DC System Sizing Principles
1. Application Outline
2. How to build a load profile
3. Battery Sizing Example
4. Sizing with Software
5. Battery Charger Sizing
The Art and Science of Battery Sizing

- Battery Sizing is a Science
- Building the load profile is an Art.
- Different electro-chemistries vary greatly
- You have more control over your battery selection than you think
APPLICATION OUTLINE
Introduction to Switchgear

- What is Switchgear?
  - The combination of electrical disconnect switches, relays, lighting, controls, fuses or circuit breakers used to control, protect and isolate electrical equipment
  - Large Panels of electrical distribution circuit breakers distribute power to a facility or grid

- Why is Switchgear used?
  - To de-energize equipment to allow work to be done and clear faults downstream
  - Fix power lines
  - Breakers are too big to flip by hand
Three main types of switchgear applications

- MV (medium voltage)
  - Utility level protection
  - Typically 8 hr. load profile
- LV (low voltage)
  - Building level protection
- Paralleling
  - Two or more gensets
  - Typically 2-8 hr. load profiles

Switchgear protects against

- Faults upstream and protects
- Equipment downstream
LV/ MV Switchgear

480V to 38kV (typical)

- DC bus = 125Vdc (normal)
- 48Vdc is also popular
- Load profile is mixed
  - High peak currents (transient)
  - Continuous loads (steady state)
  - 2-8 hr. battery backup normal
Paralleling Switchgear

120V to 600V (typical)

- DC bus = 24, 48 or 125Vdc
- Load profile is mixed
  - High peak currents (transient)
  - Continuous loads (steady state)
  - 20 min. - 4 hr. battery backup normal
The Battery’s Purpose

- Batteries provide DC power to the switchgear equipment during an outage.
- Best practice is to have individual batteries for each load/application.
- Duration of backup is dependent on the battery Ah capacity.
- Battery loads include:
  - Trip Current
  - Close Current
  - Spring Motor Rewind/Charge Current
  - Continuous Loads: Relays, Meters, Control Circuits, PLCs, Lighting, Etc.
IEEE Standards

- IEEE 1115
  - Recommended Practice for Sizing Nickel Cadmium Batteries

- IEEE 485
  - Recommended Practice for Sizing Large Lead Acid Batteries

- IEEE 1189
  - Recommended Practice for Selection of Valve Regulated Lead Acid Batteries
  - For Sizing, it refers to IEEE 485 practices
BUILDING LOAD PROFILES
Switchgear load profiles normally comprise of four components:

- **Trip**
  - Can be simultaneous, sequential or mixed
  - 1s (Ni-Cd) and 1min (Pb-acid)*

- **Close**
  - Can be sequential, simultaneous or mixed
  - 1s (Ni-Cd) and 1min (Pb-acid)*

- **Spring motor rewind/charge**
  - Usually sequential, but can be simultaneous
  - 6s (Ni-Cd) and 1min (Pb-acid)* minimum

- **Continuous loads**
  - 20mins to 24hrs (8hr most common)

*Lead-Acid has a minimum sizing duration of 1min. Why???
Coup De Fouet

![Diagram showing voltage over time with Plateau and Trough voltage points]

- Voltage (V):
  - 2.02
  - 2.015
  - 2.01
  - 2.005

- Time:
  - 0:00:00
  - 0:01:26
  - 0:02:53
  - 0:04:19
  - 0:05:46
  - 0:07:12
  - 0:08:38
  - 0:10:05
Trip / Close / Spring Charge

- **Simultaneous loads** = (# breakers x current) for one device operation time
  - 1 second minimum duration for Ni-Cd
  - 1 minute minimum duration for Pb-acid

- **Sequential loads** = One device current for (# breakers x time)
  - 1s minimum duration for Ni-Cd
  - 1 minute minimum duration for Pb-acid

- **Mixed loads** = # breakers x current + # breakers x time
  - e.g. 51 breakers
  - 17 x trip current (simultaneous)
  - 3 x time period (sequential)
Load Sequencing

- Load sequencing defines the total number of operations and where they occur during the outage / backup period.
- The number of operations and where they occur during the backup period can have a dramatic impact on battery capacity.
- We will look at a load profile example and examine how sequencing impacts battery selection.

![Graph showing load profile example](image-url)
The Voltage Window

- Batteries operate within a designed Voltage Window
  - The upper limit should allow for battery equalize/boost charging
  - The lower limit should allow for maximum usage during discharge.

- The narrower the voltage window, the larger the battery capacity has to be.
- Lead Acid usually operates between 1.75vpc and 2.33vpc depending on construction

- NiCad batteries typically operate between 1.00vpc and up to 1.65vpc depending on load voltage tolerance.

- Typical voltage windows for standard nominal voltages
  - 24Vdc: 21Vdc to 30Vdc
  - 48Vdc: 42Vdc to 58Vdc
  - 125Vdc: 105Vdc to 140Vdc
*Should be based on equipment connected to the battery.
Temperature Factor

- Battery capacities and discharge ratings are published based on a certain temperature, usually between 68°F & 77°F.
- Battery performance decreases at lower temperatures and must be accounted for with correction factors.
- Lead Acid – Temperature correction factor applied at the end of the calculation.
- NiCad – Temperature correction factor applied at each step in the calculation.

![Graph showing available capacity vs temperature for different battery types]
Other Factors to Consider

- Design Margin
  - Used to allow for future load growth or unknowns in the load list.
  - Typically 1.1 - 1.15

- Aging Factor
  - Used when the requirement is for the battery to be able to perform the same duty cycle at the end of its life as when it is new.
  - Typically 1.25 based on the IEEE recommendation to replace a battery after its capacity has fallen to 80%.

![Graph showing the capacity of Lead and Nicad batteries over life percentage.](https://via.placeholder.com/150)
SIZING EXAMPLES
125 Vdc MV Switchgear Example

From Customer:

- 20 breakers:
  - Breaker Trip/Close (T/C) = 7A for <1s
  - Spring charge motor inrush (SI) = 16A for <1s
  - Spring charge motor run (SR) = 4A for 6.0s
  - Continuous loads = 5A for 8h
  - Trip Sequence = Simultaneous @ t=0 and t=8hr
  - Close Sequence = Simultaneous after trip
  - Temperature = Temperature Controlled (room temp. 68°F)
  - Normal Aging (AF) = 1.25 AF
  - Design Margin (DM) = 1.10 DM

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Spring Charging Motor</th>
<th>Average Run Time, Sec.</th>
<th>Close or Trip Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inrush Amperes</td>
<td>Run Amperes</td>
<td></td>
</tr>
<tr>
<td>48 Vdc</td>
<td>36.0</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>125 Vdc</td>
<td>16.0</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>250 Vdc</td>
<td>9.2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>120 Vac.</td>
<td>16.0</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>240 Vac.</td>
<td>9.2</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>
Written Load Profile

- **Trip**  
  \[(20 \text{ brkrs} \times 7\text{A} = 140\text{A}) + \text{cont. load (5)} = 145 \text{Amps for .1s}\

- **Close**  
  \[(20 \text{ brkrs} \times 7\text{A} = 140\text{A}) + \text{cont. load (5)} = 145 \text{Amps for .2s}\

- **Spring SI**  
  \[(20 \text{ brkrs} \times 16\text{A} = 320\text{A}) + \text{cont. load} = 325 \text{Amps for .25s}\

- **Spring SR**  
  \[(20 \text{ brkrs} \times 4\text{A} = 80\text{A}) + \text{cont. load} = 85 \text{Amps for 6s}\

- **Cont. load**  
  \[= 5\text{A for 8h}\

Saft Battery Sizing
Load Profile - Graphical Form (NiCad)

- Spring Charge Motor Inrush: 325 Amps
- Trip/Close Loads: 145 Amps
- Spring Charge Run: 85 Amps
- Cont. Load: 5 Amps
- Duration: 9 seconds
Load Profile - Step Form (NiCad)

- Step 1 = 145A for 1sec (trip + cont.) followed by:
- Step 2 = 145A for 1sec (close + cont.)
- Step 3 = 325A for 1sec (Spring Charge Inrush + cont.)
- Step 4 = 85A for 6sec
- Step 5 = 5A for 7hr, 59min, 42 sec
- Repeat Steps 1 – 4:
- Step 6 = 145A for 1sec (trip + cont.)
- Step 7 = 145A for 1sec (close + cont.)
- Step 8 = 325A for 1sec (Spring Charge Inrush + cont.)
- Step 9 = 85A for 6sec
Load Profile - Graphical Form (Lead Acid)

- Spring Charge Motor Inrush: 325 Amps, 1 Min.
- Cont. Load: 5 Amps
Load Profile - Step Form (Lead Acid)

- Step 1 = 325A for 1min (Spring Charge Inrush + cont.)
- Step 2 = 5A for 7hr, 58min
- Step 3 = 325A for 1min (Spring Charge Inrush + cont.)
Sizing The Old Way (Fan Curves)
Sizing the “New” Way

These days we use custom software!!

- Drastically speeds up the battery selection process.
- Eliminates calculation errors.
- Ensures standards compliance by providing results in IEEE worksheet format.
- Many offer additional features:
  - Battery rack selection
  - Gassing/ventilation calculations
  - Product data sheets
IEEE 485 sizing worksheet from custom software

SIZING LEAD-ACID BATTERIES FOR STATIONARY APPLICATIONS

IEEE
Std 485-1997

<table>
<thead>
<tr>
<th>Project:</th>
<th>Battery Tag:</th>
<th>Date: 3/27/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest Expected Electrolyte Temp: 77°F</td>
<td>Minimum Cell Voltage: 1.75</td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Load</td>
<td>Change in Load</td>
<td>Duration of Period</td>
</tr>
<tr>
<td>Period (amperes)</td>
<td>Period (amperes)</td>
<td>(minutes)</td>
</tr>
</tbody>
</table>

Section 1 - If A2 is greater than A1, go to Section 2

1 A1=67.41 A1-0=67.41 M1= 1 T=M1= 1 0.5586 37.656

Section 1 Total 37.656

Section 2 - If A3 is greater than A2, go to Section 3

Section 3 - If A4 is greater than A3, go to Section 4

1 A1=67.41 A1-0=67.41 M1= 1 M1+M2+M3= 480 T=M1+M2+M3= 480 8.004 530.55
3 A3=67.41 A3-A2= 61.75 M3= 1 T=M3= 1 0.5586 34.516

Section 3 Total 80.246

Maximum Section Size: 80.246 + Random Section Size: 0 = Uncorrected Size (US): 80.246
(US): 80.246 x Temp Corr: 1.00 x Design Marg: 1.10 x Aging Factor: 1.25 = 110.3
When the cell size is greater than a standard cell size, the next larger cell is required.
Required cell size: 110.3 Amp Hours. Therefore cell part number LSe150 is required.

Saft Battery Sizing
**BaSiCS Sizing Software (NiCad)**

- **Step 1: Input General Information:**
  - Voltage Window: 105 – 140 for 125Vdc
  - Temperature: 20°C
  - Aging Factor: 1.25
  - Select Product ranges you are interested in: UP1M, SPH, SBM (typical for Swgr)
BaSiCS (Cont.)

- Step 2: Input Load Profile:
  - Input Current and Time, click Validate. Move to next step

- Step 3: CLICK: Size it
Stationary Ni-Cd battery sizing

Battery proposal

<table>
<thead>
<tr>
<th>Proposed battery</th>
<th>1 x 96 x SPH 130</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical data</td>
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<tr>
<td>Rated capacity</td>
<td>130 Ah</td>
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<tr>
<td>Fast charge voltage</td>
<td>139.2 V</td>
</tr>
<tr>
<td>Floating charge voltage</td>
<td>134.4 V</td>
</tr>
<tr>
<td>Final voltage/cell</td>
<td>1.064 V</td>
</tr>
<tr>
<td>Short-circuit current</td>
<td>4.697 A</td>
</tr>
<tr>
<td>Topping-up interval</td>
<td>13.1 years</td>
</tr>
<tr>
<td>Physical data</td>
<td></td>
</tr>
<tr>
<td>Battery weight</td>
<td>1,451.5 lb</td>
</tr>
</tbody>
</table>

Technical specifications

<table>
<thead>
<tr>
<th>Sizing method</th>
<th>IEEE</th>
</tr>
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<tbody>
<tr>
<td>Minimum system voltage</td>
<td>105.00 V</td>
</tr>
<tr>
<td>Maximum system voltage</td>
<td>140.00 V</td>
</tr>
<tr>
<td>Charge method</td>
<td>Dual rate</td>
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Battery calculation worksheet IEEE 1115-2014

<table>
<thead>
<tr>
<th>Range</th>
<th>SPH</th>
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<tbody>
<tr>
<td>No. of cells</td>
<td>sis</td>
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<tr>
<td>Final voltage/cell</td>
<td>1.064 V</td>
</tr>
<tr>
<td>Nominal temperature</td>
<td>20 °C</td>
</tr>
<tr>
<td>Minimum temperature</td>
<td>20 °C</td>
</tr>
<tr>
<td>Maximum temperature</td>
<td>20 °C</td>
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<table>
<thead>
<tr>
<th>(1) Period</th>
<th>(2) Load (Ampères)</th>
<th>(3) Changes in Load (Ampères)</th>
<th>(4) Duration of Period (Minutes)</th>
<th>(5) End of Section (Minutes)</th>
<th>(6) DF Factor</th>
<th>(7) Temp Derating Factor</th>
<th>(8) Required Section Size (3)x(8)(x/7) Rated Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1=145.00</td>
<td>A1=145.00</td>
<td>M1=0.02</td>
<td>M1=0.02</td>
<td>0.1696</td>
<td>1.0000</td>
<td>24.64</td>
</tr>
<tr>
<td>2</td>
<td>A2=145.00</td>
<td>A2,A1=0.00</td>
<td>M2=0.02</td>
<td>M2=0.02</td>
<td>0.1667</td>
<td>1.0000</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>A3=225.00</td>
<td>A3,A2=0.00</td>
<td>M3=0.02</td>
<td>M3=0.02</td>
<td>0.1636</td>
<td>1.0000</td>
<td>29.43</td>
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<tr>
<td>Total</td>
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<td></td>
<td>54.07</td>
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<table>
<thead>
<tr>
<th>Section</th>
<th>First 4 Periods Only</th>
<th>If A6&gt;A3, go to Section 5-No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1=145.00</td>
<td>A1=145.00</td>
</tr>
<tr>
<td>2</td>
<td>A2=145.00</td>
<td>A2,A1=0.00</td>
</tr>
<tr>
<td>3</td>
<td>A3=225.00</td>
<td>A3,A2=0.00</td>
</tr>
<tr>
<td>4</td>
<td>A4=225.00</td>
<td>A4,A3=0.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
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<table>
<thead>
<tr>
<th>Section</th>
<th>First 5 Periods Only</th>
<th>If A8&gt;A5, go to Section 6-Yes</th>
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<table>
<thead>
<tr>
<th>Section</th>
<th>First 6 Periods Only</th>
<th>If A7&gt;A6, go to Section 7-Yes</th>
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<table>
<thead>
<tr>
<th>Section</th>
<th>First 7 Periods Only</th>
<th>If A9&gt;A7, go to Section 8-Yes</th>
</tr>
</thead>
</table>

(SAFT) confidential and proprietary. The data here given are for information purposes only and are not binding on SAFT. They may be modified without prior notice. Please contact a SAFT representative in order to obtain confirmation of the above data.

Visit our website at www.saftbatteries.com
Lead-Acid sizing
SIZING LEAD-ACID BATTERIES FOR STATIONARY APPLICATIONS

Project:  
Battery Tag:  
Date: 3/19/2018

<table>
<thead>
<tr>
<th>Period</th>
<th>Load (amperes)</th>
<th>Change in Load (amperes)</th>
<th>Duration of Period (minutes)</th>
<th>Time to End of Section (minutes)</th>
<th>Cell Type</th>
<th>LSe</th>
<th>Capacity at T Min Rate (6A) Amps/Pos (RT) or Required Section Size (3) = (6A) = Positive Plates or (3) x (6B) = Rated Amp Hrs values</th>
<th>Sized By: David Hood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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Section 1 - If A2 is greater than A1, go to Section 2

1

<table>
<thead>
<tr>
<th>Period</th>
<th>Load (amperes)</th>
<th>Change in Load (amperes)</th>
<th>Duration of Period (minutes)</th>
<th>Time to End of Section (minutes)</th>
<th>Cell Type</th>
<th>LSe</th>
<th>Capacity at T Min Rate (6A) Amps/Pos (RT) or Required Section Size (3) = (6A) = Positive Plates or (3) x (6B) = Rated Amp Hrs values</th>
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</table>

Section 2 - If A3 is greater than A2, go to Section 3

Section 3 - If A4 is greater than A3, go to Section 4

1

<table>
<thead>
<tr>
<th>Period</th>
<th>Load (amperes)</th>
<th>Change in Load (amperes)</th>
<th>Duration of Period (minutes)</th>
<th>Time to End of Section (minutes)</th>
<th>Cell Type</th>
<th>LSe</th>
<th>Capacity at T Min Rate (6A) Amps/Pos (RT) or Required Section Size (3) = (6A) = Positive Plates or (3) x (6B) = Rated Amp Hrs values</th>
<th>Sized By: David Hood</th>
</tr>
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<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Maximum Section Size: **222.85** + Random Section Size: **0** = Uncorrected Size (US): **222.85**

(US): **222.85 x Temp Corr: 1.06 x Design Marg: 1.10 x Aging Factor: 1.25 = 324.8**

When the cell size is greater than a standard cell size, the next larger cell is required. Required cell size: **324.8** Amp Hours. Therefore cell part number **LSe350** is required.
Switchgear Sizing Conclusion

- Proper load profile generation is critical to the outcome.
- Don’t forget to consider temperature, design margin and aging factors.
- The NiCad size will often be smaller than the Lead-Acid
  - Lead-Acid Size: 350AH
  - NiCad size: 130AH !!
Application Outline - UPS

- Uninterruptible Power Supply
  - Constant Power
  - Battery Selection Depends on:
    o UPS rating
    o Power Factor
    o Efficiency
    o Run Time
    o Environmental Conditions (Temperature)

- Backing Up Critical Loads:
  - IT/Commercial Loads: 5 – 15 Minutes
  - Industrial UPS: 30 min +

- Design Life: 20 Years

- DC Bus Voltage depends on UPS manufacturer:
  - 480 Vdc common for Commercial
  - 125 Vdc common for Industrial
- From Customer:
  - 25kVA
  - 0.85 PF
  - 92% Efficiency
  - 30min backup
  - 50F
  - Normal Aging acceptable
  - DC Bus = 125Vdc (105-140)
- **Step 1: Same as Switchgear (input General Information)**

<table>
<thead>
<tr>
<th>Step 1: General</th>
<th>Step 2: Profile</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum system voltage (**)</td>
<td>Minimum temperature (**)</td>
<td>105 V</td>
<td>50 °F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum system voltage (**)</td>
<td>Nominal temperature (**)</td>
<td>140 V</td>
<td>68 °F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal system voltage</td>
<td>Maximum temperature (**)</td>
<td>V</td>
<td>68 °F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. system voltage (%)</td>
<td>Design margin (**)</td>
<td>%</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. system voltage (%)</td>
<td>Aging factor (**)</td>
<td>%</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Charge method (**)</td>
<td>Temperature compensation</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

(*) The field is required

Range:
- SCM
- SLM
- SPH
- SPL
- TLX
- UP1L
- UP4M

Automatic
UPS sizing with Basics

- Step 2: Click UPS:P sizing button (shown below)
- Step 3: Enter UPS information and backup time
- Step 4: Click: Size it
  - Selection will be based on runtime.
    - Less than 30min = H-rate
    - 30min to 1hr = M-rate
    - Greater than 1hr = L-rate
Stationary Ni-Cd battery sizing

Battery proposal

Proposed battery: 1 x 95 x SPH 170

Electrical data:
- Rated capacity: 170 Ah
- Fast charge voltage: 137.76 V
- Floating charge voltage: 133 V
- Final voltage/cell: 1.105 V
- Short-circuit current: 8,143 A
- Topping-up interval: 13.9 years

Physical data:
- Battery weight: 2,031.6 lb

Technical specifications

Sizing method: UPS
Voltage window:
- Minimum system voltage: 106.00 V
- Maximum system voltage: 140.00 V

Charge method: Dual rate

Load profile:
- Number: 1
- Power: 23,095 kW
- KVA / n / Coso: 25 / 0.92 / 0.85
- Time (nom/min/m): 00:30:00

Options:
- Nominal temperature: 88 °F
- Minimum temperature: 50 °F
- Maximum temperature: 68 °F
- Design margin: 1
- Aging factor: 1

Battery calculation worksheet IEEE 1115-2014

Range: SPH
No. of cells: 95
Final voltage/cell: 1.105 V
Nominal temperature: 68 °F
Minimum temperature: 50 °F
Maximum temperature: 68 °F

<table>
<thead>
<tr>
<th>(1) Period</th>
<th>(2) Load (Watt/Cell)</th>
<th>(3) Changes in Load (Watt/Cell)</th>
<th>(4) Duration of Period (minutes)</th>
<th>(5) End of Section (minutes)</th>
<th>(6) Kt Factor</th>
<th>(7) Temp Derating Factor</th>
<th>(8) Required Section Size (3x6)x(7) = Rated A1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1=243.14</td>
<td>A1=0</td>
<td>M1=0</td>
<td>T=M1=30.00</td>
<td>0.6810</td>
<td>1.0342</td>
<td>163.70</td>
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</tbody>
</table>

Total: 163.70

Notes:
- In this calculation, constant potential charging effects are included in our Kt factors.
- The factors are interpolated when needed and rounded down to 4 decimals in the calculation.
- Maximum Section size: 163.70 + Random size: 0.00 = Uncorrected size 163.70.
- Uncorrected size 163.70 x Design margin 1 x Aging factor 1 = 163.70.
- When the cell size is greater than a standard cell size, the next larger cell is required.
- The required cell size is 163.70 A/hours. Therefore cell SPH 170 is required.

The Kt factor is a way to represent the performance of a cell.
Kt = Nominal capacity (Ah)/Performance (A)
It is valid for a specific cell type, discharge time and final voltage.

Temperature compensated charge voltage:
Not mandatory. If used the value to apply is -2 mV°C (-1.1 mV°F) starting from +20°C to +26°C (+68°F to +78°F).

Storage:
- Store the cells indoors in a dry, clean, cool location 0°C and +30°C (+32°F and +86°F).
- Do not store in unopened shipping cases. The lid and the packing material on top of the cells must be removed.
- Make sure that the transport seals remain in place during storage.
- Do not store in direct sunlight or expose to excessive heat.
- Cells delivered discharged and filled may be stored for many years before installation.
- Cells delivered exceptionally 80% charged (for starting application) must not be stored more than 3 months (including transport).
Sizing Software

Saft Basics Software for NiCad

https://www.saftbatteries.com/basics2013/install/SaftBasics.zip
Battery Charger Sizing

Important Things to Consider!!

- Continuous Load
- Battery Type
- Battery AH Capacity
- Altitude
- Design Margin
Battery Charger Sizing

– For Example...

• 100 AH Pocket Plate NiCad Battery
• Needs to recharge in 8 hours
• Continuous DC Load is 12 amps
• Design Margin is 10%
• Altitude is less than 3000 ft.

First we need to get all the factors...
Battery Charger Sizing

- Recharge Factor
  - Per the table below, the recharge factor for Pocket Plate NiCad batteries is 1.40

<table>
<thead>
<tr>
<th>Battery Type</th>
<th>Recharge Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pocket Plate Nicad</td>
<td>1.40</td>
</tr>
<tr>
<td>Sintered/PBE Nicad</td>
<td>1.20</td>
</tr>
<tr>
<td>Lead Acid</td>
<td>1.15</td>
</tr>
</tbody>
</table>

- Altitude Derating
  - Installation < 3000 ft. = no derating
  - Installation > 3000 ft. = 6.7% derating per 3000 ft.
  - Our example is less than 3000 feet so we have no derating factor.
Battery Charger Sizing

– The Formula

\[ C = \left( \frac{AH \times RF}{RT} + CL \right) \times DM \times AD \]

Where:

- C = Charger Current
- AH = Battery Amp Hours
- RF = Recharge Efficiency Factor
- RT = Required Recharge Time
- CL = Continuous Load
- DM = Design Margin
- AD = Altitude Derating
Battery Charger Sizing

- The Calculation

\[ C = \left( \frac{100 \times 1.4}{8} + 12 \right) \times 1.10 \times 1.0 \]

\[ C = 32.45 \]

Therefore the charger should be sized at 30 amps*

*a 30 amp charger will deliver 33 amps in current limit*
Thank You!!

- Questions???