

31 AUG 2018

ABB Arc fault protection seminar for LV and MV

Arc Guard System, TVOC-2: A protection device for reliable safety

Allan Guo , Product Marketing Manager - EPCP

Arc fault protection

Electrical switchboard overview





Arc fault protection

MNS – Arc Safety

Safety Plus

The MNS solution meet and exceed the IEC 61439 -1/-2 and IEC/TR 61641 safety standards for arc flash protection.

Priority 1

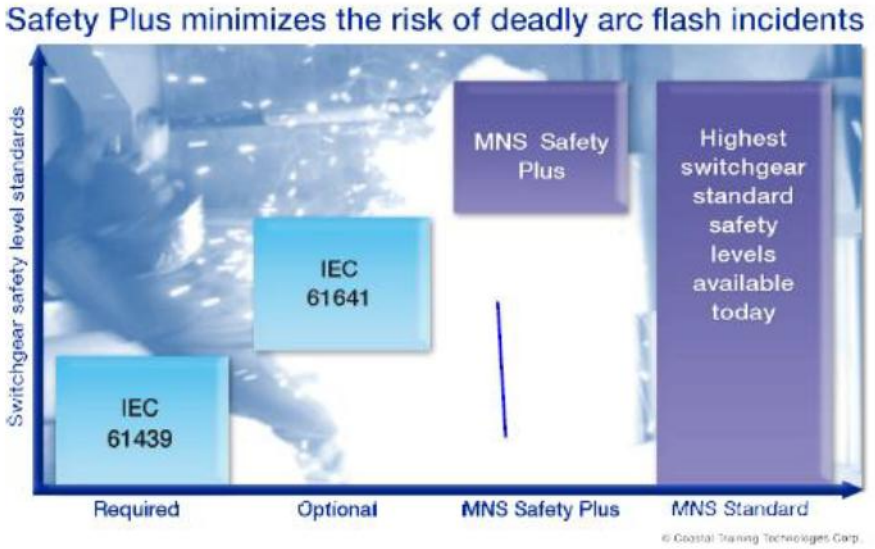
Active Protection in MNS

The basic ABB MNS principle is that an arc fault should be prevented from occurring in the first place by designing and dimensioning the equipment absolute reliable.

Priority 2

Passive protection in MNS

Limiting of the arc to the compartment where it occurs. This minimizes the consequences of an arc if it should occur.



Arc fault protection

What is arc flash/blast ?

- Arc Blast is rapid expansion of air, vaporization of metal copper, steel and alloy.
- Radiant Heat > 20,000ºC
- Fatal burn span 3.5 meters wide
- **Light > 3,000 lux**
- Noise > 140 dB
- Molten shrapnel (copper, Steel, alloy)
- Ionized toxic Gas
- Pressure blast wave > 1000kg/m2
- **Speed of blast > 1600km/hr**

Arc fault protection

Causes of arc accidents

The most common reasons for arc flash accidents	Human errors
	Mechanical faults
	Bad connections
	Aging/Insulation defect
	Animals
When do arc flash accidents occur?	25 % without operator
	10% with operator in front of a closed door
	65 % with operator working in the switchgear



What to do after arc flash accidents occur?

Arc fault protection

Arc flash standards and regulations

- Arc Flash is a workplace electrical hazard and therefore there are standards and regulations **governing** the measurement and **mitigation of the risks** associated with arc flash incidents as the safety of the people in the workplace is paramount.
- Arc flash incidents can cause damage to the electrical networks on the site by overloading parts of the electrical grid on site.
- This can also cause the electric network to shut down and cause expensive downtime.
- A proper workplace **safety audit** that includes Arc Flash incident energy calculations and risk assessment can suggest electrical equipment settings to reduce the probability of a serious arc flash related incident from occurring in the workplace.

Arc fault protection

Arc flash standards and regulations

World wide standard

Europe:

- IEC work-Arc box

Asia

- AS/NZS 3000/4836
- GB/14598.302 Specification for arc flash equipment

Arc fault protection

Arc flash standards and regulations

World wide standard

US

- **IEEE-1584**
- OHSA
- **NFPA 70E**
- ABS

Short summary

- Preliminary IEEE1584 work used in NFPA70E
- NFPA70E equations limited to **< 1000V**
- IEEE1584 equations expanded to **15,000V**
- NFPA70E 38% Arcing Fault Current is **overly** conservative and doesn't guarantee worst case incident energy.

Arc fault protection

How do we measure the extent of the hazard?

1. Calculate the **Incident Energy**, which defines the severity of the arc flash at a certain distance.
2. Measured in kJ/m^2, J/cm^2, or **cal/cm^2**
3. Arc energy is a function of fault current and time.
4. Arc hazard is a function of working distance, exposed level, protection level.

IEEE 1584 Flash Protection Boundary is the boundary within which a person could receive a second degree burn from an arc flash incident.

Arc fault protection

Incident energy (IE) calculation

IEEE 1584

For applications up to 15 kV

$$E = C_f E_n \left(\frac{t}{0.2}\right)\left(\frac{610^x}{D^x}\right)$$ ▪cal/cm²

For applications above 15 kV

$$E = 5.12x10^5 VI_{bf}\left(\frac{t}{D^2}\right)$$ ▪cal/cm²

NFPA 70E -2004

For open air:

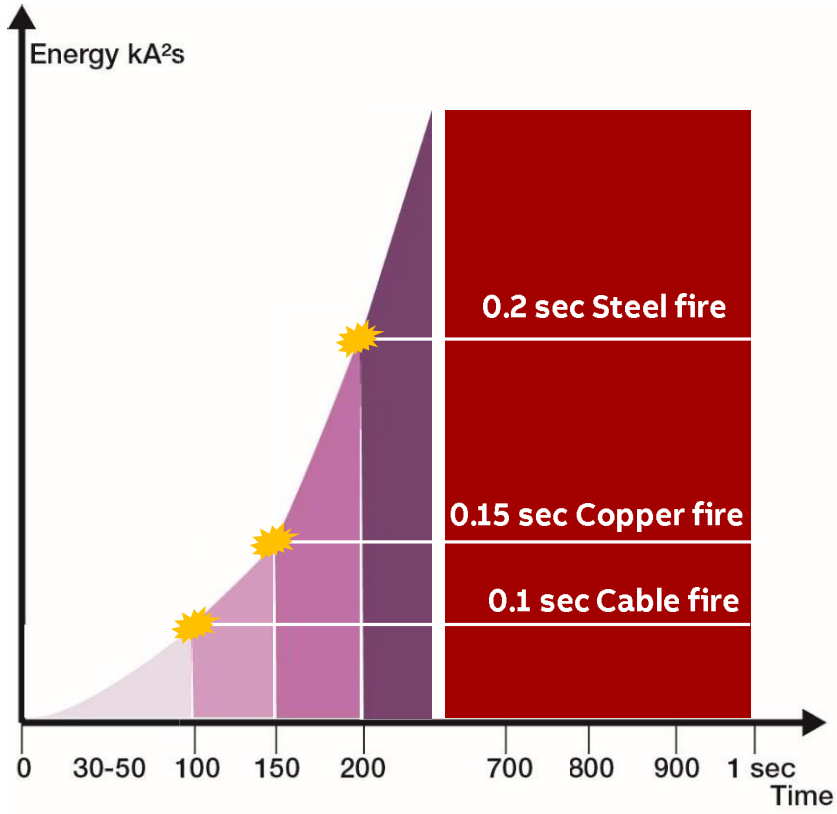
$E_{MA} = 5271D_A - 1.9593t_A[0.0016F2 - 0.0076F + 0.8938]$

For enclosed:

$E_{MB} = 1038.7D_B - 1.4738t_A[0.0093F2 - 0.3453F + 5.9675]$

Arc fault protection

What happens? Time matters!



Arc fault protection

Hazard levels

Hazard Risk Category	Typical Personal Protective Equipment (PPE)	Arc Rating (cal/cm^2)
0	Non-melting, flammable materials with at least 4.5 oz/yd^2	0 - 1.2
1	AR pants and AR shirt, or AR coverall	1.2 - 4
2	Cotton underwear, plus AR shirt and AR pants	4 - 8
3	Cotton underwear, plus AR shirt and AR pants and AR coverall	8 - 25
4	Cotton underwear, plus AR shirt and AR pants and multilayer flash suit "Moon suit"	25 - 40

Switchboard rated 36kA 400V would derive Incident Energy = **4.729** cal/cm2

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Arc fault protection

Typical PPE suit requirements

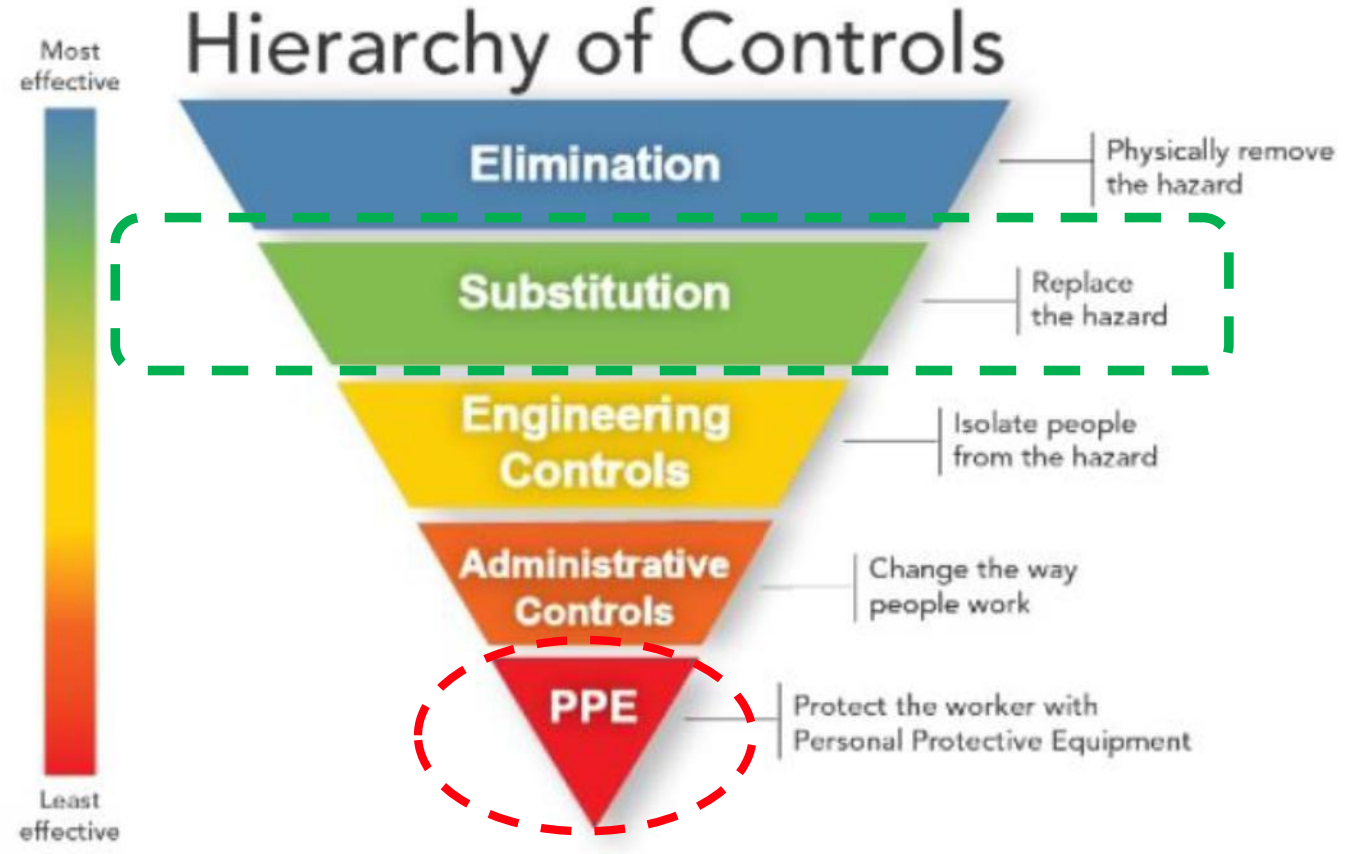


1	2	3	4
1.2 -4 cal/cm²	4-8 cal/cm²	8-25 cal/cm²	25-40 cal/cm²

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Arc fault protection

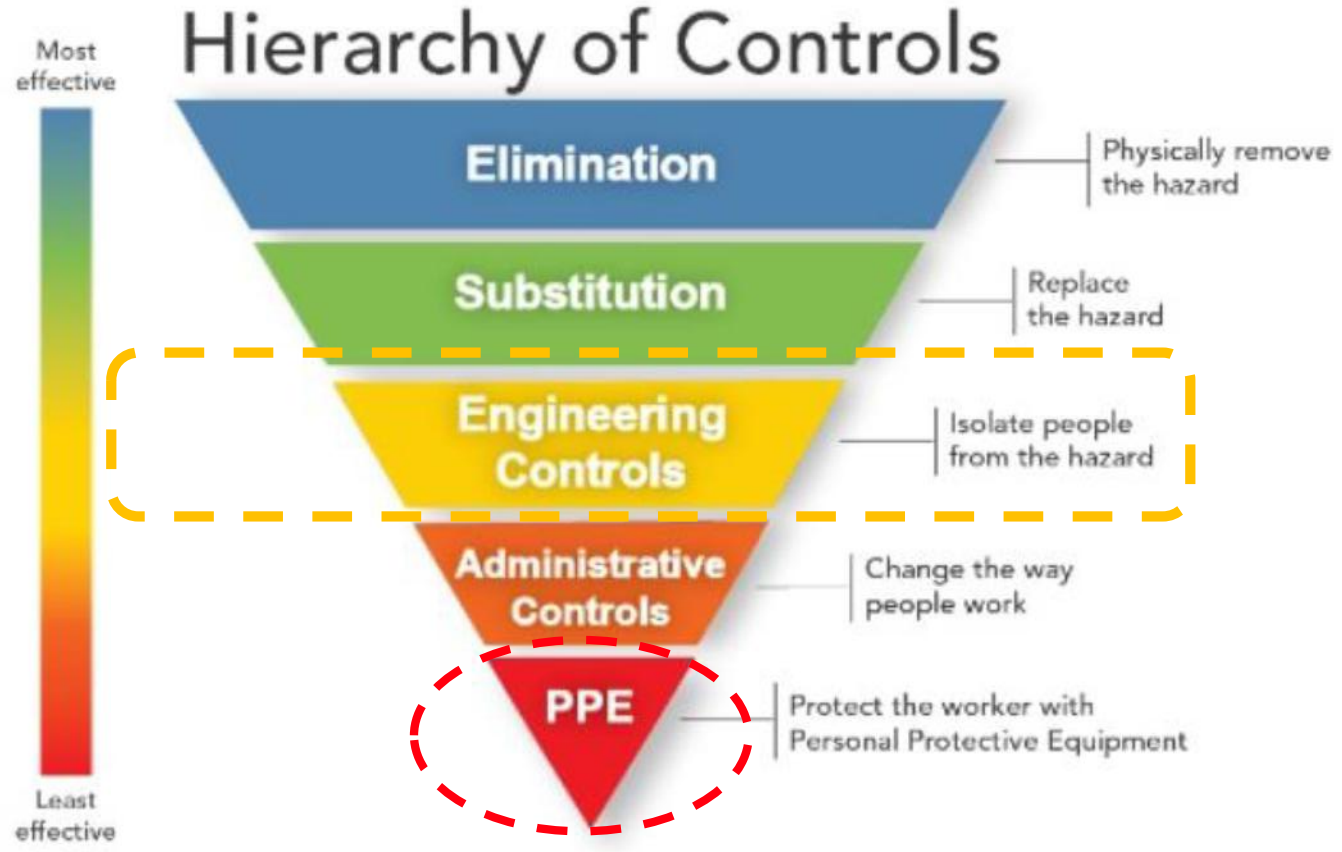
Mitigation activities



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Mitigation activities



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Mitigation activities

Engineering Controls
Increase working distances / improve position
1. Extension handles
2. Positioning for Arc Plasma physics
3. Racking robots, racking onto de-energized system
4. Remote operating devices , remote switching

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Arc fault protection

Mitigation activities

Engineering Controls
Reduce IE – Reduce fault clearing time
1. Reduce breaker settings, change to UIE curves ,remove delays
2. Reduce fuse rating or change to current limit fuse
3. Change to difference fuse type(curve)- semiconductor fuse
4. Adjust protection relay delays and settings
5.Temporary maintenance switch to lower trip settings
6.Bus differential protection
7. Zone selective interlocking schemes(ZSI)
8. Engineered parallel high speed fuses
9. **Arc flash detection – high speed trip**

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Arc fault protection

ABB engineered IE reduction solutions





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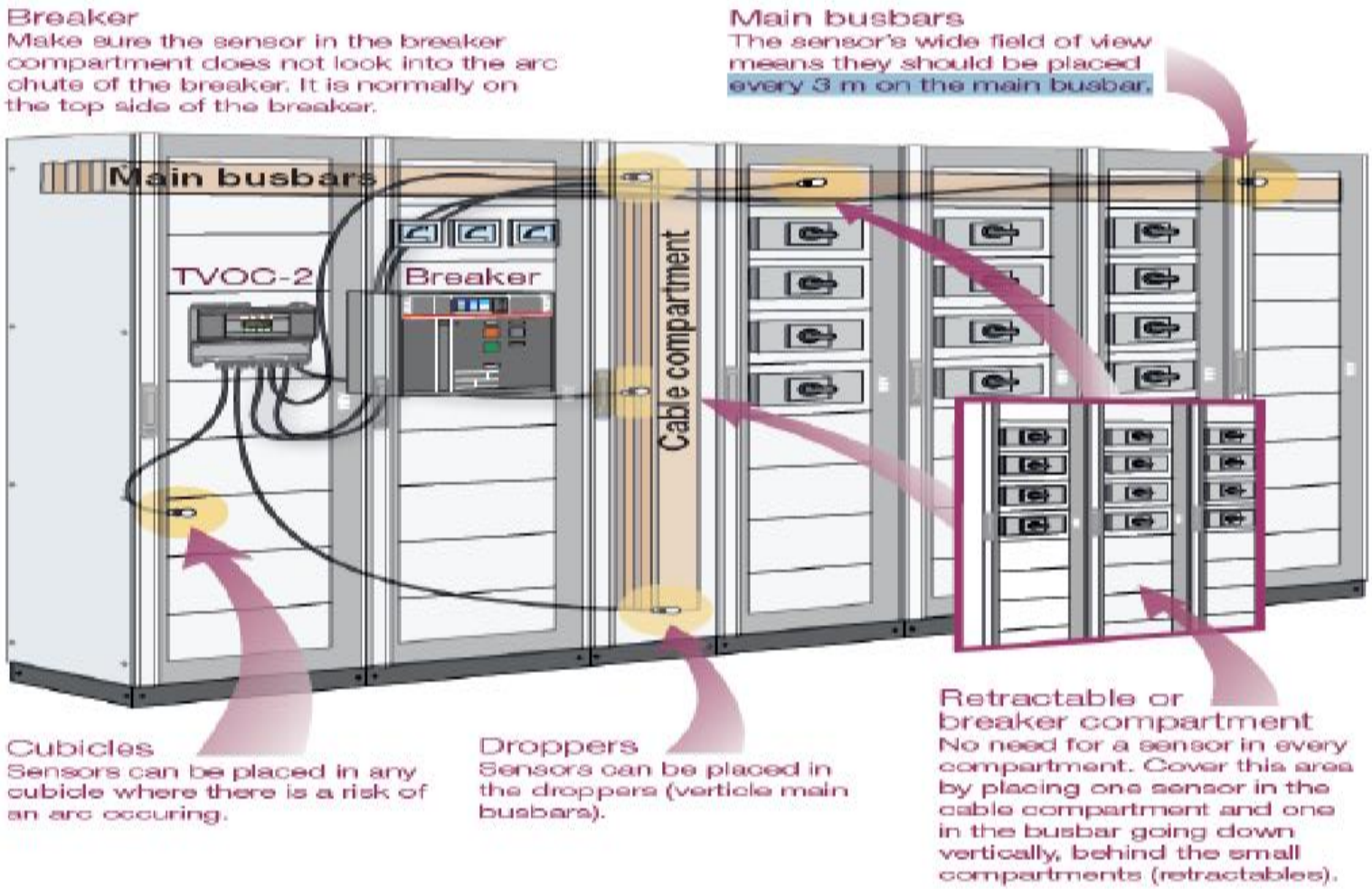
Arc fault protection

ABB Arc guard system: TVOC-2



Arc guard system: TVOC-2

Installation Example



Arc guard system: TVOC-2

How does it work?

Arc initiation → Detection → Activation → Breaker opens



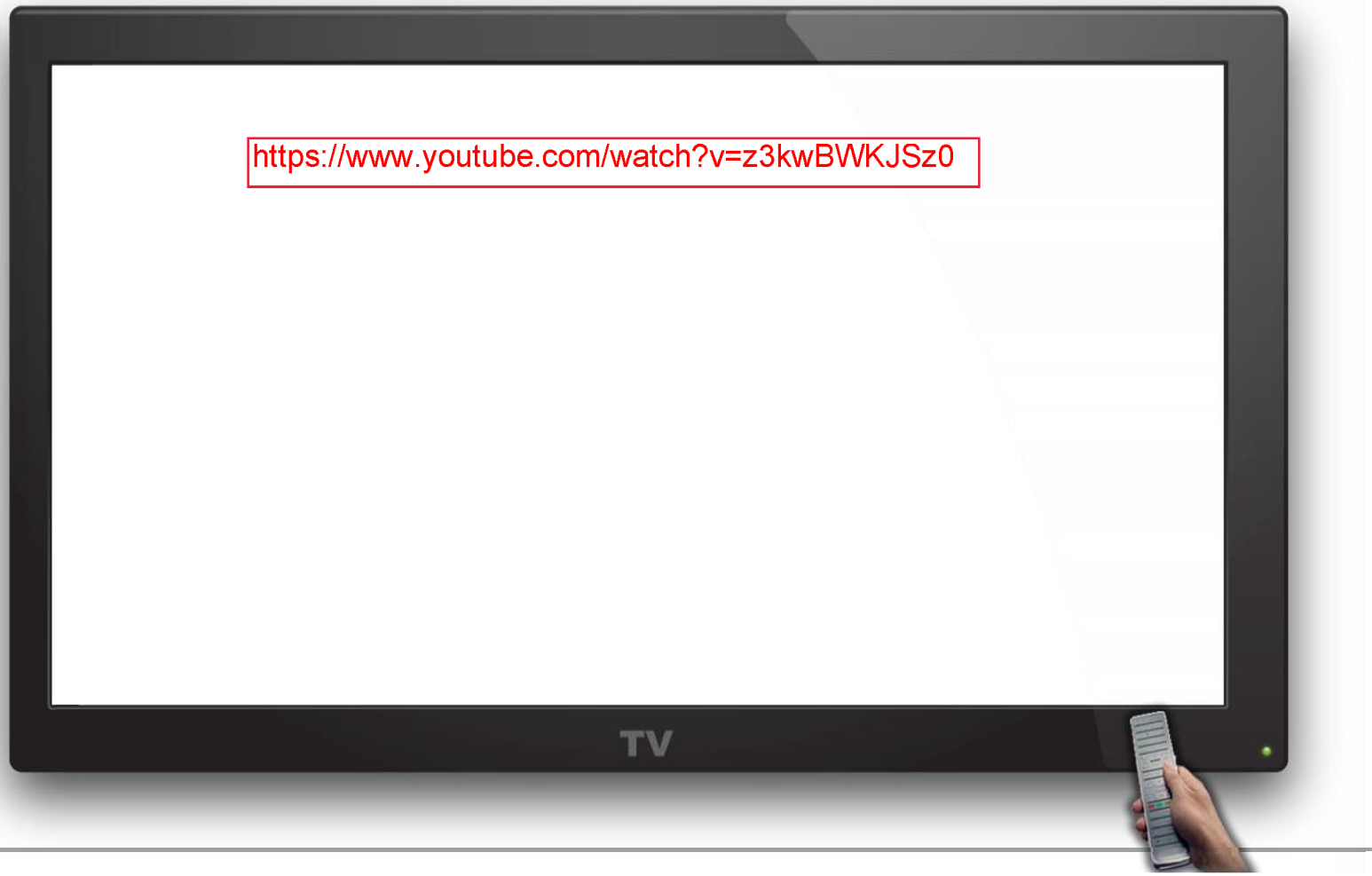




1. Arc is detected by the fiber optic sensor
2. Signal is sent to the TVOC-2 arc monitor
3. TVOC-2 arc monitor sends a trip signal to shunt trip of circuit breaker
4. **All this occurs in under 1ms**

Arc guard system: TVOC-2

How does it work?



Arc guard system: TVOC-2

Where the system is used - Ships









Arc guard system: TVOC-2

Where the system is used – Oil Rig



Arc guard system: TVOC-2

Where the system is used – Chemical industry



Arc guard system: TVOC-2

Where the system is used – Hospital





Arc guard system: TVOC-2

Where the system is used – Metal industries



Arc guard system: TVOC-2

Where the system is used – Wind power





Arc guard system: TVOC-2

Where the system is used – Papermill



Arc guard system: TVOC-2

Where the system is used – Substation



