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1 PURPOSE

The purpose of this document is to define the high-level scope of work to be performed for the P1701 HVAC Project.

It provides a consolidation of the outputs from a series of project scoping meetings held to date and is included as:

- A single, documented, point of reference summarising the project definition at project inception, and as appropriate, on-going during the life cycle of the project.

It is used:

- As an aid to communicate both within and outside the project.
- As a definite statement of the project scope.
- As a basis for detail planning and on-going project management.

The expected outcome of this project is improved control and a reduction in the frequency of OTS transgressions due to the upgrade of the P1701 HVAC systems, thereby improving the commercial availability of the plant.

2 SCOPE

The objective of this project is to:

- Improve the HVAC system's maintenance relating to HVAC equipment obsolescence;
- Improve the HVAC systems' control and instrumentation;
- Improve the HVAC systems energy efficiency;
- Align to the ISO Standard 17873 (Nuclear Facilities – Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors);
- Improving the reliability of the current HVAC system.
- Modernising control systems to improve safety, system response and condition monitoring.
- Reinstate automated control of the HVAC system.
- Address the business need to have a stable, auto controlled and reliable ventilation systems to reduce the possibility of OTS violations and to bring the ventilation systems control aligned with the SAR.

The project shall apply to the P1701 HVAC System, in particular the components of the following systems:

- White;
- Blue;
- Red;
- Purple;
- Off-gas; and
- Openings within the radiologically classified areas that these HVAC systems serve.

3 REFERENCES

This document complies with the requirements of:

ISO 9001:2015	:	Quality Management Systems – Requirements, Fifth edition 2015

The following documents are referenced in this document:

ISO 17873:2004	:	Nuclear facilities — Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors
LD-NTPSAR2012-SAR-0006	:	NTP Radiochemicals Complex Safety Assessment Report Chapter 6 Safety Structures, Systems and Components
Lesedi Design Report L1047	:	Building P1701: Radiochemical HVAC System Upgrade
RAD-SOP-5006	:	P1701 Ventilation Systems Description

4 ABBREVIATIONS AND DEFINITIONS

4.1 The following abbreviations are used in this document:

AC	:	Alternating Current
AHU	:	Air Handling Unit
BF	:	Booster Fan
CCMS		Centralised Control Monitoring System
CCR		Central Control Room
D	:	Door
DP		Differential Pressure
ECC	:	NECSA Emergency Control Centre
EC&I	:	Electrical, Control and Instrumentation
EF	:	Exhaust Fan
ESD	:	Emergency Shut-Down
HVAC	:	Heating, Ventilation, and Air Conditioning
I/O	:	Input and Output
MCC	:	Motor Control Centre
OBD	:	Opposed Blade Damper
PC&I	:	Process Control and Instrumentation
PID	:	Proportional Integral Derivative
RPO	:	Radiation Protection Officer
SC	:	Safety Classification
SF	:	Supply Fan
RF	:	Return Fan
UPS	:	Uninterruptable Power Supply
VFD	:	Variable Frequency Drive
VRF	:	Variable Refrigerant Flow

4.2 The following definitions are provided to ensure a uniform understanding of this document:

None	:	None

5 GENERAL

Safety classifications are listed by referencing the 2012 Radiochemicals Facility SAR.

The design standard referenced in this project shall be ISO 17873:2004*: Nuclear facilities—Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors*. Although the P1701 facility design pre-dates ISO 17873:2004, enough similarities between the facility and the standard exist to allow for the possibility

of a high degree of compliance to the standard without major infrastructure changes to the facility.

5.1 Background to the Building P1701: HVAC Upgrade (Project NTP-PRO-11/016)

Building P1701 houses NTP's Radiochemical Production Facility. During 2008, NTP embarked on a programme for continual improvement of its production plants. The ageing Heating, Ventilation and Air-conditioning (HVAC) system, serving NTP's Radiochemical Facility (P1701), was identified to be a priority for upgrading as it forms an integral part of the dynamic confinement during operation and thereafter.

The purpose for the project is to address the HVAC deficiencies currently experienced in P1701. This will also result in an improvement in the overall productivity of the Radiochemical Facility with a significant improvement in Nuclear Safety.

A project was established within the Engineering and Projects department to transform this 20+ year old HVAC system to a more up-to-date system. The latest technologies and standards (ISO 17873: Nuclear facilities – Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors) applicable to nuclear facilities will be utilized through which the life span will be extended with another 20 years.

The following Ventilation Systems of Building P1701 identified for upgrades are White, Blue, Red, Purple and Off-gas Systems. It is important to note that some of these systems (e.g. Purple) are critical for plant safety and integrity and cannot simply be switched off for upgrades. This will necessitate that the upgrades are performed on-line. Upgrading of P1701's Ventilation Systems will be prioritised taking into account risk factors and production operations in the Radiochemical Facility.

Lesedi Nuclear Services was approached for assistance and the following phased approach was proposed:

Phases	Description	Status
1	Initial Assessment	Completed during 2008 - Initial Assessment Report
2	Feasibility Study	Completed during 2010 - Feasibility study report
3	Detail Design	Completed during 2014 - Detailed design package
4	Procurement & Installation	This phase will encompass a licensing strategy to be communicated with the NNR, GAP analysis on the design and the plant status to ensure alignment due to considerable time lapse since project initiation. This phase of the project has not been completed.

6 RESPONSIBILITIES

No responsibilities are associated with this document.

7 PROCESS

A high-level breakdown of the work to be carried out is provided, grouped per the radiological or functional classification of the areas served by these HVAC systems:

7.1 Chilled Water Plant (No Safety Classification):

Air-conditioned air is supplied to the White and Blue Operational Areas via a chilled water system. The chiller is obsolete and needs to be replaced. The chilled water reticulation is also in poor condition. The cooling function of the chiller and the heating function of the electrical heating elements within P1701 must be replaced with either a single reverse-cycle chilled water plant and reticulation or several discrete direct expansion systems.

7.2 White Operational Area (No Safety Classification):

7.2.1 Air Handling Unit (AHU-1)

AHU-1 serves to supply conditioned air to the White Operational Area. Several of the components of AHU-1 are in poor condition, requiring that AHU-1 be replaced.

The following parameters of AHU-1 will be monitored:

- Fan run status;
- AHU-1 damper status;
- Volume of air delivered by AHU-1.

The process control of this system will be as per section 7.12.

7.2.2 Control Room Fire Damper

The wall penetration size of the inlet air ducting to the control room necessitates the fitment of a fire damper at the wall penetration to isolate the Control Room in case of a fire.

7.2.3 Control Room, Foyer Air Terminals

The fitment of security doors to the Control Room, the RPO's Offices and the P1701 Foyer has disrupted the intended airflow patterns within these areas and the adjacent passage. The air terminals and ducting in this area must be adapted to suit the current layout.

7.2.4 New White Area Exhaust Fan/Filter Bank

The fitment of security doors to the Control Room, the RPO's Offices and the P1701 Foyer has disrupted the intended airflow patterns within these areas and the adjacent passage. A new fan must be installed to extract air from these areas. The fan must:

- Be fitted with a VFD to facilitate the required pressure depression of the White Operational Area by varying the rotational speed of the new fan;
- Be fitted with dampers to automatically isolate the fan if it is stopped;
- Be monitored to determine the new fan run status;
- Be monitored to determine the new fan damper status;
- Be monitored to determine the air volume delivered by the new fan.

The air extracted by the new fan must be discharged from the P1701 facility through a filter bank, the design of which must comply to the parameters set forth within ISO 17873:2004.

The process control of this system will be as per section 7.12.

7.3 Blue Operational Area (Safety Class 3):

7.3.1 Supply Fan 3 (SF-3):

Conditioned air is delivered to the Blue Operational Area by SF-3. The following upgrades to SF-3 must be performed:

- Fit a VFD with pressure feedback control to SF-3 to facilitate the required pressure depression of the Blue Operational Area by varying the rotational speed of SF-3;
- Repair/replace the vortex damper fitted to SF-3;
- Fit an actuator to the SF-3 vortex damper to close automatically when SF-3 is stopped;
- Monitor SF-3 run status;
- Monitor SF-3 damper status;
- Monitor the air volume delivered by SF-3;
- Monitor the pressure differential between the Blue Operational Area and ambient.

The process control of this system will be as per section 7.12.

7.3.2 Return Fan 1 (RF-1):

Air is extracted from the Blue Operational Area by RF-1. The following upgrades to RF-1 must be performed:

- Fit a VFD with optional pressure feedback control to RF-1 to facilitate the required pressure depression of the Blue Operational Area by varying the rotational speed of RF-1;
- Repair/replace the damper fitted to RF-1;
- Fit an actuator to the RF-1 damper to close automatically when RF-1 is stopped;
- Monitor RF-1 run status;
- Monitor RF-1 damper status;
- Monitor the air volume delivered by RF-1;
- Monitor the pressure differential between the Blue Operational Area and ambient.

The process control of this system will be as per section 7.12.

7.3.3 Exhaust Fan 1 (EF-1):

Air is extracted from the Blue Area Plant Room by EF-1. The following upgrades to EF-1 must be performed:

- Evaluate the condition of EF-1 and review whether EF-1 has sufficient capacity to maintain the desired pressure and airflow of the area. Replace EF-1 if required;
- Fit a VFD to EF-1 to facilitate the required pressure depression of the Blue Area Plant Room by varying the rotational speed of EF-1;
- Monitor EF-1 run status;
- Monitor the air volume delivered by EF-1;
- Monitor the pressure differential between the Blue Area Plant Room and ambient.

The process control of this system will be as per section 7.12.

7.3.4 Supply Fan 4 (SF-4):

Fresh air is supplied to the Blue Area Plant Room by SF-4. The following upgrades to SF-4 must be performed:

- Evaluate the condition of SF-4 and review whether SF-4 has sufficient capacity to maintain the desired pressure and airflow of the area. Replace SF-4 if required;
- Fit a VFD to SF-4 to facilitate the required pressure depression of the Blue Area Plant Room by varying the rotational speed of SF-4;
- Monitor SF-4 run status;
- Monitor the air volume delivered by SF-4.
- Monitor the pressure differential between the Blue Area Plant Room and ambient.

The process control of this system will be as per section 7.12.

7.3.5 Exhaust Fan 2 (EF-2):

Air is extracted from the White/Blue Change Rooms by EF-2. The following upgrades to EF-2 must be performed:

- Evaluate the condition of EF-2 and review whether EF-2 has sufficient capacity to maintain the desired pressure and airflow of the area. Replace EF-2 if required;
- Fit a VFD to EF-2 to facilitate the required pressure depression of the White/Blue Change Rooms by varying the rotational speed of EF-2;
- Monitor EF-2 run status;
- Monitor the air volume delivered by EF-2;
- Monitor the pressure differential between the White/Blue Change Rooms and ambient.

The process control of this system will be as per section 7.12.

7.3.6 Supply Fan 2 (SF-2):

Air is supplied to the White/Blue Change Rooms by SF-2. The following upgrades to SF-2 must be performed:

- Evaluate the condition of SF-2 and review whether SF-2 has sufficient capacity to maintain the desired pressure and airflow of the area. Replace SF-2 if required;
- Fit a VFD to SF-2 to facilitate the required pressure depression of White Area Pipe Tunnel by varying the rotational speed of SF-2;
- Monitor SF-2 run status;
- Monitor the air volume delivered by SF-2;
- Monitor the pressure differential between the White/Blue Change Room and ambient.
- Fit a non-return damper to the discharge side of SF-2 to prevent airflow reversal from the White/Blue Change Rooms to the White Area Plant Room.

The process control of this system will be as per section 7.12.

7.3.7 Booster Fan 1 (BF-1):

Air is extracted from the IPC Laboratories by BF-1. The following upgrades to BF-1 must be performed:

- Evaluate the condition of BF-1 and review whether BF-1 has sufficient capacity to maintain the desired pressure and airflow of the area. Replace BF-1 if required.
- Fit a VFD to BF-1 to facilitate the required pressure depression of the IPC Laboratories by varying the rotational speed of BF-1;
- Monitor BF-1 run status;
- Monitor the air volume delivered by BF-1.
- Monitor the pressure differential between the IPC Laboratories and ambient.

The process control of this system will be as per section 7.12.

7.3.8 Blue Operational Area Air Terminals

The Blue Operational Area is not fitted with any return (extract) air grilles, instead relying on airflow through leakage of the ceiling of the Blue Operational Area. The fitment of regularly spaced return-air grilles within the ceiling of the Blue Operational Area is required.

7.3.9 Change Room Air Terminals

Changes were made to the change rooms layouts without moving the supply and return air grilles to suit the new layouts. Air terminals and ducting changes must be modified and/or replaced to suit the current room layouts.

7.4 Red Operational Area (Safety Class 3):

7.4.1 Supply Fan 1 (SF-1):

Fresh air is delivered to the Red Operational Area by SF-1. The following upgrades to SF-1 must be performed:

- Fit a VFD with pressure feedback control to SF-1 to facilitate the required pressure depression of the Red Operational Area by varying the rotational speed of SF-1;
- Repair the vortex damper fitted to SF-1;
- Fit actuator to the SF-1 vortex damper to close automatically when SF-1 is stopped;
- Monitor SF-1 run status;
- Monitor SF-1 damper status;
- Monitor the air volume delivered by SF-1;
- Monitor the pressure differential between the Cell Maintenance Area and ambient.

The process control of this system will be as per section 7.12.

7.4.2 Exhaust Fans 5, 6 and 7 (EF-5, EF-6 and EF-7):

Air is extracted from the Red Operational Areas by EF-5, EF-6 and EF-7. The following upgrades to these three fans must be performed:

- Fit VFDs with optional pressure feedback control to EF-5, EF-6 and EF-7 to facilitate the required pressure depression of the Red Operational Areas by varying the rotational speed of EF-5, EF-6 and EF-7;
- Repair/replace the vortex dampers fitted to EF-5, EF-6 and EF-7;

- Repair/replace the Opposed Blade Damper (OBD) type dampers fitted between EF-5, EF-6, EF-7 and the P1701 stack;
- Repair/replace the OBD type dampers fitted between EF-5, EF-6, EF-7 and the final Red Ventilation System Plenum 2;
- Fit actuators to the above dampers to automatically isolate a stopped fan.
- Monitor EF-5, EF-6 and EF-7 run statuses;
- Monitor EF-5, EF-6 and EF-7 damper statuses;
- Monitor the air volume delivered by EF-5, EF-6 and EF-7;
- Monitor the pressure differential between the Cell Maintenance Area and ambient.

EF-5, EF-6 and EF-7 are intended to run in a redundant array, therefore provision must be made within the control systems of these fans for automatic start-up functionality within the array should one of the fans fail.

The process control of this system will be as per section 7.12.

7.4.3 Exhaust Fan 14 (EF-14):

Air is extracted from the Red Area Pipe Tunnel by EF-14. The following upgrades to EF-14 must be performed:

- Evaluate the condition of EF-14 and review whether EF-14 has sufficient capacity to maintain the desired pressure and airflow of the area. Replace EF-14 if required;
- Fit a VFD to EF-14 to facilitate the required pressure depression of the Red Area Pipe Tunnel by varying the rotational speed of EF-14;
- Monitor EF-14 run status;
- Monitor the air volume delivered by EF-14;
- Monitor the pressure differential between the Red Area Pipe Tunnel and ambient.

The process control of this system will be as per section 7.12.

7.4.4 Supply Fan 6 (SF-6):

Fresh air is supplied to the Red Area Pipe Tunnel by SF-6. The following upgrades to SF-6 must be performed:

- Evaluate the condition of SF-6 and review whether SF-6 has sufficient capacity to maintain the desired pressure and airflow of the area. Replace SF-6 if required;
- Fit a VFD to SF-6 to facilitate the required pressure depression of the Red Area Pipe Tunnel by varying the rotational speed of SF-6;
- Monitor SF-6 run status;
- Monitor the air volume delivered by SF-6;

- Monitor the pressure differential between the Red Area Pipe Tunnel and ambient.

The process control of this system will be as per section 7.12.

7.4.5 Cell Maintenance Area

A new air terminal configuration is required for the delivery of fresh air to the Cell Maintenance Area. The current configuration does not adequately deliver fresh air at floor level of the area and must be reconfigured.

A non-return damper must be fitted to the grille connecting the Pool Area and the Cell Maintenance Area as a direct contamination spread path will be created when the differential pressure between the Cell Maintenance Area and Pool Area is reversed.

7.4.6 Basement

The roller shutter (inner) door fitted to D-4 is not leak-tight, thus the basement air-lock is compromised when the outer door (D-2) is opened. D-4 must be replaced with an interlocked, leak-tight door.

7.4.7 Red-Area Change Rooms

The Red area change rooms are supplied with air from the Blue Ventilation System and air is extracted by the Red Ventilation System. All avenues of air supply to this area must be fitted with non-return dampers, as a direct contamination spread path will be created when the differential pressure between the Blue and Red Operational Areas is reversed.

7.5 Purple Operational Area (Safety Class 3):

7.5.1 Fan Control System of Extract Fan 8 and 9 (EF-8 and EF-9)

EF-8 and EF-9 are responsible for the extraction of air from all hot-cells and the Decontamination Chamber to the P1701 stack. The dampers that isolate EF-8 and EF-9 when the fans are stopped are controlled by a single control system. Failure of the control system will isolate both EF-8 and EF-9, rendering the Purple Ventilation System inoperative. EF-8 and EF-9 must be fitted with separate, independent control systems to address this single point of failure. The control systems must also perform the following functions:

- Monitor EF-8 and EF-8 run statuses;
- Monitor EF-8 and EF-8 damper statuses.

The process control of this system will be as per section 7.12.

7.5.2 Missile protection barrier between of Extract Fan 8 and 9 (EF-8 and EF-9)

Because of the close proximity of EF-8 to EF-9, an assessment to determine the requirement for a missile protection barrier between EF-8 and EF-9 must be performed.

7.5.3 Fan Control System of Extract Fan 10 and 11 (EF-10 and EF-11)

EF-10 and EF-11 are responsible for the ventilation of waste storage tanks and Maintenance glovebox to the P1701 stack. The dampers that isolate EF-10 and EF-11, when the fans are stopped, are controlled by a single control system. Failure of the control system will isolate both EF-10 and EF-11, rendering the Off-Gas Ventilation System inoperative. EF-10 and EF-11 must be fitted with separate, independent control systems to address this single point of failure.

The process control of this system will be as per section 7.12.

7.5.4 Missile protection barrier between of Extract Fan 8 and 9 (EF-8 and EF-9)

Because of the close proximity of EF-10 to EF-11, an assessment to determine the requirement for a missile protection barrier between EF-10 and EF-11 must be performed.

7.6 Electrical Actuators (Safety Class 3):

Wherever practical, actuation of valves and dampers needs to be performed with fit-for-purpose (radiation-hardened) electrical actuators. Contamination of compressed instrument air supply lines has compromised the function and reliability of a large number of pneumatic actuators within the P1701 HVAC system. Replacement or fitment of radiation-hardened, electrically driven actuators needs to be considered for:

1. All newly fitted actuators;
2. Hot-cell pressure regulating valves;
3. Hot-cell filter changeover valves;
4. Any valve or damper considered to fulfil a critical safety role.

7.7 UPS Room (Possible SC implications)

The P1701 Facility UPS room is fitted with two commercial air-conditioning units of different ages and capacities. Should these air-conditioning units fail, the UPS will be rendered inoperative. The air-conditioning units must be replaced with two independent Variable Refrigerant Flow (VRF) air conditioning units, which must be supplied with UPS power.

7.8 UPS Battery Room (Possible SC implications)

The UPS battery room is connected to the Blue Ventilation System and must be disconnected, as the battery room is not radiologically classified. The battery room must be fitted with a new dedicated AHU, supplying fresh, conditioned air to the battery room.

A hydrogen off-gas risk classification of the battery room needs to be repeated to ensure that the upgraded extraction system of the battery room is adequate.

7.9 Door Seals between areas with different radiological classifications

Door seals of all doors leading to and from areas with different radiological classifications within P1701 are in poor condition or are not fitted. The repair/review and/or fitment of door seals to all doors connecting areas with different radiological classifications is required.

7.10 Air-lock door interlocks

Except for the White/Blue Change Rooms and Receiving Bay, all other air-locks leading to and from the P1701 facility are not fitted with door interlocks. To prevent a short circuit of airflow between areas with different radiological classifications, all doors connected to air-locks must be fitted with interlocks.

7.11 Electrical Distribution Boards (Safety Class 3)

Where practical, electrical distribution boards serving the P1701 HVAC system must be moved from the restricted access areas of the P1701 Basement to more readily accessible areas within P1701.

7.12 Process Control and Instrumentation (Safety Classified)

Process control and Instrumentation for HVAC system at the NTP building P1701:

Where practical, all marshalling boxes and Process Control equipment serving the P1701 HVAC system must be installed in non-radiological areas within P1701, for ease of access and maintenance activities.

All PC&I instruments and equipment to be selected according to the appropriate quality and Structures, Systems and Components safety classification guidelines and implemented according to the respective company, building and regulatory requirements and location specific environmental conditions. These units will also have the required communication interface protection with safety, security and isolation requirements to protect all communication paths/links against externally or field induced interferences.

The total HVAC monitoring and control design will include a network of locally monitored/sensing and control units which will have an independently defined operation and functionality, but make provision for a centralised control monitoring system (CCMS). It will make provision for a holistic approach to cater for all the current but also future needs, for changes or expansion.

All equipment will be sourced, implemented and maintained by the SC classification and quality dependant, qualified and approved OEM.

Each of these localised control stations will be able to operate independently as an intelligent and self-sustained functionality (i.e. as a localised nerve centre):

It will be scalable and have sufficient redundancy to accommodate future needs and expansion.

It will accommodate an intelligent and locally accessible interface for parameter setup and optimisation of operations as well as monitoring extensive equipment/component failure and operational conditions.

It will include full loop control to sustain the defined and localised HVAC functionality. With typical example; a sensing unit (DP sensor or air flow meter) providing feedback, to the incorporated intelligent controller (for instance a variable frequency (VFD)) to accurately control the Facility Supply fan motor via PID control.
The control unit will have the capability to self-start under different failure or recovery conditions, and to reach a stabilised and controlled environment.

The VFD will have the capability to monitor local items for proper and healthy functionality (i.e. monitor fan bearings, vibration on fan motor, overloading, breakage of fan belt, etc.).

For future needs and requirement, include the capability to interface via a defined network communication protocol to communicate and link with a centralised monitoring and control system.

It will feature the capability to communicate via digitally generated alarmed/failure condition to the CCR and ECC.

Feature digital Input and Output (I/O) channels to accommodate the triggering of local and remotely generated safety interlocking requirements and fail-safe demands.

It will make provision for hardwiring interfaces for Emergency Shutdown (ESD) conditions.

The control units will be installed in an environmentally safe, secured and with controlled conditions, for both machine and human sustainable requirements. A centralised MCC will also be identified for this purpose.

All Electrical and PC&I interfaces will be done in dedicated cabinets with clearly defined isolation and separation.

The control units will be powered from an Uninterruptable Power Supply (UPS) or from a sustainable power source, to minimise interruptions or interferences to operations and functionality.

8 RECORDS

Record	Retention Period	By Whom
None	None	None

9 TASK HAZARD ASSESSMENT

No task hazard assessment is associated with this document.

10 LIST OF FORMS

Form Title	Form Number	Exhibit Number
None	None	None

11 REVISION HISTORY

Rev.	Date Approved	Nature of Revision	Originated by
1	See title page	First issue	T More and J Le Roux