RELIABILITY

Low Voltage Construction

Presented by: Pete Rossomando – Director of PCS Applications Engineering
Low Voltage Construction

- **Switchgear Design Features**
  - General Cubicle Dimensions
  - Cubicle Modular Construction
  - Conduits and Cable Considerations
  - Switchgear Options
  - Breaker Stacking Arrangements
  - Seismic Considerations
  - UL 891 & UL 1558
Low Voltage Construction – Current Design

- All 11 Gauge Steel
- All silver plated copper bus (tin plated available if specified)
- Modular Cubicle design
- Standardized parts and section dimensions
- Standardized bus configurations
- Seismic Design Standard
- Lug pads designed for use with either mechanical or compression lugs
- Standard modular conduit area
- Rear Doors Standard
- All cubicles designed for either top or bottom cable entry
- Design Based on Square D NW/MTZ circuit breakers
- Common UL 891 & UL 1558 Structural Design
Low Voltage Construction

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  - General Cubicle Dimensions
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- Switchgear Options
- Breaker Stacking Arrangements
- Seismic Considerations
- UL 891 & UL 1558
Low Voltage Construction - Mechanical Layout….How wide?

**General Switchgear Widths**

- 26", 32", 36" & 40" are standard widths others are custom
- Widths apply to Generator, Distribution, Tie and Utility Sections.

26", 32", 36", 40” Wide
What’s in the 3” wire way?

- Cubicle Interconnect harnesses
- No interwiring between cubicles, plug and jack connections
- DC Bus – Distributes DC Power to each switchgear section

Interconnect Control Wires

Red, Blue, Black Wires are DC bus
Plug and Jack Connections

- Cubicle Interconnect harnesses
- No interwiring between cubicles, plug and jack connections
- Makes life easy for the contractor
Low Voltage Construction - Section Depths

Section Depth is Determined by Main Bus Ampacity

<table>
<thead>
<tr>
<th>Main Bus Ampacity</th>
<th>Section Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls Only</td>
<td>24”-30”</td>
</tr>
<tr>
<td>3000A – 6000A</td>
<td>72”</td>
</tr>
<tr>
<td>8000A – 10,000A</td>
<td>84”</td>
</tr>
</tbody>
</table>
Low Voltage Construction

- Switchgear Design Features
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- Cubicle Modular Construction
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- Switchgear Options
- Breaker Stacking Arrangements
- UL 891 & UL 1558
Note: #2 or #3 breaker compartment can be replaced with controls – CB control switches, metering, control power transformers, I/O

Main Bus  Ground Bus

Cable Compartment
Low Voltage Construction – Modular Cubicle Design

- **Front – Breaker and/or Control Section**: 24”
  - Panels for controls
  - Front Door

- **Middle - Bus Section**: 18” up to 6000A
  - 30” 8000A & 10,000A
  - Side Barriers
  - Conduits - Up to 16 3-1/2” conduits for 26”W section, 20 for 32”W section

- **Rear – Cable Section**: 30”
  - Rear Door
Low Voltage Construction

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### Low Voltage Construction – Standard Conduit Design

#### Typical Cables if cable schedule not known

<table>
<thead>
<tr>
<th>Breaker Frame Size</th>
<th># of cables/ Phase &amp; N</th>
</tr>
</thead>
<tbody>
<tr>
<td>800AF</td>
<td>3</td>
</tr>
<tr>
<td>1200AF</td>
<td>4</td>
</tr>
<tr>
<td>1600AF</td>
<td>5</td>
</tr>
<tr>
<td>2000AF</td>
<td>6</td>
</tr>
<tr>
<td>2500AF</td>
<td>7</td>
</tr>
<tr>
<td>3000AF</td>
<td>8</td>
</tr>
<tr>
<td>3200AF</td>
<td>8</td>
</tr>
<tr>
<td>4000AF</td>
<td>12</td>
</tr>
<tr>
<td>5000AF</td>
<td>15</td>
</tr>
</tbody>
</table>
Low Voltage Construction – Cable Entry & Lugs

■ All Switchgear cubicles designed for top or bottom cable entry – No dimensional changes, just specify what’s required
■ Mechanical Lugs Provided as standard
■ Optional Compression Lugs provided if specified
■ Optional Inspection windows provided if specified
■ All lugs are two hole anti-turn type
■ Bus Lug pads designed to accommodate either Mechanical or Compression lugs
■ Cable entry area does not change based on lug type
■ Unlike some ATS, dimensions do not change based on lug size or type
■ Lug type can be either, we just need to know which.
Low Voltage Construction

- Switchgear Design Features
- General Cubicle Dimensions
- Cubicle Modular Construction
- Conduits and Cable Considerations

Switchgear Options

- Breaker Stacking Arrangements
- UL 891 & UL 1558
## Low Voltage Construction Switchgear Options

### Optional Features

<table>
<thead>
<tr>
<th>Options</th>
<th>Master/Control</th>
<th>Generators</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead Lifting Device</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Portable Lifting Device</td>
<td>NA</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Steel &amp; Glastic Side Barriers</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Glastic Rear Barriers/Isolated bus</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mimic Bus</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mechanical/Compression Lugs</td>
<td>NA</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>IR Viewing Ports</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3” Steel Cubicle Base</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>System SPD</td>
<td>X</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bus Duct Risers</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>200K AIC bus bracing</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Low Voltage Construction - Options

Overhead Circuit Breaker Lifting Device

- Rail mounted
- Ships separately and mounted in field
- Can be provided on projects with bus risers
- IBC 2018 Seismic Certified
- Adds 18” to overall height
Square D NW or MTZ 3-Pole Circuit Breakers

Total section width with various stacking arrangements are determined by the width of the largest individual breaker

<table>
<thead>
<tr>
<th>Frame Size</th>
<th>65KAIC - 100KAIC</th>
<th>150KAIC</th>
<th>200KAIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>800AF-1600AF</td>
<td>26”</td>
<td>26”</td>
<td>26”</td>
</tr>
<tr>
<td>2000AF</td>
<td>26”</td>
<td>32”</td>
<td>32”</td>
</tr>
<tr>
<td>2500AF-3000AF</td>
<td>26”</td>
<td>32”</td>
<td>32”</td>
</tr>
<tr>
<td>3200AF</td>
<td>32”</td>
<td>36”</td>
<td>36”</td>
</tr>
<tr>
<td>4000AF</td>
<td>36”</td>
<td>36”</td>
<td>36”</td>
</tr>
<tr>
<td>5000AF</td>
<td>36”</td>
<td>36”</td>
<td>36”</td>
</tr>
<tr>
<td>6000AF</td>
<td>40”</td>
<td>40”</td>
<td>40”</td>
</tr>
</tbody>
</table>
Low Voltage Construction

▪ Switchgear Design Features
▪ General Cubicle Dimensions
▪ Cubicle Modular Construction
▪ Conduits and Cable Considerations
▪ Switchgear Options
▪ **Breaker Stacking Arrangements**
▪ UL 891 & UL 1558
Low Voltage Construction Mechanical Layout – Master Control Section

- Standard Master Section 36” wide
- PLC Redundancy does not change width
- Circuit Breakers typically *can not* be mounted in Master Section due to space required for controls
- SPD can be mounted in rear
- Standard Master OIT is 24” Wonderware
- Typically an Aux Master is required when *redundant I/O* is required, adds an additional 36” wide Auxiliary Section or I/O can be mounted in the rear of the section.
Generator Section widths vary based on breaker size - 26” up to 2000AF circuit breaker

Dual Gen Sections available always a minimum of 36”W

Up to (2) 3200AF

800-2000AF
Low Voltage Construction - 1 High NW/MTZ 800 – 3200A Breaker Sections

Standard Sections for Generators or Distribution – 100KAIC

- 1 High Gen or Distribution Section
- 1 high Distribution Section w/controls
- 1 High Gen or Distribution Section
- 1 High Gen or Distribution Section

- Width increases to 32” for 3200AF CB

Typical Generator Controls

26” Wide

26” Wide

32” Wide

32” Wide
Low Voltage Construction Breaker Sections 3200 & 4000AF Breakers

NW/MTZ 1-High Sections for Generator or Distribution Sections

- Width increases to 36” for 3200AF CB @ 200KAIC
- Door height increases for more venting at 3200AF and above @200KAIC
Low Voltage Construction 2 High NW/MTZ Breaker Sections 800AF – 3200AF

**Dual Generator Sections -100KAIC Only**

- **Dual Generator Design available up to (2) 3200AF circuit breakers @100KAIC**
- **Sections always 36” wide**
## Low Voltage Construction 2 High NW/MTZ Breaker Sections – Up to 100 KAIC

<table>
<thead>
<tr>
<th>Width</th>
<th>Area Available for Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>26&quot;</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>800-2000</td>
</tr>
<tr>
<td>32&quot;</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>800-2000</td>
</tr>
<tr>
<td>36&quot;</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>800-2000</td>
</tr>
<tr>
<td></td>
<td>800-2000</td>
</tr>
<tr>
<td></td>
<td>800-2000</td>
</tr>
</tbody>
</table>

- **Width increases to 32" for 3200AF CB @ 100 KAIC**
- **Width increase to 36" for 4000AF CB @100 KAIC**

*Typical Controls*
Low Voltage Construction 2 High NW/MTZ Breaker Sections

Distribution Sections – 150-200KAIC

- Width increases to 32” for 2000AF CB @ 200KAIC
- Width increases to 36” for 4000AF CB @ 100KAIC
### Low Voltage Construction 3 High NW/MTZ Distribution Sections

**Distribution Sections up to 100KAIC**

<table>
<thead>
<tr>
<th>Section</th>
<th>Width</th>
<th>Available for Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>26”</td>
<td>800</td>
</tr>
<tr>
<td>800-2000</td>
<td>26”</td>
<td>800</td>
</tr>
<tr>
<td>800</td>
<td>26”</td>
<td>800</td>
</tr>
<tr>
<td>800-2000</td>
<td>26”</td>
<td>800</td>
</tr>
<tr>
<td>800</td>
<td>26”</td>
<td>800</td>
</tr>
<tr>
<td>800-2000</td>
<td>26”</td>
<td>800</td>
</tr>
<tr>
<td>800</td>
<td>26”</td>
<td>800</td>
</tr>
<tr>
<td>800-2000</td>
<td>26”</td>
<td>800</td>
</tr>
</tbody>
</table>

- **Width remains at 26” on all 3 high combinations 800AF – 2000AF**
- **Width increase to 32” with 3200AF breaker included**
Low Voltage Construction - 3 High NW/MTZ Distribution Sections

**Distribution Sections up to 150-200KAIC**

- **Width remains at 26” on all 3 high combinations 800AF – 1600AF 2 200KAIC**
- **Width increase to 32” with 2000AF breaker included**
Low Voltage Construction - 4 High NW/MTZ Distribution Sections 800-2000AF

Distribution Sections – Up to 200KAIC

- 4 high Sections are **26”W** for manually operated breaker
- **32”W** for electrically operated

- Electrically operated requires additional room for CPTs and CB control switches
Low Voltage Construction - Tie and Utility Sections NW/MTZ 800AF to 6000AF

Sections – Up to 100KAIC

- Width remains at 26” up to 2000AF
- Width increase to 32” with 3200AF breaker
- Width increases to 36” for 4000 & 5000AF
- Width increases to 40” for 6000AF
Low Voltage Construction - Tie and Utility Sections NW/MTZ 800AF to 6000AF

Sections – Up to 150-200KAIC

- Width remains at 26” up to 1600AF
- Width increases to 32” for 2000AF breaker
- Width increases to 36” for 3200 - 5000AF
- Width increases to 40” for 6000AF
Low Voltage Construction – Additional Sections

Controls Only Section

I Line Panelboard Section

6 High 1200AF P Frame
Low Voltage Construction – Depths and Conduit Areas

- Up to 6000A Main Bus
- 72" Depth
- UL 891 or UL 1558 Design

- Up to 8000A – 10000A Main Bus
- 84" Depth
- UL 891 or UL 1558 Design
Low Voltage Construction – Front Connected Switchgear

- Designed/listed to UL 891
- Bus Bracing - 100k Max
- Main Bus Max - 4000A
- Up to 3000A Drawout UL489 NW/MTZ Breakers
- 48” Depth, Top or Bottom Cable entry
- Section Types - 1 – 4 high NW/MTZ, Tie & I Line Panelboard
Low Voltage Construction – Insulated Bus

- Insulated Bus is not required by any UL or ANSI low voltage standard
- Some customers have moved to insulated bus for perceived safety reasons – Government, US Embassies, Water Treatment
- Insulated bus applications utilize Square D PZ4 type Switchgear
- UL1558 listed
- Bus Bracing – up to 200k
- Main Bus Max - 5000A
- Includes separate control sections
Low Voltage Construction – Bus and Bracing

■ All bus designed at minimum 1000A/Square inch current density. UL rating based on current density not thermal rating – NYC requires some different current density (700A/Square Inch) – Requires more copper.

■ There’s lots of industry bus bracing levels – 50K, 65K, 85K, 100K, 150K, 200K.

■ ASCO provides two bus bracing designs – 100K and 200K.

■ Switchgear obtains label based on rating of lowest rated device.

■ That means the switchgear can have bus bracing of 200K but be labeled 100K if the breakers are rated 100K. Occurs more than you may think based on spec requirements. *Ex: 100K rated Generator Breakers with 200K Distribution Breakers*
Low Voltage Construction – Bus Risers

- Up to 2 Risers per section
- Cubicle dimensions (width and/or depth) can change based on bus duct flange
- Bus Duct Flange drawings required to make accurate drawings and complete design
- SqD, Siemens, GE, CH all have different flanges with different dimensions
- ASCO doesn’t supply the flange or associated mounting hardware
- Flanges can be shipped to manufacturing facility for fitting on riser.
Low Voltage Construction – Bus Risers

*Need to know the flange type and specific drawing for proper design*

*Most flanges look like this*
Low Voltage Construction – Bus Risers

- But some look like this
- The Square D Qwik Flange
- Mounts differently than a flanged end
- Requires custom engineering design
- Can physically mount internal to switchgear

Busway Systems
800 A – 5000 A Catalog Numbering System/Physical Data

Qwik Flange (Indoor Only)
Barriers provided between sections if specified – required by code in some areas – Ex: NYC

Sectional Barriers are steel and glastic

Not a UL1558 requirement

Steel Side Barriers at control and cable compartments

Glastic Side Barriers around bus compartment
Low Voltage Construction – Rear Barriers

- Barriers provided to isolate main bus from cable compartment
- Rear Barriers are glastic
- Rear Barriers are vented for heat rise purposes

Glastic Rear Barriers to prevent contact with main bus
Low Voltage Construction – Lifting Means

- How do we pick this thing up?
- Are their lifting eyes?
- Is sling rigging required?
- ASCO gear at one time had to be sling rigged per NEMA PB-2 Guidelines
Low Voltage Construction – Lifting Means

Bolted on Lifting Plates

Bolted on Lifting Plates
Low Voltage Construction

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- **Seismic Considerations**
- UL 891 & UL 1558
Low Voltage Construction - Seismic Requirements

- All ASCO 4000 & 7000 Series Low Voltage Switchgear has been shake table tested to IBC and OSHPD requirements
- All ASCO 4000 & 7000 Series Low Voltage Switchgear is in compliance with IBC 2018 when using Square D, 3 Pole circuit breakers
- All other breaker manufacturers are in compliance with IBC 2009
- All ASCO 4000/7000 Power Control Systems are constructed to these requirements
- Not all Systems are shipped with Seismic labels, it has to be specified or requested. New ASCO Guide Spec includes Seismic Label on all switchgear
- All ASCO Switchgear is Seismic Certified to OSHPD (California) requirements
ASCO SEISMIC Compliance - IBC

Certificate of Compliance available at www.ibcapproval.com

ASCO Power Technologies, LP
International Building Code

Product Type: ASCO Low Voltage Switchgear and Controls

Model Number: 300, 4000, 7000
Equipment Rating: up to 600V

Seismic Performance Characteristics: Sps (g) = 2.46 z/h = 1.0 Ip = 1.5

Reference Certificate of Compliance: VMA-45810-01C
To Verify System Compliance
www.IBCApproval.com

Seismic Certificate of Compliance

Scan this barcode to view the certificate of compliance.

Seismic Equipment Label

View Cert. of Comp. VMA-45810-01C
P/N 560119-001
SEISMIC Code Requirements (OSHPD)

- **What is OSHPD?**
  - Office of Statewide Health Planning and Development
  - OSHPD is one of 13 departments within the California Health and Human Services Agency
  - The Facilities Development division is responsible for approval of special seismic certification for hospitals and skilled nursing facilities

- **Applicable Codes:**
  - CBC - California Building Code
  - IBC - International Building Code
  - ICC – ES AC156 (Seismic Qualification by Shake Table Testing)
Low Voltage Construction

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- UL 891 & UL 1558
UL 891 and UL 1558

UL 891

Switchboards

UL 1558

Metal-Enclosed Low-Voltage
Power Circuit Breaker
Switchgear
Power Control Systems Standards – UL891

- Developed from NEMA Standards – Dead Front Switchboard Construction in accordance with NEC
- Molded Case, Panelboards, Insulated case breakers as defined in UL 489 allowed
- Fusible Switches allowed
- ANSI Rated Breakers as defined by ANSI 37.16, ANSI 37.13 and UL1066
- 3 cycle short circuit rating/test
- No barriers or compartmentalization required
- Typical AIC ratings 42KAIC, 50KAIC, 65KAIC, 100KAIC & 150KAIC. Can go up to 200KAIC
- Defines an interrupting current rating for the breaker
Power Control Systems Standards – UL 1558

- Based on ANSI Standard C37.20.1 for Metal Enclosed Low Voltage Circuit Breaker switchgear
- Drawout Power circuit breakers as defined in UL 1066 and ANSI are the only type allowed
- 4 cycle short circuit rating/test
- 30 or optional 60 cycle short time test
- Panelboards, UL489 listed circuit breakers and fusible switches can NOT be used in UL 1558 switchgear
- Complete breaker compartmentalization required
- Typical AIC ratings (65KAIC, 85KAIC, 100KAIC & 200KAIC)
- Defines an interrupting current rating and short time rating (30 cycle rating) for circuit breakers
- ASCO UL1558 listing is for up to 200KAIC for 4 cycles and 85KAIC for 60 cycles
Low Voltage Standards FAQ’s

FAQ: When I buy UL 1558 labeled switchgear I get full depth barriers between sections right?

Answer – No, UL 1558 does not require full depth barriers between sections, it requires compartmentalization.

FAQ: What’s the difference between UL891 design and 1558 design?

Answer – UL 891 is switchboard construction (Fixed group mounting) & UL 1558 is Switchgear Construction (Individually compartmentalized draw-out type breakers).

FAQ: Aren’t UL 891 designs less expensive than UL 1558?

Answer – Not necessarily, it depends on several variables including breaker type and AIC rating.

FAQ: UL 1558 requires insulated bus right?

Answer – UL 1558 does not require insulated bus