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Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Sequoyah Nuclear Plant, Units 1 and 2
Facility Operating License Nos. DPR-77 and DPR-79
NRC Docket Nos. 50-327 and 50-328

Subject: **Supplement to the Application to Modify Ice Condenser Technical Specifications to Address Revisions in Westinghouse Mass and Energy Release Calculation (SQN-TS-12-04) and Response to NRC Requests for Additional Information**

Reference:

1. Letter from TVA to NRC, "Application to Modify Ice Condenser Technical Specifications to Address Revisions in Westinghouse Mass and Energy Release Calculation (SQN-TS-12-04)," dated July 3, 2013 (ADAMS ML13199A281)

2. Westinghouse NSAL-14-2, "Westinghouse Loss-of-Coolant Accident Mass and Energy Release Calculation Issue for Steam Generator Tube Material Properties," dated March 31, 2014

3. WCAP-12455, Revision 1, Supplement 3R, "Sequoyah Units 1 and 2 Containment Integrity Reanalyses Engineering Report," dated March 2015

4. Electronic transmittal from A. Hon (NRC) to J. Shea (TVA), "Sequoyah Nuclear Plant, Units 1 and 2,– Request for Additional Information Related to License Amendment Request to Revise Technical Specification on Ice Condenser Ice Mass (TAC Nos. MF2446 and MF2447)," dated February 19, 2015 (ADAMS Accession Number ML15050A096)

In accordance with the provisions of 10 *Code of Federal Regulations* (CFR) 50.90, "Application for amendment of license, construction permit, or early site permit," Tennessee Valley Authority (TVA) is submitting a supplement to the Reference 1 request for an amendment to Facility Operating License Nos. DPR-77 and DPR-79 for the Sequoyah Nuclear Plant (SQN), Units 1 and 2.

This supplement contains proposed changes resulting from issues raised in Westinghouse Nuclear Safety Advisory Letter (NSAL) 14-2, "Westinghouse Loss-of-Coolant Accident Mass and Energy Release Calculation Issue for Steam Generator Tube Material Properties" (Reference 2). The issues identified in NSAL-14-2 affected plant-specific loss of coolant accident (LOCA) mass and energy (M&E) release calculation results that were used as input to the SQN containment integrity response analyses.

NSAL-14-2 documented that differences in alloy material in steam generators could result in differences in LOCA M&E release analysis calculations and therefore, could result in a slight increase in containment post-accident temperature and pressure. The original SQN M&E analysis used the density of stainless steel to calculate the mass of the steam generator tubes and the specific heat (C_p) of stainless steel for the stored metal energy.

Because the SQN steam generators were replaced with those using Alloy 690 Inconel material for its tubes, the issue identified in NSAL-14-2 applied to SQN. Westinghouse provided a plant-specific reanalysis of the SQN LOCA M&E calculation that accounted for the effect on SQN's containment pressure. The analysis is documented in WCAP-12455, Revision 1, Supplement 3R, "Sequoyah Units 1 and 2 Containment Integrity Reanalyses Engineering Report" (Reference 3).

As a result, the calculated containment pressure following a LOCA increased by 0.15 psig from the value contained in the Reference 1 License Amendment Request (LAR). The resultant additional ice burden is 69,984 lbs. over the previously requested 2,540,808 lbs. to a new value of 2,610,792 lbs. This Supplement requests that the new value of 2,610,792 lbs. replace the previously requested value of 2,540,808 lbs.

The changes in the SQN-specific LOCA mass and energy release calculations and the associated changes to the SQN containment integrity response analyses resulted in TS Limiting Condition for Operation 3.6.5.1.d being non-conservative with respect to the required total ice weight. The non-conservative SQN TS is being addressed within the TVA Corrective Action Program and administrative controls have been established in accordance with Nuclear Regulatory Commission (NRC) Administrative Letter 98-10.

Enclosure 1 has been repeated from the original LAR (Reference 1) with the changed portions denoted by revision bars. The enclosure provides a description of the proposed changes, technical evaluation of the proposed changes, regulatory evaluation and a discussion of environmental considerations. Attachment 1 to the enclosure provides the existing TS pages marked-up to show the proposed changes. Attachment 2 to the

enclosure provides the existing Bases pages marked-up to show the proposed changes for information only. Attachment 3 to the enclosure provides the retyped TS pages incorporating the proposed changes. Attachment 4 to the enclosure provides the retyped Bases pages incorporating the proposed changes for information only. Attachment 5 to the enclosure provides WCAP-12455, Revision 1, Supplement 3R (redacted to exclude the SQN Updated Final Safety Analysis Report (UFSAR) and TS markups). UFSAR changes will be processed in accordance with the TVA program requirements.

In accordance with 10 CFR 50.91(a)(1), "Notice for Public Comment," the analysis about the issue of no significant hazards consideration using the standards in 10 CFR 50.92 is being provided to the Commission in the regulatory analysis section of Enclosure 1.

TVA has determined that there are no significant hazard considerations associated with the proposed change and that the change qualifies for a categorical exclusion from environmental review pursuant to the provisions of 10 CFR 51.22(C)(9).

The SQN Plant Operations Review Committee and the TVA Nuclear Safety Review Board have reviewed this proposed change and determined that operation of SQN in accordance with the proposed change will not endanger the health and safety of the public.

In addition, this letter provides TVA's response to the NRC Requests for Additional Information (RAIs) SCVB-RAI-9 and SCVB-RAI-10 (Reference 4). TVA's response is contained in Enclosure 2 to this letter.

In accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter and the enclosure to the Tennessee Department of Environment and Conservation.

No new regulatory commitments are made in this submittal. Please address any questions regarding this request to Ed Schrull at (423) 751-3850.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 10th day of April 2015.

Respectfully,

for JW Shea

J. W. Shea
Vice President, Nuclear Licensing

Enclosures:
cc: See Page 4

Enclosures

1. Evaluation of Proposed Change

2. Response to Requests for Additional Information

cc (Enclosure):

NRC Regional Administrator - Region II
NRC Project Manager – Sequoyah Nuclear Plant
NRC Resident Inspector – Sequoyah Nuclear Plant
Director, Division of Radiological Health - Tennessee State Department of Environment and Conservation

ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT
UNITS 1 AND 2

EVALUATION OF PROPOSED CHANGE

Subject: **Supplement to the Application to Modify Ice Condenser Technical Specifications to Address Revisions in Westinghouse Mass and Energy Release Calculation (SQN-TS-12-04)**

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2. Proposed TS Bases Changes (Mark-Ups) for SQN, Units 1 and 2 (For Information Only)
3. Proposed TS Changes (Final Typed) for SQN, Units 1 and 2
4. Proposed TS Bases Changes (Final Typed) for SQN, Units 1 and 2 (For Information Only)
5. Topical Report WCAP-12455, Revision 1, Supplement 3R

1.0 SUMMARY DESCRIPTION

This evaluation supplements a previous request (Reference 1) to amend Appendix A of Facility Operating License Nos. DPR-77 and DPR-79 for the Sequoyah Nuclear Plant (SQN), Units 1 and 2, by revising Units 1 and 2 Technical Specifications (TS) 3/4.6.5, "Ice Condenser." This supplement revises the proposed changes to revise TS Limiting Condition for Operation (LCO) 3.6.5.1.d and TS Surveillance Requirement (SR) 4.6.5.1.d.2 to raise the overall ice condenser ice weight from 2,225,880 pounds (lbs.) to 2,610,792 lbs. and to raise the minimum TS ice basket weight from 1145 lbs. to 1343 lbs., respectively. The associated TS Bases sections are also revised to include these changes in ice weight values. This supplement is a result of additional reanalysis required by issues identified in Westinghouse Nuclear Safety Advisory Letter (NSAL) 14-2 (Reference 2).

The non-conservative TS are being addressed within the Tennessee Valley Authority (TVA) Corrective Action Program and administrative controls have been established in accordance with Nuclear Regulatory Commission (NRC) Administrative Letter 98-10.

2.0 DETAILED DESCRIPTION

The ice bed consists of borated ice stored in 1944 baskets within the ice condenser. The primary purpose of the ice condenser is to provide a large heat sink in the event of a release of energy from a design basis loss of coolant accident (LOCA) or main steam line break (MSLB) in containment. The LOCA requires the greatest amount of ice compared to other accident scenarios; therefore, the ice weight is based on the LOCA analysis. The amount of ice in the bed has no affect on the initiation of an accident, but rather on the mitigation of the accident. The borated solution formed by meltdown of the ice absorbs and retains iodine released during the accident and prevents dilution of the borated water injected from the refueling water storage tank and accumulators. This solution also contributes to the inventory of water used for long-term heat removal from the reactor core and containment atmosphere.

The ice absorbs energy and limits the containment peak pressure and temperature during the accident. Limiting the pressure reduces the release of fission product radioactivity from containment to the environment in the event of a design basis accident. The current ice weight value is supported by the containment integrity analysis documented in the SQN Updated Final Safety Analysis Report (UFSAR) (Reference 3), Section 6.2, "Containment Systems." The TS surveillance limits on total ice weight and on ice basket weight are intended to ensure that sufficient ice is present in an appropriate distribution to perform this function. The TS surveillance limits are currently an "as-left" measurement and include margin for ice sublimation and measurement error.

Westinghouse Electric Company (WEC) has identified several issues that affected the plant-specific LOCA mass and energy release calculation results that are used as input to the containment integrity response analysis. These issues were originally reported in WEC Nuclear Safety Advisory Letter NSAL-11-5 (Reference 4).

WCAP-12455, Revision 1, Supplement 2R that documented the containment integrity reanalysis was submitted to NRC via Reference 5. This analysis supported implementation of corrections to the mass and energy release calculation. In addition to the changes associated with NSAL-11-5, the appropriate conditions relative to NSAL-06-6 (Reference 6) were also addressed. The revised analysis determined that an increase in the analytical ice weight value is necessary to maintain the calculated containment peak pressure below the design limit. This increase in the analytical ice weight value results in TS LCO 3.6.5.1.d being non-conservative with respect to the required total ice weight.

NSAL-14-2 documented that differences in alloy material in steam generators could result in differences in LOCA M&E release analysis calculations and therefore, could result in a slight increase in containment temperature and pressure. The SQN M&E analysis originally used the density of stainless steel to calculate the mass of the steam generator tubes and the specific heat (C_p) of stainless steel for the stored metal energy.

Because the SQN steam generators were replaced with those using Alloy 690 Inconel material for its tubes, the issue identified in NSAL-14-2 applied to SQN. Westinghouse provided a plant-specific reanalysis of the SQN LOCA M&E calculation that accounted for the effect on SQN's containment pressure. The analysis is documented in WCAP-12455, Revision 1, Supplement 3R, "Tennessee Valley Authority Sequoyah Nuclear Plant Units 1 and 2 Containment Integrity Reanalyses Engineering Report" (Reference 7).

As a result, the calculated containment pressure following a LOCA increased by 0.15 psig from the value contained in the Reference 1 License Amendment Request (LAR). The resultant additional ice burden is 69,984 lbs. over the previously requested 2,540,808 lbs. to a new value of 2,610,792 lbs. This Supplement requests that the new value of 2,610,792 lbs. replace the previously requested value of 2,540,808 lbs.

The changes in the SQN-specific LOCA mass and energy release calculations and the associated changes to the SQN containment integrity response analyses resulted in TS Limiting Condition for Operation 3.6.5.1.d being non-conservative with respect to the required total ice weight.

The non-conservative TS are being addressed within the TVA Corrective Action Program and administrative controls have been established in accordance NRC Administrative Letter 98-10. To address the non-conservative TS, TVA is proposing a change to TS 3/4.6.5.1 to increase the licensing basis minimum ice weight.

Section 2.1 includes a description of the current TS LCO and TS SR affected by this proposed amendment. Section 2.2 describes the proposed revision to the TS LCO and TS SR. Section 2.3 discusses the bases for the proposed changes. The revised containment integrity analysis is provided in Attachment 5 of this enclosure.

The TVA process governing the processing and submittal of TS changes and License Amendment Requests requires that the appropriate organizations (e.g., Operations, Training, Engineering, Maintenance, Chemistry, Radiation Protection, and Work Control) identify the documents that are affected by each proposed change to the TS and Operating Licenses. Among the items that are considered are training, plant modifications, procedures, special implementation constraints, design documents, surveillance instructions associated with TS SRs, Technical Requirements Manual, TS Bases, and Updated Final Safety Analysis Report (UFSAR). The process requires that procedures and design document changes necessary to support TS Operability are approved prior to implementation of the license amendment. The process also provides assurance that the remaining changes, if any, are scheduled and tracked for configuration control.

2.1 Current Technical Specifications

TS LCO 3.6.5.1.d currently requires:

> "A total ice weight of at least 2,225,880 pounds at a 95% level of confidence, and"

TS SR 4.6.5.1.d.2 currently requires:

> "At least once per 18 months by:
>
> 1. Deleted.
>
> 2. Weighing a representative sample of at least 144 ice baskets and verifying that each basket contains at least 1145 lbs of ice. The representative sample shall include 6 baskets from each of the 24 ice condenser bays and shall be constituted of one basket each from Radial Rows 1, 2, 4, 6, 8 and 9 (or from the same row of an adjacent bay if a basket from a designated row cannot be obtained for weighing) within each bay. If any basket is found to contain less than 1145 pounds of ice, a representative sample of 20 additional baskets from the same bay shall be weighed. The minimum average weight of ice from the 20 additional baskets and the discrepant basket shall not be less than 1145 pounds/basket at a 95% level of confidence.
>
>   The ice condenser shall also be subdivided into 3 groups of baskets, as follows: Group 1 - bays 1 through 8, Group 2 - bays 9 through 16, and Group 3 - bays 17 through 24. The minimum average ice weight of the sample baskets from Radial Rows 1, 2, 4, 6, 8 and 9 in each group shall not be less than 1145 pounds/basket at a 95% level of confidence.
>
>   The minimum total ice condenser ice weight at a 95% level of confidence shall be calculated using all ice basket weights determined during this weighing program and shall not be less than 2,225,880 pounds."

2.2 Requested Technical Specification Changes

The proposed change modifies TS LCO 3.6.5.1.d and SR 4.6.5.1.d.2 to address the increase in the analytical ice weight value obtained from the revised containment integrity response analysis.

The proposed change modifies TS LCO 3.6.5.1.d and SR 4.6.5.1.d.2 as follows (revised text is in bold italics):

- TS LCO 3.6.5.1.d is revised to read:

  "A total ice weight of at least ***2,610,792*** pounds at a 95% level of confidence, and"

- TS SR 4.6.5.1.d.2 is revised to read:

  "Weighing a representative sample of at least 144 ice baskets and verifying that each basket contains at least ***1343*** lbs. of ice. The representative sample shall include 6 baskets from each of the 24 ice condenser bays and shall be constituted of one basket each from Radial Rows 1, 2, 4, 6, 8 and 9 (or from the same row of an adjacent bay if a basket from a designated row cannot be obtained for weighing) within each bay. If any basket is found to contain less than ***1343*** pounds of ice, a representative sample of 20 additional baskets from the same bay shall be weighed. The minimum average weight of ice from the 20 additional baskets and the discrepant basket shall not be less than ***1343*** pounds/basket at a 95% level of confidence.

  The ice condenser shall also be subdivided into 3 groups of baskets, as follows: Group 1 - bays 1 through 8, Group 2 - bays 9 through 16, and Group 3 - bays 17 through 24. The minimum average ice weight of the sample baskets from Radial Rows 1, 2, 4, 6, 8 and 9 in each group shall not be less than ***1343*** pounds/basket at a 95% level of confidence.

  The minimum total ice condenser ice weight at a 95% level of confidence shall be calculated using all ice basket weights determined during this weighing program and shall not be less than ***2,610,792*** pounds."

In addition, several minor editorial changes, consisting of grammatical and punctuation corrections have been incorporated as follows:

- SQN Unit 1 TS SR 4.6.5.1.e.2 is revised by addition of a period.
- SQN Unit 2 TS SR 4.6.5.1.a is revised to read "At least once per 12 hours ***by*** verifying that the maximum ice bed temperature is less than or equal to 27°F."
- SQN Unit 2 TS SR 4.6.5.1.e.2 is revised by addition of a period.
- SQN Unit 2 TS SR 4.6.5.1.f Note is revised by addition of a period.

2.3 Bases for Proposed Changes

WEC identified several issues that affected the plant-specific LOCA mass and energy release calculation results that are used as input to the containment integrity response analysis.

A containment integrity reanalysis (WCAP-12455, Revision 1, Supplement 3R) (Reference 7) was performed to implement corrections to the mass and energy release calculation. The revised analysis determined that an increase in the analytical ice weight value is necessary to maintain the calculated containment peak pressure below the design limit.

For TS LCO 3.6.5.1.d, the proposed modification raises the required total ice weight from 2,225,880 lbs. to 2,610,792 lbs. For TS SR 4.6.5.1.d.2, the proposed modification raises the minimum ice basket weight from 1145 lbs. to 1343 lbs. per basket.

Markups of the affected TS pages are provided in Attachment 1.

Corresponding changes will also be made to the TS Bases. Markups of the proposed TS Bases changes are provided in Attachment 2 for information only. The changes to the TS Bases are controlled by TS 6.8.4.j, "Technical Specification (TS) Bases Control Program."

3.0 TECHNICAL EVALUATION

The following evaluation describes the results of the current analysis, aspects of the revised analysis, the effects of the increase in ice weight, and differences between the revised analysis and the as-built plant.

<u>Current Analytical Basis</u>

The current containment integrity analysis for SQN Units 1 and 2 is documented in WCAP-12455, Revision 1, Supplement 1R (September 2001). The analysis utilizes a WEC computer model (LOTIC-1) to calculate the peak containment pressure following a LOCA inside containment. The calculated peak pressure for SQN Units 1 and 2 is 11.44 pounds per square inch gauge (psig), which is below the containment design pressure of 12.0 psig. The assumption contained in the LOTIC-1 computer model for this analysis includes an initial ice weight in the ice condenser of 1,916,000 lbs. A discussion of the SQN design basis analysis (WCAP-12455) is contained in UFSAR Section 6.2.1.3.

<u>Description of Revised Analysis</u>

A reanalysis of the SQN containment integrity analysis was performed to account for a correction to the mass and energy release calculation. The revised analysis is provided in Attachment 5 to this enclosure as WCAP-12455, Revision 1, Supplement 3R, "Tennessee Valley Authority Sequoyah Nuclear Plant Units 1 and 2 Containment Integrity Reanalyses Engineering Report," dated March 2015. The revised analysis determined that an ice weight of 2,247,250 lbs. will limit containment peak pressure to 11.48 psig in the event of a LOCA.

In addition, the revised containment pressure analysis preserves the containment spray switchover interval relationship between ice bed meltout time and containment spray switchover time. The time interval between the completion of containment spray recirculation switchover and the ice bed meltout represents margin to the acceptance criteria.

The SQN TS specify minimum operational ice weight values that provide margins above the analytical minimum ice weight values. The TS minimum ice weight ensures that adequate ice is available over an entire 18 month fuel cycle. Currently, the SQN TS minimum ice weight is 1145 lbs of ice per basket and a minimum total ice weight in the ice condenser of 2,225,880 lbs. These weights include a 15 percent conservative allowance for ice loss through sublimation and an additional 1 percent conservative allowance to account for systematic error in weighing instruments. The sublimation and instrument error allowances are retained in the proposed TS requirements. Therefore, considering these conservative allowances, the proposed minimum total ice weight of 2,610,792 lbs. conservatively bounds the new analytical minimum of 2,247,250 lbs.

Evaluation of Effects of Increased Ice Weight

As part of the original ice condenser qualification program, seismic testing of ice baskets was conducted at the Westinghouse Waltz Mill facility. Ice condenser qualification program test results were reported in WCAP-8110, "Test Plans and Results for the Ice Condenser System" (Reference 8) and supplements. The purpose of the testing was to obtain test data to qualify the ice basket design as being capable of resisting anticipated seismic excitations. The seismic load testing was performed with a consideration of 3,000,000 lbs of ice uniformly distributed across the 1944 ice baskets, or approximately 1543.2 lbs of ice in each ice basket. As the ice weight proposed in this license amendment request (and the amount of ice currently loaded in the SQN Unit 1 and Unit 2 ice condensers) is below the ice weight used in the seismic load testing, the results of the original ice condenser qualification program remain valid.

The additional ice being loaded into the ice condenser will not adversely affect the iodine removal qualities of the melting ice. The containment is designed such that the only significant flow path from the lower to the upper compartment is through the ice bed. Immediately following a LOCA, a large pressure differential exists between the lower and upper compartment; thereby providing flow through the ice bed. Later in the transient, flow is provided by two containment air return fans which circulate upper containment air into the lower compartment. Since essentially all flow between the lower and upper compartments must pass through the ice bed, the ice bed also serves as a removal mechanism for fission products postulated to be dispersed in the containment atmosphere. Radioiodine in its various forms is the fission product of primary concern in the evaluation of fission product transport and removal following a LOCA. The major benefit of the ice bed is its capacity to absorb molecular iodine from the containment atmosphere. To enhance this iodine absorption capacity of the ice, the ice solution is adjusted to an alkaline pH which promotes iodine hydrolysis to non-volatile forms. Therefore, the proposed increase in the weight of ice results in increasing the capacity of the ice bed to absorb iodine.

The ice condenser utilizes borated ice, which upon bulk melting, delivers an aqueous solution containing boron to the containment sump. The additional ice required by the reanalysis is also required to be borated by TS LCO 3.6.5.1. Therefore, the boron

concentration of the recirculated primary coolant is not diminished by the additional quantity of ice associated with the proposed minimum ice weight.

Additionally, the containment pressure response model was amended to include the heat load addition (from the energized equipment) for the hydrogen mitigation system (igniters) as 38.67 British Thermal Units per second (BTU/sec).

Evaluation of Differences between As-Built Plant and WCAP 12455, Revision 1

The WCAP-12455, Revision 1, Supplement 3R, SQN containment integrity analysis demonstrated that the ice condensers were adequately sized for the original Model 51 steam generators (SGs) for Units 1 and 2. However, the Model 51 SGs were replaced with Model 57AG SGs during the Spring 2003 refueling outage (1RFO13) for Unit 1 and the Fall 2012 refueling outage (2RFO18) for Unit 2. The WCAP-12455, Revision 1, Supplement 3R, analysis bounds the Model 57AG SGs because:

1. The primary side volume of the Model 57AG SGs is essentially equivalent to that of the Model 51 SGs and the initial primary fluid temperatures are unchanged. Thus, the mass and energy releases following a large break LOCA are not significantly affected by the replacement of the Model 51 SGs with the Model 57AG SGs.

2. The Model 57AG SGs are essentially equivalent to the Model 51 SGs with respect to sensible heat cooling. Because the rest of the Reactor Coolant System (RCS) sensible heat is unchanged, the RCS total system sensible heat remains unchanged for the Model 57AG SGs.

3. The initial secondary side mass is greater for the Model 51 SGs as compared with the Model 57AG SGs. Therefore, the initial energy of the secondary fluid for the analysis bounds the Model 57AG SGs.

Therefore, based on the above assessment, TVA has concluded that the results of the analysis provided in WCAP-12455, Revision 1, Supplement 3R, are valid for Model 57AG SGs.

The WCAP-12455, Revision 1, Supplement 3R, SQN containment integrity analysis bounds both Units 1 and 2 for reloads utilizing Mark-BW17 fuel with up to 96 fresh assemblies. However, the NRC approved the use of AREVA NP Inc. (AREVA NP) Advanced W17 High Thermal Performance (HTP) fuel as documented in a Safety Evaluation dated September 26, 2012 (Reference 9), for Units 1 and 2 (Amendments 331 and 324, respectively). AREVA Advanced W17 HTP fuel was loaded into Unit 2 during the Cycle 18 refueling outage (Fall 2012) and in Unit 1 during the Cycle 19 refueling outage (Fall 2013).

The important aspects of the fuel change that could affect the containment integrity analysis include the changes in the flow characteristics past the fuel, the RCS operating average temperature (T_{avg}), the core-stored energy and fuel-heat capacity, and the decay heat. These aspects were discussed in AREVA NP report ANP-2986, "Sequoyah HTP Fuel Transition," Revision 3 (Reference 10). ANP-2986 was reviewed by the NRC in support of the Amendments to transition to AREVA Advanced W17 HTP fuel.

- There are very small deviations in flow characteristics past the fuel. However, for an ice condenser design, because the peak pressure occurs late in the transient, well after the ice bed has melted out, the single effect of small deviations in flow is insignificant relative to containment integrity and the required ice weight.

- Total energy content, or total energy available for release to containment remains unchanged from the previous analysis. The RCS T_{avg} remains at 578.2°F.

- The change from Mark-BW fuel to Advanced W17 HTP fuel results in a negligible difference in the mechanical heat capacity of the fuel.

- Initial fuel stored energy is dependent upon fuel and clad temperature. Transients initiated from zero power assume fuel temperatures that are initially in equilibrium with the RCS temperature, independent of fuel type. Transients initiated at power; however, require an estimate of the initial fuel temperature based on power, fuel pin dimension, and material properties. The initial stored energy at power for the two assembly designs (Mark-BW and Advanced W17 HTP) is assessed by considering cladding characteristics and fuel rod power density. There is no difference in fuel rod dimensions or material, thus there is no effect on the energy present in the Advanced W17 HTP fuel rods relative to the current Mark-BW fuel design. Regarding fuel power density, the fuel pellet radius (and hence, assembly loading) is identical to the Advanced W17 HTP fuel relative to the Mark-BW assembly, thus there is no difference in power density when operated at the same power output. Accordingly, there is no significant change in the amount of stored energy in either the fuel clad or the fuel rod for the Advanced W17 HTP fuel assembly. Thus, the fuel initial stored energy for the Mark-BW assembly remains applicable to the Advanced W17 HTP fuel assembly design.

Therefore, based on the above assessment, TVA has concluded that the analysis provided in WCAP-12455, Revision 1, Supplement 3R, bounds the use of AREVA Advanced W17 HTP fuel.

<u>Evaluation of Current Cycles of Operation</u>

TVA has determined that, as a result of the reanalysis, the SQN Units 1 and 2 TS specify non-conservative values for the ice condenser ice weight. The non-conservative TS values are being addressed within the TVA Corrective Action Program and are being administratively controlled in accordance with NRC Administrative Letter 98-10, as follows.

TVA adds borated ice to the SQN ice condensers each refueling outage to ensure that the TS minimum ice weight is achieved prior to startup (this ice weight is referred to as the as-left value) in accordance with the applicable surveillance procedure. As a conservative measure, TVA adds additional ice to the ice condensers over and above the TS minimum. The addition of ice over the TS minimum is a TVA maintenance practice (servicing plan) that is based on historical ice weight data and visual inspection history of the ice baskets. During the last refueling outages (1RFO19 for Unit 1, and 2RFO19 for Unit 2), TVA continued this practice by adding additional ice to the ice condensers as part of the TVA servicing plan.

The additional ice weight provided an as-left ice weight of 2,688,375 lbs for Unit 1 at the start of Cycle 20 operation, for an average as-left ice weight per basket of 1382.9 lbs (95 percent level of confidence). The as-left ice weight for Unit 2 at the start of Cycle 20 operation was 2,666,436 lbs, for an average as-left ice weight per basket of 1371.6 lbs. (95 percent level of confidence).

Although the proposed TS change increases the TS minimum ice weight from 2,225,880 lbs. to 2,610,792 lbs., the as-left ice weight values for 1RFO19 and 2RFO19, as provided above, ensure that sufficient ice is present to support safe operation through the current cycles.

Summary

The proposed changes correct non-conservative TS requirements and provide assurance that the peak containment pressure following a postulated LOCA remains within the analytical and design containment pressure limit. The margin of safety to the containment design pressure is restored by the proposed TS changes. Accordingly, justification exists for increasing the SQN TS total minimum ice weight to 2,610,792 lbs. and a minimum ice basket weight of 1343 lbs.

4.0 REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements and Criteria

The ice condenser at SQN is designed to comply with the following applicable regulations and requirements:

- 10 CFR 50, Appendix A, General Design Criterion (GDC) 16, "Containment Design," requires that reactor containment and associated systems be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

- GDC 38, "Containment Heat Removal," requires that the nuclear power plant containment structure and its internal compartments can accommodate, with sufficient margin, the calculated pressure and temperature conditions resulting from any LOCA with consideration of the effects of potential energy sources such as the SGs. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

- GDC 50, "Containment Design Basis," requires that a system to remove heat from the reactor containment be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

- 10 CFR Part 50, Appendix K, "ECCS Evaluation Models," provides requirements to assure that all the energy sources have been considered in the LOCA analysis.

The LOCA mass and energy analysis was performed in accordance with the criteria shown in Standard Review Plan (SRP) Section 6.2.1.3 (Reference 11). In the analysis, the relevant requirements of GDC 50 and 10 CFR Part 50 Appendix K were included by confirmation that the calculated pressure is less than the design pressure, and because all available sources of energy have been included. These sources include: reactor power, decay heat, core stored energy, energy stored in the reactor vessel and internals, metal-water reaction energy, and stored energy in the secondary system.

The containment integrity peak pressure analysis was performed in accordance with the criteria shown in the SRP Section 6.2.1.1.B (Reference 12), for ice condenser containments. Conformance to GDCs 16, 38, and 50 is demonstrated by showing that the containment design pressure is not exceeded at any time in the transient. A calculated peak containment pressure of less than or equal to 12.0 psig demonstrates compliance with the containment design pressure criterion for SQN Units 1 and 2. The analysis also demonstrates that the containment heat removal systems function to rapidly reduce the containment pressure and temperature in the event of a LOCA.

4.2 Precedent

The NRC has previously approved a License Amendment Request correcting non-conservative minimum ice weights for SQN Units 1 and 2 (Amendments 279 and 270, respectively), as documented in a Safety Evaluation dated September 30, 2002 (Reference 13). This previous request was based on a containment integrity reanalysis to implement corrections to the LOTIC-I computer code input assumptions that account for a mass and energy interface error discovered by WEC. The interface between two computer models (i.e., computer model for LOCA mass and energy release for containment design and the computer model for long-term ice condenser containment {LOTIC-1}) contained an incorrect input assumption regarding the separation of steam and water from the two-phase mixture released downstream of a primary reactor coolant pipe break following a postulated LOCA. This resulted in erroneous treatment of the two-phase mixture which caused the calculated peak pressure inside containment to be non-conservatively low. The reanalysis determined that an increase in the analytical ice mass value was necessary to retain the current calculated peak pressure. Although the input error that resulted in the previous amendment is different than the errors corrected by the reanalysis provided in the proposed amendment request, both required a containment integrity reanalysis that resulted in non-conservative TS ice weight values.

4.3 Significant Hazard Consideration

The Tennessee Valley Authority (TVA) proposes to modify Sequoyah Nuclear Plant (SQN) Unit 1 and Unit 2 Technical Specifications (TS) 3/4.6.5, "Ice Condenser," Limiting Condition for Operation (LCO) 3.6.5.1.d and Surveillance Requirement (SR) 4.6.5.1.d.2 to raise the overall ice condenser weight from 2,225,880 pounds (lbs.) to 2,610,792 lbs. and to raise the minimum ice basket weight from 1145 lbs. to 1343 lbs. These changes are being proposed to address the increase in the analytical ice weight value obtained from the revised containment integrity response analyses and to resolve the resulting non-conservative TS.

TVA has concluded that the changes to SQN Unit 1 and Unit 2 TS 3/4.6.5 do not involve a significant hazards consideration. TVA's conclusion is based on its evaluation in accordance with 10 CFR 50.91(a)(1) of the three standards set forth in 10 CFR 50.92, "Issuance of Amendment," as discussed below:

1. *Does the proposed amendment involve a significant increase in the probability or consequence of an accident previously evaluated?*

   Response: No.

   The analyzed accidents of consideration in regards to changes affecting the ice condenser are a loss of coolant accident (LOCA) and a main steam line break (MSLB) inside containment. The ice condenser is a passive system and is not postulated as being the initiator of any LOCA or MSLB and is designed to remain functional following a design basis earthquake. In addition, the ice condenser does not interconnect or interact with any systems that have an interface with the reactor coolant or main steam systems.

   For SQN, the LOCA is the more severe accident in terms of containment pressure and ice bed melt out, and is therefore the more limiting accident. The revised SQN LOCA containment integrity analysis determined that the post-LOCA peak containment pressure is below the containment design pressure and that the margin to ice meltout is maintained. The analysis assumes an ice weight that ensures sufficient heat removal capability is available from the ice condenser to limit the accident peak pressure inside containment.

   TVA has evaluated the effects of the increased ice condenser ice weight and determined that the increase in ice weight does not invalidate the ice condenser seismic qualification, does not adversely affect the capacity of the ice bed to absorb iodine during a LOCA, and does not diminish the boron concentration of the recirculated primary coolant during a LOCA. TVA has also evaluated differences between the as-built plant and the assumptions of the revised analysis and determined that the results of the revised analysis remain valid for Model 57AG steam generators and for AREVA Advanced W17 High Thermal Performance (HTP) fuel.

   The proposed changes reflect the ice weight assumed in the containment integrity analysis including conservative allowances for sublimation and weighing instrument systematic error. Accordingly, the proposed changes ensure that ice weight values maintain margin between the calculated peak containment accident pressure and the containment design pressure. The results of the analysis and the margins are maintained; therefore, the consequences of a previously evaluated accident are not adversely affected by the proposed changes.

   Because 1) the ice condenser is not an accident initiator, 2) the results of the revised analysis remain valid for Model 57AG steam generators and for AREVA Advanced W17 High Thermal Performance (HTP) fuel, and 3) the proposed changes to the TS are limited to revision of the ice weight values to reflect the revised containment integrity analysis, there is no change in the probability of an

accident previously evaluated in the SQN Updated Final Safety Analysis Report (UFSAR).

Based on the above discussions, the proposed changes do not involve an increase in the probability or consequences of an accident previously evaluated.

2. *Does the proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?*

Response: No.

The ice condenser serves to limit the peak pressure inside containment following a LOCA or MSLB. The proposed changes are limited to the revision of the minimum ice weights specified in the TS. The revised containment pressure analysis determined that sufficient ice would be present to maintain the peak containment pressure below the containment design pressure. No new modes of operation, accident scenarios, failure mechanisms, or limiting single failures are introduced as a result of this proposed change.

TVA has evaluated the effects of the increased ice condenser ice weight and determined that the increase in ice weight does not invalidate the ice condenser seismic qualification, does not adversely affect the capacity of the ice bed to absorb iodine during a LOCA, and does not diminish the boron concentration of the recirculated primary coolant during a LOCA. TVA has also evaluated differences between the as-built plant and the assumptions of the revised analysis and determined that the results of the revised analysis remain valid for Model 57AG steam generators and for AREVA Advanced W17 High Thermal Performance (HTP) fuel. Because sufficient ice weight is available to maintain the peak containment pressure below the containment design pressure, the results of the revised analysis remain valid for Model 57AG steam generators and for AREVA Advanced W17 High Thermal Performance (HTP) fuel, and the increase in ice weight does not invalidate the ice condenser seismic qualification, the increased ice weight does not create the possibility of an accident that is different than any already evaluated in the SQN UFSAR.

Therefore, the proposed changes do not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. *Does the proposed amendment involve a significant reduction in a margin of safety?*

Response: No.

The operability of the ice bed ensures that the required ice inventory will 1) be distributed evenly through the containment bays, 2) contain sufficient boron to preclude dilution of the containment sump following the LOCA and 3) contain sufficient heat removal capability to condense the reactor system volume released during a LOCA. These conditions are consistent with the assumptions used in the accident analyses.

The revised analysis demonstrates that the ice condensers will continue to preclude over-pressurizing the lower containment and continue to absorb sufficient heat energy to assist in precluding containment vessel failure. TVA has evaluated the effects of the increased ice condenser ice weight and determined that the increase in ice weight does not invalidate the ice condenser seismic qualification, does not adversely affect the capacity of the ice bed to absorb iodine during a LOCA, and does not diminish the boron concentration of the recirculated primary coolant during a LOCA.

The proposed changes are required to resolve non-conservative TS currently addressed by administrative controls established in accordance with Nuclear Regulatory Commission (NRC) Administrative Letter 98-10. The revised containment integrity response analysis requires an increase in the required ice weight to ensure that the post-LOCA peak containment pressure remains within the design limits. As a result, the proposed changes restore margin between the accident peak pressure and the containment design pressure and resolve non-conservative TS ice weight values currently under administrative controls. Accordingly, the proposed changes do not involve a significant reduction in a margin of safety.

4.4 Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

5.0 ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

7.0 REFERENCES

1. Letter from TVA to NRC, "Application to Modify Ice Condenser Technical Specifications to Address Revisions in Westinghouse Mass and Energy Release Calculation," (SQN-TS-12-04), dated July 3, 2013 (ADAMS Accession Number ML13199A281)

2. NSAL-14-2, "LOCA Mass and Energy Release Analysis Calculation Issue for Steam Generator Tube Material Properties," dated March 31, 2014

3. Sequoyah Nuclear Plant, Units 1 and 2, Updated Final Safety Analysis Report

4. NSAL-11-5, "Westinghouse LOCA Mass and Energy Release Analysis," dated July 26, 2011

5. WCAP-12455, Revision 1, Supplement 2R, "Tennessee Valley Authority Sequoyah Nuclear Plant Units 1 and 2 Containment Integrity Reanalyses Engineering Report," dated April 2012. (Submitted to NRC as part of TVA submittal – Reference 1 above)

6. NSAL-06-6, "LOCA Mass and Energy Release Analysis," dated June 6, 2006

7. WCAP-12455, Revision 1, Supplement 3R, "Tennessee Valley Authority Sequoyah Nuclear Plant Units 1 and 2 Containment Integrity Reanalyses Engineering Report," dated March 2015. (Provided as Attachment 5 to this LAR submittal.)

8. WCAP-8110, "Test Plans and Results for the Ice Condenser System," dated April 16, 1973

9. NRC Safety Evaluation, "Sequoyah Nuclear Plant, Units 1 and 2 – Issuance of Amendments to revise the Technical Specification to Allow Use of AREVA Advanced W17 High Thermal Performance Fuel (TS-SQN-2011-07) (TAC Nos. ME6538 and ME6539)," dated September 26, 2012 (ADAMS Accession Number ML12249A394).

10. ANP-2986, Revision 3, "Sequoyah HTP Fuel Transition," dated July 2011 (ADAMS Accession Number ML 11210B532)

11. U.S. Nuclear Regulatory Commission, Standard Review Plan, NUREG-0800, Section 6.2.1.3, Mass and Energy Release Analysis for Postulated Loss-of-Coolant Accidents, Revision 1, dated July 1981 (ADAMS Accession Number ML052340659)

12. U.S. Nuclear Regulatory Commission, Standard Review Plan, NUREG-0800, Section 6.2.1.1.B, Ice Condenser Containments, Revision 2, dated July 1981 (ADAMS Accession Number ML052340655)

13. NRC Safety Evaluation, "Sequoyah Nuclear Plants, Units 1 and 2 – Issuance of Amendments Regarding Ice Condenser Basket Weight (TAC Nos. MB3682 and MB3683) (TS 01-04)," dated September 30, 2002 (ADAMS Accession Number ML022730675)

ATTACHMENT 1

Proposed TS Changes (Mark-Ups) for SQN, Units 1 and 2

Proposed TS Changes (Mark-Ups) for SQN, Unit 1

CONTAINMENT SYSTEMS

3/4.6.5 ICE CONDENSER

ICE BED

LIMITING CONDITION FOR OPERATION

3.6.5.1. The ice bed shall be OPERABLE with:

a. The stored ice having a boron concentration of ≥ 1800 ppm and ≤ 2500 ppm boron as sodium tetraborate and a pH of 9.0 to 9.5,

b. Flow channels through the ice condenser,

c. A maximum ice bed temperature of less than or equal 27°F,

d. A total ice weight of at least ~~2,225,880~~ 2,610,792 pounds at a 95% level of confidence, and

e. 1944 ice baskets.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With the ice bed inoperable, restore the ice bed to OPERABLE status within 48 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.6.5.1 The ice condenser shall be determined OPERABLE:

a. At least once per 12 hours by verifying that the maximum ice bed temperature is less than or equal to 27°F.

b. At least once per 18 months by verifying, by visual inspection, accumulation of ice on structural members comprising flow channels through the ice bed is ≤ 15 percent blockage of the total flow area for each safety analysis section.

c. At least once per 40 months by lifting and visually inspecting the accessible portions of at least two ice baskets from each 1/3 of the ice condenser and verifying that the ice baskets are free of detrimental structural wear, cracks, corrosion or other damage. The ice baskets shall be raised at least 10 feet for this inspection.

d. At least once per 18 months by:

1. Deleted.

2. Weighing a representative sample of at least 144 ice baskets and verifying that each basket contains at least ~~1145~~ 1343 lbs office. The representative sample shall include 6 baskets from each of the 24 ice condenser bays and shall be constituted of one basket each from Radial Rows 1, 2, 4, 6, 8 and 9 (or from the same row of an adjacent bay if a basket from a designated row cannot be obtained for weighing) within each bay. If any basket is found to contain less than ~~1145~~ 1343 pounds of ice, a representative sample of 20 additional baskets from the same bay shall be weighed. The minimum average weight of ice from the 20 additional baskets and the discrepant basket shall not be less than ~~1145~~ 1343 pounds/basket at a 95% level of confidence.

   The ice condenser shall also be subdivided into 3 groups of baskets, as follows: Group 1 - bays 1 through 8, Group 2 - bays 9 through 16, and Group 3 - bays 17 through 24. The minimum average ice weight of the sample baskets from Radial Rows 1, 2, 4, 6, 8 and 9 in each group shall not be less than ~~1145~~ 1343 pounds/basket at a 95% level of confidence.

   The minimum total ice condenser ice weight at a 95% level of confidence shall be calculated using all ice basket weights determined during this weighing program and shall not be less than ~~2,225,880~~ 2,610,792 pounds.

e. At least once per 54 months by chemical analysis of the stored ice in at least one randomly selected ice basket from each ice condenser bay verify:

1. Ice bed boron concentration is ≥ 1800 ppm and ≤ 2500 ppm as sodium tetraborate and;
2. pH is ≥ 9.0 and ≤ 9.5.

NOTE: The requirements of this SR are satisfied if the boron concentration and pH values obtained from averaging the individual sample results are within the limits specified above.

f. Each ice addition verify, by chemical analysis, that ice added to the ice condenser meets the boron concentration and pH requirements of SR 4.6.5.1.e.

NOTE: The chemical analysis may be performed on either the liquid solution or the resulting ice.

Proposed TS Changes (Mark-Ups) for SQN, Unit 2

CONTAINMENT SYSTEMS

3/4.6.5 ICE CONDENSER

ICE BED

LIMITING CONDITION FOR OPERATION

3.6.5.1. The ice bed shall be OPERABLE with:

a. The stored ice having a boron concentration of ≥ 1800 ppm and ≤ 2500 ppm boron as sodium tetraborate and a pH of 9.0 to 9.5,

b. Flow channels through the ice condenser,

c. A maximum ice bed temperature of less than or equal 27°F,

d. A total ice weight of at least ~~2,225,880~~ 2,610,792 pounds at a 95% level of confidence, and

e. 1944 ice baskets.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With the ice bed inoperable, restore the ice bed to OPERABLE status within 48 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.6.5.1 The ice condenser shall be determined OPERABLE:

a. At least once per 12 hours by verifying that the maximum ice bed temperature is less than or equal to 27°F.

b. At least once per 18 months by verifying, by visual inspection, accumulation of ice on structural members comprising flow channels through the ice bed is ≤ 15 percent blockage of the total flow area for each safety analysis section.

SURVEILLANCE REQUIREMENTS (Continued)

c. At least once per 40 months by lifting and visually inspecting the accessible portions of at least two ice baskets from each 1/3 of the ice condenser and verifying that the ice baskets are free of detrimental structural wear, cracks, corrosion or other damage. The ice baskets shall be raised at least 10 feet for this inspection.

d. At least once per 18 months by:

1. Deleted.

2. Weighing a representative sample of at least 144 ice baskets and verifying that each basket contains at least ~~1145~~ 1343 lbs of ice. The representative sample shall include 6 baskets from each of the 24 ice condenser bays and shall be constituted of one basket each from Radial Rows 1, 2, 4, 6, 8 and 9 (or from the same row of an adjacent bay if a basket from a designated row cannot be obtained for weighing) within each bay. If any basket is found to contain less than ~~1145~~ 1343 pounds of ice, a representative sample of 20 additional baskets from the same bay shall be weighed. The minimum average weight of ice from the 20 additional baskets and the discrepant basket shall not be less than ~~1145~~ 1343 pounds/basket at a 95% level of confidence.

   The ice condenser shall also be subdivided into 3 groups of baskets, as follows: Group 1 - bays 1 through 8, Group 2 - bays 9 through 16, and Group 3 - bays 17 through 24. The minimum average ice weight of the sample baskets from Radial Rows 1, 2, 4, 6, 8 and 9 in each group shall not be less than ~~1145~~ 1343 pounds/basket at a 95% level of confidence.

   The minimum total ice condenser ice weight at a 95% level of confidence shall be calculated using all ice basket weights determined during this weighing program and shall not be less than ~~2,225,880~~ 2,610,792 pounds.

e. At least once per 54 months by chemical analysis of the stored ice in at least one randomly selected ice basket from each ice condenser bay verify:

1. Ice bed boron concentration is ≥ 1800 ppm and ≤ 2500 ppm as sodium tetraborate and;

2. pH is ≥ 9.0 and ≤ 9.5.

NOTE: The requirements of this SR are satisfied if the boron concentration and pH values obtained from averaging the individual sample results are within the limits specified above.

f. Each ice addition verify, by chemical analysis, that ice added to the ice condenser meets the boron concentration and pH requirements of SR 4.6.5.1.e.

NOTE: The chemical analysis may be performed on either the liquid solution or the resulting ice.

ATTACHMENT 2

Proposed TS Bases Changes (Mark-Ups) for SQN, Units 1 and 2

(For Information Only)

Proposed TS Bases Changes (Mark-Ups) for SQN, Unit 1

(For Information Only)

3/4.6.4 COMBUSTIBLE GAS CONTROL

The hydrogen mixing systems are provided to ensure adequate mixing of the containment atmosphere following a LOCA. This mixing action will prevent localized accumulations of hydrogen from exceeding the flammable limit.

The operability of at least 66 of 68 ignitors in the hydrogen mitigation system will maintain an effective coverage throughout the containment. This system of ignitors will initiate combustion of any significant amount of hydrogen released after a degraded core accident. This system is to ensure burning in a controlled manner as the hydrogen is released instead of allowing it to be ignited at high concentrations by a random ignition source.

3/4.6.5 ICE CONDENSER

The requirements associated with each of the components of the ice condenser ensure that the overall system will be available to provide sufficient pressure suppression capability to limit the containment peak pressure transient to less than 12 psig during LOCA conditions.

3/4.6.5.1 ICE BED

The OPERABILITY of the ice bed ensures that the required ice inventory will 1) be distributed evenly through the containment bays, 2) contain sufficient boron to preclude dilution of the containment sump following the LOCA and 3) contain sufficient heat removal capability to condense the reactor system volume released during a LOCA. These conditions are consistent with the assumptions used in the accident analyses.

The minimum weight figure of ~~1145~~ 1343 pounds of ice per basket contains a 15% conservative allowance for ice loss through sublimation ~~which is a factor of~~ 15 higher than assumed for the ice condenser design. The minimum weight figure of ~~2,225,880~~ 2,610,792 pounds of ice also contains an additional 1% conservative allowance to account for systematic error in weighing instruments. In the

Proposed TS Bases Changes (Mark-Ups) for SQN, Unit 2

(For Information Only)

3/4.6.4 COMBUSTIBLE GAS CONTROL

The hydrogen mixing systems are provided to ensure adequate mixing of the containment atmosphere following a LOCA. This mixing action will prevent localized accumulations of hydrogen from exceeding the flammable limit.

The operability of at least 66 of 68 igniters in the hydrogen control distributed ignition system will maintain an effective coverage throughout the containment. This system of ignitors will initiate combustion of any significant amount of hydrogen released after a degraded core accident. This system is to ensure burning in a controlled manner as the hydrogen is released instead of allowing it to be ignited at high concentrations by a random ignition source.

3/4.6.5 ICE CONDENSER

The requirements associated with each of the components of the ice condenser ensure that the overall system will be available to provide sufficient pressure suppression capability to limit the containment peak pressure transient to less than 12 psig during LOCA conditions.

3/4.6.5.1 ICE BED

The OPERABILITY of the ice bed ensures that the required ice inventory will 1) be distributed evenly through the containment bays, 2) contain sufficient boron to preclude dilution of the containment sump following the LOCA and 3) contain sufficient heat removal capability to condense the reactor system volume released during a LOCA. These conditions are consistent with the assumptions used in the accident analyses.

The minimum weight figure of ~~1145~~ 1343 pounds of ice per basket contains a 15% conservative allowance for ice loss through sublimation ~~which is a factor of~~ 15 higher than assumed for the ice condenser design. The minimum weight figure of ~~2,225,880~~ 2,610,792 pounds of ice also contains an additional 1% conservative allowance to account for ~~systematic error~~ in weighing instruments. In the

ATTACHMENT 3

Proposed TS Changes (Final Typed) for SQN, Units 1 and 2

Proposed TS Changes (Final Typed) for SQN, Unit 1

3/4.6.5 ICE CONDENSER

ICE BED

LIMITING CONDITION FOR OPERATION

3.6.5.1. The ice bed shall be OPERABLE with:

a. The stored ice having a boron concentration of ≥ 1800 ppm and ≤ 2500 ppm boron as sodium tetraborate and a pH of 9.0 to 9.5,

b. Flow channels through the ice condenser,

c. A maximum ice bed temperature of less than or equal 27°F,

d. A total ice weight of at least 2,610,792 pounds at a 95% level of confidence, and

e. 1944 ice baskets.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With the ice bed inoperable, restore the ice bed to OPERABLE status within 48 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.6.5.1 The ice condenser shall be determined OPERABLE:

a. At least once per 12 hours by verifying that the maximum ice bed temperature is less than or equal to 27°F.

b. At least once per 18 months by verifying, by visual inspection, accumulation of ice on structural members comprising flow channels through the ice bed is ≤ 15 percent blockage of the total flow area for each safety analysis section.

c. At least once per 40 months by lifting and visually inspecting the accessible portions of at least two ice baskets from each 1/3 of the ice condenser and verifying that the ice baskets are free of detrimental structural wear, cracks, corrosion or other damage. The ice baskets shall be raised at least 10 feet for this inspection.

d. At least once per 18 months by:

1. Deleted.

2. Weighing a representative sample of at least 144 ice baskets and verifying that each basket contains at least 1343 lbs. of ice. The representative sample shall include 6 baskets from each of the 24 ice condenser bays and shall be constituted of one basket each from Radial Rows 1, 2, 4, 6, 8 and 9 (or from the same row of an adjacent bay if a basket from a designated row cannot be obtained for weighing) within each bay. If any basket is found to contain less than 1343 pounds of ice, a representative sample of 20 additional baskets from the same bay shall be weighed. The minimum average weight of ice from the 20 additional baskets and the discrepant basket shall not be less than 1343 pounds/basket at a 95% level of confidence.

The ice condenser shall also be subdivided into 3 groups of baskets, as follows: Group 1 - bays 1 through 8, Group 2 - bays 9 through 16, and Group 3 - bays 17 through 24. The minimum average ice weight of the sample baskets from Radial Rows 1, 2, 4, 6, 8 and 9 in each group shall not be less than 1343 pounds/basket at a 95% level of confidence.

The minimum total ice condenser ice weight at a 95% level of confidence shall be calculated using all ice basket weights determined during this weighing program and shall not be less than 2,610,792 pounds.

e. At least once per 54 months by chemical analysis of the stored ice in at least one randomly selected ice basket from each ice condenser bay verify:

1. Ice bed boron concentration is ≥ 1800 ppm and ≤ 2500 ppm as sodium tetraborate and;

2. pH is ≥ 9.0 and ≤ 9.5.

NOTE: The requirements of this SR are satisfied if the boron concentration and pH values obtained from averaging the individual sample results are within the limits specified above.

f. Each ice addition verify, by chemical analysis, that ice added to the ice condenser meets the boron concentration and pH requirements of SR 4.6.5.1.e.

NOTE: The chemical analysis may be performed on either the liquid solution or the resulting ice.

Proposed TS Changes (Final Typed) for SQN, Unit 2

3/4.6.5 ICE CONDENSER

ICE BED

LIMITING CONDITION FOR OPERATION

3.6.5.1. The ice bed shall be OPERABLE with:

a. The stored ice having a boron concentration of ≥ 1800 ppm and ≤ 2500 ppm boron as sodium tetraborate and a pH of 9.0 to 9.5,

b. Flow channels through the ice condenser,

c. A maximum ice bed temperature of less than or equal 27°F,

d. A total ice weight of at least 2,610,792 pounds at a 95% level of confidence, and

e. 1944 ice baskets.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With the ice bed inoperable, restore the ice bed to OPERABLE status within 48 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.6.5.1 The ice condenser shall be determined OPERABLE:

a. At least once per 12 hours by verifying that the maximum ice bed temperature is less than or equal to 27°F.

b. At least once per 18 months by verifying, by visual inspection, accumulation of ice on structural members comprising flow channels through the ice bed is ≤ 15 percent blockage of the total flow area for each safety analysis section.

c. At least once per 40 months by lifting and visually inspecting the accessible portions of at least two ice baskets from each 1/3 of the ice condenser and verifying that the ice baskets are free of detrimental structural wear, cracks, corrosion or other damage. The ice baskets shall be raised at least 10 feet for this inspection.

d. At least once per 18 months by:

   1. Deleted.

   2. Weighing a representative sample of at least 144 ice baskets and verifying that each basket contains at least 1343 lbs. of ice. The representative sample shall include 6 baskets from each of the 24 ice condenser bays and shall be constituted of one basket each from Radial Rows 1, 2, 4, 6, 8 and 9 (or from the same row of an adjacent bay if a basket from a designated row cannot be obtained for weighing) within each bay. If any basket is found to contain less than 1343 pounds of ice, a representative sample of 20 additional baskets from the same bay shall be weighed. The minimum average weight of ice from the 20 additional baskets and the discrepant basket shall not be less than 1343 pounds/basket at a 95% level of confidence.

      The ice condenser shall also be subdivided into 3 groups of baskets, as follows: Group 1 - bays 1 through 8, Group 2 - bays 9 through 16, and Group 3 - bays 17 through 24. The minimum average ice weight of the sample baskets from Radial Rows 1, 2, 4, 6, 8 and 9 in each group shall not be less than 1343 pounds/basket at a 95% level of confidence.

      The minimum total ice condenser ice weight at a 95% level of confidence shall be calculated using all ice basket weights determined during this weighing program and shall not be less than 2,610,792 pounds.

e. At least once per 54 months by chemical analysis of the stored ice in at least one randomly selected ice basket from each ice condenser bay verify:

   1. Ice bed boron concentration is ≥ 1800 ppm and ≤ 2500 ppm as sodium tetraborate and;

   2. pH is ≥ 9.0 and ≤ 9.5.

NOTE: The requirements of this SR are satisfied if the boron concentration and pH values obtained from averaging the individual sample results are within the limits specified above.

f. Each ice addition verify, by chemical analysis, that ice added to the ice condenser meets the boron concentration and pH requirements of SR 4.6.5.1.e.

NOTE: The chemical analysis may be performed on either the liquid solution or the resulting ice.

ATTACHMENT 4

Proposed TS Bases Changes (Final Typed) for SQN, Units 1 and 2

(For Information Only)

Proposed TS Bases Changes (Final Typed) for SQN, Unit 1

(For Information Only)

3/4.6.4 COMBUSTIBLE GAS CONTROL

The hydrogen mixing systems are provided to ensure adequate mixing of the containment atmosphere following a LOCA. This mixing action will prevent localized accumulations of hydrogen from exceeding the flammable limit.

The operability of at least 66 of 68 ignitors in the hydrogen mitigation system will maintain an effective coverage throughout the containment. This system of ignitors will initiate combustion of any significant amount of hydrogen released after a degraded core accident. This system is to ensure burning in a controlled manner as the hydrogen is released instead of allowing it to be ignited at high concentrations by a random ignition source.

3/4.6.5 ICE CONDENSER

The requirements associated with each of the components of the ice condenser ensure that the overall system will be available to provide sufficient pressure suppression capability to limit the containment peak pressure transient to less than 12 psig during LOCA conditions.

3/4.6.5.1 ICE BED

The OPERABILITY of the ice bed ensures that the required ice inventory will 1) be distributed evenly through the containment bays, 2) contain sufficient boron to preclude dilution of the containment sump following the LOCA and 3) contain sufficient heat removal capability to condense the reactor system volume released during a LOCA. These conditions are consistent with the assumptions used in the accident analyses.

The minimum weight figure of 1343 pounds of ice per basket contains a 15% conservative allowance for ice loss through sublimation which is a factor of 15 higher than assumed for the ice condenser design. The minimum weight figure of 2,610,792 pounds of ice also contains an additional 1% conservative allowance to account for systematic error in weighing instruments. In the

Proposed TS Bases Changes (Final Typed) for SQN, Unit 2

(For Information Only)

3/4.6.4 COMBUSTIBLE GAS CONTROL

The hydrogen mixing systems are provided to ensure adequate mixing of the containment atmosphere following a LOCA. This mixing action will prevent localized accumulations of hydrogen from exceeding the flammable limit.

The operability of at least 66 of 68 igniters in the hydrogen control distributed ignition system will maintain an effective coverage throughout the containment. This system of ignitors will initiate combustion of any significant amount of hydrogen released after a degraded core accident. This system is to ensure burning in a controlled manner as the hydrogen is released instead of allowing it to be ignited at high concentrations by a random ignition source.

3/4.6.5 ICE CONDENSER

The requirements associated with each of the components of the ice condenser ensure that the overall system will be available to provide sufficient pressure suppression capability to limit the containment peak pressure transient to less than 12 psig during LOCA conditions.

3/4.6.5.1 ICE BED

The OPERABILITY of the ice bed ensures that the required ice inventory will 1) be distributed evenly through the containment bays, 2) contain sufficient boron to preclude dilution of the containment sump following the LOCA and 3) contain sufficient heat removal capability to condense the reactor system volume released during a LOCA. These conditions are consistent with the assumptions used in the accident analyses.

The minimum weight figure of 1343 pounds of ice per basket contains a 15% conservative allowance for ice loss through sublimation which is a factor of 15 higher than assumed for the ice condenser design. The minimum weight figure of 2,610,792 pounds of ice also contains an additional 1% conservative allowance to account for systematic error in weighing instruments. In the

ATTACHMENT 5

Topical Report WCAP-12455, Revision 1, Supplement 3R

WESTINGHOUSE NON-PROPRIETARY CLASS 3

WCAP-12455
Revision 1
Supplement 3R

TENNESSEE VALLEY AUTHORITY SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2 CONTAINMENT INTEGRITY REANALYSES ENGINEERING REPORT

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March, 2015

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EXECUTIVE SUMMARY

Loss-of-Coolant Accident (LOCA) Containment Integrity Analyses have been updated to support plant operation relative to the loss-of-coolant accident mass and energy release calculation issue for steam generator tube material properties reported in NSAL-14-2 (Reference 11), initial containment upper and lower and ice condenser compartment and ice bed temperature bias direction of conservatism, include heat load addition from (from energized equipment) for the hydrogen mitigation system, and consideration for the Model 57 AG replacement steam generators. In addition, for a comprehensive reconciliation of all issues relative to the LOCA mass and energy release for the current licensing basis (CLB), all appropriate corrections relative to NSAL-06-6 (Reference 10) and NSAL-11-5 (Reference 9) were addressed.

The analyses conducted used the WCAP-10325-P-A (Reference 6) mass and energy evaluation model, which was also used for the Reference 3 current licensing basis (CLB) analysis, and are consistent with current licensed methodology.

The objective of this effort was to determine an ice weight that preserved the current LOCA containment integrity pressure margin. Additionally, the containment spray switchover interval (>150 seconds) relationship between ice bed meltout time and containment spray switchover time was to be preserved.

The results of the analysis support the following:

- An ice mass of 2,247,250 lbms
- A calculated containment peak pressure of 11.48 psig occurring at 3112.8 seconds
- Ice bed meltout occurred at 3272.3 seconds (containment spray switchover is completed at 3113 seconds thus the containment spray switchover ice bed meltout relationship is 159.3 seconds).

  The ice bed mass of 2,247,250 lbms equates to an average of 1156 lbms per basket. This average value recognizes that all baskets may not have the same initial weight nor have the same sublimation rate. To ensure that a sufficient quantity of ice exists in each basket to survive the blowdown phase of a LOCA, a minimum amount of ice per basket to survive the blowdown would be approximately 336.9 lbms, based on Table 2-3. To ensure that an adequate distribution of ice exists in the Ice Condenser to prevent early burn-through of a localized area, 336.9 lbms of ice should be the minimum weight of ice per basket at any time while also ensuring that the average weight per basket remains above 1156 lbms.

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1.0 INTRODUCTION

Loss-of-Coolant Accident (LOCA) Containment Integrity Analyses have been updated to support plant operation relative to the loss-of-coolant accident (LOCA) mass and energy (M&E) release calculation issue for steam generator tube material properties reported in NSAL-14-2, and to bound both Sequoyah Units 1 and 2 for the Model 57 AG replacement steam generators (RSG). In addition, for a comprehensive reconciliation of all issues relative to the LOCA mass and energy release current licensing basis (CLB) all appropriate corrections relative to NSAL-06-6 (Reference 10) and NSAL-11-5 (Reference 9) were addressed. The analysis includes newly generated mass and energy releases (Appendix A). The containment pressure response (containment integrity analysis) includes the effects on containment peak pressure due to initial containment temperature bias direction of conservatism with respect to the containment compartments and ice condenser ice bed, and heat load addition from (from energized equipment) for the hydrogen mitigation system.

A containment integrity analysis is performed during nuclear plant design to ensure that the pressure inside containment will remain below the containment building design pressure if a loss-of-coolant accident (LOCA) inside containment should occur during plant operation. The analysis ensures that the containment heat removal capability is sufficient to remove the maximum possible discharge of mass and energy to containment from the Nuclear Steam Supply System without exceeding the acceptance criteria (design pressure; 12 psig).

NSAL-14-2 (Reference 11) was issued relative to LOCA M&E release analyses for which Westinghouse has cognizance. This NSAL describes an issue discovered relative to a difference in steam generator tube material that affects the material volumetric heat capacity applied in the WCAP-10325-P-A (Reference 6) evaluation model. The LOCA M&E release analyses are sensitive to energy stored in the reactor coolant system (RCS) metal, including the steam generator (SG) tubes. It was determined that the input modification program database and the input modification program preprocessor were using the density for stainless steel in determining the mass of the SG tubes and the specific heat (C_p) of stainless for the stored metal energy, instead of either Alloy 600 or Alloy 690 material for the SG tube material.

The Sequoyah Units 1 and 2 have Model 57 AG replacement steam generators. It was determined based upon analytical rigor that the Model 51 original steam generator (OSG) analytical characteristics considered in the long-term LOCA M&E release analysis are bounding with respect to the Model 57 AG RSG. The containment integrity calculation depends upon the LOCA M&E release input. The key SG parameters that have the greatest impact on the LOCA M&E release calculation are those that determine the mass and energy inventory available to containment such as: SG primary and secondary volume, SG secondary metal mass, SG initial conditions modeled in the analysis, and SG tube thickness and heat transfer areas. It was determined that the energy content of the OSGs considered in the LOCA M&E release analysis are bounding with respect to the energy content of the RSG. Therefore, the analysis bounds both Units 1 and 2 with Model 57 AG RSGs.

The containment pressure response model was amended to include the heat load addition (from the energized equipment) for the hydrogen mitigation system (igniters) as 38.67 BTU/sec (Reference 12).

Legacy issues for the long-term LOCA containment ice condenser design containment pressure response input guidance used for the LOTIC1 (Reference 4) were identified. The issues were relative to the containment pressure response (containment integrity analysis) which includes the

effects on containment peak pressure due to initial containment temperature bias direction of conservatism with respect to the containment compartments and ice condenser ice bed. The basis of these issues dates back to the direction of conservatism input generation logic used in initial ice condenser containment integrity analyses. Historically, initial containment compartment air, heat slab, and the ice condenser component (ice condenser compartment and ice bed) temperatures have been biased towards the technical specification minimum values. The basis for this logic was relative to the density effect on air mass function. The logic relative to the direction of compartment temperature bias is dependent on initial ice mass, containment spray operation and energy content of the mass and energy release, which determine ice bed melt-out time. Recent sensitivity studies show that the current temperature bias logic is not always conservative and may not result in maximizing the LOCA containment pressure response. Because there is no definitive conclusion on whether high or low initial containment temperatures are limiting relative to peak pressure, future analyses will be performed assuming initial containment temperature biased both high and low to determine which input results in the highest peak pressure response. The initial temperature conditions which produce the most limiting containment pressure response will be identified as the initial temperature input assumptions.

This analysis provides the analytical basis for a change to the Sequoyah design basis initial ice mass to 2,247,250 pounds with minimal impact on current margins in peak calculated containment pressure and ice bed meltout time to containment spray switchover time.

In addition to the design basis (Reference 3), this analysis accounted for:
- An increased accumulator water temperature of 130 °F
- Revised initial conditions (Table 1-1)
- Revised plant specific decay heat curve (Table 1-2)

1.1 PURPOSE OF ANALYSIS

The purpose of this analysis is to reanalyze the long-term LOCA M&E releases and the subsequent containment integrity pressure response in order to demonstrate support for plant operation relative to the issues reported in NSAL-06-6, NSAL-11-5, and NSAL14-2, in addition to include the effects due to initial containment air temperature bias assumptions and the heat load addition for the hydrogen mitigation igniters. The objective of performing the long-term LOCA mass and energy release and LOCA containment integrity analysis was to minimize the effect on the initial analytical ice mass, to maintain the current time interval (150 seconds, minimum) relationship between containment spray switchover time and ice bed meltout time, and to provide peak pressure margin to design pressure.

This program will provide the analytical basis and the results which show that the containment design pressure is not exceeded in the event of a LOCA. The conclusions presented will demonstrate, with respect to LOCA, that containment integrity has not been compromised. This containment analysis bounds both Sequoyah Units 1 and 2 with Model 57 AG RSGs.

Rupture of any of the piping carrying pressurized high temperature reactor coolant, termed a LOCA, will result in release of steam and water into the containment. This, in turn, will result in an increase in the containment pressure and temperature. The mass and energy release rates described in Appendix A form the basis for computations to evaluate the structural integrity of the containment following a postulated accident to satisfy the Nuclear Regulatory acceptance criteria, General Design Criterion 38. Section 2.0 presents the Containment Pressure Calculations.

TABLE 1-1

SEQUOYAH UNITS 1 AND 2
SYSTEM PARAMETERS
INITIAL CONDITIONS

PARAMETERS	VALUE
Core Thermal Power (MWt)	3455
Reactor Coolant System Flowrate, per Loop (gpm)	91400.
Vessel Outlet Temperature* (°F) (without uncertainty allowance)	609.7
Core Inlet Temperature* (°F) (without uncertainty allowance)	546.2
Vessel Average Temperature (°F)	578.2
Initial Steam Generator Steam Pressure (psia)	870
Steam Generator Design**	Model 51
Steam Generator Tube Plugging (%)	0
Initial Steam Generator Secondary Side Mass (lbm)	114075
Accumulator	
Water Volume (ft^3)	1039
N_2 Cover Gas Pressure (psig)	668
Temperature (°F)	130
Safety Injection Delay (sec) (Includes time to reach pressure setpoint; 27.0 second delay plus 2.76 seconds to reach pressure setpoint)	29.76

* (Analysis value includes an additional +5.5°F allowance for instrument error and deadband)

** (Model 57 AG RSG is considered bounded by Model 51 OSG analytical model, i.e., due to total energy content)

TABLE 1-2

SEQUOYAH UNITS 1 AND 2
SYSTEM PARAMETERS
DECAY HEAT CURVE

Time (sec)	Decay Heat Generation Rate (Btu/Btu)
10	0.050708
14	0.048246
20	0.045658
40	0.040710
60	0.037863
80	0.035877
100	0.034382
140	0.032242
200	0.030132
400	0.026430
600	0.024288
800	0.022747
1000	0.021503
1600	0.018850
2000	0.017588
4000	0.014057
6000	0.012379
8000	0.011403
10000	0.010732
16000	0.0098865
20000	0.0093675
40000	0.0079143
60000	0.0071391
80000	0.0066015
100000	0.0062030
140000	0.0056076
200000	0.0049979
400000	0.0038661
600000	0.0032651
800000	0.0028811
1000000	0.0026162
1400000	0.0022614
2000000	0.0019338
4000000	0.0013904
6000000	0.0011374
8000000	0.00098265
10000000	0.00087175

Key Assumptions

-18 month fuel cycle
-Standard and V5H fuel
-End of Cycle Core Average Burnup of 52,687 Mwd/MTU
-Low bound for enrichment: 3.0%

2.0 LOCA CONTAINMENT INTEGRITY ANALYSIS

2.1 Description of LOTIC-1 Model and Interface Issue

The evaluation model used for the long-term LOCA mass and energy release ice condenser containment design response is the LOTIC1 version of the LOTIC computer code described in Reference 4. This evaluation model has been reviewed and generically approved by the Nuclear Regulatory Commission (NRC). The approval letter is included with Reference 4.

The LOTIC model of the containment consists of five distinct control volumes: the upper compartment, the lower compartment, the portion of the ice bed from which the ice has melted, the portion of the ice bed containing unmelted ice, and the dead ended compartment. The ice condenser control volume with unmelted and melted ice is further subdivided into six subcompartments to allow for maldistribution of break flow to the ice bed.

The conditions in these compartments are obtained as a function of time by the use of fundamental equations solved through numerical techniques. These equations are solved for three phases in time. Each phase corresponds to a distinct physical characteristic of the problem. Each of these phases has a unique set of simplifying assumptions based on test results from the ice condenser test facility (Reference 5). These phases are the blowdown period, the depressurization period, and the long term.

The most significant simplification of the problem is the assumption that the total pressure in the containment is uniform. This assumption is justified by the fact that after the initial blowdown of the Reactor Coolant System, the remaining mass and energy released from this system into the containment are small and very slowly changing. The resulting flow rates between the control volumes will also be relatively small. These flow rates then are unable to maintain significant pressure differences between the compartments.

In the control volumes, which are always assumed to be saturated, steam and air are assumed to be uniformly mixed and at the control volume temperature. The air is considered a perfect gas, and the thermodynamic properties of steam are taken from the American Society of Mechanical Engineers (ASME) steam table.

The condensation of steam is assumed to take place in a condensing node located, for the purpose of calculation, between the two control volumes in the ice storage compartment. The exit temperature of the air leaving this node is set equal to a specific value that is equal to the temperature of the ice filled control volume of the ice storage compartment. Lower compartment exit temperature is used if the ice bed section is melted.

2.2 Containment Pressure Calculation

The following are the major input assumptions used in the LOTIC analysis for the pump suction pipe rupture case with the steam generators considered as an active heat source for the Sequoyah Nuclear Plant Containment:

1. Minimum safeguards are employed in all calculations, e.g., one of two spray pumps and one of two spray heat exchangers; one of two residual heat removal (RHR) pumps and one of two RHR heat exchangers providing flow to the core; one of two safety injection pumps and one of two centrifugal charging pumps; and one of two air return fans.

2. 2,247,250 lbm of ice initially in the ice condenser.

3. The blowdown, reflood, and post reflood mass and energy releases described in Appendix A herein were used.

4. Blowdown and post-blowdown ice condenser drain temperature of 190°F and 130°F are used. (These values are based on the Long-Term Waltz-Mill ice condenser test data described in Reference 5.)

5. Nitrogen from the accumulators in the amount of 3479 lbs. is included in the calculations.

6. Hydrogen gas was added to the containment in the amount of 21,366 Standard Cubic Feet (SCF) over 24 hours. Sources accounted for were radiolysis in the core and sump post-LOCA, corrosion of plant materials (Aluminum, Zinc, and painted surfaces found in containment), reaction of 1% of the Zirconium fuel rod cladding in the core, and hydrogen gas assumed to be dissolved in the Reactor Coolant System water. (This bounds tritium producing core designs)

7. Essential service water temperature of 87°F is used on the spray heat exchanger and the component cooling heat exchanger.

8. The air return fan is assumed to be effective 10 minutes after the transient is initiated.

9. No maldistribution of steam flow to the ice bed is assumed. (This assumption is conservative, and contributes to early ice bed meltout time.)

10. No ice condenser bypass is assumed. (This assumption depletes the ice in the shortest time and is thus conservative.)

11. The initial conditions in the containment are a temperature of 125°F in the lower and dead-ended volumes, 105°F in the upper volume and 27°F in the ice condenser. All volumes are at a pressure of 0.3 psig and a 10% relative humidity, except the ice condenser which is at 100% relative humidity.

12. The minimum Emergency Core Cooling System (ECCS) and Containment Spray flow rates versus time assumed in the peak containment pressure calculations were calculated based upon the assumption of loss of offsite power (See Reference 1, Table 3-1).

13. Containment structural heat sinks are assumed with conservatively low heat transfer rates. (See Tables 2-1 and 2-2) Note: The Dead-Ended compartment structural heat sinks were conservatively neglected.

14. The Containment compartment volumes were based on the following: Upper Compartment 651,000 ft^3; Lower Compartment 248,500 ft^3; and Dead-Ended Compartment 129,900 ft^3.

15. The operation of one containment spray heat exchanger (Overall conductance (UA) = 2.953 * 10^6 Btu/hr-°F) for containment cooling and the operation of one RHR heat exchanger (UA = 1.402 * 10^6 Btu/hr-°F) for core cooling. The component cooling heat exchanger was modeled at 2.793 * 10^6 Btu/hr-°F. All heat exchangers were modeled as strictly counterflow heat exchangers.

16. The air return fan returns air at a rate of 40,000 cfm from the upper to the lower compartment.

17. An active sump volume of 38,400 ft^3 is used.

18. 100.7% of 3455 MWt power is used in the calculations.

19. Subcooling of emergency core cooling (ECC) water from the RHR heat exchanger is assumed.

20. Nuclear service water flow to the containment spray heat exchanger was modeled as 3400 gpm. Also, the nuclear service water flow to the component cooling heat exchanger was modeled as 4000 gpm.

21. Decay Heat Model - On November 2, 1978 the Nuclear Power Plant Standards Committee (NUPPSCO) of the American Nuclear Society (ANS) approved ANS Standard 5.1 for the determination of decay heat. This standard was used in the mass and energy release model with the following input specific for the Sequoyah Units 1 and 2. The primary assumptions which make this calculation specific for the Sequoyah Units 1 and 2 are the enrichment factor, minimum/maximum new fuel loading per cycle, and a conservative end of cycle core average burnup. A conservative lower bound for enrichment of 3% was used. Table 1-2 lists the decay heat curve used in the Sequoyah Ice Weight Optimization analysis.

Significant assumptions in the generation of the decay heat curve:

A. Decay heat sources considered are fission product decay and heavy element decay of U-239 and N_p-239.

B. Decay heat power from the following fissioning isotopes are included; U-238, U-235 and Pu-239.

C. Fission rate is constant over the operating history of maximum power level.

D. The factor accounting for neutron capture in fission products has been taken from Equation 11 of Reference 2 (up to 10,000 seconds) and Table 10 of Reference 2 (beyond 10,000 seconds).

E. The fuel has been assumed to be at full power for 1096 days.

F. The number of atoms of U-239 produced per second has been assumed to be equal to 70% of the fission rate.

G. The total recoverable energy associated with one fission has been assumed to be 200 MeV/fission.

H. Two sigma uncertainty (two times the standard deviation) has been applied to the fission product decay.

22. Core stored energy based on the time in life for maximum fuel densification. The assumptions used to calculate the fuel temperatures for the core stored energy calculation account for appropriate uncertainties associated with the models in the PAD code (e.g., calibration of the thermal model, pellet densification model, cladding creep model, etc.). In addition, the fuel temperatures for the core stored energy calculation account for appropriate uncertainties associated with manufacturing tolerances (e.g., pellet as-built density). The total uncertainty for the fuel temperature calculation is a statistical combination of these effects and is dependent upon fuel type, power level, and burnup.

23. Reloads utilizing Mark-BW17 fuel with up to 96 fresh assemblies are bounded based on the evaluation provided in Reference 8.

24. Heat load addition (from energized equipment) for the hydrogen mitigation system (igniters) was modeled as 38.67 BTU/sec (Reference 12).

The minimum time at which the RHR pumps can be diverted to the RHR sprays are specified in the plant operating procedures as 60 minutes after the accident.

2.3 Structural Heat Removal

Provision is made in the containment pressure analysis for heat storage in interior and exterior walls. Each wall is divided into a number of nodes. For each node, a conservation of energy equation expressed in finite difference form accounts for transient conduction into and out of the node and temperature rise of the node for the containment structural heat sinks used in the analysis. The heat sink and material property data used are found in Tables 2-1 and 2-2.

The heat transfer coefficient to the containment structure is based primarily on the work of Tagami (Reference 7). When applying the Tagami correlations, a conservative limit was placed on the lower compartment stagnant heat transfer coefficients. They were limited to a steam-air ratio of 1.4 according to the Tagami correlation. The imposition of this limitation is to restrict the use of the Tagami correlation within the test range of steam-air ratios where the correlation was derived.

With these assumptions, the heat removal capability of the containment is sufficient to absorb the energy releases and still keep the maximum calculated pressure below the design pressure.

2.4 Analysis Results

The results of the analysis show that the maximum calculated containment pressure is 11.48 psig, for the double-ended pump suction minimum safeguards break case. This pressure peak occurs at approximately 3112.8 seconds, with ice bed meltout at approximately 3272.3 seconds.

The ice bed meltout occurred at 3272.3 seconds, containment spray switchover to sump recirculation is completed at 3113 seconds, thus the containment spray switchover ice bed meltout time relationship is 159.3 seconds.

The following plots show the containment integrity transient, as calculated by the LOTIC-1 code.

Figure 2-1, Containment Pressure Transient
Figure 2-2, Upper Compartment Temperature Transient
Figure 2-3, Lower Compartment Temperature Transient
Figure 2-4, Active and Inactive Sump Temperature Transient
Figure 2-5, Ice Melt Transient

Tables 2-3 and 2-4 give energy accountings at various points in the transient. Table 2-5 provides the sequence of events, which includes results calculated in Appendix A.

2.5 Relevant Acceptance Criteria

The LOCA mass and energy analysis has been performed in accordance with the criteria shown in Standard Review Plan (SRP) subsection 6.2.1.3. In this analysis, the relevant requirements of General Design Criterion (GDC) 50 and the Code of Federal Regulations (CFR) 10 CFR Part 50 Appendix K have been included by confirmation that the calculated pressure is less than the design pressure, and because all available sources of energy have been included. These sources include reactor power, decay heat, core stored energy, and energy stored in the reactor vessel and internals, metal-water reaction energy, and stored energy in the secondary system.

The containment integrity peak pressure analysis has been performed in accordance with the criteria shown in the SRP Section 6.2.1.1.b, for ice condenser containments. Conformance to GDC's 16, 38, and 50 is demonstrated by showing that the containment design pressure is not exceeded at any time in the transient. This analysis also demonstrates that the containment heat removal systems function to rapidly reduce the containment pressure and temperature in the event of a LOCA.

A calculated peak containment pressure of 12.0 psig or less will demonstrate satisfaction of the criteria for Sequoyah Units 1 and 2 relative to containment design pressure. In addition, the margin of time between the completion of containment spray realignment and ice bed meltout of ≥ 150 seconds (based upon an initial ice mass of 2,247,250 lbm) is met.

2.6 Conclusions

Based upon the information presented in this report, it may be concluded that operation with an initial ice weight of 2,247,250 pounds for the Sequoyah Nuclear Plant is acceptable. Operation with an initial ice mass of 2,247,250 pounds results in a calculated peak containment pressure of 11.48 psig, as compared to the design pressure of 12.0 psig. Further, the ice bed mass of 2,247,250 pounds equates to an approximate average of 1,156 lbm per basket. This average value recognizes that all baskets may not have the same initial weight nor have the same sublimation rate. To ensure that a sufficient quality of ice exists in each basket to survive the blowdown phase of a LOCA, a minimum amount of ice per basket to survive the blowdown would be approximately 336.9 lbm, based on Table 2-3. To ensure that an adequate distribution of ice exists in the ice condenser to prevent early burn-through of a localized area, 336.9 lbm of ice should be the minimum weight per basket at any time while also ensuring that the average weight per basket remains above 1,156 lbm.

3.0 REFERENCES

1. WCAP-12455, Revision 1, "TENNESSEE VALLEY AUTHORITY SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2 CONTAINMENT INTEGRITY ANALYSES FOR ICE WEIGHT OPTIMIZATION ENGINEERING REPORT," September 1995.

2. ANSI/ANS-5.11979, "American National Standard for Decay Heat Power in Light Water Reactors," August 1979.

3. WCAP-12455, Revision 1, Supplement 1R, "TENNESSEE VALLEY AUTHORITY SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2 CONTAINMENT INTEGRITY REANALYSES ENGINEERING REPORT," September, 2001.

4. "Long Term Ice Condenser Containment Code - LOTIC Code," WCAP-8354-P-A, April 1976 (Proprietary), WCAP-8355-A (Non-Proprietary).

5. WCAP-8110, Supplement 6, (Non-Proprietary), "Test Plans and Results for the Ice Condenser system, Ice condenser Full-Scale Section Test at the Waltz Mill Facility," May 1974.

6. "Westinghouse LOCA Mass and Energy Release Model for Containment Design March 1979 Version," WCAP-10325-P-A, May 1983 (Proprietary), WCAP-10326-A (Non-Proprietary).

7. Tagami, Takasi, Interim Report on Safety Assessments and Facilities Establishment Project in Japan for Period Ending June, 1965 (No. 1).

8. TVA-01-113, John W Irons (W) to Mr. D. L. Lundy (TVA),"Tennessee Valley Authority, Sequoyah Units 1 and 2, Transmittal - Wesdyne Letter NDP-01-0367, 'Revision to LOCA M&E Confirmation for Sequoyah Tritium Production Core Designs,'" August 21, 2001.

9. NSAL-11-5, "Westinghouse LOCA Mass and Energy Release Calculation Issues," July 26, 2011.

10. NSAL-06-6, "LOCA Mass and Energy Release Analysis," June 6, 2006.

11. NSAL-14-2, "Westinghouse Loss-of-Coolant Accident Mass and Energy Release Calculation Issue for Steam Generator Tube Material Properties, March 31, 2014.

12. TVA Letter N10656 from William J. Pierce (TVA) to Mr. Ronald Kucharski (Westinghouse), "Sequoyah Nuclear Plant Units 1 and 2 - Nuclear Steam Supply System Master Services Agreement - CONTRACT No. 4411 - LETTER N10656 Purchase Order No. 718845 – Large Break Loss-of-Coolant Accident Long Term Containment Integrity Analysis – N2N-081," August 12, 2014.

Table 2-1 Sequoyah Units 1 and 2 Structural Heat Sink Table

	Upper Compartment	Area (Ft^2)	Thickness (Ft)
1.	Operating Deck	4,880	
	Concrete		1.007
2.	Crane Wall	18,280	
	Paint		0.0005
	Concrete		1.2985
3.	Refueling Canal (Steel Lined)	3,840	
	Stainless Steel		0.02083
	Concrete		1.5
4.	Operating Deck	760	
	Paint		0.00125
	Concrete		1.5
5.	Containment Shell & Misc. Steel	49,960	
	Paint		0.000625
	Steel		0.0403
6.	Misc. Steel	2,260	
	Paint		0.000625
	Steel		0.121
Lower Compartment			
7.	Operating Deck, Crane Wall & Interior Concrete	32,200	
	Concrete		1.415
8.	Area in Contact with Sump Water	15,540	
	Concrete		1.604
9.	Interior Concrete	3,590	
	Paint		0.0011
	Concrete		1.499
10.	Reactor Cavity	2,270	
	Stainless Steel		0.02082
	Concrete		2.0

Table 2-1 Sequoyah Units 1 and 2
Structural Heat Sink Table (Continued)

Lower Compartment (Continued)		Area (Ft^2)	Thickness (Ft)
11.	Containment Shell & Misc. Steel	19,500	
	Paint		0.000625
	Steel		0.04953
12.	Misc. Steel	9,000	
	Paint		0.000625
	Steel		0.1008
Ice Condenser			
13.	Ice Basket	149,600	
	Steel		0.00663
14.	Lattice Frames	75,865	
	Steel		0.0217
15.	Lower Support Structure	28,670	
	Steel		0.0587
16.	Ice Condenser Floor	3,336	
	Paint		0.000833
	Concrete		0.33
17.	Containment Wall Panels & Containment Shell	19,100	
	Steel & Insulation		1.0
	Steel		0.0625
18.	Crane Wall Panels & Crane Wall	13,055	
	Composite Panel (Steel and Insulation)		1.2
	Concrete		1.0

Table 2-2 Sequoyah Units 1 and 2
Material Properties Table

Material	Thermal Conductivity Btu/hr - ft -°F	Volumetric Heat Btu/ft^3 -°F
$Paint_1$	0.2	14.0
$Paint_2$	0.0833	28.4
Concrete	0.8	28.8
Stainless Steel	9.4	56.35
Carbon Steel	26.0	56.35
Steel and Insulation Composite Panel on Steel (Ice Condenser)	0.15	2.75
Steel and Insulation Composite Panel on Concrete (Ice Condenser)	0.25	3.663

Note: $Paint_1$ = on steel $Paint_2$ = on concrete

Table 2-3 Sequoyah Units 1 and 2 Energy Accounting

	Approx.† End of Blowdown (t = 10.0 Seconds)	Approx.†† End of Reflood (t = 228.1 Seconds)
	(In Millions of Btus)	
Ice Heat Removal	199.212	254.662
Structural Heat Sinks *	16.784	54.255
RHR Heat Exchanger Heat Removal *	0.00	0.00
Spray Heat Exchanger Heat Removal *	0.00	0.00
Energy Content of Sump	186.951	235.714
Ice Melted (Pounds)(10^6)	0.6549	0.8825

* Integrated Energies

†- End of Blowdown is redefined in LOTIC-1 to occur at 10 seconds, per results from the Waltz Mill Ice condenser test.

††- The approximate time is the time closest to the event that is captured in the LOTIC-1 code major print out. Table 2-5 provides the actual sequence of events.

Table 2-4 Sequoyah Units 1 and 2 Energy Accounting

	Approx.†† Time of Peak Pressure (t = 3112.8 Seconds)	Approx.†† Time of Ice Melt (t = 3272.3 Seconds)
	(In Millions of Btus)	
Ice Heat Removal	587.510	587.874
Structural Heat Sinks *	67.118	71.915
RHR Heat Exchanger Heat Removal *	14.473	15.917
Spray Heat Exchanger Heat Removal *	0.0	2.878
Energy Content of Sump	669.023	668.420
Ice Melted (Pounds)(10^6)	2.2457	2.247250

* Integrated Energies

††- The approximate time is the time closest to the event that is captured in the LOTIC-1 code major print out. Table 2-5 provides the actual sequence of events.

Table 2-5 Sequoyah Units 1 and 2 Double Ended Pump Suction LOCA Minimum Safeguards Sequence of Events

Event	Time (sec)
Rupture	0.00
Accumulator Flow Starts	14.5
End of Blowdown	32.40
Assumed Initiation of ECCS	29.76
Accumulators Empty	62.06
End of Reflood	228.1
Assumed Initiation of Spray System	250.0
Low Level Alarm from Refueling Water Storage Tank	1681.0
Start of ECCS Cold Leg Recirculation	1691
Low-Low Level Alarm from RWST - Sprays Stopped	2803.0
Peak Containment Pressure	3112.8
Spray Pumps Restart in Recirculation Mode	3113.0
Ice Bed Meltout	3272.3
RHR Spray Realignment	3600.0

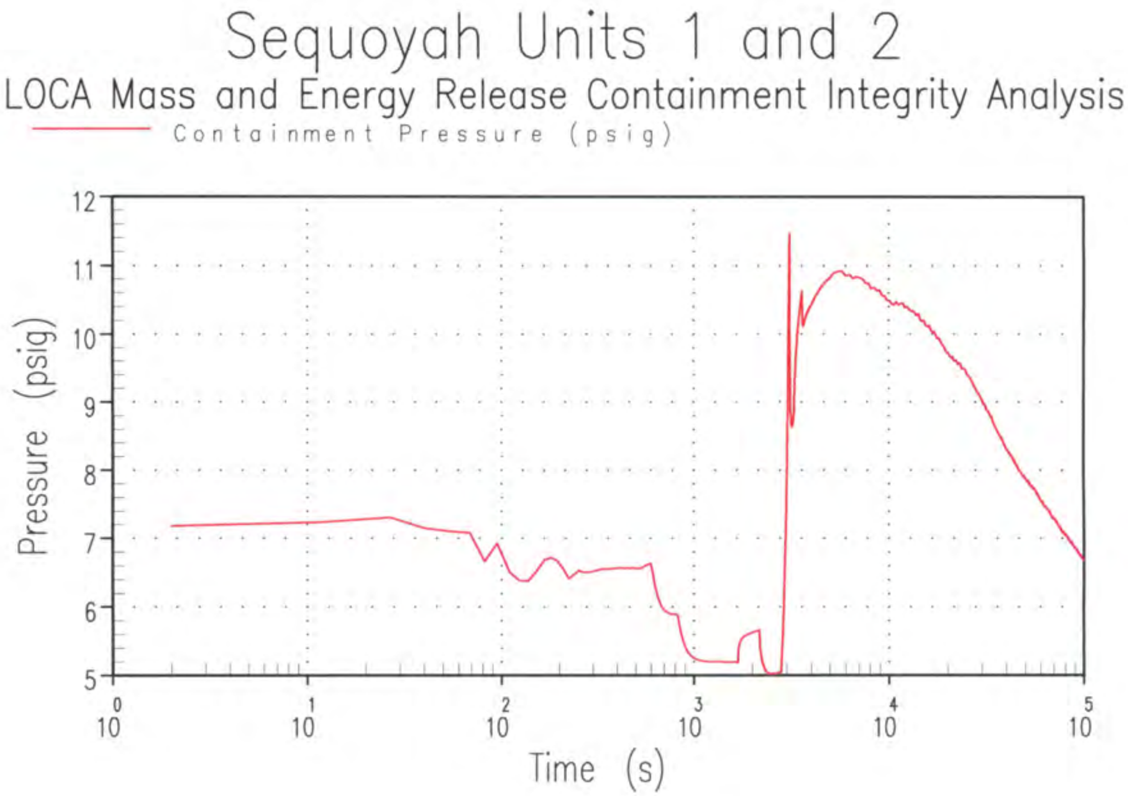

Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Containment Pressure (psig)
Pressure (psig)
12
11
10
9
8
7
6
5
Time (s)
10^0
10^1
10^2
10^3
10^4
10^5

Figure 2-1

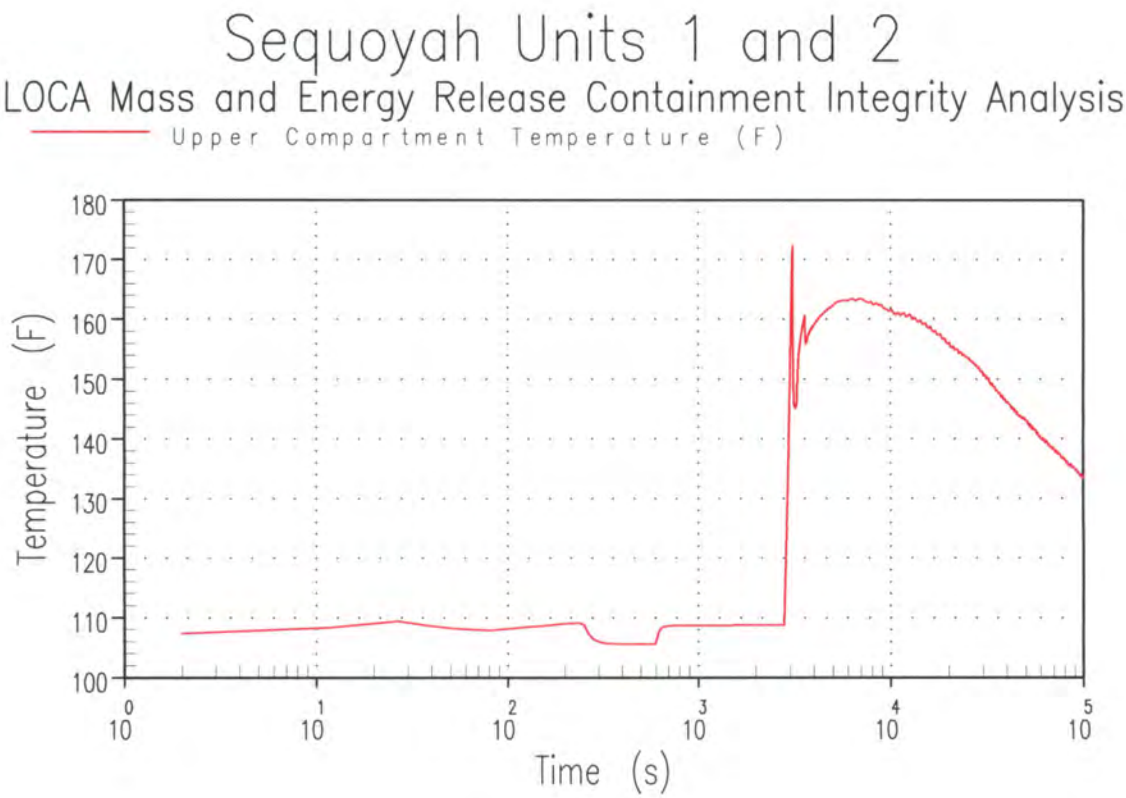

Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Upper Compartment Temperature (F)
Temperature (F)
180
170
160
150
140
130
120
110
100
10^0
10^1
10^2
10^3
10^4
10^5
Time (s)

Figure 2-2

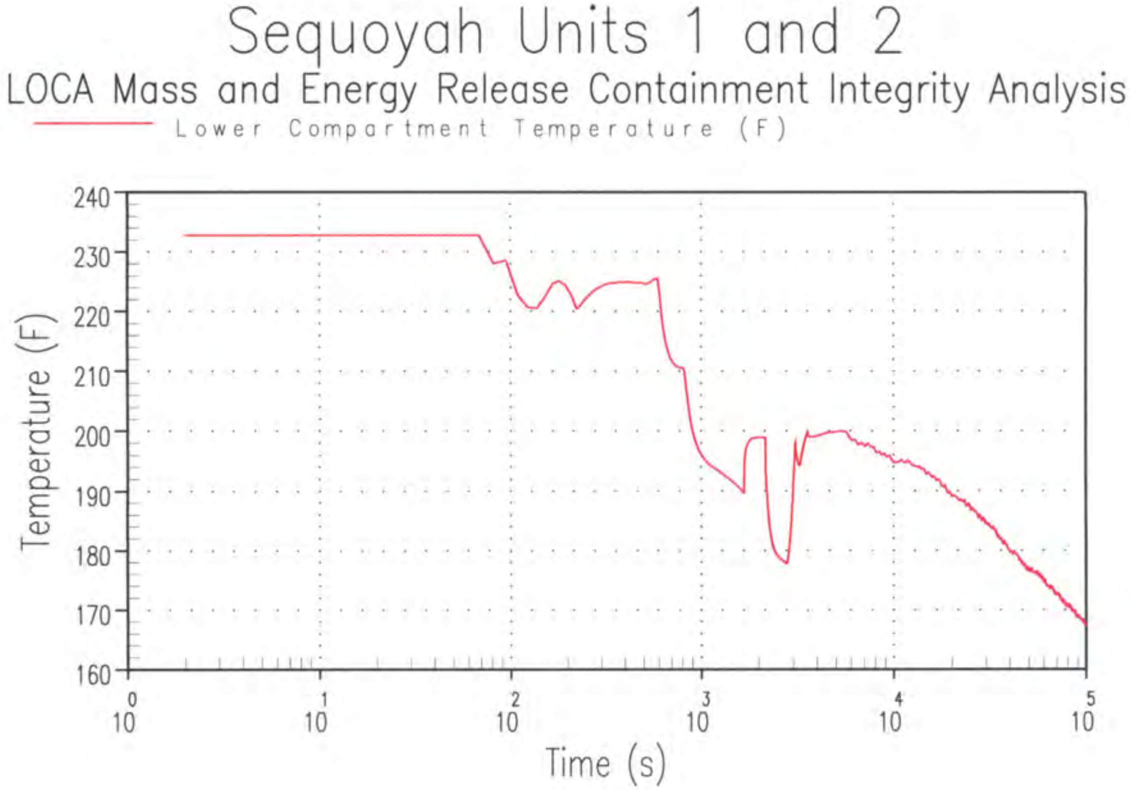

Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Lower Compartment Temperature (F)
240
230
220
210
200
190
180
170
160
Temperature (F)
10^0
10^1
10^2
10^3
10^4
10^5
Time (s)

Figure 2-3

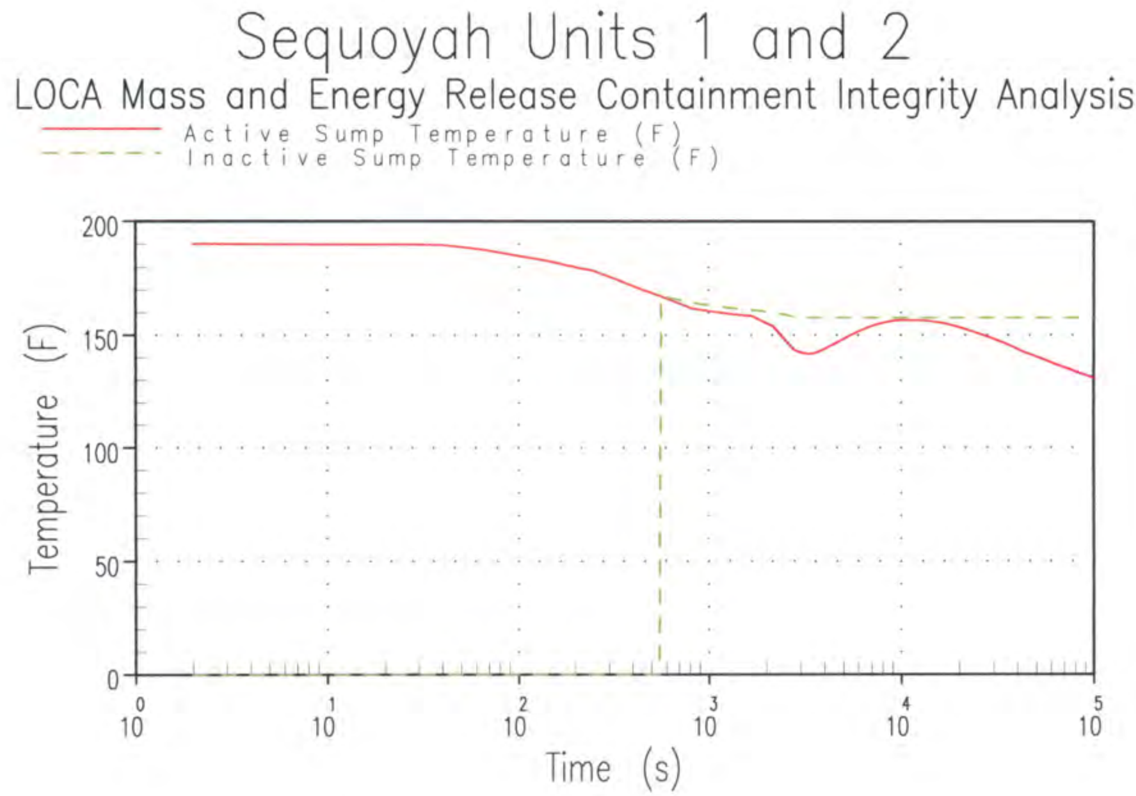

Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Active Sump Temperature (F)
Inactive Sump Temperature (F)
200
150
100
50
0
Temperature (F)
10^0
10^1
10^2
10^3
10^4
10^5
Time (s)

Figure 2-4

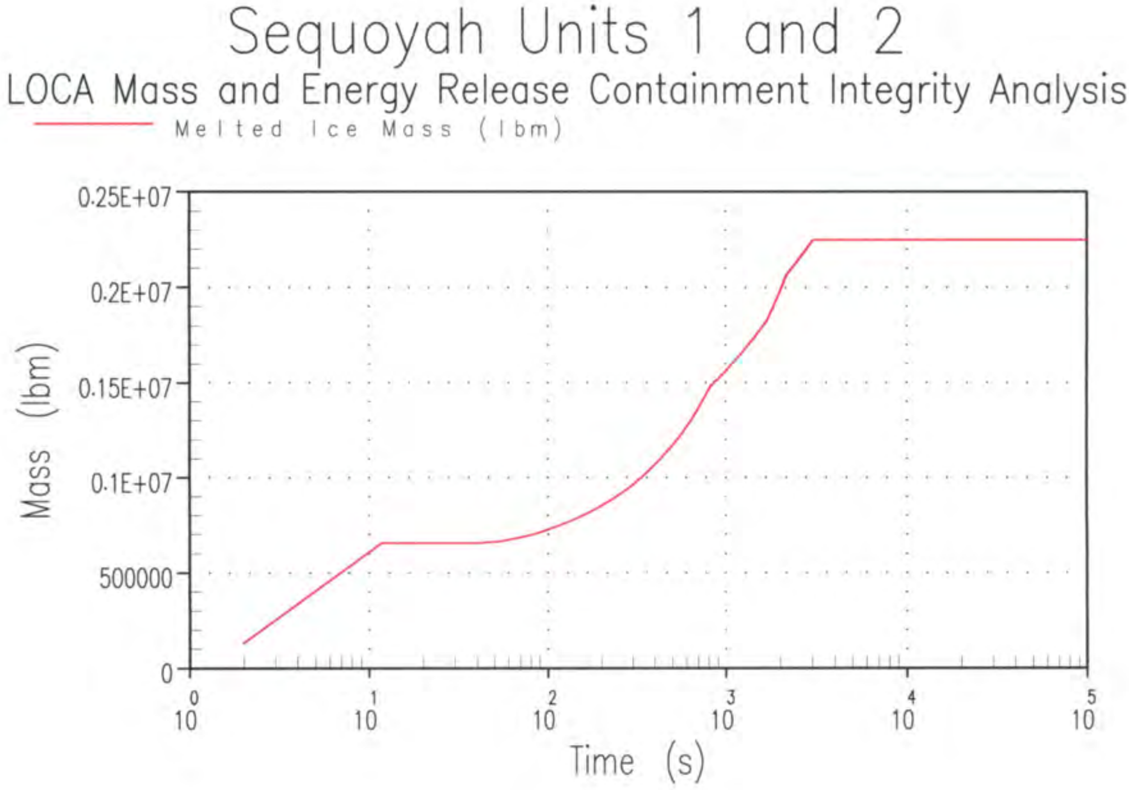

Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Melted Ice Mass (lbm)
0.25E+07
0.2E+07
0.15E+07
0.1E+07
500000
0
Mass (lbm)
10^0
10^1
10^2
10^3
10^4
10^5
Time (s)

Figure 2-5

APPENDIX A – LOCA Mass and Energy Release

Introduction

The evaluation model used for the long-term LOCA mass and energy release calculations is the March 1979 model described in Reference 1. This evaluation model has been reviewed and approved by the Nuclear Regulatory Commission (NRC) (References 1 and 2), and has been used in the analysis of other ice condenser plants.

This report section presents the long-term LOCA mass and energy (M&E) releases that were generated in support of recent issues reported in NSAL-11-5 (Reference 11), NSAL-06-6 (Reference 12), and NSAL-14-2 (Reference 13). These mass and energy releases are then subsequently used in the LOTIC-1 computer code (Reference 3) for containment integrity analysis peak pressure calculations.

Purpose of Analysis

The purpose of the analysis was to calculate the long-term LOCA mass and energy releases and the subsequent containment integrity response in order to support recent changes to the Westinghouse computer code, EPITOME, i.e., NSAL-11-5 (Reference 11), and to correct steam generator tube material properties as identified in NSAL-14-2 (Reference 13). In addition, for a comprehensive reconciliation of all issues relative to the LOCA mass and energy release analysis of record (AOR) all appropriate corrections relative to NSAL-06-6 (Reference 12) were also addressed. This LOCA M&E release analysis bounds both Units 1 and 2 with Model 57 AG RSGs.

This effort will address current Sequoyah Units 1 and 2 specific plant conditions and revised models as a means of using available analytical margins and minimizing the effect on the amount of ice required in the ice condenser. The objective of performing the long-term LOCA mass and energy release and LOCA containment integrity analysis will be to minimize the effect on the initial ice mass, to maintain the current time interval (150 seconds, minimum) relationship between containment spray switchover time and ice bed meltout time, and to provide peak pressure margin to design pressure.

A key element in minimizing the impact on initial ice mass was reducing the energy available to containment in the event of a LOCA. Areas such as core stored energy, decay heat, and available steam generator metal heat were investigated and available margins were implemented into the analysis. These margins combined with a better segmental representation of the mass and energy release transient from the computer models resulted in margins that reduced energy input into containment.

The following are the analytical bases and the results, which show that the containment design pressure is not exceeded in the event of a LOCA. The conclusions presented will demonstrate, with respect to a LOCA, that containment integrity has not been compromised. Further, since the LOCA requires the greatest amount of ice compared to other accident scenarios, the initial ice mass based on LOCA results will be acceptable for the other accident scenarios.

Rupture of any of the piping carrying pressurized high temperature reactor coolant, termed a

LOCA, will result in release of steam and water into the containment. This will lead to an increase in the containment pressure and temperature. The mass and energy release rates described in this document form the basis of further computations to evaluate the structural integrity of the containment following a postulated accident in order to satisfy the Nuclear Regulatory Commission (NRC) acceptance criterion, General Design Criterion 38. Subsection 1.4 presents the long-term LOCA mass and energy release analysis for containment pressurization evaluations. Section 2 presents the LOCA containment pressure calculations.

System Characteristics and Modeling Assumptions

The mass and energy release analysis is sensitive to the assumed characteristics of various plant systems, in addition to other key modeling assumptions. Some of the most critical items are Reactor Coolant System (RCS) initial conditions, core decay heat, safety injection flow, and metal and steam generator heat release modeling. Specific assumptions concerning each of these items are discussed below. Tables 1-1 through 1-3 present key data assumed in the analysis. The data provided in References 2 and 3 was used, in part, to develop the plant data presented in Tables 1-1 through 1-3.

For the long-term mass and energy release calculations, operating temperatures to bound the highest average coolant temperature range were used. The core rated power of 3,455 MWt adjusted for calorimetric error (+0.7 percent of power) was modeled in the analysis. The use of higher temperatures is conservative because the initial fluid energy is based on coolant temperatures, which are at the maximum levels attained in steady-state operation. Additionally, an allowance of +5.5°F is reflected in the vessel/core temperature in order to account for instrument error and deadband. The initial RCS pressure in this analysis is based on a nominal value of 2,250 psia. Also included is an allowance of +50 psi, which accounts for the measurement uncertainty on pressurizer pressure. The selection of 2,300 psia as the limiting pressure is considered to affect the blowdown phase results only, since this represents the initial pressure of the RCS. The RCS rapidly depressurizes from this value until the point at which it equilibrates with containment pressure.

The rate at which the RCS depressurizes is initially more severe at the higher RCS pressure. Additionally, the RCS has a higher fluid density at the higher pressure (assuming a constant temperature) and subsequently has a higher RCS mass available for releases. Therefore, 2,300 psia initial pressure was selected as the limiting case for the long-term LOCA mass and energy release calculations. These assumptions conservatively maximize the mass and energy in the RCS.

The selection of the fuel design features for the long-term LOCA mass and energy calculation is consistent with the analysis of record (Reference 10), based on the need to conservatively maximize the core stored energy. The margin in core stored energy was chosen to be +15 percent. Thus, the analysis fuel conditions were adjusted to provide a bounding analysis for Westinghouse Standard 17X17 and V5H fuel for Sequoyah Units 1and 2. The following items serve as the basis to ensure conservatism in the core stored energy calculation:

- A conservatively high reload core loading
- Time of maximum fuel densification, that is, highest beginning-of-life (BOL) temperatures
- Irradiated fuel assemblies assumed to have an average burnup >15,000 MWD/MTU

Regarding safety injection flow, the mass and energy calculation considered the historically limiting configuration of minimum safety injection flow.

The following summarized assumptions were employed to ensure that the mass and energy releases were conservatively calculated, thereby maximizing energy release to containment:

1. Maximum expected operating temperature of the reactor coolant system (RCS) (100-percent full-power conditions)

2. An allowance in temperature for instrument error and deadband assumed on the vessel/core inlet temperature (+5.5°F)

3. Margin in volume of 3 percent (which is composed of a 1.6-percent allowance for thermal expansion, and a 1.4-percent allowance for uncertainty)

4. Core rated power of 3,455 MWt

5. Allowance for calorimetric error (+0.7 percent of power)

6. Conservative coefficient of heat transfer (that is, steam generator primary/secondary heat transfer and RCS metal heat transfer)

7. Core-stored energy based on the time in life for maximum fuel densification. The assumptions used to calculate the fuel temperatures for the core-stored energy calculation account for appropriate uncertainties associated with the models in the PAD code (such as calibration of the thermal model, pellet densification model, or cladding creep model). In addition, the fuel temperatures for the core-stored energy calculation account for appropriate uncertainties associated with manufacturing tolerances (such as pellet as-built density). The total uncertainty for the fuel temperature calculation is a statistical combination of these effects and is dependent upon fuel type, power level, and burnup.

8. An allowance for RCS initial pressure uncertainty (+50 psi)

9. A maximum containment backpressure equal to design pressure

10. The steam generator metal mass was modeled to include all portions of the steam generators that are in contact with the fluid on the secondary side. In active portions of the steam generators such as the elliptical head, upper shell, and miscellaneous internals (poor heat transfer due to location) were conservatively assumed available for release to containment. [Model 57 AG RSG is considered bounded by Model 51 OSG in analysis, i.e., due to total energy content.)

11. A provision for modeling steam flow in the secondary side through the steam generator turbine stop valve was conservatively addressed only at the start of the event. A turbine stop valve isolation time equal to 1.19 seconds was used.

12. As noted in Section 2.4 of Reference 4, the option to provide more specific modeling pertaining to decay heat has been exercised to specifically reflect the Sequoyah Nuclear Plant Units 1 and 2 core heat generation, while retaining the two sigma uncertainty to assure conservatism (see Table 1-2).

13. Steam generator tube plugging leveling (0-percent uniform)

    a. Maximizes reactor coolant volume and fluid release

    b. Maximizes heat transfer area across the steam generators tubes

    c. Reduces coolant loop resistance, which reduces the Δp upstream of the break and increases break flow

Therefore, based on the previously noted conditions and assumptions, a bounding analysis of the Sequoyah Nuclear Plant Units 1 and 2 was performed for the release of mass and energy from the RCS in the event of a LOCA.

LOCA Mass and Energy Release Phases

The containment system receives mass and energy releases following a postulated rupture in the RCS. These releases continue over a time period, which is typically divided into four phases:

1. Blowdown – the period of time from accident initiation (when the reactor is at steady-state operation) to the time that the RCS and containment reach an equilibrium state at containment design pressure.

2. Refill – the period of time when the reactor vessel lower plenum is being filled by accumulator and Emergency Core Cooling System (ECCS) water. At the end of blowdown, a large amount of water remains in the cold legs, downcomer, and lower plenum. To conservatively consider the refill period for the purpose of containment mass and energy releases, it is assumed that this water is instantaneously transferred to the lower plenum along with sufficient accumulator water to completely fill the lower plenum. This allows an uninterrupted release of mass and energy to containment. Therefore, the refill period is conservatively neglected in the mass and energy release calculation.

3. Reflood – begins when the water from the reactor vessel lower plenum enters the core and ends when the core is completely quenched.

4. Post-reflood (froth) – describes the period following the reflood transient. For the pump suction break, a two-phase mixture exits the core, passes through the hot legs, and is superheated in the steam generators prior to release to containment. After the broken loop steam generator cools, the break flow becomes two-phase.

Computer Codes

The Reference 1 mass and energy release evaluation model is comprised of mass and energy

release versions of the following codes: SATAN-VI, WREFLOOD, FROTH, and EPITOME. These codes were used to calculate the long-term LOCA mass and energy releases for Sequoyah Units 1 and 2.

The SATAN-VI code calculates blowdown (the first portion of the thermal-hydraulic transient following break initiation), including pressure, enthalpy, density, mass, energy flow rates, and energy transfer between primary and secondary systems as a function of time.

The WREFLOOD code addresses the portion of the LOCA transient where the core reflooding phase occurs after the RCS has depressurized (blowdown) due to the loss of water through the break and when water supplied by the ECCS refills the reactor vessel and provides cooling to the core. The most important feature is the steam/water mixing model (see subsection Reflood Mass and Energy Release Data).

The FROTH code models the post-reflood portion of the transient. The FROTH code is used for the steam generator heat addition calculation from the broken and intact loop steam generators.

The EPITOME code continues the FROTH post-reflood portion of the transient from the time at which the secondary side equilibrates to containment design pressure to the end of the transient. It also compiles a summary of data on the entire transient, including formal instantaneous mass and energy release tables and mass and energy balance tables with data at critical times.

Break Size and Location

Generic studies (Reference 1, Section 3.3) have been performed with respect to the effect of postulated break size on the LOCA mass and energy releases. The double-ended guillotine break has been found to be limiting due to larger mass flow rates during the blowdown phase of the transient. During the reflood and froth phases, the break size has little effect on the releases.

Three distinct locations in the RCS loop can be postulated for pipe rupture:

1. Hot leg (between vessel and steam generator)
2. Cold leg (between pump and vessel)
3. Pump suction (between steam generator and pump)

The limiting break location analyzed for the EPITOME reanalysis is the double-ended pump suction guillotine (DEPSG) (10.46 ft^2). Break mass and energy releases have been calculated for the blowdown, reflood, and post-reflood phases of the LOCA for each case analyzed. The following paragraphs provide a discussion on each break location.

The hot leg double-ended guillotine has been shown in previous studies (Reference 1, Section 3.3) to result in the highest blowdown mass and energy release rates. Although the core flooding rate would be the highest for this break location, the amount of energy released from the steam generator secondary is minimal because the majority of the fluid that exits the core bypasses the steam generators, venting directly to containment. As a result, the reflood mass and energy releases are reduced significantly as compared to either the pump suction or cold leg break locations, where the core exit mixture must pass through the steam generators before venting through the break. For the hot leg break, generic studies have confirmed that there is no

reflood peak (that is, from the end of the blowdown period the containment pressure would continually decrease). The mass and energy releases for the hot leg break have not been included in the scope of this containment integrity analysis because, for the hot leg break, only the blowdown phase of the transient is of any significance. Since there are no reflood or post-reflood phases to consider, the limiting peak pressure calculated would be the compression peak pressure and not the peak pressure following ice bed meltout.

The cold leg break location has been found in previous studies (Reference 1, Section 3.3) to be much less limiting in terms of the overall containment energy releases. The cold leg blowdown is faster than that of the pump suction break, and more mass is released into the containment. However, the core heat transfer is greatly reduced, and this results in a considerably lower energy release into containment. Studies have determined that the blowdown transient for the cold leg is less limiting than that for the pump suction break. During cold leg reflood, the flooding rate is greatly reduced and the energy release rate into the containment is reduced. Therefore, the cold leg break is not included in the scope of this program.

The pump suction break combines the effects of the relatively high core flooding rate, as in the hot leg break, and the addition of the stored energy in the steam generators. As a result, the pump suction break yields the highest energy flow rates during the post-blowdown period by including all of the available energy of the RCS in calculating the releases to containment. This break has been determined to be the limiting break for the Westinghouse-design ice condenser plants.

In summary, the analysis of the limiting break location for an ice condenser containment has been performed and is shown in this report. The DEPSG break has historically been considered to be the limiting break location, by virtue of its consideration of all energy sources in the RCS. This break location provides a mechanism for the release of the available energy in the RCS, including both the broken and intact loop steam generators.

Application of Single-Failure Criteria

An analysis of the effects of the single-failure criteria has been performed on the mass and energy release rates for the DEPSG break. An inherent assumption in the generation of the mass and energy release is that offsite power is lost. This results in the actuation of the emergency diesel generators, required to power the Safety Injection System. This is not an issue for the blowdown period, which is limited by the compression peak pressure.

The limiting minimum safety injection case has been analyzed for the effects of a single-failure. In the case of minimum safeguards, the single failure postulated to occur is the loss of an emergency diesel generator. This results in the loss of one pumped safety injection train, that is, ECCS pumps and heat exchangers.

Mass and Energy Release Data

Blowdown Mass and Energy Release Data

The February 1978 version of the SATAN-VI code is used for computing the blowdown transient (Reference 4). This version of SATAN-VI is licensed with the Reference 1 model and has been used for previous Sequoyah Nuclear Plant Units 1 and 2 LOCA mass and energy release calculations.

The SATAN-VI code utilizes the control volume (element) approach with the capability for modeling a large variety of thermal fluid system configurations. The fluid properties are considered uniform and thermodynamic equilibrium is assumed in each element. A point kinetics model is used with weighted feedback effects.

The major feedback effects include moderator density, moderator temperature, and Doppler broadening. A critical flow calculation for subcooled (modified Zaloudek), two-phase (Moody), or superheated break flow is incorporated into the analysis. The methodology for the use of this model is described in Reference 1.

Table A-1 presents the calculated LOCA mass and energy releases for the blowdown phase of the DEPSG break. For the pump suction breaks, break path 1 in the mass and energy release tables refers to the mass and energy exiting from the steam generator side of the break; break path 2 refers to the mass and energy exiting from the pump side of the break.

Reflood Mass and Energy Release Data

The WREFLOOD code used for computing the reflood transient is a modified version of that used in the 1981 ECCS evaluation model, Reference 4.

The WREFLOOD code consists of two basic hydraulic models – one for the contents of the reactor vessel and one for the coolant loops. The two models are coupled through the interchange of the boundary conditions applied at the vessel outlet nozzles and at the top of the downcomer. Additional transient phenomena, such as pumped safety injection and accumulators, reactor coolant pump performance, and steam generator release are included as auxiliary equations that interact with the basic models as required. The WREFLOOD code permits the capability to calculate variations (during the core reflooding transient) of basic parameters such as core flooding rate, core and downcomer water levels, fluid thermodynamic conditions (pressure, enthalpy, density) throughout the primary system, and mass flow rates through the primary system. The code permits hydraulic modeling of the two flow paths available for discharging steam and entrained water from the core to the break; that is, the path through the broken loop and the path through the unbroken loops.

A complete thermal equilibrium mixing condition for the steam and emergency core cooling injection water during the reflood phase has been assumed for each loop receiving ECCS water. This is consistent with the usage and application of the Reference 1 mass and energy release evaluation model. Even though the Reference 1 model credits steam/mixing only in the intact loop and not in the broken loop, justification, applicability, and NRC approval for using the mixing model in the broken loop has been documented (Reference 5). This assumption is justified and supported by test data, and is summarized as follows.

The model assumes a complete mixing condition (thermal equilibrium) for the steam/water interaction. The complete mixing process is made up of two distinct physical processes. The first is a two-phase interaction with condensation of steam by cold ECCS water. The second is a single-phase mixing of condensate and ECCS water. Since the steam release is the most important influence to the containment pressure transient, the steam condensation part of the mixing process is the only part that need be considered. (Any spillage directly heats only the sump.)

The most applicable steam/water mixing test data has been reviewed for validation of the containment integrity reflood steam/water mixing model. This data is generated in 1/3 scale tests (Reference 6), which are the largest scale data available and thus most clearly simulate the flow regimes and gravitational effects that would occur in a pressurized water reactor (PWR). These tests were designed specifically to study the steam/water interaction for PWR reflood conditions.

From the entire series of 1/3 scale tests, one group corresponds almost directly to containment integrity reflood conditions. The injection flow rates from this group cover all phases and mixing conditions calculated during the reflood transient. The data from these tests were reviewed and discussed in detail in Reference 1. For all of these tests, the data clearly indicate the occurrence of very effective mixing with rapid steam condensation. The mixing model used in the containment integrity reflood calculation is therefore wholly supported by the 1/3 scale steam/water mixing data.

Additionally, the following justification is also noted. The post-blowdown limiting break for the containment integrity peak pressure analysis is the DEPSG break. For this break, there are two flow paths available in the RCS by which mass and energy may be released to containment. One is through the outlet of the steam generator; the other is via reverse flow through the reactor coolant pump. Steam that is not condensed by ECCS injection in the intact RCS loops passes around the downcomer and through the broken loop cold leg and pump in venting to containment. This steam also encounters ECCS injection water as it passes through the broken loop cold leg, complete mixing occurs, and a portion of it is condensed. It is this portion of steam, which is condensed, for which this analysis takes credit. This assumption is justified based upon the postulated break location and the actual physical presence of the ECCS injection nozzle. A description of the test and test results is contained in References 1 and 6.

Table A-2 presents the calculated mass and energy release for the reflood phase of the pump suction double ended rupture with minimum safety injection.

The transients of the principal parameters during reflood are given in Table A-5.

Post-Reflood Mass and Energy Release Data

The FROTH code (Reference 7) is used for computing the post-reflood transient.

The FROTH code calculates the heat release rates resulting from a two-phase mixture level present in the steam generator tubes. The mass and energy releases that occur during this phase are typically superheated due to the depressurization and equilibration of the broken loop and intact loop steam generators. During this phase of the transient, the RCS has equilibrated

with the containment pressure, but the steam generators contain a secondary inventory at an enthalpy that is much higher than the primary side. Therefore, a significant amount of reverse heat transfer occurs. Steam is produced in the core due to core decay heat. For a pump suction break, a two-phase fluid exits the core, flows through the hot legs, and becomes superheated as it passes through the steam generator. Once the broken loop cools, the break flow becomes two-phase. The methodology for the use of this model is described in Reference 1.

After steam generator depressurization/equilibration, the mass and energy release available to containment is generated directly from core boiloff/decay heat.

Table A-3 presents the two-phase post-reflood (froth) mass and energy release data for the pump suction double-ended break case.

Decay Heat Model

The American Nuclear Society (ANS) Standard 5.1 (Reference 8) was used in the LOCA mass and energy release model for the determination of decay heat energy. This standard was validated by the Nuclear Power Plant Standards committee (NUPPSCO) in October 1978 and subsequently approved. The official standard (Reference 8) was issued in August 1979.

Significant assumptions in the generation of the decay heat curve are the following:

1. Decay heat sources considered are fission product decay and heavy element decay of U-239 and Np-239.

2. Decay heat power from the following fissioning isotopes is included: U-238 (Reference 1), U-235, and Pu-239 (fissioning isotopes) are included.

3. Fission rate is constant over the operating history of maximum power level.

4. The factor accounting for neutron capture in fission products has been taken from Equation 11, of Reference 8 (up to 10,000 seconds) and Table 10 of Reference 8 (beyond 10,000 seconds).

5. The fuel has been assumed to be at full power for 1,096 days.

6. The number of atoms of U-239 produced per second has been assumed to be equal to 70 percent of the fission rate.

7. The total recoverable energy associated with one fission has been assumed to be 200 MeV/fission.

8. Two sigma uncertainty (two times the standard deviation) has been applied to the fission product decay.

Steam Generator Equilibration and Depressurization

Steam generator equilibration and depressurization is the process by which secondary-side energy is removed from the steam generators in stages. The FROTH computer code calculates the heat removal from the secondary mass until the secondary temperature is saturated at the containment design pressure. After the FROTH calculations, steam generator secondary energy is removed until the steam generator reaches T_{sat} at the user-specified intermediate equilibration pressure, when the secondary pressure is assumed to reach the actual containment pressure. The heat removal of the broken loop steam generator and intact loop steam generators are calculated separately.

During the FROTH calculations, steam generator heat removal rates are calculated using the secondary-side temperature, primary-side temperature, and a secondary-side heat transfer coefficient determined using a modified McAdam's correlation (Reference 9). Steam generator energy is removed during the FROTH transient until the secondary-side temperature reaches saturation temperature at the containment design pressure. The constant heat removal rate used is based on the final heat removal rate calculated by FROTH. The remaining steam generator energy available to be released is determined by calculating the difference in secondary energy available at the containment design pressure and that at the (lower) user-specified equilibration pressure, assuming saturated conditions. This energy is then divided by the energy removal rate, resulting in an equilibration time. The steam generator energy equilibrium model in the FROTH computer code as described above has been reviewed and approved by the NRC in References 1 and 3.

Sources of Mass and Energy

The sources of mass considered in the LOCA mass and energy release analysis are given in Table A-4a.

These sources are the RCS, accumulators, and pumped safety injection. The energy inventories considered in the LOCA mass and energy release analysis are given in Table A-4b. The energy sources include:

- RCS water
- Accumulator water
- Pumped injection water
- Decay heat
- Core-stored energy
- RCS metal – primary metal (includes steam generator tubes)
- Steam generator metal (includes transition cone, shell, wrapper, and other internals)
- Steam generator secondary energy (includes fluid mass and steam mass)
- Secondary transfer of energy (feedwater into and steam out of the steam generator secondary)

The mass and energy inventories are presented at the following times, as appropriate:

- Time zero (initial conditions)
- End of blowdown time
- End of refill time
- End of reflood time
- Time of broken loop steam generator equilibration to pressure setpoint
- Time of intact loop steam generator equilibration to pressure setpoint

The sequence of events for the DEPSG case is shown in Table 2-5.

The energy release from the Zirc-water reaction is considered as part of the Reference 1 methodology. Based on the way that the energy in the fuel is conservatively released to the vessel fluid, the fuel cladding temperature does not increase to the point where the Zirc-water reaction is significant. This is in contrast to the Code of Federal Regulations (CFR) 10 CFR 50.46 analyses, which are biased to calculate high fuel rod cladding temperatures and therefore a non-significant Zirc-water reaction. For the LOCA mass and energy calculation, the energy created by the Zirc-water reaction value is small and is not explicitly provided in the energy balance tables. The energy that is determined is part of the mass and energy releases and, therefore, is already included in the LOCA mass and energy release.

The consideration of the various energy sources in the mass and energy release analysis provides assurance that all available sources of energy have been included in this analysis. Therefore, the review guidelines presented in Standard Review Plan (SRP) Section 6.2.1.3 have been satisfied.

References

1. WCAP-10325-P-A, May 1983 (Proprietary) and WCAP-10326-A (Non-Proprietary), "Westinghouse LOCA Mass and Energy Release Model for Containment Design March 1979 Version."
2. Letter from Herbert N. Berkow (NRC) to James A. Gresham (Westinghouse), Subject – Acceptance of Clarifications of Topical Report WCAP-10325-P-A, "Westinghouse LOCA Mass and Energy Release Model for Containment Design – March 1979 Version" (TAC No. MC7980), October 18, 2005.
3. WCAP-8354-P-A, April 1976 (Proprietary) and WCAP-8355-A (Non-Proprietary), "LONG TERM ICE CONDENSER CONTAINMENT CODE – LOTIC CODE."
4. WCAP-9220-P-A, February 1978 (Proprietary) and WCAP-9221-A (Non-Proprietary), "Westinghouse ECCS Evaluation Model February 1978 Version."
5. Docket No. 50-315, "Amendment No. 126, Facility Operating License No. DPR-58 (TAC No. 71062), for D.C. Cook Nuclear Plant Unit 1," June 9, 1989.
6. EPRI 294-2, "Mixing of Emergency Core Cooling Water with Steam; 1/3-Scale Test and Summary," (WCAP-8423), Final Report, June 1975.
7. WCAP-8264-P-A, Revision 1, August 1975 (Proprietary) and WCAP-8312-A, Revision 2 (Non-Proprietary) "TOPICAL REPORT WESTINGHOUSE MASS AND ENERGY RELEASE DATA FOR CONTAINMENT DESIGN."
8. ANSI/ANS-5.1-1979, "American National Standard for Decay Heat Power in Light Water Reactors," August 1979.
9. W. H. McAdam, "Heat Transmission," McGraw-Hill 3rd edition, 1954, p.172.
10. WCAP-12455, Revision 1, Supplement 1R, "Tennessee Valley Authority Sequoyah Nuclear Plant Units 1 and 2 Containment Integrity Reanalysis Engineering Report," September 2001.
11. NSAL-11-5, "Westinghouse LOCA Mass and Energy Release Calculation Issues," July 26, 2011.
12. NSAL-06-6, "LOCA Mass and Energy Release Analysis," June 6, 2006.
13. NSAL-14-2, "Westinghouse Loss-of-Coolant Accident Mass and Energy Release Calculation Issue for Steam Generator Tube Material Properties, March 31, 2014.

Table 1-1 System Parameters Initial Conditions

Parameters	Value
Core Thermal Power (MWt)	3,455
Reactor Coolant System Flow Rate, per Loop (gpm)	91,400
Vessel Outlet Temperature(1) (°F)	609.7
Core Inlet Temperature(1) (°F)	546.7
Vessel Average Temperature(1) (°F)	578.2
Initial Steam Generator Steam Pressure (psia)	870
Steam Generator Design(2)	Model 51
Steam Generator Tube Plugging (%)	0
Initial Steam Generator Secondary-Side Mass (lbm)	114075
Accumulator	
Water Volume (ft^3)	1,017.977/tank plus 21.7 (average) per line
N2 Cover Gas Pressure (psig)	662
Temperature (°F)	130
Safety Injection Delay (sec) (includes time to reach pressure setpoint)	27.76
Auxiliary Feedwater Flow (gpm/steam generator)	220

Note:

1. Analysis value includes an additional +5.5°F allowance for instrument error and dead band.
2. Model 57 AG RSG is considered bounded by Model 51 OSG analytical model, i.e., relative to total energy content.

Table 1-2 System Parameters Decay Heat Curve

Time (sec)	Decay Heat (Btu/Btu)
10.	0.050708
14.	0.048246
20.	0.045658
40.	0.040710
60.	0.037863
80.	0.035877
100.	0.034382
140.	0.032242
200.	0.030132
400.	0.026430
600.	0.024288
800.	0.022747
1000.	0.021503
1600.	0.018850
2000.	0.017588
4000.	0.014057
6000.	0.012379
8000.	0.011403
10000.	0.010732
16000.	0.0098865
20000.	0.0093675
40000.	0.0079143
60000.	0.0071391
80000.	0.0066015
100000.	0.0062030
140000.	0.0056076
200000.	0.0049979
400000.	0.0038661
600000.	0.0032651
800000.	0.0028811
1000000.	0.0026162
1400000.	0.0022614
2000000.	0.0019338
4000000.	0.0013904
6000000.	0.0011374
8000000.	0.00098265
10000000.	0.00087175

Key Assumptions:
-18 month fuel cycle
-Standard and V5H fuel
-End of Cycle Core Average Burnup of 52,687 Mwd/MTU
-Low bound for enrichment: 3.0%

Table 1-3 Safety Injection Flow Minimum Safety Injection	
Injection Mode	
RCS Pressure (psig)	**Total Flow (gpm)**
0	4,957.1
12	4,810.0
20	4,711.9
40	4,445.9
60	4,132.9
80	3,771.2
100	3,364.8
120	2,933.3
140	2,413.7
160	1,697.9
180	966.3
200	959.6
Injection Mode (Post-Reflood Phase)	
RCS Pressure (psia)	**Total Flow (gpm)**
12	4,810.0
Recirculation Mode (w/o Residual Heat Removal (RHR) Spray)	
RCS Pressure (psia)	**Total Flow (gpm)**
0	3,299
Recirculation Mode (w/ RHR Spray)	
RCS Pressure (psia)	**Total Flow (gpm)**
0	1,060

TABLE A-1
Blowdown Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
1.036524E-03	9.324942E+04	5.093813E+04	4.005444E+04	2.181881E+04
2.008932E-03	4.115275E+04	2.241750E+04	4.084271E+04	2.224703E+04
3.007741E-03	4.114171E+04	2.241223E+04	4.059235E+04	2.210956E+04
4.143011E-03	4.113414E+04	2.240872E+04	4.032043E+04	2.196015E+04
1.012810E-01	4.089357E+04	2.234067E+04	2.138466E+04	1.164191E+04
2.021712E-01	4.173553E+04	2.294369E+04	2.326942E+04	1.267586E+04
3.016192E-01	4.585372E+04	2.541498E+04	2.348032E+04	1.279984E+04
4.014336E-01	4.641546E+04	2.598103E+04	2.311673E+04	1.261439E+04
5.014493E-01	4.573460E+04	2.588497E+04	2.234258E+04	1.220184E+04
6.015365E-01	4.464142E+04	2.554895E+04	2.160179E+04	1.180370E+04
7.018537E-01	4.497266E+04	2.600474E+04	2.098082E+04	1.146832E+04
8.011348E-01	4.479201E+04	2.614142E+04	2.044825E+04	1.117925E+04
9.010319E-01	4.415756E+04	2.599491E+04	2.003387E+04	1.095391E+04
1.002053E+00	4.330982E+04	2.571517E+04	1.970612E+04	1.077644E+04
1.101123E+00	4.239665E+04	2.539016E+04	1.953801E+04	1.068584E+04
1.201536E+00	4.136615E+04	2.500327E+04	1.941895E+04	1.062183E+04
1.301772E+00	4.022670E+04	2.456009E+04	1.933091E+04	1.057410E+04
1.401584E+00	3.895020E+04	2.403688E+04	1.925678E+04	1.053353E+04
1.501197E+00	3.755132E+04	2.343093E+04	1.920938E+04	1.050750E+04
1.601487E+00	3.611778E+04	2.278977E+04	1.919018E+04	1.049710E+04
1.702380E+00	3.478045E+04	2.219223E+04	1.917043E+04	1.048643E+04
1.801531E+00	3.349413E+04	2.160057E+04	1.911849E+04	1.045786E+04
1.901128E+00	3.213910E+04	2.093818E+04	1.904649E+04	1.041821E+04
2.001012E+00	3.090399E+04	2.032522E+04	1.898590E+04	1.038498E+04
2.101914E+00	2.972744E+04	1.972661E+04	1.894376E+04	1.036228E+04
2.201056E+00	2.864812E+04	1.916661E+04	1.887764E+04	1.032638E+04
2.301510E+00	2.751638E+04	1.855359E+04	1.845055E+04	1.009157E+04
2.401472E+00	2.571165E+04	1.745872E+04	1.818370E+04	9.946218E+03
2.501035E+00	2.253041E+04	1.538819E+04	1.799270E+04	9.842614E+03
2.601420E+00	2.086621E+04	1.437020E+04	1.781754E+04	9.747676E+03
2.701047E+00	2.104288E+04	1.461134E+04	1.758823E+04	9.622790E+03
2.801436E+00	2.008270E+04	1.398242E+04	1.731800E+04	9.475478E+03
2.901051E+00	1.932345E+04	1.349960E+04	1.707045E+04	9.340969E+03
3.001526E+00	1.887025E+04	1.323164E+04	1.684492E+04	9.218802E+03
3.101263E+00	1.830795E+04	1.286873E+04	1.661427E+04	9.093716E+03
3.201294E+00	1.766842E+04	1.244428E+04	1.638651E+04	8.970279E+03
3.301038E+00	1.706049E+04	1.204025E+04	1.617889E+04	8.858056E+03
3.401045E+00	1.645055E+04	1.162984E+04	1.598202E+04	8.751770E+03

TABLE A-1
Blowdown Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
3.501324E+00	1.586199E+04	1.123144E+04	1.579390E+04	8.650262E+03
3.601309E+00	1.533521E+04	1.087569E+04	1.562608E+04	8.559926E+03
3.701022E+00	1.487631E+04	1.056531E+04	1.546822E+04	8.475022E+03
3.801057E+00	1.446500E+04	1.028498E+04	1.531018E+04	8.389888E+03
3.901422E+00	1.409272E+04	1.003006E+04	1.516213E+04	8.310260E+03
4.001051E+00	1.377621E+04	9.813011E+03	1.503143E+04	8.240145E+03
4.200345E+00	1.327393E+04	9.460640E+03	1.478153E+04	8.105932E+03
4.400193E+00	1.285647E+04	9.157703E+03	1.455413E+04	7.983910E+03
4.600123E+00	1.254709E+04	8.923235E+03	1.433539E+04	7.866497E+03
4.800307E+00	1.228646E+04	8.714112E+03	1.406405E+04	7.719971E+03
5.000081E+00	1.210046E+04	8.553191E+03	1.368144E+04	7.512572E+03
5.201040E+00	1.194364E+04	8.406341E+03	1.420660E+04	7.811150E+03
5.400140E+00	1.184107E+04	8.294253E+03	1.535867E+04	8.442306E+03
5.600314E+00	1.175656E+04	8.189220E+03	1.505990E+04	8.278937E+03
5.800812E+00	1.169592E+04	8.098801E+03	1.489280E+04	8.190661E+03
6.000332E+00	1.178821E+04	8.100421E+03	1.481461E+04	8.149823E+03
6.201125E+00	1.200443E+04	8.176670E+03	1.463734E+04	8.055267E+03
6.400453E+00	1.235786E+04	8.352846E+03	1.447039E+04	7.966671E+03
6.600190E+00	1.293373E+04	8.675174E+03	1.446609E+04	7.968581E+03
6.800097E+00	1.228529E+04	8.518308E+03	1.430274E+04	7.880635E+03
7.000485E+00	1.054879E+04	7.941480E+03	1.408806E+04	7.763919E+03
7.200045E+00	9.603711E+03	7.533475E+03	1.398265E+04	7.707256E+03
7.400300E+00	9.598126E+03	7.467565E+03	1.387211E+04	7.646977E+03
7.600785E+00	9.926779E+03	7.551819E+03	1.370966E+04	7.556906E+03
7.800465E+00	1.040034E+04	7.719451E+03	1.355876E+04	7.472679E+03
8.000613E+00	1.101603E+04	7.966088E+03	1.341691E+04	7.393425E+03
8.201025E+00	1.175943E+04	8.287522E+03	1.325502E+04	7.302784E+03
8.400218E+00	1.260961E+04	8.681543E+03	1.308257E+04	7.206458E+03
8.600764E+00	1.359408E+04	9.169438E+03	1.291776E+04	7.114593E+03
8.800629E+00	1.456130E+04	9.654372E+03	1.274875E+04	7.020458E+03
9.000293E+00	1.532288E+04	1.002808E+04	1.257690E+04	6.924834E+03
9.200256E+00	1.585749E+04	1.028553E+04	1.240623E+04	6.829846E+03
9.400592E+00	1.620259E+04	1.044390E+04	1.222956E+04	6.731524E+03
9.600612E+00	1.638355E+04	1.051371E+04	1.205212E+04	6.632738E+03
9.801132E+00	1.644928E+04	1.052382E+04	1.187184E+04	6.532408E+03
1.000039E+01	1.644969E+04	1.050175E+04	1.169103E+04	6.431771E+03
1.020076E+01	1.641224E+04	1.046012E+04	1.150688E+04	6.329252E+03
1.020193E+01	1.641181E+04	1.045975E+04	1.150577E+04	6.328637E+03
1.040116E+01	1.621986E+04	1.032200E+04	1.132065E+04	6.225547E+03
1.060046E+01	1.569126E+04	9.976976E+03	1.114435E+04	6.127364E+03
1.080103E+01	1.493351E+04	9.496666E+03	1.097401E+04	6.032368E+03
1.100037E+01	1.311543E+04	8.343756E+03	1.082730E+04	5.950443E+03
1.120076E+01	1.034484E+04	6.635343E+03	1.089271E+04	5.986762E+03

TABLE A-1
Blowdown Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
1.140078E+01	9.359313E+03	6.128585E+03	1.083378E+04	5.950649E+03
1.160005E+01	1.014868E+04	6.674914E+03	1.047403E+04	5.750394E+03
1.180119E+01	9.660632E+03	6.307046E+03	1.052870E+04	5.784792E+03
1.200055E+01	8.682998E+03	5.755931E+03	1.070191E+04	5.880069E+03
1.220113E+01	8.528790E+03	5.807887E+03	1.023003E+04	5.614327E+03
1.240049E+01	8.055787E+03	5.633740E+03	1.037892E+04	5.700871E+03
1.260025E+01	7.794186E+03	5.522755E+03	1.016877E+04	5.581891E+03
1.280066E+01	7.627731E+03	5.417838E+03	1.009529E+04	5.539643E+03
1.300066E+01	7.529659E+03	5.348903E+03	9.967305E+03	5.468189E+03
1.320019E+01	7.391979E+03	5.255849E+03	9.924495E+03	5.442938E+03
1.340005E+01	7.260564E+03	5.179291E+03	9.759564E+03	5.350425E+03
1.360054E+01	7.123860E+03	5.102348E+03	9.736670E+03	5.337741E+03
1.380097E+01	6.985855E+03	5.028804E+03	9.579300E+03	5.249635E+03
1.400040E+01	6.847124E+03	4.955197E+03	9.503549E+03	5.207968E+03
1.420024E+01	6.687610E+03	4.862002E+03	9.343120E+03	5.118512E+03
1.440023E+01	6.536303E+03	4.765933E+03	9.255632E+03	5.069757E+03
1.460068E+01	6.394795E+03	4.656940E+03	9.108728E+03	4.987587E+03
1.480119E+01	6.280937E+03	4.554409E+03	9.026193E+03	4.932704E+03
1.500007E+01	6.192564E+03	4.464644E+03	8.926057E+03	4.847151E+03
1.520064E+01	6.115813E+03	4.382443E+03	8.953234E+03	4.811930E+03
1.540119E+01	6.044775E+03	4.306859E+03	8.915888E+03	4.732005E+03
1.560047E+01	5.974450E+03	4.238762E+03	9.013443E+03	4.723072E+03
1.580054E+01	5.897959E+03	4.175022E+03	8.980437E+03	4.654588E+03
1.600030E+01	5.813894E+03	4.114326E+03	9.060584E+03	4.657362E+03
1.620021E+01	5.724992E+03	4.056894E+03	8.970271E+03	4.581491E+03
1.640039E+01	5.634367E+03	4.002875E+03	8.899221E+03	4.520635E+03
1.660040E+01	5.554608E+03	3.959815E+03	8.890546E+03	4.494450E+03
1.680050E+01	5.479178E+03	3.924536E+03	8.491591E+03	4.278899E+03
1.700011E+01	5.447443E+03	3.947813E+03	8.913957E+03	4.482263E+03
1.720011E+01	5.338971E+03	3.971010E+03	7.841317E+03	3.934967E+03
1.740127E+01	5.154110E+03	3.981679E+03	9.281921E+03	4.639601E+03
1.760074E+01	4.917515E+03	3.973492E+03	7.392412E+03	3.700203E+03
1.780021E+01	4.691942E+03	3.969832E+03	8.982251E+03	4.406809E+03
1.800029E+01	4.387271E+03	3.900817E+03	1.408733E+04	7.014074E+03
1.820013E+01	4.053378E+03	3.805995E+03	1.015876E+04	5.148661E+03
1.840033E+01	3.994956E+03	3.954468E+03	5.132030E+03	2.590909E+03
1.860039E+01	3.660281E+03	3.854104E+03	1.083155E+04	5.118234E+03
1.880091E+01	3.275454E+03	3.666973E+03	1.017753E+04	4.925194E+03
1.900073E+01	3.086599E+03	3.621848E+03	4.422222E+03	2.140467E+03
1.920050E+01	2.775439E+03	3.378446E+03	1.009071E+04	4.419034E+03
1.940015E+01	2.424582E+03	2.988527E+03	8.072030E+03	3.529016E+03
1.960024E+01	2.249327E+03	2.784707E+03	5.113069E+03	2.249523E+03
1.980083E+01	2.099331E+03	2.605156E+03	3.575304E+03	1.573314E+03

TABLE A-1
Blowdown Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
2.000035E+01	1.924934E+03	2.394714E+03	4.434839E+03	1.777219E+03
2.020076E+01	1.758555E+03	2.192515E+03	6.836441E+03	2.634172E+03
2.040076E+01	1.612399E+03	2.014550E+03	5.633213E+03	2.151167E+03
2.060077E+01	1.465033E+03	1.833801E+03	4.740422E+03	1.796161E+03
2.080066E+01	1.348466E+03	1.690844E+03	4.529285E+03	1.691737E+03
2.100037E+01	1.242530E+03	1.560179E+03	4.281290E+03	1.567779E+03
2.120018E+01	1.142801E+03	1.436797E+03	3.883717E+03	1.391525E+03
2.140022E+01	1.045629E+03	1.316151E+03	3.474973E+03	1.214251E+03
2.160033E+01	9.520670E+02	1.199755E+03	3.175854E+03	1.078737E+03
2.180010E+01	8.695630E+02	1.097083E+03	2.954489E+03	9.731390E+02
2.200041E+01	8.030931E+02	1.014058E+03	2.756418E+03	8.798542E+02
2.220038E+01	7.375344E+02	9.325402E+02	2.589838E+03	8.019166E+02
2.240040E+01	6.970995E+02	8.823094E+02	2.459706E+03	7.397042E+02
2.260003E+01	6.576844E+02	8.326805E+02	2.353681E+03	6.884901E+02
2.280015E+01	6.179950E+02	7.829282E+02	2.270057E+03	6.469486E+02
2.300037E+01	5.787588E+02	7.336723E+02	2.206126E+03	6.136488E+02
2.320023E+01	5.410350E+02	6.862472E+02	2.164099E+03	5.885862E+02
2.340027E+01	5.021791E+02	6.372829E+02	2.135602E+03	5.689009E+02
2.360046E+01	4.629392E+02	5.878046E+02	2.109098E+03	5.512573E+02
2.380018E+01	4.229846E+02	5.372496E+02	2.066391E+03	5.309481E+02
2.400052E+01	3.859947E+02	4.907442E+02	2.008658E+03	5.083154E+02
2.420079E+01	3.607620E+02	4.590108E+02	1.958467E+03	4.888255E+02
2.440029E+01	3.339327E+02	4.251072E+02	1.918407E+03	4.724441E+02
2.460017E+01	3.059207E+02	3.896629E+02	1.842221E+03	4.482802E+02
2.480043E+01	2.826956E+02	3.602495E+02	1.756015E+03	4.227018E+02
2.500071E+01	2.636421E+02	3.361201E+02	1.788514E+03	4.257005E+02
2.520033E+01	2.487895E+02	3.173058E+02	1.830284E+03	4.303057E+02
2.540020E+01	2.387318E+02	3.045943E+02	1.853910E+03	4.305396E+02
2.560064E+01	2.378374E+02	3.035863E+02	1.998448E+03	4.584258E+02
2.580003E+01	2.337805E+02	2.983628E+02	2.218473E+03	5.026645E+02
2.600007E+01	2.301027E+02	2.937590E+02	2.400007E+03	5.371763E+02
2.620031E+01	2.247858E+02	2.870408E+02	0.000000E+00	0.000000E+00
2.640030E+01	2.197824E+02	2.807128E+02	0.000000E+00	0.000000E+00
2.660010E+01	2.159078E+02	2.758223E+02	3.142241E+03	6.792960E+02
2.680004E+01	2.128564E+02	2.719758E+02	0.000000E+00	0.000000E+00
2.700033E+01	2.087074E+02	2.667209E+02	0.000000E+00	0.000000E+00
2.720004E+01	2.017402E+02	2.578696E+02	0.000000E+00	0.000000E+00
2.740050E+01	1.935704E+02	2.474893E+02	0.000000E+00	0.000000E+00
2.760026E+01	1.873325E+02	2.395745E+02	0.000000E+00	0.000000E+00
2.780020E+01	1.832012E+02	2.343389E+02	2.208988E+04	4.622344E+03
2.800045E+01	1.767759E+02	2.261727E+02	0.000000E+00	0.000000E+00
2.820043E+01	1.720580E+02	2.201790E+02	0.000000E+00	0.000000E+00
2.840038E+01	1.714279E+02	2.194383E+02	0.000000E+00	0.000000E+00

TABLE A-1
Blowdown Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
2.860026E+01	1.663962E+02	2.130158E+02	0.000000E+00	0.000000E+00
2.880016E+01	1.627050E+02	2.083231E+02	0.000000E+00	0.000000E+00
2.900029E+01	1.615322E+02	2.068521E+02	0.000000E+00	0.000000E+00
2.920009E+01	1.586714E+02	2.032184E+02	0.000000E+00	0.000000E+00
2.940028E+01	1.546922E+02	1.981531E+02	0.000000E+00	0.000000E+00
2.960008E+01	1.468982E+02	1.882138E+02	0.000000E+00	0.000000E+00
2.980059E+01	1.359297E+02	1.742166E+02	0.000000E+00	0.000000E+00
3.000050E+01	1.245293E+02	1.596728E+02	0.000000E+00	0.000000E+00
3.020024E+01	1.133116E+02	1.453581E+02	0.000000E+00	0.000000E+00
3.040011E+01	1.031495E+02	1.323881E+02	0.000000E+00	0.000000E+00
3.060019E+01	9.503527E+01	1.220298E+02	0.000000E+00	0.000000E+00
3.080061E+01	8.671672E+01	1.113899E+02	0.000000E+00	0.000000E+00
3.100052E+01	7.573684E+01	9.735866E+01	0.000000E+00	0.000000E+00
3.120027E+01	6.626544E+01	8.524626E+01	0.000000E+00	0.000000E+00
3.140025E+01	5.669924E+01	7.300640E+01	0.000000E+00	0.000000E+00
3.160105E+01	4.625035E+01	5.961789E+01	0.000000E+00	0.000000E+00
3.180012E+01	3.571325E+01	4.609699E+01	0.000000E+00	0.000000E+00
3.200028E+01	2.292607E+01	2.965303E+01	0.000000E+00	0.000000E+00
3.220038E+01	8.825887E+00	1.145208E+01	0.000000E+00	0.000000E+00
3.240020E+01	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

Notes:

M&E exiting from the SG side of the break (path 1)

M&E exiting from the pump side of the break (path 2)

TABLE A-2
Reflood Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
3.240020E+01	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
3.285020E+01	4.592973E-04	5.338310E-04	1.659478E+02	1.211917E+01
3.305020E+01	4.593178E-04	5.338548E-04	1.659478E+02	1.211917E+01
3.315020E+01	4.593285E-04	5.338672E-04	1.659478E+02	1.211917E+01
3.325020E+01	4.590006E-04	5.334860E-04	1.659478E+02	1.211917E+01
3.330020E+01	4.590016E-04	5.334872E-04	1.659478E+02	1.211917E+01
3.343770E+01	2.606705E+01	3.030729E+01	1.659478E+02	1.211917E+01
3.356270E+01	1.145729E+01	1.331739E+01	1.659478E+02	1.211917E+01
3.366270E+01	1.350754E+01	1.570044E+01	1.659478E+02	1.211917E+01
3.378770E+01	1.896155E+01	2.204120E+01	1.659478E+02	1.211917E+01
3.388770E+01	2.392483E+01	2.781255E+01	1.659478E+02	1.211917E+01
3.398770E+01	2.779173E+01	3.230975E+01	1.659478E+02	1.211917E+01
3.411270E+01	3.129730E+01	3.638753E+01	1.659478E+02	1.211917E+01
3.421270E+01	3.406170E+01	3.960366E+01	1.659478E+02	1.211917E+01
3.431270E+01	3.668188E+01	4.265239E+01	1.659478E+02	1.211917E+01
3.441270E+01	3.918162E+01	4.556140E+01	1.659478E+02	1.211917E+01
3.451270E+01	4.157642E+01	4.834869E+01	1.659478E+02	1.211917E+01
3.461270E+01	4.387844E+01	5.102839E+01	1.659478E+02	1.211917E+01
3.471270E+01	4.609765E+01	5.361204E+01	1.659478E+02	1.211917E+01
3.481270E+01	4.876561E+01	5.671860E+01	1.659478E+02	1.211917E+01
3.491270E+01	5.086219E+01	5.916017E+01	1.659478E+02	1.211917E+01
3.501270E+01	5.233639E+01	6.087732E+01	1.659478E+02	1.211917E+01
3.511270E+01	5.477569E+01	6.371886E+01	1.659478E+02	1.211917E+01
3.521270E+01	5.670000E+01	6.596073E+01	1.659478E+02	1.211917E+01
3.523770E+01	5.713540E+01	6.646822E+01	1.659478E+02	1.211917E+01
3.531270E+01	5.806576E+01	6.755225E+01	1.659478E+02	1.211917E+01
3.543770E+01	6.032627E+01	7.018661E+01	1.659478E+02	1.211917E+01
3.645020E+01	7.702767E+01	8.966446E+01	1.659478E+02	1.211917E+01
3.745020E+01	9.067569E+01	1.056013E+02	1.659478E+02	1.211917E+01
3.845645E+01	1.028266E+02	1.198058E+02	1.659478E+02	1.211917E+01
3.945645E+01	1.665646E+02	1.945380E+02	1.911781E+03	2.388860E+02
4.046895E+01	3.513144E+02	4.136070E+02	4.677299E+03	6.716519E+02
4.096895E+01	3.540968E+02	4.170064E+02	4.715788E+03	6.849147E+02
4.146895E+01	3.533736E+02	4.161511E+02	4.706945E+03	6.854325E+02
4.246895E+01	3.495890E+02	4.116273E+02	4.660262E+03	6.798468E+02
4.346895E+01	3.454046E+02	4.066234E+02	4.607654E+03	6.729396E+02
4.446895E+01	3.412005E+02	4.015966E+02	4.553959E+03	6.657427E+02
4.546895E+01	3.370694E+02	3.966579E+02	4.500427E+03	6.584911E+02
4.646895E+01	3.330525E+02	3.918568E+02	4.447657E+03	6.512981E+02

TABLE A-2
Reflood Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
4.676895E+01	3.318729E+02	3.904470E+02	4.432024E+03	6.491615E+02
4.746895E+01	3.291670E+02	3.872136E+02	4.395929E+03	6.442227E+02
4.846895E+01	3.254158E+02	3.827317E+02	4.345344E+03	6.372905E+02
4.946895E+01	3.218058E+02	3.784194E+02	4.296054E+03	6.305269E+02
5.046895E+01	3.183342E+02	3.742732E+02	4.248083E+03	6.239392E+02
5.146895E+01	3.149966E+02	3.702878E+02	4.201423E+03	6.175294E+02
5.246895E+01	3.117876E+02	3.664567E+02	4.156050E+03	6.112962E+02
5.346895E+01	3.087013E+02	3.627726E+02	4.111928E+03	6.052359E+02
5.446895E+01	3.056128E+02	3.590890E+02	4.069135E+03	5.993406E+02
5.546895E+01	3.022003E+02	3.550296E+02	4.027857E+03	5.937291E+02
5.646895E+01	2.988978E+02	3.511021E+02	3.987695E+03	5.882725E+02
5.746895E+01	2.957006E+02	3.473008E+02	3.948608E+03	5.829652E+02
5.846895E+01	2.926038E+02	3.436197E+02	3.910550E+03	5.778014E+02
5.946895E+01	2.896026E+02	3.400531E+02	3.873482E+03	5.727750E+02
6.046895E+01	2.866921E+02	3.365950E+02	3.837360E+03	5.678799E+02
6.146895E+01	2.838672E+02	3.332393E+02	3.802148E+03	5.631096E+02
6.254395E+01	3.512177E+02	4.131696E+02	2.900808E+02	1.722925E+02
6.334395E+01	3.903106E+02	4.603306E+02	3.075479E+02	1.989205E+02
6.354395E+01	3.915072E+02	4.617902E+02	3.080791E+02	1.998127E+02
6.454395E+01	3.873277E+02	4.568094E+02	3.062888E+02	1.973869E+02
6.554395E+01	3.804155E+02	4.485298E+02	3.033001E+02	1.931130E+02
6.654395E+01	3.737805E+02	4.405830E+02	3.004105E+02	1.889811E+02
6.754395E+01	3.676146E+02	4.331997E+02	2.976723E+02	1.850786E+02
6.854395E+01	3.620151E+02	4.264969E+02	2.951253E+02	1.814692E+02
6.954395E+01	3.567036E+02	4.201406E+02	2.927044E+02	1.780420E+02
7.054395E+01	3.515873E+02	4.140198E+02	2.903926E+02	1.747674E+02
7.104395E+01	3.490392E+02	4.109719E+02	2.892578E+02	1.731554E+02
7.154395E+01	3.465416E+02	4.079847E+02	2.881426E+02	1.715719E+02
7.254395E+01	3.417033E+02	4.021989E+02	2.859743E+02	1.684963E+02
7.354395E+01	3.369149E+02	3.964750E+02	2.838194E+02	1.654471E+02
7.454395E+01	3.326617E+02	3.913899E+02	2.818927E+02	1.627137E+02
7.554395E+01	3.287455E+02	3.867100E+02	2.801088E+02	1.601958E+02
7.654395E+01	3.250051E+02	3.822410E+02	2.783558E+02	1.577883E+02
7.754395E+01	3.214884E+02	3.780399E+02	2.767027E+02	1.555192E+02
7.854395E+01	3.181745E+02	3.740821E+02	2.751401E+02	1.533769E+02
7.954395E+01	3.150081E+02	3.703011E+02	2.736422E+02	1.513251E+02
8.054395E+01	3.119770E+02	3.666823E+02	2.722039E+02	1.493567E+02
8.154395E+01	3.090682E+02	3.632102E+02	2.708200E+02	1.474641E+02
8.254395E+01	3.062727E+02	3.598738E+02	2.694913E+02	1.456481E+02
8.354395E+01	3.031549E+02	3.561645E+02	2.682590E+02	1.439647E+02
8.454395E+01	3.001442E+02	3.525838E+02	2.670714E+02	1.423441E+02
8.554395E+01	2.972470E+02	3.491387E+02	2.659311E+02	1.407888E+02
8.654395E+01	2.944584E+02	3.458235E+02	2.648357E+02	1.392960E+02

TABLE A-2
Reflood Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
8.754395E+01	2.917737E+02	3.426326E+02	2.637834E+02	1.378626E+02
8.854395E+01	2.891888E+02	3.395607E+02	2.627722E+02	1.364860E+02
8.954395E+01	2.866994E+02	3.366030E+02	2.618002E+02	1.351636E+02
9.014395E+01	2.852500E+02	3.348812E+02	2.612352E+02	1.343952E+02
9.054395E+01	2.843017E+02	3.337548E+02	2.608659E+02	1.338931E+02
9.154395E+01	2.819922E+02	3.310118E+02	2.599676E+02	1.326722E+02
9.254395E+01	2.797673E+02	3.283698E+02	2.591039E+02	1.314988E+02
9.354395E+01	2.776239E+02	3.258249E+02	2.582732E+02	1.303710E+02
9.554395E+01	2.735694E+02	3.210122E+02	2.567060E+02	1.282444E+02
9.754395E+01	2.698060E+02	3.165464E+02	2.552560E+02	1.262787E+02
9.954395E+01	2.663132E+02	3.124029E+02	2.539143E+02	1.244612E+02
1.015440E+02	2.630582E+02	3.085425E+02	2.526682E+02	1.227746E+02
1.035440E+02	2.600263E+02	3.049476E+02	2.515111E+02	1.212094E+02
1.055440E+02	2.572117E+02	3.016110E+02	2.504396E+02	1.197610E+02
1.075440E+02	2.546003E+02	2.985160E+02	2.494477E+02	1.184210E+02
1.095440E+02	2.521789E+02	2.956467E+02	2.485298E+02	1.171817E+02
1.115440E+02	2.499354E+02	2.929888E+02	2.476809E+02	1.160360E+02
1.135440E+02	2.478585E+02	2.905287E+02	2.468962E+02	1.149775E+02
1.155440E+02	2.459377E+02	2.882538E+02	2.461712E+02	1.140001E+02
1.175440E+02	2.441630E+02	2.861523E+02	2.455019E+02	1.130981E+02
1.195440E+02	2.425253E+02	2.842132E+02	2.448846E+02	1.122664E+02
1.215440E+02	2.410158E+02	2.824262E+02	2.443158E+02	1.115003E+02
1.235440E+02	2.396265E+02	2.807816E+02	2.437920E+02	1.107952E+02
1.255440E+02	2.383496E+02	2.792704E+02	2.433104E+02	1.101469E+02
1.275440E+02	2.371781E+02	2.778839E+02	2.428680E+02	1.095516E+02
1.295440E+02	2.361051E+02	2.766142E+02	2.424622E+02	1.090057E+02
1.315440E+02	2.351244E+02	2.754537E+02	2.420904E+02	1.085058E+02
1.335440E+02	2.342298E+02	2.743952E+02	2.417505E+02	1.080487E+02
1.355440E+02	2.334158E+02	2.734321E+02	2.414401E+02	1.076314E+02
1.375440E+02	2.326770E+02	2.725581E+02	2.411573E+02	1.072513E+02
1.395440E+02	2.320084E+02	2.717672E+02	2.409002E+02	1.069056E+02
1.403440E+02	2.317585E+02	2.714717E+02	2.408038E+02	1.067762E+02
1.415440E+02	2.313958E+02	2.710426E+02	2.406645E+02	1.065885E+02
1.435440E+02	2.314523E+02	2.711090E+02	2.408689E+02	1.065995E+02
1.455440E+02	2.316183E+02	2.713052E+02	2.414900E+02	1.066661E+02
1.475440E+02	2.320489E+02	2.718145E+02	2.425626E+02	1.068660E+02
1.495440E+02	2.326999E+02	2.725844E+02	2.440204E+02	1.071774E+02
1.515440E+02	2.334982E+02	2.735287E+02	2.457745E+02	1.075647E+02
1.535440E+02	2.343709E+02	2.745612E+02	2.477376E+02	1.079923E+02
1.555440E+02	2.352570E+02	2.756095E+02	2.498367E+02	1.084308E+02
1.575440E+02	2.361110E+02	2.766201E+02	2.520170E+02	1.088583E+02
1.595440E+02	2.369025E+02	2.775567E+02	2.542417E+02	1.092603E+02
1.615440E+02	2.376130E+02	2.783975E+02	2.564884E+02	1.096284E+02

TABLE A-2
Reflood Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
1.635440E+02	2.382327E+02	2.791309E+02	2.587450E+02	1.099585E+02
1.655440E+02	2.387579E+02	2.797526E+02	2.610065E+02	1.102493E+02
1.675440E+02	2.391884E+02	2.802621E+02	2.632724E+02	1.105015E+02
1.685440E+02	2.393686E+02	2.804755E+02	2.644075E+02	1.106136E+02
1.695440E+02	2.395260E+02	2.806617E+02	2.655447E+02	1.107167E+02
1.715440E+02	2.397737E+02	2.809550E+02	2.678267E+02	1.108971E+02
1.735440E+02	2.399347E+02	2.811456E+02	2.701223E+02	1.110451E+02
1.755440E+02	2.400122E+02	2.812373E+02	2.724354E+02	1.111630E+02
1.775440E+02	2.400091E+02	2.812337E+02	2.747698E+02	1.112531E+02
1.795440E+02	2.399280E+02	2.811378E+02	2.771288E+02	1.113174E+02
1.815440E+02	2.397710E+02	2.809521E+02	2.795152E+02	1.113578E+02
1.835440E+02	2.395221E+02	2.806575E+02	2.819177E+02	1.113676E+02
1.855440E+02	2.391645E+02	2.802343E+02	2.842865E+02	1.113372E+02
1.875440E+02	2.387360E+02	2.797272E+02	2.866818E+02	1.112869E+02
1.895440E+02	2.382368E+02	2.791365E+02	2.891064E+02	1.112177E+02
1.915440E+02	2.376673E+02	2.784625E+02	2.915622E+02	1.111308E+02
1.935440E+02	2.370161E+02	2.776920E+02	2.940438E+02	1.110222E+02
1.955440E+02	2.362620E+02	2.767997E+02	2.964971E+02	1.108797E+02
1.973440E+02	2.355341E+02	2.759384E+02	2.987418E+02	1.107434E+02
1.975440E+02	2.354502E+02	2.758392E+02	2.989935E+02	1.107278E+02
1.995440E+02	2.345783E+02	2.748076E+02	3.015368E+02	1.105667E+02
2.015440E+02	2.336312E+02	2.736871E+02	3.041462E+02	1.103944E+02
2.035440E+02	2.326123E+02	2.724818E+02	3.068205E+02	1.102128E+02
2.055440E+02	2.315282E+02	2.711995E+02	3.095519E+02	1.100246E+02
2.075440E+02	2.303782E+02	2.698393E+02	3.123416E+02	1.098307E+02
2.095440E+02	2.291614E+02	2.684003E+02	3.151911E+02	1.096321E+02
2.115440E+02	2.278759E+02	2.668801E+02	3.181039E+02	1.094302E+02
2.135440E+02	2.265218E+02	2.652791E+02	3.210802E+02	1.092258E+02
2.155440E+02	2.251001E+02	2.635983E+02	3.241196E+02	1.090201E+02
2.175440E+02	2.236106E+02	2.618376E+02	3.272231E+02	1.088143E+02
2.195440E+02	2.220245E+02	2.599628E+02	3.303526E+02	1.085949E+02
2.215440E+02	2.203431E+02	2.579758E+02	3.333230E+02	1.083433E+02
2.235440E+02	2.185390E+02	2.558440E+02	3.361956E+02	1.080551E+02
2.255440E+02	2.166774E+02	2.536445E+02	3.390847E+02	1.077666E+02
2.275440E+02	2.147572E+02	2.513762E+02	3.419955E+02	1.074787E+02
2.281440E+02	2.141699E+02	2.506824E+02	3.428733E+02	1.073926E+02

Notes:
M&E exiting from the SG side of the break (path 1)
M&E exiting from the pump side of the break (path 2)

TABLE A-3
Post-Reflood Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
2.282000E+02	2.195331E+02	2.724019E+02	4.443179E+02	1.179457E+02
2.332000E+02	2.195570E+02	2.724315E+02	4.442941E+02	1.178238E+02
2.382000E+02	2.185729E+02	2.712104E+02	4.452781E+02	1.179156E+02
2.432000E+02	2.185653E+02	2.712009E+02	4.452858E+02	1.178000E+02
2.482000E+02	2.185354E+02	2.711639E+02	4.453156E+02	1.176889E+02
2.532000E+02	2.175136E+02	2.698959E+02	4.463375E+02	1.177883E+02
2.582000E+02	2.174505E+02	2.698177E+02	4.464005E+02	1.176840E+02
2.632000E+02	2.173642E+02	2.697107E+02	4.464868E+02	1.175844E+02
2.682000E+02	2.163046E+02	2.683959E+02	4.475464E+02	1.176913E+02
2.732000E+02	2.161867E+02	2.682495E+02	4.476643E+02	1.175982E+02
2.782000E+02	2.160402E+02	2.680678E+02	4.478108E+02	1.175110E+02
2.832000E+02	2.158693E+02	2.678557E+02	4.479817E+02	1.174288E+02
2.882000E+02	2.147454E+02	2.664612E+02	4.491056E+02	1.175486E+02
2.932000E+02	2.145355E+02	2.662007E+02	4.493155E+02	1.174744E+02
2.982000E+02	2.143001E+02	2.659086E+02	4.495509E+02	1.174054E+02
3.032000E+02	2.140370E+02	2.655822E+02	4.498140E+02	1.173422E+02
3.082000E+02	2.137472E+02	2.652226E+02	4.501038E+02	1.172844E+02
3.132000E+02	2.134287E+02	2.648274E+02	4.504223E+02	1.172326E+02
3.182000E+02	2.130820E+02	2.643971E+02	4.507691E+02	1.171866E+02
3.232000E+02	2.127051E+02	2.639295E+02	4.511459E+02	1.171468E+02
3.282000E+02	2.122986E+02	2.634252E+02	4.515524E+02	1.171132E+02
3.332000E+02	2.118604E+02	2.628813E+02	4.519907E+02	1.170861E+02
3.382000E+02	2.113912E+02	2.622992E+02	4.524598E+02	1.170654E+02
3.432000E+02	2.108880E+02	2.616748E+02	4.529630E+02	1.170519E+02
3.482000E+02	2.103527E+02	2.610106E+02	4.534983E+02	1.170449E+02
3.532000E+02	2.097812E+02	2.603015E+02	4.540698E+02	1.170455E+02
3.582000E+02	2.091753E+02	2.595496E+02	4.546757E+02	1.170532E+02
3.632000E+02	2.085326E+02	2.587522E+02	4.553184E+02	1.170685E+02
3.682000E+02	2.086640E+02	2.589153E+02	4.551870E+02	1.169195E+02
3.732000E+02	2.079294E+02	2.580038E+02	4.559216E+02	1.169540E+02
3.782000E+02	2.079478E+02	2.580266E+02	4.559032E+02	1.168285E+02
3.832000E+02	2.071127E+02	2.569903E+02	4.567383E+02	1.168841E+02
3.882000E+02	2.070133E+02	2.568670E+02	4.568377E+02	1.167833E+02
3.932000E+02	2.060698E+02	2.556963E+02	4.577812E+02	1.168615E+02
3.982000E+02	2.058400E+02	2.554111E+02	4.580110E+02	1.167881E+02
4.032000E+02	2.056170E+02	2.551345E+02	4.582340E+02	1.167177E+02
4.082000E+02	2.053561E+02	2.548107E+02	4.584949E+02	1.166579E+02
4.132000E+02	2.050124E+02	2.543843E+02	4.588386E+02	1.166154E+02
4.182000E+02	2.045828E+02	2.538512E+02	4.592682E+02	1.165910E+02
4.232000E+02	2.040597E+02	2.532021E+02	4.597913E+02	1.165863E+02
4.282000E+02	2.034389E+02	2.524317E+02	4.604122E+02	1.166021E+02
4.332000E+02	2.027192E+02	2.515388E+02	4.611318E+02	1.166388E+02
4.382000E+02	2.025700E+02	2.513536E+02	4.612811E+02	1.165542E+02

TABLE A-3
Post-Reflood Mass and Energy Releases – Double Ended Pump Suction Guillotine Break Minimum Safeguards)

TIME	BREAK PATH NO. 1 FLOW		BREAK PATH NO. 2 FLOW	
		THOUSAND		THOUSAND
SECONDS	LBM/SEC	BTU/SEC	LBM/SEC	BTU/SEC
4.432000E+02	2.022692E+02	2.509803E+02	4.615819E+02	1.165016E+02
4.482000E+02	2.018110E+02	2.504119E+02	4.620400E+02	1.164823E+02
4.532000E+02	2.011891E+02	2.496402E+02	4.626619E+02	1.164975E+02
4.582000E+02	2.010155E+02	2.494248E+02	4.628355E+02	1.164174E+02
4.632000E+02	2.006102E+02	2.489219E+02	4.632408E+02	1.163864E+02
4.682000E+02	1.999490E+02	2.481014E+02	4.639020E+02	1.164094E+02
4.732000E+02	1.995988E+02	2.476669E+02	4.642522E+02	1.163663E+02
4.782000E+02	1.994708E+02	2.475081E+02	4.643802E+02	1.162759E+02
4.832000E+02	1.989195E+02	2.468240E+02	4.649315E+02	1.162751E+02
4.882000E+02	1.984236E+02	2.462087E+02	4.654274E+02	1.162624E+02
4.932000E+02	1.978253E+02	2.454663E+02	4.660257E+02	1.162713E+02
4.982000E+02	1.974607E+02	2.450139E+02	4.663903E+02	1.162303E+02
5.032000E+02	1.970255E+02	2.444739E+02	4.668255E+02	1.162042E+02
5.082000E+02	1.965563E+02	2.438916E+02	4.672948E+02	1.161852E+02
5.132000E+02	1.961901E+02	2.434373E+02	4.676609E+02	1.161440E+02
5.182000E+02	1.957497E+02	2.428909E+02	4.681013E+02	1.161184E+02
5.232000E+02	1.950586E+02	2.420333E+02	4.687924E+02	1.161460E+02
5.282000E+02	1.945455E+02	2.413966E+02	4.693056E+02	1.161355E+02
8.205637E+02	1.945455E+02	2.413966E+02	4.693056E+02	1.161355E+02
8.206637E+02	7.704602E+01	9.538966E+01	5.868050E+02	1.364997E+02
8.232000E+02	7.699391E+01	9.532500E+01	5.868571E+02	1.390490E+02
1.688200E+03	6.367970E+01	7.880440E+01	6.001713E+02	1.285680E+02
1.690900E+03	6.365156E+01	7.876949E+01	3.916184E+02	1.131540E+02
1.690900E+03	6.365156E+01	7.876949E+01	3.916184E+02	1.131540E+02
1.695900E+03	6.359945E+01	7.870484E+01	3.882705E+02	1.260598E+02
2.180455E+03	6.359945E+01	7.870484E+01	3.882705E+02	1.260598E+02

Table A-4a
Double-Ended Pump Suction Guillotine Break

TIME (SECONDS)		0.00	32.40	32.40 +δ	228.14	820.66	2180.45
		MASS (THOUSAND LBM)					
Initial	In RCS and ACC	786.21	786.21	786.21	786.21	786.21	786.21
Added Mass	Pumped Injection	0.00	0.00	0.00	123.49	516.80	1315.74
	Total Added	0.00	0.00	0.00	123.49	516.80	1315.74
*** TOTAL AVAILABLE ***		786.21	786.21	786.21	909.70	1303.01	2101.95
Distribution	Reactor Coolant	529.68	102.60	102.70	173.58	173.58	173.58
	Accumulator	256.53	139.43	139.33	0.00	0.00	0.00
	Total Contents	786.21	242.03	242.03	173.58	173.58	173.58
Effluent	Break Flow	0.00	544.16	544.16	736.10	1129.41	1928.06
	ECCS Spill	0.00	0.00	0.00	0.00	0.00	0.00
	Total Effluent	0.00	544.16	544.16	736.10	1129.41	1928.06
*** TOTAL ACCOUNTABLE ***		786.21	786.19	786.19	909.68	1302.99	2101.64

Table A-4b
Double-Ended Pump Suction Guillotine Break (Continued)

TIME (SECONDS)		0.00	32.40	32.40+δ	228.14	820.66	2180.45
		ENERGY (MILLIONS BTU)					
Initial Energy	In RCS, ACC, S GEN	888.83	888.83	888.83	888.83	888.83	888.83
Added Energy	Pumped Injection	0.00	0.00	0.00	9.02	37.74	102.61
	Decay Heat	0.00	8.58	8.58	30.31	80.09	167.60
	Heat From Secondary	0.00	3.89	3.89	3.89	14.55	34.18
	Total Added	0.00	12.47	12.47	43.22	132.38	304.39
*** TOTAL AVAILABLE ***		888.83	901.30	901.30	932.05	1021.21	1193.22
Distribution	Reactor Coolant	309.09	17.81	17.82	35.85	35.85	35.85
	Accumulator	25.57	13.90	13.89	0.00	0.00	0.00
	Core Stored	25.13	12.81	12.81	3.92	3.64	3.49
	Primary Metal	160.86	150.25	150.25	133.58	83.42	58.49
	Secondary Metal	92.48	92.10	92.10	83.05	63.06	37.87
	Steam Generator	275.71	285.96	285.96	254.31	199.11	138.33
	Total Contents	888.83	572.82	572.82	510.72	385.08	274.03
Effluent	Break Flow	0.00	327.89	327.89	420.48	635.27	929.79
	ECCS Spill	0.00	0.00	0.00	0.00	0.00	0.00
	Total Effluent	0.00	327.89	327.89	420.48	635.27	929.79
*** TOTAL ACCOUNTABLE ***		888.83	900.71	900.71	931.19	1020.36	1203.82

Table A-5
Double-Ended Pump Suction Guillotine Break – Minimum Safeguards

TIME	FLOODING		CARRYOVER FRACTION	CORE HEIGHT	DOWNCOMER HEIGHT	FLOW FRAC	TOTAL	INJECTION ACCUM	SPILL	ENTHALPY
(SECONDS)	TEMP (°F)	RATE (IN/SEC)		(FT)	(FT)		(POUNDS MASS PER SECOND)			(BTU/LBM)
32.4	201.5	0.000	0.000	0.00	0.00	0.250	0.0	0.0	0.0	0.00
33.1	199.9	22.608	0.000	0.56	1.13	0.000	7473.5	6809.6	0.0	97.30
33.3	198.7	25.971	0.000	1.08	1.19	0.000	7418.1	6754.1	0.0	97.29
35.2	198.7	1.880	0.323	1.50	5.80	0.362	7073.8	6409.8	0.0	97.17
36.5	199.1	1.817	0.436	1.62	8.74	0.375	6891.7	6227.7	0.0	97.10
40.5	200.2	3.741	0.625	1.95	16.11	0.581	5535.3	4926.6	0.0	96.74
41.0	200.2	3.674	0.640	2.01	16.12	0.578	5450.9	4844.5	0.0	96.71
42.5	200.5	3.444	0.675	2.16	16.12	0.578	5309.6	4701.9	0.0	96.62
46.8	201.6	3.089	0.719	2.51	16.12	0.576	4996.9	4383.0	0.0	96.40
54.5	204.4	2.768	0.744	3.00	16.12	0.571	4564.6	3942.5	0.0	96.04
61.5	207.3	2.570	0.754	3.39	16.12	0.564	4255.5	3628.0	0.0	95.74
62.5	207.8	3.077	0.754	3.45	16.10	0.603	611.5	0.0	0.0	73.03
63.3	208.2	3.325	0.749	3.50	16.02	0.606	590.3	0.0	0.0	73.03
63.5	208.3	3.330	0.749	3.52	15.99	0.606	589.4	0.0	0.0	73.03
71.0	212.5	2.952	0.756	4.00	15.28	0.602	604.8	0.0	0.0	73.03
80.5	217.7	2.627	0.762	4.53	14.75	0.600	617.8	0.0	0.0	73.03
90.1	222.0	2.405	0.767	5.00	14.48	0.596	625.0	0.0	0.0	73.03
101.5	226.3	2.225	0.771	5.51	14.39	0.591	630.4	0.0	0.0	73.03
113.5	230.2	2.101	0.775	6.00	14.49	0.587	634.0	0.0	0.0	73.03
127.5	234.0	2.011	0.779	6.54	14.76	0.584	636.4	0.0	0.0	73.03
140.3	236.9	1.963	0.782	7.00	15.09	0.582	637.7	0.0	0.0	73.03
145.5	238.0	1.958	0.783	7.19	15.24	0.583	637.7	0.0	0.0	73.03
155.5	239.9	1.972	0.784	7.54	15.50	0.586	636.9	0.0	0.0	73.03
167.5	242.0	1.983	0.786	7.97	15.74	0.592	635.9	0.0	0.0	73.03
168.5	242.1	1.983	0.786	8.00	15.75	0.592	635.9	0.0	0.0	73.03
183.5	244.3	1.961	0.788	8.53	15.94	0.598	635.7	0.0	0.0	73.03
197.3	243.9	1.917	0.787	9.00	16.04	0.602	636.4	0.0	0.0	73.03

Table A-5
Double-Ended Pump Suction Guillotine Break – Minimum Safeguards (Continued)

TIME	FLOODING		CARRYOVER FRACTION	CORE HEIGHT	DOWNCOMER HEIGHT	FLOW FRAC	TOTAL	INJECTION ACCUM	SPILL	ENTHALPY
(SECONDS)	TEMP (°F)	RATE (IN/SEC)		(FT)	(FT)		(POUNDS MASS PER SECOND)			(BTU/LBM)
213.5	243.9	1.835	0.787	9.54	16.10	0.604	638.2	0.0	0.0	73.03
228.1	244.3	1.732	0.789	10.00	16.12	0.604	640.6	0.0	0.0	73.03

APPENDIX B – FSAR Markups

[WCAP-12455, Revision 1, Supplement 3R is redacted to exclude the SQN FSAR markups. UFSAR changes will be processed in accordance with the TVA program requirements.]

APPENDIX C – Tech Spec Markups

WCAP-12455, Revision 1, Supplement 3R is redacted to exclude the TS markups. TS markups are included as Attachment 1 of the Enclosure.]

APPENDIX D – EQ Data

Containment Pressure and Temperatures for 30-Day Transient

TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
2.0	7.2	107.3	232.8	190.0	0.0
61.6	7.1	107.9	232.8	187.9	0.0
125.2	6.4	108.4	220.5	183.4	0.0
190.2	6.7	108.8	224.7	180.4	0.0
255.4	6.5	108.3	222.5	178.1	0.0
320.4	6.5	105.7	224.5	174.9	0.0
385.4	6.6	105.6	224.9	172.3	0.0
450.4	6.6	105.6	224.8	170.1	0.0
515.4	6.6	105.6	224.6	168.3	0.0
580.4	6.6	105.6	225.4	166.7	166.9
645.4	6.2	108.2	216.2	165.2	166.2
711.4	5.9	108.6	211.6	163.8	165.5
776.4	5.9	108.6	210.6	162.5	164.8
840.4	5.7	108.6	207.1	161.6	164.2
905.4	5.4	108.6	200.2	161.2	163.7
970.4	5.3	108.6	197.0	160.8	163.4
1035.4	5.2	108.6	195.4	160.5	163.1
1100.4	5.2	108.7	194.5	160.1	162.8
1165.4	5.2	108.7	193.9	159.8	162.5
1231.4	5.2	108.7	193.4	159.6	162.3
1296.4	5.2	108.7	192.9	159.3	162.1
1361.4	5.2	108.7	192.3	159.1	161.9
1426.4	5.2	108.7	191.8	158.9	161.7
1491.4	5.2	108.7	191.3	158.8	161.5
1556.4	5.2	108.7	190.7	158.6	161.3
1621.4	5.2	108.7	190.2	158.5	161.2
1687.4	5.2	108.7	189.5	158.4	161.0
1748.3	5.5	108.7	197.7	157.7	160.9
1813.3	5.6	108.7	198.5	157.1	160.8
1878.3	5.6	108.7	198.8	156.4	160.7
1943.3	5.6	108.7	198.9	155.8	160.5
2002.3	5.6	108.7	198.9	155.3	160.4
2018.6	5.6	108.7	198.9	155.1	160.4

TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
2035.1	5.6	108.7	198.9	155.0	160.3
2051.3	5.6	108.7	198.9	154.8	160.3
2067.6	5.6	108.7	198.9	154.7	160.2
2083.8	5.6	108.7	198.9	154.5	160.2
2100.1	5.6	108.7	198.9	154.4	160.2
2116.3	5.7	108.7	198.9	154.3	160.1
2132.6	5.7	108.7	198.9	154.1	160.1
2148.8	5.7	108.7	198.9	154.0	160.0
2165.3	5.7	108.7	198.9	153.9	160.0
2181.6	5.4	108.7	192.9	153.6	160.0
2197.8	5.3	108.7	190.8	153.3	159.9
2214.1	5.3	108.7	188.9	153.0	159.9
2230.3	5.2	108.7	187.4	152.7	159.8
2246.6	5.2	108.7	186.1	152.4	159.8
2262.8	5.2	108.7	185.0	152.1	159.8
2279.3	5.1	108.7	184.0	151.8	159.7
2295.6	5.1	108.7	183.2	151.5	159.7
2311.8	5.1	108.7	182.5	151.2	159.6
2328.1	5.1	108.7	182.0	150.9	159.6
2344.3	5.1	108.7	181.5	150.6	159.5
2360.6	5.0	108.7	181.1	150.3	159.5
2376.8	5.0	108.7	180.7	150.0	159.5
2393.3	5.0	108.7	180.4	149.7	159.4
2409.6	5.0	108.7	180.1	149.4	159.4
2425.8	5.0	108.7	179.9	149.2	159.3
2442.1	5.0	108.7	179.7	148.9	159.3
2458.3	5.0	108.7	179.5	148.6	159.2
2474.6	5.0	108.7	179.3	148.3	159.2
2490.8	5.0	108.8	179.2	148.1	159.1
2507.3	5.0	108.8	179.1	147.8	159.0
2523.6	5.0	108.8	178.9	147.5	159.0
2539.8	5.0	108.8	178.8	147.3	158.9
2556.1	5.0	108.8	178.7	147.0	158.9
2572.3	5.0	108.8	178.7	146.7	158.8
2588.6	5.0	108.8	178.6	146.5	158.8
2604.8	5.0	108.8	178.5	146.2	158.7
2621.1	5.0	108.8	178.4	146.0	158.7

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
2637.6	5.0	108.8	178.4	145.7	158.6
2653.8	5.0	108.8	178.3	145.5	158.5
2670.1	5.0	108.8	178.2	145.2	158.5
2686.3	5.0	108.8	178.2	145.0	158.4
2702.6	5.0	108.8	178.1	144.7	158.4
2718.8	5.0	108.8	178.0	144.5	158.3
2735.1	5.0	108.8	178.0	144.2	158.2
2751.6	5.0	108.8	177.9	144.0	158.2
2767.8	5.0	108.8	177.9	143.7	158.1
2784.1	5.0	108.8	177.8	143.5	158.0
2800.3	5.0	108.8	177.8	143.3	158.0
2816.6	5.2	111.6	178.0	143.2	158.0
2832.8	5.4	114.5	178.4	143.1	157.9
2849.1	5.5	117.3	178.9	143.0	157.9
2865.6	5.7	120.2	179.6	142.9	157.9
2881.8	5.9	123.1	180.4	142.9	157.9
2898.1	6.1	126.1	181.2	142.8	157.9
2914.3	6.3	129.1	182.2	142.7	157.9
2930.6	6.6	132.2	183.2	142.6	157.9
2946.8	6.8	135.5	184.3	142.6	157.8
2963.1	7.1	139.0	185.5	142.5	157.8
2979.3	7.4	142.6	186.8	142.4	157.8
2995.8	7.8	146.4	188.2	142.3	157.8
3012.1	8.2	150.4	189.7	142.3	157.8
3028.3	8.6	154.6	191.3	142.2	157.8
3044.6	9.2	158.9	192.8	142.1	157.8
3060.8	9.8	163.0	194.2	142.1	157.8
3077.1	10.4	166.7	195.5	142.0	157.8
3093.3	11.0	169.6	196.9	142.0	157.7
3109.8	11.4	172.0	198.4	141.9	157.7
3126.1	9.6	155.6	196.7	141.9	157.7
3142.3	8.9	148.6	196.0	141.9	157.7
3158.6	8.7	146.3	195.5	141.9	157.7
3174.8	8.6	145.5	195.2	141.8	157.7
3191.1	8.6	145.2	194.9	141.8	157.7
3207.3	8.7	145.2	194.7	141.8	157.7
3223.8	8.7	145.2	194.5	141.7	157.7

TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
3240.1	8.7	145.3	194.3	141.7	157.7
3256.3	8.8	145.8	194.2	141.6	157.7
3272.6	8.9	146.7	194.2	141.6	157.7
3288.8	9.1	149.5	194.6	141.6	157.7
3305.1	9.3	151.4	195.0	141.6	157.7
3321.3	9.5	152.7	195.4	141.6	157.7
3337.6	9.6	153.7	195.8	141.6	157.7
3354.1	9.7	154.5	196.2	141.6	157.7
3370.3	9.8	155.1	196.5	141.6	157.7
3386.6	9.9	155.7	196.8	141.6	157.7
3402.8	10.0	156.2	197.1	141.6	157.7
3419.1	10.0	156.7	197.4	141.6	157.7
3435.3	10.1	157.1	197.7	141.6	157.7
3451.6	10.2	157.6	198.0	141.7	157.7
3468.1	10.2	158.0	198.2	141.7	157.7
3484.3	10.3	158.3	198.5	141.7	157.7
3500.6	10.3	158.7	198.7	141.7	157.7
3516.8	10.4	159.0	198.9	141.8	157.7
3533.1	10.4	159.4	199.1	141.8	157.7
3549.3	10.5	159.7	199.3	141.8	157.7
3565.6	10.5	160.0	199.5	141.9	157.7
3582.1	10.6	160.3	199.7	141.9	157.7
3598.3	10.6	160.6	199.8	141.9	157.7
3614.6	10.3	157.3	199.5	142.0	157.7
3630.8	10.1	156.1	199.2	142.1	157.7
3647.1	10.1	156.0	199.1	142.1	157.7
3663.3	10.1	156.2	199.1	142.2	157.7
3679.6	10.1	156.4	199.0	142.3	157.7
3696.1	10.2	156.7	199.0	142.3	157.7
3712.3	10.2	156.9	199.0	142.4	157.7
3728.6	10.2	157.1	199.0	142.5	157.7
3744.8	10.2	157.3	199.0	142.5	157.7
3761.1	10.2	157.5	199.0	142.6	157.7
3777.3	10.3	157.6	199.0	142.7	157.7
3793.6	10.3	157.8	199.0	142.8	157.7
3809.8	10.3	157.9	199.0	142.8	157.7
3826.3	10.3	158.0	199.0	142.9	157.7

TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
3842.6	10.3	158.1	199.0	143.0	157.7
3858.8	10.3	158.3	199.0	143.0	157.7
3875.1	10.3	158.4	199.0	143.1	157.7
3891.3	10.4	158.4	199.1	143.2	157.7
3907.6	10.4	158.5	199.1	143.3	157.7
3923.8	10.4	158.6	199.1	143.3	157.7
3940.3	10.4	158.7	199.1	143.4	157.7
3956.6	10.4	158.8	199.1	143.5	157.7
3972.8	10.4	158.9	199.1	143.6	157.7
3989.1	10.4	158.9	199.1	143.6	157.7
4021.1	10.4	159.1	199.1	143.8	157.7
4086.1	10.5	159.5	199.2	144.1	157.7
4151.1	10.5	159.8	199.3	144.4	157.7
4217.1	10.5	160.0	199.4	144.7	157.7
4282.1	10.6	160.3	199.4	144.9	157.7
4347.1	10.6	160.5	199.5	145.2	157.7
4412.1	10.6	160.8	199.6	145.5	157.7
4477.1	10.7	161.0	199.6	145.8	157.7
4542.1	10.7	161.2	199.7	146.1	157.7
4607.1	10.7	161.3	199.7	146.4	157.7
4672.1	10.7	161.5	199.7	146.6	157.7
4738.1	10.8	161.7	199.8	146.9	157.7
4803.1	10.8	161.8	199.8	147.2	157.7
4868.1	10.8	161.9	199.8	147.4	157.7
4933.1	10.8	162.1	199.8	147.7	157.7
4998.1	10.8	162.2	199.8	148.0	157.7
6167.8	10.8	162.9	198.3	151.9	157.7
7362.7	10.8	163.1	197.9	154.4	157.7
8599.8	10.7	162.6	196.6	155.9	157.7
9849.1	10.5	161.3	195.2	156.5	157.7
11193.4	10.4	160.7	195.0	156.6	157.7
12522.2	10.3	160.3	194.3	156.5	157.7
13847.2	10.3	160.0	194.0	156.2	157.7
15301.7	10.2	159.3	192.3	155.8	157.7
16690.5	10.0	158.0	191.5	155.2	157.7
18264.9	9.9	157.4	190.7	154.4	157.7
19777.7	9.7	156.0	189.4	153.5	157.7

TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
21384.5	9.6	155.0	189.1	152.6	157.7
22972.0	9.6	154.4	188.7	151.7	157.7
24663.2	9.5	153.7	187.6	150.8	157.7
26324.5	9.3	152.5	186.4	150.0	157.7
28098.6	9.2	151.7	185.7	149.2	157.7
29839.4	9.0	150.9	184.5	148.4	157.7
31655.3	8.9	150.0	184.0	147.5	157.7
33410.9	8.8	149.4	183.7	146.7	157.7
35262.8	8.7	148.6	182.4	145.9	157.7
37144.0	8.5	147.7	181.0	145.0	157.7
38947.8	8.4	146.6	180.4	144.2	157.7
40882.5	8.3	145.7	179.5	143.3	157.7
42793.0	8.2	145.0	179.4	142.6	157.7
44711.6	8.1	144.7	178.2	141.9	157.7
46657.2	8.0	143.9	177.6	141.3	157.7
48683.2	7.9	143.3	177.1	140.7	157.7
50764.1	7.8	142.6	176.8	140.1	157.7
52735.6	7.8	142.1	176.3	139.6	157.7
54760.7	7.7	141.5	176.1	139.0	157.7
56729.2	7.7	141.0	175.6	138.5	157.7
58814.8	7.6	140.8	175.1	138.0	157.7
60849.1	7.6	140.3	174.5	137.4	157.7
62918.8	7.5	139.6	174.0	137.0	157.7
65019.2	7.4	139.1	173.4	136.5	157.7
67074.2	7.4	138.8	173.1	136.1	157.6
69243.0	7.3	138.3	172.6	135.7	157.6
71497.9	7.3	138.2	172.3	135.3	157.6
73701.9	7.2	137.5	171.8	134.9	157.6
75915.6	7.1	137.0	171.2	134.5	157.6
78227.1	7.1	136.9	170.6	134.1	157.6
80434.7	7.0	136.5	170.4	133.7	157.6
82564.5	7.0	136.2	170.1	133.3	157.6
84801.5	7.0	135.9	169.6	133.0	157.6
86963.4	6.9	135.2	169.5	132.7	157.6
89333.3	6.9	134.9	168.7	132.4	157.5
91639.2	6.8	134.9	168.5	132.0	157.5
94004.8	6.8	134.3	167.9	131.7	157.5

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
96341.2	6.7	133.9	168.0	131.4	157.5
98628.8	6.7	133.7	167.9	131.1	157.5
100989.2	6.7	133.2	167.1	130.8	157.5
103336.4	6.6	133.2	166.6	130.5	157.5
105672.6	6.6	133.0	166.8	130.2	157.5
108068.8	6.5	132.5	166.0	129.9	157.5
110444.0	6.5	132.4	165.7	129.7	157.4
112920.4	6.5	131.9	165.4	129.5	157.4
115374.1	6.5	131.7	165.5	129.2	157.4
117819.3	6.4	131.5	165.2	129.0	157.4
120307.5	6.4	131.4	164.9	128.7	157.4
122842.3	6.4	131.2	164.3	128.5	157.4
125389.1	6.3	130.8	164.3	128.2	157.4
127936.2	6.3	130.6	164.0	127.9	157.3
130445.6	6.3	130.2	163.2	127.7	157.3
132996.5	6.2	129.8	163.2	127.4	157.3
135512.4	6.2	129.8	163.0	127.2	157.3
138134.3	6.2	129.5	162.2	126.9	157.3
140702.8	6.1	128.9	162.3	126.6	157.3
143285.8	6.1	128.7	161.8	126.4	157.3
145860.9	6.1	128.6	161.8	126.2	157.2
148382.9	6.1	128.6	161.6	126.0	157.2
150985.6	6.0	128.5	160.8	125.8	157.2
153549.4	6.0	128.0	160.8	125.6	157.2
156162.5	6.0	127.9	160.9	125.4	157.2
158779.7	6.0	127.9	160.3	125.2	157.2
161354.0	5.9	127.3	160.1	125.1	157.2
164016.9	5.9	127.3	159.9	124.9	157.1
166672.0	5.9	127.0	159.9	124.7	157.1
169319.9	5.9	127.1	159.7	124.5	157.1
172039.6	5.9	126.8	159.1	124.3	157.1
174711.7	5.8	126.3	159.2	124.1	157.1
177400.5	5.8	126.5	159.0	123.9	157.1
180143.5	5.8	126.2	158.3	123.8	157.0
182883.5	5.8	126.1	158.1	123.6	157.0
185610.1	5.7	125.6	157.9	123.4	157.0
188360.6	5.7	125.5	158.1	123.2	157.0

TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
191121.6	5.7	125.5	157.3	123.0	157.0
193892.4	5.7	125.0	157.2	122.8	157.0
196637.3	5.7	125.0	157.3	122.6	156.9
199463.9	5.6	124.8	156.5	122.4	156.9
202270.3	5.6	124.7	156.4	122.2	156.9
205009.5	5.6	124.2	156.3	122.1	156.9
207803.1	5.6	124.2	156.6	121.9	156.9
210567.5	5.6	124.2	156.3	121.8	156.9
213357.0	5.6	124.1	155.8	121.7	156.8
216139.0	5.5	123.8	155.8	121.6	156.8
218909.4	5.5	123.8	155.8	121.5	156.8
221699.0	5.5	123.8	155.5	121.3	156.8
224508.5	5.5	123.6	155.6	121.2	156.8
227334.7	5.5	123.6	155.0	121.1	156.8
230116.0	5.5	123.2	154.9	121.0	156.7
232955.5	5.5	123.1	155.2	120.9	156.7
235778.9	5.5	123.2	154.9	120.8	156.7
238618.0	5.4	123.0	154.3	120.7	156.7
241424.1	5.4	122.7	154.3	120.6	156.7
244292.8	5.4	122.7	154.1	120.4	156.7
247146.2	5.4	122.4	154.2	120.3	156.6
249988.7	5.4	122.5	154.3	120.2	156.6
252884.4	5.4	122.5	153.7	120.1	156.6
255712.6	5.4	122.2	153.4	120.0	156.6
258584.8	5.3	122.0	153.6	119.9	156.6
261446.4	5.3	122.1	153.7	119.8	156.6
264420.8	5.3	121.8	153.4	119.7	156.5
267263.2	5.3	121.9	153.3	119.5	156.5
270168.7	5.3	121.8	152.7	119.4	156.5
273072.4	5.3	121.4	152.6	119.3	156.5
275974.7	5.3	121.3	152.7	119.2	156.5
278864.1	5.3	121.3	152.7	119.1	156.5
281830.7	5.2	121.3	152.1	119.0	156.4
284710.6	5.2	121.0	151.9	118.9	156.4
287713.4	5.2	121.0	151.8	118.7	156.4
290636.4	5.2	120.8	151.5	118.6	156.4
293585.4	5.2	120.5	151.7	118.5	156.4

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
296551.2	5.2	120.5	151.6	118.4	156.4
299487.3	5.2	120.5	151.4	118.3	156.3
302488.0	5.1	120.4	150.8	118.2	156.3
305420.3	5.1	120.0	150.8	118.0	156.3
308478.7	5.1	120.1	150.5	117.9	156.3
311434.3	5.1	119.8	150.5	117.8	156.3
314437.8	5.1	119.7	150.6	117.7	156.2
317435.8	5.1	119.7	150.6	117.6	156.2
320429.1	5.1	119.6	150.2	117.5	156.2
323479.2	5.1	119.5	149.7	117.3	156.2
326470.4	5.0	119.2	149.6	117.2	156.2
329546.8	5.0	119.3	149.4	117.1	156.2
332593.6	5.0	119.0	149.2	117.0	156.1
335643.0	5.0	118.8	149.4	116.9	156.1
338670.9	5.0	118.8	149.4	116.7	156.1
341727.8	5.0	118.7	149.2	116.6	156.1
344812.1	5.0	118.6	148.8	116.5	156.1
347898.4	5.0	118.5	148.4	116.4	156.0
351019.3	4.9	118.3	148.7	116.3	156.0
354113.8	4.9	118.2	148.3	116.2	156.0
357214.8	4.9	118.1	147.9	116.0	156.0
360308.4	4.9	117.9	147.7	115.9	156.0
363424.0	4.9	117.6	147.6	115.8	156.0
366547.9	4.9	117.5	147.6	115.7	155.9
369678.1	4.9	117.5	147.6	115.5	155.9
372806.0	4.9	117.4	147.4	115.4	155.9
376013.8	4.8	117.2	147.1	115.3	155.9
379147.9	4.8	117.2	147.0	115.2	155.9
382295.3	4.8	117.1	146.6	115.0	155.8
385464.8	4.8	116.9	146.2	114.9	155.8
388639.4	4.8	116.6	146.1	114.8	155.8
391804.6	4.8	116.5	146.1	114.7	155.8
395001.6	4.8	116.5	146.0	114.6	155.8
398234.2	4.7	116.2	145.7	114.4	155.7
401432.8	4.7	116.2	145.7	114.3	155.7
404606.2	4.7	116.2	145.5	114.2	155.7
407775.7	4.7	116.1	145.1	114.1	155.7

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
410929.4	4.7	116.0	144.9	114.0	155.7
414086.5	4.7	115.8	144.8	114.0	155.6
417251.6	4.7	115.7	144.9	113.9	155.6
420466.2	4.7	115.7	144.6	113.8	155.6
423633.2	4.7	115.5	144.5	113.7	155.6
426809.1	4.7	115.5	144.6	113.7	155.6
429988.9	4.7	115.4	144.7	113.6	155.6
433165.6	4.7	115.4	144.6	113.5	155.5
436354.1	4.6	115.4	144.3	113.5	155.5
439546.8	4.6	115.4	144.0	113.4	155.5
442742.8	4.6	115.2	143.8	113.3	155.5
445990.0	4.6	115.2	144.0	113.3	155.5
449196.3	4.6	115.1	143.7	113.2	155.4
452406.8	4.6	115.0	143.5	113.1	155.4
455614.2	4.6	114.8	143.4	113.1	155.4
458827.5	4.6	114.7	143.5	113.0	155.4
462042.2	4.6	114.7	143.6	112.9	155.4
465246.7	4.6	114.7	143.6	112.9	155.3
468544.3	4.6	114.5	143.2	112.8	155.3
471794.3	4.6	114.5	143.2	112.7	155.3
475044.3	4.6	114.5	143.1	112.7	155.3
478294.3	4.6	114.4	142.9	112.6	155.3
481544.3	4.5	114.4	142.8	112.5	155.3
484794.3	4.5	114.3	142.7	112.5	155.2
488044.3	4.5	114.2	142.6	112.4	155.2
491344.3	4.5	114.1	142.5	112.3	155.2
494594.3	4.5	114.1	142.4	112.3	155.2
497844.3	4.5	114.0	142.3	112.2	155.2
501094.3	4.5	113.9	142.2	112.1	155.1
504344.3	4.5	113.9	142.1	112.1	155.1
507594.3	4.5	113.8	142.0	112.0	155.1
510844.3	4.5	113.7	141.9	111.9	155.1
514144.3	4.5	113.6	141.8	111.9	155.1
517394.3	4.5	113.6	141.6	111.8	155.0
520644.3	4.5	113.5	141.5	111.7	155.0
523894.3	4.5	113.4	141.4	111.7	155.0
527144.3	4.4	113.3	141.3	111.6	155.0

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
530394.3	4.4	113.3	141.2	111.5	155.0
533644.3	4.4	113.2	141.1	111.5	154.9
536894.3	4.4	113.1	141.0	111.4	154.9
540194.3	4.4	113.1	140.9	111.3	154.9
543444.3	4.4	113.0	140.8	111.2	154.9
546694.3	4.4	112.9	140.7	111.2	154.9
549944.3	4.4	112.8	140.6	111.1	154.9
553194.3	4.4	112.8	140.4	111.0	154.8
556444.3	4.4	112.7	140.3	111.0	154.8
559694.3	4.4	112.6	140.2	110.9	154.8
562994.3	4.4	112.5	140.1	110.8	154.8
566244.3	4.4	112.5	140.0	110.8	154.8
569494.3	4.4	112.4	139.9	110.7	154.7
572744.3	4.3	112.3	139.8	110.6	154.7
575994.3	4.3	112.2	139.7	110.6	154.7
579244.3	4.3	112.2	139.6	110.5	154.7
582494.3	4.3	112.1	139.5	110.4	154.7
585794.3	4.3	112.0	139.3	110.4	154.6
589044.3	4.3	112.0	139.2	110.3	154.6
592294.3	4.3	111.9	139.1	110.2	154.6
595544.3	4.3	111.8	139.0	110.2	154.6
598794.3	4.3	111.7	138.9	110.1	154.6
602044.3	4.3	111.7	138.8	110.0	154.6
605294.3	4.3	111.6	138.7	110.0	154.5
608544.3	4.3	111.6	138.7	109.9	154.5
611844.3	4.3	111.5	138.6	109.9	154.5
615094.3	4.3	111.5	138.5	109.8	154.5
618344.3	4.3	111.4	138.4	109.8	154.5
621594.3	4.3	111.4	138.4	109.7	154.4
624844.3	4.3	111.3	138.3	109.7	154.4
628094.3	4.2	111.3	138.2	109.6	154.4
631344.3	4.2	111.2	138.1	109.6	154.4
634644.3	4.2	111.2	138.1	109.5	154.4
637894.3	4.2	111.1	138.0	109.5	154.4
641144.3	4.2	111.1	137.9	109.5	154.3
644394.3	4.2	111.0	137.8	109.4	154.3
647644.3	4.2	111.0	137.8	109.4	154.3

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
650894.3	4.2	110.9	137.7	109.3	154.3
654144.3	4.2	110.9	137.6	109.3	154.3
657444.3	4.2	110.8	137.6	109.2	154.2
660694.3	4.2	110.8	137.5	109.2	154.2
663944.3	4.2	110.8	137.4	109.1	154.2
667194.3	4.2	110.7	137.3	109.1	154.2
670444.3	4.2	110.7	137.3	109.1	154.2
673694.3	4.2	110.6	137.2	109.0	154.2
676944.3	4.2	110.6	137.1	109.0	154.1
680244.3	4.2	110.5	137.0	108.9	154.1
683494.3	4.2	110.5	137.0	108.9	154.1
686744.3	4.2	110.4	136.9	108.8	154.1
689994.3	4.2	110.4	136.8	108.8	154.1
693244.3	4.2	110.3	136.7	108.8	154.0
696494.3	4.2	110.3	136.7	108.7	154.0
699744.3	4.2	110.2	136.6	108.7	154.0
702994.3	4.1	110.2	136.5	108.6	154.0
706294.3	4.1	110.1	136.4	108.6	154.0
709544.3	4.1	110.1	136.4	108.5	154.0
712794.3	4.1	110.1	136.3	108.5	153.9
716044.3	4.1	110.0	136.2	108.4	153.9
719294.3	4.1	110.0	136.2	108.4	153.9
722544.3	4.1	109.9	136.1	108.4	153.9
725794.3	4.1	109.9	136.0	108.3	153.9
729094.3	4.1	109.8	135.9	108.3	153.9
732344.3	4.1	109.8	135.9	108.2	153.8
735594.3	4.1	109.7	135.8	108.2	153.8
738844.3	4.1	109.7	135.7	108.1	153.8
742094.3	4.1	109.6	135.6	108.1	153.8
745344.3	4.1	109.6	135.6	108.0	153.8
748594.3	4.1	109.5	135.5	108.0	153.7
751894.3	4.1	109.5	135.4	108.0	153.7
755144.3	4.1	109.4	135.3	107.9	153.7
758394.3	4.1	109.4	135.3	107.9	153.7
761644.3	4.1	109.3	135.2	107.8	153.7
764894.3	4.1	109.3	135.1	107.8	153.7
768144.3	4.1	109.3	135.0	107.7	153.6

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
771394.3	4.1	109.2	135.0	107.7	153.6
774644.3	4.1	109.2	134.9	107.7	153.6
777944.3	4.0	109.1	134.8	107.6	153.6
781194.3	4.0	109.1	134.7	107.6	153.6
784444.3	4.0	109.0	134.7	107.5	153.6
787694.3	4.0	109.0	134.6	107.5	153.5
790944.3	4.0	108.9	134.5	107.4	153.5
794194.3	4.0	108.9	134.4	107.4	153.5
797444.3	4.0	108.8	134.4	107.3	153.5
800744.3	4.0	108.8	134.3	107.3	153.5
803994.3	4.0	108.8	134.2	107.3	153.5
807244.3	4.0	108.7	134.2	107.2	153.4
810494.3	4.0	108.7	134.1	107.2	153.4
813744.3	4.0	108.6	134.1	107.2	153.4
816994.3	4.0	108.6	134.0	107.1	153.4
820244.3	4.0	108.6	134.0	107.1	153.4
823544.3	4.0	108.5	133.9	107.1	153.4
826794.3	4.0	108.5	133.9	107.0	153.3
830044.3	4.0	108.5	133.8	107.0	153.3
833294.3	4.0	108.5	133.7	107.0	153.3
836544.3	4.0	108.4	133.7	106.9	153.3
839794.3	4.0	108.4	133.6	106.9	153.3
843044.3	4.0	108.4	133.6	106.9	153.3
846294.3	4.0	108.3	133.5	106.9	153.2
849594.3	4.0	108.3	133.5	106.8	153.2
852844.3	4.0	108.3	133.4	106.8	153.2
856094.3	4.0	108.2	133.4	106.8	153.2
859344.3	4.0	108.2	133.3	106.7	153.2
862594.3	4.0	108.2	133.3	106.7	153.2
865844.3	4.0	108.1	133.2	106.7	153.1
869094.3	4.0	108.1	133.2	106.6	153.1
872394.3	4.0	108.1	133.1	106.6	153.1
875644.3	4.0	108.0	133.1	106.6	153.1
878894.3	3.9	108.0	133.0	106.6	153.1
882144.3	3.9	108.0	133.0	106.5	153.1
885394.3	3.9	107.9	132.9	106.5	153.0
888644.3	3.9	107.9	132.8	106.5	153.0

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
891894.3	3.9	107.9	132.8	106.4	153.0
895194.3	3.9	107.8	132.7	106.4	153.0
898444.3	3.9	107.8	132.7	106.4	153.0
901694.3	3.9	107.8	132.6	106.3	153.0
904944.3	3.9	107.7	132.6	106.3	152.9
908194.3	3.9	107.7	132.5	106.3	152.9
911444.3	3.9	107.7	132.5	106.2	152.9
914694.3	3.9	107.6	132.4	106.2	152.9
917994.3	3.9	107.6	132.4	106.2	152.9
921244.3	3.9	107.6	132.3	106.2	152.9
924494.3	3.9	107.5	132.3	106.1	152.8
927744.3	3.9	107.5	132.2	106.1	152.8
930994.3	3.9	107.5	132.2	106.1	152.8
934244.3	3.9	107.4	132.1	106.0	152.8
937494.3	3.9	107.4	132.0	106.0	152.8
940744.3	3.9	107.4	132.0	106.0	152.8
944044.3	3.9	107.3	131.9	105.9	152.7
947294.3	3.9	107.3	131.9	105.9	152.7
950544.3	3.9	107.3	131.8	105.9	152.7
953794.3	3.9	107.3	131.8	105.9	152.7
957044.3	3.9	107.2	131.7	105.8	152.7
960294.3	3.9	107.2	131.7	105.8	152.7
963544.3	3.9	107.2	131.6	105.8	152.7
966844.3	3.9	107.1	131.6	105.7	152.6
970094.3	3.9	107.1	131.5	105.7	152.6
973344.3	3.9	107.1	131.5	105.7	152.6
976594.3	3.9	107.0	131.4	105.6	152.6
979844.3	3.9	107.0	131.3	105.6	152.6
983094.3	3.9	107.0	131.3	105.6	152.6
986344.3	3.9	106.9	131.2	105.6	152.5
989644.3	3.9	106.9	131.2	105.5	152.5
992894.3	3.8	106.9	131.1	105.5	152.5
996144.3	3.8	106.8	131.1	105.5	152.5
999394.3	3.8	106.8	131.0	105.4	152.5
1002644.0	3.8	106.8	131.0	105.4	152.5
1005894.0	3.8	106.7	130.9	105.4	152.4
1009144.0	3.8	106.7	130.9	105.4	152.4

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
1012394.0	3.8	106.7	130.9	105.3	152.4
1015694.0	3.8	106.7	130.8	105.3	152.4
1018944.0	3.8	106.7	130.8	105.3	152.4
1022194.0	3.8	106.6	130.8	105.3	152.4
1025444.0	3.8	106.6	130.7	105.2	152.4
1028694.0	3.8	106.6	130.7	105.2	152.3
1031944.0	3.8	106.6	130.6	105.2	152.3
1035194.0	3.8	106.5	130.6	105.2	152.3
1038494.0	3.8	106.5	130.6	105.2	152.3
1041744.0	3.8	106.5	130.5	105.1	152.3
1044994.0	3.8	106.5	130.5	105.1	152.3
1048244.0	3.8	106.5	130.5	105.1	152.2
1051494.0	3.8	106.4	130.4	105.1	152.2
1054744.0	3.8	106.4	130.4	105.1	152.2
1057994.0	3.8	106.4	130.4	105.0	152.2
1061294.0	3.8	106.4	130.3	105.0	152.2
1064544.0	3.8	106.3	130.3	105.0	152.2
1067794.0	3.8	106.3	130.2	105.0	152.2
1071044.0	3.8	106.3	130.2	105.0	152.1
1074294.0	3.8	106.3	130.2	104.9	152.1
1077544.0	3.8	106.3	130.1	104.9	152.1
1080794.0	3.8	106.2	130.1	104.9	152.1
1084094.0	3.8	106.2	130.1	104.9	152.1
1087344.0	3.8	106.2	130.0	104.9	152.1
1090594.0	3.8	106.2	130.0	104.8	152.0
1093844.0	3.8	106.2	129.9	104.8	152.0
1097094.0	3.8	106.1	129.9	104.8	152.0
1100344.0	3.8	106.1	129.9	104.8	152.0
1103594.0	3.8	106.1	129.8	104.8	152.0
1106844.0	3.8	106.1	129.8	104.7	152.0
1110144.0	3.8	106.0	129.8	104.7	152.0
1113394.0	3.8	106.0	129.7	104.7	151.9
1116644.0	3.8	106.0	129.7	104.7	151.9
1119894.0	3.8	106.0	129.6	104.7	151.9
1123144.0	3.8	106.0	129.6	104.6	151.9
1126394.0	3.8	105.9	129.6	104.6	151.9
1129644.0	3.8	105.9	129.5	104.6	151.9

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
1132944.0	3.8	105.9	129.5	104.6	151.8
1136194.0	3.8	105.9	129.5	104.6	151.8
1139444.0	3.8	105.8	129.4	104.5	151.8
1142694.0	3.8	105.8	129.4	104.5	151.8
1145944.0	3.8	105.8	129.4	104.5	151.8
1149194.0	3.8	105.8	129.3	104.5	151.8
1152444.0	3.8	105.8	129.3	104.5	151.8
1155744.0	3.8	105.7	129.2	104.4	151.7
1158994.0	3.8	105.7	129.2	104.4	151.7
1162244.0	3.8	105.7	129.2	104.4	151.7
1165494.0	3.8	105.7	129.1	104.4	151.7
1168744.0	3.7	105.7	129.1	104.4	151.7
1171994.0	3.7	105.6	129.1	104.3	151.7
1175244.0	3.7	105.6	129.0	104.3	151.7
1178494.0	3.7	105.6	129.0	104.3	151.6
1181794.0	3.7	105.6	128.9	104.3	151.6
1185044.0	3.7	105.5	128.9	104.3	151.6
1188294.0	3.7	105.5	128.9	104.2	151.6
1191544.0	3.7	105.5	128.8	104.2	151.6
1194794.0	3.7	105.5	128.8	104.2	151.6
1198044.0	3.7	105.5	128.8	104.2	151.6
1201294.0	3.7	105.4	128.7	104.2	151.5
1204594.0	3.7	105.4	128.7	104.1	151.5
1207844.0	3.7	105.4	128.6	104.1	151.5
1211094.0	3.7	105.4	128.6	104.1	151.5
1214344.0	3.7	105.4	128.6	104.1	151.5
1217594.0	3.7	105.3	128.5	104.1	151.5
1220844.0	3.7	105.3	128.5	104.0	151.4
1224094.0	3.7	105.3	128.5	104.0	151.4
1227394.0	3.7	105.3	128.4	104.0	151.4
1230644.0	3.7	105.2	128.4	104.0	151.4
1233894.0	3.7	105.2	128.3	103.9	151.4
1237144.0	3.7	105.2	128.3	103.9	151.4
1240394.0	3.7	105.2	128.3	103.9	151.4
1243644.0	3.7	105.2	128.2	103.9	151.3
1246894.0	3.7	105.1	128.2	103.9	151.3
1250144.0	3.7	105.1	128.2	103.8	151.3

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
1253444.0	3.7	105.1	128.1	103.8	151.3
1256694.0	3.7	105.1	128.1	103.8	151.3
1259944.0	3.7	105.0	128.0	103.8	151.3
1263194.0	3.7	105.0	128.0	103.8	151.3
1266444.0	3.7	105.0	128.0	103.7	151.2
1269694.0	3.7	105.0	127.9	103.7	151.2
1272944.0	3.7	105.0	127.9	103.7	151.2
1276244.0	3.7	104.9	127.9	103.7	151.2
1279494.0	3.7	104.9	127.8	103.7	151.2
1282744.0	3.7	104.9	127.8	103.6	151.2
1285994.0	3.7	104.9	127.7	103.6	151.2
1289244.0	3.7	104.9	127.7	103.6	151.1
1292494.0	3.7	104.8	127.7	103.6	151.1
1295744.0	3.7	104.8	127.6	103.6	151.1
1299044.0	3.7	104.8	127.6	103.5	151.1
1302294.0	3.7	104.8	127.6	103.5	151.1
1305544.0	3.7	104.7	127.5	103.5	151.1
1308794.0	3.7	104.7	127.5	103.5	151.1
1312044.0	3.7	104.7	127.4	103.5	151.0
1315294.0	3.7	104.7	127.4	103.4	151.0
1318544.0	3.7	104.7	127.4	103.4	151.0
1321844.0	3.7	104.6	127.3	103.4	151.0
1325094.0	3.7	104.6	127.3	103.4	151.0
1328344.0	3.7	104.6	127.3	103.4	151.0
1331594.0	3.7	104.6	127.2	103.3	151.0
1334844.0	3.7	104.6	127.2	103.3	150.9
1338094.0	3.7	104.5	127.1	103.3	150.9
1341344.0	3.7	104.5	127.1	103.3	150.9
1344594.0	3.7	104.5	127.1	103.3	150.9
1347894.0	3.7	104.5	127.0	103.2	150.9
1351144.0	3.7	104.4	127.0	103.2	150.9
1354394.0	3.6	104.4	126.9	103.2	150.9
1357644.0	3.6	104.4	126.9	103.2	150.8
1360894.0	3.6	104.4	126.9	103.2	150.8
1364144.0	3.6	104.4	126.8	103.1	150.8
1367394.0	3.6	104.3	126.8	103.1	150.8
1370694.0	3.6	104.3	126.8	103.1	150.8

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
1373944.0	3.6	104.3	126.7	103.1	150.8
1377194.0	3.6	104.3	126.7	103.1	150.8
1380444.0	3.6	104.2	126.6	103.0	150.7
1383694.0	3.6	104.2	126.6	103.0	150.7
1386944.0	3.6	104.2	126.6	103.0	150.7
1390194.0	3.6	104.2	126.5	103.0	150.7
1393494.0	3.6	104.2	126.5	103.0	150.7
1396744.0	3.6	104.1	126.5	102.9	150.7
1399994.0	3.6	104.1	126.4	102.9	150.7
1403244.0	3.6	104.1	126.4	102.9	150.7
1406494.0	3.6	104.1	126.4	102.9	150.6
1409744.0	3.6	104.1	126.3	102.9	150.6
1412994.0	3.6	104.1	126.3	102.9	150.6
1416244.0	3.6	104.0	126.3	102.8	150.6
1419544.0	3.6	104.0	126.3	102.8	150.6
1422794.0	3.6	104.0	126.2	102.8	150.6
1426044.0	3.6	104.0	126.2	102.8	150.6
1429294.0	3.6	104.0	126.2	102.8	150.5
1432544.0	3.6	104.0	126.2	102.8	150.5
1435794.0	3.6	104.0	126.1	102.8	150.5
1439044.0	3.6	103.9	126.1	102.8	150.5
1442344.0	3.6	103.9	126.1	102.7	150.5
1445594.0	3.6	103.9	126.1	102.7	150.5
1448844.0	3.6	103.9	126.0	102.7	150.5
1452094.0	3.6	103.9	126.0	102.7	150.4
1455344.0	3.6	103.9	126.0	102.7	150.4
1458594.0	3.6	103.9	126.0	102.7	150.4
1461844.0	3.6	103.9	126.0	102.7	150.4
1465144.0	3.6	103.8	125.9	102.7	150.4
1468394.0	3.6	103.8	125.9	102.6	150.4
1471644.0	3.6	103.8	125.9	102.6	150.4
1474894.0	3.6	103.8	125.9	102.6	150.4
1478144.0	3.6	103.8	125.8	102.6	150.3
1481394.0	3.6	103.8	125.8	102.6	150.3
1484644.0	3.6	103.8	125.8	102.6	150.3
1487944.0	3.6	103.7	125.8	102.6	150.3
1491194.0	3.6	103.7	125.7	102.6	150.3

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
1494444.0	3.6	103.7	125.7	102.5	150.3
1497694.0	3.6	103.7	125.7	102.5	150.3
1500944.0	3.6	103.7	125.7	102.5	150.2
1504194.0	3.6	103.7	125.6	102.5	150.2
1507444.0	3.6	103.7	125.6	102.5	150.2
1510694.0	3.6	103.7	125.6	102.5	150.2
1513994.0	3.6	103.6	125.6	102.5	150.2
1517244.0	3.6	103.6	125.5	102.5	150.2
1520494.0	3.6	103.6	125.5	102.4	150.2
1523744.0	3.6	103.6	125.5	102.4	150.2
1526994.0	3.6	103.6	125.5	102.4	150.1
1530244.0	3.6	103.6	125.5	102.4	150.1
1533494.0	3.6	103.6	125.4	102.4	150.1
1536794.0	3.6	103.5	125.4	102.4	150.1
1540044.0	3.6	103.5	125.4	102.4	150.1
1543294.0	3.6	103.5	125.4	102.4	150.1
1546544.0	3.6	103.5	125.3	102.3	150.1
1549794.0	3.6	103.5	125.3	102.3	150.0
1553044.0	3.6	103.5	125.3	102.3	150.0
1556294.0	3.6	103.5	125.3	102.3	150.0
1559594.0	3.6	103.5	125.2	102.3	150.0
1562844.0	3.6	103.4	125.2	102.3	150.0
1566094.0	3.6	103.4	125.2	102.3	150.0
1569344.0	3.6	103.4	125.2	102.3	150.0
1572594.0	3.6	103.4	125.1	102.2	150.0
1575844.0	3.6	103.4	125.1	102.2	149.9
1579094.0	3.6	103.4	125.1	102.2	149.9
1582344.0	3.6	103.4	125.1	102.2	149.9
1585644.0	3.6	103.3	125.0	102.2	149.9
1588894.0	3.6	103.3	125.0	102.2	149.9
1592144.0	3.6	103.3	125.0	102.2	149.9
1595394.0	3.6	103.3	125.0	102.2	149.9
1598644.0	3.6	103.3	124.9	102.1	149.8
1601894.0	3.6	103.3	124.9	102.1	149.8
1605144.0	3.6	103.3	124.9	102.1	149.8
1608444.0	3.6	103.3	124.9	102.1	149.8
1611694.0	3.6	103.2	124.9	102.1	149.8

TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
1614944.0	3.6	103.2	124.8	102.1	149.8
1618194.0	3.6	103.2	124.8	102.1	149.8
1621444.0	3.6	103.2	124.8	102.1	149.8
1624694.0	3.6	103.2	124.8	102.0	149.7
1627944.0	3.6	103.2	124.7	102.0	149.7
1631244.0	3.6	103.2	124.7	102.0	149.7
1634494.0	3.6	103.1	124.7	102.0	149.7
1637744.0	3.6	103.1	124.7	102.0	149.7
1640994.0	3.5	103.1	124.6	102.0	149.7
1644244.0	3.5	103.1	124.6	102.0	149.7
1647494.0	3.5	103.1	124.6	102.0	149.7
1650744.0	3.5	103.1	124.6	101.9	149.6
1654044.0	3.5	103.1	124.5	101.9	149.6
1657294.0	3.5	103.1	124.5	101.9	149.6
1660544.0	3.5	103.0	124.5	101.9	149.6
1663794.0	3.5	103.0	124.5	101.9	149.6
1667044.0	3.5	103.0	124.4	101.9	149.6
1670294.0	3.5	103.0	124.4	101.9	149.6
1673544.0	3.5	103.0	124.4	101.9	149.6
1676794.0	3.5	103.0	124.4	101.8	149.5
1680094.0	3.5	103.0	124.3	101.8	149.5
1683344.0	3.5	102.9	124.3	101.8	149.5
1686594.0	3.5	102.9	124.3	101.8	149.5
1689844.0	3.5	102.9	124.3	101.8	149.5
1693094.0	3.5	102.9	124.2	101.8	149.5
1696344.0	3.5	102.9	124.2	101.8	149.5
1699594.0	3.5	102.9	124.2	101.8	149.5
1702894.0	3.5	102.9	124.2	101.7	149.4
1706144.0	3.5	102.9	124.2	101.7	149.4
1709394.0	3.5	102.8	124.1	101.7	149.4
1712644.0	3.5	102.8	124.1	101.7	149.4
1715894.0	3.5	102.8	124.1	101.7	149.4
1719144.0	3.5	102.8	124.1	101.7	149.4
1722394.0	3.5	102.8	124.0	101.7	149.4
1725694.0	3.5	102.8	124.0	101.7	149.3
1728944.0	3.5	102.8	124.0	101.6	149.3
1732194.0	3.5	102.7	124.0	101.6	149.3

TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
1735444.0	3.5	102.7	123.9	101.6	149.3
1738694.0	3.5	102.7	123.9	101.6	149.3
1741944.0	3.5	102.7	123.9	101.6	149.3
1745194.0	3.5	102.7	123.9	101.6	149.3
1748444.0	3.5	102.7	123.8	101.6	149.3
1751744.0	3.5	102.7	123.8	101.6	149.2
1754994.0	3.5	102.7	123.8	101.5	149.2
1758244.0	3.5	102.6	123.8	101.5	149.2
1761494.0	3.5	102.6	123.7	101.5	149.2
1764744.0	3.5	102.6	123.7	101.5	149.2
1767994.0	3.5	102.6	123.7	101.5	149.2
1771244.0	3.5	102.6	123.7	101.5	149.2
1774544.0	3.5	102.6	123.6	101.5	149.2
1777794.0	3.5	102.6	123.6	101.5	149.1
1781044.0	3.5	102.5	123.6	101.4	149.1
1784294.0	3.5	102.5	123.6	101.4	149.1
1787544.0	3.5	102.5	123.5	101.4	149.1
1790794.0	3.5	102.5	123.5	101.4	149.1
1794044.0	3.5	102.5	123.5	101.4	149.1
1797344.0	3.5	102.5	123.5	101.4	149.1
1800594.0	3.5	102.5	123.4	101.4	149.1
1803844.0	3.5	102.5	123.4	101.4	149.1
1807094.0	3.5	102.4	123.4	101.3	149.0
1810344.0	3.5	102.4	123.4	101.3	149.0
1813594.0	3.5	102.4	123.3	101.3	149.0
1816844.0	3.5	102.4	123.3	101.3	149.0
1820094.0	3.5	102.4	123.3	101.3	149.0
1823394.0	3.5	102.4	123.3	101.3	149.0
1826644.0	3.5	102.4	123.2	101.3	149.0
1829894.0	3.5	102.3	123.2	101.3	149.0
1833144.0	3.5	102.3	123.2	101.2	148.9
1836394.0	3.5	102.3	123.2	101.2	148.9
1839644.0	3.5	102.3	123.2	101.2	148.9
1842894.0	3.5	102.3	123.1	101.2	148.9
1846194.0	3.5	102.3	123.1	101.2	148.9
1849444.0	3.5	102.3	123.1	101.2	148.9
1852694.0	3.5	102.3	123.1	101.2	148.9

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
1855944.0	3.5	102.2	123.0	101.2	148.9
1859194.0	3.5	102.2	123.0	101.1	148.8
1862444.0	3.5	102.2	123.0	101.1	148.8
1865694.0	3.5	102.2	123.0	101.1	148.8
1868994.0	3.5	102.2	122.9	101.1	148.8
1872244.0	3.5	102.2	122.9	101.1	148.8
1875494.0	3.5	102.2	122.9	101.1	148.8
1878744.0	3.5	102.1	122.9	101.1	148.8
1881994.0	3.5	102.1	122.8	101.1	148.8
1885244.0	3.5	102.1	122.8	101.0	148.7
1888494.0	3.5	102.1	122.8	101.0	148.7
1891794.0	3.5	102.1	122.8	101.0	148.7
1895044.0	3.5	102.1	122.7	101.0	148.7
1898294.0	3.5	102.1	122.7	101.0	148.7
1901544.0	3.5	102.1	122.7	101.0	148.7
1904794.0	3.5	102.0	122.7	101.0	148.7
1908044.0	3.5	102.0	122.6	101.0	148.7
1911294.0	3.5	102.0	122.6	101.0	148.6
1914544.0	3.5	102.0	122.6	100.9	148.6
1917844.0	3.5	102.0	122.6	100.9	148.6
1921094.0	3.5	102.0	122.5	100.9	148.6
1924344.0	3.5	102.0	122.5	100.9	148.6
1927594.0	3.5	101.9	122.5	100.9	148.6
1930844.0	3.5	101.9	122.5	100.9	148.6
1934094.0	3.5	101.9	122.4	100.9	148.6
1937344.0	3.5	101.9	122.4	100.9	148.6
1940644.0	3.5	101.9	122.4	100.8	148.5
1943894.0	3.5	101.9	122.4	100.8	148.5
1947144.0	3.5	101.9	122.3	100.8	148.5
1950394.0	3.5	101.9	122.3	100.8	148.5
1953644.0	3.5	101.8	122.3	100.8	148.5
1956894.0	3.5	101.8	122.3	100.8	148.5
1960144.0	3.5	101.8	122.2	100.8	148.5
1963444.0	3.5	101.8	122.2	100.8	148.5
1966694.0	3.5	101.8	122.2	100.7	148.4
1969944.0	3.4	101.8	122.2	100.7	148.4
1973194.0	3.4	101.8	122.1	100.7	148.4

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
1976444.0	3.4	101.7	122.1	100.7	148.4
1979694.0	3.4	101.7	122.1	100.7	148.4
1982944.0	3.4	101.7	122.1	100.7	148.4
1986194.0	3.4	101.7	122.0	100.7	148.4
1989494.0	3.4	101.7	122.0	100.7	148.4
1992744.0	3.4	101.7	122.0	100.6	148.4
1995994.0	3.4	101.7	122.0	100.6	148.3
1999244.0	3.4	101.7	121.9	100.6	148.3
2002494.0	3.4	101.6	121.9	100.6	148.3
2005744.0	3.4	101.6	121.9	100.6	148.3
2008994.0	3.4	101.6	121.9	100.6	148.3
2012294.0	3.4	101.6	121.9	100.6	148.3
2015544.0	3.4	101.6	121.9	100.6	148.3
2018794.0	3.4	101.6	121.9	100.6	148.3
2022044.0	3.4	101.6	121.8	100.6	148.2
2025294.0	3.4	101.6	121.8	100.6	148.2
2028544.0	3.4	101.6	121.8	100.5	148.2
2031794.0	3.4	101.6	121.8	100.5	148.2
2035094.0	3.4	101.6	121.8	100.5	148.2
2038344.0	3.4	101.6	121.8	100.5	148.2
2041594.0	3.4	101.6	121.8	100.5	148.2
2044844.0	3.4	101.5	121.8	100.5	148.2
2048094.0	3.4	101.5	121.7	100.5	148.2
2051344.0	3.4	101.5	121.7	100.5	148.1
2054594.0	3.4	101.5	121.7	100.5	148.1
2057894.0	3.4	101.5	121.7	100.5	148.1
2061144.0	3.4	101.5	121.7	100.5	148.1
2064394.0	3.4	101.5	121.7	100.5	148.1
2067644.0	3.4	101.5	121.7	100.5	148.1
2070894.0	3.4	101.5	121.7	100.5	148.1
2074144.0	3.4	101.5	121.6	100.5	148.1
2077394.0	3.4	101.5	121.6	100.4	148.1
2080644.0	3.4	101.5	121.6	100.4	148.0
2083944.0	3.4	101.5	121.6	100.4	148.0
2087194.0	3.4	101.5	121.6	100.4	148.0
2090444.0	3.4	101.5	121.6	100.4	148.0
2093694.0	3.4	101.4	121.6	100.4	148.0

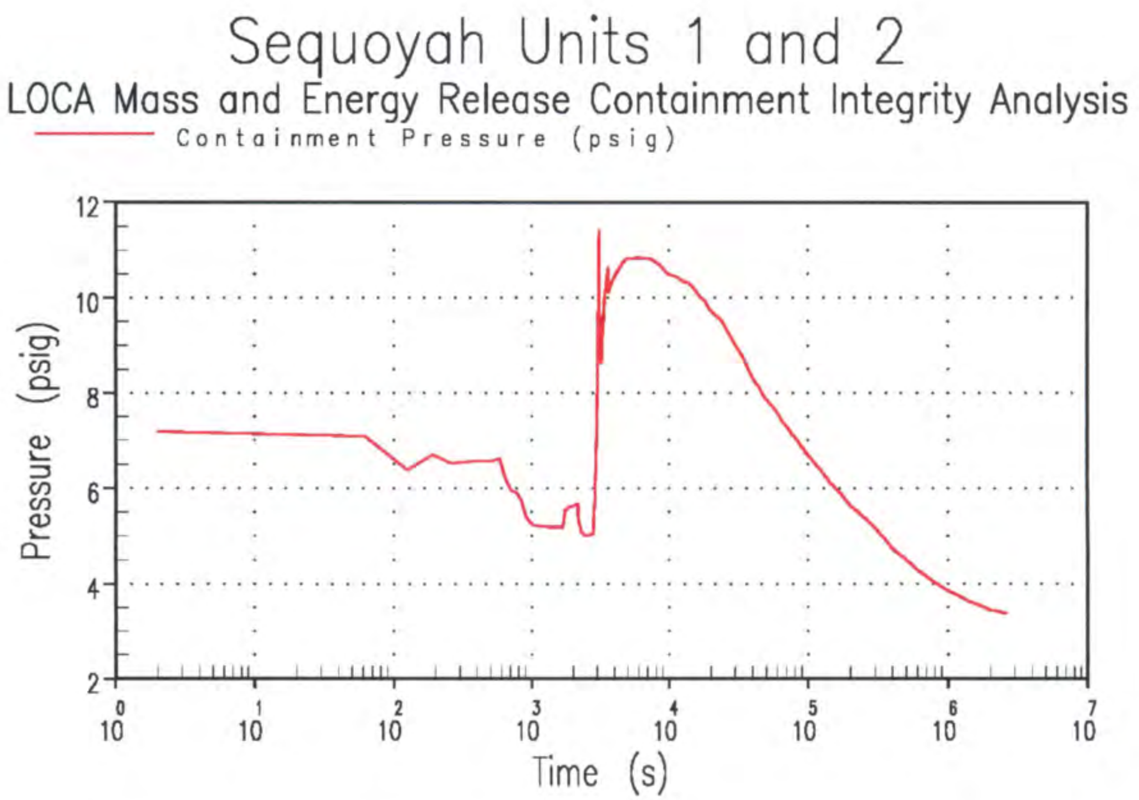
TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
2096944.0	3.4	101.4	121.6	100.4	148.0
2100194.0	3.4	101.4	121.5	100.4	148.0
2103444.0	3.4	101.4	121.5	100.4	148.0
2106744.0	3.4	101.4	121.5	100.4	148.0
2109994.0	3.4	101.4	121.5	100.4	147.9
2113244.0	3.4	101.4	121.5	100.4	147.9
2116494.0	3.4	101.4	121.5	100.4	147.9
2119744.0	3.4	101.4	121.5	100.4	147.9
2122994.0	3.4	101.4	121.5	100.4	147.9
2126244.0	3.4	101.4	121.4	100.4	147.9
2129544.0	3.4	101.4	121.4	100.3	147.9
2132794.0	3.4	101.4	121.4	100.3	147.9
2136044.0	3.4	101.4	121.4	100.3	147.8
2139294.0	3.4	101.4	121.4	100.3	147.8
2142544.0	3.4	101.3	121.4	100.3	147.8
2145794.0	3.4	101.3	121.4	100.3	147.8
2149044.0	3.4	101.3	121.4	100.3	147.8
2152294.0	3.4	101.3	121.3	100.3	147.8
2155594.0	3.4	101.3	121.3	100.3	147.8
2158844.0	3.4	101.3	121.3	100.3	147.8
2162094.0	3.4	101.3	121.3	100.3	147.8
2165344.0	3.4	101.3	121.3	100.3	147.7
2168594.0	3.4	101.3	121.3	100.3	147.7
2171844.0	3.4	101.3	121.3	100.3	147.7
2175094.0	3.4	101.3	121.3	100.3	147.7
2178394.0	3.4	101.3	121.2	100.3	147.7
2181644.0	3.4	101.3	121.2	100.2	147.7
2184894.0	3.4	101.3	121.2	100.2	147.7
2188144.0	3.4	101.3	121.2	100.2	147.7
2191394.0	3.4	101.2	121.2	100.2	147.7
2194644.0	3.4	101.2	121.2	100.2	147.6
2197894.0	3.4	101.2	121.2	100.2	147.6
2201194.0	3.4	101.2	121.2	100.2	147.6
2204444.0	3.4	101.2	121.1	100.2	147.6
2207694.0	3.4	101.2	121.1	100.2	147.6
2210944.0	3.4	101.2	121.1	100.2	147.6
2214194.0	3.4	101.2	121.1	100.2	147.6

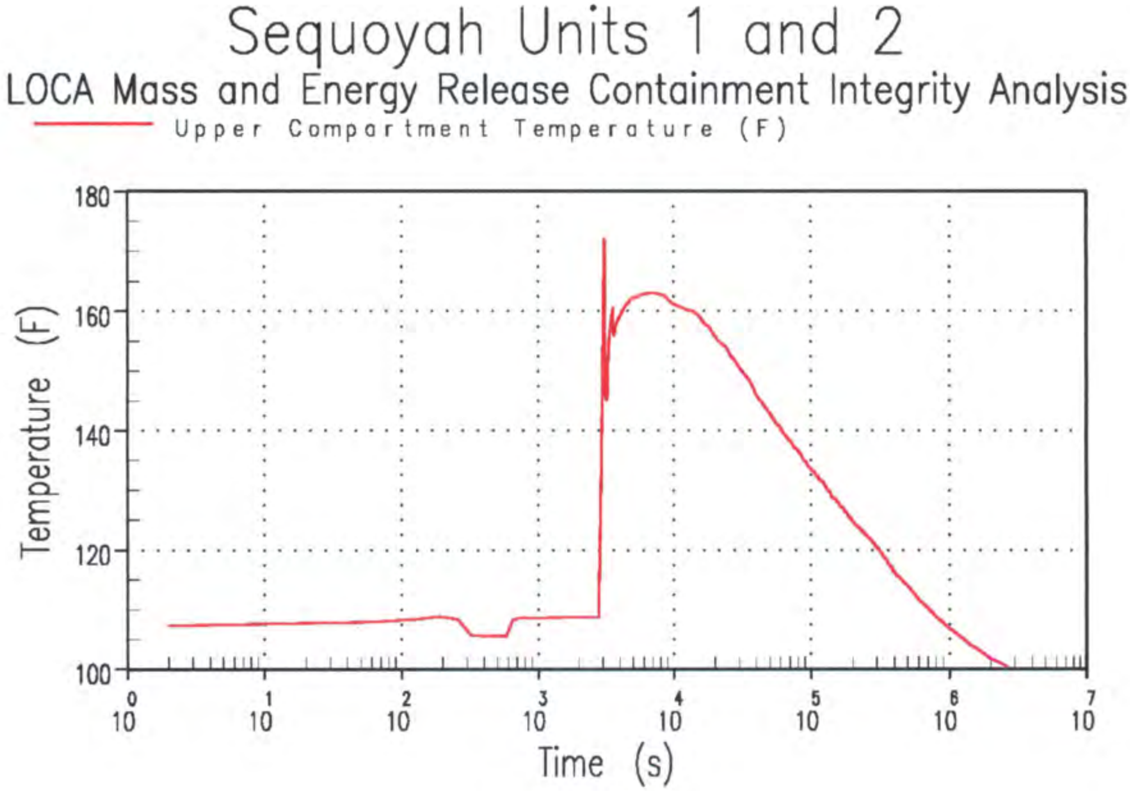
TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
2217444.0	3.4	101.2	121.1	100.2	147.6
2220694.0	3.4	101.2	121.1	100.2	147.6
2223994.0	3.4	101.2	121.1	100.2	147.5
2227244.0	3.4	101.2	121.1	100.2	147.5
2230494.0	3.4	101.2	121.0	100.2	147.5
2233744.0	3.4	101.2	121.0	100.1	147.5
2236994.0	3.4	101.2	121.0	100.1	147.5
2240244.0	3.4	101.1	121.0	100.1	147.5
2243494.0	3.4	101.1	121.0	100.1	147.5
2246744.0	3.4	101.1	121.0	100.1	147.5
2250044.0	3.4	101.1	121.0	100.1	147.5
2253294.0	3.4	101.1	121.0	100.1	147.4
2256544.0	3.4	101.1	120.9	100.1	147.4
2259794.0	3.4	101.1	120.9	100.1	147.4
2263044.0	3.4	101.1	120.9	100.1	147.4
2266294.0	3.4	101.1	120.9	100.1	147.4
2269544.0	3.4	101.1	120.9	100.1	147.4
2272844.0	3.4	101.1	120.9	100.1	147.4
2276094.0	3.4	101.1	120.9	100.1	147.4
2279344.0	3.4	101.1	120.9	100.1	147.4
2282594.0	3.4	101.1	120.8	100.1	147.3
2285844.0	3.4	101.1	120.8	100.1	147.3
2289094.0	3.4	101.0	120.8	100.0	147.3
2292344.0	3.4	101.0	120.8	100.0	147.3
2295644.0	3.4	101.0	120.8	100.0	147.3
2298894.0	3.4	101.0	120.8	100.0	147.3
2302144.0	3.4	101.0	120.8	100.0	147.3
2305394.0	3.4	101.0	120.8	100.0	147.3
2308644.0	3.4	101.0	120.7	100.0	147.3
2311894.0	3.4	101.0	120.7	100.0	147.2
2315144.0	3.4	101.0	120.7	100.0	147.2
2318394.0	3.4	101.0	120.7	100.0	147.2
2321694.0	3.4	101.0	120.7	100.0	147.2
2324944.0	3.4	101.0	120.7	100.0	147.2
2328194.0	3.4	101.0	120.7	100.0	147.2
2331444.0	3.4	101.0	120.7	100.0	147.2
2334694.0	3.4	101.0	120.6	100.0	147.2

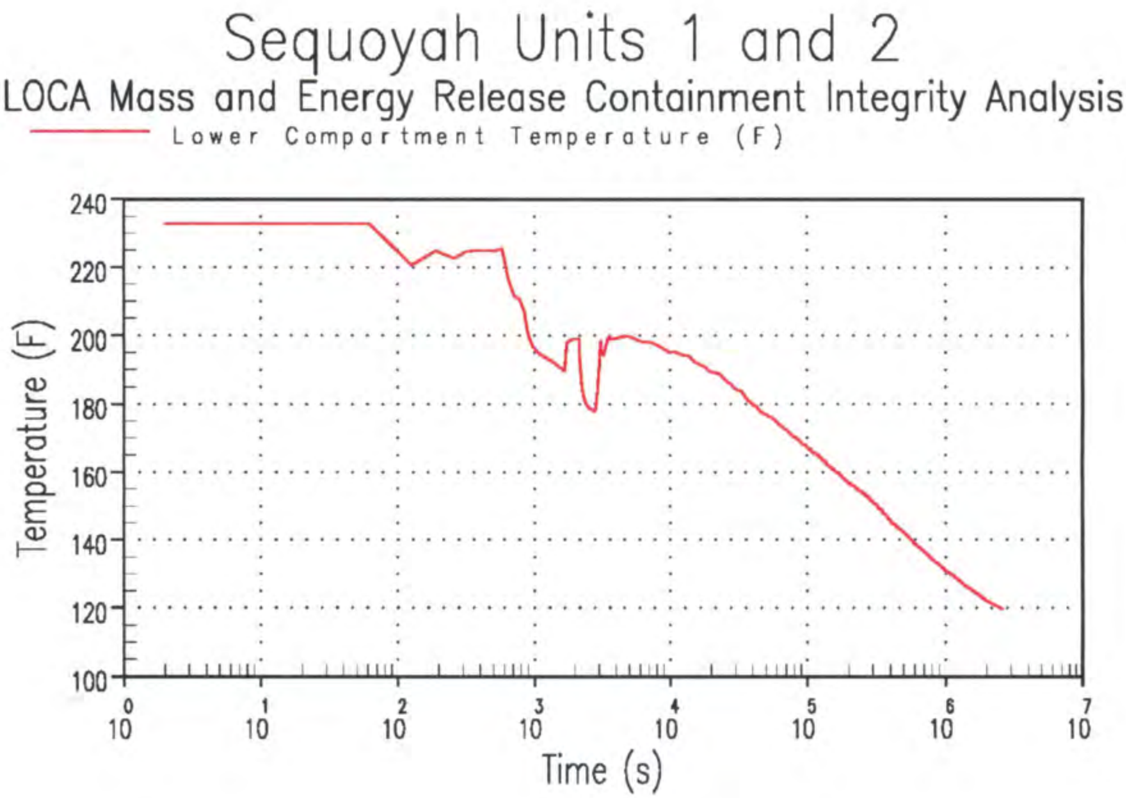
TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
2337944.0	3.4	100.9	120.6	100.0	147.2
2341194.0	3.4	100.9	120.6	99.9	147.2
2344494.0	3.4	100.9	120.6	99.9	147.1
2347744.0	3.4	100.9	120.6	99.9	147.1
2350994.0	3.4	100.9	120.6	99.9	147.1
2354244.0	3.4	100.9	120.6	99.9	147.1
2357494.0	3.4	100.9	120.6	99.9	147.1
2360744.0	3.4	100.9	120.5	99.9	147.1
2363994.0	3.4	100.9	120.5	99.9	147.1
2367294.0	3.4	100.9	120.5	99.9	147.1
2370544.0	3.4	100.9	120.5	99.9	147.1
2373794.0	3.4	100.9	120.5	99.9	147.0
2377044.0	3.4	100.9	120.5	99.9	147.0
2380294.0	3.4	100.9	120.5	99.9	147.0
2383544.0	3.4	100.9	120.5	99.9	147.0
2386794.0	3.4	100.8	120.4	99.9	147.0
2390044.0	3.4	100.8	120.4	99.9	147.0
2393344.0	3.4	100.8	120.4	99.8	147.0
2396594.0	3.4	100.8	120.4	99.8	147.0
2399844.0	3.4	100.8	120.4	99.8	147.0
2403094.0	3.4	100.8	120.4	99.8	146.9
2406344.0	3.4	100.8	120.4	99.8	146.9
2409594.0	3.4	100.8	120.4	99.8	146.9
2412844.0	3.4	100.8	120.3	99.8	146.9
2416144.0	3.4	100.8	120.3	99.8	146.9
2419394.0	3.4	100.8	120.3	99.8	146.9
2422644.0	3.4	100.8	120.3	99.8	146.9
2425894.0	3.4	100.8	120.3	99.8	146.9
2429144.0	3.4	100.8	120.3	99.8	146.9
2432394.0	3.4	100.8	120.3	99.8	146.9
2435644.0	3.4	100.7	120.2	99.8	146.8
2438944.0	3.4	100.7	120.2	99.8	146.8
2442194.0	3.4	100.7	120.2	99.8	146.8
2445444.0	3.4	100.7	120.2	99.7	146.8
2448694.0	3.4	100.7	120.2	99.7	146.8
2451944.0	3.4	100.7	120.2	99.7	146.8
2455194.0	3.4	100.7	120.2	99.7	146.8

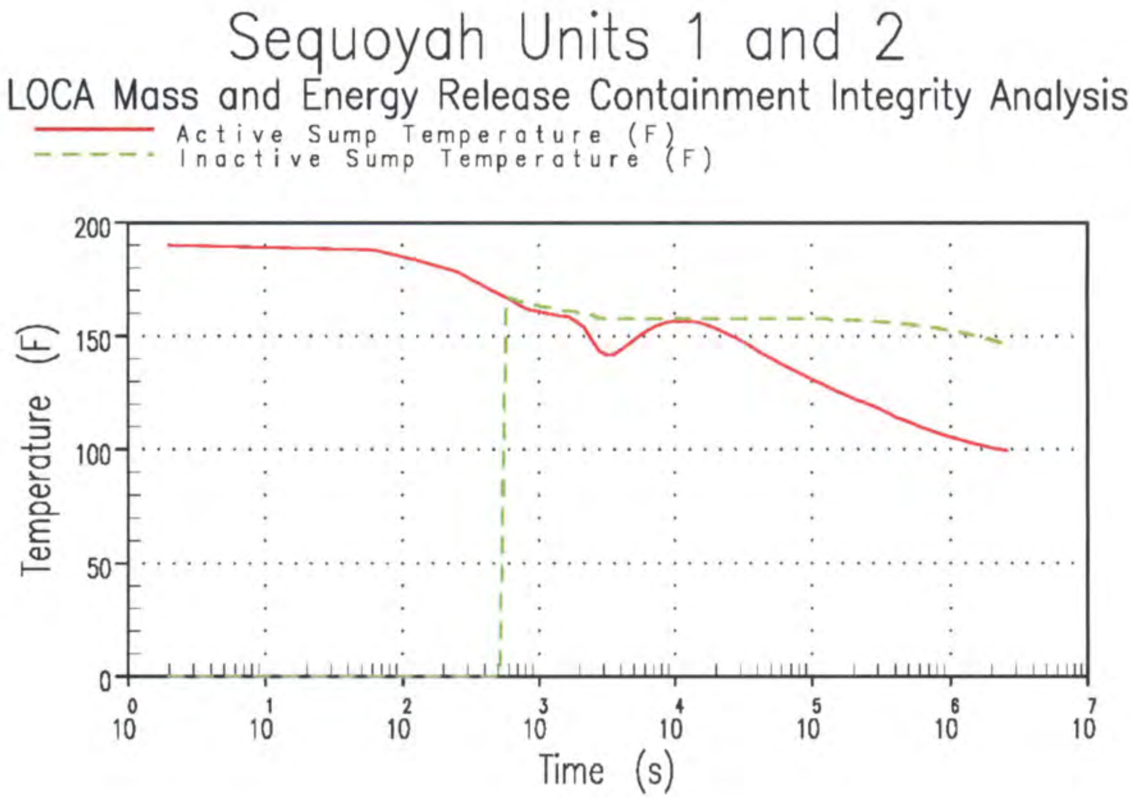
TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
2458444.0	3.4	100.7	120.2	99.7	146.8
2461744.0	3.4	100.7	120.1	99.7	146.8
2464994.0	3.4	100.7	120.1	99.7	146.7
2468244.0	3.4	100.7	120.1	99.7	146.7
2471494.0	3.4	100.7	120.1	99.7	146.7
2474744.0	3.4	100.7	120.1	99.7	146.7
2477994.0	3.4	100.7	120.1	99.7	146.7
2481244.0	3.4	100.7	120.1	99.7	146.7
2484494.0	3.4	100.6	120.1	99.7	146.7
2487794.0	3.4	100.6	120.0	99.7	146.7
2491044.0	3.4	100.6	120.0	99.7	146.7
2494294.0	3.4	100.6	120.0	99.7	146.7
2497544.0	3.4	100.6	120.0	99.6	146.6
2500794.0	3.4	100.6	120.0	99.6	146.6
2504044.0	3.4	100.6	120.0	99.6	146.6
2507294.0	3.4	100.6	120.0	99.6	146.6
2510594.0	3.4	100.6	120.0	99.6	146.6
2513844.0	3.4	100.6	119.9	99.6	146.6
2517094.0	3.4	100.6	119.9	99.6	146.6
2520344.0	3.4	100.6	119.9	99.6	146.6
2523594.0	3.4	100.6	119.9	99.6	146.6
2526844.0	3.4	100.6	119.9	99.6	146.5
2530094.0	3.4	100.6	119.9	99.6	146.5
2533394.0	3.4	100.5	119.9	99.6	146.5
2536644.0	3.4	100.5	119.9	99.6	146.5
2539894.0	3.4	100.5	119.8	99.6	146.5
2543144.0	3.4	100.5	119.8	99.6	146.5
2546394.0	3.4	100.5	119.8	99.6	146.5
2549644.0	3.4	100.5	119.8	99.5	146.5
2552894.0	3.4	100.5	119.8	99.5	146.5
2556144.0	3.4	100.5	119.8	99.5	146.5
2559444.0	3.4	100.5	119.8	99.5	146.4
2562694.0	3.4	100.5	119.8	99.5	146.4
2565944.0	3.4	100.5	119.7	99.5	146.4
2569194.0	3.4	100.5	119.7	99.5	146.4
2572444.0	3.4	100.5	119.7	99.5	146.4
2575694.0	3.4	100.5	119.7	99.5	146.4

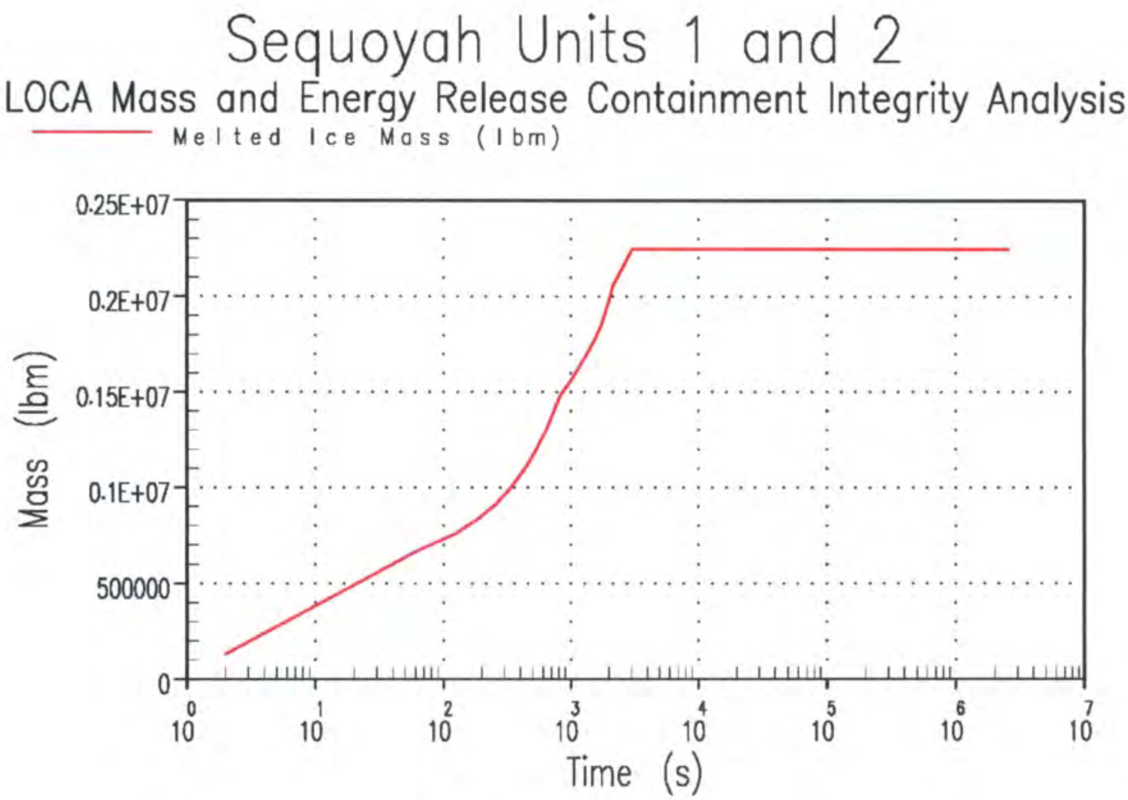
TIME (SEC)	CONTAINMEN T PRESSURE (PSIG)	UPPER COMPARTMENT (DEG-F)	LOWER COMPARTMENT (DEG-F)	ACTIVE SUMP (DEG-F)	INACTIVE SUMP (DEG-F)
2578944.0	3.4	100.5	119.7	99.5	146.4
2582244.0	3.4	100.4	119.7	99.5	146.4
2585494.0	3.4	100.4	119.7	99.5	146.4
2588744.0	3.4	100.4	119.7	99.5	146.4
2591994.0	3.4	100.4	119.6	99.5	146.3


Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Containment Pressure (psig)
Pressure (psig)
12
10
8
6
4
2
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
Time (s)


Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Upper Compartment Temperature (F)
Temperature (F)
180
160
140
120
100
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
Time (s)


Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Lower Compartment Temperature (F)
Temperature (F)
240
220
200
180
160
140
120
100
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
Time (s)


Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Active Sump Temperature (F)
Inactive Sump Temperature (F)
Temperature (F)
200
150
100
50
0
Time (s)
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7


Sequoyah Units 1 and 2
LOCA Mass and Energy Release Containment Integrity Analysis
Melted Ice Mass (lbm)
0.25E+07
0.2E+07
0.15E+07
0.1E+07
500000
0
Mass (lbm)
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
Time (s)

Enclosure 2

TVA RESPONSE to NRC RAIs

1. RAI SCVB-RAI-9
2. RAI SCVB-RAI-10

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI)

NRC provided the following RAIs in an email transmittal to TVA (Reference 1). TVA responses to these RAIs are presented below.

1. RAI SCVB-RAI-9

In UFSAR Section 6.2.1.3.4, under heading "Containment Pressure Calculation", the ice temperature used in the containment pressure calculation as per assumption (10) is 15°F. On the other hand, Surveillance Requirement (SR) 4.6.5.1a states:

> *"At least once per 12 hours by verifying that the maximum ice bed temperature is less than or equal to 27°F."*

The ice bed temperature is a key parameter for the ice condenser performance for pressure suppression, i.e., assuming a lower ice bed temperature for the long term pressure response is less conservative than using a higher temperature. For a conservative containment pressure calculation, please justify using a non-conservative assumption of ice temperature of 15°F instead of 27°F.

TVA Response:

The analysis in the TVA-14-74 (Reference 2) letter has been revised to use an ice bed temperature of 27°F (see Reference 3).

2. RAI SCVB-RAI-10

In UFSAR Section 6.2.1.3.4, under heading "Containment Pressure Calculation", the input assumption (10) for containment pressure calculation states the initial containment air temperature of 100°F in the lower volume and dead-ended volumes, and 85°F in the upper volume. On the other hand, TS 3.6.1.5 states that the maximum values of 105°F in the upper volume and 125°F in the lower volume shall be maintained.

By sensitivity analyses, please justify these temperatures in the UFSAR would maximize the peak containment transient pressure compared to the transient pressure obtained by using the initial TS maximum values.

TVA Response:

The analysis in the TVA-14-74 (Reference 2) letter has been revised to use the maximum containment air temperatures allowed by TS 3.6.1.5. Using the maximum containment air temperatures results in the highest peak containment pressure (Reference 3).

References:

1. Electronic transmittal from A. Hon (NRC) to J. Shea (TVA), "Sequoyah Nuclear Plant, Units 1 and 2,– Request for Additional Information Related to License Amendment Request to Revise Technical Specification on Ice Condenser Ice Mass (TAC Nos. MF2446 And MF2447)," dated February 19, 2015, L44 150219 001 (ADAMS Accession Number ML15050A096)

2. Westinghouse letter TVA-14-74 to TVA, "Tennessee Valley Authority Sequoyah Nuclear Plant Units 1 and 2, Long Term LOCA Mass and Energy Release and Containment Pressure Response Analysis," dated October 1, 2014

3. WCAP-12455, Revision 1, Supplement 3R, "Tennessee Valley Authority Sequoyah Nuclear Plant Units 1 and 2 Containment Integrity Reanalyses Engineering Report," dated March 2015