Design Analysis
Ginna Station

Station Blackout Temperature Effects

on Vital Batteries

Rochester Gas and Electric Corporation

89 East Avenue

Rochester, New York 14649

EWR-3341

Revision 0

November 30, 1990

Prepared by: George W Daniels — 12-18-90
Electrical Engineer — Date

Reviewed by: Kenneth G Laubacher — 12-21-90
Electrical Engineer — Date

Approved by: Charles A. Forbell Jr. — 1·18·91
Manager, Electrical Engineering — Date

Changed or New Equipment/System Information Requires Copy to Ginna. (Check Applicable Box)	Safety Class (1)	Review by NS&L (Y/N)
[ ] **Setpoints** (Instrument, Relief Valve, Time Delay, other)		(2)
[X] **Operating Parameters** (Flow, Pressure, Temperature, Volume, other)	NSR	Y (2)
[ ] **Operational Restrictions**		(3)

NS&L review by: Mark D Flaherty — 1-18-91
Nuclear Engineer — date

(1) If box is checked, mark "NSR" if Nuclear Safety Related, "SS" if Safety Significant, or "NNS" if Non Nuclear Safety.
(2) If Safety Class is "NSR" or "SS", review by NS&L is required.
(3) If box is checked, review by NS&L is required.

Revision Status Sheet

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Design Review
WR 3341

Revision 0
Date 11/30/90

42-91

Design Analysis

1.0 **Objective**

1.1 The objective of this analysis is to establish the dynamic temperature response and resulting temperature extremes of the battery rooms at Ginna Station, to a Station Blackout (SBO) event, and to evaluate the effect of the temperature changes during the assumed four hours of that event, on vital battery capacity.

2.0 **Design Inputs** None

3.0 **Referenced Documents**

3.1 Design Analysis, Ginna Station, Sizing of Vital Batteries, EWR 3341, Rev. 0 3-12-90.

3.2 Guidelines and Technical Bases for NUMARC Initiatives, NUMARC 87-00, 7.2.2 Assessing Class IE Battery Capacity.

3.3 IEEE Recommend Practice for Maintenance Testing of Large Lead Storage Batteries for Generating Stations, ANSI/IEEE Std. 450-1987, Table 1, Temperature Correction Factors.

3.4 Updated Final Safety Analysis Report (UFSAR), Ginna Station, Figure 1.2-16, Control, Battery, and Relay Rooms.

3.5 Gould, Stationary Power Cells (Antimony), Type: NAX (Specifications), GB-3326C 5-74 5M.

3.6 Solidstate Controls Inc., Series SV Single and Three Phase Static Inverters, General Specifications, 81-234 9/84/IM.

3.7 Solidstate Controls Inc., SCI Series BCS Thyri-Power Battery Charger Systems, General Specifications, 81-423 9/84/IM.

3.8 R. E. Ginna, Control Building Environmental Study, August 1990, Devonrue Inc.

3.9 Storage Batteries, George Wood Vinal, John Wiley & Sons, p. 420.

3.10 Heat and Mass Transfer, Frank M. White, Addison-Wesley Publishing Co.

4.0 Assumptions

4.1 High temperatures may develop in the battery rooms if a SBO event occurs during hot weather. The loss of HVAC due to SBO can result in a temperature rise in the battery rooms to 107°F according to Ref. 3.8. This temperature increase will not degrade the battery capacity (see Ref. 3.3) or result in any anomalous battery performance in either the charge or discharge mode of operation. Certain authors (Ref. 3.9) recommend maintaining operating battery temperatures below 110°F. It is therefore assumed that no battery capacity degradation occurs at the high temperature limit of this event.

4.2 The battery chargers and inverters are designed to operate in the temperature range -10°C to 40°C (14°F TO 104°F) (see Refs. 3.6 and 3.7). The peak temperature of 107°F is above this design range but is acceptable under the requirements of Ref. 3.2. It is shown in this analysis however that the heat capacity of the batteries, which was not accounted for in Ref. 3.8, significantly moderates battery room temperature transients. The lower extreme of the ambient temperature design range for the chargers and inverters is well below the lowest temperature that would occur in the battery room in an SBO according to this analysis. It is therefore assumed that ambient temperature will not prevent or degrade battery charger function as designed at the end of the four hour SBO, or inverter function during the entire period of the event.

4.3 The vital battery load during the SBO is specified in Ref. 3.1. See Sections 1.4 and 7.2 for SBO details.

4.4 Heating for the battery rooms was installed in 1987. Prior to this time the heat sources in the rooms were the battery chargers, inverters, and lights. The battery rooms, with the air handling room, make up the lowest level of the Control Building. This space has exterior walls on three sides and the floor which are below grade. The Turbine Building is on the fourth side. The Relay Room is on the floor above. Ref. 3.4 shows this arrangement. A thermal model for this space is developed which consists of the battery room air, the batteries, and the exterior walls and floor. Heat transfer from the air to the batteries, walls, and floor is by natural convection. Heat transfer through the walls and floor to exterior soil is by conduction.

4.5 The battery room temperature control system is designed to maintain temperature at 75°F ± 2°F. For the low

temperature SBO transients the initial temperature is assumed to be 73°F.

4.6 A search of surveillance records showed that the lowest battery room temperature documented prior to the installation of heating was 60°F. Using this steady state temperature and the heat sources available (no external heat) it is possible to estimate the effective exterior ambient soil temperature (34°F). This calculation is shown in Section 6. Material thermal properties for air, water, and concrete were obtained from Ref. 3.10.

4.7 Battery charger efficiency is assumed to be 90 percent (Ref. 3.7). Under normal operating conditions with the chargers supplying 100 amps (normal) this will result in approximately 1200 watts of heat dissipated into the room. The chargers do not function during SBO.

4.8 Inverter efficiency is assumed to be 80 per cent (Ref. 3.6). The inverters operate close to their rating (7.5 KVA) normally. This results in approximately ~~2700~~ 1785 watts of dissipated heat. The inverters function during SBO.

4.9 There are 6, 40 watt fluorescent light units in A battery room and 8, 40-watt units in B battery room. It will be assumed that about 300 watts of heat is due to lighting. This lighting is lost during SBO.

5.0 <u>Computer Codes</u>

5.1 Battery Room thermal transient analysis (BATRMTRS.FOR) (SEE Appendix 1).

This is a FORTRAN program which simulates the time dependent behavior of the battery room air, battery, exterior wall temperature, under initial conditions developed in Section 6.0 of this analysis.

5.2 Load Change Report Spreadsheet (See Appendix 2)

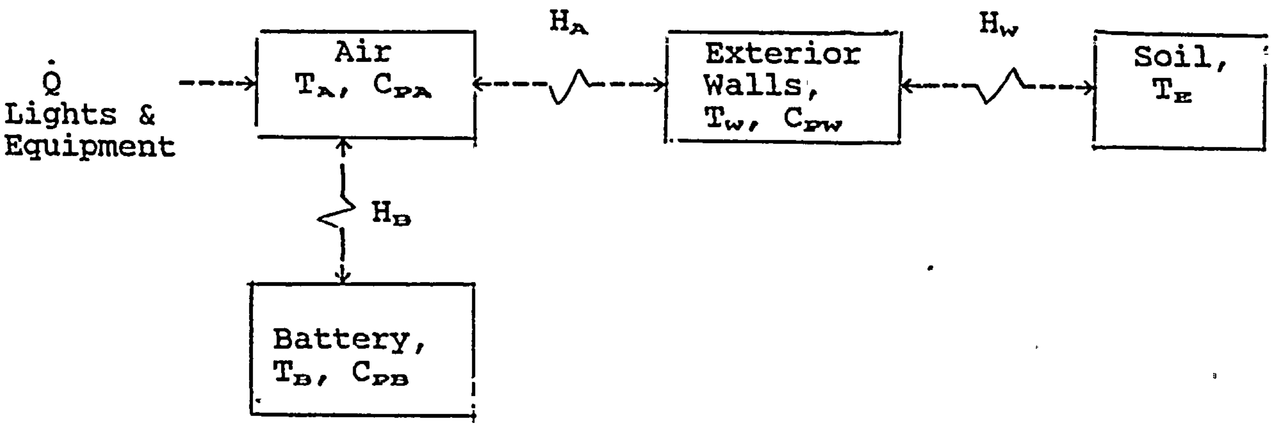
This is a spreadsheet program written in the Symphony environment. It is documented and maintained in the Electrical Engineering Central Technical File.

6.0 <u>Analysis</u>

6.1 Heat Transfer Model

6.1.1 The physical configuration of the battery rooms is described in Section 4.0 of this analysis. Based on this

configuration, in the absence of the battery room heater, the significant heat sources are the lights and electrical equipment in the rooms. The principal sources and sinks are shown in the following sketch.



$H_A = \bar{h}_A$ A (ext. walls & floor), $H_B = \bar{h}_B$ A (Batteries)

$$H_W = \frac{\text{A (ext. walls \& floor)} \cdot \text{K (thermal conductivity of concrete)}}{\text{d (thickness of concrete)}}$$

$\bar{h}_A$ and $\bar{h}_B$ are estimated natural convection heat transfer coefficients

C_{PA}, C_{PW}, C_{PB} are heat capacities of air, walls & floor, and batteries respectively

T_A, T_W, T_B are temperatures of air, wall and batteries

6.1.2 The state equations for the configuration described in 6.1.1 are,

$$\frac{d}{dt} T_A = \frac{1}{CPA} [\dot{Q} - H_A(T_A - T_W) - H_B(T_A - T_B)]$$

$$\frac{d}{dt} T_B = \frac{H_B}{CPB} (T_A - T_B)$$

$$\frac{d}{dt} T_W = \frac{2}{CPW} [H_A(T_A - T_W) - H_W(T_W - T_E)]$$

6.1.3 Heat capacity calculations.

Battery room air

V_{air} (Volume of (each) battery room) = 18 ft x 12.5 ft x 40f.
= 9000 ft^3

C_p [air @ 300°K (80.6°F)] = 100.5 J/Kg·K = 0.24 BTU/lb_m°F
p ["] = 1.177 Kg/m^3 = .073478 lb_m/ft^3

M_{air} (mass of air) = V_{air} p = 9000 ft^3 · .073478 lb_m/ft_3
= 661.302 lb_m

$C_{PA} = M_{air} \cdot C_p$ = 661.3 lb_m · 0.24 Btu/lb_m°F = 158.7 Btu/°F

Battery water

5 gals H_2O per cell x 60 cells = 300 gals

Cp [H_2O @ 300°K (80.6°F)] = 4177 J/Kg·K = 0.9976 Btu/lb_m°F
p [ ] = 997 Kg/m^3 = 62.24 lbm/ft^3
300 gal = 1.1356m^3 = 40.1 ft^3
(1 gal = 0.13368 ft^3)

$C_{PB} = M_{H2O} \cdot C_{PH2O}$ = 40.1 ft^3 · 62.24 lb_m/ft^3 · 0.9976Btu/lb_m°F
= 2489.9 Btu/°F.

Concrete in exterior walls and floor

"B" battery room

All walls and floor 1.5' thick concrete volume.

east wall	1.5 ft · 18 ft. · 40 ft	=	1080.0 ft^3
south wall	1.5 ft · 18 ft. · 12.5 ft	=	337.5 ft^3
floor	1.5 ft · 12.5 ft. · 40 ft	=	750.0 ft^3
	Total	=	2167.5 ft^3

"A" battery room (doesn't have, east exterior wall)
Total = 1087 ft^3

p = 2300 Kg/m^3 = 143.58 lb_m/ft^3
Cp = 880 J/Kg°K = 0.2109 Btu/lb_mF
C_{PW} ("B" battery room) = 2168 ft^3 · 144 lb_m/ft^3 ·
0.2109 Btu/lb_m°F = 65841 Btu/°F

C_{PW} ("A" battery room) = 1087 ft^3 · 144 lb_m/ft^3 ·
0.2109 Btu/lb_m°F = 33012 Btu/°F

6.1.4 Heat transfer coefficient estimates

"B" battery room

A_w (exterior wall area) = 18' x 12.5' (south wall) + 18' x 40' (east wall) = 945 ft^2

A_F (floor area) = 12.5 x 40 = 500 ft^2

Total = 1445 ft^2

"A" battery room (doesn't have east ext. wall)

Total = 725 ft^2

estimate $\bar{h}$ wall = $5 W/m^2 {}^\circ K$ = 0.8805 Btu/hr°F ft^2

H_A ("B" battery room = $\bar{h}A$ = 1272 Btu/hr°F

H_A ("A" battery room = $\bar{h}A$ = 638 Btu/hr°F

Batteries (60 cells in each battery)
cell vertical surface area (neglect horizontal area)
Cell Area = (22.125" · 14.5" + 22.125" · 7.375") = 6.72 ft^2

Battery Area = 60 · 6.72 = 403 ft^2

H_B = $\bar{h}A$ (battery) = .881 Btu/hrft^2°F · 403 ft^2 = 335 Btu/hr°F (note: assume same $\bar{h}$ walls)

Conductive heat transfer through walls

$$H_w = \frac{A \text{ (ext wall)} \cdot K \text{ (thermal conductivity of concrete)}}{d \text{ (thickness of concrete)}}$$

$$H_w \text{ ("B" battery room)} = \frac{1445 \text{ ft}^2 \cdot 0.5778 \text{ Btu/hr ft°F}}{1.5 \text{ ft}} = 557 \text{ Btu/hr°F}$$

H_w ("A" battery room) = 279 Btu/hr°F

6.1.5 The initial conditions for the SBO cooldown are calculated as follows:

Assuming all heat is dissipated to exterior walls and floor, total heat entering room to maintain 73°F (T_A) air temperature is given by,

$$\dot{Q} = \frac{H_A \cdot H_w}{H_w + H_A} (T_A - T_E)$$

To find T_E consider the steady state conditions before heating was installed, (Q = 10236 Btu/hr)

$$(T_A - T_w)_{\text{air-wall}} = \frac{\dot{Q}}{\bar{h}A} = \frac{\dot{Q}}{HA}$$

$$= \frac{10236 \text{ Btu/hr}}{1272 \text{ Btu/hr°F}} = 8.045°F$$

This would yield a wall temperature

$$T_w = T_A - 8.045 \approx 60°F - 8°F = 52°F$$

The external temperature can then be estimated from,

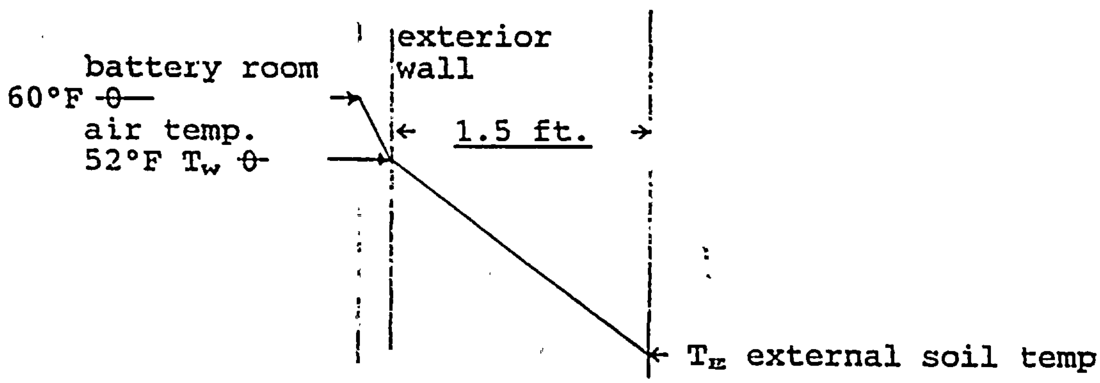
$$q'' = \frac{\dot{Q}}{A_{exterior}} = \frac{10236 \text{ Btu/hr}}{1445 \text{ ft}^2} = 7.0837 \text{ Btu/hr ft}^2$$

$$q'' = -K \frac{T_E - T_W}{d_{wall}} \rightarrow T_E - T_W = -\frac{q'' \cdot d_{wall}}{k}$$

$$= -\frac{7.0837 \times 1.5}{.5778}$$

$$= -18.39°F$$

The sketch below shows the steady state temperature distribution for the "unheated" battery room.



$$T_E = T_w - 18.39°F = 52°F - 18.39° = 33.61°F$$

Since accuracy is no better than two significant figures:

$$T_E = 34°F$$

The total heat required to maintain the battery room at 73°F and the initial wall temperature can now be estimated.

$$\dot{Q} = \frac{1272 \times 557}{1272 + 557} (73°F - 34°F) = 15108 \text{ Btu/hr}$$

Note that this is 4872 Btu/hr larger than the internal heat sources. The battery room heater provides the additional heat.

The initial steady state wall temperature can now be calculated

$$T_w = T_A - \frac{\dot{Q}}{HA} = 73 - \frac{15108}{1272} = 73 - 11.9 = 61.1°F$$

6.1.6 Computer Code Development

A FORTRAN program was written, using the state equations from Section 6.1.2. The difference equations were developed using the modified Euler-Gauss method which provides reasonable (<10%) accuracy for this type of calculation. The source code for this program is given in Appendix 1.

6.2 Battery Capacity Evaluation

6.2.1 The effect of battery room cooldown during SBO on battery capacity is evaluated using the methods developed for battery sizing analyses (Ref. 3.1) and electrolyte temperature correction factors (Ref. 3.3). The temperature correction factors are used to modify (increase) the actual battery load to create a temperature corrected load. These connected loads are then used in the battery sizing analysis.

6.2.2 In order to simplify battery capacity calculations, cooling is modeled as a step function. It is assumed that temperature does not change during the first hour of the SBO, and then drops to a lower, constant value, for the last three hours. The value of the final temperature is lowered until the battery capacity is exceeded. This is then considered to be the limiting temperature for operation. The conservatism of this approach is evaluated by comparing the "step" temperature model with the continuous temperature drop data from the thermal analysis.

6.2.3 The battery capacity calculation is performed using the Load Change Report Spreadsheet. This program is written in the Symphony environment and is maintained in the Electrical Engineering Central File. The primary use of

this program is in evaluation of proposed and actual d.c. load changes on battery capacity margin. In this analysis it is used as described in 6.2.1 and 6.2.2 to evaluate temperature effects on vital battery capacity margin. Use of the program is described in Appendix 2.

7.0 Results

7.1 Tables 1, 2, and 3 show the temperature of battery room air, battery cells, and exterior walls during one minute, ten minute, and five hour periods after initiation of Station Blackout. The battery temperature after four hours is about 71.8°F.

7.2 The temperature correction factor from Ref. 3.3 for 71.8 is about 1.034. The battery sizing analyses yield maximum cell size correction factors of 1.64 and 1.10 for the "A" and "B" batteries respectively (see Ref. 3.1). Since both of these results exceed the required temperature correction of 1.034, it is concluded that the battery capacity meets the SBO 4 hour coping requirement. The cell sizing calculations are shown in Tables A5A and B5A.

7.3 The transient thermal response of the battery room environment predicted by this analysis is significantly slower than the predicted in Ref. 3.8. Since Ref. 3.8 addresses loss of HVAC and resulting heating in hot weather, the results do not directly conflict with those presented here. However application of the heat transfer model used in this analysis, to the heatup problem results in a much slower response.

7.4 Although outside the formal scope of this analysis, the model developed here is applied to battery room heat up for the case in which external soil temperature is 75°F and the initial steady state battery room temperature is 75°F. Both SBO and loss of offsite power are considered. Although refinements to the model would increase the accuracy, the physical processes which control the temperature transient are made clear. The battery room temperature remains below 90°F in either case (Tables 4-9).

Appendix 1

BATTMATES.FOR.

```
CC      Battery Room thermal transient analysis
        PRINT *,'ENTER TIME INTERVAL IN MINUTES'
        READ (*,20) DELT
        PRINT *,'ENTER PRINT INTERVAL IN MINUTES'
        READ (*,20) P
20      FORMAT ( F8.3 )
        PRINT *,'ENTER TOTAL TIME IN MINUTES'
        READ (*,30) TOT
30      FORMAT ( F8.3 )
        M=INT(P/DELT)
        N=INT(TOT/P)
        QDTBO=5118X2 = 10236
        CPA=159X2 = 318
        CPB=2490X2 = 4980
        CPW=~~65572~~ 98,500
        HA=~~1272~~ 1910
        HB=355X2= 710
        AW=~~556~~ 836
        TE=~~33.5~~ 26.0
        TA=73
        TW=~~61~~ 58
        TB=T4
        DO 50 J=0,N
        DO 60 K=0,M
        FI=(1/CPA)*(QDTBO-(HA+HB)*TA+HB*TB+HA*TW)
```

```
      GI=(1/CPB)*(TA-TB)
      HI=(2/CPW)*(HA*(TA-TW)-HW*(TW-TE))
      TA1=TA+DELT*FI
      TW1=TW+DELT*HI
      TB1=TB+DELT*GI
      FI1=(1/CPA)*(QDTBO-(HA+HB)*TA1+HB*TB1+HA*TW1)
      GI1=(1/CPB)*(TA1-TB1)
      HI1=(2/CPW)*(HA*(TA1-TW1)-HW*(TW1-TE))
      TA=TA+(DELT/2)*(FI+FI1)
      TB=TB+(DELT/2)*(GI+GI1)
      TW=TW+(DELT/2)*(HI+HI1)
      T = ( P*J - K*DELT)
-0    CONTINUE
      OPEN( UNIT=10, FILE='BATRMTMP.OUT')
      WRITE(10,40) T,TA,TB,TW
      WRITE(*,40) T,TA,TB,TW
40    FORMAT(1X,F8.2,3X,F12.5 ,3X,F12.5,3X,F12.5)
30    CONTINUE
      CLOSE( 10 )
      END
```

Type 4: Computer Software Package Documentation Summary

1. Title of Report or Analysis Station Blackout Effects on Vital Batteries

2. Author G.W. Daniels

3. Verification of Program (s)

(a)

(1) Name of Program Battery Room Thermal Transient Analysis

(2) Description (include source code location) (Attached)

(3) Algorithm Bases

[X] Found in text, page 2, 5, 11

[X] Reference Heat and Mass Transfer, Frank M. White, Addison-Wesley Pub. Co.

(4) Numerical Methods Used

(i) Description: Second Order Runge-Kutta

(ii) Reference Brief Numerical Methods, Wendel E. Grove, Prentice-Hall Inc.

(iii) Other ______

Appendix 2

LOAD CHANGE REPORT
VITAL BATTERY B
EWR 3341
REPORT DATE: 02/09/90

PRINT DATE: 07/06/90

SPREADSHEET INSTRUCTIONS

OBJECTIVE:

To give the users the procedure and documentation requirements for using the Load Change Report Spreadsheet. This spreadsheet calculates the required cell size of Ginna Station Vital Battery B based on present loads. Symphony version 2.0 was used to perform the calculations. The Symphony file is LCR_B1B.WR1.

PROCEDURE:

1. Load Symphony, then retrieve LCR_B1B. Enter each load addition or deletion as a separate line item on page 2, using the referenced Electrical Load Change (ELC) form as the source document. Attach all referenced ELC forms to this report.

2. To obtain the hard copies of Load Change Report pages 1, 2 and 3, hold down the ALT key while striking the P key. The updated report will be automatically saved. Next, the screen will show the form in the Allways Application. Hit F10, select P for print, and G for go.

3. To exit Allways, hit F10, select Q to quit. After it has returned to Symphony, exit Symphony. The Symphony Access System menu should appear on the screen.

4. To obtain the hard copy of Load Change Report page 4, select "PRINTGRAPH" from the Symphony Access Menu. Use Image-Select to retrieve FIGB1.PIC. Select Settings, Image, Size, Full, Quit, Quit, Quit and Go.

5. Exit "PRINTGRAPH". The Symphony Access System menu should reappear on the screen.

Please keep in mind, ALT-P can only be used once. If the user wishes to get another printout, he must use ALT-M instead of ALT-P, because the Allways Application need only be attached once. ALT-M will function the same as ALT-P except it won't attach Allways again.

DOCUMENTATION REQUIREMENTS:

1. The current revision of this report dated 02/09/90 pages 1 through 4 and attached ELC forms shall be filed in the Electrical Engineering Central Technical File.

2. The current revision of this report is referenced by the following documents in the Electrical Engineering Central Technical File:

   1. EDS-151 "Index - Electrical Engineering Central Technical File"
   2. EDS-152 "Design Verification Model"

Time (min)	Tair (°F)	Tbatteries (°F)	Twalls (°F)
.05	70.50226	73.00000	60.99733
.10	69.00332	73.00000	60.99089
.15	68.10223	73.00000	60.98219
.20	67.55907	73.00000	60.97214
.25	67.23011	73.00000	60.96130
.30	67.02943	73.00000	60.94999
.35	66.90551	73.00000	60.93840
.40	66.82753	73.00000	60.92663
.45	66.77712	73.00000	60.91481
.50	66.74316	73.00000	60.90298
.55	66.71911	73.00000	60.89116
.60	66.70100	73.00000	60.87933
.65	66.68643	73.00000	60.86750
.70	66.67400	73.00000	60.85568
.75	66.66286	73.00000	60.84385
.80	66.65244	73.00000	60.83203
.85	66.64251	73.00000	60.82020
.90	66.63293	73.00000	60.80838
.95	66.62339	73.00000	60.79655

Table 1.

Time (min)	Tair (°F)	Tbatteries (°F)	Twalls (°F)
1.00	66.61121	72.99786	60.78171
2.00	66.42575	72.99554	60.54597
3.00	66.24506	72.99281	60.31615
4.00	66.06881	72.98972	60.09213
5.00	65.89697	72.98664	59.87373
6.00	65.72943	72.98356	59.66082
7.00	65.56610	72.98048	59.45328
8.00	65.40685	72.97739	59.25094
9.00	65.25159	72.97431	59.05370
10.00	65.10023	72.97123	58.86142

Table 2

Time (min)	Tair (°F)	Tbatteries (°F)	Twall (°F)
10.00	65.11355	72.97150	58.87835
20.00	63.79964	72.93719	57.21142
30.00	62.77537	72.89900	55.91513
40.00	61.97540	72.85620	54.90628
50.00	61.34925	72.81038	54.12008
60.00	60.85844	72.76456	53.50659
70.00	60.47269	72.71873	53.02711
80.00	60.16732	72.66805	52.65153
90.00	59.92418	72.61459	52.35611
100.00	59.72976	72.56113	52.12292
110.00	59.57317	72.50767	51.93798
120.00	59.44592	72.45421	51.79042
130.00	59.34149	72.40075	51.67204
140.00	59.25470	72.34729	51.57611
150.00	59.18159	72.29383	51.49770
160.00	59.11912	72.24037	51.43282
170.00	59.06509	72.18691	51.37872
180.00	59.01731	72.13345	51.33262
190.00	58.97448	72.07999	51.29280
200.00	58.93545	72.02654	51.25780
210.00	58.89965	71.97308	51.22697
220.00	58.86628	71.91962	51.19926
230.00	58.83385	71.86616	51.17275
240.00	58.80428	71.81270	51.14984
250.00	58.77470	71.75924	51.12693
260.00	58.74543	71.70578	51.10443
270.00	58.71882	71.65232	51.08534
280.00	58.69223	71.59886	51.06625
290.00	58.66564	71.54540	51.04716
300.00	58.63905	71.49194	51.02806

Table 3.

Battery room heat up under SBO conditions.

BATRMTR1.FOR

Time (min)	Tair	Tbatteries	Twalls
10.00	78.97565	75.01507	76.06673
20.00	79.63584	75.03034	76.90488
30.00	80.15108	75.05125	77.55647
40.00	80.55375	75.07416	78.06388
50.00	80.86861	75.09707	78.45927
60.00	81.11543	75.11998	78.76781
70.00	81.30933	75.14289	79.00887
80.00	81.46231	75.16580	79.19768
90.00	81.58344	75.18871	79.34587
100.00	81.68002	75.21162	79.46278
110.00	81.75716	75.23454	79.55487
120.00	81.81980	75.25745	79.62840
130.00	81.87035	75.28036	79.68658
140.00	81.91272	75.30327	79.73428
150.00	81.94785	75.32618	79.77272
160.00	81.97693	75.34909	79.80343
170.00	82.00185	75.37200	79.82890
180.00	82.02476	75.39491	79.85181
190.00	82.04357	75.41782	79.86939
200.00	82.06051	75.44073	79.88467
210.00	82.07745	75.46365	79.89994
220.00	82.09439	75.48656	79.91521
230.00	82.10695	75.50747	79.92479
240.00	82.11793	75.53238	79.93243
250.00	82.12889	75.55529	79.94006
260.00	82.13986	75.57820	79.94770
270.00	82.15083	75.60111	79.95534
280.00	82.16180	75.62402	79.96297
290.00	82.17278	75.64693	79.97061
300.00	82.18374	75.66985	79.97825

Table 4

Time (min)	Tair	Tbatteries	Twalls
1.00	78.22250	75.00134	75.10972
2.00	78.31583	75.00288	75.22825
3.00	78.40672	75.00442	75.34380
4.00	78.49536	75.00596	75.45645
5.00	78.58176	75.00750	75.56627
6.00	78.66599	75.00904	75.67331
7.00	78.74810	75.01058	75.77767
8.00	78.82819	75.01212	75.87940
9.00	78.90623	75.01366	75.97857
10.00	78.98235	75.01521	76.07525

SBO conditions.

BATRMTR1.FOR

Table 5

Lowest Expected Electrolyte Temp (F): 73 Minimum Cell Voltage: 1.75 Cell Mfg: GNB Cell Type: NAX 1200 By: GWD

(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 K Factor(KT)	(7) Required Section Size (3)x(6)=Rated Amp Hours Pos Values	Neg Values
Section 1 -- First Period Only -- If A2 is greater than A1, go to Section 2.							
1	A1 962	A1-0= 962	M1 1	T=M1= 1	0.882353	848.82	***
					Sec 1 Total	848.82	***
Section 2 -- First Two Periods Only -- If A3 is greater than A2, go to Section 3.							
1	A1 962	A1-0= 962	M1 1	T=M1+M2 3	0.918774	883.86	0
2	A2 623	A2-A1 -339	M2 2	T=M2= 2	0.900574	0	-305.29
					Sec Subtotal	883.86	-305.29
					2 Total	578.57	***
Section 3 -- First Three Periods Only -- If A4 is greater than A3, go to Section 4.							
1	A1 962	A1-0= 962	M1 1	T=M1+... 12	1.079923	1038.89	0
2	A2 623	A2-A1 -339	M2 2	T=M2+M3 11	1.062346	0	-360.14
3	A3 507	A3-A2 -116	M3 9	T=M3= 9	1.026912	0	-119.12
					Sec Subtotal	1038.89	-479.26
					3 Total	559.63	***
Section 4 -- First Four Periods Only -- If A5 is greater than A4, go to Section 5.							
1	A1 1081.	A1-0= 1081	M1 1	T=M1+... 60	2	2162.72	0
2	A2 623	A2-A1 -458.	M2 2	T=M2+... 59	1.973431	0	-904.54
3	A3 507	A3-A2 -116	M3 9	T=M3+M4 57	1.921919	0	-222.94
4	A4 589.3	A4-A3 82.3	M4 48	T=M4= 48	1.714833	141.24	0
					Sec Subtotal	2303.96	-1127.48
					4 Total	1176.48	***
Section 5 -- First Five Periods Only -- If A6 is greater than A5, go to Section 6.							
1	A1	A1-0=	M1	T=M1+...			
2	A2	A2-A1	M2	T=M2+...			
3	A3	A3-A2	M3	T=M3+...			
4	A4	A4-A3	M4	T=M4+M5			
5	A5	A5-A4	M5	T=M5=			
					Sec Subtotal		
					5 Total		***
Section 6 -- First Six Periods Only -- If A7 is greater than A6, skip this Section.							
1	A1 1081.	A1-0= 1081	M1 1	T=M1+... 240	4.724	5108.35	0
2	A2 623	A2-A1 -458.	M2 2	T=M2+... 239	4.706	0	-2157.05
3	A3 507	A3-A2 -116	M3 9	T=M3+... 237	4.671	0	-541.84
4	A4 470	A4-A3 -37	M4 48	T=M4+... 228	4.518	0	-167.17
5	A5 173.3	A5-A4 -296.	M5 179	T=M5+M6 180	3.846	0	-1140.87
6	A6 258.4	A6-A5 85.0	M6 1	T=M6= 1	0.88235	75.04	0
					Sec Subtotal	5183.39	-4006.93
					6 Total	1176.46	***

Maximum Section Size 1176 + Random Section Size 0 = Uncorrected Size (US) 1176

(US) 1176 x Temp Corr 1.02 x Design Marg 1 x Aging Factor 1.0 = 1200

Required cell size = 1200 Ampere Hours. Cell 1200 is installed.

Cell size correction factor for first hour= 1.253959635

Cell size correction factor for last 3 hours= 1.635491325

CELL SIZING WORK SHEET

TABLE A5A

Lowest Expected Electrolyte Temp (F): 73 Minimum Cell Voltage: 1.75 Cell Mfg: GNB Cell Type: NAX 1200 By: GWD

(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 K Factor(KT)	(7) Required Section Size (3)x(6)=Rated Amp Hours Pos Values	Neg Values
Section 1 -- First Period Only -- If A2 is greater than A1, go to Section 2.											
1	A1	1186	A1-0=	1186	M1	1	T=M1=	1	0.882353	1046.47	***
									Sec 1 Total	1046.47	***
Section 2 -- First Two Periods Only -- If A3 is greater than A2, go to Section 3.											
1	A1	1186	A1-0=	1186	M1	1	T=M1+M2	3	0.918774	1089.67	0
2	A2	492	A2-A1	-694	M2	2	T=M2=	2	0.900574	0	-625
									Sec Subtotal	1089.67	-625
									2 Total	464.67	***
Section 3 -- First Three Periods Only -- If A4 is greater than A3, go to Section 4.											
1	A1	1186	A1-0=	1186	M1	1	T=M1+...	12	1.079923	1280.79	0
2	A2	492	A2-A1	-694	M2	2	T=M2+M3	11	1.062346	0	-737.27
3	A3	248	A3-A2	-244	M3	9	T=M3=	9	1.026912	0	-250.57
									Sec Subtotal	1280.79	-987.84
									3 Total	292.95	***
Section 4 -- First Four Periods Only -- If A5 is greater than A4, go to Section 5.											
1	A1		A1-0=		M1		T=M1+...				
2	A2		A2-A1		M2		T=M2+...				
3	A3		A3-A2		M3		T=M3+M4				
4	A4		A4-A3		M4		T=M4=				
									Sec Subtotal		
									4 Total		***
Section 5 -- First Five Periods Only -- If A6 is greater than A5, go to Section 6.											
1	A1	1186	A1-0=	1186	M1	1	T=M1+...	240	4.724	5602.66	0
2	A2	492	A2-A1	-694	M2	2	T=M2+...	239	4.706	0	-3265.96
3	A3	248	A3-A2	-244	M3	9	T=M3+...	237	4.671	0	-1139.72
4	A4	232.2	A4-A3	-15.7	M4	227	T=M4+M5	228	4.518	0	-71.01
5	A5	289.5	A5-A4	57.2	M5	1	T=M5=	1	0.88235	50.51	0
									Sec Subtotal	5653.17	-4476.69
									5 Total	1176.48	***
Section 6 -- First Six Periods Only -- If A7 is greater than A6, skip this Section.											
1	A1		A1-0=		M1		T=M1+...				
2	A2		A2-A1		M2		T=M2+...				
3	A3		A3-A2		M3		T=M3+...				
4	A4		A4-A3		M4		T=M4+...				
5	A5		A5-A4		M5		T=M5+M6				
6	A6		A6-A5		M6		T=M6=				
									Sec Subtotal		
									6 Total		***

Maximum Section Size 1176 + Random Section Size 0 = Uncorrected Size (US) 1176

(US) 1176 x Temp Corr 1.02 x Design Marg 1 x Aging Factor 1.0= 1200

Required cell size = 1200 Ampere Hours. Cell 1200 is installed.

Cell size correction factor for last 3 hours=. 1.100861486

CELL SIZING WORK SHEET

TABLE B5A

Time (min)	Tair (°F)	Tbatteries	Twalls
.05	76.44152	75.00002	75.00185
.10	77.22379	75.00006	75.00620
.15	77.64950	75.00011	75.01190
.20	77.88237	75.00016	75.01831
.25	78.01093	75.00025	75.02511
.30	78.08307	75.00034	75.03211
.35	78.12469	75.00043	75.03922
.40	78.14983	75.00053	75.04638
.45	78.16602	75.00062	75.05357
.50	78.17738	75.00071	75.06075
.55	78.18611	75.00080	75.06794
.60	78.19343	75.00089	75.07513
.65	78.19997	75.00098	75.08231
.70	78.20610	75.00108	75.08949
.75	78.21199	75.00117	75.09663
.80	78.21775	75.00126	75.10377
.85	78.22344	75.00135	75.11091
.90	78.22909	75.00144	75.11805
.95	78.23471	75.00153	75.12514

SBO conditions
BATRMTR1.FOR

Table 6

Time(min)	Tair	T batteries	Twalls
10.00	82.95094	75.02875	77.13339
20.00	84.27222	75.06347	78.80965
30.00	85.30215	75.10165	80.11315
40.00	86.10672	75.14521	81.12765
50.00	86.73634	75.19103	81.91826
60.00	87.22981	75.23685	82.53519
70.00	87.61762	75.28268	83.01732
80.00	87.92528	75.33579	83.39511
90.00	88.16986	75.38925	83.69233
100.00	88.36530	75.44271	83.92681
110.00	88.52269	75.49617	84.11283
120.00	88.65060	75.54963	84.26115
130.00	88.73539	75.60309	84.38007
140.00	88.84270	75.65655	84.47662
150.00	88.91605	75.71001	84.55534
160.00	88.97856	75.76347	84.62028
170.00	89.03320	75.81693	84.67325
180.00	89.08102	75.87036	84.72139
190.00	89.12329	75.92384	84.76046
200.00	89.16248	75.97730	84.79556
210.00	89.17801	76.03076	84.82610
220.00	89.23336	76.08422	84.85633
230.00	89.26296	76.13768	84.87924
240.00	89.29254	76.19114	84.90215
250.00	89.32211	76.24460	84.92506
260.00	89.35170	76.29806	84.94798
270.00	89.38127	76.35152	84.97089
280.00	89.41027	76.40498	84.99306
290.00	89.43583	76.45844	85.01086
300.00	89.46143	76.51189	85.02866

Battery room heat up under Loss of Offsite Power. (no HVAC) conditions.

BATRMTR2.FOR

Table 7

Time (min)	Tair	Tbatteries	Twalls
1.00	81.44488	75.00214	75.21941
2.00	81.63137	75.00446	75.45647
3.00	81.81311	75.00745	75.68755
4.00	81.99034	75.01053	75.91283
5.00	82.16315	75.01361	76.13244
6.00	82.33160	75.01669	76.34653
7.00	82.49586	75.01978	76.55525
8.00	82.65598	75.02286	76.75872
9.00	82.81212	75.02594	76.95706
10.00	82.96432	75.02902	77.15042

Loss of Offsite Power Conditions.

BATRMTR2.FOR

Table 8

Loss of Offsite Power conditions
BATRMTR2.FOR

Time (min)	T_{air}	$T_{batteries}$	T_{walls}
.05	77.88304	75.00003	75.00371
.10	79.44758	75.00012	75.01240
.15	80.29899	75.00024	75.02377
.20	80.76471	75.00038	75.03661
.25	81.02184	75.00052	75.05020
.30	81.16612	75.00066	75.06421
.35	81.24938	75.00079	75.07842
.40	81.29962	75.00093	75.09274
.45	81.33199	75.00107	75.10711
.50	81.35470	75.00121	75.12148
.55	81.37216	75.00134	75.13586
.60	81.38678	75.00148	75.15023
.65	81.39986	75.00162	75.16458
.70	81.41210	75.00175	75.17891
.75	81.42387	75.00189	75.19323
.80	81.43539	75.00203	75.20751
.85	81.44676	75.00217	75.22179
.90	81.45805	75.00230	75.23603
.95	81.46927	75.00244	75.25027

Table 9

Attachment 4

LOAD CHANGE REPORT
VITAL BATTERY A
EWR 3341
REPORT DATE: 01/23/91

SPREADSHEET INSTRUCTIONS

OBJECTIVE:

To give the users the procedure and documentation requirements for using the Load Change Report Spreadsheet. This spreadsheet calculates the required cell size of Ginna Station Vital battery A, based on present loads. Symphony version 2.0 was used to perform the calculations. The Symphony file is LCR_B1A.WR1.

PROCEDURE:

1. Load Symphony, then retrieve LCR_B1A. Enter each load addition or deletion as a separate line item on page 2, using the referenced Electrical Load Change (ELC) form as the source document. Attach all referenced ELC forms to this report.

2. To obtain the hard copies of Load Change Report pages 1, 2 and 3, hold down the ALT key while striking the P key. The updated report will be automatically saved. Next, the screen will show the form in the Allways Application. Hit F10, select P for print, and G for go.

3. To exit Allways, hit F10, select Q to quit. After it has returned to Symphony, exit Symphony. The Symphony Access System menu should appear on the screen.

Please keep in mind, ALT-P can only be used once. If the user wishes to get another printout, he must use ALT-M instead of ALT-P, because the Allways Application need only be attached once. ALT-M will function the same as ALT-P except it won't attach Allways again.

DOCUMENTATION REQUIREMENTS:

1. The current revision of this report dated 01/23/91, pages 1 through 4 and attached ELC forms shall be filed in the Electrical Engineering Central Technical File.

2. The current revision of this report is referenced by the following documents in the Electrical Engineering Central Technical File:

    1. EDG-15I "Index - Electrical Engineering Central Technical File"
    2. EDG-15B "Design Verification Model"

Attachment 4

LOAD CHANGE REPORT
VITAL BATTERY A
EWR 3341
REPORT DATE: 01/23/91

PRINT DATE: 01/23/91
BY: JAY

BASED ON BATTERY SIZING ANALYSIS REV 0, EWR 3341, APPROVED 3/12/90

UPDATED FOR EWRS:

EWR No.	ELC RE	ELC DATE	LOAD NAME	DC PANEL	L1	L2	L3	L4	L5	L6	REPORT DATE	SIZED BY	IN SERVICE DATE
					(LOAD AMPS, (-)=DELETE)								
3341	N/A	N/A	INITIAL	N/A	106	366	37	116	339	52	02/09/90	GWD	
4756	N/A	N/A	ANN ALARM	MCB PANEL 1A	0.2						07/06/90	PMS	07/31/90
4968	0	01/04/91	72/EOP	DCPDPCB02A		-366			-261		01/11/91	JAY	04/20/91
4773	0	01/23/90	INVCVT-1A	DCPDPCB03A	-2.24						01/23/91	JAY	04/22/91
4773	0	01/23/90	INVCVT-1A	DCPDPCB03A	10.09						01/23/91	JAY	04/22/91

91
MY

TOTALS L1=	114.05	A1=L1+...L5=	345.05
L2=	0	A2=L1+...L4=	267.05
L3=	37	A3=L1+...L3=	151.05
L4=	116	A4=L1+L2=	114.05
L5=	78	A5=L1=	114.05
L6=	52	A6=L1+L6=	166.05

Attachment 4

Project: Ginna Station Vital Battery A | Date 01/23/91 |

Lowest Expected Electrolyte Temp (F): 73 | Minimum Cell Voltage: 1.75 | Cell Mfg: GNB | Cell Type: NAX 1200 | By: JAY

(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 K Factor(KT)	(7) Required Section Size (3)x(6)=Rated Amp Hours Pos Values	Neg Values
Section 1 -- First Period Only -- If A2 is greater than A1, go to Section 2.							
1	A1= 345.0	A1-0= 345.	M1: 1	T=M1= 1	0.882353	304.46	***
					Sec 1 Total	304.46	***
Section 2 -- First Two Periods Only -- If A3 is greater than A2, go to Section 3.							
1	A1= 345.0	A1-0= 345.	M1: 1	T=M1+M2= 3	0.918774	317.02	0
2	A2= 267.0	A2-A1: -78	M2: 2	T=M2= 2	0.900574	0	-70.24
					Sec Subtotal	317.02	-70.24
					2 Total	246.78	***
Section 3 -- First Three Periods Only -- If A4 is greater than A3, go to Section 4.							
1	A1= 345.0	A1-0= 345.	M1: 1	T=M1+...M3: 12	1.079923	372.63	0
2	A2= 267.0	A2-A1: -78	M2: 2	T=M2+M3= 11	1.062346	0	-82.86
3	A3= 151.0	A3-A2 -116	M3: 9	T=M3= 9	1.026912	0	-119.12
					Sec Subtotal	372.63	-201.98
					3 Total	170.65	***
Section 4 -- First Four Periods Only -- If A5 is greater than A4, go to Section 5.							
1	A1= 345.0	A1-0= 345.	M1: 1	T=M1+...M4: 60	2	690.1	0
2	A2= 267.0	A2-A1 -78	M2: 2	T=M2+...M4: 59	1.973431	0	-153.93
3	A3= 151.0	A3-A2 -116	M3: 9	T=M3+M4= 57	1.921919	0	-222.94
4	A4= 114.0	A4-A3 -37	M4: 48	T=M4= 48	1.714833	0	-63.45
					Sec Subtotal	690.1	-440.32
					4 Total	249.78	***
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+...M5:			
4	A4=	A4-A3	M4:	T=M4+M5=			
5	A5=	A5-A4	M5:	T=M5=			
					Sec Subtotal		
					5 Total		***
Section 6 -- First Six Periods Only -- If A7 is greater than A6, skip this Section.							
1	A1= 345.0	A1-0= 345.	M1: 1	T=M1+...M6 120	2.941176	1014.85	0
2	A2= 267.0	A2-A1 -78	M2: 2	T=M2+...M6 119	2.971795	0	-231.8
3	A3= 151.0	A3-A2 -116	M3: 9	T=M3+...M6 117	3.02899	0	-351.36
4	A4= 114.0	A4-A3 -37	M4: 48	T=M4+...M6 108	3.193429	0	-118.16
5	A5= 114.0	A5-A4 0	M5: 59	T=M5+M6= 60	2	0	0
6	A6= 166.0	A6-A5 52	M6: 1	T=M6= 1	0.882353	45.88	0
					Sec Subtotal	1060.73	-701.32
					6 Total	359.41	***

Maximum Section Size 359 + Random Section Size 0 = Uncorrected Size (US) 359

(US) 359 x Temp Corr 1.02 x Design Marg 1 x Aging Factor 1.20= 439

Required cell size = 439 Ampere Hours. Cell 1200 is installed.

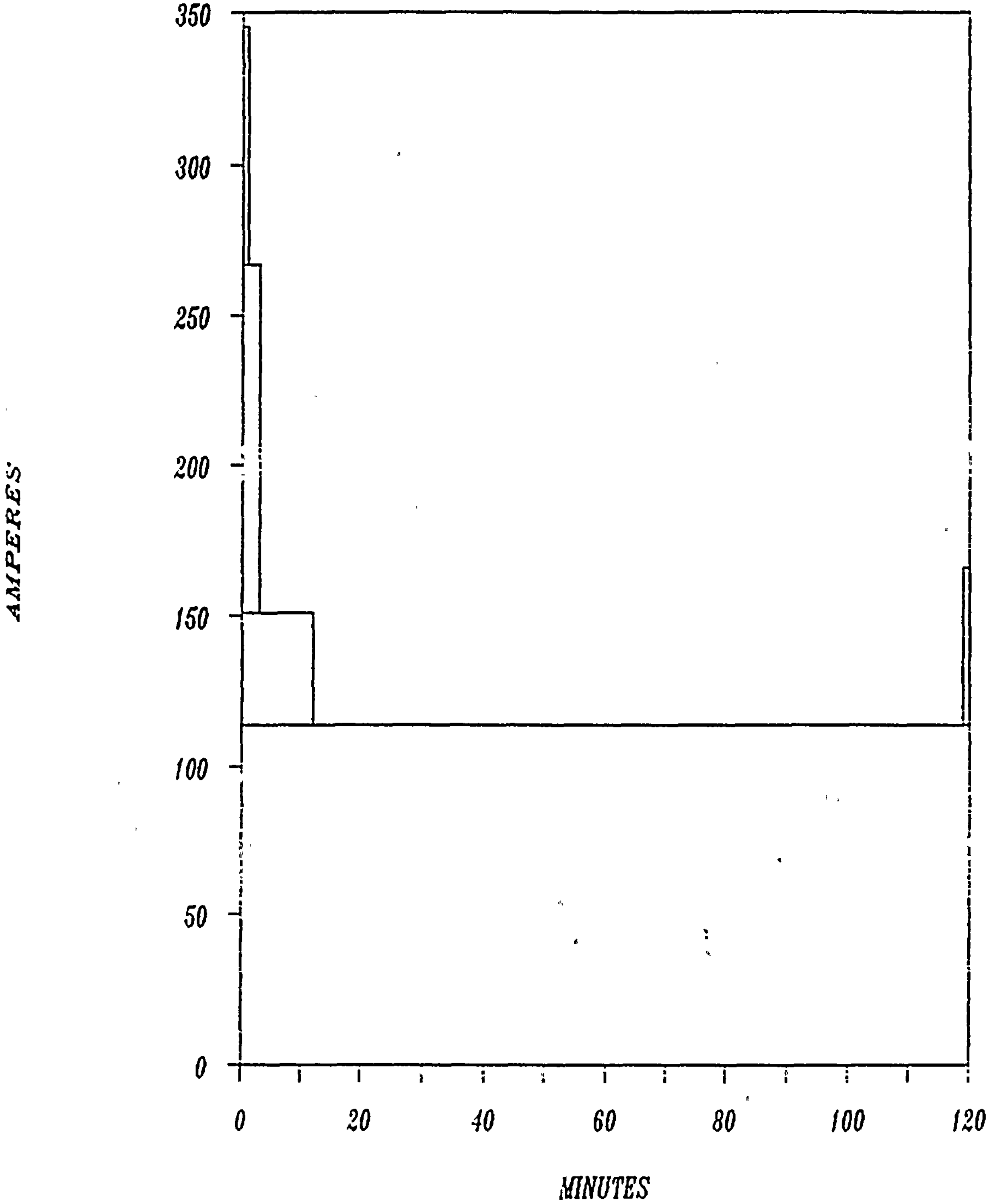
CELL SIZING WORK SHEET

TABLE A5

Attachment 4

PAGE 4 of 4, "A" BATTERY DUTY CYCLE

FIGURE A1



Attachment 5

LOAD CHANGE REPORT
VITAL BATTERY B
EWR 3341
REPORT DATE: 01/23/91

PRINT DATE: 01/23/91

SPREADSHEET INSTRUCTIONS

OBJECTIVE:

To give the users the procedure and documentation requirements for using the Load Change Report Spreadsheet. This spreadsheet calculates the required cell size of Ginna Station Vital battery B based on present loads. Symphony version 2.0 was used to perform the calculations. The Symphony file is LCR_B1B.WR1.

PROCEDURE:

1. Load Symphony, then retrieve LCR_B1B. Enter each load addition or deletion as a separate line item on page 2, using the referenced Electrical Load Change (ELC) form as the source document. Attach all referenced ELC forms to this report.

2. To obtain the hard copies of Load Change Report pages 1, 2 and 3, hold down the ALT key while striking the P key. The updated report will be automatically saved. Next, the screen will show the form in the Allways Application. Hit F10, select P for print, and G for go.

3. To exit Allways, hit F10, select Q to quit. After it has returned to Symphony, exit Symphony. The Symphony Access System menu should appear on the screen.

Please keep in mind, ALT-P can only be used once. If the user wishes to get another printout, he must use ALT-M instead of ALT-P, because the Allways Application need only be attached once. ALT-M will function the same as ALT-P except it won't attach Allways again.

DOCUMENTATION REQUIREMENTS:

1. The current revision of this report dated 01/23/91 ,pages 1 through 4 and attached ELC forms shall be filed in the Electrical Engineering Central Technical File.

2. The current revision of this report is referenced by the following documents in the Electrical Engineering Central Technical File:

   1. EDG-15I 'Index - Electrical Engineering Central Technical File'
   2. EDG-15B 'Design Verification Model'

Attachment 5

LOAD CHANGE REPORT
VITAL BATTERY B
EWR 3341
REPORT DATE: 01/23/91

PRINT DATE: 01/23/91
BY: JAY

BASED ON BATTERY SIZING ANALYSIS REV 0, EWR 3341, APPROVED 3/12/90

UPDATED FOR EWRS:

EWR No.	ELC RE	ELC DATE	LOAD NAME	DC PANEL	L1	L2	L3	L4	L5	L6	REPORT DATE	SIZED BY	IN SERVICE DATE
3341	N/A	N/A	INITIAL	N/A	211	0	37	244	694	52	02/09/90	GWD	02/09/90
4968	0	01/04/91	MOV3150,3151	DCPDPSH01B				-120	-490		01/11/91	JAY	04/20/91
4968	0	01/04/91	72/SOB	DCPDPSH01B	-73				-73		01/11/91	JAY	04/20/91
4773	0	01/23/90	INVCVT-1B	DCPDPCB03B	-2.53						01/23/91	JAY	04/22/91
4773	0	01/23/90	INVCVT-1B	DCPDPCB03B	9.96						01/23/91	JAY	04/22/91

91
[handwritten initials]

TOTALS L1=	165.63	A1=L1+...L5=	437.63
L2=	0	A2=L1+...L4=	306.63
L3=	37	A3=L1+...L3=	132.63
L4=	124	A4=L1+L2=	165.63
L5=	131	A5=L1=	165.63
L6=	52	A6=L1+L6=	197.63

Attachment 5

Project: Ginna Station Vital Battery B | Date 01/23/91 | Page 3 of 4

Lowest Expected Electrolyte Temp (F): 73 | Minimum Cell Voltage: 1.75 | Cell Mfg: GNB | Cell Type: NAX 1200 | By: JAY

(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 K Factor(KT)	(7) Required Section Size (3)x(6)=Rated Amp Hours Pos Values	Neg Values
Section 1 -- First Period Only -- If A2 is greater than A1, go to Section 2.							
1	A1= 437.4	A1-0= 437.	M1= 1	T=M1= 1	0.882353	385.97	***
					Sec 1 Total	385.97	***
Section 2 -- First Two Periods Only -- If A3 is greater than A2, go to Section 3.							
1	A1= 437.4	A1-0= 437.	M1= 1	T=M1+M2= 3	0.918774	401.9	0
2	A2= 306.4	A2-A1=-131	M2= 2	T=M2= 2	0.900574	0	-117.98
					Sec Subtotal	401.9	-117.98
					2 Total	283.92	***
Section 3 -- First Three Periods Only -- If A4 is greater than A3, go to Section 4.							
1	A1= 437.4	A1-0= 437.	M1= 1	T=M1+...M3 12	1.079923	472.39	0
2	A2= 306.4	A2-A1=-131	M2= 2	T=M2+M3= 11	1.062346	0	-139.17
3	A3= 182.4	A3-A2=-124	M3= 9	T=M3= 9	1.026912	0	-127.34
					Sec Subtotal	472.39	-266.51
					3 Total	205.88	***
Section 4 -- First Four Periods Only -- If A5 is greater than A4, go to Section 5.							
1	A1= 437.4	A1-0= 437.	M1= 1	T=M1+...M4 119	2.971795	1299.95	0
2	A2= 306.4	A2-A1 -131	M2= 2	T=M2+...M4 118	3.001116	0	-393.15
3	A3= 182.4	A3-A2 -124	M3= 9	T=M3+M4= 116	3.055274	0	-378.85
4	A4= 145.4	A4-A3 -37	M4= 107	T=M4= 107	3.200264	0	-118.41
					Sec Subtotal	1299.95	-890.41
					4 Total	409.54	***
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+...M5			
4	A4=	A4-A3	M4=	T=M4+M5=			
5	A5=	A5-A4	M5=	T=M5=			
					Sec Subtotal		
					5 Total		***
Section 6 -- First Six Periods Only -- If A7 is greater than A6, skip this Section.							
1	A1= 437.4	A1-0= 437.	M1= 1	T=M1+...M6 120	2.941176	1286.56	0
2	A2= 306.4	A2-A1 -131	M2= 2	T=M2+...M6 119	2.971795	0	-389.31
3	A3= 182.4	A3-A2 -124	M3= 9	T=M3+...M6 117	3.02899	0	-375.59
4	A4= 145.4	A4-A3 -37	M4= 107	T=M4+...M6 108	3.193429	0	-118.16
5	A5= 145.4	A5-A4 0	M5= 1	T=M5+M6= 1	0.882353	0	0
6	A6= 197.4	A6-A5 52	M6= 0	T=M6= 0	0.864125	44.93	0
					Sec Subtotal	1331.49	-883.06
					6 Total	448.43	***

Maximum Section Size 448 + Random Section Size 0 = Uncorrected Size (US) 448

(US) 448 x Temp Corr 1.02 x Design Marg 1 x Aging Factor 1.10= 503

Required cell size = 503 Ampere Hours. Cell 1200 is installed.

CELL SIZING WORK SHEET

TABLE B5

Attachment 5

PAGE 4 of 4, "B" BATTERY DUTY CYCLE

FIGURE B1