

CALCULATION COVER SHEET

Calculation Preparation, Review
and Approval
Form PED-QP-3.1 Form Page No. 1 of 2
Calculation Cover Sheet

* Short Term Calc: ☒ YES ☐ NO

CALCULATION NUMBER

o FCP 5916

Calc. Page No. 1

*TOTAL PAGES 33

QA Category: ☒ COE ☐ LIMITED COE ☐ FIRE PROT.
☐ NON COE

o FILE NO. _____

PED DEPARTMENT 357

CALCULATION TITLE

OPERATING TEMPERATURE LIMITS FOR
DG-1 AND DG-2

VENDOR CALC IN

☐ MR NO. _____
☒ ENGR. ANALYSIS 90-062
☐ DBD NO. _____
☐ ECN NO. _____
☐ OTHER _____

* APP. OVALS - SIGNATURE & DATE

PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)	*REV. NO.	SUPERSEDES *CALC. NO.	CONFIRMATION *REQUIRED (✓)	
					YES	NO
<u>Knea will</u> <u>4-20-92</u>	<u>K. L. Hyl</u> <u>4-20-92</u>	<u>K. L. Hyl</u> <u>4-20-92</u>	<u>A</u>			<input checked="" type="checkbox"/>
<u>Knea will</u> <u>8-7-92</u>	<u>Daniel B. Bough</u> <u>8-7-92</u>	<u>B. D. Rohrig</u> <u>8/10/92</u>	<u>B</u>			<input checked="" type="checkbox"/>

* EXTERNAL ORGANIZATION DISTRIBUTION

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9208190182 920814
PDR ADOCK 05000285
P PDR

* SEE INSTRUCTIONS ON REVERSE SIDE
COMPLETED BY DOCUMENT CONTROL

PED-QP-3.24

REV 2

CALCULATION PREPARATION, REVIEW AND APPROVAL
FORM PED-QP-3.2 Form Page No. 1 of 1

CALC. PAGE NO. 1 A

CALCULATION NO.

PRODUCTION ENGINEERING DIVISION
CALCULATION REVISION SHEET

FC05916

REV. NO.	DESCRIPTION / REASON FOR CHANGE
B	P 3 OPPO MAY SUPERCEDE EA-FC-90-062 r 2 INSTEAD OF REVISING, FOR THE PURPOSE OF CLARITY AND DOCUMENT CONTROL
B	P 5a PROVIDED ADDON JUSTIFICATION OF THE 1 DEGREE ΔT FAN INLET / AMBIENT
B	P 6 MWO 92 2346 WAS DONE TO REMEASURE DG-2 AIR FLOW
B	P 7 REMOVED NONESSENTIAL INFORMATION AND ADDON STATEMENT CONCERNING GENERATOR CAPACITY
B	P 10, 11 UTILIZED DATA FROM MWO LOGGED ON P 6
B	P 12 REORDER GRAPH IN A MORE PROFESSIONAL FORMAT AND USED DATA FROM P 6
B	P 13 WORDING CHANGE FOR CLARITY
B	P 14-17 ADDON CLARITY TO TABLE THRESHOLD ^{EM} B.342 TITLES WITH RESPECT TO AMBIENT AIR AND FAN INLET TEMPERATURES. A MISTAKE WAS NOTED WHERE TURBOCHARGER INLET TEMPERATURES FOR 110 °F WERE USED FOR ALL CASES. THIS WAS CORRECTED TO THE PROPER TURBOCHARGER INLET TEMPERATURE AND THE NEW DEVIATION NUMBERS WERE THEN USED. THIS RESULTED IN OVERCONSERVATION IN THE CALCULATION
B	P 18 REMOVED UNNECESSARY WORDING
B	P 19, 20 REORDER GRAPHS WITH NEW DEVIATION CURVES
B	P 25, 26 INSERTED TEST DATA FROM MWO 922346
B	P 34 ADDON LETTER TO EXPLAIN GENERATOR LIMIT
B	P 35 ADDON FAX FOR 208 °F WATER COOLANT AIR FLOW REQUIREMENTS

CALCULATION COVER SHEET

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CALCULATION NUMBER _____

Calc. Page No. 2

FACILITY/SYSTEM _____

KEYWORD ○ _____

CALCULATIONS USED AS INPUT
IN THE ANALYSIS

EQUIPMENT TAGS

CALC./REV. NO.

DEPT. NO. ○

SYSTEM

ADDED

DEPT. NO.

DG-JW

JW-3-1

DG-JW

JW-3-2

DG

DG-1

DG

DG-2

CALCULATION PREPARATION, REVIEW AND APPROVAL
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CALCULATION NO. _____

PRODUCTION ENGINEERING CALCULATION
SUMMARY SHEET

Rev. No. _____

OBJECTIVE

The objective of this calculation is to determine the Emergency Diesel Generator Upper Outdoor Air Ambient Temperature Limits for various coolant temperatures and chemical makeups. This is considered an interim calculation until EA-FC-90-062 r3 can be prepared, reviewed and issued, or superseded.



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CALCULATION NO.

EC-05916

PRODUCTION ENGINEERING CALCULATION
SUMMARY SHEET

Rev. No. A

METHODS

To determine the Diesel Generator Upper Ambient Air Temperature Limit, the following steps are necessary.

1. Determine the KW Capacity of the diesel generator without considering the effects of elevated air temperature on jacket water temperature or turbo charger intake.
2. Predict Turbocharger intake temperature at elevated conditions
3. Predict Jacket Water temperatures at elevated conditions:
 - a. Determine fan flow rates at elevated temperatures
 - b. Compare fan flows to required flows to maintain jacket water at 190 F and 208 deg F
4. Determine Deration factors from the predicted jacket water temperatures and turbocharger intake temperatures
5. Plot Derated Power vs Time and Required Load for each deisel

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CALCULATION NO.

FC-5516

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Rev. No. B

ASSUMPTIONS

1. Ambient air pressures are considered constant
2. The diesels are in a cold shutdown condition with the jacket water at a temperature of 125 F prior to the start of the accident.
3. Turbocharger inlet air temperature delta T with outside ambient air does not change dramatically with outside air temperature increases, i.e. the outside air temperature to turbocharger intake delta T from 90 deg F ambient can be used to predict turbocharger intake temperatures at 110 deg F ambient conditions.
4. The radiator fan intake is equivalent to outdoor temperature + 1 deg F. This is validated by test data gathered during the last test performed on DG-2.
For DG-1, the test data requires some interpretation. During the hot weather testing performed in 1991, the outdoor ambient temperature recorded was 95 deg F with fan inlet temperatures of 96 deg F on the north side of the radiator and 100 F on the south side. The majority of air flow in DG-1 entering the fan comes from the north side of the engine (ref EA-90-091 rev 0, attachment 8.8 fig 6A and 7a). The configuration of the equipment in the room is such that a natural plenum is formed between the north wall and the engine skid through which the fresh air travels. The air on the south side is mostly eddies formed from fan blade tip recirculation containing heat rejected from the radiator.
The 1 deg F assumption is justifiable based on the following factors:
 - a. The fan shroud/fan blade tip clearance was reduced substantially when the new fan blades were installed. This resulted in reduced tip recirculation.
 - b. The majority of the makeup air comes from the north side of the engine down the natural plenum
 - c. Any preheating of the air supplying the radiator is done by heat rejected by the radiator or the diesel engine itself. Heat removal from the engine by this air reduces the thermal loading on the jacket water cooling system. Air that backwashes from the blade tip /fan shroud gap removes heat from the radiator but is not measured as fan flow during testing, which indicates that more air cooling is supplied to the radiator than can be measured in a test configuration.
5. Only the minimum amount of emergency safeguards equipment

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Rev. No. B

ASSUMPTIONS

required to respond to a large break LOCA is considered to be the required load for the diesels. Additional optional loads that may be desired to assist operations in accident response, such as station air compressors, are not included in the required electrical load calculations.

6. Although the new fans draw more air, the air flow in the room is such that the turbocharger inlet air temperature is assumed to be unaffected.

REV.1

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CALCULATION NO.

FC-05916PRODUCTION ENGINEERING CALCULATION
SUMMARY SHEETRev. No. A

INPUTS / REFERENCES

REF.
NO.

1. Letter From Ted Fryar to Randy Mueller , Dated 2/10/80 contained in EA-FC-90-062 r 2 Attachment 8.2-b
2. MWO 913677 Replace Fan with Substitute Replacement Item per ECM 91-306
3. MWO 913676 Replace Fan with Substitute Replacement Item per ECM 91-306
4. Diesel Generator Deration Curves from EA-FC-90-062 r 2 Attachment 8.2-a
5. Fax Transmission from Young Radiator Company to Dan Borcyk dated 4/8/91
6. Fax Transmission from Young Radiator Company to Dan Borcyk dated 4/15/91 found in EA-FC-90-062 r 2 Attachment 8.9a
7. FC03382 r ⁵/~~A~~ Diesel Generator LOCA Loads
8. Mechanical Engineering Review Manual Seventh Edition
9. EA-FC-90-062 r 2 Diesel Generator Upper Temperature Operating Limits
10. MWO 922346 PROVIDE MAINTENANCE SUPPORT FOR TO SUPPORT D6-2 AIR FLOW TESTING



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Rev. No. B

CONCLUSIONS

DG-1 Upper Ambient Air Temperature Limits:

DG-1 will satisfactorily supply the minimum required power to support Emergency Safeguard equipment in a post LOCA scenario with a 50 % ethylene glycol coolant solution in the Jacket Water system up to an outdoor ambient condition of 104 deg F

DG-1 will satisfactorily supply the minimum required power to support Emergency Safeguard equipment in a post LOCA scenario with a treated water coolant solution in the Jacket Water system up to an outdoor ambient condition of 110 deg F

DG-2 Upper Ambient Air Temperature Limits:

DG-2 will satisfactorily supply the minimum required power to support Emergency Safeguard equipment in a post LOCA scenario with a 50 % ethylene glycol coolant solution in the Jacket Water system up to an outdoor ambient condition of 110 deg F

DG-2 will satisfactorily supply the minimum required power to support Emergency Safeguard equipment in a post LOCA scenario with a treated water coolant solution in the Jacket Water system up to an outdoor ambient condition of 110 deg F with a wide degree of margin that could be used for optional loads.

NOTE:

Generator Limitations: The generator portion of the Emergency Diesel Generators is limited to a maximum power output of 2718 kW for DG-1 and 2656 KW for DG-2 based on power factor as discussed in Calculation FC-03382. This calculation (FC-5916) only considers the derated power capabilities of the Engine.

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PRODUCTION ENGINEERING DIVISION
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FL-25916

Rev. No. A

CALCULATE THE NET ~~HP~~ KW AVAILABLE FOR EACH DIESEL GENERATOR

REF.
NO.

CASE 1 FAN REPLACED, 50/50 ETHYLENE GLYCOL COOLANT
2000 HP RATING BASE HP

3950 HP 2000 HP ENGINE RATING

- 120 HP RADIATOR FAN DRIVE

- 20 HP GENERATOR COOLING FAN

- 180 HP 50/50 GLYCOL SOLUTION COOLING WATER

3630 AVAILABLE ENGINE HORSEPOWER

CONVERT TO KW GENERATOR OUTPUT

3630 MECH HORSEPOWER

X .746 BHP/KW

2708 KW

X .97 GEN EFF

2627 KW ←

①
②

① p8.2b-3

① p8.2b-3

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CALCULATION NO.

FL-05916

PRODUCTION ENGINEERING DIVISION
CALCULATION SHEET

Rev. No. A

CASE 2 FAN REPLACED, TREATED WATER COOLANT
2000 hr RATING

REF.
NO.

3950 HP 2000 hr RATING
- 120 HP RADIATOR FAN DRIVE
- 20 HP GENERATOR COOLING FAN
3810 HP AVAILABLE ENGINE HORSEPOWER

① 8.26-3

②

CONVERT TO KW GENERATOR OUTPUT

3810
x .746 BHP/KW

2842

x .97 GEN EFF

2757 KW ←

1 p 8.26-3

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CALCULATION NO.

FC-05910

PRODUCTION ENGINEERING DIVISION
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REF.
NO.

FROM FAN FLOW DATA, PREDICT FAN FLOWS AT ELEVATED
TEMPERATURES

JW-3-1 (DG-1) RADIATOR FAN

116583.3 SCFM @ 53 °F

$$K_d = \frac{460 + 53}{530} = .968$$

$$116583.3 \times .968 = 112,852 \text{ SCFM @ } 70^\circ\text{F}$$

2

JW-3-2 (DG-2) RADIATOR FAN

TEST TEMP = ~~53~~ ⁷⁷ °F, FLOW = ~~105,451~~ ^{114,556} SCFM

TO PREDICT AIR FLOW AT HIGHER TEMPERATURES

$$K_d = \left(\frac{14.7}{P_{act}} \right) \cdot \left(\frac{460 + 0^\circ\text{F}}{530} \right)$$

ASSUME THAT PRESSURE IS RELATIVELY CONSTANT

$$K_d = \frac{460 + 0^\circ\text{F}}{530} = \frac{460 + 77}{530} = \frac{1.01}{.9773}$$

$$\text{SCFM } (K_d) = \text{SCFM}_{70}$$

$$114,556 \cdot 1.01 = 115,701$$

$$\text{105,451} \cdot \left(\frac{1.01}{.9773} \right) = 108,663 @ 70^\circ\text{F}$$

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REF.
NO.

Temperature Corrected Air Flows

FCS Emergency Diesel Radiator Fans

Temp	Kd	SCFM DG-1	SCFM DG-2
90	1.038	108,721	99,315 111466
100	1.0566	106,807	97,542 109502
101	1.058	106,666	97,413 109358
102	1.060	106,464	97,229 109152
103	1.062	106,264	97,046 108946
104	1.064	106,064	96,864 108742
105	1.066	105,865	96,682 108538
106	1.068	105,667	96,500 108334
107	1.070	105,469	96,320 108132
108	1.072	105,272	96,140 107931
109	1.074	105,077	95,961 107730
110	1.076	104,881	95,783 107529

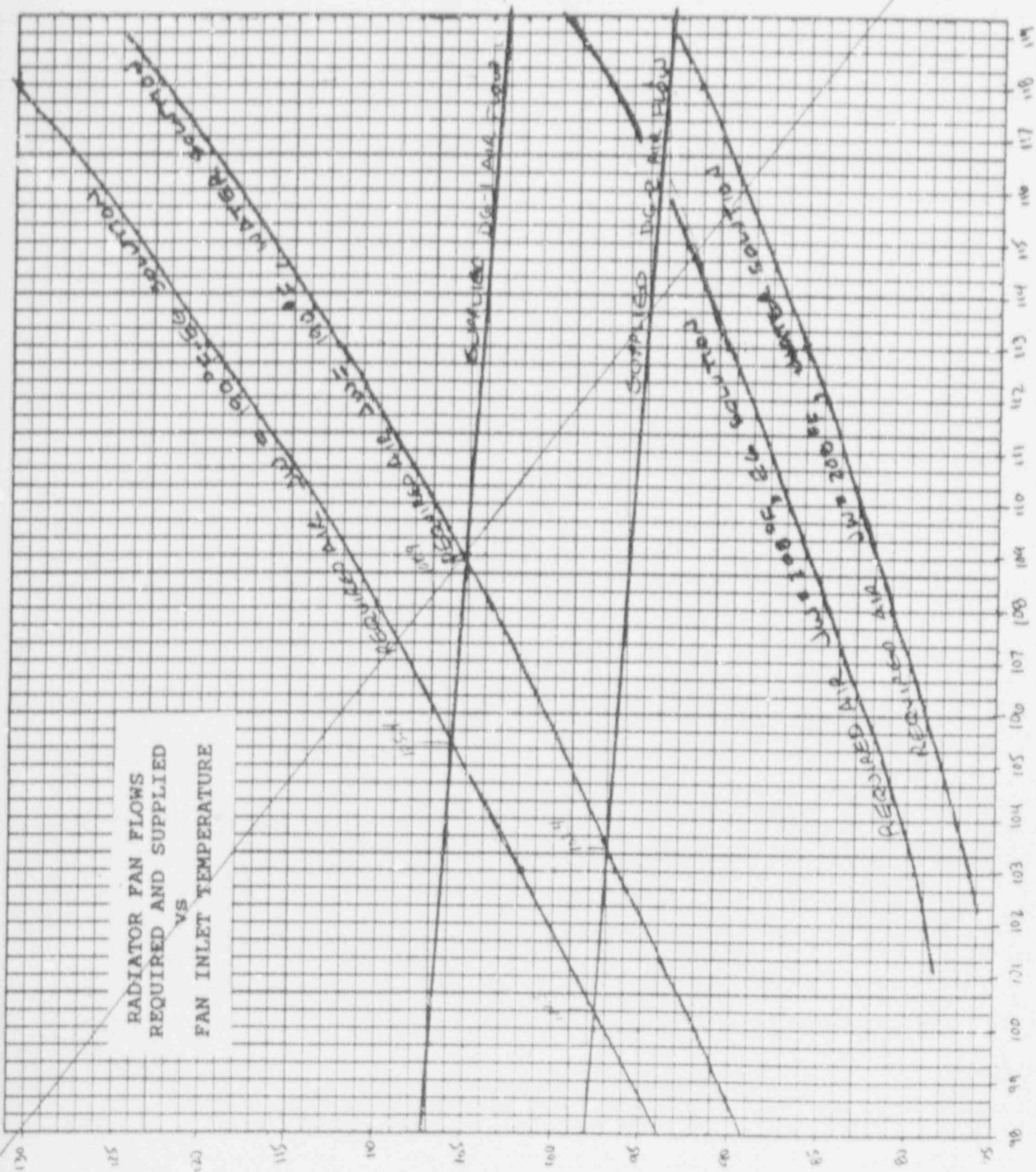
B

NEXT PLOT THE SUPPLIED FLOWS ABOVE AGAINST TEMPERATURE
AND PLOT THE REQUIRED FLOWS FROM REFERENCES
5 AND SIX AGAINST TEMPERATURES ON THE SAME
GRAPH

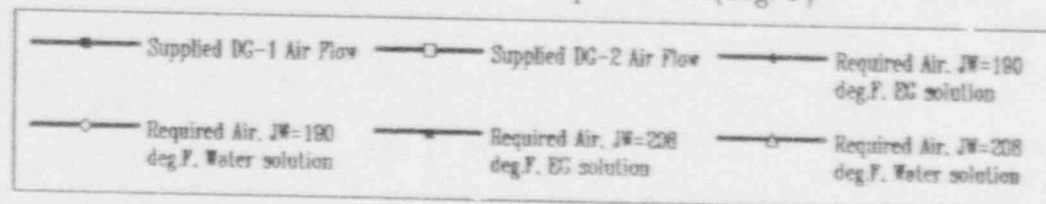
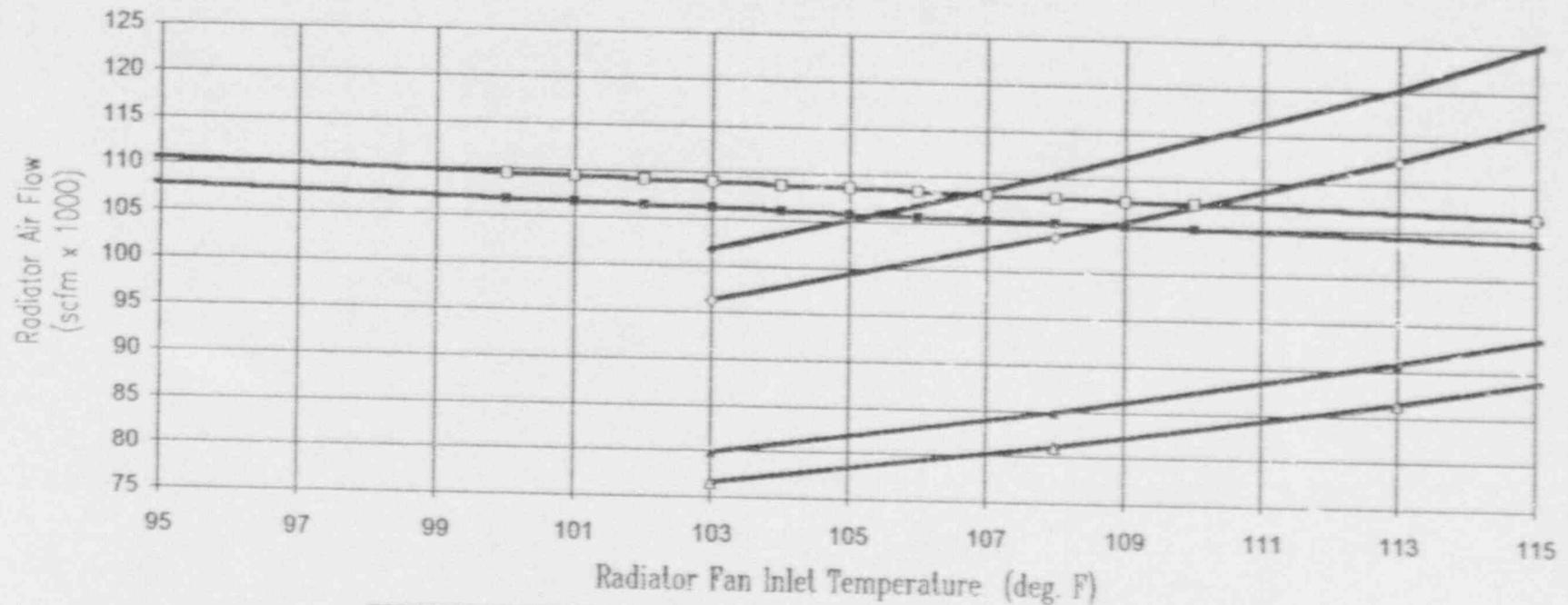
RADIATOR FAN FLOWS
REQUIRED AND SUPPLIED
VS
FAN INLET TEMPERATURE

RADIATOR
AIR
FLOW
(SCFM X 1000)

RADIATOR FAN INLET TEMPERATURE OF



RADIATOR FAN FLOWS REQUIRED AND SUPPLIED VS. FAN INLET TEMPERATURE



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REF.
NO.

From the Deration Curve (Ref 4) select the deration % for the corresponding Jacket Water and Turbocharger Inlet Temperatures.

Note: From discussion in EA-FC-90-062 r 2 the Jacket Water system does not immediately warm up. Usually it takes more than 15 minutes of engine operating time before the TCV valve is fully open and the Jacket Water has reached its normal operating ~~setpoint~~ temperature.

The Turbocharger intake temperature is taken from information contained in attachment 8.8a-1 of EA-FC-90-062 r 2.



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DG-1 Derated Power

110 DEG AMBIENT TEMP

~~111~~ ~~110~~ deg F Fan Inlet, Ethylene Glycol Coolant

REF.
NO.



Time min	Turbo inlet Temp F	JW temp F	KW init	Derate %	Derate KW
0	118	125	2627	100	2627
10	118	174	2627	.99	2601
20	120	200-208	2627	.915	2404
30	122	200-208	2627	.91	2391
40	123	200-208	2627	.907	2383
50	122	200-208	2627	.91	2391
60	123	200-208	2627	.907	2383
70	124	200-208	2627	.905	2377
90	124	200-208	2627	.905	2377
120	125	200-208	2627	.903	2372

DG-1 Derated Power

104 DEG F AMBIENT AIR

105 deg F Fan Inlet, Ethylene Glycol Coolant

Time min	Turbo inlet Temp F	JW temp F	KW init	Derate %	Derate KW
0	118 112	125	2627	100 1.0	2627
10	118 112	174	2627	.99 1.0	2601 2627
20	120 114	190	2627	.985 1.0	2588 2627
30	122 116	190	2627	.975 .995	2561 2613
40	123 117	190	2627	.972 .99	2553 2600
50	122 116	190	2627	.975 .995	2561 2613
60	123 117	190	2627	.972 .99	2553 2600
70	124 118	190	2627	.972 .987	2553 2593
90	124 118	190	2627	.972 .987	2553 2593
120	125 119	190	2627	.970 .985	2548 2587



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Rev. No. A

REF.
NO.

DG-1 Derated Power
109 108 deg F AMBIENT AIR
~~100~~ deg F Fan Inlet, Water Coolant

Time min	Turbo inlet Temp F	JW temp F	KW init	Derate %	Derate KW
0	110 116	125	2757	100 .995	2757 2743
10	110 116	174	2757	99 .945	2729 2743
20	120 118	190	2757	985 .987	2715 2728
30	122 120	190	2757	975 .985	2688 2715
40	123 121	190	2757	972 .983	2680 2710
50	122 120	190	2757	975 .985	2688 2715
60	123 121	190	2757	972 .983	2680 2710
70	124 122	190	2757	972 .98	2680 2701
90	124 122	190	2757	972 .98	2680 2701
120	125 123	190	2757	970 .977	2674 2694

DG-1 Derated Power
111 110 deg F AMBIENT AIR
~~110~~ deg F Fan Inlet, Water Coolant

Time min	Turbo inlet Temp F	JW temp F	KW init	Derate %	Derate KW
0	118	125	2757	100 .99	2757 2727
10	118	174	2757	.99	2727
20	120	200-208	2757	.915	2522
30	122	200-208	2757	.91	2509
40	123	200-208	2757	.907	2500
50	122	200-208	2757	.91	2509
60	123	200-208	2757	.907	2500
70	124	200-208	2757	.905	2495
90	124	200-208	2757	.905	2495
120	125	200-208	2757	.903	2489

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REF.
NO.

DG-2 Derated Power

111 110 deg F AMBIENT AIR
110 deg F Fan Inlet, Ethylene Glycol Coolant

Time min	Turbo inlet Temp F	JW temp F	KW init	Derate %	Derate KW
0	121	125	2627	100.965	2627.2587
10	124	174	2627	.973	2556
20	127	200-208	2627	.895	2351
30	129	200-208	2627	.89	2338
40	129	200-208	2627	.89	2338
50	132	200-208	2627	.88	2312
60	133	200-208	2627	.88	2312
70	132	200-208	2627	.88	2312
90	133	200-208	2627	.88	2312
120	136	200-208	2627	.875	2299

B

DG-2 Derated Power

107 106 deg F AMBIENT AIR
99 deg F Fan Inlet, Ethylene Glycol Coolant

Time min	Turbo inlet Temp F	JW temp F	KW init	Derate %	Derate KW
0	121 118	125	2627	100.995	2627.2614
10	124 121	174	2627	.972.985	2553.2587
20	127 124	190	2627	.968.973	2522.2556
30	129 126	190	2627	.957.967	2514.2540
40	129 126	190	2627	.957.967	2514.2540
50	132 129	190	2627	.947.957	2488.2508
60	133 130	190	2627	.945.955	2482.2504
70	132 129	190	2627	.947.957	2488.2508
90	133 130	190	2627	.945.955	2482.2508
120	136 133	190	2627	.940.950	2469.2485

2540

2514

2508

2514

B

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REF.
NO.

DG-2 Derated Power

110 109 °F AMBIENT
103 deg F Fan Inlet, Water Coolant

Time min	Turbo inlet Temp F	JW temp F	KW init	Derate %	Derate KW
0	121 120	125	2757	100 .985	2757 2716
10	124 123	174	2757	.972 .975	2680 2688
20	127 126	190	2757	.960 .967	2646 2646
30	129 128	190	2757	.957 .96	2638 2646
40	129 128	190	2757	.957 .96	2638 2646
50	132 131	190	2757	.947 .955	2610 2633
60	133 132	190	2757	.945 .95	2605 2619
70	132 131	190	2757	.947 .956	2610 2639
90	133 132	190	2757	.945 .95	2605 2619
120	136 135	190	2757	.940 .943	2591 2600

DG-2 Derated Power

111 110 °F AMBIENT AIR
110 deg F Fan Inlet, Water Coolant

Time min	Turbo inlet Temp F	JW temp F	KW init	Derate %	Derate KW
0	121	125	2757	100 .985	2757 2716
10	124	174	2757	.973	2682
20	127	200-208	2757	.895	2467
30	129	200-208	2757	.89	2454
40	129	200-208	2757	.89	2454
50	132	200-208	2757	.88	2426
60	133	200-208	2757	.88	2426
70	132	200-208	2757	.88	2426
90	133	200-208	2757	.88	2426
120	136	200-208	2757	.875	2412

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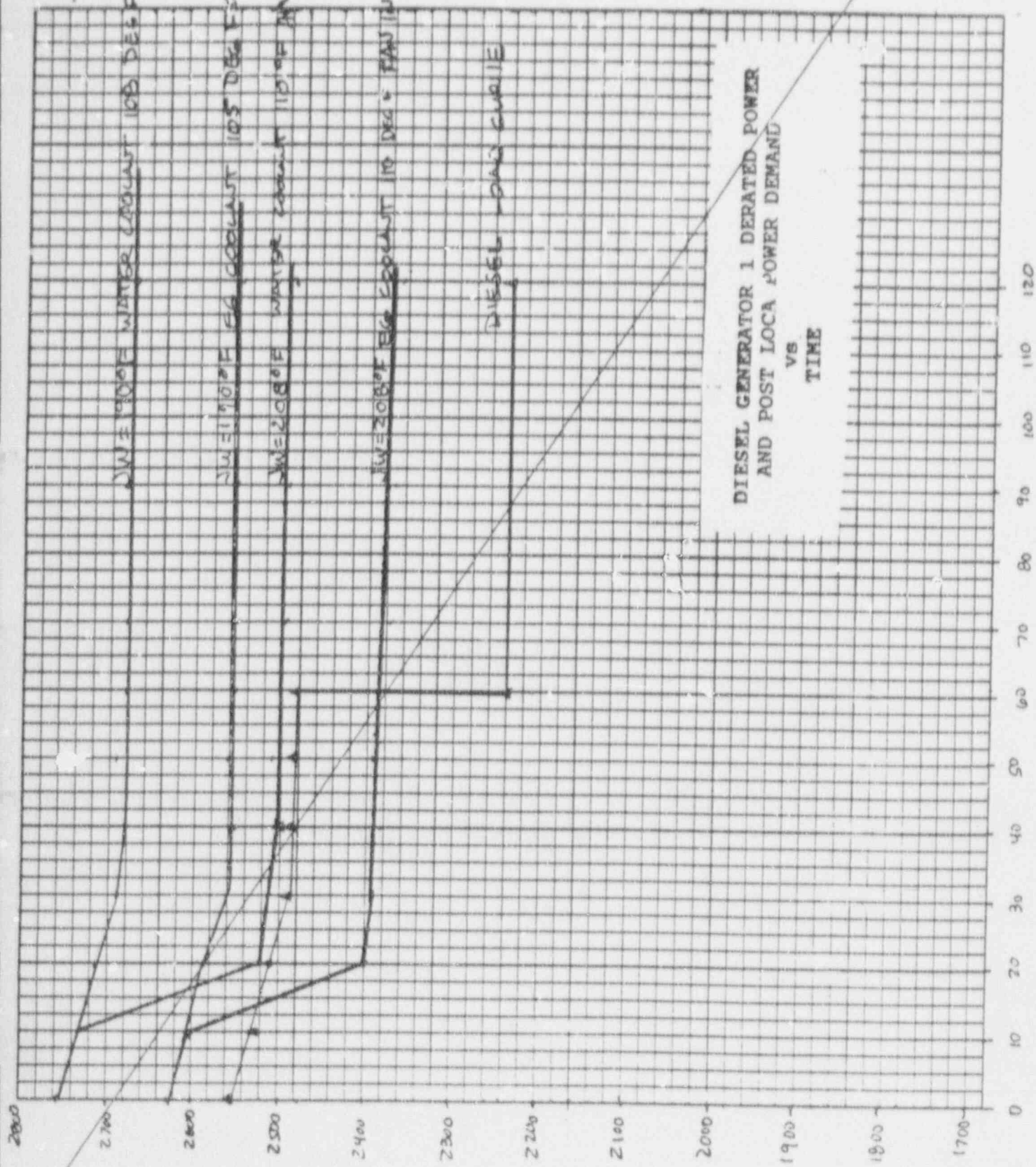
PRODUCTION ENGINEERING DIVISION
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B

REF.
NO.

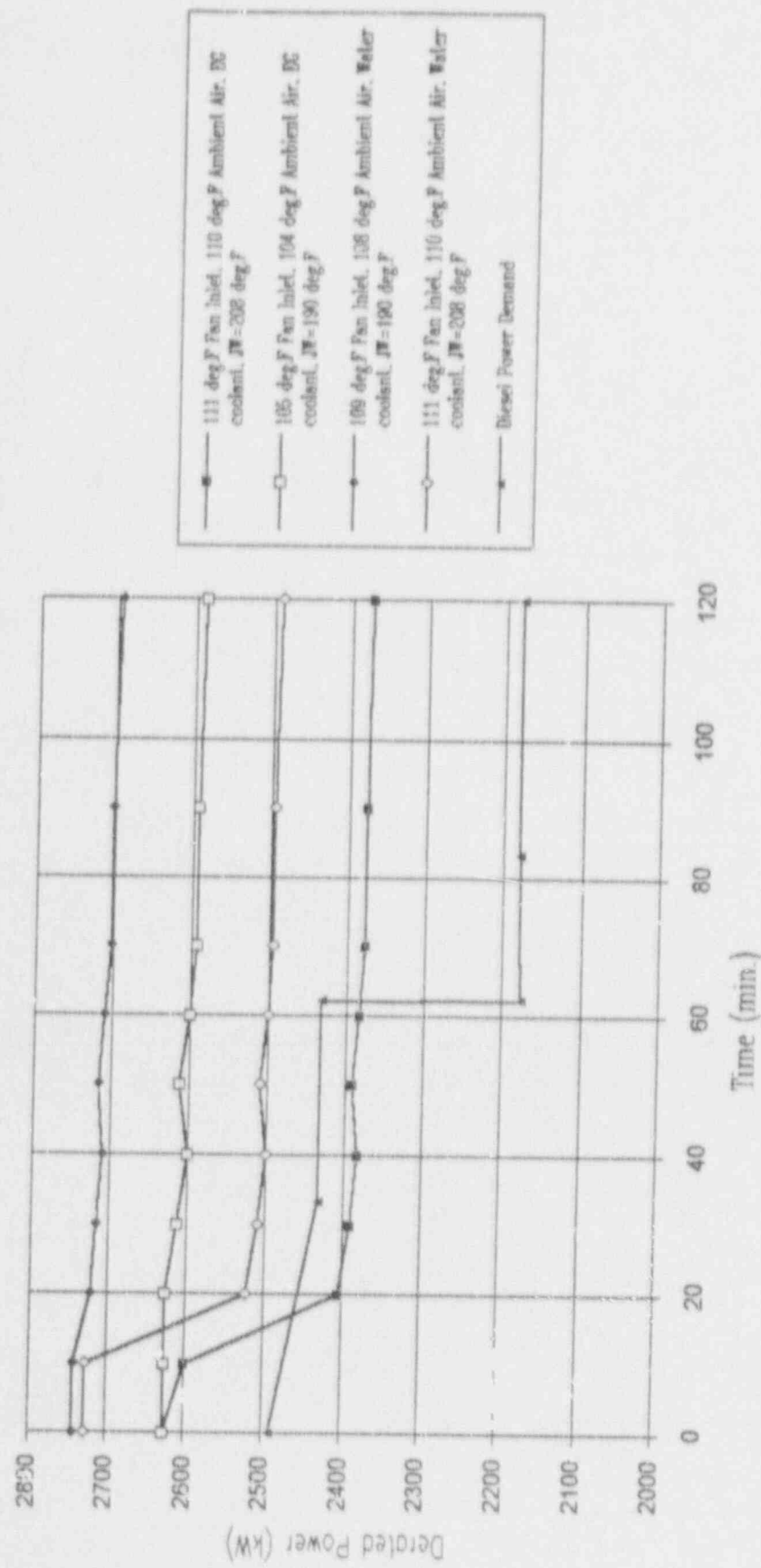
PLOT THE DERATED POWER VS TIME AND THE REQUIRED
POWER VS TIME TO DETERMINE CONDITIONS FOR DIESEL
OPERATION AT ELEVATED AIR TEMPERATURES

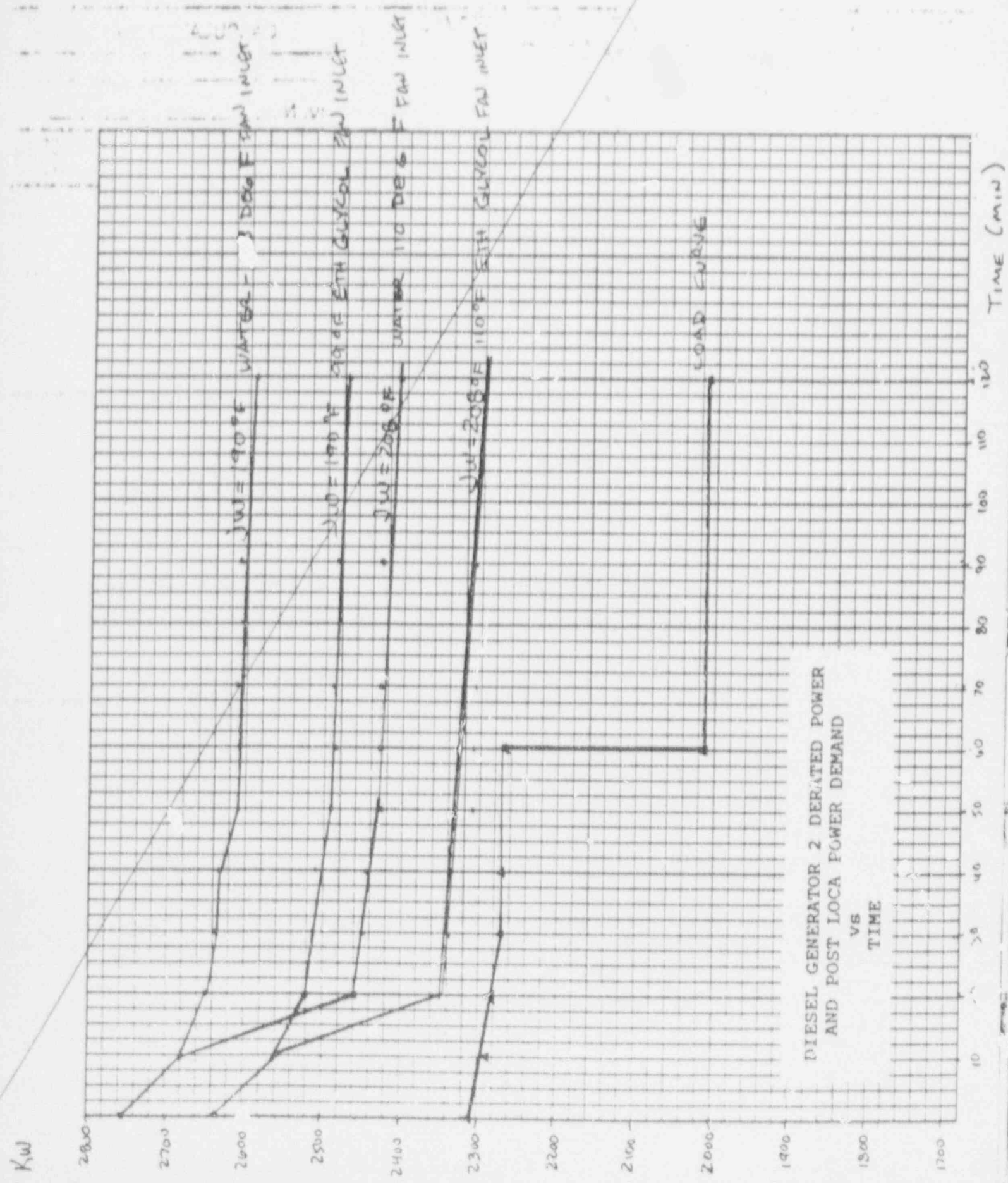


KW



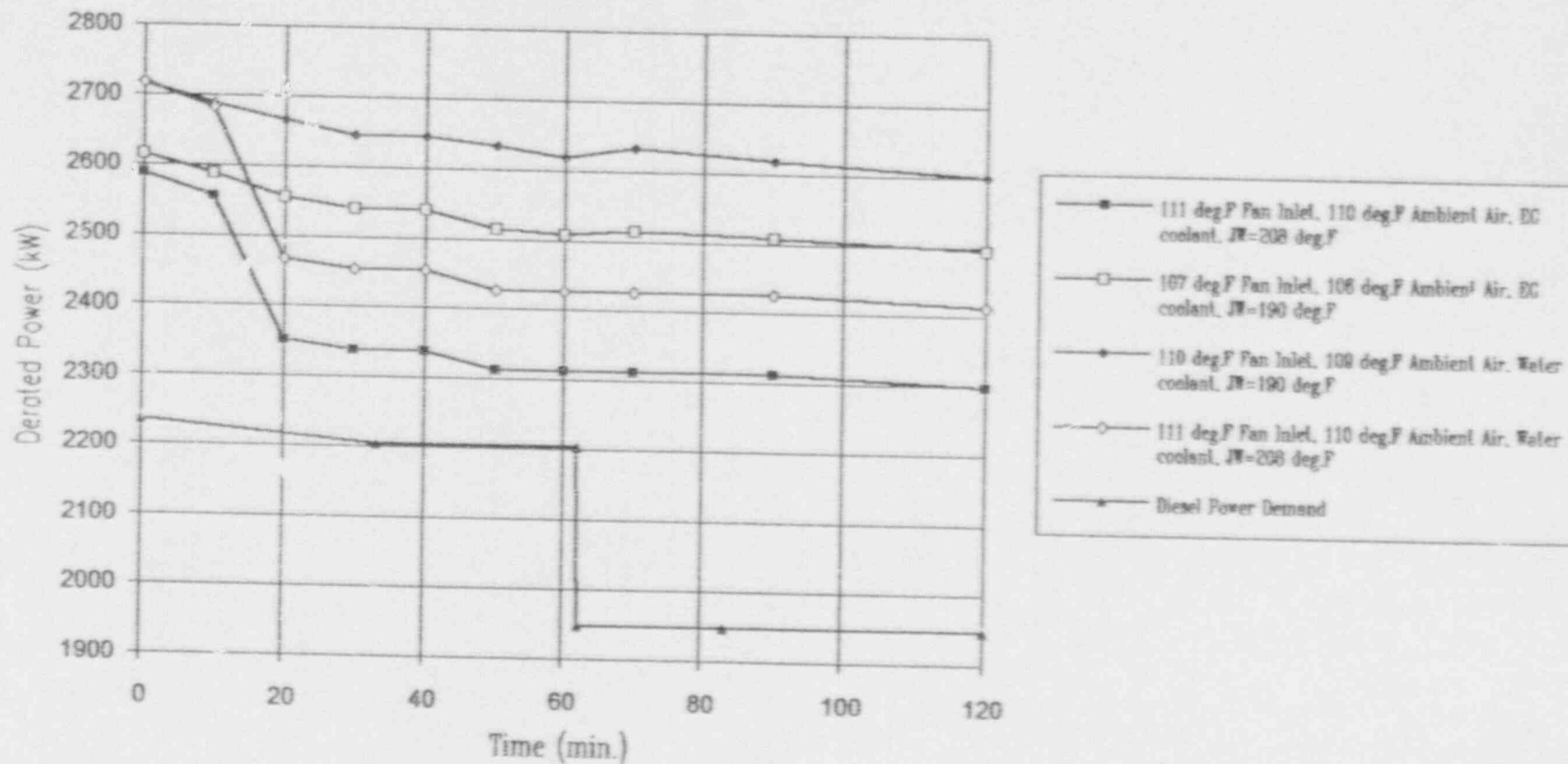
DG-1 ENGINE DERATED POWER
AND POST-LOCA POWER DEMAND
VS.
TIME





DIESEL GENERATOR 2 DERATED POWER
AND POST LOCA POWER DEMAND
VS
TIME

DG-2 ENGINE DERATED POWER AND POST-LOCA POWER DEMAND VS. TIME



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 Reviewer's Checklist-Calculations

CALCULATION NUMBER

FC-05916 r A

	<u>YES</u>	<u>NO</u>	<u>N/A</u>
1. Is Calculation Cover Sheet attached and completed, as required, to the calculation?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Is the calculation objective stated? Was this achieved?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Are inputs correctly selected and incorporated into the analysis?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Have inputs and/or assumptions which require confirmation at a later date, been identified on the Calculation Cover Sheet and in the calculation body?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
5. Are the applicable codes, standards, regulatory requirements, and other references including issue and addenda identified such that they are traceable to source document?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
6. Was an appropriate calculation method used? Was the basic theory appropriate?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Have assumptions been noted and justified?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Are the calculations free of arithmetic errors?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Is the calculation consistent with the design basis requirements?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Is the conclusion stated?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Is the calculation legible and suitable for microfilming?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B

Calc Preparation, Review and Approval
 PED-QP-3.5 Page 2 of 2
 Reviewer's Checklist-Calculations

CALCULATION NUMBER

FL-05916 rA

- | | YES | NO | N/A |
|---|-------------------------------------|--------------------------|-------------------------------------|
| 12. Are all blocks on the Calculation Cover Sheet addressed correctly? | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. Have Forms PED-QP-3.2, 3, 4 and 5 been used and correctly completed? | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. If the calculation has been prepared to supersede another calculation, has all the valid information been transferred in the new calculation? | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

REVIEWER COMMENTS:

Reviewer

Date

4-20-92



FC05916 r 5 p 21

	<u>YES</u>	<u>NO</u>	<u>N/A</u>
1. Is Calculation Cover Sheet attached and completed, as required, to the calculation?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Is the calculation objective stated? Was this achieved?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Are inputs correctly selected and incorporated into the analysis?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Have inputs and/or assumptions which require confirmation at a later date, been identified on the Calculation Cover Sheet and in the calculation body?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
5. Are the applicable codes, standards, regulatory requirements, and other references including issue and addenda identified such that they are traceable to source document?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
6. Was an appropriate calculation method used? Was the basic theory appropriate?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Have assumptions been noted and justified?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Are the calculations free of arithmetic errors?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Is the calculation consistent with the design basis requirements?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Is the conclusion stated?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Is the calculation legible and suitable for microfilming?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- | | <u>YES</u> | <u>NO</u> | <u>N/A</u> |
|---|-------------------------------------|--------------------------|-------------------------------------|
| 12. Are all blocks on the Calculation Cover Sheet addressed correctly? | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. Have forms PED-QP-3.2, 3, 4 and 5 been used and correctly completed? | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. If the calculation has been prepared to supersede another calculation, has all the valid information been transferred in the new calculation? | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

REVIEWER COMMENTS:

Paul S. Boyer
Reviewer

12/7/92
Date

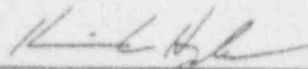
Calc Preparation, Review and Approval
 PED-QP-3.7 Page 1 of 1
 Independent Reviewer's Checklist - Calculations

CALCULATION NUMBER

FL-05916 r A

	<u>YES</u>	<u>NO</u>	<u>N/A</u>
1. Are the calculation methods accurate and appropriate?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Are input data sufficiently detailed?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Are the calculation assumptions reasonable?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Has the basis for engineering judgement been included in the calculation, when used?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
5. Is the calculation documented sufficiently such that the analysis is understandable to someone competent in the discipline without recourse to the Preparer?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Have the design interface requirements been satisfied?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Are the results reasonable and do they resolve the calculation objective?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. If an alternate calculation was used to verify the adequacy of the analysis, is it attached to the calculation?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
9. If qualification testing was used to verify the adequacy of the analysis, has it been documented using a retrievable source, or attached to the calculation?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
10. Are calculations involving Technical Specification values and associated margins of safety identified?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

INDEPENDENT REVIEWER COMMENTS:


 Independent Reviewer

14-20-92
 Date

B

FC-05916 R.3

	<u>YES</u>	<u>NO</u>	<u>N/A</u>
1. Are the calculation methods accurate and appropriate?	<u>X</u>	_____	_____
2. Are input data sufficiently detailed?	<u>X</u>	_____	_____
3. Are the calculation assumptions reasonable?	<u>X</u>	_____	_____
4. Has the basis for engineering judgement been included in the calculation, when used?	_____	_____	<u>X</u>
5. Is the calculation documented sufficiently such that the analysis is understandable to someone competent in the discipline without recourse to the Preparer?	<u>X</u>	_____	_____
6. Have the design interface requirements been satisfied?	<u>X</u>	_____	_____
7. Are the results reasonable and do they resolve the calculation objective?	<u>X</u>	_____	_____
8. If an alternate calculation was used to verify the adequacy of the analysis, is it attached to the calculation?	_____	_____	<u>X</u>
9. If qualification testing was used to verify the adequacy of the analysis, has it been documented using a retrievable source, or attached to the calculation?	_____	_____	<u>X</u>
10. Are calculations involving Technical Specification values and associated margins of safety identified?	_____	_____	<u>X</u>

INDEPENDENT REVIEWER COMMENTS:

DD. Bohig 10/10/92
 Independent Reviewer Date

DIESEL GENERATOR DERATION CURVES

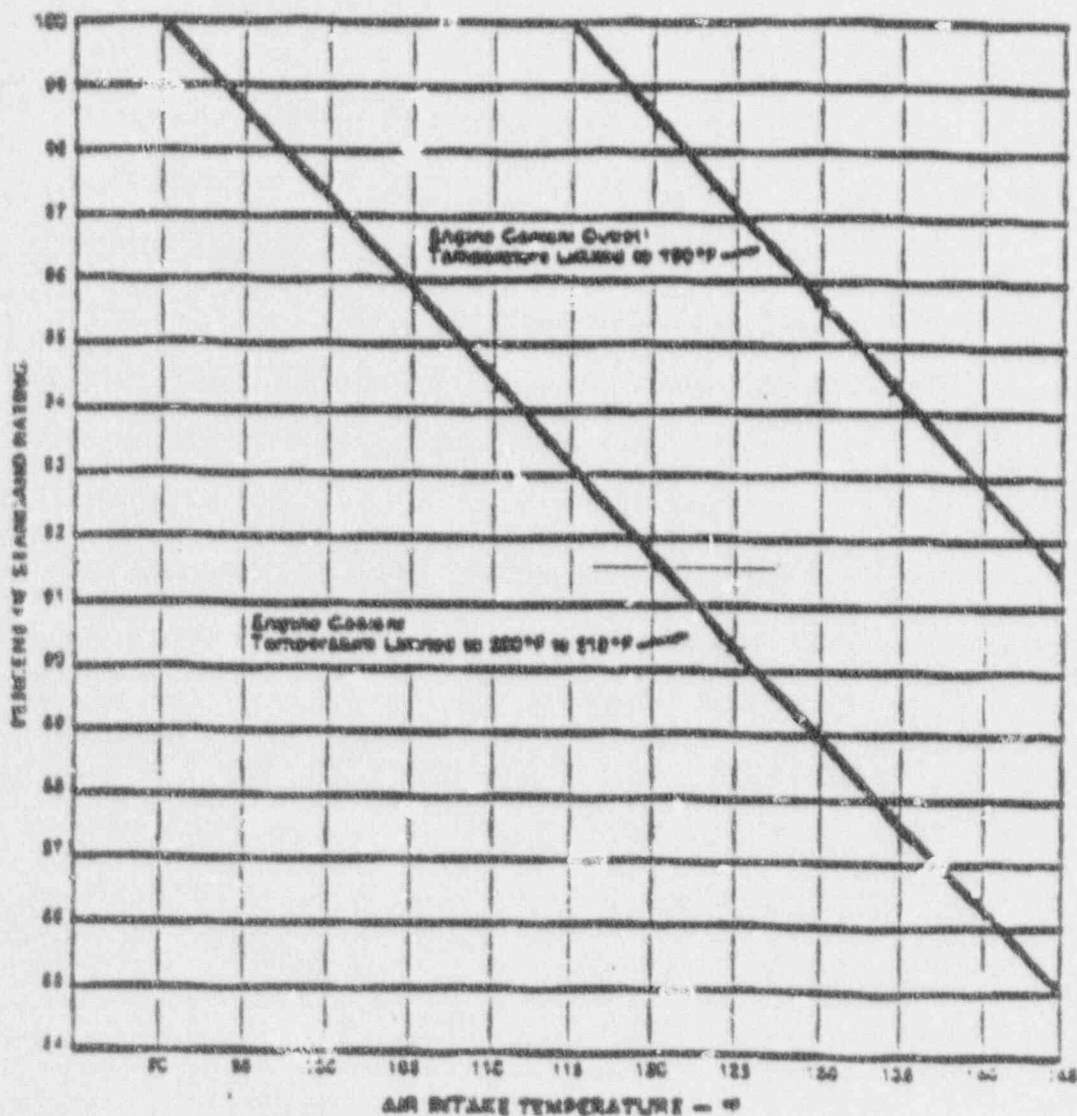
FC-05914 rA
EA-FC-90-062
Rev. 2
Attachment 8.2a-2
24

ENGINE TEMPERATURE
SWITCH NOMINAL
SETTINGS

Switch	Picture	Descent
ETS 1	208° F.	198° F.
ETS or ETS 2	215° F.	205° F.

ETS 1 — Hot engine alarm SC, HC, S.
ETS — Hot engine alarm MD, LD.
ETS 2 — Hot engine shutdown SC, HC, S.

The D/G @ 0 make is equivalent to an "S" unit



Rating at Elevated Temperature (°F)
For EMD 845B4

12 Blade, 22 Degree Pitch, 9G-2, 4-14-92
Standard Velocity / Temperature Measurement

11	Vel. = 2269 Temp. = 132.7	21	Vel. = 2240 Temp. = 130.4	31	Vel. = 2030 Temp. = 134.3	41	Vel. = 2292 Temp. = 131.2	51	Vel. = 2211 Temp. = 130	61	Vel. = 2510 Temp. = 128	71	Vel. = 2205 Temp. = 119.3	81	Vel. = 2301 Temp. = 118.1	91	Vel. = 2410 Temp. = 126.3
12	Vel. = 2316 Temp. = 130.2	22	Vel. = 2311 Temp. = 126.7	32	Vel. = 2058 Temp. = 129.2	42	Vel. = 2085 Temp. = 128.2	52	Vel. = 1922 Temp. = 129	62	Vel. = 2219 Temp. = 123.4	72	Vel. = 2360 Temp. = 115.5	82	Vel. = 2518 Temp. = 111.9	92	Vel. = 2575 Temp. = 118.2
13	Vel. = 2548 Temp. = 120.8	23	Vel. = 2621 Temp. = 122.4	33	Vel. = 2228 Temp. = 126.6	43	Vel. = 2255 Temp. = 121.1	53	Vel. = 1400 Temp. = 123	63	Vel. = 2113 Temp. = 121.5	73	Vel. = 2150 Temp. = 109.3	83	Vel. = 2487 Temp. = 109.6	93	Vel. = 2180 Temp. = 188.6
14	Vel. = 2241 Temp. = 112.7	24	Vel. = 2450 Temp. = 115.9	34	Vel. = 2216 Temp. = 121	44	Vel. = 2094 Temp. = 112.6	54	Vel. = 1280 Temp. = 112.6	64	Vel. = 1940 Temp. = 111.4	74	Vel. = 1890 Temp. = 105.1	84	Vel. = 1920 Temp. = 102.6	94	Vel. = 2005 Temp. = 101.4
15	Vel. = 1980 Temp. = 107.6	25	Vel. = 2177 Temp. = 107.9	35	Vel. = 1930 Temp. = 111	45	Vel. = 1760 Temp. = 107.4	55	Vel. = 980 Temp. = 109.2	65	Vel. = 1725 Temp. = 102.9	75	Vel. = 1830 Temp. = 100.6	85	Vel. = 2005 Temp. = 98.5	95	Vel. = 1920 Temp. = 98.4

Equipment used: TSI Model 8350 Velocimeter, Model 1011

Vel. = Velocity in ft./min. (standardized to 70 f and 14.7 Psia)

Temp. = Temperature in degrees F

Time constant = 15 seconds

Inlet Temperatures = (M. = 57.5F), (E. = 58.8 F), (W. = 57.7 F), (S. = 58.2F)

FLORIAN - A
25

12 Blade, 22 Degree Pitch, 06-2, 6-10-92
Standard Velocity /Temperature Measurement

11	21	31	41	51	61	71	81	91
Vel. = 2600	Vel. = 2430	Vel. = 2360	Vel. = 2500	Vel. = 1820	Vel. = 2620	Vel. = 2350	Vel. = 2440	Vel. = 2680
Temp. = 156	Temp. = 153	Temp. = 154	Temp. = 155	Temp. = 157	Temp. = 155	Temp. = 153	Temp. = 150	Temp. = 150
12	22	32	42	52	62	72	82	92
Vel. = 2610	Vel. = 2710	Vel. = 2270	Vel. = 2320	Vel. = 935	Vel. = 2310	Vel. = 2620	Vel. = 2770	Vel. = 2460
Temp. = 156	Temp. = 150	Temp. = 153	Temp. = 155	Temp. = 157	Temp. = 157	Temp. = 151	Temp. = 147	Temp. = 145
13	23	33	43	53	63	73	83	93
Vel. = 2800	Vel. = 3020	Vel. = 2490	Vel. = 2490	Vel. = 960	Vel. = 2370	Vel. = 2400	Vel. = 2700	Vel. = 2580
Temp. = 146	Temp. = 147	Temp. = 153	Temp. = 154	Temp. = 155	Temp. = 151	Temp. = 147	Temp. = 145	Temp. = 141
14	24	34	44	54	64	74	84	94
Vel. = 2630	Vel. = 2805	Vel. = 2600	Vel. = 2530	Vel. = 860	Vel. = 2190	Vel. = 2080	Vel. = 2410	Vel. = 2260
Temp. = 146	Temp. = 144	Temp. = 148	Temp. = 147	Temp. = 149	Temp. = 146	Temp. = 143	Temp. = 141	Temp. = 140
15	25	35	45	55	65	75	85	95
Vel. = 2380	Vel. = 2440	Vel. = 2080	Vel. = 2100	Vel. = 890	Vel. = 2000	Vel. = 1960	Vel. = 2180	Vel. = 2020
Temp. = 143	Temp. = 140	Temp. = 142	Temp. = 144	Temp. = 144	Temp. = 139	Temp. = 141	Temp. = 138	Temp. = 139

Equipment used= ISI Model 8350 Velocicalc, MT-00077; Digital Temp. MT-10104

Vel. = Velocity in Ft./Min. (standardized to 70 F and 14.7 Psia)

Temp. = Temperature in degrees F

Time constant = 15 seconds

Inlet Temperatures = (N. = 77.7F), (E. = 79 F), (W. = 77.2 F), (S. = 77.2F)

MWO 922346

07/10/92 11:00 AM 77 F 14.7 Psia

12 Blade, 22 Degree Pitch, DG-2, 4-14-92
Calculated Flow Rates

11	21	31	41	51	61	71	81	91
SCFM= 2521.11	SCFM= 2488.80	SCFM= 2254.44	SCFM= 2545.67	SCFM= 2456.67	SCFM= 2611.11	SCFM= 2543.33	SCFM= 2556.67	SCFM= 2677.78
Temp. = 132.7	Temp. = 130.4	Temp. = 132.3	Temp. = 131.2	Temp. = 130	Temp. = 128	Temp. = 119.3	Temp. = 118.1	Temp. = 126.3
12	22	32	42	52	62	72	82	92
SCFM= 2571.11	SCFM= 2567.78	SCFM= 2286.67	SCFM= 2316.67	SCFM= 2135.56	SCFM= 2465.56	SCFM= 2622.22	SCFM= 2797.78	SCFM= 2861.11
Temp. = 130.2	Temp. = 126.7	Temp. = 129.2	Temp. = 128.2	Temp. = 129	Temp. = 123.4	Temp. = 115.5	Temp. = 111.9	Temp. = 118.2
13	23	33	43	53	63	73	83	93
SCFM= 2851.11	SCFM= 2912.22	SCFM= 2675.56	SCFM= 2483.33	SCFM= 1564.44	SCFM= 2347.78	SCFM= 2388.89	SCFM= 2674.44	SCFM= 2422.22
Temp. = 120.8	Temp. = 122.4	Temp. = 126.6	Temp. = 121.1	Temp. = 123	Temp. = 121.5	Temp. = 109.3	Temp. = 109.6	Temp. = 108.6
14	24	34	44	54	64	74	84	94
SCFM= 2490	SCFM= 2722.22	SCFM= 2462.22	SCFM= 2326.67	SCFM= 1333.33	SCFM= 2153.56	SCFM= 2100	SCFM= 2133.33	SCFM= 2227.78
Temp. = 112.7	Temp. = 115.9	Temp. = 121	Temp. = 112.6	Temp. = 112.6	Temp. = 111.4	Temp. = 105.1	Temp. = 102.6	Temp. = 101.4
15	25	35	45	55	65	75	85	95
SCFM= 2200	SCFM= 2418.89	SCFM= 2144.44	SCFM= 1955.56	SCFM= 1088.89	SCFM= 1916.67	SCFM= 2033.33	SCFM= 2227.78	SCFM= 2133.33
Temp. = 107.4	Temp. = 107.9	Temp. = 111	Temp. = 107.4	Temp. = 109.2	Temp. = 102.9	Temp. = 100.6	Temp. = 98.5	Temp. = 98.4

Total Calculated Flow Rate= 105451.1 SCFM

Average Temperature in Duct = 116.94 Degrees F

12 Blade, 22 Degree Pitch, DG-2, 6-10-92
Calculated Flow Rates

11 SCFM= 2888.89 Temp.= 156	21 SCFM= 2700 Temp.= 153	31 SCFM= 2622.22 Temp.= 154	41 SCFM= 2777.78 Temp.= 155	51 SCFM= 2022.22 Temp.= 157	61 SCFM= 2911.11 Temp.= 155	71 SCFM= 2611.11 Temp.= 153	81 SCFM= 2711.11 Temp.= 150	91 SCFM= 2977.78 Temp.= 150
12 SCFM= 2900 Temp.= 156	22 SCFM= 3011.11 Temp.= 150	32 SCFM= 2522.22 Temp.= 153	42 SCFM= 2577.78 Temp.= 155	52 SCFM= 1038.89 Temp.= 157	62 SCFM= 2566.67 Temp.= 157	72 SCFM= 2911.11 Temp.= 151	82 SCFM= 3077.78 Temp.= 147	92 SCFM= 2733.33 Temp.= 145
13 SCFM= 3111.11 Temp.= 146	23 SCFM= 3355.56 Temp.= 147	33 SCFM= 2766.67 Temp.= 153	43 SCFM= 2766.67 Temp.= 154	53 SCFM= 1066.67 Temp.= 155	63 SCFM= 2633.33 Temp.= 151	73 SCFM= 2666.67 Temp.= 147	83 SCFM= 3000 Temp.= 145	93 SCFM= 2866.67 Temp.= 141
14 SCFM= 2922.22 Temp.= 146	24 SCFM= 3116.67 Temp.= 144	34 SCFM= 2888.89 Temp.= 148	44 SCFM= 2811.11 Temp.= 147	54 SCFM= 955.556 Temp.= 149	64 SCFM= 2433.33 Temp.= 146	74 SCFM= 2311.11 Temp.= 143	84 SCFM= 2677.78 Temp.= 141	94 SCFM= 2511.11 Temp.= 140
15 SCFM= 2644.44 Temp.= 143	25 SCFM= 2711.11 Temp.= 140	35 SCFM= 2311.11 Temp.= 142	45 SCFM= 2333.33 Temp.= 144	55 SCFM= 988.889 Temp.= 144	65 SCFM= 2222.22 Temp.= 139	75 SCFM= 2177.78 Temp.= 141	85 SCFM= 2422.22 Temp.= 138	95 SCFM= 2322.22 Temp.= 139

Total Calculated Flow Rate= 114555.6 SCFM

Average Temperature in Duct = 148.16 Degrees F

FL-05916
P26

Standard Velocity / Temperature Measurement
12 Blade, Pitch @ 22

11 Vel. = Temp. =	21 Vel. = Temp. =	31 Vel. = Temp. =	41 Vel. = Temp. =	51 Vel. = Temp. =	61 Vel. = Temp. =	71 Vel. = Temp. =	81 Vel. = Temp. =	91 Vel. = Temp. =
2440 122	2395 117	2275 120	2019 117	1950 119	2120 118	2610 123	2480 117	2109 114
12 Vel. = Temp. =	22 Vel. = Temp. =	32 Vel. = Temp. =	42 Vel. = Temp. =	52 Vel. = Temp. =	62 Vel. = Temp. =	72 Vel. = Temp. =	82 Vel. = Temp. =	92 Vel. = Temp. =
2589 111	2700 110	2360 115	2340 116	2330 119	2450 115	2713 117	3030 102	2380 103
13 Vel. = Temp. =	23 Vel. = Temp. =	33 Vel. = Temp. =	43 Vel. = Temp. =	53 Vel. = Temp. =	63 Vel. = Temp. =	73 Vel. = Temp. =	83 Vel. = Temp. =	93 Vel. = Temp. =
2520 96	2440 99	2280 112	2198 104	2080 110	2770 104	2500 105	2060 90	2470 94
14 Vel. = Temp. =	24 Vel. = Temp. =	34 Vel. = Temp. =	44 Vel. = Temp. =	54 Vel. = Temp. =	64 Vel. = Temp. =	74 Vel. = Temp. =	84 Vel. = Temp. =	94 Vel. = Temp. =
2170 91	2458 95	2250 102	2360 93	1830 96	2830 95	2340 96	2690 86	2137 90
15 Vel. = Temp. =	25 Vel. = Temp. =	35 Vel. = Temp. =	45 Vel. = Temp. =	55 Vel. = Temp. =	65 Vel. = Temp. =	75 Vel. = Temp. =	85 Vel. = Temp. =	95 Vel. = Temp. =
1605 87	2465 89	1940 91	2140 87	1780 90	3007 85	2000 90	2080 80	1635 82

Equipment used= TSI Model 8350 Velocalc, MT-7777; Digital Temp. MT-101002

Vel. = Velocity in Ft./Min. (standardized to 70 F and 14.7 psia)

Temp. = Temperature in degrees F

Time constant = 15 seconds

Inlet Temperatures = (N. = 48 F), (E. = 54 F), (S. = 62 F), (W. = 48 F)

Calculated Flow Rates
12 Blade, 22 Degree Pitch

11 SCFM= 2711.11 Temp.= 122	21 SCFM= 2661.11 Temp.= 117	31 SCFM= 2527.78 Temp.= 120	41 SCFM= 2243.33 Temp.= 117	51 SCFM= 2166.67 Temp.= 119	61 SCFM= 2355.56 Temp.= 118	71 SCFM= 2677.78 Temp.= 123	81 SCFM= 2755.56 Temp.= 117	91 SCFM= 2343.33 Temp.= 114
12 SCFM= 2876.67 Temp.= 111	22 SCFM= 3000 Temp.= 110	32 SCFM= 2622.22 Temp.= 115	42 SCFM= 2600 Temp.= 114	52 SCFM= 2588.89 Temp.= 119	62 SCFM= 2722.22 Temp.= 115	72 SCFM= 3014.44 Temp.= 117	82 SCFM= 3366.67 Temp.= 102	92 SCFM= 2644.44 Temp.= 103
13 SCFM= 2800 Temp.= 96	23 SCFM= 2711.11 Temp.= 99	33 SCFM= 2533.33 Temp.= 112	43 SCFM= 2442.22 Temp.= 104	53 SCFM= 2511.11 Temp.= 110	63 SCFM= 3077.78 Temp.= 104	73 SCFM= 2777.78 Temp.= 105	83 SCFM= 3177.78 Temp.= 90	93 SCFM= 2744.44 Temp.= 94
14 SCFM= 2411.11 Temp.= 91	24 SCFM= 2731.11 Temp.= 95	34 SCFM= 2500 Temp.= 102	44 SCFM= 2622.22 Temp.= 93	54 SCFM= 2033.33 Temp.= 96	64 SCFM= 3144.44 Temp.= 95	74 SCFM= 2600 Temp.= 96	84 SCFM= 2988.89 Temp.= 86	94 SCFM= 2374.44 Temp.= 90
15 SCFM= 1783.33 Temp.= 87	25 SCFM= 2738.89 Temp.= 89	35 SCFM= 2155.56 Temp.= 91	45 SCFM= 2377.78 Temp.= 87	55 SCFM= 1977.78 Temp.= 90	65 SCFM= 3341.11 Temp.= 85	75 SCFM= 2222.22 Temp.= 90	85 SCFM= 2311.11 Temp.= 80	95 SCFM= 1816.67 Temp.= 82

Total Calculated Flow Rate= 116583.3 SCFM

Average Temperature in Duct = 102.49 Degrees F

Normalized Saw Flow = 112844

FL-05a1u r A



FC-05910 r A 24

2825 Four Mile Road, Racine, Wisconsin 53404
Telephone: 414-839-1010 • EasyLink: 627-63631
TWX: 910-271-2367 • Telex: 26-4435
Telefax: 414-839-1013

FACSIMILE TRANSMISSION

TRANSMIT TO:

FAX NO. 402-636-3946

C.O. _____

NAME DAN BORCYK

TITLE _____

COMPANY OMAHA PUBLIC POWERCITY OMAHASTATE NE

ZIP _____

NUMBER OF PAGES BEING TRANSMITTED, INCLUDING THIS COVER 3HEAT LOAD: 120,970 Btu/hrCOOLANT FLOW, TEMP. IN.: 1100 GPM, 190°FALTITUDE: 1007 ftRADIATOR FACE AREA: 105.1 ft² RAD. TUBE LENGTH: 12.25 ft

°F T _{AIR IN}	50% EG-WATER AIRFLOW REQ SCFM	W/G	gpm FACE VEL	1wg std. air EST. TOTAL SYST. RESISTANCE
---------------------------	-------------------------------------	-----	-----------------	---

103	101,782	.63	968	1.85
-----	---------	-----	-----	------

108	110,184	.72	1048	2.17
-----	---------	-----	------	------

113	120,144	.84	1143	2.50
-----	---------	-----	------	------

118	131,986	.98	1255	2.90
-----	---------	-----	------	------

123	146,384	1.16	1392	3.45
-----	---------	------	------	------

WATER ONLY

103	96,311	.58	916	1.75
-----	--------	-----	-----	------

108	103,766	.65	987	1.90
-----	---------	-----	-----	------

113	112,446	.75	1069	2.30
-----	---------	-----	------	------

118	122,679	.87	1167	2.57
-----	---------	-----	------	------

123	134,912	1.02	1283	3.05
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TRANSMISSION FROM:

NAME TOM TILLER

TITLE _____

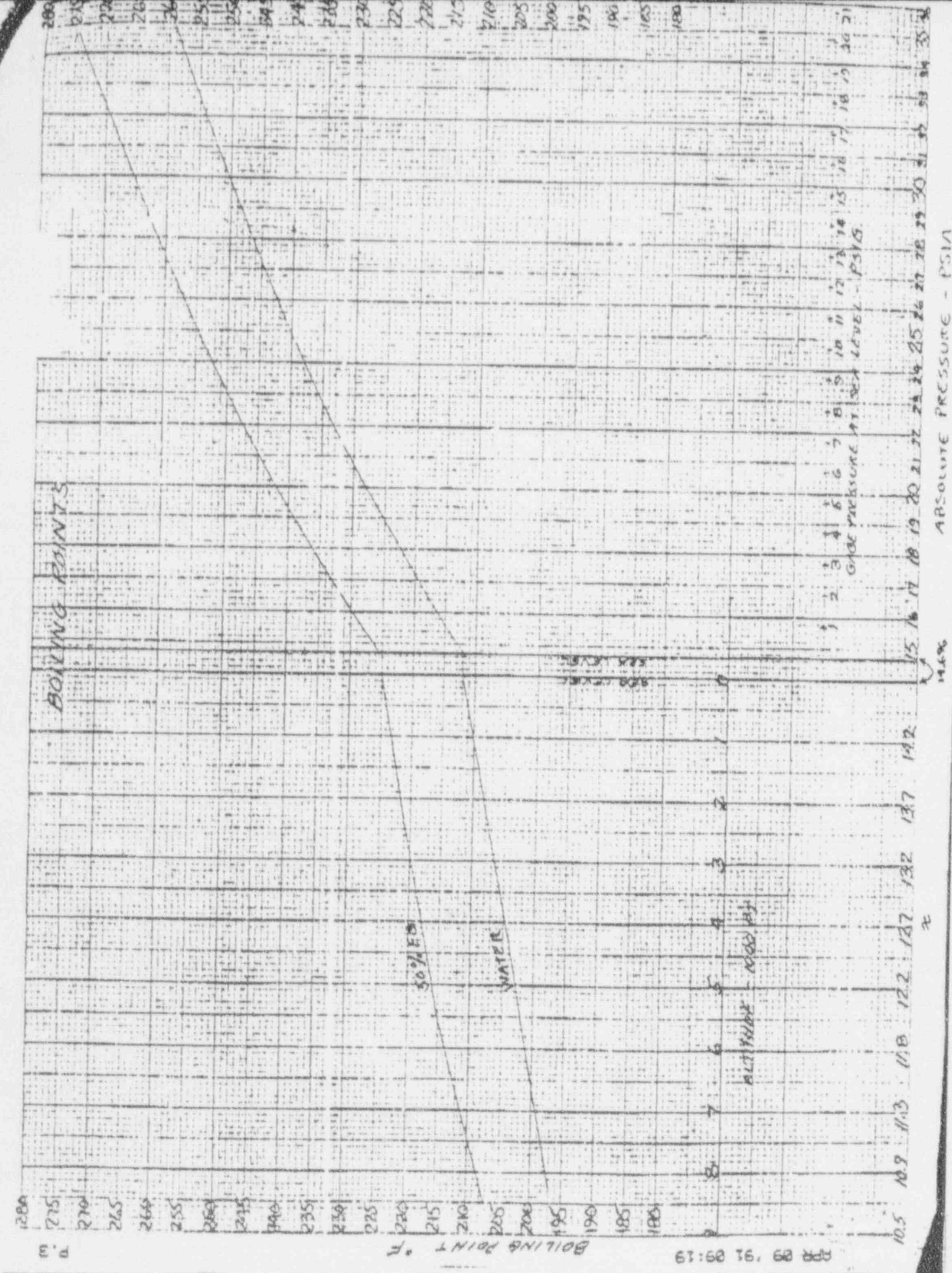
☒ RACINE, WI ☐ LEXINGTON, TN ☐ CENTERVILLE, IA
414-839-1013 901-968-3617 515-858-8634

FORM NO. 3813 REV. 8/88

DATE 4/8/91 TIME _____AM
PM

T'd

APR 09 09:23:17



BOILING POINTS

APR 09 '91 09:19

P. 03

NE DREYER CO.
MADE IN U. S. A.

10 X 10 PER HALF INCH

TO

ALTITUDE-RELATIVE DENSITY TABLE FOR AIR
Altitudes in Feet--Standard Air at 0 Alt. (29.92 In. Bar.) = 1.

Alt.	Den.	Bar.	Alt.	Den.	Bar.	Alt.	Den.	Bar.	Alt.	Den.	Bar.
0	1.00	29.92	1500	.944	28.26	3000	.891	26.68	6000	.795	23.79
100	.996	29.81	1600	.941	28.15	3200	.885	26.48	6200	.789	23.61
200	.992	29.70	1700	.937	28.04	3400	.878	26.28	6400	.784	23.43
300	.989	29.58	1800	.933	27.93	3600	.872	26.08	6500	.781	
400	.985	29.47	1900	.930	27.83	3800	.865	25.88	6600	.778	23.26
500	.981	29.36	2000	.926	27.72	4000	.858	25.68	6800	.772	23.08
600	.977	29.25	2100	.923	27.62	4200	.852	25.49	7000	.766	22.90
700	.974	29.14	2200	.919	27.51	4400	.846	25.30	7200	.760	22.73
800	.970	29.02	2300	.916	27.41	4600	.839	25.10	7400	.754	22.56
900	.966	28.91	2400	.912	27.30	4800	.833	24.91	7600	.748	22.38
1000	.962	28.80	2500	.909	27.20	5000	.826	24.72	7800	.743	22.21
1100	.959	28.69	2600	.905	27.09	5200	.820	24.53	8000	.737	22.04
1200	.955	28.58	2700	.902	26.99	5300			8200	.731	21.87
1300	.952	28.47	2800	.898	26.89	5400	.814	24.35	8400	.726	21.70
1400	.948	28.36	2900	.895	26.78	5600	.808	24.16	8600	.720	21.54
						5800	.802	23.98	8800	.714	21.37

TEMPERATURE-RELATIVE DENSITY TABLE FOR DRY OR SATURATED AIR
Temp. in deg. Fahr. Standard Air = 70° F. = 1.

TEMP.	DENSITY RATIO		TEMP.	DENSITY RATIO		TEMP.	DENSITY RATIO	
	DRY *	WET **		DRY *	WET **		DRY *	WET **
-5	1.165	1.163	62	1.015	1.007	105	.938	.911
0	1.152	1.151	64	1.011	1.003	110	.930	.899
5	1.140	1.138	66	1.008	.999	115		.886
10	1.128	1.126	68	1.004	.994	120		.873
15	1.116	1.114	70	1.000	.990	125		.860
20	1.104	1.	72	.996	.985	130	.898	.846
25	1.093	1.08	74	.992	.981	135	.891	.832
30	1.082	1.078	76	.989	.977	140	.883	.817
35	1.071	1.067	78	.985	.972	145	.876	.802
40	1.060	1.056	80	.982	.968	150	.869	.786
42	1.056	1.051	82	.978	.963	155	.862	.769
44	1.052	1.047	84	.974	.959	160	.855	.751
46	1.047	1.042	86		.954	165	.848	.731
48	1.043	1.038	88		.95	170	.841	.713
50	1.039	1.033	90		.94	175	.835	.692
52	1.035	1.029	92		.941	180	.828	.671
54	1.031	1.025	94		.936	185	.822	.647
56	1.027	1.020	96		.932	190	.815	.622
58	1.023	1.016	98		.927	195	.809	.597
60	1.019	1.012	100	.946	.922	200	.803	.569

* Radiator-Type Coolers

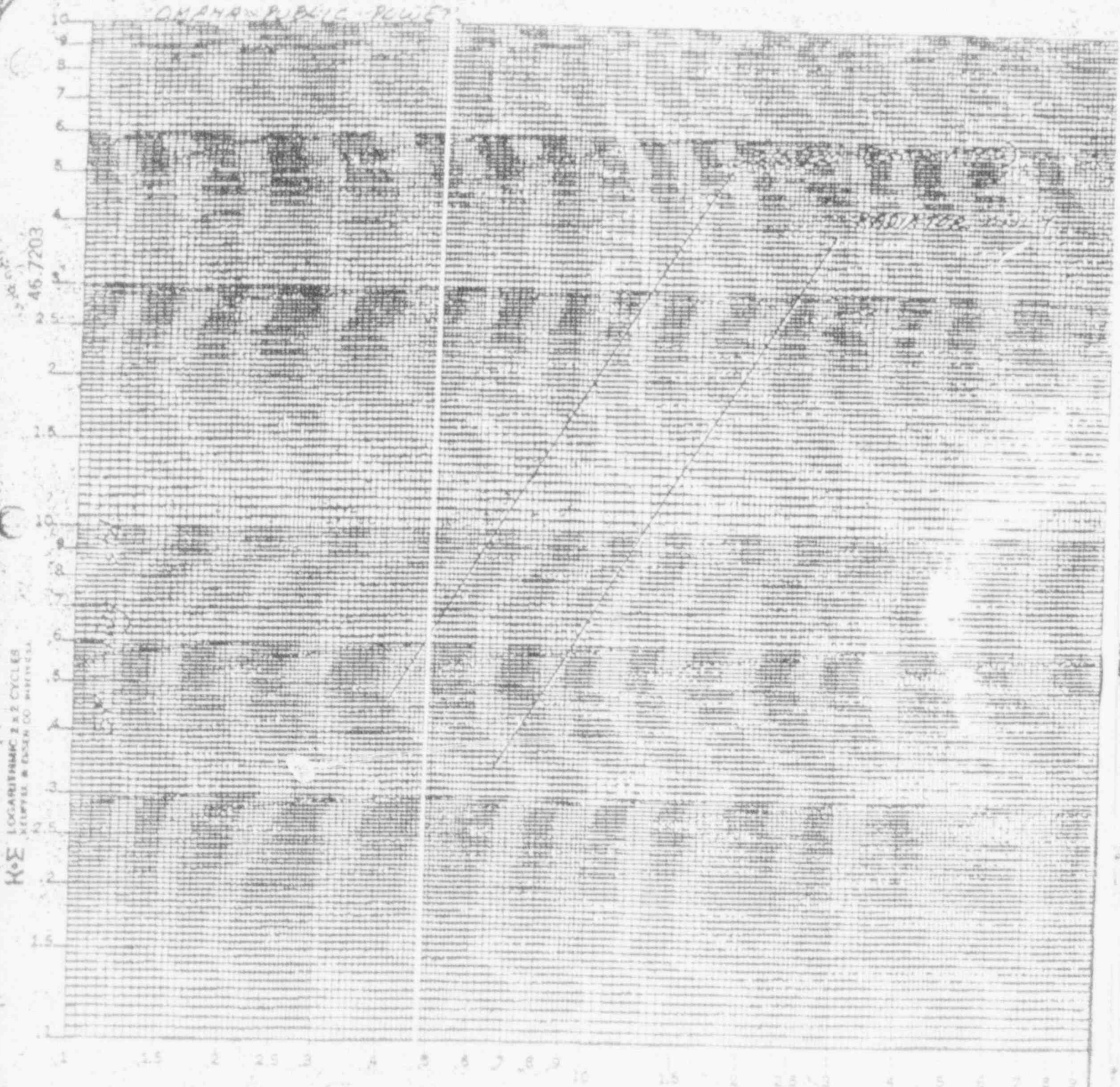
** Cooling Towers

16. 60 600

OMAHA PUBLIC POWER

46.7203

LOGARITHMIC 2 X 2 CYCLES
SCALING & DATA CO. BUREAU



CORE FACE VELOCITY
(cm/sec)

AIR 0.75 lbs/ft³

2825 Four Mile Road, Racine, Wisconsin 53404
 Telephone: 414-639-1010 • EasyLink: 827-63631
 TWX: 910-271-2397 • Telex: 26-4435
 Telefax: 414-639-1013

FACSIMILE TRANSMISSION

TRANSMIT TO:

FAX NO. 402-636-3946

C.O. _____

NAME DAN BORCYK

TITLE _____

COMPANY OMAHA PUBLIC POWER

CITY OMAHA

STATE _____

ZIP _____

NUMBER OF PAGES BEING TRANSMITTED, INCLUDING THIS COVER _____

HEAT LOAD: 120,970 Btu/hr

COOLANT, FLOW, TEMP IN: 50% EG-WATER, 1100 GPM, 208°F

ALTITUDE: 1007 ft

RADIATOR FACE AREA: 105.1 ft²

RADIATOR TUBE LENGTH: 12.25 ft

°F	AIRFLOW REQ.	SPM	FACE VEL.	EST. TOTAL SYST. RESISTANCE
T _{AIR IN}	SCFM	1WG SP		1WG SP std. air
103	79,777	.42	759	1.30
108	84,873	.47	807	1.42
* 113	90,658	.52	862	1.57
118	97,279	.59	926	1.78
123	104,933	.67	998	2.00
128	113,934	.76	1084	2.29
133	124,539	.89	1185	2.60
138	137,294	1.05	1306	3.10

THE 9 ft dia, 8 blade fan @ 600 rpm is probably limited to 2.00 inwg ACTUAL static pressure which leaves no room for de-rating. As you have suggested, purchase of a fan to overcome the system resistance appears to be a logical approach. THE system resistances shown on the attached sheet yield the following operating points on the un-rated fan curve: (Approx.) 8° pitch, 100,000 SCFM, 1.3 inwg; 10° pitch, 105,000 SCFM, 2.00 inwg; 12° pitch, 113,000 SCFM, 2.20 inwg; 14° pitch 120,000 SCFM, 2.40 inwg.

TRANSMISSION FROM:

NAME TOM TILLER

TITLE _____

☒ RACINE, WI
 414-639-1013

☐ LEXINGTON, TN
 901-968-3617

☐ CENTERVILLE, IA
 515-858-8834

FORM NO. 3613 REV. 6/89

DATE 4.8.91 TIME _____

Memorandum

FC-05416 p 34

DATE: July 1, 1991

PED-FC-91-472

FROM: P. F. Vovk

TO: R. P. Clemens

SUBJECT: Maximum Generator/Exciter KW Ratings for TDB Figure III.26.A

The subject TDB figures (attached) were submitted for PRC approval on June 28, 1991. The initial (horizontal line on the first part of each curve) KW rating shown for each diesel generator is limited by the generator and exciter base load ratings as shown on the attached data sheet on the generating unit (Attachment 8.4-1 of EA-FC-90-062 Rev. 2). The base load KW rating of the generator/exciter is 2500 KW (3125 kVA x 0.8 pf). Per calculation FC03382 Rev. 3, the actual power factor for the load on DG-1 is 0.87 and for DG-2 is 0.85. This yields the following generator/exciter base load KW limits:

DG-1 = $3125 \text{ kVA} \times 0.87 \text{ pf} = 2718 \text{ KW at } 0.87 \text{ pf}$
DG-2 = $3125 \text{ kVA} \times 0.85 \text{ pf} = 2656 \text{ KW at } 0.85 \text{ pf}$

The above KW ratings represent the continuous KW loading which can be supported by the generator/exciter. Since the engine KW limit is greater than the generator/exciter KW limit, the KW is limited to the generator/exciter KW limit for both diesel generators. This applies only during the horizontal section of the TDB figures. The sections following the initial horizontal section are limited due to the engine derating with increased temperature.

Paul Vovk 7-1-91

P. F. Vovk
Engineer - Electrical
Production Engineering Division

PFV/sf

Attachments

c: K. A. Miller
D. G. Flegle
D. G. Borczyk
PED Library



2825 Four Mile Road, Racine, Wisconsin 53404
Telephone: 414-639-1010 • EasyLink: 627-53631
TWX: 910-271-2397 • Telex: 254435
Telefax: 414-639-1013

FACSIMILE TRANSMISSION

TRANSMIT TO:

FAX NO. 402-636-3946

C.C. _____

NAME DAN BORCYK

TITLE _____

COMPANY OMAHA PUBLIC POWER

CITY OMAHA

STATE NE ZIP _____

NUMBER OF PAGES BEING TRANSMITTED, INCLUDING THIS COVER 1

HEAT LOAD : 120,970 Btu/hr

COOLANT, FLOW, TEMP IN : WATER, 1100 GPM, 208°F

ALTITUDE : 1007 ft

RADIATOR FACE AREA : 105.1 ft²

RAD TUBE LENGTH : 1125 ft

°F T AIR IN	- WATER - AIRFLOW REQ SCFM	1WG-SP	GPM FACE VEL	ESTIMATED SYSTEM TOTAL RESISTANCE 1WG-SP AIR
103°	76,457	39	727	1.22
108°	81,097	43	771	1.30
113°	86,336	48	821	1.45
118°	92,294	54	878	1.65
123°	99,200	61	943	1.85

TRANSMISSION FROM:

NAME TOM TILLER

TITLE _____

☒ RACINE, WI 414-639-1013
☐ LEXINGTON, TN 901-968-3817
☐ CENTERVILLE, IA 515-856-2634

FORM NO. 3513 REV. 6/89

DATE 4/15/91 TIME _____

AM
PM

APR 15 91 09:58

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

JUL 02 1992

ID No. LIC-92-207R
(from 9.1)

SECTION A

Page 1 of 12

10 CFR 50.59 Applicability Screening

9.1 Activity Identification

Procedure Change No. _____ affecting Procedure _____
Modification Request No. _____ Design [] Installation [] Testing []
Temporary Modification No. _____ Engineering Change Notice No. _____
Other Licensing Request for Safety Evaluation For Change in DG Coolant Philosophy
Document Title: _____

Nuclear Safety Evaluation Conclusion

- ☒ This activity is not a 10 CFR 50.59 activity, because it:
- Does not change the facility as described in the USAR.
 - Does not change procedures as described in the USAR.
 - Does not involve conducting tests or experiments not described in the USAR.
 - Does not affect Nuclear Safety in a way not previously evaluated in USAR.

- ☒ This activity is being done pursuant to 10 CFR 50.59.
- This safety evaluation must be reviewed by SARC; ref Tech. Spec. 5.5.2.7.
 - This activity must be reported in the annual report; ref 10 CFR 50.59, Item b, Paragraph 2.

- [] This activity involves an Unreviewed Safety Question. The activity must be canceled, or revised and re-evaluated, or NRC authorization is required prior to implementation; ref 10 CFR 50.59, Item c.

We hereby certify that this Nuclear Safety Evaluation is complete and accurate to the best of our knowledge.

Prepared by Donald G. Flegle

Print Name

Date 6-30-92 Time 0850

Donald G. Flegle

Signature

Extension 6879

Reviewed by Richard P. Rowning

Print Name

Date 6-30-92 Time 0949

Richard P. Rowning

Signature

Extension 6887

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

ID No. LIC-92-207R
(from 9.1)

SECTION A

Page 2 of 6

10 CFR 50.59 Applicability Screening

9.2 What (specifically) is being done?

Previously, there had been a commitment to the NRC to operate the emergency diesel generator (DG) jacket water system with a solution consisting of deionized water with corrosion inhibitor additive during the summer months. This plan for DG operation was presented to the NRC in EA-90-62. OPPD has determined that this coolant change will no longer be necessary. This safety evaluation will ensure that the change to maintain the 50/50 glycol/water solution year around does not constitute a safety hazard.

9.3 Why is this being done (briefly)?

Engineering Calculation FCO-910 has determined that the diesel generators may be safely operated at high temperatures even with the use of a glycol/water mixture in the jacket water system.

9.4 Does the activity involve a change to the Technical Specifications?

[X] NO - • This activity meets the requirements of current Technical Specifications. The following sections were reviewed: _____

2.7 & 3.7

• Continue with 9.5

[] YES - • Technical Specification Section _____ must be revised prior to performing this activity.

• Exit this procedure and continue with NOD-QP-7.

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

ID No. LIC-92-207R -
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SECTION A

Page 3 of 13
+2
-6

10 CFR 50.59 Applicability Screening

9.5 Does the activity involve a change in the facility?

[] NO - Go to 9.6

[X] YES - Is this aspect of the facility described in the USAR?

List USAR Sections reviewed: 6.1.2.2, 7.3, 8.1.2, 8.2, 8.4

[] NO - Go to 9.6

[X] YES - list USAR Sections 8.4.1.1

- Does the USAR description require any changes or revisions due to this activity?

~~[X]~~ NO - continue with 9.6

6-30-92 ☒ YES - • 10 CFR 50.59 applies to this activity

DA7

8-30-92

- Section B of the Nuclear Safety Evaluation must also be completed.

- Continue with 9.6

9.6 Does the activity involve changes to procedures?

[X] NO - Go to 9.7

[] YES - Are related procedures (including definitions or descriptions of activities or controls over functions) outlined, summarized, completely described, or implied in the USAR?

List USAR Sections reviewed: _____

[] NO - Go to 9.7

[] YES - list USAR Sections _____

- Does the USAR description require any changes or revisions due to this activity?

[] NO - Continue with 9.7

[] YES - • 10 CFR 50.59 applies to this activity

- Section B of the Nuclear Safety Evaluation must also be completed

- Continue with 9.7

A-3

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

ID No. LIC-92-207R
(from 9.1)

SECTION A

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10 CFR 50.59 Applicability Screening

9.7 Does the activity involve tests or experiments?

☒ NO - Go to 9.8

☐ YES - Is the test/experiment one which has been previously anticipated in the USAR?

☐ YES • List USAR Sections _____

• Go to 9.8

☐ NO - (i.e., it is not described in the USAR; including one-of-a-kind tests or new system configurations)

Could this test/experiment degrade the margins of safety during normal operations or anticipated transients, or could it degrade the adequacy of structures, systems or components to prevent accidents or mitigate accident conditions?

☐ NO - _____

- Continue with 9.8

☐ YES - • 10 CFR 50.59 applies to this activity
• Section B of the Nuclear Safety Evaluation must also be completed.
• Continue with 9.8

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

ID No. LIC-92-207R
(from 9.1)

SECTION A

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10 CFR 50.59 Applicability Screening

9.8 Could the activity adversely affect nuclear safety?

[X] NO - Explain The activity concerned calls for retaining the JW
solution of a 50/50 glycol water mix year around. The high
temperature operability limit for DG-1 with a 50/50
glycol/water mix is reduced to 104°F. The high temperature
operability limit for DG-2 with a 50/50 glycol/water mix is
110°F and is the same as using water as a coolant. These
operability limits are substantiated by short (continued)

- Go to Nuclear Safety Evaluation Conclusion or continue with
Section B of the Nuclear Safety Evaluation, if required.

[] YES - How _____

Has this effect been previously evaluated in the USAR?

[] YES - discussed in USAR Section _____

- Continue with Nuclear Safety Evaluation Conclusion

[] NO - • 10 CFR 50.59 applies to this activity

• Continue with Section B of the Nuclear Safety
Evaluation

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

FC-154
R13

FORM E

Page 6 of 13

ATTACHMENT 1

Reference Sections

9.8 (Continued)

term calculation FC05916.

The advantages to using the 50/50 glycol/ water mix during the summer months are:

1. Reduces the Diesel Generator down time required for spring and fall coolant changes.
2. Provides constant operability limits and reduces confusion over which coolant is used and what diesel operability limits are used.
3. Offers more protection against unseasonable cold periods. A 50/50 glycol/water mix offers freeze protection against cold ambient air temperatures flowing through the radiator with little or no jacket water flow circulating through the radiator.

It should be noted that the DG operability limits are based on the engine 2000 hour rating and not the maximum load that could safely be carried by that DG for a shorter period of time. Since temperatures in excess of 104°F are very rare in Nebraska and since these high temperatures typically occur for a short period of time in the afternoon, it is not anticipated that high temperatures will cause any plant shutdown. In the worst case scenario, if ambient temperatures exceed 104°F then DG-1 would be declared inoperable because of Tech. Spec. 3.7 (1) c.iii and the plant would enter a 7 day LCO. However the DG would still be capable of performing its safety function even at the higher temperatures up to (and beyond) 110°F. Therefore this not considered to be an activity which adversely affects nuclear safety.

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

ID No. LIC-92-207R
(from 9.1)

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SECTION B

Unreviewed Safety Question Determination

10.1.1 Identify Plant Specific Design, Operating and Technical Documents		
<u>Document Title</u>	<u>ID Number</u>	<u>Revision</u>
<u>Operating Temp. Limits</u>	<u>FC05916</u>	<u>A</u>
<u>For DG-1 and DG-2</u>		
<u>Diesel Generator Upper</u>	<u>EA-FC-90-062</u>	<u>2</u>
<u>Temp. Operating Limits</u>		
10.1.2 Identify Applicable NRC Documents/Industry Standards		
<u>Title</u>	<u>ID Number</u>	<u>Revision</u>
<u>EDG Max. Temp. Limits</u>	<u>92-095 (NRC)</u>	<u>N/A</u>
<u>SAIC Technical Eval.</u>	<u>TAC No.M77596</u>	<u>N/A</u>
10.1.3 Identify Related Drawings		
<u>Title</u>	<u>ID Number</u>	<u>Revision</u>
<u>N/A</u>		
10.2 List safety functions the affected structures or components perform: <u>The emergency diesel generator provides a source of AC power in case offsite power is lost.</u>		
 <u>List applicable accidents for which these safety functions are required: Loss of offsite power or loss of voltage on a vital 4160 v AC bus.</u>		

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

ID No. LIC-92-207R
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SECTION B

Unreviewed Safety Question Determination

10.3 System Interactions Analyses			
Criteria	Applicable	Criteria	Applicable
Fire Protection	[]	Structural Impact	[]
Electrical Equipment Qualifications	[]	Separation Criteria	[]
High Energy Line Break Review	[]	Single Failure Criteria	[]
Seismic Interaction and Qualification	[]	Possibility of Operator Error	[]
Electrical Systems Analysis	[X]	Heavy Loads	[]
Human Factors Review	[]	Impact on HVAC	[]
Security Review	[]	System/Component Performance	[X]
Environmental Radiological Release	[]	Natural Phenomena	[]
Materials Compatibility	[]	Installation of Temporary Modifications	[]
Containment Integrity	[]	Testing of Temporary Modifications	[]
Control Room Habitability	[]	Other: _____	[]
Missile Protection	[]		
Discussion of Applicable Systems Interactions Analyses			
(Include Attachment Sheet as needed)			
See Attachment			

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

ID No. LIC-92-207R
(from 9.1)

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ATTACHMENT SHEET

10.3 System Interaction Analyses

Electrical Systems Analysis

The emergency diesel generators provide AC electrical power to the plant vital buses in case offsite AC power is lost. The amount of power available from each engine needs to be greater than the minimum engineered safeguards loads for that engine. In addition to this practical consideration there is a Technical Specification that the emergency loads not exceed the 2000 hour rating of the engine. (The 2000 hour rating of the engine is the amount of power that the engine can routinely produce before a maintenance inspection should be performed) Because higher ambient temperatures can produce greater engine wear, the engine vendor derates the engine at air temperatures greater than 90°F. This derating causes an "intersection" of the emergency load and the 2000 hour rating of the engine. While the engine is capable of producing more power than required, plant Technical Specifications require that emergency loads be less than the engine 2000 hour rating.

System/Component Performance

The diesel engines may be cooled using either a glycol/water mixture or water alone (with a rust inhibitor). Because glycol is heavier and more viscous than water it takes more power to pump the glycol/water mixture through the cooling system. The power required to pump the coolant is subtracted from the engine power available for driving the generator when determining the KW rating of the system. During previous summers the glycol/mixture was replaced with water in order to avoid this "glycol pumping penalty". Now because of significant improvements in overall cooling performance due to radiator cleaning, higher capacity radiator fans, improved fan tip clearance, etc. it is no longer considered to be necessary to change to water during the summer months. The 2000 hour rating will be above the maximum emergency loading required by Tech. Spec. 3.7 up to 104°F for DG-1 and 110°F for DG-2. Should temperatures exceed 110°F both DG's would be considered inoperable and a plant shutdown would be required.

NUCLEAR SAFETY EVALUATION
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(from 9.1)

SECTION B

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Unreviewed Safety Question Determination

- 10.4 Could the proposed activity increase the probability of occurrence of an accident previously evaluated in the USAR? YES []
NO [X]

Explain: The activity only affects equipment which operates to mitigate an accident. The activity cannot increase the probability of any accident.

- 10.5 Could the proposed activity increase the consequences of an accident previously evaluated in the USAR? YES []
NO [X]

Explain: Accident consequences will not be changed by the continuation of a glycol/water mixture because DG operation remains unchanged. USAR Table 8.4-1 shows how DG ratings change with temperature. It must be noted that the USAR has not yet been updated to reflect (Continued)

- 10.6 Could the proposed activity increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the USAR? YES []
NO [X]

Explain: Equipment malfunction probabilities are not increased since this activity involves only a temperature rating which affects Technical Specification 3.7 (1) c.iii. This requires FCS to maintain emergency loads below the 2000 hr. engine rating.

- 10.7 Could the proposed activity increase the consequences of a malfunction of equipment important to safety previously evaluated in the USAR? YES []
NO [X]

Explain: As stated in 10.6, this activity does not affect malfunctions of equipment. EA-FC-90-062 and Calculation FC05916 document the ability of the DG to operate properly with a glycol/water mixture even at temperatures up to 110°F.

NUCLEAR SAFETY EVALUATION
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ID No. LIC-92-207R
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ATTACHMENT SHEET

10.5 (Continued)

Engineering Analysis EA-FC-90-062. This analysis differentiates between DG engine capacity based on whether the engine coolant is water or a glycol/water mixture. Either coolant is acceptable, however the glycol/water mixture causes a greater engine capacity derating. This is true whether the temperature is hot or cold. Because emergency loading on DG-1 is higher than on DG-2, the temperature at which the emergency loading exceeds the 2000 hour rating of the engine is reduced to 104°F. This does not mean that the engine will not carry the emergency loads, it simply means that the maintenance inspection interval should be shortened to something less than 2000 hours. For more details refer to EA-FC-90-062 Rev. 2). Furthermore as shown on page 19 of Short Term Calculation FC-05916 Rev. A, the emergency loading decreases after 60 minutes to a level well below the 2000 hour rating of the engine. Thus from a safety standpoint there is no doubt that the DG would be able to carry the required load. The problem is simply that Tech. Spec. 3.7 (1) c.iii does not consider the effects of temperature on engine rating. It is concluded that leaving the glycol/water mixture in the DG's is safe and does not increase the probabilities or the consequences of any accident.

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

ID No. LIC-92-207R
(from 9.1)

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SECTION B

Unreviewed Safety Question Determination

- 10.8 Could the proposed activity create the possibility of an accident of a different type than any previously evaluated in the USAR? YES []
NO [X]

Explain: No different accident types are created by this activity.

Instead a situation may occur where a Technical Specification for emergency loading of the diesel generators is exceeded for DG-1 at 104°F rather than at 110°F. Technical Specifications allow the diesels to be inoperable for up to 7 days (total both diesels) per month.

- 10.9 Could the proposed activity create the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the USAR? YES []
NO [X]

Explain: The possibility that the DG would malfunction is dependent on emergency loading and temperature. This possibility exists whether the DG coolant used is water or glycol/water mixture. This evaluation is supported by EA-FC-90-062 and Calculation FC05916. No new malfunction types are created.

- 10.10 Does the proposed activity reduce the margin of safety as defined in the basis for any Technical Specification? YES []
NO [X]

Explain: No Technical Specification Basis discusses the type of coolant used in the diesel generators, nor is there any discussion of high temperature operation of the diesel generators. Using the 2000 hour rating of the engine builds conservatism into the Tech. Spec. without having to consider temperature effects. At some temperature, no matter
(Continued)

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

ID No. LIC-92-207R
(from 9.1)

Page ____ of ____

ATTACHMENT SHEET

10.10 (Continued)

what coolant is used, engine derating would cause a violation of Tech. Spec. 3.7 (1) c.iii. However the margin of safety defined in the Tech. Spec. does not address temperature effects.