Welcome to

Whitecode Consulting

CPD for Substations and LV Distribution

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Substation

When talking about electrical distribution, a substation is generally defined as an area containing plant or equipment to reduce the voltage of the distribution system to a lower level

External Substation

Kiosk Substation

Containerised Substation

Substation

The International Electrotechnical Commission has classified voltage bands into the following levels (IEC 60038)

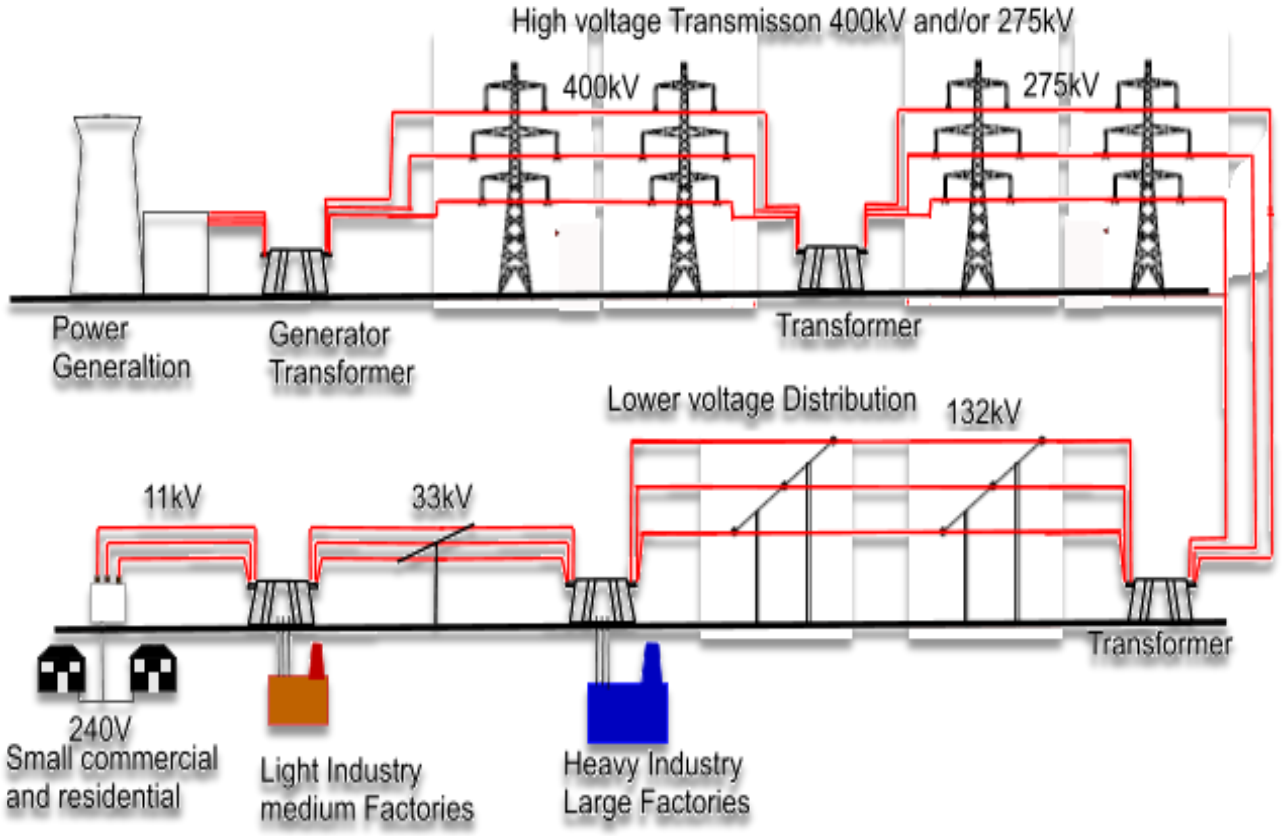
This classification system is fast gaining acceptance, but other terminology is still used, for example 11kV is often referred to as high voltage:

Low Voltage (LV) - 70V to 1000V

Medium Voltage (MV) - 1000V to 35kV

High Voltage (HV) - 35kV to 230 kV

Extra High Voltage (EHV) - above 230 kV



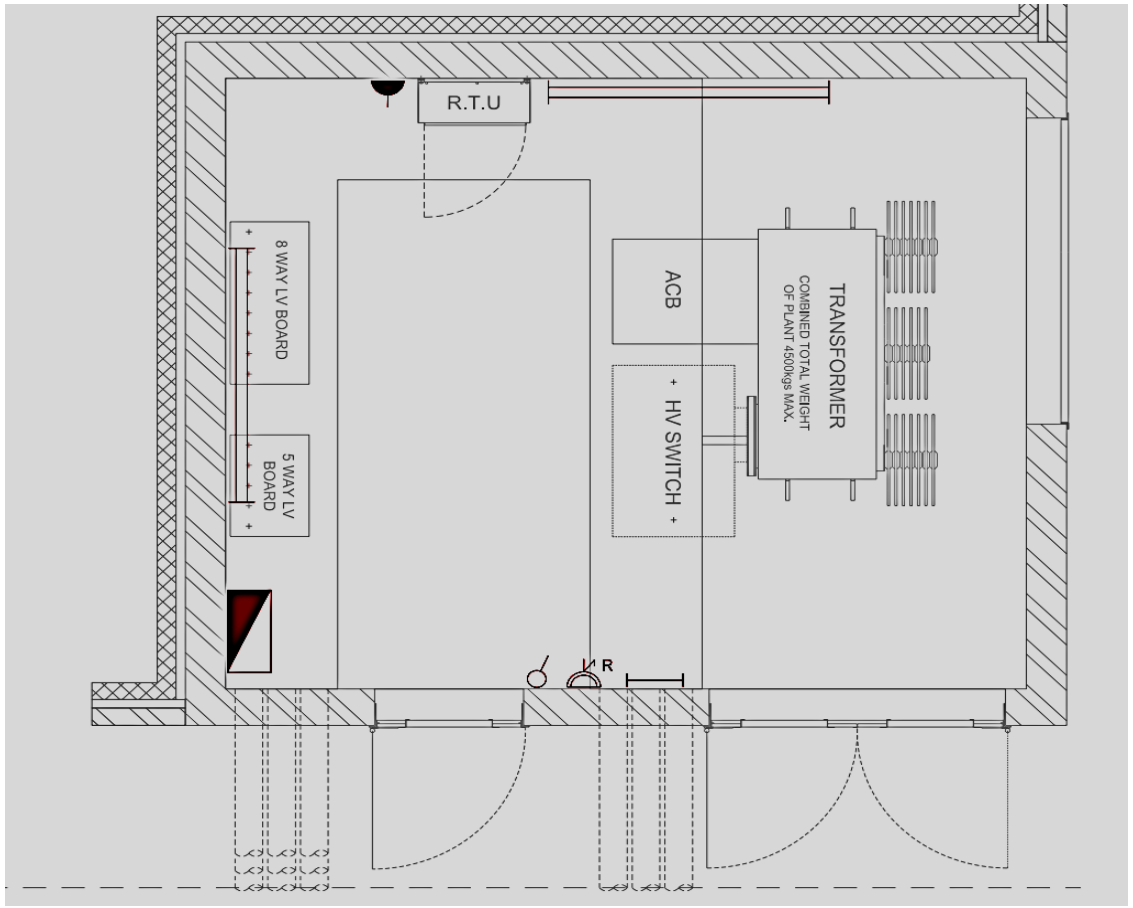
Simplified UK Electical Power Transmission system

11kV to 400V Substations

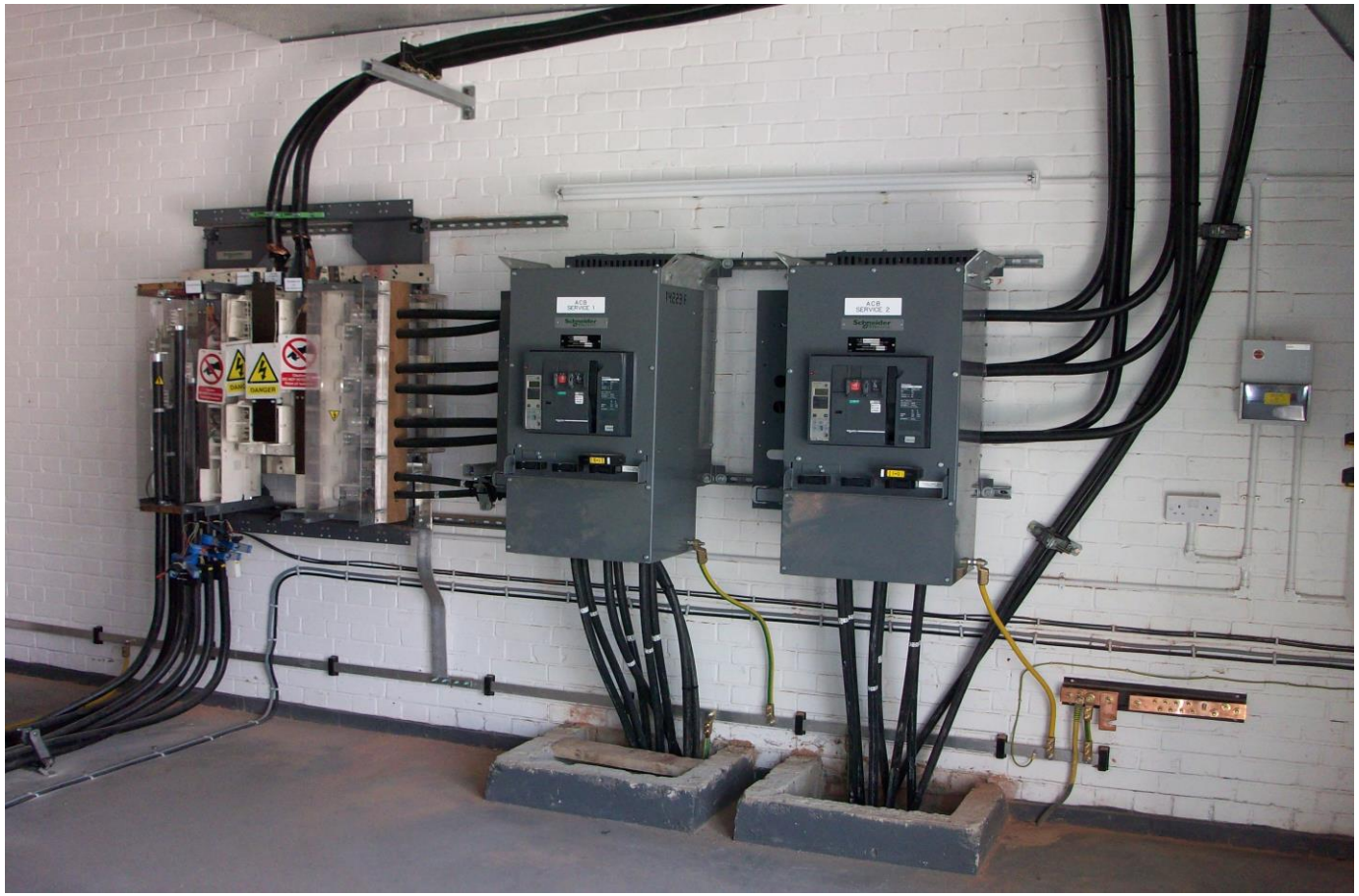
- Any substations forming part of a multi-dwelling residential development will be an 11kV to 400V substation
- This takes 11,000 Volts and reduces it to 400 Volts
- 400V is then distributed around the site
- 400V is UK three phase voltage
- 230V is UK single phase voltage
- Larger sites are likely to have multiple substations

What's Inside?

- The diagram shows a typical UKPN substation layout containing:
  - Transformer – main item of plant; this is the piece of kit that turns 11,000V into 400V
  - HV Switch; this is an 11,000V switch that allows an open point to be created on the 11,000V network (aka a ring main unit)
  - Air Circuit Breaker; this is the first point of overload and short circuit protection on the 400V side of the transformer
  - Ring Transfer Unit; this allows the RMU to be remotely controlled, without personnel having to physically attend site
  - LV Boards; these are used to split the large supply from the ACB into multiple smaller supplies
  - Ancillary items including single phase distribution board, lights and switch, RCD protected socket and power supply for the RTU

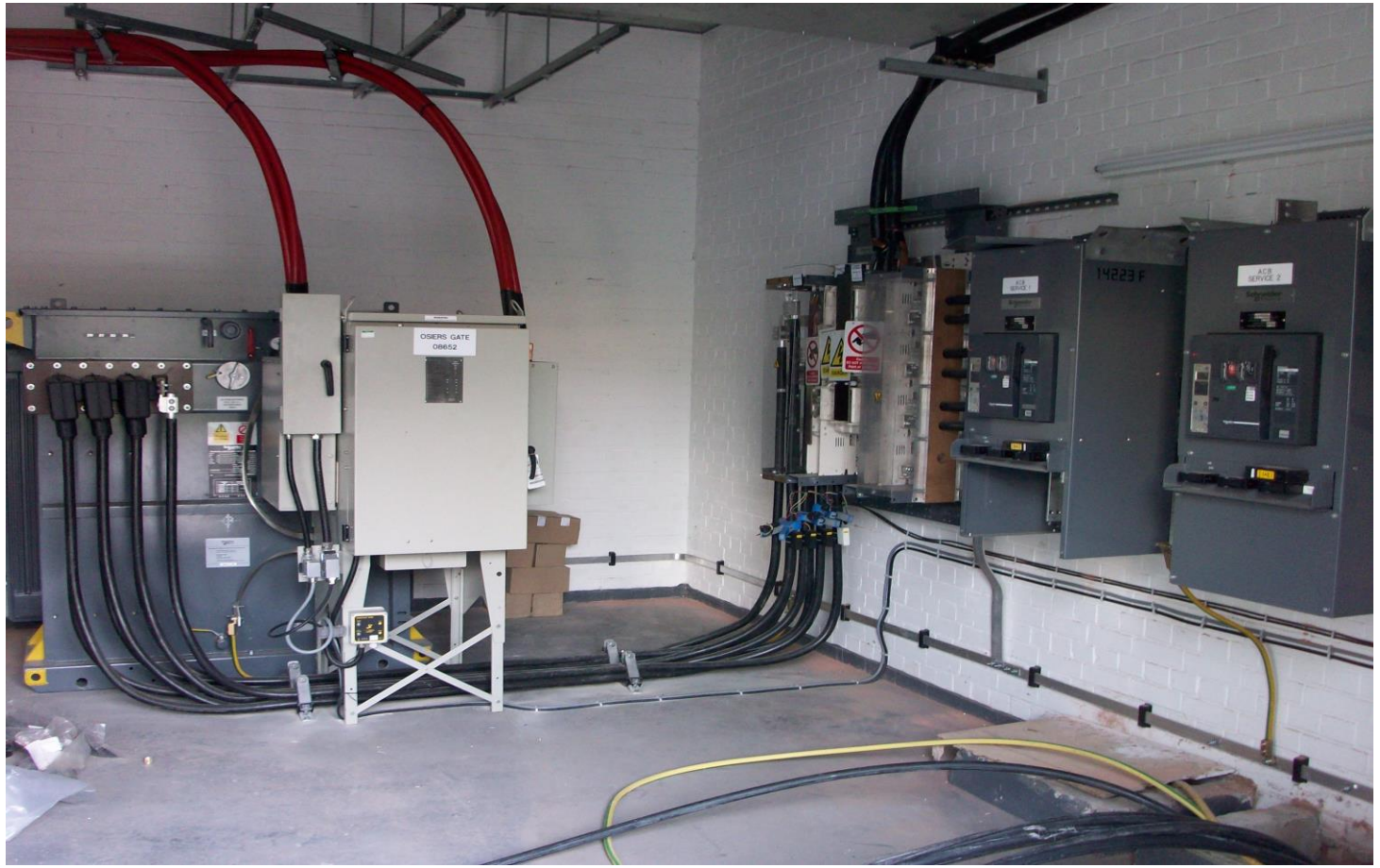


ACB's and Fuse Board



Transformer and RMU (1)

Transformer and RMU (2)



Location of Substations

- Site will generally need a substation if the estimated maximum demand is over 150 to 250 kVA, depending on what is available from the network and passing main
- Almost all multi-dwelling residential units will require an on site substation
- The substation needs to be located so that the distribution network operator has 24 hour unimpeded access
- Ability to naturally ventilate needs to be taken into consideration, as mechanical ventilation is usually not an option

Location of Substations

- In addition to locating the substation in a position to suit the DNO, consideration also needs to be given to how the electrical loads will be served
- The further away from the substation a load is, the greater the losses will be in the cable and the higher the earth fault impedance will be
- If a load is some distance from a substation, the cable to serve it will need to be larger than if it were located closer; the load itself can also compound the problem
- Bear in mind that there is a practical limit on the cable size that can be utilised
- The substation must be positioned as close to the centre of the load as possible; for example, if there is a large energy centre with large CHP and chillers, the substation must be located as close to that as possible
- UKPN have previously requested that customer/BNO distribution equipment is within 10 meters of the substation

Acronyms!

- DNO – Distribution Network Operator
  - Companies licensed to distribute electricity in Great Britain by the Office of Gas and Electricity Markets, for example UK Power Networks
- ICP – Independent Connection Provided
  - An accredited company that is entitled to build electricity networks to the specification and quality required for them to be owned by either a DNO, such as UK Power Networks, or an IDNO, such as ESP
- IDNO – Independent Distribution Network Operator
  - An IDNO is an accredited company with a wider scope than an ICP; after building a local electricity network, it will continue to own the local network and provide maintenance and 24-hour fault repairs
- BNO – Building Network Operator
  - A BNO is a term used to describe an organisation that owns or operates the electricity distribution network within a multi-occupancy building between the intake cut out position (the first point of isolation) and the customer's installation

Map of DNO's

Area ID	Area	Company
10	East England	UK Power Networks
11	East Midlands	Western Power Distribution
12	London	UK Power Networks
13	North Wales, Merseyside and Cheshire	Scottish Power Energy Networks
14	West Midlands	Western Power Distribution
15	North East England	Northern Power Grid
16	North West England	Electricity North West
17	North Scotland	Scottish Hydro Electric Power Distribution
18	South Scotland	Scottish Power Energy Networks
19	South East England	UK Power Networks
20	Southern England	Southern Electric Power Distribution
21	South Wales	Western Power Distribution
22	South West England	Western Power Distribution
23	Yorkshire	Northern Power Grid

List of IDNO's

- There is no map for IDNO's because they are non-geographical and can operate in any location
- The area ID's determine the start of the MPAN so it is clear who owns the network

Area ID	Name	Licensee	MPAS Operator ID
24	Envoy	Independent Power Networks	IPNL
25	ESP Electricity	ESP Electricity	LENG
26	Energetics	Global Utilities Connections (Electric) Ltd	GUCL
27	GTC	The Electricity Network Company Ltd	ETCL
28	EDF IDNO	UK Power Networks (IDNO) Ltd	EDFI
29	HARLAXTON ENERGY NETWORKS LTD	Harlaxton (IDNO)	HARL
30	Peel Electricity Networks Ltd	Peel Electricity Networks (IDNO)	PENL

What is a Building Network Operator (BNO)?

- The term BNO is defined as an organisation that owns or operates the electrical distribution network within a multiple occupancy building, between the intake position and the installation within a dwelling
- The BNO may be an Independent Distribution Network Operator (IDNO) or a third party; they are exempt from holding an electricity distribution licence, such as a facilities management company
- They are responsible for the design, installation and maintenance of the building network and ensuring that the network meets the requirements of the Building Regulations and BS 7671 if unlicensed; different rules apply for licensed BNO's
- Once installed, they are entitled to recover the costs of providing the service of conveying electricity through their network; this is done under different regulations to a licensed electricity distributor and further details on how this can be recovered can be made available through Ofgem (this is beyond the scope of this presentation)
- The majority of developers operate as unlicensed BNO's

Low Voltage Distribution

- Low voltage is distributed from the transformer in a number of ways
- With on site substations, multiple supplies may be provided by UKPN and/or ICP to serve various buildings
- For most large London developments where UKPN are the DNO, a single large incoming supply will be provided by them from each substation; it is then the developers responsibility to divide/distribute the supply around the building
- Secondary supplies for life safety equipment are sometimes derived from the same substation to negate the need for generators; in cases where this is being considered, a risk assessment will be required which needs to be approved by both Building Control and the Fire Service

J Type Fuse Board

- Fuse distribution board capable of accepting fuses from 200A to 800A
- Normally found directly after, or very close to, the transformer
- Used to divide the large outgoing supply from the transformer into a smaller supplier to serve areas of the building
- Usually unmetered and on some sites may have been ‘sealed’ by EDF

MSDB's

- Multi-service distribution boards are fuse distribution boards, usually fitted with 100A fuses, to provide unmetered single or three phase supplies up to 100A
- Commonly referred to as 'Ryefield Boards', although they may be produced by an alternative manufacturer
- Lucy Switchgear manufacture boards with a J-type fused feeder, as per the example on the right

Landlords Distribution Board

- Range from very large floor-standing switch panels to smaller wall-mounted units
- Larger boards will generally be the main distribution board
- Small boards will generally be sub-distribution boards

Cubicle Switchboards

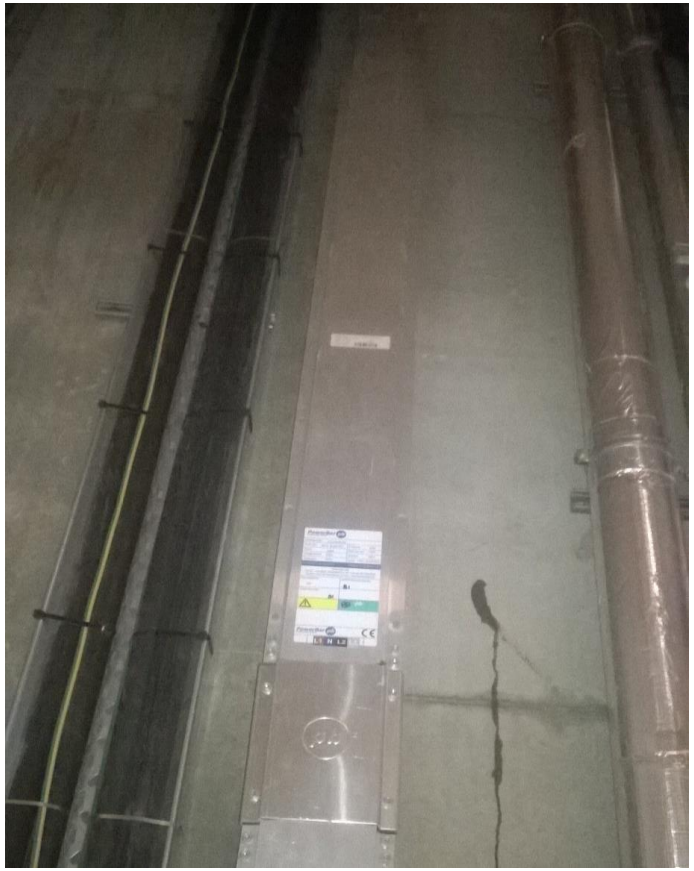
- Switchgear must always be mounted on a plinth with chamfered edges

Cable Distribution and Containment

- Cables connect transformer to main fuse board, to landlords boards, to MSDB's, etc.
- Cables need to be supported along their entire length
- Cables may be cleated directly to building structure, but when there are multiple cables, a cable tray or ladder would be more effective
- The cable tray can be light, medium or heavy duty
- A cable ladder should be used for very large cables

Busbar Distribution

- A Busbar can be thought of as an extension of the distribution board
- Copper or Aluminium bars in a metallic enclosure
- They can be four or five pole
- They are less labour-intensive than cable installation, as no separate containment is required
- There is a higher capital cost involved however



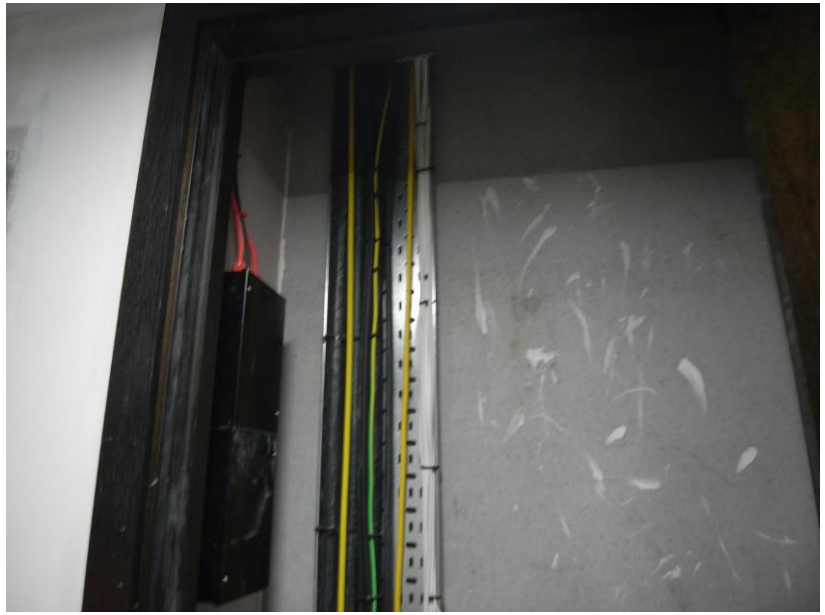
Busbar Distribution

- A Busbar can be used in place of cables, in order to overcome certain voltage drop or current-carrying capacity issues, etc.
- It is useful where space is tight, e.g. where cable bends are unachievable; a Busbar can be bent on a tight 90^{o} angle
- A water ingress will damage the Busbar beyond repair
- Cast-Resin Busbars can be IP68 and fire-rated

Tap Off Units

- Tap off units are used to connect equipment to the Busbar with short lengths of cable
- They may or may not have circuit protection, depending on requirements
- Some manufactures make MSDB's that bolt straight to the Busbar

Cable Distribution and Containment



Thank you for Listening

Any Questions?