



# IECEX OD 017

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## IECEX Operational Document

**IEC System for Certification to Standards relating to  
Equipment for use in Explosive Atmospheres**

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**Operational Document - Drawing and documentation  
Guidance for IEC Ex Certification – for use by  
Manufacturers and ExTLS**





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# **IECEX OPERATIONAL DOCUMENT**

**IEC System for Certification to Standards relating to Equipment for use  
in Explosive Atmospheres (IECEX System)**

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**IECEX Certified Equipment Scheme – Drawing and Documentation Guidance  
for IEC Ex Certification – for use by Manufacturers and ExTLS**

**INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION**

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## **DRAWING AND DOCUMENTATION GUIDANCE FOR IEC EX CERTIFICATION – FOR USE BY MANUFACTURERS AND EXTLS**

### **1 Scope**

Certification drawings form part of the complete certification package. The content requirement and purpose for certification drawings and other documentation that forms the specification of the product is covered by this document.

This document has been prepared to assist manufacturers in the preparation of drawings and documentation to be submitted with an application for certification.

Note: Because the explosion protection standards are concept based and can be applied to a wide diversity of products, the information given in this document cannot be totally exhaustive nor cover every eventuality. IECEx Certification Bodies and Testing Laboratories are happy to advise on the needs in particular cases. They have a forum, the Ex Testing and Assessment Group (ExTAG), through which a common approach on this and other issues can be achieved throughout the world.

### **2 Purpose**

The drawings and other documentation used to demonstrate explosion protection conformity of the product are used by the certifying body for comparison with a prototype or sample and in conjunction with an Ex test report to demonstrate conformity with the standard(s).

The drawings and other documentation that forms the specification of the product used to demonstrate explosion protection conformity are a definitive specification of the product that has been certified.

The certificate holder/manufacturer uses the drawings and documents to record the controlled details (the elements of the design which provide the protection for the applicable explosion protection technique(s)). It is recommended that manufacturers prepare drawings specifically for the purpose of certification and do not necessarily provide every detail necessary to manufacture the product. The details provided in these drawings may only be modified by reference to the certifying body.

These drawings and documents are also used for audit and/or final inspection purposes. In particular, the certification body responsible for issuing the IECEx QAR will use the drawings and documents during audit against the requirements of ISO/IEC 80079-34.

The certification drawings and documents do not need to provide any information with regard to features not related to conformity with the standard(s). However in such cases the manufacturer must ensure an effective system for controlling manufacturing drawings derived from the certification drawings.

Changes to the certification drawings and documents can be implemented only after the certification body has issued a revision to the certificate to incorporate the new drawings and documents.

In this operational document, it is assumed that the terms "drawings" and "documentation" refer to information that has an equal level of control within the manufacturer's documentation systems, though possibly held in different formats. In 4.2.3 of IECEx Operational Document ISO/IEC 80079-34, concerning control of manufacturing documents, both the drawings and documentation referred to in this operational document are referred to as "Schedule Drawings".

This document has been written to apply to the current editions of the relevant IEC standards plus the immediate previous editions, applicable at the date of issue

### 3 Drawing and Documentation Content

The manufacturer will often require the maximum degree of flexibility to cater for production changes and product variants while the certifying body will require a level of detail which demonstrates that every aspect of the certification process and the relevant standards have been clearly considered and that all details relevant to conformity have been defined unambiguously. The trade off to be achieved relates to the work that the certifying body would need to carry out to ensure conformity over the whole range of the defined flexibility.

This document provides guidance regarding the detail required for each standard. It is not sufficient to include statements in drawings and other documentation that forms the specification of the product that simply replicate clauses from the applicable standard, eg 'All fasteners require the use of a tool' – the drawing should clearly show or make reference to a specific fastener.

Where typical drawings are used, the drawing must specify what it is typical of. A drawing of an enclosure showing the typical position of a widget does not control the location of the widget unless boundaries of permitted positions are defined.

Where a generalised statement is used in a drawing it must be clear where it applies. For example a general note stating "All gasket material to be 3mm thick neoprene rubber" is only valid if the drawing clearly shows the position of every gasket critical to conformity.

Material specifications on drawings are generally to be taken as material purchasing specifications and should be adequate for that purpose. Any material bought against the specification should perform sufficiently like that used for the prototype sample to give confidence that the test results would be replicated. Where possible, materials should be specified against an IEC standard or an industry recognised specification.

Where a material is specified only by its performance, the manufacturer must be able to demonstrate during production audit (see ISO/IEC 80079-34) how this requirement is met in production. For example material specified "epoxy glass resin with a CTI of greater than 175" would require proof of compliance with the CTI limit for each purchased batch. This can be achieved for example by an epoxy manufacturer's declaration or a third party.

## 4 Specific Requirements

The drawing and documentation requirements for the various explosion protection techniques are as follows:

### 4.1 General Requirement

#### 4.1.1

All drawings shall be identified by: Drawing Number; Revision Number; Date of Revision; Title; Name of the Design Authority in whose Drawing Record System the drawing is recorded (with relationship to the manufacturer if different).

#### 4.1.2

All measurements given on drawings should be expressed in SI units.

#### 4.1.3

All dimensions relevant to compliance with the standards shall be tolerated unless not required by a specific standard.

#### 4.1.4

A drawing/document shall show details of labelling, including all details required for compliance with the standards and all specific warning information required by the standards. The label material and method of marking and fixing shall be provided.

#### 4.1.5

Materials of parts relevant to the type of protection shall be unambiguously identified. Where possible, this should be by reference to a material grade given in an IEC Standard.

Where no relevant IEC Standard is available, reference may be made to other nationally, regionally or industry recognised standards, but the applicant should be prepared to submit a copy of the standard if requested.

Where no standard is available, or where the standard does not control all relevant requirements, the material manufacturer's data sheet shall be submitted.

#### 4.1.6

The specification for plastic materials shall include the following:

- name of the manufacturer;
- the exact and complete reference of the material, including its colour, percentage of fillers and any other additives, if used;
- the possible surface treatments, such as varnishes, etc.;
- the temperature index TI, corresponding to the 20 000 h point on the thermal endurance graph without loss of flexural strength exceeding 50 %, determined in accordance with IEC 60216-1 and IEC 60216-2 and based on the flexing property in accordance with ISO 178. If the material does not break in this test before exposure to the heat, the index shall be based on the tensile strength in accordance with ISO 527-2 with test bars of Type 1A or 1B. As an alternative to the TI, the relative thermal index (RTI – mechanical impact) may be determined in accordance with ANSI/UL 746B.

The data by which these characteristics are defined shall be supplied.

**4.1.7**

For enclosures of light alloys, the percentage content (and tolerance) of aluminium, titanium and magnesium will normally be required. The reference to a material grade given in an ISO standard would be sufficient (eg AISi12).

**4.1.8**

For earthing and bonding connections, the form of connection, capacity and corrosion protection shall be identified.

**4.1.9**

For rotating machines, the drawing or document shall identify all possible points where rotational clearance is relevant, together with information to determine how the minimum clearances required by the standards are achieved on assembly.

**4.1.10**

For luminaires, details of mounting and guarding (where applicable) to be provided.

**4.1.11**

Where ingress protection is relevant, materials of gaskets (and 'O' rings) and the method of ensuring or controlling compression of the gaskets in service shall be clear. Dimensions of gaskets and related features shall be specified.

**4.1.12**

Correctly scaled and dimensioned general arrangement and enclosure drawings including layout.

**4.1.13**

Details for permanent joints (e.g. welding) are to be specified .

**4.1.14**

Clamping and sealing arrangement of covers and doors are to be specified.

**4.1.15**

Circuit diagram (single line) including details of external connections.

**4.1.16**

If repairable, winding and winding insulation data should be specified.

**4.1.17**

Ratings of all protection devices are to be specified.

**4.1.18**

Technical description of the equipment with specification

**4.1.19**

For elastomerics that contribute to the explosion protection of the equipment, the following is required:"

- the name or registered trademark of the resin manufacturer or compounder;
- Either a full specification of the elastomeric material, including its colour, type and percentage of fillers and other additives, if used or, if this is confidential information and not provided by the material supplier, an outline description of the material and the manufacturer's precise identifying code, together with a declaration from the material

manufacturer that a change in material specification will result in a change to the identifying code

- the possible surface treatments, such as varnishes, etc.;
- the continuous operating temperature (COT).

#### **4.1.20**

Identification of bearings including conditions of use. Bearing data sheets to be provided detailing the working temperatures for the bearings.

#### **4.1.21**

Identification of the paint or coating applied to the equipment with material data sheet indicating electrical conductivity

#### **4.1.22**

Identification of type of battery by either of the manufacturer's name and part number or by the electrochemical system, nominal voltage and capacity. Mounting, connection and orientation must be specified. Manufacturer's data sheet to be provided.

#### **4.1.23**

For radio, laser and ultrasonic equipment, identification and details on threshold power and thermal initiation time and frequency.

#### **4.1.23**

For components which have IECEX component certificates, these components are to be identified in the parts list with their IECEX certificate number.

#### **4.1.24**

Cable/conduit entry points are to be identified and their locations specified.

#### **4.1.25**

All routine tests conducted are to be included in the drawings or documentation.

## **4.2 Flameproof Enclosure d**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

### **4.2.1**

Length of flamepath and maximum flamepath gap for each constructional gap/joint with maximum constructional tolerance.

### **4.2.2**

Length, size and minimum yield strength or grade of fasteners. Fastener data and characteristics may be included in a table cross referenced to the applicable drawing(s)

### **4.2.3**

Spacing of boltholes in covers.

### **4.2.4**

Size and tolerance of clearance holes for fasteners. This may be included in a table cross referenced to the applicable drawing(s)

### **4.2.5**

Depth of drilling and tapping. This may be included in a table cross referenced to the applicable drawing(s)

### **4.2.6**

Minimum thickness of metal around holes. This may be included in a table cross referenced to the applicable drawing(s)

### **4.2.7**

Maximum and minimum diameter of shafts and bores together with maximum "m" and minimum "k" radial clearances of rotating parts.

### **4.2.8**

Location and details of threaded entries, including range of sizes and maximum number, pitch, class of fit, length of thread provided in enclosure (chamfers and undercuts taken into account)

### **4.2.9**

Area in which cable entries, switch operators, windows, receptacles etc may be fitted to be shown.

### **4.2.10**

Method of retaining a non threaded fitting e.g. a fitting having a spigot joint.

### **4.2.11**

Hole spacing on face of enclosure where a certified component is to be fitted.

### **4.2.12**

Values of 'm' and 'k'.

### **4.2.13**

Overall dimensions of the enclosure including minimum wall thickness.

**4.2.14**

Weld type and size.

**4.2.15**

Minimum thickness of window, material and method of mounting.

**4.2.16**

Layout and heat dissipation of internal components showing location and approximate dimensions of each component, including clearances between components and the nearest sidewall. The purpose is to control:

- Location of sources of heat, for temperature classification purposes, for temperature withstand of plastic parts, window cement, other potting materials, cable entries, etc., and for confirming the local ambient for items such as IS safety barriers
- Dimensions relevant to pressure piling effects

Where the certificate is to cover variations in content, sufficient detail of the range must be given so that the design limits for each variant are absolutely clear.. The ExTL can then select the worst case arrangement(s) for test purposes.

**4.2.17**

Surface roughness of flamepaths.

**4.2.18**

Cemented joints require cement to be specified and manufacturers data sheet submitted and the shortest distance through the cemented joint is to be specified.

**4.2.19**

Washers (if used), washer thickness.

**4.2.20**

Setting compounds used in stopping boxes etc must be specified and data sheet provided.

**4.2.21**

Sintered metal components forming part of an enclosure or combustible sensor are to be fully specified – material, max bubble pore size, minimum density, dimensions etc.

**4.2.22**

Comparative Tracking Index (CTI) for insulating material subject to electrical stress if the type of protection depends on it, e.g. through going bushes.

**4.2.23**

State gross and net internal volumes if not evident from general dimensions.

**4.2.24**

Declare any cells/batteries and precautions taken.

**4.2.25**

Details and location of any internal thermal protective devices.

**4.2.26**

Length and diameters for press-fitted or interference fitted part.

**4.2.27**

Identification of grease if applied to the joints and specification data sheet with details on ageing process, solvent evaporation, corrosion, flash point.

**4.2.28**

Thickness of electroplating of flamepaths if relevant.

**4.2.29**

Details of safety devices for battery protection against excessive temperature, reverse polarity and exceeding the manufacturer charging specification

### **4.3 Increased safety e**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

#### **4.3.1**

Minimum creepage and minimum clearance distances.

#### **4.3.2**

Comparative Tracking Index (CTI). A data sheet for the material is required to substantiate the repeatability of the characteristic.

#### **4.3.3**

Type and details of terminals used in junction boxes if required (eg type, material, rating).

#### **4.3.4**

Insulation on windings shall be specified by manufacturer's data sheet. All relevant processes – e.g. for impregnation, shall also be defined.

#### **4.3.5**

All insulating materials to be specified and data sheets supplied where not defined by reference to an IEC standard.

#### **4.3.6**

Drawings for motors shall identify the radial airgap and indicate how it is achieved during manufacture. For example, this may be by confirming that the gap is set and measured during manufacture, or by providing information to clearly show how a defined, but non-measurable gap, is achieved by considering the various tolerances and eccentricities that may contribute to the actual build

#### **4.3.7**

Warning label drawings shall be supplied (either separate drawing(s) or document(s) or included on other relevant drawings or documents) – including material and method of marking and fixing.

#### **4.3.8**

If motors are intended for use with soft starters/frequency converters, these devices shall be specified.

#### **4.3.9**

Details of temperature limiting devices: identification and rating, specification of supplying voltage, mounting, wiring, insulation and termination

#### **4.3.10**

Details of associated external protection devices (e.g. certified overload protection device for a motor) if a dedicated device is required, otherwise appropriate detail to allow a generic protection device to be correctly selected.

#### **4.3.11**

Details of electrical components of luminaires including lamps, lampholders, ballasts, terminals, starting circuits, fuses and batteries.

#### **4.3.12**

Rotating Machines - Rotor bars shall be detailed as to method of location and achieving tightness within the slots, and the method of fixing/connection to shorting rings

**4.3.13**

Internal as well as external fan clearances and method of achieving

**4.3.14**

Relevant and main data for gaskets including material, dimensions, placement and security.

**4.3.15**

Details of anti-condensation heaters: identification and rating, specification of supplying voltage, mounting, wiring, insulation and termination.

**4.3.16**

The minimum conductor dimension of wires used for winding

**4.3.17**

Specification for rolling bearing minimum radial or axial clearance between stationary and rotating parts for non-rubbing seals, if relevant .Specification of clearances for sleeve bearings if relevant

**4.3.18**

Potential air gap sparking risk assessment for cage rotor ignition risk factors.

**4.3.19**

Potential stator winding discharge risk assessment for motors.

#### **4.4 Intrinsic safety i**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

##### **4.4.1**

Components used in a circuit on which the intrinsic safety depends must be specifically marked on the circuit diagram or in the parts list. It is recommended that these components be identified. A note explaining any identification symbol should be included in the drawing (eg "These components are safety components and may not be altered without approval of the Certification Body"). It is also recommended that the boundary between the parts of the circuit(s) upon which intrinsic safety depends and other parts of the circuit(s) be clearly defined, e.g. by a dotted line.

##### **4.4.2**

All safety distances in relation to the tracks on the wiring board must be specified.

##### **4.4.3**

All safety distances between components/terminals/within safety components must be specified.

##### **4.4.4**

Minimum track width must be specified.

##### **4.4.5**

Minimum cross-sectional area, conductor type and insulation thickness of wires must be specified.

##### **4.4.6**

The Comparative Tracking Index (CTI) for the wiring board must be specified (Because comparatively low and easily achieved values are often adequate, a generic specification may be sufficient provided that sufficient details are given to allow compliance to be checked during production audit (see ISO/IEC 80079-34).).

##### **4.4.7**

Ratings/tolerances/types of all components on which intrinsic safety depends must be specified.

##### **4.4.8**

If transformers are used, the internal insulation system must be specified (distances/insulation class/materials) as well as any internal thermal trips and fuses. In addition, for transformers providing galvanic internal separation distances are required.

##### **4.4.9**

If galvanic separation of components is used the internal separation distances must be specified (eg opto couplers) unless addressed otherwise by the standard.

##### **4.4.10**

General Arrangement drawings, correctly scaled, marked types.

##### **4.4.11**

Block diagram depicting:

- Which parts of the circuit are in a safe area(s) and which parts are in a hazardous area(s)
- The connections between assemblies (eg. J4 of Display PCB connects to J2 of Main PCB)

**4.4.12**

Correctly scaled PCB layout drawings including:

- PCB material and thickness
- Distance between layers (if applicable)
- Track material and thickness

This may be provided as electronic Gerber (or alternative) files.

**4.4.13**

Full schematics/circuit diagrams – component designations to correlate with parts list.

**4.4.14**

Full parts list including:

- Nominal values
- Tolerances
- Ratings
- Manufacturer's part number

**4.4.15**

Assembly manufacturing drawings for:

- Transformers
- Optocouplers
- Relays

**4.4.16**

Details of application and properties of insulating varnishes (conformal coatings).

**4.4.17**

Full specification of all equipment in a dedicated system.

**4.4.18**

The drawings or documentation should indicate that Annex F, when applied, has been used in determining the separation distances and any other critical aspects.

**4.4.19**

Details of any encapsulants used, generic name and type of encapsulant

**4.4.20**

The documentation shall include the following information as applicable:

- electrical parameters for the entity concept:
  - power sources: output data such as  $U_o$ ,  $I_o$ ,  $P_o$  and, if applicable,  $C_o$ ,  $L_o$  and/or the

- permissible  $L_o/R_o$  ratio;
- power receivers: input data such as  $U_i$ ,  $I_i$ ,  $P_i$ ,  $C_i$ ,  $L_i$  and the  $L_i/R_i$  ratio;
- any special requirements for installation, live maintenance and use;

NOTE A control drawing is a recommended form of consolidating connection information and special requirements for installation and use.

- the maximum value of  $U_m$  which may be applied to terminals of non-intrinsically safe circuits or associated apparatus;
- any special conditions which are assumed in determining the type of protection, foreexample that the voltage is to be supplied from a protective transformer or through a diode safety barrier;
- conformance or non-conformance with dielectric strength test requirement;
- the designation of the surfaces of any enclosure only in circumstances where this is relevant to intrinsic safety;
- the environmental conditions for which the apparatus is suitable;
- If Annex F has been applied, the documentation shall state the ambient pollution degree and overvoltage category.

## **4.5 Encapsulation m**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

### **4.5.1**

The encapsulation compound(s) shall be specified by the manufacturer's data sheet. At least the following data shall be available:

- Name and address of the manufacturer of the compound
- The exact and complete reference of the compound and if relevant percentage of fillers and any other additives, mixture ratios and the type designation.
- If applicable, any treatment of the surface of the compound, eg varnishing
- If applicable, to obtain correct adhesion of the compound to a component, any requirement for pre-treatment of the component, eg. cleaning, etching.
- The dielectric strength in accordance with IEC 60234-1 at the maximum temperature of the equipment as per the requirements of IEC 60079-18
- Temperature range of the compounds (continuous operating temperature)
- In the case where the compound forms part of the external enclosure the temperature index TI value as per IEC 60079-0. As an alternative to TI, the relative thermal index (RTI – mechanical impact) may be determined in accordance with ANSI/UL 746B.
- The colour of the compound where the compound specification will be influenced by changing the colour.

### **4.5.2**

The production process of filling the equipment with compound shall be described. Preferable is a quality system work instruction or manufacturer's recommended instruction.

### **4.5.3**

A drawing must show the minimum distance from components within the encapsulation to the nearest surface of the compound. Dimensions must also be shown of compound thickness between all components containing voids.

### **4.5.4**

Maximum electrical input parameters must be specified

### **4.5.5**

Circuit diagram and physical layout of circuit boards.

### **4.5.6**

Detail and location of any included protective device, e.g. thermal fuse

### **4.5.7**

Specification of any required external protective device, e.g. fuse.

## **4.6 Pressurisation p**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

### **4.6.1**

Schematic diagram showing the purge and pressurisation “plumbing”, components, pressure gauges etc.

### **4.6.2**

Where relevant a schematic diagram showing the control circuit for purging and pressurisation, normal operation and shut down. Define settings and limits and provide a statement on safety integrity that is compatible with the level of protection being claimed. NB use of IEC 61508 is a preferred option.

### **4.6.3**

General Arrangement of purged enclosure with dimensions. Gross free volume to be stated on drawings or documents. Show material and method of construction.

### **4.6.4**

State purging gas.

### **4.6.5**

State maximum, minimum and normal operating pressure.

### **4.6.6**

Show intake and outlet ducting and manifold distribution system if applicable.

### **4.6.7**

Show/state details of certified components/equipment.

### **4.6.8**

Detail windows and all other throughgoing devices e.g. pushbuttons, indicator lamps, etc

### **4.6.9**

Show layout of internal components and their thermal dissipation.

### **4.6.10**

Show how venting of any large enclosure volume is achieved.

### **4.6.11**

State presence of any cells/batteries and precautions taken.

## **4.7 Non-sparking n**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

### **4.7.1**

General Arrangement of enclosure giving principle dimensions.

### **4.7.2**

Degree of Protection sealing methods and seal details.

### **4.7.3**

Details of connection facilities, showing how the conductor is secured to comply with the standard.

### **4.7.4**

Details of connection methods for jointing internal wiring.

### **4.7.5**

All Clearances and Creepage distances, showing actual paths. For connection facilities, this should take into account all potential positions of the moving parts, e.g. with terminals fully open and fully tightened.

### **4.7.6**

Rotating Machines – Rotor bars shall be detailed as to fixing to the rotor and the method of fixing/connection to shorting rings.

### **4.7.7**

Specification of any required external protective device, e.g. fuse..

### **4.7.8**

Details of frequency converters and their parameters for the motor to operate within its temperature class are to be supplied. As a minimum, the type of converter, the minimum set up information such as minimum carrier frequency and the acceptable speed ranges should be provided.

### **4.7.9**

Details/specification of fuses if applicable.

### **4.7.10**

Plugs and Sockets – General Arrangement showing special facilities (if applicable) to ensure plug and socket cannot vibrate loose.

### **4.7.11**

Luminaires – lampholder, starter and starter holder types to be specified.

### **4.7.12**

Warning labels where applicable.

### **4.7.13**

Enclosed break devices and non-incendive components. Specify free internal volume of components.

### **4.7.14**

Thermal stability parameters of any poured seals or encapsulating materials.

**4.7.15**

For sealed or encapsulated devices specify any free volume.

**4.7.16**

Details of temperature limiting and/or regulating devices (eg type of device such as Thermistor or Thermostat, in the case of the thermostat, how the contacts are protected, e.g. by a sealed construction or by an enclosed-break construction,, and in either case the limiting temperature), -identification and rating, specification of supplying voltage, mounting, wiring, insulation and termination

**4.7.17**

Details of associated external protection devices (e.g. temperature control on heater).

**4.7.18**

Specification for rolling bearing minimum radial or axial clearance between stationary and rotating parts for non-rubbing seals, if relevant .Specification of clearances for sleeve bearings if relevant.

**4.7.19**

Potential air gap sparking risk assessment for cage rotor ignition risk factors.

**4.7.20**

Potential stator winding discharge risk assessment for motors.

**4.7.21**

Details of anti-condensation heaters: identification and rating, specification of supplying voltage, mounting, wiring, insulation and termination

#### **4.8 Dust Protection by Enclosure t or tD**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

##### **4.8.1**

Sealing method/arrangement/shaft seals/bellows.

##### **4.8.2**

General Arrangement of enclosure/equipment.

##### **4.8.3**

Internal electrical equipment. General Arrangement Layout. Power rating.

##### **4.8.4**

All gasket sizes, material, thickness, shape.

##### **4.8.5**

Hole spacing for fasteners. Specify fastener type.

##### **4.8.6**

Joints. Sizes, type, thread engagement, flange, spigot.

##### **4.8.7**

Warning labels.

##### **4.8.8**

Shows on drawing all holes into enclosure, threaded entries, thread length.

##### **4.8.9**

Materials of enclosure, window material, thickness, sealing.

## **4.9 Oil-immersion o**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

### **4.9.1**

A general arrangement drawing showing enclosure details, bolt/screw hole spacing, enclosure material specification.

### **4.9.2**

Pressure relief device and its release pressure for sealed devices.

### **4.9.3**

Breathing device and drying agent details if enclosure is not sealed. A maintenance specification is required for the drying agent.

### **4.9.4**

Means by which external and internal fasteners are secured from accidental loosening as well as details for securing devices such as liquid level indicators, fill and drain plugs.

### **4.9.5**

Liquid level indicating devices with markings to show the minimum and maximum levels for the protective liquid for the temperature range for which the liquid will be subject to in service. The level to which electrical equipment shall be filled to be detailed.

### **4.9.6**

Evidence demonstrating that transparent parts will retain their mechanical strength and optical properties when in contact with the protective liquid.

### **4.9.7**

The dipstick and its sealing and guide hole details for non-sealed apparatus. Warning label for replacement of dipstick after use.

Name, description, flashpoint etc of protective liquid.

### **4.9.8**

Specification of protective liquid including name, description, flashpoint, etc.

### **4.9.9**

Method of sealing and securing devices for draining the liquid.

### **4.9.10**

Oil expansion facility for non-sealed enclosures.

### **4.9.11**

Details of means of interrupting the supply in the event that an internal fault produces evolution of gas

### **4.9.12**

Details of electrical terminations and explosion protection technique applied.

#### **4.10 Powder Filling q**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

##### **4.10.1**

General arrangement showing enclosure details, methods of securing the enclosure (e.g. cementing/rivetting/welding cementing of screws/lead-seal safety-wiring of screws), material specification and thickness.

##### **4.10.2**

The specification of the particle material, the size range of the particles, as well as the filling process and the measures taken to ensure proper filling.

##### **4.10.3**

Free volume of any electrical devices or components that have a cavity not filled with powder (e.g. relays) to be stated.

##### **4.10.4**

Total capacitance with tolerance(s) of all capacitors and working voltage of each capacitor.

##### **4.10.5**

Cable entry and/or bushing sealing.

##### **4.10.6**

Sealing to achieve degree of protection.

##### **4.10.7**

Maximum width of gap.

##### **4.10.8**

PCB trackwork and component layouts (scaled), PCB coatings, component list with component values and tolerances, minimum distance through filling compound between electrically conductive materials and (i) insulated components and (ii) inner surface of enclosure

##### **4.10.9**

Fuse current rating  $I_n$

##### **4.10.10**

Thermal protection device

#### **4.11 Cap Lamps**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

##### **4.11.1**

Enclosure materials – Refer 4.1.5, 4.1.6, 4.1.7

##### **4.11.2**

Segregation distances for all wiring connections and printed wiring boards that can affect the type of protection.

##### **4.11.3**

Over-current protection used in the cap light.

##### **4.11.4**

General arrangement and sealing details (gaskets, o-rings etc) for both headpiece enclosure and battery container.

#### **4.12 Electrical Resistance Trace Heating**

The following dimensions/details must be shown in the drawings/documents for the apparatus:

##### **4.12.1**

Metallic braid coverage.

##### **4.12.2**

Warning label if required.

##### **4.12.3**

Maximum withstand temperature

##### **4.12.4**

The means of isolating all line conductors from the supply, over-current protection and means of protecting against earth faults.

##### **4.12.5**

Temperature control device if used.