ENCLOSURE 1

DESIGN CALCULATION

FOR

THE EMERGENCY DIESEL GENERATORS LOADING DC 1809

REVISION 2

JUNE 17, 1988

SAN ONOFRE NUCLEAR GENERATING STATION

UNIT 1

DC 1809
PAGE 1

Calculation Title Page

Project SAN ONOFRE UNIT 1 Job Order No. 6137 Discipline Electrical

Subject EMERGENCY DIESEL GENERATOR LOADING

Calculation No. DC-1809 QA Class Safety Related No. Pages 44

Responsible Engineer P Sano (SIGNATURE) Date 11-12-85

Independent Review Engineer Nader Haghighat (SIGNATURE) Date 11-18-85

ORIGINAL ISSUE

	NAME	DATE	SIGNATURE
Group Leader	G. ENGMANN	11/18/85	Gary R Engmann
Discipline Sup. Engineer	A. T. KANEKO	11/13/85	Gary R Engmann for ATK
Professional Engineer (if required)			

RECORD OF REVISIONS

NO.	REASON FOR REVISION	DATE	RESP. ENGR.	IRE	GL	DSE	PE
1	Use of BHP for SI & FW Pumps results in increase of 441 KW	3/5/86	PSano	N.H.	GLG	ATK	
2	REVISED TO ADD SUPPLEMENT "S1" TO DOCUMENT THE MAXIMUM POSSIBLE	6/17/88	as Noted	CDL	ATK	ATK	
	LOADING ON THE DIESEL GENERATORS. "S1" COMPLETELY REVISES THIS CALC.						

PROFESSIONAL ENGINEER'S SEAL

SCE 30-131 REV 10/86.

DESIGN INPUT SHEET

☒ Design Requirements
☐ Design Input Change

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DESIGN CALCULATION NO. DC 1809 - 0

SUBJECT: Emergency Diesel Generator Loading

PROJECT: SONGS 1

QUALITY CLASS: Safety Related

SEISMIC CLASS: A

SPECIFICATION REFERENCE: N/A

Design Input

The purpose of the calculation is to verify the maximum loading expected on Emergency Diesel Generators 1 and 2 at San Onofre Unit 1, to demonstrate that the limit of 4500 kW + 5% = 4725 kW is not exceeded, as committed to the NRC (Reference 1)

The existing Calculation results, shown in the Emergency Diesel Generator Specification (Reference 3), were updated by using the same load calculations assumptions as in the Auxiliary System Load Calculation DC-1857 Rev. 0 (Reference 2)

RESPONSIBLE ENGINEER	DATE	INDEPENDENT REVIEW ENGINEER	DATE	GROUP LEADER	DATE
P Sane	11-12-85	Nader Haghighat	11-18-85		11/18/85

SCE 20-08 REV 6/81

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: Emergency Diesel Generator Loading DESIGN CALCULATION NO. DC-1809 REVISION 1

J.O. NO. 6137 MADE BY P Sana DATE 11-12-85 (3-5-86) CHK. BY N. HASHTCHAT DATE 11-18-85

EMERGENCY DIESEL GENERATOR LOADING

SAN ONOFRE UNIT 1

Contents

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ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: Emergency Diesel Generator Loading DESIGN CALCULATION NO DC 1809 REVISION 0

J.O. NO. 6137 MADE BY P Sane DATE 11-12-85 CHK. BY N. HAGHIGHAT DATE 11-18-85

1.0 INTRODUCTION

The purpose of this calculation is to verify the maximum loading expected on Emergency Diesel Generators 1 and 2 at San Onofre Unit 1, to demonstrate that the limit of 4500 KW + 5% = 4725 KW is not exceeded, as committed to the NRC (Reference 1).

2.0 METHODOLOGY AND ASSUMPTIONS

The existing calculation results, shown in the Emergency Diesel Generator Specification (Reference 3), were updated by using the same load calculation assumptions as in the Auxiliary System Load calculation DC-1857 Rev. 0, (Reference 2).

Basically these calculations were based on either the values of the brake horsepower if they were available, or a standard 75% ratio between brake horsepower and nominal horsepower for the smaller motors (100-hp and below).

As assumed in the existing calculations results of Reference 3, the maximum loading of the Emergency Diesel Generator occurs following SISLOP. The schedule

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J.O. NO. 6137 MADE BY P Sarva DATE 11-12-85 CHK. BY N. HAGHIGHAT DATE 11-16-85

of the loads is about the same as the existing Tabulations, with the following exceptions:

a. The Vital Buses loads are not included in this new calculation. The Vital Buses are normally served from the 125-V DC Battery Chargers through the 125-V DC Buses. During SISLOP the 125-V DC Buses is served by the 125-V DC Batteries. When AC power is restored by the Emergency diesel Generators, the Battery chargers are back in service to recharge the Batteries and serve the 125-V DC load. Therefore the 125 KW loads shown for Battery Chargers A and B, includes the Vital Buses loads.

b. At time T = 10+ sec., the load due to the actuation of Injection Valves 850 A, 850 B, and 850 C was added to emergency diesel generators 1 and 2 loads.

c. At time T=10+sec., the load due to the actuation of MOV 1202, 1204, and 22 was added to the load of emergency diesel generator 2.

The update of the calculations was based on a review of References 2 through 8.

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CALCULATION SHEET

SUBJECT: Emergency Diesel Generator Loading DESIGN CALCULATION NO. DC 1809 REVISION 1

J.O. NO. 6137 MADE BY P Sana DATE 11-12-85 CHK. BY N. HASHIGHAT DATE 11-19-85

3.0 CONCLUSIONS

The maximum Loadings of the Diesel Generators occur between 20 seconds and 30 minutes of the SISLOP sequence with the following values:

Rev 1

Emergency Diesel Generator	Maximum Load (kW)
No.1	4,535.5
No.2	4,623.3

It can be seen that these maxima are well within the limit 4500 kW + 5% = 4725 kW

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ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: Emergency Diesel Generator Loading DESIGN CALCULATION NO. DC-1809 REVISION 0

J.O. NO. 6137 MADE BY P Saxe DATE 11-12-85 CHK. BY M. HAGHIGHAT DATE 11-18-85

4.0 REFERENCES

1. Letter to J. T. Reilly from J. L. Reeder, dated Aug. 23, 1985
2. Design Calculation DC-1857, Rev 0 - Auxiliary System Load Calculation (4.16 kV and 480-V AC) San Onofre Unit 1, Dated October 1, 1985.
3. San Onofre Unit 1 - Emergency Diesel Generator Specification E73001 (Table 4-III)
4. Load Sequencer Schedule Drawings:
   5149178-7, 5149179-9
   5149181-8, 5149182-7
5. Emergency Operating Condition 4 kV and 480-V Loads. LOP - SIS - SISLOP Train No. 1 Drawing 5149957-5
   5149958-4
6. One Line Diagrams:

5146828-20	Main One Line
5102162-12	4.16 kV Buses 1A & 1C
5102163-11	4.16 kV Buses 1B & 2C
5148062-3	480-V Switchgear 1
5148363-3	480-V Switchgears 2 & 3
5102165-31	MCC 1 (Front)
5102166-26	MCC 1 (Rear)
5112200-6	MCC 1A
5149306-11	MCC 1B
5102167-23	MCC 2
5102169-32	MCC 2A
5149307-10	MCC 2B
5102170-27	MCC 3 (Front)
5102171-21	MCC 3 (Rear)

7. San Onofre Unit 1 - System Description Volumes I and II
8. San Onofre Unit 1 - FSAR

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ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: Emergency Diesel Generator Loading DESIGN CALCULATION NO. DC-1809 REVISION 1

J.O. NO. 6137 MADE BY P Save DATE 11-12-85 CHK. BY N. HAGHIGHAT DATE 11-18-85

5.0 CALCULATIONS

Using the methodology and the assumptions of Section 2, the calculations were performed as shown by Tables 5.1 (A), (B), and (C) pages 9, 10, and 11. Each load was listed with its rated voltage (kV), its rated (HP), and its actual power (kW) based on the methodology and assumptions of Section 2, in particular Table 10 in page 90 in the auxiliary system load Calculation (DC-1857 Rev.0), (Reference 2), which lists the actual kW and kVAR load of typical 480-V motors ranging from 1/3 HP to 100 HP.

Rev. 1

For Load Group 2, the kW loads for the Safety Injection Pumps and the Feedwater Pumps are based on the actual brake horsepower requirement during SISLOP obtained from the SONGS 1 FSA, as shown by Table 5.2 (Copy of FSA Table 4.2), and the performance curves for the Feedwater pump and the Safety injection pump, respectively Figure 5.1 (Copy of FSA Figure 4.2), and Figure 5.2 (Copy of FSA Figure 4.7).

Using the proportionality of the kW with the hp:

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SUBJECT: Emergency Diesel Generator Loading DESIGN CALCULATION NO. DC-1809 REVISION 1

J.O. NO. 6137 MADE BY PSarva DATE 3.5.86 CHK. BY _____ DATE _____

Rev. 1

	Feedwater Pump		Safety Injection Pump	
	Nameplate	During SISLOP	Nameplate	During SISLOP
Horsepower	3,500	4,100	700	725
KW	2,449	2,869	598	619
Δ (KW)	420		21	
Total Δ (KW)	441			

The total KW loads shown for group 2 and group 3 shown in Table 5.1 (B) and) respectively are increased by 441 KW :

Load Group	Calc Rev	DG KW Loading	
		DG 1	DG 2
2	0	3,521.7	3,522.8
	1	3,962.7	3,963.8
3	0	4,094.5	4,182.3
	1	4,535.5	4,623.3

DWG. NO.

TABLE 5.1 (A)

SAN ONOFRE UNIT 1

EMERGENCY DIESEL GENERATOR LOADING SCHEDULE FOR EMERGENCY CORE COOLING SYSTEM (SISLOP)

LOAD GROUP	TIME AFTER SIS	LOAD NAME	KV	HP	KW	DIESEL GENERATOR LOADING (KW) NO.1	NO.2
1	10 sec.						
		Communication Power Dist. Panel	.44		5.1	5.1	5.1
		Battery Charger A, B	"		125	125	125
		D.G. Auxiliary Loads:					
		Standby Lube Oil Pump	.46	100	66	66	66
		Instrument Air Compresser	"	2	1.4	1.4	1.4
		Jacket Water Rad. Fan A	"	30	18.8	18.8	18.8
		" " " " B	"	30	18.8	18.8	18.8
		" " " " C	"	30	18.8	18.8	18.8
		" " " " D	"	30	18.8	18.8	18.8
		Diesel Fuel Transfer Pump	"	2	1.4	1.4	1.4
		Emergency Fan A	"	25	16.5	16.5	16.5
		" " B	"	25	16.5	16.5	16.5
		" " C	"	25	16.5	16.5	16.5
		" " D	"	30	18.8	18.8	18.8
		Battery Charger C, D	"		48	48	48
		Lighting Transformer	"		16.9	16.9	16.9
		Starting Air Compressor 1	"	40	28	28	28
		" " " 2	"	40	28	28	28
	10 Sec.	GROUP 1 TOTAL				4633	4633

SUBJECT: Emergency Diesel Generator Loading
J.O. NO. 6137 MADE BY P Saue DATE 11-12-85 CHK. BY N. HAGHIGHAT DATE 11-14-85
DESIGN CALCULATION NO. DC1809 REVISION 0
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TABLE 5.1 (B)

SAN ONOFRE UNIT 1

EMERGENCY DIESEL GENERATOR LOADING SCHEDULE
FOR EMERGENCY CORE COOLING SYSTEM (SISLOP)

LOAD GROUP	TIME AFTER SIS	LOAD NAME	KV	HP	KW	DIESEL GENERATOR LOADING (KW) NO.1	NO.2
2	10+Sec	Safety Injection Pumps	4.16	725	598	* 619	619
		Feedwater Pumps	"	4,100	2869	* 2,869	2,869
		Feedwater Pump Lube Oil Pump	0.44	1/4	.2	.2	.2
		Emergency Siren	0.46	10	6.5	6.5	6.5
		MOV LCV 1100 B	0.44	2/3	0.6	0.6	
		MOV LCV 1100 C	"	2/3	0.6		0.6
		MOV LCV 1100 D	"	2/3	0.6		0.6
		MOV 883	"	2/3	0.6		0.6
		MOV 850B	"	1.6	1.3	1.8	
		MOV 850A	"	1.6	1.3		1.3
		MOV 850C	"	1.6	1.3		1.3
		MOV 20	"	2	1.4	1.4	
		MOV 22	"	2	1.4	1.4	
		MOV 21	"	2	1.4		1.4
Rev.1		GROUP 2 TOTAL				3,492.4	3,500.5
	10+Sec	TOTAL LOAD (GROUPS 1&2)				3,962.7	3,962.8

Rev.1
* Note : Brake horsepower values

SUBJECT: Emergency Diesel Generator Loading
J.O. NO 6137 MADE BY P Saxe DATE 11-12-85 DESIGN CALCULATION NO DC1809 REVISION 1
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TABLE 5.1 (C)

SAN ONOFRE UNIT 1

EMERGENCY DIESEL GENERATOR LOADING SCHEDULE FOR EMERGENCY CORE COOLING SYSTEM (SISLOP)

LOAD GROUP	TIME AFTER SIS	LOAD NAME	KV	HP	KW	DIESEL GENERATOR LOADING (KW) NO.1	NO.2
3	20 sec.	Charging Pumps	4.16	600	405	405	405
		Component Cooling Pump N	0.44	125	86.7	86.7	
		" " " S	"	125	86.7		86.7
		" " " Center	"	125	86.7		86.7
		Saltwater Cooling Pumps	0.48	100	78	78	78
		MOV 720 A and B	0.44	.3	0.3	0.3	0.3
		Feedwater Pump Lube Oil Cooler Fan 1	0.44	2	1.4	1.4	1.4
		" " " " " " 2	0.44	2	1.4	1.4	1.4
		GROUP 3 TOTAL				572.8	659.5
Rev.1 →	20 sec To 30 min.	TOTAL LOAD (GROUPS 1, 2, &3)				4,535.5	4,623.3
	30 min.	End Safety Injection and Begin Long Term Cooling:					
		1. Shutdown:					
		Safety Injection Pumps	4.16	700	598	-619	-619
		Feedwater Pumps	4.16	3500	2449	-2,869	-2,869
		Total Shutdown Load				-3,488	-3,488
4		2. Long Term Cooling					
		Recirculation Pump	0.44	108	78	78	78
		Boric Acid Batch Tank Heater	0.44		120	120	120
		Boric Acid Transfer Pump	0.44	10	6.5	6.5	6.5
		MOV 866 A&B	0.44	1/8	0.1	0.1	0.1
		Total Long Term Cooling				+204.6	+204.6
	30 min To 48 HR.	TOTAL NET LOAD (30 Min. To 48 HRS.)				1,252.1	1,339.9

SUBJECT: Emergency Diesel Generator Loading — SHEET 12 OF 15 SHEETS

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CHK. BY N. HAGHIGHAT — DATE 11-18-85

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SEE CO 3078 REV 10/78 (CS)

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CALCULATION SHEET

SUBJECT: Emergency Diesel Generator Loading DESIGN CALCULATION NO. DC-1809 REVISION 1

J.O. NO. 6135 MADE BY P Sowa DATE 3-5-85 CHK. BY _____ DATE _____

TABLE 5.2

Table 4.2 Safety Injection System - Mechanical and Electrical System Parameters

A. GENERAL SYSTEM PARAMETERS	
Injection Water (refueling water) Temperature	40 F - 90 F
Injection Water Boric Acid Concentration	22,200 - 16,750 ppm Boric Acid
B. COMPONENTS - MECHANICAL FEATURES	
1. FEEDWATER PUMPS	
Number of Units	2
Design Flow Rate (feedwater service)	7,000 gpm
Design Head	1,825 ft
Shutoff Head	2,360 ft
Maximum Flow Conditions (safety injection service)	
Flow Required	10,500 gpm
Head	975 ft
NPSH (net positive suction head)	180 ft
Temperature of Pumped Fluid:	
Feedwater	351 F
Safety Injection Water	40 F - 90 F
Basic Material	Chrome alloy steel
(See pump performance curve, Figure 4.6)	
2. SAFETY INJECTION PUMPS	
Number of Units	2
Design Flow Rate	10,500 gpm
Design Head	245 ft
Design Pressure	150 psig
Design Temperature	250 F
Pumped Fluid	Boric acid solution
Temperature or Pumped Fluid	40 F - 90 F
Basic Material	Stainless Steel
(See pump performance curves, Figure 4.7)	
3. RECIRCULATION PUMPS	
Number of Units	2
Design Flow Rate	800 gpm
Design Head	160 ft
Design Pressure	150 psig
Design Temperature	300 F
Pumped Fluid	Boric acid solution
Temperature of Pumped Fluid	40 F - 271 F

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: Emergency Diesel Generators Loading DESIGN CALCULATION NO. DC-1809 REVISION 1

J.O. NO. 6137 MADE BY PSave DATE 3-5-85 CHK. BY _____ DATE _____

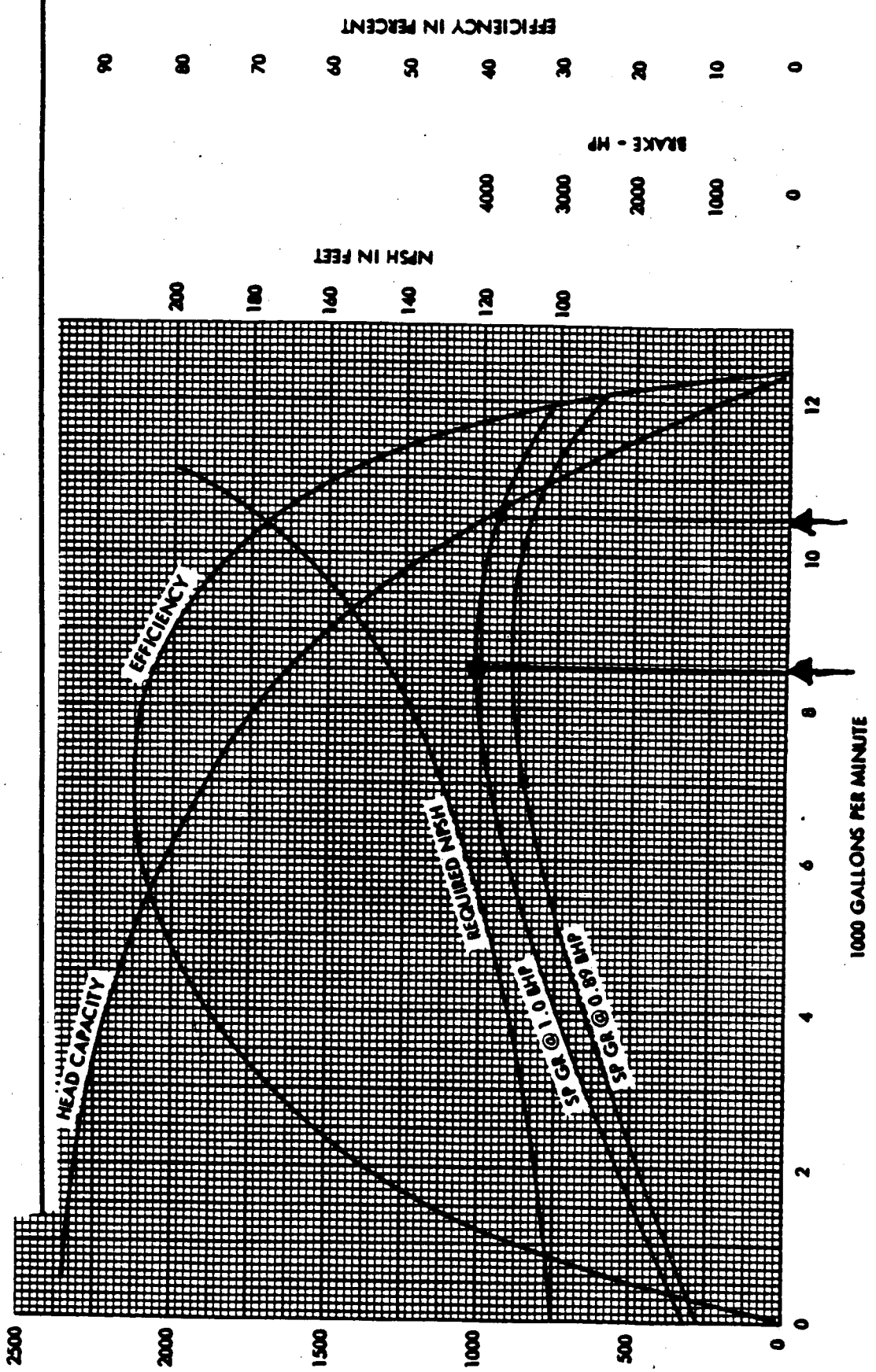

FIGURE 4.6 (FSA)
FEEDWATER PUMP PERFORMANCE CURVES

4-37

FIGURE 5.1

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CALCULATION SHEET

SUBJECT: Emergency Diesel Generator Loading DESIGN CALCULATION NO. DC-1809 REVISION 1

J.O. NO. 6137 MADE BY PSane DATE 3-5-85 CHK. BY _____ DATE _____

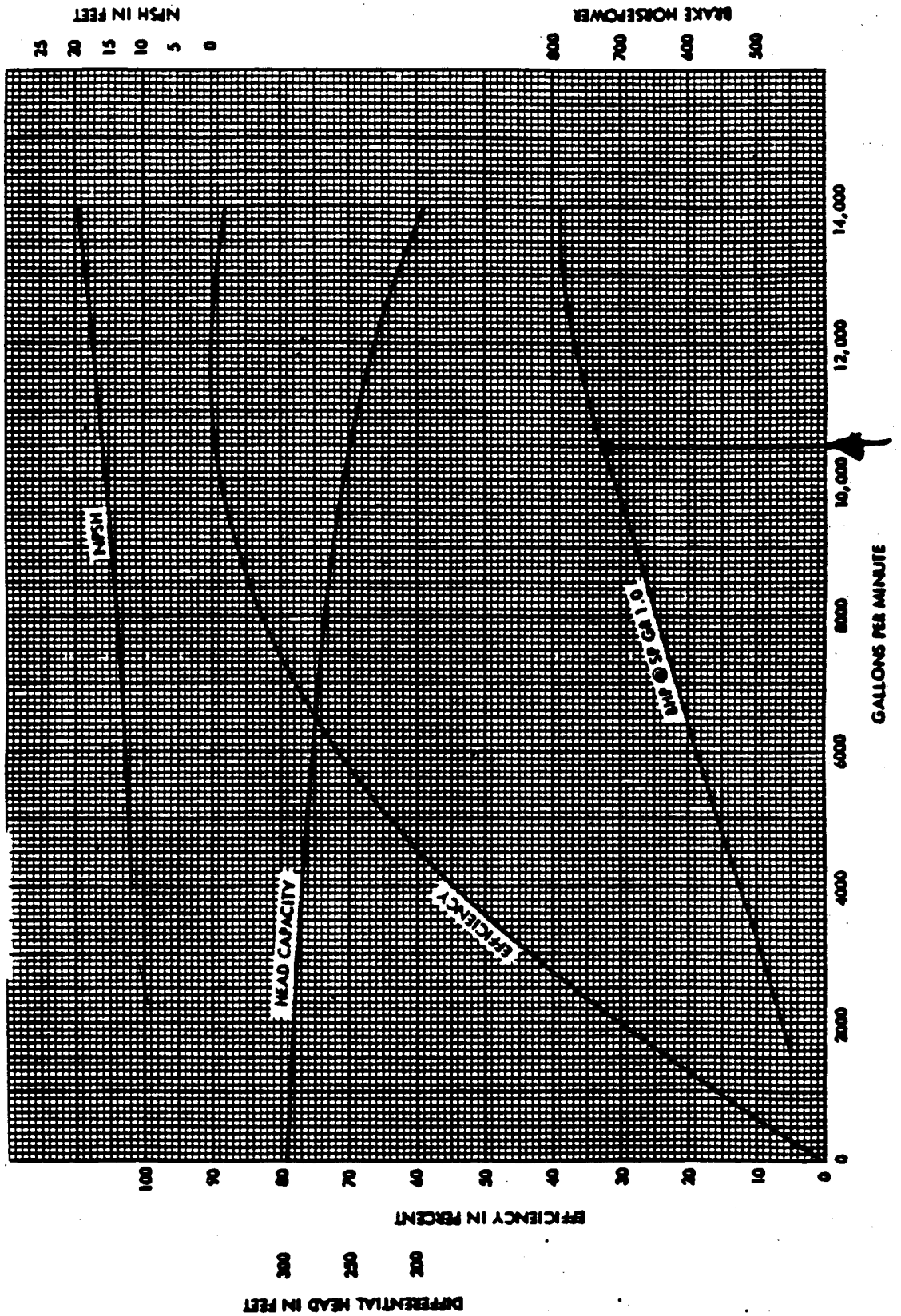

FIGURE 4.7 (FSAR)
SAFETY INJECTION PUMP PERFORMANCE CURVES

4-40

FIGURE 5.2

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDM DATE 6/17/88

EMERGENCY DIESEL GENERATOR LOADING

SONGS 1

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ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDM DATE 6/17/88

1.0 PURPOSE

The purpose of this calculation is to determine the maximum continuous load on the Emergency Diesel Generators 1 & 2 upon initiation of the Safety Injection System coincident with a Loss of Offsite Power (SISLOP) signal for the mitigation of a Loss of Coolant (LOCA) or a secondary side Main Steam Line Break (MSLB) condition.

Revision 2 of this calculation, in the form of supplement S1 which completely revises the existing calculation, is prepared to document the possible maximum loading that could be imposed on the diesel generator following SISLOP, based on present system requirements (i.e., loads that operate on automatic or administrative controls), with the results evaluated against the SONGS 1 Technical Specifications diesel generator load limit of 4725 KW (4500 +5%).

DWG. NO.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EM DATE 6/17/88

2.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the calculations indicate that the maximum continuous loading on either diesel generator occurs between 25 minutes and 30 minutes following SISLOP initiation, with 5152 KW load on Diesel Generator No. 1 and 5016 KW on Diesel Generator No. 2, as shown by Table 6.1.G. These maxima exceed the SONGS 1 Technical Specifications load limit of 4725 KW (4500 +5%).

It is therefore recommended to (a) raise the Technical Specifications load limit and/or (b) re-evaluate load requirements for possible reduction of the generator loading to within the Technical Specifications load limit KW thru administrative controls and/or physical modifications.

DWG. NO.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. ____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY [illegible] DATE 6/17/88

3.0 METHODOLOGY AND ASSUMPTIONS

The continuous load KW calculations were performed as described in the following sub-sections.

3.1 Safety Load Determination

The list of safety Loads required following SISLOP were obtained from the Load Sequencer Schedule Drawings (Reference 5.3) and input from Nuclear and Mechanical Engineering. These loads consist of several load groups which are started automatically by the Sequencer as well as by system conditions, and loads that are administratively controlled.

It should be noted that 480V Switchgear No. 3, normally served from 4160V Swithchgear No. 1 Train 1), is transferred to 4160V Switchgear No. 2 (Train 2) following SISLOP.

3.2 Individual Load Calculations

The load characteristics were obtained from SONGS Station Equipment Data manual (Reference 5.1) and Design Calculation DC-1857 Rev 1 (Reference 5.7). As shown by Tables 6.1.A through 6.1.H, the motor continuous load kilowatts (KW) were calculated by using the following methodology:

$$KW_{input} = 0.746 \times BHP / EFF$$

where :

BHP is the brakehorsepower provided by Mechanical Design Calculation (Reference 5.1) for 4160V and 480V switchgear motor loads. For 480V MCC motor loads, BHP is assumed 75% of motor rated HP as shown on Design Calculation DC-1857 Rev. 1.

EFF (Efficiency) and PF (Power Factor) are the rated full load values for the 4160V and 480V motors operating above or close to their rated HP and obtained from motor data sheets in the Equipment Data Manual (Reference 5.6) or, when not available, from Westinghouse typical medium voltage motor characteristics (Reference 5.8).

DWG. NO.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. MADE BY A. MATIONG DATE 6/17/88 CHK. BY BM DATE 6/17/88

For MCC motors, typical values of EFF and PF were used for motors operating at 75% of rated HP (extrapolated from Design Calculation DC-1857, pages 25 and 86).

The static load KWs as well as the data used to calculate transformer and cable KW losses were extrapolated from the one-line diagrams and Design Calculations DC-1809 Rev. 1 and DC-1931, Rev. 0. The data used in the calculation for the KW input to MOV-850C UPS was extrapolated from Design Calculation DC-943 Rev.1 (Reference 5.12).

3.3 Emergency Diesel Generator Loading Calculations

The sum of the individual loads of each safety load group (i.e., SUM A and SUM B) were used to obtain the operating load totals for the subsequent loadingtime intervals (SUM C and SUM D), as shown on Tables 6.1.A thru 6.1.H.

The sum of the peak operating load and the corresponding transformer and cable losses represent the highest continous loading on the diesel generator.

Upon SISLOP initiation, the following are assumed:

A. As a conservative approach, the Auxiliary Feedwater pump is actuated after 40 seconds.

B. The Waste Sump pump operates after 10 minutes (based on relay time delay setting).

C. The Recirculating pump and associated MOVs are manually activated after 25 minutes, during transition phase from injection to recirculation.

D. The Safety Injection pump, the Feedwater pump and the Feedwater pump lube oil cooling fan operations are secured after 30 minutes.

E. The Emergency Siren and the Thunderbolt evacuation system are turned off after 30 min.

F. The controls for the diesel generator starting air system auxiliaries are placed in the non-auto mode after 30 minutes.

G. Motor operated valve (MOV) stroke time is between 9 and 11 seconds.

H. As a conservative approach, all other intermittent loads operate continuously.

DWG. NO.

SUBJECT		PROJECT
EMERGENCY DIESEL GENERATOR LOADING		SAN ONOFRE GEN. STA. UNIT 1
QUALITY CLASS	SEISMIC CLASS	SPECIFICATION REFERENCE
SAFETY RELATED	A	N/A

4.0 DESIGN INPUT

The purpose of this calculation is to determine the maximum continuous load in kilowatts that would be imposed on Diesel Generators 1 and 2 upon initiation of SISLOP.

Prior to start of the calculation, it was necessary to determine and identify all the loads that could turn on and draw power from the diesel generators. The following documents and their associated one-line diagrams and elementary diaagrams were reviewed and used to derive the groups of loads in accordance with their sequence of operation.

Dwg. 5149957 Rev. 11 - Emergency Operating Condition Train No. 1

Dwg. 5149958 Rev. 10 - Emergency Operating Condition Train No. 2

Dwg. 5146828 Rev. 25 - Main One Line Diagram

Dwg. 5149178 Rev. 9 - Load Sequence Schedule Load Train No. 1

Dwg. 5149179 Rev. 11 - Load Sequence Schedule Load Train No. 1

Dwg. 5149181 Rev. 10 - Load Sequence Schedule Load Train No. 2

Dwg. 5149182 Rev. 11 - Load Sequence Schedule Load Train No. 2

System Description Manual Dwgs:

SD -SO1-580-I-1-1 - Safety Injection System P&ID

SD-SO1-580-II-1-1 - Recirculation System P&ID

SD-SO1-580-III-1-0 - Containment Spray System P&ID

Loads that operate on permissives or are manually controlled and not locked-out by the sequencer which could start were also identified in the load list.

DESIGN INPUT SHEET

☒ Design Requirements
☐ Design Input Change

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DESIGN CALCULATION NO. DC1809—REV. 2

SUBJECT		PROJECT
EMERGENCY DIESEL GENERATOR LOADING		SAN ONOFRE GEN. STA. UNIT 1
QUALITY CLASS: SAFETY RELATED	SEISMIC CLASS: A	SPECIFICATION REFERENCE: N/A

Design Input

The brake horsepower of the motor-driven loads were estimated, based on required operating conditions, from available data (referenced in the calculation) and converted into kilowatt (KW) values in order to obtain a more realistic loading on the diesel generators. The brake horsepower requirements of the feedwater, safety injection, charging, auxiliary feedwater, and component cooling pumps were obtained from Design Calculation DC-2990, Rev. A, dated 5/27/88 (subsequently revised on 6/15/88 to change the Charging pump requirement to 670 BHP).

RESPONSIBLE ENGINEER	DATE	INDEPENDENT REVIEW ENGINEER	DATE	GROUP LEADER	DATE
[signature]	6/17/88	[signature]	6/17/88	[signature]	6/17/88

SCE 20-00 REV 6/81

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY [illegible] DATE 6/17/88

5.0 REFERENCES

5.1 Mechanical Design Calculation DC-2990 Rev A, LOCA Injection Mode Pump Loads, dated 5/27/88 (subsequently revised on 6/15/88 to change the Charging pump requirement to 670 BHP)

5.2 Lotus 123 Computer Application Program

5.3 Load Sequencer Schedule Drawings:

5149178-9 5149179-11 5149181-10 5149182-11

5.4 Emergency Operating Condition, 4KV and 480V, LOP-SIS-SISLOP Drawings:

5149957-11 5149958-10

5.5 One Line Diagrams:

5146828-25	5102162-16	5102163-15	5148062-8
5148063-9	5102165-37	5102166-29	5118200-7
5149306-12	5102167-27	5102168-19	5102169-36
5149307-11	5102170-31	5102171-25	

5.6 SONGS 1 System Description Manuals

5.7 Design Calculation DC-1857 Rev. 1 San Onofre Unit 1 4160V and 480V Auxiliary System Load Calculation

5.8 Westinghouse Medium Voltage Motors Typical Characteristics (Attachment A)

5.9 Elgar Uninterruptible Power System Technical Data

5.10 IEEE Std 399-1980, Recommended Practice for Industrial and Commercial Power System Analysis, Section 4.9.2.1

5.11 Emergency Operating Instruction (EOI).

5.12 MOV-850C UPS Battery Calculation DC-943, Rev. 0

5.13 Design Calculation DC-1931, Rev.0, SONGS 1 Auxiliary System Short Circuit Duties

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EM DATE 6/17/88

6.0 CALCULATIONS

Using the methodology and assumptions of Section 3.0, the following calculations were performed and the calculated motor and static loads are shown on Tables 6.1.A thru 6.1.H. The transformer and cable losses are added to the peak continuous KW to represent the maximum continuous loading on the diesel generator.

A. Motor Loads

Feedwater Pump Motor: 4100 BHP, 96.5% Eff.

$$KW_{input} = 0.746 \times BHP / Eff. = 3169.53 \text{ KW}$$

All the other motor loads were calculated similarly by the computer (Reference 5.1, 5.8 and 5.10).

B. Static Loads

Communication Power Distribution Panel:

$$KW_{input} = KVA_{rated} \times PF_{rated} = 3.00 \times 0.86 = 2.58 \text{ kilowatts}$$

(Reference 5.7, page 95 and E/D Dwg. 456016)

UPS for MOV-850C:

Elgar UPS 373-3 Data (Reference 5.9 and 5.12)

Inverter input	Inverter output
I_{dc} = 40 amps (no load @ output)	V_{ac} = 480 volts, 30
V_{dc} = 125 volts	pf = 0.80

Effective DC power = Effective AC power

$$V_{dc} \times I_{dc} = 1.732 \times V_{ac} \times I_{ac} \times pf$$

Substituting the values above, I_{ac} = 7.52 amps (UPS output)

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J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EM DATE 6/17/88

The UPS maximum DC amps available = 400 amps

Therefore 10% of available UPS amps is being utilized.

The UPS efficiency, based on manufacturer technical data, is 75% @ 25% load and it is used to calculate the UPS input current.

$I_{ac\ input} = I_{ac\ output} / Eff. = 7.52/0.75 = 10.03$ amps

UPS input pf = 0.75

$KW_{input} = 1.732 \times 0.48 \times 10.03 \times 0.75 = 6.25$ KW

C. Transformer and Cable Losses

$I = KW_{input} / (1.732 \times KV \times PF)$ ---------- amps

R = cable or transformer resistance ---- ohms

$KW = 3 I^2 R / 1000$ ---------- loss in kilowatts

Using Train B parameters for cable data (Reference 5.13, calculation sheets 22 thru 25 and Attachment A.1 pages A.1-1 thru A.1-4),

Diesel Generator Feeder:

$I = 5431$ kva $/ (1.732 \times 4.16)$ kv $= 753.75$ amps

$R = 0.00391 / 1000 \times 30 = 0.00001$ ohms

$KW = 3 \times (753.75)^2 \times 0.00001 / 1000 = 0.017$ kilowatts

Safety Injection Pump:

$I = 516.10 / (1.732 \times 4.16 \times 0.82) = 87.35$ amps

$R = 0.016 / 1000 \times 260 = 0.00416$ ohms

$KW = 3 \times (87.35)^2 \times 0.00416 / 1000 = 0.095$ kilowatts

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SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. MADE BY A. MATIONG DATE 6/17/88 CHK. BY EM DATE 6/17/88

Feedwater Pump:

$I = 3169.53 / (1.732 \times 4.16 \times 0.94) = 467.98$ amps

$R = 0.018 / 1000 \times 89 = 0.0016$ ohms

$KW = 3 \times (467.98)^2 \times 0.0016 / 1000 = 1.053$ kilowatts

Charging Pump:

$I = 526.13 / (1.732 \times 4.16 \times 0.9) = 81.14$ amps

$R = 0.0238 / 1000 \times 387 = 0.0092$ ohms

$KW = 3 \times (81.14)^2 \times 0.0092 / 1000 = 0.182$ kilowatts

Station Service Transformer Primary Feeder:

The transformer load KW and KVAR is first determined by subtracting the 4160V motor load KW and KVAR from the total diesel generator load KW and KVAR. These KW and KVAR loads are calculated in tabulated form in the following pages and the resultant transformer KW and KVAR are shown in the table for the 25-minute period. The transformer KVA and primary current are then calculated as follows:

$$KVA = \sqrt{KW^2 + KVAR^2}$$

$$KVA = \sqrt{792.40^2 + 345.01^2} = 864.25 \text{ kilovolt-amps}$$

$$I_{pri} = KVA / (1.732 \times KV_{pri})$$

$I_{pri} = 864.25 / (1.732 \times 4.16) = 119.95$ amps

$R = 0.0153 / 1000 \times 249 = 0.0038$ ohms

$KW = 3 \times (119.95)^2 \times 0.0038 / 1000 = 0.164$ kilowatts

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CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. ____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY BM DATE 6/17/88

LOAD DATA (FOR CALCULATION OF TRANSFORMER LOSSES)

LOAD GROUP 1 (10 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	INPUT KV	INPUT KW	INPUT P.F.	INPUT KVA	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2	DIESEL GEN. KVAR LOADING NO. 1	DIESEL GEN. KVAR LOADING NO. 2
COMMUNICATION POWER DISTRIBUTION PANEL	0.44	2.58	0.86	3.00	2.58	2.58	1.53	1.53
BATTERY CHARGER SET A/B	0.44	130.00	1.00	130.00	130.00	130.00	0.00	0.00
MANUAL TRANSFER SW. #7	0.48	12.24	0.85	14.40	0.00	12.24	0.00	7.59
BATTERY ROOM SPACE HEATERS	0.48	4.50	1.00	4.50	0.00	4.50	0.00	0.00
AUX. AIR COMP. & TRASH SYSTEM	0.46	16.46	0.86	19.13	16.46	0.00	9.76	0.00
TURB-GEN TURNING GEAR MOTOR X30	0.46	27.98	0.83	33.70	0.00	27.98	0.00	18.80
UPS FOR MOV-850C	0.48	6.25	0.75	8.33	0.00	6.25	0.00	5.51
MOTOR OPERATED VALVE MOV-850A	0.44	0.75	0.62	1.21	0.00	0.75	0.00	0.96
MOTOR OPERATED VALVE MOV-850B	0.44	1.34	0.82	1.63	1.34	0.00	0.93	0.00
REHEATER STEAM DUMP VALVES:								
MOV-25 THRU MOV-34 (1.6 HP EACH - LUMPED)	0.46	13.36	0.82	16.29	13.36	0.00	9.33	0.00
D.G. AUXILIARY LOADS:								
STANDBY LUBE OIL PUMP MOTOR G69/G70	0.46	65.82	0.80	82.28	0.00	0.00	0.00	0.00
INSTRUMENT AIR COMPRESSOR MOTOR K5A/K6A	0.46	1.42	0.69	2.05	1.42	1.42	1.49	1.49
INSTRUMENT AIR COMPRESSOR MOTOR K5B/K6B	0.46	1.42	0.69	2.05	1.42	1.42	1.49	1.49
JACKET WATER RAD. FAN MOTOR A-13A/A-14A	0.46	18.86	0.84	22.45	18.86	18.86	12.18	12.18
JACKET WATER RAD. FAN MOTOR A-13B/A-14B	0.46	18.86	0.84	22.45	18.86	18.86	12.18	12.18
JACKET WATER RAD. FAN MOTOR A-13C/A-14C	0.46	18.86	0.84	22.45	18.86	18.86	12.18	12.18
JACKET WATER RAD. FAN MOTOR A-13D/A-14D	0.46	18.86	0.84	22.45	18.86	18.86	12.18	12.18
FUEL OIL TRANSFER PUMP MOTOR G74A/G74B	0.46	1.42	0.69	2.05	1.42	1.42	1.49	1.49
FUEL OIL TRANSFER PUMP MOTOR G75A/G75B	0.46	1.42	0.69	2.05	1.42	1.42	1.49	1.49
EMERGENCY VENT FAN MOTOR EF-1A/EF-2A	0.46	16.46	0.86	19.13	16.46	16.46	9.76	9.76
EMERGENCY VENT FAN MOTOR EF-1B/EF-2B	0.46	16.46	0.86	19.13	16.46	16.46	9.76	9.76
EMERGENCY VENT FAN MOTOR EF-1C/EF-2C	0.46	16.46	0.86	19.13	16.46	16.46	9.76	9.76
EMERGENCY VENT FAN MOTOR EF-1D/EF-2D	0.46	18.86	0.84	22.45	18.86	18.86	12.18	12.18
BATTERY CHARGER SET C/D	0.46	44.00	1.00	44.00	44.00	44.00	0.00	0.00
FUEL OIL WASTE PUMP MOTOR	0.46	0.75	0.62	1.20	0.75	0.75	0.94	0.94
PERIMETER LIGHTING PANEL @ MCC 1B	0.48	16.90	1.00	16.90	16.90	0.00	0.00	0.00
PERIMETER LIGHTING PANEL @ MCC 2B	0.48	17.30	1.00	17.30	0.00	17.30	0.00	0.00
STARTING AIR COMP. MOTOR K3A/K4A	0.46	27.98	0.83	33.70	27.98	27.98	18.80	18.80
STARTING AIR COMP. MOTOR K3B/K4B	0.46	27.98	0.83	33.70	27.98	27.98	18.80	18.80
AFTER COOLER FAN MOTOR E-18A/E-19A	0.46	0.59	0.60	0.99	0.59	0.59	0.79	0.79
AFTER COOLER FAN MOTOR E-18B/E-19B	0.46	0.59	0.60	0.99	0.59	0.59	0.79	0.79
STARTING AIR DRYER X3A/X4A	0.21	0.15	1.00	0.15	0.15	0.15	0.00	0.00
STARTING AIR DRYER X3B/X4B	0.21	0.15	1.00	0.15	0.15	0.15	0.00	0.00
SUM 1A = TOTAL LOAD (WITH MOV)					432.14	453.10	157.82	170.65
SUM 1B = TOTAL LOAD (WITHOUT MOV)					417.45	452.35	147.56	169.69

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ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDN DATE 6/17/88

LOAD DATA (FOR CALCULATION OF TRANSFORMER LOSSES)

LOAD GROUP 2 (11 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	INPUT KV	INPUT KW	INPUT P.F.	INPUT KVA	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2	DIESEL GEN. KVAR LOADING NO. 1	DIESEL GEN. KVAR LOADING NO. 2
SAFETY INJECTION PUMP MOTOR G50B/G50A	4.16	516.10	0.82	629.39	516.10	516.10	360.24	360.24
FEEDWATER PUMP MOTOR G3B/G3A	4.16	3169.53	0.94	3371.84	3169.53	3169.53	1150.39	1150.39
FEEDWATER PUMP L.O. PUMP MOTOR G3BLO/G3ALO	0.44	0.19	0.66	0.28	0.19	0.19	0.21	0.21
FEEDWATER PP L.O. COOLING FAN MOTOR A17B/A17	0.44	0.72	0.52	1.38	0.72	0.72	1.18	1.18
EMERGENCY SIREN MOTOR	0.46	6.51	0.87	7.48	6.51	6.51	3.69	3.69
THUNDERBOLT EVACUATION SYSTEM	0.46	20.00	0.85	23.53	20.00	20.00	12.39	12.39
MOTOR OPERATED VALVE LCV-1100B	0.44	0.52	0.60	0.87	0.52	0.00	0.69	0.00
MOTOR OPERATED VALVE LCV-1100C	0.44	0.52	0.60	0.87	0.52	0.52	0.69	0.69
MOTOR OPERATED VALVE LCV-1100D	0.44	0.52	0.60	0.87	0.00	0.52	0.00	0.69
MOTOR OPERATED VALVE MOV-20	0.44	1.42	0.69	2.05	1.42	0.00	1.49	0.00
MOTOR OPERATED VALVE MOV-21	0.44	1.42	0.69	2.05	0.00	1.42	0.00	1.49
MOTOR OPERATED VALVE MOV-22	0.44	1.42	0.69	2.05	0.00	1.42	0.00	1.48
MOTOR OPERATED VALVE MOV-850C	0.44	1.34	0.82	1.63	0.00	1.34	0.00	0.93
MOTOR OPERATED VALVE MOV-1204	0.44	1.42	0.69	2.05	1.42	0.00	1.49	0.00
SUM 2A = TOTAL LOAD (WITH MOV)					3716.92	3718.26	1532.46	1533.39
SUM 2B = TOTAL LOAD (WITHOUT MOV)					3713.04	3713.04	1528.10	1528.10
OPER. LOAD TOTAL (GROUPS 1 THRU 2): FROM 11+ SEC. TO 21 SEC. (SUM 2C) = SUM 1A + SUM 2A					4149.06	4171.36	1690.28	1704.04

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CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDL DATE 6/17/88

LOAD DATA (FOR CALCULATION OF TRANSFORMER LOSSES)

LOAD GROUP 3 (21 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	INPUT KV	INPUT KW	INPUT P.F.	INPUT KVA	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2	DIESEL GEN. KVAR LOADING NO. 1	DIESEL GEN. KVAR LOADING NO. 2
CHARGING PUMP MOTOR G8B/G8A	4.16	526.13	0.90	584.58	526.13	526.13	254.81	254.81
CHARGING PUMP L.O. FAN MOTOR G8BF/G8AF	0.44	0.59	0.60	0.99	0.59	0.59	0.79	0.79
COMPONENT COOLING PUMP MOTOR G15A/G15B	0.44	79.36	0.91	87.21	79.36	79.36	36.16	36.16
COMPONENT COOLING PUMP MOTOR G15C (Note 1)	0.44	0.00	0.91	0.00	0.00	0.00	0.00	0.00
SALTWATER COOLING PUMP MOTOR G13A/G13B	0.48	81.09	0.88	92.14	81.09	81.09	43.77	43.77
REFUELING WATER PUMP MOTOR G27A/G27B	0.44	101.36	0.91	111.38	101.36	101.36	46.18	46.18
HYDRAZINE ADD PUMP MOTOR G200A/G200B	0.44	0.75	0.62	1.20	0.75	0.75	0.94	0.94
MOTOR OPERATED VALVE MOV-720B/720A	0.44	0.24	0.50	0.48	0.24	0.24	0.42	0.42
SUM 3A = TOTAL LOAD (WITH MOV)					789.51	789.51	383.07	383.07
SUM 3B = TOTAL LOAD (WITHOUT MOV)					789.27	789.27	382.65	382.65
OPER. LOAD TOTAL (GROUPS 1 THRU 3):								
FROM 21+ SEC. TO 30 SEC. (SUM 3C) = SUM 1B + SUM 2B + SUM 3A					4920.00	4954.91	2058.73	2080.86
FROM 30+ SEC. TO 40 SEC. (SUM 3D) = SUM 1B + SUM 2B + SUM 3B					4919.76	4954.67	2058.31	2080.44

Note:
1. Administratively locked-out.

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CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDL DATE 6/17/88

LOAD DATA (FOR CALCULATION OF TRANSFORMER LOSSES)

LOAD GROUP 4 (40 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	INPUT KV	INPUT KW	INPUT P.F.	INPUT KVA	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2	DIESEL GEN. KVAR LOADING NO. 1	DIESEL GEN. KVAR LOADING NO. 2
AUXILIARY FEEDWATER PUMP MOTOR G10S	0.44	168.45	0.90	187.17	168.45	0.00	81.58	0.00
SUM 4A = TOTAL LOAD (WITH MOV)								
SUM 4B = TOTAL LOAD (WITHOUT MOV)					168.45	0.00	81.58	0.00
OPER. LOAD TOTAL (GROUPS 1 THRU 4): FROM 40+SEC. TO 50 SEC. (SUM 4C) = SUM 1B + SUM 2B + SUM 3B + SUM 4B					5088.21	4954.67	2139.90	2080.44

LOAD GROUP 5 (50 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	INPUT KV	INPUT KW	INPUT P.F.	INPUT KVA	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2	DIESEL GEN. KVAR LOADING NO. 1	DIESEL GEN. KVAR LOADING NO. 2
MOTOR OPERATED VALVE MOV-1202	0.44	1.42	0.69	2.05	1.42	0.00	1.49	0.00
SUM 5A = TOTAL LOAD (WITH MOV)					1.42	0.00	1.49	0.00
SUM 5B = TOTAL LOAD (WITHOUT MOV)								
OPER. LOAD TOTAL (GROUPS 1 THRU 5): FROM 50+ SEC. TO 60 SEC. (SUM 5C) = SUM 1B + SUM 2B + SUM 3B + SUM 4B + SUM 5A					5089.63	4954.67	2141.38	2080.44
FROM 60+ SEC. TO 10 MIN. (SUM 5D) = SUM 1B + SUM 2B + SUM 3B + SUM 4B + SUM 5B					5088.21	4954.67	2139.90	2080.44

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CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. ____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EM DATE 6/17/88

LOAD DATA (FOR CALCULATION OF TRANSFORMER LOSSES)

LOAD GROUP 6 (10 MINUTES AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	INPUT KV	INPUT KW	INPUT P.F.	INPUT KVA	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2	DIESEL GEN. KVAR LOADING NO. 1	DIESEL GEN. KVAR LOADING NO. 2
WASTE SUMP PUMP MOTOR 673A/673B	0.44	1.42	0.69	2.05	1.42	1.42	1.49	1.49
SUM 6A = TOTAL LOAD (WITH MOV)								
SUM 6B = TOTAL LOAD (WITHOUT MOV)					1.42	1.42	1.49	1.49
OPER. LOAD TOTAL (GROUPS 1 THRU 6): FROM 10 MIN. TO 25 MIN. (SUM 6D) = SUM 5D + SUM 6B					5089.63	4956.09	2141.38	2081.93

LOAD GROUP 7 (25 MINUTES AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	INPUT KV	INPUT KW	INPUT P.F.	INPUT KVA	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2	DIESEL GEN. KVAR LOADING NO. 1	DIESEL GEN. KVAR LOADING NO. 2
RECIRCULATING PUMP MOTOR 645A/645B	0.44	48.08	0.86	55.30	48.08	48.08	28.53	28.53
MOTOR OPERATED VALVE MOV-866A/MOV-866B	0.44	0.14	0.50	0.27	0.14	0.14	0.24	0.24
MOTOR OPERATED VALVE MOV-19/MOV-18	0.44	0.40	0.50	0.80	0.40	0.40	0.69	0.69
MOTOR OPERATED VALVE MOV-356/MOV-357	0.44	0.52	0.60	0.87	0.52	0.52	0.69	0.69
MOTOR OPERATED VALVE MOV-358	0.44	0.52	0.60	0.87	0.00	0.52	0.00	0.69
MOTOR OPERATED VALVE MOV-883	0.44	0.52	0.60	0.87	0.00	0.52	0.00	0.69
SUM 7A = TOTAL LOAD (WITH MOV)					49.13	50.17	30.15	31.53
SUM 7B = TOTAL LOAD (WITHOUT MOV)					48.08	48.08	28.53	28.53
OPER. LOAD TOTAL (GROUPS 1 THRU 7): FROM 25+ MIN. TO 25+ MIN. & 10 SEC. (SUM 7C) = SUM 6D + SUM 7A					5138.76	5006.26	2171.53	2113.47
FROM 25+ MIN. & 10 SEC. TO 30 MIN. (SUM 7D) = SUM 6D + SUM 7B					5137.70	5004.16	2169.91	2110.46

TOTAL D.G. NO. 1 KVA $= \sqrt{KW^2 + KVAR^2} = \sqrt{5137.70^2 + 2169.91^2}$ = 5577.141

TOTAL D.G. NO. 2 KVA $= \sqrt{5004.16^2 + 2110.46^2}$ = 5430.990

480V OPER. LOAD TOTAL = TOTAL D.G. OPER. LOAD - SUM 4160V LOAD

FOR D.G. NO. 1				1010.43	925.94	792.40	404.47	345.01
FOR D.G. NO. 2				864.25				

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CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDR DATE 6/17/88

Station Service Transformer:

Ratings (from Station Equipment Data Manual Section 32)

1250 KVA, 4160V-480V, 3Ø, 14.2 KW total losses

KVA = 864.25 kilovolt-amps

KW = 14.2 x 864.25 / 1250 = 9.82 kilowatts

Station Service Transformer Secondary Feeder:

$I_{sec} = I_{pri} \times KV_{pri} / KV_{sec}$

$I = 119.95 \times 4160 / 480 = 1039.56$ amps

$R = 0.000366 / 1000 \times 51 = 0.00002$ ohms

$KW = 3 \times (1039.56)^2 \times 0.00002 / 1000 = 0.061$ kilowatts

Component Cooling Water Pump:

$I = 79.36 / (1.732 \times 0.44 \times 0.91) = 114.44$ amps

$R = 0.00903 / 1000 \times 147 = 0.00133$ ohms

$KW = 3 \times (114.44)^2 \times 0.00133 / 1000 = 0.052$ kilowatts

Saltwater Cooling Pump:

$I = 81.09 / (1.732 \times 0.48 \times 0.88) = 110.84$ amps

$R = 0.0255 / 1000 \times 261 = 0.00666$ ohms

$KW = 3 \times (110.84)^2 \times 0.00666 / 1000 = 0.245$ kilowatts

Refueling Water Pump:

$I = 101.36 / (1.732 \times 0.44 \times 0.91) = 146.16$ amps

$R = 0.00474 / 1000 \times 121 = 0.00057$ ohms

$KW = 3 \times (146.16)^2 \times 0.00057 / 1000 = 0.037$ kilowatts

DWG. NO.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EM DATE 6/17/88

Recirculating Pump:

$I = 48.08 / (1.732 \times 0.44 \times 0.86) = 73.36$ amps

$R = 0.00774 / 1000 \times 51 = 0.00039$ ohms

$KW = 3 \times (73.36)^2 \times 0.00039 / 1000 = 0.006$ kilowatts

TOTALS:

Train B: KW losses = 11.736 kilowatts *

Train A: $KVA_{load} = \sqrt{925.94^2 + 404.47^2} = 1010.43$ KVA

Transformer losses = $14.2 \times 1010.43 / 1250$

= 11.48 kilowatts

For simplicity of calculation, it is assumed that Train A cable losses are not significantly different from that of Train B. Therefore:

KW losses = 13.40 kilowatts *

* conservatively rounded off to 14 KW (D.G. No. 1) and 12 KW (D.G. No. 2) to allow for losses of other miscellaneous smaller loads.

DWG. NO.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDL DATE 6/17/88

TABLE 6.1.A

LOAD GROUP 1 (10 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	RATED KV	RATED P.F.	RATED KVA	RATED KW	RATED HP	RATED EFF.	REQUIRED BRAKE HP	REQUIRED INPUT KW	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2
COMMUNICATION POWER DISTRIBUTION PANEL	0.44	0.86	3.00					2.58	2.58	2.58
BATTERY CHARGER SET A/B	0.44	1.00		130.00				130.00	130.00	130.00
*MANUAL TRANSFER SW. #7	0.48	0.85						12.24	0.00	12.24
*BATTERY ROOM SPACE HEATERS	0.48	1.00		4.50				4.50	0.00	4.50
*AUX. AIR COMP. & TRASH SYSTEM	0.46	0.86			25.00	0.850	18.75	16.46	16.46	0.00
*TURB-GEN TURNING GEAR MOTOR X30	0.46	0.83			40.00	0.800	30.00	27.98	0.00	27.98
*UPS FOR MOV-850C	0.48	0.75				0.750		6.25	0.00	6.25
MOTOR OPERATED VALVE MOV-850A	0.44	0.62			1.00	0.750	0.75	0.75	0.00	0.75
MOTOR OPERATED VALVE MOV-850B	0.44	0.82			1.60	0.670	1.20	1.34	1.34	0.00
REHEATER STEAM DUMP VALVES:										
*MOV-25 THRU MOV-34 (1.6 HP EACH - LUMPED)	0.46	0.82			16.00	0.670	12.00	13.36	13.36	0.00
AUXILIARY LOADS:										
STANDBY LUBE OIL PUMP MOTOR G69/G70 (Note 1)	0.46	0.8			100.00	0.850	75.00	65.82	0.00	0.00
INSTRUMENT AIR COMPRESSOR MOTOR K5A/K6A	0.46	0.69			2.00	0.790	1.50	1.42	1.42	1.42
*INSTRUMENT AIR COMPRESSOR MOTOR K5B/K6B	0.46	0.69			2.00	0.790	1.50	1.42	1.42	1.42
JACKET WATER RAD. FAN MOTOR A-13A/A-14A	0.46	0.84			30.00	0.890	22.50	18.86	18.86	18.86
JACKET WATER RAD. FAN MOTOR A-13B/A-14B	0.46	0.84			30.00	0.890	22.50	18.86	18.86	18.86
JACKET WATER RAD. FAN MOTOR A-13C/A-14C	0.46	0.84			30.00	0.890	22.50	18.86	18.86	18.86
JACKET WATER RAD. FAN MOTOR A-13D/A-14D	0.46	0.84			30.00	0.890	22.50	18.86	18.86	18.86
FUEL OIL TRANSFER PUMP MOTOR G74A/G74B	0.46	0.69			2.00	0.790	1.50	1.42	1.42	1.42
*FUEL OIL TRANSFER PUMP MOTOR G75A/G75B	0.46	0.69			2.00	0.790	1.50	1.42	1.42	1.42
EMERGENCY VENT FAN MOTOR EF-1A/EF-2A	0.46	0.86			25.00	0.850	18.75	16.46	16.46	16.46
EMERGENCY VENT FAN MOTOR EF-1B/EF-2B	0.46	0.86			25.00	0.850	18.75	16.46	16.46	16.46
EMERGENCY VENT FAN MOTOR EF-1C/EF-2C	0.46	0.86			25.00	0.850	18.75	16.46	16.46	16.46
EMERGENCY VENT FAN MOTOR EF-1D/EF-2D	0.46	0.84			30.00	0.890	22.50	18.86	18.86	18.86
BATTERY CHARGER SET C/D	0.46	1.00						44.00	44.00	44.00
*FUEL OIL WASTE PUMP MOTOR	0.46	0.62			1.00	0.750	0.75	0.75	0.75	0.75
PERIMETER LIGHTING PANEL @ MCC 1B	0.48	1.00						16.90	16.90	0.00
PERIMETER LIGHTING PANEL @ MCC 2B	0.48	1.00						17.30	0.00	17.30
STARTING AIR COMP. MOTOR K3A/K4A	0.46	0.83			40.00	0.800	30.00	27.98	27.98	27.98
STARTING AIR COMP. MOTOR K3B/K4B	0.46	0.83			40.00	0.800	30.00	27.98	27.98	27.98
*AFTER COOLER FAN MOTOR E-18A/E-19A	0.46	0.60			0.75	0.710	0.56	0.59	0.59	0.59
*AFTER COOLER FAN MOTOR E-18B/E-19B	0.46	0.60			0.75	0.710	0.56	0.59	0.59	0.59
*STARTING AIR DRYER X3A/X4A	0.21	1.00		0.15				0.15	0.15	0.15
*STARTING AIR DRYER X3B/X4B	0.21	1.00		0.15				0.15	0.15	0.15

NOTE 1. OPERATION OF THE SHAFT-DRIVEN PUMP IS CREDITED TO PRECLUDE START OF THE MOTOR-DRIVEN PUMP

SUM 1A = TOTAL LOAD (WITH MOV) 432.14 453.10

SUM 1B = TOTAL LOAD (WITHOUT MOV) 417.45 452.35

* DENOTES LOAD NOT INCLUDED IN PREVIOUS REVISIONS OF THE CALCULATION.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY [illegible] DATE 6/17/88

TABLE 6.1.B

LOAD GROUP 2 (11 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	RATED KV	RATED P.F.	RATED KVA	RATED KW	RATED HP	RATED EFF.	REQUIRED BRAKE HP	REQUIRED INPUT KW	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2
SAFETY INJECTION PUMP MOTOR G50B/G50A	4.16	0.82			700.00	0.954	660.00	516.10	516.10	516.10
FEEDWATER PUMP MOTOR G3B/G3A	4.16	0.94			3500.00	0.965	4100.00	3169.53	3169.53	3169.53
FEEDWATER PUMP L.O. PUMP MOTOR G3BLO/G3ALO	0.44	0.66			0.25	0.750	0.19	0.19	0.19	0.19
FEEDWATER PP L.O. COOLING FAN MOTOR A17B/A17	0.44	0.52			1.00	0.780	0.75	0.72	0.72	0.72
EMERGENCY SIREN MOTOR	0.46	0.87			10.00	0.860	7.50	6.51	6.51	6.51
*THUNDERBOLT EVACUATION SYSTEM	0.46	0.85						20.00	20.00	20.00
MOTOR OPERATED VALVE LCV-1100B	0.44	0.60			0.66	0.710	0.50	0.52	0.52	0.00
MOTOR OPERATED VALVE LCV-1100C	0.44	0.60			0.66	0.710	0.50	0.52	0.52	0.52
MOTOR OPERATED VALVE LCV-1100D	0.44	0.60			0.66	0.710	0.50	0.52	0.00	0.52
[illegible]OR OPERATED VALVE MOV-20	0.44	0.69			2.00	0.790	1.50	1.42	1.42	0.00
[illegible]TOR OPERATED VALVE MOV-21	0.44	0.69			2.00	0.790	1.50	1.42	0.00	1.42
MOTOR OPERATED VALVE MOV-22	0.44	0.69			2.00	0.790	1.50	1.42	0.00	1.42
MOTOR OPERATED VALVE MOV-850C	0.44	0.82			1.60	0.670	1.20	1.34	0.00	1.34
*MOTOR OPERATED VALVE MOV-1204	0.44	0.69			2.00	0.790	1.50	1.42	1.42	0.00

SUM 2A = TOTAL LOAD (WITH MOV) 3716.92 3718.26

SUM 2B = TOTAL LOAD (WITHOUT MOV) 3713.04 3713.04

OPER. LOAD TOTAL (GROUPS 1 THRU 2):

FROM 11+ SEC. TO 21 SEC. (SUM 2C) = SUM 1A + SUM 2A 4149.06 4171.36

* DENOTES LOAD NOT INCLUDED IN PREVIOUS REVISIONS OF THE CALCULATION

DWG. NO.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDR DATE 6/17/88

TABLE 6.1.C

LOAD GROUP 3 (21 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	RATED KV	RATED P.F.	RATED KVA	RATED KW	RATED HP	RATED EFF.	REQUIRED BRAKE HP	REQUIRED INPUT KW	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2
CHARGING PUMP MOTOR G8B/G8A	4.16	0.90			600.00	0.950	670.00	526.13	526.13	526.13
*CHARGING PUMP L.O. FAN MOTOR G8BF/G8AF	0.44	0.60			0.75	0.710	0.56	0.59	0.59	0.59
COMPONENT COOLING PUMP MOTOR G15A/G15B	0.44	0.91			125.00	0.940	100.00	79.36	79.36	79.36
COMPONENT COOLING PUMP MOTOR G15C (Note 1)	0.44	0.91			125.00	0.940	100.00	0.00	0.00	0.00
SALTWATER COOLING PUMP MOTOR G13A/G13B	0.48	0.88			100.00	0.920	100.00	81.09	81.09	81.09
REFUELING WATER PUMP MOTOR G27A/G27B	0.44	0.91			150.00	0.920	125.00	101.36	101.36	101.36
HYDRAZINE ADD PUMP MOTOR G200A/G200B	0.44	0.62			1.00	0.750	0.75	0.75	0.75	0.75
MOTOR OPERATED VALVE MOV-720B/720A	0.44	0.50			0.30	0.700	0.23	0.24	0.24	0.24
SUM 3A = TOTAL LOAD (WITH MOV)									789.51	789.51
SUM 3B = TOTAL LOAD (WITHOUT MOV)									789.27	789.27

OPER. LOAD TOTAL (GROUPS 1 THRU 3):

FROM 21+ SEC. TO 30 SEC. (SUM 3C) = SUM 1B + SUM 2B + SUM 3A — 4920.00 4954.91

FROM 30+ SEC. TO 40 SEC. (SUM 3D) = SUM 1B + SUM 2B + SUM 3B — 4919.76 4954.67

* DENOTES LOAD NOT INCLUDED IN PREVIOS REVISIONS OF THE CALCULATION

Note:

1. Administratively locked-out.

DWG. NO.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. ____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EM DATE 6/[illegible]

TABLE 6.1.D

LOAD GROUP 4 (40 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	RATED KV	RATED P.F.	RATED KVA	RATED KW	RATED HP	RATED EFF.	REQUIRED BRAKE HP	REQUIRED INPUT KW	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2
*AUXILIARY FEEDWATER PUMP MOTOR G10S	0.44	0.90			250.00	0.930	210.00	168.45	168.45	0.00
SUM 4A = TOTAL LOAD (WITH MOV)										
SUM 4B = TOTAL LOAD (WITHOUT MOV)									168.45	0.00
OPER. LOAD TOTAL (GROUPS 1 THRU 4): FROM 40+SEC. TO 50 SEC. (SUM 4C) = SUM 1B + SUM 2B + SUM 3B + SUM 4B									5088.21	4954.67

*NOTES LOAD NOT INCLUDED IN PREVIOUS REVISIONS OF THE CALCULATION

TABLE 6.1.E

LOAD GROUP 5 (50 SECONDS AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	RATED KV	RATED P.F.	RATED KVA	RATED KW	RATED HP	RATED EFF.	REQUIRED BRAKE HP	REQUIRED INPUT KW	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2
*MOTOR OPERATED VALVE MOV-1202	0.44	0.69			2.00	0.790	1.50	1.42	1.42	0.00
SUM 5A = TOTAL LOAD (WITH MOV)										
SUM 5B = TOTAL LOAD (WITHOUT MOV)									1.42	0.00
OPER. LOAD TOTAL (GROUPS 1 THRU 5): FROM 50+ SEC. TO 60 SEC. (SUM 5C) = SUM 1B + SUM 2B + SUM 3B + SUM 4B + SUM 5A									5089.63	4954.67
FROM 60+ SEC. TO 10 MIN. (SUM 5D) = SUM 1B + SUM 2B + SUM 3B + SUM 4B + SUM 5B									5088.21	4954.67

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDL DATE 6/17/88

TABLE 6.1.F

LOAD GROUP 6 (10 MINUTES AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	RATED KV	RATED P.F.	RATED KVA	RATED KW	RATED HP	RATED EFF.	REQUIRED BRAKE HP	REQUIRED INPUT KW	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2
*WASTE SUMP PUMP MOTOR G73A/G73B	0.44	0.69			2.00	0.790	1.50	1.42	1.42	1.42
SUM 6A = TOTAL LOAD (WITH MOV)										
SUM 6B = TOTAL LOAD (WITHOUT MOV)									1.42	1.42
ER. LOAD TOTAL (GROUPS 1 THRU 6): FROM 10 MIN. TO 25 MIN. (SUM 6D) = SUM 5D + SUM 6B									5089.63	4956.09

*DENOTES LOAD NOT INCLUDED IN PREVIOUS REVISIONS OF THE CALCULATION

DWG. NO.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. ____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EDL DATE 6/17/88

TABLE 6.1.G

LOAD GROUP 7 (25 MINUTES AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	RATED KV	RATED P.F.	RATED KVA	RATED KW	RATED HP	RATED EFF.	REQUIRED BRAKE HP	REQUIRED INPUT KW	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2
RECIRCULATING PUMP MOTOR G45A/G45B (Note 1)	0.44	0.86			75.00	0.900	58.00	48.08	48.08	48.08
MOTOR OPERATED VALVE MOV-866A/MOV-866B	0.44	0.50			0.17	0.700	0.13	0.14	0.14	0.14
*MOTOR OPERATED VALVE MOV-19/MOV-18	0.44	0.50			0.50	0.700	0.38	0.40	0.40	0.40
*MOTOR OPERATED VALVE MOV-356/MOV-357	0.44	0.60			0.66	0.710	0.50	0.52	0.52	0.52
*MOTOR OPERATED VALVE MOV-358	0.44	0.60			0.66	0.710	0.50	0.52	0.00	0.52
MOTOR OPERATED VALVE MOV-883	0.44	0.60			0.66	0.710	0.50	0.52	0.00	0.52
A = TOTAL LOAD (WITH MOV)									49.13	50.17
7B = TOTAL LOAD (WITHOUT MOV)									48.08	48.08

OPER. LOAD TOTAL (GROUPS 1 THRU 7):

FROM 25+ MIN. TO 25+ MIN. & 10 SEC. (SUM 7C) = SUM 6D + SUM 7A — 5138.76 5006.25

FROM 25+ MIN. & 10 SEC. TO 30 MIN. (SUM 7D) = SUM 6D + SUM 7B — 5137.70 5004.16

PEAK LOAD = SUM 7D + SUM I^2R LOSSES (WITHOUT MOV)@ — 5151.70 5016.16

*DENOTES LOAD NOT INCLUDED IN PREVIOUS REVISIONS OF THE CALCULATION

@SEE DETAILED CALCULATION FOR LOSSES IN PRECEDING PAGES

Note:

1. Recirculating pump data obtained from SONGS 1 Equipment Data Manual Section 3, pages 3-4 and 3-5.

DWG. NO.

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: EMERGENCY DIESEL GENERATOR LOADING DESIGN CALCULATION NO. DC-1809 REVISION 2

J.O. NO. _____ MADE BY A. MATIONG DATE 6/17/88 CHK. BY EM DATE 6/17/88

TABLE 6.1.H

LOAD GROUP 8 (30 MINUTES AFTER SISLOP) LOAD REQUIREMENTS

LOAD DESCRIPTION	RATED KV	RATED P.F.	RATED KVA	RATED KW	RATED HP	RATED EFF.	REQUIRED BRAKE HP	REQUIRED INPUT KW	DIESEL GEN. KW LOADING NO. 1	DIESEL GEN. KW LOADING NO. 2
CHARGING PUMP G8B/G8A ADD'L LOAD (Note 1)	4.16				600.00	0.950	84.00	65.96	65.96	65.96
SUM 8A = TOTAL LOAD (WITH MOV)										
SUM 8B = TOTAL LOAD (WITHOUT MOV)									65.96	65.96
[illegible]. LOAD TOTAL (GROUPS 1 THRU 8): BEYOND 30 MINUTES (SUM 8C) = SUM 7D + SUM 8B - SUM ##									1433.19	1299.65

LOADS ASSUMED TO HAVE SINCE BEEN TERMINATED (SEE PARAGRAPH 2.3 FOR DESCRIPTION OF THESE LOADS)

Note:

1. Additional power (65.96 KW) is required by the charging pump to increase the flow rate during recirculation.

DWG. NO.

ATTACHMENT A
(DC-1809 REV. 2, SUPPLEMENT S1)

SHT. A1 OF A4

STANDARD INDUCTION MOTOR

CLASS [redacted] S.F.

NUMBER OF POLES 2
[redacted] HKZ= 0.5 X NEMA
DESIGN A1
4000 VOLTS, 60 HZ, 3 PH
SERVICE FACTOR= 1.15
CLASS B INSULATION TEMP. RISE
ENCL. DP
LOAD CHARACTERISTIC:
TORQUE PROP. TO SPEED SQUARE
MAX. TORQ. 40 % FLT

HP	AMPS	RPM	FRH	EFFICIENCY % FL	3/4FL	1/2FL	POWER FACTOR % FL	3/4FL	1/2FL	INRUSH % R/H
300	40	3578	3508	94.86	94.90	94.22	85.38	81.77	72.92	620
350	46	3577	3508	95.00	95.07	94.44	86.11	82.65	74.53	620
400	51	3575	3508	95.11	95.34	94.98	88.35	86.22	79.84	602
450	58	3574	3508	95.20	95.43	95.07	87.38	85.01	78.10	588
500	62	3574	3510	95.33	95.67	95.80	90.82	89.98	84.97	631
600	75	3570	3510	95.32	95.75	95.69	89.92	88.93	84.60	598
700	87	3579	4011	95.60	95.77	95.39	90.39	89.54	85.17	613
800	99	3577	4011	95.73	95.98	95.66	90.78	90.09	86.41	586
900	112	3578	4011	95.79	95.98	95.66	90.44	89.38	85.04	620
1000	124	3576	4011	95.84	96.09	95.86	90.27	89.33	85.41	578
1250	155	3577	4011	96.07	96.31	96.11	90.43	89.62	85.67	610
1500	186	3579	4512	96.08	96.27	96.00	90.55	90.14	87.22	540
1750	215	3578	4512	96.26	96.47	96.23	90.82	90.52	87.71	545
2000	246	3579	4512	96.36	96.55	96.30	90.84	90.32	87.16	574
2250	273	3580	4512	96.54	96.71	96.48	91.76	91.10	87.94	845
2500	305	3581	5014	96.58	96.66	96.33	91.31	90.98	88.22	566
3000	366	3582	5014	96.76	96.82	96.43	91.26	90.97	87.15	615
3500	417	3585	5614	96.92	96.95	96.10	93.64	93.81	92.81	641
4000	488	3586	5616	96.54	96.45	95.80	91.48	90.90	87.80	629
4500	544	3583	5616	96.86	96.78	96.30	92.13	92.54	91.17	542
5000	603	3585	5614	96.74	96.73	96.25	92.32	92.09	89.74	633
5500	656	3584	5616	96.82	96.90	96.55	93.17	93.48	92.23	601

HTR BFT2	LOAD BFT2	STG.SECS FV	STG.SECS 80%V	LK.RTR.SECS FV	LK.RTR.SECS 80%V	VAR	PFFC
68	123	6.02	11.21	33.44	55.12	12.0	95.1
91	141	5.71	10.66	29.32	48.41	17.0	95.6
99	158	5.71	10.78	27.57	45.62	17.3	96.1
55	174	5.65	10.70	25.03	41.38	17.2	95.5
63	191	4.95	9.26	22.44	37.48	11.3	96.9
63	221	5.51	10.56	21.59	35.93	12.0	96.0
105	251	5.82	11.24	21.05	36.65	11.0	96.2
109	279	5.91	11.58	20.77	34.75	17.0	96.0
114	307	5.22	10.07	17.72	29.70	12.0	95.8
119	333	5.55	10.84	17.77	28.71	13.0	95.6
135	394	4.69	9.07	14.25	23.96	10.0	95.7
192	450	5.38	10.78	13.04	21.91	10.0	95.2
219	501	5.09	10.14	11.91	20.00	14.0	95.3
229	547	4.42	8.69	10.21	17.22	10.0	95.3
261	590	3.83	7.66	8.67	14.74	11.0	96.0
340	628	4.88	9.82	10.40	17.55	14.0	95.6
382	693	4.00	7.86	8.37	14.49	15.0	95.8
629	749	4.01	7.89	8.31	14.28	19.0	96.4
662	785	4.14	8.20	8.54	14.42	10.0	95.2
695	813	4.64	9.62	9.22	15.56	12.0	95.1
768	831	3.54	7.02	7.48	12.71	17.0	95.6
861	839	3.61	7.25	7.87	13.37	14.0	95.9

NUMBER OF POLES 4
L[redacted]X2= 1.0 X NEMA
D[redacted] AL
[redacted] VOLTS, 60 HZ, 3 PH
SERVICE FACTOR= 1.15
CLASS B INSULATION TEMP. RISE
ENCL. DP
LOAD CHARACTERISTICS
TORQUE PROP. TO SPEED SQUARE
MAX. TORQ. 60 % FLT

STANDARD INDUCTI[redacted] MOTOR
CLASS D [redacted] S.F.

HP	AMPS	RPM	FRA	EFFICIENCY % FL	3/4FL	1/2FL	POWER FACTOR % FL	3/4FL	1/2FL	INRUSH % K/HP
250	36	1779	3505	94.33	94.76	94.58	80.05	75.27	64.90	545 5.3
300	43	1781	3507	94.63	94.99	94.66	78.72	73.23	62.65	904 5.8
350	49	1777	3507	94.55	95.12	95.14	82.04	78.31	69.29	922 5.02
400	55	1781	3507	94.95	95.41	95.36	82.73	78.33	68.52	840 6.0
450	62	1782	3507	95.05	95.48	95.42	82.49	77.97	68.01	849 6.1
500	66	1781	3509	95.28	95.78	95.84	84.96	81.57	73.30	640 5.9
600	80	1781	3509	95.48	95.94	95.99	84.92	81.13	72.82	824 5.7
700	93	1784	4008	95.70	96.16	96.17	84.89	81.90	74.11	594 5.4
800	106	1784	4008	95.82	96.25	96.28	85.13	82.13	74.34	615 5.62
900	120	1785	4010	95.98	96.31	96.21	84.29	80.88	72.40	831 5.8
1000	131	1785	4010	96.11	96.46	96.42	85.24	82.21	74.38	835 5.79
1250	164	1786	4509	96.22	96.55	96.48	85.19	82.60	75.29	976 5.2
1500	195	1787	4509	96.38	96.71	96.67	85.91	83.37	76.23	819 5.9
1750	228	1787	4511	96.46	96.74	96.65	85.53	82.70	75.10	637 5.76
2000	256	1787	5010	96.45	96.75	96.67	87.28	85.36	79.28	599 5.30
2250	289	1787	5010	96.40	96.70	96.63	86.95	85.03	78.88	588 5.23
2500	322	1787	5012	96.64	96.87	96.72	86.40	84.40	78.07	573 5.12
3000	372	1791	5811	96.90	97.13	97.01	89.54	88.53	84.28	614 5.28
3500	432	1791	5814	96.93	97.20	97.15	89.89	89.23	85.58	599 5.13
4000	490	1791	5814	97.03	97.30	97.26	90.50	89.99	86.74	620 5.27

MTR WK2	LOAD WK2	SEC.SECS FV	SEC.SECS 80%V	LR.RTR.SECS FV	LR.RTR.SECS 80%V	KVAR PFFC
79	1018	9.62	18.46	30.98	51.85	18.6 95.7
85	1196	8.38	19.81	24.67	41.33	2.0 95.5
90	1373	9.70	18.97	25.31	42.57	5.0 95.3
101	1545	7.28	13.75	19.03	32.24	9.0 96.6
107	1719	8.96	13.13	17.10	29.04	2.0 96.2
125	1879	7.20	13.73	17.87	30.46	10.0 96.7
142	2201	7.85	13.89	17.01	29.00	5.0 96.3
160	2513	6.39	10.60	20.22	34.48	13.0 96.1
211	2814	7.80	15.39	18.07	30.91	15.0 96.1
238	3107	7.39	14.45	17.14	29.25	18.0 95.8
265	3395	7.24	14.20	16.73	28.67	12.0 96.1
359	4072	8.72	17.60	19.04	32.43	18.0 95.3
410	4711	7.80	15.34	16.22	27.93	19.0 95.7
477	5312	6.94	13.87	14.59	25.14	19.0 95.7
632	5880	7.27	14.91	14.01	23.82	14.0 95.5
648	6417	7.10	14.24	12.91	21.98	18.0 95.0
701	6926	7.04	14.14	12.37	21.03	17.0 94.6
295	7863	8.73	18.97	16.62	28.51	14.0 96.1
376	8703	8.50	18.03	15.68	27.01	12.0 96.0
634	9454	7.78	17.08	15.12	26.17	8.0 96.2

ATTACHMENT A
(DC-1809 REV. 2, SUPPLEMENT S1)

SHT. A2 of A4

NUMBER OF POLES 6
LOAD WK2= 1.0 X NEMA
DESIGN A1
4000 VOLTS, 60 HZ, 3 PH
SERVICE FACTOR= 1.15
CLASS B INSULATION TEMP. RISE
ENCL. DP
LOAD CHARACTERISTICS
TORQUE PROP. TO SPEED SQUARE
MAX. TORQ. 60 % FLT

STANDARD MOTOR
CLASS [illegible].15SF.

HP	AMPS	RPM	FRM	EFFICIENCY % FL	3/4FL	1/2FL	POWER FACTOR % FL	3/4FL	1/2FL	INRUSH % K/H	MIN BFT2	LOAD BFT2	STG.SECS FV	80%V	LR.RTR.SECS FV	80%V	KVAR	PFFC
150	22	1186	3505	93.29	93.70	93.28	78.57	73.49	62.43	539	5.4							
200	30	1187	3505	93.78	93.96	93.46	77.05	71.63	60.27	559	5.1	85	1717	10100	18.76	39.63	66.83	98.0 95.7
250	36	1186	3505	93.76	94.32	94.18	80.42	76.47	66.64	527	5.2	98	2231	8.75	16.15	34.58	57.83	80.2 95.1
300	43	1186	3507	94.18	94.62	94.40	79.48	75.45	65.58	529	5.2	107	2743	9.59	18.21	27.77	47.09	82.2 95.1
350	51	1186	3507	94.16	94.62	94.39	78.77	74.69	64.75	530	5.2	120	3238	8.95	16.84	28.34	47.66	80.0 94.7
400	56	1188	3509	94.63	95.07	94.90	81.64	77.60	68.19	591	5.1	126	3722	8.79	16.98	29.27	48.93	85.0 93.9
450	64	1189	3509	94.71	95.04	94.76	80.52	75.93	65.46	632	5.1	156	4198	7.83	14.78	23.18	39.60	86.0 95.7
500	71	1189	3509	94.93	95.17	94.97	79.97	74.82	63.94	633	5.2	171	4685	8.95	12.97	19.50	33.36	91.0 95.6
												193	5185	6.51	12.04	19.83	33.69	93.0 95.2
600	82	1189	4008	95.18	95.31	95.13	82.92	80.02	71.68	583	5.5							
700	96	1190	4010	95.41	95.75	95.59	82.41	79.66	70.81	624	5.9	217	6028	8.38	16.22	23.28	39.96	96.0 95.3
800	111	1189	4010	95.46	95.74	95.48	81.10	77.47	68.21	601	5.7	313	6982	7.43	14.25	20.33	34.99	93.0 95.4
												349	7756	7.42	14.19	19.85	34.01	94.0 94.6
900	125	1189	4509	95.54	95.94	95.69	81.21	78.88	70.09	493	4.4							
1000	138	1190	4509	95.75	96.07	95.91	81.49	78.50	70.39	535	5.1	456	8591	10.49	21.04	28.41	44.73	99.0 93.2
1250	171	1191	4511	95.91	96.20	96.02	81.96	78.78	70.50	578	5.4	517	9408	9.19	18.10	23.95	40.70	93.0 93.7
												838	11378	7.88	15.34	20.80	35.52	90.0 94.2
1500	203	1192	5010	96.26	96.54	96.39	82.64	80.31	73.12	537	5.0							
1750	237	1192	5010	96.23	96.55	96.46	82.55	80.48	73.58	517	4.8	966	13257	9.89	20.06	27.31	46.57	99.0 93.8
2000	269	1193	5012	96.39	96.65	96.51	83.00	80.92	73.22	570	5.3	1004	15056	9.90	20.31	24.89	42.17	80.0 93.3
												1205	16778	8.42	16.83	22.51	38.76	95.0 94.0
2250	298	1193	5011	96.49	96.70	96.55	84.35	81.67	74.15	603	5.5							
2500	327	1192	5014	96.68	96.93	96.82	85.12	83.09	76.58	574	5.2	1715	18434	8.46	16.77	19.27	32.85	86.0 95.2
3000	392	1195	5614	96.91	97.10	96.94	84.92	82.68	75.83	634	5.7	1810	20028	8.19	17.10	19.25	32.86	91.0 95.1
												2392	23041	7.11	15.50	24.11	41.51	91.0 95.2

ATTACHMENT A
(DC-1809 REV. 2, SUPPLEMENT S1)
SHT. A3 OF A4

ATTACHMENT A
(DC-1809 REV. 2, SUPPLEMENT S1)
SHT. A4 OF A4

DESIGN A
4000 VOLTS, 60 HZ, 3 PH
SERVICE FACTOR= 1.15
CLASS B INSULATION TEMP. RISE
ENCL. DP
LOAD CHARACTERISTICS
TORQUE PROP. TO SPEED SQUARE
MAX. TORQ. 60 % FLT

CLASS - 1.15 SF

HP	AMPS	RPM	FRM	EFFICIENCY % FL	3/4FL	1/2FL	POWER FACTOR % FL	3/4FL	1/2FL	INRUSH % K/H	WR2	LOAD WR2	STG.SECS FV	80%V	LK.RTR.SECS FV	80%V	KVAR	PFFC
150	22	888	3505	93.03	93.31	93.14	78.22	72.65	61.08	585	130	3455	9.38	17.40	35.14	59.22	65.0	96.9
200	29	888	3507	92.96	93.62	93.33	81.15	76.49	65.80	561	170	4907	9.56	17.95	36.76	61.83	76.3	97.2
250	36	887	3507	93.33	93.99	93.95	80.11	75.78	65.48	533	185	5534	9.57	17.67	26.06	44.04	93.1	96.3
300	43	889	3507	93.80	94.29	94.09	79.18	74.69	63.14	578	218	6540	8.39	15.58	24.13	40.90	108.0	96.4
350	49	888	3509	93.85	94.32	94.36	82.25	78.46	69.73	539	282	7528	8.48	15.87	28.60	47.97	118.0	96.5
400	56	888	4008	94.10	94.74	94.76	82.29	79.33	70.78	519	328	8498	11.12	21.54	30.25	51.51	120.0	95.5
450	62	888	4008	94.26	94.91	94.98	83.12	80.58	72.61	518	374	9459	11.09	21.61	31.00	52.89	128.0	95.6
500	68	890	4010	94.46	95.03	95.02	83.73	81.03	72.99	552	455	10399	10.35	20.01	28.43	48.60	144.0	96.2
600	81	890	4010	94.71	95.26	95.27	84.11	81.59	73.86	558	513	12249	9.91	19.15	28.51	48.63	168.0	96.1
700	97	891	4509	94.97	95.54	95.58	81.76	79.81	72.49	502	650	14056	11.24	22.32	31.52	53.76	191.0	94.2
800	111	893	4509	95.36	95.74	95.59	81.15	78.07	69.32	573	758	15825	9.22	17.83	30.23	51.55	242.0	94.9
900	122	892	4511	95.50	95.93	95.89	82.97	80.84	72.47	598	932	17550	9.66	18.94	34.45	58.91	246.0	95.2
1000	136	893	5010	95.56	95.94	95.82	82.59	79.77	71.57	573	1010	19260	9.84	18.98	27.21	46.00	265.0	94.7
1250	167	893	5010	95.72	96.19	96.13	84.13	82.02	74.08	560	1229	23165	9.47	18.36	28.18	44.40	309.0	95.2
1500	200	894	5611	95.89	96.33	96.36	83.99	82.01	75.48	523	1713	27348	12.94	26.40	32.60	54.99	354.0	94.7
1750	234	894	5611	96.00	96.39	96.37	84.00	81.68	74.63	558	1961	31169	11.39	22.77	26.41	44.66	421.0	94.9
2000	265	894	5614	96.13	96.50	96.47	84.37	82.07	75.12	574	2252	34860	10.69	21.26	25.84	43.74	482.0	95.1
2250	298	895	5614	96.22	96.57	96.53	84.39	82.08	75.16	578	2431	38433	10.29	20.44	26.48	44.74	537.0	95.1

ENCLOSURE 2

Failure Analysis Associates®

ENGINEERING AND SCIENTIFIC SERVICES
2225 EAST BAYSHORE ROAD, P.O. BOX 51470
PALO ALTO, CALIFORNIA 94303 (415) 856-9400 TELEX 704216

FaAA-PA-R-88-06-06

June 15, 1988

Mr. David Pilmer
Southern California Edison Company
P.O. Box 800
Rosemead, California 91770

RECEIVED
JUN 17 1988
D. F. PILMER

RE: Analysis of Piston Skirt Integrity
Delaval Diesel Engines
San Onofre Nuclear Generating Station, Unit 1
FaAA Project No.: PA12842

Dear Mr. Pilmer:

This letter is in response to your letter of June 13, 1988 concerning the integrity of the modified AF piston skirts in service at San Onofre in the Delaval diesel engines. As you are aware, Failure Analysis Associates® performed an analysis of the modified AF piston skirts intended for use at the Shoreham Nuclear Power Station. These engines were rated at a BMEP of 225 psig at 100% load, and our results concerning the integrity of the modified AF piston skirts was that "cracks will initiate and may propagate in the AF. However, any cracks in the AF are predicted to arrest at depths less than 0.5 inch" (pg. iii of FaAA-84-5-18). These results are in accordance with the field observations of the modified AF Shoreham pistons. These pistons were suitable for their intended purpose at Shoreham in that they did not impair the operability of the engines.

Subsequent to the analysis of the Shoreham pistons, I also performed a corresponding analysis of the San Onofre pistons taking into consideration the reduced BMEP rating of 154 psig (from the factory test log). This reduction in the BMEP provides a reduction of the peak firing pressure. The peak firing pressure is the major contributor to stress in the piston skirt and is also available from the factory test logs of the engines. The results of my analysis on the San Onofre engines were, to my knowledge, never transmitted in writing to either Southern California Edison or the TDI Owner's Group. The results of my analysis were that cracks are likely to initiate in the piston skirt, and, under worst case conditions, the cracks could grow but would arrest at a depth of less than 0.45 inch. This is somewhat less than the predicted arrested crack depth of the Shoreham piston skirts.

In your letter of June 13, you requested an analysis of the piston skirt integrity at 135 psig ± 5%. Since the 135 psig + 5% (= 142) BMEP is close to the value of 154 that I previously analyzed, the conclusion concerning the

piston skirt integrity at 142 would be virtually the same as that at 154. Consequently, the conclusions for the Shoreham (at 225 BMEP) and San Onofre engines (at 142 BMEP) are nearly the same, with the arrested crack depth for San Onofre being more favorable.

The above analysis, and conclusions drawn therefrom, consider the final state of the cracks in the piston skirts after a very large number of stress cycles. If fewer cycles were placed on the piston skirts, then the depth of cracks present would be less than the final arrested depths mentioned above. The depth of such cracks after a limited number of stress cycles following crack initiation could be calculated by fracture mechanics procedures. The reduced size of cracks resulting from fewer cycles of operation would provide even more favorable crack depths.

Sincerely,

David O. Harris

David O. Harris
Managing Engineer
Fracture Mechanics

cc: J.M. Thomas/FaAA, PA