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Guidance on Practice for In Service Inspection and Testing of Electrical Equipment (IEC)

GP 32-51

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) GP 32-51. This Guidance on Practice (GP) is based on parts of heritage documents from the merged BP companies as follows:

British Petroleum

RP 32-5

Inspection and Testing of Plant in Service (Electrical Equipment)

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Introduction

This Guidance on Practice does not reference any national legislative documents, codes, or standards. Requirements for a particular country's statutory obligations or national codes or standards shall be taken into account when applying this Guidance on Practice.

The guidance given is applicable to fixed and temporarily fixed installations from energy source through interconnecting conductors/cables up to and including the utilisation equipment. It is also applicable to electrical instrumentation, portable and transportable equipment. Furthermore, advice is included on the requirements for assessing the specialised electrical equipment used in hazardous areas.

In view of the large variety of electrical equipment in use and the diverse and variable operating conditions to be found in 'Offshore' and 'On-shore' locations, full and detailed requirements for assessment cannot be given in this document. However, guidance is given on those requirements considered essential for assessing equipment and systems integrity from which more specific requirements can be developed by site engineers.

If guidance for assessing equipment or systems of a type not specifically considered in this document is required, reference to the nearest type should provide a reasonable guide.

Integrity failures on low voltage systems can in certain instances lead to fault conditions having serious consequences, therefore no distinction is drawn between the requirements for various voltage levels. Site engineers need to take account of local circumstances and risk potential in deciding what allowances if any should be made for low voltage equipment.



1. Scope

This GP provides guidance for in service inspection and testing of Electrical Equipment designed and maintained in accordance with IEC standards.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

BP

Integrity Management Standard.

European Standard (EN)

EN 12464-1 Light and lighting - Lighting of work places - Part 1: Indoor work places.

International Electrotechnical Commission (IEC)

IEC 60079-17 Electrical apparatus for explosive gas atmospheres – Part 17: Inspection and maintenance of electrical installations in hazardous areas (other than mines).

IEC 60422 Mineral insulating oils in electrical equipment – Supervision and maintenance guidance.

ISO/IEC 17020 General criteria for the operation of various types of bodies performing inspection.

IEC 62086-2 Electrical apparatus for explosive gas atmospheres - Electrical resistance trace heating – Part 2: Application guide for design, installation and maintenance.

IEC 60694 Common specifications for high-voltage switchgear and controlgear standards.

3. Symbols and abbreviations

For the purpose of this GP the following symbols and abbreviations apply:

CT Current Transformer

DC Direct Current

DLA Dielectric Loss Analysis

IA Inspection Authority

IR Insulation Resistance

PCA Phase Current Analysis

PCB Polychlorinated biphenyl



PD	Partial Discharge
PI	Polarisation Index
SF ₆	Sulphur Hexafluoride

4. General requirements

4.1. Identification

Fixed installations and temporarily fixed installations shall be clearly and permanently identified. Circuit identification shall relate unambiguously to the connected equipment.

4.2. Registration

A register should be compiled of all equipment requiring regular test and inspection. Each item should be uniquely identified (tagged) and registered before being taken into service.

4.3. Support documentation

- a. For each plant, a dossier containing relevant data for equipment should be compiled.
This may be a self contained document or a reference to the source/location of the relevant data.
- b. A person should be appointed as the custodian with responsibility for ensuring it is updated and readily accessible to Engineers preparing and implementing these procedures.
- c. Dossiers should include manufacturer's handbooks, general arrangement drawings, single-line and schematic drawings and hazardous area certification when applicable.
- d. The site installation single line, wiring, and control schematics should also be incorporated.
- e. For each plant, a record should be maintained of the calculations and settings applied to associated protective relay systems.

4.4. Inspection procedures

- a. For each circuit and/or component part, test and inspection programmes that include procedures outlining the extent and frequency should be prepared.
- b. In preparing procedures, account should be taken of the guidance given in this document, and the following:
 1. Statutory regulations
 2. Recognised international/national codes and standards
 3. Manufacturers' recommendations
 4. Historical records
 5. Severity of duty
 6. Deterioration rates
 7. Consequences of failure
 8. Provision of duplicate services and the demands of the production programme
 9. Environmental conditions
 10. The possibility of inadvertent damage
- c. Procedures shall stress the requirement for applying the site or facility Safety Rules and 'Permit to Work' systems before any work is undertaken on electrical equipment.



- d. Special procedures should be available for the handling/containment/disposal of substances hazardous to health, i.e. PCB insulation.
- e. Procedures should stress the need for test voltages to be the lowest value possible consistent with achieving a satisfactory test.

4.5. Records

- a. A file or other suitable permanent record should be established for all items/circuits to be regularly tested/inspected.
- b. The records should contain a permanent operational history including details of faults, repairs, modifications, and the results of tests and inspections carried out.
- c. This history shall provide the evidence, where necessary, to third parties or statutory bodies that all reasonable steps have been taken to ensure the integrity of the electrical systems.

4.6. Sensitive components

Components such as solid state devices shall be disconnected when test voltages are applied to the associated circuits. Testing of these devices should only be carried out strictly in accordance with manufacturers' recommendations.

There is a high risk of damaging sensitive components such as solid state devices when performing routine testing.

4.7. Guidance on certification

If intrusive maintenance activity results from inspection findings it may be necessary to reinstate the certification in accordance with the flowchart shown in Annex A.

4.8. Examination requirements

Electrical systems should be scheduled for examination according to the following inspection types where these are referenced in the following clauses and in Table 2:

- a. Initial Examination - Identifies problems that often become evident shortly after commissioning. These could be due to manufacturing faults, deficient design, or poor installation practices. Evidence of overheating on cables and loose terminations are typical of the faults anticipated. It is likely that such faults would develop into serious failures if undetected.
- b. Periodic Examinations - Identify those problems more likely to occur as a consequence of age, severity of duty, and environmental condition, e.g. deterioration on insulation, earthing/grounding system degradation, corrosion on protective housings, and slow or inoperative protection, etc.
- c. Intermediate Inspections - Are non-intrusive visual inspections to assess the general condition of enclosures and interconnecting systems. Guidance will be given where this is applicable.

4.9. Examination intervals

In view of the varying operating environments and variety of equipment, it is not possible to give actual intervals between examinations.

- a. Table 2 should be used for initial intervals for the type of equipment under reasonable operating and environmental conditions. However, these frequencies are for guidance only and should be adjusted to take account of any local factors such as:
 - 1. Statutory regulations.



2. Recognised international/national codes and standards.
 3. Manufacturers' recommendations.
 4. Historical records.
 5. Severity of duty.
 6. Deterioration rates.
 7. Consequences of failure.
 8. Provision of duplicate services and the demands of the production programme.
 9. Environmental conditions.
 10. The possibility of inadvertent damage.
 11. Associated equipment scheduled examinations (e.g., pumps in the case of motors).
 12. Associated work programmes (e.g. re-lamping programmes).
- b. Intervals allocated on the basis of the above considerations should not be regarded as fixed and should be increased or decreased in the light of experience. This should be achieved by a formal, documented review of the allocated interval following on at the end of each inspection/examination when the outcome is known.

4.10. Operational history

Previous recorded history and failure rate data for similar electrical equipment from existing operational installations should be used to assist in specifying examination requirements and examination frequencies for new equipment/systems.

Although conditions between installations can vary widely, there is nevertheless some similarity between the application and performance of the same electrical systems at different sites. This is especially true for conventional equipment with proven performance.

4.11. Condition monitoring

- a. The application of appropriate monitoring techniques may be incorporated into the inspection and maintenance activity to reduce the requirements for unnecessary shutdown or invasive work.

Off-line techniques are shown in the individual clauses for the different equipment types.

- b. Specific methods which should be considered include:
1. Thermography for identifying the condition of electrical connections and contacts.
 2. Partial discharge or ultrasonic measurement for assessing the health of insulation systems.
 3. Envelope analysis for assessing bearing condition.
 4. Switchgear performance monitoring for profiling the tripping and closing performance of circuit breakers.

Sometimes referred to as Kelman profiling.

5. Oil analysis for monitoring the condition of transformer windings.
6. Phase current analysis for examining motor stator and rotor condition.
7. Battery condition monitoring.

