Scared of Medium Voltage?

Embrace New Technologies for Safe, Reliable, and Cost Effective Power

Tuesday 2:30pm January 24th, 2017

Presented by Marc Buchwald

Authored by Jeff M. Miller, PE, ENV SP

Schneider Electric

Speaker Bio: Marc Buchwald

WWW Water Wastewater Competency Center | Business Development Manager

- Marc Buchwald is a regional Business Development Manager for Schneider Electric's Water Wastewater Competency Center. Marc graduated from NJIT with a BS in Industrial Engineering and brings 40+ years of experience helping clients with Electrical and Automation solutions. He is an active member in NJAWWA (technical program committee), NYAWWA, NJWEA, NYWEA, LIWC, AEA NJ, NEWAE and NEWWA.

Marc Buchwald
Schneider Electric
Business Development Manager
Water Wastewater Competency Center

2001 Route 46, Suite 402
Parsippany, NJ 07054
Mobile: 201.404.3514
Marc.Buchwald@Schneider-Electric.com
www.schneider-electric.com

Embrace New MV Technologies for Safe, Reliable, and Cost Effective Power

How come you don't have comfortable seats like ours?

If I answer questions will I get free stuff?

Why Medium Voltage?

Applications | Safety | Reliability | Costs

What is Medium Voltage?

Electrical Power Distribution ANSI/IEEE

Alternating Current (AC) …

- Extra Low Voltage: < 50 V
- Low Voltage: 50 V to < 1000 V
- **Medium Voltage: 1 kV to 69 kV**
  - **E.g. 2400V, 4160V, 6.9kV, 13.8kV, 34.5kV**
- High Voltage: > 69 kV to 230 kV
- Extra High Voltage: > 230 kV to 800 kV
- Ultra High Voltage: > 800 kV








Medium Voltage verses Low Voltage

Comparison

Typical Medium Voltage: 4160 V and higher

- Good > 500 hp
- Lower power distribution capital costs
- Higher electrical maintenance costs
- Good for long cable runs with smaller sized cables
- Lower voltage drop and energy loss
- Special cable terminations
- Additional training needed
- Potential Utility Bill savings from primary metering
- Footprint may be higher or lower depending on all electrical and process equipment items
- Less equipment items in a process train
- Inherently low harmonic for MV VFDs

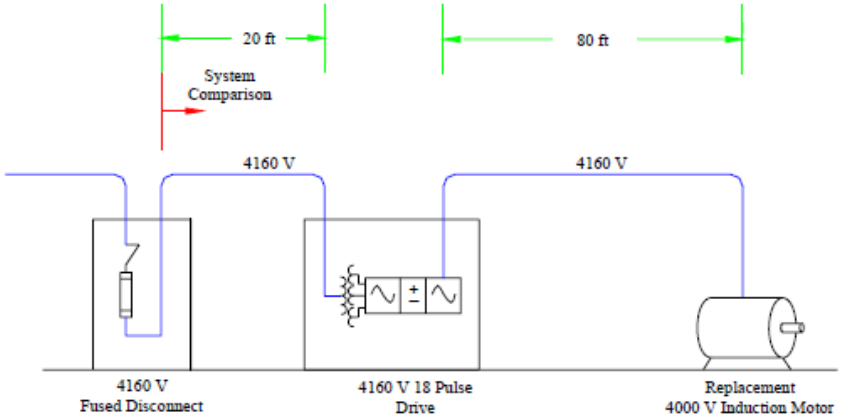
Typical Low Voltage: 480 V

- Good at < 800 hp
- Less required working space around electrical equipment
- Motors are more reliable and less costly
- Motors are slightly more efficient
- Large conductors and conduit needed
- Higher process equipment capital and maintenance costs for large applications
  - Example: 8-12 LV pumps vs. 2-6 MV pumps
- Equipment not stocked or hard to find >1000 hp
- Motor can be slightly more reliable (less and less as MV is trending more reliable)

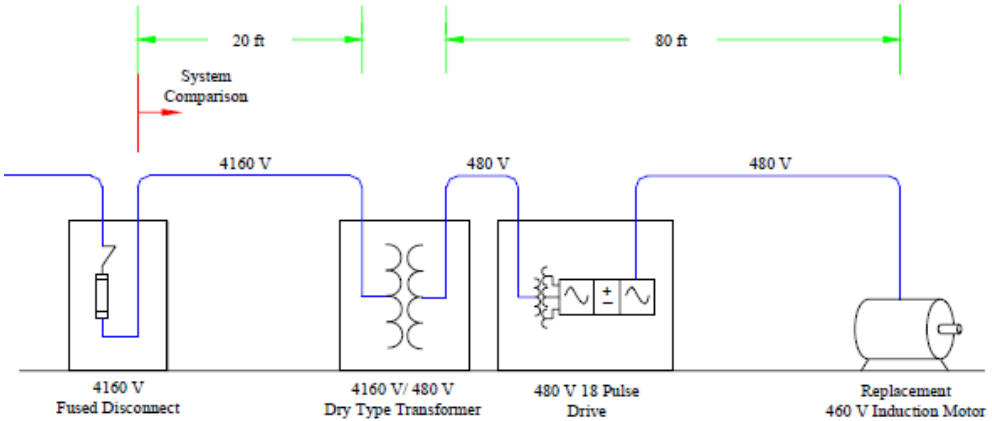
Example Electrical Costs for VFD Driven Equipment

Medium Voltage verses Low Voltage Application Costs

- Existing 4160V electrical distribution onsite
- Only one item of motor driven equipment with no economies from multiple trains of equipment
- Low electricity cost of $0.07/kWhr
- Only 12 years considered for VFD application since life can be 10-18 years



Medium Voltage Drive Configuration



Low Voltage Drive Configuration

Example Electrical Costs for VFD Driven Equipment

Medium Voltage verses Low Voltage Application Costs

Electrical CapEx Costs

	300 HP		500 HP		800 HP	
	Medium Voltage Drive	Low Voltage Drive	Medium Voltage Drive	Low Voltage Drive	Medium Voltage Drive	Low Voltage Drive
Wiring	$12,600	$15,200	$12,600	$19,200	$12,600	$30,300
Transformer	NA	$22,100	NA	$26,500	NA	$35,400
Drive	$107,200	$42,200	$113,200	$57,200	$121,200	$116,500
Motor	$21,300	$19,300	$26,600	$24,100	$35,100	$31,800
TOTAL	$141,100	$98,800	$152,400	$127,000	$168,900	$214,000

Electrical OpEx Costs

	300 hp		500 hp		800 hp	
	Medium Voltage Drive	Low Voltage Drive	Medium Voltage Drive	Low Voltage Drive	Medium Voltage Drive	Low Voltage Drive
Wiring						
MV	0.09 kW	0.02 kW	0.26 kW	0.05 kW	0.65 kW	0.13 kW
LV	NA	0.75 kW	NA	0.68 kW	NA	1.83 kW
Transformer	NA	6.87 kW	NA	9.08 kW	NA	12.2 kW
Drive	8.20 kW	11.20 kW	13.60 kW	14.70 kW	21.80 kW	22.00 kW
Motor	11.3 kW	5.55 kW	14.72 kW	10.15 kW	19.62 kW	16.23 kW
TOTAL	19.58 kW	24.39 kW	28.58 kW	34.66 kW	42.08 kW	52.39 kW
ANNUAL COST*	$3,600	$4,500	$5,300	$6,400	$7,700	$9,600
12 YR DIFFERENCE	-	$10,600	-	$13,400	-	$22,800

Total 12 Year Electrical Costs

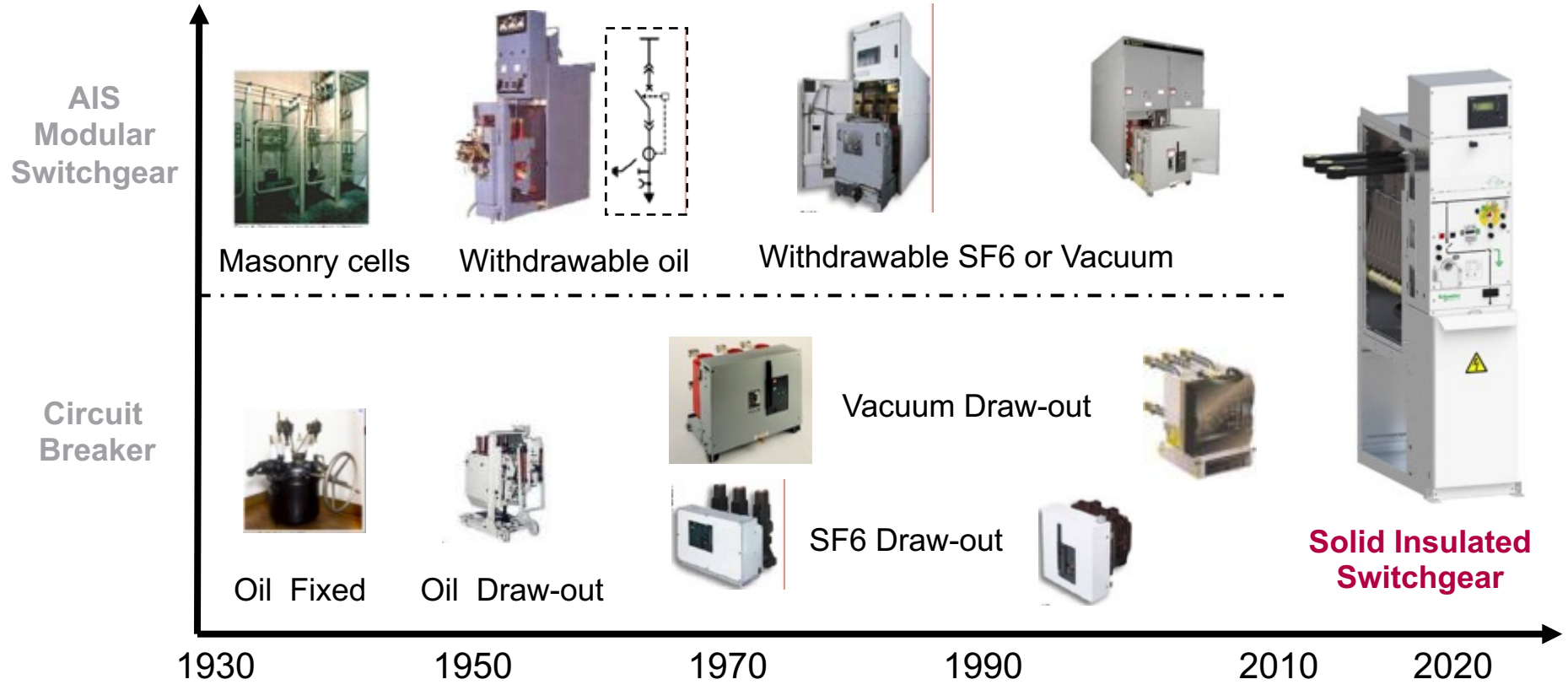
	300 hp		500 hp		800 hp	
	Medium Voltage Drive	Low Voltage Drive	Medium Voltage Drive	Low Voltage Drive	Medium Voltage Drive	Low Voltage Drive
TOTAL COST (000)	$184	$153	$215	$204	$262	$330

Does not include other costs such as process equipment, utility savings and reliability.

Evolution of Medium Voltage Switchgear

Technologies

History of Medium Voltage Switchgear



Metal Clad and Metal Enclosed Switchgear

Types of Switchgear Construction

Metal Clad Switchgear (IEEE C37.20.2)

- Switchgear is assembled into different compartments of a section's enclosure.
- Withdrawable compartments stab onto bus for connection. Isolation by withdrawing compartment.
- Manual grounding
- Higher CapEx and OpEx costs

Metal Enclosed Switchgear (IEEE C37.20.3)

- Switchgear is assembled in an enclosure section with bolted bus connections. Simple design.
- Isolation by grounding disconnect switch
- Low maintenance
- Reduced risk of arc flash (no racking)
- Smaller footprint with front access
- Intuitive interlocked design

Switchgear

Types of Insulated Switchgear

Air Insulated Switchgear (AIS)

- Uses air or vacuum to provide electrical insulation between components and contacts

Gas Insulated Switchgear (GIS)

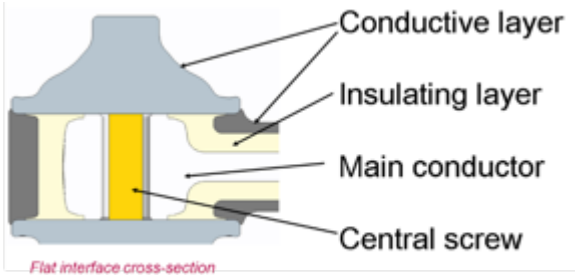
- Encapsulates MV components in sealed pressurized SF6 gas to provide better insulation than air.
- Vacuum or gas breaking contacts.
- Very low maintenance
- 50% lighter and smaller
- Reduced risk of arc flash

Shielded Solid Insulated Switchgear (2SIS)

- Encapsulates MV components/compartment in shielded solid insulation (epoxy, EPDM). Vacuum for breaking contacts.
- Advantages of GIS without SF6 gas. Extremely low maintenance
- Long Life
- Safety: fully grounded device
- Limited configurations available

Shielded Solid Insulated Switchgear (2SIS)

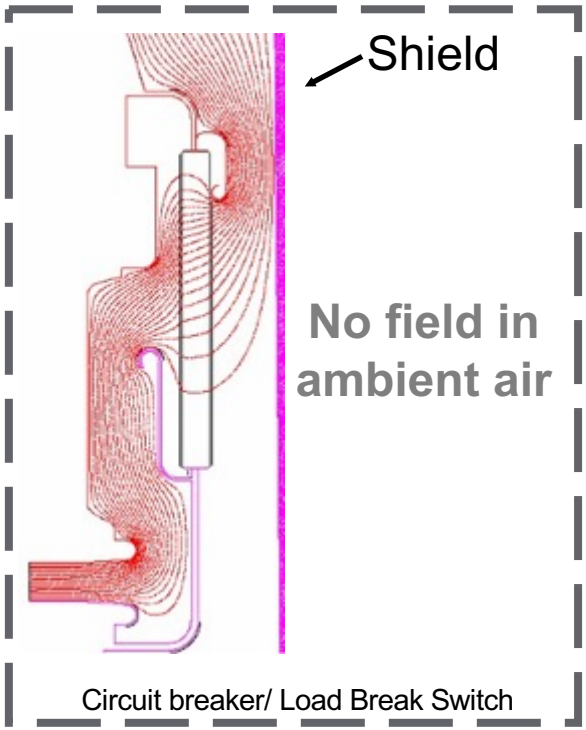
- Entire Live Current Path is Fully Epoxy Resin (EPDM) Insulated
  - Phase to phase arc flash is not possible, only phase to ground
  - No Exposed Live Parts. All surfaces at ground potential.
  - Protected from Environmental Exposure
- EPDM: Ethylene Propylene Diene Monomer
  - Outstanding resistance to heat, ozone and weather
  - Excellent electrical insulating properties with flame resistance
  - Good resistance to steam, polar substances, ketones, diluted acids, alkalines
- 30+ Lifespan with minimal tracking or aging of EPDM

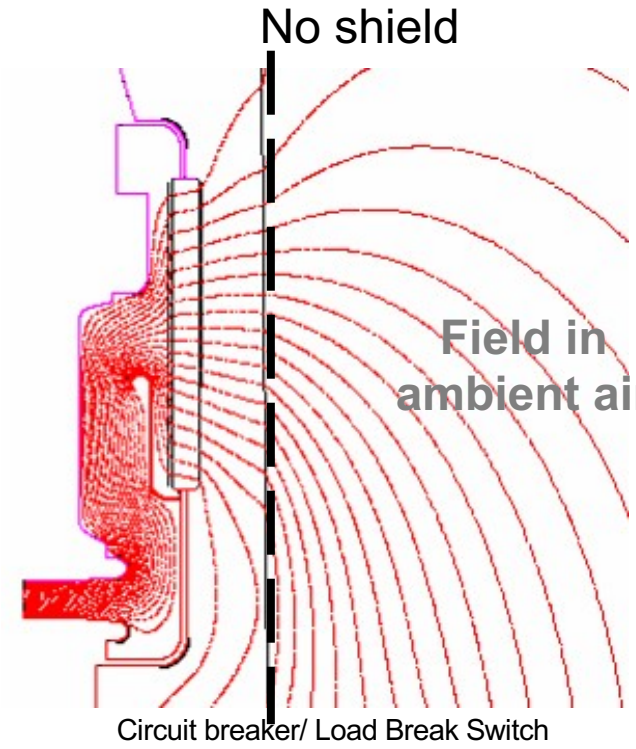


Compact Modular Switchgear with Minimal Footprint

Shielded Solid Insulated Switchgear (2SIS) vs Solid Insulated Switchgear (SIS)

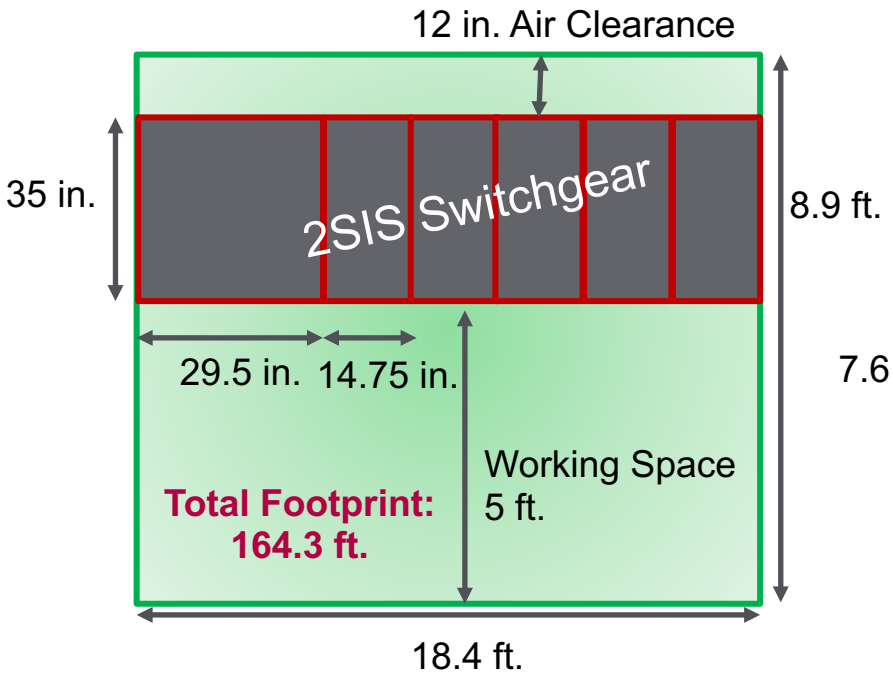
2SIS vs SIS

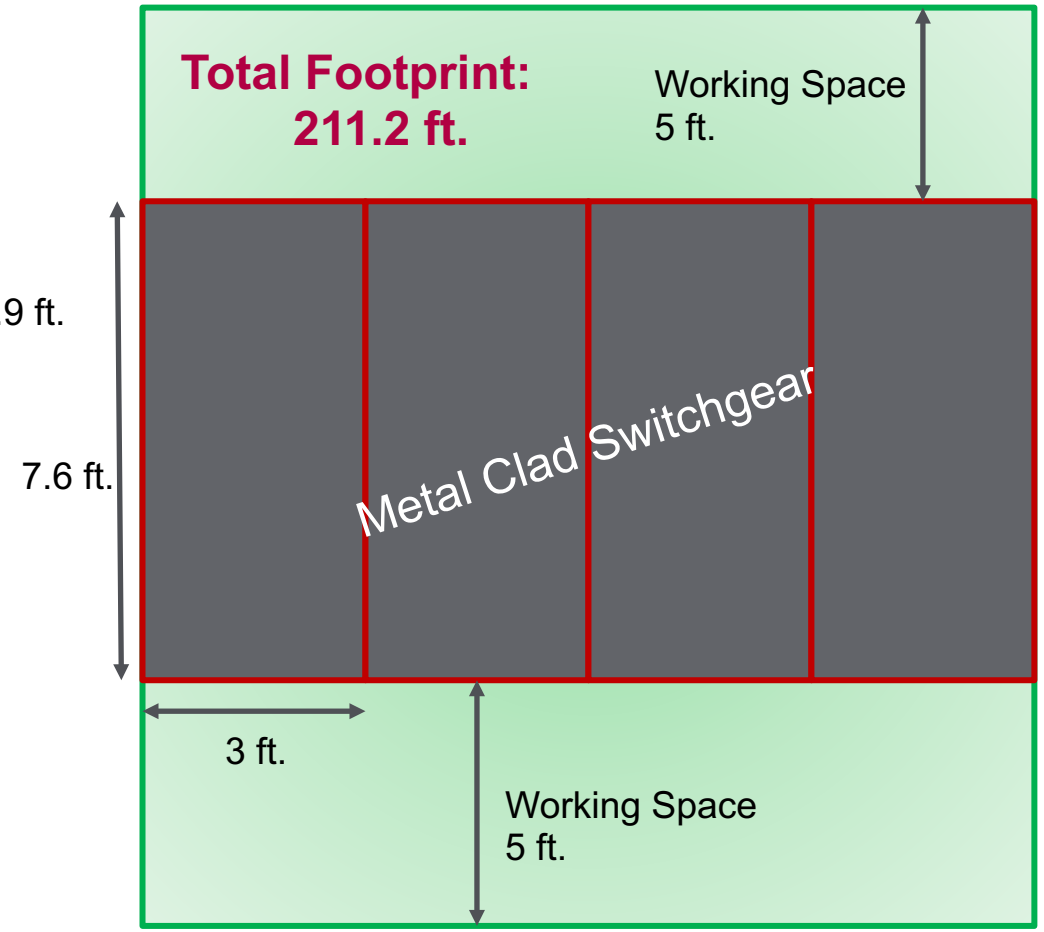




Shielded Solid Insulated Switchgear (2SIS)

Space Savings

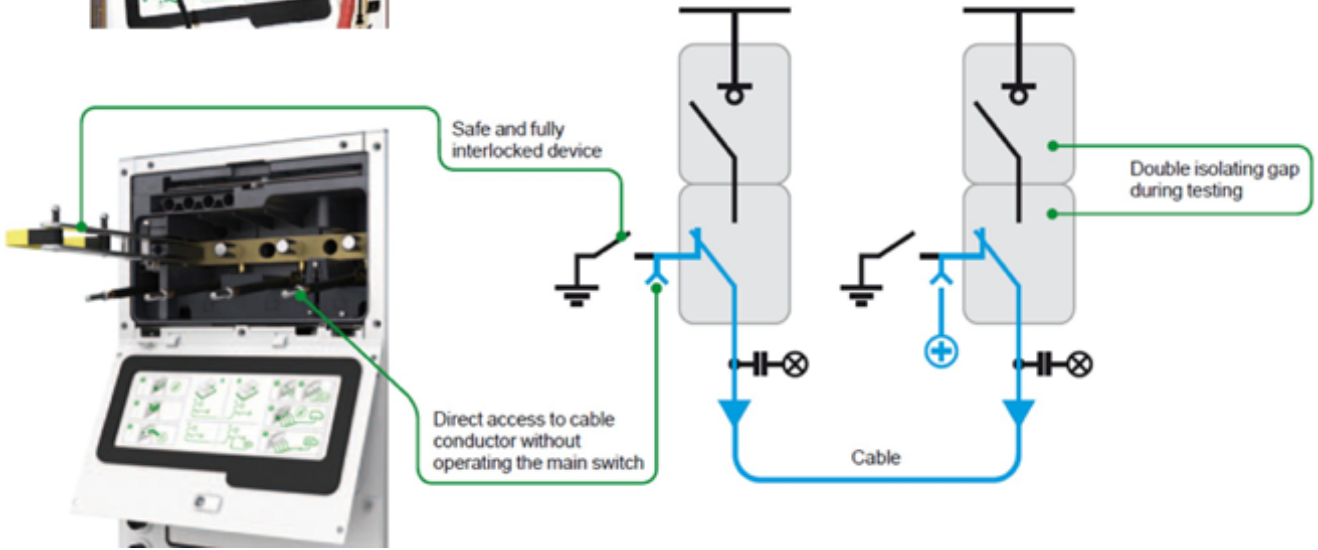




30% Footprint Savings!

Shielded Solid Insulated Switchgear (2SIS) Safety

Cable testing and diagnosis: dedicated device, for easy access and total safety



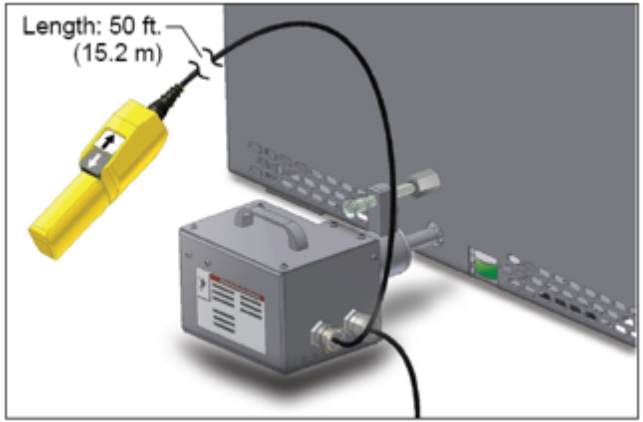
Enhancing Safety of Medium Voltage Switchgear

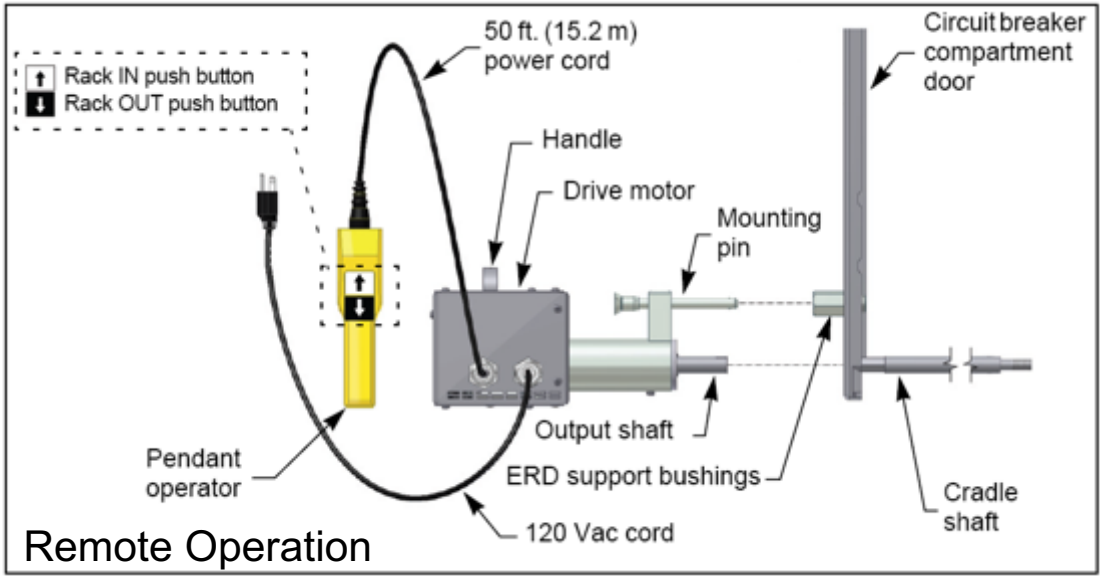
Arc Flash

Remote Operation and Racking

- Electric operators mounted to equipment for remote operation
- Personnel protection
- No equipment protection with long recovery time
- Low cost

Remote Racking





Time Delay Switch Operation

Lowers PPE Requirements for Operation

- Time delay close and open
- Local control with 10 sec or longer delayed operation to allow personnel removal from area during operation
- No special wiring or relaying
- May not be suitable for all applications
- Can be retrofitted onto existing gear.

Remote Voltage Indication

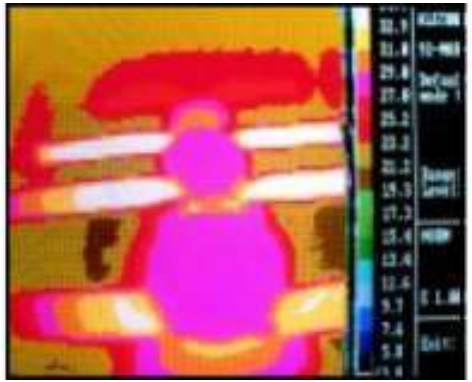
Lowers PPE Requirements for Voltage Verification

- Part of lockout/tagout process is to verify equipment dead
  - Equipment considered energized until verified dead
  - Have to open up equipment to verify!
- Remote indication allows verification with door closed.
- Can be retrofitted onto existing gear.

Infrared Viewing Windows

Closed Door Themographic Surveys

- Allows infrared scanning of cables and bus connections without opening doors. Lowers arc flash hazard.
- Can be retrofitted onto existing gear.
- All cables and connections may not be visible.
- Low cost



Arc-Resistant Switchgear (IEEE C37.20.7)

Passive Arc Flash Mitigation

- Structurally reinforced switchgear and cubicle construction and requires venting the internal energy, molten metal, and debris generated during a fault event in order to meet the Arc-resistant IEEE C37.20.7
- Type 1: Arc-Resistant freely accessible front protection only
- Type 2: Arc-Resistant freely accessible exterior (front, back and sides) protection
- Suffix
  - B: Arcing doesn’t cause holes in low voltage isolating walls
  - C: Arcing doesn’t cause holes in compartment walls
  - D: Type 1 only, installation limits accessibility of external surfaces so not surfaces considered in evaluation

Arc-Resistant Switchgear (IEEE C37.20.7)

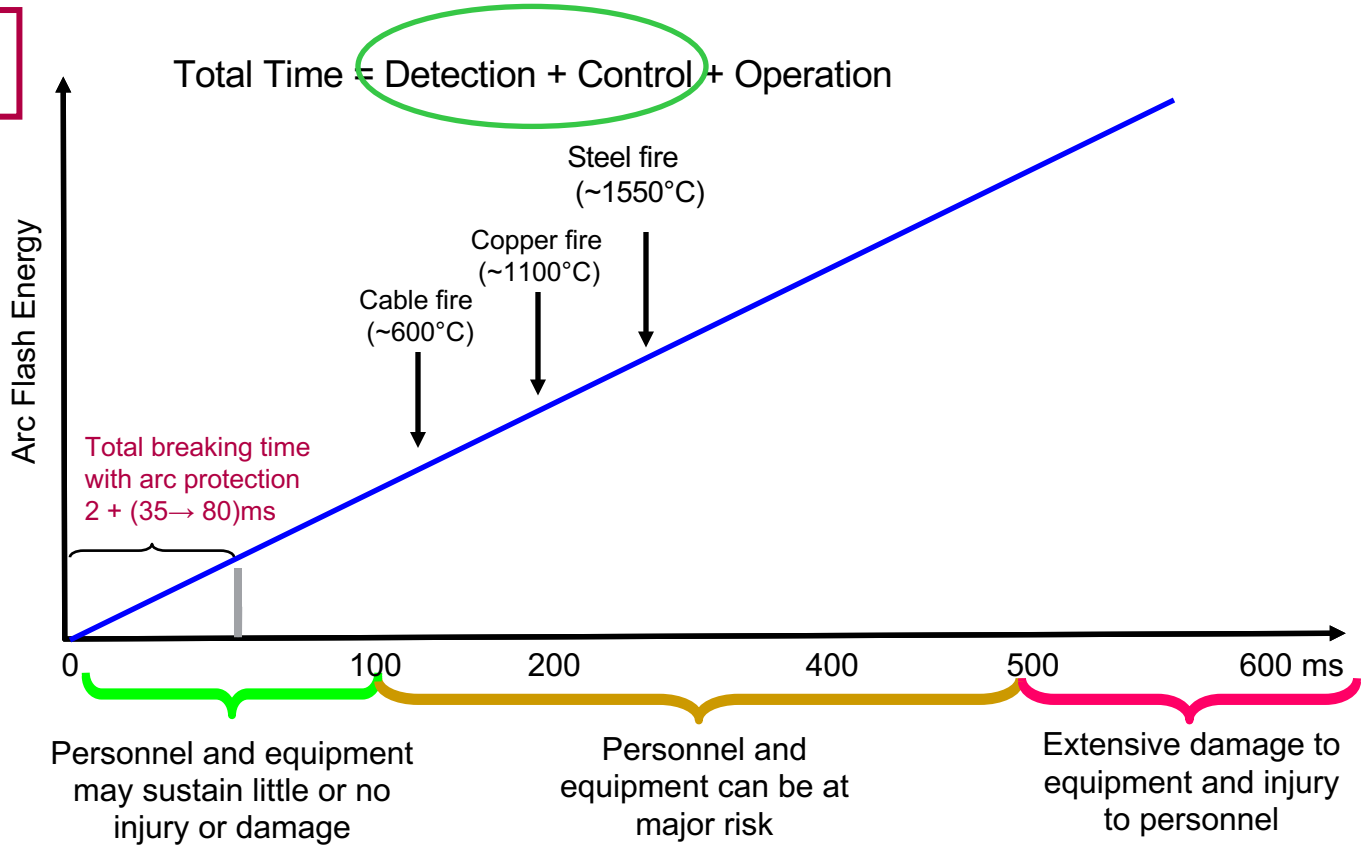
Passive Arc Flash Mitigation

- Tested to meet IEEE C37.20.7
- Reduces PPE requirements
- Does not reduce arc flash incident energy
- Does not protect equipment within switchgear. Long recovery time.
- High cost
- Existing gear cannot be retrofitted

Arc Flash Protective Relay and Arc Terminator

Lower Incident Energy of Arc Flash Event

An arc is developed within one millisecond



Arc Flash Protective Relay

Lower Incident Energy of Arc Flash Event

Fault Cleared < 3 Cycles (180ms)

No Fault Protection

Arc Flash Protective Relay

Lower Incident Energy of Arc Flash Event

- Arc Flash Protective Relay with operation on simultaneous current & light or light only to signal circuit breaker to trip fast.
- Reduces incident energy; arc flash hazard reduction
- Reduces pressure buildup
- Reduces release of toxic materials
- Lowers equipment damage
- Reduces operating downtime
- Low cost effective
- Reduces PPE requirements

Arc Terminator

Lower Incident Energy of Arc Flash Event

- Arc Terminator is an ultra-fast switch to short buses < 5.5ms when a fault is sensed significantly reducing incident energy with integral controller.
- Tested to meet IEEE C37.20.7
- Reduces incident energy; arc flash hazard reduction; reduces pressure buildup; reduces release of toxic materials
- Eliminates need for reinforced switchgear
- Eliminates special requirements for buildings or plenums
- Minimizes equipment damage
- Reduces operating downtime
- Less costly than Arc-Resistant enclosures but provides equipment protection
- Reduces PPE requirements

	Arc-resistant Enclosures	ZSI/Bus Diff	Arc Detection Relays	ERMS	Remote Operation	Arc Terminator
Arc Flash Solution Objective	Redirect the arc flash energy away from the operator	Detect fault and trip	Quickly sense the arc flash and signal the breaker to trip	Lower protective settings and incident energy	Person is out of the arc flash zone	Quickly sense and extinguish the arc in < 5.5 ms
Lower Incident Energy	-	√	√	√	-	√
Personnel Protection	√	Lower PPE	Lower PPE	Lower PPE	√	√ Lowest PPE when active
Relative Costs	$$$ – $$$$	$$	$	$	$	$$ – $$$
Recovery Time After Event	Weeks	Weeks	Hours - weeks	Weeks	Weeks	2-4 hours
Equipment Damage from an Arc Flash Event	Yes	Yes	Yes Damage dependent on arc flash level	Yes	Yes	Minimal
Tested to Meet IEEE C37.20.7	Yes	No	No	No	No	Yes

Questions?

Marc Buchwald

Schneider Electric

Business Development Manager
Water Wastewater Competency Center

2001 Route 46, Suite 402
Parsippany, NJ 07054
Mobile: 201.404.3514
Marc.Buchwald@Schneider-Electric.com
www.schneider-electric.com


Merci • Gracias • Danke • Спасибо • 谢谢 • شكرا • Dziękuję • Paldies • Баярлалаа
Dhanybhad • Aguyje • Salamat • Mulţumesc • Murakoze Dankje • Obrigado • Aitäh
Vinaka • Grazie • 감사합니다 • Дзякую вам • Ďakujem Hvala • Tack • 多謝 • Дякую
Thank you!
Благодаря • ありがと • Ευχαριστώ • Köszönöm • X
вала • Takk • Merci • Gracias • Danke • Спасибо • 谢谢 • شكرا • Dziękuję • Paldies •
Баярлалаа • Aguyje • Salamat • Mulţumesc • Murakoze Dankje • Obrigado • Aitäh

APPENDIX

Note: The additional material presented hereafter is not part of the oral presentation, but is provided for reference within this document.

Medium Voltage

Useful Links

- Business Specific Web Content Registration: https://partner.schneider-electric.com/partners/Menu/registration
- White Papers: http://products.schneider-electric.us/technical-library/?event=detail&oid=0900892680c291b4
  - Comparison of MV and LV VFD Retrofits for W/WW Facilities: http://static.schneider-electric.us/assets/wwt_expertise/MV-LV-Comparison.pdf
  - Arc Flash Mitigation Using Active High Speed Switching: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6825866
  - Moving from Withdrawable to Fixed Circuit Breaker Switchgear in ANSI Medium Voltage Applications: http://www.schneider-electric.com/en/download/document/998-2095-06-12-15AR0_EN/
  - 2SIS Technology in MV Switchgear Easily Adapts to Harsh Environments While Minimizing Internal Arc Probability: http://www.plantengineering.com/single-article/sponsored-white-paper-2sis-technology-in-mv-switchgear-easily-adapts-to-harsh-environments-while-minimizing-internal-arc-probability/6e99f31c2c9c7137787308d2058503cc.html
- Medium Voltage Distribution: http://www.schneider-electric.us/en/work/products/medium-voltage-switchgear-and-energy-automation.jsp
  - Switchgear: http://www.schneider-electric.us/en/product-category/86140-mv-switchgear/?filter=business-6-medium-voltage-distribution-and-grid-automation
  - Arc Terminator: http://www.schneider-electric.us/en/download/document/6000HO1001/
  - Arc Flash Protection Relay: http://www.schneider-electric.us/en/work/products/medium-voltage-switchgear-and-energy-automation.jsp
  - MV Motor Control: http://www.schneider-electric.us/en/product-range-presentation/7264-motorpact-medium-voltage-controllers?parent-category-id=86143&filter=business-6-medium-voltage-distribution-and-grid-automation
  - MV VFD: http://www.schneider-electric.us/en/product-range-presentation/63063-altivar-1260-drive?parent-category-id=50000&parent-subcategory-id=82620&filter=business-1-industrial-automation-and-control
- Schneider Electric YouTube Water Wastewater Playlist: https://www.youtube.com/playlist?list=PLa7UGrWOTyjlPKyz9RhPEKYnB-JyBWuEi
  - Arc Terminator Active Arc Flash Mitigation: https://youtu.be/hzbuAfoAH5s
  - Premset Values: Safety with 2SIS: https://youtu.be/TpFg0sHELck

Scared of Medium Voltage?
Embrace New Technologies for Safe, Reliable, and Cost Effective Power

Presentation Abstract

Many utilities shy away from Medium Voltage (MV) power distribution and equipment for fear of personnel safety, maintaining staff skill sets, operational and maintenance concerns, etc., but are those fears justified considering processes still require an equal amount of power to operate at lower voltages? Imposing low voltage criteria based on these concerns may actually substantially increase complexity, capital and operational expenditures while possibly negatively impacting personnel safety, reliability, and the sustainability of your electrical infrastructure. In contrast, recent evolutions of MV technologies have taken some substantial leaps forward to address past fears and concerns while providing an excellent means of lowering not only the lifecycle costs of your electrical infrastructure but those of your facility and operations as well. This presentation discusses current day MV technologies and how they can be applied to increase safety and lower costs so utilities can make informed decisions on their electrical architecture and process equipment. Low voltage as well as various medium voltage technologies will be contrasted giving the pros and cons of each while also showing specific examples of the benefits of the newer medium voltage technologies.