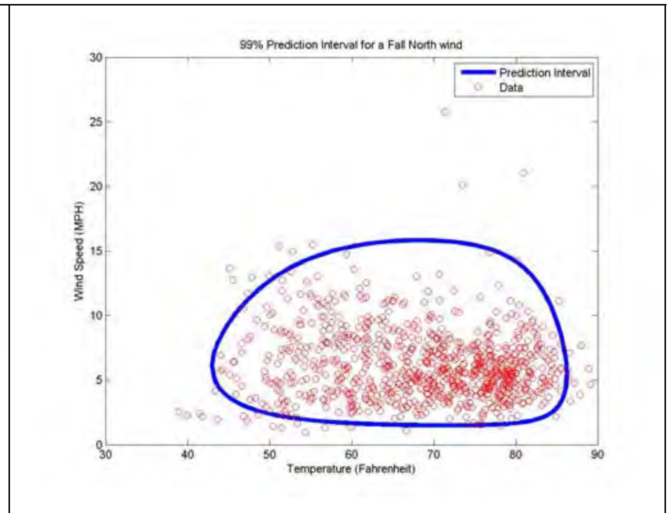


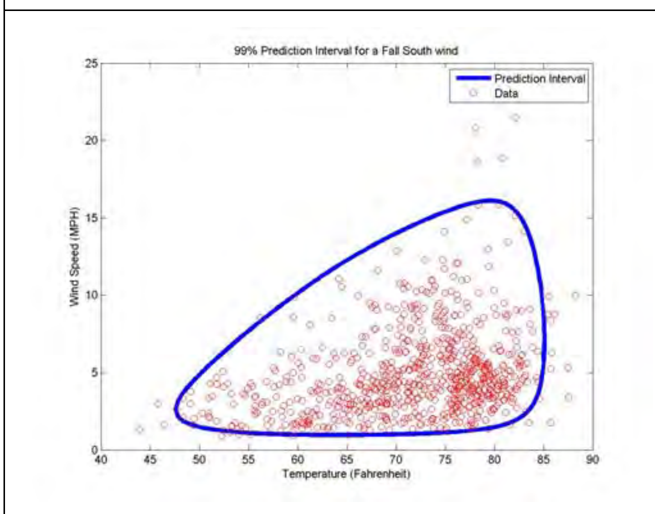


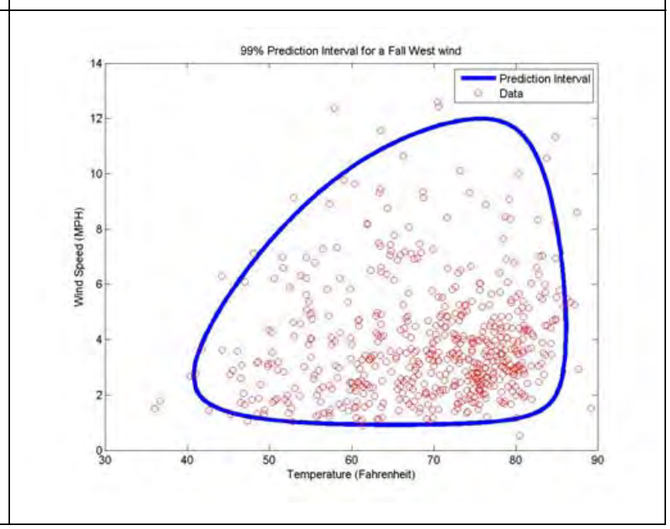
1 Day Data

Fall Prediction Interval, 4 Directions



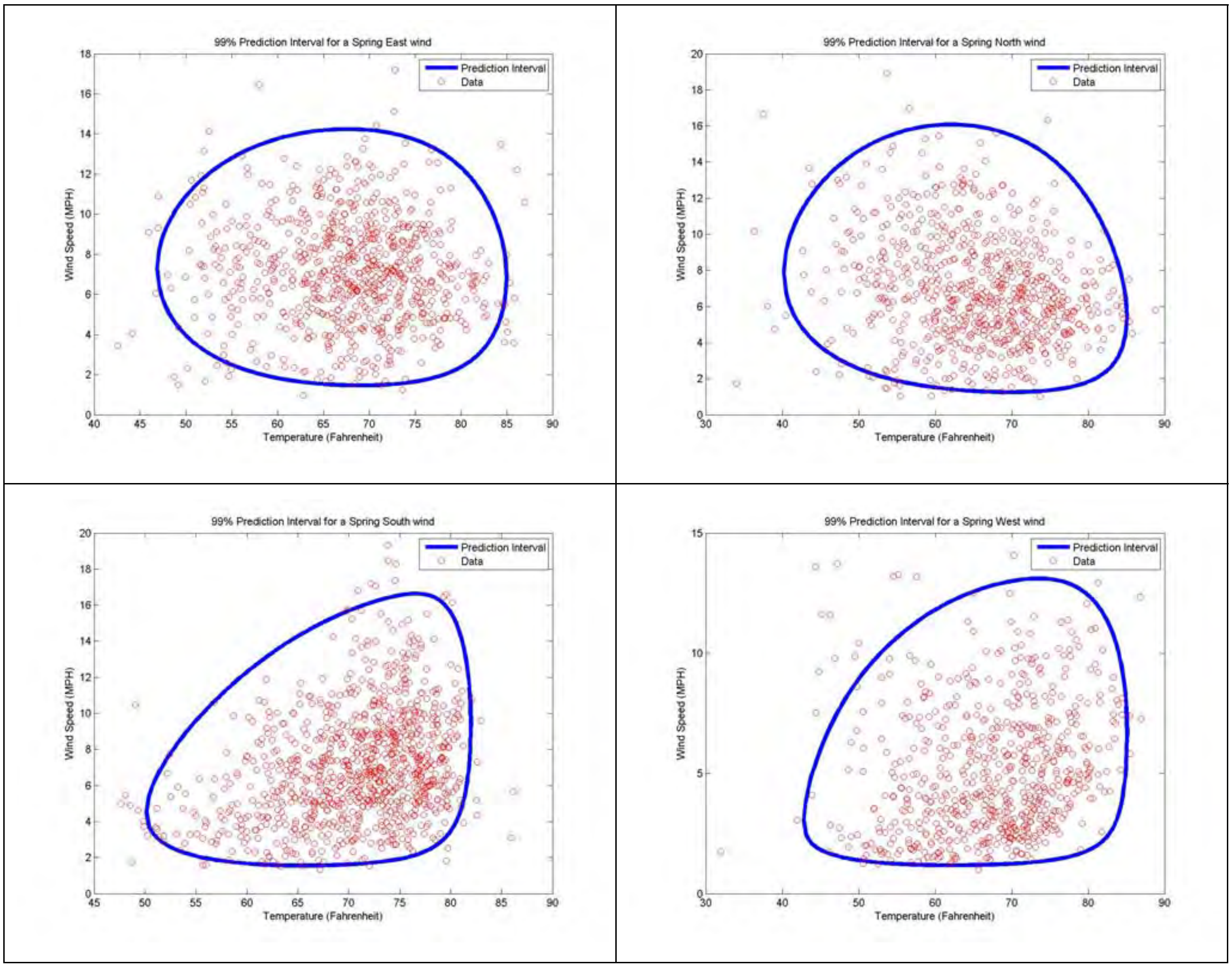






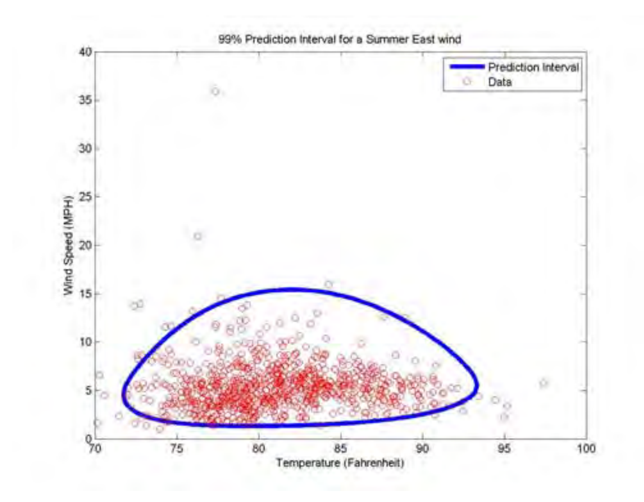
1 Day Data

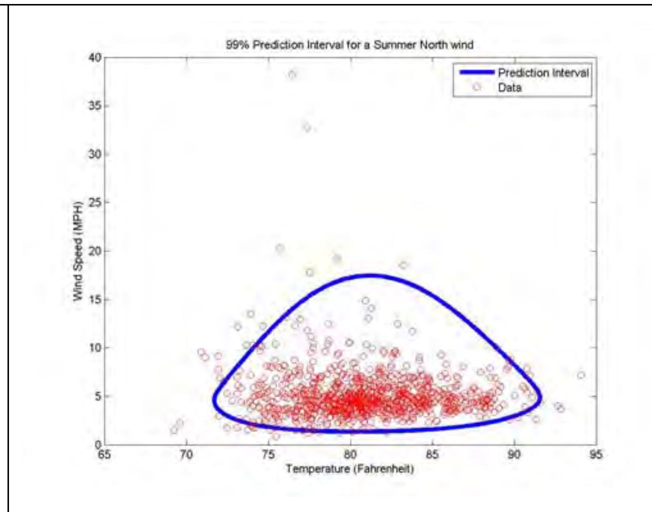
Spring Prediction Interval, 4 Directions

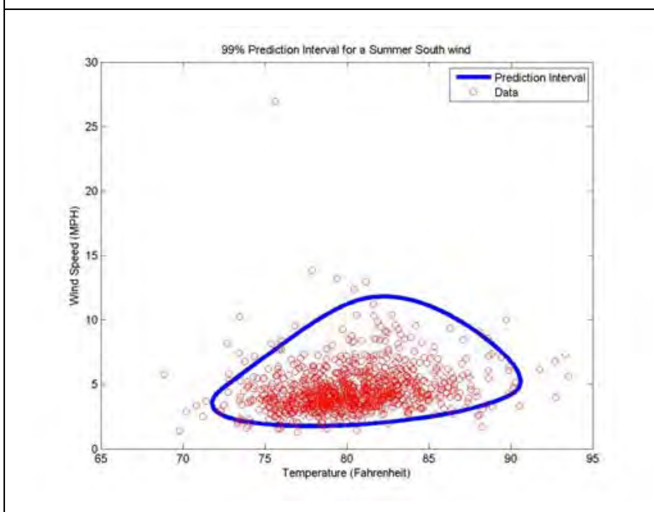


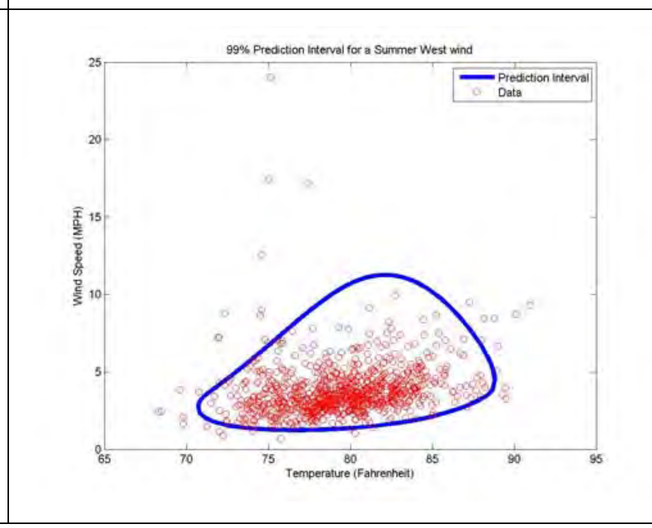
1 Day Data

Summer Prediction Interval, 4 Directions



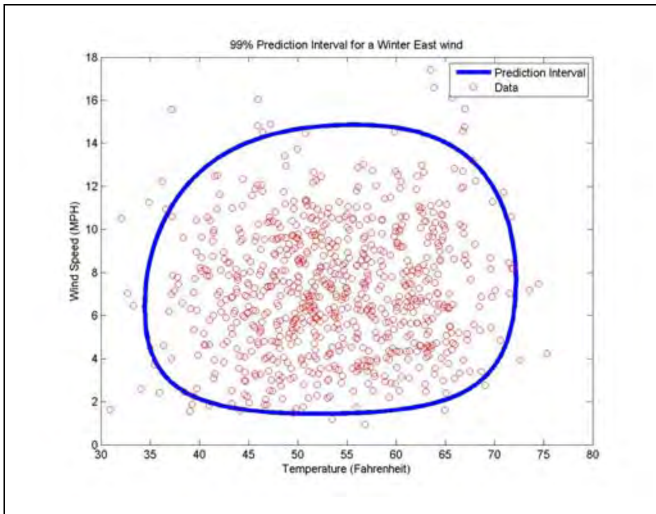


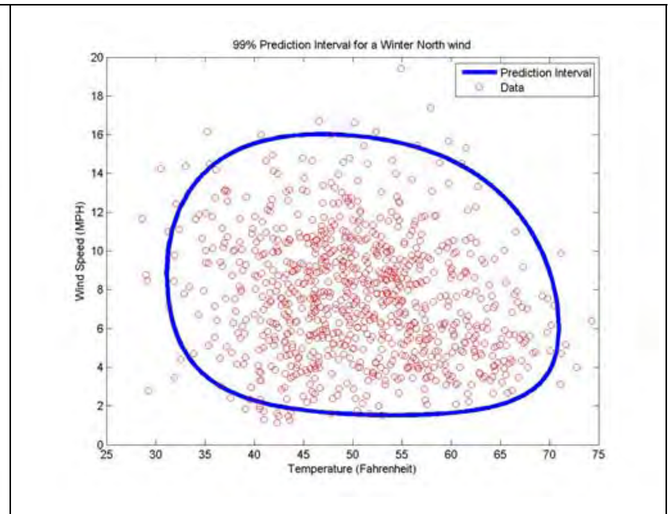


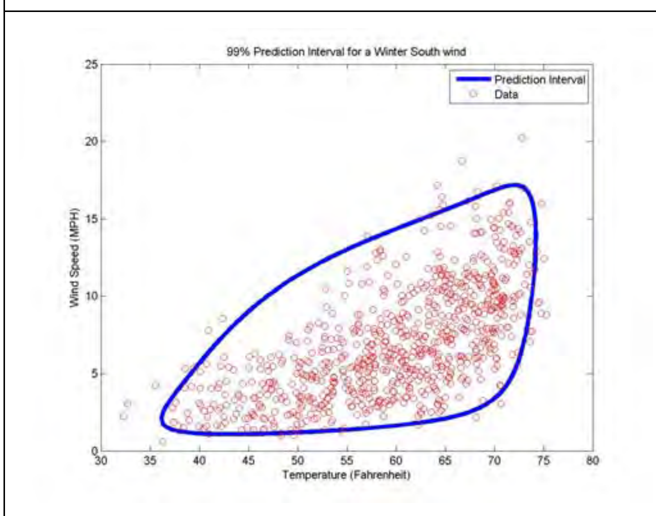


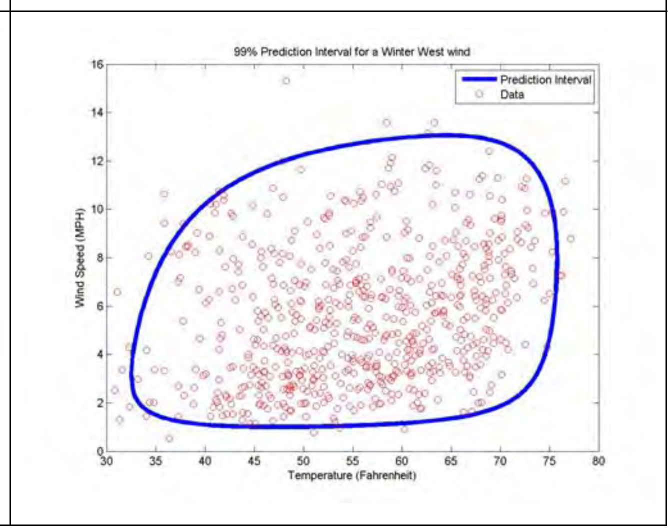
1 Day Data

Winter Prediction Interval, 4 Directions



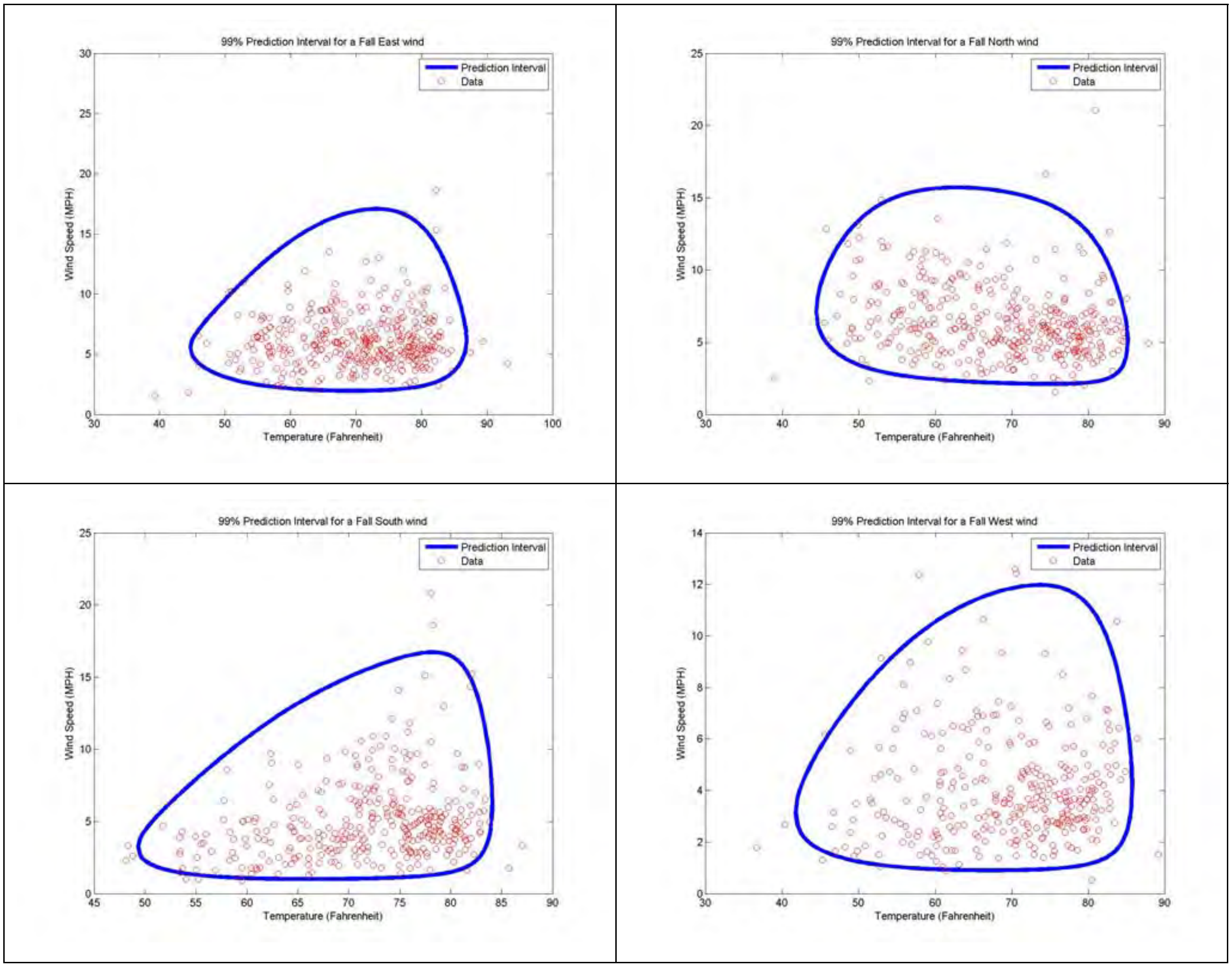






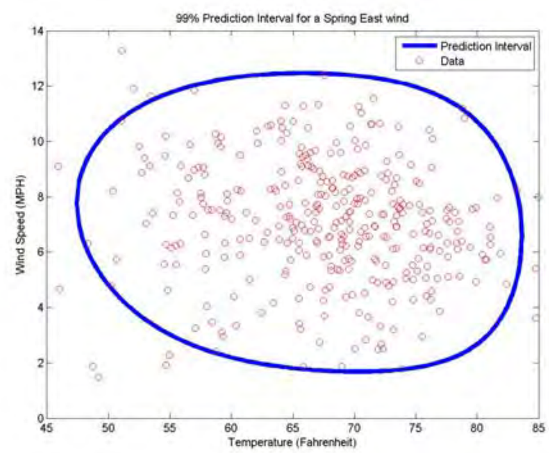
3 Day Data

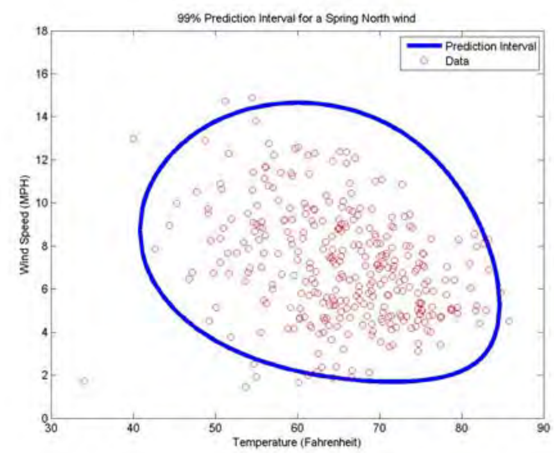
Fall Prediction Interval, 4 Directions

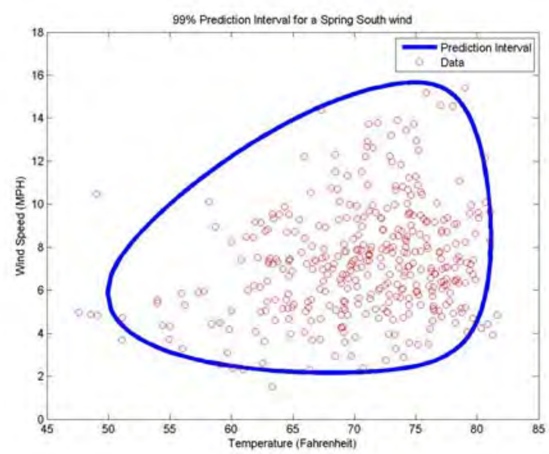


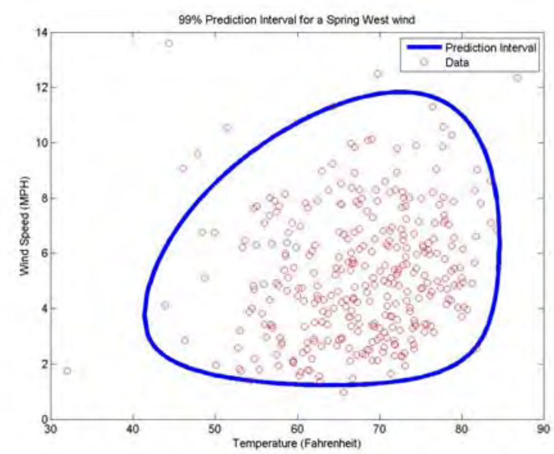
3 Day Data

Spring Prediction Interval, 4 Directions



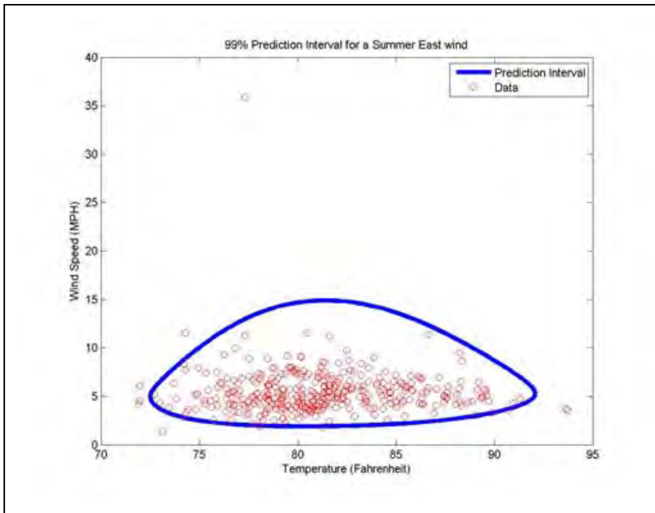


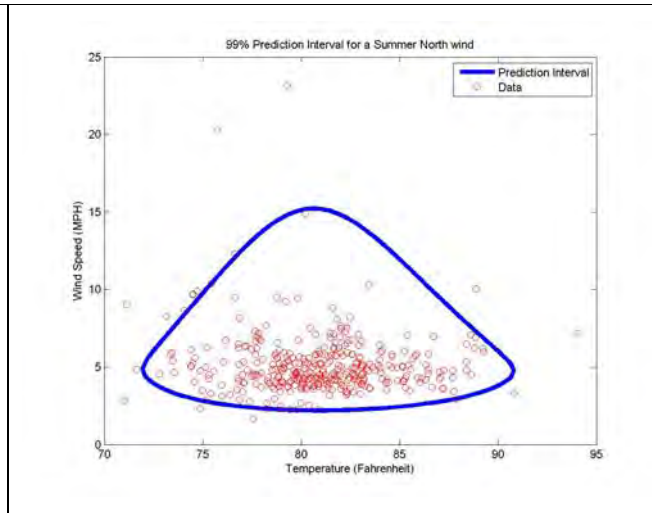


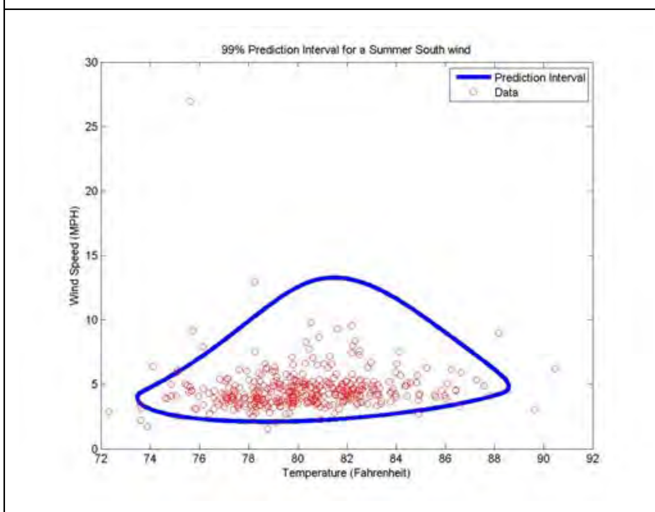


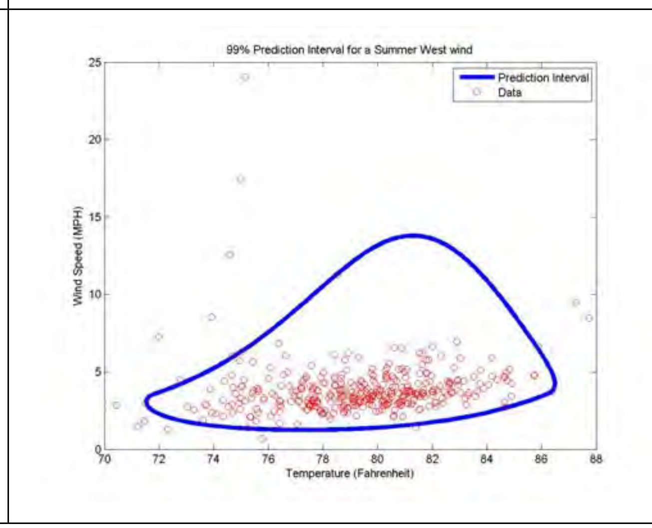
3 Day Data

Summer Prediction Interval, 4 Directions



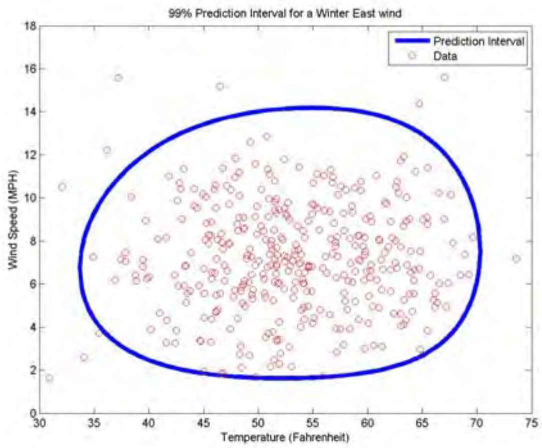


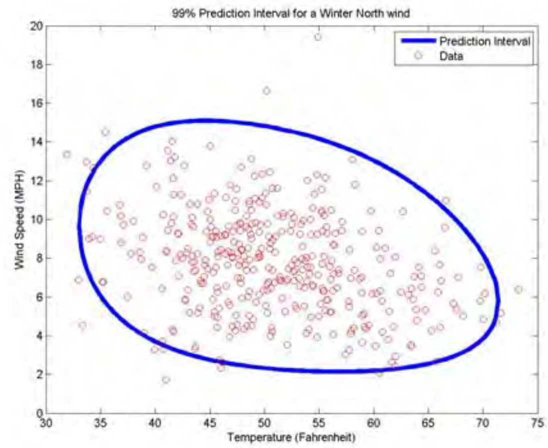


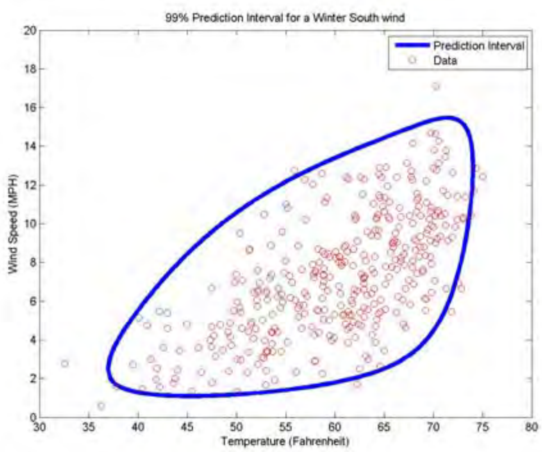


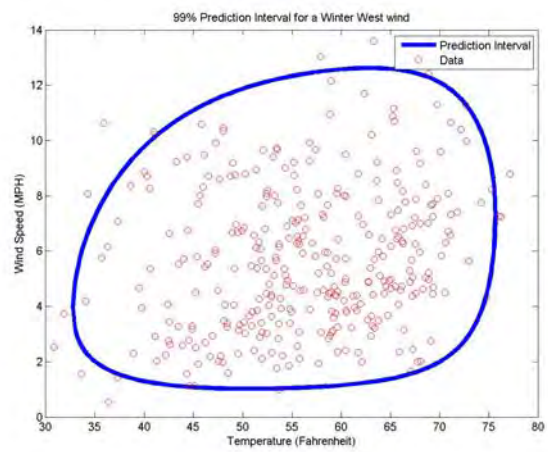
3 Day Data

Winter Prediction Interval, 4 Directions







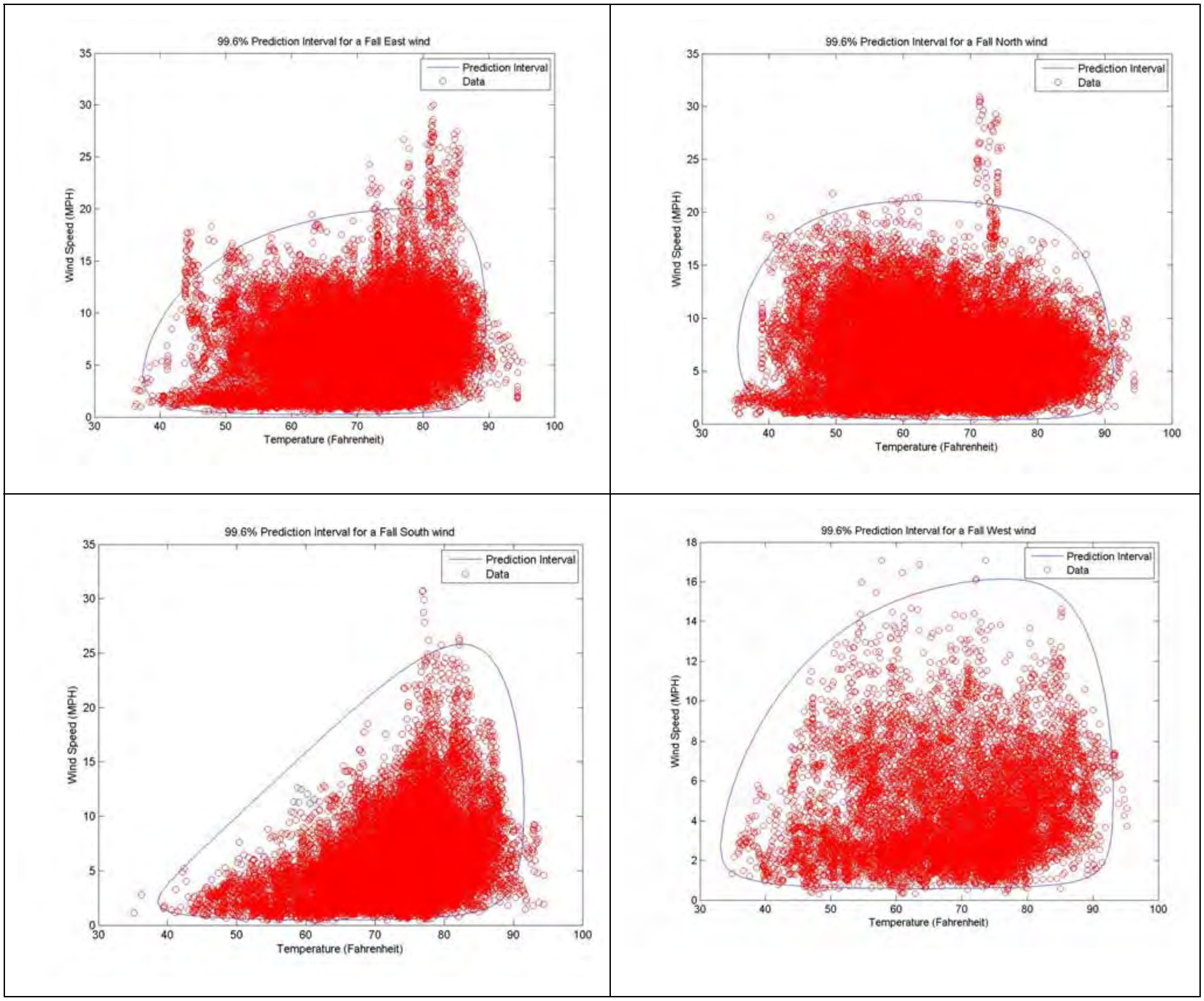


Attachment C:

MET Tower Data 99.9% Prediction Intervals

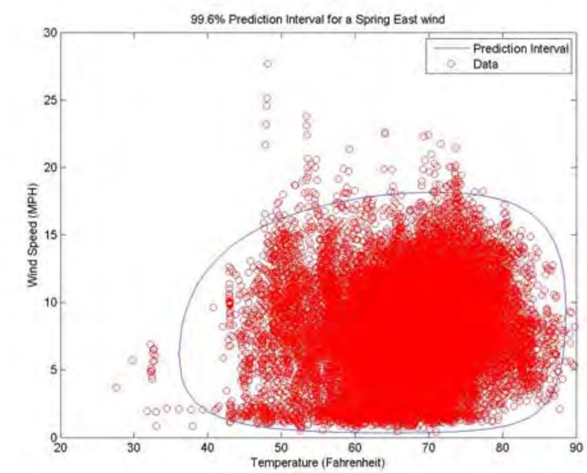
1 Hour Data

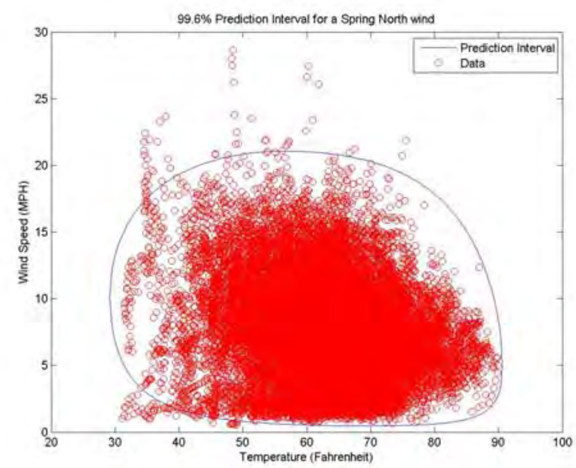
Fall 99.9% Prediction Interval, 4 Directions

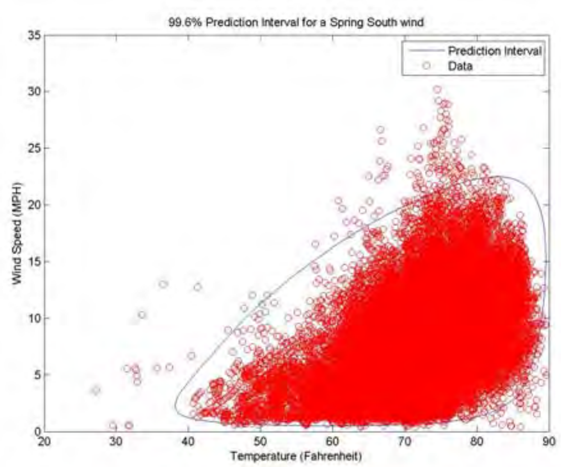


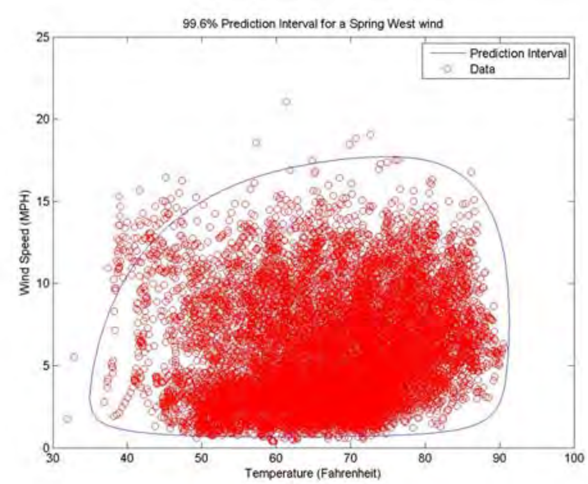
1 Hour Data

Spring 99.9% Prediction Interval, 4 Directions



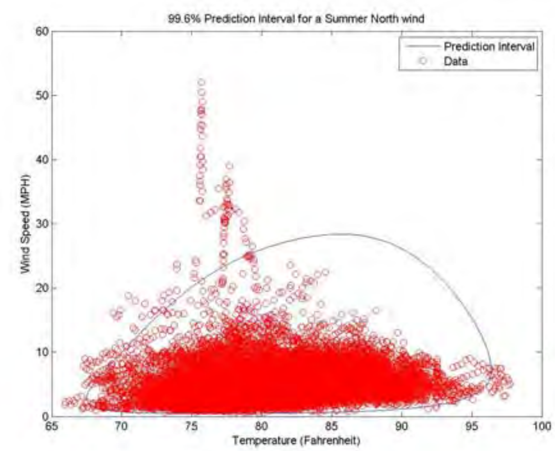


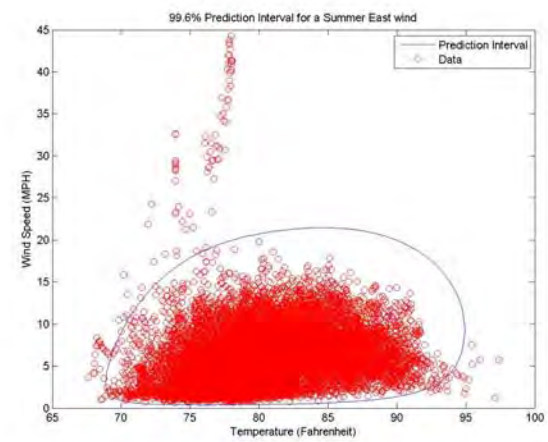


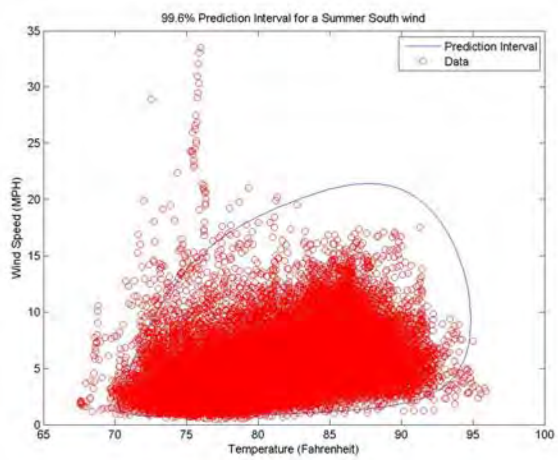


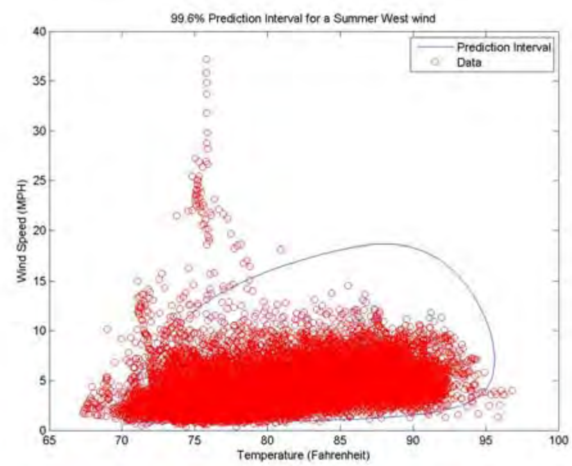
1 Hour Data

Summer 99.9% Prediction Interval, 4 Directions



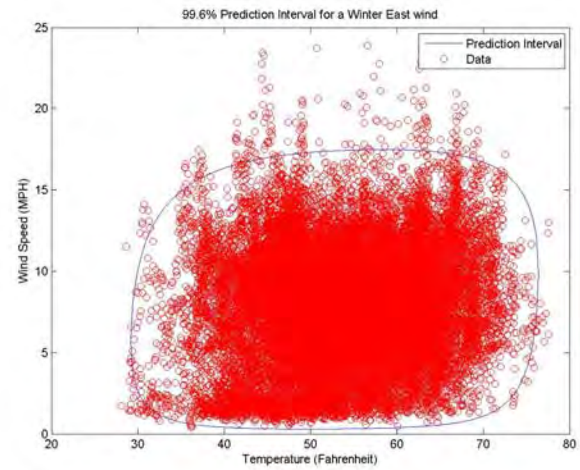


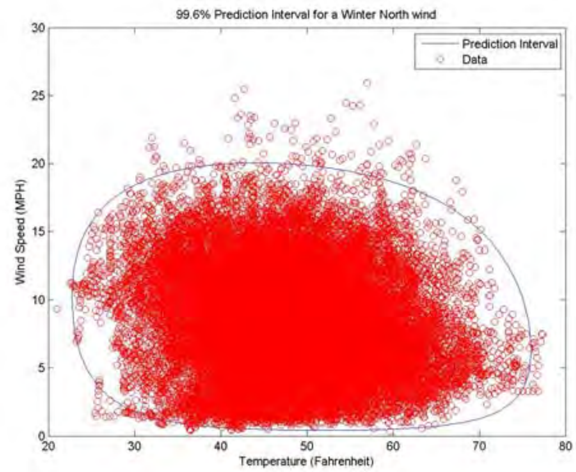


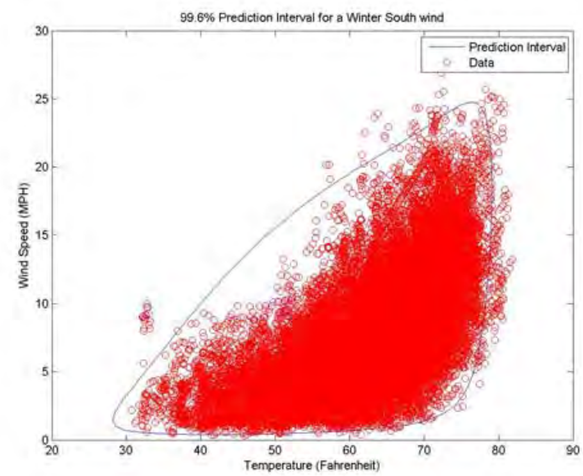


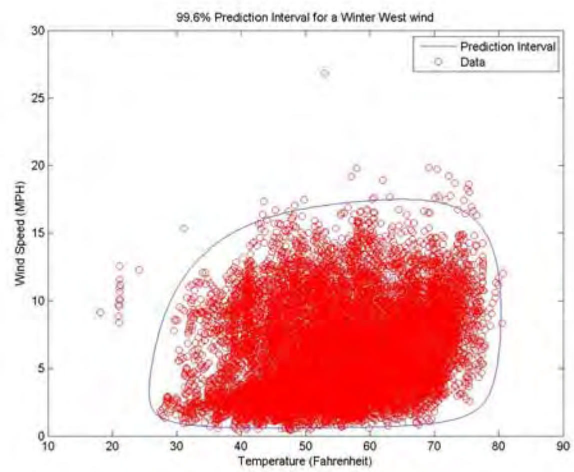
1 Hour Data

Winter 99.9% Prediction Interval, 4 Directions









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