

 Eskom National Transmission Company South Africa TM	Scope of Work	NTCSA Northern Grid
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Title: **Hazardous Locations (substation battery rooms) assessment, inspection and testing.**

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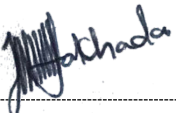
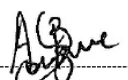
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1. Introduction

Lead acid batteries are typically housed in battery rooms, while nickel cadmium batteries are housed in control room cabinets. Vented lead acid batteries with a liquid electrolyte release hydrogen and oxygen through water electrolysis. The generated hydrogen and oxygen are allowed to escape freely through the cell vent cap, potentially creating an explosive gas atmosphere. Safety standards require steps to be taken in areas where an explosive gas atmosphere may occur to (a) eliminate the likelihood of an explosive gas atmosphere occurring around the source of ignition or (b) eliminate the source of ignition. To prevent or eliminate the occurrence of an explosive gas atmosphere the ventilation inside hazardous locations (Haz Loc) must be sufficient to make sure that the hydrogen concentration never enters the explosive range. A mixture of hydrogen and air, in hydrogen concentrations of between 4% (LEL – lower explosive limit) and 74% (UEL – upper explosive limit), is explosive and burning is enhanced by oxygen enrichment. To eliminate the source of ignition, correct equipment must be used inside Haz Loc. Working procedures that prevent the usage of equipment that generates sparks, arcs and excessively hot surfaces that can ignite the gas and cause an explosion are put in place.

The National Transmission Company South Africa (NTCSA) Northern Grid has five (5) Customer Load Networks (CLN), namely Carletonville, Rustenburg, Lephalale, Polokwane and Phalaborwa. The Grid has a total of 27 substations (including two new ones). Substations consist of battery rooms (Haz Loc) that do not have any valid Certificates of Compliance (CoC) and accompanying test reports as required by the Electrical Installations Regulations of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) (OHS Act). Also, there is considerable lack of documentation that is needed for compliance to statutory requirements and good practice of managing Haz Loc. These non-compliances could lead to a contravention of the OHS Act Regulations. The unavailability of the CoCs, Hazardous Area Zone Classification, zoning drawings, equipment certificates, maintenance records, etc. were identified as a serious safety risk that may have serious consequences to the health and safety of persons working or accessing the battery rooms at Northern Grid substations. Management took a decision to initiate a project to ensure that all battery rooms at Northern Grid substations be assessed, tested and issued with all required documentation in accordance with the OHS Act and applicable South African National Standards (SANS). The project will ensure legislative compliance of Northern Grid battery rooms and address any unsafe working conditions that may exist.

2. Supporting Clauses

2.1 Scope

This document details the technical requirements as stated in the OHS Act, Electrical Machinery Regulations Section 9, regarding electrical machinery in hazardous locations which informs the Scope of Work (SoW) to be carried out at Northern Grid substations.

2.1.1 Purpose

To detail the SoW to be carried out at all listed Northern Grid substations that are required to comply with the Electrical Machinery Regulations 9 of the OHS Act, including all other applicable standards, procedures and regulations.

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2.1.2 Applicability

This document shall apply throughout NTCSA Northern Grid.

2.1.3 Effective date

This document shall be effective from the date of authorisation.

2.2 Normative/Informative References

The following standards contain provisions that, through reference in the text, constitute requirements of this SoW. All standards and specifications are subject to revision, and parties to agreements based on this procedure are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

2.2.1 Normative

- [1] Occupation Health and Safety Act, 1993 (Act 85 of 1993)
- [2] 32-727: Safety, Health, Environment and Quality Policy
- [3] ISO 45001:2018, Occupational Health and Safety Management Systems-Requirements
- [4] 9001:2015 Quality Management Systems- Requirements
- [5] 240-56176113 Classification of Battery Rooms
- [6] 240-56536505 Hazardous location Standard
- [7] 240-6219622, Life-saving Rules Standard
- [8] 240-114967625: Operating Regulations for High Voltage
- [9] 32-136 Contractor Health and Safety Requirements
- [10] 32-95 Occupational Health and Safety Incident Management Procedure
- [11] SANS 10142-1: The wiring of premises – part 1: Low voltage installations.
- [12] 240-61182045 Maintenance Engineering Standard for Batteries and Chargers
- [13] GG 46750 – GNR 2398 National Code of Practice - Electrical Machinery in Hazardous Locations
- [14] SANS 10108: The classification of hazardous locations and the selection of apparatus for use in such locations.
- [15] 240-56177186 Battery room standard

2.2.2 Informative

- [1] SANS 60079-14: Explosive atmospheres – part 14: Electrical installation design, selection and erection.
- [2] SANS 10086-1: The installation, inspection and maintenance of equipment used in explosive atmospheres – part 1: Installations including surface installation or mines.
- [3] SANS 10086-3: The installation, inspection and maintenance of equipment used in explosive atmospheres – part 3: Repair and overhaul of apparatus used in explosive atmospheres.

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- [4] SANS 60079-10-1: Explosive atmospheres – part 10-1: Explosive atmospheres – Classification of areas – explosive gas atmospheres.
- [5] SANS 60079-17: Explosive atmospheres – part 17: Explosive atmospheres – part 17: Electrical installations, inspection and maintenance.
- [6] SANS 60079-19: Explosive atmospheres part 19: Explosive atmospheres – part 19: Explosive atmospheres – part 19: Equipment repair, overhaul and reclamation
- [7] ARP 0108: Regulatory requirements for explosion protected apparatus.
- [8] SANS 60079-25: Intrinsically safe electrical systems

2.3 Definitions

Certificate of Compliance: Certificate in the form of Annexure 1 that is issued by a registered person in respect of an electrical installation or part of an electrical installation.

Competent Person: a person who has, in respect of the work or task to be performed, the required knowledge, training and experience and, where applicable, qualifications, specific to that work or task: Provided that where appropriate qualifications and training are registered in terms of the provisions of the National Qualification Framework Act, 2000 (Act No.67 of 2000), those qualifications and that training must be regarded as the required qualifications and training; and is familiar with the Act and with the applicable regulations made under the Act;

GMR 2.1: Designated persons who is appointed in terms of the Occupational Health and Safety Act (Act No. 85 of 1993) General Machinery Regulation 2(1).

Ignition source: Any part or process that can cause an ignition of an explosive atmosphere.

Explosive atmosphere: Mixture with air, under atmospheric conditions, of flammable substances in the form of gas or vapour or mist or dust or fibre (or a combination of these) in which, after ignition, combustion spreads throughout the whole mixture.

Hazardous Location: Area in which an explosive gas atmosphere, or an explosive dust atmosphere, or an explosive gas/dust atmosphere is, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment.

NTCSA Requirements: NTCSA requirements, which evolve from directives, policies, standards, procedures, specifications, work instructions, guidelines or manuals.

Master Installation Electrician (MIE): Professionally qualified and registered for the verification and certification of the construction, testing and inspection of any electrical installation for which they can prove competency.

OHS Act: Occupational Health and Safety Act, Act No. 85 of 1993 aimed to provide for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery; the protection of persons other than persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work; to establish an advisory council for occupational health and safety; and to provide for matters connected therewith.

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2.4 Abbreviations

Abbreviation	Explanation
AC	Alternating Current
HV	High Voltage
PPE	Personal Protective Equipment
GMR 2.1	General Machinery Regulation 2(1)
COC	Certificate of Compliance
kV	Kilo Volts
MIE	Master Installation Electrician
OHS Act	Occupational Health and Safety Act (Act No. 85 of 1993)
HAZ-LOC	Hazardous Location
LEL	Lower Explosive Limit
UEL	Upper Explosive Limit

2.5 Roles and Responsibilities

Responsible Person	Role
GMR 2.1	Accountable for the compliance to the OHS Act with regards to documentation, inspection, testing and maintenance of electrical equipment in hazardous locations on existing sites. Ensure compliance to relevant regulations when work is being executed as per SoW and as per NTCSA's requirements and standards. Revise this scope of work when necessary.
Project Manager	Manages the contract signed with the Principal Contractor and ensures that H&S specifications are developed and issued with tender enquiries, and that the Principal Contractor's H&S plan is approved prior to commencement of work. He must ensure that applicable legal and other requirements are complied with by the Principal Contractor and (if applicable) their contractors.
HV Plant Manager	Provide resources and access to sites for executing the scope of work within the substations and monitor the execution of the work leading to the project execution.
Secondary Plant Manager	Assist with the specification, selection and integration of control and instrumentation devices that are required in the battery rooms for monitoring, detection and alarms.

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2.6 Project Justification

The OHS Act requires that there should be management and regulatory compliance to the Occupational Health and Safety Act 85 of 1993, Electrical Machinery Regulations section 9. Many of the Northern Grid battery rooms do not have any valid CoC and accompanying test reports as required by the Electrical Installations Regulations of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) (OHS Act). Also, there is considerable lack of documentation that is needed for compliance to statutory requirements and good practice of managing Haz Loc. These non-compliances could lead to a contravention of the OHS Act Regulations. The unavailability of the CoCs, Hazardous Area Zone Classification, zoning drawings, equipment certificates, maintenance records, etc. were identified as a serious safety risk that may have serious consequences to the health and safety of persons working or accessing the battery rooms at Northern Grid substations.

Having a project initiated to address the gaps in compliance to the Act will ensure that the working conditions at Northern Grid battery rooms are safe and without risk to health of employees, preventing injuries and plant damage. Failure to implement the project could eventually lead to the plant being shut down (Prohibition Notice) by the Department of Employment and Labour (DEL) should the conditions of the plant deteriorate to an unsafe environment for people to work on.

The project deliverables include the execution of the SoW as provided in this document, full compliance of Northern Grid battery rooms to the Haz Loc requirements and training of maintenance and operating personnel in the management of Haz Loc.

2.7 Scope of Work

2.7.1 General requirements

An MIE is required to do the inspections, testing and issuing of the CoC in accordance with applicable SANS in the Northern Grid battery rooms. The services will be provided in various Northern Grid substations as identified in the SoW. The professional service provider shall be registered member with the DEL and must have a valid registration number and proof of rendering such services in the past five (5) years.

The service provider shall provide the hazardous location (Haz Loc) classification report where such report does not exist. The classification report shall as a minimum indicate the calculation indicating how the classification was determined by considering the following: -

- The geometry of the source of release.
- Release velocity.
- Concentration.
- Ventilation calculations.
- Grade of release.
- Determine the extent of zone.
- Temperature class.
- The explosive level (Lower Explosive Limit and the Upper Explosive Limit).
- Risk Assessment.
- The type of Explosive Protection Equipment required in that particular room.
- The Gas Group.

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2.7.2 Classification of Hazardous Locations

The classification report shall as a minimum include the following:

- Indicate the information that will be displayed on the Haz Loc signage for the area.
- Haz Loc Drawing.
- The type of inspections and the frequency of the inspection to be conducted.
- The demarcation indicating the hazardous area.

The MIE shall carry out the following tasks:

- Assess battery room electrical installations, test and issue certificates of compliance (CoC) for specialised (hazardous locations) and normal electrical installations after reparations, modifications or new installations.
- Assess and analyse any other Haz Loc areas and recommend appropriate classifications on existing, modified and new plant and equipment as and when required for the duration of the contract period.
- Do inspections and issue valid CoC's as per SANS requirements:
- Select and approve electrical components for designated Haz Loc areas, in accordance with the relevant OHS Act, SANS and other relevant codes of practice requirements.
- Verify and advise end users of the correct rating of protective devices, through appropriate calculations in accordance with the applicable approved design standards and specifications.
- Verify and advise end users of the correct conductor rating and current carrying capacity for the protective devices and connected load, through calculation in accordance with the applicable design standards.
- Assess and perform appropriate tests on connections of conductors, earthing and bonding. Ensure the circuit is mechanically sound and electrically continuous.
- Ensure that circuits, fuses, switching devices, terminals, earth leakage units, circuit breakers and distribution boards are correct and permanently identified, marked and labelled.
- Calculate and verify the voltage rating, voltage drop, current carrying capacity and short circuit capacity in accordance with appropriate SANS requirements.
- Verify and advise end users of appropriate ventilation in applicable Haz Loc Zones/Areas through appropriate calculation in accordance with the relevant SANS standards.
- Verify and advise end users that the appropriate signs and demarcation is in place.
- Provide all relevant documentation and inspection test reports for each site.
- Predict remaining life of components and advise of what spares and materials to keep for future repairs.
- Use appropriate test equipment and perform periodic tests.
- Ensure that all required tests are executed for the CoC of a specific Haz Loc zone.
- Record test results, measurements, calculate ratios and compare with specifications. Identify compliance / non-compliance and provide all the necessary reports for all the tests done.

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- Complete all related test documentation. Compare test results/ratios with specifications and report any identified non-compliance.
- Ensure that applicable tools and test equipment are in proper working condition and calibrated timeously and provide valid calibration certificates.
- Check all relevant documentation, such as drawings for correctness and equipment validity.
- In terms of new installations, Handover documents must be checked for correctness.
- Before commissioning of the equipment, an initial detailed inspection schedule shall be completed for the different protection types, for all equipment installed in hazardous locations in accordance with SANS 60079-14 and SANS 60079-17.
- Issue and sign off CoC's, for Haz Loc and Non-Haz Loc related plant and equipment as and when required.
- Ensure that the end users are advised of the required Haz Loc signage is to be displayed at all hazardous locations.
- Review Haz Loc zones and reassess classification.
- Conduct required inspections and tests to reconfirm area classification zones as per the SANS. Analyse results by calculating exposure zone in accordance with the relevant SANS standards and applicable procedural requirements. Reassess Haz Loc zones and propose revised classification where appropriate.
- Compile inspection / test reports for proof of compliance, highlighting problem areas, risks involved, and corrective action are taken.
- Implement and coordinate Haz Loc area upgrade projects as and when required by the Transmission Grids.
- Ensure that all relevant documentation, CoC's are handed over to the end users at the end of each project.
- Provide technical advice and guidance end users for the purchasing of SANS approved material / spares applicable to plant and equipment in Haz Loc areas.
- Advise on any Maintenance procedures if so, required by end users.

NB: The MIE must have an accreditation certificate indicating that they have been trained and certified to perform inspections and testing in hazardous locations. They should also have a valid registration with the DOL.

2.7.3 List of Northern Grid Substations to be assessed.

Northern Grid substations consists typically of 220V, 110V and 50V batteries (see Appendix), which are used for DC essential supplies such as breakers, isolators, compressed air system, control and instrumentation including other DC auxiliaries. The schedule, sequence and prioritisation of the execution of the work, including the order in which substations need to be tested and issued with COC, need to be agreed upon prior to the commencement of any work.

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**Hazardous Locations (substation battery rooms)
assessment, inspection and testing.**

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Sub-Station					
No:	Name	Voltage (Vdc)	CLN	No of Battery Rooms	GPS Coordinates
1.	Pluto	110Vdc	Carletonville	12	-26.217500S 27.455556E
2.	Carmel	220Vdc	Carletonville	1	-26.423981S 27.306241E
3.	Midas	220Vdc	Carletonville	1	-26.387500S 27.529167E
4.	Watershed	220Vdc	Carletonville	2	-26.089924S 26.144909E
5.	Hermes	110Vdc	Carletonville	12	-26.901587S 26.784742E
6.	Ararat	220Vdc	Rustenburg	1	-25.562227S 27.187392E
7.	Bighorn	220Vdc	Rustenburg	1	-25.681667S 27.509167E
8.	Dinaledi	110Vdc	Rustenburg	1	-25.576797S 27.853926E
9.	Marang	110Vdc	Rustenburg	1	-25.614797S 27.333392E
10.	Ngwedi	220Vdc	Rustenburg	1	-25.406257S 27.084674E
11.	Trident	220Vdc	Rustenburg	1	-25.634444S 27.182500E
12.	Mookodi	110Vdc	Carletonville	1	-27.009400S 24.741348E
13.	Warmbad	220Vdc	Lephalale	1	-24.890000S 28.326389E
14.	Spitskop	220Vdc	Lephalale	2	-24.965833S 27.228056E
15.	Medupi	220Vdc	Lephalale	1	-23.704910S 27.563224E
16.	Matimba	220Vdc	Lephalale	1	-23.668371S 27.615790E
17.	Borutho	220Vdc	Lephalale	1	-23.901769S 28.97199E
18.	Witkop	220Vdc	Polokwane	1	-24.043333S 29.357222E
19.	Foskor	110Vdc	Phalaborwa	1	-24.027580S 31.127178E
20.	Merensky	110Vdc	Phalaborwa	1	-24.717222S 30.221389E
21.	Senakagwedi	110Vdc	Polokwane	1	-24.813194S 30.116806E
22.	Tabor	220Vdc	Polokwane	1	-23.371389S 29.783333E
23.	Leseding	110Vdc	Polokwane	1	-24.439721S 30.016406E
24.	Acornhoek	110Vdc	Phalaborwa	1	-24.598245S 31.053616E
25.	Spencer	110Vdc	Polokwane	1	-23.487844S 30.380619E
26.	Silimela	220Vdc	Polokwane	1	-25.086325S 29.294789E
27.	Manogeng	220Vdc	Polokwane	1	-25.107983S 29.824916E

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2.8 Feasibility study

This section covers the alternatives considered for improving compliance of Northern Grid battery rooms to Haz Loc requirements. The required project comes at a cost to the organisation and the cost-effective option should be considered to minimise the financial impact that this project will have to the organisation, while making sure the statutory requirements are met.

2.8.1 Status quo (Do nothing)

The only advantage that the do-nothing option has is that it will result in financial savings with regards to any expenditure that might be required.

This option is rejected since it does not support the long-term objective of the organisation improving the reliability of the network and minimising the safety risk that the network pose both to the public and the environment. This option is also not supported because it will result in non-compliant status for the Grid and Unsafe for our employees.

2.8.2 Partial Haz Loc Review

Partial implementation involves using Master Installation Electricians (MIE) that are available within Eskom business to assist in assessing each substation and determine the gaps in compliance that must be addressed. Where possible, the MIE will also assist with alignment to the Haz Loc requirements. The SoW determined by MIE will then be planned for future implementation and phased out in order of priority or included in planned refurbishment projects scopes of each substation. Although this approach will assist in quantifying the noncompliance, it is not recommended as it does not address health and safety concerns with immediate effect. Also, this option is not cost effective.

2.8.3 Full Haz Loc Review (preferred option)

The project will be done at the Grid level and will be considered complete when the scope has been fully executed and the substations are fully compliant. It is highly recommended to implement the complete SoW as identified because of the following advantages over the option of accepting the status quo or partial implementation.

- Increase safety of the plant and personnel.
- Minimal environmental impact.
- Improved technical performance over long term.
- Savings on maintenance cost.

The execution of the full project scope will assist Northern Grid to be compliant by:

- Prioritizing all classified areas to be repaired according to their Risk profile.
- Removing all non-compliant equipment in the plant.
- Upgrading or replacing plant equipment and certifying the equipment with supporting documents.
- Performing final inspection, tests and issuing valid Certificate of Compliance by the registered Master Installation Electrician (MIE).
- Training all staff working in these high-risk areas.

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- Formulating the schedules for future legal inspections.

The drawback of the project is that the business will incur high some cost which could have been reinvested in some other areas of the business. This is weighed against the competing financial requirements within the business.

3. Acceptance

This document has been seen and accepted by:

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4. Revisions

Date	Rev.	Compiler	Remarks
October 2024	1	TE Makhada	New issue

5. Development Team

The following people were involved in the development of this document:

- Emmanuel Makhada
- Sibusiso Mngoma
- Letuma Bosaletsi

6. Acknowledgements

I would like to acknowledge all the Supervisors and EAs of Northern Grid CLNs for the provision of information as requested.

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