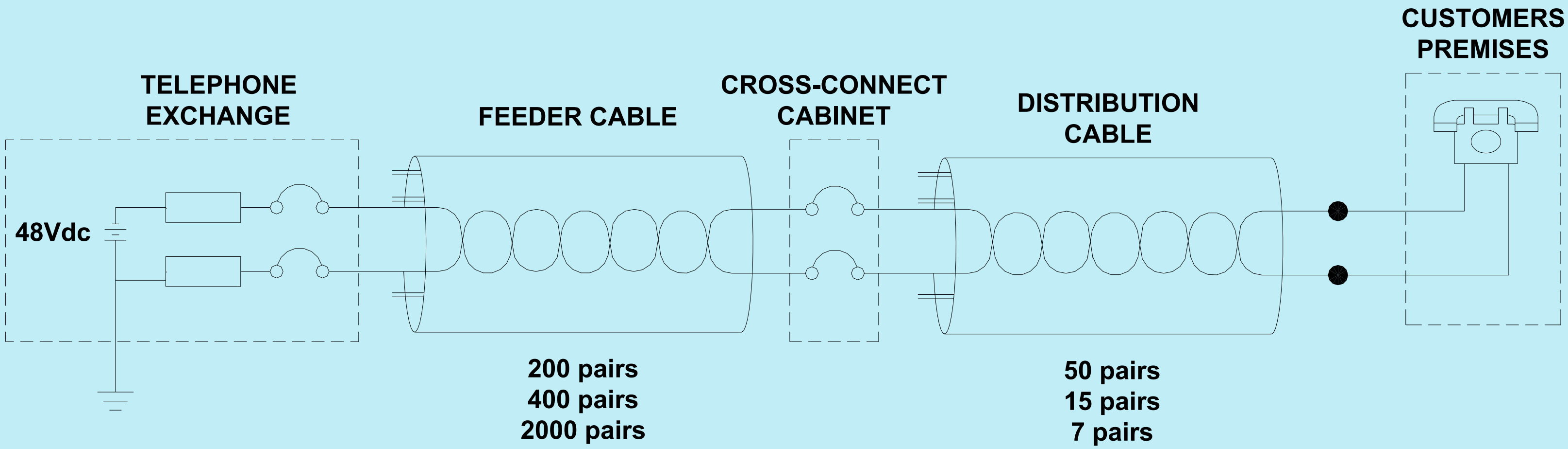
Typical Telecommunications Network



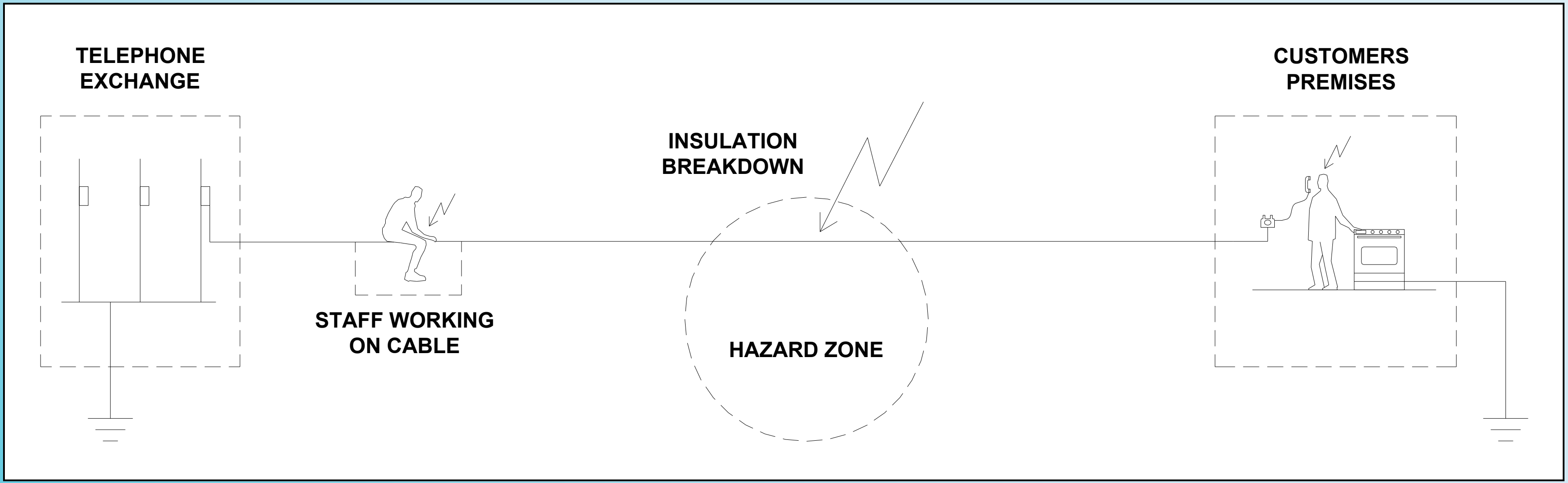
- **Chorus' increasingly common roadside electronic cabinets are all effectively small Telephone Exchanges**

Telecommunications Circuits

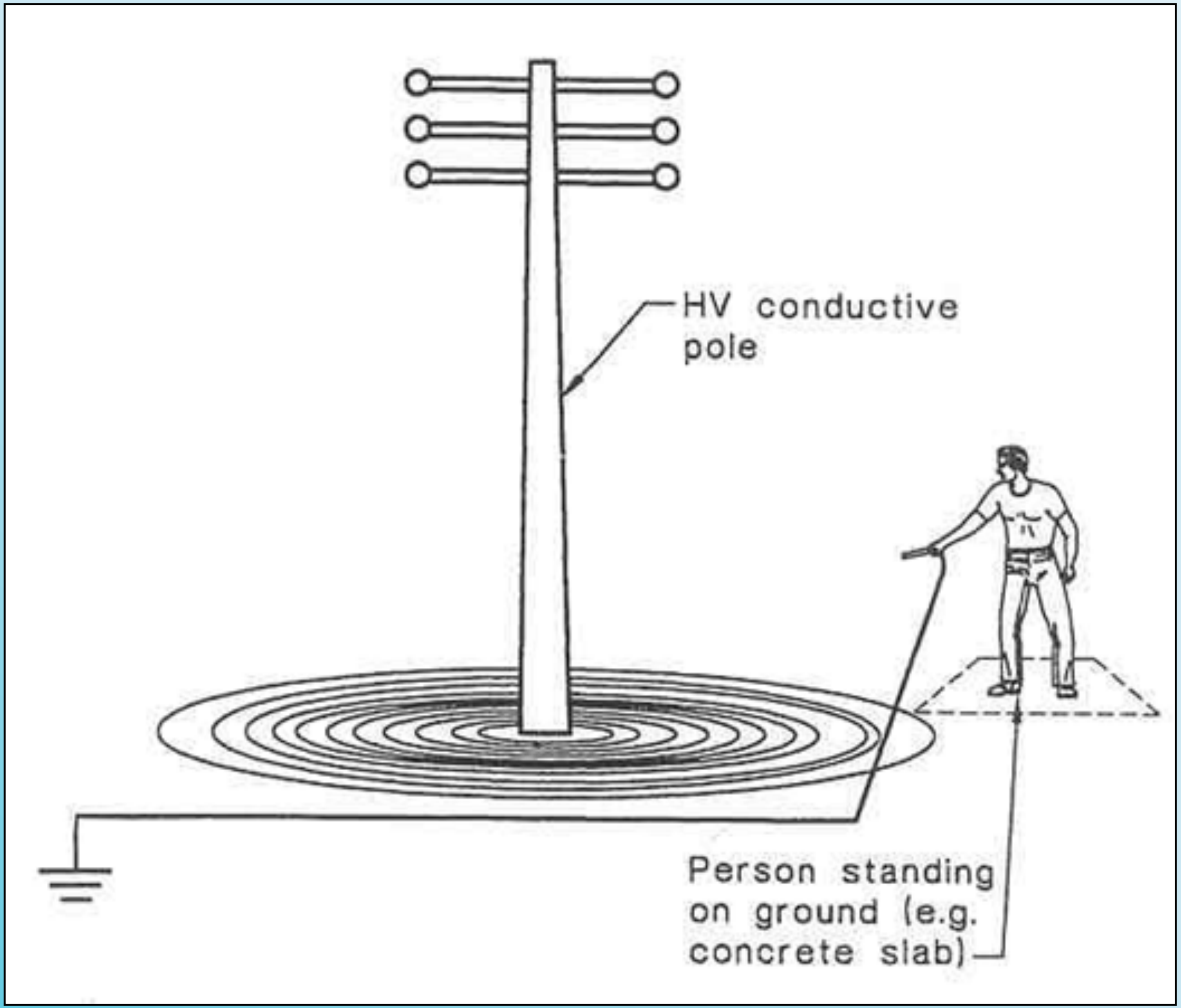
- **One earth reference on each working circuit – the Exchange earth**
- **Maximum voltages normally carried on each circuit**
  - **80 Vac   ringing voltage (occasionally there)**
  - **48 Vdc   always there**

Key Mechanisms

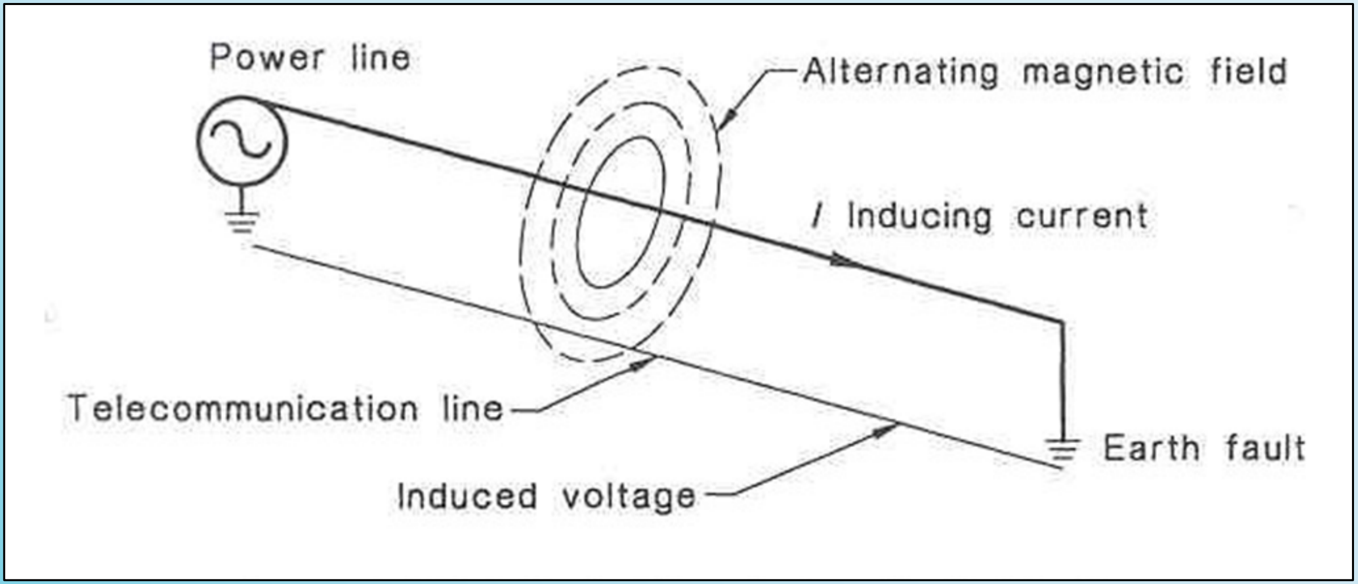
- **Earth Potential Rise (EPR)**



- **Via direct coupling to Exchange earth OR**
- **Insulation breakdown**

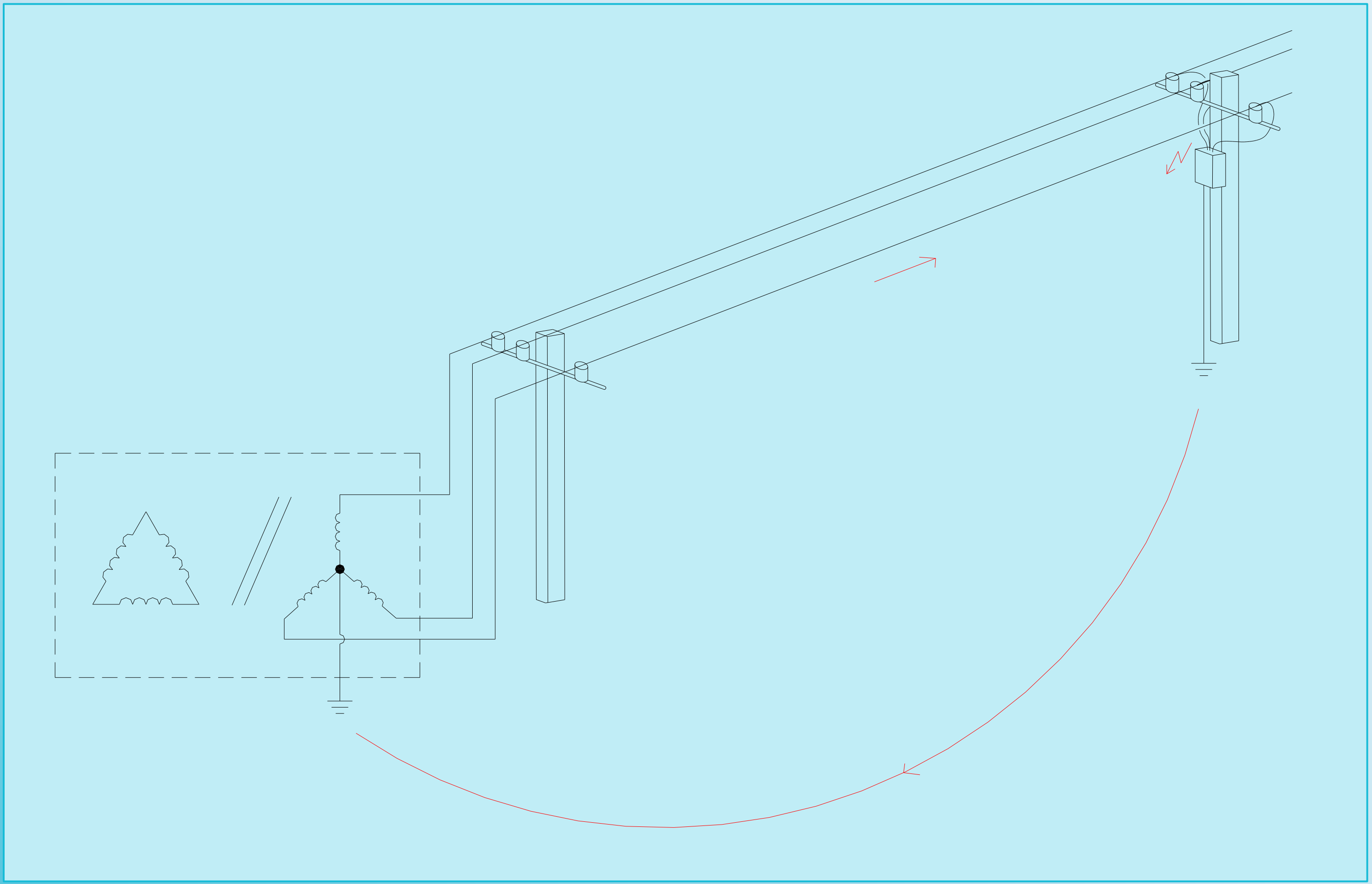

HV conductive
pole
Person standing
on ground (e.g.
concrete slab)

Induced Voltage



- **Requires 'out of balance' power current (usually earth return current)**

Induced Voltage (cont.)



Induced Voltage (cont.)

- Earth currents return on average at the below depths:
  ρ = 10 Ω-m 300 m
  ρ = 100 Ω-m 900 m
  ρ = 1,000 Ω-m 3,000 m

- No insulation breakdown is required to impress voltages onto telecommunications conductors

- Mitigation options more limited, and generally more costly

Induced Voltage (cont.)

$$E = C \times L \times I \times K$$

- E = induced voltage (V)
- C = coupling factor (mutual impedance) (Ω/km)
  - = fn (ρ,s)
    - ρ = deep earth soil resistivity
    - s = separation
- L = length of parallel (km)
- I = inducing current (A)
- K = shielding factor (≤ 1.0)

Key Impacts

1. **Human hazard**
2. **Damage to telecommunications plant**
3. **Noise interference**

Key Impacts (cont.)

1. **Human hazard**

2. **Damage to telecommunications plant**

    - **Almost always result from HV phase – earth fault**
    - **Maximum impressed voltage readily calculated prior to construction**
    - **Consequences major (danger)**
    - **Hence ‘predictive’ approach**

Key Impacts (cont.)

3. **Noise interference**
   - **Arises from ‘normal’ power network operation (not faults)**
   - **Maximum impressed voltage very difficult to predict**
   - **Causes mal-operation of signalling systems, degradation of call quality (unusable?), slowing down of available broadband speed**

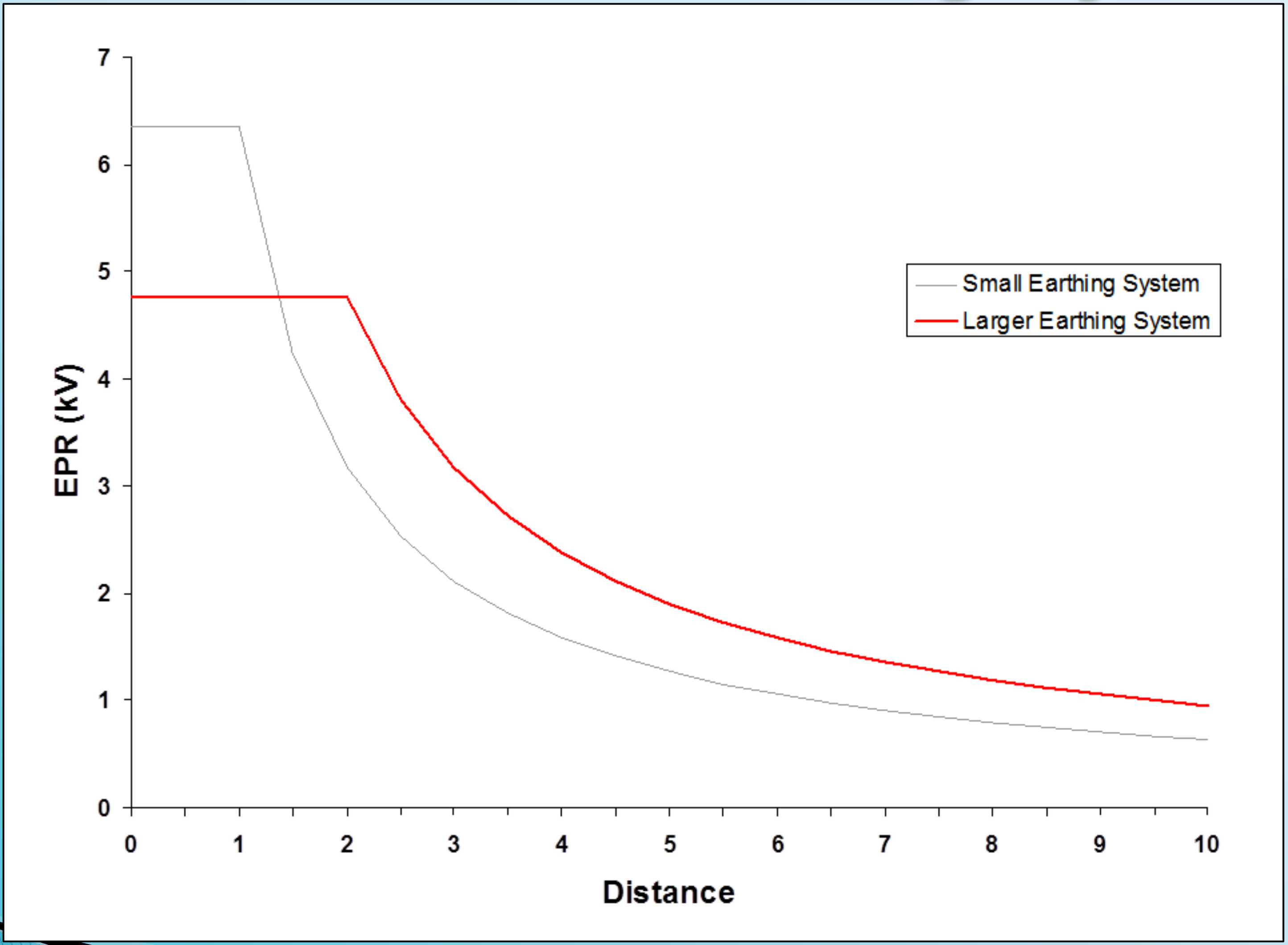
- **Consequences more minor (nuisance)**
- **Rarely a problem**
- **Hence ‘reactive’ approach**

Key Power Co-ordination Aspects of Power Networks

General

- The portion of the earth return current flowing through the soil is the key factor for both EPR and induced voltage hazards
- If no voltage is impressed onto telecommunications conductors, there is no problem

Size of Power Earthing System

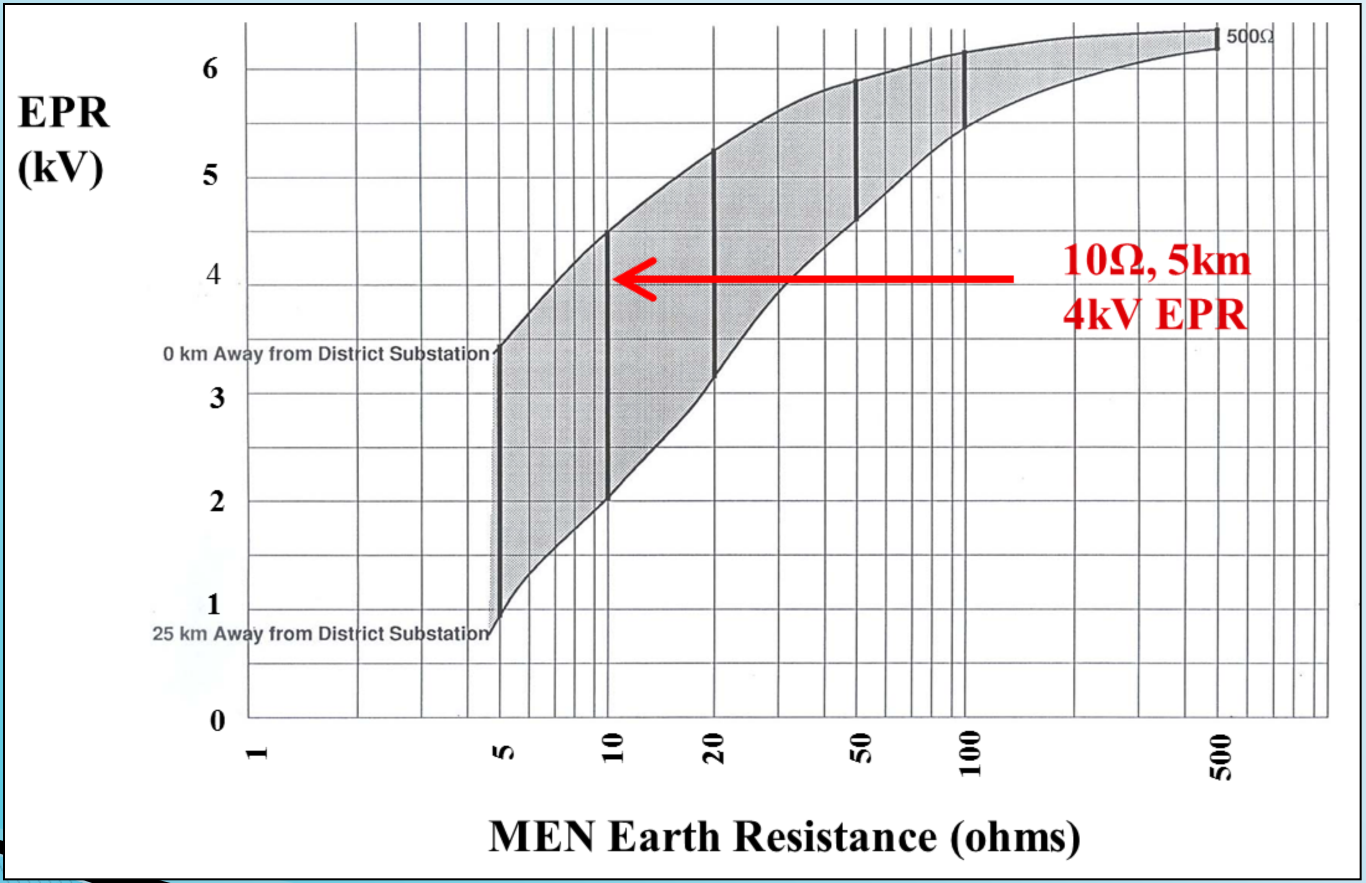


Urban

- Extensive interbonded MEN systems in urban areas greatly limit EPR magnitude. They do not cause hazard problems.
  - Can still have EPR hazard from conductive HV power poles and other power earthing systems, that are NOT bonded to extensive interbonded MEN systems.
- Induced voltage hazard rare in urban areas due to extensive ‘shielding’.

Rural

- Rural EPR levels are very high for HV earth faults



Rural (cont.)

- **HV earth faults at rural distribution transformers are a particular concern.**
  - **EPR typically > 3 kV is transferred onto LV MEN system.**
  - **Mains-powered telecommunications equipment may suffer insulation breakdown (to remote earth on incoming telecommunications cable conductors).**

- **Possible solutions:**

  1. **Separation of HV and LV earths at the distribution transformer.**
  2. **Petersen coil (or similar) at Zone Substation.**

Key Power Co-ordination Aspects of Telecommunications Networks

Insulated copper conductor multi twisted pair telecommunications cables

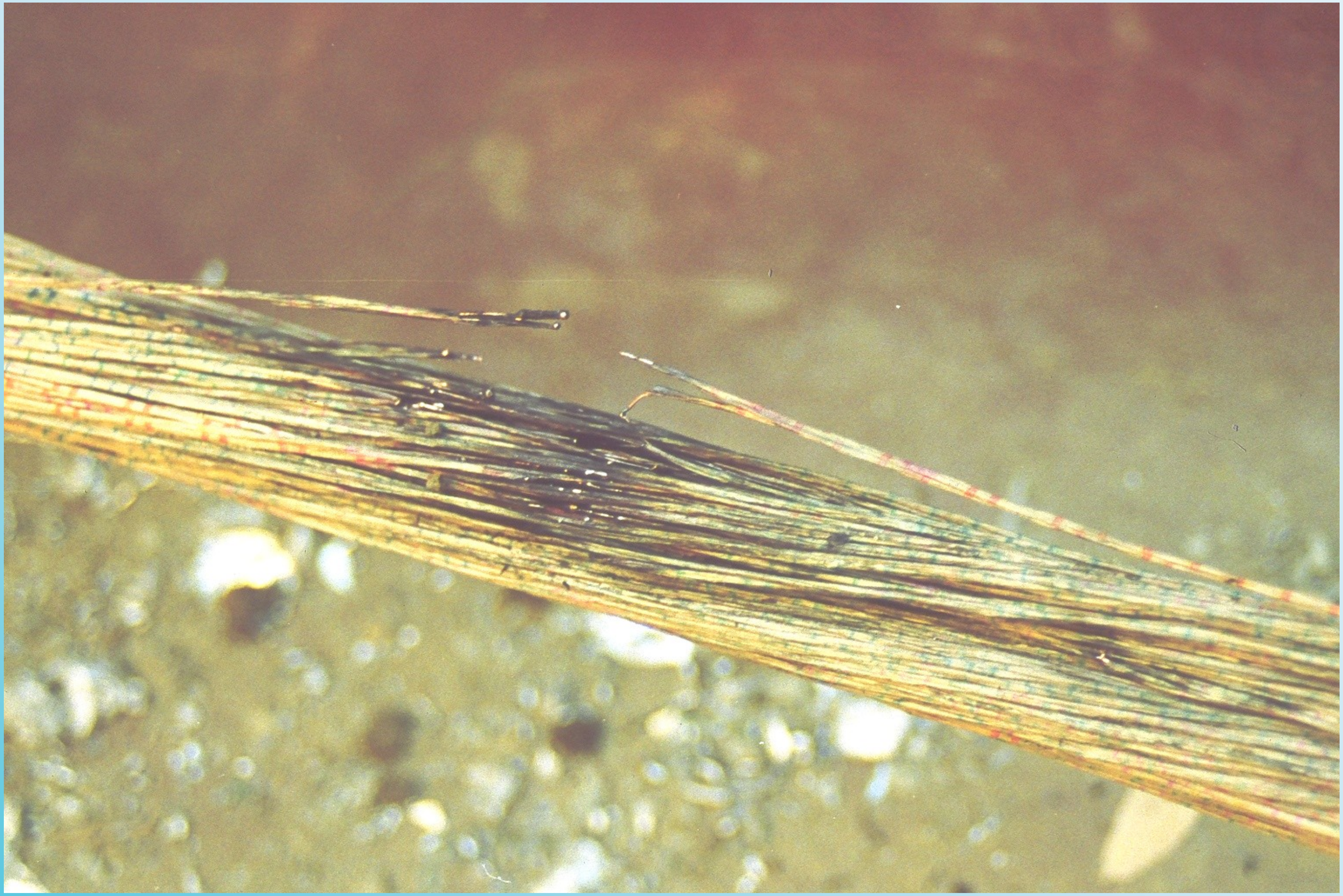
1. **All ‘working pairs’ have a (remote) earth reference provided by the Telephone Exchange earth.**
2. **Mains-powered customer’s telecommunications equipment which bridges the power and telecommunication networks is increasingly common.**

3. Typical copper conductor sizes are 0.4 mm and 0.63 mm diameter (0.13 mm^2 and 0.31 mm^2).

4. Individual plastic insulated copper conductors in telecommunications cables (since 1970) have been spark tested during manufacture to 1.4 kVrms.

Typical Insulation Levels

Telecommunications Plant	Insulation (kV)	Installed
Buried cables with paper insulated conductors (PCUT, PCUB, PCQL)	1.0	Before 1970
Buried cables with plastic insulated conductors - not grease filled or pressurised (PEUT)	1.5	1970 - 1975
Pillars, pedestals, OJs	1.5	1970 -
Buried grease filled or pressurised cables with plastic insulated conductors (PEFUT, PEUB, CPUB)	2.5	1975 -
As above, but installed in the ground in pipe	4.0	1975 -



Telecommunications Industry Mitigation Options

1. **EPR Hazard**

- **Shift telecommunications plant to lower EPR area**
- **Replace network plant (e.g. cables) with plant with a higher insulation rating**
- **Shift locally earthed network plant**
- **Install isolation units at customer's premises**

- **Replace copper cable network plant with fibre optic cables**
- **Special safety practices for telecommunications staff**

2. **Induced Voltage Hazard**

- **Reroute parallel telecommunications cables to:**
  - **Reduce length of parallel**
  - **Increase separation**

- **Install fibre optic cable to roadside electronic cabinet**
  - **Reduces parallel to 1/3 of former length**

Fibre Optic Cable Networks

1. Minimal or nil Power Co-ordination impacts
2. UFB rollout in urban areas is due to be completed in 2020
3. However, retirement of urban copper telecommunication cable networks could easily be 10 or more years later

4. **Minor Power Co-ordination issues still apply if the fibre optic cables contain any metallic parts e.g.**
   - **Steel strength member**
   - **Metallic moisture barrier**
   - **Copper tracer wire (for future cable location)**
   - **Metal catenary wire (aerial f/o cables)**

(Ref. PCOG 4.5, 12.2.3)