Form 01077 (R7-89)

FORM 101.1	REVISION 13

CERTIFICATION OF ENGINEERING CALCULATION

STATION AND UNIT NUMBER Oconee Units 1, 2, & 3

TITLE OF CALCULATION Battery Load and Voltage Profile for Station Blackout Event

CALCULATION NUMBER OSC-4756

ORIGINALLY CONSISTING OF:

PAGES 1 THROUGH 88 6-18-92

TOTAL ATTACHMENTS 1 TOTAL MICROFICHE ATTACHMENTS

TOTAL VOLUMES 1 TYPE I CALCULATION/ANALYSIS YES ☒ NO ☐

TYPE I REVIEW FREQUENCY 3 years

THESE ENGINEERING CALCULATIONS COVER QA CONDITION 1 ITEMS. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED AND I CERTIFY THAT THE ABOVE CALCULATION HAS BEEN ORIGINATED, CHECKED OR APPROVED AS NOTED BELOW:

ORIGINATED BY [signature] DATE 6-18-92

CHECKED BY [signature] DATE 6-24-92

APPROVED BY [signature] DATE 6-24-92

ISSUED TO TECHNICAL SERVICES DIVISION ____ DATE ____

RECEIVED BY TECHNICAL SERVICES DIVISION ____ DATE ____

MICROFICHE ATTACHMENT LIST: ☐ Yes ☐ No SEE FORM 101.4

REV. NO.	CALCULATION PAGES (VOL)			ATTACHMENTS (VOL)			VOLUMES		ORIG	CHKD	APPR	ISSUE DATE
	REVISED	DELETED	ADDED	REVISED	DELETED	ADDED	DELETED	ADDED	DATE	DATE	DATE	REC'D DATE

1.0 PURPOSE 2

2.0 ASSUMPTIONS 2

3.0 REFERENCES 2

4.0 SUMMARY OF RESULTS AND CONCLUSIONS 2

5.0 DESIGN METHOD 2

6.0 LOAD PROFILE 3

7.0 CALCULATION OF BATTERY VOLTAGE 5

1.0 PURPOSE

The purpose of this calculation is to show that the Oconee 125Vdc Instrumentation and Control Batteries can supply adequate voltage to loads during the coping duration of a Station Blackout Event.

2.0 ASSUMPTIONS

1. Loads are distributed equally between the panelboards, and loads on each unit are equal to Unit 1 loads.

2. Because of auctioneering diodes, total station loads are shared equally between batteries in service.

3. Inrush on an inverter due to a load starting is negligible.

4. Load growth factor, aging factor, and temperature factor are 1.1, 1.25, and 1.11 respectively, as required by IEEE Std 485-1983, with battery electrolyte temperature of 60°F.

5. Inverter loads are constant power loads, i.e. if voltage goes down, current goes up.

6. Non-inverter loads are static loads; if voltage goes down, current goes down.

7. Three units are operating at the time of the Station Blackout Event.

8. Four batteries with 58 cells each are operable at the time of the Station Blackout event.

3.0 REFERENCES

1. OSC-2429-Oconee Units 1, 2, and 3 Oconee 125V Control Battery Duty Cycle and Voltage Profile
2. OSC-2769-Oconee Nuclear Station, Unit 1 125VDC I&C Battery Load Test Report
3. Drawing 0-705-One-line 125Vdc Vital Instrumentation and Control System
4. IEEE Standard 485-1983
5. IEEE Standard 450-1987
6. Oconee Station Blackout Response (in accordance with NUMARC 87-00)
7. Oconee Technical Specifications Section 3.7

4.0 SUMMARY OF RESULTS AND CONCLUSIONS

The battery output voltage will remain above 105V for the entire 4 hour SBO coping duration, with 4 batteries with 58 cells each operating.

5.0 DESIGN METHOD

The coping duration for a Station Blackout Event (SBO) at Oconee is four hours (See Reference 6). During this time, 125Vdc Vital Instrumentation and Control Power must be available to provide indication of pertinent plant parameters and control of switchgear. Existing dc calculations show that voltage will be adequate at all loads for a period of one hour if all loads are aligned to the system. Calculations exist showing voltage adequacy under some conditions to two hours. This calculation will document that adequate voltage will be available at least 4 hours after the loss of AC if the non-safety related inverters (1KI, 1KX, 1KU, 2KI, 2KX, 2KU, 3KI, 3KX, and 3KU) are removed from the safety-related 125Vdc distribution centers with-in 30 minutes or less after the loss of AC auxiliary power. This increase in discharge time is possible because the non-safety related inverters are a significant portion

of the total load on the safety-related DC system (47% of the 0-1 minute load and 59% of the after 1 minute load).

Technical Specifications allow 3 units to operate if five out of six batteries are operable. If a single failure of one battery occurs, the system is required to have enough capacity with four out of six batteries to supply adequate voltage.

In addition, a battery is assumed operable if 58 of 60 cells are operable. This calculation assumes that all four operable batteries have only 58 cells. Voltage is considered adequate if the battery voltage does not fall below 105V at any time within the discharge cycle. This corresponds to a minimum of 1.81 volts per cell for a 58 cell battery (See References 4 and 5).

The battery load profile is determined using the appropriate load profile from OSC-2429. This profile is modified to include the reduction in load 30 minutes into the event when the non-safety inverters are removed. This profile is used with the battery manufacturers data curves to determine the battery voltage at the beginning and end of each load period. These voltages are incorporated into a battery voltage curve.

6.0 LOAD PROFILE

The load profile for each battery when 4 batteries are operable with 58 cells per battery is calculated in OSC-2429. As stated in this calculation, each battery in the units with one battery operable will initially carry all three of the non-safety inverters for the unit (I_{Ins}), 1/4 of the total station safety-related inverter load (I_{Is}), and 1/4 of the total station safety-related non-inverter load (I_r). All loads are expressed on a 125Vdc base.

The total non-safety related inverter load for each unit is I_{Ins} = 219 amps (see OSC-2429). This load is removed from the batteries 30 minutes after the loss of AC auxiliary power. There are 12 safety-related inverters which pull 39 amps each. Each battery carries 3 of these inverters: I_{Is} = 1/4 (12 x 39 amps) = 3 x 39 amps = 117 amps.

There are 12 safety-related panelboards which provide the safety-related, non-inverter load. Each battery will carry the equivalent load of three of these panelboards. The initial non-inverter load is I_{R1}; after one minute, the total non-inverter load is reduced to I_{R2}; at 239 minutes the non-inverter load increases to I_{R3} to account for closing two breakers to restore AC power at the end of the four hour coping duration. I_{R3} is based on a sequence of events in which the SK or SL breakers close when auxiliary AC power returns, followed by their spring charging motors running subsequent with the closing of the standby breakers in each unit. The SK and SL breakers, as well as all six of the S breakers, are fed from 1DIC and 1DID. If a Unit 1 battery is inoperable, then one battery could feed all of these breaker operations; 10 amps for each of the spring charging motors plus 6.7 amps for each breaker close, for a total of 60.2 amps. Restoration of AC auxiliary power through the standby bus causes the worst-case 125Vdc control power loading, since more breakers must close than if AC power is restored via the Startup breakers. In addition, the I_{R3} calculated above assumes that the SK and S breakers are allowed to close automatically. If the breakers were to be placed in the "manual" mode prior the restoration of power, then only one breaker could close at one time, and the resulting control power load would be reduced.

I_{R1} = 135 A
I_{R2} = 33 A
I_{R3} = 93.2 A

The worst case load profile for each battery, corrected for load growth (1.1), temperature (1.11), and aging (1.25), is shown in Figure 1.

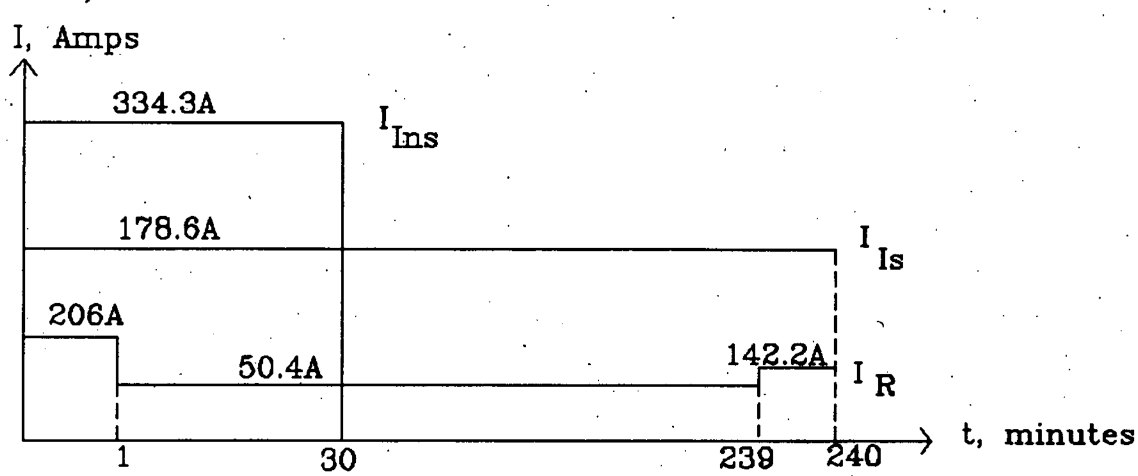


Figure 1: Load profile for 1 battery during SBO corrected to 125Vdc

The load profile in Figure 1 shows currents from test data corrected to a 125VDC base in OSC-2769. As mentioned in OSC-2429, tests were ran on Units 1 and 2, and the results of the two tests were comparable. This profile is conservative in that it uses test data from Unit 1 loads. Unit 1 loads are slightly higher than Unit 2 and 3 loads. In addition, the load profile assumes certain 4KV breaker operations in the first minute which would not occur during a station blackout. Using the assumptions in Section 2.0 concerning constant power inverter and static non-inverter load currents, an equation can be written to model the total battery current as a function of the actual battery voltage.

$$I(t) = I_R(t)\,\frac{V_B(t)}{125} + I_I(t)\,\frac{125}{V_B(t)}$$

$$\text{where } I_I(t) = I_{Ins}(t) + I_{Is}(t)$$

$$V_B(t) = \text{No. Cells x } \frac{\text{Voltage}}{\text{Cell}} = 58 \text{ x } V_c(t)$$

$$I(t) = (0.464) \text{ x } V_c(t) \text{ x } I_R(t) + \frac{2.16 \text{ x } I_I(t)}{V_c(t)}$$

where: $I(t)$ = Total Battery Current
$I_I(t)$ = Total Invertor Current
$I_R(t)$ = Total Non-Invertor Current
$I_{Ins}(t)$ = Non-Safety Invertor Current
$I_{Is}(t)$ = Safety Invertor Current
$V_B(t)$ = Actual Battery Voltage
$V_C(t)$ = Cell Voltage

7.0 CALCULATION OF BATTERY VOLTAGE

This calculation will use an iterative process, starting with $V_c(t)$= 2.06V, the open circuit voltage of a fully charged cell. This $V_c(t)$ is inserted into the I(t) equation developed above to calculate I(t) for the given time. This I(t) is divided by the number of positive plates of the battery to find the amps per positive plate; this value can be used in the manufactures capacity curves to determine the ending cell voltage for this discharge rate for the given period of time. This new $V_c(t)$ is then plugged back in to the I(t) equation to determine a new I(t). The 125V Vital Instrumentation and control batteries are FTC-23 cells with 11 positive plates per cell. This iterative process continues until the new $V_c(t)$ equals the $V_c(t)$ value which was used to calculate it.

For t=0-1 minute

- Assume $V_c(t)$= 2.06 V

$$I(t)=I_R(t)\frac{V_B(t)}{125}+I_I(t)\frac{125}{V_B(t)}$$

$$I_I(t)=334.3A+178.6A=512.9A$$

$$I_R=I_{R1}=206A$$

$$V_B(t)=No.Cells\ x\ \frac{Voltage}{Cell}=58\ x\ V_c(t)$$

$$I(t)=(0.464)\ x\ 2.06V\ x\ 206A+\frac{2.16\ x\ 512.9A}{2.06V}=734.7A$$

$$\frac{734.6A}{11pp}=66.79A/pp$$

Using the battery manufacturer's discharge curves, a discharge of 66.79A/pp for 1 minute yields a final voltage of 1.85 volts per cell.

- Assume $V_c(t)$= 1.85 V

$$I(t)=I_R(t)\frac{V_B(t)}{125}+I_I(t)\frac{125}{V_B(t)}$$

$$I_I(t)=334.3A+178.6A=512.9A$$

$$I_R=I_{R1}=206A$$

$$V_B(t)=No.Cells\ x\ \frac{Voltage}{Cell}=58\ x\ V_c(t)$$

$$I(t)=(0.464)\ x\ 1.85V\ x\ 206A+\frac{2.16\ x\ 512.9A}{1.85V}=775.7A$$

$$\frac{775.7A}{11pp}=70.5A/pp$$

From manufacturers curves, 70.5 A/pp for 1 minute yields 1.84 volts per cell.

- Assume $V_c(t)$= 1.84 volts per cell.

$$I(t)=(0.464)\ x\ 1.84V\ x\ 206A+\frac{2.16\ x\ 512.9A}{1.84V}=778.0A$$

$$\frac{778.0A}{11pp}=70.7A/pp$$

$$70.7A/pp\ for\ 1\ minute\ yields\ V_c(t)=1.84V$$

The voltage per cell at the end of the first minute is 1.84V. This equates to a battery voltage of 106.72V.

<u>t= 1^+ minute</u>

- Assume $V_c(t)$= 1.84 V

$$I_I(t)=334.3A+178.6A=512.9A$$

$$I_R=I_{R2}=50.4A$$

$$I(t)=(0.464)\ x\ 1.84V\ x\ 50.4A+\frac{2.16\ x\ 512.9A}{1.84V}=645.1A$$

$$\frac{645.1A}{11pp}=58.7A/pp$$

$$70.7A/pp\ x\ 1\ minute=70.7A\text{-}min/pp$$

At 1 minute, the battery has discharged 70.7 A•min/pp at a rate of 70.7 A/pp. The new estimated rate of discharge at 1^+ minute is 58.7 A/pp. To find a cell voltage for the time immediately after the discharge rate decreases, an equivalent time to discharge the same amount of energy as discharged in 1 minute at 70.6 A/pp will be found. The energy discharged was 70.7A-min/pp. The equivalent time required to discharge that amount of energy at a rate of 58.7A/pp is 70.7A-min/pp ÷ 58.7A/pp = 1.2 minutes. From the manufacturer's curve, 58.7A/pp for 1.2 minutes corresponds to a cell voltage of 1.86V.

- Assume $V_c(t)$= 1.86 V

I(t)=639.1A=58.1A/pp
70.7 A-min/pp is equivalent to 58.1 A/pp for 1.22 minutes
From the manufacturer's curves, $V_c(t)$= 1.86V

$V_B(t)$=107.9 V

<u>t= 30^- minutes</u>

- Assume $V_c(t)$= 1.86V

I(t)=58.1A/pp
The total accumulated discharge at 30 minutes is:
70.7 A-min/pp + (58.1 A/pp)(29 min)=1755.6 A-min/pp
1755.6A-min/pp is equivalent to 58.1A/pp for 30.22 minutes
From the manufacturer's curves, $V_c(t)$=1.84V

- Assume $V_c(t)$= 1.84 V

I(t)=645.1 A= 58.7A/pp
The total accumulated discharge at 30 minutes is:
70.7 A-min/pp + (58.7 A/pp)(29 min)=1773 A-min/pp
1773 A-min/pp is equivalent to 58.7A/pp for 30.2 minutes
From the manufacturer's curves, $V_c(t)$=1.84V

$V_B(t)$= 106.72 V

t= 30^+ minutes

Thirty minutes after the lose of Ac auxiliary power, the non-safety related inverters are disconnected from the DC Distribution Centers.

- Assume $V_c(t)$= 1.84 V

I_{ins}= 0 A
I_{ls}= 178.6A
I_R=50.4A
I(t)=252.7A = 23.0 A/pp

The total accumulated discharge at 30 minutes is 1773 A-min/pp
1773 A-min/pp is equivalent to 23.0 A/pp for 77.1 minutes
From the manufacturer's curves, $V_c(t)$=1.94V

- Assume $V_c(t)$= 1.94 V

I(t)=244.2 A= 22.2A/pp
1773 A-min/pp is equivalent to 22.2A/pp for 79.9 minutes
From the manufacturer's curves, $V_c(t)$=1.94V

$V_B(t)$= 112.5 V

t= 239^- minutes

- Assume $V_c(t)$= 1.94 V

I(t)=244.2A = 22.2 A/pp
The total accumulated discharge at 239 minutes is:
1773 A-min/pp + (22.2 A/pp)(239 min-30 min)= 6412.8 A-min/pp
6412.8 A-min/pp is equivalent to 22.2A/pp for 288.9 minutes
From the manufacturer's curves, $V_c(t)$=1.88 V

- Assume $V_c(t)$= 1.88 V

I(t)=249.2 A= 22.65A/pp
1773 A-min/pp + (22.65 A/pp)(209 min)= 6506.9 A-min/pp
6506.9 A-min/pp is equivalent to 22.65A/pp for 287.3 minutes
From the manufacturer's curves, $V_c(t)$=1.88 V
$V_B(t)$= 109.0 V

t= 239⁺ minutes

Two hundred and thirty nine minutes into the event, certain switchgear is assumed to operate as described in Section 6.0.

- Assume $V_c(t)$= 1.88 V

I_{lms}= 0 A
I_{ls}= 178.6A
I_R=142.2A

I(t)=329.2A = 29.9 A/pp
The total accumulated discharge at 239 minutes is:
1773 A-min/pp + (22.65 A/pp)(209 min)= 6506.9A-min/pp
6506.9 A-min/pp is equivalent to 29.9A/pp for 217.6 minutes
From the manufacturer's curves, $V_c(t)$=1.84 V

- Assume $V_c(t)$=1.84 V

I(t)=331.1 A= 30.1A/pp
6506.9 A-min/pp is equivalent to 30.1A/pp for 216.2 minutes
From the manufacturer's curves, $V_c(t)$=1.84 V
$V_B(t)$= 106.72 V

t= 240 minutes

- Assume $V_c(t)$= 1.84 V

I(t)=331.1A = 30.1 A/pp
The total accumulated discharge at 240 minutes is:
6506.9 A-min/pp + (30.1 A/pp)(1 min)= 6537 A-min/pp
6537 A-min/pp is equivalent to 30.1A/pp for 217.2 minutes
From the manufacturer's curves, $V_c(t)$=1.84 V
$V_B(t)$= 106.72 V

The battery voltage profile for the entire station blackout event is shown in Figure 2.

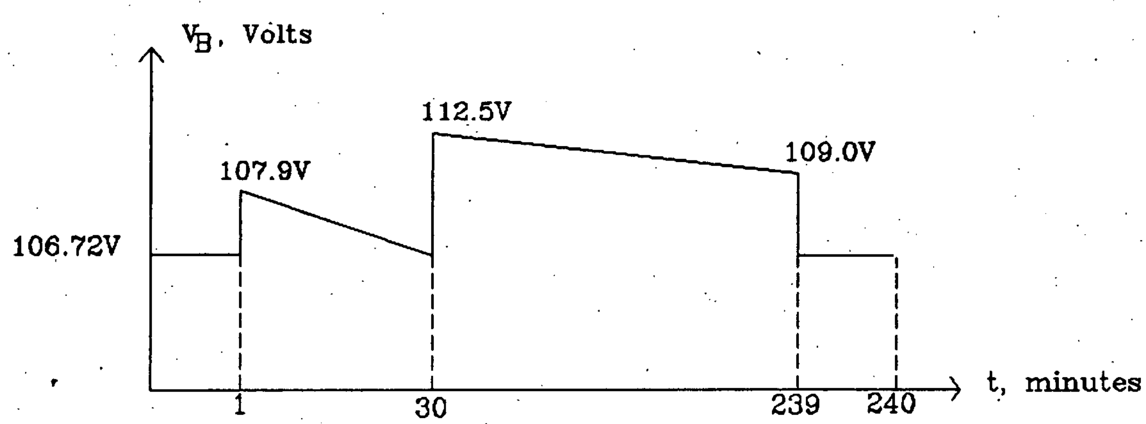


Figure 2: Battery Voltage Profile for Station Blackout Event

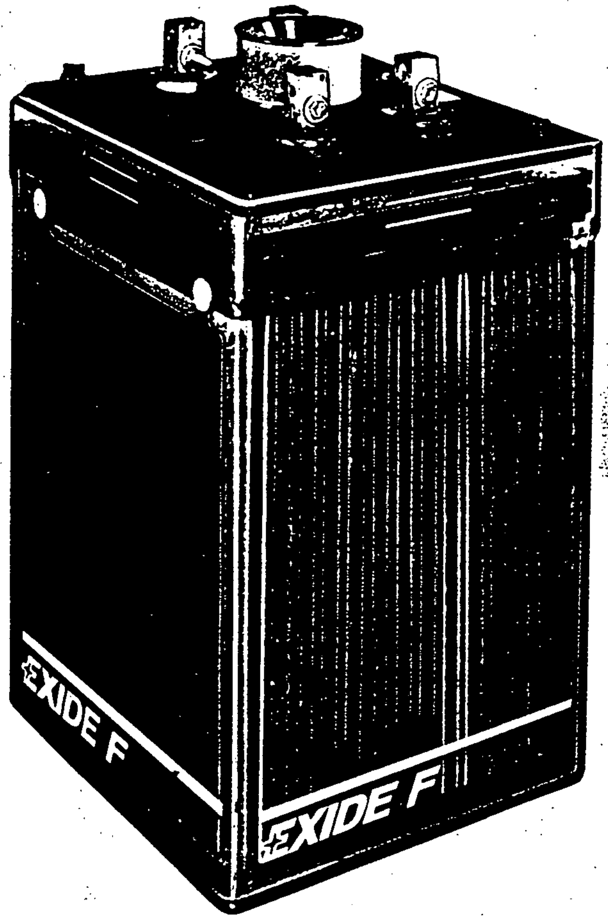
EXIDE®

Calcium Flat Plate

Type FTC

Long Duration

- ☐ Lowest maintenance—lowest water loss, lowest maintenance costs
- ☐ Highest 1 minute rates
- ☐ Flat-plate construction—calcium alloy grids
- ☐ For floating applications where high ambient temperatures are not probable
- ☐ 20 year life expectancy
- ☐ An extra large electrolyte reservoir, in conjunction with tailored plate design, maximizes performance for discharges of more than two hours in duration while maintaining excellent short duration-high current performance. This design provides an extremely attractive, less expensive alternative for many switchgear-type applications as well as the traditional long duration requirements characteristic of communications applications.



SPECIFICATIONS

PLATE DIMENSIONS—

	HEIGHT	WIDTH	THICKNESS
POSITIVE:	14.4 in/366 mm	12.1 in/307 mm	0.32 in/8.1 mm
NEGATIVE:	14.4 in/366 mm	12.1 in/307 mm	0.24 in/6.1 mm

SEDIMENT SPACE: 1.0 in/25.4 mm
ELECTROLYTE OVER PLATES: 2.9 in/73.7 mm
CONTAINER: Styrene Acrylonitrile Copolymer
COVER: Styrene Butadiene
SEPARATORS: Microporous rubber
RETAINERS: "Vitrex"—glass fiber
POST TYPE: Double posts
POST SEAL TYPE: Axial Compression with Machined Post
PLATE SUSPENSION TYPE—
POSITIVE: Ledge hung
NEGATIVE: Ledge hung
ELECTROLYTE WITHDRAWAL TUBE: One per cell
VENT TYPE: Flame arrestor, fused alumina
FLOAT VOLTAGE—
ACCEPTABLE RANGE: 2:17—2.26 VPC
RECOMMENDED: 2.25 VPC
SPECIFIC GRAVITY: 1.215 (1.250 and 1.300 available on request)
BOLT CONNECTORS: Stainless steel, standard English measure hex-head
INTERCELL CONNECTORS: Lead-plated copper

OSC-4756
Attachment 1
Page 1 of 4
ZGU 6-18-92

OSC-4756
Attachment 1
page 2 of 4
[initials] 6-18-92

Capacities-Dimensions-Weights

TYPE*	NOM. A.H. CAP.	OVERALL DIMENSIONS						WEIGHTS—VOLUMES								OUTLINE DRAWING: SEE CATALOG SECTION
		LENGTH		WIDTH		HEIGHT		UNPACKED		DOMESTIC PACKED		ELECTROLYTE ONLY 1.215 SP. GR.				
		in	mm	in	mm	in	mm	lbs	kg	lbs	kg	lbs	kg	gal	l	
FTC-11	840							183	83.0	192	87.0	51	23.1	5.0	19.1	
FTC-13	1010	7.5	191					197	89.4	206	93.4	48	21.8	4.7	17.9	
FTC-15	1180							217	98.4	227	103.0	46	20.9	4.5	17.2	
FTC-17	1340	9.0	229					250	113.4	262	118.8	59	26.8	5.8	22.0	
FTC-19	1510			14.5	368	22.7	577	271	122.9	283	128.4	57	25.9	5.6	21.3	57.35
FTC-21	1680	10.7	272					303	137.4	315	142.9	70	31.8	6.9	26.2	
FTC-23	1850							320	145.1	332	152.6	68	30.8	6.7	25.4	
FTC-25	2020							367	166.5	383	173.7	90	40.8	8.9	33.6	
FTC-27	2180	13.2	335					385	174.6	402	182.3	88	39.9	8.7	32.9	
FTC-29	2350							405	183.7	422	191.4	85	38.6	8.4	31.8	

*Suffix Number Indicates Total Plates Per Cell

Average Cell Performance Data*

Discharge rates in amperes.

1.215 SP. GR. ELECTROLYTE AT 77° (25°C), INCLUDING CELL CONNECTORS

TYPE	NOM. A.H. CAP.	72 HR.	24 HR.	12 HR.	8 HR.	5 HR.	4 HR.	3 HR.	2 HR.	1.5 HR.	1 HR.	30 MIN.	15 MIN.	1 MIN.	TO 1.50 VPC 1 MIN.
To 1.75 VPC Final															
FTC-11	840	15.0	42.5	76.5	105	147	170	206	266	311	375	464	557	723	1375
FTC-13	1010	18.0	51.0	91.8	126	176	204	247	319	373	450	557	659	835	1585
FTC-15	1180	21.0	59.5	107	147	206	238	288	372	435	525	649	756	941	1785
FTC-17	1340	24.0	68.0	122	168	235	272	330	425	497	600	740	852	1045	1990
FTC-19	1510	27.0	76.5	138	189	265	306	371	478	559	675	832	945	1150	2195
FTC-21	1680	30.0	85.0	153	210	294	340	412	531	622	750	924	1030	1260	2400
FTC-23	1850	33.0	93.5	168	231	324	374	446	584	684	825	1015	1110	1325	2600
FTC-25	2020	36.0	102	183	252	353	408	486	637	746	900	1105	1190	1410	2800
FTC-27	2180	39.0	110	199	273	382	442	526	690	808	975	1200	1260	1495	2980
FTC-29	2350	42.0	119	214	294	412	476	567	743	870	1050	1290	1330	1580	3150
To 1.81 VPC Final															
FTC-11	840		38.7	69.0	95	133	155	185	232	265	310	368	435	550	
FTC-13	1010		46.4	82.8	114	160	186	223	278	318	372	441	513	750	
FTC-15	1180		54.2	96.6	133	187	217	260	325	371	434	514	589	831	
FTC-17	1340		61.9	110	152	214	248	297	371	424	496	587	662	804	
FTC-19	1510		69.7	124	171	240	279	334	418	477	558	658	732	875	
FTC-21	1680		77.4	138	190	267	310	371	464	531	620	732	800	940	
FTC-23	1850		85.1	152	209	294	341	408	510	584	682	804	864	997	
FTC-25	2020		92.9	166	228	320	372	445	557	637	744	875	926	1050	
FTC-27	2180		101	179	247	347	403	482	603	690	806	947	985	1095	
FTC-29	2350		108	193	266	374	434	519	649	743	868	1020	1040	1130	

*Rates shown depict average values and are subject to IEEE-485

AVERAGE CAPACITY OF MEAN—SIZE CELLS INCLUDING CONNECTORS

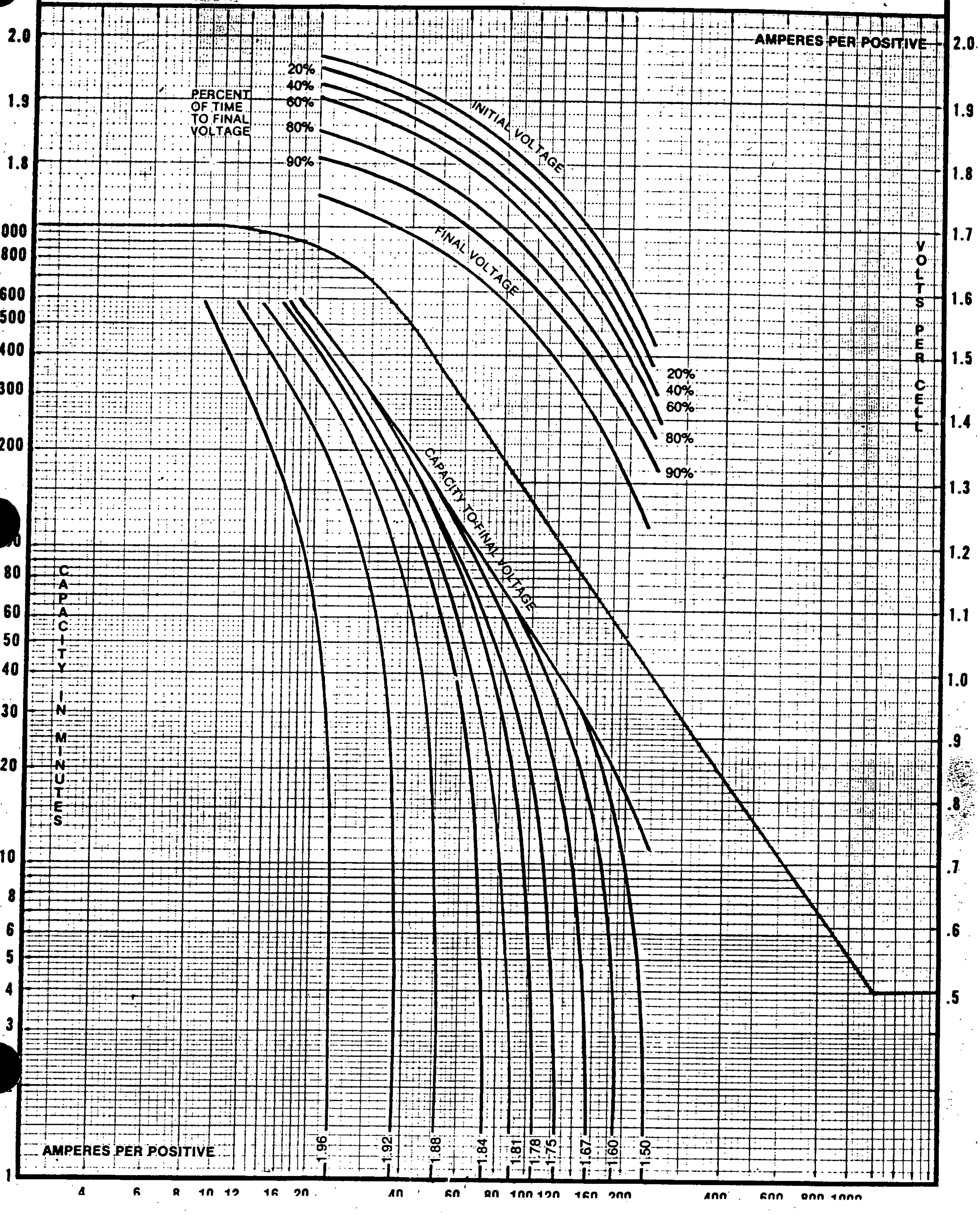
S-1016 OSC-4736 Attachment 1

Type: FTC page 3 of 4 LGM 6-18-92

Temp. 77°F (25°C)

Sp. Gr. 1.215

Date: 12/76



OSC-4756
Attachment 1
Page 4 of 4
[illegible] 6-18-92

Standard-Rack Selection Guide for "FTC" Cells*

CAUTION: Additional length may be required for seismic and high seismic racks.

[illegible] OF CELLS	CELL SIZE	(QUANTITY REQUIRED) CATALOG NUMBER—RACK LENGTH IN INCHES				
		1 TIER	2 TIER	2 STEP	2 STEP/TIER	3 TIER
12	11-15	(1)80426-96	(1)80486-60	(1)80497-60	N/A	N/A
	17-19	(1)80428-120	(1)80486-60	(1)80497-60	N/A	N/A
	21-23	(1)80430-144	(1)80487-72	(1)80498-72	(1)80899-60	(1)80888-60
	25-29	(1)60432-168	(1)80488-84	(1)80499-84	(1)80899-60	(1)80888-60
24	11-15	(2)80426-96	(1)80489-96	(1)80500-96	(1)80899-60	(1)80889-72
	17-19	(2)80428-120	(1)80491-120	(1)80502-120	(1)80899-60	(1)80890-84
	21-23	(2)80430-144	(1)80493-144	(1)80504-144	(1)80900-72	(1)80891-96
	25-29	(2)80432-168	(1)80495-168	(1)80506-168	(1)80901-84	(1)80893-120
26	11-15	(2)80427-108	(1)80490-108	(1)80501-108	(1)80899-60	(1)80889-72
	17-19	(1)80428-120 +(1)80429-132	(1)80492-132	(1)80503-132	(1)80900-72	(1)80891-96
	21-23	(2)80430-144	(1)80493-144	(1)80504-144	(1)80901-84	(1)80892-108
	25-29	(2)80433-180	(1)80496-180	(1)80507-180	(1)80902-96	(1)80894-132
27	11-15	(1)80427-108 +(1)80428-120	(1)80491-120	(1)80502-120	(1)80899-60	(1)80889-72
	17-19	(2)80429-132	(1)80492-132	(1)80503-132	(1)80900-72	(1)80891-96
	21-23	(1)80430-144 +(1)80431-156	(1)80494-156	(1)80505-156	(1)80901-84	(1)80892-108
	25-29	(3)80429-132	(2)80489-96	(2)80500-96	(1)80902-96	(1)80894-132
30	11-15	(2)80428-120	(1)80491-120	(1)80502-120	(1)80900-72	(1)80890-84
	17-19	(2)80430-144	(1)80493-144	(1)80504-144	(1)80901-84	(1)80891-96
	21-23	(2)80432-168	(1)80495-168	(1)80506-168	(1)80902-96	(1)80893-120
	25-29	(3)80430-144	(1)80489-96 +(1)80491-120	(1)80500-96 +(1)80502-120	(1)80904-120	(1)80895-144
[illegible]	11-15	(3)80432-168	(2)80491-120	(2)80502-120	(1)80904-120	(1)80897-168
	17-19	(4)80430-144	(2)80493-144	(2)80504-144	(1)80906-144	(2)80891-96
	21-23	(4)80432-168	(2)80495-168	(2)80506-168	(1)80908-168	(2)80893-120
	25-29	(5)80432-168	(3)80493-144	(3)80504-144	(1)80902-96 +(1)80904-120	(2)80895-144
66	11-15	(3)80433-180	(1)80492-132 +(1)80493-144	(1)80503-132 +(1)80504-144	(1)80906-144	(1)80898-180
	17-19	(2)80431-156 +(2)80432-168	(1)80494-156 +(1)80495-168	(1)80505-156 +(1)80506-168	(1)80908-168	(2)80892-108
	21-23	(4)80430-144 +(1)80431-156	(3)80492-132	(3)80503-132	(1)80902-96 +(1)80903-108	(2)80894-132
	25-29	(6)80431-156	(3)80494-156	(3)80505-156	(1)80904-120 +(1)80905-132	(2)80896-156

**This rack selection guide is applicable for standard racks with or without shock-protecting equipment.*
For additional information about standard racks, see Catalog Sections 55.10, 55.22 through 55.28. For information about shock-protecting equipment, see seismic and high seismic racks for "FTC" Series Cells, see Sections, 55.01, 55.45, 55.60, 55.65, and 55.80.

Accessories

	CATALOG NUMBER
†**PORTABLE HYDROMETER**	81332
†**HYDROMETER HOLDER—WALL MOUNT**	27717
†**THERMOMETER** (Portable or Flame) Arrestor Mounting)	88330
†**CELL NUMBER SET:** 1-30	49930
1-60	49931
1-120	49932
1-240	49933
†**CELL LIFTING DEVICE:** FTC-11, 13, 15	62265
FTC-17, 19	62264
FTC-11, 23	62266
FTC-25, 27, 29	62267
[illegible] **ARRESTOR** (Supplied With Each Cell)	71655

[illegible]**DED WITH 12 OR MORE CELLS**

For complete information about these and all other accessories, see Catalog Section 55.91.

Note:
All inter-cell, inter-tier, inter-step, end-to-end inter-rack, back-to-back inter-rack connectors, terminal lugs, and terminal plates are included with every battery. Across-aisle inter-rack connectors are not included.

EXIDE

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5K 8/85

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ATTACHMENT IV

ROOM HEATUP CALCULATION FOR STATION BLACKOUT EVENT