AUG 1 1985 E. HARRIS Rev. 4

CALCULATION TITLE PAGE NOTED 21 1984 V.R. REED Rev. 3 4

*SEE INSTRUCTIONS ON REVERSE SIDE

NOTED JAN 16 1984 Rev 2

A 5010.64 (FRONT)

CLIENT & PROJECT		PAGE 1 OF
NMPC - NMP2	[redacted]	61 6

CALCULATION TITLE (Indicative of the Objective):	QA CATEGORY (✓)
NORMAL STATION BATTERY 2BYS-BAT1B (1B1, 1B2, 1B3, 1B4) SIZING NORMAL STATION BATTERY CHARGER 2BYS-CHGR1B1 SIZING	☐ I - NUCLEAR SAFETY RELATED ☑ II ☐ III ☐ OTHER

CALCULATION IDENTIFICATION NUMBER				
J. O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALC. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.
12177	ELECTRICAL 391C	EC-45	NA	NA

* APPROVALS - SIGNATURE & DATE						
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)	REV. NO. OR NEW CALC NO.	SUPERSEDES * CALC. NO. OR REV. NO.	CONFIRMATION * REQUIRED (✓) YES	NO
J.M. Knudsen 12/2/83	Moran 1-17-84		REV. 2	EC-45 REV. 1	✓	
J.M. Knudsen 11/28/84 7/30/84	Hasko 12-17-84 Moran 8-8-85		REV 3	REV. 2		✓
S. Tsaw 7/7/88	M. Meritt		REV 5			✓
S. GLOVER 1-19-89	C Kolna 1/22/89 1-24-89		REV. 6	REV 5		✓

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DISTRIBUTION*					
GROUP	NAME & LOCATION	COPY SENT (✓)	GROUP	NAME & LOCATION	COPY SENT (✓)
RECORDS MGT. FILES (OR FIRE FILE IF NONE) Elect. Engrg.	M.T. Schildecker 4. July (NMPC)				

9304290063 911031
PDR ADOCK 05000410
S PDR

9304290063

07-15-91

[illegible]

CALCULATION IDENTIFICATION NUMBER				PAGE 2 △5
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
12177	ELECTRICAL	EC-45	N/A	

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STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

▲5010.65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 3 (5)
12177	ELECTRICAL	EC-45	N/A	

IOC from G. Fligg to J. Knudsen, 2/26/81	47
IOM dated 5/10/82	48
IOC From J. Sternchos to A.K. Gwal, 6/25/85	54
G.E. letter dated 6-19-85	55
G.E BULLETIN GET-6590, PAGE 8-7	60,61

1. Objective

EC-45, checks the Ampere-hour Capacity of Battery 2BYS-BAT1B (1B1, 1B2, 1B3, 1B4) in order to verify the adequacy of the batteries already purchased, and the adequacy of the purchased Battery Charger 2BYS-CHGR1B1.

2. Assumptions

a. The UPS loads from calculation EC-123, Rev. 2 are used in this calculation, unless otherwise noted

b. No factors for inaccuracies and growth are used.

c. Battery is sized to support the necessary loads for an orderly shutdown following simultaneous LOOP and unit trip.

d. Battery is sized for a two hour support time.

e. The lowest expected electrolyte temperature is the lowest room temperature in which the battery will be installed. ie 65°F

f. The method employed is the sizing procedure outlined in IEEE-485-1978

g. UPS inverters are not a charger load.

h. The essential lighting load of UPS 2YBB-UPS1D is assumed to occur for 90 minutes to satisfy the requirements of NEC article 700.

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i. Only 13 amperes out of 39.63 amperes of auxiliary relay and indicating light loads on "CEC" panels (pages 38 through 41 of this calculation) are considered in the battery duty cycle since all the loads will not be energized simultaneously. This is considered as random load that may appear any time during the duty cycle. The load is considered to occur for a full minute, to be conservative.

j The circuit breakers assumed to be tripping, are shown on pages 58 & 59. The tripping load is based on the 13.8KV, 4.16KV and 600V Undervoltage trips, all set at 3.0 seconds in accordance with applicable ER drawings.

SINCE EACH SWITCHGEAR AND LOAD CENTER D.C. BUS COULD BE CONNECTED TO EITHER BATTERY (2BYS-BAT1A OR 2BYS-BAT1B) FOR THE PURPOSE OF THIS CALCULATION IT IS ASSUMED THAT THE ENTIRE BREAKER TRIP LOAD IS SUPPLIED BY 2BYS-BAT1B.

K. ESOP is assumed to operate for 90 minutes

l. One high voltage disconnect switch is assumed to operate. Only the inrush current is assumed for one full minute which is conservative.

m. The load required to close one 13.8KV and one 4.16KV circuit breakers simultaneously has been assumed as the worst case breaker closing load. This is considered to be a random load that may occur at any time during the duty cycle. The breaker closing load has been assumed for one full minute to be conservative.

n. The ESOP and the diesel generator fuel oil booster pump are not considered as charger continuous load, because it is assumed they will have preformed their intenied function before AC power is restored (120 minutes).

3. Sources

a. Purchase Specification NMP2-E033A, Addendum 2, dated November 2, 1982.

b. Technical data by seller, by Gould Inc., dated March 17 1977 (Revised 5/27/83)

c. IEEE recommended practice for sizing Large Lead Storage Batteries for Generating Stations and Substations. IEEE 485-1978

(5) d. ETP-110.0.1 Verification of Lead Storage Battery Size (REV.0)

e. Specification NMP2-E035A, Uninterruptible Power Supplies, Add 4. dated 6/29/81; Exide and Elgar Instruction manuals

f. Drawings: 12177-EE-1BR-5, 12177-EE-M01G-1, 12177-EE-M01D-1

g. IOC G. Fligg to J. Knudsen, 2/26/81 (Attached)

h. Purchase Specification NMP2-E034A, Addendum 5, 11/8/82, "Static Battery Chargers".

i. Gould - Brown Boveri Bulletin 10.2-1E

j. SWEC ESK-11GM001-10

(6) k. Brown Boveri Bulletin IB6.1.2.7-1C (NMPC DOC. NO. N2G13200MISE001)

l. SWEC ESK-6WCS01-10

(6) m. ELGAR Instruction Manual UPS 103-1-176 (REV. 2) & UPS - 253-1-106, REV. 0 (NMPC NO. N2E20900IPW[illegible]

(6) n. EXIDE Instruction Manual 101-710-343 -77223 (UPS) REV. 00 (NMPC NO N2E35600IPWSUP001)

CALCULATION IDENTIFICATION NUMBER				PAGE 8 △5
J.O. OR W.O. NO. 12177	DIVISION & GROUP ELECTRICAL	CALCULATION NO. EC-45	OPTIONAL TASK CODE N/A	

△4 o. General Electric Bulletin GET-6590, Page 8-7. (SEE ATTACHMENTS, PAGES 60 & 61)

p. General Electric 4.16KV Swgr Instruction Manual (GEK 41902C).

q. General Electric Starter drawing 1.080-002-017A, 015B & 016B.

r. General Electric ESOP motor diagram 1.080-002-013A (later).

s. General Electric motor data sheet (ESOP) 1.080-002-0033,

t. Field data from nameplate of ESOP (from Rich York) hand carried by G. Nelson; Page 37 of this calculation,

u. Relay load charts pages 38-41 of this calculation,

v. TERRY RCIC pneumatic Gland Seal turbine System Instruction Manual, Section 10 NMPC Document # N2T12900TURBIN002, and dwg 1.340-211-223D.

w. IOM dated May 10, 1982, attached

△6 x. IOC from J. Sternchos to A.K. Gwal, attached (DATED 6/23/83)

y. Calculation EC-123, Rev. 2

z. ESK's: 5NPS01-13, 5RCS01-8, 5CNM04-10, 5FWS01-10
5CWS01-10, 5CWS03-9, 5CWS05-9, 5CNM06-11, 5ABM01-8
5ABM02-7, 5RCS02-8, 5CNM05-10, 2FWS02-10, 5CWS06-9
5CWS04-9, 5CWS02-9, 5FWS04-8, 5NPS04-13, 5CCS01-9
5HDL01-7, 5CNM01-6, 5CNM03-8, 5HDL03-9, 5CCS03-9
5CCP01-9, 5CNM07-9, 5CNM02-7, 5HDL02-9, 5CCS02-9
5CCP04-4, 5CCP06-4, 5RDS01-8, 5CCP03-8, 5RDS02-8
5CCP02-8, 5CCP05-4.

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12177	ELECTRICAL	EC-45	N/A	

4. Conclusions

The battery size, (2) 60-35 plate cells, as recommended by Gould Inc. in proposal, "Technical Data by Seller", Section 3 of NMP2-E033A, Addendum 1 dated March 2, 1978, is acceptable.

A 500 Ampere Battery Charger as Supplied by Power Conversion Products in "Technical Data by Seller", Section 3 of NMP2-E034A, Addendum 2, dated January 4, 1979 is acceptable.

5. Reason for Revision

5a. Reason for Revision 1

To calculate the Ampere-hour capacity of battery 2BYS-BAT1B(1B1, 1B2, 1B3, 1B4) and to verify the adequacy of Battery Charger 2BYS-CHGR 1B1. (Revision 0 of calculations EC-44 and EC-48 were only estimates of the battery and battery charger capacities).

5b. Reason for Revision 2

New loads were added to the battery.

5c. Reason for Revision 3

To reflect latest load information relative to FGCC

5d. Reason for Revision 4

To correct ESOP and Switchgear loads

5e. Reason for Revision 5

Revision 5 is done to improve legibility and to correct inaccuracies and typographical errors throughout the calculation. In addition the following changes have been incorporated:

1. UPS load per calculation EC-123 Rev 2 in lieu of EC-123 Rev. 0.
2. Starting time for ESOP is not required to be "checked later" as stated in Rev. 4, the reason being that the assumption made, (1 minute) is very conservative.
3. Latest loads for panels 2BYS-PNL3101, 3102, & 3107.
4. Incorporate breaker trip load for LOOP with Unit trip scenario. This scenario represents the worst possible case.

Revised pages : all, except pages 37 thru 41 and 45 thru 57

New pages : 58, 59

5f. REASON FOR REVISION 6:

REVISION 6 HAS BEEN ISSUED TO ADD REV./DATE TO SOURCES d, K, m, n, o, Y AND CORRECTED REFERENCE SOURCE (PAGE 13) TO SOURCE K.

PAGES REVISED : 1,2,7,8,13,3

PAGES ADDED : 11A, 60, 61

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12177	ELECTRICAL	EC-45	N/A	(5)

6. Loads Connected to the battery

Loads connected to the battery are Shown on Table 1. pages 17 and 18. These loads were determined as follows:

a. Circuit Breaker Operation

15KV, 5KV, manufactured by General Electric Co:

CLOSE OPERATION

1. circuit breaker control switch to close position
2. Close release coil (6 Amperes) is energized, releasing closing spring (Opening spring is charged simultenously)
3. Closing Spring is then charged (14 Amperes) while close circuit is interlocked open.

TRIP OPERATION

1. circuit breaker control switch to trip position or protective relay contact closes.
2. Trip coil (6 Amperes) is energized, releasing opening spring

See page 8 of this calculation, source p.

b. 600V Electrically Operated breakers manufactured by ITE:

CLOSE OPERATION

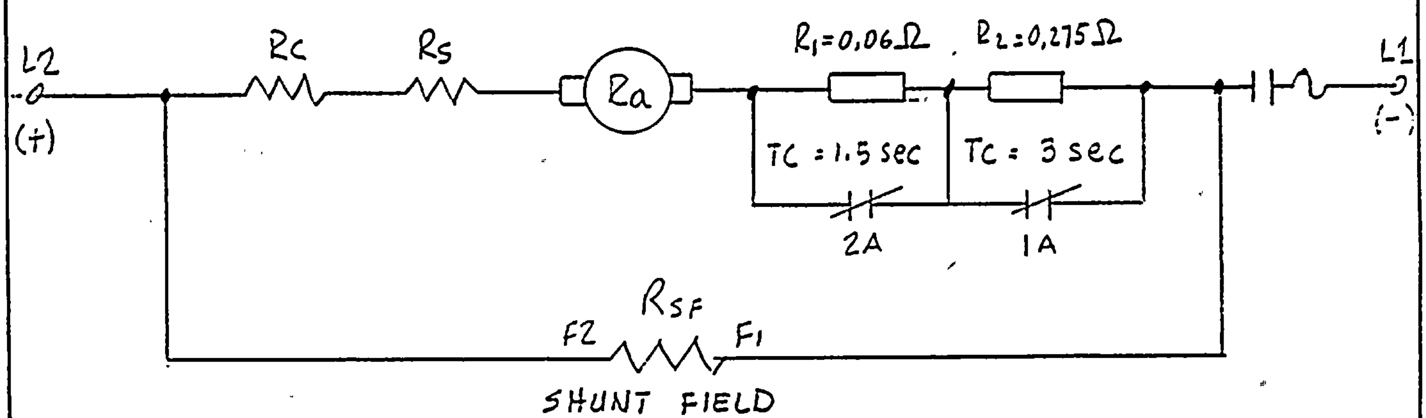
1. Circuit breaker Control switch to close position
2. Close release coil is energized, releasing closing spring
   CLOSE and TRIP springs are charged simultaneously after
   close

TRIP OPERATION

1. Circuit breaker Control Switch to trip position or Protective
   relay contact closes.
2. Trip coil is energized (1.3 Amperes) releasing opening
   spring.

   See source K., page 7 of this calculation. △6

c. Emergency Seal Oil Pump



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J.O. OR W.O. NO. 12177	DIVISION & GROUP ELECTRICAL	CALCULATION NO. EC-45	OPTIONAL TASK CODE N/A	

The following parameters are depicted in the above shown circuit

R_a = Armature Resistance

R_C = Commutating field Resistance

R_S = Series Field Resistance

TC = Time to Close

R_{SF} = Shunt Field Resistance

ESOP Nominal HP rating = 20

ESOP Nominal Volt rating = 125

I_{SF} = Shunt field Amperes = 0.925 Amperes (source t.)

wk^2 = load and motor inertia

ESOP starting current can be found as follows:

$$I_{START} = \frac{VOLTS}{R_a + R_C + R_S + R_1 + R_2} + I_{SF}$$

Assuming that $R_a + R_C + R_S \approx 0$ and neglecting I_{SF} since it is very small

$$I_{START} = \frac{123.8\ V}{(0.06 + 0.275)\ \Omega} \simeq 370 \text{ Amperes or less}$$

It is assumed that the 370 Amperes start immediately and last 1 full minute. This is very conservative since the motor will be up to speed in much less than 1 minute.

(Maybe 50 seconds less).

See G.E. Co. drawings, SWEC numbers 1.010-002-097D; 1.080-002-017A, 1.080-002-015D & 1.080-002-016D FOR starter wiring and resistor values.

d. UPS Input KW

2VBB-UPS1D - 70,100 VA load (See source y., page 8, this calculation). Load Power factor = 0.90 per Lighting Specialist.; efficiency of UPS unit is 84% when source is battery (per Source n.); Diversity and Utilization factor = 0.9 (per IOM dated May 10, 1982 page 48 of this calculation).

$$\text{Input KW} = \frac{70{,}100 \times 0.9 \times 0.9}{0.84} = 67.60$$

$$I_{o\ TIME} = \frac{67{,}600\ W}{123.8\ V} \approx 546\ A$$ where 123.8V is the battery open circuit voltage.

$$I_{120\ MINUTES} = \frac{67{,}600 W}{101 V} \approx 669\ A$$

$$I_{90\ MINUTES} = 546 + (669 - 546)\frac{90}{120} \approx 638\ A$$

$$I_{45\ MINUTES} = (546 + 638)\cdot\tfrac{1}{2} \approx 592\ A$$

2VBB-UPS3B - Although this UPS is only loaded to 7,080 VA, it will be assumed that it is operated under full load. Per Spec. NMP2-E035A Addendum 5 pages A5-19 and A5-21, the input dc current with minimum input dc voltage when the UPS is operated under full load, is 113 A. The minimum required dc voltage is 103 V. Based on the above values of current and voltage it will be conservatively assumed that the input KW of the UPS is Input KW = 113 × 103 = 11.64 KW, then

$$I_{0\,TIME} = \frac{11,640\ W}{123.8\ V} = 94\ A$$

$$I_{120\,MINUTES} = \frac{11,640\ W}{101\ V} = 115\ A$$

$$I_{90\,MINUTES} = 94 + (115-94)\frac{90}{120} = 110\ A$$

$$I_{45\,MINUTES} = \frac{94+110}{2} = 102\ A$$

e. Miscellaneous loads

Miscellaneous loads are depicted in Table 1 along with the loads already discussed in this section.

TABLE 1 : CONNECTED LOADS

	DESCRIPTION	LOAD: TRIP COIL QUANT	LOAD: TRIP COIL AMP/COIL	LOAD: TIMERS QUANT	LOAD: TIMERS AMP/TIM	LOAD: AUX. RELAYS QUANT	LOAD: AUX. RELAYS AMP/REL	LOAD: IND. LIGHTS QUANT	LOAD: IND. LIGHTS AMP/LT	AMPERES INRUSH	AMPERES STEADY STATE	HP	KW	KVA	ACTUAL INPUT KW
	2VBB - UPS1D	-	-	-	-	-	-	-	-	-	-	-	-	75	67.6
	2VBB - UPS3B	-	-	-	-	-	-	-	-	-	-	-	-	10	11.64
	2GMO-P2 (ESOP)	-	-	-	-	-	-	-	-	370	141	20	-	-	-
	2ICS-C1 (COMPR)	-	-	-	-	-	-	-	-	145	58	7.5	-	-	-
	2EGF-P4 (DGFP)	-	-	-	-	-	-	-	-	30	7.5	1	-	-	-
13.8KV SWGR	2NPS - SWG001	8	6	-	-	-	-	28	0.06	49.38	1.68	-	-	-	-
13.8KV SWGR	2NPS - SWG003	8	6	-	-	-	-	28	0.06	49.38	1.68	-	-	-	-
13.8KV SWGR	2NPS - SWG004,5	-	-	-	-	-	-	4	0.06	0.24	0.24	-	-	-	-
13.8KV SWGR	2NPS - SWG002	2	6	-	-	-	-	6	0.06	12.35	0.36	-	-	-	-
4.16KV SWGR	2NNS-SWG011, 012 013, 014, 015	17	6	-	-	-	-	65	0.06	105.9	3.9	-	-	-	-
4.16KV SWGR	2NNS-SWG016, 017 018	-	-	-	-	-	-	6	0.06	0.36	0.36	-	-	-	-
600V SWGR	FEEDER BREAKERS	49	1.3	3	0.06	13	0.06	43	0.06	67.24	2.58	-	-	-	-

TABLE 1 : CONNECTED LOADS

	DESCRIPTION	LOAD: TRIP COIL QUANT	LOAD: TRIP COIL AMP/COIL	LOAD: TIMERS QUANT	LOAD: TIMERS AMP/TIM	LOAD: AUX. RELAYS QUANT	LOAD: AUX. RELAYS AMP/REL	LOAD: IND. LIGHTS QUANT	LOAD: IND. LIGHTS AMP/LT	AMPERES INRUSH	AMPERES STEADY STATE	HP	KW	KVA	ACTUAL INPUT KW
125VDC	2BYS-SWG001B	–	–	–	–	–	–	1	0.06	–	–	–	–	–	–
	2CEC-PNL732	–	–	–	–	10	0.03	10	0.06	0.90	5.69*	–	–	–	–
	2CEC-PNL733	–	–	–	–	4	0.03	4	0.06	0.36	5.86*	–	–	–	–
	2CEC-PNL744	–	–	–	–	7	0.03	7	0.06	0.63	28.13*	–	–	–	–
	2YUL-MDS2	1	5.93	–	–	–	–	1	0.06	30.0**	7.0	0.75	–	–	–
	2YUC-MDS4	1	5.93	–	–	–	–	1	0.06	30.0**	7.0	0.75	–	–	–
	2YUC-MDS20	1	5.93	–	–	–	–	1	0.06	30.0**	7.0	0.75	–	–	–
	2YXC-MDS1	1	5.93	–	–	–	–	1	0.06	30.0**	7.0	0.75	–	–	–
	2BYS-PNLB101										16.30***				
	2BYS-PNLB102										5.80***				
	2BYS-PNLB107										30.50***				

* See Assumption i., page 5 of this calculation

** See Assumption l., page 5 of this calculation

*** See panel schedules, pages 42-44 of this calculation

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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CALCULATION IDENTIFICATION NUMBER				PAGE 19 ⚠5
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12177	ELECTRICAL	EL-45	N/A	

NOTES FOR TABLE 1

1. The tripping load occurs within 0.23 seconds. Tripping load is 274.66 Amperes, maximum. (35×5)+(49×.2)+(35×.35).

2. The immediate motor inrush is 545 Amperes (370+145+30) and it is assumed to last for one full minute, which is conservative.

3. Used total of 180 indicating lights for all switchgear; 180×0.06=10.80 Amperes. This value plus 1.89 Amperes for PGCC relays and lights and 0.24 Amperes for high voltage switch indicating lights, equals 12.93 Amperes. This load of 12.93 Amperes is used on page 22 of this calculation.

4. See sources m and n for UPS sources.

5. The load Amperes for 2BYS-PNLB107 does not include intermittent use of breaker test cabinets. it is assumed testing will be interrupted during loss of AC power. Also, the load does not include 2EGF*P4, since it is counted separately with other motor loads.

7. Determination of the battery duty cycle

Page 22 depicts the battery loads considered, the time they occur and their duration. Certain loads such as the high voltage switches have been designated as random load since they may appear any time during the duty cycle.

Page 23 depicts the sum of battery loads by time period. The ½ total load is also shown, because the Duty cycle Diagram is constructed for a single battery although in reality two identical batteries are used.
Page 24 depicts the battery Duty Cycle Diagram.

The following constitutes the basis for selection of "Start Time" and "duration" for certain dc loads:

2EGF-P4 : Per FSAR page 9.5-24a the electric motor driven fuel booster pump is a standby pump. However, the pump starts and primes the engine driven pump, when the start signal is given for the engine to start. The pump

stops after a speed signal is given from the engine. But, the fuel booster pump will also start if fuel pressure in the main header downstream of the engine driven pump falls to 25psi. Based on the above it will be assumed that the pump starts at t=0 and continues to run for 120 minutes.

Random load : The current from panels 2CEC-PNL732, 733 and 744 (13 Amperes), the inrush current resulting from the opening of one high Voltage switch (30 Amperes) and the closing of one 13.8KV and one 4.16KV circuit breakers (28A) will constitute the random load. This load will be applied at the most critical time of the duty cycle in order to simulate the worst case load on the battery. This is in accordance with IEEE Std 485-1978.

WORK SHEETS
FOR
STORAGE BATTERIES - LEAD-ACID

A. Length of duty cycle 120 minutes

B. Loads

		Amp	Start Min (1)	Duration Min
Breaker Tripping	(2)			
ALL SWGR AND PGCC PANELS		274.66	0	1
Continuous Control				
INDICATING LIGHTS		12.93	0	120
Emergency Lighting		546-592		
2VBB-UPS1D		638	0	90
Inverters		94-102		
2VBB-UPS3B		110-115	0	120
Motor Starting Inrush	(3)			
EMERGENCY SEAL OIL PUMP (2GMO-P2)		310	0	1
TURB. GLAND SEAL COMPR (2ICS-C1)		145	0	1
DIESEL GEN FUEL PUMP (2EGF-P4)		30	0	1
Motor Running				
EMERGENCY SEAL OIL PUMP (2GMO-P2)		141	1	89
TURB. GLAND SEAL COMPR (2ICS-C1)		58	1	119
DIESEL GEN FUEL PUMP (2EGF-P4)		7.5	1	119
Other Loads				
2BYS-PNLB101, 102, 107		60	0	120
RANDOM LOAD: 2YUL-MDS2		30		1
2CEC-PNL732, 733, 744		13		1
Breaker Closing, etc.	(4)			
13.8 & 4.16 KV SWGR, 1 EACH (RANDOM LOAD)		23		1

(1) "Start" means time from start of cycle to load application. For other notes, see next page.

BATTERY LOAD TABULATION

BY TIME PERIOD

TIME PERIOD	INCREMENTAL LOADS, AMPERES	TOTAL LOAD AMPERES	1/2 TOTAL LOAD (AMPERES)
0 – 1 min.	271.66 + 12.93 + 546 + 94 + 370 + 145 + 30 + 60	1532.59	≈ 766
JUST AFTER 1 min	12.93 + 546 + 94 + 141 + 58 + 7.5 + 60	[illegible]	≈ 460
45 min	12.93 + 592 + 102 + 141 + 58 + 7.5 + 60	[illegible]	≈ 487
90 min	12.93 + 638 + 110 + 141 + 58 + 7.5 + 60	[illegible]	≈ 514
JUST AFTER 90 MIN	12.93 + 110 + 58 + 7.5 + 60	[illegible]	≈ 124
120 min	12.93 + 115 + 58 + 7.5 + 60	253.43	≈ 127

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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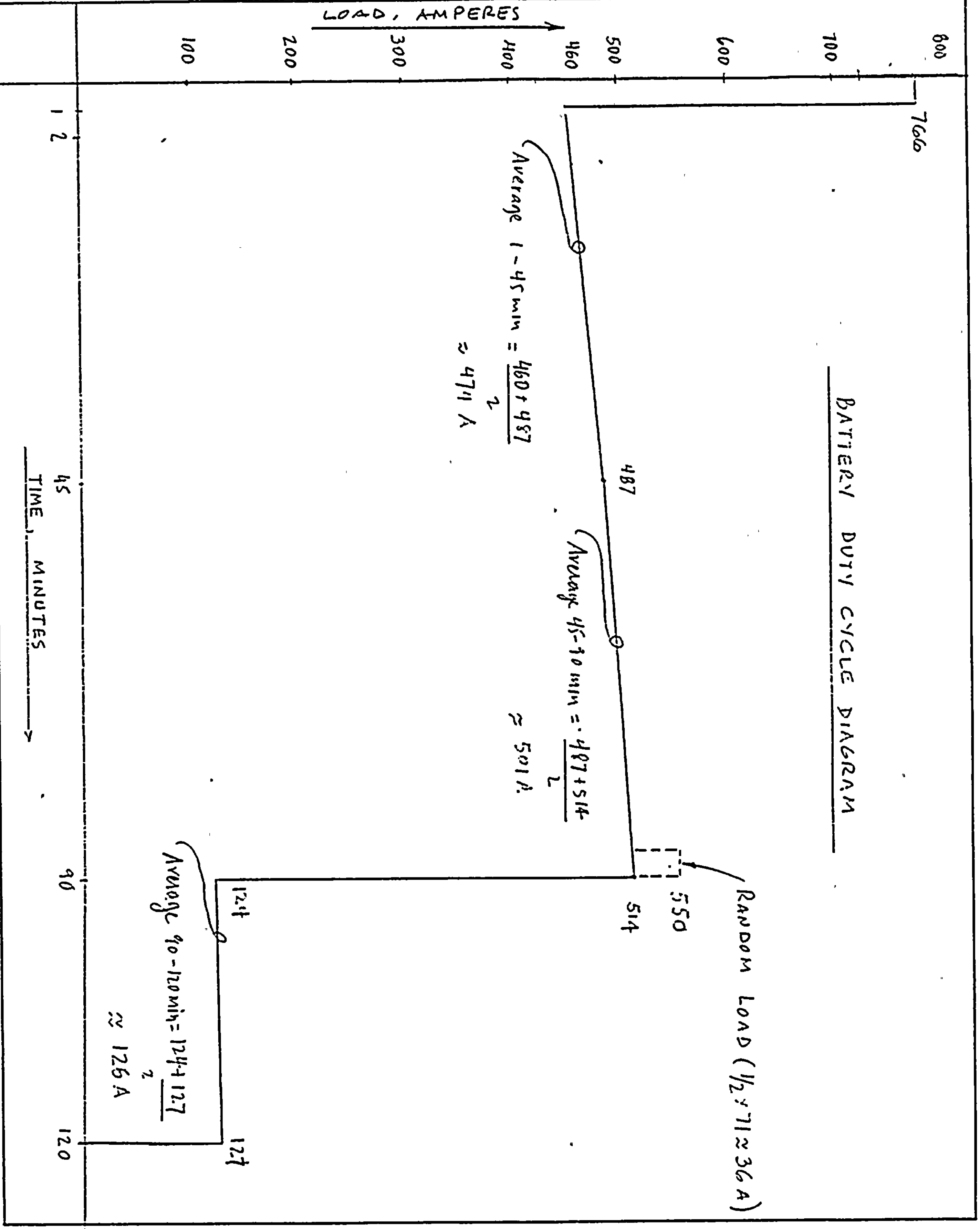
CALCULATION IDENTIFICATION NUMBER				PAGE 24 (5)
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
12177	ELECTRICAL	EC-45	N/A	



CALCULATION IDENTIFICATION NUMBER				PAGE 25 (5)
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
12177	ELECTRICAL	EC-44	N/A	

8. Explanation of Battery sizing form (page 30, this calculation) complying with IEEE-485 and EC-110.0.1.1-0, page 3

(1) Period is a particular segment of the load profile. For example, 0 to 1 minute is period no. 1, since it is the first period starting from zero (on the left side). The term section is the number of periods under consideration. Section 3 indicates 3 periods are being considered.

(2) Load (amperes), A1 for example, is the load for period 1. (1532.59/2 ≈ 766 amperes in this case)

(3) Change in load (amperes), is the change from one period to the next.

(4) Duration of period (minutes) M1, is the time for a particular period in minutes.

(5) Time to end of section (minutes), T, is the time from T=0 to the time at the end of the section under consideration.

(6A) R_T = Amperes per positive plate
Section 1 R_T is obtained by first referring to Gould capacity Table, page 45, 1 minute rating to 1.75 volts per cell column and finding the nearest value equal to or greater than A1. (See (2), above).

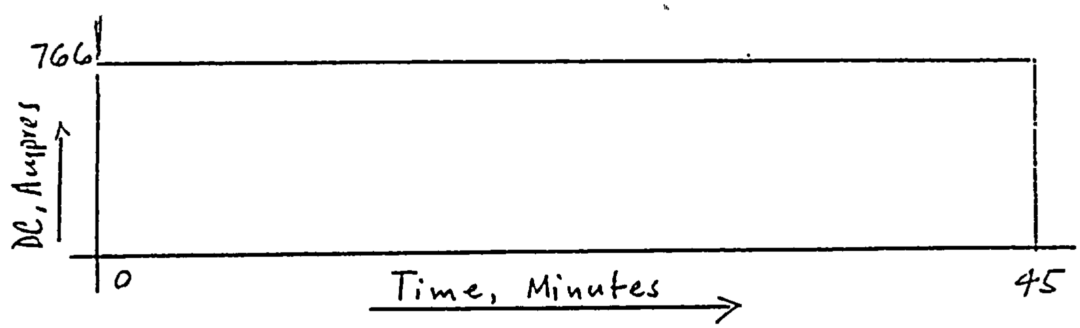
This value is then divided by $\frac{\text{Plates/cell}-1}{2}$ for the battery type matching the 1 minute rating used above, the quotient being R_T. For example, type NCX-750 has a 1 minute rating of 880 Amperes. This type has 11 plates per cell. (11-1)/2 equals 5; 880/5 = 176 Amperes/p.p. In our case A1 = 766 Amperes; therefore 766/176. (R_T) = 4.35 p.p. or positive plates for Section 1. It should be noted that there is always one more negative plate than positive plates

<u>Section 2 R_T</u> is obtained directly from the battery manufacturer's discharge characteristics for the type of cell whose size this calculation is attempting to verify. In our case the Gould characteristic curve is TC-107011B for NCX-2550, shown on page 46 of this calculation. For example, Section 2, period A1, shows a value of 766 Amperes. T, [see (4) above] = M1 + M2 = 45 minutes. Refer to TC-107011B where the 3/4 hour line intersects the 1.75 final voltage curve. A vertical line dropped from this point will intersect the Bose line or Amperes per positive plate line at 86.5 Amperes/p.p. This is the discharge rate for 3/4 hour to 1.75 volts/cell final voltage.

(7) Required Section Size : (3) ÷ (6A) = Number of positive plates ; using the numbers above we have,

$$766 \text{ Amperes} \times \frac{1 \text{ p.p.}}{86.5 \text{ Amperes/p.p.}} = + 8.86 \text{ p.p.}$$

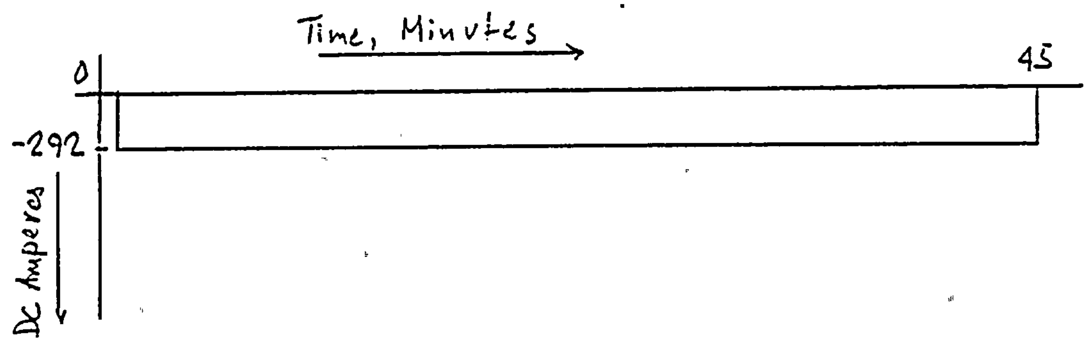
This represents the required number of positive plates for the following period.



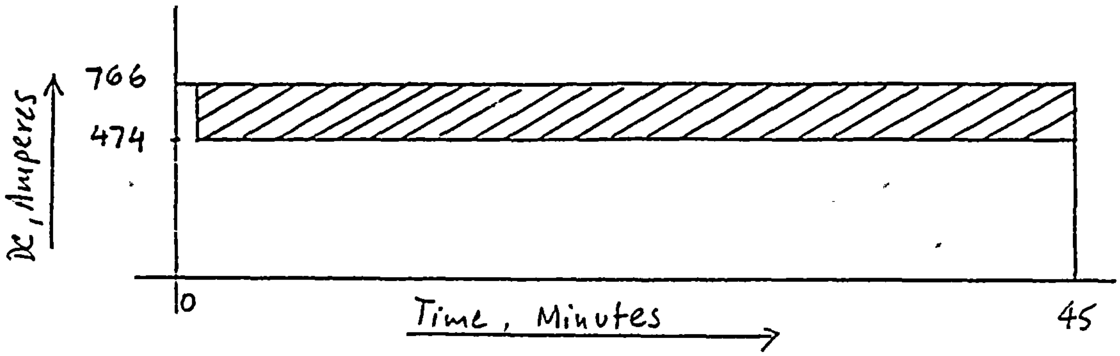
Continuing with Section 2 the second period is 474 - 766 = -292 Amperes. The time T is 44 minutes Referring to TC-107011B yields 86.7 Amperes/p.p. ; thus

$$-292 \times \frac{1 \text{ p.p.}}{86.7 \text{ A/p.p}} = 3.37 \text{ Amperes for the fictitious}$$

period shown below.



Superimposed, the profile looks as follows with no random load



The difference value (3.37) is subtracted from the positive value giving the number of positive plates required; this is 5.49 p.p.

Section 3 R_T is obtained in a similar fashion using the appropriate discharge rate from Gould characteristic curve TC-1070118 for 90 minutes, 89 minutes and 45 minutes.

Since each section subsequent to section 2 in the duty cycle is not greater than the previous section, the only additional consideration is the Random equipment load, which as mentioned earlier is 7.1 Amperes and has not been included in the duty cycle.

R = Random period, minutes

AR = Random load, amperes applied at the end of the section from which the largest number of positive plates was obtained.

MR = Duration of Random period.

T = Time to end of Random Section

Take the number of positive plates required from section 3 as previously calculated. For our case 8.16 p.p. Go to Gould capacity Table on page 45 and in the one minute rating to 1.75 volts per cell column, find the value corresponding to a type with the same or greater number of positive plates. For our case 9.0 is the next greater whole number. Select NCX-1350 with one minute rating of 1494 Amperes.

For NCX-1350 R_T = 1494 Amperes/9 p.p. = 166 A/p.p.

Dividing AR by R_T : 36 Amperes $\times \frac{1\text{ p.p.}}{166\text{ Amperes}} \simeq 0.22$ p.p. for the Random load.

The number of positive plates required for each section and the Random load are inserted in the appropriate spaces on page 30 for final verification sizing.

J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION IDENTIFICATION NUMBER: CALCULATION NO.	OPTIONAL TASK CODE	PAGE
12177	ELECTRICAL	EC-45	N/A	30. (5)

Lowest Expected Electrolyte Temp: 65° F   Minimum Cell Voltage 1.75 V/C   Cell Manufacturer Gould   Cell Type 2- NCX-2550

(1) Period	(2) Load (Amperes)	(3) Change in Load (Amperes)	(4) Duration of Period (Minutes)	(5) Time to End of Section (Minutes)	(6) Capacity at T Min. Rate @ 77 F (6A) Amps/Pos (R_T) or (6B) K Factor (K_T)	(7) Required Section Size (3) ÷ (6A) = Positive Plates (3) x (6B) = Rated Amp Hours Pos Values	Neg Values
Section 1 - First Period Only - If A2 is greater than A1, go to Section 2.							
1	A1= 766	A1-0= 766	M1= 1	T=M1= 1	176	4.35	***
					Sec 1 Total		***
Section 2 - First Two Periods Only - If A3 is greater than A2, go to Section 3.							
1	A1= 766	A1-0+ 766	M1+ 1	T=M1+M2= 45	86.5	8.86	
2	A2= 474	A2-A1=-292	M2= 44	T=M2= 44	86.7		3.37
					Sec Sub Total	8.86	3.37
					2 Total	5.49	***
Section 3 - First Three Periods - If A4 is greater than A3, go to Section 4							
1	A1= 766	A1-0= 766	M1= 1	T-M1+M2+M3= 90	60.5	12.66	
2	A2= 474	A2-A1=-292	M2= 44	T=M2+M3 89	60.7		4.81
3	A3= 501	A3-A2= 27	M3= 45	T=M3= 45	86.5	0.31	
					Sec Sub Total	12.97	4.81
					3 Total	8.16	***
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5							
1	A1= 766	A1-0= 766	M1=	T=M1+...M4=			
2	A2= 474	A2-A1=-292	M2=	T=M2+M3+M4=			
3	A3= 501	A3-A2= 27	M3=	T=M3+M4=			
4	A4= 126	A4-A3=-375	M4=	T=M4=			
					Sec Sub Total		
					4 Total		***
Section 5 - First Five Periods Only - If A6 is greater than A5, go to Section 6							
1	A1=	A1-0=	M1=	T=M1+...M5=			
2	A2=	A2-A1=	M2=	T=M2+...M5=			
3	A3=	A3-A2=	M3=	T=M3+M4+M5=			
4	A4=	A4-A3=	M4=	T=M4+M5=			
5	A5=	A5-A4=	M5=	T=M5=			
					Sec Sub Total		
					5 Total		***
Random Equipment Load Only (if needed)							
R	AR= 36	AR-0= 36	MR= 1	T=MR= 1	166	0.22	***

[WAS PAGE 10]

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

▲ 5010.65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 31
12177	ELECTRICAL	EC-45	N/A	△5

Maximum Section Size 8.16 Plus Random Section Size 0.22 Equals 8.38

Uncorrected Size ________. Uncorrected Size 8.38 Times Temperature Correction 1.08 Times Design Margin 1.0 Times Aging Factor 1.25 . Equals 11.31 . When the cell size is greater than a standard cell size, the next larger cell is required.

Required Cell Size: (A) 12 Positive Plates

or

(B) 1300 Ampere Hours

Therefore cell NCX - 1800 is

for half capacity. .
(acceptable, ~~not acceptable~~)

Since the battery supplied consists of NCX-2550 cells, the UMP2 battery has 41.7% excess capacity. (ie $\frac{2550}{1800} = 1.4166$)

CALCULATION IDENTIFICATION NUMBER				PAGE 32 ⚠5
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
12177	ELECTRICAL	EC-45	N/A	

9. Voltage Profile determination

To determine the voltage at different times during the duty cycle the Work Sheet for Lead-Acid batteries Voltage Profile calculation is filled out; this appears on page 33 of this calculation. Columns (2) & (3) are based on data from the battery duty cycle. Column (4) or Adjusted Amperes is determined by multiplying the Ampere Rate on column (3) by the temperature correction factor, 1.08 and by the Aging factor, 1.25. Columns (5) and (6) are defined on the work sheet itself. Columns (3) and (4) use average values when the time span is long (30 minutes or longer); when the time span is short, say 1 minute, maximum values are used. Column (7) assumes that Ampere-Hours at the end of one step is equal to the beginning of the next step. Data on column (8) is obtained from Gould graph TC-10701[illegible] by plotting the appropriate curve at the intersection of the lines defined by data on columns (5) and (7). Column (9) is defined on the work sheet. Based on column (9) the voltage profile is plotted as shown on page 34.

EC-45
gc 33 (5)

WORK SHEETS FOR STORAGE BATTERIES
LEAD - ACID - VOLTAGE PROFILE CALCULATIONS

Calculated by ____________
Date ____________
Checked by ____________
Date ____________

J.O. No. 12177
Client NMPC
Station NMP2
Battery No. 2BYS-BAT1B
Spec No. NMP2-E033A
Spec Dated ____________

Length of Duty Cycle 120 minutes
Nominal Battery Voltage 125 v
No. Positive Plates per cell 17
No. of cells 60
Amp Hours per positive plate vs Amps per positive plate data source PAGE 45, GOULD TC-107011B

(1) Step	(2) Time in Min.	(3) Ampere Plate	(4) Adjusted Amps	(5) (4) / # Pos. Plates Amps per Positive Plate	(6) (2) x (5) / 60 Amp Hours Per Pos.	(7) Cumulative A.H. Discharge	(8) Volts per Cell (5) at (7)	(9) Battery Voltage (8) x number of cells in Series
1	1	766	1034	60.82	1.01	Beginning 0		
						End 1.01	1.917	115.02
2	44	474	640	37.65	27.61	Beginning 1.01	1.959	117.54
						End 28.62	1.935	116.10
3	44	501	676	39.76	29.16	Beginning 28.62	1.931	115.86
						End 57.78	1.890	113.40
4	1	550	743	43.70	0.73	Beginning 57.78	1.886	113.16
						End 58.51	1.885	113.10
5	30	126	170	10.00	5.00	Beginning 58.51	1.977	118.62
						End 63.51	1.970	118.20
6						Beginning		
						End		
7						Beginning		
						End		
n						Beginning		
						End		

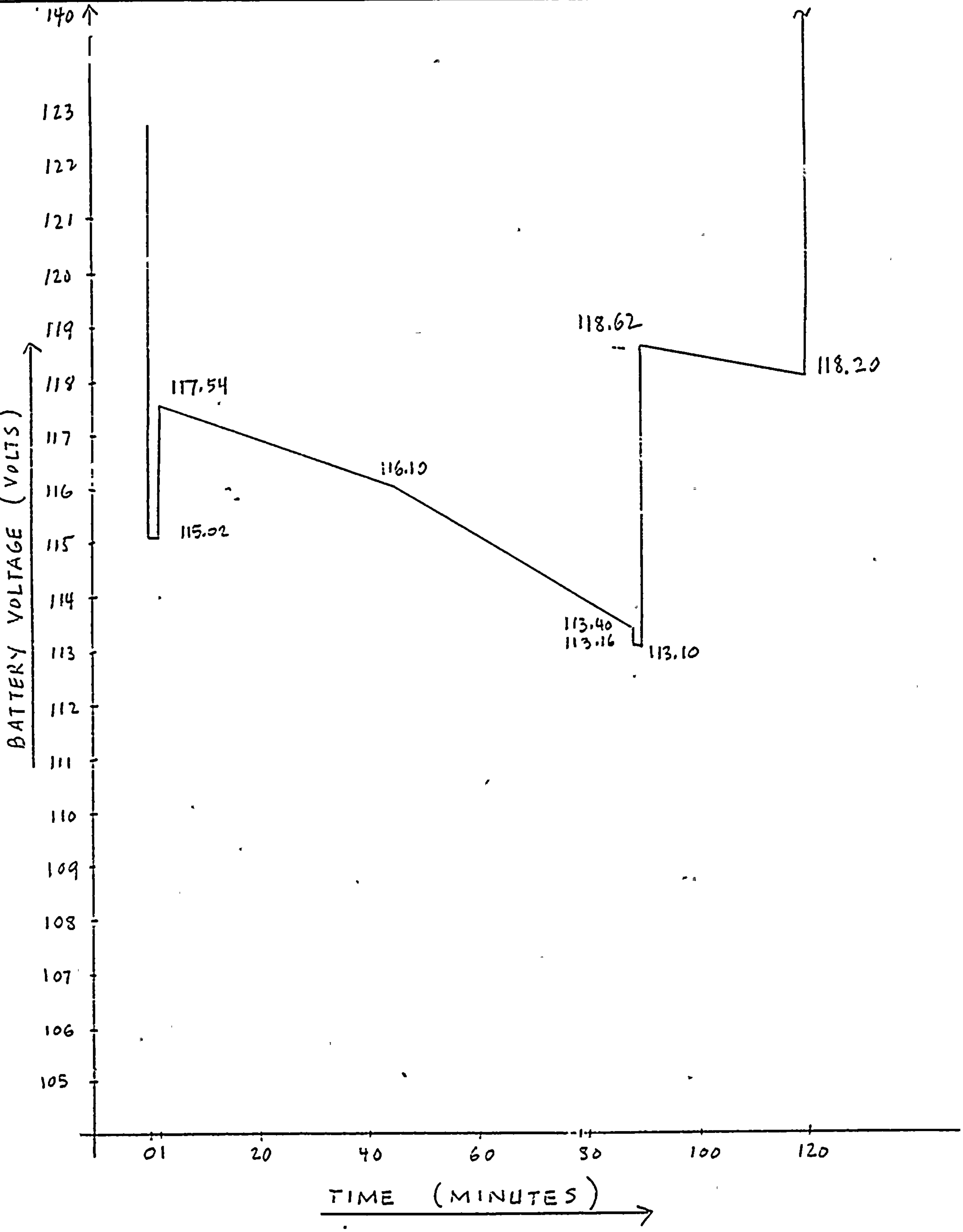
[WAS PAGE 8]

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

5010.65

CALCULATION IDENTIFICATION NUMBER				PAGE 34
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
12177	ELECTRICAL	EC-45	N/A	5



10. Battery Charger Calculation

Calculate the minimum charger rating:

$$A_r = \frac{AH \times C}{T_1} + A_c$$

where A_r = Required minimum charger rating in amperes
AH = Total ampere hours discharged from the battery during its specified duty cycle
C = Constant to allow for ampere hour efficiency. Use 1.10
A_c = Continuous battery load while charging, amperes
T_1 = Required maximum time for recharging

In this case AH equals equals (1734 Ampere hours x2) or 3468 Ampere-hours. 1734 Ampere hours is obtained from Gould curve # TC-107011B for a 2 hour discharge cycle as follows: for a discharge cycle of of 2 hours and 1.75 volts per cell the discharge characteristics of cell NCX-2550 yields 102 Ampere-hours per p.p.; since a NCX-2550 has 17 p.p. the discharge current will be 17x102 = 1734 Ampere-hours. For additional information on the determination of AH, see source g., attached.

T_1 is taken as 24 hours in accordance with source g.

$A_c = 12.93 \div 60 \approx 72$ Amperes

$$A_r = \frac{1734 \times 2 \times 1.1}{24} + 72 \approx 231 \text{ Amperes}$$

Assume a 300 Ampere Charger is provided and check the charging time.

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 36
12177	ELECTRICAL	EC-45	N/A	5

$$T_1 = \frac{1734 \times 1.1 \times 2}{300 - 72} = 16.73 \text{ hours}$$

Since a 500 Ampere battery charger is actually being supplied by Power Conversion Products, the Charging time (T_{500}) can be calculated as follows:

$$T_{500} = \frac{1734 \times 1.1 \times 2}{500 - 72} = 8.91 \text{ hours} \approx 9.0 \text{ hours}$$

A 500 Ampere Battery Charger is satisfactory since a 9.0 hour recharge time is less than 24 hours.

2GMO-P2-(ESOP)

20HP : 3000 RPM · 120V

NAMEPLATE INFO, HANDCARRIED FROM FIELD BY G. NOLAN; SEE P8, SOURCE ꜩ

Arm Amps 141 Wound Shunt

Field Amps .925 Field Ω @ 25°C 93Ω

INS CL F - Duty : Cont

Max Amb : 40°C

Suit : 2500 RPM
101 V
167 Amp Cold
Type : CO287AT
Enc. OPFG
Inst : GEH-3967
Model: 5CD173ZA801A800
SN CH-1-1022-DH

MRR 78-0165A-5
SSS 959 line 3

x Rush Pond 7998 (GE Turbine Gen.)

Vacuum Pump

2BYS-SWG001B to 2CEC-PNL732 (P809, P810, P815, P802)

DWG. No.	STEADY STATE LOAD	TRANSIENT LOAD	AMPS	SIZE AMPS
ESK-8SPR07	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ .06
		(1) 86-HEA	5.50	5.50
ESK-8SPR08	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ .06
		(1) 63-HGA	0.027	
		(1) 30-HAA	0.022	
ESK-8YUC05	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ .06
		(1) 94-HFA	0.486	
ESK-8SPX08	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ .06
		(1) 86-HEA	5.50	
ESK-5NNS13	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ .06
		(1) 86-HEA	5.50	
ESK-5NNS13	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ .06
		(1) 86-HEA	5.50	
ESK-8SPR10	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ .06
		(1) 86-HEA	5.50	
ESK-8SPR11	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ .06
		(1) 63-HGA	0.027	
		(1) 30-HAA	0.022	
ESK-8YUC05	(2) 74-HGA		0.06	0.06
	(2) Light		0.50	~~0.50~~ .06
		{(1) 94-HAA} {(1) 94-HFA}	0.486	
		{(1) 94-HAA} {(1) 94-HFA}	0.486	
			TOTAL SIZE AMPS	8.30

~~8.30 x 1.5 = 12.45~~

0.9 Inrush
5.64 Random

2BYS-SWG001B to 2CEC-PNL733 (P806, P807)

DWG. NO.	STEADY STATE LOAD	TRANSIENT LOAD	AMPS	SIZE AMPS
ESK-8SPR06	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		(1) 86-HEA	5.50	5.50
ESK-8SPR08	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		(1) 63-HGA	0.32	—
		(1) 30-BAA	0.022	—
ESK-8YUC05	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		{(1) 94-HAA, (2) 94-BFA}	0.368	—
ESK-8SPX04	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		(1) 86-HEA	5.50	—
		~~TOTAL SIZE AMPS~~		~~6.62~~

SIZE AMPS = 6.62 x 1.5 = 9.93 Amps.

D.3.86 Dwiwoh
9.86 Ransom

2BYS-SWG001B to 2CEC-PNL744 (P.866, P867, P865)

DWG No	STEADY STATE LOAD	TRANSIENT LOAD	AMPS	SIZE AMPS
ESK-8SPG04	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		(1) 86-HEA	5.50	5.50
		(1) 86-HEA	5.50	5.50
		(1) 86-HEA	5.50	5.50
ESK-8SPU04	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		(1) 86-HEA	5.50	
		(1) 86-HEA	5.50	
		(2) 94-HFA	0.368	
		(1) 59-HFA	0.486	
		(1) 50-HGA	0.032	
		(1) 50-HGA	0.032	
ESK-8SP503	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		(1) 63-HGA	0.027	
		(1) 30-HAA	0.022	
ESK-8SPM04	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		(1) 30-HAA	0.022	
		(1) 63-HGA	0.027	
ESK-8SPU03	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		(1) 86-HEA	5.50	
		(1) 86-HEA	5.50	
		(2) 94-HEA	0.368	
			TOTAL SIZE AMPS	~~17.9~~

~~17.9 x 1.5 = 26.85~~

3 5

2BYS-SWG001A to 2CEC-PNL744 (P864)				
DWG. No.	STEADY ST.		AMPS	SIZE AMPS
ESK-8SPU02	(1) 74-HGA		0.03	0.03
	(1) Light		0.25	~~0.25~~ 0.06
		S (2) 94-HFA	0.368	—
		P (2) 86-HEA	11.00	11.00 *
ESK-8SPU06	(1) 74-HGA		0.03	0.03
	Light		0.25	~~0.25~~ 0.06
		(1) AMX-HFA	0.486	—
		TOTAL SIZE AMPS		~~11.56~~

0.63 Inrush
28.13 Random

~~11.56 x 1.5 = 17.34 Amp~~

5.86
28.13
~~5.64~~
~~29.63~~ = 13 Amps Random Load for PGCC Panels
~~3~~

~~Estimated Diversity Factor~~

.63
.36
.9
1.89

PRIN	ISSUE 1	ISSUE 2	ISSUE 3	ISSUE 4
APPR.				

CLIENT N.M.P.C. STA NINE MILE - UNIT 2 REF DWGS ENG. 420-221 095 JO 12177

PNL NO SERIES LVB EQPT NO 2BYS-PNLB101 LOC CONTROL BLDG COL 10.5/AD ELEV 306

SVCE 125VDC PH ___ W 2 NEUT ___ MNS: LUGS ONLY, ~~CKT BRKR~~ ~~FUSED SW~~ - CONN:

BR CKTS ___ ~~CKT BRKR,~~ FUSED SW - MTG: ~~FL~~, SURF - NEMA TYPE 12 FDR SIZE ___

XFMR MK NO ___ EQPT NO ___ KVA ___ ADD'L FEATURES ESSA F.

NO	SERVICE	LOAD CONN	LOAD TERM CAB	AMP	CKT	CKT	AMP	LOAD TERM CAB	LOAD CONN	SERVICE
✓	2FU1SN35 (80TEIFNTY [illegible])	5A	-703	30	1	2	30	*753	12VA	2HVY420 (7HVY10)
	2SWPA62 (1SWP03)	50W	*753		3	4		*753	36VA	2HVCN35 (7HVC10
	2MSSN05 (1MSS05)	12VA	*753		5	6		*753	6W	2HVPN11 (7HVP08)
	2FPL-PNL177 (2)	2A			7	8		*753	6W	2HVPN12 (7HVP08)
	2FPL-PNL176 (2)	2A			9	10		*753	6W	2HVPN13 (7HVP08)
H	2CNMN06 (5CNM09)	140VA	*753		11	12		—	1.62A	2FLN33 (7FPL17)
	[illegible]	2A	[illegible]		13	14		—	1.0A	2SCIA[illegible] (7SCI[illegible])
	SPARE			60	15	16	60			SPARE
				60	17	18	60			
					19	20				
					21	22				
					23	24				
					25	26				
					27	28				
					29	30				
					31	32				
					33	34				
					35	36				
					37	38				
					39	40				
					41	42				

CONN LOAD: [illegible]

ULT LOAD: [illegible]

TOTAL LOAD: [illegible]

1 2 MASTER

NOTED DEC 29 1997 S. TSOMBARIS

EC-45

PAGE 42

TOTAL ESTIMATED AMPERES = 16.30

ISSUE 1 ORIGINAL ISSUE

DESIGNED BY / DRAWN BY AK / DSGN CHK'D BY / CHK'D BY

STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS.

DWG. NO. EE-10C-2

2BYS-PNLB101
DIV I SIDE

MASTER

5/24/82

PRINTS	ISS (1)			ISSUE (2)			ISS (3)			ISSUE (4)		
APP. CARD												

STONE & WEBSTER ENGINEERING CORP. BOSTON, MASS.

ISSUE 1 2 3 4 — DESCRIPTION: ORIGINAL ISSUE

CLIENT N.M.P.C. STA NINE MILE - UNIT 2 REF DWGS 0001.420-221-095 JO 12177

PNL NO SERIES 6VB EQPT NO 2BYS-PNLB102 LOC CBCR COL 14/AG ELEV 306

SVCE 125VDC PH ___ W 2 ~~NEUT~~ ___ MNS: LUGS ONLY, ~~CKT BRKR~~ ~~FUSED SW~~ - CONN: TOP

BR CKTS ___ ~~CKT BRKR,~~ FUSED SW - MTG: ~~FL~~, SURF - NEMA TYPE 12 FDR SIZE 2-1/C 750KCM PER LEG BOT

XFMR MK NO ___ EQPT NO ___ KVA ___ ADD'L FEATURES ~~VB-6~~ 225A BUS

NO	SERVICE	LOAD CONN	LOAD TERM CAB	AMP	CKT	CKT	AMP	LOAD TERM CAB	LOAD CONN	SERVICE	NO
	2WCSN19(828E255TY)SH	10VA	5A	30	1	2	30	C*754	6VA	2DRSB05(11DKS01)	
	2EGFB05(7EGF02)	6VA	C*754	↓	3	4	↓	C*704	75W	2RCSB15(761E791TY)SH 5	
	2HVCN36(7HVC15)	36VA	C*754		5	6		C*704	2A	807E165TY)SH.3 NMT	
	2EGAB03(11EGA02)	*10VA	C*752		7	8		~~*704~~	~~12W~~	~~(761E791TY)~~ SPARE	
HVY 014	2HVYB20L 1HVY10	10W	*754		9	10		*754	50W	2SWPB62 (11SWP03)	
	2FPWB06(7FPW07)	30W	*754		11	12				SPARE	
	2WCS-IPNL188(3)	1.5A*			13	14				↓	
	↓			60	15	16	60				
				60	17	18	60				
					19	20					
					21	22					
					23	24					
					25	26					
					27	28					
					29	30					
					31	32					
					33	34					
					35	36					
					37	38					
					39	40					
					41	42					

CONN LOAD: ~~[illegible]~~ 3.5A *EST

ULT LOAD: ~~[illegible]~~

TOTAL LOAD: ~~EST 5A~~ EST [illegible]

1 2

MASTER

* ANNOTED DEC 29 1987 S. TSOMBARIS (U)

TOTAL ESTIMATED AMPERES = 5.80

EL-45
PAGE 43

2BYS-PNLB102
DIV II SIDE

MASTER

DWG. NO. EE-11C-2
5/29/82

PRINTS				ISSUE (2)					ISSUE (4)		
APP. CARD											

STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS.

ISSUE	DESCRIPTION
1	ORIGINAL ISSUE
2	
3	
4	

CLIENT N.M.P.C. STA NINE MILE - UNIT 2 REF DWGS 0001.420-221-120 JO 12177
PNL NO VB-6 EQPT NO 2BYS-PNLB107 LOC NORM. SWGR COL L 6.0 / AK ELEV 261'
SVCE ____ PH ___ W ___ NEUT ____ MNS: LUGS ONLY, CKT BRKR FUSED SW - CONN: TOP
BR CKTS ____ ~~CKT BRKR,~~ FUSED SW - MTG: ~~FL~~, SURF - NEMA TYPE ___ FDR SIZE 1-1/c #4/0 PER LEG BOT
XFMR MK NO ____ EQPT NO ____ KVA ____ ADD'L FEATURES 1 F.L.S

NO	SERVICE	LOAD CONN	LOAD TERM CAB	AMP	CKT	CKT	AMP	LOAD TERM CAB	LOAD CONN	SERVICE	NO
	2ENS-BTC1,2,3	— x		30	1	2	30	—	—	2NNS-BTC1,2 (NPS-BTC1,2,3)	
	2RTX-XSR1B 1.130-203 006	1A*			3	4		-	1A	2MTX-XM1B (AUX CKT)	
	2RCS-PNL1B(3)2RCSB22	250W			5	6		—	15A*	2-JB7175(2EXSN04)8EXS09	
	SPARE				7	8		—	~~1A~~	2CTS-BTC1,3	
	2MTX-XM1D (AUX CKT)	1A			9	10		—	7.5A	2EGF*P4	
	SPARE				11	12				SPARE	
	2-JB7...(2EC...) [illegible]	-A		↓	13	14	↓			SPARE	
	2CES-PNL421 (2SPSY03)(1)	2A*		60	15 (40)	16 (40)	60		2A*	2CES-PNL421(8SPX09)	
	2CES-PNL421 (2SPRY17)(2)	2A*		60	17 (40)	18 (40)	60		2A*	2CES-PNL421 (2SPRX17)(3)	
					19	20					
					21	22					
					23	24					
					25	26					
					27	28					
					29	30					
					31	32					
					33	34					
					35	36					
					37	38					
					39	40					
					41	42					

CONN LOAD: 3? [illegible] 41.5 [illegible]
ULT LOAD: ____
TOTAL LOAD EST 40A
* - EST

NOTED DEC 29 1987 S. TSOMBARIS (B)

TOTAL ESTIMATED AMPERES = 38.0

EC-45
PAGE 44

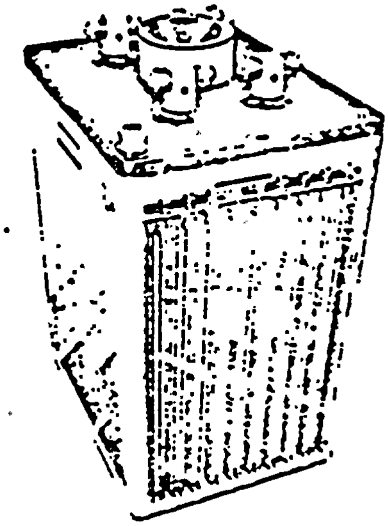
SEP 3 198[illegible]
MASTER

2BYS-PNLB107-

DWG. NO. EE-10E-2

DESIGNED BY
DRAWN BY A KENT
DSGN CHK'D BY
CHK'D BY
RESP. ENGR:
DSGN ENGR:
A 5215.10

TYPE: NCX



CAPACITIES—600 A.H. TO 2550 A.H. @ 8 HOUR RATE TO 1.75 V.P.C. AVERAGE

SPECIFICATIONS

Container—Styrene-Acrylonitrile Plastic.

Cover—Acryl.-Buta.-Styr. Terpolym. Plastic.

Separators—Microporous Material.

Retainers—Fiberglass Mats.

Posts—See Below.①

Post Seals—Floating O-Ring—Seal Nut.

Vents—Screw Type—Spray Proof.②

Level Lines—High and Low—All Jar Faces.

Electrolyte—Height Above Plates—2-3/4".

Electrolyte Withdrawal Tube—Each Cell.

Sediment Space—1-1/16".

Specific Gravity—1.215 @ 77°F. (25°C.).

Inter-Cell Connectors—Lead Plated Copper.

Plate Dimensions	Height	Width	Thick-ness
Positive Plate	15"	12½"	.320
Negative Plate	15"	12½"	.215

① Posts—600 A.H. to 1200 A.H. Two—1½" square. 1344 A.H. to 1950 A.H. Four—1" square. (Except 1848 A.H.) 1848 A.H. to 2550 A.H. Four—1½" square.

② Combined Filling Funnel—Explosion resistant vent is available at additional cost. Specify Gould "Pre-Vent".**

Type	Plates Per Cell	Ampere Hour Capacities to 1.75 V.P.C. Average*				1 Minute Rate in Amperes*		Overall Dimensions in Inches			Approximate Wgt. in Lbs.		Elect. Gals. Per Cell
		8 Hr.	5 Hr.	3 Hr.	1 Hr.	To 1.75 V.P.C. Avg.	To 1.50 V.P.C. Avg.	L	W	H	Net Wgt.	Packed Wgt.	
NCX-600	9	600	540	468	300	712	1355	7-3/8	14-1/2	22-1/8	177	189	6.0
NCX-672	9	672	588	492	300	636	1210	7-3/8	14-1/2	22-1/8	178	190	6.0
NCX-750	11	750	875	585	375	880	1675	7-3/8	14-1/2	22-1/8	195	207	5.6
NCX-840	11	840	735	615	375	790	1500	7-3/8	14-1/2	22-1/8	196	208	5.6
NCX-900	13	900	810	702	450	1044	1985	7-3/8	14-1/2	22-1/8	213	225	5.1
NCX-1008	13	1008	882	738	450	942	1790	7-3/8	14-1/2	22-1/8	214	226	5.1
NCX-1050	15	1050	945	819	525	1204	2290	7-3/8	14-1/2	22-1/8	231	243	4.9
NCX-1200	17	1200	1080	936	600	1360	2585	7-3/8	14-1/2	22-1/8	249	261	5.0
NCX-1344	17	1344	1176	984	600	1240	2360	9-1/4	14-1/2	22-1/2	268	280	6.8
NCX-1350	19	1350	1215	1053	675	1494	2840	9-1/4	14-1/2	22-1/2	282	294	6.3
NCX-1500	21	1500	1350	1170	750	1620	3060	9-1/4	14-1/2	22-1/2	301	313	6.0
NCX-1650	23	1650	1485	1287	825	1782	3390	11-3/8	14-1/2	22-1/2	348	366	8.0
NCX-1680	21	1680	1470	1230	750	1530	2910	11-3/8	14-1/2	22-1/2	332	350	8.3
NCX-1800	25	1800	1620	1404	900	1932	3675	11-3/8	14-1/2	22-1/2	364	382	7.6
NCX-1848	23	1848	1617	1353	825	1661	3160	14-9/16	14-1/2	22-1/2	397	415	12.6
NCX-1950	27	1950	1755	1521	975	2080	3955	11-3/8	14-1/2	22-1/2	380	398	7.3
NCX-2016	25	2016	1764	1476	900	1788	3400	14-9/16	14-1/2	22-1/2	415	433	12.1
NCX-2100	29	2100	1890	1638	1050	2240	4260	14-9/16	14-1/2	22-1/2	446	464	11.5
NCX-2184	27	2184	1911	1599	975	1924	3660	14-9/16	14-1/2	22-1/2	433	451	11.5
NCX-2250	31	2250	2025	1755	1125	2400	4565	14-9/16	14-1/2	22-1/2	462	480	10.9
NCX-2400	33	2400	2160	1872	1200	2560	4865	14-9/16	14-1/2	22-1/2	479	497	10.3
NCX-2550	35	2550	2295	1989	1275	2720	5170	14-9/16	14-1/2	22-1/2	496	514	9.7

* Includes voltage drop across intercell connections used in standard layouts. ** ™Gould, Inc.

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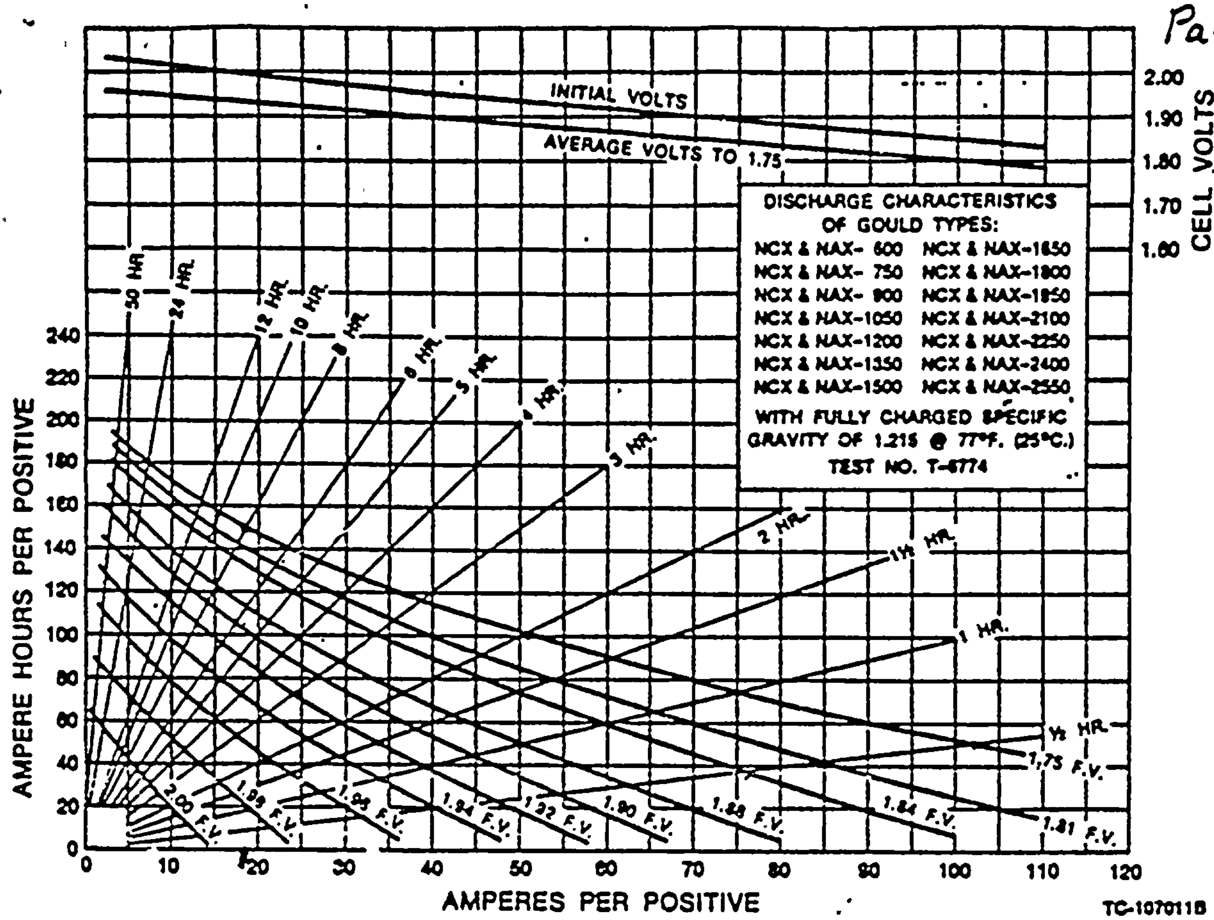
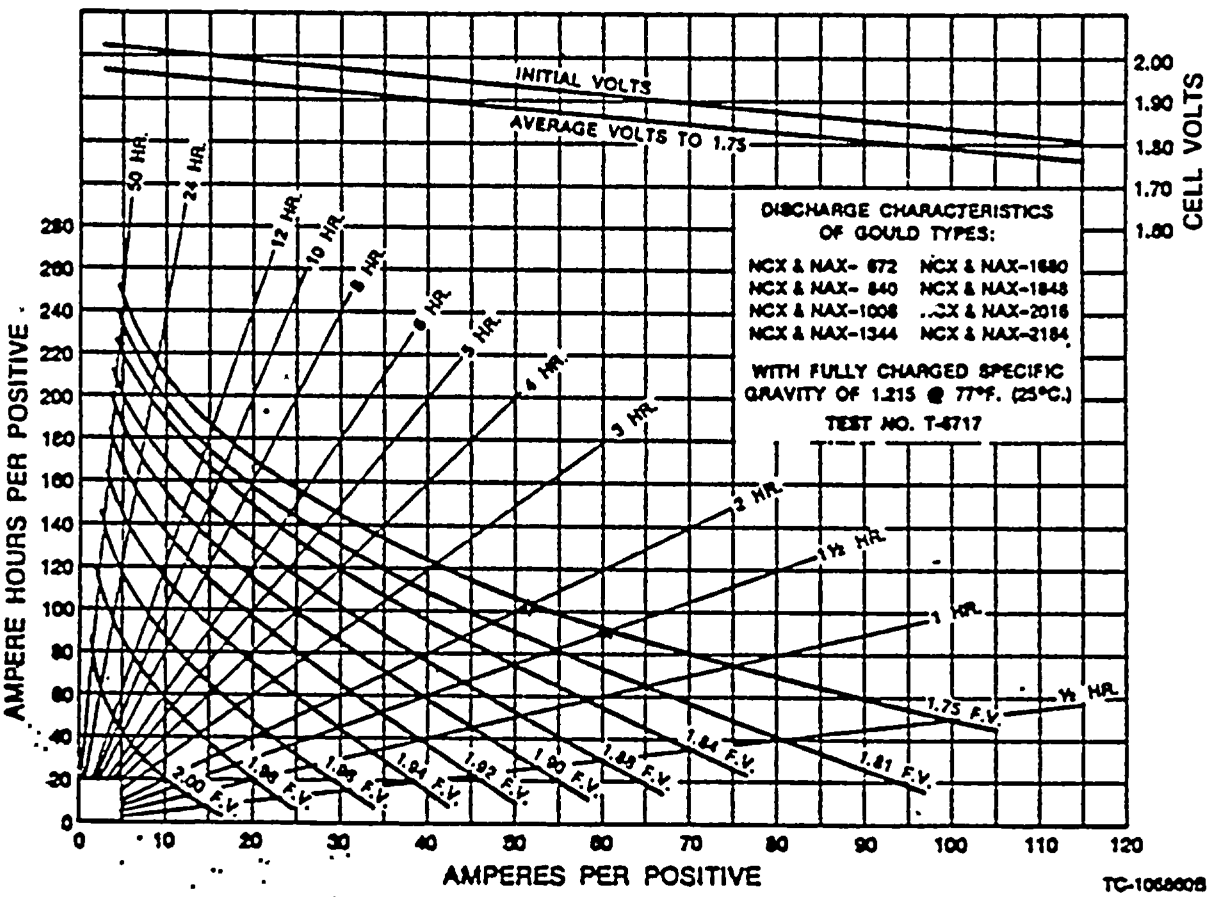


TC-107011B



TC-1066608

Gould Inc., Industrial Battery Division
2050 Cabot Boulevard West, Langhorne, Pa. 19047
Telephone (215) 752-0555

GOULD

EC-45 △3

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PAGE 47 △5

INTEROFFICE CORRESPONDENCE

TO:	LOCATION	SUBJECT / REFERENCE / J.O. NO.
John Knudsen GSOC	SR	Sizing of Battery Chargers
FROM: George Fligg	LOCATION 245/7	

MESSAGE:— As per your request, I have attached information as to the sizing of battery chargers. The recharge time to be used is 24 hours for the main station and eight hours for an unattended station. This will yield the smallest battery charger which could be used. However, it is S&WEC's policy to size the battery charger for the size of the battery and the length of time of the duty cycle. For example, assume that you were using a duty cycle of two hours and a Gould battery NCX 1500 which has a two hour discharge current rating of 510 amperes. In this case you would assume that 1,020 ampere XXXXX hours had been discharged and you would size the battery charger on that basis.

If you need further information, just give me a call on 3-0884.

February 26, 1981

DATE

SIGNATURE: G O Fligg

TELEPHONE

REPLY:

DATE

SIGNATURE

TELEPHONE

△ 640.138

REPLIER RETURN WHITE COPY — RETAIN THIS COPY

EC-45 ATTACHMENT A

PAGE 48

STONE & WEBSTER ENGINEERING CORPORATION - CHERRY HILL OPERATIONS CENTER

INTEROFFICE MEMORANDUM

J.O. OR W.O. NO 12177-EC-~~3224~~ (5)

SUBJECT	TOPICAL INFORMATION REPORT FOR TRANSFORMER AND BUS LOADING AND ASSIGNMENTS	DATE	May 10, 1982
		FROM	TLOtt:JR
TO	All Electrical Engineers and Squad Leaders	CC	JCGabriel KNKhanna DFSabatini

The attached information will be issued as Topical Information Report by our Boston office before long.

In the meantime, I am sending this to you for your information. This document will be used as a guide and not as a rigid standard.

T. L. Ott

T. L. Ott

Attachment

GENERAL

This design criteria is presented as a guide for both allowable bus loadings and assignments of loads to various plant loads. This criteria is meant as a guide to engineers for a standard Stone & Webster design. Finalization of this criteria is dependent on several factors. Among these are: client preferences and approval, economic studies and the complement of equipment to be powered. Whether at a later date assignment or loading criteria should be altered depend on such things as how far the plant design is completed, possible additional loads in the future, costs of adding new equipment, redesign of sills, tray systems, duct lines, and status of purchase orders and equipment production. However, the guidelines set forth in the following design criteria are a useful tool in designing an adequate and flexible distribution system.

Spare and future positions should be provided on all buses if possible. The number of each should be worked out with the client at an early stage. Floor sills should be extended to allow additional equipment to be added if necessary.

For most power plant work, the voltage of the medium voltage and low voltage buses is established early in the design of the plant. The number of medium voltage buses is dependent on several variables including requirements of the large mechanical systems, client preference, philosophy of plant operation and equipment economics, and in the case of nuclear plants - regulatory requirements.

The initial step is to ascertain what the electrical loads are and their power requirements. Then the maximum simultaneously running loads must be calculated for each bus and transformer contemplated. The engineer should use the motor and electric load list as well as logic descriptions, system descriptions, and consultation with the lead power engineer during this stage of design to ascertain the maximum coincident loading of each bus.

TRANSFORMERS

Power transformers should be conservatively sized to allow for future load growth. Station service transformers will generally be about 10 percent of total generator output for nuclear plants.

For fossil plants approximately 7 percent of generator output is used for station service. If a scrubber is required, another 3 percent will be used to power the scrubber auxiliaries.

As loads are defined further, the transformers sizes can be finalized allowing for worst case loading and providing at least 15 percent margin for future growth.

For criteria on sizing smaller transformers, see the information in low voltage load assignments below.

MEDIUM VOLTAGE BUSES

Generally in plants where both 15 kV class and 5 kV class buses are selected, motors above 2500 HP are assigned to the 15 kV class buses. Motors above 250 HP, up to 2500 HP, are assigned to the 5 kV class buses.

In plants where 7.5 kV class buses are utilized as the highest distribution voltage, motors above 4000 HP would be assigned this bus with motors 250 HP to 4000 HP being assigned to the 5 kV class buses.

These HP break points are only guidelines and economic studies should continue to be done for loads which are in question.

METAL CLAD SWITCHGEAR

Metal clad switchgear should not have a coincident loading above 60 to 70 percent of the main bus rating during the early stages of the project to allow for further load growth as the project progresses. If during the latter stage of the project the loads grow, it is best to keep the maximum switchgear bus loading to about 90 percent of the full load rating of the main breaker and bus under the worst operating condition.

To determine maximum running loads on metal clad switchgear early in the project, the electrical engineer should consult with the lead power engineer to determine maximum coincident loading on each bus. Be sure to consider - pumps out for maintenance, transformer failures and bus failures and the subsequent effect on the remaining buses in the analysis.

In the early stages nameplate horsepower should be used for the large motors. This builds in a little extra conservatism for possible increases in brake horsepower (BHP) requirements later. In the latter stages of the project, known BHP at runout conditions should be used.

LOW VOLTAGE BUSES

On low voltage distribution systems, several types of equipment are utilized to feed motor and other type loads. Load center secondary unit substations are used to feed loads directly, as well as providing a power source to MCC's and panelboards (if a separate panelboard system is used). Loads from 60 to 250 HP or 60-250 KVA are generally fed directly from a load center power circuit breaker. If loads in this size range require frequent starting and stopping, reversing control, or two speed control, consider the use of locally mounted starters equipped with nonautomatic breakers.

Loads from 1 HP to 50 HP or 1 to 50 KVA can be assigned to MCC's (some projects have elected to use separate 600 volt class panelboards in lieu of MCC feeder circuit breakers for non-motor loads. S&W's standard design, however, calls for these breakers to be mounted on the MCC). Motor operated valves of any size should be assigned to an MCC. When assigning low voltage loads, care should be taken to assure that auxiliaries to large motors (i.e., lube oil pumps) are on MCC's fed by the same power train as the pump motor itself.

Small loads less than 1 HP or 1 KVA should be assigned to 120 volt panelboards. (If automatic control is required, local starters or contactors should be utilized).

LOAD CENTERS

Since the low voltage loads change dramatically during the life of the project, it is good to have ample capacity in the load centers (LC's) early in the project's life. In the early stage of a project, it is usually a good practice to add connected, continuously running loads and multiplying by .80 for diversity and .90 for utilization (brake HP vs. nameplate HP) to arrive at an estimated load for directly connected loads; for MCC load estimates see the paragraph below. At later stages of the project, maximum running loads should not be greater than 80 percent of the self cooled transformer rating. Also, note that on double ended load centers, the total coincident LC load should not be greater than the highest rating of a single transformer so that one transformer can be out-of-service without forcing load shedding to occur. Transformers are usually not larger than 1000 KVA with a standard 5.75 percent impedance, because above this size ~~either~~ the available short circuit current can become too high for the LC feeder breakers ~~and~~ or MCC's unless a higher impedance transformer is purchased. This inturn can cause voltage profile problems.

Motor control centers are placed for convenience in an area close to motor loads. This keeps cable distances short for voltage considerations and usually means that the total load on a given MCC can be kept fairly well below the standard 600 amp bus. In the early stages of a project, the loads should be held to about 300 amps maximum (400-500 amps on industrial projects). Whenever possible, loads of a common system should be grouped on the same MCC to try to assure system power continuity. Spares and spaces should be grouped to allow for future starters of varying sizes and types. The decision as to whether to allow loads on a MCC above the 300 amp target, or create another MCC, is a matter of judgement and should be discussed with the Lead Electrical Engineer. The standard S&W design calls for panelboards to be fed from the local MCC. Since these loads must also be added to the MCC load, some guidelines are listed below for panel loads.

The following is a list of typical assumptions for bus loading on MCC's, panelboards, and load centers.

1. Motor operated valves (MOV's) and motor operated doors can be ignored when reflecting MCC loads to the load center. For a particular MCC loading, use 20 percent of the total horsepower per MCC that are MOV's or doors.

2. Intermittent loads such as cranes, small compressors, sump pumps, elevators, motor space heaters, switchgear space heaters, etc., can be ignored when reflected to the load center unless the load is on for longer than one hour at a time. (Some judgement is required here and the Lead Electrical Engineer shall provide guidance for each application. On MCC's, add 20 percent of the total of these to the MCC load).

3. Lighting loads should be added on a watts per square foot basis initially until actual loads are known. The lighting specialist can provide estimates based on the type of lighting selected. Add one half amp per duplex receptacle.

4. Since other panelboard loads are unknown until much later, add the distribution transformer KVA until loads are better defined. Keep the number of these transformers reasonable. Consult the equipment specialist for past experience in this area.

5. Work with the building service engineers for an estimate of diversity for various areas of the plant if electric unit heaters are used as well as air conditioning.

6. Ignore welding and vacuum cleaner receptacles.

7. Add continuous loads on the MCC bus and multiply by .80 for diversity and .90 for utilization in the early stages. Later as the motor and load list information is complete, use all of the continuous coincident loads and multiply by .90 for utilization.

These guidelines should be discussed in detail with the Lead Electrical Engineer, and where appropriate, with the client to ensure project agreement before the equipment is purchased if possible.

LOADS CONNECTABLE TO DIESEL GENERATORS

Diesel generators are often used as emergency power sources. In nuclear plants they usually supply the 4160 volt standby buses. In fossil plants, they may feed either 4160 volt or low voltage buses. In nuclear plants, loads other than Class IE safety related loads are often either fed from Class IE buses with an automatic LOCA trip or are assigned to buses which are manually connectable to the diesel bus.

In fossil plants, loads that are important to an orderly shutdown or personnel safety are assigned to buses which can be fed by a diesel generator.

In general, the list below suggests possible candidates for assignment to buses which can be fed from a diesel generator.

1. Emergency lighting
2. Security systems
3. UPS systems/instrumentation buses
4. Battery chargers
5. Instrument air compressors
6. Fire protection systems
7. Scrubber agitators
8. Turning gears
9. Boiler controls
10. Loads which allow for orderly shutdown of the plant or prevent subsequent damage.

LOADS CONNECTABLE TO UPS SYSTEMS

Many factors are involved in assignments of loads to UPS buses vs. standard instrument and control buses. The assignment of many of the loads to UPS buses should be done in conjunction with the Controls engineers. Items such as the acceptability of power interruption, voltage variations, etc., make a joint effort here very important.

The above load assignment guidelines are a good starting point. When followed, they have been found to usually offer an economical and effective design. However, many factors can influence and change these general rules, such as client preference, or late changes in horsepower which would have changed the type equipment feeding the load, but due to transformer size limitations, etc., an exception may have to be made and the load remain on the existing bus. Also, discretion needs to be used with certain type loads, i.e., it might be preferrable to have a 2 KW motor space heater rated at 120 volts and fed from a panelboard if 480 volt heaters are not available as standard.

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(A) ATTACHMENT 'B'

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EC-45

(5)

INTEROFFICE CORRESPONDENCE

TO: AK Gual	LOCATION 5R	SUBJECT / REFERENCE / J.O. NO. 12677 ~~ESOP~~ operating time ESOP
FROM: J Steruchis	LOCATION 5B	

MESSAGE: —

After reviewing GE's letter dated 6/19/85 and the size of the CO_2 system, the information given in the River Bend Project is applicable. The ESOP will operate for 90 min. The 9112 CO_2 system has 2 13 Ton CO_2 (Liquid) Tanks. Thus the purge Time will be Less Than 60 min.

6/25/85 — DATE

J Steruchis — SIGNATURE

3317 — TELEPHONE

REPLY:

DATE

SIGNATURE

TELEPHONE

040.138

NOTED JUN 24 1985 2 SUP 4 PAGE 55 EC-45 5

GENERAL ELECTRIC

APPARATUS AND ENGINEERING SERVICES OPERATION

GENERAL ELECTRIC COMPANY • ONE UNIVERSITY OFFICE PARK, 29 SAWYER ROAD • WALTHAM, MASSACHUSETTS 02254 • (617) 647-7200

June 19, 1985

Copy to:

JM Knudsen S&W
J Sternchos S&W

NIAGARA MOHAWK POWER CORPORATION
Nine Mile Point Nuclear Station, Unit #2
J.O. 12177 - Purchase Order No. 2
Steam Turbine Generator Equipment
Turbine No. 170X632
Requisition 306-31261

Mr. A. K. Gwal
Stone & Webster Engineering Corporation
P.O. Box 5200
Cherry Hill, New Jersey 08034

Dear Sir:

As requested by Mr. J. M. Knudsen, I am forewarding our current station battery recommendaions for the emergency bearing oil pump (DCM E11.601B) and the emergency seal oil pump (278A6692).

You will note that time is addressed in the case of the EBOP but not for the ESOP. This is because the time requirements for a successful coast-down are well known, but the events which must precede a safe ESOP shutdown are more difficult to time and are as follows:

1. The machine gas should be vented from operating pressure down to 2-5 PSIG. This can and should be done during coastdown.

2. The purging of hydrogen with carbon dioxide cannot commence until the shaft is at or near standstill because the rotor fans will mix the gases and produce erratic readings on the purge analyzer at the sample connection.

3. It will be necessary to admit approximately 7400 CU. FT. of CO_2 to achieve a safe gas mixture (<5% H_2 in CO_2). It is reasonable to assume that this can be done in 60 minutes with a 6 bottle manifold and 4 bottle changes made expeditiously. We do not know the limitations of a bulk CO_2 supply and CO_2 discharge tends to be self limiting depending on piping configuration because of the formation of solid carbon dioxide (dry ice) at points where rapid expansions take place. There is considerable discussion of the ramifications of handling carbon dioxide in the turbine-generator instruction

2 13 Tons of liquid CO_2

RECEIVED STONE & WEBSTER
JUN 24 1985
12177
DOCUMENT CONTROL

GENERAL ELECTRIC

book, volume II, tab 29, GEK-45944.

4. The final and perhaps most difficult variable is operations priorities at the time of the event.

In summary, a 2 hour run time for the ESOP is probably appropriate, but all of the foregoing must be considered.

Yours very truly,

T. J. Grady

T. J. Grady Project Application Engineer
NEW ENGLAND DISTRICT

Attachment

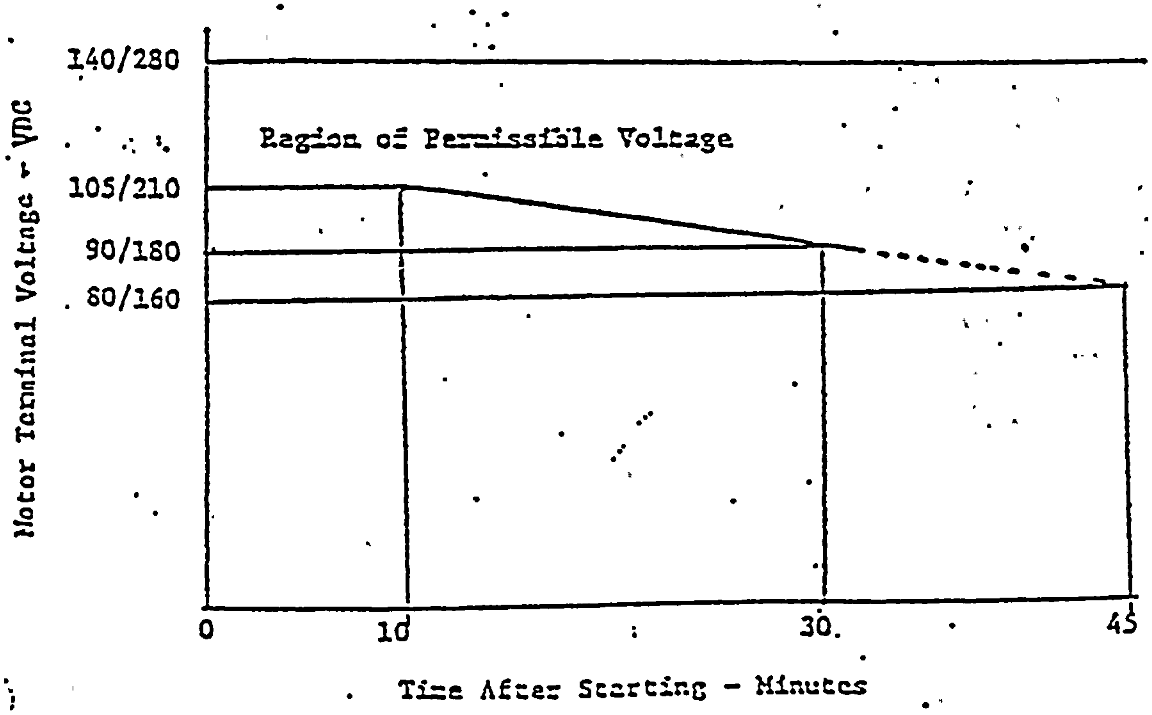
TJG:slb:305.1

Pg. 57
EC-45

DC Voltage Range of Motor and Starter for the Emergency Bearing Oil Pump (EBOP)

The motor for the emergency bearing oil pump has a nameplate voltage of 120 vdc or 240 vdc depending upon the voltage of the customer's station battery. The motor, motor starter and emergency bearing oil pump are suitable for operation in the voltage range of 105 vdc to 140 vdc (or 210 vdc to 280 vdc). The station battery should have sufficient capacity to start and operate the EBOP, along with all other loads on the battery, for the period of time required to shut the turbine down safely upon a trip concurrent with a loss of power to the a-c driven oil pumps.

For purposes of establishing the required battery capacity, the load due to the EBOP should be based on the assumption that, in starting, the motor will draw 5 times full load current for 10 seconds. During this period and for 10 minutes thereafter, the voltage at the motor terminals must remain above 105 vdc (210 vdc for 240 vdc systems). Between 10 and 30 minutes after starting of the EBOP, the voltage must remain above a linear reduction with time to 90 vdc (180 vdc for 240 vdc systems) at the end of 30 minutes after starting. After 30 minutes, further drop off in voltage is permissible. Should the voltage drop below approximately 80 vdc (160 vdc for 240 vdc systems), the starter will drop out and shut down the EBOP motor. This must not be permitted to occur for at least an additional 15 minutes if there is any possibility that full condenser vacuum might be maintained, prolonging the time required for the turbine to coast to a standstill. This might be the case if power to the condenser cooling water pumps is maintained while power to the a-c driven lube oil pumps is lost.



STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

▲ 5010.65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 57
12177	ELECTRICAL	EC-45	N/A	△5

CIRCUIT BREAKERS TRIPPING ON BUS UNDERVOLTAGE

SWGR I.D.	CUBICLE	ESK
2NPS-SWG001	1-3	5NPS01-13
	1-6	5RCS01-8
	1-7	5CNM04-10
	1-8	5FWS01-10
	1-9	5CWS01-10
	1-10	5CWS03-9
	1-11	5CWS05-9
	1-12	5CNM06-11
2NPS-SWG002	2-2	5ABM01-8
	2-3	5ABM02-7
2NPS-SWG003	3-4	5RCS02-8
	3-5	5CNM05-10
	3-7	5FWS02-10
	3-2	5CWS06-9
	3-9	5CWS04-9
	3-10	5CWS02-9
	3-12	5FWS04-8
	3-14	5NPS04-13
2NNS-SWG011	11-4	5CCS01-9
	11-6	5HDL01-7
	11-7	5CNM01-6
	11-8	5CNM03-8
2NNS-SWG012	12-2	5HDL03-9
	12-4	5CCS03-9
	12-5	5CCP01-9

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

5010.65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 59
12177	ELECTRICAL	EC-45	N/A	5

2NNS-SWG013	13-2	5CNM07-9
	13-3	5CNM02-7
	13-4	5HDL02-9
	13-8	5CCS02-9
	13-9	5CCP04-4
2NNS-SWG014	14-2	5CCP06-4
	14-7	5RDS01-8
	14-9	5CCP03-8
2NNS-SWG015	15-2	5RDS02-8
	15-4	5CCP02-3
	15-6	5CCP05-4

TOTAL SWITCHGEAR BREAKERS = 36

TOTAL 600V LOAD CENTER BREAKERS = [illegible]

STONE & WEBSTER ENGINEERING CORPORATION

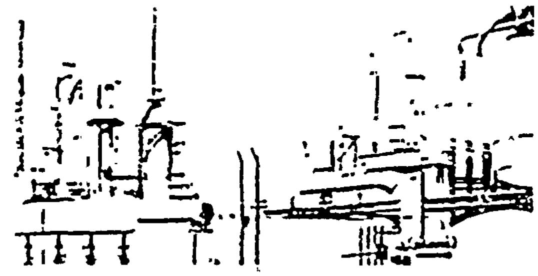
CALCULATION SHEET

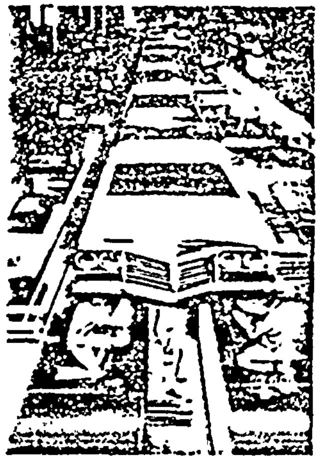
△ 6

▲ 5010.65

CALCULATION IDENTIFICATION NUMBER				PAGE 60
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
12177	ELECTRICAL ENGR'G	EC-45		

GET-6590

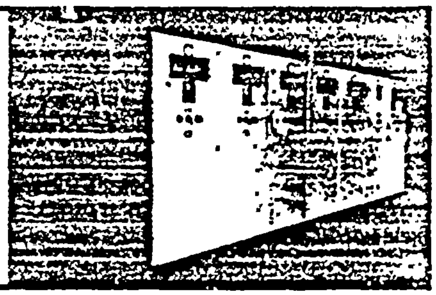


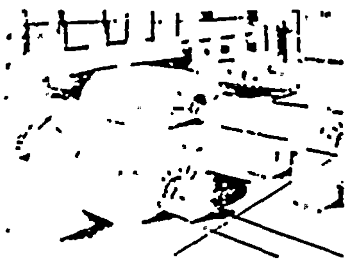


Magne-blast

METALCLAD SWITCHGEAR

Application Guide





GENERAL ELECTRIC

transformers are usually connected to the bus (E) and a separate set of three-potential transformers are recommended for this purpose only.

NUMBER REQUIRED — Three-wire systems require two potential transformers. Four-wire solidly grounded systems usually require three potential transformers.

RELAY AND CONTROL FUNCTIONS

The determination of relay and control functions has been simplified by their listing in the basic pre-engineered equipment specifications in this guide and in GE Handbook sections 6732 and 6733, which also include normal options for the principal applications encountered.

CLOSING, TRIPPING, AND POWER REQUIREMENTS

Breaker Operation and Control Power

Successful operation of metalclad switchgear is dependent upon a reliable source of control power which at all times will maintain voltage at the terminals of electrically operated devices within the rated operating-voltage range. In general, the operating-voltage range of switchgear equipment is determined by the rated operating-voltage range of the circuit breaker. These ranges, as established by NEMA standards, are given in Table B-3.

There are two primary uses of control power in metalclad switchgear which merit separate consideration when selecting the source of control power: namely, closing power and tripping power. The applicable current requirements are listed in Table B-4.

Closing Power

It is generally preferable that the availability of closing power be independent of voltage conditions on the power

TABLE B-3 STANDARD CONTROL VOLTAGES AND OPERATING RANGE

Normal Control Voltage		OPERATING RANGE—VOLTS	
Volts		Stored-energy Mechanism / Spring Motor and Closing Spring-Release Coil	Trip Coil of Both Mechanisms
DC	24	—	14-30
	48	36-52	28-60
	125	90-130	70-140
	250	190-250	140-250
AC	115	95-125	95-125
	230	190-250	190-250

system associated with the switchgear. The 48V, 125V or 250V dc battery is normally considered the most reliable auxiliary power source. In many instances, however, particularly where the switchgear consists of only a few circuit breaker units, the storage battery or other independent power source necessary to achieve this goal may represent an investment out of proportion to the advantage gained.

The choice between dc closing power derived from a storage battery and ac closing power derived from transformers connected to the switchgear's power system is economic, dictated by the desired system reliability.

Other factors influencing the choice are:

- Closing of breakers with the power system de-energized
- Availability of housing facilities for a battery and its charging equipment.
- Effect of low ambient temperature on battery.
- Availability of adequate maintenance for a battery and its charging equipment.
- Future additions to the equipment sufficient to shift the economic preference from an ac to a dc system.

TABLE B-4. OPERATING CURRENTS OF STORED-ENERGY-OPERATED CIRCUIT BREAKERS‡

Type of Breaker	Closing Current in Amperes										Tripping Current in Amperes*				
	At 48 Volts DC		At 125 Volts DC		At 250 Volts DC		At 115 Volts AC		At 230 Volts AC		DC Volts			AC Volts	
	Closing Spring Release Coil	Spring Motor	Closing Spring Release Coil	Spring Motor	Closing Spring Release Coil	Spring Motor	Closing Spring Release Coil	Spring Motor	Closing Spring Release Coil	Spring Motor	48	125	250	115	230
AM—4.16-250 AM—4.16-350 AM—7.2-500 AM—13.8-500 AM—13.8-750 AM—13.8-1000	6.5	32	6	14	3	7	8	14	4	10	6.5	6	3	23	10

‡ Values listed for operating currents are for estimating purposes only.

* Fuses for the tripping circuit should have an ampere rating of at least 2 times the tripping current and not less than 35 amperes.