Session 7 – Ingress Protection Fundamentals

IP Codes (IEC60529)

The IEC protection code (International Protection IP)

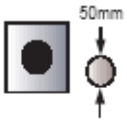
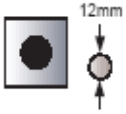
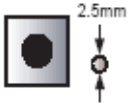
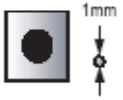
The IP codes are used to define protection against the ingress of solid foreign objects and water with harmful effects. Since the IP code is used for all equipment annex B of the IEC standard gives instructions to technical committees for applying IP codes. The protection against the ingress of solid foreign objects is also used as a means of specifying protection against accidental contact with live parts and therefore serves two different but related purposes.

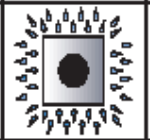
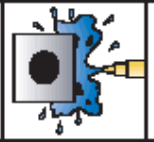
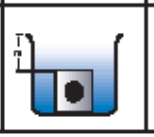
Interpreting the IP code

The IP code defined in the second edition of "IEC60529 Degrees of protection provided by enclosures (IP code)" consists of 2 numerals and 2 optional extra letters. The first numeral **0, 1,...6,**
or **X defines the protection against ingress of solid foreign objects and against access to hazardous** parts. The second numeral **0, 1,...8, or X defines the protection against the ingress of water.**

SOURCE IEx

IP Codes (IEC60529)

First Digit	PROTECTION AGAINST SOLID FOREIGN OBJECTS AND ACCESS TO HAZARDOUS PARTS		
0	—	Non-protected	Non-protected
1		Protected against solid foreign objects of 50mm diameter and greater	Protected against access to hazardous parts with the back of a hand
2		Protected against solid foreign objects of 12.5mm diameter and greater	Protected against access to hazardous parts with a finger
3		Protected against solid foreign objects of 2.5mm diameter and greater	Protected against access to hazardous parts with a tool
4		Protected against solid foreign objects of 1.0mm diameter and greater	Protected against access to hazardous parts with a wire
5		Dust-protected	Protected against access to hazardous parts with a wire
6		Dust-tight	Protected against access to hazardous parts with a wire

Second Digit	PROTECTION AGAINST LIQUIDS	
0	—	Non-protected
1		Protected against drops of water falling vertically
2		Protected against drops of water falling at up to 15° from the vertical
3		Protected against spraying water at up to 60° from the vertical
4		Protected against splashing water from all directions
5		Protected against jet of water from all directions
6		Protected against jet of water of similar force to heavy seas
7		Protected against the effects of immersion
8		Protected against prolonged effects of immersion under pressure to a specified depth

IP Codes (IEC60529)
Secondary Letters

IP67 AH

3RD Character
- A Back of hand
- B Finger
- C Tool
- D Wire

4TH Character
- H High voltage apparatus
- M Motion during water test
- S Stationary during water test
- W Weather conditions

Remember that IP codes do not infer things such as corrosion resistance with the first two numbers, i.e. NEMA 4 vs. NEMA 4X

IP Codes (IEC60529)

	TYPICAL INSTALLATIONS
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.*

Typical Applications and IP ratings

	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

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IP Codes – General Notes

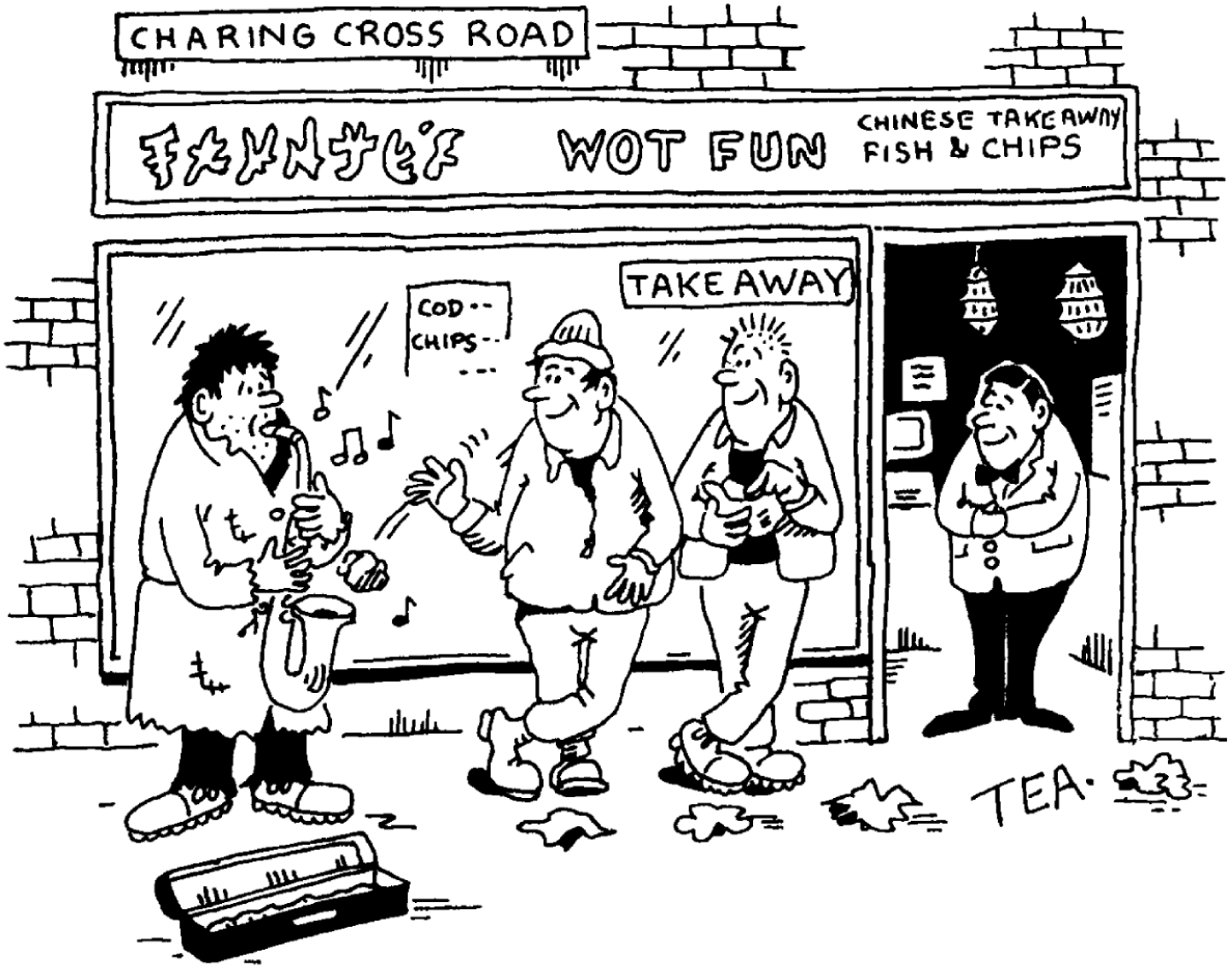
The effects of continuous exposure to weather and the environment are difficult to evaluate, and therefore the choice of material for the enclosure is as important as the actual IP designation. It should be noted that IP ratings are for ingress only and that tests are comparative and are conducted with 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.. Typical materials used for enclosures range from sheet steel, Glass Reinforced Polyester, ABS, Aluminum and Stainless Steel.

Enclosures of molded 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 molded 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 molding materials now
available makes it essential for specifiers to consult the manufacturer for information on the ability of molded 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.

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. 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. Thus it can be seen that to specify higher degrees of protection could mean purchasing equipment that is more expensive, while 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 anticipated.

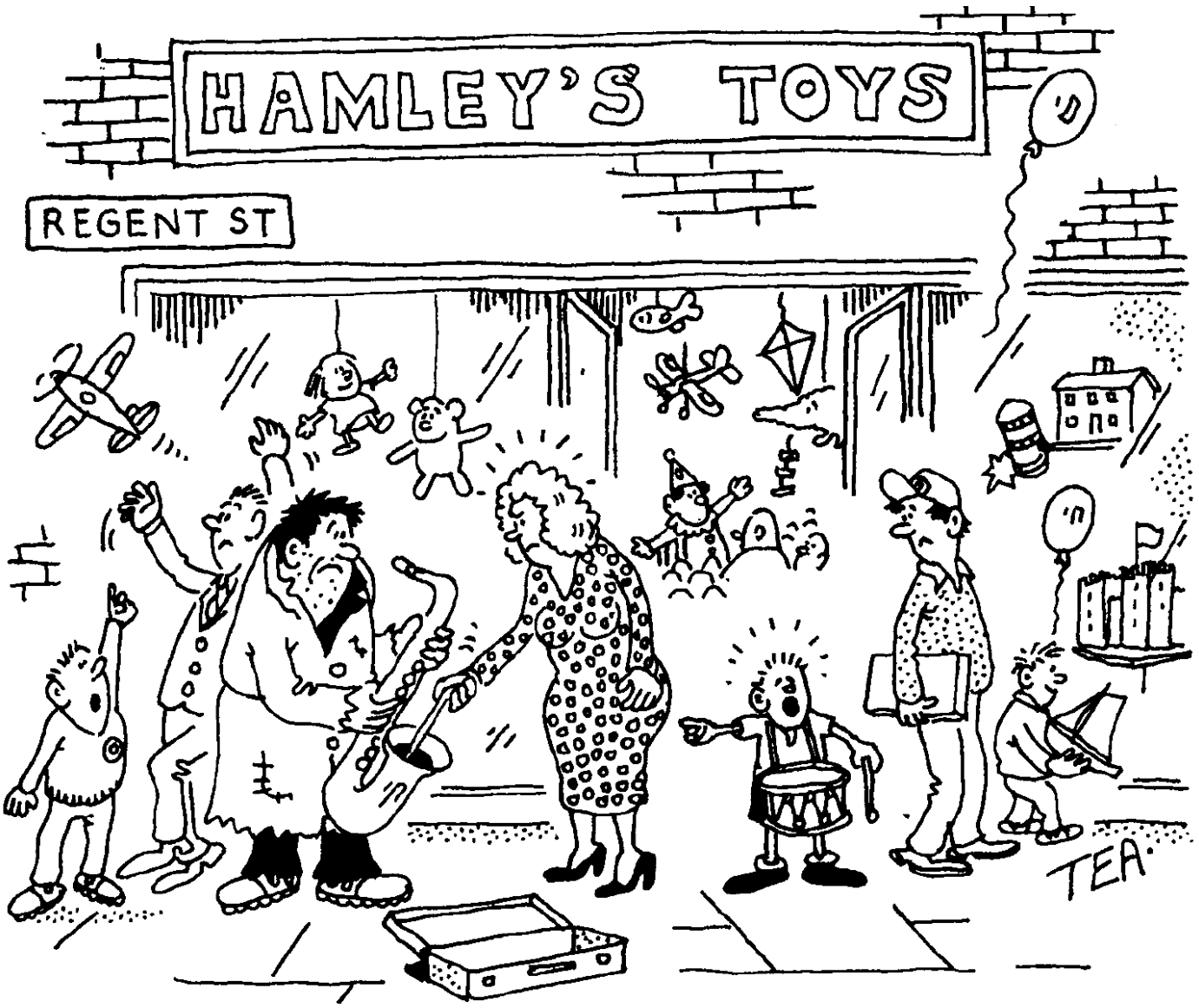
Real World Examples of IP Codes…

IP1X – 50mm diameter sphere – no penetration



Real World Examples of IP Codes…

IP2X – Test Finger

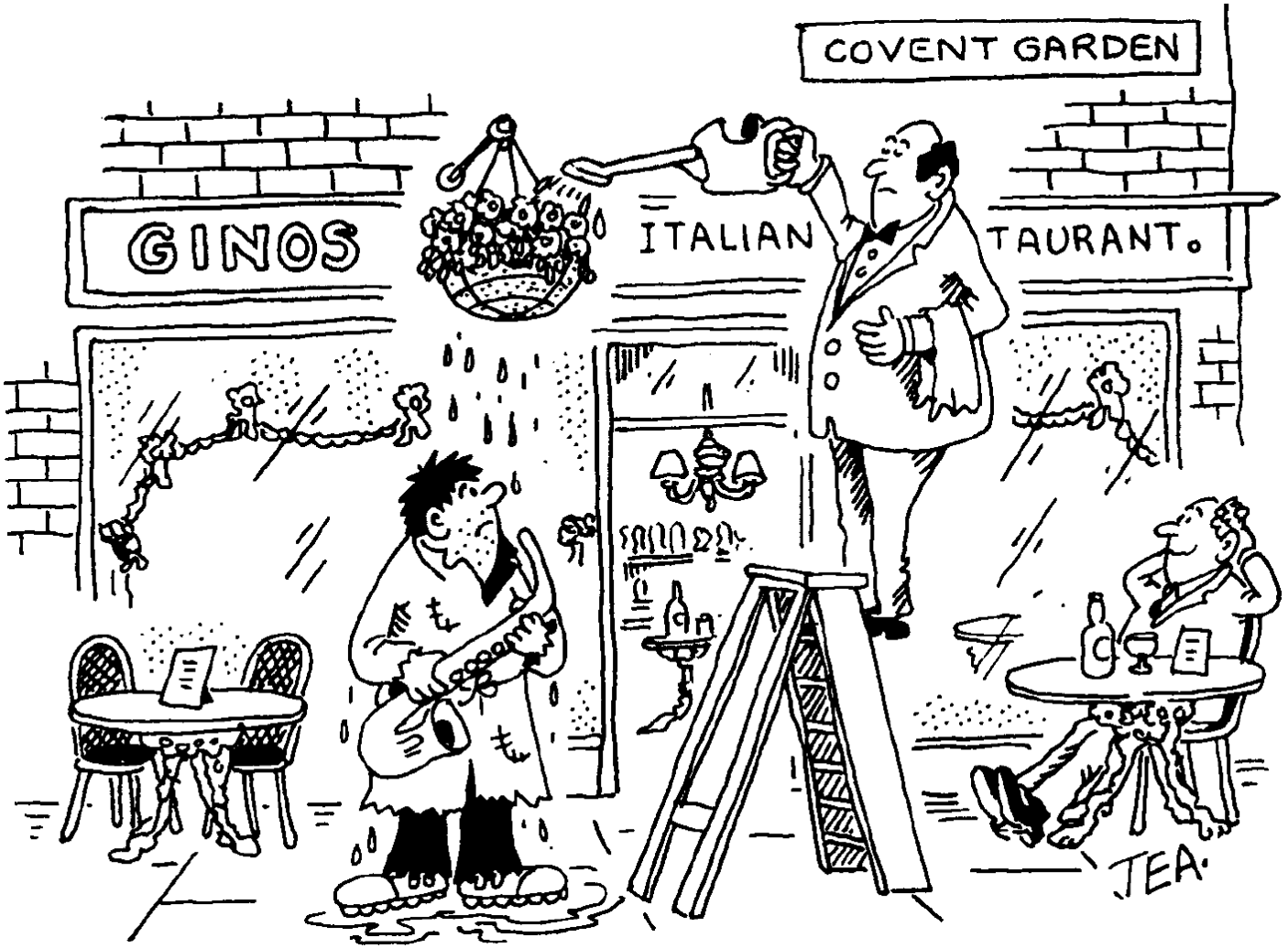


Real World Examples of IP Codes…

IP3X – 2.5mm probe

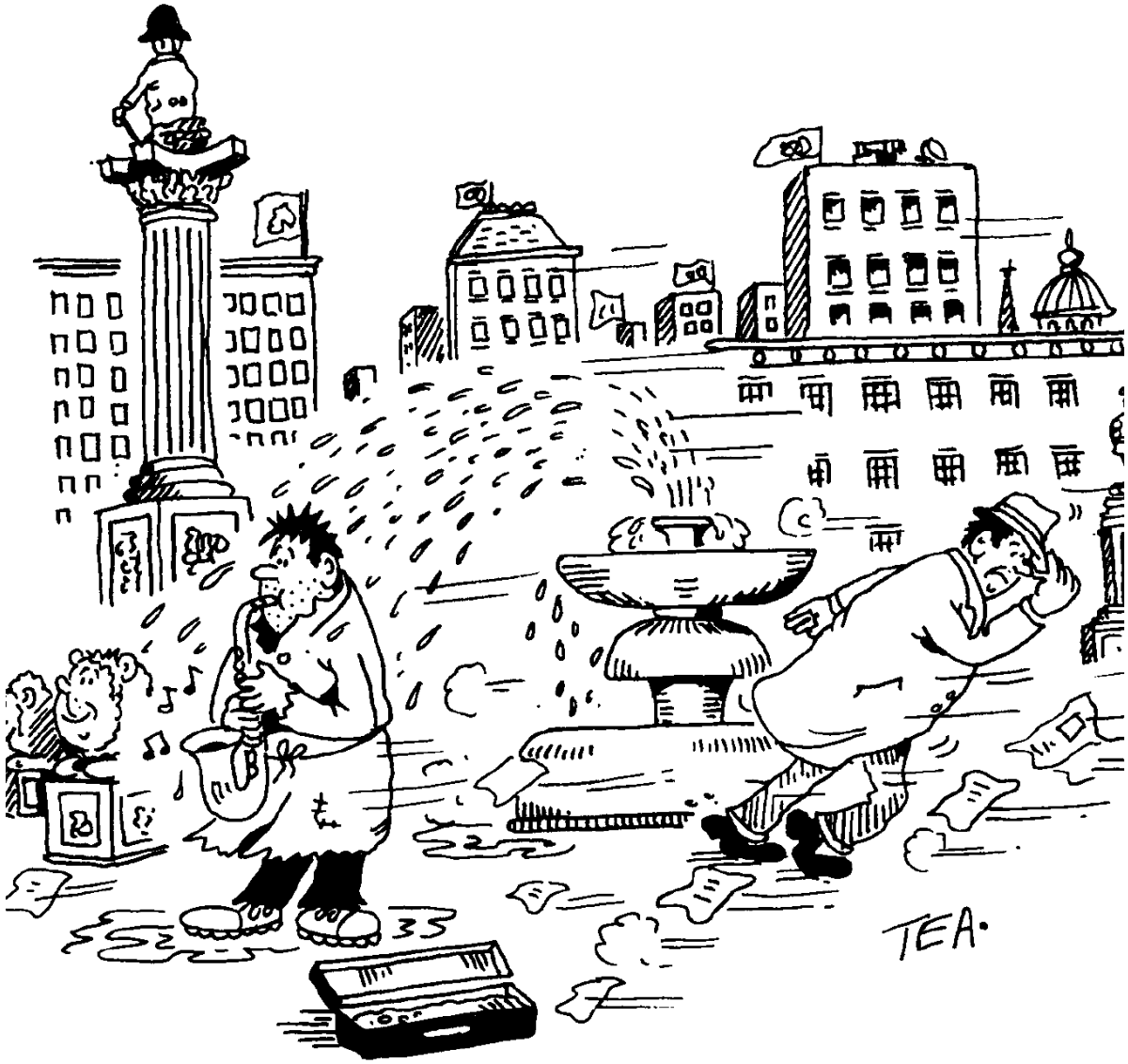
Real World Examples of IP Codes…

IPX1 – Vertically dripping



Real World Examples of IP Codes…

IPX2 – Dripping 15° From the vertical

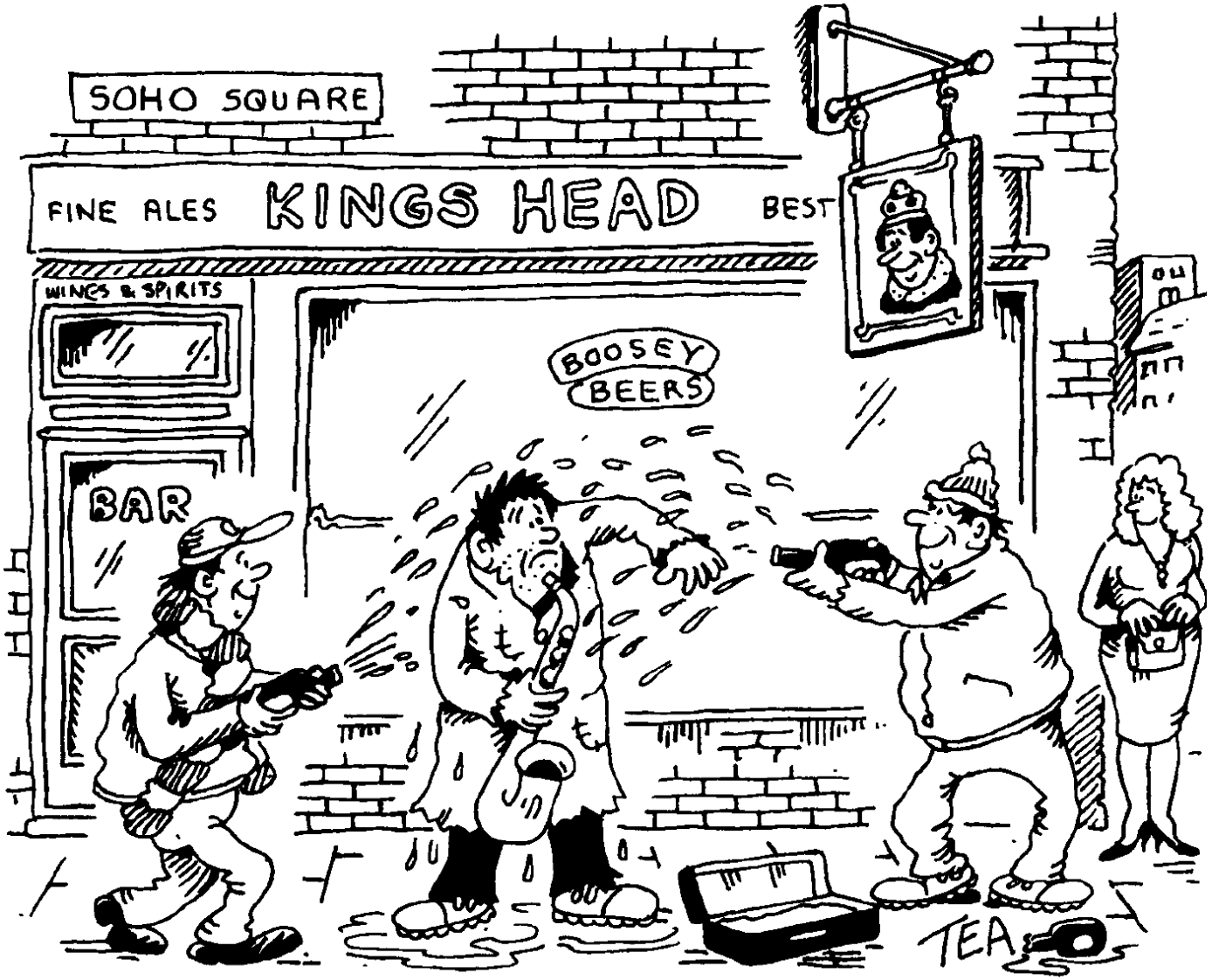


Real World Examples of IP Codes…

IPX3 – Limited spraying

Real World Examples of IP Codes…

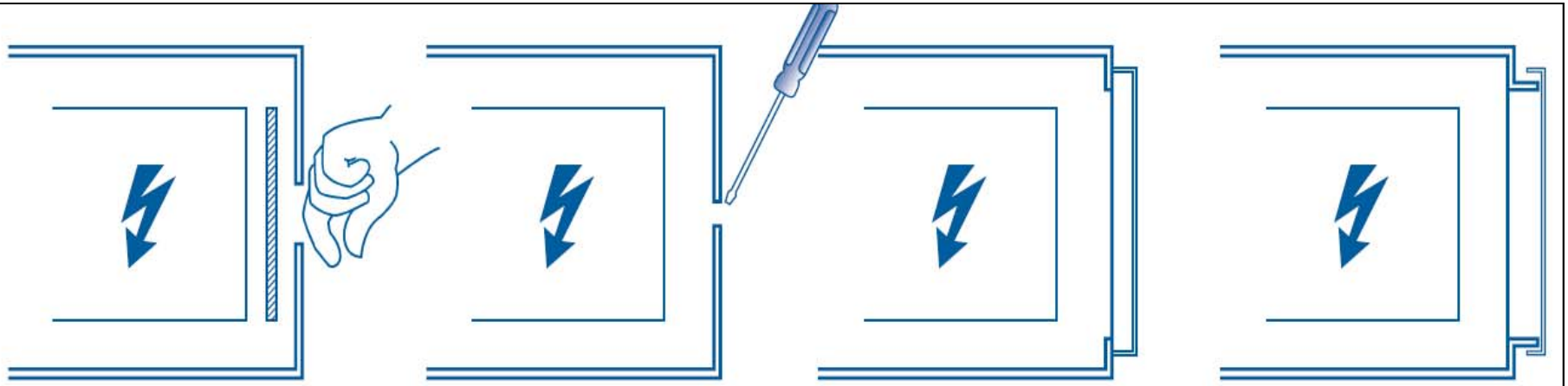
IPX4 – Splashing from all directions



Real World Examples of IP Codes…

Completely protected!!!

IP Codes – The Basics…



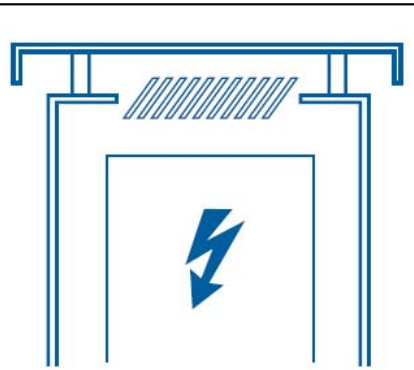
The IP code for this example without the barrier is IP1X, but with the internal barrier fitted as shown it can become IP1XC or even IP1XD.

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

IP Codes for Ventilated Equipment…

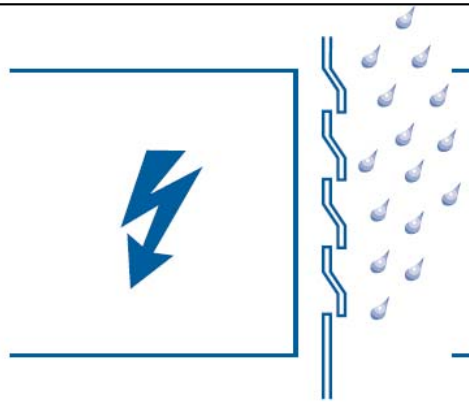


This example provides:

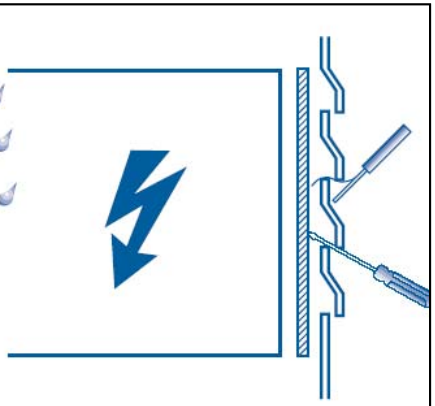
1 Basic protection against solid objects to IP2X/3X, and due to the tortuous path, complies with IP2XD/3XD.

2 Protection against water ingress to IPX2.

3 Allows for ventilation of the equipment.

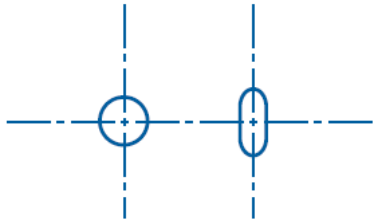


Similarly, side louvres can be engineered to provide the same protection.

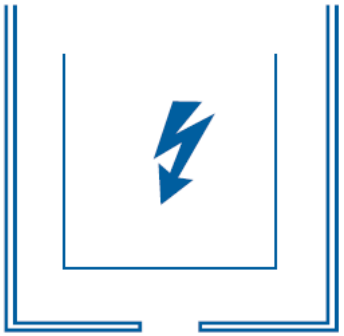


Additional internal barriers can be used to enhance the protection against small tools and individual wire strands, although this may well affect the efficiency of the ventilation. The test probe is not deemed to have entered the enclosure until the final barrier has been penetrated.

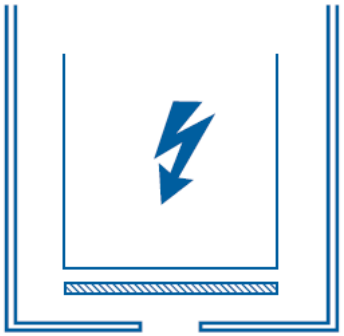
IP Requirements for Drainage Holes



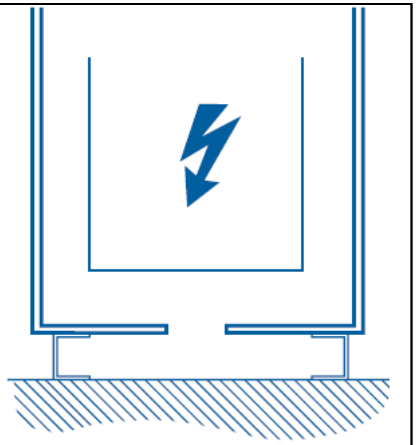
The minimum recommended aperture sizes to allow for drainage and overcome the surface tension of water are 5.0mm diameter, or a 3.0mm width slot of 20.0mm² area.



The basic protection with drainage holes would then be IP2X.

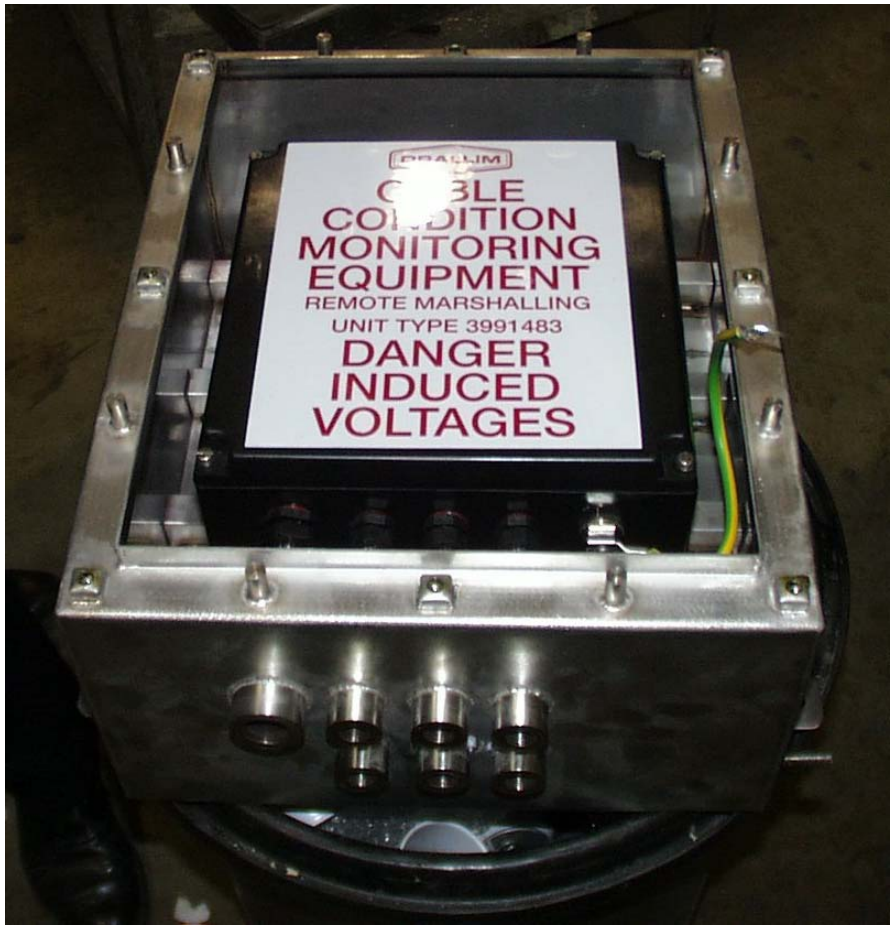


This can be improved by the use of internal barriers, and a rating of IP2XD can be achieved



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

One Note about IP68 Submersible Equipment…



The typical standard is based upon a 3 meter depth for an indefinite amount of time. However, the client and the manufacture may require performance beyond this criteria and is discussed with the manufacture during the engineering stage. Typical changes to standard products include reinforcement of structure with additional bracing, bolt patterns and standoffs, and welded hubs instead of clearance holes and standard hubs.

Final note on IP numbers…

Do not assume that higher the IP number, the better the protection…
IP66 vs. IP67 (From personal Experience…)