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 FCØ 5916	Calc. Page No. 1 *TOTAL PAGES 33
	QA Category: ☒ CQE ☐ LIMITED CQE ☐ FIRE PROT. ☐ NON CQE o FILE NO. ____ PED DEPARTMENT 357	

CALCULATION TITLE	VENDOR CALC NO.
OPERATING TEMPERATURE LIMITS FOR DG-1 AND DG-2	☐ MR NO. ☒ ENGR. ANALYSIS 90-062 ☐ DBD NO. ☐ ECN NO. ☐ OTHER

* APPROVALS - SIGNATURE & DATE

PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)	*REV. NO.	SUPERSEDES *CALC. NO.	CONFIRMATION *REQUIRED (✓) YES	NO
[signature] 4-20-92	[signature] 4-20-92	[signature] 4-20-92	A			✓
[signature] 8-7-92	[signature] 8-7-92	[signature] 8/10/92	B			✓

* EXTERNAL ORGANIZATION DISTRIBUTION

NAME & LOCATION	COPY SENT (✓)	NAME & LOCATION	COPY SENT (✓)

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PDR ADOCK 05000285
P PDR

CALC. PAGE NO. 1 A

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

PRODUCTION ENGINEERING DIVISION
CALCULATION REVISION SHEET

CALCULATION NO. FC05916

REV. NO.	DESCRIPTION / REASON FOR CHANGE
B	P3 OPPD MAY SUPERCEDE EA-FC-90-062 r 2 INSTEAD OF REVISING, FOR THE PURPOSE OF CLARITY AND DOCUMENT CONTROL
B	p 5a PROVIDED ADDED 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 ADDED STATEMENT CONCERNING GENERATOR CAPACITY
B	p 10, 11 UTILIZED DATA FROM MWO ADDED ON p 6
B	p 12 REDREW GRAPH IN A MORE PROFESSIONAL FORMAT AND USED DATA FROM p 6
B	p 13 WORDING CHANGE FOR CLARITY
B	p 14-17 ADDED CLARITY TO TABLE ~~TITLES~~ B-7-42 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 DERATION NUMBERS WERE THEN USED. THIS RESULTED IN OVERCONSERVATISM IN THE CALCULATION
B	p 18 REMOVED UNNECESSARY WORDING
B	p 19, 20 REDREW GRAPHS WITH NEW DERATION CURVES
B	p 25, 26 INSERTED TEST DATA FROM MWO 922346
B	p 34 ADDED LETTER TO EXPLAIN GENERATOR LIMIT
B	p 35 ADDED FAX FOR 208 °F WATER COOLANT AIR FLOW REQUIREMENTS

CALCULATION COVER SHEET

Calculation Preparation, Review and Approval Form PED-QP-3.1 Form Page No. 2 of 2 Calculation Cover Sheet	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 FORM PED-QP-3.3 FORM Page No. 1 of 5	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 superceded

B

CALCULATION PREPARATION, REVIEW AND APPROVAL FORM PED-QP-3.3 FORM Page No. 2 of 5	CALCULATION NO.
PRODUCTION ENGINEERING CALCULATION SUMMARY SHEET	FC-05916 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 temperarures
   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

CALCULATION PREPARATION, REVIEW AND APPROVAL
FORM PED-QP-3.3 FORM Page No. 3 of 5

PRODUCTION ENGINEERING CALCULATION
SUMMARY SHEET

CALCULATION NO. FC-5916

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, ie 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 meausured in a test configuration. (B)

5. Only the minimum amount of emergency safeguards equipment

REV.1

CALCULATION PREPARATION, REVIEW AND APPROVAL FORM PED-QP-3.3 FORM Page No. 3 of 5	CALCULATION NO.
PRODUCTION ENGINEERING CALCULATION SUMMARY SHEET	FC-5916 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.

CALCULATION PREPARATION, REVIEW AND APPROVAL
FORM PED-QP-3.3 FORM Page No. 4 of 5

PRODUCTION ENGINEERING CALCULATION
SUMMARY SHEET

CALCULATION NO. FC-05916

Rev. 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 ECN 91-306
3. MWO 913676 Replace Fan with Substitute Replacement Item per ECN 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 ~~4~~ 5 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 DG-2 AIR FLOW TESTING

B

REV.1

CALCULATION PREPARATION, REVIEW AND APPROVAL
FORM PED-QP-3.3 FORM Page No. 5 of 5

PRODUCTION ENGINEERING CALCULATION
SUMMARY SHEET

CALCULATION NO. FC-5916

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.

B

REV.1

CALCULATION PREPARATION, REVIEW AND APPROVAL FORM PED-QP-3.4 Form Page No. 1 of 1

PRODUCTION ENGINEERING DIVISION CALCULATION SHEET

CALCULATION NO. FL-05916

Rev. No. A

	REF. NO.
CALCULATE THE NET ~~KW~~ AVAILABLE FOR EACH DIESEL GENERATOR	
CASE 1 FAN REPLACED, 50/50 ETHYLENE GLYCOL COOLANT 2000 hr RATING BASE HP	
3950 HP 2000 hr ENGINE RATING	①
- 120 HP RADIATOR FAN DRIVE	②
- 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	① p 8.2b-3
2708 KW	
X .97 GEN EFF	① p 8.2b-3
2627 KW ⇐	

CALCULATION PREPARATION, REVIEW AND APPROVAL FORM PED–QP–3.4 Form Page No. 1 of 1

PRODUCTION ENGINEERING DIVISION CALCULATION SHEET

CALCULATION NO. FL-05916

Rev. No. A

		REF. NO.
CASE 2	FAN REPLACED, TREATED WATER COOLANT	
	2000 hr RATING	
3950 HP	2000 HR RATING	① 8.26-3
− 120 HP	RADIATOR FAN DRIVE	②
− 20 HP	GENERATOR COOLING FAN	
3810 HP	AVAILABLE ENGINE HORSEPOWER	

CONVERT TO KW GENERATOR OUTPUT

		REF. NO.
3810		
x .746	BHP/KW	
2842		
x .97	GEN EFF	1 p 8.26-3
2757	KW ⇐	

CALCULATION PREPARATION, REVIEW AND APPROVAL FORM PED–QP–3.4 Form Page No. 1 of 1 PRODUCTION ENGINEERING DIVISION CALCULATION SHEET	CALCULATION NO. FC-05916 Rev. No. A

	REF. NO.
FROM FAN FLOW DATA, PREDICT FAN FLOWS AT ELEVATED TEMPERATURES	
JW-3-1 (DG-1) RADIATOR FAN	
116583.3 SCFM @ 53 °F	(2)
$K_d = \frac{460+53}{530} = .968$	
116583.3 × .968 = 112,852 SCFM @ 70°F	
JW-3-2 (DG-2) RADIATOR FAN	
TEST TEMP = ~~53 °F~~ 77 °F, FLOW = ~~105,451~~ 114,556 SCFM △B	(3)
TO PREDICT AIR FLOW AT HIGHER TEMPERATURES	
$K_d = \left(\frac{14.7}{P_{act}}\right) \cdot \left(\frac{460 + °F}{530}\right)$	
ASSUME THAT PRESSURE IS RELATIVELY CONSTANT	
$K_d = \frac{460 + °F}{530} = \frac{460 + 77}{530}$ (~~58~~) = 1.01 (~~.9773~~) △B	
SCFM (K_d) = $SCFM_{70}$	
114,556 (~~105,451~~) (1.01) (~~.9773~~) = 115,701 (~~103,063~~) @ 70°F △B	

CALCULATION PREPARATION, REVIEW AND APPROVAL
FORM PED–QP–3.4 Form Page No. 1 of 1

PRODUCTION ENGINEERING DIVISION
CALCULATION SHEET

CALCULATION NO. FC-05916

Rev. No. A

REF. NO.

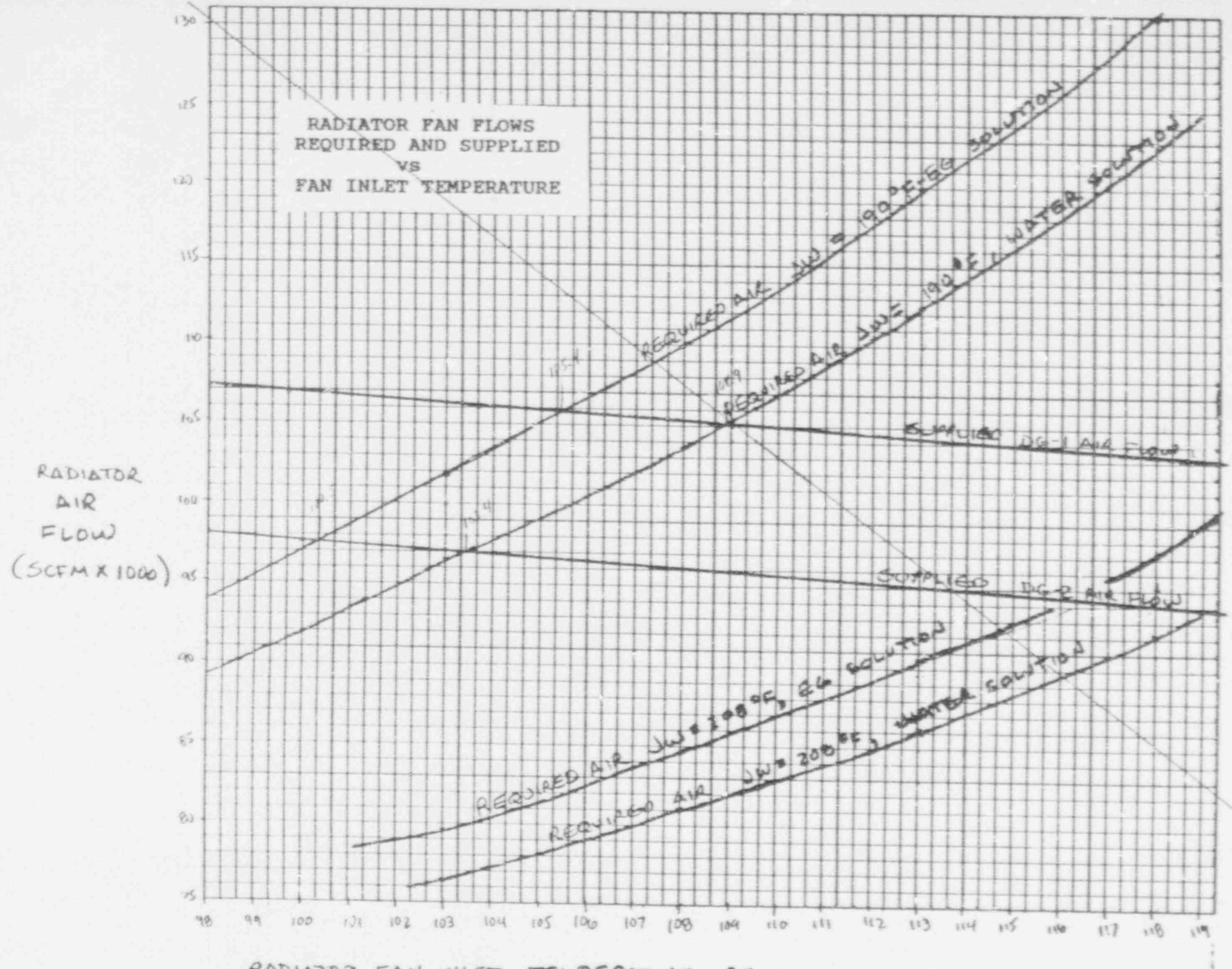
Temperature Corrected Air Flows

FCS Emergency Diesel Radiator Fans

Temp	Kd	SCFM DG-1	SCFM DG-2
90	1.038	108,721	~~99,315~~ 111,466
100	1.0566	106,807	~~97,542~~ 109 507
101	1.058	106,666	~~97,413~~ 109 358
102	1.060	106,464	~~97,229~~ 109152
103	1.062	106,264	~~97,046~~ 108,946
104	1.064	106,064	~~96,864~~ 108 742
105	1.066	105,865	~~96,682~~ 108 538
106	1.068	105,667	~~96,500~~ 108 334
107	1.070	105,469	~~96,320~~ 108132
108	1.072	105,272	~~96,140~~ 107931
109	1.074	105,077	~~95,961~~ 107 730
110	1.076	104,881	~~95,783~~ 107 529

(B)

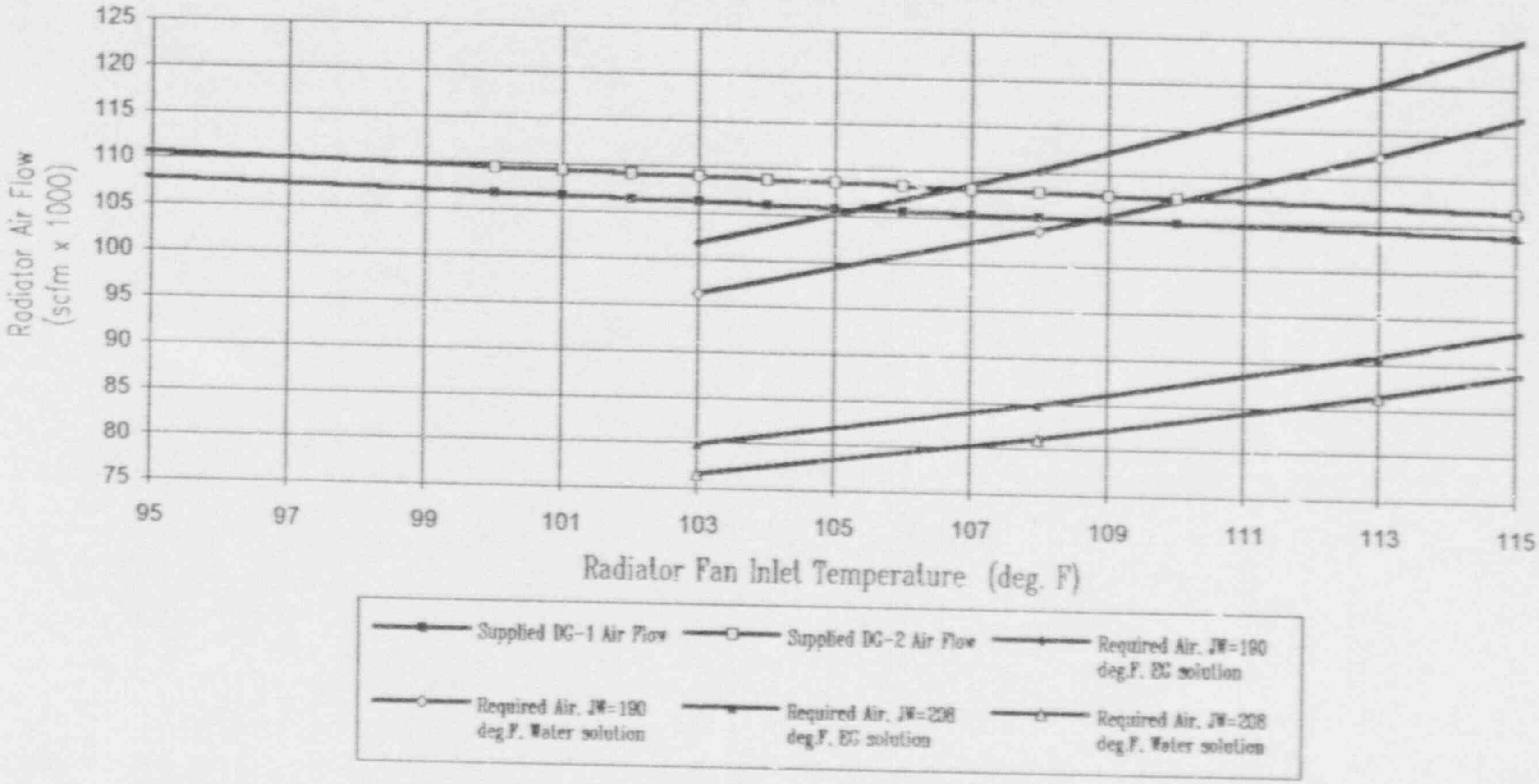
NEXT PLOT THE SUPPLIED FLOWS ABOVE AGAINST TEMPERATURE AND PLOT THE REQUIRED FLOWS FROM REFERENCES 5 AND SIX AGAINST TEMPERATURES ON THE SAME GRAPH



FC-05916 AA

12

RADIATOR FAN FLOWS
REQUIRED AND SUPPLIED
vs.
FAN INLET TEMPERATURE



CALCULATION PREPARATION, REVIEW AND APPROVAL FORM PED-QP-3.4 Form Page No. 1 of 1	CALCULATION NO.
PRODUCTION ENGINEERING DIVISION CALCULATION SHEET	FC-05916 Rev. No. A

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. B

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

CALCULATION PREPARATION, REVIEW AND APPROVAL FORM PED—QP—3.4 Form Page No. 1 of 1	CALCULATION NO.
PRODUCTION ENGINEERING DIVISION CALCULATION SHEET	FC-05916 Rev. No. A

REF. NO.

DG-1 Derated Power
110 DEG AMBIENT TEMP
~~110~~ 111 deg F Fan Inlet, Ethylene Glycol Coolant

△B

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

△B

CALCULATION PREPARATION, REVIEW AND APPROVAL
FORM PED--QP--3.4 Form Page No. 1 of 1

PRODUCTION ENGINEERING DIVISION
CALCULATION SHEET

CALCULATION NO. FC-05916

Rev. No. A

REF. NO.

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

Time min	Turbo inlet Temp F	JW temp F	KW init	Derate %	Derate KW
0	~~118~~ 116	125	2757	~~100~~ .995	~~2757~~ 2743
10	~~118~~ 116	174	2757	~~.99~~ .995	~~2729~~ 2743
20	~~120~~ 118	190	2757	~~.985~~ .987	~~2715~~ 272
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
110 deg F AMBIENT AIR
~~110~~ 111 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

B

CALCULATION PREPARATION, REVIEW AND APPROVAL
FORM PED–QP–3.4 Form Page No. 1 of 1

PRODUCTION ENGINEERING DIVISION
CALCULATION SHEET

CALCULATION NO. F6-05916

Rev. No. A

REF. NO.

DG-2 Derated Power

110 deg F AMBIENT AIR

~~110~~ 111 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~~ .985	~~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

106 °F AMBIENT AIR

~~99~~ 107 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	~~.960~~ .973	~~2522~~ 2556	
30	~~129~~ 126	190	2627	~~.957~~ .967	~~2514~~ 2540	
40	~~129~~ 126	190	2627	~~.957~~ .[illegible]	~~2514~~ ~~2514~~	2540
50	~~132~~ 129	190	2627	~~.947~~ .9[illegible]7	~~2488~~ ~~2508~~	2514
60	~~133~~ 130	190	2627	~~.945~~ .955	2482 ~~2514~~	2508
70	~~132~~ 129	190	2627	~~.947~~ .957	2488 ~~2508~~	2514
90	~~133~~ 130	190	2627	~~.945~~ .955	~~2482~~ 2508	
120	~~136~~ 133	190	2627	~~.940~~ .950	2469 2495	

(B)

CALCULATION PREPARATION, REVIEW AND APPROVAL
FORM PED–QP–3.4 Form Page No. 1 of 1

PRODUCTION ENGINEERING DIVISION
CALCULATION SHEET

CALCULATION NO. FC-05916

Rev. No. A

REF. NO.

DG-2 Derated Power

109 °F AMBIENT

~~103~~ 110 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~~ 2666
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~~ .955	~~2610~~ 2637
90	~~133~~ 132	190	2757	~~.945~~ .95	~~2605~~ 2619
120	~~136~~ 135	190	2757	~~.940~~ .943	~~2591~~ 2600

DG-2 Derated Power

110 °F AMBIENT AIR

~~110~~ 111 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

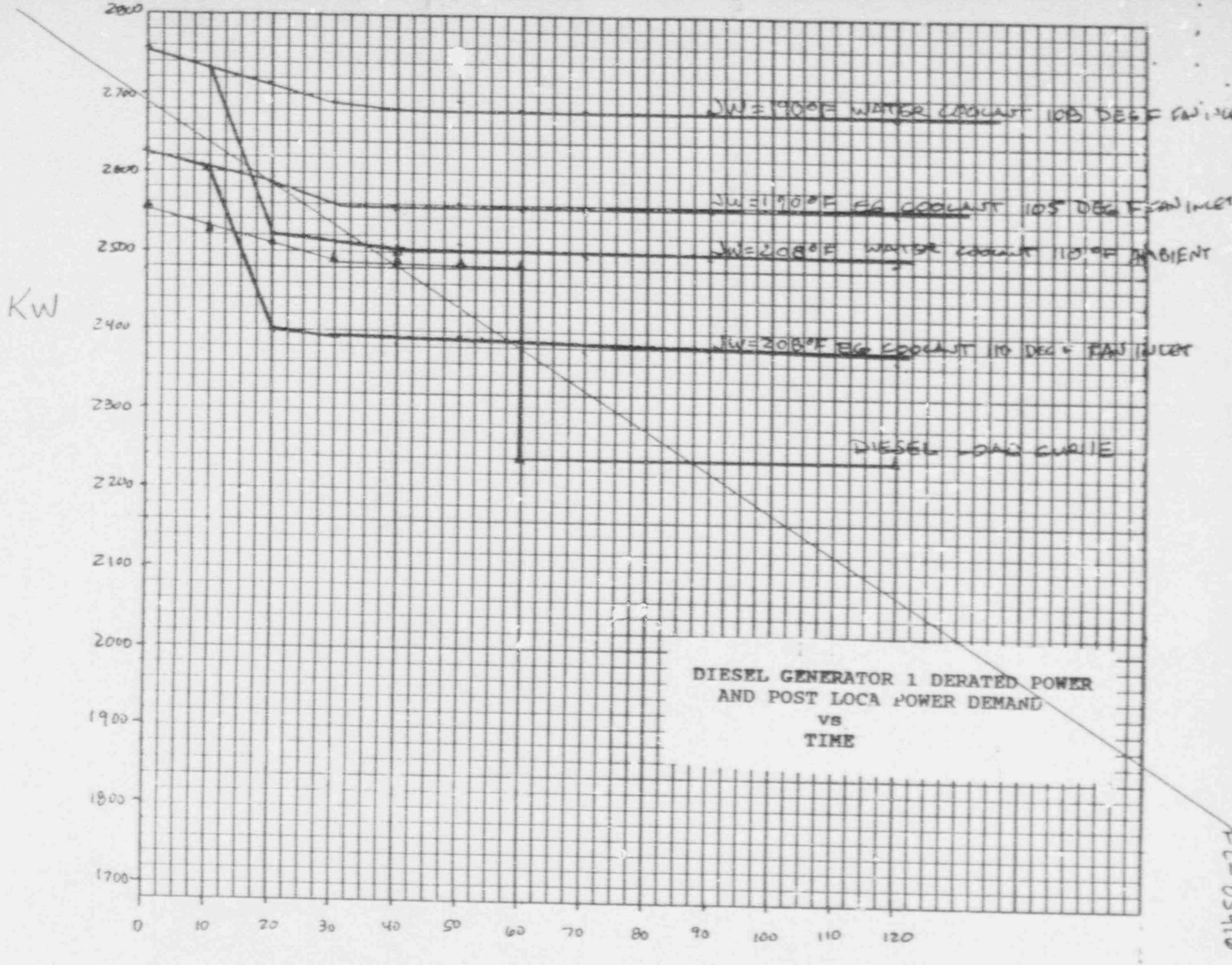
CALCULATION PREPARATION, REVIEW AND APPROVAL
FORM PED-QP-3.4 Form Page No. 1 of 1

PRODUCTION ENGINEERING DIVISION
CALCULATION SHEET

CALCULATION NO. FC-05916
Rev. No. B

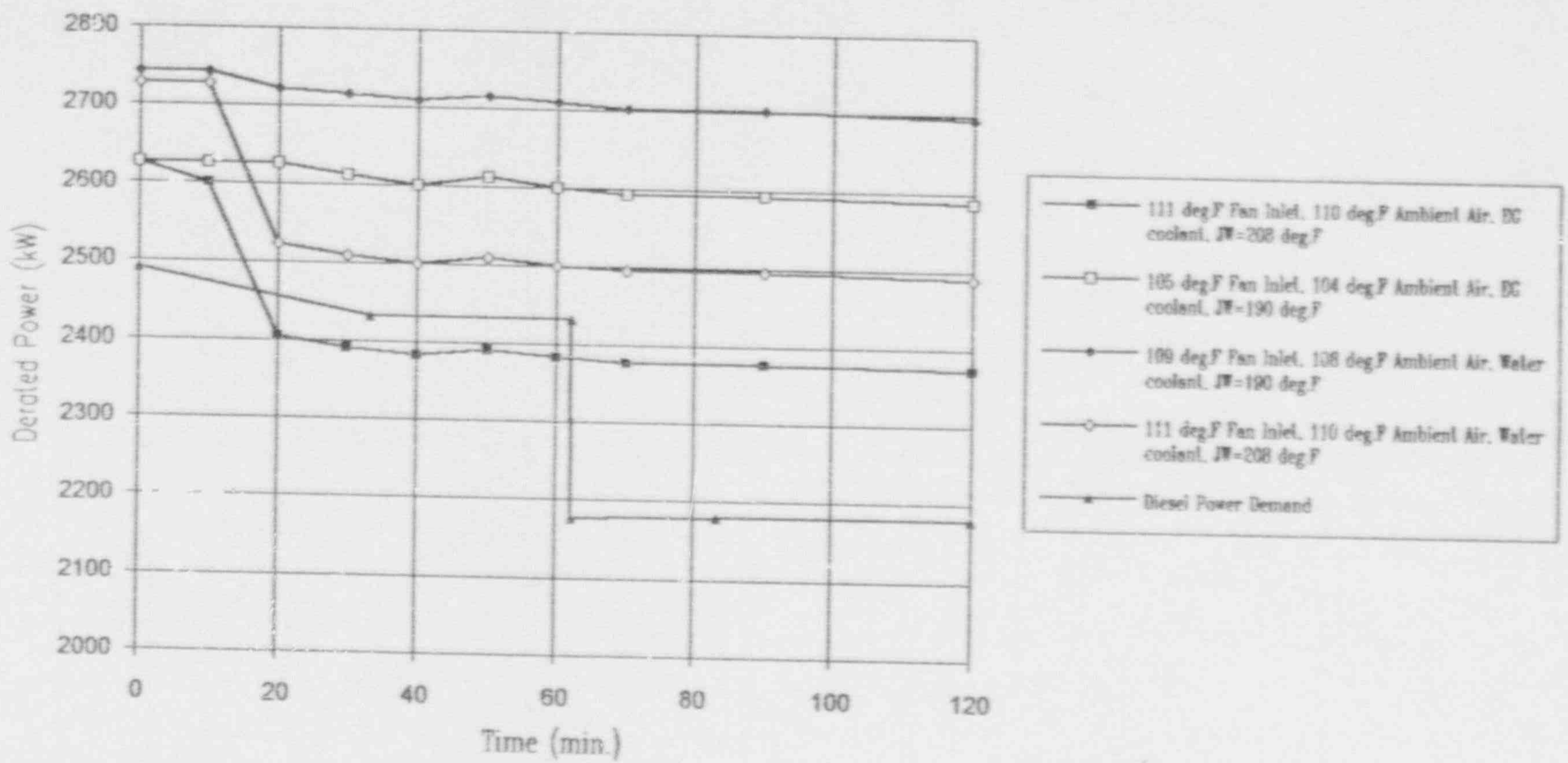
REF. NO.

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

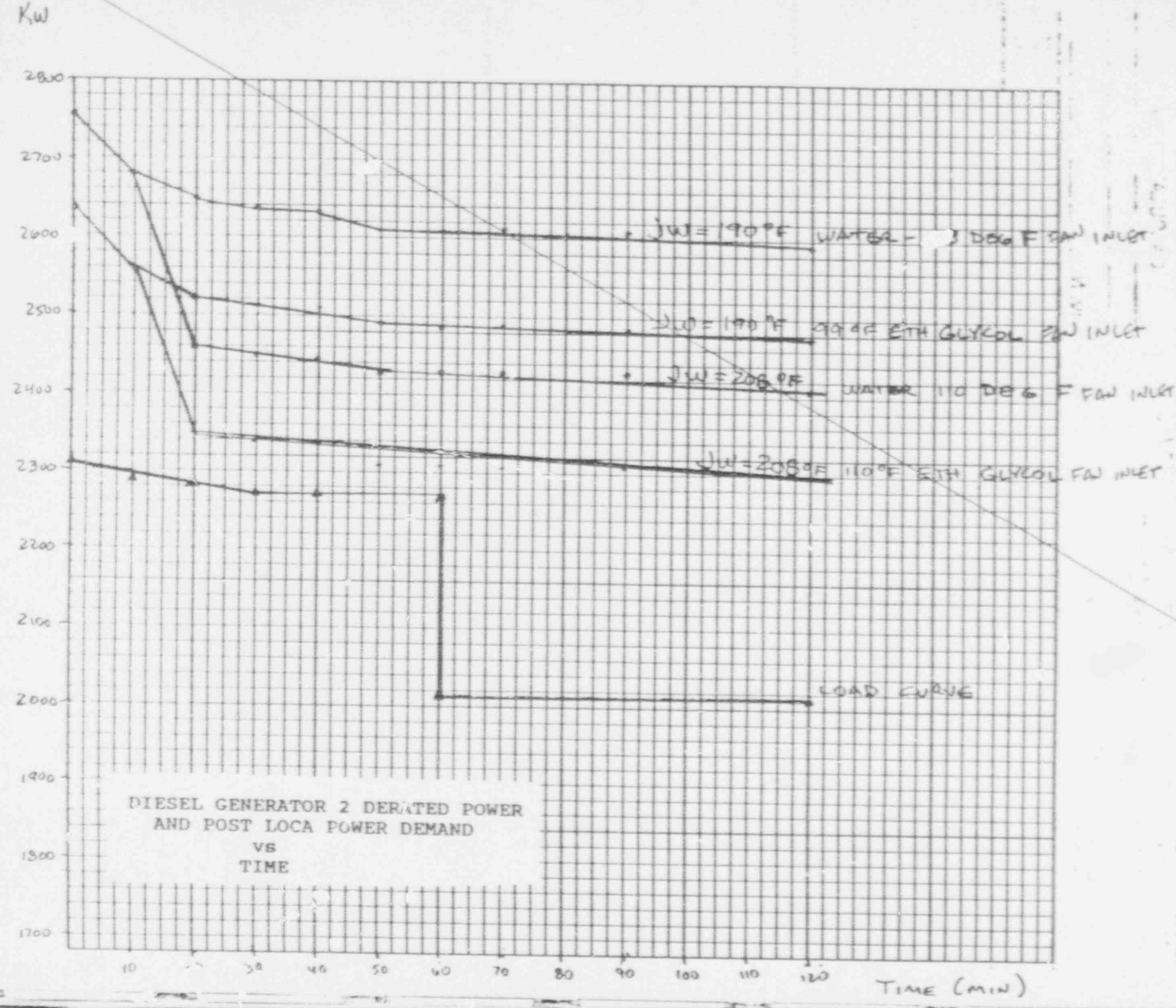


FC-05916 RA
19

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

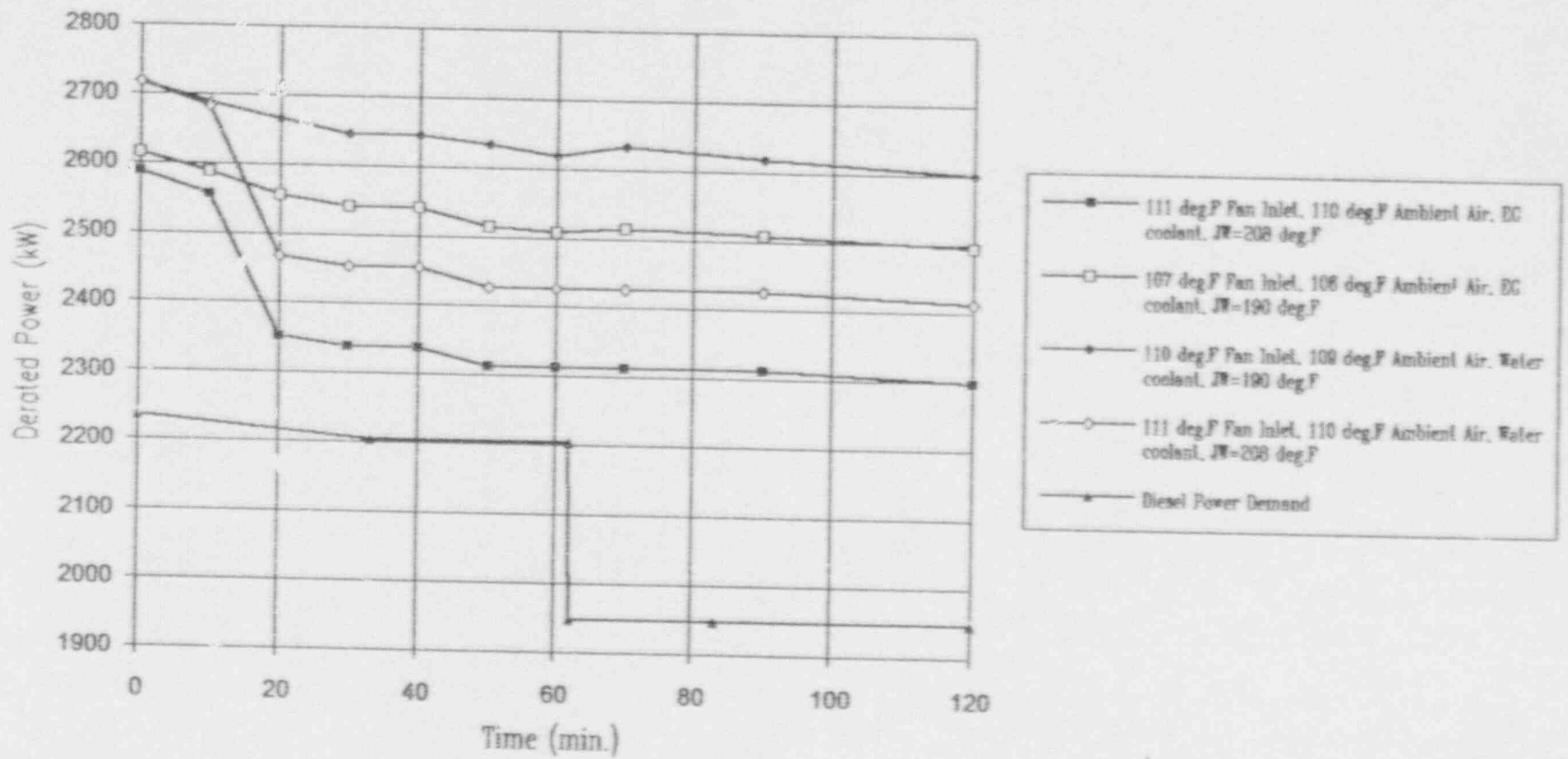


FC-05916 rA
20



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

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



FL-05916 r B
p 20

Calc Preparation, Review and Approval PED-QP-3.5 Page 1 of 2 Reviewer's Checklist-Calculations	CALCULATION NUMBER FC-05916 r A

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

B

Calc Preparation, Review and Approval PED-QP-3.5 Page 2 of 2 Reviewer's Checklist-Calculations	CALCULATION NUMBER
	FC-05916 rA

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

REVIEWER COMMENTS:

[signature] 4-20-92
Reviewer Date

CALCULATION NUMBER

FC05916 r 3 p 21

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

	CALCULATION NUMBER
	FC-5916 r B p22

		YES	NO	N/A
12.	Are all blocks on the Calculation Cover Shee addressed correctly?	✓		
13.	Have forms PED-QP-3.2, 3, 4 and 5 been used and correctly completed?	✓		
14.	If the calculation has been prepared to supersede another calculation, has all the valid information been transferred in the new calculation?			✓

REVIEWER COMMENTS:

[signature] 8/7/92
Reviewer Date

Calc Preparation, Review and Approval PED-QP-3.7 Page 1 of 1 Independent Reviewer's Checklist - Calculations	CALCULATION NUMBER FC-05916 r A

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

INDEPENDENT REVIEWER COMMENTS:

[signature] 12-20-92

Independent Reviewer Date

B

CALCULATION NUMBER
FC-05916 R.3

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

INDEPENDENT REVIEWER COMMENTS:

B. D. Bohlig 10/10/92

Independent Reviewer Date

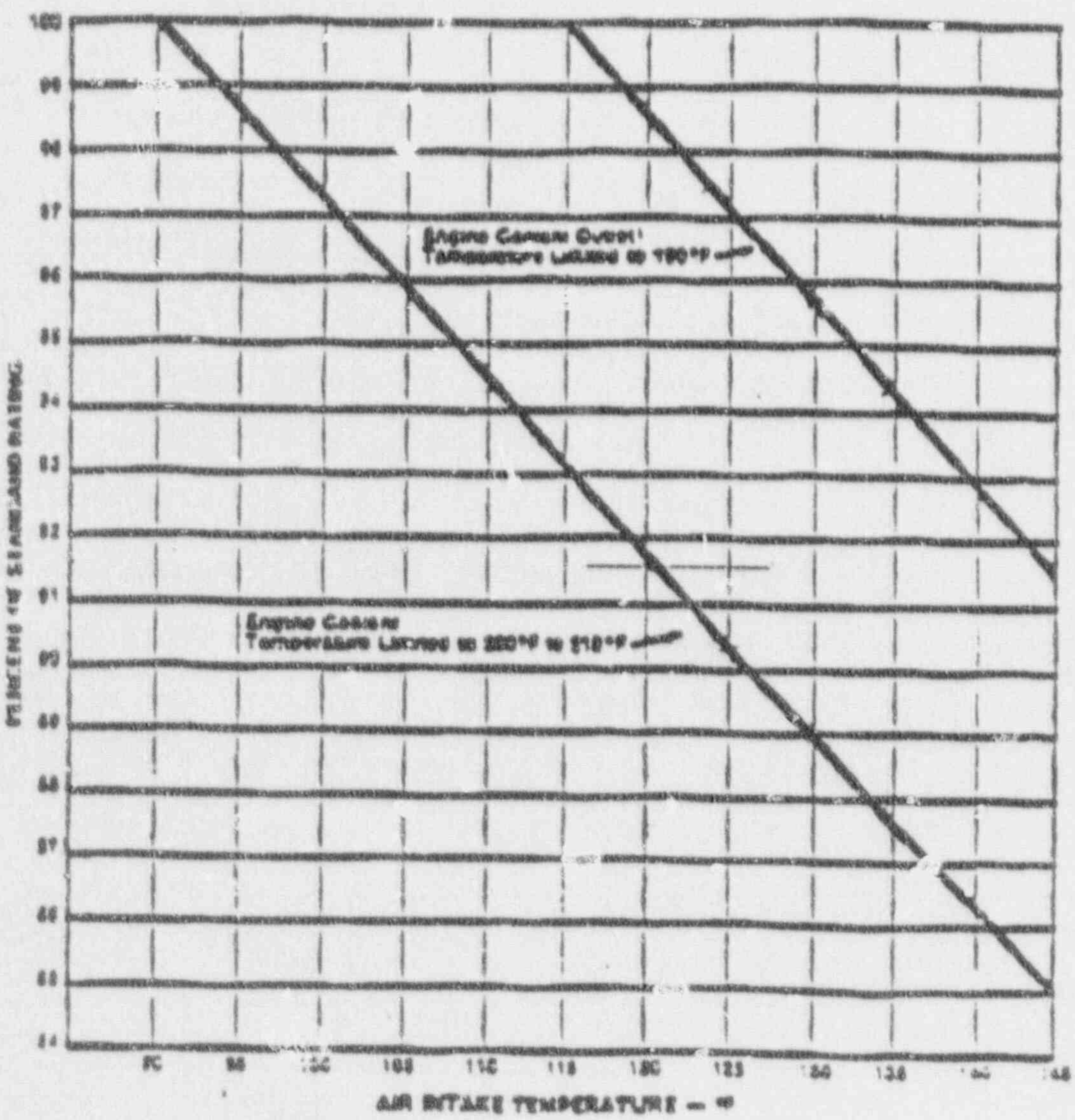
DIESEL GENERATOR DERATION CURVES

ENGINE TEMPERATURE SWITCH NOMINAL SETTINGS

Switch	Pickup	Dropout
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 @ Omaha is equivalent to an "S" UNIT



Rating at Elevated Temperature (°F)
For EMD 645E4

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

11 Vel.= 2269 Temp.= 132.7	21 Vel.= 2240 Temp.= 130.4	31 Vel.= [illegible] Temp.= [illegible]	41 Vel.= 2292 Temp.= 131.2	51 Vel.= 2211 Temp.= 130	61 Vel.= 2350 Temp.= 128	71 Vel.= 2289 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.= 2235 Temp.= 121.1	53 Vel.= 1408 Temp.= 123	63 Vel.= 2113 Temp.= 121.5	73 Vel.= 2150 Temp.= 109.3	83 Vel.= 2407 Temp.= 109.6	93 Vel.= 2180 Temp.= 108.6
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.= 1200 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.= 107.4	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 Velocicalc, MT-7;Digital Temp. MT-10111
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. = 57.5F), (E. = 58.8 F), (W. = 57.7 F), (S. = 58.2F)

FLO546 -A
25

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

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

Equipment used= TSI 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

FC-05916 r B 25

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

11 SCFM= 2521.11 Temp.= 132.7	21 SCFM= 2488.80 Temp.= 130.4	31 SCFM= 2254.44 Temp.= 132.3	41 SCFM= 2545.67 Temp.= 131.2	51 SCFM= 2456.67 Temp.= 130	61 SCFM= 2611.11 Temp.= 128	71 SCFM= 2543.33 Temp.= 117.3	81 SCFM= 2556.67 Temp.= 118.1	91 SCFM= 2677.78 Temp.= 126.3
12 SCFM= 2571.11 Temp.= 130.2	22 SCFM= 2567.78 Temp.= 126.7	32 SCFM= 2286.67 Temp.= 129.2	42 SCFM= 2316.67 Temp.= 128.2	52 SCFM= 2135.56 Temp.= 129	62 SCFM= 2465.56 Temp.= 123.4	72 SCFM= 2622.22 Temp.= 115.5	82 SCFM= 2797.78 Temp.= 111.9	92 SCFM= 2861.11 Temp.= 118.2
13 SCFM= 2851.11 Temp.= 120.8	23 SCFM= 2912.22 Temp.= 122.4	33 SCFM= 2675.56 Temp.= 126.6	43 SCFM= 2483.33 Temp.= 121.1	53 SCFM= 1564.44 Temp.= 123	63 SCFM= 2347.78 Temp.= 121.5	73 SCFM= 2388.89 Temp.= 109.3	83 SCFM= 2674.44 Temp.= 109.6	93 SCFM= 2422.22 Temp.= 108.6
14 SCFM= 2490 Temp.= 112.7	24 SCFM= 2722.22 Temp.= 115.9	34 SCFM= 2462.22 Temp.= 121	44 SCFM= 2326.67 Temp.= 112.6	54 SCFM= 1333.33 Temp.= 112.6	64 SCFM= 2153.56 Temp.= 111.4	74 SCFM= 2100 Temp.= 105.1	84 SCFM= 2133.33 Temp.= 102.6	94 SCFM= 2227.78 Temp.= 101.4
15 SCFM= 2200 Temp.= 107.4	25 SCFM= 2418.89 Temp.= 107.9	35 SCFM= 2144.44 Temp.= 111	45 SCFM= 1955.56 Temp.= 107.4	55 SCFM= 1088.89 Temp.= 109.2	65 SCFM= 1936.67 Temp.= 102.9	75 SCFM= 2033.33 Temp.= 100.6	85 SCFM= 2227.78 Temp.= 98.5	95 SCFM= 2133.33 Temp.= 98.4

Total Calculated Flow Rate= 105451.1 SCFM

Average Temperature in Duct = 116.94 Degreees F

FC-05A6 - A 26

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

Cell	SCFM=	Temp.=
11	2888.89	156
12	2900	156
13	31[illegible]1.11	146
14	2922.22	146
15	2644.44	143
21	2700	153
22	3011.11	150
23	3355.56	147
24	3116.67	144
25	2711.11	140
31	2622.22	154
32	2522.22	153
33	2766.67	153
34	2888.89	148
35	2311.11	142
41	2777.[illegible]8	1[illegible]5
42	2577.78	155
43	2766.67	154
44	2811.11	147
45	2333.33	144
51	2022.22	157
52	1038.89	157
53	1066.67	155
54	955.556	149
55	988.889	144
61	2911.11	155
62	2566.67	[illegible]7
63	2633.33	151
64	2433.33	146
65	2222.22	139
71	2611.11	153
72	2911.11	151
73	2666.67	147
74	2311.11	143
75	2177.78	141
81	2711.11	150
82	3077.78	147
83	3000	145
84	2677.78	141
85	2422.22	138
91	2977.78	150
92	2733.33	145
93	2866.67	141
94	2511.11	140
95	2322.22	139

Total Calculated Flow Rate= 114555.6 SCFM

Average Temperature in Duct = 148.16 Degreees F

FC-05916 r A

29

Standard Velocity /Temperature Measurement
12 Blade , Pitch @ 22

11 Vel.= 2440 Temp.= 122	21 Vel.= 2395 Temp.= 117	31 Vel.= 2275 Temp.= 120	41 Vel.= 2019 Temp.= 117	51 Vel.= 1950 Temp.= 119	61 Vel.= 2120 Temp.= 118	71 Vel.= 2610 Temp.= 123	81 Vel.= 2480 Temp.= 117	91 Vel.= 2109 Temp.= 114
12 Vel.= 2589 Temp.= 111	22 Vel.= 2700 Temp.= 110	32 Vel.= 2360 Temp.= 115	42 Vel.= 2340 Temp.= 114	52 Vel.= 2330 Temp.= 119	62 Vel.= 2450 Temp.= 115	72 Vel.= 2713 Temp.= 117	82 Vel.= 3030 Temp.= 102	92 Vel.= 2380 Temp.= 103
13 Vel.= 2520 Temp.= 96	23 Vel.= 2440 Temp.= 99	33 Vel.= 2280 Temp.= 112	43 Vel.= 2198 Temp.= 104	53 Vel.= 2080 Temp.= 110	63 Vel.= 2770 Temp.= 104	73 Vel.= 2500 Temp.= 105	83 Vel.= 2860 Temp.= 90	93 Vel.= 2470 Temp.= 94
14 Vel.= 2170 Temp.= 91	24 Vel.= 2458 Temp.= 95	34 Vel.= 2250 Temp.= 102	44 Vel.= 2360 Temp.= 93	54 Vel.= 1830 Temp.= 96	64 Vel.= 2830 Temp.= 95	74 Vel.= 2340 Temp.= 96	84 Vel.= 2690 Temp.= 86	94 Vel.= 2137 Temp.= 90
15 Vel.= 1605 Temp.= 87	25 Vel.= 2465 Temp.= 89	35 Vel.= 1940 Temp.= 91	45 Vel.= 2140 Temp.= 87	55 Vel.= 1780 Temp.= 90	65 Vel.= 3007 Temp.= 85	75 Vel.= 2000 Temp.= 90	85 Vel.= 2080 Temp.= 80	95 Vel.= 1635 Temp.= 82

Equipment used= TSI Model 8350 Velocicalc, MT-?????;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 Degreees F

NORMALIZED FAN FLOW = 112844

FC-05A6 rA

FC-05916 r A 24

Young RADIATOR COMPANY

2825 Four Mile Road, Racine, Wisconsin 53404
Telephone: 414-639-1010 • EasyLink: 627-63631
TWX: 910-271-2397 • Telex: 26-4435
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 3

HEAT LOAD : 120,970 Btu/m

COOLANT FLOW, TEMP. IN : 1100 GPM, 190°F

ALTITUDE : 1007 ft

RADIATOR FACE AREA : 105.1 ft² RAD TUBE LENGTH : 12.25 ft

°F TAIR IN	50% EG-WATER AIRFLOW REQ SCFM	IWG	fpm FACE VEL	iwg 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

TRANSMISSION FROM:

NAME TOM TILLER TITLE

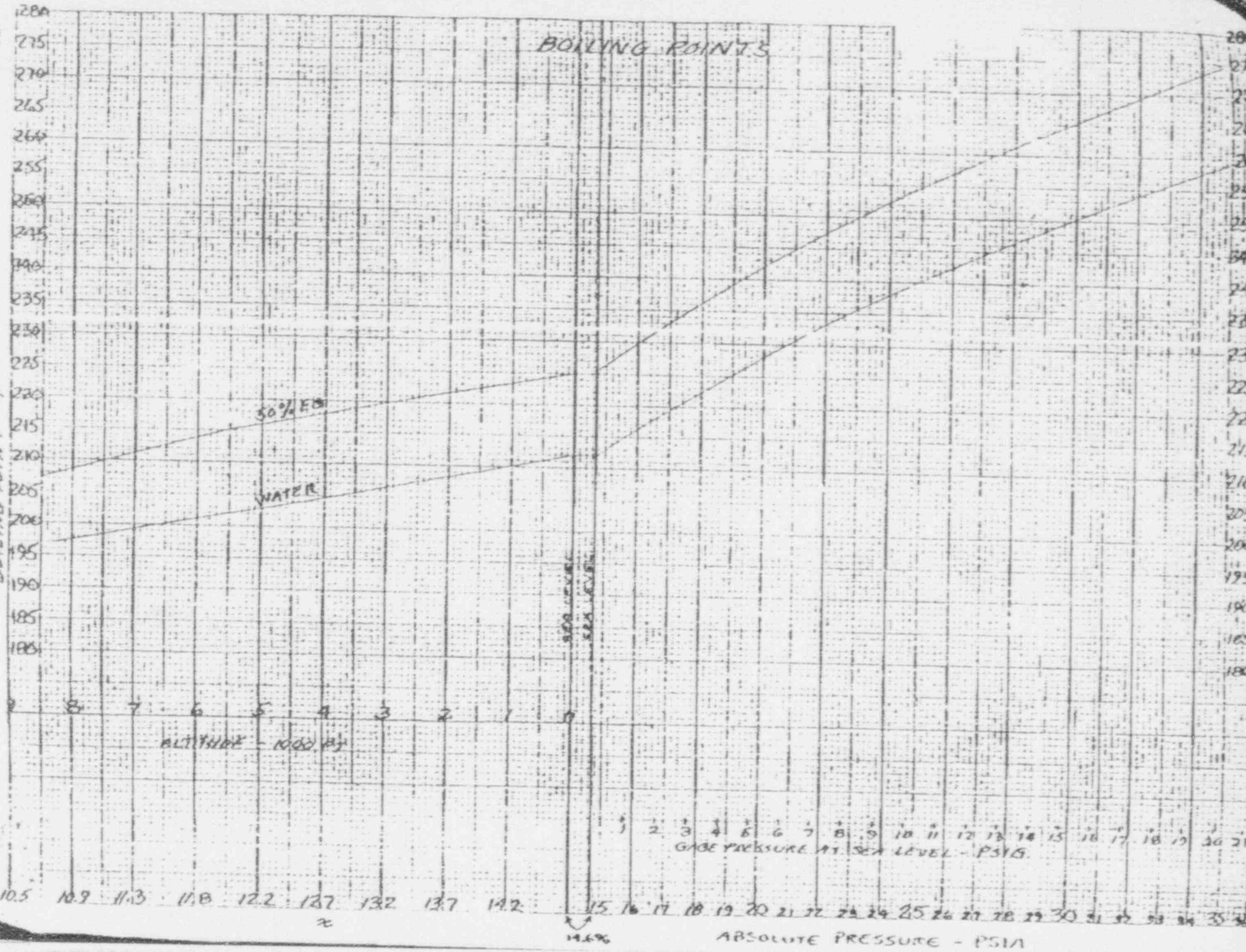
☑ RACINE, WI 414-639-1013 ☐ LEXINGTON, TN 901-968-3617 ☐ CENTERVILLE, IA 515-856-8634

FORM NO. 3813 REV. 6/89

DATE 4.8.91 TIME AM PM

P.1

APR 09 '91 03:17


BOILING POINTS
BOILING POINT °F
50% EG
WATER
SEA LEVEL
ALTITUDE - 1000 FT
GAGE PRESSURE AT SEA LEVEL - PSIG
ABSOLUTE PRESSURE - PSIA
14.696

ENVIRONMENTAL ELEMENTS CORPORATION
AIR MOVING EQUIPMENT—FANS

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
									6500	.781	
300	.989	29.58	1800	.933	27.93	3600	.872	26.08	6600	.778	23.26
400	.985	29.47	1900	.930	27.83	3800	.865	25.88	6800	.772	23.08
500	.981	29.36	2000	.926	27.72	4000	.858	25.68	7000	.766	22.90
600	.977	29.25	2100	.923	27.62	4200	.852	25.49	7200	.760	22.73
700	.974	29.14	2200	.919	27.51	4400	.346	25.30	7400	.754	22.56
800	.970	29.02	2300	.916	27.41	4600	.839	25.10	7600	.748	22.38
900	.966	28.91	2400	.912	27.30	4800	.833	24.91	7800	.743	22.21
1000	.962	28.80	2500	.909	27.20	5000	.826	24.72	8000	.737	22.04
1100	.959	28.69	2600	.905	27.09	5200	.820	24.53	8200	.731	21.87
						5300					
1200	.955	28.58	2700	.902	26.99	5400	.814	24.35	8400	.726	21.70
1300	.952	28.47	2800	.898	26.89	5600	.808	24.16	8600	.720	21.54
1400	.948	28.36	2900	.895	26.78	5800	.802	23.98	8800	.714	21.37

TEMPERATURE-RELATIVE DENSITY TABLE FOR DRY OR SATURATED AIR

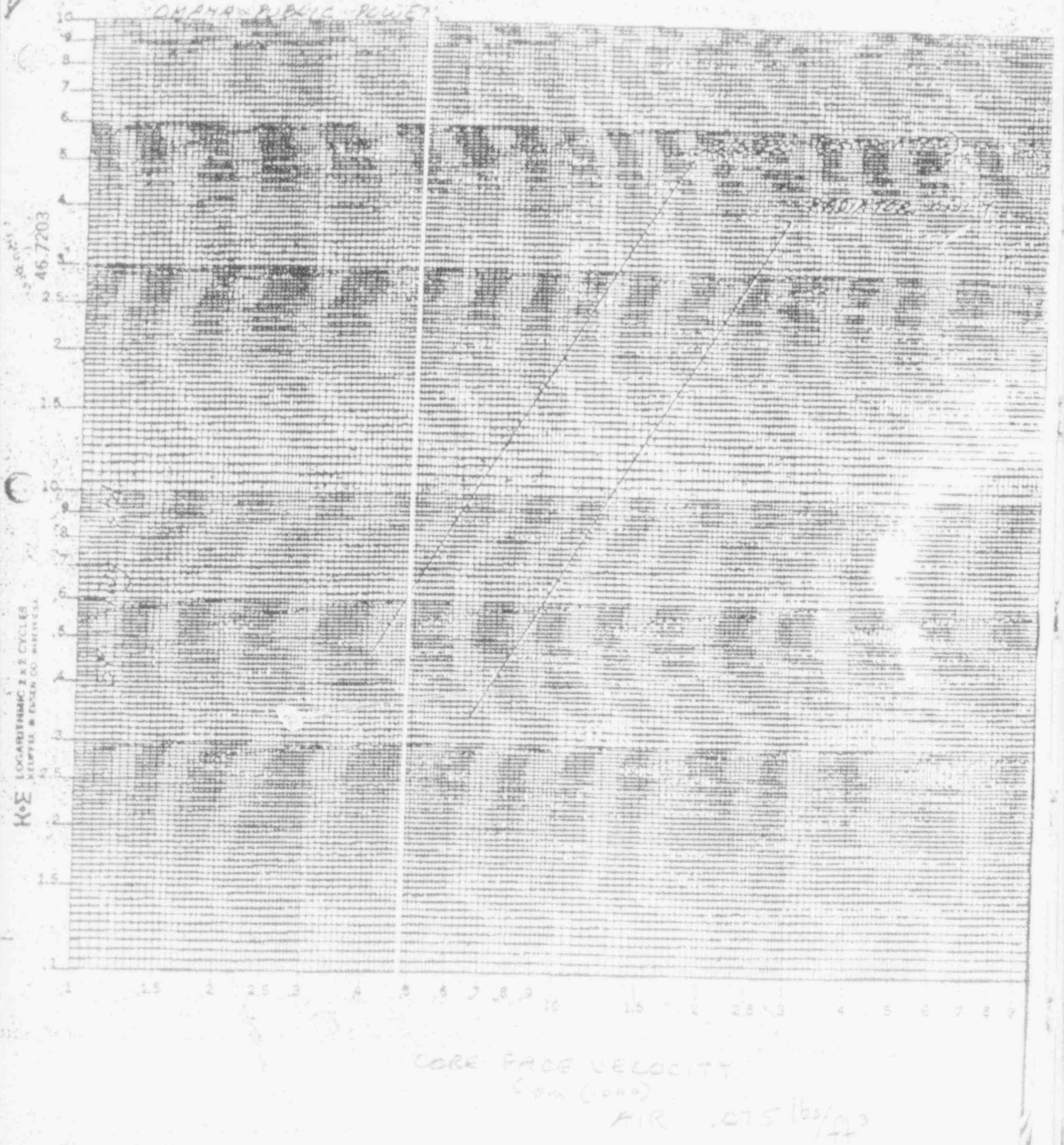
Temp. in deg. Fahr. Standard Air = 70°F. = 1.

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	[illegible]	72	.996	.985	130	.898	.846
25	1.093	[illegible]	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	.766
42	1.056	1.051	82	.978	.963	155	.862	.769
44	1.052	1.047	84	[illegible]	.959	160	.855	.751
46	1.047	1.042	86	[illegible]	.954	165	.848	.731
48	1.043	1.038	88	[illegible]	[illegible]	170	.841	.713
50	1.039	1.033	90	[illegible]	[illegible]	175	.835	.692
52	1.035	1.029	92	[illegible]	.941	180	.828	.671
54	1.031	1.025	94	[illegible]	.936	185	.822	.647
56	1.027	1.020	96	[illegible]	.932	190	.815	.622
58	1.023	1.016	98	.950	.927	195	.809	.597
60	1.019	1.012	100	.946	.922	200	.803	.569

1.015

*Radiator-Type Coolers **Cooling Towers

FC-05916 rA 32



FC-05916 rA 33

Young Radiator Company

2825 Four Mile Road, Racine, Wisconsin 53404
Telephone: 414-639-1010 • EasyLink: 627-69631
TWX: 910-271-2397 • Telex: 26-4435
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 ______ ZIP ______

NUMBER OF PAGES BEING TRANSMITTED, INCLUDING THIS COVER ______

HEAT LOAD: 120,970 Btu/m

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

ALTITUDE: 1007 ft

RADIATOR FACE AREA: 105.1 ft^2

RADIATOR TUBE LENGTH: 12.25 ft

°F T AIR IN	AIRFLOW REQ. SCFM	IWG SP	fpm FACE VEL.	EST. TOTAL SYST. RESISTANCE iwg SP std. air
103	79,727	.42	759	1.30
108	84,873	.47	807	1.42
* 113	90,658 –	.52	862	1.57
118	97,279	.59	926	.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 iwg ACTUAL ~~iwg~~ 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 resistance shown on the attached sheet yield the following operating point on the un-derated fan curve: (Approx.) 8° pitch, 100,000 SCFM, 1.3 iwg; 10° pitch, 105,000 SCFM, 2.00 iwg; 12° pitch, 113,000 SCFM, 2.20 iwg; 14° pitch 120,000 SCFM, 2.40 iwg.

TRANSMISSION FROM:

NAME TOM TILLER TITLE ______

☑ RACINE, WI 414-639-1013 ☐ LEXINGTON, TN 901-968-3617 ☐ CENTERVILLE, IA 515-856-8634

FORM NO. 3613 REV. 6/89

DATE 4/8/91 TIME ______

Memorandum

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 kVA x 0.87 pf = 2718 KW at 0.87 pf
DG-2 = 3125 kVA x 0.85 pf = 2656 KW at 0.85 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. Borcyk
PED Library

Young RADIATOR COMPANY

2825 Four Mile Road, Racine, Wisconsin 53404
Telephone: 414-639-1010 • EasyLink: 627-63631
TWX: 910-271-2397 • Telex: 26-4435
Telefax: 414-639-1013

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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/m

COOLANT, FLOW, TEMP IN: WATER, 1100 GPM, 202°F

ALTITUDE : 1007 ft

RADIATOR FACE AREA : 105.1 ft² RAD TUBE LENGTH: 11.25 ft

°F TAIR IN	-WATER- AIRFLOW REQ SCFM	IWG SP	fpm FACE VEL	ESTIMATED SYSTEM TOTAL RESISTANCE IWG STD 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 901-968-3617 ☐ CENTERVILLE, IA 515-856-8634

FORM NO. 3013 REV. 6/89

DATE 4/15/91 TIME AM/PM

P.1

APR 15 '91 09:58

FORT CALHOUN STATION
GENERAL FORM

PRC Reviewed
PRC Mtg. Minutes
JUL 02 1992

FC-154
R13

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

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

SECTION A

Page 1 of ~~12~~ 13

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

~~[X]~~ RRR 7-2-92 DGF 7-2-92 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.

[X] 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 7-2-92 DGF Time 0850

[signature] (Signature) Extension 6879

Reviewed by Richard R. Rowning (Print Name) Date 6-30-92 7-2-92 RRR Time 0949

[signature] (Signature) Extension 6887

C/FORMS

FORT CALHOUN STATION
GENERAL FORM

FC-154
R13

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

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

SECTION A

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 FC0591b 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 (from 9.1)

SECTION A

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

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

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

• Continue with 9.6

6-30-92
6-30-92

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

FORT CALHOUN STATION
GENERAL FORM

FC-154
R13

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

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

SECTION A

10 CFR 50.59 Applicability Screening

9.7 Does the activity involve tests or experiments?

[X] 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

/FORMS

FORT CALHOUN STATION
GENERAL FORM

FC-154
R13

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

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

SECTION A

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 lim ts 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

FORT CALHOUN STATION
GENERAL FORM

FC-154
R13

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

FORM E

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.

FORT CALHOUN STATION
GENERAL FORM

FC-154
R13

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

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

SECTION B

Unreviewed Safety Question Determination

10.1.1 Identify Plant Specific Design, Operating and Technical Documents

Document Title	ID Number	Revision
Operating Temp. Limits For DG-1 and DG-2	FC05916	A
Diesel Generator Upper Temp. Operating Limits	EA-FC-90-062	2

10.1.2 Identify Applicable NRC Documents/Industry Standards

Title	ID Number	Revision
EDG Max. Temp. Limits	92-095 (NRC)	N/A
SAIC Technical Eval.	TAC No.M77596	N/A

10.1.3 Identify Related Drawings

Title	ID Number	Revision
N/A		

10.2 List safety functions the affected structures or components perform: The emergency diesel generator provides a source of AC power in case offsite power is lost.

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.

FC/FORMS

FORT CALHOUN STATION
GENERAL FORM

FC-154
R13

NUCLEAR SAFETY EVALUATION

Reference NOD-QP-3

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

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

FC/FORMS

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

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

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

Reference NOD-QP-3

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

SECTION B

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.

FORT CALHOUN STATION
GENERAL FORM

FC-154
R13

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

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

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.

FORT CALHOUN STATION
GENERAL FORM

FC-154
R13

NUCLEAR SAFETY EVALUATION
Reference NOD-QP-3

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

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)

FORT CALHOUN STATION
GENERAL FORM

FC-154
R13

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.