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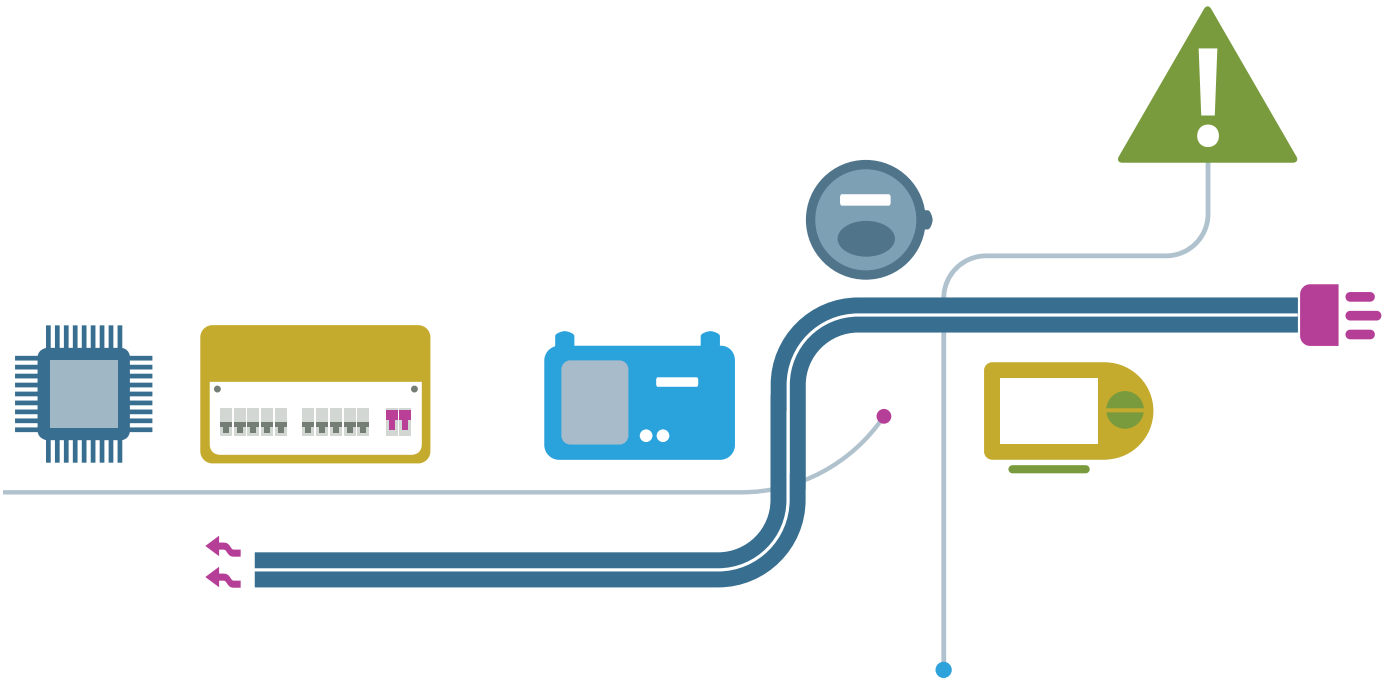
GUIDE TO IP CODES



COMPANIES INVOLVED IN THE PREPARATION OF THIS GUIDE

Eaton Electric Ltd
Reddings Lane, Tyseley
Birmingham
West Midlands
B11 3EZ
Tel: +44 (0) 121 685 2100
Fax: +44 (0) 121 706 9996
Email: ukcommorders@eaton.com
www.eaton.uk.com

NCE Switchgear
79 Beardmore Way
Clydebank Industrial Estate
Dalmuir, Scotland
G81 4HT
Tel: +44 (0) 141 952 1166
Fax: +44 (0) 141 952 1188
Email: sales@nceswitchgear.com
www.nceswitchgear.com

Elsteel UK Ltd
Off Davy Way
Llay Industrial Estate, Llay
Wrexham
LL12 0PG
Tel: +44 (0) 1978 855909
Fax: +44 (0) 1978 855824
Email: sales@elsteel.co.uk
www.elsteel.co.uk

Rappell Group Ltd
Moston Road
Sandbach
CW11 3HL
Tel: +44 (0) 1270 761135
Fax: +44 (0) 1270 762997
Email: sales@rappell.co.uk
www.rappell.co.uk

Hager Engineering Ltd
Hortonwood 50, Telford
Shropshire
TF1 7FT
Tel: +44 (0) 1952 675612
Fax: +44 (0) 1952 675645
Email: sales@hager.co.uk
www.hager.co.uk

Schneider Electric Ltd
Stafford Park 5, Telford
Shropshire
TF3 3BL
Tel: +44 (0) 1952 290029
Fax: +44 (0) 1952 292238
www.schneider-electric.co.uk

Legrand Electric Ltd
Great King Street North
Birmingham
B19 2LF
Tel: +44 (0) 370 608 9020
Fax: +44 (0) 345 600 6760
Email: powersales.uk@legrand.co.uk
www.legrand.co.uk

Siemens Ltd
Sharston Road
Wythenshawe
Manchester
M22 4RA
Tel: +44 (0) 161 945 3956
Fax: +44 (0) 8456 053114
www.siemens.co.uk

ABOUT BEAMA

BEAMA is the long established and respected trade association for the electrotechnical sector. The association has a strong track record in the development and implementation of standards to promote safety and product performance for the benefit of manufacturers and their customers.

This Guide provides guidance on the degree of protection provided by enclosures (IP Code).

This Guide has been produced by BEAMA's Installation Sector which comprises of major UK manufacturing companies operating under the guidance and authority of BEAMA, supported by specialist central services for guidance on European Single Market, Quality Assurance, Legal and Health & Safety matters.

Details of other BEAMA Guides can be found on the BEAMA website www.beama.org.uk

Acknowledgements
BEAMA would like to thank IEC and BSI for allowing references to their standards; Health and Safety Executive (HSE) for reference to their documents.

CONTENTS

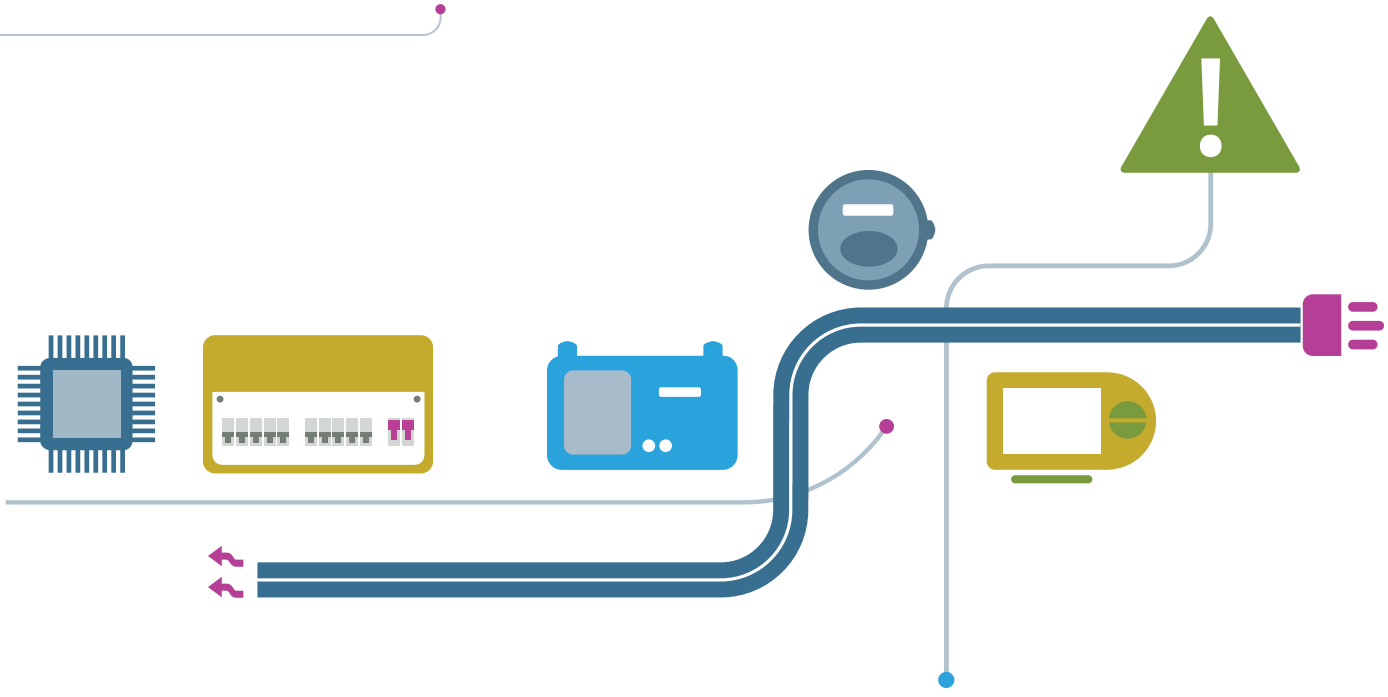
PREFACE

The purpose of this guide is to provide an easily understood document, aiding understanding and application of the requirements for degrees of protection provided by enclosures.

Principally, these requirements are detailed in BS EN 60529:1992+A2:2013 (IEC 60529:1989+A1:1999+A2:2013) 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. International Protection (IP) is commonly referred to in the UK as "Ingress Protection". For technical correctness this guide uses the IEC Normative reference.

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.

READERS SHOULD NOTE THE REQUIREMENTS IN THE STANDARD CALL FOR COMPARATIVE TESTS AND THESE BEAR NO ACTUAL RELATIONSHIP TO SPECIFIC WEATHER OR CORROSIVE CONDITIONS.



1 INTRODUCTION

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

Whilst this method 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.

If the degree of protection of the equipment or the enclosure is not specified in the manufacturer's literature, then the manufacturer should be consulted.

For the most cost effective solution, the appropriate level of ingress protection that meets the need of the application should be specified. 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 6, 7 and 8). Within a sealed enclosure, it may also be necessary to use devices with a higher free air rating and conductors with increased cross sectional area.

Designation with a degree of protection implies that the enclosure also complies with all the lower degrees except for IPX7, IPX8 and IPX9.

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 BEAMA member products are within the scope of 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 OVERVIEW

Degrees of protection are classified in three general categories.

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

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 harmful ingress of solid particles, including dust. 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 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.

BS EN 60529 states in clause 2, that measures to protect against the following, are not considered and should form part of the product specification where relevant.

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

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 6, 7 and 8 of this guide.

DESIGNATION WITH A DEGREE OF PROTECTION IMPLIES THAT THE ENCLOSURE ALSO COMPLIES WITH ALL THE LOWER DEGREES EXCEPT FOR IPX7, IPX8 AND IPX9.

4
DESIGNATIONS

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

Code Letters

INTERNATIONAL PROTECTION (IP)

FIRST NUMERAL 0-6 or letter X
Covers two criteria of protection, of:

- persons by prevention or limiting ingress of parts of the human body and
- equipment against the ingress of solid objects

SECOND NUMERAL 0-9 or letter X
Resistance to ingress of water

ADDITIONAL LETTER (Optional)
Enhanced personnel protection, see section 6

A: up to the guard/stop face of 50mm sphere

B: up to the guard/stop face of test finger

C: up to the guard/stop face of 2.5mm x 100mm probe

D: up to the guard/stop face of 1mm x 100mm probe

SUPPLEMENTARY LETTER (Optional)
For specific applications

H: High voltage equipment

M: Moving or rotating equipment (Tested while in motion)

S: Moving or rotating equipment (Tested whilst at rest)

W: Weather conditions (Agreed between user and manufacturer)

Letter 'X'

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. For example, 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.
1 Some product standards require a minimum of IP2X.

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., to give added protection for personnel.

1 Some product standards require a minimum of IP2X.

5
SELECTION

THE IP CODE APPLIES WHEN THE EQUIPMENT/ENCLOSURE IS PROPERLY INSTALLED, ACCORDING TO THE MANUFACTURERS' INSTRUCTIONS.

PRODUCT STANDARDS MAY DEFINE THE INGRESS OF DUST AND/OR WATER THAT IS DEEMED NOT TO HAVE A HARMFUL EFFECT.

SOME EQUIPMENT/ ENCLOSURES MAY HAVE MORE THAN ONE IP CLASSIFICATION.

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.

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. For example, 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: IEC 61439-1 states 'for fixed assemblies not subject to tilting in normal service, IPX2 is not applicable'.

2 Skilled Person (electrically): A person who possesses, as appropriate to the nature of the electrical work to be undertaken, adequate education, training and practical skills, and who is able to perceive risks and avoid hazards which electricity may create. (BS 7671 refers).

3 Instructed Person (electrically): A person adequately advised or supervised by a skilled person to enable that person to perceive risks and to avoid hazards which electricity can create. (BS 7671 refers).

5
SELECTION

TABLE 1: EXAMPLES OF TYPICAL SPECIFICATIONS OF IP CLASSIFICATIONS

Typical Installations	Considerations	Typical minimum IP classifications
Residential (households, dwellings and similar)/ Office/ School	Generally clean, dry and free from harmful deposits of dust, but some condensation may be present due to atmospheric conditions	IP2XC for dry conditions
Control rooms / Sub-Stations / Switch-rooms	Generally dry and free from harmful deposits of dust, but some condensation may be present due to atmospheric conditions	IP2X where access is restricted to skilled or instructed persons
Commercial / Light Industrial	May not be clean, but normally dry and free from harmful deposits of dust	a) IP2XC where condensation is not present b) IP21C where condensation may be present c) IP54 where fluids may be present e.g. lathes, millers, etc *NOTE: Special consideration needs to be given to the corrosion resistance of the enclosure*
Heavy Industrial, Chemical, Steel making, etc	May not be totally clean, with possible presence of corrosive elements and harmful deposits of dust	IP54 with special consideration given to corrosion resistance of the enclosure
Food processing	Will vary depending on the type of food being processed and the possible requirements for washing down	a) IP53 where fine powders are present b) IP54 if the equipment is subject to splashing c) IP55 if the equipment is to be washed or hosed down at low pressure d) IP56 if the equipment is to be subject to powerful water jets e) IP59 if the equipment is subject to high pressure and temperature water jets
Weatherproof	Will vary depending on installation location, type of equipment to be enclosed, internal conditions within enclosures and other external influences. **See section 6 of this guide**	a) IP33W for assemblies for public networks e.g. feeder pillars b) IP54W for enclosures installed in dusty environments (e.g. railway applications) and / or housing sensitive equipment c) IP56W for equipment installed in locations subject to water jets e.g. carwash *NOTE: For all weatherproof applications the designer should ensure that the internal conditions within the enclosure are suitable for equipment enclosed and the enclosure is adequately protected against other external influences e.g. UV radiation.* ***See section 6 of this guide***
Swimming pools / Pumping stations	Will vary on depths and levels of submersion	a) IPX7 for equipment subject to temporary immersion b) IPX8 for equipment permanently immersed

5
SELECTION

FIGURE 1A - IP1X

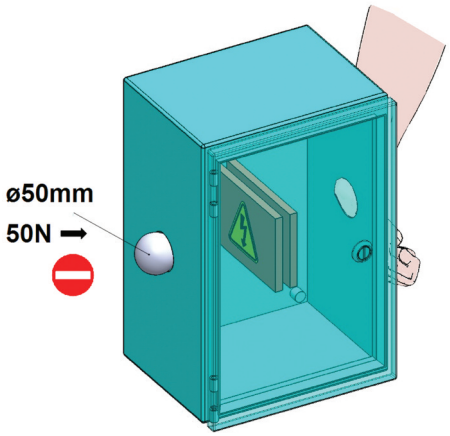


FIGURE 1B - IP2X (SEE NOTE 1 BELOW)

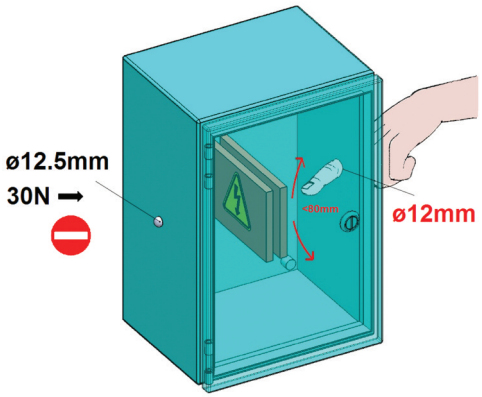


FIGURE 1C - IP3X

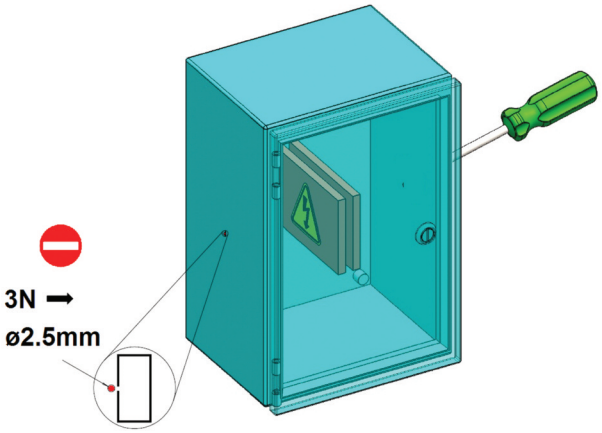


FIGURE 1D - IP4X

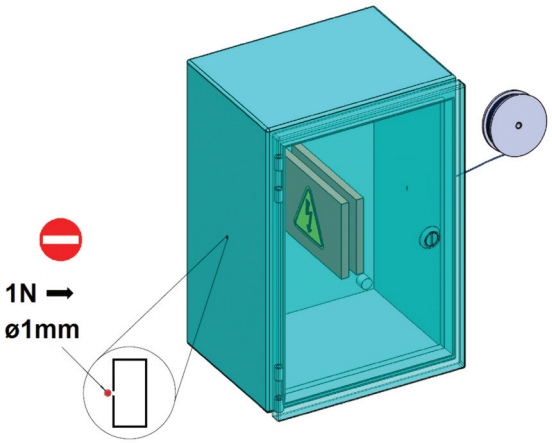


FIGURE 1E - IP5X

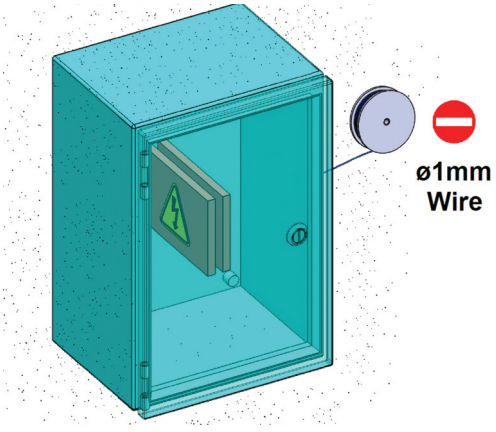
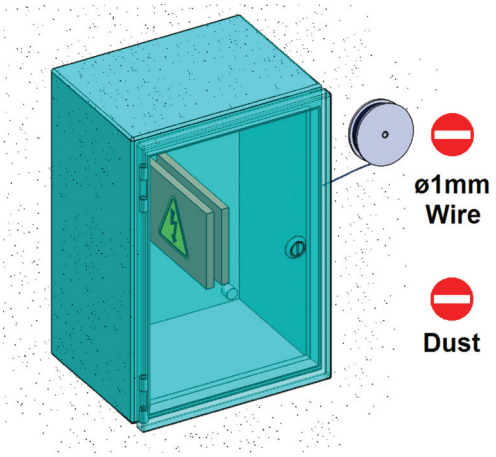


FIGURE 1F - IP6X



NOTE 1: Where hazardous live parts are covered with basic insulation (as defined in the appropriate product standard), which can only be removed by destruction or by the use of a tool, the probe can touch the insulation.

5
SELECTION

FIGURE 2A - IPX1

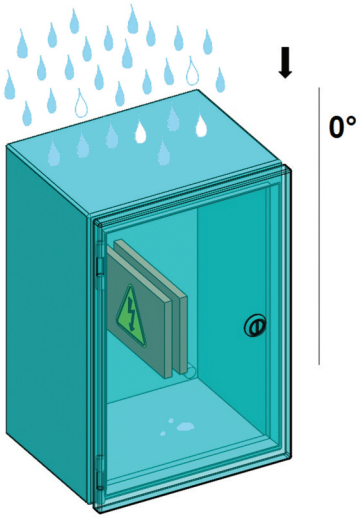


FIGURE 2B - IPX2

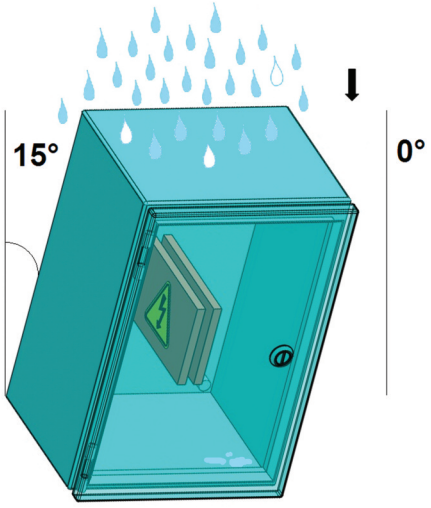


FIGURE 2C - IPX3

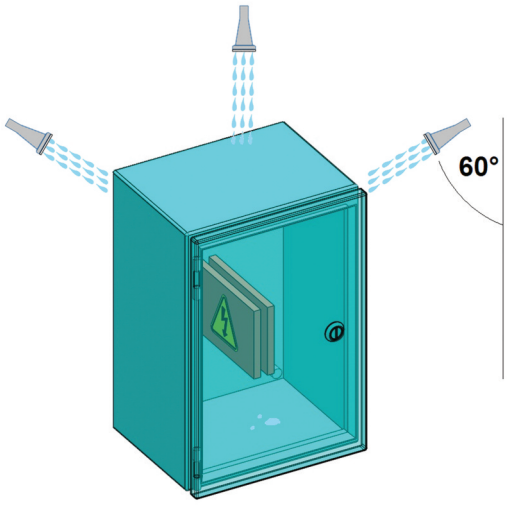


FIGURE 2D - IPX4

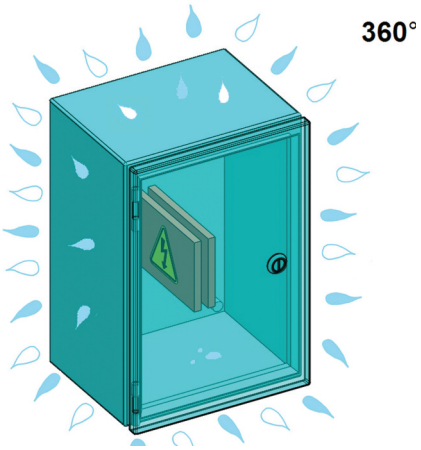


FIGURE 2E - IPX5

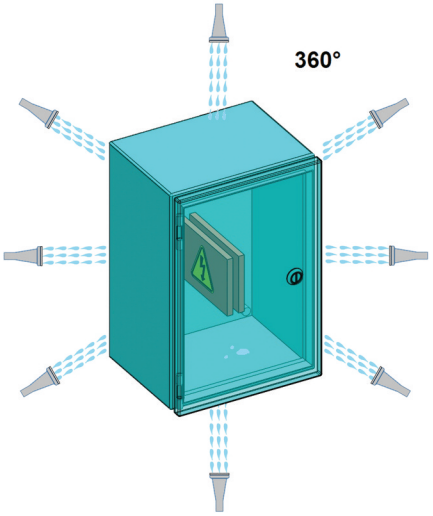
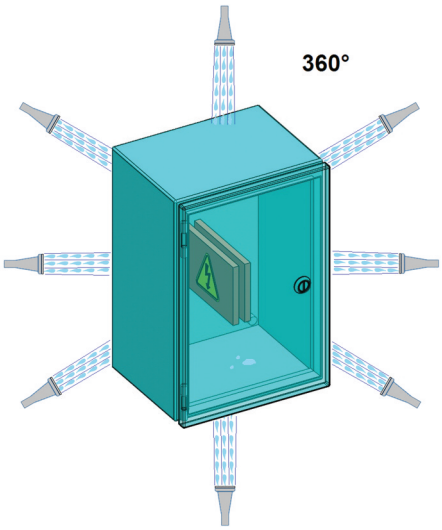


FIGURE 2F - IPX6



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SELECTION

FIGURE 2G - IPX7 / IPX8

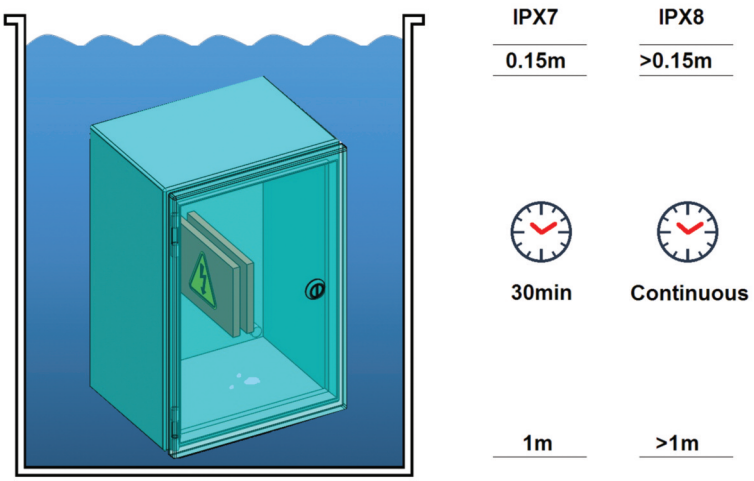


FIGURE 2H - IPX9

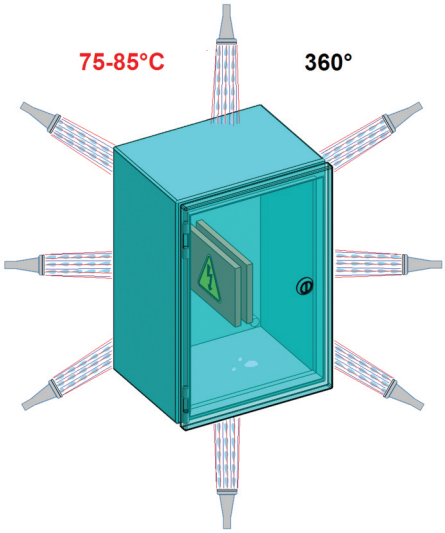


FIGURE 3A – IPXXB (SEE NOTE 1 BELOW)

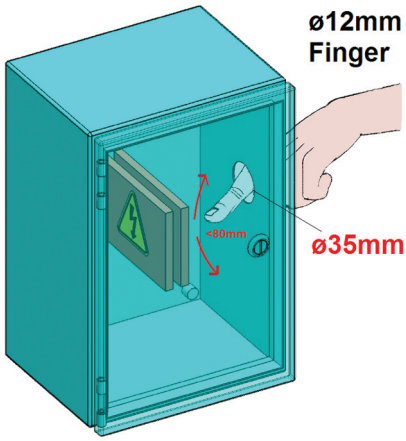


FIGURE 3B – IPXXC (SEE NOTE 1 BELOW)

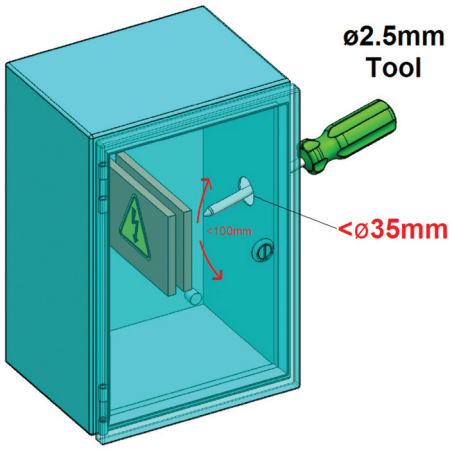
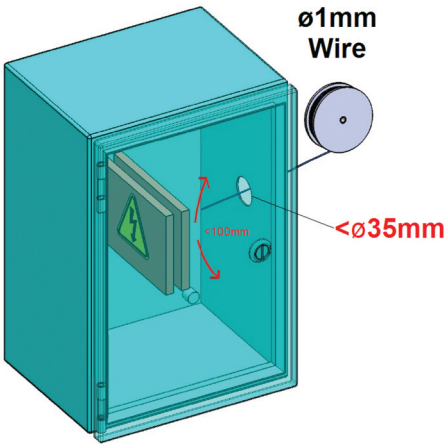


FIGURE 3C – IPXXD (SEE NOTE 1 BELOW)



NOTE 1: Where hazardous live parts are covered with basic insulation (as defined in the appropriate product standard), which can only be removed by destruction or by the use of a tool, the probe can touch the insulation.

6 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. 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, UV RADIATION, ACID RAIN AND OTHER SPECIAL ENVIRONMENTS AS WELL AS THE NORMAL EXPECTED WEATHER CONDITIONS.

Thus, both the material and the finish 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 generally 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, use of anti-condensation heaters, climate controls or by ensuring any condensation created does not cause harm and may be allowed to drain away. Generally an air temperature inside the enclosure, of 5 degrees above external ambient, will prevent condensation within the enclosure.

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 7 & 10.

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 7.

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 the manufacturer and user.

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

7
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 dew point. 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 and taking into consideration the declared IP classification.

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 10.

TO OBTAIN THE INTENDED BENEFIT OF DRAINAGE, EQUIPMENT/ ENCLOSURES MUST BE MOUNTED IN ACCORDANCE WITH THE MANUFACTURERS' INSTRUCTIONS.

8 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, slots and/or vents as required. Suitably located louvres, slots and/or vents can provide protection against the ingress of heavy dust and occasional drips of condensate falling from above. Louvres, slots and vents can theoretically be of infinite length providing that the test criteria is met.

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.

9 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.

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.

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.

10
TYPICAL EXAMPLES

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

FIGURE 4A - BASIC ENCLOSURES

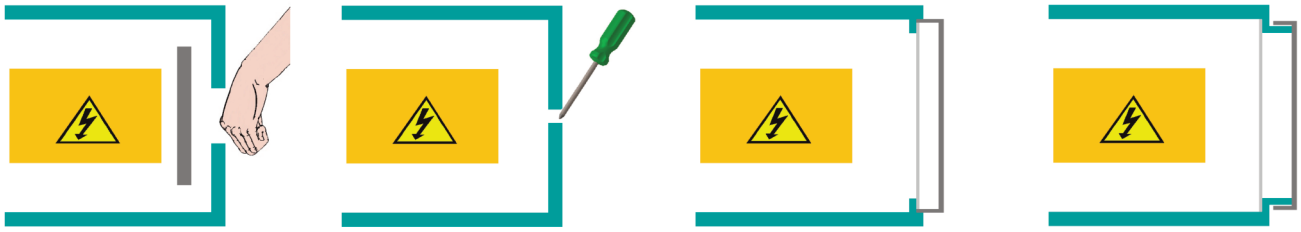


FIGURE 4B - DRAINAGE HOLES

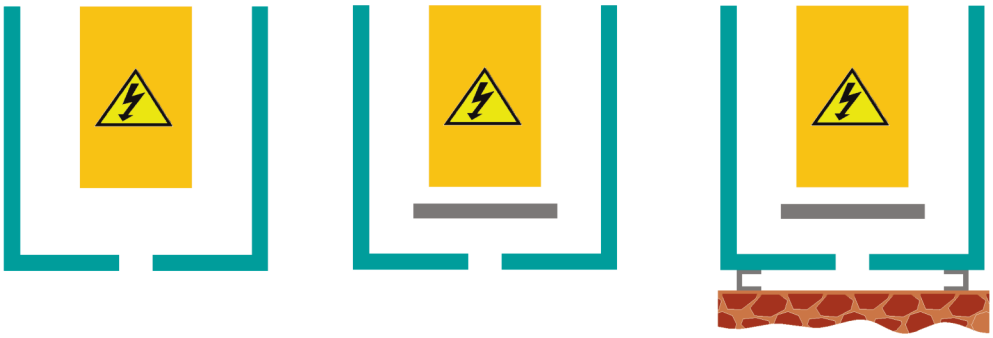
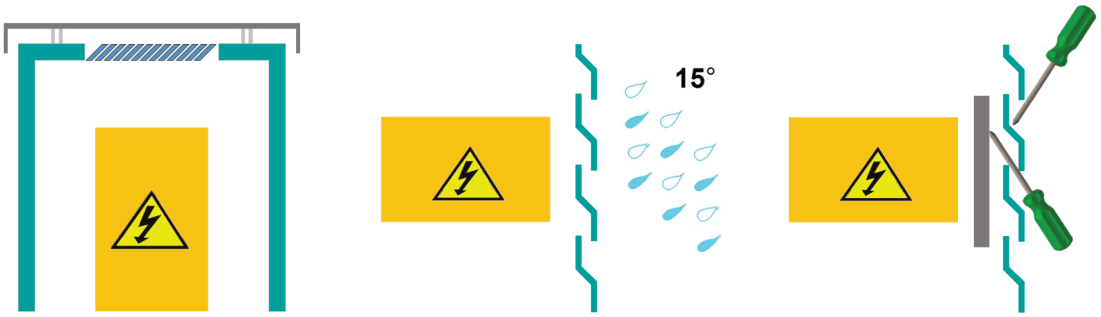


FIGURE 4C - VENTILATED EQUIPMENT



Westminster Tower
3 Albert Embankment
London SE1 7SL

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