GUIDE TO THE 'IP' CODES FOR ENCLOSURES



Third Edition

DEGREE OF PROTECTION

BS EN 60529: 1992 (IEC 529 1989)

The Electrical Installation Equipment Manufacturers' Association

INTRODUCTION TO EIEMA

The Electrical Installation Equipment Manufacturers' Association is an independent, incorporated Association of manufacturers of electrical installation equipment whose roots go back to the early days of the electrotechnical industry. In 1972 EIEMA Limited was formed from the Electrical Installation Equipment Department of BEAMA – The British Electrotechnical and Allied Manufacturers' Association.

EIEMA has 45 members ranging from companies which are the UK Divisions of large multinational companies to small owner managed niche market companies. EIEMA is organised into four Product Groups as follows:

- **Single Phase Product Group (SPPG)**
  Wiring Accessories, MCBs, RCDs, Power Track, Consumer Units.
- **Industrial Products Group (IPG)**
  Fuses, Distribution Boards (standard), Switch & Fusegear, MCCBs (as well as MCBs and RCDs), ACBs, Industrial Plugs and Sockets.
- **Engineered Product Systems Group (EPSG)**
  Low Voltage Switchboards, Busduct products.
- **Cutout & Feeder Pillar Group (COFP)**
  Cutouts, Feeder Pillars.

The benefits of membership fall into two broad categories which are representation and access to Association services. The main areas in which the Association represents its members are in legislative and standardisation matters. The former is done both directly by established relationships with appropriate Government or EU departments in London and Brussels, and through BEAMA and various European manufacturers' groups.

Active participation in the work of numerous national, international and European standards committees has provided the background and support to ensure safety and performance for the design, development and manufacture of EIEMA members' products. The result is quality equipment of the highest standard throughout each group of the Association.

Other services offered by the Association include legal, statistics and export support. In addition the Association is a channel for liaison with customer associations such as the Electrical Distributors' Association (EDA) and the Electrical Contractors' Association (ECA).

Acknowledgements

EIEMA would like to thank: IEC and BSI for allowing references to their standards.

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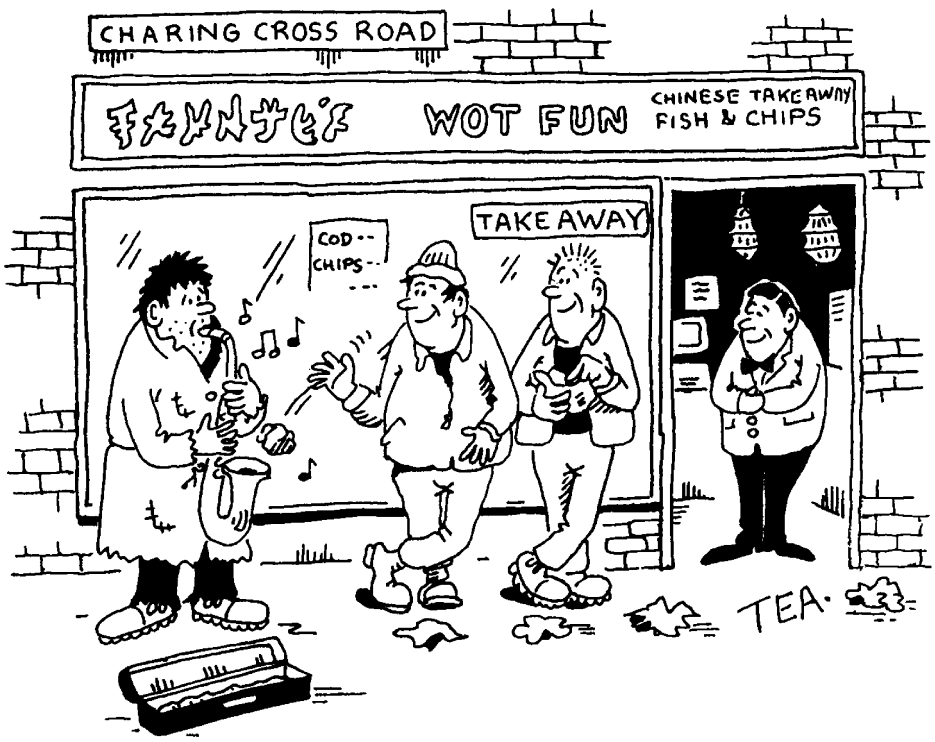
PREFACE

The object of this guide is to provide an easily understood document, aiding interpretation of the requirements for enclosure protection related to EIEMA products.

Principally, these requirements are detailed in BS EN 60529:1992 (IEC 60529:1989 second edition) which defines the degrees of protection provided by enclosures classified under the International Protection (IP) Code and the test conditions required to meet these classifications. This guide should be read in conjunction with those documents.

Readers should note, the requirements in the Standard call for comparative tests and these bear no actual relationship to specific weather or corrosive conditions.

The guide seeks to provide a simplified understanding of the standard, accompanied by some typical examples as foreseen for the general products available from EIEMA member Companies. As BS EN 60529 is a document covering a wide range of equipment, only those sections relevant to EIEMA products are covered.



IP1X 50.0mm dia sphere – no penetration

Certain additional information has been included having regard to the particular considerations necessary for equipment intended for exposure to weather and to the requirement for natural ventilation, which exists with some products.

It is the intention of EIEMA to review this guide periodically, to reflect changes in related specifications, product standards and working practices.

1 INTRODUCTION

BS EN 60529 describes a system for classifying degrees of protection provided by enclosures, principally for electrical equipment.

It should be noted that empty enclosures may be supplied and therefore could be used for other applications.

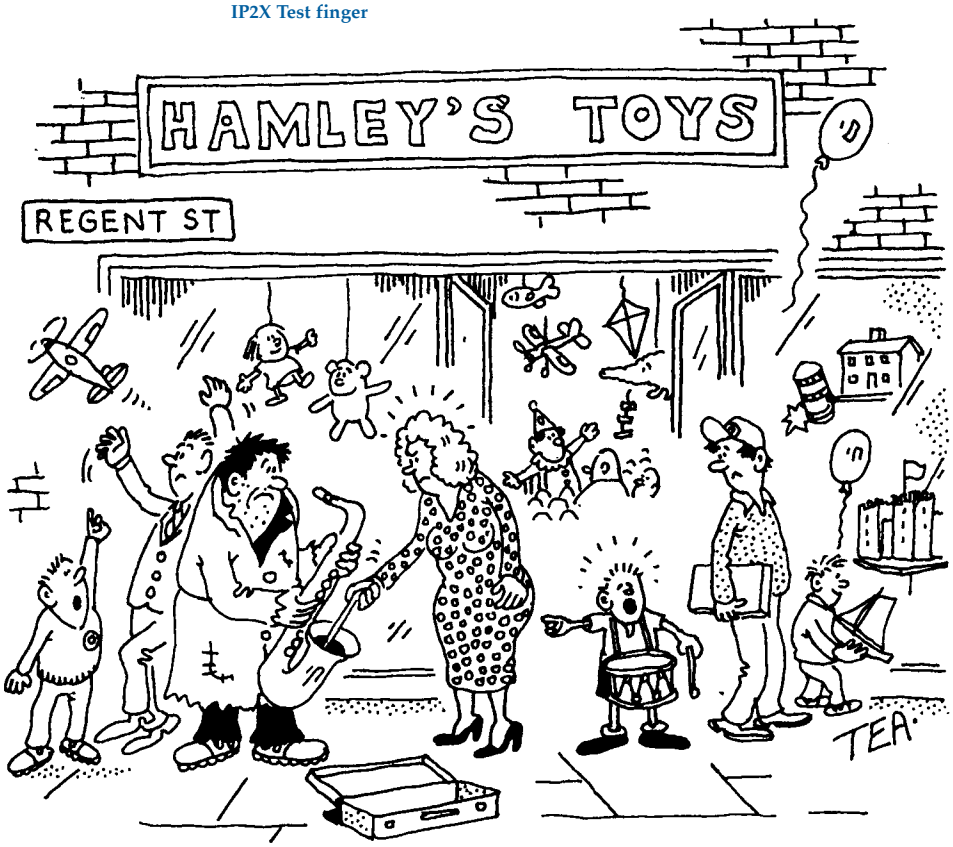
Whilst this system is suitable for use with most types of electrical equipment, it should not be assumed that all the listed degrees of protection are applicable to a particular type of equipment.

The manufacturer of the equipment or enclosure should be consulted to determine the degree of protection available and the parts of equipment to which the stated degree of protection applies, if this is not clearly stated in the literature or on the enclosure.

It is particularly important where enclosures need to be adapted or modified by the user for the attachment of other equipment or for installation and cabling, that any instructions provided by the enclosure manufacturer should be strictly observed, to ensure the required degree of protection is maintained.

BS EN 60529 provides for an optional extension of the IP Code by single additional letters A, B, C or D if the actual protection of persons against access to hazardous parts is higher than that indicated by the first characteristic numeral. This particularly applies to ventilated equipment where internal barriers etc., give added protection for personnel, and this consideration was not included in the First Edition of the standard.

IP2X Test finger



Designation with a degree of protection implies that the enclosure also complies with all the lower degrees except for the immersion categories.

In general the higher the IP code, the more expensive the enclosure, but specifying a higher degree of protection does not necessarily ensure it is the most suitable for a particular application. For instance ventilation reduces the possibility of internal condensation *(See sections 7, 8 & 9)*. It may also be necessary to de-rate equipment, which relies upon natural ventilation if a sealed enclosure is required.

2 SCOPE

The code letters IP of BS EN 60529 refer to International Protection as applicable to enclosures of electrical equipment with a rated voltage not exceeding 72.5kV. It should be noted that this standard is also applicable to empty enclosures provided that the general test requirements are met and that the selected degree of protection is suitable for the type of equipment to be enclosed.

The majority of EIEMA products are required to conform to the Low Voltage Directive. This guide is therefore only intended to describe the classifications for degrees of protection provided by enclosures of electrical equipment with a rated voltage not exceeding 1000V ac and 1500V dc.

3 OBJECT

Degrees of protection are classified in three general categories.

1) Protection of persons against access to hazardous parts inside enclosures.

This is intended to cover protection of persons against accidental contact with electrically 'live' or otherwise hazardous mechanical parts contained within the enclosure, e.g. rotating blades, switch mechanisms etc.

2) Protection of the equipment inside the enclosure against the ingress of solid foreign objects.

Intended to cover protection of the equipment mounted inside against tools, and/or strands of wire and/or the harmful ingress of dust particles.

Barriers, shapes of openings or any other means - whether attached to the enclosure or formed by the enclosed equipment - suitable to prevent or limit the penetration of the specified test probes are considered as a part of the enclosure, except when they can be removed without the use of a key or tool.

3) Protection of the equipment inside the enclosure against harmful ingress of water.



Intended to cover protection of equipment from harmful effects due to dripping, spraying, splashing and hosing or total immersion.

It should be noted that the specified degrees of protection in this third area of BS EN 60529 do not include a strict classification for weather resistance, corrosion prevention, or resistance to other physically hazardous conditions.

IP3X 2.5mm probe

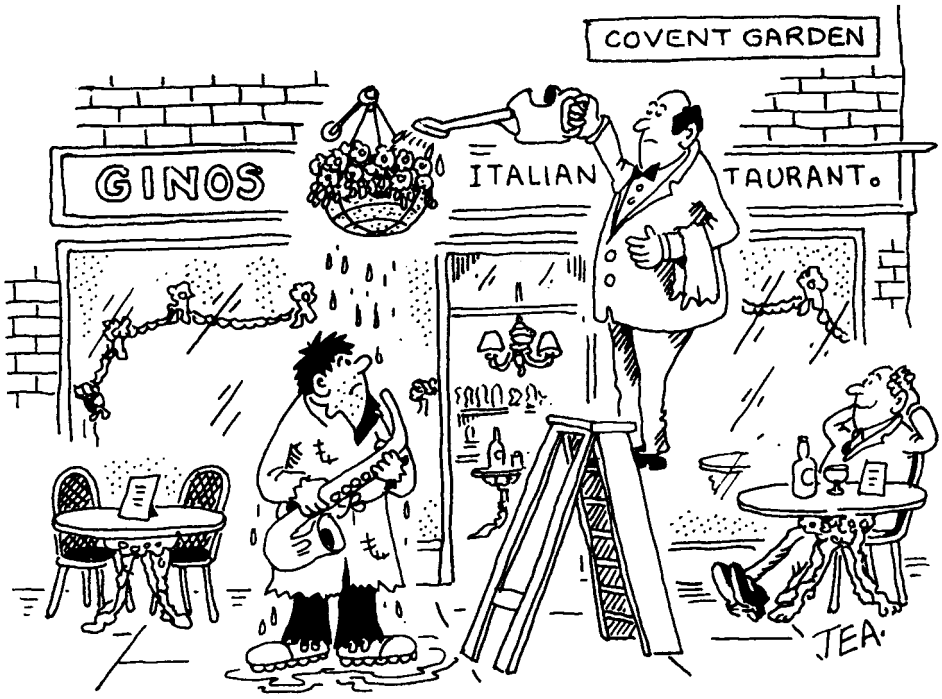
BS EN 60529 states in clause 2, that measures to protect against,

- **mechanical impact**
- **corrosion**
- **corrosive solvents**
- **fungus**
- **vermin**
- **solar radiation**
- **icing**
- **moisture (condensation)**
- **explosive atmospheres**
- **contact with moving parts external to the enclosure**

are not considered and should form part of the product specification where relevant.

Where an enclosure needs to be machined or adapted for the attachment of cable glands, conduit or any other equipment, any instructions provided by the enclosure manufacturer should be strictly observed to ensure the required degree of protection is maintained.

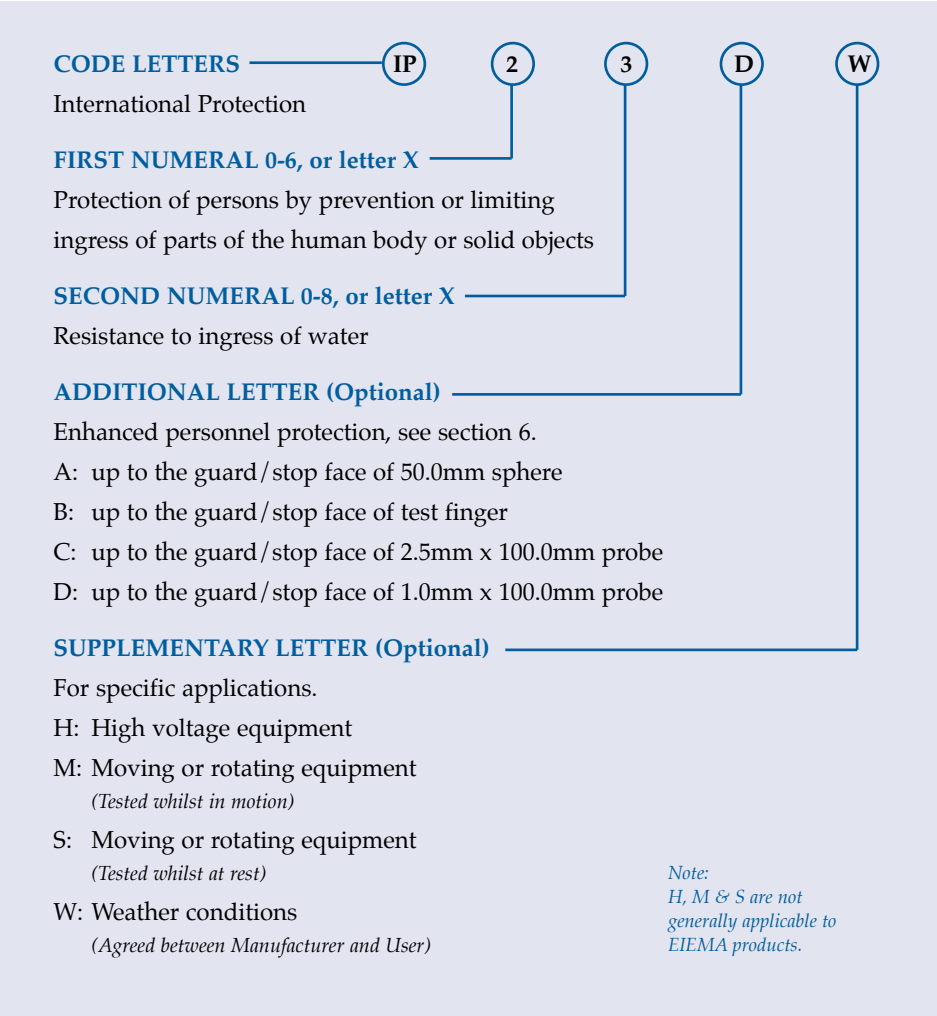
Although not a part of BS EN 60529, some general notes on weather resistance, drainage holes and the need for natural ventilation in certain products are included in sections 7, 8 and 9 of this guide.



IPX1 – Vertically dripping

4 DESIGNATIONS

The degrees of protection provided by an enclosure are indicated by the IP code in the following way:



'X' Letter

The letter 'X' is used in place of the first or second numeral by equipment manufacturers to indicate that tests are not applicable to the product[1]. It is also used in standards to indicate that for the range of products covered such protection is not required.

eg: IP4X specifies that protection against the 1.0mm probe is required and that there is no requirement for the protection from the ingress of water.

Note 1: Some product standards require a minimum of IP2X.

IPX2 – Dripping 15° from the vertical



5 SELECTION

Selection should be made by initially considering the protection required at the place of installation:

a) of persons likely to use or come into contact with the equipment.

b) the suitability of the enclosure for the working environment for which it is intended.

The specified/claimed IP Code applies when the equipment/enclosure is properly installed, according to the manufacturers' instructions.

In areas where only skilled [2] and/or instructed persons [3] have access, an enclosure with a lower protection category may be acceptable, whereas the opposite would apply where uninstructed persons have access.

e.g. In general, wiring accessory product standards specify protection against access to hazardous parts. A typical requirement for accessories used in domestic or commercial environments will be IP2XD.

Note 2: ***Skilled Person****. A person with technical knowledge or sufficient experience to enable him/her to avoid dangers which electricity may create.*

Note 3: ***Instructed Person****. A person adequately advised or supervised by skilled persons to enable him/her to avoid dangers which electricity may create.*

	TYPICAL INSTALLATIONS
Installation	**Considerations**
Residential/Office/ School	Generally clean, dry and free from harmful deposits of dust, but some condensate may be present due to atmospheric conditions. Minimum protection typically IP2XC for dry conditions.
Control rooms/ Sub-Stations	Generally dry and free from harmful deposits of dust, but some condensate may be present due to atmospheric conditions. Where access is restricted to skilled or instructed persons, IP2X is the typical minimum requirement for dry conditions.
Commercial/ Light Industrial	May not be clean, but normally dry and free from harmful deposits of dust. Suitable minimum protection, **a)** Where condensate is not present, IP2XC **b)** Where condensate may be present, IP21C. **c)** Equipment installed within range of fire sprinkler systems, IP22C. Machine control equipment, where fluids may be present, e.g. lathes, millers etc., typically IP54. Consideration should also be given to the corrosive properties of certain fluids
Heavy Industrial, Chemical, Steel making etc	May not be totally clean, with possible presence of corrosive elements and harmful deposits of dust. Protection to IP54 will be typically required, with special consideration given to the corrosion resisting properties of the enclosure.
Food Processing	Will vary depending on the type of food being processed and the possible requirement for washing down. Where fine powders are present, a minimum of IP53 should be used. This should be increased to IP54/55 if the equipment needs to be washed/hosed down.
Weatherproof	If subjected to exposure to any weather condition, agreement between the User and Manufacturer is necessary together with additional consideration given to the corrosion resisting properties of the enclosure and fittings. *See section 7.*

Note: A comprehensive explanation of IP codes is given on pages 9 and 10.

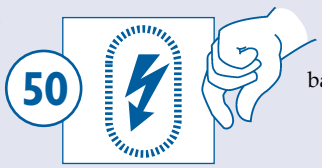
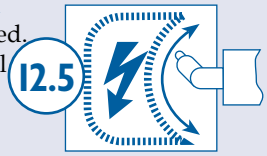
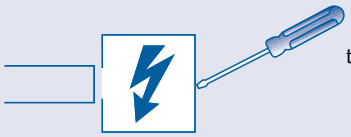
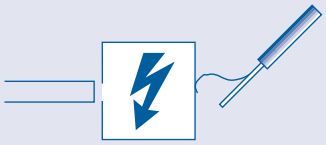
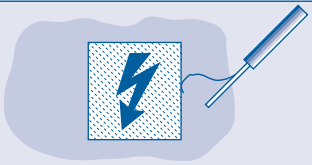
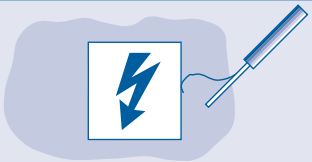
6 IP CODES

First numeral

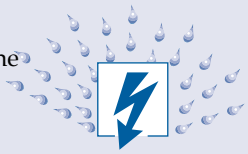
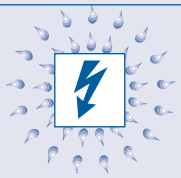
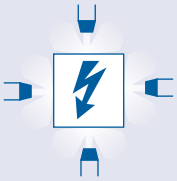
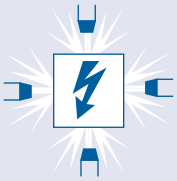
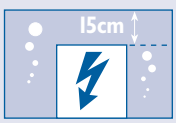
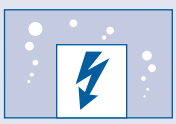
Second numeral

Additional letter

FIRST NUMERAL

Protection against ingress of solid foreign objects			Meaning protection of persons against access to hazardous parts with:
IP	**Requirements**	**Example**	
0	no protection		no protection provided
1	full penetration of **50.0mm** diameter sphere not allowed and shall have adequate clearance from hazardous parts. Contact with hazardous parts not permitted		back of hand
2	full penetration of **12.5mm** diameter sphere not allowed. The jointed test finger shall have adequate clearance from hazardous parts		finger
3	the access probe of **2.5mm** diameter shall not penetrate		tool
4	the access probe of **1.0mm** diameter shall not penetrate		wire
5	limited ingress of dust permitted (no harmful deposit, refer to standard)		wire
6	totally protected against ingress of dust		wire

SECOND NUMERAL

Protection against harmful ingress of water			Meaning for protection from ingress of water:
IP	**Requirements**	**Example**	
0	no protection		no protection provided
1	protected against vertically falling drops of water.		vertically dripping
2	protected against vertically falling drops of water with enclosure tilted 15° from the vertical.		Enclosure tilted 15° from the vertical
3	protected against sprays to 60° from the vertical.		limited spraying
4	protected against water splashed from all directions.		splashing from all directions
5	protected against low pressure jets of water from all directions.		hosing jets from all directions
6	protected against strong jets of water		strong hosing jets from all directions
7	protected against the effects of immersion between 15.0 cm and 1.0 m		temporary immersion
8	protected against longer periods of immersion under pressure		immersion

ADDITIONAL LETTER

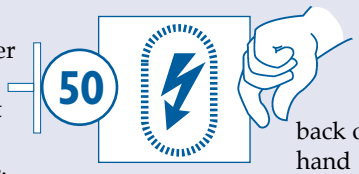
(Optional)

IP	Requirements	Example	Meaning protection of persons against access to hazardous parts with:

A

For use with first numerals 0

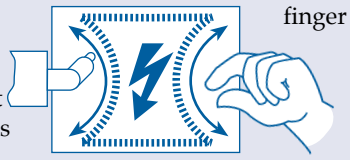
penetration of 50.0mm diameter sphere up to guard face must not contact hazardous parts.



B

For use with first numerals 0 & 1

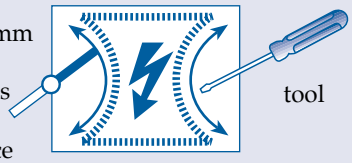
test finger penetration to a maximum of 80.0mm must not contact hazardous parts



C

for use with first numerals 0, 1 & 2

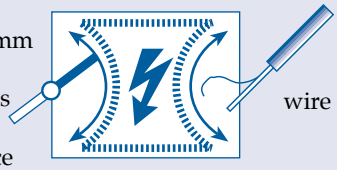
wire of 2.5mm diameter x 100.0mm long must not contact hazardous parts when spherical stop face is partially entered



D

For use with first numerals 0, 1, 2 & 3

wire of 1.0mm diameter x 100.0mm long must not contact hazardous parts when spherical stop face is partially entered



Limited penetration allowed with X1, X2, X3, X4, X5 and all four additional letters. Refer to standard.

7 WEATHERPROOF APPLICATIONS

The effects of continuous exposure to weather and the environment are difficult to evaluate, and therefore the choice of material for the enclosure is as important as the actual IP designation.

The object of this guide is to draw attention of the user to the type of pitfalls that can be encountered in the selection of materials. (BS EN 60529 does not include any guidance to the selection of enclosure materials.)

It should be noted that IP ratings are for ingress only and that tests are comparative and are conducted with fresh water.

Therefore, they in no way indicate the enclosure's ability to withstand the effects of corrosion from salt water, chemicals, acid rain and other special environments as well as the normal expected weather conditions.

Thus, both the material and the finish also become important factors.

Steel is often used but needs thorough pre-treatment in addition to an appropriate quality paint finish.

Stainless steel is relatively more expensive at the outset, but gives a long maintenance free life in most environments.

Aluminium is also often used for outdoor use, but its grade, location and finish needs careful consideration to avoid corrosion. If the protective finish becomes damaged, it can quickly corrode, however the oxides of aluminium themselves form a protective coating against corrosion in some atmospheres.

Enclosures of moulded materials are available for use in harsh environments and generally provide good resistance to corrosion and chemicals. However to avoid deterioration, careful consideration is required when choosing moulded enclosures as some materials do not perform well with dilute acids or certain chemicals or when exposed to ultra violet light (direct sun light). The vast range of moulding materials now available makes it essential for specifiers to consult the manufacturer for information on the ability of moulded materials to withstand hostile environments.

It should be noted that enclosures on exposed outdoor sites might be subject to dust, rain, hail, sleet and snow, all of which can be windborne.

Consideration should also be given to the possible effects of condensation, which can be caused by occasional temperature changes. This may be solved by ventilation or by ensuring any condensation created does not cause harm and may be allowed to drain away.

Drainage holes may be sufficient to disperse the condensate, but these apertures may reduce the IP rating. However, if correctly designed, drainage holes can enhance the weatherproof capabilities of an enclosure. *See sections 8 & 11.*

Attention should also be paid to any gaskets used for the higher IP ratings such that water cannot readily be drawn past the seal. This is most likely to occur when a warm enclosure is suddenly cooled causing a pressure drop inside. *See section 8.*

Thus it can be seen that to specify higher degrees of protection could mean purchasing equipment that is more expensive, whilst the same objective may be achieved by having a lower degree of protection with a construction and materials suitable for the application. An exception to this principle will apply where hosing down operations are envisaged.

The use of the supplementary letter 'W' in the Code indicates that the unit is suitable for use under specified weather conditions and is provided with additional protective features as agreed between Manufacturer and User.

For additional guidance on environmental testing, reference should be made to IEC/BS EN 60068-1.



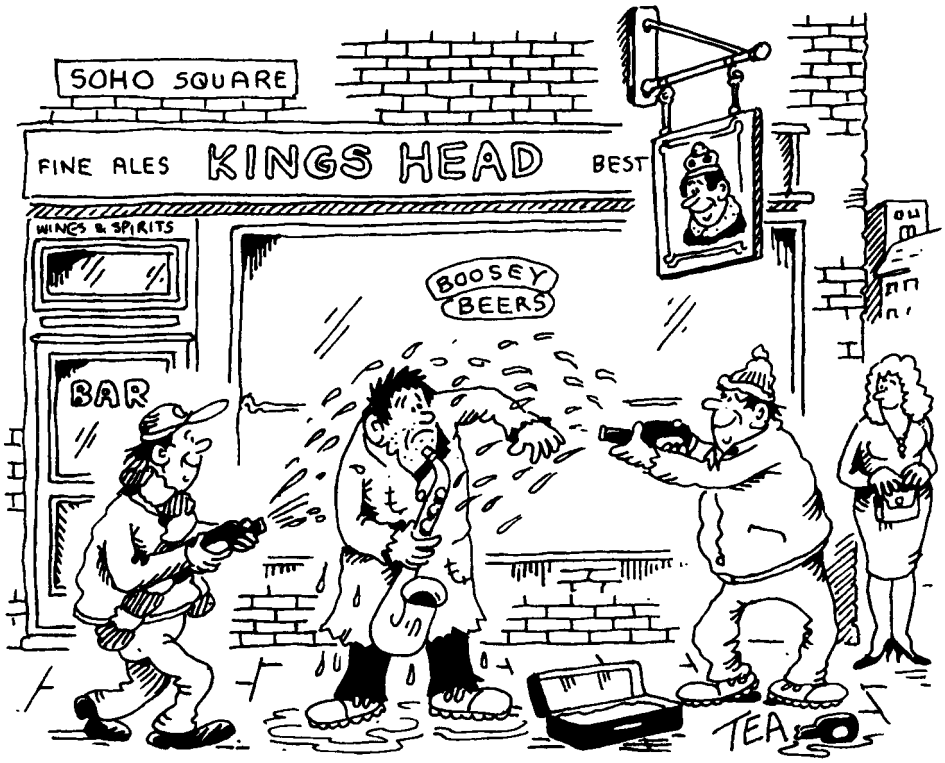
IPX3 – Limited spraying)

8 DRAINAGE HOLES

Certain installations require consideration for the effects of internal condensation within enclosures. Normally, this will be produced as a result of cyclic temperatures where a high humidity is present. When the internal ambient temperature is high the air expands and a proportion is expelled. On cooling the internal air pressure is reduced and as a result cool, moisture-laden air is drawn in, producing condensation when the air reaches its dewpoint. If the conditions are repetitive there will be a cumulative build up of condensed water unless drainage holes are provided.

Drainage holes must be adequately dimensioned and located to permit the free exit of water from the enclosure, making due allowance for the effects of surface tension. Generally drainage holes with a minimum of 5.0mm diameter are required, and therefore internal barriers are required to achieve the enhanced personnel protection of IP ratings, IP2XC or IP2XD. Even higher ratings can be achieved if external barriers are employed, or the enclosure is so positioned to prevent access for penetration of the drain holes. *See section 11.*

To obtain the intended benefit of drainage, enclosures must be mounted in accordance with the manufacturers' instructions.



IPX4 – Splashing from all directions

9 VENTILATED EQUIPMENT

Ventilation can provide an important contribution to the satisfactory operation of enclosed equipment. Where significant heat is generated in an enclosure, ventilation is generally employed to permit the equipment to operate within its designed performance characteristics.

To minimise enclosure size and cost it is common practice to employ natural ventilation, using louvres and/or vents as required. Suitably located louvres and/or vents can provide protection against the ingress of heavy dust and occasional drips of condensate falling from above.

Typically applicable codes for totally dry situations are IP2XC or IP3X. For installations where externally falling condensate is anticipated, IP21C or IP31 would be appropriate.

Ventilation is also beneficial in reducing the possibility of internal condensation caused by changes in air temperature and humidity.

10 EMPTY ENCLOSURES

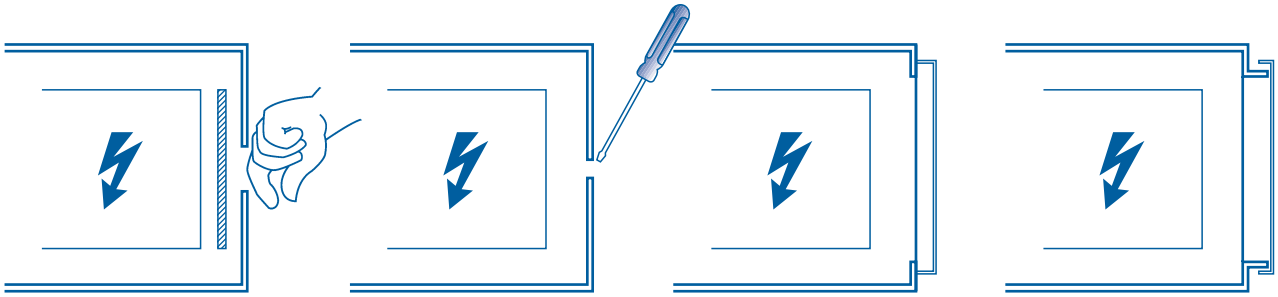
BS EN 60529 requires the final manufacturer/installer of an assembly to ensure that after any electrical equipment has been installed within the enclosure, it still meets the required IP rating.

Suppliers of empty enclosures who claim an IP rating must provide adequate instructions for the arrangement and subsequent positioning of hazardous parts or other parts which may be affected by the penetration of solid objects and/or water.

11 TYPICAL EXAMPLES

The following are some typical examples chosen with EIEMA products in mind. It is impossible to show every type of design and it is recognised that other design variations are possible.

1 Basic enclosures



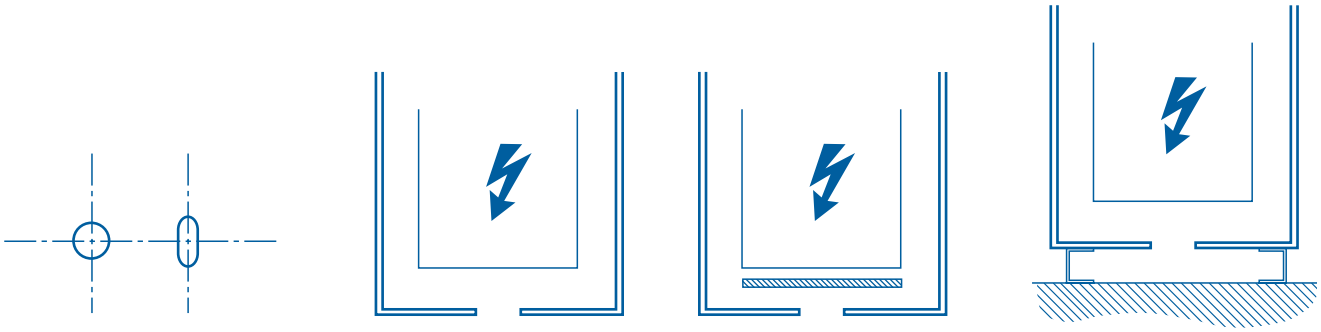
The IP code for this example without the barrier is IP1X, but with the internal barrier fitted as shown it can become IP1XC or even IP1XD.

Smaller aperture to prevent access of small tools etc, therefore IP3X, but also needs an internal barrier if wire strands need to be excluded.

Hinged or removeable door type suitable for IP ratings generally up to IP42, and would require good quality gasket to achieve higher values.

Door overlaps the enclosure aperture and when gasketted, this type of design can achieve the highest IP ratings

2 Drainage holes



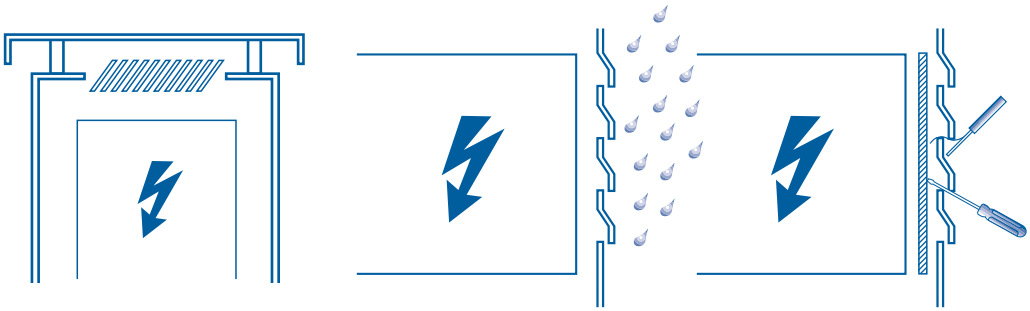
The minimum recommended aperture sizes to allow for drainage and overcome the surface tension of water are 5.0mm diameter, or a 3.0mm width slot of 20.0mm^2 area.

The basic protection with drainage holes would then be IP2X.

This can be improved by the use of internal barriers, and a rating of IP2XD can be achieved

The IP rating can be affected by the installation position; here the mounting surface acts as an external barrier and limits accessibility.

3 Ventilated equipment



This example provides:

1 Basic protection against solid objects to IP2X/3X, and due to the tortuous path, complies with IP2XD/3XD.

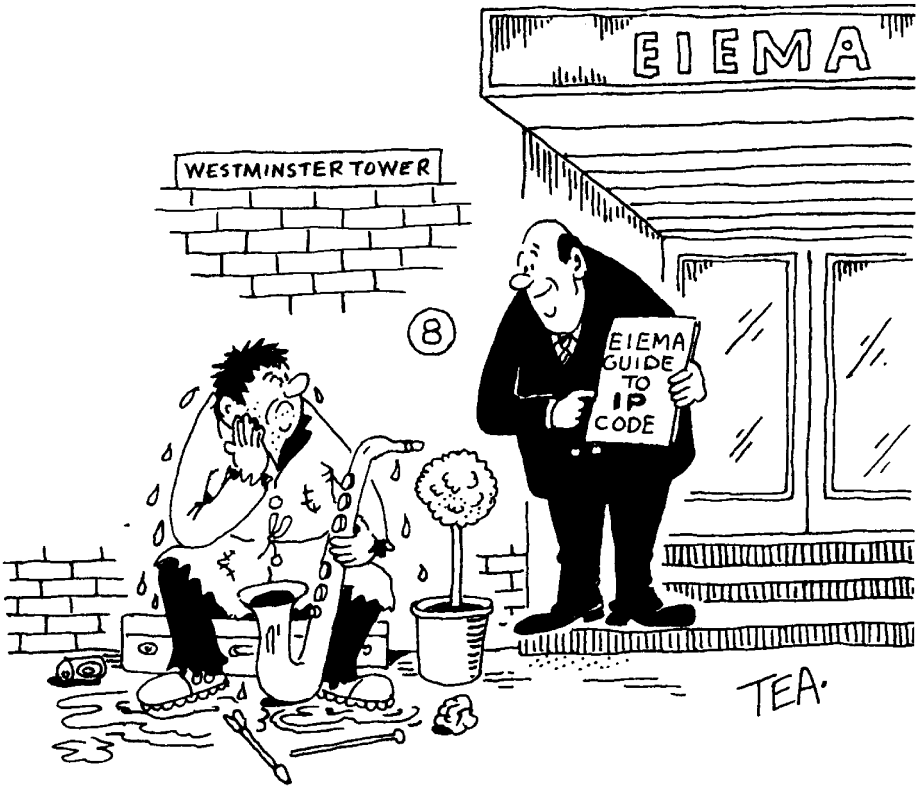
2 Protection against water ingress to IPX2.

3 Allows for ventilation of the equipment.

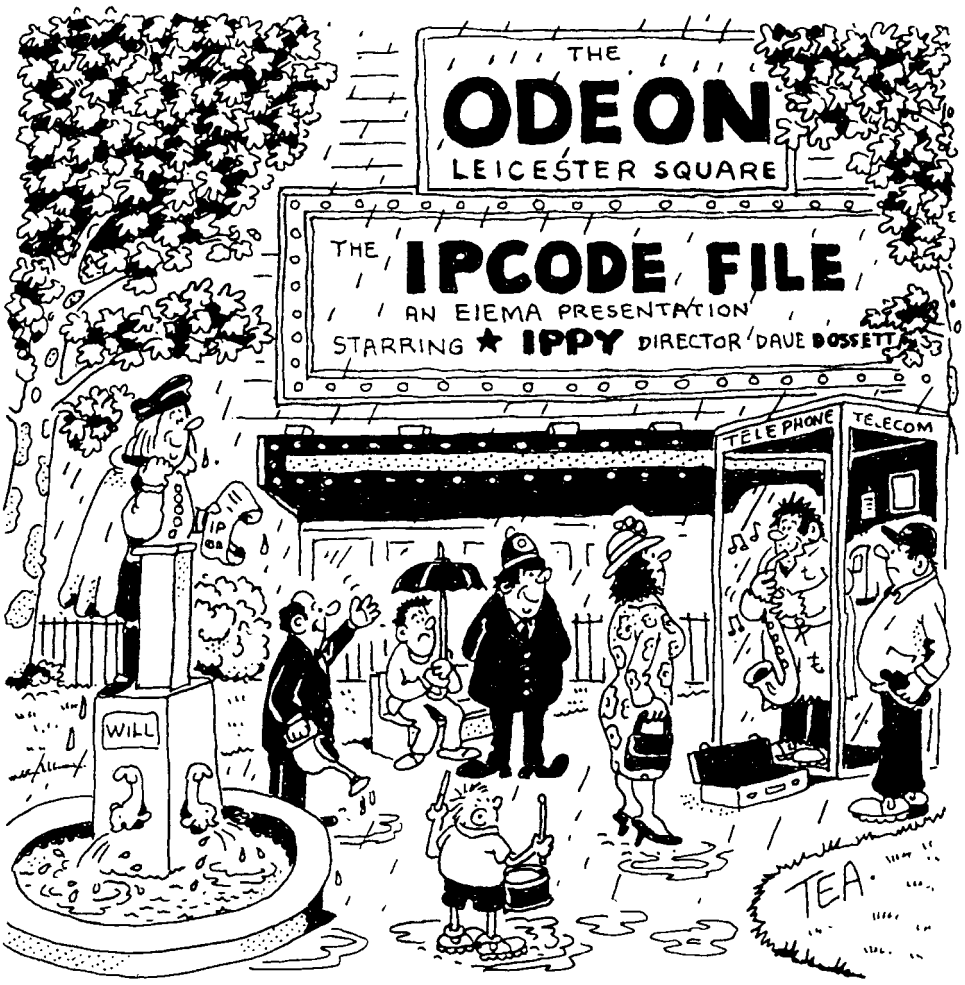
Similarly, side louvres can be engineered to provide the same protection.

Additional internal barriers can be used to enhance the protection against small tools and individual wire strands, although this may well affect the efficiency of the ventilation. The test probe is not deemed to have entered the enclosure until the final barrier has been penetrated.

APPY IPPY buys his copy of "IP Guide"



We hope that this guide is as helpful to you as it is to Appy Ippy.



The pursuit of excellence is the watchword of EIEMA members, who are totally committed to manufacturing quality. This is evidenced by the fact that members of the Association are independently assessed to the stringent quality standard ISO 9000 series. Certification of conformity of manufacturers quality management systems with the requirements of this standard is not easily achieved and once attained is constantly monitored by regular, independent quality audits. Specifiers and users can be assured of the attention to quality at all levels of the manufacturing process. This is in addition to rigorous product type tests to ensure conformity with standards and so demonstrate compliance with the requirements of National and EC legislation.

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GUIDE TO THE 'IP' CODES FOR ENCLOSURES

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