“The New Generation of Medium Voltage Switchgear”
Joe Richard is the US Launch Manager for Schneider Electric’s Premset Switchgear. Joe graduated from the Georgia Institute of Technology with a BS degree in Electrical Engineering in 2007, and has been with Schneider Electric since 2008. He has worked in a variety of roles including Sales, Marketing, and Business Development. Joe’s main focus has been Medium Voltage Distribution Switchgear and its applications. His professional interests include Power Distribution, Energy Efficiency, Power Protection and Automation, Energy Storage, and Renewable Energy.
1. Describe what is Shielded Solid Insulation
2. List the differences between current and new switchgear designs
3. List the benefits of the new generation of medium voltage switchgear and how it addresses current market needs
4. Describe how to design with new switchgear technology, and application considerations
History of MV Switchgear

- **AIS Modular Switchgear**
  - Masonry cells
  - Withdrawable oil
  - Withdrawable SF6 or Vacuum

- **Circuit Breaker**
  - Oil Fixed
  - Oil Draw-out
  - SF6 Draw-out
  - Vacuum Draw-out

Timeline:
- 1930: Oil Fixed
- 1950: Oil Draw-out
- 1970: SF6 Draw-out
- 1990: Vacuum Draw-out
- 2010: Solid Insulated Switchgear
- 2020: Solid Insulated Switchgear
Design Innovations

- Insulation Systems
- Circuit Breaker
- Grounding Switch
- Maintenance Requirements
- Small Footprint/Front Accessibility
- Asset Monitoring

Application Issues

- Reliability
- Safety
- Maintenance
- Total Cost of Ownership
Insulation System

Insulation Deteriorates Over Time
- Humidity
- Dust
- Chemicals
- Temperature

Corona
- Ozone and audible sounds
- Equipotential lines and sharps

Improvements from Component Design
- Shaping and grounded shielding
- Computer analysis plus lab verification
- Analytical processes to manage reliability
Epoxy Insulation
Standard Application

IEEE Std C37.20.3-2013

Insulating materials used for the isolation or support of the primary conductors shall be tested for flame resistance and tracking resistance in accordance with the requirements of IEEE Std C37.20.3.

6.2.7.1 Flame-resistance tests

Sheet, molded, or cast primary insulating materials used in switchgear assemblies shall have a minimum average ignition time of 60 s and a maximum average burning time of 500 s when tested in accordance with method II in ASTM D229-96.

UL Listing

UL 94, the Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances testing Insulating
Epoxy Insulation

Temperature and Lifespan Testing

Lifespan Testing Based on Continuous Temperature Testing

4. Service conditions

30+ Year Lifespan with Minimal Tracking or Degradation

a) The temperature of the switchgear is within the limits of

Insulating EPDM

½ conductive EPDM

½ conductive EPDM

30+ Year Lifespan with Minimal Tracking or Degradation
Epoxy Insulation

Solid insulation covered by a conductive layer

Conductive layer

Insulating layer

Main conductor

Central screw

Flat interface cross-section
Shielded Solid Insulation Switchgear

2SIS vs SIS

- **2SIS**:
  - Shield
  - No field in ambient air
  - Circuit breaker/Load Break Switch

- **SIS**:
  - No shield
  - Field in ambient air
  - Circuit breaker/Load Break Switch
Epoxy Insulation

Busbar Connections

Busbar with Solid Insulation

Busbar Connection to Circuit Breaker

Elbow Cable Connections
Solid Insulated Switchgear

Entire Live Current Path is Fully Epoxy Resin Insulated
- No Exposed Live Parts
- Protected from Environmental Exposure

Compact Medium Voltage Switchgear
- Reduced Footprint
- Modular Design
Shielded Solid Insulation Switchgear

- All surfaces at ground potential
- No dielectric ageing
- Long product life expectancy
- Reduced internal arc risk
- Accidentally touchable
- Insensitive to harsh environment
Circuit Breakers

Mounting

Metal Clad Switchgear
C37.20.2

Metal Enclosed Switchgear
C37.20.3

Withdrawable
Easy to maintain both circuit breaker and withdrawing mechanism

Removable
Circuit breaker removal without withdrawing mechanism

Fixed
Circuit breaker lifetime maintenance free
Circuit Breaker

Environmental Robustness

Moisture and Humidity

Dust and Chemicals

Insects and Vermin

Factory Sealed Enclosures
Enclosed Core Unit

Vacuum Circuit Breaker

Isolation Switch

Grounding Switch

Sealed at Factory

Completely Epoxy Insulated
Grounding Switches

Maintenance Safety

Manual Grounding

Integral Grounding

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Grounding Switch Applications

Maintenance Safety

• Internal Grounding Switch
Hardware Design

- Ideally, 10 years hands off
- Vibration Resistant Hardware
- Interlocking Cubicles
- Pre-formed Bussing
- No Withdrawable Mechanism
  - Bus Fingers
  - Mechanism

Vibration-resistant Hardware

Installation Verification

Spiralock

Conical Bolt Design
Maintenance Intervals

Maintenance Cost Comparison

Years Installed

Yearly Maintenance Cost

Cumulative Maintenance Cost

Yearly  3 Years  10 Years
Small Form Factor

Base Form Factor

Reduced Footprint

Innovation

Modularity

Arc Resistance

Breaker Size

Sensors

Protection & Automation

Cable Testing

Cable Sizes and Access

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Small Footprint and Front Accessibility

Total Footprint: 211 sq. ft.

Metal Clad Switchgear

Working Space 5 ft.
7.6 ft.
3 ft.

Total Footprint: 82 sq. ft.

18 in. Air Clearance
36 in.
14.75 in.
29.5 in.
14.75 in.
Working Space 5 ft.
8.6 ft.
9.5 ft.
Small Footprint Design

Installation

Lighter Weight Sections

Traditional ~2500 lbs/section VS Innovation ~600 lbs/section

Easier Cable Entry

Easy Front Access Cabling
Asset Monitoring

Advancement

Infrared Scanning

Corona Detection

Temperature History

Thermal Monitoring

Partial Discharge Monitoring

Environmental Monitoring
Asset Monitoring
Watchdog/Alarm Systems

Future Goal: Autonomous

• “All’s well”
Environmental Impact – Core Materials

<table>
<thead>
<tr>
<th>Product weight</th>
<th>SIS</th>
<th>AIS</th>
<th>Metalclad</th>
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<tr>
<td>Steel</td>
<td>73.0</td>
<td>154.0</td>
<td>732.4</td>
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<tr>
<td>Copper</td>
<td>9.0</td>
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<td>Epoxy Resin</td>
<td>34.0</td>
<td>52.0</td>
<td>60.1</td>
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<tr>
<td>Autres</td>
<td>22.3</td>
<td>65.0</td>
<td>24.7</td>
</tr>
</tbody>
</table>
Environmental Impact – CO2 Contribution

Global Warming (g ~CO2)
M+D+U, 20 years, 30%In

- SIS
- AIS
- Metalclad
Design Considers

1. Footprint – Layout – Front/Rear Accessibility
   I. Top or Bottom Cable Entry – Cabling Space

2. Protection and Controls
   I. LV Mounting Space
   II. Sensor vs. Standard Instrument Transformers
   III. Combined Relaying and Metering
   IV. Remote Operation and Controls

3. Safety
   I. Maintenance Procedures and Requirements
   II. Safety Interlocking
   III. Reducing Arc Flash Risk

4. Electrical Requirements
   I. Voltage, Current, and Interrupting Ratings

5. Environment Application
   I. Heat and Humidity
   II. Chemical Contaminants
   III. Rodents, Vermin, and Insects

6. Equipment Coupling

7. Reliability

8. Cost
   I. Cap Ex
   II. Op Ex
Questions?