



Medium Voltage Trends

Presented by Marc Buchwald, Power Systems Architect

10/20/2023

So what is MV?

- Per ANSI standards C84.1-1989 divides voltages into five classifications. These classifications can be combined into the categories below: High (HV), Extra-High (EHV) & Ultra-High Voltages (UHV) - 115,000 to 1,100,000 VAC
- Medium Voltage (MV) - 2,400 to 69,000 VAC
- Low Voltage (LV) - 240 to 600 VAC
- It has to meet the following ANSI standards as well as be UL listed
- IEEE/ANSI C37.20.2 metal-clad switchgear standards
- IEEE/ANSI C37.20.7 metal-clad switchgear standards for Arc Resistant

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NEC Article 110 – Clearances and working distances

IEEE/ANSI C37.20.3 metal-enclosed switchgear standards

Historically MV was the province of the generating Utilities, but over time, as loads grew larger, more and more End Users took over the MV distribution. You can see in the following slides how the equipment has evolved over time, to become smaller, safer and more flexible.

Property of ASCO Power Technologies™

Some Definitions

- MV is defined by 2 ANSI specs – MetalClad and MetalEnclosed – Analogous to Switchgear and Switchboards in Low Voltage gear
- It have a continuous current rating as well as a SC current rating, previously expressed in MVA but now as Ka.
- There are 3 types of Dielectric Insulation used, Air Insulated (AIS), Gas Insulated (GIS) and Solid Insulated (2SIS)
- There are also 3 types of commonly used dielectric mediums for interruption, Air, Vacuum and SF6 gas.

History of MV Switchgear

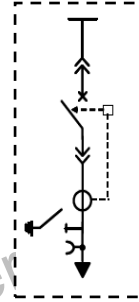
AIS
Modular
switchgear



Masonry cells



Withdrawable oil



Withdrawable SF6 or Vacuum



Vacuum Draw-out



Solid Insulated
Switchgear

Circuit
Breaker



Oil Fixed



Oil Draw-out



SF6 Draw-out



1930

1950

1970

1990

2010

2020

HVL/CC — Compact Metal Enclosed Load Interrupter

Ratings/Features

- Current carrying capacity up to 1200A at 15kV, 600A up to 38kV
- Short-time current rating of 25 kA up to 38 kV
- Dimensions as small as 14.75" w
- 20" w and 29.5" w options available
- Over-toggle and stored-energy operating mechanism options
- Quick ship options available
- Direct connections available for Schneider Electric transformers
- Designed for Front Access Only

Benefits

- Load break switch is sealed-for-life tank, significantly reducing maintenance requirements
- Smallest footprint in the industry
- Fully compartmentalized for user safety
- Fuselogic – missing/blown fuse indication (available option)



HVL — Metal Enclosed Load Interrupter

Ratings/Features

- Current carrying capacity up to 1,200 A at 15 kV, 600 A up to 38 kVA
- Switch interrupting capacity 1,200A up to 15kV, 600A up to 25 kV, 400A up to 38kV
- Short-time rating of 48 kA up to 15 KV and 25KA up to 38 kV
- Over toggle and stored-energy operating mechanism options
- Direct connections available for Schneider Electric transformers
- Fuselogic – missing/blown fuse indication (optional)
- Duplex switch options available
- Many options available including NEMA 3R, boric acid fuses, and motor operated

Benefits

- Air insulated load break switch
- Fuselogic protection system prevents closing of the switch if a fuse is blown or has not been installed
- Direct drive operating mechanism adds dependability and consistency
- During opening, the current is forced along an arc path where arc chutes extinguish the arc, preventing erosion of the main contacts
- All live parts are mounted on insulators attached to grounded sheet metal of the enclosure, minimizing the potential of phase-to-phase faults



MasterClad – Air Insulated Switchgear

Ratings/Features

- Meets IEEE/ANSI C37.20.2 Metal-Clad Switchgear
- 5kV and 15 kV arc-resistant switchgear
- 4000A 15kV 50kA (63kA for indoor applications)
- 3000A 15kV 63kA for N3R applications
- 2750A 27kV 40kA
- 1200 A -4000 A withdrawable vacuum circuit breakers
- Direct connections (throat) to Cast, Liquid or Dry transformers
- Indoor, Outdoor or sheltered aisle enclosures
- 15 kV Arc Resistant Type 2B per ANSI/IEEE C37.20.7
- 27 kV Arc Resistant Type 2B per ANSI/IEEE C37.20.7 using PIX-A

Benefits

- Long life and minimum maintenance
 - Interrupters are sealed for life
 - Capable of 20-100 full fault interruptions
- Grounded metal barriers between compartments and insulated bussing -live parts are not exposed.
- Interlocks with the breaker racking system



Altivar MV Variable Frequency Drives

Medium voltage variable speed drive in
4.16 kV up to 4,000 HP / 490 Amps &
6.6 kV up to 6,275 HP / 490 Amps



GIS offer for NA...most complete offer complied with ANSI standards ([UL listed](#))

DVCAS



- Up to 38kV, 600A , 25kA
- CB, Load-break switch, RMU
- Single busbar
- Factory gas-filled
- Arc resistant
- Self-powered protection relay



CBGS-0



- Up to 38kV, 2000A , 31.5kA
- CB, disconnect switch + fuse
- Single busbar
- Factory gas-filled
- Arc resistant
- SF6 breaker



GHA



- Up to 38kV, 2500A , 40kA
- CB
- Single or Double busbar
- Factory gas-filled
- Arc resistant
- Top entry, infrared windows, zero sequence CT



WS/WI

- Up to 52kV, 2500A , 31.5kA
- CB
- Single or double busbar
- On-site gas-filled
- Arc resistant
- Hydro One Blanket



SureSeT™ Switchgear

EvoPacT™ Vacuum Circuit Breaker



Metalclad Switchgear (AIS)

Voltage

Up to 15kV

Continuous Current

Up to 2000A

Interrupting Current

Up to 40kA

Basic Impulse Level

95kV BIL

Property of ASCO Power Technologies™

Property of ASCO Power Technologies™

Property of ASCO Power Technologies™

Property of ASCO Power Technologies™

**Smarter.
Smaller.
Stronger.**

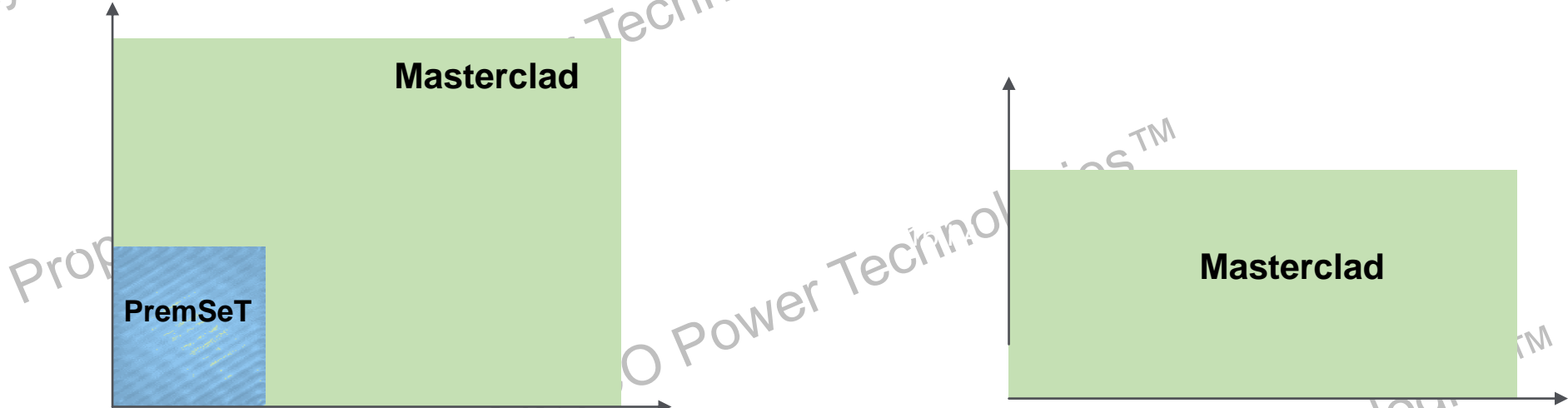
The future is SeT



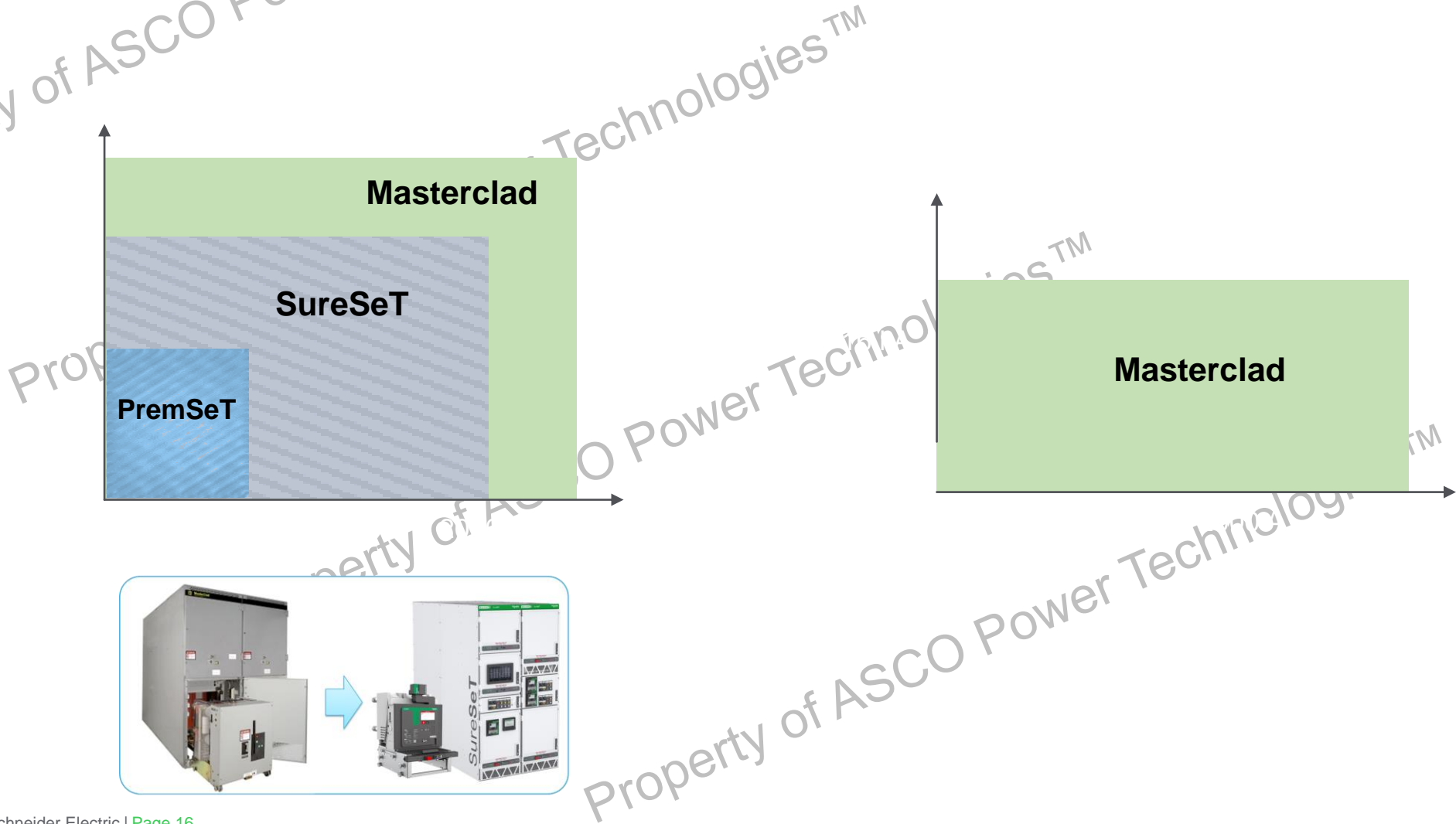
SureSetTM

Property of ASCO Power TechnologiesTM

MV Offer Portfolio



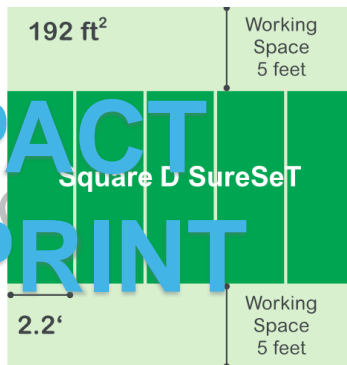
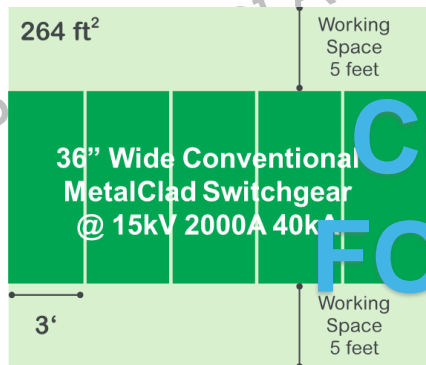
MV Offer Portfolio





SureSeT™
EvoPacT™

over 25% smaller footprint



COMPACT
FOOTPRINT



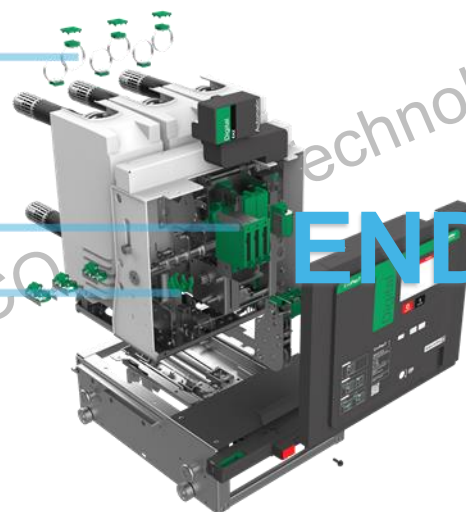
PARTNER
READY

INTEGRATED
ELECTRICAL
CONTROLS

Integrated remote
racking and operation

EQUIPMENT
HEALTH
MONITORING

integrated sensing for
continuous health monitoring



HIGH
ENDURANCE

Offer Structure – SureSeT & EvoPacT

FUTURE

COMPONENTS



STRUCTURES

SEMI-ASSEMBLED

COMPLETE
SWITCHGEAR



OVERVIEW

SureSeT™ Switchgear

EvoPacT™ Vacuum Circuit Breaker



Metalclad Switchgear (AIS)

Voltage

Up to 15kV

Continuous Current

Up to 2000A

Interrupting Current

Up to 40kA

Basic Impulse Level

95kV BIL

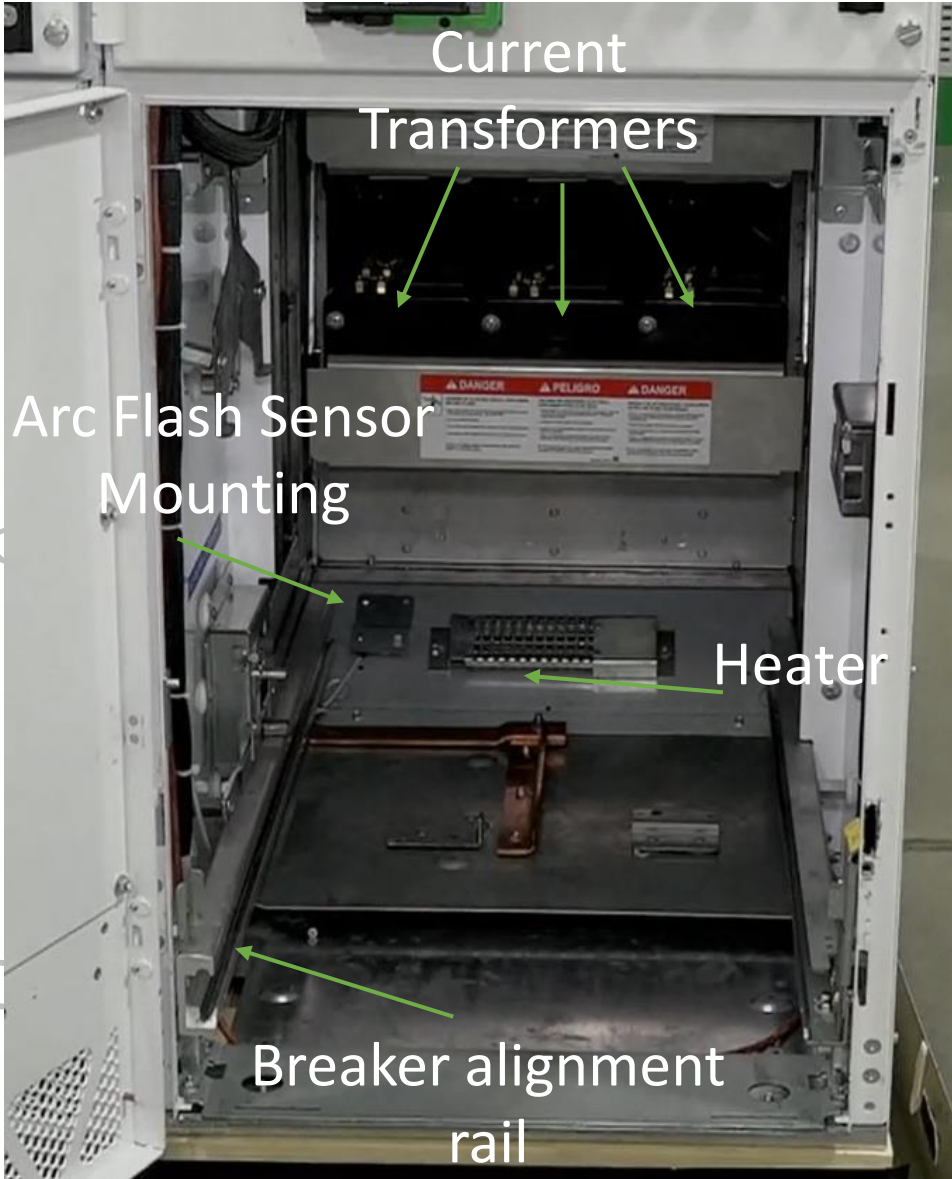
SureSeT Front & Rear



SureSeT Circuit Breaker Compartment



Manual Racking



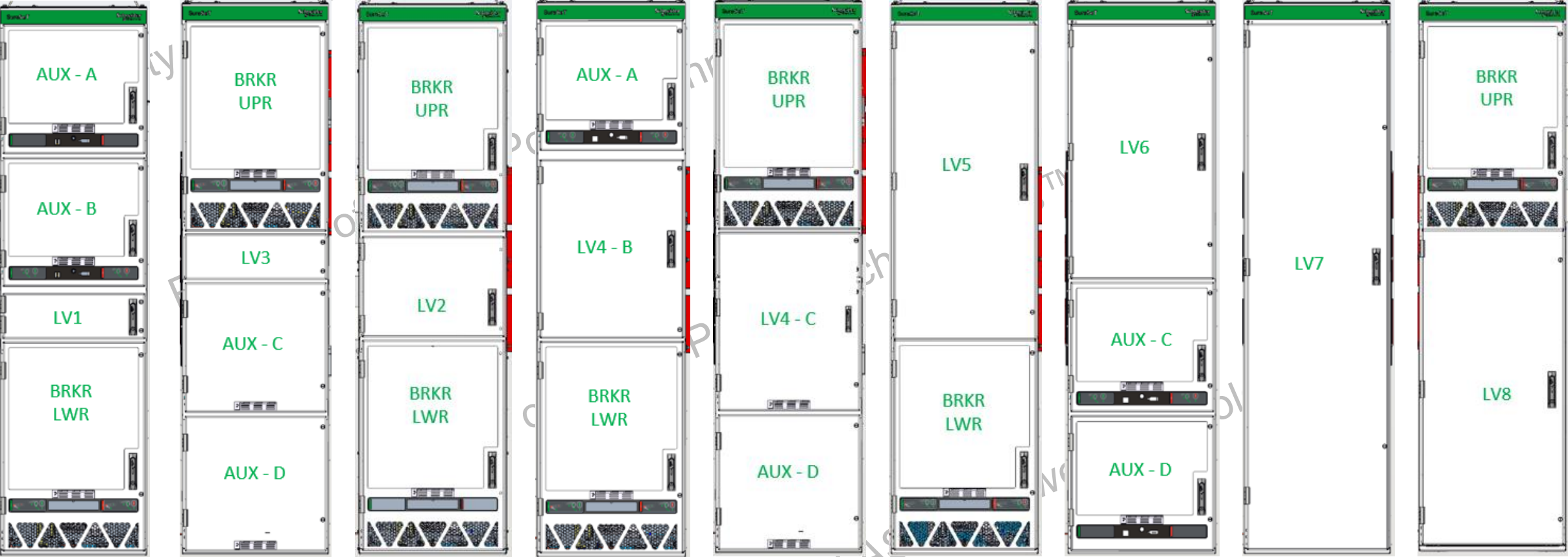
Current Transformers

Arc Flash Sensor Mounting

Heater

Breaker alignment rail

SureSeT Switchgear Section Overview



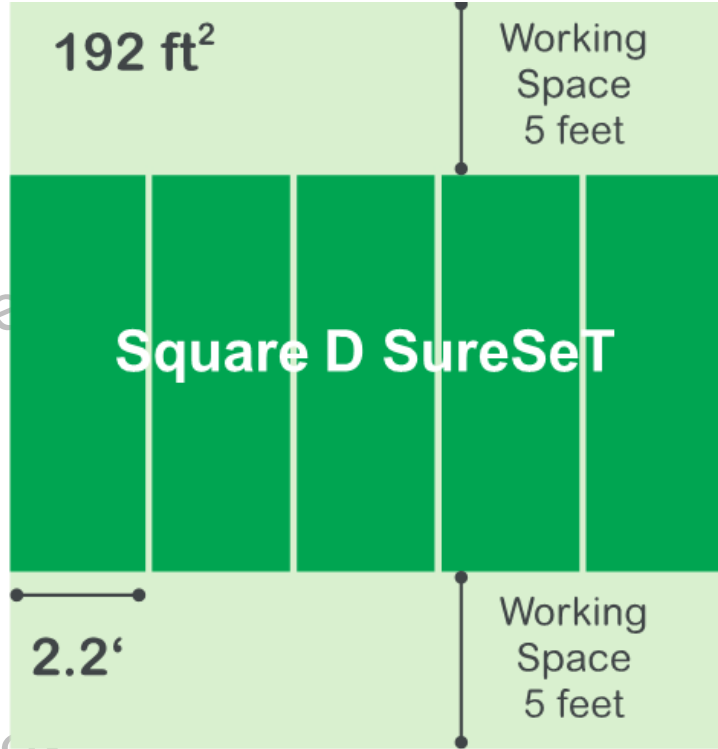
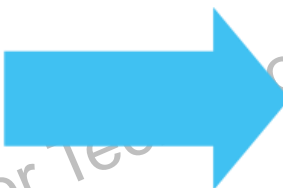
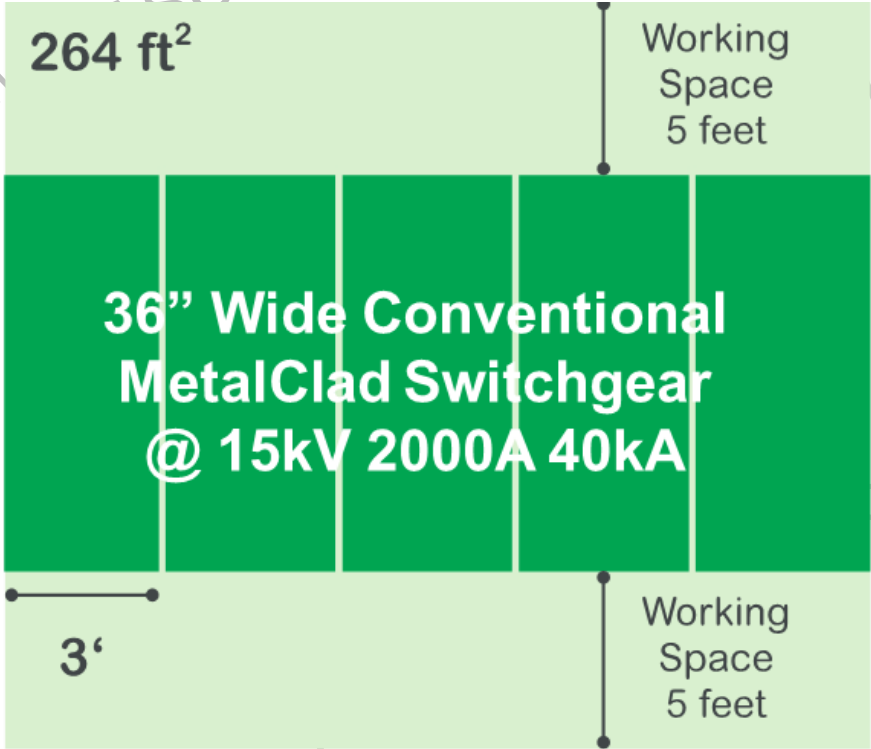
Why SureSeT?

Conventional Metalclad → SureSeT + EvoPacT



Compact design

Efficiency



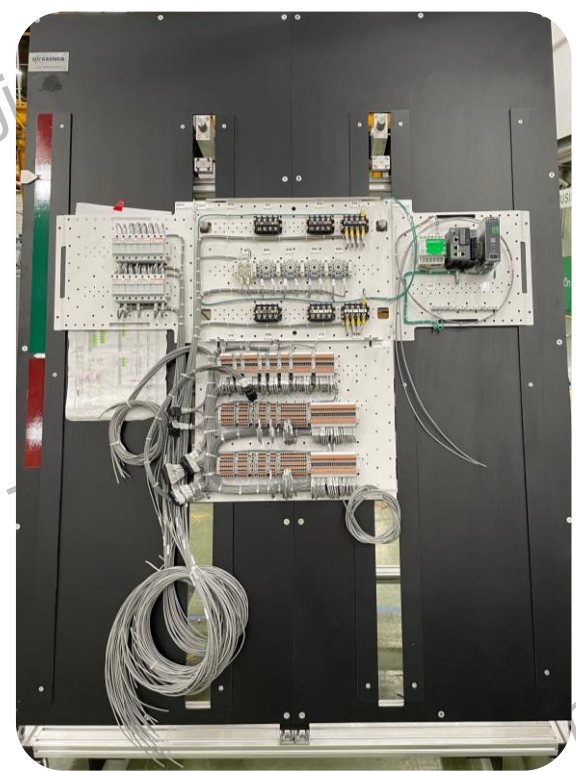
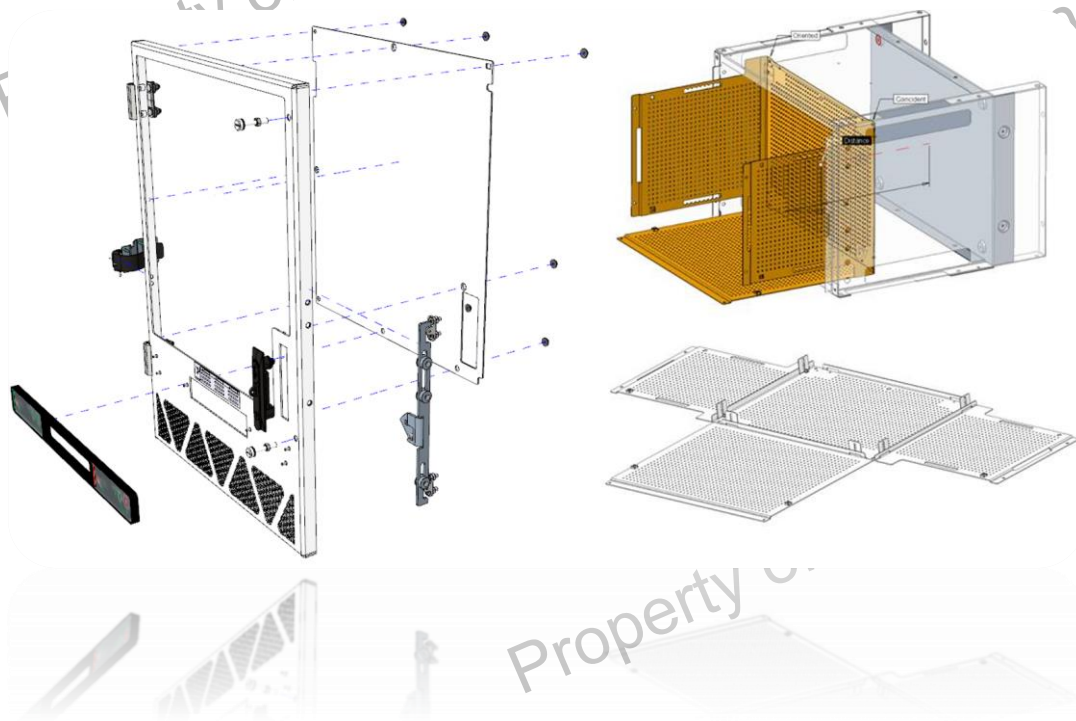
Compartmentalized Design

Safety



Partner Ready Design

Efficiency



Extensions rails for traditional VTs and CPTs

Safety, Efficiency



Insulated copper bus & shielded cable for VT/CPT connections

Safety, Resiliency



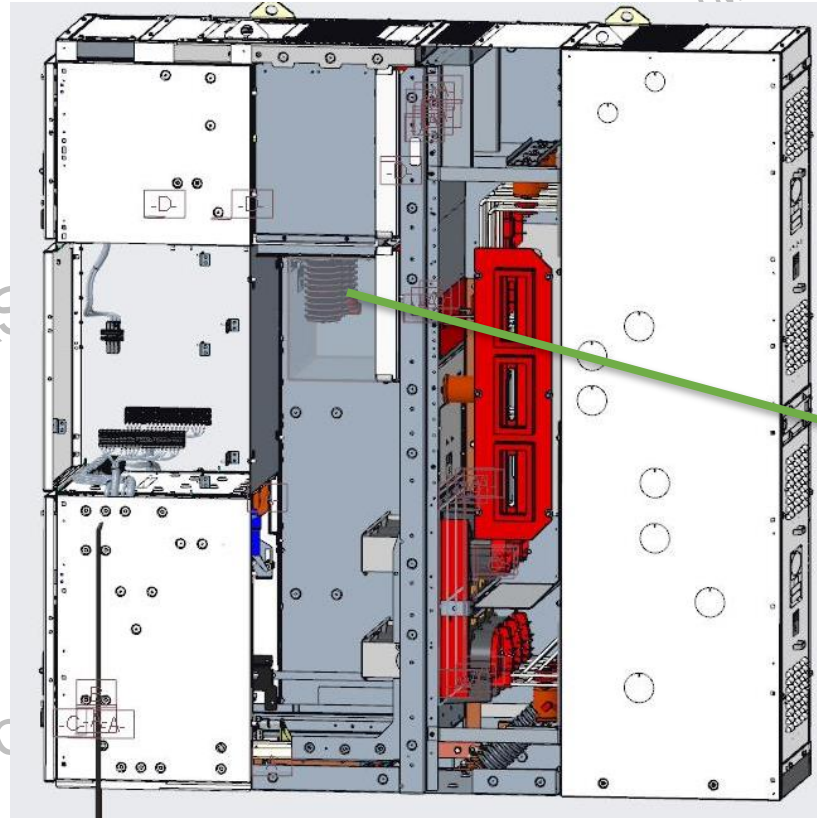
Continuous switchgear health monitoring

Safety, Efficiency, Resiliency



Resistive voltage divider type LPVTs [Optional]

Safety, Efficiency, Resiliency



High endurance

Resiliency

30,000 breaker operations

1,000 racking operations

No-load mechanical (8)	Rated continuous current switching (9)
Col 5	Col 6
10 000	1000
5000	500

Table 24— Schedule of operating endurance capabilities for circuit breakers ^a (1) (6) (7)

Line No.	Circuit breaker ratings			Number of operations (each operation is comprised of one closing plus one opening) (3) (4) (5)			
	Rated maximum voltage	Rated continuous current	Rated short-circuit current	Between servicing (6)	No-load mechanical (8) ^{b, c}	Rated continuous current switching (9)	Inrush current switching (10)
	kV, rms	A, rms	kA, rms				
	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
Class S1 circuit breakers							
1	4.76, 15	1200, 2000	20, 25, 31.5	2000	10 000	1000	750
2	4.76, 8.25, 15	1200, 2000, 3000, 4000	40, 50	1000	5000	500	400
3	15	1200, 2000, 3000, 4000	63	500	2000	500	400
4	27	1200, 2000, 3000	16, 25	500	2500	200	100
5	38	1200, 2000, 3000, 4000	16, 25, 31.5, 40	250	2000	100	100
Class S2 circuit breakers (11)							
6	15.5 and above	All	All	500	2000	100	100
Circuit breakers 100 kV and above (11)							
7	All	All	All	500	2000	100	100

^a Numbers in parenthesis refer to the items in 6.8.1 and Table 24.

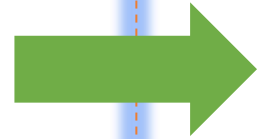
^b Circuit breaker class M1, normal mechanical endurance according to the values given in Col. 5 are the minimum required no-load mechanical endurance with servicing at intervals no more frequently than given in Col. 4.

^c Circuit breaker class M2, special service requirements, is optional for any circuit breaker and consists of 10 000 operations (for all ratings) with limited maintenance. Class M2 meets the requirements for class M1.

- a) A test consisting of moving the removable element, by its intended means, a minimum of 500 test cycles between the test and the connected positions to demonstrate the proper sequential operation and establish satisfactory function of the elements listed in Table 7.

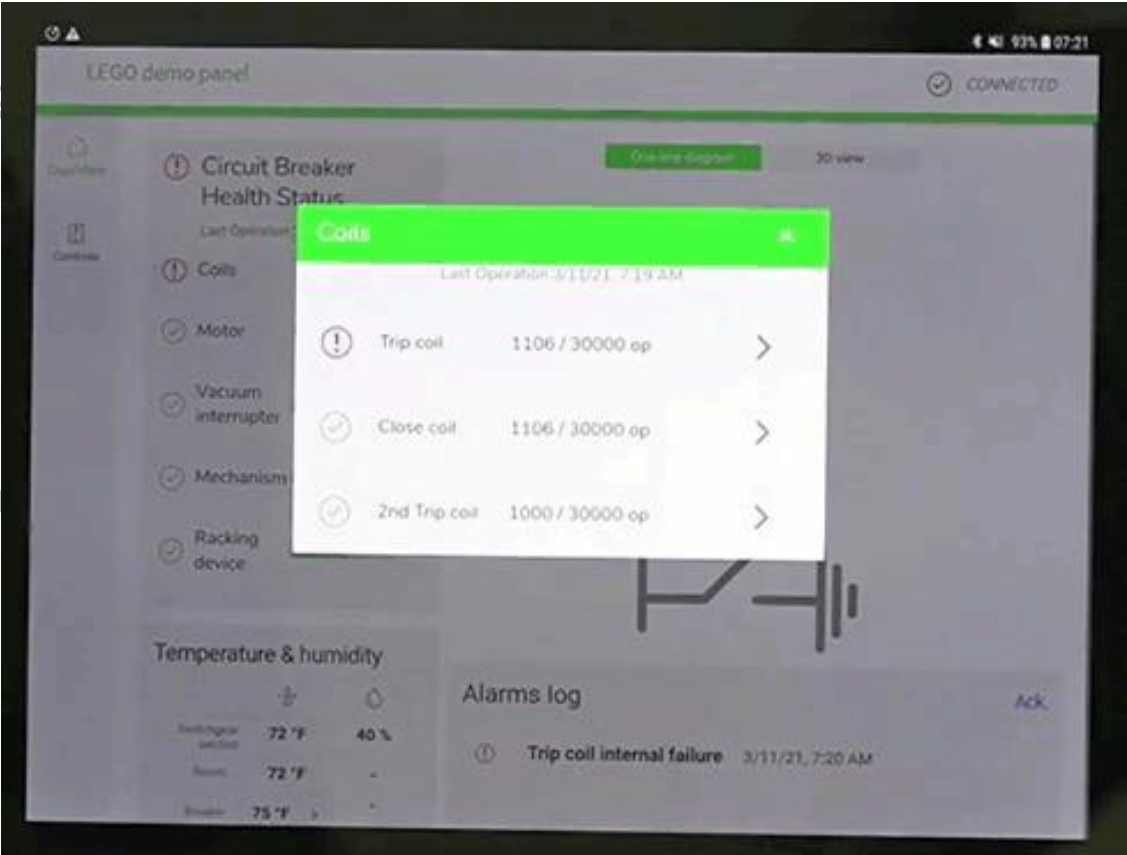
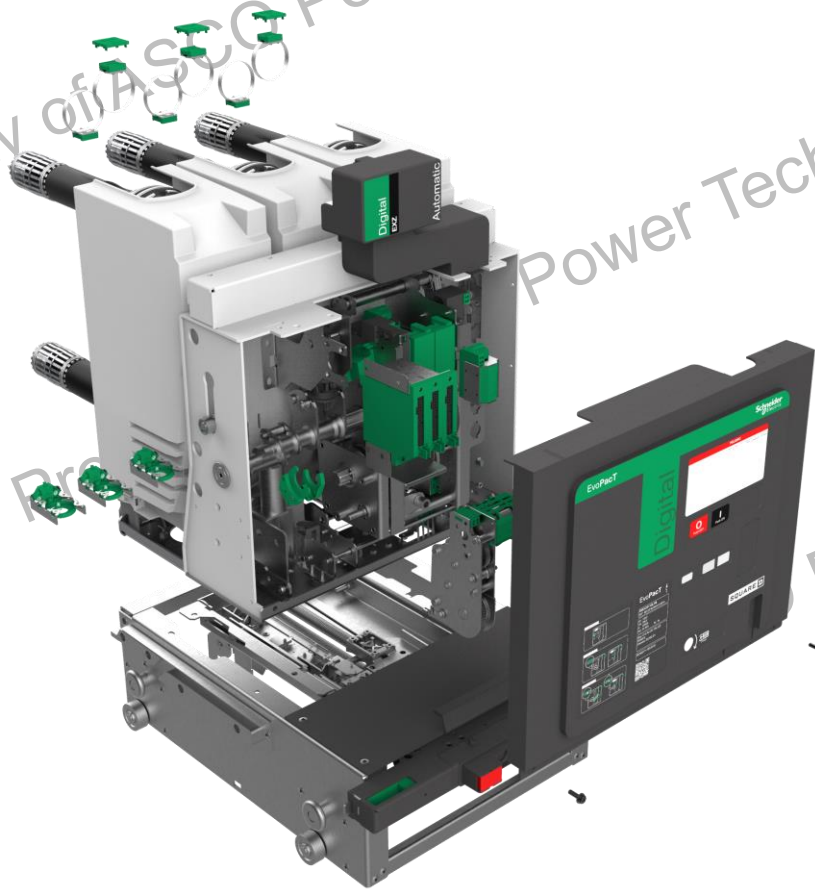
Remote control using wireless mobile device

Safety



Continuous circuit breaker health monitoring

Safety, Efficiency, Resiliency



Time delay in remote operation

Safety



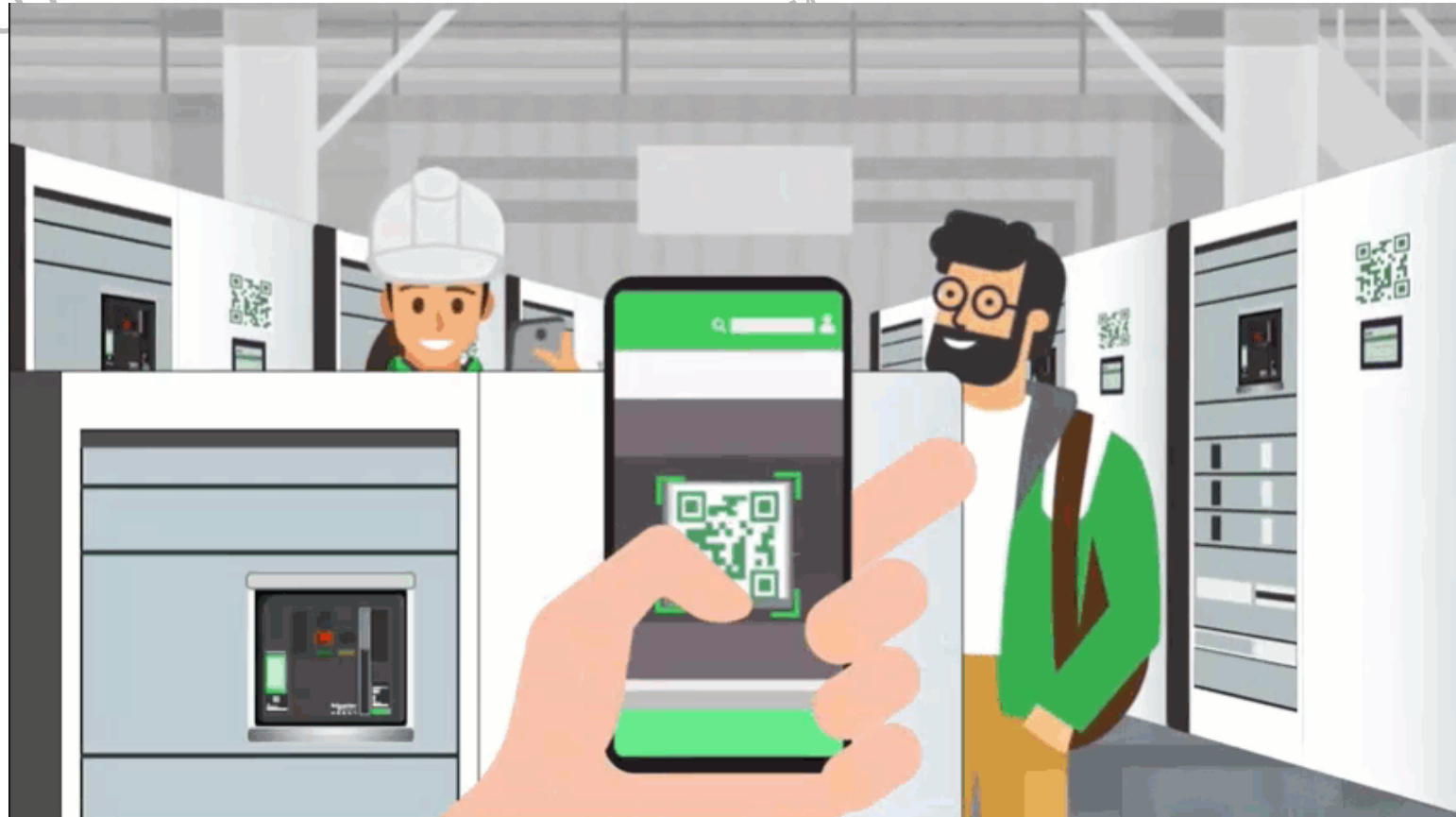
Closed door mechanical trip

Safety



Easy access to asset specific documents

Efficiency



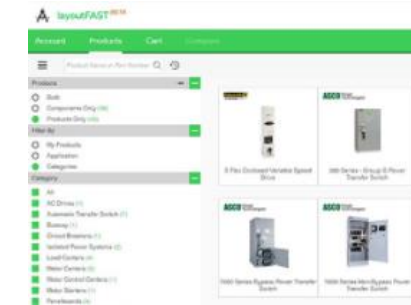
Resources



FLYER



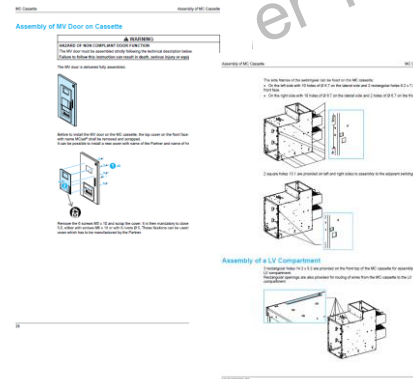
GUIDE SPEC



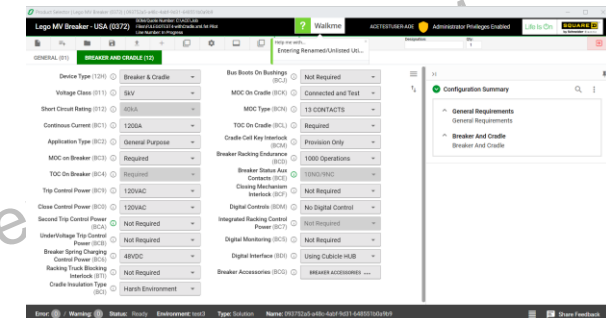
LAYOUTFAST



PRODUCT CATALOG
(available before sell)



USER GUIDE
(available before sell)



PRODUCT SELECTOR

Premset



Shielded Solid Insulated Switchgear (2SIS)

Voltage

Up to 15kV

Continuous Current

Up to 1200A

Interrupting Current

Up to 25kA

Basic Impulse Level

95kV BIL



Life Is On



Premset



Modern Issues

Premset

What is Solid Insulated Switchgear?

Design of Premset

Features and Benefits

Connectivity

Environmental Impact

Conclusion

Modern Issues



Workforce



**CapEx
OpEx**



**Equipment
Space**



Safety

Premset



Shielded Solid Insulated Switchgear (2SIS)

Voltage
Up to 15kV

Continuous Current
Up to 1200A

Interrupting Current
Up to 25kA

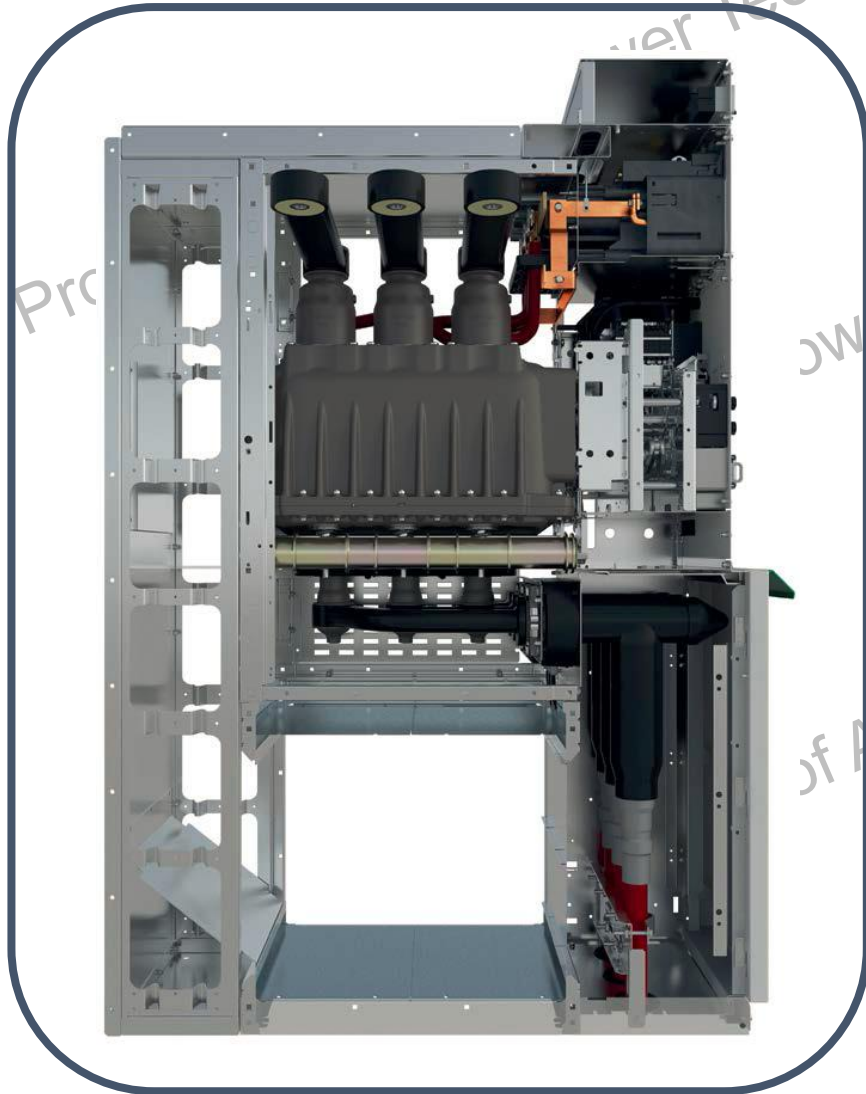
Basic Impulse Level
95kV BIL



Life Is On



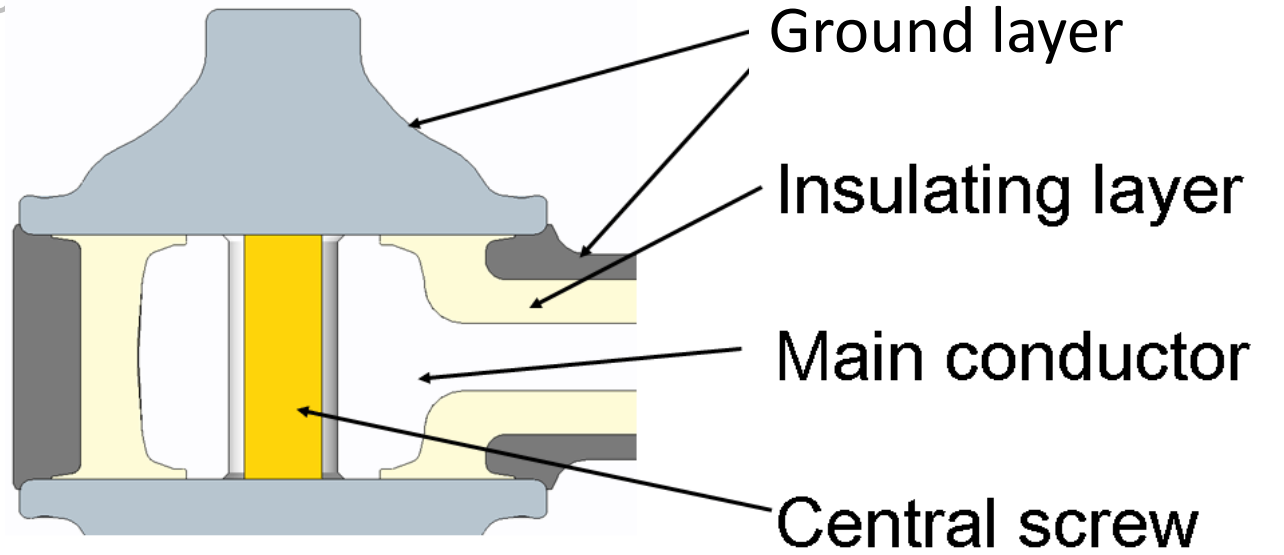
What is Shielded Solid Insulated Switchgear?



- 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

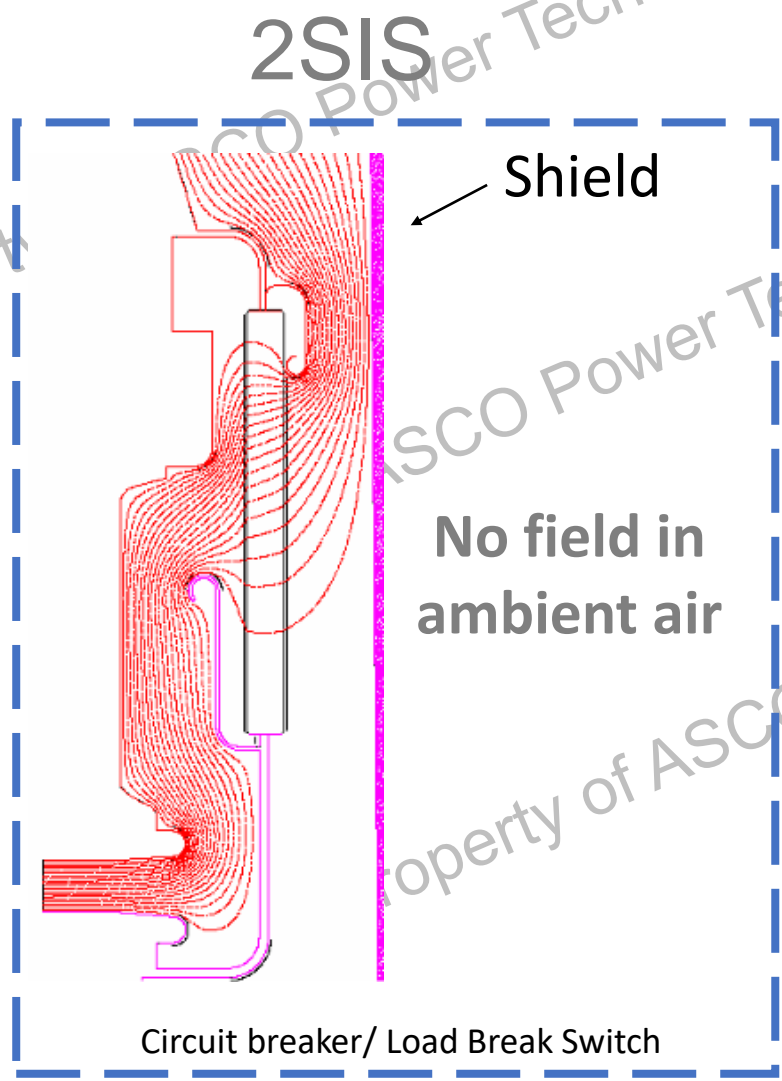
Epoxy Insulation

Solid insulation covered by a conductive layer

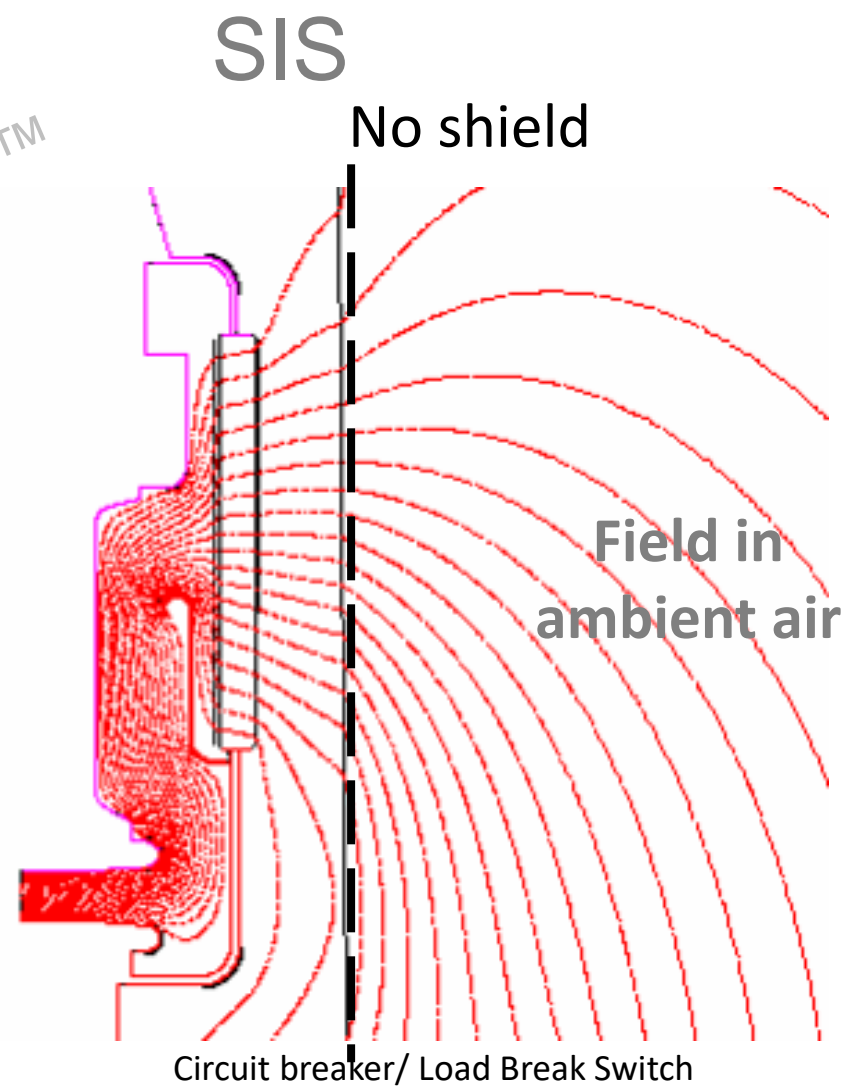


Flat interface cross-section

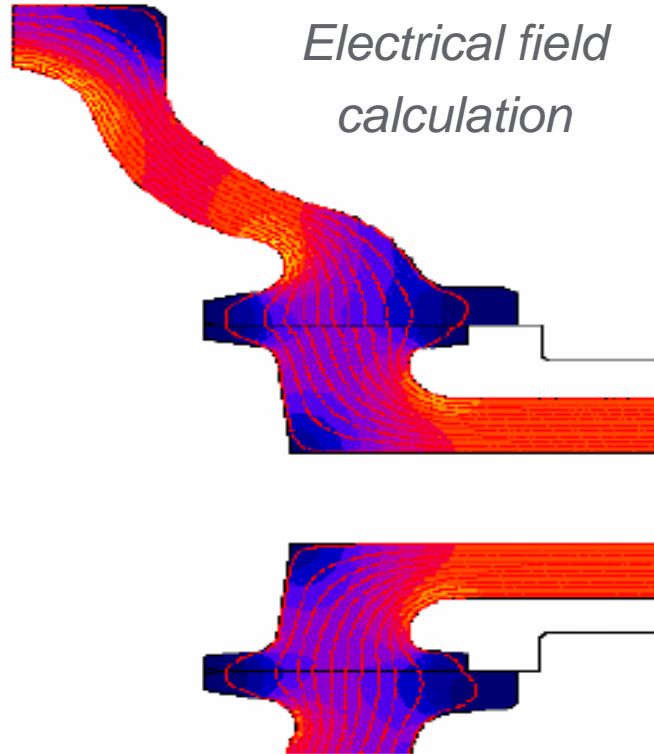
Shielded Solid Insulation Switchgear



VS



Shielded Solid Insulation Switchgear



All surfaces at ground potential

- Decreased dielectric ageing
- Long product life expectancy
- Minimized internal arc risk
- Accidentally touchable

Insensitive to harsh environment

Epoxy Insulation



Busbar Connections



Busbars with Solid Insulation



Busbar Connection to Circuit Breaker



Elbow Cable Connections

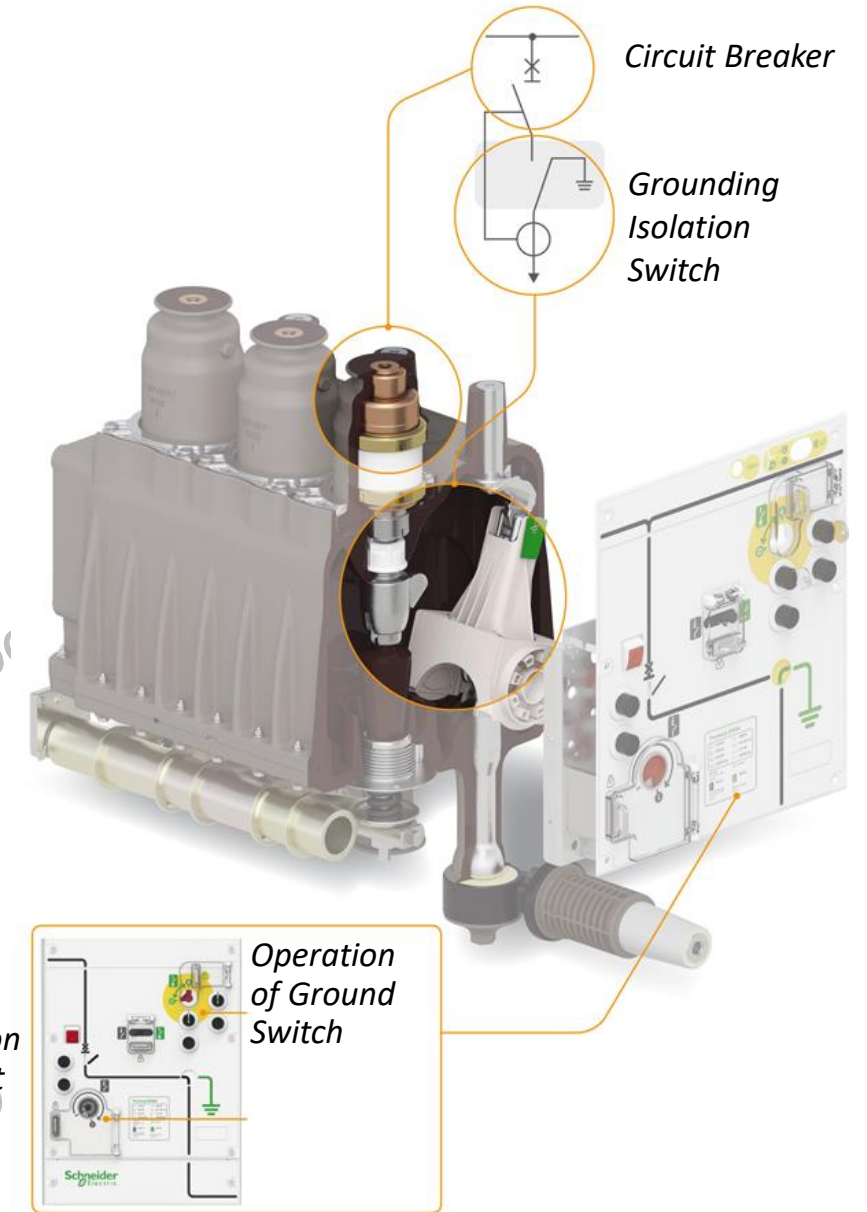
Core Unit

Vacuum Circuit Breaker

Grounding Isolation Switch

Sealed at Factory

Completely Epoxy Insulated



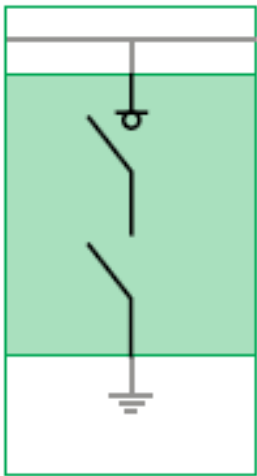
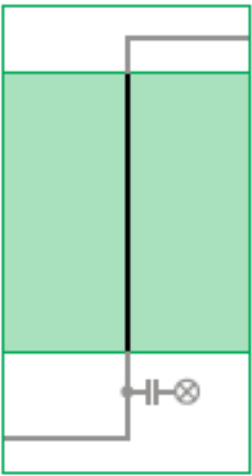
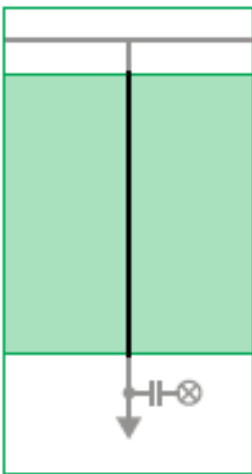
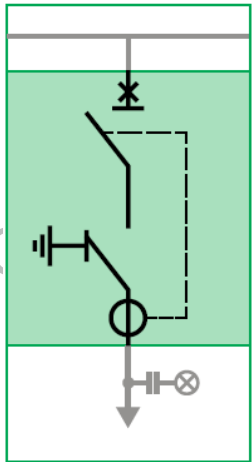
ologies™



- 1) Low Voltage Compartment
- 2) Cable Test Device
- 3) Operator Interface
- 4) Cable Compartment
- 5) Busing Compartment
- 6) Vacuum Circuit Breaker + Isolating Ground Switch
- 7) Bussing to Cable Compartment
- 8) Low Power Voltage Transformers

Modular Design

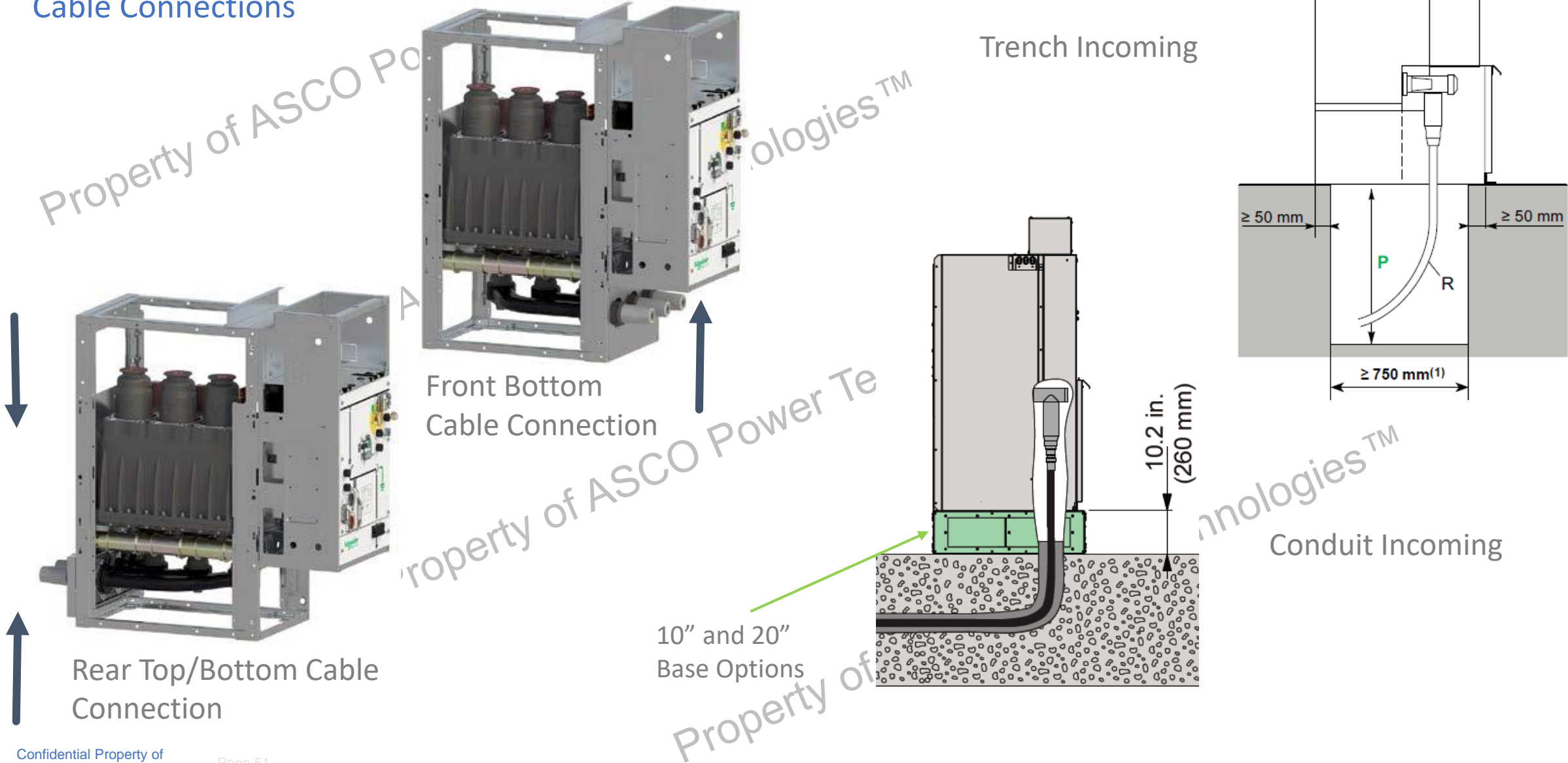
Section Types



	D02N	D06H	D12H	G06	G12	ES-B
Type	200A CB	600A CB	1200A CB	600A Riser	1200A Riser	Bus Ground Switch
Width	14.75 in.	14.75 in.	29.5 in.	14.75 in.	14.75 in.	14.74 in.

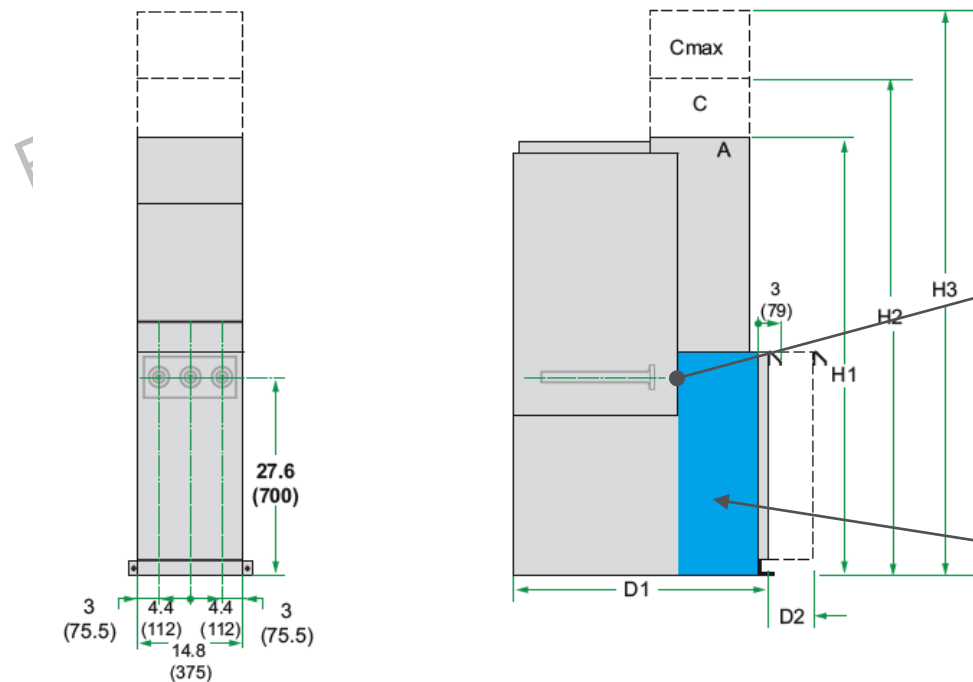
Modular Design

Cable Connections



Modular Design

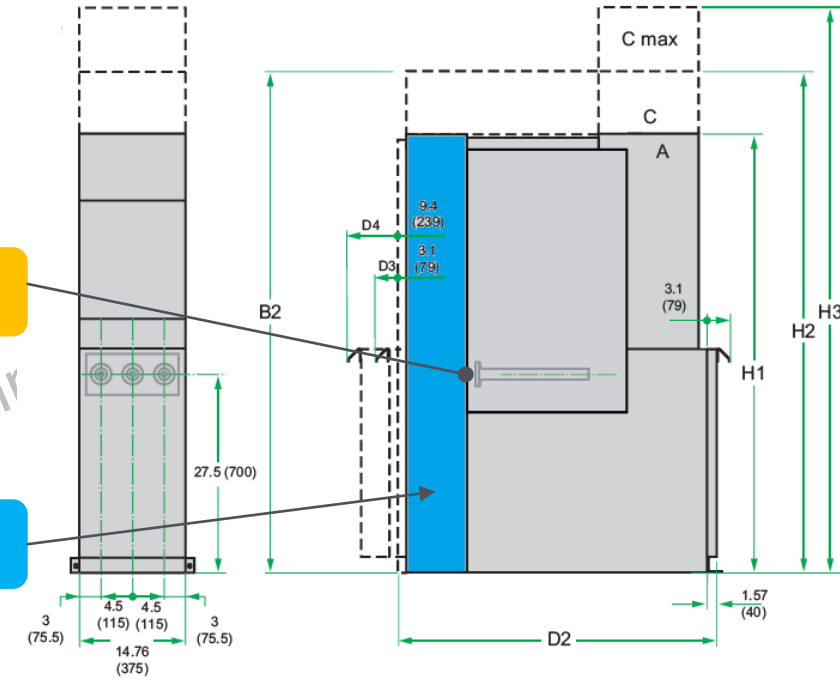
Front Access Only Design – Bottom Cables Only



Cable Elbow Location

Cable Compartment

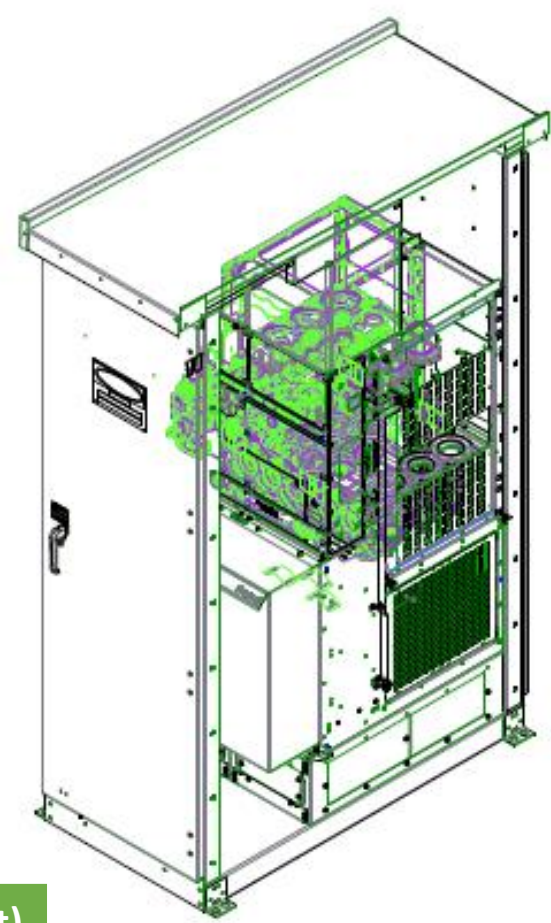
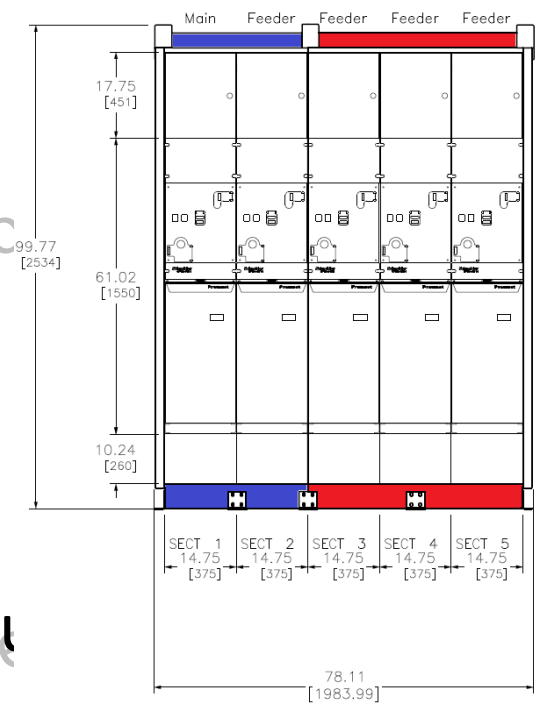
Rear Access Design – Top or Bottom Cables



H1	No LV box	61 in. (1550 mm)
H2	LV box C	78.5 in. (1994 mm)
H3	LV box Cmax	86.5 in. (2198 mm)
B2	Top cable entry	73.4 in. (1864 mm)
D2	Standard depth rear connection	49.7 in. (1262 mm)
D3	Standard door depth	3.1 in. (79 mm)
D4	Additional door depth	9.4 in. (239 mm)

Type 3R – Outdoor Enclosure

- “Box in box” Enclosure
- All Electrical Ratings
- Bottom Cable Incoming Only
- Internal Heater and Thermostat
- 10” Base and 17” LV Box always incl
- Front and Rear Access Required
- Exterior Paint: ANSI 49 Grey or Munsell 7GY 3.29/1.5 Green

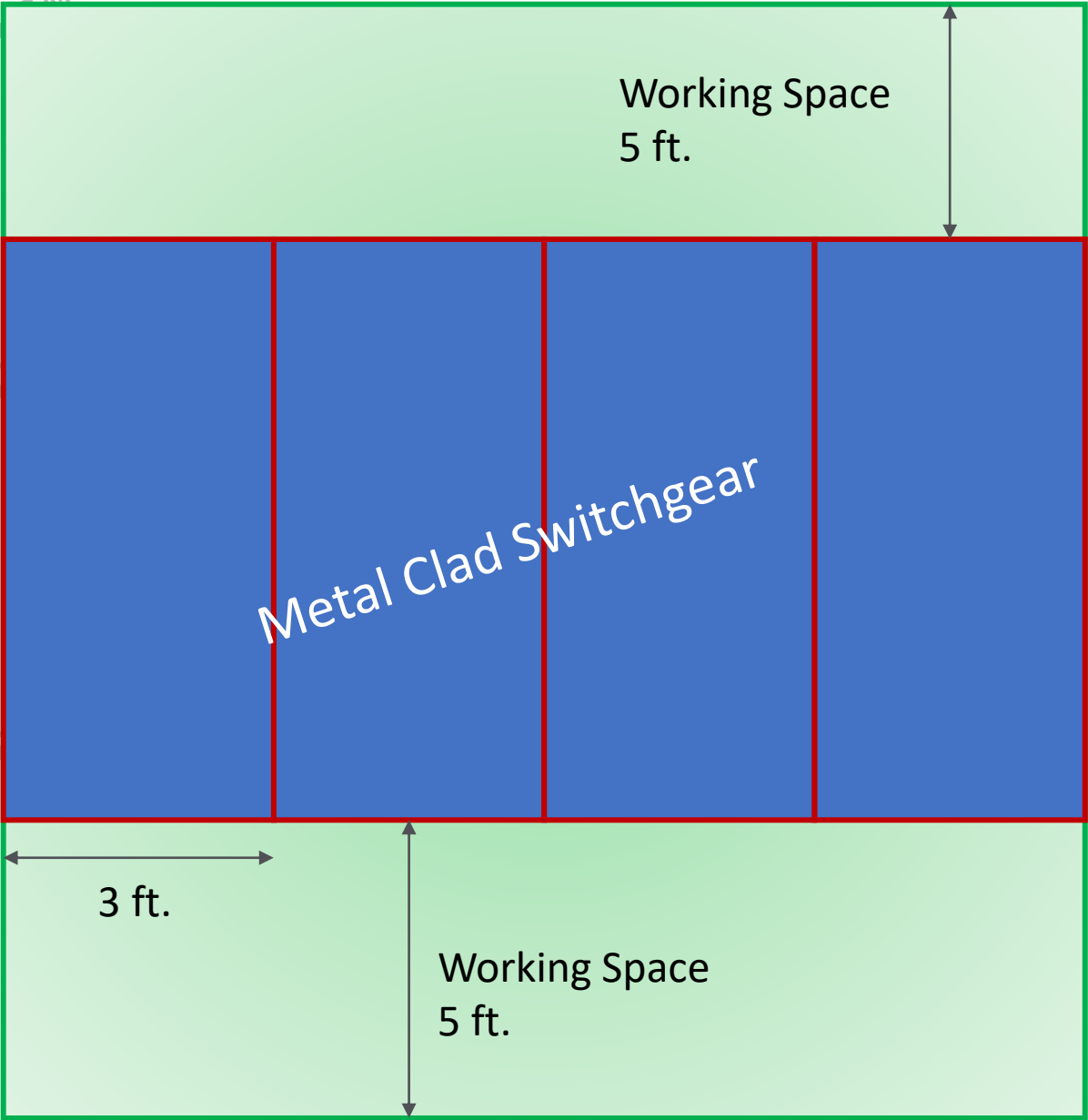


3R Enclosure	Width	Depth	Height (front)
“Two wide”	30 in.	62 in.	100 in.
“Three wide”	45 in.		

Space Savings

Small Footprint and Front Accessible

Total Footprint:
211 sq. ft.

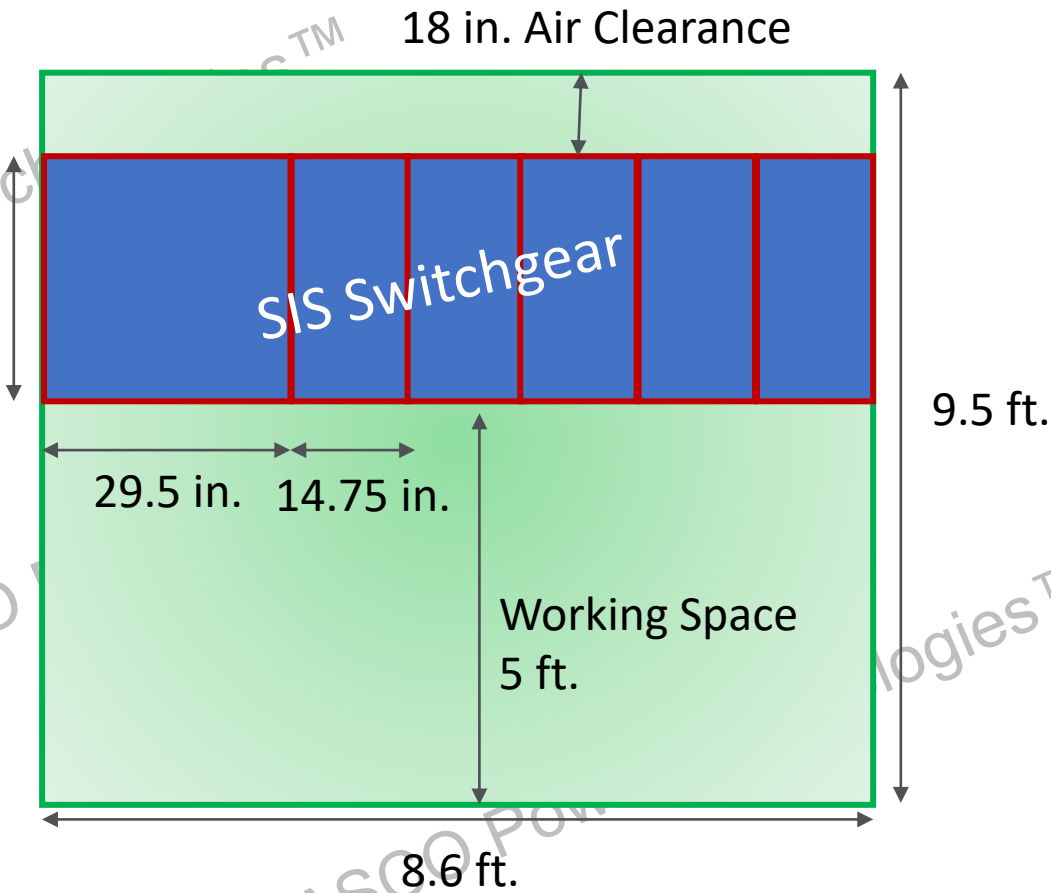


Space Savings

Small Footprint and Front Accessible

Total Footprint:
82 sq. ft.

60% Footprint Savings!



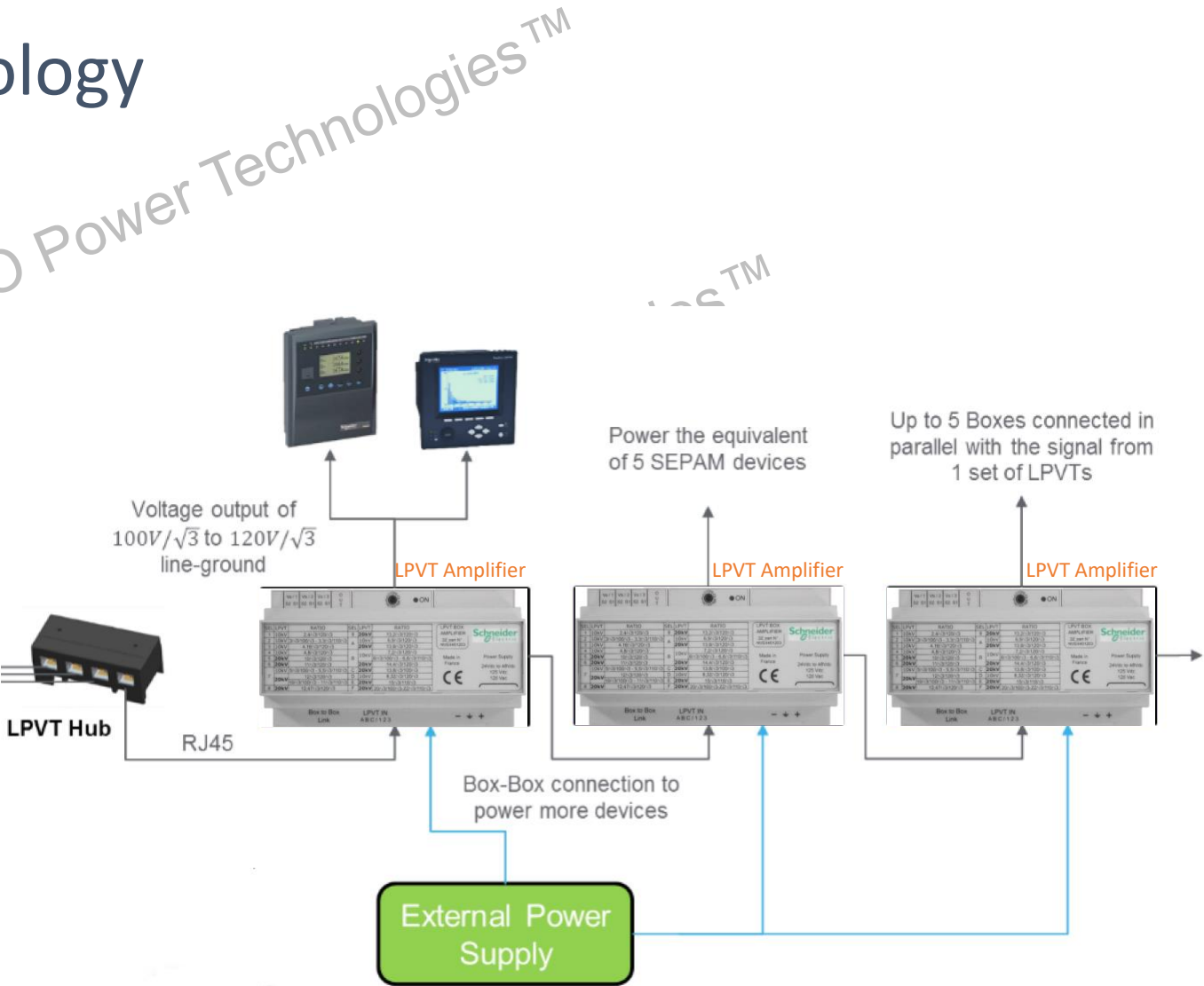
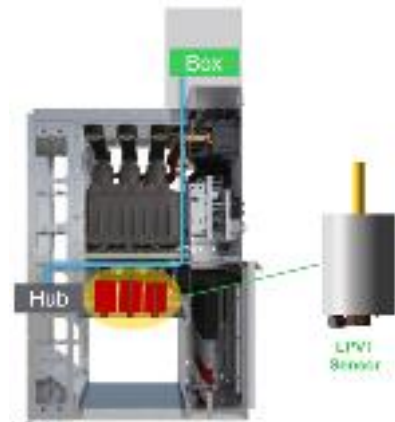
Sensor Technology

LPVT

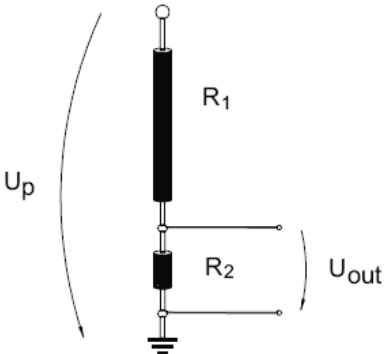
Busbar Measurement



Cable Measurement



Resistive divider






- Bus mounted Sensors
- Resistive Divider Technology
- Sensors have built-in Overvoltage Protection
- Ph to Gnd Measurement

Sensor Technology

Technologies™

CTs

Metering	<div>ARU1</div> 	100/1	200/1	400/1	600/1	300/5	400/5	600/5	800/5	1000/5	1250/5				
		Burden 2.5VA					Burden 5VA								
		IEC Accuracy: CI 0.2s Fs≤5					IEC Accuracy: CI 0.2s Fs≤5								
		IEEE Burden Class: 0.6 B-2.5					IEEE Burden Class: 0.3 B-0.2								
Relaying	<div>ARU2 CTs</div> 	100/1		200/1		400/1		600/1		800/1		1000/1		1250/1	
		1.5 VA		2.5 VA				5 VA							
		IEC Accuracy: 5P-20													
		IEEE: C30		IEEE: C50				IEEE: C100							
Metering	<div>ARC6</div> 	100/5		150/5		200/5		300/5		400/5		600/5			
		Burden: 5VA						Burden: 15VA							
		IEC Accuracy: CI 0.2s Fs≤5													
		IEEE Burden Class: 0.3 B-0.2						IEEE Burden Class: 0.3 B-0.6							

Property

Connected Product

SMD + TH110

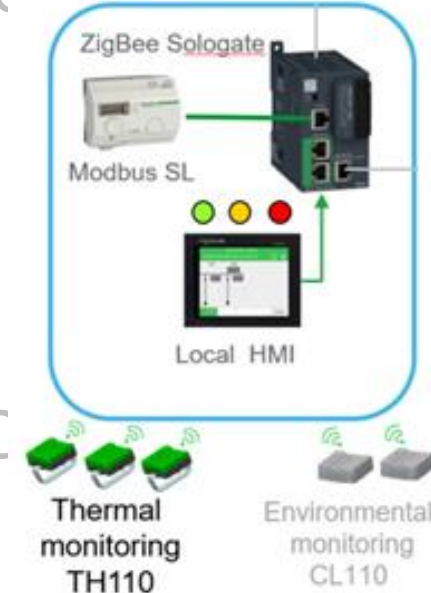
- Capability for continuous remote thermal monitoring using self-powered sensors
- Capable of monitoring absolute temperature, temperature differential and historic temperature trend
- Elimination of yearly IR Scans results in reduced cost of ownership
- Functional as both a standalone system or as an integrated part of Schneider Electric's Ecostruxure platform.

[White Paper](#): How thermal monitoring reduces risk of fire

Ecostruxure™



Substation
Monitoring
Device



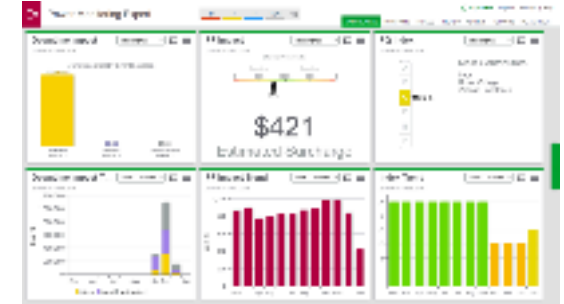
Connected Product

Standard Connectivity



Power Monitoring Expert

- Manage power measurement and quality
- Maximize operational efficiency
- Simplify reporting and compliance



Asset Advisor

- 24/7 cloud enabled monitoring
- Long term operational insight and analytics
- Predictive analytics and smart alarming delivered to your mobile

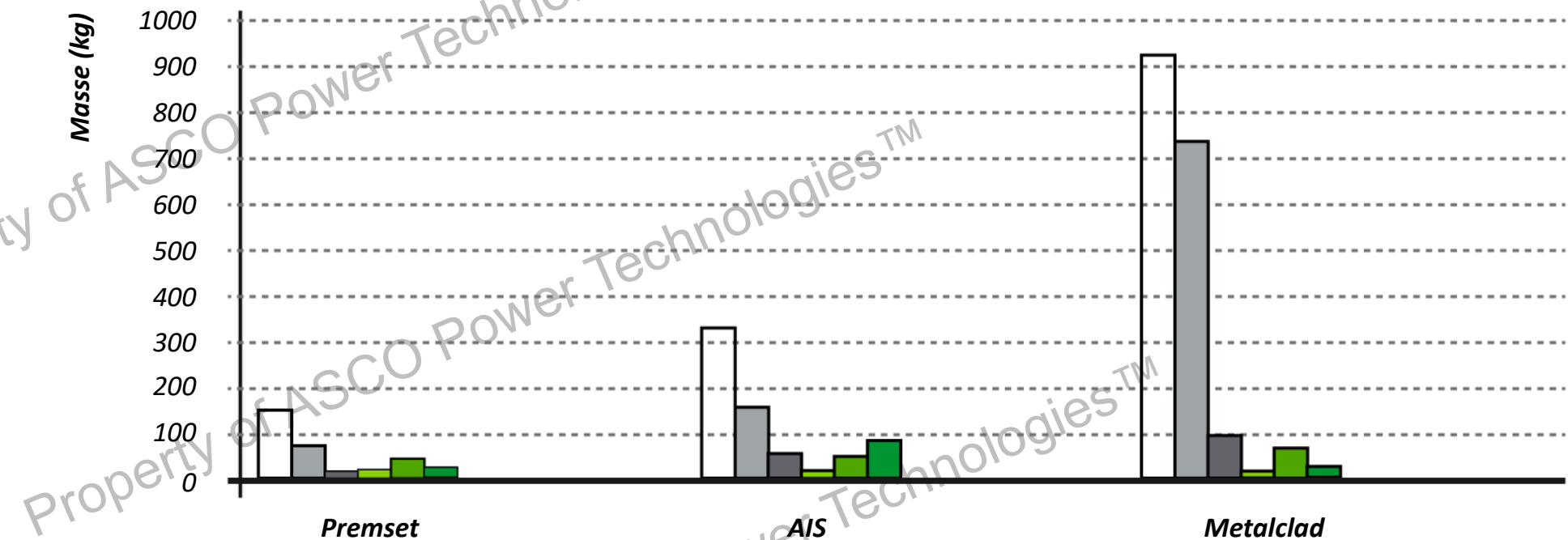


Facility Expert

- Easily access and manage facility asset information
- Anticipate and manage facility maintenance and repair
- Provide visibility on total energy consumption (gas, water, steam, electricity, etc.)



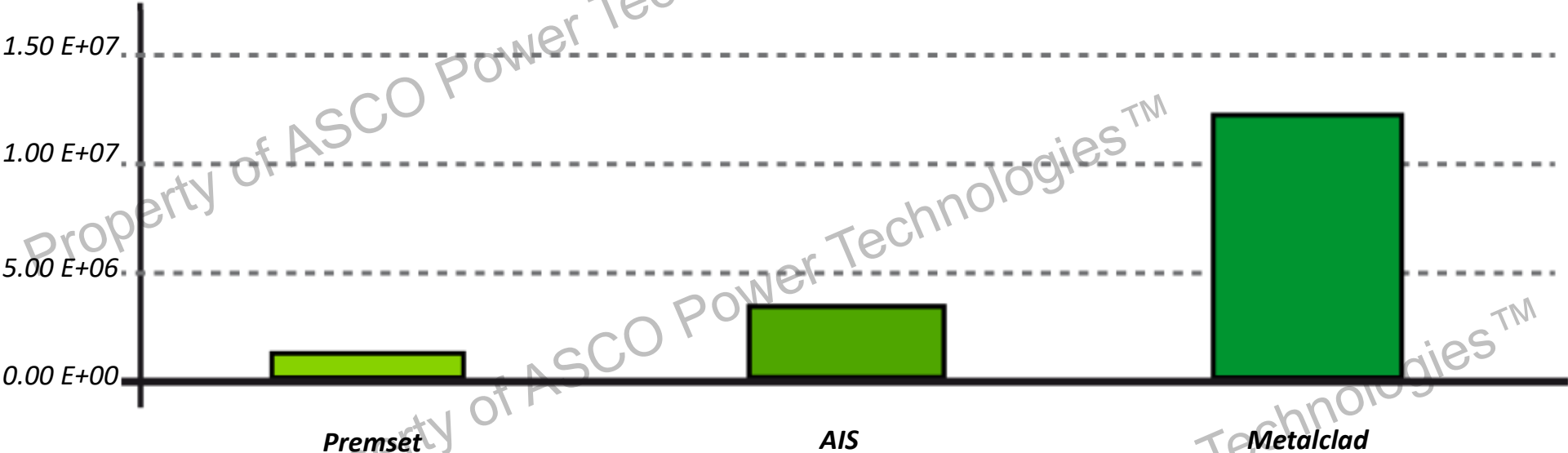
Environmental Impact – Core Materials



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

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



Conclusion

Workforce



- Reduced Maintenance
- Modular Design
- Reduced Lead Times

CapEx/OpEx



- Reduced Purchase Cost
- Reduced Total Cost of Ownership

Safety

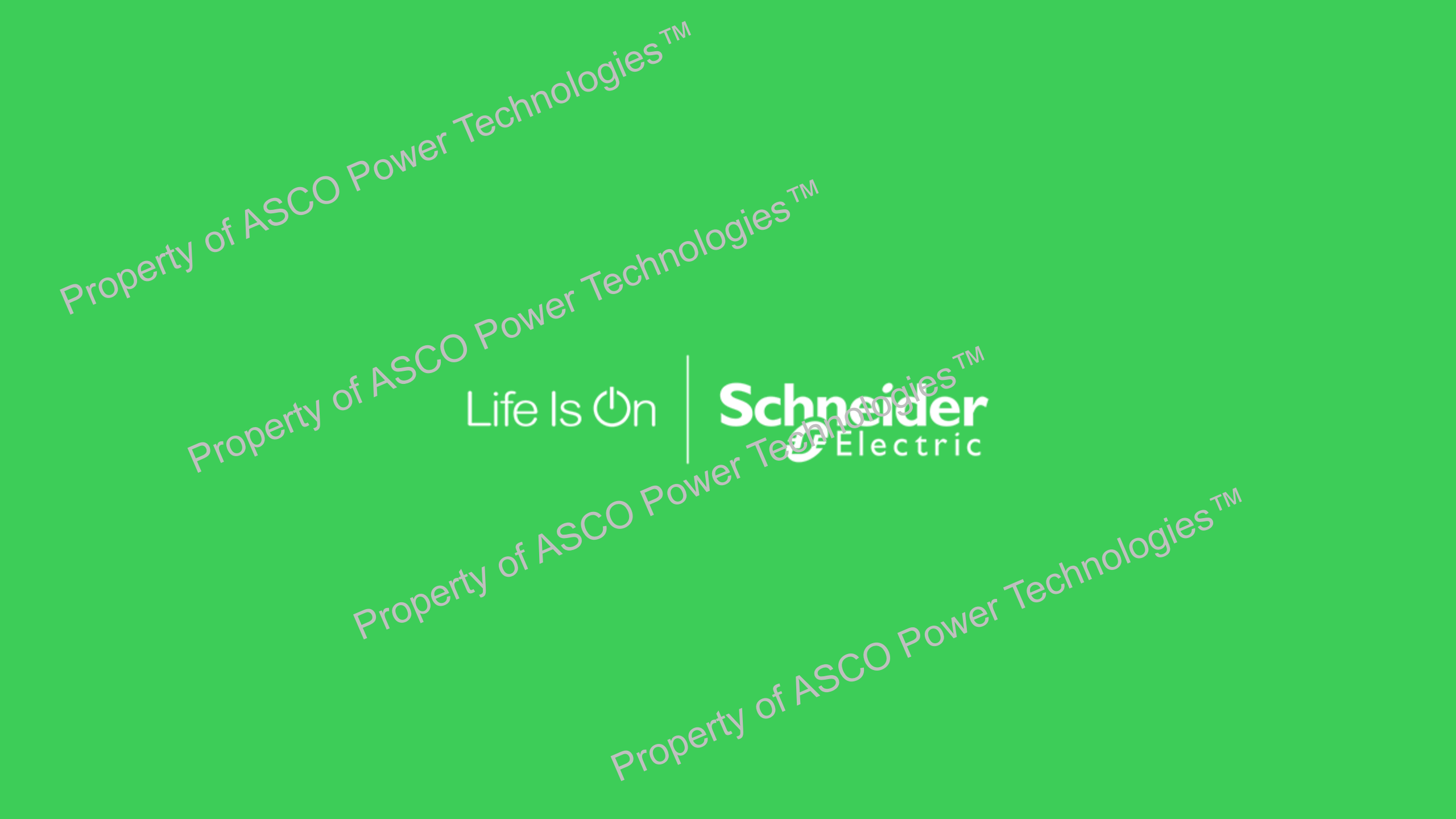


- Incidental Touch Safe
- Reduced Arc Risk
- Long Maintenance Intervals

Equipment Space



- Small Footprint
- Front Accessible



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Life Is On

Schneider
Electric

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