203: Electrical installations technology  
**Handout 17: Conduit systems**

**Learning outcome**

The learner will:

1. know wiring systems of electrical installations.

**Assessment criteria**

The learner can:

3.2 identify **wiring systems** for different **environments**

3.5 identify purpose of **specialised** equipment for installing **wiring systems**

3.6 calculate spacing factor of **wiring enclosures**.

**Range**

**Wiring systems**: Cable tray, cable trunking, cable conduit, ladder racking, thermoplastic multi-core, flat profile, SWA, MICC, FP200, thermoplastic single-core, support methods and requirements, component parts.

**Environments**: Domestic, commercial, hazardous, industrial installation, agricultural.

**Specialised**: Conduit and tray benders, stocks, dies, formers.

**Wiring enclosures**: Conduit, trunking.

**Conduit systems**

Conduit is used as a containment system for electrical cables. There are three main types:

* metal (steel)
* PVC
* flexible.

|  |  |
| --- | --- |
| **Metal (steel) conduit**  The most common form of conduit used for electrical installation work is steel conduit. The screwed steel conduit system is undoubtedly the most popular for permanent wiring installations, particularly in modern commercial and industrial buildings. | 01 steel conduit.png |

**Advantages of steel conduit:**

* affords conductors good mechanical protection
* permits easy rewiring
* minimises fire risks
* can be utilised as the circuit protective conductor.

**Disadvantages of steel conduit:**

* under certain conditions, moisture is liable to form on the inside of the conduit
* expensive compared with some other systems
* liable to corrosion when subject to acid, alkali and other fumes.

**Types of steel conduit finish:**

* galvanised for outdoors or situations where steam or dampness is present.
* black enamelled for general work in dry situations.

**Typical sizes** are 16, 20, 25 and 32mm diameters – available in 3.75 metre lengths.

The working of steel conduit, ie cutting, threading, bending, etc, will be covered in Unit 204.

**Steel conduit accessories**

|  |  |
| --- | --- |
| 02 conduit-fittings.png | 03 electrical conduit fittings.png |
| 04a conduit boxes.png | |

**Specialist steel conduit tools**

|  |  |
| --- | --- |
| 05 conduit bending machine.png | 05 conduit formers.png |
| 06 conduit stocks and dies.png |

|  |  |
| --- | --- |
| **PVC conduit**  The basic material is polyvinyl chloride (PVC), which is produced in both flexible and rigid forms. It is impervious to acids, alkalis, oil, aggressive soils, fungi and bacteria, and is unaffected by sea, air and atmospheric conditions. It withstands all pests and does not attract rodents. PVC conduit may be buried in lime, concrete or plaster without harmful effects. | 08 pvc conduit.png |

**Advantages of PVC conduit:**

* light in weight and easy to handle
* easy to saw, cut and clean
* simple to form and bend
* does not require painting
* minimal condensation, due to low thermal conductivity in walls
* speed of erection
* excellent electrical and fire resistant properties.

**Disadvantages of PVC conduit:**

* care must be taken when gluing joints to avoid forming a barrier across the inside of the conduit
* if insufficient adhesive is used the joints may not be waterproof
* PVC expands around five times as much as steel and this expansion must be allowed for.

**Types of PVC conduit:**

* **Heavy Gauge Super High Impact**: Designed to withstand arduous site conditions and extreme weather conditions. Major building contractors and government departments often specify this type of conduit for use.
* **Light Gauge Super High Impact**: Suitable for pre-cast and *in situ* concrete work.
* **Heavy Gauge Standard Impact**: Suitable for typical conduit installations.
* **Heavy Gauge High Temperature Material**: Suitable for installations where 80/85°C temperatures are expected.

**Typical sizes**

Rigid round PVC conduit is typically available in the following sizes: 16, 20, 25, 32, 38 and 50mm diameter in 3 metre lengths.

|  |  |
| --- | --- |
| 09 pvc conduit accessories.png | 10 pipe bending spring.png |

|  |  |
| --- | --- |
| **Flexible conduit**  Flexible conduits are used to connect to motors or other devices where isolation from vibration is useful.  Flexible conduit can be obtained in PVC or metallic form. Whichever type is used, a separate cpc must be installed throughout the entire length of the conduit and terminated to an appropriate earth terminal at each end. | 12 flexible conduit.png |

**Sizing conduit**

The size of conduit required is worked out using **Tables E1**, **E2**, **E3** and **E4** of the IET On‑Site Guide; these are reproduced on the following pages of this Handout. For each of the cables that are going to be installed, a term for that particular size of cable is given in either **Table E1** or **E3**, depending on whether we are dealing with short straight runs or long runs or runs with bends. The terms for all the cables are added together and compared to the factors for conduit given in **Table E2** or **E4**. The size of conduit that is most suitable for use with these cables is the one whose factor is equal to or greater than the sum of the cable factors.

**Table E1 – Cable factors for use in conduit in short straight runs**

|  |  |  |
| --- | --- | --- |
| **Type of conductor** | **Conductor cross‑sectional area (mm2)** | **Cable factor** |
| **Solid** | **1** | **22** |
|  | **1.5** | **27** |
|  | **2.5** | **39** |
| **Stranded** | **1.5** | **31** |
|  | **2.5** | **43** |
|  | **4** | **58** |
|  | **6** | **88** |
|  | **10** | **146** |
|  | **16** | **202** |
|  | **25** | **385** |

**Table E2 – Conduit factors for use in short straight runs**

|  |  |
| --- | --- |
| **Conduit diameter (mm)** | **Conduit factor** |
| **16** | **290** |
| **20** | **460** |
| **25** | **800** |
| **35** | **1400** |
| **38** | **1900** |
| **50** | **3500** |
| **63** | **5600** |

**Table E3 – Cable factors for use in conduit in long straight runs over 3m or runs  
of any length incorporating bends**

|  |  |  |
| --- | --- | --- |
| **Type of conductor** | **Conductor cross‑sectional area (mm2)** | **Cable factor** |
| **Solid or Stranded** | **1** | **16** |
| **1.5** | **22** |
| **2.5** | **30** |
| **4** | **43** |
| **6** | **58** |
| **10** | **105** |
| **16** | **145** |
| **25** | **217** |

The above tables reproduced from the IET On‑Site Guide

**Table E4 – Conduit factors for runs incorporating bends and long straight runs**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Length of run (m)** | **Conduit diameter (mm)** | | | | | | | | | | | | | | | | | | | |
| **16** | **20** | **25** | **32** | **16** | **20** | **25** | **32** | **16** | **20** | **25** | **32** | **16** | **20** | **25** | **32** | **16** | **20** | **25** | **32** |
| **Straight** | | | | **One bend** | | | | **Two bends** | | | | **Three bends** | | | | **Four bends** | | | |
| **1** | **Covered by**  **Tables**  **E1 and E2** | | | | **188** | **303** | **543** | **947** | **177** | **286** | **514** | **900** | **158** | **256** | **463** | **818** | **130** | **213** | **388** | **692** |
| **1.5** | **182** | **294** | **528** | **923** | **167** | **270** | **487** | **857** | **143** | **233** | **422** | **750** | **111** | **182** | **333** | **600** |
| **2** | **177** | **286** | **514** | **900** | **158** | **256** | **463** | **818** | **130** | **213** | **388** | **692** | **97** | **159** | **292** | **529** |
| **2.5** | **171** | **278** | **500** | **878** | **150** | **244** | **442** | **783** | **120** | **196** | **358** | **643** | **86** | **141** | **260** | **474** |
| **3** | **167** | **270** | **487** | **857** | **143** | **233** | **422** | **750** | **111** | **182** | **333** | **600** |  |  |  |  |
| **3.5** | **179** | **290** | **521** | **911** | **162** | **263** | **475** | **837** | **136** | **222** | **404** | **720** | **103** | **169** | **311** | **563** |  |  |  |  |
| **4** | **177** | **286** | **514** | **900** | **158** | **256** | **463** | **818** | **130** | **213** | **388** | **692** | **97** | **159** | **292** | **529** |  |  |  |  |
| **4.5** | **174** | **282** | **507** | **889** | **154** | **250** | **452** | **800** | **125** | **204** | **373** | **667** | **91** | **149** | **275** | **500** |  |  |  |  |
| **5** | **171** | **278** | **500** | **878** | **150** | **244** | **442** | **783** | **120** | **196** | **358** | **643** | **86** | **141** | **260** | **474** |  |  |  |  |
| **6** | **167** | **270** | **487** | **857** | **143** | **233** | **422** | **750** | **111** | **182** | **333** | **600** |  |  |  |  |  |  |  |  |
| **7** | **162** | **263** | **475** | **837** | **136** | **222** | **404** | **720** | **103** | **169** | **311** | **563** |  |  |  |  |  |  |  |  |
| **8** | **158** | **256** | **463** | **818** | **130** | **213** | **388** | **692** | **97** | **159** | **292** | **529** |  |  |  |  |  |  |  |  |
| **9** | **154** | **250** | **452** | **800** | **125** | **204** | **373** | **667** | **91** | **149** | **275** | **500** |  |  |  |  |  |  |  |  |
| **10** | **150** | **244** | **442** | **783** | **120** | **196** | **358** | **643** | **86** | **141** | **260** | **474** |  |  |  |  |  |  |  |  |

Additional factors

* For 38mm diameter use 1.4 x (32mm factor)
* For 50mm diameter use 2.6 x (32mm factor)
* For 63mm diameter use 4.2 x (32mm factor)

The above table reproduced from the IET On‑Site Guide

**Example 1**

The following cables are to be drawn into a straight 2m length of conduit:

* 2 off solid core 1.5mm2
* 4 off solid core 2.5mm2
* 4 off stranded 4mm2.

Calculate the conduit size required to accommodate these cables.

**Solution:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Factor for 2 off solid core 1.5mm2 from On-Site Guide Table E1 |  |  |
|  |  |  |  |
|  | Factor for 4 off solid core 2.5mm2 from On-Site Guide Table E1 |  |  |
|  |  |  |  |
|  | Factor for 4 off stranded 4mm2 from On-Site Guide Table E1 |  |  |
|  |  |  |  |
|  |  |  |  |
|  | From On-Site Guide Table E2, size required |  |  |

**Example 2**

The following cables are to be drawn into a 2m length of conduit with 2 bends:

* 2 off solid core 1.5mm2
* 4 off solid core 2.5mm2
* 4 off stranded 4mm2

Calculate the conduit size required to accommodate these cables.

**Solution:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Factor for 2 off solid core 1.5mm2 from On-Site Guide Table E3 |  |  |
|  |  |  |  |
|  | Factor for 4 off solid core 2.5mm2 from On-Site Guide Table E3 |  |  |
|  |  |  |  |
|  | Factor for 4 off stranded 4mm2 from On-Site Guide Table E3 |  |  |
|  |  |  |  |
|  |  |  |  |
|  | From On-Site Guide Table E4, size required |  |  |