Dept. Sys Anal Date Oct, 1994 Designed by J P Akus Approved by	PENNSYLVANIA POWER & LIGHT COMPANY CALCULATION SHEET Project: 250 VDC Battery 1D650 - Battery and Battery Charger Sizing Calculation	Calc #. EC-088-0506 Sht No. 9 of 19

CHARGER CAPACITY FOR 250 VDC BATTERY 1D650

The Ampere capacity of the Battery charger is calculated as follows:

I1 = Lc + (1.1Ah)/T (From IEEE 946)

I2 = Lc + Ln (From IEEE 946)

I1 = AMPS, CHARGER CAPACITY
I3 = Recommended Charger Rated Output (Larger of I1 or I2)
Lc = CONTINUOUS LOAD AMPS
Ln = Largest noncontinuous load during normal plant operation
Ah = CALCULATED AMP-HRS EMERGENCY DISCHARGE
T = DESIRED RECHARGE TIME IN HOURS

17
2

Emergency Discharge of Battery

Ah = I1T1 + I2T2 + I3T3 + I4T4 (AMP-HRS)

The Technical Specification Load Profiles shall be used for the to determine the Emergency Discharge of the Battery. (From EC-088-1005)

TIME	CURRENT (AMPS)
0 -60 sec	800
60 sec - 10 Min	610
10 - 30 Min	535
30 - 240 Min	27

Ah = (800)(1)/60 + (610)(9)/60 + (535)(20)/60 + (27)(210)/60

Ah 377.7

Continuous Load

The continuous Load amps on the Battery during normal plant operation are:

Load	Amperes
Unit 1 Computer	332

Recharge Time (HRS) 12

Largest Noncontinuous Load

During normal plant operation the following is the largest load expected to be operating. This load operates during system testing.

Load	Amperes
1P112	73.3

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Determine the required Charger Output Capacity

$I1 = Lc + (1.1Ah)/T$

$I1 =$ 366.6

$I2 = Lc + Ln$

$I2 =$ 405.3

I3 =	**405.3**

Therefore for 250 VDC Battery 1D650, the existing two (2), 300 Amp rated Battery Chargers are adequate.

The existing battory chargers are equipped with Battery Charger Paralleling Networks to provide even sharing of the load.

Lowest Expected Electrolyte Temp: 60 Deg F | Minimum Cell Voltage: 1.78 | Cell MFR: C&D | Cell Type: LCR - 25

Section	Load (Amperes)	Change in Load (Amperes)	Duration of Period (Minutes)	Time to End of Section (Minutes)	Capacity at T Min Rate Amps/Pos Plate	Required Section Size	
						Pos Values	Neg Values
Section 1- First Period Only - If A2 is greater than A1 go to Section 2.							
1	A1 1040	A1-0 1040	M1 = 1	T = M1 = 1	129.1	8.06	
					Sub Total	8.06	
					Total	8.06	
Section 2- First Two Periods Only - If A3 is greater than A2, go to Section 3.							
1	A1 = 1040	A1-0 = 1040	M1 = 1	T = M1 + M2 = 10	116.3	8.94	
2	A2 = 575	A2-A1 = -465	M2 = 9	T = M2 = 9	117.3	0.00	-3.96
					Sub Total	8.94	-3.96
					Total	4.98	
Section 3- First Three Periods Only - If A4 is greater than A3, go to Section 4.							
1	A1 = 1040	A1-0 = 1040	M1 = 1	T = M1 + M2 + M3 = 30	93.2	11.16	
2	A2 = 575	A2-A1 = -465	M2 = 9	T = M2 + M3 = 29	94.7	0.00	-4.91
3	A3 = 350	A3-A2 = -225	M3 = 20	T = M3 = 20	105.7	0.00	-2.13
					Sub Total	11.16	-7.04
					Total	4.12	
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5.							
1	A1 = 1040	A2-A1 = 1040	M1 = 1	T = M1 + M2 + M3 + M 240	29.2	35.62	
2	A2 = 575	A2-A1 = -465	M2 = 9	T = M2 + M3 + M4 = 239	30.0	0.00	-15.50
3	A3 = 350	A3-A2 = -225	M3 = 20	T = M3 + M4 = 230	30.5	0.00	-7.38
4	A4 = 175	A4-A3 = -175	M4 = 210	T = M4 = 210	32.6	0.00	-5.37
					Sub Total	35.62	-28.25
					Total	7.37	

Max Section Size: 8.06 + Random Section 0 = Uncorrected Size (US): **8.06**

US X Temp Correction 1.11 X Design Margin 1.0 X Aging Factor 1.25 = **11.18**

Required Cell Size: **12**

Dept. Sys Anal Date Oct, 1994 Designed by J P Akus Approved by	PENNSYLVANIA POWER & LIGHT COMPANY CALCULATION SHEET Project: 250 VDC Battery 1D660 - Battery and Battery Charger Sizing Calculation	Calc #. EC-088-0506 Sht No. 12 of 19

CHARGER CAPACITY FOR 250 VDC BATTERY 1D660

The Ampere capacity of the Battery charger is calculated as follows:

I1 = Lc + (1.1Ah)/T (From IEEE 946)

I2 = Lc + Ln (From IEEE 946)

I1 = AMPS, CHARGER CAPACITY
I3 = Recommended Charger Rated Output (Larger of I1 or I2)
Lc = CONTINUOUS LOAD AMPS
Ln = Largest noncontinuous load during normal plant operation
Ah = CALCULATED AMP-HRS EMERGENCY DISCHARGE
T = DESIRED RECHARGE TIME IN HOURS

2

Emergency Discharge of Battery

Ah = I1T1 + I2T2 + I3T3 + I4T4 (AMP-HRS)

The Technical Specification Load Profiles shall be used for the to determine the Emergency Discharge of the Battery. (From EC-088-1005)

TIME	CURRENT (AMPS)
0 -60 sec	1040
60 sec - 10 Min	575
10 - 30 Min	350
30 - 240 Min	175

Ah = (1040)(1)/60 + (575)(9)/60 + (350)(20)/60 +(175)(210)/60

Ah 832.8

2

Continuous Load

The continuous Load amps on the Battery during normal plant operation are:

Load	Amperes
1D666	131

Recharge Time (HRS) 12

Largest Noncontinuous Load

During normal plant operation the following is the largest load expected to be operating. This load operates during system testing.

Load	Amperes
1P112	140.1

Dept. Sys Anal Date Oct, 1994 Designed by J P Akus Approved by	PENNSYLVANIA POWER & LIGHT COMPANY CALCULATION SHEET Project: 250 VDC Battery 1D660 - Battery and Battery Charger Sizing Calculation	Calc #. EC-088-0506 Sht No. 13 of 19

Determine the required Charger Output Capacity

$I1 = Lc + (1.1Ah)/T$

$I1 =$ 207.3

$I2 = Lc + Ln$

$I2 =$ 271.1

I3 =	**271.1**

Therefore for 250 VDC Battery 1D650, the existing one (1), 300 Amp rated Battery Charger is adequate.

Lowest Expected Electrolyte Temp: 60 Deg F | Minimum Cell Voltage: 1.78 | Cell MFR: C&D | Cell Type: LCR - 25

Section	Load (Amperes)	Change in Load (Amperes)	Duration of Period (Minutes)	Time to End of Section (Minutes)	Capacity at T Min Rate Amps/Pos Plate	Required Section Size Pos Values	Required Section Size Neg Values
Section 1- First Period Only - If A2 is greater than A1 go to Section 2.							
1	A1 270	A1-0 270	M1 = 1	T = M1 = 1	129.1	2.09	
					Sub Total	2.09	
					Total	2.09	
Section 2- First Two Periods Only - If A3 is greater than A2, go to Section 3.							
1	A1 = 270	A1-0 = 270	M1 = 1	T = M1 + M2 = 10	116.3	2.32	
2	A2 = 245	A2-A1 = -25	M2 = 9	T = M2 = 9	117.3	0.00	-0.21
					Sub Total	2.32	-0.21
					Total	2.11	
Section 3- First Three Periods Only - If A4 is greater than A3, go to Section 4.							
1	A1 = 270	A1-0 = 270	M1 = 1	T = M1 + M2 + M3 = 30	93.2	2.90	
2	A2 = 245	A2-A1 = -25	M2 = 9	T = M2 + M3 = 29	94.7	0.00	-0.26
3	A3 = 155	A3-A2 = -90	M3 = 20	T = M3 = 20	105.7	0.00	-0.85
					Sub Total	2.90	-1.12
					Total	1.78	
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5.							
1	A1 = 270	A2-A1 = 270	M1 = 1	T = M1 + M2 + M3 + M 240	29.2	9.25	
2	A2 = 245	A2-A1 = -25	M2 = 9	T = M2 + M3 + M4 = 239	30.0	0.00	-0.83
3	A3 = 155	A3-A2 = -90	M3 = 20	T = M3 + M4 = 230	30.5	0.00	-2.95
4	A4 = 155	A4-A3 = 0	M4 = 210	T = M4 = 210	32.6	0.00	0.00
					Sub Total	9.25	-3.78
					Total	5.46	

Max Section Size: 5.46 + Random Section 0 = Uncorrected Size (US): **5.46**

US X Temp Correction 1.11 X Design Margin 1.0 X Aging Factor 1.25 = **7.58**

Required Cell Size: **8**

2

2D650SZ.XLS

Dept. Sys Anal Date Oct, 1984 Designed by J P Akus Approved by	PENNSYLVANIA POWER & LIGHT COMPANY CALCULATION SHEET Project: 250 VDC Battery 2D650 - Battery and Battery Charger Sizing Calculation	Calc #. EC-088-0506 Sht No. 15 of 19

CHARGER CAPACITY FOR 250 VDC BATTERY 2D650

The Ampere capacity of the Battery charger is calculated as follows:

I1 = Lc + (1.1Ah)/T (From IEEE 946)

I2 = Lc + Ln (From IEEE 946)

I1 = AMPS, CHARGER CAPACITY
I3 = Recommended Charger Rated Output (Larger of I1 or I2)
Lc = CONTINUOUS LOAD AMPS
Ln = Largest noncontinuous load during normal plant operation
Ah = CALCULATED AMP-HRS EMERGENCY DISCHARGE
T = DESIRED RECHARGE TIME IN HOURS

2

Emergency Discharge of Battery

Ah = I1T1 + I2T2 + I3T3 + I4T4 (AMP-HRS)

The Technical Specification Load Profiles shall be used for the to determine the Emergency Discharge of the Battery. (From EC-088-1005)

TIME	CURRENT (AMPS)
0 -60 sec	270
60 sec - 10 Min	245
10 - 30 Min	155
30 - 240 Min	155

Ah = (270)(1)/60 + (245)(9)/60 + (155)(20)/60 +(155)(210)/60

2

Ah 635.4

Continuous Load

The continuous Load amps on the Battery during normal plant operation are:

Load	Amperes
2D288	120

Recharge Time (HRS) 12

Largest Noncontinuous Load

During normal plant operation the following is the largest load expected to be operating. This load operates during system testing.

Load	Amperes
2P220	13.4

Dept.	Sys Anal	PENNSYLVANIA POWER & LIGHT COMPANY	Calc #. EC-088-0506
Date	Oct, 1994	CALCULATION SHEET	
Designed by	J P Akus	Project:	Sht No. 16 of 19
Approved by		250 VDC Battery 2D650 - Battery and Battery Charger Sizing Calculation	

Determine the required Charger Output Capacity

$I1 = Lc + (1.1Ah)/T$

$I1 =$ 178.2

$I2 = Lc + Ln$

$I2 =$ 133.4

I3 =	**178.2**

Therefore for 250 VDC Battery 2D650, the existing two (2), 300 Amp rated Battery Charger are adequate,. only one required.

The existing battery chargers are equipped with Battery Paralleling Networks to provide even sharing of the load.

Lowest Expected Electrolyte Temp: 60 Deg F | Minimum Cell Voltage: 1.78 | Cell MFR: C&D | Cell Type: LCR - 25

Section	Load (Amperes)	Change in Load (Amperes)	Duration of Period (Minutes)	Time to End of Section (Minutes)	Capacity at T Min Rate Amps/Pos Plate	Required Section Size	
						Pos Values	Neg Values
Section 1- First Period Only - If A2 is greater than A1 go to Section 2.							
1	A1 700	A1-0 700	M1 = 1	T = M1 = 1	129.1	5.42	
					Sub Total	5.42	
					Total	5.42	
Section 2- First Two Periods Only - If A3 is greater than A2, go to Section 3.							
1	A1 = 700	A1-0 = 700	M1 = 1	T = M1 + M2 = 10	116.3	6.02	
2	A2 = 410	A2-A1 = -290	M2 = 9	T = M2 = 9	117.3	0.00	-2.47
					Sub Total	6.02	-2.47
					Total	3.55	
Section 3- First Three Periods Only - If A4 is greater than A3, go to Section 4.							
1	A1 = 700	A1-0 = 700	M1 = 1	T = M1 + M2 + M3 = 30	93.2	7.51	
2	A2 = 410	A2-A1 = -290	M2 = 9	T = M2 + M3 = 29	94.7	0.00	-3.06
3	A3 = 150	A3-A2 = -260	M3 = 20	T = M3 = 20	105.7	0.00	-2.46
					Sub Total	7.51	-5.52
					Total	1.99	
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5.							
1	A1 = 700	A2-A1 = 700	M1 = 1	T = M1 + M2 + M3 + M 240	29.2	23.97	
2	A2 = 410	A2-A1 = -290	M2 = 9	T = M2 + M3 + M4 = 239	30.0	0.00	-9.67
3	A3 = 150	A3-A2 = -260	M3 = 20	T = M3 + M4 = 230	30.5	0.00	-8.52
4	A4 = 150	A4-A3 = 0	M4 = 210	T = M4 = 210	32.6	0.00	0.00
					Sub Total	23.97	-18.19
					Total	5.78	

Max Section Size: 5.78 + Random Section 0 = Uncorrected Size (US): **5.78**

US X Temp Correction 1.11 X Design Margin 1.0 X Aging Factor 1.25 = **8.02**

Required Cell Size: **9**

2

2D660SZ.XLS

Dept.	Sys Anal	PENNSYLVANIA POWER & LIGHT COMPANY	Calc #. EC-088-0506
Date	Oct, 1994	CALCULATION SHEET	
Designed by	J P Akus	Project:	Sht No. 16 of 19
Approved by		250 VDC Battery 2D660 - Battery and Battery Charger Sizing Calculation	

CHARGER CAPACITY FOR 250 VDC BATTERY 2D660

The Ampere capacity of the Battery charger is calculated as follows:

I1 = Lc + (1.1Ah)/T (From IEEE 946)

I2 = Lc + Ln (From IEEE 946)

I1 = AMPS, CHARGER CAPACITY
I3 = Recommended Charger Rated Output (Larger of I1 or I2)
Lc = CONTINUOUS LOAD AMPS
Ln = Largest noncontinuous load during normal plant operation
Ah = CALCULATED AMP-HRS EMERGENCY DISCHARGE
T = DESIRED RECHARGE TIME IN HOURS

2

Emergency Discharge of Battery

Ah = I1T1 + I2T2 + I3T3 + I4T4 (AMP-HRS)

The Technical Specification Load Profiles shall be used for the to determine the Emergency Discharge of the Battery. (From EC-088-1005)

TIME	CURRENT (AMPS)
0 -60 sec	700
60 sec - 10 Min	410
10 - 30 Min	150
30 - 240 Min	150

Ah = (700)(1)/60 + (410)(9)/60 + (150)(20)/60 + (150)(210)/60

Ah 648.2

2

Continuous Load

The continuous Load amps on the Battery during normal plant operation are:

Load	Amperes
2D289	120

Recharge Time (HRS) 12

Largest Noncontinuous Load

During normal plant operation the following is the largest load expected to be operating. This load operates during system testing.

Load	Amperes
HV-E41-2F006	39

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Determine the required Charger Output Capacity

$I1 = Lc + (1.1Ah)/T$

$I1 =$ 179.4

$I2 = Lc + Ln$

$I2 =$ 159

I3 =	**179.4**

Therefore for 250 VDC Battery 2D660, the existing one (1), 300 Amp rated Battery Charger is adequate.