At the heart of our strategy is a **simple powerful idea:** using natural resources much more productively is both profitable and better for the environment.
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- MiCOM Px20 Series Multifunction Protection Relays  
- MiCOM Px30 Series Multifunction Protection Relays  
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- VAMP 221 Arc Flash Detection  
- VAMP 321 Arc Flash Detection
MV Air-Insulated Switchgear (AIS)

Circuit Breaker Switchgear up to 27 kV

Masterclad Metal-Clad

Ratings/Features
• Meets IEEE/ANSI C37.20.2 metal-clad switchgear
• 5 kV and 15 kV arc-resistant switchgear
• 4,000 A 15 kV 50 kA (63 kA for indoor applications)
• 3,000 A 15 kV 63 kA for N3R applications
• 2,750 A 27 kV 40 kA
• 1,200 A – 4,000 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
• Arc Terminator — active arc flash mitigation
• 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

VR Circuit Breaker

Ratings/Features
• Three-cycle vacuum circuit breaker
• Up to 27 kV
• Up to 63 kA/164 kA pk
• Up to 4,000 A at 15 kV, 2,750 A at 27 kV
• Capacitive switching rated C1 at 410 A

Arc Terminator Arc Mitigation

Ratings/Features
• Up to 15 kV, 50 kA fault current
• Use of Arc Terminator in Masterclad provides Arc Resistant Type 2BC per ANSI/IEEE C37.20.7

Benefits
• Active arc-resistant solution
• Eliminates the need for reinforced switchgear
• Extinguishes high-magnitude arc currents within 1/4 of a cycle, prevents buildup of high internal pressures
• Confines the effects of the arc to the point of initiation
• Light detectors are placed in each compartment for flash detection of an arcing event
• After the arc is extinguished, normal protective devices function to detect and interrupt the current
Metal-Enclosed Switchgear

HVL/cc Metal-Enclosed Load Interrupter

Ratings/Features
- Current-carrying capacity up to 1,200 A at 15 kV, 600 A up to 38 kV
- 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 inside a 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 of 1,200 A up to 15 kV, 600 A up to 25 kV, 400 A up to 38 kV
- Short-time rating of 48 kA up to 15 kV and 25 kA 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 and attached to grounded sheet metal of the enclosure, minimizing the potential of phase-to-phase faults
MV Air-Insulated Switchgear (AIS)

MiniBreak Compact Height Switch
Ratings/Features
- Up to 5.5 kV and 200 A
- 12.5 kA, 2 s short-circuit rating
- 100 load-break operations
- Fused or non-fused versions
- Indoor or outdoor applications

Benefits
- Only 66 inches in height
- Easy to handle due to its lightweight and compact design
- Ideal for installations in which space is limited
- Free-standing enclosures

Motor Control Centers

Motorpact Full Voltage Motor Controller
450 A and 720 A FVNR
Ratings/Features
- Up to 7.2 kV, 50 kA 2 s, 3,000 A
- 200 A, 400 A, 450 A, and 720 A available contactor ratings
- NEMA Type 2B Arc Resistant
- Configurations
  - Full Voltage Non-Reversing
  - Reversing
  - Two-speed, one-winding
  - Two-speed, two-winding

Benefits
- Vacuum contactor is capable of 2.5 million mechanical operations
- Available in three widths (14.75", 20", 29.5")
- Robust construction and compact design
- No ventilation openings
- Withdrawable vacuum contactor
- Can be combined with Masterclad if circuit breaker is required

Motorpact Full Voltage
Motorpact Reduced Voltage Motor Controller

**Ratings/Features**
- Up to 7.2 kV, 50 kA 2 s, 3,000 A
- 450 A continuous
- NEMA Type 2 Arc Resistant

**Configurations**
- Reduced-voltage soft starter (RVSS)
- Reduced-voltage autotransformer (RVAT)

**Benefits**
- Eases the impact of motor starting on your electrical infrastructure
- Voltage taps permit the adjustment of starting voltage to suit system capabilities (RVAT)
- Acceleration times up to 30 seconds for medium duty making it suitable for a long starting period (RVAT)
- Starting parameters can be fine-tuned to meet wide variety of unique load conditions (RVSS)
- Advanced protection module protects both the motor and the solid-state power structure (RVSS)
- Robust construction and compact design
- No ventilation openings
- Can be combined with Masterclad if circuit breaker is required

Motorpact Sequential Smart Start Motor Controller

**Ratings/Features**
- Cascade the starting and stopping of three or more motor starters within a single soft starter
- Up to 7.2 kV, 50 kA 2 s, 3,000 A
- 450 A continuous
- NEMA Type 2 Arc Resistant

**Configurations**
- S3 — Sequential Smart Start

**Benefits**
- Optimized cost by sharing a single soft start for multiple motors
- Depending on the application and number of motors being controlled, the S3 can lower your implementation costs between 25% and 65% per motor
- Reduces size and weight of installation by sharing the soft start
- Lighter weight parts reduce personnel requirements for installation
MV Gas-Insulated Switchgear (GIS)

Circuit Breaker Switchgear up to 38 kV

DVCAS Vacuum Circuit Breaker Switchgear

**Ratings/Features**
- Up to 38 kV, 600 A, and 20 kA
- SF6 as insulating medium
- Switchgear constructed to ANSI/IEEE C37.20.3, metal-enclosed switchgear
- Arc-resistant, complies with IEC 62271-200, AFLR 31.5 ka/1 second
- Available in NEMA 1 and 3R versions
- Utilizes plug-in bushings for connecting incoming cables with T-type plug-in connectors
- Modular units with options
- Incoming line section and a load interrupter switch
- Transformer protection section and a vacuum circuit breaker
- Isolation switch and outgoing line bussed auxiliary section

**Benefits**
- Compact for installation in medium voltage transformer substations and wind farm turbines (largest modular unit only 24" wide)
- Reduced maintenance due to medium voltage components being housed in a sealed-for-life, stainless steel, gas-tight cubicle
- Self-powered VIP relay provides phase functions (50 – 51) and ground functions (50N)
- Can be installed in wind farms up to 6,561 ft/2,000 m above sea level

CBGS-0 SF6 Circuit Breaker Switchgear

**Ratings/Features**
- Up to 38 kV, 31.5 kA, 2,000 A
- Fixed SF6 circuit breaker
- Solid insulated bus bar system
- Internal arc tested 31.5 kA/1 s per IEC 62271-200
- Complies with ANSI/IEEE C37.20.3 metal-enclosed switchgear

**Benefits**
- Completely front-accessible
- Impervious to environmental influences due to medium voltage components being protected from the environment
- Circuit breaker compartment housed in a sealed-for-life tank insulated with SF6 gas
- Compact design 24”W for mains/feeders and 48”W for tie
- Use of T-type connectors eliminates the need for a cable vault or trough
MV Gas-Insulated Switchgear (GIS)

GHA Vacuum Circuit Breaker Switchgear
Ratings/Features
• Up to 38 kV, 2,500 A, 40 kA (3 s)
• Vacuum circuit breaker
• Modular design of switchgear sections
• Internal arc tested 40 kA/1 s per IEC 62271-200

Benefits
• No gas handling during erection, extension work, and panel replacement
• Innovative fault-tolerant bus bar link “B-link”
• Customizable low voltage cabinet
• Intelligent Gas Density Information System (IDIS) for gas monitoring
• Camera system provides visible disconnect of the isolation and grounding switch
• Low maintenance with a sealed-for-life circuit breaker and bus bar compartments
• Use of T-type connectors eliminates the need for a cable vault or trough
• Completely front-accessible

MV Distribution Transformers

Model III Packaged Unit Substation
Ratings/Features
• Primary voltages: 2.4 kV – 13.8 kV
• Ratings of 75 kVA – 1,000 kVA at 480 V
• Ratings of 75 kVA – 500 kVA at 240 V
• Branch circuit breakers from 15 A – 1,200 A
• 80, 115, 150 °C transformer temperature rise

Benefits
• Combines primary switch, dry-type transformer, and I-Line™ distribution into a single, compact unit
• Efficient performance — Meets with DOE required efficiency
• Compact design — Small size allows passing through standard-size doorways and narrow hallways
• Easy expansion — Substations divide a system into isolated areas
• Primary power is purchased from the utility at the lower primary power rates, resulting in operational cost savings throughout the life of the equipment
• Overall installed cost is lower because of the cost benefits of medium voltage distribution cable as compared to low voltage cable or busway
• Efficient design — Can be installed against a wall or in a corner without derating
Power-Cast II and Uni-Cast II Transformers

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<th>Power-Cast II</th>
<th>Uni-Cast II</th>
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<tr>
<td>Secondary</td>
<td>Cast</td>
<td>Epoxy Encapsulated</td>
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<td>Primary Voltage</td>
<td>Up to 46 kV</td>
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<tr>
<td>kVA</td>
<td>112.5 kVA thru 13 MVA</td>
<td>112.5 kVA thru 3 MVA</td>
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</tbody>
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**Features**
- Cast windings designed with a solid resin dielectric
- Available with copper or aluminum windings
- Partial discharge free
- Superior dynamic short-circuit current strength
- Resistance to moisture and atmospheric contaminants
- Optional blower cooling provides as much as 50% increase in capacity
- 2010 Department of Energy; Energy-Efficiency Compliant

**Benefits**
- Designed to meet the demands of higher operating voltages
- Rugged durability for harsh environments
- Superior dynamic short-circuit current strength

Power-Dry II Transformers

**Ratings/Features**
- Available with primary voltages up to 35 kV in 112.5 kVA through 13 MVA sizes with a 220 °C insulation system
- Secondary voltages available through 15 kV
- Vacuum Pressure Impregnated
- Can be used stand-alone with air terminal chambers for cable termination or as part of a substation lineup
- Optional blower cooling provides 33.33% increase in capacity
- 2010 Department of Energy; Energy-Efficiency Compliant

**Benefits**
- Liquid-free and lighter weight than cast-coil units
- Low installation, maintenance, and energy costs
- Flexible design ideal for power upgrades or retrofit applications
- No special waste disposal considerations
**Liquid-Filled Substation Transformer**

**Ratings/Features**
- Available in primary voltages up to 69 kV in 225 kVA through 20 MVA
- Secondary voltages ratings from 600 V through 35 kV
- Available as stand-alone installation using terminal compartments or close-coupled to primary and secondary switchgear providing a complete substation lineup
- Mineral oil or high-fire-point fluids options
- Higher standard impulse levels than dry-type units
- Self-cooled and fan-cooled overload capabilities
- Copper or aluminum windings
- Secondary busway connection option
- 2010 Department of Energy; Energy-Efficiency Compliant

**Benefits**
- Unrivaled reliability
- High efficiency
- Sealed-tank construction allows for installation in less-than-ideal environments

---

**Liquid-Filled Pad Mount Transformers**

**Ratings/Features**
- Available with primary voltages up to 46 kV in 45 kVA through 20 MVA, sizes with 600 V through 25 kV secondary ratings
- Copper or aluminum windings
- Mineral oil or high-fire-point fluid available
- Self-cooled overload capabilities
- Fusing and switching options
- Loop feed option available
- Secondary busway connections and circuit breaker options available
- 2010 Department of Energy; Energy-Efficiency Compliant

**Benefits**
- Compact and tamper-resistant for underground power distribution systems
- Designed to save space and energy
- High efficiency with low operating costs
- Sealed-tank construction allows for installation in less-than-ideal environments
MV Outdoor Circuit Breakers

Dead Tank Circuit Breaker

FVR Station Breaker

Ratings/Features
- Free-standing medium voltage vacuum station breaker
- 15 kV, 600 A to 4,000 A, 110 kV BIL, 12.5 kA to 40 kA
- 27 kV, 1,200 A and 2,000 A, 125 kV BIL, 12.5 kA to 25 kA
- 38 kV, 1,200 A and 2,000 A, 150 kV BIL, 12.5 kA to 31.5 kA
- 38 kV, 1,200 A, 200 kV BIL, 25 kA
- Arc Resistant Class B, enclosure for breakers rated 2,000 A and below per EEMAC and IEC
- No fans required for 3,000 A rated breaker
- Seismic zone 4 per UBC

Benefits
- High-speed operation — three cycles or less
- Interrupter assemblies and contact wear indicators accessible via a bolted panel for ease of maintenance
- Hermetically sealed interrupters protect contacts from corroding elements and contamination
- Breaker height is adjustable from minimum to maximum in three-inch increments
- Minimal moving parts on the motor-driven, spring-charged Type RI mechanism

VOX Station Breaker

Ratings/Features
- Vacuum interruption technology
- Up to 38 kV, 40 kA, 2,000 A
- IEC and ANSI ratings available
- SF6 insulation in a stainless steel, sealed-for-life, corrosion-free tank
- Large accommodation for bushing current transformer
- Suitable for high-speed auto-recloser switching duty
- -65 °C test available

Benefits
- Maintenance-free vacuum switching
- Immune from external influences such as salt, dust, humidity, small particles, and rodents
- Compact and lightweight design makes it easy to transport, handle, and install
- Separate support frame can be preinstalled to accept the breaker tank and control cabinet
- Reduced inspection and maintenance required with sealed-for-life tank
**RL Series Sectionalizer/Load Break Switch**

**Ratings/Features**
- Up to 38 kV
- Ampacity: 630 A
- Fault interruption rating: 16/12.5 kA
- SF6 insulated
- Automatic sectionalizing based on both current and voltage
- Controller features include: sectionalizer function, monitoring, metering, control, and communications
- Compatible with ADVC Controller

**Benefits**
- 316 marine grade stainless steel allows for installation in all environments and security of a heavy-duty enclosure
- Simple, low-cost solution
- Easy installation with the choice of manual switching or complete automation
- Automation and communication features embedded in the sectionalizer to provide flexibility in outdoor applications

---

**W-Series Single-Phase Recloser**

**Ratings/Features**
- Up to 24 kV and 400 A rated load current
- Up to 6 kA short-circuit current
- Ideal for single-wire ground return applications
- Epoxy bushing insulates the vacuum interrupter
- Integrated CT and VT for optimized automation, remote control, data logging, and monitoring
- Compatible with ADVC Controller

**Benefits**
- Vacuum arc interrupter, contained in an epoxy bushing, eliminates the need for insulants like oil and gas
- Improved reliability with a single magnetic actuator for both tripping and closing
- 316 marine grade stainless steel tank and lid giving it the ultimate protection from the environment
U-Series Three-Phase Recloser

Ratings/Features
- Up to 27 kV and 630 A rated load current
- Up to 12.5 kA short-circuit current
- Easily integrated into smart grid applications with advanced capabilities such as loop automation and automatic changeover
- Flexible for use in stand-alone pole-mounted or complex substation applications
- Solid epoxy dielectric bushings with vacuum arc detection
- Compatible with ADVC Controller

Benefits
- Current and voltage transformers molded into the I-side terminal allow easy monitoring for your overhead voltage network
- Reduced purchasing, installation, and operating costs with intelligent solid-dielectric switchgear
- 316 marine grade stainless steel tank and lid giving it the ultimate protection from the environment

N-Series Three-Phase Recloser

Ratings/Features
- Up to 38 kV and 800 A rated load current
- Up to 16 kA short-circuit current
- Up to 800 A rated load current
- Applications include overhead network protection, loop automation, automatic changeover, generator control, smart grid, and feeder automation
- Integrated CTs and VTs
- Vacuum interrupters in a SF6 gas-filled tank
- Sold with ADVC Controller

Benefits
- Capable of making intelligent switching decisions in just fractions of a second with load- and source-side voltage measurement and current measurement built into the unit
- Reduced purchasing, installation, and operating costs with intelligent solid-dielectric switchgear
- 316 stainless steel tank and lid giving it the ultimate protection from the environment
Pole-Mounted Switchgear

ADVC Controller

Features

- Stainless steel cubicle in two sizes:
  - ULTRA for complex applications and customer space
  - COMPACT for straightforward overhead feeder installations
- Two operator interface options:
  - flexVUE for users who prefer working with status lamps and command buttons
  - setVUE for users who prefer a menu-driven operator interface
- Control panel provides access to system status, event log, measurement, protection, automation, and communication
- Communication connections:
  - Control and protection include DB9, RJ45, and RJ11
  - Remote applications include a combination of RS232, RS485, Ethernet and V23
- Power supply and batteries located at the bottom of the cubicle provide uninterrupted power to the switchgear, protective relays, and communication devices

Benefits

- Defer capital works by offering features that reduce stresses
- Easily integrated into smart grid applications with advanced capabilities
- Flexible applications from complex substation to stand-alone pole mounted
- Automatic isolation of permanent faults
Overhead Network Control

Easergy T200P Remote Network Control

Features
- Management of one or two switches of any type
- Pole mounted
- 24 Vdc or 48 Vdc UPS
- Fault passage indicator and loss-of-voltage detection
- Current, voltage, power, and energy measurements
- Transmits via Ethernet, RS232, RS485, Radio, PSTN, GSM, GPRS, private line

Benefits
- Reliability with numerous auto-tests, particularly on the power supplies and battery
- The auto-tests ensure the availability of equipment without the need for preventive maintenance
- Reduce outage time with an all-in-one monitoring and control unit
- Compatible with all remote control systems and embedded web pages
- Easy to implement

Easergy Flair 200C Remote Monitoring Network

Features
- Three-phase communicating fault passage indicator
- Insensitive to capacitive currents
- Detects fault currents without voltage measurements
- Six digital inputs, three digital outputs
- Rechargeable battery backup
- One communication port for Ethernet, RS232, RS485, Radio, PSTN, GSM, GPRS

Benefits
- Embedded Web server allows for remote access
- Cost-efficient solution to monitor your MV substation without a SCADA system
- Improves quality of service by reducing fault-finding times
- Compact cubicle for one or two measurement and fault current detection channels
**Easergy Flair 2xd Range**

**Features**
- Fault detection and ammeter: Flair 21D and 22D
- Overcurrent detection and ground fault detection
- Real-time indication of your load
- Output contact for interfacing with SCADA system
- Optional outdoor indicator lamp

**Benefits**
- Ready to use — no settings, starts by itself
- No maintenance
- No minimum current to operate — Flair 22DV
  - Can be used on the complete MV network
  - Dual power (self-powered and lithium battery)

---

**Easergy Flite 110-SA**

**Features**
- Single-phase line mounted fault passage indicator
- Automatically adapts to the network voltage frequency, then activates the fault detection function
- Indicates both permanent and transient faults
- Two sensors for detecting current and voltage
- Detects both short-circuits and low-current ground faults
- Highly visible with red flashing light
- User adjustable

**Benefits**
- Hooks directly on the line without special tools
- Configurable on-site for easy coordination with the upstream protection system
- If a permanent fault occurs while the device is already indicating a transient fault, the flashing automatically changes from transient to permanent enabling maintenance staff to deal with faults according to their priority level
- Can be used on up to 69 kV systems
Fault Passage Indicators

**Easergy Flite 116-SA/G200**

**Features**
- Automatically adapts to the network voltage frequency, then activates the fault detection function
- Communicates via a low-power, license-free radio with a G200 RTU mounted on the pole
- G200 RTU is able to manage the communications of up to 9 Flite 116-SA (3 MV lines) and transmits the information to the SCADA system over protocols such as DNP3, IEC 870-5-101, or Modbus
- Indicates both permanent and transient faults
- Detects both short-circuits and low-current ground faults
- Highly visible with red flashing light

**Benefits**
- Hooks directly on the line without special tools
- The payback is quick because the outage time is being decreased, the reduction of non-distributed energy is important, and the quality of the network improved
- If a permanent fault occurs while the device is already indicating a transient fault, the flashing automatically changes from transient to permanent enabling maintenance staff to deal with faults according to their priority level
- Can be used on up to 69 kV systems

Metal-Enclosed Bus Duct System

**Power-Zone Non-Segregated Busway System**

**Features**
- 600 V up to 38 kV
- 5 kV, 15 kV, or 38 kV fluidized bed epoxy insulation
- 1,200 A up to 6,000 A bus ratings
- Copper or aluminum construction
- Aluminum, steel, or stainless steel housing
- Weatherproof housing available as an option
- Components include: equipment terminations, elbows and tees, expansion joints, fire and smoke barriers

**Benefits**
- Custom designed and manufactured for each application
- The bus conductors are completely enclosed in a grounded metal housing for the protection of both personnel and property
Reactivar Medium Voltage Fixed Capacitors

Features
- Standard rating up to 600 kVAR @ 2.4 kV, 900 kVAR, 4.8 kV, 60 Hz (specials available)
- Low dielectric loss including discharge resistors
- Internally mounted discharge resistors
- Internally delta-connected capacitor elements
- Built to applicable NEMA, IEEE, and IEC standards
- Available for indoor and outdoor installations
- Painted ASA 70 gray

Benefits
- Reactive compensation of steady induction motor loads
- Reduce energy costs by improving inefficiencies that reside in the motor loads
- Reduce the need to oversize transformers, cables, switching, and protection devices

Medium Voltage Metal-Enclosed Reactive Compensation Systems

Features
- Designed and built per applicable ANSI/NEMA/IEEE and/or IEC standards
- Standard metal enclosures available up to 20 MVAR, up to 34.5 kV, 50/60 Hz
- Steel or aluminum based enclosure bays
- Externally or internally fused capacitor elements
- Current-limiting capacitor fuses with blown fuse pop-up indicators
- Inrush current limiting or tuned (antiresonant or filtered) reactors
- Fully grounding switches
- Options include single-state, multistage, antiresonant, and filtered capacitor systems
- Available for indoor and outdoor installations

Benefits
- Centralized reactive compensation of larger facilities
- Reduce kVA demand and lower utility imposed charges for poor power factor
- Provide voltage support and harmonic filtering

Medium Voltage Hybrid Ultra-Fast Reactive Compensation Solution

Features
- Custom designed and built to specific load and objective requirements
- Ultra-fast response time and seamless VAR injection
- Compensation of large inductive inrush currents

Benefits
- Reduce flicker and improve voltage regulation
- Real-time (dynamic) reactive compensation systems for rapidly fluctuating MV loads
- Transient-free compensation
Engineered Product Solutions

Walk-In Substations (Powerhouse/Power-Zone Center)

Powerhouse/Power-Zone Center
Features
• Containerized substation — comprising:
  - MV switchboard (AIS, GIS)
  - LV switchboard
  - Monitoring, control, protection, measurement
• Pre-engineered solution
• Pre-assembled at works
• Pre-commissioned in factory
• Up to 52 kV

Benefits
• Increased reliability owing to full assembly/quality control in the factory
• Reduced erection and commissioning time/cost
• Reduced cost and reduced time to network connection
• Can be depreciated much faster than a block building due to classification as electrical equipment

Medium and High Voltage Open-Rack-Style Reactive Compensation Systems
Features
• Custom designed per installation requirements and protection configurations
• Open-style, elevated rack mounting
• Systems rated up to 230 kV, 50/60 Hz
• Internally fused capacitors
• Double-wye ungrounded configuration with neutral CT protection (standard)
• Inrush current limiting or tuned (antiresonant or filtered) air-core, open-style reactors

Benefits
• Compensation systems for utility distribution and transmission grids
• Various equipment topologies available to cover project-specific utility application and installation needs
• Special topologies for reactive compensation of wind and solar farms

Power Factor Correction and Harmonic Filtering

Medium and High Voltage Open-Rack-Style Reactive Compensation Systems
<table>
<thead>
<tr>
<th>Application</th>
<th>Sepam 10 Series</th>
<th>Sepam 20 Series</th>
<th>Sepam 40 Series</th>
<th>Sepam 80 Series</th>
<th>MiCOM Px10 Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeder</td>
<td>Multifunction protection relay for basic applications</td>
<td>Multifunction protection relay for standard applications</td>
<td>Multifunction protection relay for demanding applications</td>
<td>Multifunction protection unit for critical and customized applications</td>
<td>Multifunction protection relays for basic electrical schemes</td>
</tr>
<tr>
<td>Transformer</td>
<td>Designed to provide the necessary protection for the operation of machines, industrial electrical distribution networks, and utility substations for all voltage levels.</td>
<td>Designed to adapt to demanding applications that call for current and voltage metering when providing protection for machines, industrial electrical distribution networks, and utility substations for all voltage levels.</td>
<td>The SEPAM relay line’s most robust and advanced IED allowing for custom-designed application via Logipam™ (ladder logic programming). The Sepam 80 has been IEC 61508 compliant and SIL2 rated for use in nuclear power plants.</td>
<td>Nondirectional overcurrent and ground-fault protection, especially adapted for LV and MV applications.</td>
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<tr>
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<td>Feeder</td>
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<td>Feeder</td>
<td>Feeder</td>
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<td>Transformer</td>
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<td>Generator</td>
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<td>Wall/Surface, Panel, or DIN Rail</td>
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<td>Display Type</td>
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# Protection and Control

<table>
<thead>
<tr>
<th>MiCOM Px20 Series</th>
<th>MiCOM Px30 Series</th>
<th>MiCOM Px40 Series</th>
<th>VAMP 221 Series</th>
<th>VAMP 321 Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multifunction protection relays for standard electrical schemes</td>
<td>Multifunction protection relays for complex electrical schemes</td>
<td>Multifunction protection relays for complex electrical schemes</td>
<td>Dedicated arc detection schemes</td>
<td>Dedicated arc detection schemes</td>
</tr>
<tr>
<td>The Px20 series is designed to provide the essentials of protection. Applications range from main or backup protection to neutral systems protection.</td>
<td>Designed for the rigorous requirements with focus on feeder and transformer protection and control. Programmable scheme logic (PSL) for flexibility and customization.</td>
<td>This series is the most advanced of the MiCOM portfolio. The series offers enhanced user-friendly customization capability with its PSL available with graphic configuration tool.</td>
<td>Arc Detection</td>
<td>Arc Protection Event and Disturbance Recording</td>
</tr>
<tr>
<td>Feeder</td>
<td>Feeder</td>
<td>Feeder</td>
<td>Arc Detection</td>
<td>Arc Protection</td>
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<td>Motor</td>
<td>Motor</td>
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<td></td>
<td>Event and Disturbance Recording</td>
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<td>Bus Bar</td>
<td>Transformer</td>
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<td>Line Differential</td>
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<td>Modbus™ RTU</td>
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<td>IEC 60870-5-103</td>
<td>DNP3/IP</td>
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<td></td>
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<tr>
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<td>Courier</td>
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<tr>
<td>IEC 61850</td>
<td>IEC 60870-5-103</td>
<td>IEC 61850</td>
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<td>Panel or Rack</td>
<td>Panel or DIN Rail</td>
<td>Panel or DIN Rail</td>
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<tr>
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<td>Surface, or Rack</td>
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<tr>
<td>Digital</td>
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<td>Modbus™ RTU</td>
<td>IEC 60870-5-103</td>
<td>IEC 61850</td>
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<td>IEC 60870-5-103</td>
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<tr>
<td>K-Bus/Courier</td>
<td>Courier</td>
<td>Courier</td>
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<tr>
<td>IEC 61850</td>
<td>IEC 60870-5-103</td>
<td>IEC 61850</td>
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<tr>
<td>Panel or Rack (with adaptor)</td>
<td>Panel, Wall/</td>
<td>Panel or Rack</td>
<td>Panel or DIN Rail</td>
<td>Panel or DIN Rail</td>
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<tr>
<td></td>
<td>Surface, or Rack</td>
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<td>Digital</td>
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</table>
Arc Flash Mitigation
Arc Flash Mitigation

Characteristics of Arc Flash 31
- Typical Causes of an Arc Flash Event

Safe Work Practices Enhance Protection 32
- NFPA 70E and Others

Mitigation Techniques 33
- Passive Arc Mitigation
- Active Arc Mitigation
- Remote Racking Systems
An arc flash occurs when uncontrolled energy moves between phases, phase to ground, or neutral.

Typical Causes of an Arc Flash Event

An arc flash event can be initiated either by equipment failure or human error. The most prevalent cause is human error. Some statistics indicate that 65 percent of these incidents occur while a person is working on the equipment and that only 25 percent occur while no one is around it. That leaves 10 percent when someone is in the vicinity of the equipment but not working on it.

Human error causes include, but are not limited to, mishandling tools, leaving tools behind after working on the equipment, or coming in contact with live parts. Company operating procedures can go a long way in reducing these typical causes. Some company’s best practices require that employees remove all personal clothing and jewelry prior to the start of the work day. Other requirements include a complete inventory of tools etc. when entering or exiting the work site. Operational procedures like these reduce the occurrence of left-behind tools and prevent potential hazards.

Equipment failure is attributed to one or more of the following:

- Damaged insulation
- Airborne particles contaminating insulators
- Improper installation
- Voltage spikes
- Overcurrent events
- Oxidation on terminal points
- Animal entry into equipment (i.e., snakes, rats, squirrels)
- Too much moisture entering live part areas
- Loose electrical connections
- Chemical vapors

These possible causes can be significantly reduced by instituting a functioning periodic maintenance program for all electrical equipment. The investment in equipment maintenance pays off threefold: decreased unexpected downtime due to mechanical failure, arc flash event reduction, and the extension of the equipment’s useful life.
If arc flash hazards are unknown, you cannot possibly plan to avoid them properly. That is why it is so important to know your equipment and the hazards that exist as it is installed.

Limiting your exposure to arc flash hazards is always best either through engineered solutions or processes. You must address the items listed below to minimize the arc flash hazards at the workplace. OSHA 29 CFR-1910, Subpart S provides legal requirements for employers to guard against arc flash hazards. It sets general requisites for safe work practices, personal protective equipment (PPE), and hazard analysis.

- Identifying hazards by means of an arc flash study.
- Avoiding hazards with warning labels, live work permits, maintenance procedures, and even system redesign if possible.
- Protecting workers against hazards with PPE, proper tools, and training. This may be the most important measure you can employ.

An arc flash study shows you the equipment that should be labeled, its risk/hazard levels, and defines protection zones based on the available fault current of the system. This helps to determine the proper PPE needed in each of the protection zones. You may discover that the fault level exceeds currently available PPE so you would not be able to work on the equipment live without other means of reducing the fault level. Refer to IEEE 1584: Guide to Performing Arc Flash Calculations. This standard provides the formulas necessary for analyzing arc flash hazards.

**NFPA 70E and Others**

NFPA 70E® and NEC® drive labeling of equipment with arc flash hazards. Live work permits must be used to set proper procedures in place before work begins on live equipment. Once again, it can’t be stressed enough that proper maintenance significantly reduces the possibility of an arc flash event. Clean equipment also means you are getting the maximum effort from your system at all times.

A system redesign may be an option to reduce your available fault current in that system. Reducing these currents can make the system more affordable to manage as well.

Providing proper PPE is only one part of the overall protection. Tools that protect against accidental contact with live parts are important too. But the best value is training your personnel on the use of the PPE and tools you provide. Safety must become a habit and repetitive training develops that habit.

PPE is the final barrier against arc flash hazard for the individual. It does not prevent the arc flash but it protects a person against the arc flash itself. This equipment must be worn when in the arc flash protection boundary. Each arc flash protection boundary dictates the level of PPE required for working in that area. This equipment includes, but is not limited to, a face shield, hearing protection, cotton or flame-resistant clothing, gloves, and insulated blankets. Flame-resistant clothing is normally defined by the calories per square centimeter of energy they can protect against (i.e., 40 calories). That is why an arc flash hazard study is a must for you to conduct.

Below is NFPA 70E Table 3-3.9.1 showing examples of PPE required for each risk/hazard category as defined by NFPA 70E.

<table>
<thead>
<tr>
<th>Risk/Hazard Category</th>
<th>Incident Energy (cal/cm²)</th>
<th>Examples of PPE Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2 or lower</td>
<td>Non-melting clothing</td>
</tr>
<tr>
<td>1</td>
<td>2 – 4</td>
<td>FR shirt and pants</td>
</tr>
<tr>
<td>2</td>
<td>4 – 8</td>
<td>FR shirt and pants, cotton underwear</td>
</tr>
<tr>
<td>3</td>
<td>8 – 25</td>
<td>FR shirt and pants, FR coveralls, cotton underwear</td>
</tr>
<tr>
<td>4</td>
<td>25 – 40 and higher</td>
<td>FR shirt and pants, full-coverage flash suit, cotton underwear</td>
</tr>
</tbody>
</table>

These measures provide a means to protect your operating personnel from the flash hazards associated with arc energy. It must be stressed that the protective clothing mentioned here does not protect against the pressure wave that is generated during the arcing event.

We will look at all of the following methods for arc flash mitigation that you should consider for your facility.

- Passive Arc-Resistant
  - Arc-Resistant Enclosures
- Active Arc Mitigation Systems
  - Relay-Based
    - Zone Selective Interlocking
    - Bus Differential Relay Protection (87B)
  - Arc Flash Reduction Maintenance Switch (ARMS)
  - Arc Flash Relay System (VAMP)
- Arc Terminator
- Remote
  - Motor-Driven Racking Device
Arc flash hazards can also be controlled by engineered solutions utilizing either traditional arc-resistant equipment or relay-based protection. Traditional arc-resistant equipment meeting IEEE C37.20.7 Test Guide can provide a passive approach to arc flash containment. Active system control includes either a relay-based arc flash reduction or arc flash elimination such as Arc Terminator. The following will show each type and its associated pros and cons. This will help you understand each method and decide which will be most appropriate for your application.

Passive Arc Mitigation

Passive system enclosures offer arc flash containment and redirect the fault energy up and away from the installed equipment and personnel. Schneider Electric can provide both the non-plenum and plenum style depending on the restrictions at the installation site.

Equipment such as our Masterclad AR and Motorpact MCC has been certified to IEEE C37.20.7 Test Standard. Accessibility types define the level of containment obtained through design and testing.

Test Levels
- Preferred arcing short-circuit current is the rated short-time current of the equipment
- Preferred arcing duration is 0.5 s at the rated power frequency of the equipment

Note: A 2BC accessibility type can be obtained that will allow for the low voltage compartment to be opened as well as provide compartment-to-compartment isolation.

Plenum Requirements When Using Metalclad Arc-Resistant Switchgear

<table>
<thead>
<tr>
<th>SC Rating</th>
<th>Ceiling &lt; 156&quot; (PZC Only)*</th>
<th>156&quot; – 168&quot;</th>
<th>169&quot; – 192&quot;</th>
<th>&gt; 192&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 36 kA</td>
<td>PL</td>
<td>STD</td>
<td>STD</td>
<td>STD</td>
</tr>
<tr>
<td>≥ 36 kA – 40 kA</td>
<td>PL</td>
<td>PL</td>
<td>STD</td>
<td>STD</td>
</tr>
<tr>
<td>≥ 41 kA – 50 kA</td>
<td>PL</td>
<td>PL</td>
<td>PL</td>
<td>AS</td>
</tr>
<tr>
<td>&gt; 50 kA</td>
<td>PL</td>
<td>PL</td>
<td>PL</td>
<td>PL</td>
</tr>
</tbody>
</table>

STD: Standard option
AS: Arc Shield
PL: Exhaust plenum
*PZC (Lectrus) orders are allowed to install plenums on lower ceiling houses
The passive envelope does provide designed and tested protection as long as there is no physical compromise of the enclosure, such as having the medium voltage door open while the equipment is operating. You must wear the proper PPE based on the established arc flash boundary.

Examples of personnel activities or installation conditions not covered by this guide include, but are not limited to:

- Specifically excludes working in, on, above, and below the equipment
- Including equipment installed over a cable vault that persons could enter
- Excludes operating personnel who open doors and/or panels during duties
- Does not imply protection from equipment damage; it is expected that equipment involved in an internal arcing fault will require rework or replacement
- Does not cover all effects that may constitute a risk, such as arc blast or the release of toxic materials

While total elimination of the effects of arc flash are not possible here, additional procedures can further reduce those effects when used in conjunction with the type of equipment.

Remember that when you open the doors on this type of equipment live, you are still required to wear the proper PPE for the arc flash hazard calculated by study.
Active Arc Mitigation

Active systems can achieve some level of protection even while the equipment is still energized. Many different methods of using protective relays are available, some of which will be addressed here.

System design concepts should address some, if not all, of the following when selecting a method:

- Fewer faults
- Clear faults quickly
- Redirect arc flash energy where possible
- Stand outside the arc flash zone
- Additional considerations:
  - Speed and isolation of faults
  - Protection of personnel
  - Recovery time after event
  - Where to redirect the incident energy
  - Cost
  - Installation requirements

Zone Selective Relay-Based Approaches

The objective of Zone Selective Interlocking (ZSI) is to trip the breaker closest to the fault without time constraints and still maintain system coordination. Certainly this method provides good coordination and uses standard protective relays and is applicable to both low and medium voltage systems. However, it may not allow you to obtain your desired arc flash energy level because of the need to coordinate settings. It can also be application intensive for some breaker arrangements.

The speed of operation is dependant on the relay plus the breaker speed. While it can reduce your PPE level, an arc flash hazard study must be conducted to determine the level obtained. This method does provide good isolation of the fault and will isolate the damage as well. The recovery time after an event is dependant on the fault magnitude.

The cost of this method is small if you utilize standard relays with a ZSI feature. Sepam relays provide this along with standard protective features.
**Bus Differential Protection Using the VAMP Relay System**

The VAMP protective system is another Schneider Electric product that offers bus differential as well as other protective functions.

While bus differential may not perform well in all situations, such as internal faults, protection is obtained through low-cost digital relays such as VAMP. It may not be as discreet as a ZSI system in some cases and could be application intensive in some low voltage systems. However, it may provide an overall benefit where applicable.

Once again, speed of operation is dependant on the relay and breaker speeds. It can lower the PPE requirements but an arc flash hazard study must be conducted to determine that.

Equipment damage will occur and the amount of damage is dependant on the fault magnitude. The cost to implement this system is usually slightly higher than that of a Zone Selective Interlocking scheme. The VAMP system is a cost-effective method that meets your system needs in one package.

**Arc Flash Reduction Using the VAMP Relay System**

The VAMP offer is designed specifically for arc flash reduction. It detects an arc flash and associated current spike to trigger an upstream breaker. Reaction time varies from 2 to 7 ms depending on the relay options. This system can be used in both low and medium voltage applications. Since this is a stand-alone product, coordination with other protective devices is required to maximize its function. Equipment damage will occur but is greatly reduced due to its speed of operation. The total operating time is the sum of the relay and breaker speeds. The recovery time after an event is dependant on the arc fault magnitude. The level of PPE needed can be reduced while this system is active. The cost of this system is only slightly more than of the previously mentioned relay schemes.

**AMS or Arc Flash Reduction Maintenance Switch**

Arc flash reduction through temporary secondary settings is possible with an integrated selector switch and relay scheme. Temporary secondary settings can be determined after an arc flash hazard study is performed. This can lower the PPE requirements during the maintenance activity as desired. In some applications, temporary settings could interfere with normal operations. The possibility of fault propagation must be considered as well. Once again, the relay and breaker response speed is important to reducing the fault level. Equipment damage is limited only by the fault magnitude. The cost of this is small when compared to the previously discussed methods.

Schneider Electric provides a system using our Sepam relay that fits these requirements.
Arc Terminator Active Arc Mitigation

Arc Terminator provides IEEE C37.20.7 Type 2BC levels for equipment and personnel protection in NEMA Type 1 enclosures. The Arc Terminator system provides the best of all protection when compared to other methods. It combines both current and arc flash inputs to trigger a high-speed switch that shunts the bus to ground extinguishing the uncontrolled arc in less than 4 ms, and this operating time is not dependent on the operating speed of the upstream breaker. It can reduce the PPE level to zero in systems up to 50 kA available fault current*. Out of all systems currently available, this system provides the fastest recovery time after event, taking hours instead of days or weeks. The Arc Terminator may require coordination with the utility for a fully coordinated system approach. The Arc Terminator system costs about 35 percent more than standard non-arc-resistant structures. However, the cost of installation is small when compared to the overall benefit obtained for both personnel and equipment protection.

The Arc Terminator self-test feature notifies you if a system component is not functioning as required. It completes a thorough system check every five hours giving you confidence that the system is ready to operate if needed.

*Note: While the fault energy is reduced, the shock hazard is not and requires that you wear the appropriate protective clothing to protect you from coming in contact with live parts.

Personal Protection Equipment Requirements when Using the Arc Terminator System

<table>
<thead>
<tr>
<th>4.76 – 15.0 kV Class with Arc Terminator System¹</th>
<th>4.76 – 15.0 kV Class without Arc Terminator System²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arc Fault Current (in kA)</td>
<td>Working Distance (in inches)</td>
</tr>
<tr>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>40</td>
<td>18</td>
</tr>
<tr>
<td>50</td>
<td>18</td>
</tr>
</tbody>
</table>

¹ Data based upon IEEE Std. 1583-2002 methodology
² Data based upon functional Arc Terminator system
³ Data assumes fault clearing time of 50 ms (three cycles), five-cycle breakers will have higher incident energy levels
Remote Racking Systems

Remote Racking

There are alternatives that enhance personnel protection that are not as costly as the active systems discussed. Where space allows, keeping maintenance personnel outside the arc flash boundary can best be accomplished by a remote racking device as shown below. Maintenance personnel can mount the device to the equipment and step away with the control box and 50 ft cable to a safe area to rack the breaker in or out. It is not dependent on relay protection and provides good isolation from an arc flash event where space permits.

Remote Racking Device

Typical Remote Racking Configuration
Solutions from The Global Specialist in Energy Management™!

**We design** energy management solutions...

**Safe:** Protecting people and assets.

**Reliable:** Delivering ultra-secured power for critical applications.

**Efficient:** Building integrated solutions for energy efficiency.

**High-performing:** Deploying life cycle services and connectivity everywhere.

**Green:** Implementing state-of-the-art solutions for renewable energies.

Make the most of your energy℠