

Automation & Power World

Improving safety Through arc resistant switchgear and arc reducing components

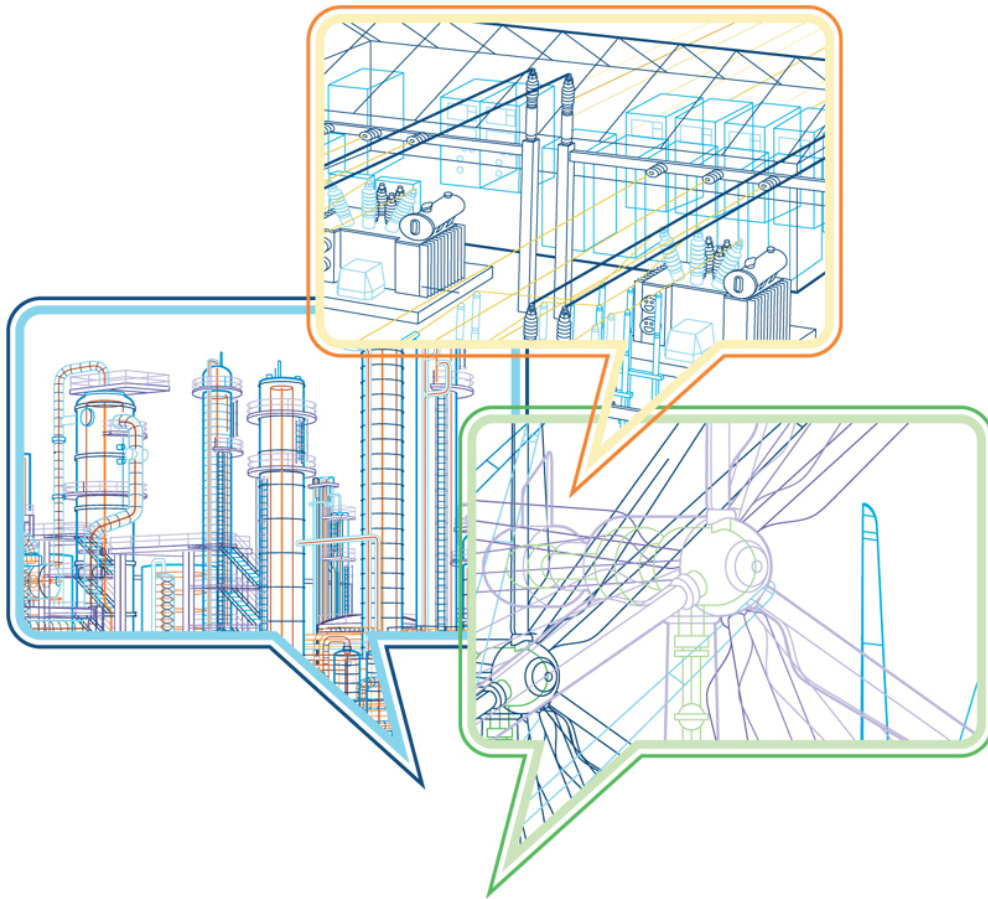
Automation & Power World 2011

April 18-21, 2011 in Orlando, Florida



Automation & Power World 2011

April 18-21, 2011 in Orlando, Florida



- Save the date for this “must attend” event!
- April 18-21, 2011
- Orlando World Center Marriott, Florida
- Over 400 hours of educational training
 - Business forum
 - Customer case studies
 - Hands-on training
 - Panel discussions
 - Technical workshops
- Earn PDHs and CEUs
- Technology & Solution Center
 - Over 70,000 sq. ft. of exhibits
- Network with your peers
- www.abb.com/a&pworld

ABB Automation & Power World

At-a-glance

400+

Educational workshops

Automation & Power World offers over 400 hours of educational workshops specifically designed to make engineers, maintenance and management more valuable to their companies.

70K

Technology & Solution Center

Over 1 ½ acres (70,000 ft²) of with nearly 100 tons of electrical gear and 100's of experts ready to answer any of your questions and share the future of Automation & Power Solutions.

4,000

Connect with Peers

With over 4,000 of your peers in attendance, this is a powerful opportunity to network and learn from the industry. In addition, over 45 customers will be sharing their own case studies.

Educational workshops developed for all audiences

Just a few examples

Roles

Engineering

Management

Maintenance

Company types

Industrials

EPCs

Utilities

OEMs

- The coming wave of process safety system migration
- Implementing an alarm management strategy for a 100,000 I/O system - Case study
- Replacement and retrofit of large motors: Challenges and solutions
- Dynamic studies for large scale renewable energy integration at a Texas CREZ - Case study
- Secure commissioning of your process plant - Case study
- New arc flash mitigation technologies and techniques for a safer working environment
- Robotics 101
- A better approach to non-revenue water loss
- Electric vehicles: Are they real this time?
- Why is SIL more important than architecture?

Past attendees input



“I am impressed with the different parts of the program, the workshops and also the exhibit set-up... there is a lot of information to pick up.”

Duane Souers, Georgia Pacific

“It’s a great opportunity to get a lot of exposure to people and products in one week.”

Pardeep Gill, Alcoa



“It is well worth the time given the opportunities to: learn from industry experts, network with peers in the same industry, learn about emerging technologies, and build excellent supplier relationships.”

Sanjin Osmancevic, National Grid

Jerry Earl – Product Manager
Medium-voltage
metal-clad switchgear

ABB – Lake Mary, FL

Introduction

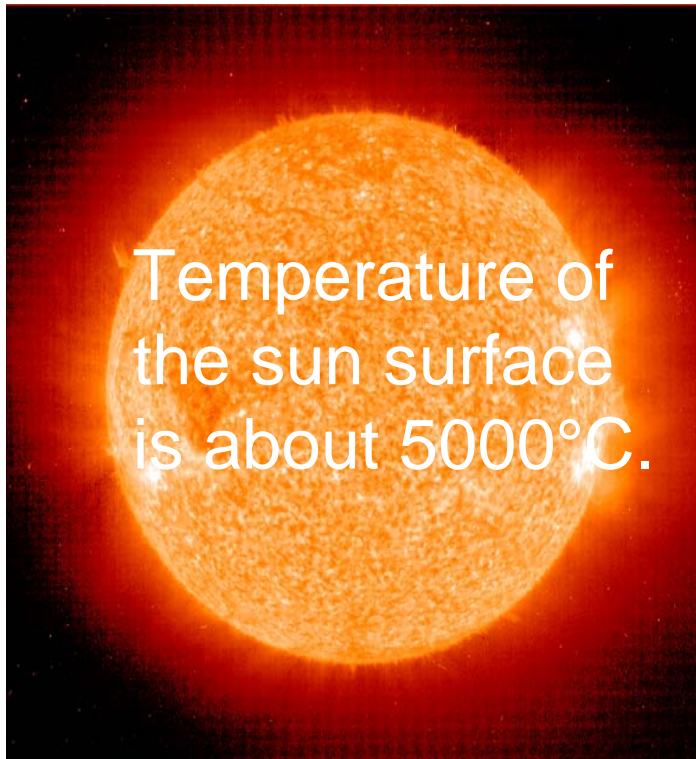
Today's topics



- Arc flash characteristics
- Causes of arc flash incidents
- Current standards and how they apply
- Safety techniques
- Arc flash mitigation techniques
 - Space and distance
 - Arc-resistant switchgear
 - Relays to mitigate arc flash hazard



What is an arc flash?



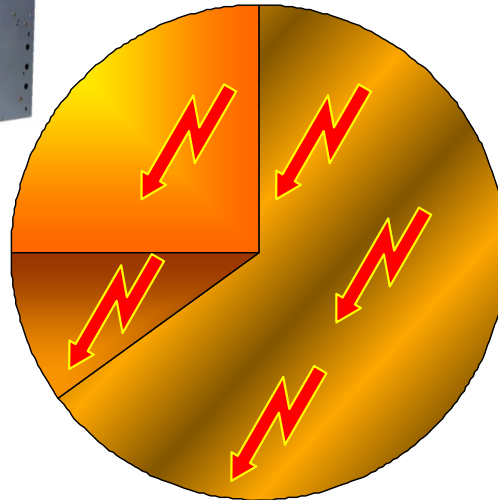
- The result of a rapid release of energy due to an arcing fault between phases, neutral or a ground.
 - An arc arises when at least part of the current passes through a dielectric, usually air
 - Maximum peak power up to 40 MW
 - Arc temperature up to five times the surface temperature of the sun (20,000°C)
 - Light intensity more than 2000 times that of normal office light
 - Volumetric expansion approximately 40,000+ - 1

Arcing incidents happen When?

Without operator,
25%

With operator in
front of a closed
door, 10%

With operator working
in the switchgear, 65%



Hazards of an arc flash

- We all know about the heat that is generated but what are the other hazards besides the fire ball?
 - Shrapnel – push buttons, lights and relays make great projectiles
 - Pressure waves – generate extremely violent forces on the human body
 - Hot gases – frequently the cause of death is not the burns on the body but the hot gases that are inhaled and burn the lungs
 - Toxic fumes – long term health risks
 - Molten metal – as the copper vaporizes and melts, droplets can splatter and burn through most current PPE

Common causes of arc faults in switchgear



- Human error
 - Accidental touch
 - Dropping or misplacement of tools & other parts
 - Improper installation practices
 - Wrong tools used selected
- Mechanical failures
 - Voids in insulation and insulation breakdown
 - Breaker failures in contacts, springs, stabs, etc.
 - Loose connections and bolts
 - Warping due to shifts in floor, aging connectors, etc.
- Intrusion
 - Snakes, mice, rats, raccoons, bees, etc.
- Environmental issues
 - Dust, contamination, moisture

Arc flash danger statistics

- Currently, OSHA lumps arc flash incidents in with electrical incidents.
- A recent survey showed that 5-10 people per day go to burn centers due to arc flash incidents – that does not include those going to local and regional hospitals
 - That is 2000-3500 people a year in the US!
 - With the high mortality rate of burn injuries, this can translate to hundreds of deaths a year
- IEEE did a study with a large utility and over the last 53 years, they have had 1 major arc flash incident every 18 months.

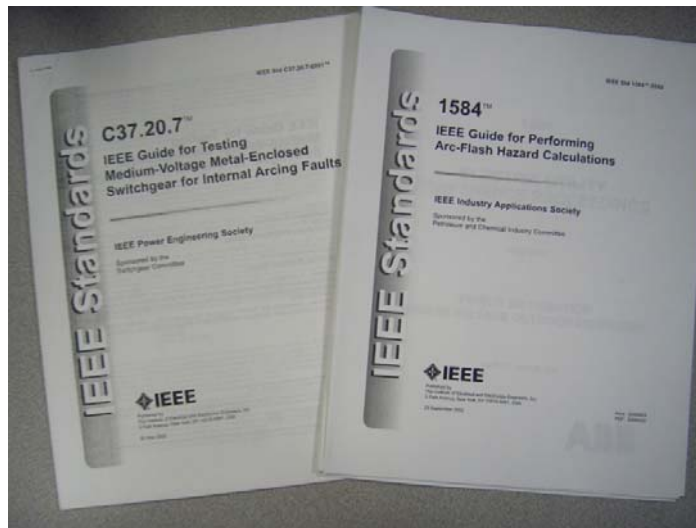
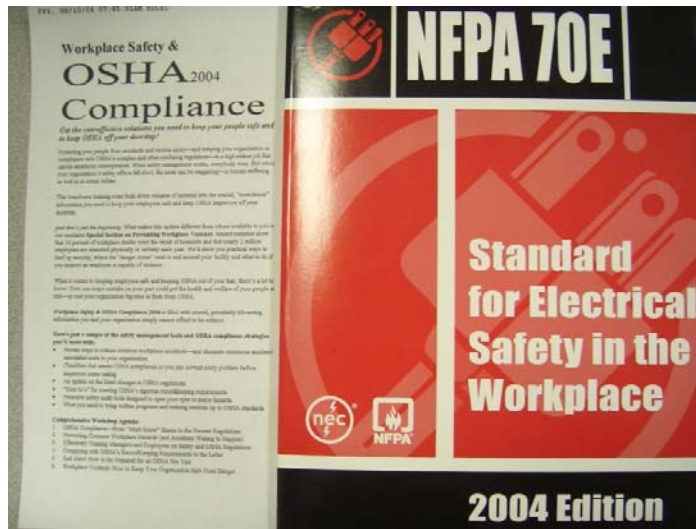
Arc-resistant standards

Evolution of arc-resistant switchgear standards

- Interest in Europe – uninsulated bus was common
- Annex AA to IEC 298 was approved in 1981
- EEMAC G14-1 was published in 1987 in Canada
 - Type A – arc-resistant construction at the front only
 - Type B – arc-resistant construction at the front, back, and sides
 - Type C – arc-resistant construction at the front, back, and sides, and between compartments
- IEEE C37.20.7-2007 includes
 - Type 1 – similar to EEMAC Type A above
 - Type 2 – similar to EEMAC Type B above
 - Annex A addresses suffixes “B” and “C”
 - Type 1C – Type 1, but also with arc-resistance designs or features between adjacent compartments
 - Type 2B – Type 2 with LV instrument compartment door open – relay and maintenance personnel survive
 - Type 2C - Type 2 with arc-resistance features between adjacent compartments – switchgear survives with minimum damage
 - Type 2BC – The ultimate in protection – combines types 2B and 2C

Arc-resistant standards

Industry recognition of arc flash hazards



- OSHA 29 Code of Federal Regulations (CFR) Part 1910, Subpart S
- NFPA 70E-2009, “Standard for Electrical Safety in the Workplace”
- IEEE 1584-2002, “Guide for Arc Flash Hazard Analysis”
- IEEE C37.20.7-2007, IEEE Guide for Testing Medium-Voltage Metal-Enclosed Switchgear for Internal Arcing Faults

Arc-resistant standards

Current requirements and how they apply

- OSHA 29 Code of Federal Regulations (CFR) Part 1910, Subpart S
 - Safe practices to prevent electrical shock or burns must be implemented
 - Mandates that exposed workers must be qualified
 - Requires provisions for the appropriate personnel protective equipment (PPE)
- NFPA 70E-2009, “Standard for Electrical Safety in the Workplace”
 - Details steps to comply with the OSHA requirements
 - Worker training
 - Appropriate safe tools
 - Safety program
 - Arc flash PPE ratings
 - Equipment warning labels

The new NFPA 70E – 2009, Table 130.7 (C) (9)

Arc-resistant switchgear type 1 or 2


- Applies to clearing times of <0.5 sec with a perspective fault current not to exceed the arc-resistant rating of the equipment

Category	Hazard/Risk
Insertion or removal of CBs from cubicles	4
CB operation with enclosure door closed	0
doors open	
Insertion or removal of CBs from cubicles	0
doors closed	
Insertion or removal of ground and test	0
device with door closed	
Insertion or removal (racking) of voltage	0
transformers on or off the bus, door closed	
Work on control circuits with energized electrical	2
conductors and circuit parts 120V, exposed	

Safety measures you can take

- Principle factors to determine arc flash hazard:
 - Available short circuit current
 - Duration of the arc (clearing time)
 - Distance from arc to personnel
 - Arc gap
- Actions you can take to minimize hazards (in order of preference):
 - Elimination
 - Substitution
 - Engineering controls
 - Work practices
 - Personal protective equipment
 - Training and communication

Work practices

 WARNING	
Arc Flash & Shock Hazard Appropriate PPE Required	
FLASH PROTECTION Flash Hazard Category: <u>4</u> Min. Arc Rating (cal/cm ²): <u>40</u> Flash Protection Boundary: <u>35</u> PPE: <input checked="" type="checkbox"/> Cotton underwear <input type="checkbox"/> FR shirt and pants (or FR coverall) <input checked="" type="checkbox"/> Full flash suit and hood <input type="checkbox"/> Hard hat <input checked="" type="checkbox"/> Safety glasses or goggles <input type="checkbox"/> Hearing protection <input type="checkbox"/> Leather gloves and shoes	SHOCK PROTECTION 220 VAC Shock Hazard When: <u>The lower cover is open.</u> Limited Approach Boundary: <u>48 inches</u> Restricted Approach Boundary: <u>20 inches</u> Prohibited Approach Boundary: <u>10 inches</u> PPE: <input checked="" type="checkbox"/> Class 40 <input type="checkbox"/> V-Rating <input type="checkbox"/>
Equipment ID: 15763	

- Safe distances from electrical switchgear
 - flash boundary can be established
- Warning labels and correct PPE per NFPA 70E
- Operating procedures
 - Work on de-energized switchgear
 - Safety tools & equipment
 - Training of personnel

Arc flash introduction

Mitigation techniques

Move the people away from the equipment

- Remote racking mechanisms for breakers
- Automatic secondary disconnects on breakers
- Relays & meters moved to separate panels
- Eliminate need for maintenance

Redirecting energy away from workers

- Arc-resistant switchgear
 - Type 2 – Arc-resistant construction at front, back and sides of equipment
 - Type 2BC – Arc-resistant construction from compartment to compartment and isolation of the instrument compartment

Reduce the clearing time of the breakers

- Maintenance mode switch with all breakers having instantaneous over-current trips active
- Differential relays to detect internal faults
- Light detection relays for extremely fast detection times

Use of fast acting fuses

- Not a practical solution today due to cost and size constraints in most applications
- Viable solution when separating parallel gear to reduce total available fault

Improving safety via distance

- Many equipment failures occur during breaker open, close or racking operations
 - Use remote racking devices where possible
 - Use extension poles where possible
 - Have automatic secondary disconnects to avoid opening breaker door
 - Use of arc-resistant switchgear allows closed door racking
- Most maintenance activities involve relays and relay testing.
 - Remove relays from switchgear and install on remote racks

Significantly reduced maintenance needs

- Monitoring connections
 - Use of **infra-red windows** reduces requirements for entering equipment and lowers worker exposure
- Eliminate need for most breaker maintenance
 - **Magnetic actuated breakers** have fewer moving parts
 - Magnetic actuated breakers don't require annual maintenance like spring- stored energy devices
 - Longer life due to fewer moving parts leads to fewer failure points, lower spare parts inventory. Less frequent replacements and maintenance lowers worker exposure

AMVAC circuit breaker

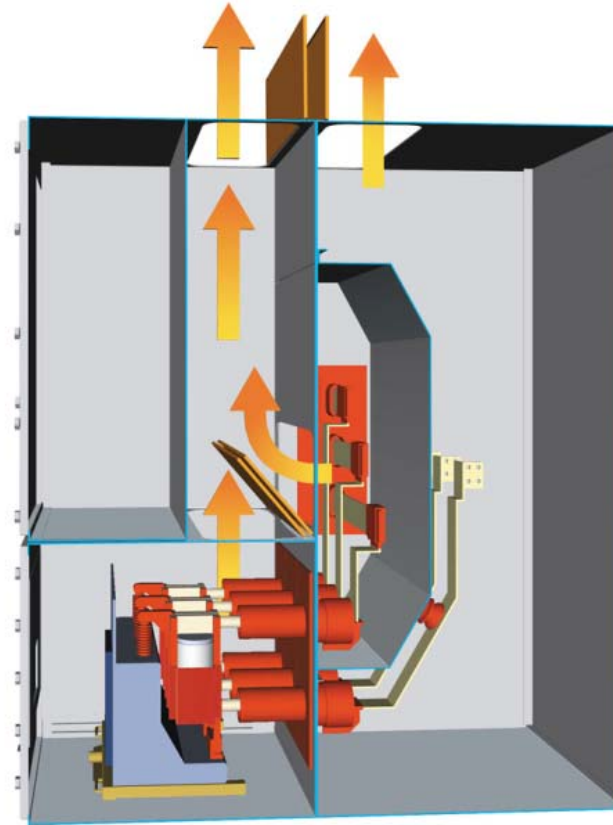


- Operating mechanism rated for 100,000 operations
 - 10 times ANSI requirement
- Interrupter assemblies rated for 30,000 full load operations
- Virtually maintenance free (minor lubrication needed)
- Only seven moving parts
 - 90% less parts
- Permanent magnet for holding force and latch
- Dual capacitors store energy
- Full operation for up to 90 seconds after loss of control power
- Interchangeable with ADVAC

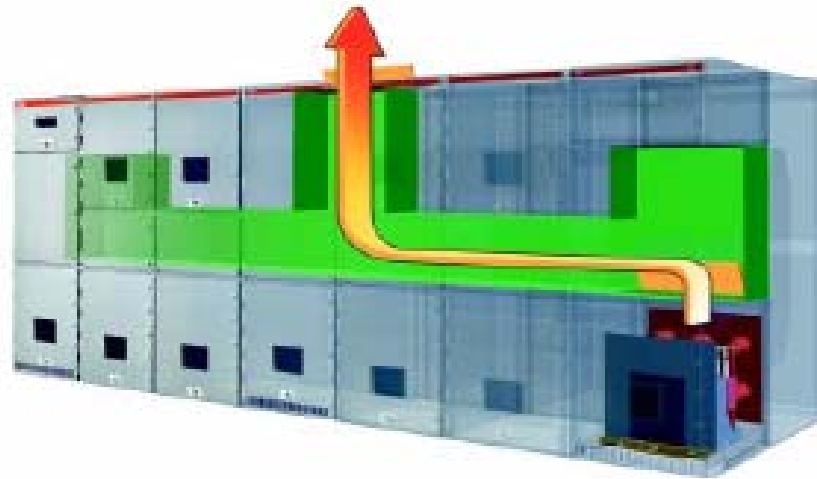
Redirecting energy from the workers

Characteristics of arc-resistant switchgear

- Enhanced safety for personnel and equipment
 - Flap/vent system to relieve pressure
 - Patented collection chamber
 - Gases are safely expelled out the roof
- More than 25 years experience in arc-resistant switchgear
- Design allows for flexibility in configurations and promotes superior safety performance
- Reduces damage to adjacent equipment, thus reducing down time



Characteristics of arc-resistant switchgear

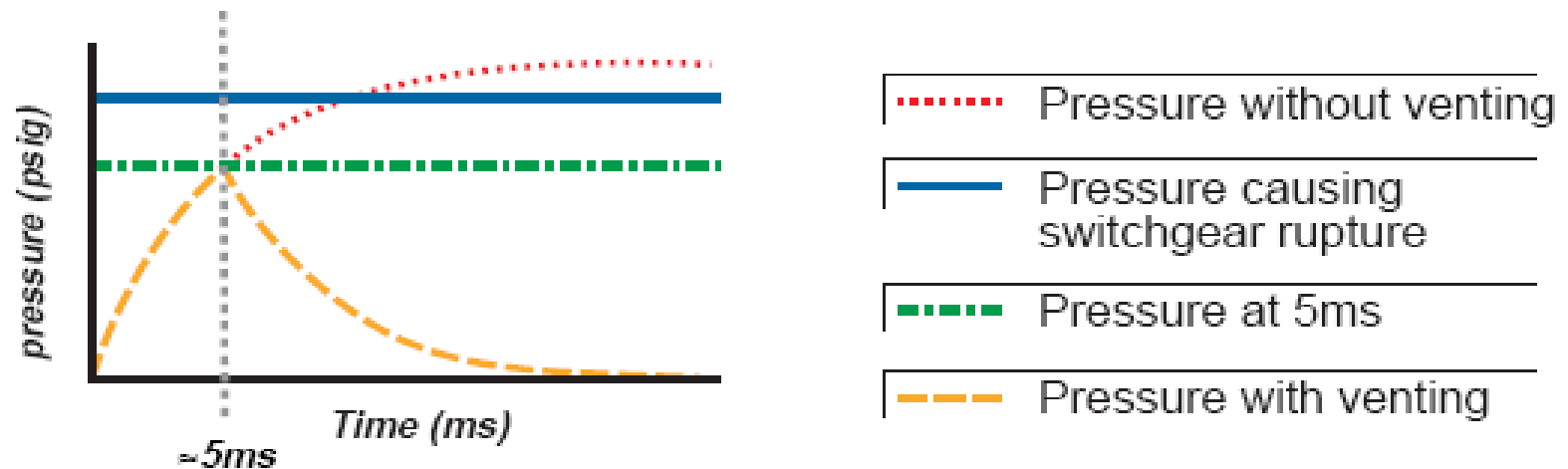


- Robust construction to direct gases to exhaust chambers
- Vent flaps designed to open under pressure and safely expel gases
- Special ventilation
 - Under normal conditions, open to allow air to flow
 - Under arc fault conditions, slams shut to prevent exit of gases
- Double wall construction with 3/16" air gap is very effective in resisting burn through
- Closed door racking and operation of circuit breakers, PTs, CPT fuses

Arc-resistant switchgear

Pressure relief

Characteristics of arc-resistant switchgear designs



Typical pressure vs. time relationship for switchgear internal arc fault

Arc-resistant standards

- **Characteristics of Arc-resistant switchgear designs**
 - Vertical clearance above switchgear is required to allow for plenum
 - Plenum is used to exhaust arc gases outside the building



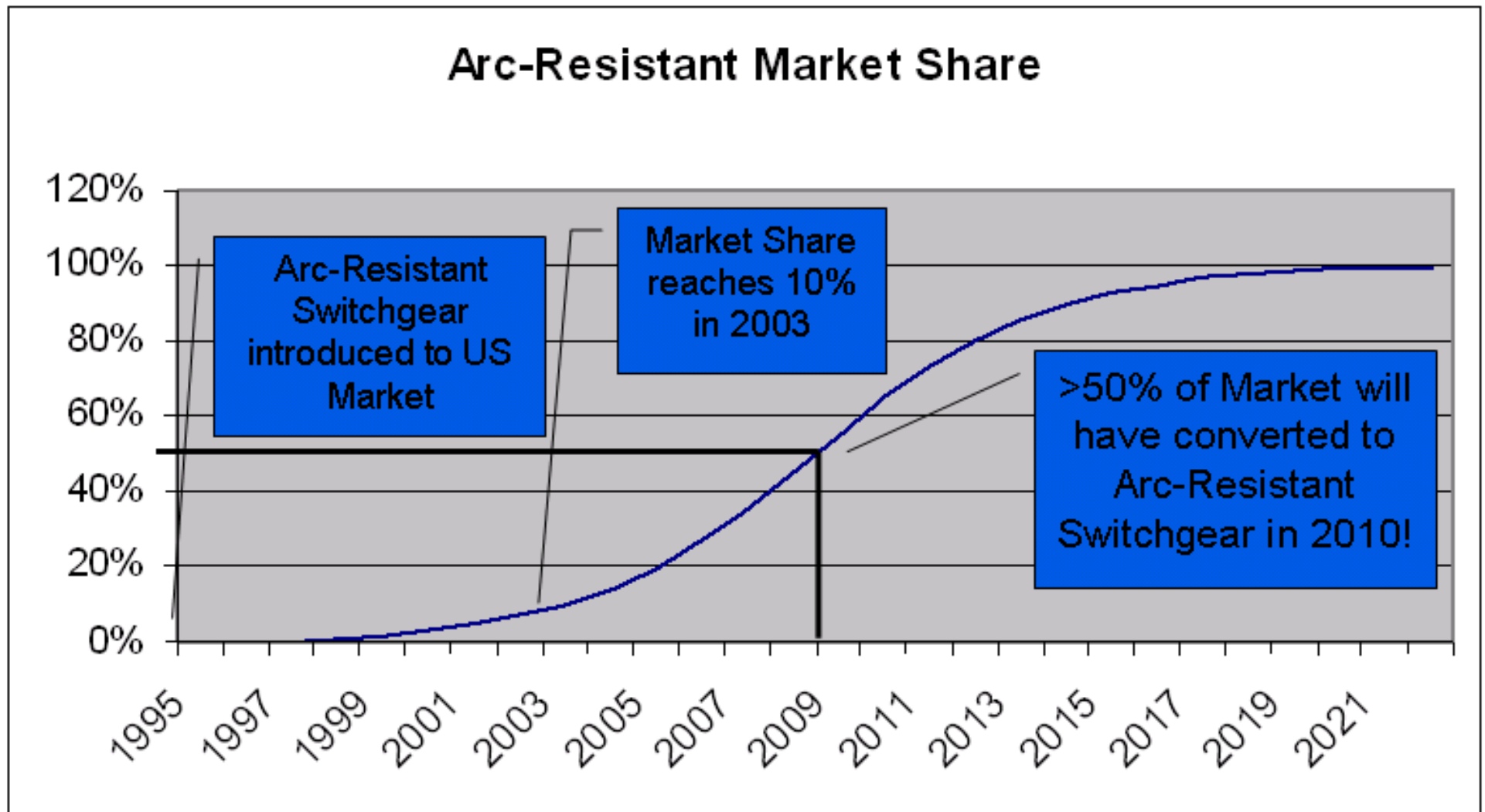
Roof-mounted plenum vents exhaust gases outside the building.

Separate low voltage control compartment modules are critical to ensuring the integrity of the control bus under arc fault conditions.

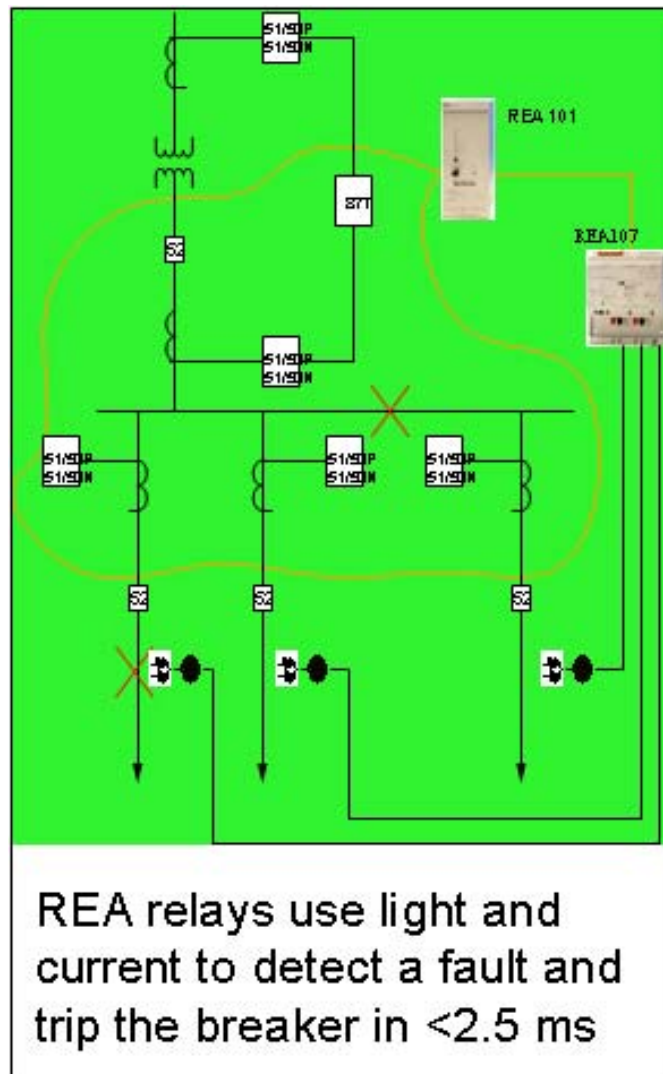
Two-high circuit breaker configuration

Exhaust plenum mounted on roof of two-high switchgear in PDC building.

Customer adoption of arc-resistant switchgear

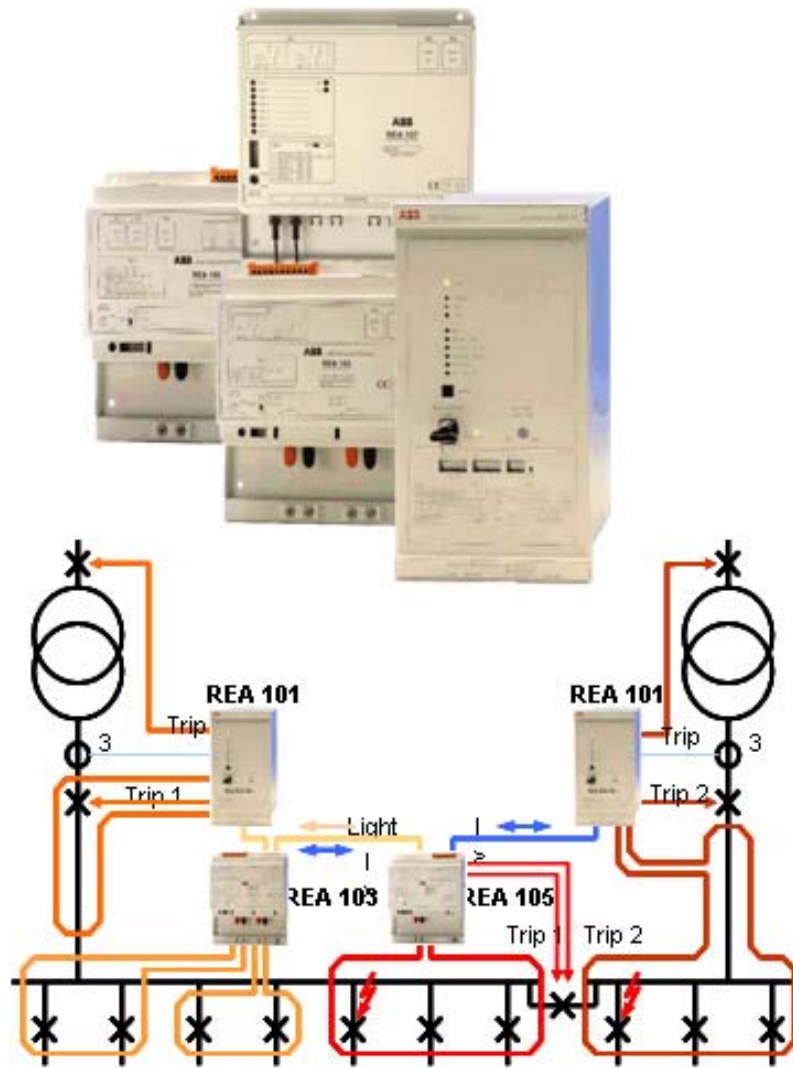


Arc flash mitigation relays



- Advantages:
 - Fastest acting system (<2.5 ms)
 - Can be retrofitted into existing systems
 - Does not impact existing relaying scheme
 - Uses light and current for system reliability
 - Lower cost than bus differential scheme
 - Covers all compartments in the switchgear
- Disadvantages:
 - Takes an outage to install in existing gear
 - Fiber optic sensors installation procedures

The REA features



- REA 101 arc protection relay
- Fast trip time (< 2.5 ms)
- Unique fiber optic sensor technology with self supervision
- Current supervision for secure and reliable arc detection
- Easy to configure via front mounted dip switches
- Suitable for existing LV / MV switchgear installations or new applications
- Minimize potential risk of injury or death while increasing reliability
- Includes standard 12 year warranty

Target applications and methods with the REA

- New equipment
 - Utilities
 - Industrial
 - Power plants
- Existing installations
 - Medium voltage switchgear
 - Vacuum
 - Air magnetic
 - Low voltage motor control centers

Effect of arc flash protection on incident energy

Select Equipment Type

☒ Switchgear
☐ Panelboard or MCC (<1000V)

Select Grounding Method

☐ Ungrounded or High Resistance Grounded System
☒ Grounded Systems

Color	Hazard
Red	Above 4
Orange	4
Yellow	3
Green	Below 3

Voltage (kV)	13.8
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Incident Energy Comparisons

	REA101	Incident Energy (cal/cm ²)										Clearing Time (sec)
	0.09	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	
10	1.08	1.25	2.50	3.75	5.00	6.25	7.51	8.76	10.01	11.26	12.51	
20	2.25	2.61	5.23	7.84	10.45	13.06	15.68	18.29	20.90	23.51	26.13	
30	3.46	4.02	8.04	12.06	16.08	20.10	24.12	28.14	32.16	36.18	40.20	
40	4.69	5.46	10.91	16.37	21.83	27.29	32.74	38.20	43.66	49.12	54.57	
50	5.95	6.92	13.84	20.75	27.67	34.59	41.51	48.42	55.34	62.26	69.18	
60	7.22	8.40	16.79	25.19	33.59	41.98	50.38	58.78	67.17	75.57	83.97	
70	8.51	9.89	19.78	29.67	39.56	49.45	59.35	69.24	79.13	89.02	98.91	
80	9.80	11.40	22.80	34.20	45.60	56.99	68.39	79.79	91.19	102.59	113.99	
90	11.11	12.92	25.84	38.76	51.67	64.59	77.51	90.43	103.35	116.27	129.19	
100	12.43	14.45	28.90	43.35	57.80	72.25	86.69	101.14	115.59	130.04	144.49	

Bolted Fault
Current (kA)

Arc-resistant switchgear & the REA together

- Arc-resistant SafeGear is like a seatbelt - It offers the most complete personnel and equipment protection for your switchgear when the unit is in normal operation
- The REA is designed to complement SafeGear and works when the equipment is opened and energized for maintenance, testing or service
- The REA is like an airbag – It does not eliminate the need for PPE but it does reduce the energy and in many cases, may reduce the PPE required. Do your own arc flash calculation and see the results!

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Workshop Statistics

Over 400 hours of training

- ~45 customer presented case studies
- 87 sessions in the Technology and Solution Center
- 11 hours of panel discussions consisting of customers, industry experts and ABB executives
- Nearly 50 hours of hands on technical training

ABB Automation & Power World

Registration options

	Full Conference	Courtesy Registration
Access to ABB product developers and application experts in the 70,000 ft ² (over 1.5 acre) Technology & Solution Center		
Access to a series of complimentary and educational workshops.		
Free Lunch and Tuesday Evening Reception		
Access to over 300 additional educational workshops – Including ARC Analysts presentations		
Up to \$1,500 off a future ABB purchase*		
Complimentary ARC report valued at \$2,500!*		
Evening Events (Monday and Wednesday)		
* See www.abb.com/a&pworld for more details	Cost	Free!
	\$300 per day or \$800 for all three days.	

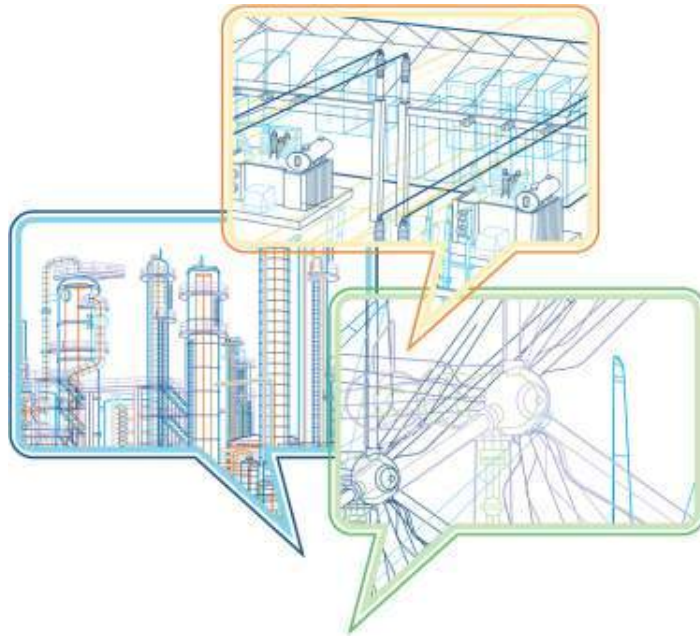
Top ten reasons to attend



1. Become more valuable, choose from over 400 educational workshops and hands-on training sessions
2. Connect with thousands of peers and industry experts from 40 countries
3. Ask questions of, and give feedback to, ABB product developers and executive management
4. Get up to date with new and emerging technologies and industry trends
5. Learn how to maximize the value from your existing assets
6. Discover how to improve grid reliability, energy efficiency and industrial productivity
7. Apply lessons learned from over 45 customer-presented case studies
8. Focus on critical non-technical issues facing your company in the business forums
9. Succeed professionally by earning CEUs on select workshops and PDHs for every workshop you attend
10. See the widest range of technologies from one company at one conference!

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for a better world™

