4

STONE & WEBSTER ENGINEERI... ...ION

CALCULATION TITLE PAGE

*SEE INSTRUCTIONS ON REVERSE SIDE

NOTED AUG 1 1985 E. HARRIS

NOTED JAN 16 1984 J. [illegible] Rev 2

07-15-91

5010 64 (FRONT)

CLIENT & PROJECT	PAGE 1 OF 18
NMPC - NMP2 [redacted]	

CALCULATION TITLE (Indicative of the Objective):	QA CATEGORY (✓)
STATION COMPUTER BATTERY 2BYS-BAT1C (1C1, 1C2, 1C3, 1C4) SIZING STATION COMPUTER BATTERY CHARGER 2BYS-CHGR 1C1 SIZING	☐ I - NUCLEAR SAFETY RELATED ☑ IIA ☐ 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 3910	EC-46		

* APPROVALS - SIGNATURE & DATE			REV. NO. OR NEW CALC NO.	SUPERSEDES * CALC. NO. OR REV. NO.	CONFIRMATION *REQUIRED (✓)	
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE (S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES	NO
J.M.KNUDSEN 1/11/84	[signature] 1/16/84	—	2			✓
[signature] 7/31/85	[signature] 8/6/85		REV.3	REV-2		✓
S.W. GLOVER 12-19-88	J Kirkpatrick 12/22/88		REV.4	REV.3		✓

MICROFILMED

DISTRIBUTION*

GROUP	NAME & LOCATION	COPY SENT (✓)	GROUP	NAME & LOCATION	COPY SENT (✓)
RECORDS MGT. FILES (OR FIRE FILE IF NONE)			ELECTRICAL DIVISION	D. SABATINI, 3Y	✓
			ELECTRICAL NMP2	A.K. GWAL, SR	✓
			ELECTRICAL NMP2	G. NOLAN, SR	✓
	E3	✓	ELECTRICAL NMP2	E. KHALAFALLA - SR	✓
	E033	✓	" "	R. DAS, SR	
	E034A	✓	[illegible]	V. Maisic site	✓

9304290089 911031
PDR ADOCK 05000410
S PDR

9304290089

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CALCULATION SUMMARY

▲ 001047

CALCULATION NO	DATE	PAGE
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CLIENT: NMPC - NMP2

J O NUMBER: 12177

SUBJECT: STATION COMPUTER BATTERY 2BYS-BAT1C (1C1, 1C2, 1C3, 1C4) SIZING
STATION COMPUTER BATTERY CHARGER 2BYS-CHGR1C SIZING

PROBLEM:

To calculate the Ampere-Hour capacity of Battery 2BYS-BAT1C (1C1, 1C2, 1C3, 1C4) in order to determine the adequacy of the Batteries already purchased and to check the adequacy of the purchased Battery Charger, 2BYS-CHGR1C1

AUDIT REMARKS

CHECKER'S REMARKS:

APPROACH/ASSUMPTIONS:

~~1) The dc input current for 2VBB-UPS1C from INSTR MAN. 101 710 348-77223 (UPS) is used as a base. This is max. of 70GA at min. voltage of 101V.~~

2) No factors for inaccuracies and growth are used.

3) Battery is sized to support the UPS for an orderly shutdown following the loss of offsite power ~~and loca~~

4) Battery is sized for a two hour support time.

5) The lowest expected electrolyte temperature is the lowest Room Temperature in which the Battery will be installed.

6) The method employed is the sizing procedure outlined in IEEE-485-1978

AUDIT REMARKS ∠ △4

CHECKER'S REMARKS. 7) The UPS Inverter is not a Charger load.

SOURCES—DATA/EQUATIONS:

1) Purchase specification NMP2-E033A, Addendum 2, dated NOV. 2, 1982

2) Technical Data by seller, Gould Inc, dated March 17, 1977 (Revised 5/27/83)

3) IEEE Recommended Practise for sizing Large Lead Storage Batteries for Generating Stations and Substations. IEEE 485-1978.

4) ETP-110.01 Verification of Lead Storage Battery Size. REV. 0 DATED 1/30/??

~~5) Supplement #1 to GED course, Appendix V~~

~~6) Westinghouse "CONSULTANTS GUIDE TO WESTINGHOUSE UPS SYSTEM," CHAP. VI~~

7) SPEC E035A DATED 1/12/?? 8) CALC EC-123 REV. 3 △3

AUDIT REMARKS ∠

CHECKER'S REMARKS:

CONCLUSIONS:

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

— A 500 Amp. Battery Charger as supplied by Power Conversion Products is acceptable.

AUDIT REMARKS

CHECKER'S REMARKS:

AUDIT SUMMARY		CALCULATED BY	DATE
CHECKS	CORRECTIVE ACTION TAKEN BY	CHECKED BY	DATE
INFRACTIONS	DATE	AUDITED BY	DATE

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

~~3~~ Rev. 4

5010.65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 5 of 18
12177	3910	EC-46 REV. 3		

LOAD DEVELOPEMENT

UPS INPUT KW

2VBS-UPS1G – 61,100 VA LOAD FROM CALC EC-123 PAGE 6

P.F. = 0.8, EFF. = .84 WHEN SOURCE IS BATTERY

DIVERSITY & UTILIZATION FACTOR = 0.9 [FOR DIVERSITY & UTILIZATION FACTOR SEE J.O 12177-EC-32-4 ATTACHED 'A']

$$\text{INPUT KW} = \frac{61{,}100 \times 0.8 \times .9}{0.84} = 52.371\text{ KW}$$

$$I_{O\,TIME} = \frac{52{,}371}{123.8} = 423.03\text{ A}$$

123.8 ← BATT. OPEN CIRC. VOLT

$$I_{120M} = \frac{52{,}371}{101} = 518.5\text{ A}$$

101 ← MIN. OPER. VOLTAGE

2VBB-UPS1B – 73,342 VA LOAD FROM CALC. EC-123 PAGE 6.

P.F = 0.8, EFF = .84 WHEN SOURCE IS BATTERY

DIVERSITY & UTILIZATION FACTOR = 0.9 [FOR DIVERSITY & UTILIZATION FACTOR SEE J.O. 12177-EC-32-4 ATTACHED A]

$$\text{INPUT KW} = \frac{73.342 \times 0.8 \times .9}{0.84} = 62.865\text{ KW}$$

$$I_{O\,TIME} = \frac{62{,}865}{123.8} = 507.8\text{ A}$$

123.8 ← BATT OPEN CIRC VOLTS

$$I_{120\,M} = \frac{62{,}865}{101} = 622.4\text{ A}$$

101 ← MIN OPER VOLT

2VBB-UPS3A – USE FULL 10KVA – WORST CASE

INPUT KW = 113 × 103 = 11.64 (REF SPEC 35A)

$$I_O = \frac{11.64}{123.8} = 94\text{ A}$$

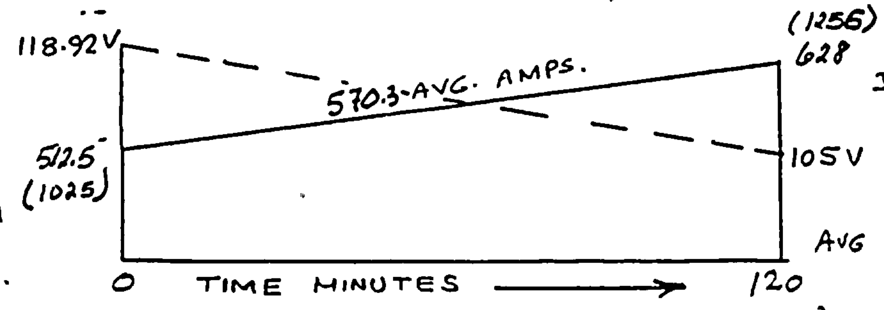
123.8 ← BAT- OPEN CIRC. VOLTS

$$I_{120} = \frac{11640}{101} = 115\text{ A}$$

HENCE THE FOLLOWING LOAD AND VOLTAGE PROFILE

LOAD PROFILE IS FOR A SINGLE BATTERY HALF THE ABOVE CAPACITY

TOTAL I_O –
423.03
507.8
94.00
1024.83 A



I_{120} = 518.5
622.4
115
TOTAL 1255.9 A

$$\text{AVG AMPS} = \frac{512.5 + 628}{2} = 570.3\text{A}$$

123.8 (118.92V AFTER LOAD APPLICATION)

105V (1.75 VPC, FINAL VOLTAGE)

AMPS PER NCX 2550 = 568 AMPS

Lowest Expected Electrolyte Temp: 65° F Minimum Cell Voltage 1.75 V Cell Manufacturer Gould Cell Type NCX

(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= 570.3	A1-0= 570.3	M1= 120	T=M1= 120	51	11.2	***
					Sec 1 Total	11.2	***
Section 2 - First Two Periods Only - If A3 is greater than A2, go to Section 3.							
1	A1=	A1-0+	M1+	T=M1+M2=			
2	A2=	A2-A1=	M2=	T=M2=			
					Sec Sub Total		
					2 Total		***
Section 3 - First Three Periods - If A4 is greater than A3, go to Section 4							
1	A1=	A1-0=	M1=	T=M1+M2+M3=			
2	A2=	A2-A1=	M2=	T=M2+M3			
3	A3=	A3-A2=	M3=	T=M3=			
					Sec Sub Total		
					3 Total		***
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5							
1	A1=	A1-0=	M1=	T=M1+...M4=			
2	A2=	A2-A1=	M2=	T=M2+M3+M4=			
3	A3=	A3-A2=	M3=	T=M3+M4=			
4	A4=	A4-A3=	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=	AR-0=	MR=	T=MR=			***

Maximum Section Size 11.2 Plus Random Section Size — Equals 11.2

Uncorrected Size 11.2. Uncorrected Size 11.2 Times Temperature Correction 1.08 Times Design Margin 1.0 Times Aging Factor 1.25 Equals 15.12 When the cell size is greater than a standard cell size, the next larger cell is required.

Required Cell Size: (A) 16 Positive Plates

33 Total plates/cell or NCX-2400 or

(B) 2400 Ampere Hours

Therefore cell NCX-2550 * is

FOR HALF THE CAPACITY (acceptable, ~~not acceptable~~) / •2-NCX-2550 ARE PURCHASED AND ARE AT NMP2 SITE)

SINCE A 2250 A-H BATTERY WILL HANDLE 1/2 NMP-2 CAPACITY, 2550/2400 IS 1.06 AND THE NCX-2550 INCLUDES: 6.3 % EXCESS CAPACITY.

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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J.O./W.O./CALCULATION NO.	REVISION	PAGE
12177 EC-46	2	7 of 18

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
J.M. Knudsen 1/ /84		

SUBJECT/TITLE STATION COMPUTER BATTERY 2BYS-BAT(C)(1C)(2C)(3C)(4C) SIZING
STATION COMPUTER BATTERY CHARGER 2BYS-CHGR(C)

QA CATEGORY/CODE CLASS: II

Battery Charger Calculation

1. $A_r = \frac{AH \times C}{T_1} + A_c$ where A_r = Required minimum charger rating in Amperes

AH = Total Ampere-Hours discharged from battery during its specified duty cycle. 3468 AH, See Gould Cu. # TC-107011B; See I.O.C. G. FLIGG to J. Knudsen, 2/24/81.

C = Charger conversion factor for Lead Acid Cells - 1.1

A_c = Continuous load while charging. See below. Equals zero for UPS load.

T_1 = Required maximum time for Recharging - 24 hours (G. Fligg I.O.C. to J. Knudsen, 2/24/81)

A_c = 0; UPS IS FED FROM 2VBB-PNL300 when charger is in operation

$A_r = \frac{1734 \times 1.1 \times 2}{24}$

A_r = 159 Amps, Say a 200 Ampere Charger

Check on actual charging time T_2

$T_2 = \frac{1734 \times 1.1 \times 2}{200}$ = 19.07 Hrs; This is less than the 24 hr. max. recharge time and is satisfactory.

A 500 Ampere Battery Charger is being supplied by PCP (Power Conversion Products) See Specification NMP2-E034A, Addendum No. 2

New $T_2 = \frac{1734 \times 1.1 \times 2}{500}$ = 7.63 Hours recharge time

T_2 = 7.63 Hrs

This is 16.37 Hrs faster than the 24 Hr maximum and is satisfactory!

*SEE BATTERY DATA, PAGE 11

PRINTS		ISSUE ②				ISSUE ④		
APR CARD								

STONE & WEBSTER ENGINEERING CORP.
BOSTON, MASS.

CLIENT N.M.P.C. STA NINE MILE - UNIT 2 REF DWGS 0001, 420-221-078 JO 12177
PNL NO SERIES 6VB EQPT NO 2VBS-PNLC100 LOC CSB COL L M.D / AD ELEV 261'-0"
SVCE 208Y/120V PH 3 W 5 NEUT SOLID MNS: [redacted], [redacted], [redacted] SW - CONN: TOP
BR CKTS 28 [redacted], FUSED SW - MTG: FL, SURF - NEMA TYPE 12 FDR SIZE [redacted]
XFMR MK NO ____ EQPT NO ____ KVA ____ ADD'L FEATURES 200A - NON-FUSIBLE MAIN

NO	SERVICE	LOAD KVA	LOAD AMPS	AMP	CKT	CKT	AMP	LOAD AMPS	LOAD KVA	SERVICE	NO
	2CEC-CP600 (CPU-1)	2.5		30	1	2	30		.7	2CEC-CP603 (LCS#1)	
	2CEC-CP612 (DIG GEN)	.5			3	4			1.0	2CEC-CP608 (MT#1)	
	2CEC-CP619 (AI/DI I/O)	2.5			5	6			2.5	2CEC-CP620 (DI I/O)	
	2CEC-CP607 (CCM)	.7			7	8			2.5	2CEC-CP624 (DI I/O#3)	
	2CEC-CP622 (DI I/O#1)	2.5			9	10			2.5	2CEC-CP626 (DI I/O#5)	
	2CEC-CP625 (DI I/O#4)	2.5			11	12			.4	2CEC-CP617 (AI I/O#4)	
	2CEC-CP616 (AI I/O#3)	.4			13	14	20		.24	2CEC-CP800H ([illegible])	
	2CEC-CP618 (AI I/O#5)	.4			15	16	20		.2	2CEC-CP801 (PC30 TYPER)	
	2CEC-PNL800A ([illegible])	.24		20	17	18	30				
				30	19	20					
					21	22					
					23	24					
					25	26					
					27	28					
					29	30					
					31	32					
					33	34					
					35	36					
					37	38					
					39	40					
					41	42					

A B C

CONN LOAD: ____
ULT LOAD: ____
TOTAL LOAD ____ USED FULL 71.303 KW OF UPS

OCT 29 1986

TOTAL CONNECTED LOADS { PHASE A = 7.4 KVA; " B = 7.1 KVA; " C = 8.14 KVA

EE-11J PAGE 8 OF 18

2VBS-PNLC100
COMPUTER UPS PANEL (PMS)

DWG. NO. EE-11J

PRINTS		ISSUE ②				ISSUE ④		
APR 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 0001.420-221-144 JO 12177

PNL NO SERIES 6VB EQPT NO 2VBS-PNLC101 LOC CSB COL L 14.0 / AD ELEV 261'

SVCE 208Y/120V PH 3 W 5 NEUT SOLID MNS: ~~LUGS ONLY~~, ~~CKT BRKR~~, ~~FUSED~~ SW - CONN: TOP

BR CKTS 28 ~~CKT BRKR~~, FUSED SW - MTG: ~~FL~~, SURF - NEMA TYPE 12 FDR SIZE ____ ~~BOT~~

XFMR MK NO ____ EQPT NO ____ KVA ____ ADD'L FEATURES 200A. NON-FUSIBLE MAIN

NO	SERVICE	LOAD KVA	LOAD AMPS	AMP	CKT	CKT	AMP	LOAD AMPS	LOAD KVA	SERVICE	NO
	2CEC-CP601 (CPU-2)	2.5		30	1	2	30		.7	2CEC-CP604 (LCS#2)	
	2CEC-CP609 (MHD)	1.0		20	3	4			1.0	2CEC-CP656 (MT#2)	
	2CEC-CP623 (DI I/O#2)	2.5		30	5	6			2.5	2CEC-CP627 (DI I/O#6)	
	2CEC-CP628 (DI I/O#7)	2.5			7	8			2.5	2CEC-CP610 (DI I/O#8)	
	2CEC-CP611 (DI I/O#9)	2.5			9	10			2.5	2CEC-CP621 (DI I/O#10)	
	2CEC-CP640 (DI I/O#11)	2.5			11	12			.4	2CEC-CP613 (AI I/O)	
	2CEC-CP614 (AI I/O#1)	.4			13	14			.4	2CEC-CP615 (AI I/O#2)	
	2CEC-CP801 (P632 TYPER)	.2		20	15	16	20		.48	2CEC-CP802 (R607, R608 K602, K603)	
	2CEC-CP803 (P635 TYPER P618 CRD)	.9		20	17	18	20		.44	2CEC-PNL800A (K605, K606 K600)	
	2CEC-PNL800B (R609 K601)	.24		20	19	20	20		.6	2CEC-PNL800C (P633, 634, 63[illegible])	
	2CEC-CP657 (SW CAB)			30	21	22	30				
					23	24					
					25	26					
					27	28					
					29	30					
					31	32					
					33	34					
					35	36					
					37	38					
					39	40					
					41	42					

A B C

CONN LOAD: ____
ULT LOAD: ____
TOTAL LOAD ____

OCT 29 19[illegible]

TOTAL CONNECTED LOAD { PHASE A = 9.84 KVA
" B = 7.68 KVA
" C = 9.24 KVA

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△3

DWG. NO. EE-11BH

2VBS-PNLC101

COMPUTER UPS PANEL (PMS)

SENDER — RETAIN YELLOW COPY. — FORWARD WHITE AND PINK COPIES.

REPLIER — RETURN WHITE COPY. RETAIN PINK COPY FOR FILE.

INTEROFFICE CORRESPONDENCE

TO:	LOCATION	SUBJECT / REFERENCE / J.O. NO.
John Knudsen GHOC	SR	Sizing of Battery Chargers
FROM: George Fligr	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 SWNEC'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 3-0684.

February 26, 1981

DATE

G O Fligr

SIGNATURE

TELEPHONE

REPLY:

DATE

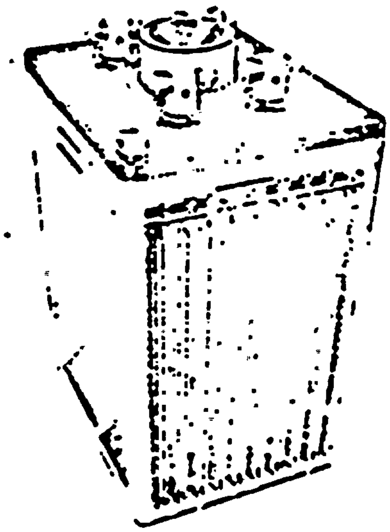
SIGNATURE

TELEPHONE

946.138

REPLIER RETURN WHITE COPY — RETAIN THIS COPY

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.

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Plate Dimensions	Height	Width	Thickness
Positive Plate	15"	12½"	.220
Negative Plate	15"	12½"	.215

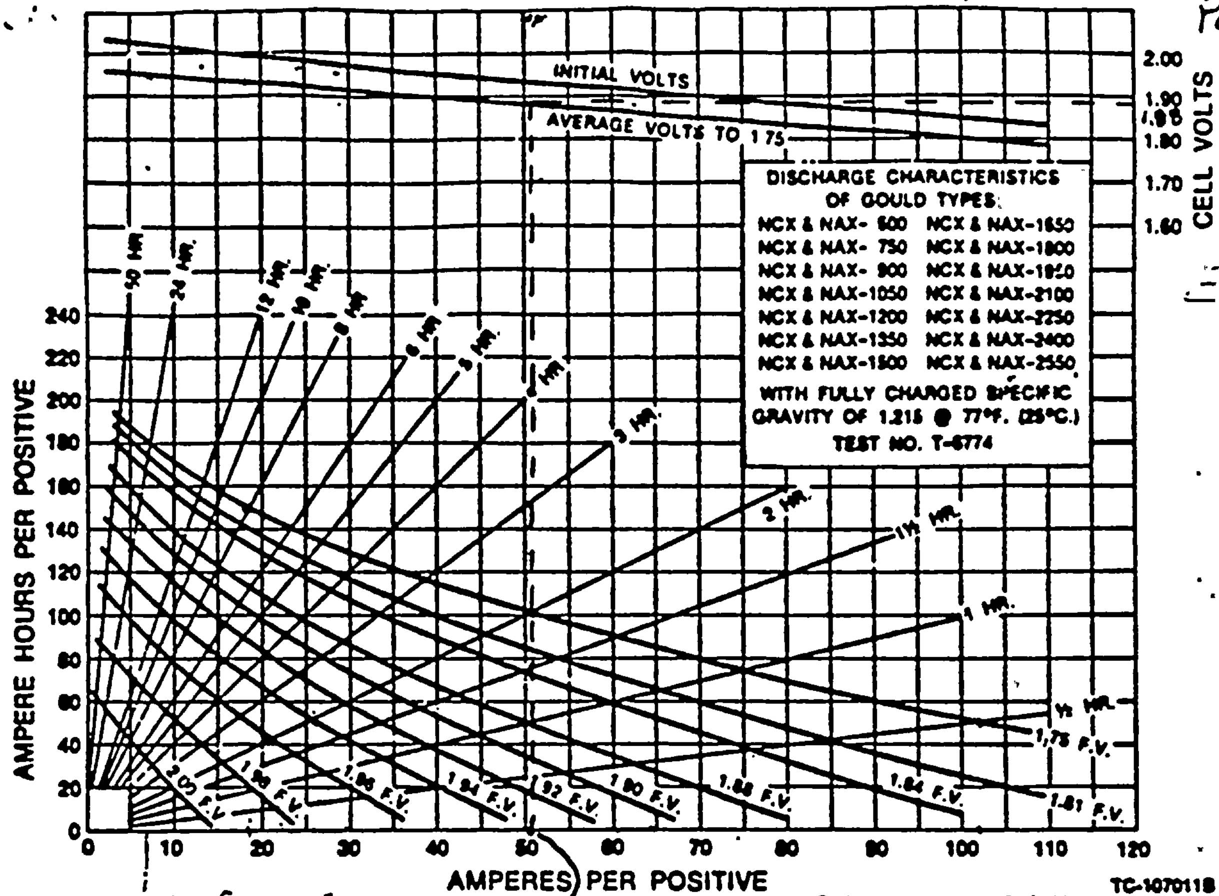
① Posts—600 A.H. to 1200 A.H. Two—1½" square. 1344 A.H. to 1950 A.H. Four—1" square. (Except 1848 A.H.) 1848 A.H. to 2550 A.H. Four—1½" square.

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	675	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	3080	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	1593	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. ** TMGould, Inc.

3



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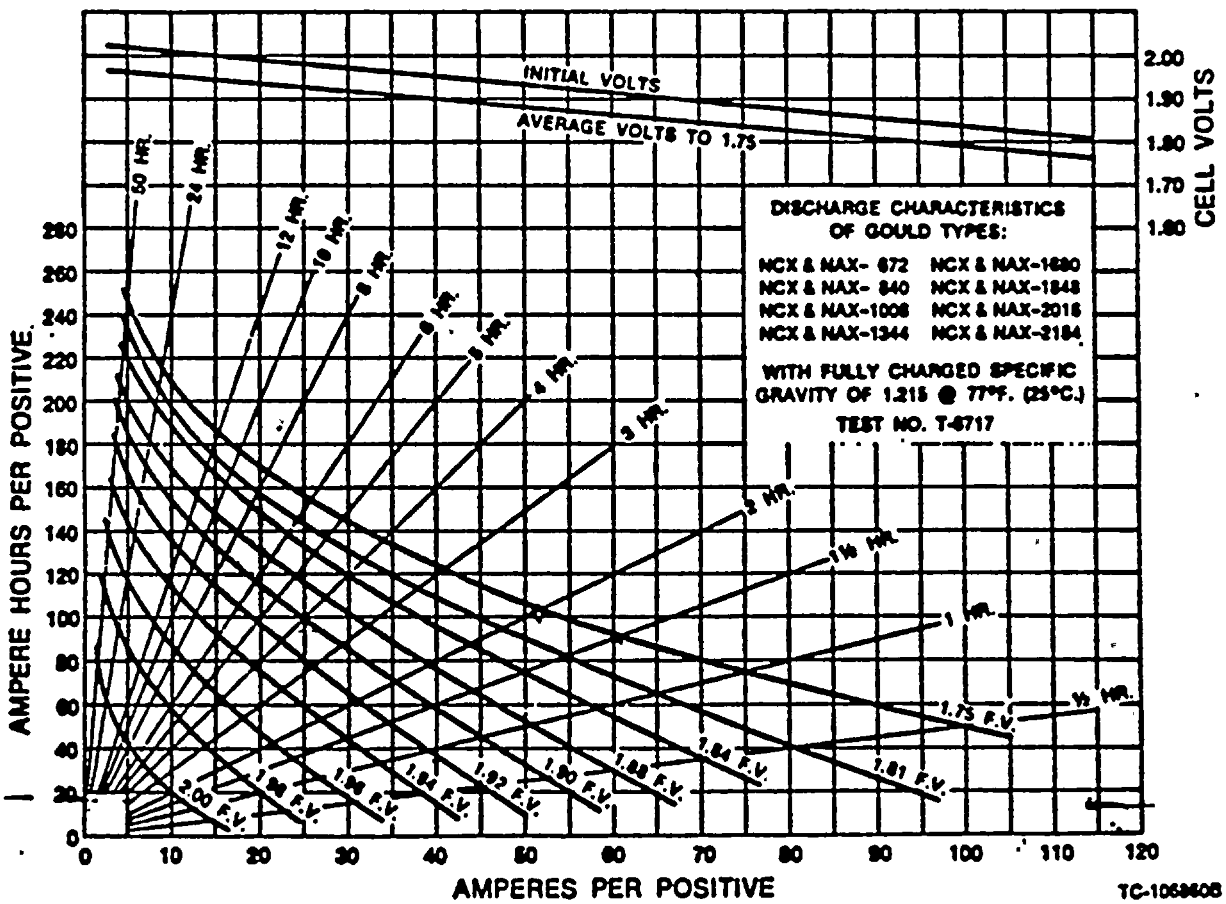

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GOULD

STONE & WEBSTER ENGINEERING CORPORATION • CHERRY HILL OPERATIONS CENTER

INTEROFFICE MEMORANDUM

J.O. OR W.O. NO 12177-EC-32-4

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

Attachment

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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).

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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.