LG 1015 A Guide to the Licensing Requirements for the In-service Inspection of Nuclear Installations 0

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1. PURPOSE

The purpose of this document is to give guidance to licensees and prospective licensees in the formulation of an in-service inspection programme. Although not intended as mandatory, close adherence to these guidelines will greatly assist in satisfying the requirements of the relevant nuclear licence issued by the Council for Nuclear Safety.

2. SCOPE

The scope of this licensing guide covers all aspects relating to periodic inspections, tests and examinations of mechanical components whose failure or degradation would adversely affect compliance with the nuclear risk criteria enforced by the Council for Nuclear Safety.

3. INTRODUCTION

In terms of the contents of this document in-service inspection is a programmed system of planned periodic inspections and tests performed at regular intervals on all mechanical plant equipment related to nuclear risk during the service life of the installation. Its purpose is to detect, characterise and monitor defects and anomalies which could become a potential threat to plant integrity. This is achieved by searching for, identifying and evaluating these defects and anomalies by comparing them with any prior in-service examination records, including the base-line pre-service inspection data, and also by assessing their acceptance for future operation.

4. DEFINITIONS

CNS: Council for Nuclear Safety
ISI: In-Service Inspection
PSI: Pre-Service Inspection
SAQCC: South African Qualification and Certification Committee
UT: Ultrasonic Inspection
PT: Dye Penetrant surface inspection
MT: Magnetic Particle surface inspection
RT: Radiographic/Gammagraphic inspection
NDE: Non-Destructive Examination

5. IN-SERVICE INSPECTION PROGRAMME

In order for the CNS to grant a nuclear licence it will be necessary for the specific installation to have in place an administrative system for implementing and controlling in-service inspection activities of that installation. Such a system is known as an In-Service Inspection Programme (ISIP).

The ISIP provides the details necessary for the preparation, scheduling, implementation and resolution required to perform an ISI of the plant.

The ISIP should address the scope, techniques, materials, inspection periodicity, personnel, procedures, reports and evaluations relevant to the implementation of such a programme.

The ISIP provides for the necessary inspections and tests of all relevant components of the plant. A component is here defined as any mechanical part of any system of the nuclear installation which could, due to some form of in-service degradation or failure to function, have a significant impact on the risk of nuclear damage either to the operators or to the public. Such components would typically include: vessels, containments, piping systems, pumps, valves, storage tanks including their respective supports and specialised equipment. The selection of components for the ISIP is the responsibility of the licensee but is subject to scrutiny by the CNS.

Before a nuclear licence can be issued by the CNS it will be necessary for the prospective licensee to submit a report giving a plant description and a risk and hazard analysis. This submission should be the source document for identifying those systems and components that need to be included in the ISIP. All potential hazards will thus be identified, together with the corresponding systems and components where any in-service degradation or failure could have a significant impact on the risk of nuclear damage to the operator and/or the public.

The ISIP will provide for the generation, control, distribution, analysis and storage of all records and reports in connection with PSI/ISI. These are considered as quality assurance records and are maintained as stipulated by the records control procedure in the appropriate nuclear licence which will allow for access by the CNS.

ISI may be performed during planned outages, unplanned outages and also whilst the plant is in operation. The activities are conducted by qualified personnel using written procedures generated in accordance with the quality assurance programme relevant to the plant.

6. RESPONSIBILITIES

The licensee is responsible for complying with the appropriate nuclear licence in establishing an In-Service Inspection Programme prior to executing a mandatory programme of examinations, inspections and tests which will, inter alia:

(i) demonstrate conformance to the requirements of any applicable codes, standards and regulations,

(ii) indicate compliance with any additional requirements of the CNS,

(iii) enable CNS monitoring of ISI activities (as required).

The licensee is also responsible for ensuring that all contractors employed to perform ISI activities do so under the control of the licensee.

The licensee must provide access to any CNS inspector in order for the inspector to carry out his duties. These duties will include the following:

(i) Verification that the required examinations, systems hydro tests, pressure tests, visual examinations etc. have been conducted by the licensee and the results recorded.

(ii) Verification that the in-service tests required on pumps, valves and components supports have been completed by the licensee and the results recorded.

(iii) Verification that the NDE methods used by the licensee follow the techniques specified in the approved procedures and are carried out by appropriately qualified and certificated operators.

(iv) Requirement by the CNS inspector, at any time, for requalification of any procedure or operator if the inspector has a justifiable reason to believe this to be necessary.

(v) Certification of the examination records, by the CNS inspector, only after verifying that the requirements of the ISIP have been met by the licensee and that the records are correct.

(vi) Verification that repairs are performed in accordance with the requirements of the licensee's repair programme.

(vii) Review, by the CNS Inspector, of the relevant parts of the licensee's quality assurance programme to verify its correct implementation.

7. REPORTING REQUIREMENTS

At appropriate times, as agreed with the CNS, the following reports shall be produced by the licensee as a minimum:

(i) Scope Report - To be formally submitted to the CNS prior to the planned inspections with sufficient time for its review prior to implementing the ISI activities. See section 7.1. Such a report could e.g. be submitted on an annual basis as an ISI intent for the subsequent year.

(ii) "Results of Inspections" Report - To be formally submitted to the CNS no later than 90 days following the last planned inspection as defined in the corresponding Scope Report. See section 7.2.

7.1 SCOPE REPORT

The Scope Report is a document listing the ISI examinations, tests and inspections that are planned to be carried out on components that are included in the overall scope of the ISIP.

The Scope Report shall complete its review cycle, as required by the quality assurance system of that installation, prior to being formally submitted to the CNS. This will be done in sufficient time for review by the CNS prior to the first scheduled examination/test.

The Scope Report shall contain at least the following:

(i) INTRODUCTION

a) Objective
b) Schedule

(ii) REFERENCES

a) Technical Procedures to be used
b) Relevant Reports/Documents/Submissions
c) Relevant Correspondence

(iii) INSPECTION/TEST PROPOSALS

a) Non-Destructive Examination
b) Visual Inspection of components and supports
c) Hydro Tests and Leak Tests
d) Functional Tests on Pumps
e) Functional Tests on Valves
f) Functional Tests on other relevant components
g) Other Inspections or Tests.

7.2 "RESULTS OF INSPECTIONS" REPORT

This report is a document listing:-

(a) all reductions and extensions to the original scope as defined in the corresponding Scope Report,

(b) all recordable indications and/or anomalies found and

(c) a brief summary of all the in-service inspections, examinations, tests, repairs and replacements that were carried out since those reported in the previous "Results of Inspections" report relevant to the ISIP.

This report also describes any major issues raised during the implementation of this part of the ISI.

The report shall complete its review cycle, as required by the quality assurance system of that installation, prior to being formally submitted to the CNS. This shall be no later than 90 days following the last scheduled examination/test identified in the correspondence Scope Report.

The report shall contain at least the following:

(i) INDEX - a listing of the contents of the report and the appropriate page numbers.

(ii) SUMMARY - a listing, with supporting statements, of all of the major issues raised or identified since the previous "Results of Inspections" report.

(iii) REFERENCES -

(a) Records, documents and submissions used in the performance of the ISIP.

b) Correspondence, both from the CNS and from the licensee, that is unique to these specific examinations/tests.

(iv) INSPECTIONS UNDERTAKEN

This section contains a brief summary of the inspections completed on the relevant components etc. within the following categories:

a) Non-Destructive Examination (NDE)
b) Visual Inspection of components and supports
c) Hydro Tests and Leak Tests
d) Functional Tests on Pumps
e) Functional Tests on Valves
f) Functional Tests on other relevant components
g) Other Inspections or Tests.

This summary shall be based on the details reported in the appendices to this report.

(v) REPAIRS AND REPLACEMENTS

This section briefly summarises the type of repairs or replacements carried out on components that are included in the ISI scope. It shall be based on the details given in Appendix B of the report.

(vi) NON-CONFORMANCE REPORTS (NCRs)

This section provides a list of all the NCRs, generated in accordance with the relevant non-conformance procedures(s), relating to the inspections and tests on components falling within the boundaries of the ISIP and carried out since the previous "Results of Inspections" report.

(vii) APPENDICES

Appendix A - Summary of changes to the Scope Report

Appendix B - Summary of repairs and replacements

Appendix C - Recordable Indications log for volumetric indications

Appendix D - Recordable Indications log for surface indications

Appendix E - Results of visual inspection (components and supports).

Appendix F - Results of hydro and leak tests.

Appendix G - Status of pump testing

Appendix H - Status of valve testing

Appendix I - Status of other functional tests.

Appendix J - Status of other items relevant to the ISIP.

Appendix K - Issues relevant to future inspections/tests.

8. PROCEDURES

All procedures relating to the ISIP shall be listed and controlled according to the procedure for document control described in the quality assurance programme relevant to the nuclear installation.

Aspects of the ISIP that shall be covered by these procedures will include the following:

Technical documentation and records management.
Modifications.
Training and certification.
Functional testing including pumps and valves.
Repair/Replacement including defect removal.
Pressure and leak testing.
Review and evaluation of inspection/test results.
Calibration and maintenance of inspection/test equipment.
NDE procedures, including UT, PT, MT, RT and visual inspection of all relevant component configurations.
Non-Conformance reporting and evaluation.

The CNS shall, at the earliest opportunity, be made aware by the licensee of any additions, changes or revisions to any of the procedures relevant to the implementation of the ISIP.

9. QUALIFICATION OF EXAMINATION PERSONNEL

All personnel performing inspection and testing within the ISIP shall be trained (where necessary), qualified and certificated to perform the appropriate non-destructive inspection, visual examination or testing of components and systems in accordance with procedures approved by the quality assurance programme in place at the installation.

It is recommended by the CNS that personnel performing NDE under the ISIP be qualified and certified according to the national SAQCC scheme. However, other schemes will be considered for acceptability by the CNS on a case-by-case basis.

Further details of the requirements for qualifications, training and certification of personnel employed to perform work required of the ISIP will be provided by the CNS on request.

10. ISIP DATABASE

It is recommended that, in order to ensure adequate control over the implementation and status of the ISI, a database of all inspections and tests scheduled and performed under the overall scope of the ISIP shall be kept.

It is expected that this database will form part of the total maintenance database of the plant.

The ISIP database will contain, as a minimum, a listing of all ISI requirements for nuclear risk-related welds, vessels, components, supports, valves, pumps etc.. The database will also be a record of inspections and tests performed during the course of the life of the plant commencing with the Pre-Service Inspection and will include a record of intentions and commitments for future inspections.

The database will include drawings pertaining to the implementation of the ISIP (including isometrics, support drawings, flow diagrams and vessel drawings). All of these drawings will be controlled according to the quality assurance programme in place at the installation.

The person responsible for managing the ISIP shall ensure that provision is made for the recovery of the ISIP database in case of loss e.g. by computer system failure or corruption.

A description of the structure of the database will be given to the CNS by the licensee prior to implementation of the ISIP. It will contain details of the following:

(i) All NDE activities.
(ii) All visual inspections including flanges, supports.
(iii) Hydro and leak tests, including wall thickness and internal/external visual inspection of tanks, vessels and pipework.
(iv) Pump tests.
(v) Valve tests.
(vi) Other functional tests.
(vii) Other inspections /tests.

During implementation of the ISIP it will be necessary to update and amend the database. When amendments are made, backups should be made at the end of that working day. On acceptance of the "Results of Inspections" report by the CNS an updated version of the ISIP data base will be distributed to all controlled-copy holders.

Amendments to the database will occur from time to time, probably for one of the following reasons:

(i) A change of a test/inspection planned date.
(ii) The completion of a test/inspection.
(iii) Waivers or exemptions. (see section 11)
(iv) Database error.
(v) Plant modification.
(vi) Repair or replacement.
(vii) Drawing revision.

The ISIP shall have in place adequate procedural control for such amendments according to the Quality Assurance requirements. This will also ensure that all controlled-copy holders are kept up-to-date with the amendments.

11. WAIVERS, EXEMPTIONS AND CHANGES TO THE ISIP

Any changes to the ISIP are to be made in accordance with established procedures approved by the quality assurance programme in place at the installation. The CNS shall be kept informed of all such changes in sufficient time to enable it to review and determine the acceptability or otherwise of the proposed changes. It is envisaged that most changes to the ISIP will arise due to the revision of procedures.

However, changes to the database other than amendments will need to be effected by a different technique. One such way is by use of the waiver and exemption request.

A waiver is a request to the CNS to defer inspections/tests required by the ISIP to some other date, or to accept revised acceptance criteria or methods for a limited time period.

An exemption is a request to the CNS to delete an inspection/test from the ISIP.

For various reasons, from time to time, the licensee will find the need to make these requests and in so doing shall explain to the CNS the reason for the request and justify the change to the ISIP from a nuclear risk point of view.

It is required that a formalised system of control for such requests, including a waiver/exemption log and control procedure, be included in the administrative management system of the ISIP. It will be necessary to incorporate these waivers and exemptions into the database amendment system previously referred to in section 10.

12. ACCEPTANCE CRITERIA

All anomalies found during inspection and testing that need to be evaluated are assessed in accordance with relevant acceptance standards for their significance

and acceptability for continued operation or repair/replacement. Any condition which could compromise the structural integrity or impair the ability of a component to perform its function, such that the risk of nuclear damage is considered significant, will require processing under the corrective action reporting system and shall be identified to the CNS.

One fundamental part of inspection and testing is the method of assessing the results of the examinations such that a judgement can be made as to one or more of several options regarding future actions.

As examples of these options the following are to be considered:

(i) A defect found by NDE is regarded as unacceptable in that it cannot be tolerated for further operation of that component. Assuming that there is no recourse to a second opinion as, for example, by the use of a more sophisticated level of fracture mechanics, this defect must then be removed (by repair or replacement).

(ii) An indication from NDE is evaluated as being acceptable for a limited period of operation and a commitment is made by the licensee to make a further inspection at a predetermined time and to re-evaluate the acceptability of that flaw at that time.

(iii) As a result of finding an unacceptable condition the original inspection scope needs to be temporarily increased in order to gain confidence that such an unacceptable condition is not generically present on similar items.

(iv) Pump parameters viz. speed, flow rate, vibration amplitude, inlet/outlet pressure and bearing temperature are acceptable or otherwise.

(v) Valve parameters viz. operational leak rate, stroke times, fail safe position, check valve opening force etc. are acceptable or otherwise.

(vi) Leak rates from flanges, manholes, valve bonnets etc. are acceptable or otherwise.

In each case it would be necessary to have in place defined acceptance criteria which would be justified in terms of the acceptable risk of nuclear damage due to degradation causing loss of function or integrity of that particular component.

Evaluation techniques based on fracture mechanics, fatigue laws, erosion/corrosion rates etc. will be necessary for the metallurgical type of concern.

Other techniques, based on fluid dynamics, structural and mechanical engineering together with plant design parameters, will be needed for evaluating the results of functional testing etc.

Some recourse to the use of provisions contained in national or international codes may be used on condition that the CNS has accepted their accuracy and reliability.

For example, the standards for examination evaluations and acceptance for flaw indications, as laid down in the ASME Section XI sub-sections IWA-3000, IWB-3000 and IWC-3000 (or later versions thereof), would be considered as acceptable to the CNS if used in conjunction with the risk-based criteria as propounded by the CNS from time-to-time.

Similar comments apply to the standards for examination evaluations and acceptance for supports, pumps and valves, as laid down in ASME XI sub-sections IWF-3000, IWP-3000 and IWV-3000 (or later versions thereof).

13. REPAIRS

Although repairs are not directly controlled under the ISIP the following requirements are included here as a guide to the licensee in this ISI related activity.

Repairs to components that fall under the scope of the ISIP shall be performed taking into account the following requirements:

(i) The NDE procedure(s) used to detect and identify the necessity for the repair and also to confirm acceptability of the finished repair shall be controlled and implemented according to the administrative requirements of the ISIP.

(ii) The flaw removal, dimensional checking and surface preparation methods shall be controlled and implemented according to the requirements of the quality assurance programme in place at the installation.

(iii) The weld procedures, applicable heat treatments and welder qualifications shall be controlled and implemented according to the requirements of the quality assurance programme in place at the installation,

(iv) Prior to authorising repairs by welding the licensee shall conduct an evaluation of the suitability of the welding procedure(s) to be used to make the repair. This evaluation should consider the cause(s) of failure to ensure that the selected repair procedure is suitable.

(v) Repair programmes on components that fall under the scope of the ISIP shall be subject to review by the CNS.

(vi) After repairs by welding on pressure retaining boundaries and components a system hydrostatic test shall be performed unless an exemption request is accepted in writing by the CNS. This test shall be implemented according to procedures controlled by the quality assurance programme in place at the installation.

14. REPLACEMENTS

Although replacements are not directly controlled under the ISIP the following section is included as a guide to the licensee in this ISI related activity.

If, as a result of inspections and tests carried out under the ISI Programme, it is found necessary to replace a component, then the following applies. Replacements are here defined as spare and renewal components, attachments, subassemblies or parts of a component, such as valves, and system changes, such as rerouting of piping, up to but not including the installation of complete systems.

The licensee shall be responsible for making available to the CNS the specification requirements for design, fabrication, examination, installation, inspection and testing of the replacement as applicable.

Replacements shall meet the requirements (including mechanical interfaces, fits, tolerances and material suitability) of the construction code and of the quality assurance requirements in place at the installation unless justified by the licensee and exempted in writing by the CNS.

Prior to authorising the installation of a replacement component the licensee shall assess the suitability of the replacement in terms of nuclear risk.

If the replacement is required because of a failure of a part or component the evaluation shall consider the cause(s) of failure of the existing part or component to ensure that the selected replacement is suitable. If cause of failure appears to be a deficiency in the specification for the existing part or component the specification for the replacement shall reflect appropriate corrective provisions and this shall be reflected in and controlled by the modification programme in place at the plant. Any such corrective provisions shall be consistent, wherever possible, with relevant requirements of the current construction code. The report of the evaluation shall be made a part of the component record file.

Items normally exempt from these requirements, where a deficiency has been found through ISI, include the following:

(i) gaskets,
(ii) instruments,
(iii) electrical conducting and insulating material,
(iv) piping, valves and fittings of one inch nominal pipe size and less,
(v) non-structural pump and valve internals,
(vi) pump seal package and valve packing.

Welding required for the installation of a replacement shall be performed by welders qualified and working according to procedures which shall conform to the quality assurance programme in place at the installation.

All such welds shall be examined by NDE acording to the requirements of the ISIP such that an acceptable pre-service inspection of the replacement part or component has been conducted prior to that part of the plant or system being returned to service.

15. SUPPORTS

Component supports are those mechanical supports that are designed to transmit loads from the component and piping to the load-carrying building or foundation structures.

Component supports encompass those structural elements relied upon to either support the weight or provide structural stability to components and piping.

The ISIP shall make provision for the visual inspection of these component supports according to controlled and approved ISI procedures and performed by suitably qualified personnel.

The licensee is responsible for identifying the scope and periodicity of inspections subject to the approval of the CNS. However, the following guidelines are offered.

Component supports selected for examination should be the supports of those components that are required to be examined under the scope of the ISIP. For pre-service, all supports need to be examined once and this examination should be performed following the initiation of any hot functional tests as applicable.

During ISI the required examinations should be completed in accordance with the inspection schedule of the respective components.

When the results of examinations require corrective measures the component supports immediately adjacent shall be examined. Also, the examinations shall be extended to include additional supports equal in number and similar in type, design and function to those initially examined during the inspection.

When these additional examinations require corrective measures the remaining component supports within the system of the same type, design and function as above shall all be examined.

Records of all support examinations including results, evaluations, dispositioning and corrective actions shall be retained for the life of the system, plant or installation as applicable.

16. IN-SERVICE TESTING OF PUMPS

It is the licensee's responsibility to define the scope for pump testing based on the risk of nuclear damage if the function of the pump were to be impaired due to degradation. The scope of testing is subject to the approval of the CNS.

This guide recognises that many types of pump are in use in different nuclear installations performing various functions. The present discussion is directly related to centrifugal and displacement type pumps as used in light-water-cooled nuclear reactors. A similar approach should be adopted when other types are identified.

The pump characteristics to be tested should include the following where applicable:

(i) Pump speed

(ii) Inlet pressure

(iii) Outlet pressure

(iv) Flow Rate

(v) Vibration amplitude

(vi) Proper lubricant level or pressure

(vii) Bearing Temperature

In general the pump test should verify that each pump develops a differential pressure applicable to the flow rate as determined from the manufacturer's pump performance curve within specified margins.

All pump in-service tests shall be conducted in accordance with authorised and controlled ISIP procedures. The frequency of such tests shall be subject to approval by the CNS.

After a pump has been replaced, a new set of reference values shall be determined from the results of the first in-service test run after the pump is put into service. When a reference value may have been affected by repair or routine servicing of the pump, a new reference value shall be determined or the previous value reconfirmed by an inservice test run prior to, or within, 96 hours after return of the pump to normal service. Deviations between the previous and new set of reference values shall be identified and verification that the new values represent acceptable pump operation shall be placed in the record of tests.

Records of all pump in-service testing performed under the ISIP, including results, evaluations, dispositioning and corrective actions, shall be retained for the life of the installation.

17. IN-SERVICE TESTING OF VALVES

The intention for the in-service testing of valves is to assess operational readiness and their actuating and position indicating systems.

The following guide is based on the requirements of a light- water-cooled nuclear reactor. A similar approach should be adopted when other types of nuclear installation are considered.

It is the licensee's responsibility to define the scope for valve testing based on the risk of nuclear damage if the function of the valve were to be impaired due to degradation. The scope of testing is subject to the approval of the CNS.

Depending on the type of valve that is to be tested the characteristics to be examined should include the following where applicable:

(i) Test for valve position indicator,
(ii) Valve exercise test,

(iii) Valve stroke time test (note should made of those valves with limiting stroke times),

(iv) Valve fail-safe actuator test,

(v) Valve leak rate test.

All valve in-service tests shall be conducted in accordance with authorised and controlled ISIP procedures. The frequency of such tests shall be subject to approval by the CNS.

Corrective action should be initiated immediately a test or examination reveals an unacceptable condition. If this condition cannot be corrected within 24 hours the valve should be declared inoperable and appropriate action taken accordingly.

When a valve or its control system has been replaced or repaired or has undergone maintenance that could affect its performance, and prior to the time it is returned to service, it shall be tested to demonstrate that the performance parameters which could be affected by the replacement, repair or maintenance are within acceptable limits.

Records of all valve in-service testing performed under the ISIP, including results, evaluations, dispositioning and corrective actions, shall be retained for the life of the installation.

N.B. The contents of this document will be revised from time to time by the CNS; therefore the user is advised that it is his/her responsibility to ensure that he/she has the latest revision of this document.