Eskom	USER REQUIREMENT SPECIFICATION	NUCLEAR PROJECT MANAGEMENT

Title: **URS for Control Room Envelope (CRE) Unfiltered Inleakage Measurement for Eskom Koeberg Nuclear Power Station**

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CONTENTS

1. INTRODUCTION

Control Room Habitability (CRH) refers to the ability of the Control Room Ventilation System (DVC) to provide a safe and comfortable working environment for plant operators during normal and emergency conditions. In 1971 the United States Nuclear Regulatory Commission (U.S. NRC) addressed CRH by adding General Design Criterion (GDC) 19 to Appendix A of 10 CFR Part 50 (General Design Criteria for Nuclear Power Plants). GDC 19 states:

> *"A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident."*

The demonstration that a facility's Control Room (CR) conforms to GDC 19 typically requires:

- An assessment of the radiological doses to CR operators in the Control Room Envelope (CRE) in accordance with U.S. NRC Regulatory Guide (RG) 1.196 [6] for the Design Basis Accidents (DBAs) identified in U.S. NRC RG 1.183 [9]; and
- A discussion of the basis for and validation of the assumed unfiltered inleakage used in CR operator dose calculations in accordance with the guidance on acceptable test methods provided in U.S. NRC RG 1.197 [8].

The unfiltered inleakage at Koeberg Nuclear Power Station (KNPS) should be determined to demonstrate that the CRE's inleakage characteristics is consistent with the licensing basis and design basis for KNPS as reflected in CRH evaluation and to confirm that the CRH requirement stated in GDC 19 is met.

1.1 PURPOSE

The purpose of this User Requirement Specification (URS) is to specify the user requirements to the appointed supplier that would conduct Control Room (CR) unfiltered inleakage measurements of the Control Room Ventilation Systems (Unit 1 and 2) at the Eskom KNPS.

1.2 APPLICABILITY

This document has been prepared as part of the Control Room Habitability (CRH) analysis undertaken as part of the Koeberg Steam Generator Replacement (SGR) project. This document will thus be applied within this context.

2. REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs at the time of contract signature.

2.1 NORMATIVE

[1] Koeberg Safety Analysis Report, Part II, Chapter 4, Section II-4.5, Revision 5.

[2] KBA1217DVC001-014: Koeberg Nuclear Power Station Control Room Air Conditioning System Design Basis Information (Dossier de Système Élémentaire).

[3] U.S. Nuclear Regulatory Commission, “General Design Criteria”, Title 10 of the Code of Federal Regulations, Part 50, Appendix A, Washington D.C.

[4] Nuclear Energy Institute, “Control Room Habitability Guidance”, NEI 99-03, Revision 0, June 2001.

[5] ASTM International, “Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution”, ASTM E741 – 00.

[6] U.S. Nuclear Regulatory Commission, “Control Room Habitability at Light-Water Nuclear Power Reactors”, Regulatory Guide 1.196, Revision 1, Washington D.C., January 2007.

[7] U.S. Nuclear Regulatory Commission, Generic Letter 2003-01, “Control Room Habitability”, Washington D.C., June 2003.

[8] U.S. Nuclear Regulatory Commission, “Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors”, Regulatory Guide 1.197, Washington D.C., May 2003.

[9] U.S. Nuclear Regulatory Commission, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors”, Regulatory Guide 1.183, Washington D.C., July 2000.

[10] Eskom, “Nuclear Safety Level 2 Supplier Quality Management Requirements”, 238-102.

[11] Eskom, “Process for Performing Safety Screenings, Safety Evaluations, Safety Justifications and Safety Cases”, KAA-709, Revision 6.

2.2 INFORMATIVE

[12] “Nuclear Power Plant Control Room Ventilation System Design for Meeting General Design Criterion 19”, Murphy, K.G. and Campe, K.M., 13th AEC Air Cleaning Conference, 1974.

[13] “Control Room Envelope Unfiltered Air Inleakage Test Protocols”, Lagus, P.L. and Grot, R., 24th DOE/NRC Nuclear Air Cleaning Conference, 1996.

[14] “Ventilation Systems and Interactions with Control Room Habitability”, Campbell, R.R., 26th DOE/NRC Nuclear Air Cleaning Conference, 2000.

[15] Eskom, “Fitness for Duty Process for Contractors who are required to Perform Work Inside the Owner Controlled Area of Koeberg Nuclear Power Station”, 335-68, Revision 2.

[16] KBA0117DVC500: 01 DVC System Control Room and Computer Room Air Conditioning Main Electrical Building Levels +11.50 and +15.50.

[17] KBA0117DVC501: 01 DVC System Control Room and Computer Room Air Conditioning Main Electrical Building Levels +19.00 and +24.10.

[18] KBA0217DVC500: 02 DVC System Control Room and Computer Room Air Conditioning Main Electrical Building Levels +11.50 and +15.50.

[19] KBA0217DVC501: 02 DVC System Control Room and Computer Room Air Conditioning Main Electrical Building Levels +19.00 and +24.10.

[20] National Nuclear Regulator, “Quality and Safety Management Requirements for Nuclear Installations”, RD-0034, Revision 0, August 2008.

[21] ASTM International, “Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems”, ASTM E 1186 – 17.

3. DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

3.1.1 Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

3.1.2 Unfiltered inleakage: leakage of unfiltered air into the DVC Control Room Ventilation System, i.e. all air that enters the control room envelope without passing through the external air intake filters.

3.1.3 Emergency conditions: out of normal and unplanned plant conditions that threaten plant and personnel health and could result in plant damage, plant shut down, injury, health impacts and/or loss of life.

3.2 ABBREVIATIONS

Abbreviation	Description
ASTM	American Society for Testing and Materials
DBA	Design Basis Accident
CR	Control Room
CRE	Control Room Envelope
CRH	Control Room Habitability
DVC	Control Room Ventilation System
FFD	Fit for Duty
GDC	General Design Criteria
KNPS	Koeberg Nuclear Power Station
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
RG	Regulatory Guide
SGR	Steam Generator Replacement
URS	User Requirement Specification
U.S. NRC RG	United States Nuclear Regulatory Commission Regulatory Guide

4. SERVICE REQUIREMENTS

4.1 THE *EMPLOYER'S* OBJECTIVE AND PURPOSE OF THE *SERVICE*

The Employer's objectives and purpose of the service are to:

- Determine the unfiltered inleakage into the Koeberg Nuclear Power Station (KNPS) CREs;
- Demonstrate that the CRE's inleakage characteristics is consistent with the licensing basis and design basis for KNPS as reflected in CRH evaluation; and
- Confirm that the CRH requirement stated in GDC 19 is met.

4.2 THE *EMPLOYER'S* SERVICE REQUIREMENTS

The supplier conducts tests to establish the amount of unfiltered inleakage into the KNPS Unit 1 and 2 CREs. A phased approach must be implemented, by the supplier, including the following categories:

Phase A Optional pre-test site walkdown.

Phase B Pre-test walkdown report compilation, site preparations and test planning.

Phase C Test execution.

Phase D Final report compilation.

The requirements, from the supplier, include the following:

4.2.1 General requirements

4.2.1.1 The supplier is required to sign the confidentiality / non-disclosure agreement before accessing Employer documentation.

4.2.1.2 The supplier shall have experience in performing the unfiltered inleakage test for nuclear power plant control rooms. Due to the complex nature of the KNPS control room envelope and site processes, only suppliers with experience with performing unfiltered inleakage tests at KNPS will be considered for the service.

4.2.1.3 The supplier must have experience in applying the ASTM E741 – 00 Standard [5] test method to measure unfiltered inleakage.

4.2.1.4 Due to the large volume served by the KNPS DVC system (9873 m^3 combined), experience in measuring unfiltered inleakage in large ventilation systems is required.

4.2.2 Phase A: Optional Pre-test Site Visit

Apart from the main compliant tender, the following option should be provided if the supplier is unfamiliar with the KNPS DVC system and CRE: a plant walkdown will be performed with the following supplier requirements:

4.2.2.1 Identify potential improvements to the CRE to be done prior to performing the test. Supplier may, in addition, propose solutions to the Employer (This is to be proposed as an option by the supplier and not part of the main offer).

4.2.2.2 Identify an unfiltered inleakage test method that would be most applicable to the KNPS control room ventilation systems design and layout. The method must comply with the ASTM E741 – 00 Standard [5] and satisfy the requirements of U.S. NRC Generic Letter 2003-01 [7], and U.S. NRC RGs 1.196 [6] and 1.197 [8] with regards to the endorsement of NEI 99-03 [4].

4.2.2.3 Submission of a pre-test walkdown report for Employer acceptance (refer to deliverable described in Section 6.1).

4.2.3 Phase B: Test planning

4.2.3.1 The supplier must provide a work plan (as described in section 6.2) which includes a test procedure that details the measurement of unfiltered inleakage with the plant in the following configurations:

a. All electrical building ventilation systems (1DVC, 1DVL-1,1 DVL-2, 1DVL-3 and 1DVW) in emergency mode operation with single failure of the highest flow DVC iodine train supply fan on Unit 1.

b. All electrical building ventilation systems (2DVC, 2DVL-1, 2DVL-2, 2DVL-3 and 2DVW) in emergency mode operation with single failure of the highest flow DVC iodine train supply fan on Unit 2.

c. Elective scope: allowance should be made for two additional tests. Configuration will be finalised between the supplier and the Employer during finalisation of the work plan. This must be priced separately as part of the main offer.

4.2.3.2 The work plan must identify all nuclear and conventional safety risks.

4.2.3.3 The supplier's approved unfiltered inleakage test procedure, which complies with requirement in section 4.2.2.2, shall be submitted to the Employer for acceptance before being applied by the supplier.

4.2.4 Phase C: Test Execution

4.2.4.1 The supplier performs a final inspection walkdown of DVC and the CRE boundaries to confirm leak tightness and identify any improvements that could be made prior to test execution.

4.2.4.2 The supplier must measure unfiltered inleakage with the plant in the configurations detailed in the work plan.

4.2.4.3 The unfiltered inleakage test, performed by the supplier, is performed in accordance with the test procedure that has been accepted by the Employer.

4.2.4.4 In addition to unfiltered inleakage measurements, the following DVC system design parameters must also be measured, by the supplier, for both units in each plant configuration, refer to the DVC system design documents ([2], [16], [17], [18] and [19]):

a. External make-up air filtered flow rate.
b. Total recirculation flow rate as provided by main recirculation fans.
c. Differential pressure across all CRE boundaries.

4.2.4.5 Supplier tests must not in any way negatively affect or interrupt plant operation or the ability of personnel to effectively operate the plant.

4.2.4.6 Supplier must confirm that the plant configuration is as required by the work plan before executing test activities.

4.2.4.7 The supplier provides unfiltered inleakage results within an uncertainty margin per reference 5 and as agreed with the Employer.

4.2.4.8 Optional scope: The supplier shall identify sources / areas of infiltration (in accordance with ASTM E1186 [21]).

4.2.5 Phase D: Final Reporting

Phase D requires submission of a final report, by the supplier, documenting the entire testing process and providing results and recommendations (if required). The requirements include:

4.2.5.1 The supplier submits a final report to the Employer which must include all of the deliverables listed in Section 6.3 and 6.4.

4.2.5.2 The Employer reviews, comments and may add recommendations where applicable before accepting the final report, compiled by the supplier.

4.3 EQUIPMENT REQUIREMENTS

4.6.1. The supplier provides / supplies all the Equipment and Consumables required to perform the unfiltered inleakage test.

4.6.2. All Equipment used should have valid calibration certificates.

4.4 QUALITY REQUIREMENTS

4.7.1. The supplier shall comply with the quality requirements as specified in the Employer's 238-102: Nuclear Safety Level 2 Supplier Quality Management Requirements [10].

4.7.2. All personnel performing and supervising the works shall be suitably qualified. Their qualification shall be presented to the Employer for acceptance prior to work being performed.

5. TRAINING AND ACCESS REQUIREMENTS

Access to KNPS is subject to the applicant complying with the Koeberg Fit for Duty (FFD) requirements. These requirements are listed in procedure 335-68 [15] and includes several activities to be completed on site before access is granted. The activities are estimated to take one week and should be taken into account when the supplier plans work and site visits.

6. DELIVERABLES

As outlined in Section 4, for each phase to be considered complete, the supplier must submit the following reports to the Employer, for its acceptance:

6.1. Comprehensive initial walk down report prior to Employer acceptance of the method, including:

a) Description of a proposed unfiltered inleakage measurement method.

b) Potential improvements to be taken into account prior to the site testing.

6.2. Detailed work plan including:

a) System configuration requirements for DVC and other applicable systems.

b) List and full description of activities. Descriptions should be detailed step-by-step actions and include the following:

i. Action number.

ii. Detailed description of action. Include full system component identification where necessary.

iii. Person(s) responsible for action.

c) Duration and preferred schedule of activities.

d) Visual representation of test setup.

e) Roles and responsibilities of personnel performing tests.

f) Comprehensive nuclear and conventional risk assessment of all activities and system configurations.

6.3. Comprehensive post testing report including:

a) Definition of CRE boundaries.

b) Confirmation of the following DVC system design parameters, as specified in the DVC system design documents ([2], [16], [17], [18] and [19]):

i. External make-up air filtered flow rate.

ii. Total recirculation flow rate as provided by main recirculation fans.

iii. Differential pressure across all CRE boundaries.

c) Discussion of the measurement method applied, with added emphasis on activities relating specifically to the Koeberg DVC system.

d) Visual representation of test setup.

e) Equipment calibration results and certificates.

f) Unfiltered inleakage results for both KNPS units in metric flow rate values.

g) Comparison of measurement results / samples.

h) Uncertainty analysis of results.

i) Discussion of test results including identification of areas of concern and recommendations in reducing the amount of unfiltered inleakage, should it be required.

j) Optional scope: results from inleakage source identification, as described in paragraph 4.2.2.

6.4. All test data as used in the post testing report to be electronically provided in MICROSOFT EXCEL format (“.xls”, “.xlsx” or “.csv”).

The supplier must submit the reports to the Employer for review and acceptance. During the review process the Employer will be allowed to comment and, where applicable, request changes / corrections as required before being accepted.

7. EMPLOYER SCOPE OF SUPPLY

The Employer supplies the following in support of the service:

- Access to training facilities for the Employer generic training.
- Security access permits as required for site access.
- Permit to Work.
- Any required safety evaluations per Koeberg process KAA-709 [11].
- Presentation of the work plan / safety case to any Koeberg management committees.
- Appropriate facilities for the supplier's staff.

On request from the supplier, copies of applicable Employer standards, procedures, guides, work instructions and plant drawings will be provided.

8. DEVELOPMENT TEAM

Name	Designation or Business area
A.Davies	Project Engineer

9. ACCEPTANCE

This document has been seen and accepted by

Name	Designation or Business area
M Matjee	Nuclear Systems Engineering
N.M. Breedt	Senior Consultant, Contract Management

APPENDIX A: REVISION INFORMATION

Date	Rev.	Compiler	Remarks
June 2016	0	N. Fourie	New document to specify the requirements of unfiltered inleakage measurements to be conducted in the DVC system at KNPS.
Sep 2019	1	N. Fourie	Document revised based on operating experience gained from initial tests. Requirements updated for future repeat tests.
Nov 2023	2	A Davies	Document revised based on operating experience gained from initial tests and testing of control rooms separately.