“The New Generation of Medium Voltage Switchgear”

Your Presenter

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Learning Objectives

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

Vacuum Draw-out

SF6 Draw-out

Solid Insulated Switchgear

1930 1950 1970 1990 2010 2020

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

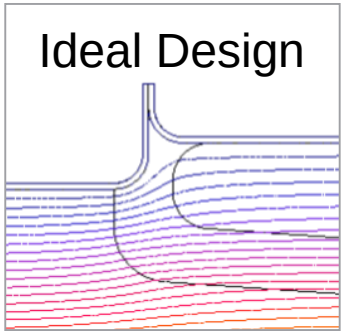
- Humidity
- Dust
- Chemicals
- Temperature

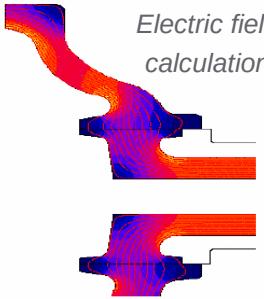
Corona

- Ozone and audible sounds
- Equipotential lines and sharps

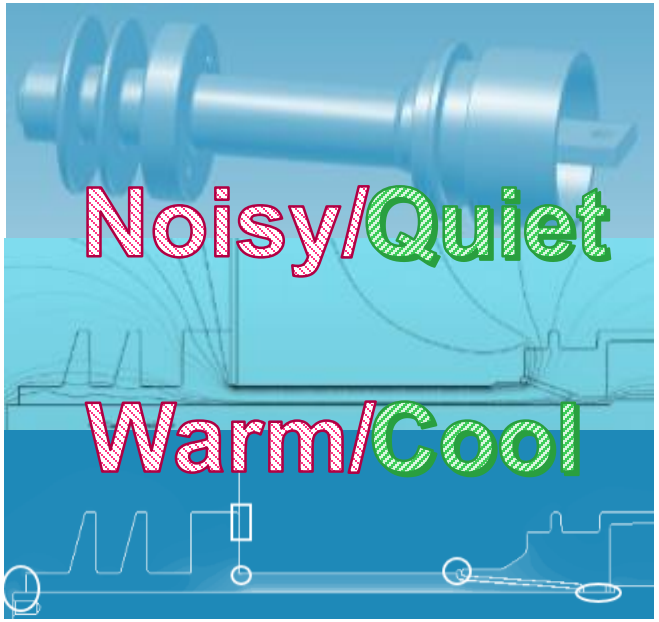
Improvements from Component Design

- Shaping and grounded shielding
- Computer analysis plus lab verification
- Analytical processes to manage reliability





Electric field calculation



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

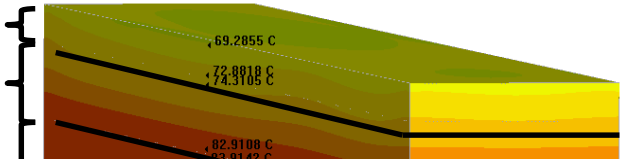
Lifespan Testing Based on Continuous Temperature Testing

4. Service conditions

Standards for the design and perform… s as
described in this clause… on-
struction and ratings as defined in this st…

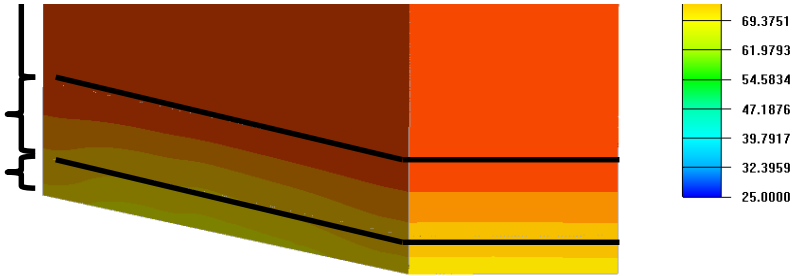
a) The tem…
switchgear is within the limits o…

½ conductive EPDM
Insulating EPDM



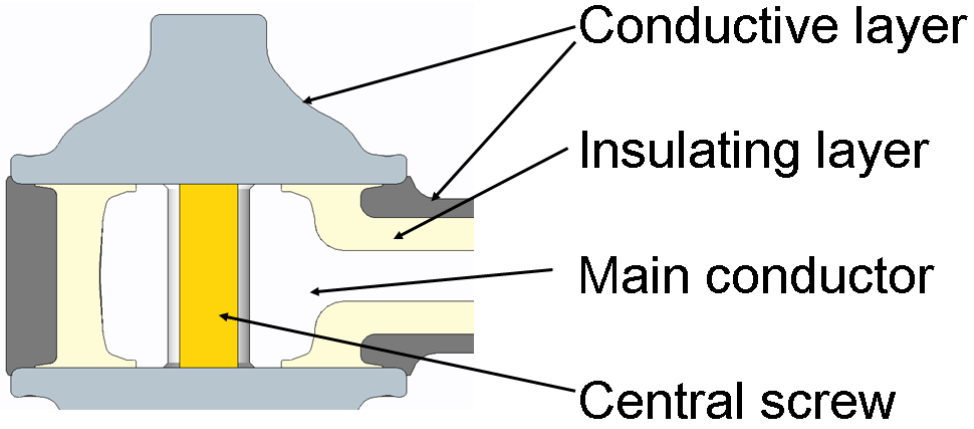
30+ Year Lifespan with Minimal Tracking or Degradation

Insulating EPDM
½ conductive EPDM



Epoxy Insulation

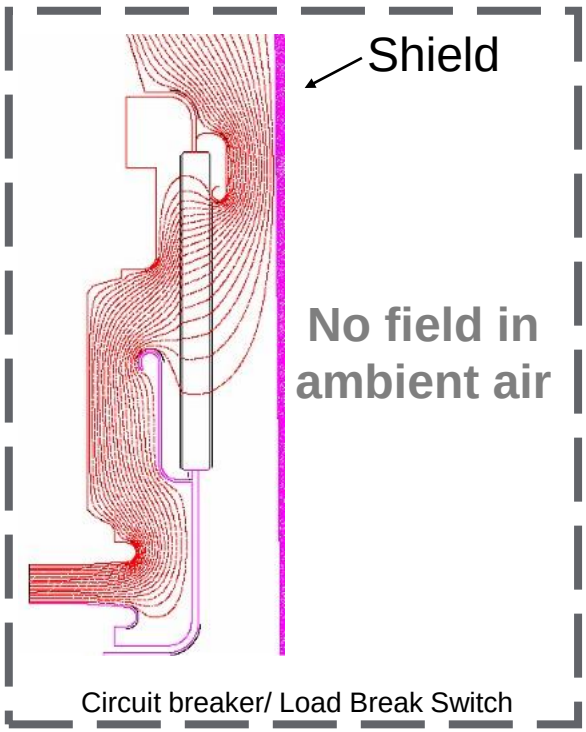
Solid insulation covered by a conductive layer

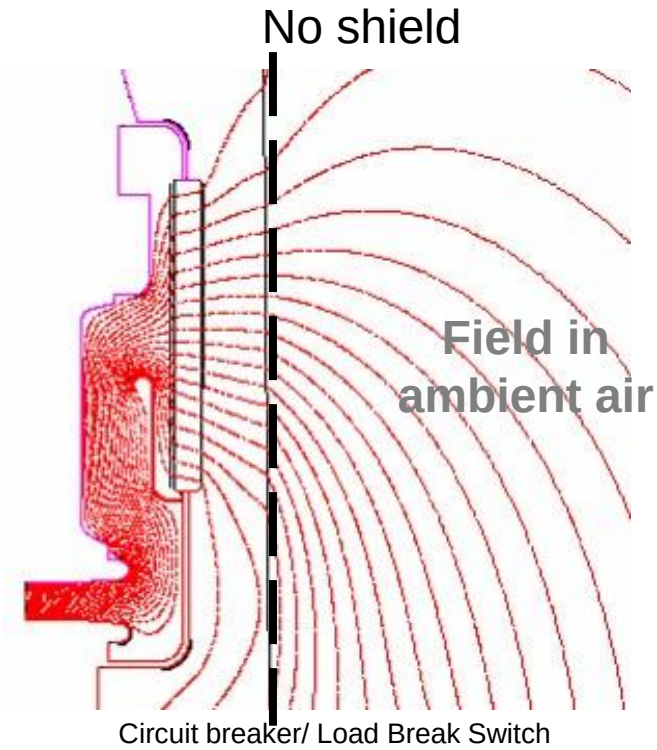


Flat interface cross-section

Shielded Solid Insulation Switchgear

2SIS vs SIS





Epoxy Insulation

Busbar Connections

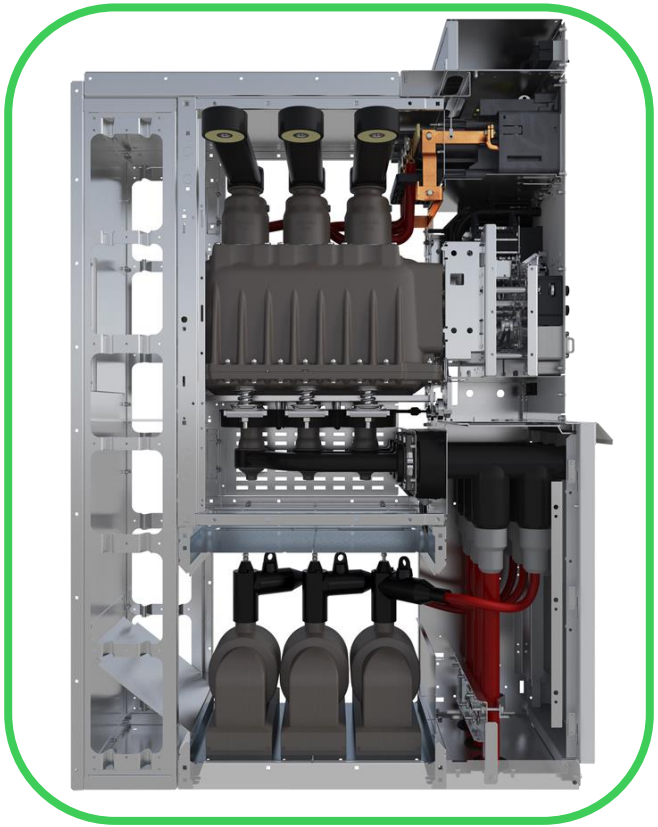
Busbars with Solid Insulation

Busbar Connection to Circuit Breaker

Elbow Cable Connections

Solid Insulated Switchgear

New Switchgear Technology



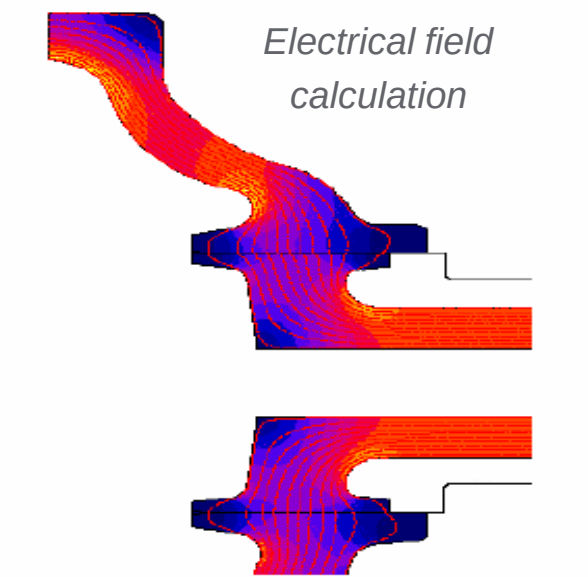
Entire Live Current Path is Fully Epoxy Resin Insulated

- 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

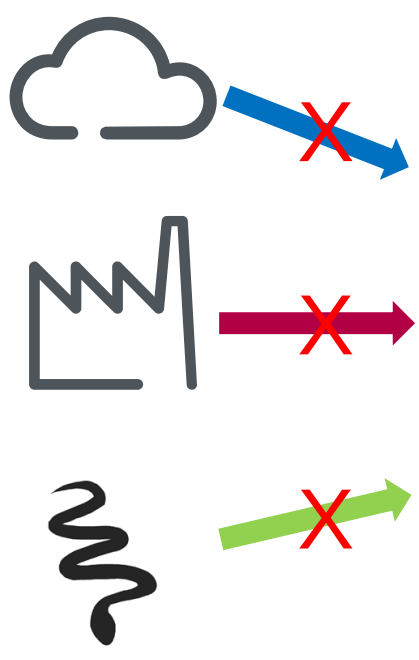
Circuit Breaker

Environmental Robustness

Moisture and Humidity

Dust and Chemicals

Insects and Vermin



Factory Sealed Enclosures

Enclosed Core Unit

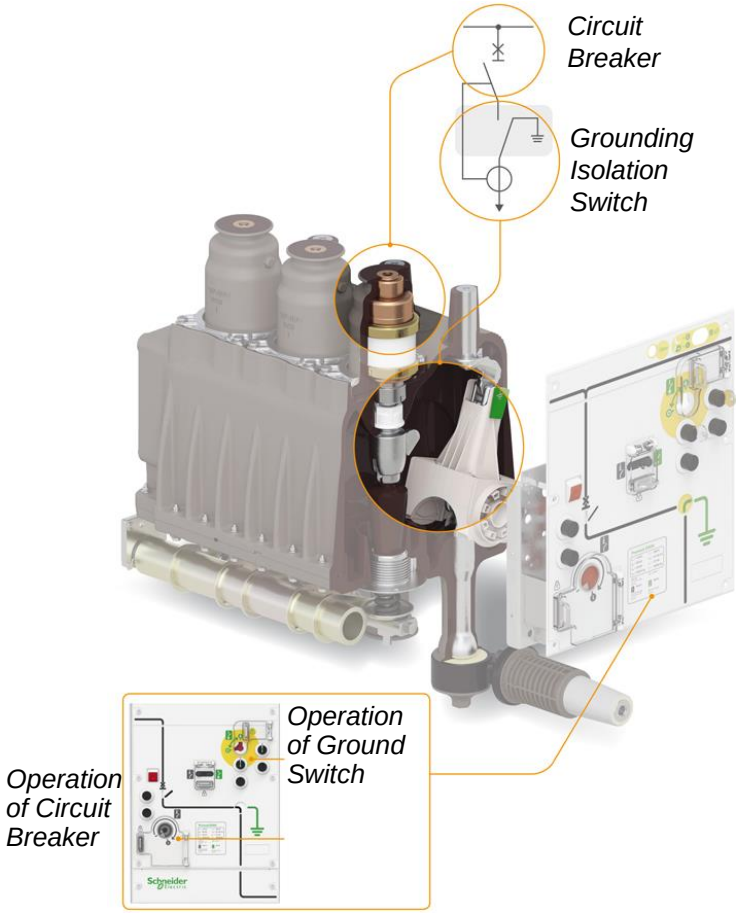
Vacuum Circuit Breaker

Isolation Switch

Grounding Switch

Sealed at Factory

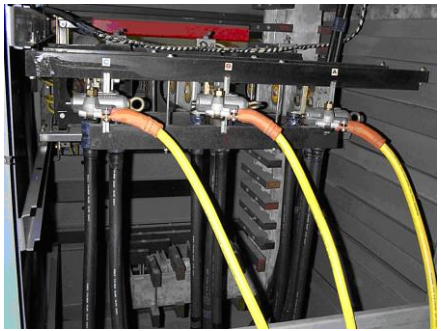
Completely Epoxy Insulated



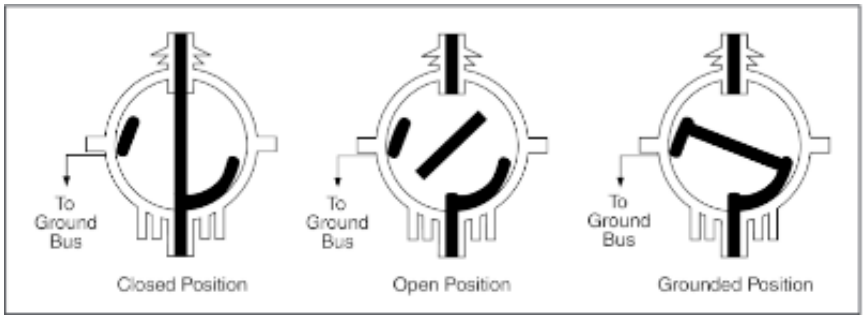
Grounding Switches

Maintenance Safety

Manual Grounding



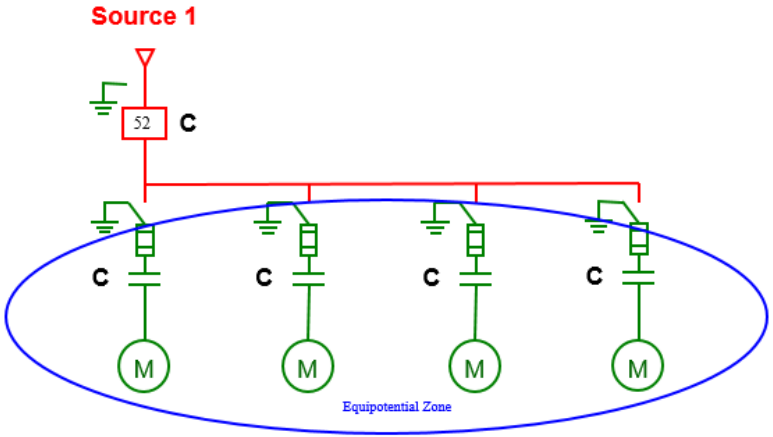
Integral Grounding

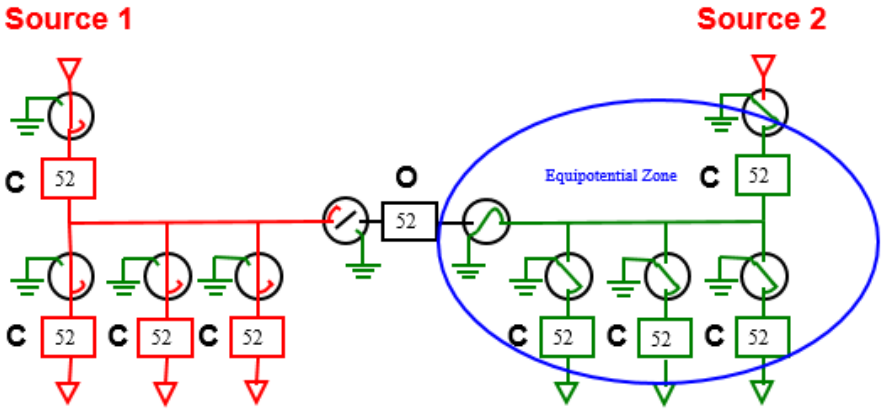


Grounding Switch Applications

Maintenance Safety

- Internal Grounding Switch



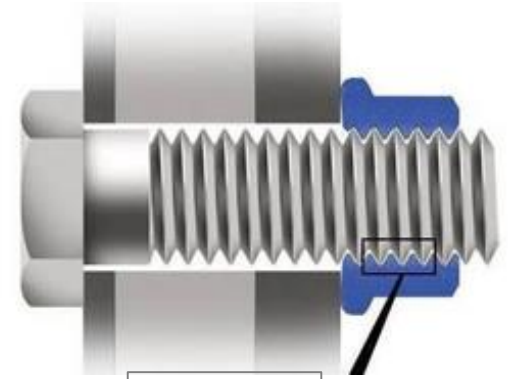


Hardware Design

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

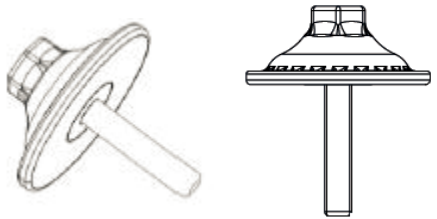
Vibration-resistant Hardware

Installation Verification



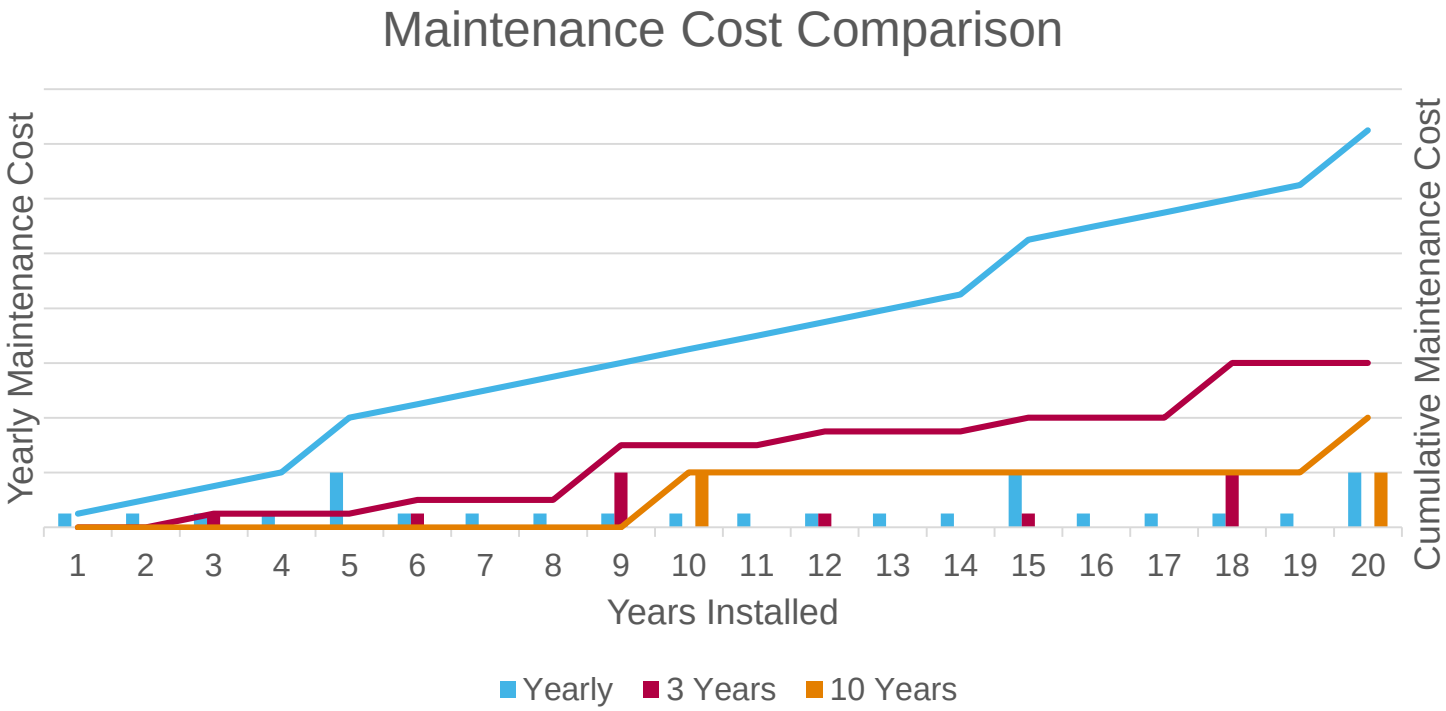
Spiralock

Conical Bolt Design



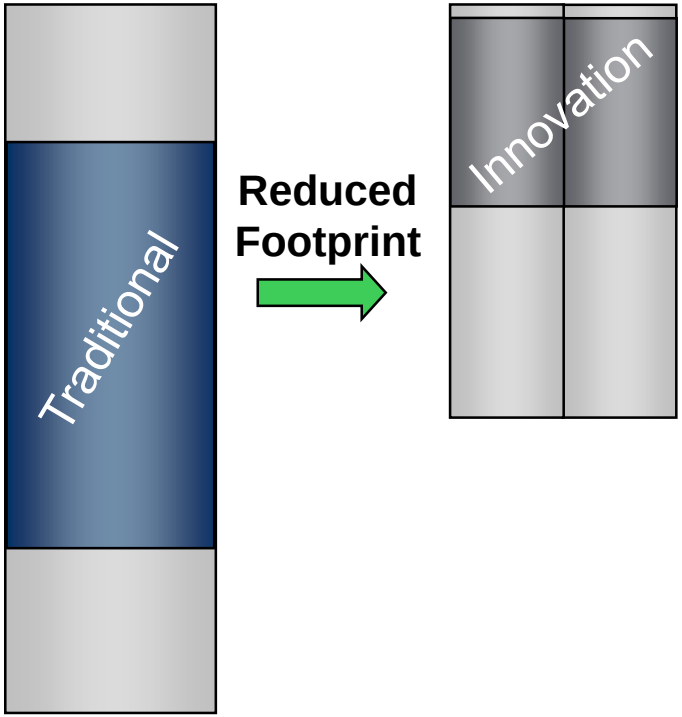
Maintenance Intervals

Maintenance

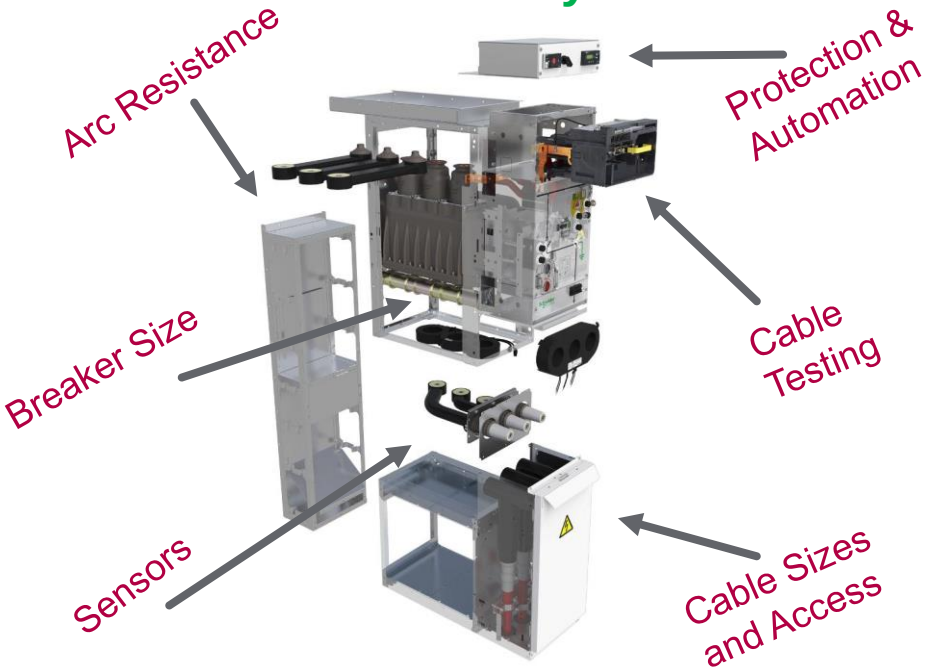


Small Form Factor

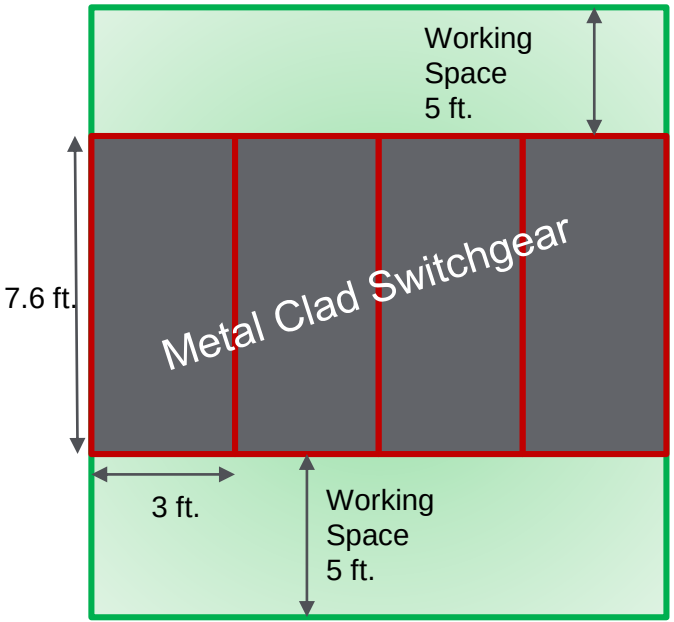
Base Form Factor



Modularity

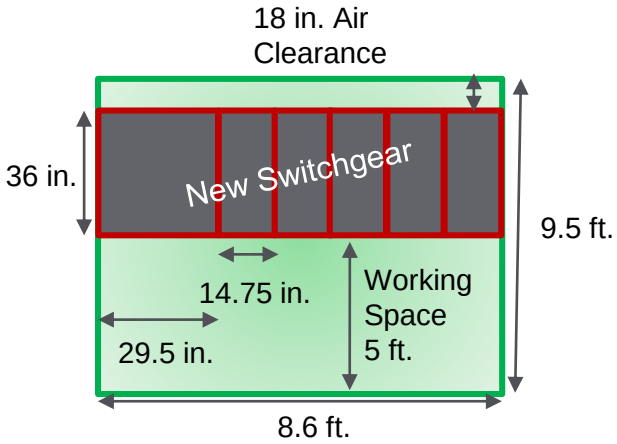


Small Footprint and Front Accessibility



Total Footprint:
211 sq. ft.

60% Footprint Savings!



Total Footprint:
82 sq. ft.

Small Footprint Design

Installation

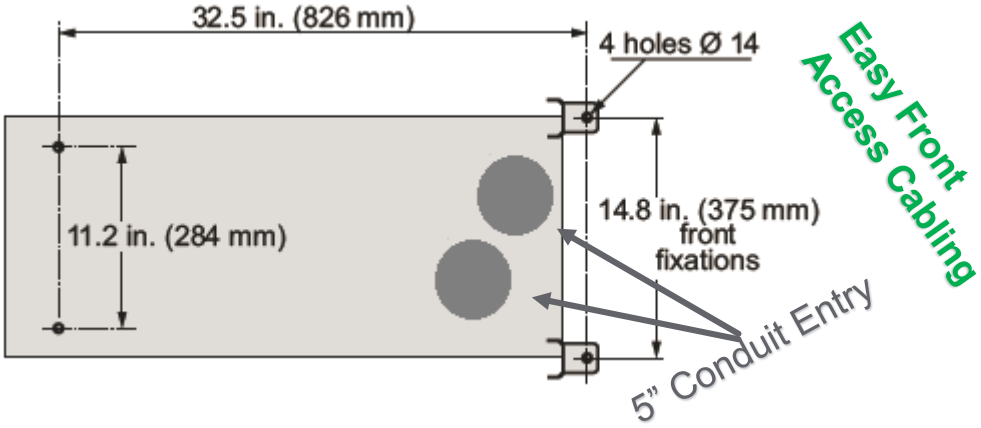
Lighter Weight Sections

VS

Traditional
~2500 lbs/section

Innovation
~600 lbs/section

Easier Cable Entry

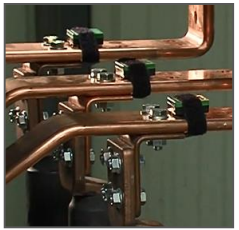


Asset Monitoring

Advancement

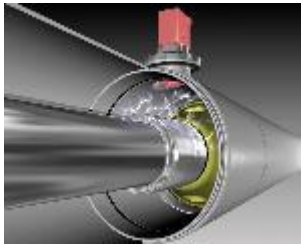
Infrared Scanning

Thermal Monitoring

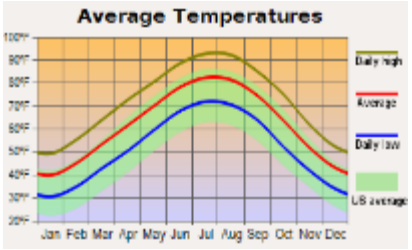


Corona Detection

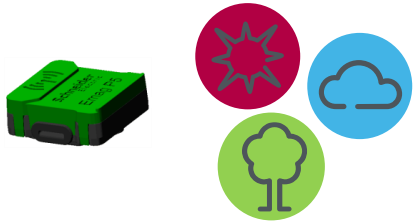
Partial Discharge Monitoring



Temperature History



Environmental Monitoring



Asset Monitoring

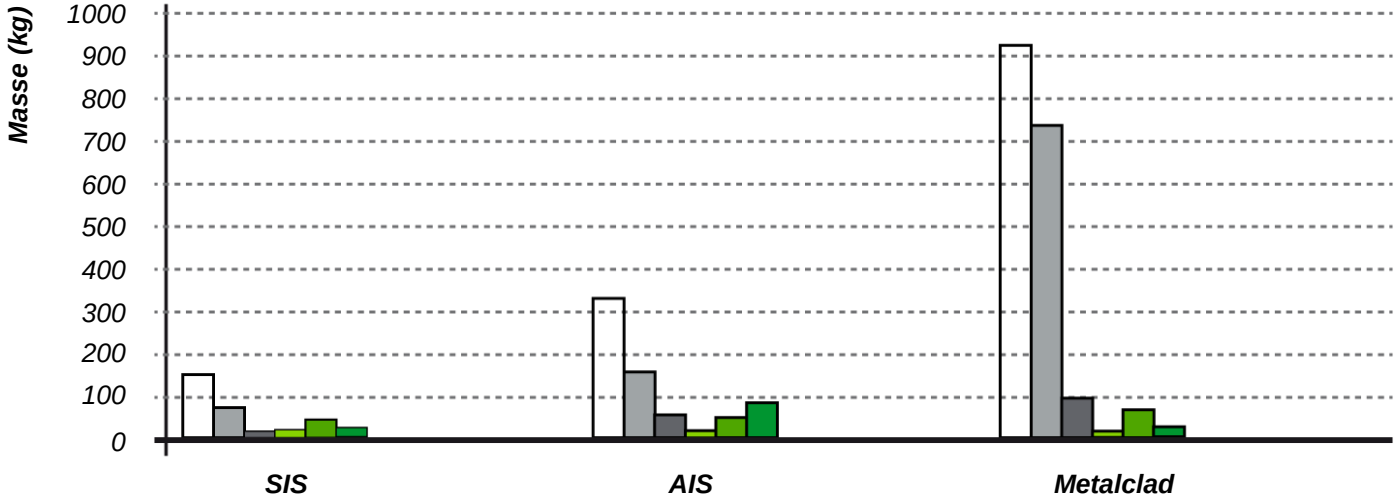
Watchdog/Alarm Systems

- *“All’s well”*

Watchdog Monitoring Systems

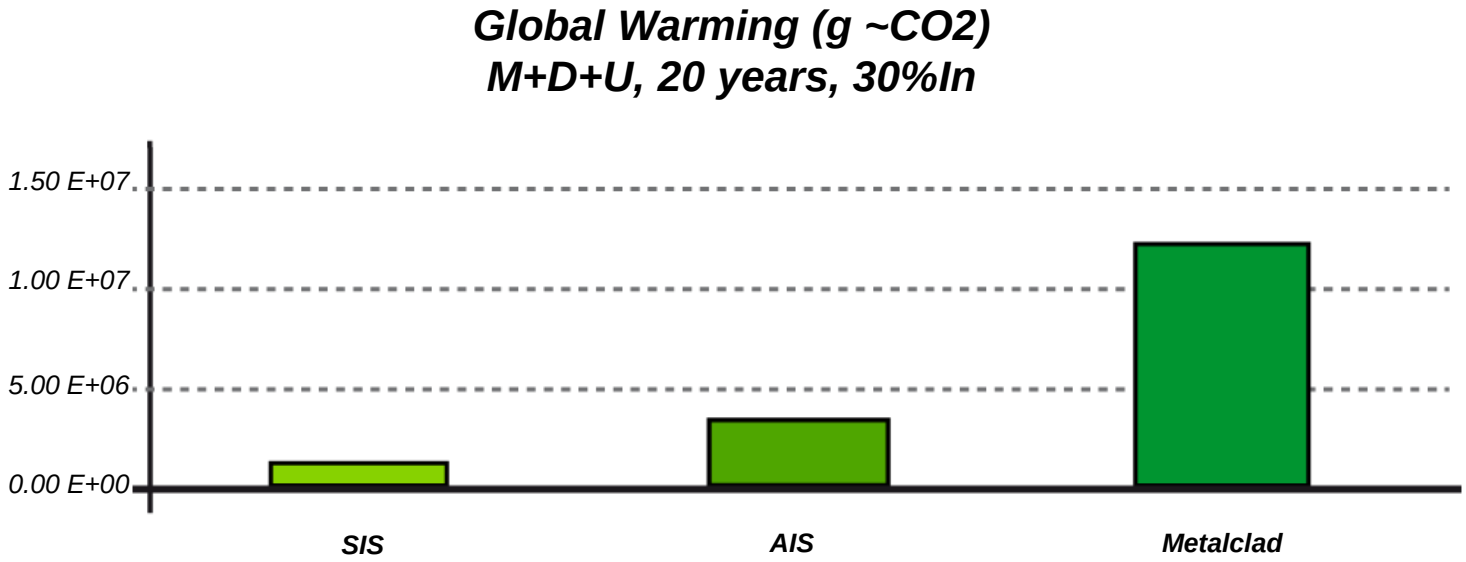
Future Goal: Autonomous

Environmental Impact – Core Materials



Product weight	***148.3***	***326.0***	***923.0***
Steel	***73.0***	***154.0***	***732.4***
Copper	***9.0***	***45.0***	***95.2***
Aluminium	***10.0***	***10.0***	***10.6***
Epoxy Resin	***34.0***	***52.0***	***60.1***
Autres	***22.3***	***65.0***	***24.7***

Environmental Impact – CO2 Contribution



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?