

# Medium Voltage (MV) & High Voltage (HV) Training



# Electrical System Basics and Equipment



## MV vs. HV - Definitions

**Differences between USA and the rest of the world**

**IEC define a high voltage fuse as a fuse-link rated for 3 phase systems above 1kV to 72.5 kV**

**IEEE define a medium voltage fuse-link as a fuse rated for single and 3 phase systems between 1kV and 38kV**



# Electrical System Basics

## Generation voltage

10 kV-25kV **MV** (Medium Voltage)

## Transmission voltage

**HV** (High Voltage) – 132kV to 475 kV

Or **EHV** (Extra high voltage) – 500 kV  
to 800 kV

## Distribution voltage

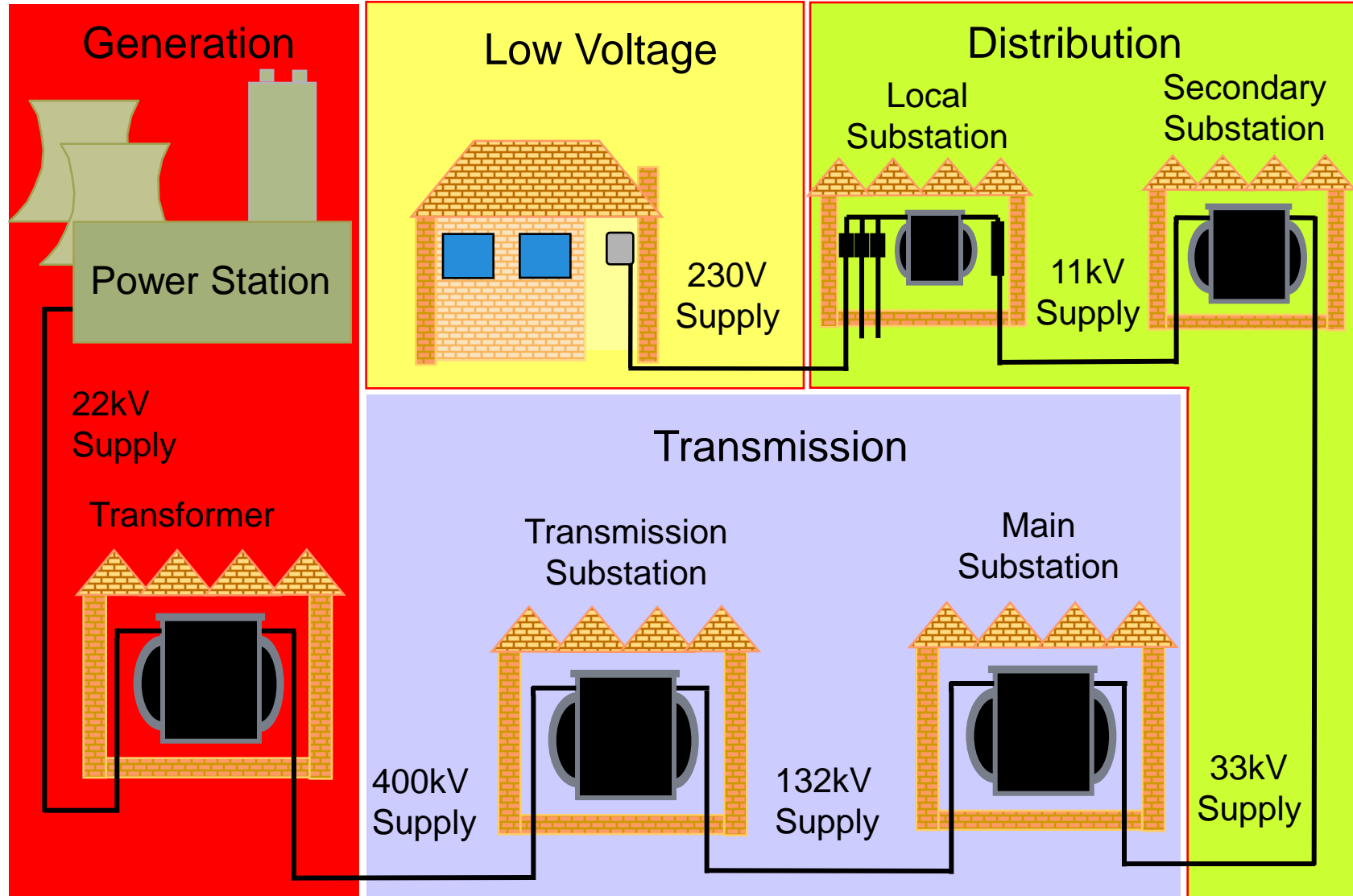
**MV** (Medium Voltage) – 1.1kV to 72.5 kV

## Low voltage

**LV** 1 V to 1kV

# Electrical System Basics

*Fuses Generally Used in Distribution and Low Voltage*





# Why High Voltage

**Power = Volts X Amps**

**If we increase voltage, we can decrease current**

**If we decrease current, we can use smaller  
conductors (less copper) and have lower losses  
(around 7% typical)**

**Transmit and distribute at high and medium voltages**

**Typically on overhead line systems**



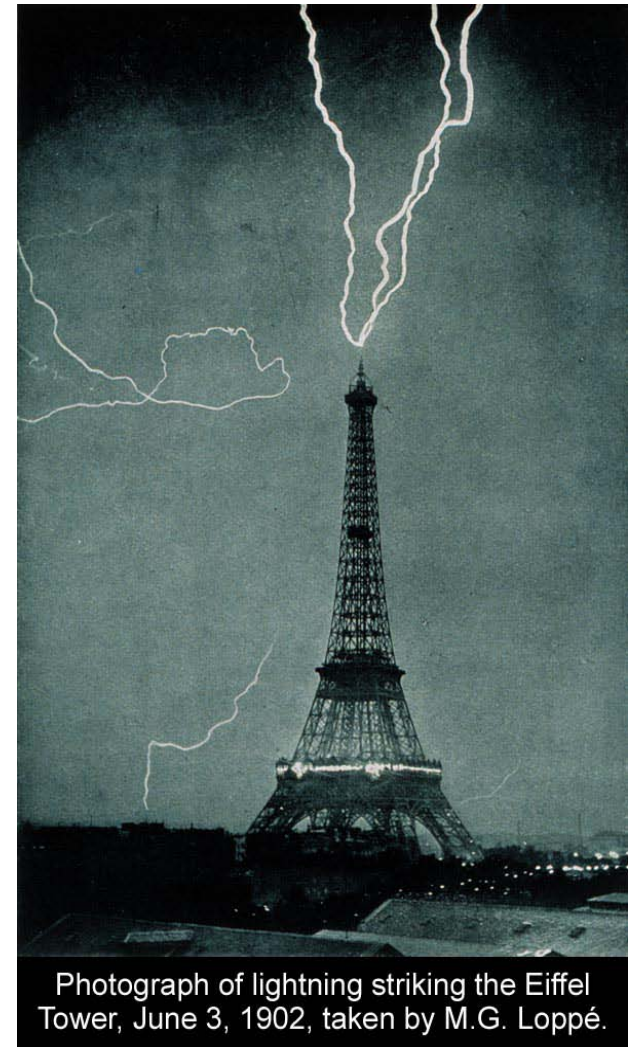
# Why Overhead Line Systems

**Predominantly driven by cost**  
**For 1 kilometre of overhead line**  
**£5,000**

**For 1 kilometre of**  
**underground cable £25,000**

**Overhead systems susceptible**  
**to faults permanent & transient**

**Need for protection and isolation**

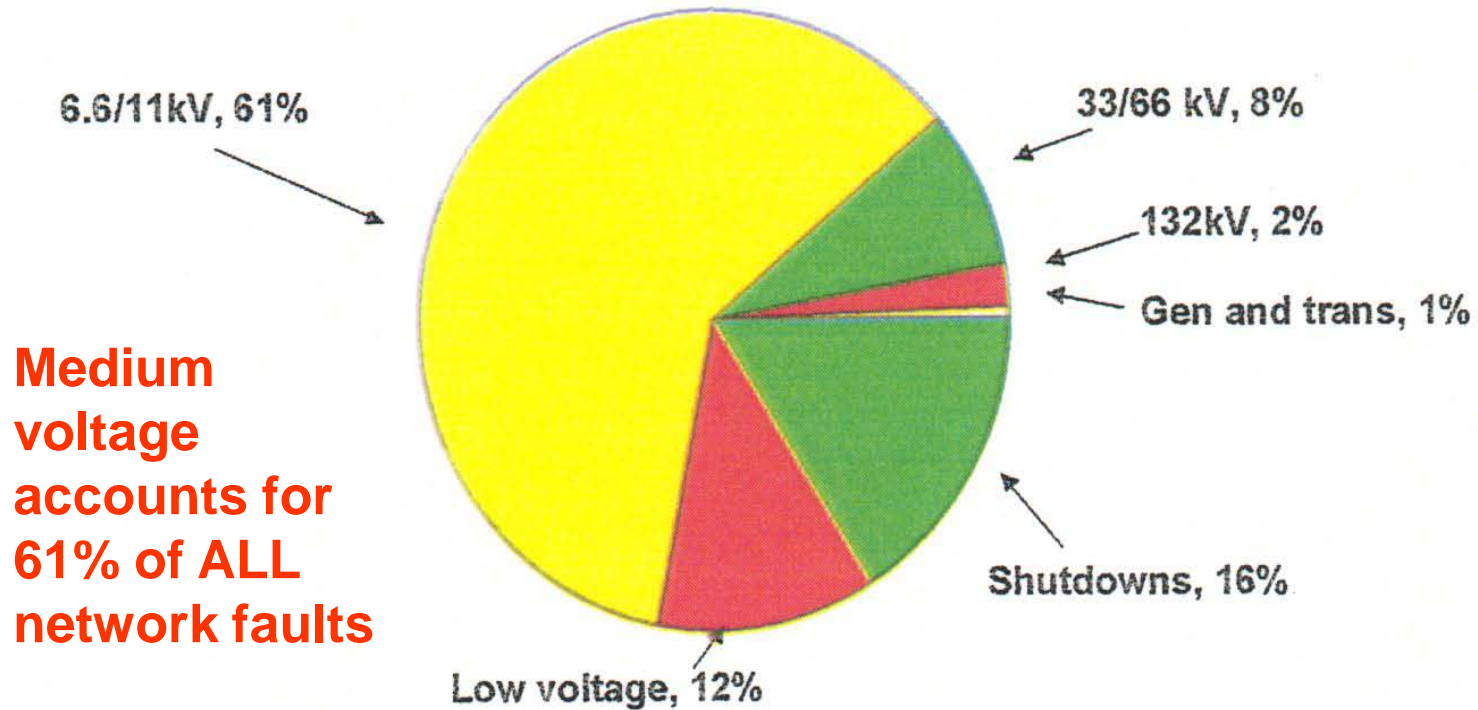


Photograph of lightning striking the Eiffel Tower, June 3, 1902, taken by M.G. Loppé.



# Urban and Rural System Statistics

Typical Contributions to Customer Unavailability  
percentages of customer minutes lost per year



**Medium voltage accounts for 61% of ALL network faults**



# MV Systems Protection- Objectives

**Protect equipment and people**

**Provide fault discrimination**

**Provide isolation points**

**Cost effective and reliable**

**Minimize customer outages**

**Environmental considerations**



## Protection Options

Circuit breaker based system – Far too expensive.

**Fuse based systems most widely used**

Cost effective and environmentally safe

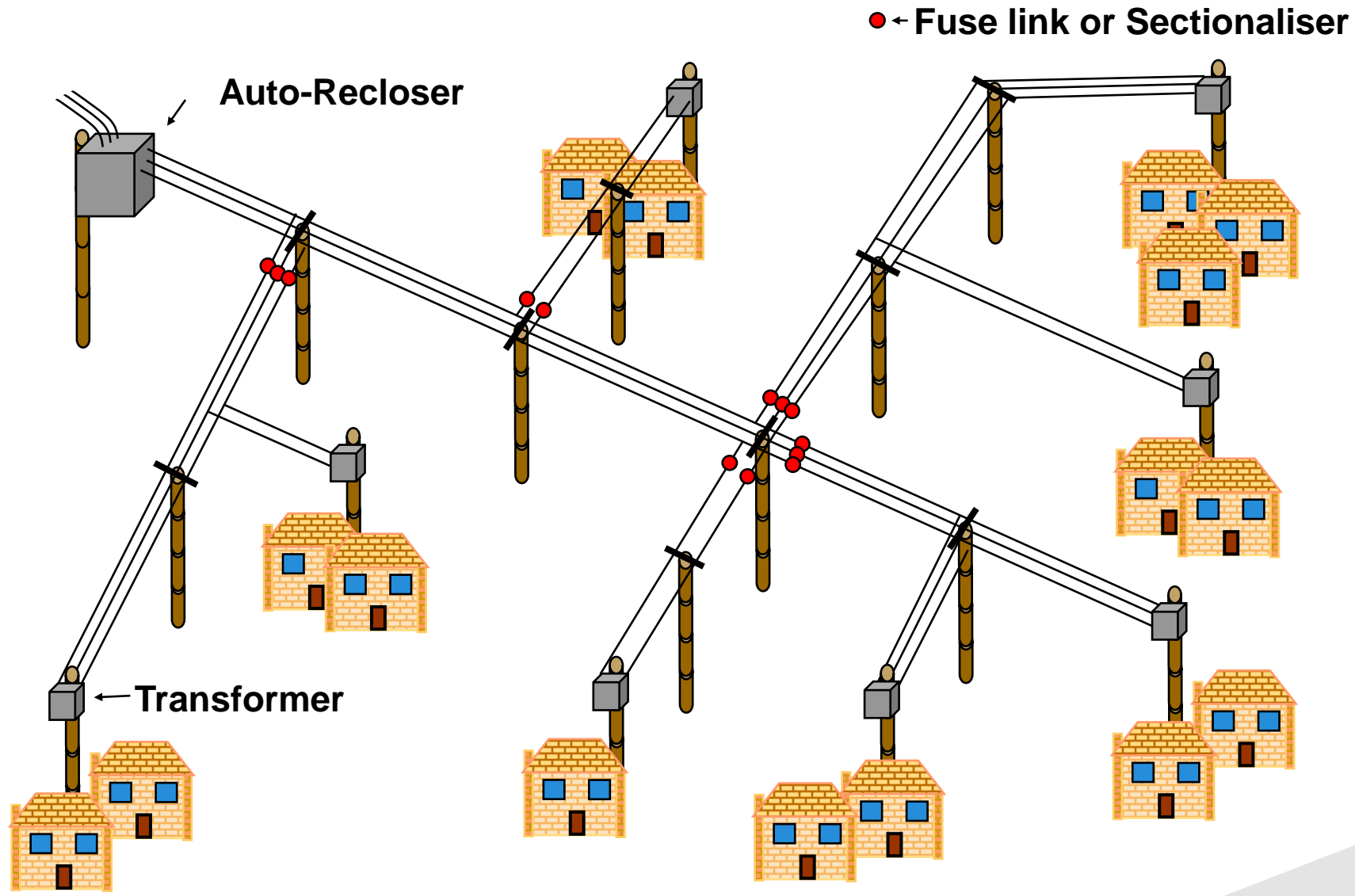
Can be easily combined with switches

Variety of options

In current-limiting form - the best solution for transformer protection



# OHL Distribution Network Systems





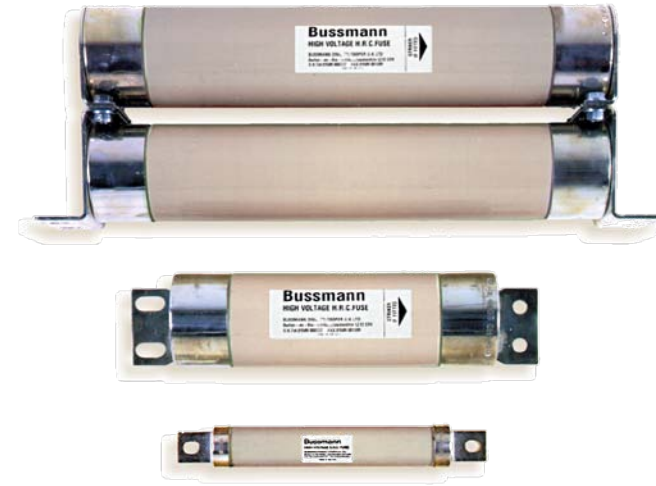
# Equipment on Overhead Systems

- **Fuse Link** - Usually an expulsion fuse-link mounted in a holder (cutout), opens on an overcurrent condition, “de-latches” and swings open to isolate the fault.
- **Auto Re-Closer** - A circuit breaker that opens and close rapidly to allow a temporary fault to clear
- **Cutouts, Fuse mounts, DOEF** - All mean the same thing – an expulsion fuse link holder
- **Sectionalizer** – Electronic device which replaces an expulsion fuse and holder, will “de-latch” on an over current condition - isolating the fault

## DIN



## Air / Motor



## VT (Voltage transformer)



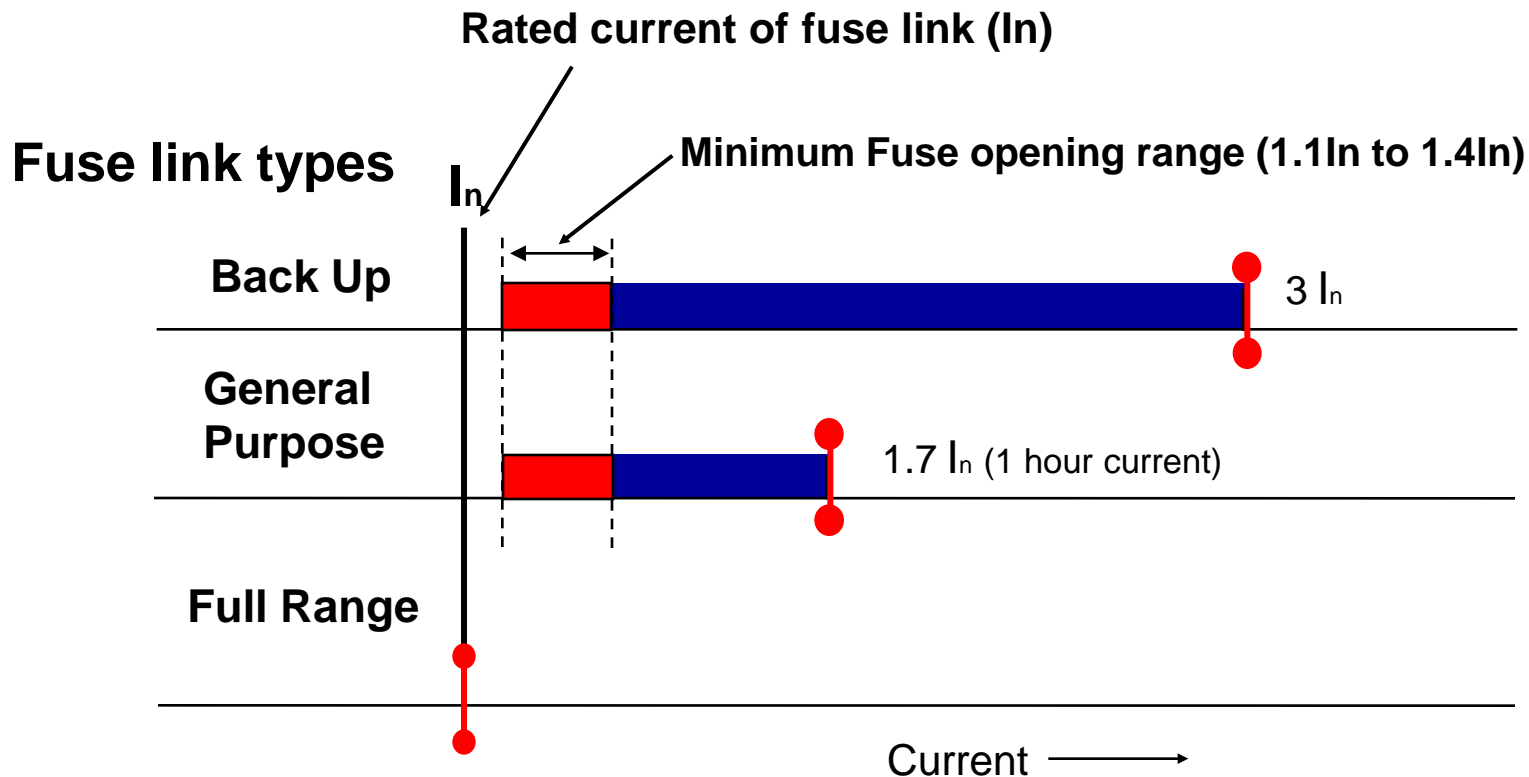
## Oil tight fuses



## Part referencing system for current limiting fuse links

kV	1st Letter General Type	2nd Letter Barrel Diameter (mm)	3rd Letter Barrel Length (mm)	4th Letter Striker (mm)	5th/6th letter and or digit - termination or fixing	Amps A
	<ul style="list-style-type: none"> <li>A / B / D / N • fuse links for use in air</li> <li>V or W • fuse links primarily for use in motor circuits</li> <li>F • fuse links with Full Range characteristics</li> <li>O • fuse links sealed for use in oil switches</li> <li>S • DIN Range</li> <li>T • DIN Outdoor Range</li> </ul>	<ul style="list-style-type: none"> <li>M = 20,6</li> <li>B = 25,4</li> <li>D = 50,8</li> <li>E, H, L = 63,5</li> <li>F, I, K = 76,2</li> <li>X = 88</li> </ul>	<ul style="list-style-type: none"> <li>U = 86</li> <li>W = 142</li> <li>O = 192</li> <li>C = 195</li> <li>D = 203</li> <li>F = 254</li> <li>L = 292</li> <li>G = 359</li> <li>N = 403</li> <li>M = 442</li> <li>Q = 537</li> <li>I = 565</li> <li>K = 914</li> </ul>	<ul style="list-style-type: none"> <li>S = Striker to DIN43625, form C, 50N</li> <li>E = Striker to DIN43625, 80N</li> <li>H or M = Striker to BS2692-1</li> <li>N = None fitted</li> </ul>	<ul style="list-style-type: none"> <li>A = No Tags. Ferrule diameter as the 2nd letter</li> <li>B = Offset tag, single bolt fixing</li> <li>C and D = Tags to BS2692-1</li> <li>F = Offset tag, double bolt fixing</li> <li>J = Ferrule to DIN 43625</li> <li>O = Tags to BS2692-1</li> <li>6 = Tags to BS2692-1</li> <li>22 = 5/16-BSW stud one end only</li> <li>02/03 double and triple barrel fuse link</li> <li>F2/F3 double and triple barrel variants</li> </ul>	

# MV Fuse classification



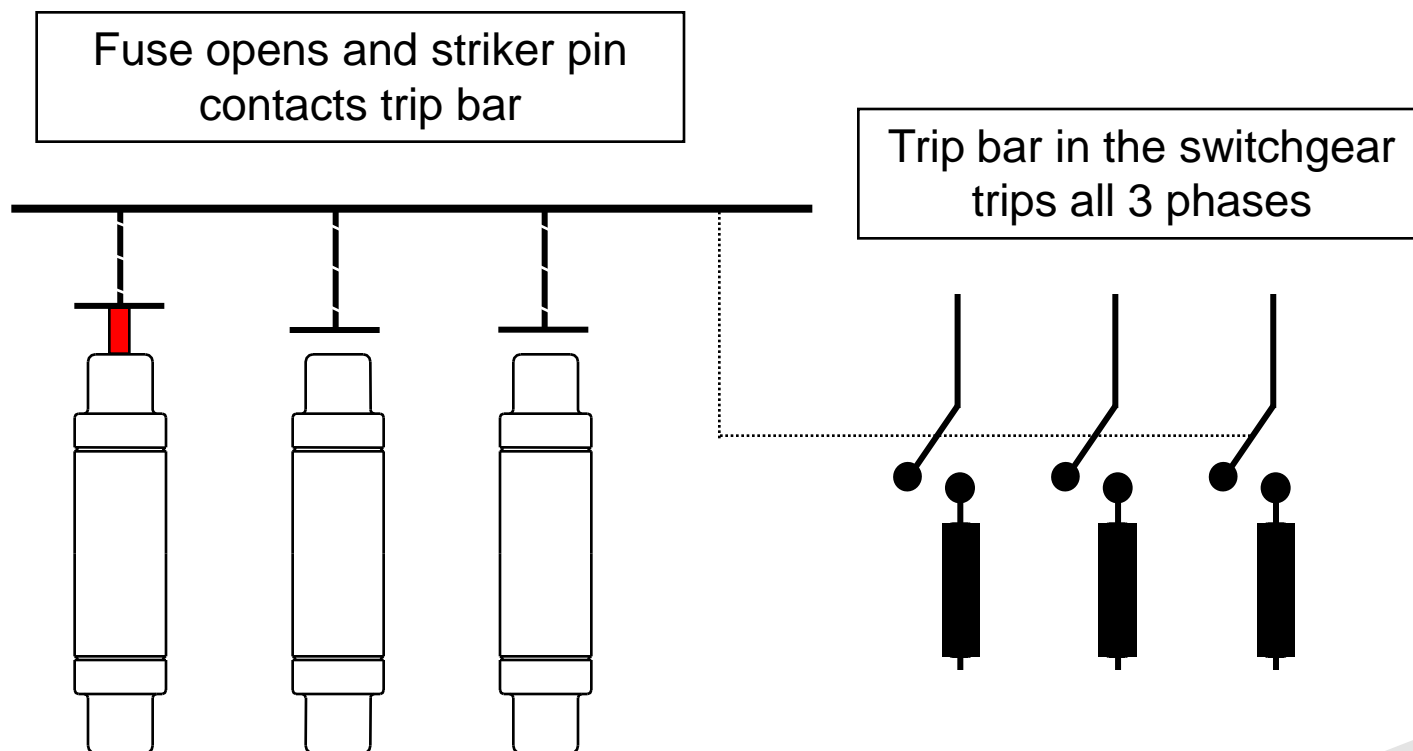
 Minimum breaking current

 Zone of uncertain operation. Fuse-link will open but cannot clear fault

# The Importance of the Striker

## Back up and General Purpose Fuses

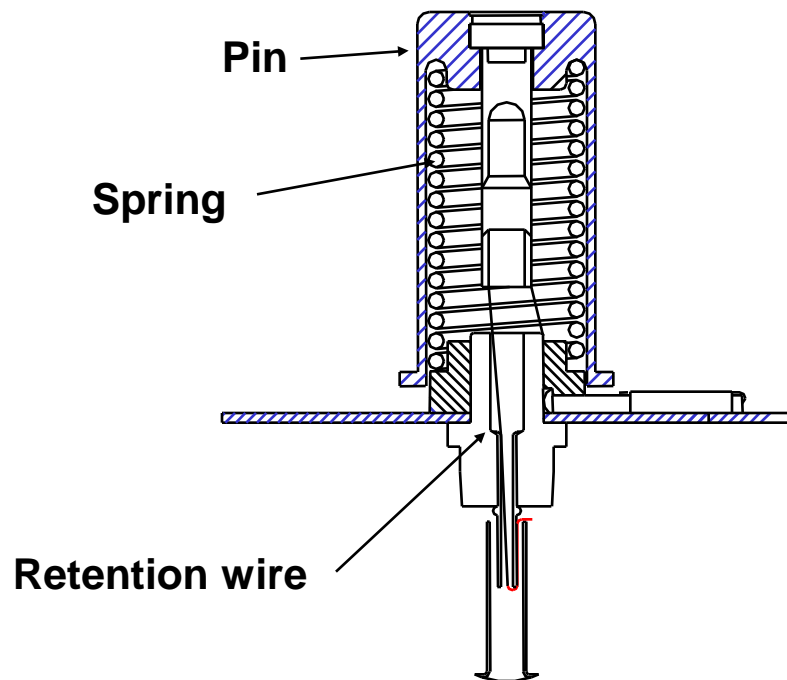
Rely on striker pin to trip fuse-switch for low level over currents where the fuse-links cannot clear the fault  
Provides “full range” operation



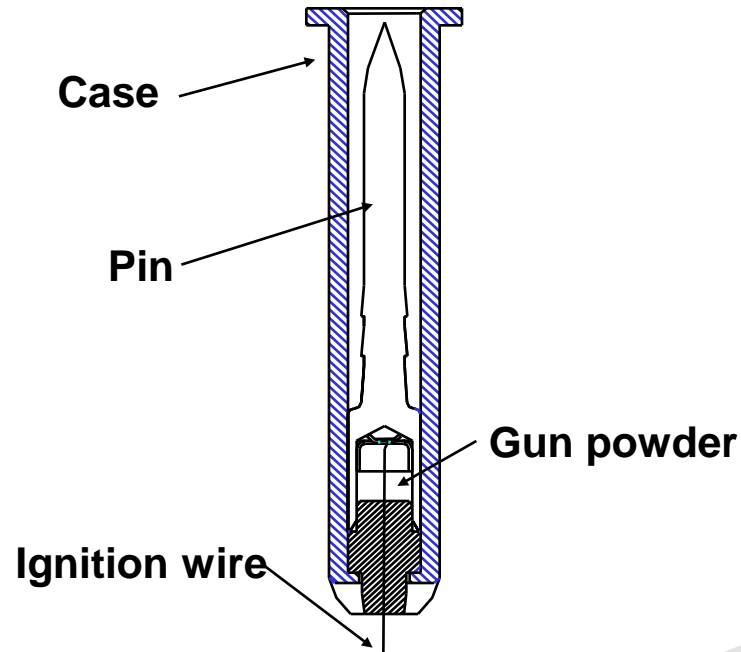
## Two types of Strikers

- Spring (Din fuses)
- Pyrotechnic (Oil fuses / Air fuses)

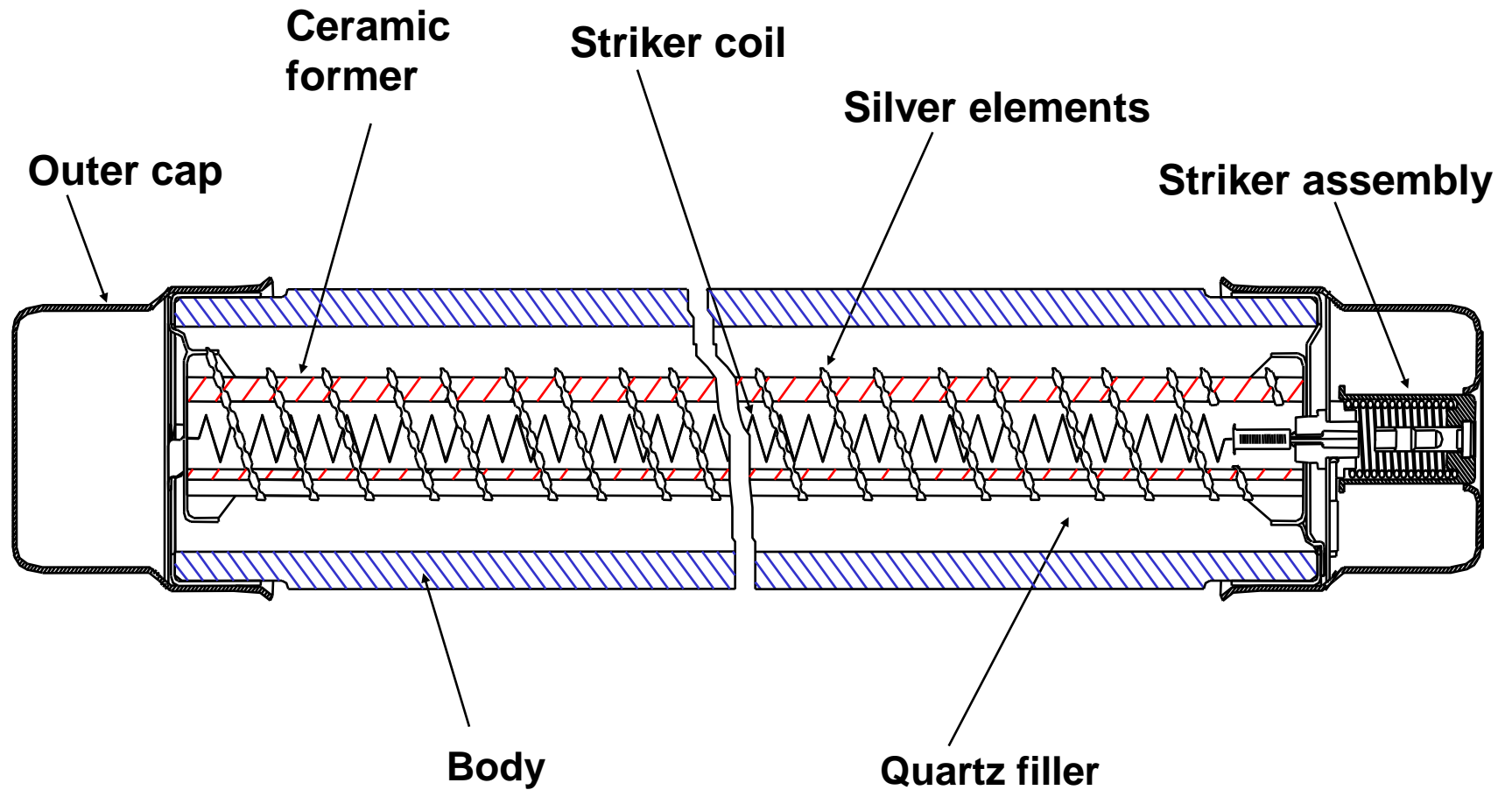
Spring Striker



Pyrotechnic "Gun Powder" Striker



# Back-Up Fuse Construction





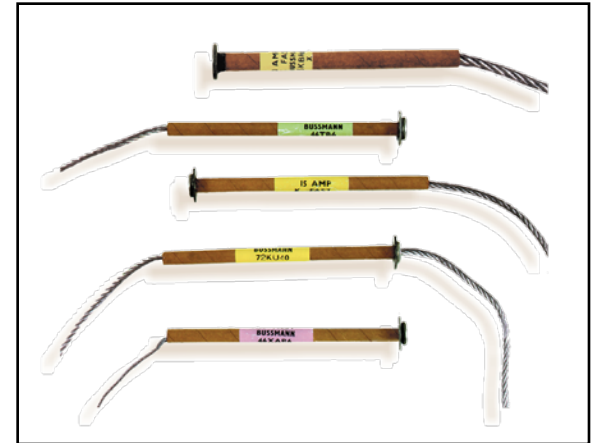
# Expulsion Fuse Link and cut-out

**Overhead line cut-out secures fuse-link**

**Fuse-link melts during over current condition**

**Fuse-link cutout de-latches and swings downward, extinguishing over current and isolating fault**

**Inexpensive protection**





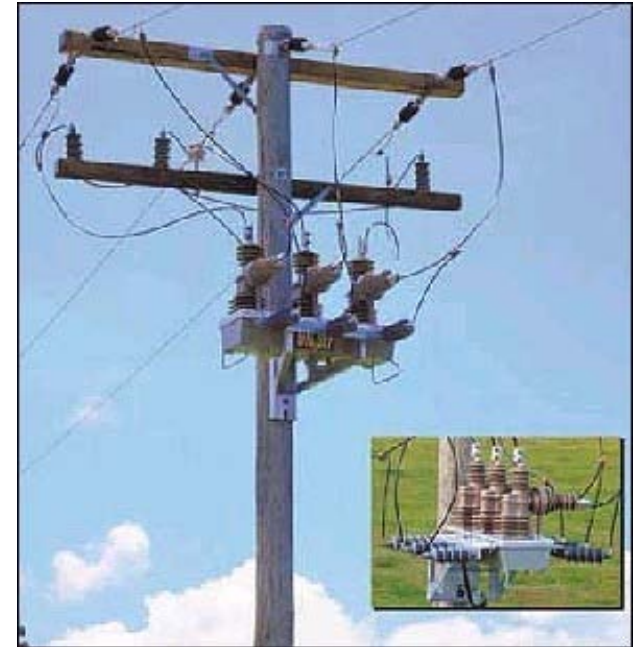
# Auto Re-Closer

**A pole mounted circuit breaker**

**Or a ground mounted circuit breaker with an auto-reclose sequence relay fitted**

**Open and closes rapidly to  
Remove a temporary fault on  
an overhead line**

**Usually set to O-C 3 times  
locks out on fourth**





# Sectionaliser

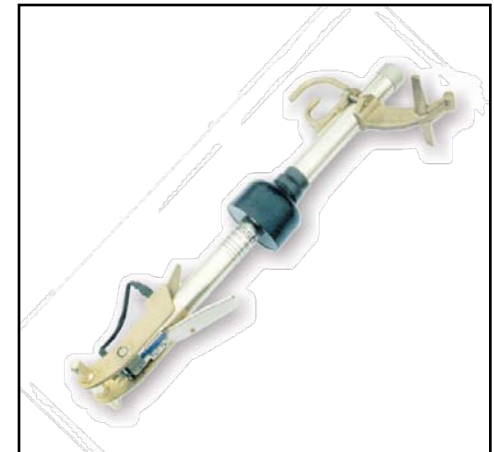
**Applied in conjunction with auto-recloser (opens fault)**

**Contains Electronic circuit board and CTs to monitor current**

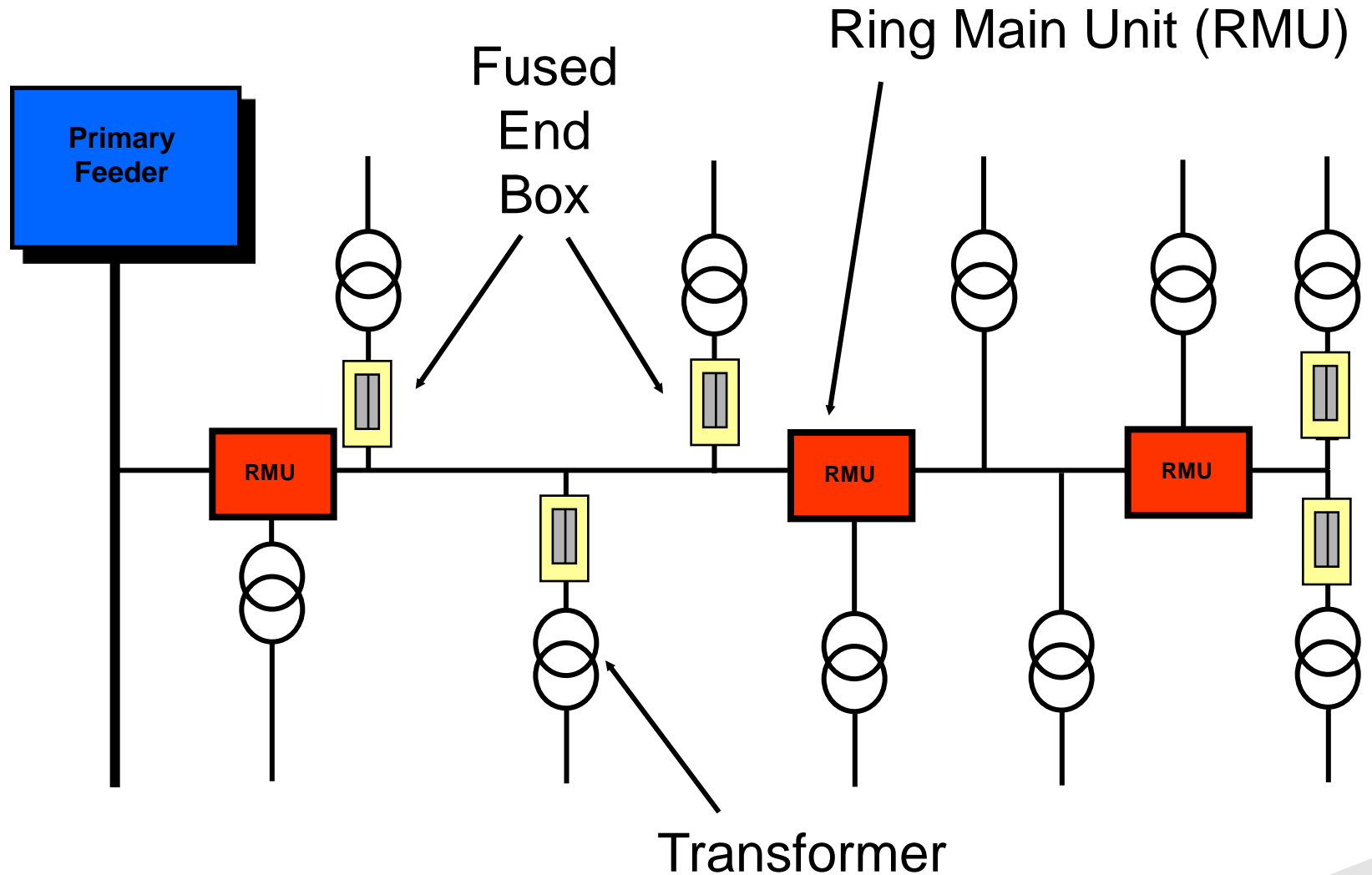
**After auto-recloser has opened a specified number of times, the sectionaliser actuator “de-latches”**

**Sectionaliser swings downward, isolating fault**

**Cost-effective protection**



# Urban Distribution Systems





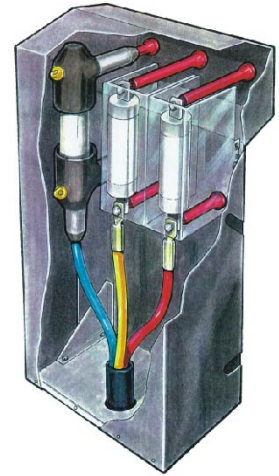
## RMU's and fuse switches

Switchgear used to protect transformers and over-head lines on a network – R.M.U. – Ring Main Unit, consists of a fuse switch or circuit breaker, with two ring switches, very common and where 70% of MV current limiting powder fuses end up.

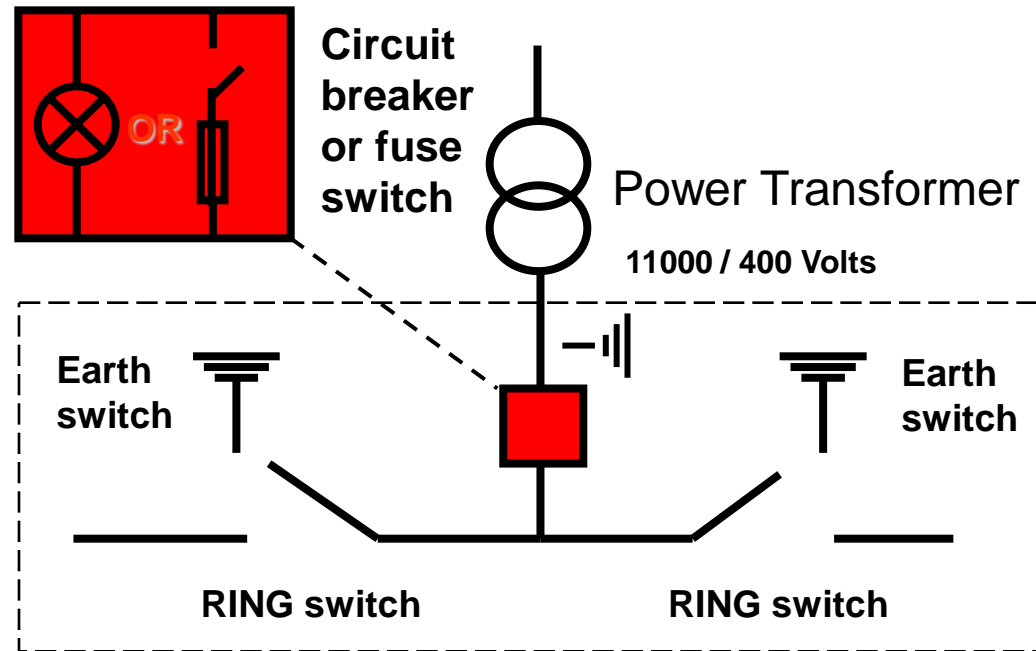


## Fused End Boxes

– Fused end boxes contain current-limiting fuses but do not provide isolation or switching.



# Ring Main Unit (RMU)



**Non-Fused Switch - Provides power supply from either source**

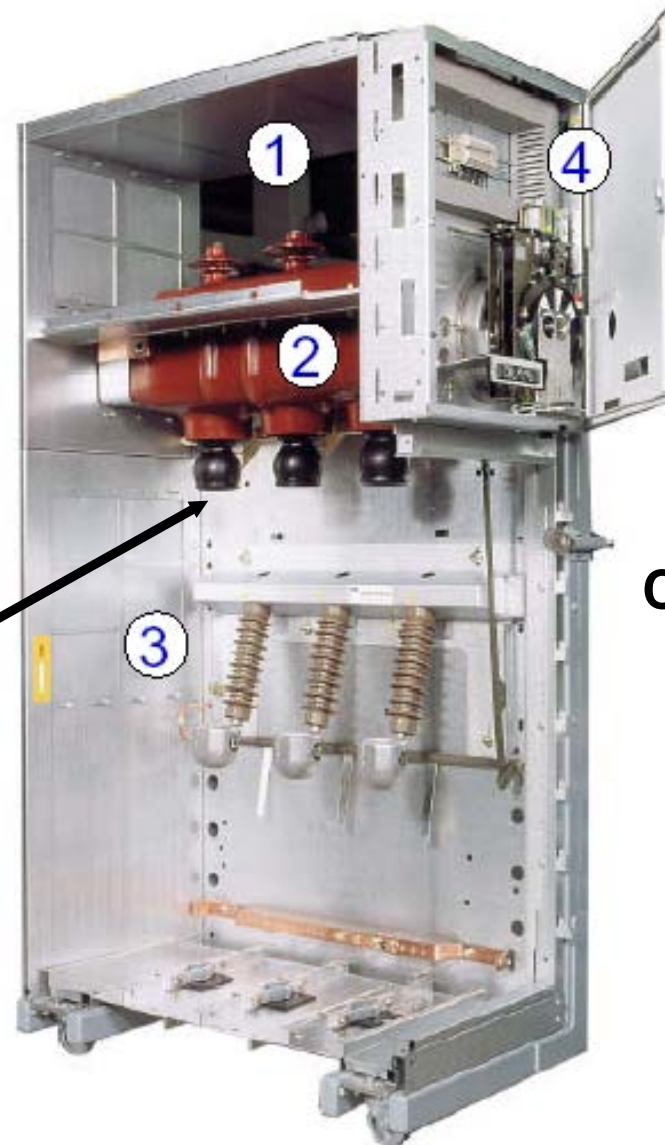
**Fuse Switch/CB - Provides isolation and protection for load (transformer)**

**Earth Switch - Switches incoming cables to earth during routine maintenance**

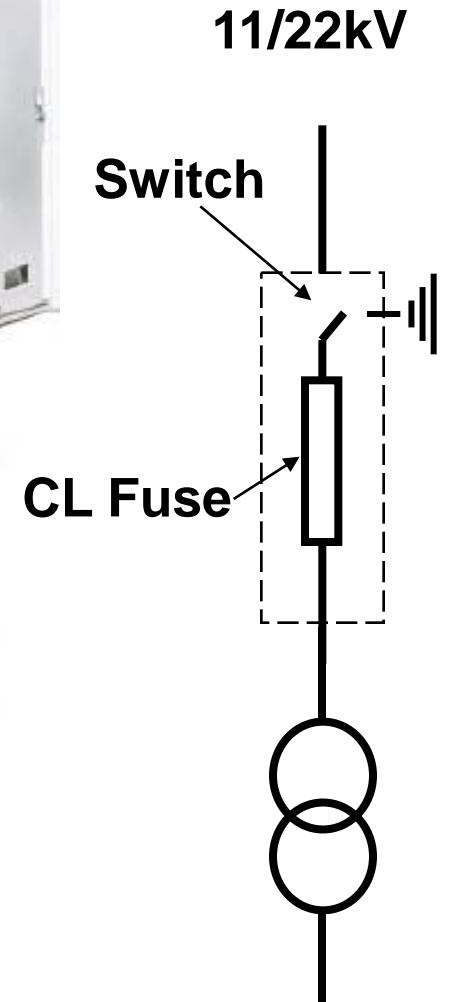


# Fused Switch

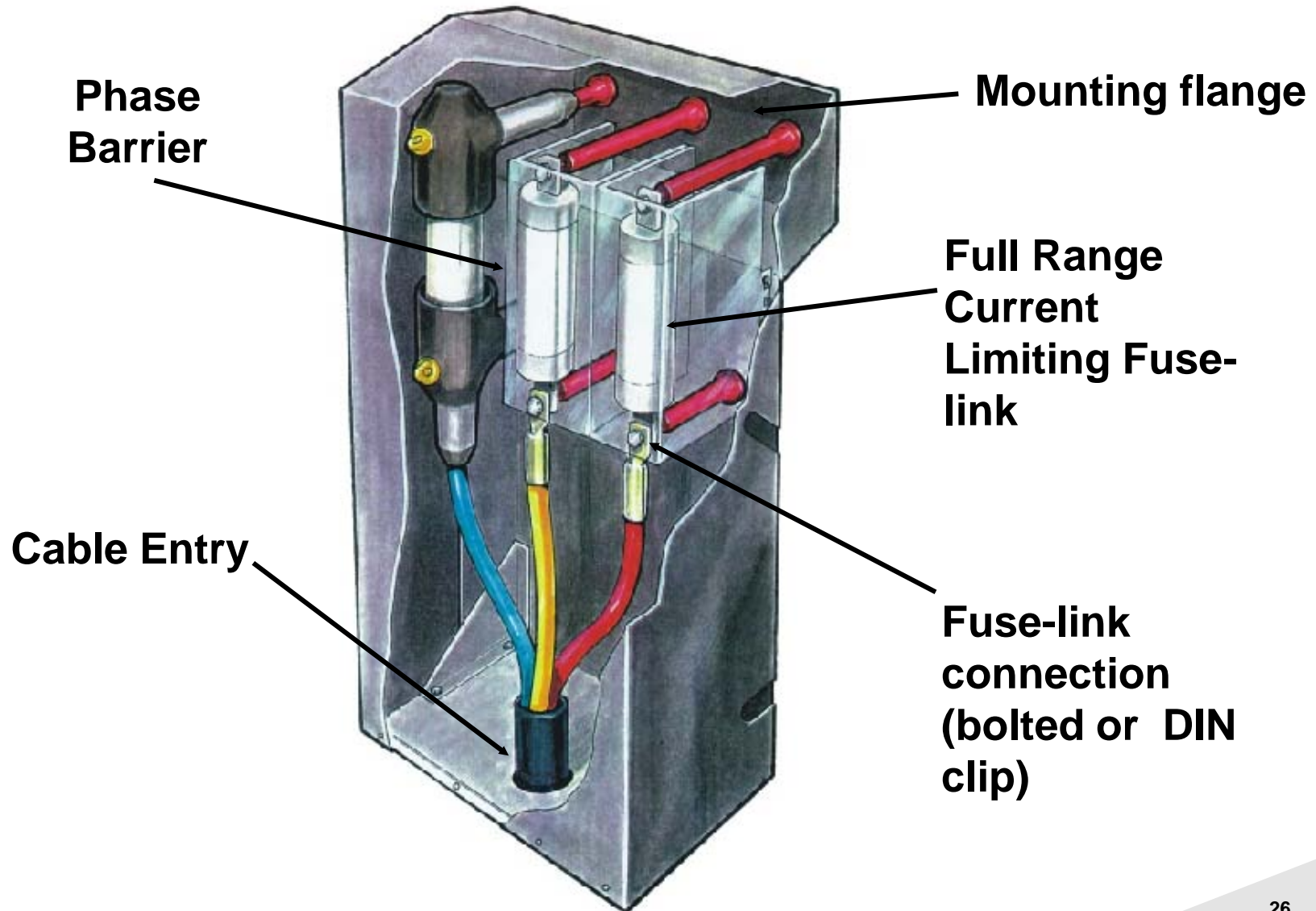
- 1) Busbar compartment
- 2) Switching compartment
- 3) Cable compartment
- 4) Low voltage compartment



**Current Limiting (CL) Fuse-links**



# Fused End Box





**All countries have a generation, transmission and distribution system to get electricity to facilities**

**Medium and low voltage fuse-links are used mostly in the DISTRIBUTION part of the system**

**Medium voltage non-current limiting fuse links and Sectionalisers mounted in cut-outs are used in overhead lines**

**Medium voltage current limiting fuses are generally used in Ring main units (RMUs), fused switches and fused-end boxes in urban networks**