Inspection requirements for installations

According to the law (Electrical Machinery Regulations of the OHS Act), apparatus and installations must be inspected at least once every two years by a competent person, to ensure that explosion protection is still valid.

SANS 10086-1 defines grades of inspection as follows.

Visual inspection (V): An inspection with the equipment live that identifies, without the use of access equipment or tools, those defects, for example, missing bolts, which will be apparent to the unaided eye.

Close inspection (C): An inspection with the equipment live that encompasses those aspects covered by a visual inspection and, in addition, identifies those defects, for example, loose bolts, which will be apparent only by the use of access equipment, for example, steps (where necessary) and tools. Close inspections do not normally require the enclosure to be opened, or the equipment to be de-energised.

Detailed inspection (D): An inspection with the equipment de-energised (except Ex i equipment) that encompasses those aspects covered by a close inspection and, in addition, identifies those defects, for example, loose terminations, which will only be apparent by de-energising the equipment and opening up the enclosure, or using, where necessary, tools or test equipment (or both).

Types of inspection are as per Table 1.

The grade of periodic inspections and the interval between (frequency of) periodic inspections shall be determined taking into account the type of equipment, manufacturer’s guidance if any, the factors governing its deterioration, the zone of use and the results of previous inspections.

Where inspection grades and intervals have been established for similar apparatus, plants and environments, this experience shall be used in determining the inspection strategy.

Once an interval and a grade for periodic inspections have been fixed, interim sample inspections and review of results must be used to support or modify this interval and grade.

When large numbers of similar items such as luminaires, junction boxes, stop-starts, etc., are installed in a similar environment, it may be feasible to carry out periodic inspections on a sample basis, provided that the number of samples in addition to the inspection frequency is subjected to review. It is, however, strongly recommended that all items be subjected at least to visual inspection.

An extract from a typical inspection sheet for Ex i installations is shown in Table 2.

The inspection and maintenance of installations shall be carried out only by experienced personnel, whose training has included

- instruction on the various types of protection and installation practices,
- the relevant rules and regulations, and
- the procedure for this type of equipment.

<table>
<thead>
<tr>
<th>Inspection Type</th>
<th>Explanation</th>
<th>Purpose</th>
<th>Inspection Grades (V/C/D) applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>Inspection of all electrical apparatus, systems and installations before they are brought into service.</td>
<td>To check that selected type of protection and installation is correct. If supplier has quality control, only explosion protection features affected by installation need to be checked, e.g. flamepaths on Ex d terminal box.</td>
<td>D (full or partial)</td>
</tr>
<tr>
<td>Periodic</td>
<td>Inspection of all electrical apparatus, systems and installations carried out on routine basis</td>
<td>To establish if the explosion protection of the item and installation is still intact. V or C. A visual or close periodic inspection might reveal the need for a detailed inspection.</td>
<td></td>
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<tr>
<td>Sample</td>
<td>Inspection of a proportion of the electrical apparatus, systems and installations</td>
<td>To establish if the interval and grade of periodic inspections are valid. V, C or D.</td>
<td></td>
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<tr>
<td>Continuous supervision</td>
<td>Frequent attendance, inspection, service, care and maintenance of the electrical installation by skilled personnel who have experience in the specific installation and its environment in order to maintain the explosion protection features of the installation in satisfactory condition</td>
<td>An alternative to periodic inspections, in cases where skilled staff carry out regular inspections of all grades as part of normal and maintenance work. The objective is to be able to pro-actively detect and repair faults. V, C or D.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Types and grades of inspection
The general principles of area classification.

Appropriate continuing education or training shall be undertaken by personnel on a regular basis. Evidence of the relevant experience and training claimed shall be available.

Maintenance requirements for installations

Definition of maintenance: Any routine actions carried out on equipment, normally while installed, in order to restore the equipment to its original (as-new) state. Specialised knowledge is essential, but specialised equipment is generally not required.

Essential maintenance principles are as follows:

- All maintenance work to be carried out under a permit-to-work (normally hot work) procedure to ensure that no ignition sources are created.
- Except for intrinsically safe apparatus, all explosion-protected apparatus must be de-energised before starting maintenance work. A time delay (as part of special conditions of use) may apply to apparatus containing hot or energy-storing components (e.g. transformers, capacitors). This time delay must be applied even when the permit-to-work procedure requires monitoring for explosive gases/vapours (unless the absence of explosive gases/vapours can be guaranteed).
- Maintenance work shall be restricted to the following:
  - Disconnection of, and removal or replacement of, items of electrical apparatus and cabling.
  - Safety barrier earth connections shall not be removed without first disconnecting the hazardous area circuits, except that where duplicate earth connections are provided a single earth may be removed to facilitate earth resistance checking.
  - Adjustment of any controls that are necessary for the calibration of the electrical apparatus or system.
  - Removal and replacement of any plug-in components or assemblies. Replacement parts shall be identical to the ones being replaced or shall be included in the certified spares list. Consult the supplier.
  - Use of any test instruments specified in the relevant documentation. Suitably explosion-protected test apparatus must be used. Where test instruments are not specified in the relevant documentation, only those instruments that do not affect the intrinsic safety of the circuit under test may be used. Special Conditions of Use for testers must therefore be strictly observed, e.g. prevention of unsafe actions such as charging of batteries only in non-hazardous locations, and elimination of ignition sources that can be created by taking certain measurements, even with an explosion-protected test devices. This applies for example to multimeters and resistance meters. This means that for such measurements to be done, a procedure suitable to prevent ignition of explosive atmospheres will have to be followed.

Other maintenance work on associated apparatus or parts of an intrinsically safe circuit mounted in a non-hazardous area shall be carried out only if the electrical apparatus or part of a circuit is disconnected from the part of the circuit located in a hazardous area.

Repair requirements

Definition of repair: Any actions carried out on equipment, and where specialised knowledge, techniques and equipment are required, in order to restore the equipment to its original (as-new) state.

Enclosures

Enclosures of an intrinsically safe apparatus and an associated apparatus are only required where intrinsic safety is dependent upon them. They are, however, often required for other reasons, such as environmental conditions. Therefore, if the apparatus has an enclosure, repair and overhaul activities shall not reduce the protection offered by the enclosure (i.e. its IP rating).

Cable entries

Special entries are used to maintain the degree of ingress protection of the enclosure. Any repairs shall not result in a reduction in the degree of ingress protection.

Terminations

When refurbishing terminal compartments, any replacement terminals shall be of the same type as that which they replace. If the same type is not available, any alternative type used shall satisfy the creepage (according to the comparative tracking index) and clearance requirements, specified in the relevant standard, for the maximum voltage of the apparatus and the separation required by the standard to avoid inadvertent cross-connection, for example by providing Earthed or insulating screens or barriers between connections.

Marking of external conductors (for example light blue sheaths) shall be observed.

Soldered connections

When it is necessary to carry out repairs that require soldering techniques to be used, care shall be taken to ensure that the basis of certification is not invalidated; for example, different requirements of redundancy apply to the connection, dependent on whether machine or hand soldering is used; and different requirements for creepage distances.
apply, dependent on whether the soldered joint is sweated and coated or not.

Fuses

Fuses shall normally be replaced in all circumstances, either with a replacement of identical type or, if this is not possible, with an alternative which has:

• the same rating or a lower rating;
• at least the same prospective current rating at the same or greater voltage;
• the same type of construction; and
• the same physical size.

If this is not possible, an evaluation of the effects of the chosen fuse on intrinsic safety shall be carried out by a person fully cognizant of the requirements of the standard in accordance with which the apparatus was originally manufactured. This evaluation shall be fully documented.

When a fuse is found to have ruptured, the cause shall be investigated, as well as whether any other components have been damaged as a result.

Relays

If a relay is faulty, it shall be replaced by an identical one.

Shunt diode safety barriers

Shunt diode safety barriers are totally encapsulated and no repair shall be attempted. If a barrier device is replaced, the replacement shall always have the same safety description and the value chosen for \( U_{\text{m}} \) shall be equal to or greater than the \( U_{\text{m}} \) of the original barrier. Care shall be taken that differing physical construction does not destroy the 50 mm separation required between the intrinsically safe circuits and non-intrinsically safe circuits.

Printed circuit boards

Printed circuit boards often have critical distances between conducting tracks (creepage distances), which shall not be reduced. Therefore, when components are replaced, care shall be taken in positioning them on the board. Where varnish is damaged during repair, insulating varnish of the type prescribed in the certification documents shall be applied in the approved manner, for example, one coat when using dipping, two coats when using other methods. In the case of resoldering components, ensure that creepage and clearance distances are not affected.

Optocouplers

Only optocouplers of the same or directly equivalent type and certification shall be used as replacements.

Electrical components

Components such as resistors, transistors and zener diodes can normally be replaced by identical replacements purchased from any source. However, in exceptional circumstances, certain manufacturers use a “select on test” procedure for some components. Where this is done, the documentation supplied with the apparatus shall indicate that replacements be either obtained from the apparatus manufacturer or selected by the method he recommends.

Batteries

Only those types specified in the certification documents shall be used as replacements. Where batteries are encapsulated, the whole assembly shall be replaced.

Internal wiring

Certain distances between conductors are critical. Therefore, if disturbed, internal wiring shall be relocated in its original position. If insulation, screens, outer sheaths, or double insulation of wiring or the method of fixing (or a combination of these) are damaged, they shall be replaced by equivalent material or shall be refixed in the same configuration (or both).

Transformers

If a transformer is found to be faulty, the replacement shall be obtained from the manufacturer. No attempt shall be made to repair or replace any embedded (encapsulated) thermal trip device.

Encapsulated components

Encapsulated components, for example batteries with internal current-limiting resistors or fuse-zener diode assemblies, are non-repairable and shall be replaced only by assemblies of the original design from the manufacturer.

Non-electrical parts

Where the apparatus has non-electrical parts, for example fittings or a window, that do not affect the electrical circuit or creepage and clearance distances and hence the intrinsic safety, these parts can be replaced by new parts of equivalent type. For non-metallic parts, electrostatic properties shall be taken into account.

Testing

After completion of the repair or overhaul of apparatus that contains intrinsically safe circuits only, the insulation between the intrinsically safe circuit and the enclosure shall be checked by applying an AC voltage of 500 V at 50 Hz to 60 Hz between the terminals and the enclosure for 1 min. This test can be omitted if the enclosure is of insulating material and if one side of the circuit is galvanically connected to the enclosure for safety reasons.

Modifications

Modifications that might affect the intrinsic safety of the apparatus shall not be carried out without re-certification.

Repairers

The legal requirement in South Africa is: repair of explosion-protected apparatus shall either be conducted under a product certification scheme approved by the approving authority, or repaired units shall be assessed and/or tested by an approved test laboratory.

This aspect is of particular importance in the case of local agents for international companies where repair work has traditionally been carried out under the so-called “Extended Workbench” concept. In some cases, these agents have even assisted factory owners to set up internal repair workshops.

There are however areas where the tradition of repairs by the agent or the plant workshop is still strongly entrenched. These areas must be addressed before further incidences occur in our industry. The prime examples are radios, gas sensors and other instruments, and motorised valves.
How to apply for certification of intrinsically safe apparatus and loops

First we take a look at the types of testing carried out by an approved test laboratory (ATL):

Type testing: Determining by means of assessment and testing whether a product design complies with a specific standard(s). A product design that passes type testing can be certified. Intrinsically safe apparatus as well as loops have to be certified.

Batch testing: Determining by means of assessment and routine tests whether a batch of production units comply with the certified design and with the specified standard(s).

Assessment of imported certified apparatus: Determining by means of an assessment of certification documentation and samples whether a product complies with a specific standard(s). In cases where the standard(s) is not an IEC or EN standard, a comparison against this standard and additional assessment/testing as required may be carried out.

The validity of local certification of imported certified apparatus depends on the continued validity of the overseas certification in most cases. In many cases the ATL issues a type approval; it is therefore the responsibility of the supplier and end user to verify the continued validity of the overseas certification on which the local approval is based.

It is worth noting that most overseas certificates have a finite validity period, after which renewal of certification is by no means automatic.

Group II products certified under the ATEX New Approach Directive (Directive 94/9/EC of the European Community) may currently enter the South African market without any local intervention by an ATL (Note - This practice is due for review in the first amendment of ARP 0108). Suppliers and end users must be aware of the following exceptions:

- No self certification is allowed; and
- No certification against the Essential Health and Safety Requirements is allowed, i.e. the apparatus must fully comply with an EN standard (indicated by marking such as EEx d IIB T3).
- All Group I products must be assessed by a local ATL.

Requirements for products and documentation

An accurate description of what has to be done, the deliverables, timescale and provision for payment must be given, including any particular requirements such as confidentiality arrangements between a supplier and a manufacturer, procedures to prevent unnecessary damage to sensitive expensive samples, etc.

Items to be included in submissions for testing include:

Prototype (modification)
- Samples (see below)
- Documentation (see below)

Batch
- Units for testing
- Previous reports

Imported
- Sample
- Overseas certificate and certification drawings
- Report (if available)
- Manufacturer quality system certificate

Samples and documentation: Find out which number of samples required must be established, and whether if they need to be prepared in a particular way. For example, enclosures or parts of enclosures made of plastic materials have to undergo a number of environmental resistance tests, followed by the prescribed tests related to the explosion protection. Actual production units have to be used as follows: Group I: 6 units; Group II: 2 units; Dust: 2 units, except for the resistance to light (if exposed) and insulation resistance tests, which are done on test pieces with specific dimensions. Where equipment contains coated, encapsulated or potted assemblies as part of the protection, sealed as well as unsealed samples of such assemblies must be provided.

Specific components of intrinsically safe apparatus, e.g. transformers, gas sensors, relays, and opto-couplers, may have to undergo individual destructive tests. In such cases, component samples must be provided in addition to the complete unit.

Apparatus drawings have to comply with acceptable drawing standards and practice. Two sets of especially large production drawings have to be provided, as one set is placed on record and the other approved (stamped) and returned.

Proof of certain physical and chemical properties of materials (e.g. anti-static, insulation, heat resistance or water absorption properties of polymeric materials), and performance properties of electrical and electronic equipment (e.g. maximum surface temperature of equipment under rated load, charge dissipation periods of capacitors, intrinsically safe cable parameters) that are relevant to explosion protection, may be provided in the form of data sheets from reputable manufacturers, thereby saving testing costs.

For approval of intrinsically safe loops, a loop drawing and system parameter calculations are required (examples are available), as well as cable specifications from the manufacturers, and copies of apparatus certificates.

Conclusion

End users and suppliers cannot use ignorance as an excuse for breaking the law by unsafe behaviour. Sources of information and assistance are available from local and international standards, technical committees and working groups; from the SA Flameproof Association (SAFA); and from accredited Test Houses and Training Providers.

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