Modular Intermediate Level Waste Encapsulation Plant (MILWEP)

MILWEP Ventilation Basis of Design

1865_RP_HVAC_0001
Issue B

Prepared for:

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Magnox Reference: WD-REP-0180-18

DOCUMENT APPROVAL

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Drawing Accepted

SIGNED VRC HELD ON FILE

Magnox Ltd – MILWEP

TECHNICAL REPORT

MILWEP Ventilation Basis of Design

Contract Title:	MILWEP VENTILATION DESIGN SUPPORT		
Contract No:	1865		
Document Ref no:	1865_RP_HVAC_001	REV	B
Client Project No:	TBC	BUILD No:	
Client Document Ref No:	TBC		
Document Checking Level:	2		
Configuration Cat:	N/A		
Functional Hierarchy:	N/A		

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HISTORY SHEET

Rev	Date	Reason for revision	Revised by
A	29-08-18	Client comments addressed – first Approved Issue for NSG Acceptance	B Jackson
B	28-09-18	Section 7 Control Philosophy amended, Chapel Cross Process Extract standardised with Berkeley & Hinkley and Client comments on Revision A addressed.	B Jackson

CIRCULATION LIST

Purpose of issue:
1 For comment
2 For action
3 For information
4 For Acceptance

Name	Location	Remarks	Purpose of Issue
Richard James	NSG		4
Joe Wilcox	NSG		3
Jack Melton	Magnox		3
Gareth Morris	Alpha		3
Ben Jackson	Alpha		3

REFERENCES

This document should be read in conjunction with the following reference documents.

The latest available revision of each document or drawing should be used.

No	Reference	Description
1	ES_0_1738_1	Ventilation Systems for Radiological Facilities
2	L138	Dangerous Substances and Explosive Atmospheres Regulations 2002 Approved Code of Practice and guidance
3	NSG Project ref NS2380	Provision of Cementation System - Jacobs (for Capenhurst)
4	Data Sheet 35.05-04/16	Nuclear Grade Radial Flow Plug-In HEPA Inserts
5	NS4000-12-500-2018	DSEAR Assessment for Proposed MILWEP Facility at Berkeley
6	NS4000-14-500-2007	DSEAR Assessment for Proposed MILWEP Facility at Hinkley
7	NS4000-13-500-2011	DSEAR Assessment for MILWEP Facility at Chapelcross
8	1865_NFR_HVAC_001	MILWEP Ventilation Design Support Airflow Moisture Assessment
9	L24	Workplace (Health, Safety and Welfare) Regulations 1992 - Approved Code of Practice and guidance
10	CIBSE Guide A	Environmental Design
11	1865_CAL_HVAC_002	MILWEP Ventilation Calculations
12	NS4000-11-500-0024	MILWEP Phase 2 – Detail Design Development - Plant Systemisation
13	1865_DRG_HVAC_001	Berkeley Ventilation Flow Diagram
14	1865_DRG_HVAC_003	Hinkley Ventilation Flow Diagram
15	NS4000-13-470-2002	Chapelcross Ventilation Flow Diagram
16	NS4000-12-500-0016	Berkeley Engineering Schedule
17	NS4000-14-500-0022	Hinkley Engineering Schedule
18	NS4000-13-500-0018	Chapelcross Engineering Schedule
19	GVM/14 CIBSE Guide M	Maintenance Engineering & Management
20	1865_SP_EC&I_001	MILWEP Ventilation Control Philosophy / Function Design Specification

DEFINITIONS/GLOSSARY

AHU	Air Handling Unit
AID	Automatic Isolation Damper
ATEX	ATmosphere EXplosibles
BD	Balancing Damper
BoD	Basis of Design
BRK	Berkeley
CB	6m^3 Concrete Box
CE	Conformite Europeen
CHX	Chapelcross
CIBSE	Chartered Institution of Building Services Engineers
CS&A	Civil, Structural & Architectural
DOP	Dispersed Oil Particulate
dP	differential pressure
DSEAR	Dangerous Substance and Explosive Atmosphere Regulations
EGSH	Electrically Generated Steam Humidifier
EH&S	Environment, Health & Safety
ES	Engineering Schedule
FHB	Fuel Handling Building
FD	Fire Damper
HAZOP	HAZard & OPerability
HEPA	High Efficiency Particulate Air
HMI	Human Machine Interface
HPA	Hinkley Point A
HSE	Health and Safety Executive
HVAC	Heating, Ventilation and Air Conditioning
ID	Isolation Damper
ILW	Intermediate Level Waste
I/O	Input/Output
IRR	Ionising Radiations Regulations 2017
LCP	Local Control Panel
LEAV	Lower Exposure Action Value
MFU	Mobile Filtration Unit
MILWEP	Modular Intermediate Level Waste Encapsulation Plant
NFR	Note for the record
O&M	Operating & Maintenance
P&E	Plant & Equipment
P&ID	Piping & Instrumentation Diagram
PLC	Programmable Logic Controller
PUWER	Provision and Use of Work Equipment Regulations
RH	Relative Humidity
TS	TRU-Shield^{TM}
UEAV	Upper Exposure Action Value
VCP	Ventilation Control Panel
VFD	Ventilation Flow Diagram
VSD	Variable Speed Drive

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1. Introduction

Intermediate Level Waste (ILW) has been accumulated across the Magnox sites as a result of nuclear power generation. Government policy for sites in England and Wales is for the disposal at a national geological facility, which is scheduled for 2040. Until that time, the waste will be packaged into suitable containers for interim storage on the sites in purpose-built facilities and eventual transport and disposal. Scottish policy is for long term on site storage.

The Modular Intermediate Level Waste Encapsulation Plant (MILWEP) project is concerned with the development of a generic, standalone modular encapsulation facility capable of safely encapsulating ILW.

ILW will be delivered to MILWEP in 6m^3 Concrete Boxes (CBs) or in drums within TRU-Shield^{TM} (TS) containers for removal from the TS and loading into CBs in MILWEP. All CBs will then be encapsulated.

The plant is to be configured to suit the specific requirements of the Berkeley (BRK), Hinkley Point A (HPA) and Chapelcross (CHX) sites. The requirements for each site differ due to the variations in the throughput requirements, waste characteristics, inventories and site infrastructure / topology. Both BRK and HPA have temporary purpose built new buildings to house MILWEP, whereas CHX has MILWEP installed within the existing Fuel Handling Building (FHB).

This document describes the design basis for the ventilation systems serving MILWEP on all three sites. The ventilation systems consist of supply ventilation to the buildings and extract ventilation to both the building and the process. At CHX the existing FHB building ventilation will be utilised, only a process extract vent is required.

2. Scope

An existing HVAC detailed design was completed and the costs associated with implementing this design were high, so a Value Engineering Study was completed to rationalise the design.

The purpose of this document is to define the revised Basis of Design (BoD for the ventilation systems serving the MILWEP Facility at BRK, HPA & CHX.

The building ventilation system comprises of a supply air system and an extract system, designed to be configured as a ‘recirculation’ system for cool seasons and as a ‘once through’ system for warm seasons to efficiently control the environment within the building.

Additional proprietary standalone Heating, Ventilation and Air Conditioning (HVAC) systems and controls are provided for the BRK/HPA control rooms and the change rooms.

The Process Extract provides both containment, moisture management and hydrogen dilution to the air extracted from the CBs when they are being processed at specific stations in the facility.

3. Ventilation System Design Objectives

The design objectives of the ventilation systems are separate for each system, which are summarised below;

3.1 Process Extract

- Minimise the spread of contamination from areas of higher contamination potential (in the CB ullage) to areas of lower contamination potential (general building area).
- Maintain the CB ullage under the temporary lid at a nominal depression to provide a minimum containment velocity through the temporary lid fill port.
- Remove airborne particulate from the discharge air to ensure that the emissions are within the prescribed discharge limits for the facility.
- To manage the hydrogen evolved from the curing process to ensure that the concentration in air does not exceed 1% by volume.
- To maintain the process extract airflow below 80% Relative Humidity (RH) to protect the High Efficiency Particulate Air (HEPA) filtration from potential damage.
- To satisfy any Safety Functional Requirements placed on the system [Ref's 16 to 18].

3.2 Building Ventilation

This subsection only applies to BRK & HPA; CHX is Process Extract only.

- Provide a satisfactory working environment for personnel to meet pertinent legislation.
- To maintain the air conditions in the building within specified limits suitable for the process, plant and equipment.
- To provide conditioned air for entrainment into the Process Extract.
- To dilute and dissipate the hydrogen evolved from the curing process to ensure that the concentration in air does not exceed 1% by volume during fault recovery.
- To minimise energy usage whilst maintaining the necessary air conditions in the facility by;
    - Providing a balanced system, i.e. total supply air to the building equates to the total extract from the building (Building Extract plus Process Extract). The balanced system is acceptable due to the majority of the building volume being ‘Unclassified’ from a contamination perspective (local C3 areas are served by the Process Extract System).
    - To provide two modes of operation; ‘Recirculation’ for low external temperatures and ‘Once Through’ for high external temperatures. The mode control will be automatic to ensure that the temperature is controlled to protect the product.

4. Ventilation Philosophy

4.1 Containment Philosophy

Absolute physical containment is impractical for nuclear plants because of the need to provide for personnel access to the plant and areas within, in addition to entry/exits for services and waste products. This leads to a design philosophy where the contained material or process is surrounded by barriers. The requirement for access leads to further penetrations and further barriers enclosing zones of progressively lesser contamination potential until the external environment is reached.

The building layout is described as a series of barriers enclosing the various zones, which are classified according to the contamination potentials within the plant. The number of barriers depends upon the sources of contamination, the efficiency of each barrier and the number and type of penetrations.

In adhering to these principles, the design and operation of the plant ensures that the plant does not become a significant source of operator dose uptake and that the aerial effluent discharges from the ventilation systems remain within the allowable discharge limits.

This philosophy is simple to apply to MILWEP, as the process lends itself to very few contamination classification boundaries through the facility because the contamination risk remains at source, i.e. in the CB ullage under the temporary lid.

The Process Extract has been designed in accordance with ES_0_1738 [Ref. 1]. This code of practice calls for containment velocities through any gaps/openings between areas of different contamination classification, with the airflow cascaded from areas of lower to areas of higher classification. The contamination boundary will be the temporary lid and this is the barrier which the Process Extract protects. The CB ullage is classed as C3, with the external area temporarily classed as C2 during lid movements; Unclassified at all other times. The containment velocity flowrate through the temporary lid is derived from empirical results recorded during commissioning trials on a similar design system [Ref. 3]. This provides a containment velocity into the temporary lid fill port and accounts for possible in leakage.

The building itself is Unclassified and as such can be treated as a conventional industrial building. Maintaining a depression within the Unclassified facility is deemed unnecessary, as it requires a greater volume of air to be extracted from the building, resulting in larger and more costly components. Therefore, it would be considered to be ‘As Low As is Reasonably Practicable’ and the ‘Best Available Technique’ to have a balanced ventilation system, as there is a negligible risk to people and the environment.

The Process Extract will draw airflow from the general building area, across the temporary C2 area and through adventitious gaps around the temporary lid and the open grout port and into the ductwork to support the cascade airflow route required to protect the contamination boundary. Note that the design is sized based around on a minimum containment velocity through the temporary lid fill port and no allowance is made for adventitious gaps around the temporary lid, as the path of least resistance is via the port. No minimum containment velocity is stipulated between the general building area and the C2 area, as it is not required.

4.2 Hydrogen Management

The Dangerous Substance and Explosive Atmosphere Regulations (DSEAR [Ref. 2]) state that the hydrogen concentration in air shall be maintained at <1% by volume (25% of Lower Flammable Limit; Regulation 6). The facility DSEAR Assessments [Ref's 5 to 7] and Engineering Substantiation Reports [Ref's 16 to 18] demonstrate that the Process Extract airflow rate is designed to satisfy this criterion.

The Process Extract does not have duty / standby facilities within the design because it was assessed at the value engineering study that the electrical supply is far less robust than the duty only ventilation plant. The DSEAR Assessments for BRK & HPA [Ref's 5 & 6] discuss the availability offered by duty and standby plant and as such would require review to ensure that the case can be met without the standby plant. However, the assessments also state that the facility remains in a safe state with the ventilation in fault and not operational, but will require a managed recovery procedure. This may include evacuation of the facility if appropriate. The managed recovery procedure is afforded by adopting ATEX Rated plant and equipment as specified in the DSEAR Assessment, which enables purging of the facility and restoration of the vent plant to full operation. The DSEAR Assessment for CHX [Ref. 7] makes no claim on standby plant.

The Supply Air System has space provided in the Air Handling Unit (AHU) to retrofit humidification capability in the future to ensure that a minimum of 30%RH is maintained in the facility during the minimum external temperature if deemed required. This design feature will ensure that static electricity does not occur and as such removes the potential ignition source during fault recovery to dissipate accumulated hydrogen. This feature is currently not included and this is a contingency for future proofing the supply air installation.

It is noted that the DSEAR Assessments for BRK and HPA have been developed on the basis of a combined Process/Building ventilation system and require review and update as necessary if the system architecture and operating philosophies outlined in this updated Basis of Design invalidates the conclusions/arguments previously made.

4.3 Moisture Management

The Process Extract design utilises the dilution method for the prevention of condensation within the system whilst also ensuring that the HEPA Filtration is not challenged by exposing it to airflow exceeding 80% RH.

The 80%RH airflow limit at the HEPA Filtration stage has been used as the basis for the moisture management design as this scenario is more onerous than that to prevent condensation within the general process ductwork.

Dilution viability was investigated [Ref. 8] and determined by calculating [Ref. 11] the airflow conditions at two points; from the curing boxes and from the grouting boxes and building area. The ratio of the moisture laden airflow from the curing boxes to that of the dry air from the grouting stations and building area is set such that the mixed airflow condition does not contain enough moisture to exceed 80%RH at the HEPA filter in the worst-case airflow scenario, which is at the building design temperature. The curing and grouting station extract flow rates are fixed, with the extra extract air being taken from the building to vary the ratio as required. This technique also assumed that the ductwork loses all of the heat gained from the curing process and as such demonstrates that insulation is not required.

5. Basis of Design

5.1 Design Conditions

The design conditions adopted for the MILWEP design are as follows:

External Temperature

Winter:	-5°C dry bulb temperature	-5°C wet bulb temperature
Summer:	28°C dry bulb temperature	19°C wet bulb temperature

Internal Temperature

Minimum:	5°C
Maximum:	40°C

Humidity

Minimum:	30%RH
Maximum:	80%RH*

* There is no requirement to control maximum humidity in the building. However, the Process Extract is sized to ensure that the airflow incident on the HEPA filters is below 80% [Ref. 4] to prevent them from becoming wet (blinding).

Note 1: Workplace (Health, Safety and Welfare) Regulations 1992 states that "During working hours, the temperature in all workplaces inside buildings shall be reasonable." The Health and Safety Executive (HSE) Workplace Health, Safety and Welfare Guide [Ref. 9] states that "For workplaces where the activity is mainly sedentary e.g. offices, the temperature should normally be at least 16°C. If work involves physical effort it should be at least 13°C." The Chartered Institution of Building Services Engineers (CIBSE) Guide A [Ref. 10] recommends a range, within factories, from 11°C to 14°C for heavy work and to 19°C to 21°C for sedentary work.

Whilst a figure of 13˚C is recognised as the minimum working temperature when undertaking rigorous physical effort, the Client has advised that it is not a legal requirement. It is the duty of the employer to determine a reasonable level of comfort and the Client shall ensure this. If the internal temperature did fall within the 5-15˚C range and it was not considered to be acceptable to cease operation, then it would be possible for operators to limit the time spent in the main building, returning frequently to the warmth of the control room with their standalone HVAC systems. The majority of the operations within the main building are relatively short duration and are discrete tasks.

The Client requirements are for the minimum internal temperature of 5˚C correlating to an external temperature of -5˚C, as below 5˚C the quality of the product could be impaired. When the external temperature is above 5˚C the internal environment would be maintained at above 15˚C to ensure that the curing process is not impaired.

The location of the Berkeley and Hinkley sites only see temperatures below 5˚C infrequently, and therefore for the majority of the time the internal temperature will satisfy both the process requirement and that for operator comfort. Temperatures less than 5˚C normally only occur during the night-time, when operator occupancy of the building is not planned.

The exception to this is the control room, which will have local HVAC to ensure higher temperatures are achieved in the Winter and lower temperatures in the Summer. The change rooms also have local heating.

5.2 Process and Environmental Heating & Cooling

The HVAC systems shall be designed to manage the heat loads within the building and thus maintain the temperature within the range indicated.

Heat loads will typically include:

- Grout exothermic heat
- Mechanical (e.g. cranes, motors, hydraulic power packs)
- Control and Instrumentation (e.g. panels)
- Lighting (general areas / special task lighting)
- Occupancy (differing levels of operator activity)
- Solar gains through the building fabric

The requirement for local heating and cooling has only been deemed necessary within the Control Rooms and local heating within the Change Rooms.

The heat gains within MILWEP are identified and recorded in the BRK & HPA Heat Load Calculations [Ref. 11].

The equivalent calculation has not been completed for CHX, as the process is to be installed in the existing FHB, where the building will be ventilated using the existing plant.

5.3 Noise Criteria

The Control of Noise at Work Regulations 2005 (see Section 6) gives action levels for employee noise exposure:

- The Lower Exposure Action Value (LEAV) is a daily or weekly personal noise exposure of 80 dB(A)
- The Upper Exposure Action Value (UEAV) is a daily or weekly personal noise exposure of 85 dB(A)
- The Exposure Limit Value is a daily or weekly personal noise exposure of 87dB (A).

The regulations state an employer, who carries out work which is likely to expose any employees to noise at or above the LEAV of 80dB(A), shall make personal hearing protectors available.

The regulations also state when any employee is likely to be exposed to noise at or above the UEAV of 85 dB(A), the employer shall reduce exposure to as low a level as is reasonably practicable and provide personal hearing protectors.

The ventilation plant and equipment will be specified with a maximum noise level of 80dB(A) to ensure that the LEAV is not breached if practicable.

5.4 Design Life

The design life of MILWEP ventilation systems shall be 10 years. Equipment shall be designed to meet the design life or allow for economic replacement (dependent on cost/benefit analysis) in accordance with CIBSE Guide M [Ref. 19]. It is noted that the expected plant operational lifetime is well within the design life, estimated at 5 years.

5.5 Standardisation

The Process extract is standardised for BRK, HPA & CHX in the form of a high integrity Mobile Filtration Unit (MFU).

The Building Ventilation Systems is standardised for BRK & HPA in the form of ductwork, damper and grille sizes and AHU duties.

5.6 Equipment

All HVAC Plant & Equipment (P&E) will be listed in the Equipment Lists and shown on the Ventilation Flow Diagrams (VFDs) or Piping & Instrumentation Diagrams (P&IDs) to ensure clarity for Operating & Maintenance (O&M) personnel. All plant and equipment shall be assigned a Unique number as defined in the plant systemisation document [Ref. 12].

5.7 Process Extract Stack

The Process Extract discharge stub stack shall be designed in accordance with ES_0_1738_1 [Ref. 1] and shall maintain a minimum efflux velocity of 15m/s to meet best practice, minimise rain ingress and also prevent condensed moisture from running down the stack internal face. The requirement for a cowl to prevent rain ingress and/or provide a minimum efflux velocity shall be confirmed during the detail design update.

The Process Extract Stack shall have online sampling as required by the Site Environmental Department (typically tritium and isokinetic particulate sampling).

5.8 Stack Effluent

The aerial effluent discharge for the MILWEP Process Extract may have a Low Active liquid effluent arising from the discharge stack, which will be collected locally and disposed of in accordance with Site specific procedures. The liquid effluent will be minimized, as stated in the subsection above.

5.9 Installation

The design of HVAC system P&E will take due consideration of space and handling limitations inherent within the three facilities. Outline Installation Method Statements will be prepared and assessed via Constructability & Hazards of Construction workshops.

5.10 Testing and Commissioning

The Process Extract MFU will be works tested at the manufacturers' premises prior to dispatch to Magnox for installation and commissioning. The Building HVAC system will not be, with the exception of the AHU and Extract Fan to ensure that the design duties can be achieved.

The works testing of the P&E will be agreed with the Commissioning Lead and recorded in the Technical Specification prior to issue to ensure that all testing & commissioning scope is captured.

Commissioning is a key area of scrutiny in the detailed design review to ensure that all requirements are captured in the design.

The design shall incorporate test points, balancing dampers and Variable Speed Drives (VSDs) on fans to aid commissioning to achieve design flow rates.

5.11 Operability

The design of ventilation P&E will give due consideration to the operability of the equipment under normal, maintenance and credible fault conditions. Operability is a key area of scrutiny in the HAZard & OPerability (HAZOP) study and the detailed design review to ensure that all requirements are captured in the design.

5.12 Maintenance

The design and layout of HVAC P&E including ductwork will consider the needs of the plant operators to routinely maintain plant. Maintenance is a key area of scrutiny in the detailed design review to ensure that all requirements are captured in the design. The design will also consider plant failure and replacement with attention given to access, handling and routing through buildings.

5.13 Spares

A Spares List requirement will be stated in the Technical Specification. The Spares List will then be provided to Magnox for rationalisation utilising Learning from Experience and obtain purchasing codes for the required spares. The Client will then order the required P&E to support commissioning and the first twelve months of operation.

5.14 Decommissioning

The Process Extract P&E will be designed with due consideration to the eventual Post Operational Clean-Out and decommissioning of the facility, with particular regard to ease of decontamination, dismantling and disposal.

Inspection and access points, together with flange joints for dismantling will be provided throughout the Process Extract system to aid dismantling and decommissioning.

The Building Ventilation system will not have any specific decommissioning features, as it serves an unclassified building.

6. MILWEP Mechanical HVAC System Description

The following system descriptions shall be read in conjunction with the VFDs [Ref's 13 to 15].

All standards listed in brackets are listed in full in Section 9.2.

6.1 Process Extract

6.1.1 BRK & HPA

The Process Extract System serving BRK, HPA & CHX comprises of:

- An MFU installed within the building, containing;
    - A single stage safe change HEPA filter, comprising of a single duty only housing (ES_0_1711_2) containing one insert (ES_0_1737_2; type 1 or 2 to be determined), complete with depression relief valve and filter. The filter bank shall include locally positioned differential pressure instrument.
    - Manual Isolation Damper (ID) upstream of the filter housing to facilitate filter change.
    - A duty only extract fan suitable for the application, complete with anti-vibration mountings and flexible connections if deemed necessary. The manufacturer may adopt two axial fans in series for this application, hence the anti-vibration mountings and flexible connections may not be required. This is standard for an MFU and is acceptable due to the fans meeting the leak tightness required.
    - Manual ID downstream of the fan to facilitate maintenance and filter change. [Note; the manual isolation damper upstream of the filter housing can also be used to isolate the filter and fan.]
    - Local Control Panel (LCP), housing the variable speed drive, indication and alarms, differential pressures (fan and filter), fan speed and airflow and the control architecture associated with the MFU (see Control Philosophy for details).
    - Local instruments feeding signals to the LCP.
- Ductwork manufactured in high integrity stainless steel specification (ES_0_1723_2) with bolted flanged connections for installation. The opportunity exists to utilise proprietary high integrity ductwork for the Process Extract System, such as the Jacob pipework systems range (supplied by Truduct) if deemed acceptable to the Client. This type of ductwork has been used before within the Magnox fleet for similar applications.
- Proprietary travelling extract rail to facilitate extract from a CB being moved between the grouting and curing stations. This is a smooth bore flexible hose that moves along a rigid header duct whilst maintaining extract on the connected CB. This is not required at CHX.

- CB Process Station (both curing and grouting) extract. Each station has a flexible connection to the CB and a bypass extract duct complete with extract grille and balancing damper/valve. The operator manually actuates a three-port valve to divert the extract to the leg in use; CB flexible when a CB is present and bypass when not (except CHX, which is a single Process Station with the extract always online). Dilution extract legs are fitted to the extract from each Curing Process Station (if in the facility) to lower relative humidity at source. Each station also has a local flow instrument (except CHX) to provide the operator with visual confirmation that the flexible connection has been successfully made and that the bypass is isolated.
- It is noted that the number of stations vary dependent on site to meet individual throughput requirements. Currently, BRK has three grouting and three curing stations, Hinkley has two grouting stations and three curing stations and CHX has a single station. The Process Extract airflow rate remains constant and varying degrees of dilution airflow are balanced to suit the number of Process Stations on line.
- Hydrogen monitoring ports on the Curing Station CB leg to facilitate the connection of the hydrogen monitoring system (not on CHX and not described in this BoD).
- Ductwork supports to the standard shall be required and tertiary steelwork may be required where the standard ductwork supports cannot be used in isolation. Note; if proprietary high integrity ductwork is utilised, the support standards contained within ES_0_1723_2 shall be used.
- Manual balancing dampers where necessary in the ductwork to facilitate commissioning.
- Dispersed Oil Particulate (DOP) injection, sample and return points provided to test filter efficiency (ES_0_1707_1) on the ductwork system.
- Discharge stub stack, complete with stack sampling ports to facilitate the connection of isokinetic stack sampling probe for particulate/tritium/Carbon-14 as necessary. Return lines and extra ports as required (stack sampling not described in this BoD). The stub stack shall also have a drain (complete with isolation valve and blank flange) for use by operations staff if necessary using collection vessels. The requirement for a cowl will be determined.

The airflow instrument may require location in the ductwork system if the MFU is not suitable due to having turbulent flow. However, the preferred option would be for it to be MFU mounted if a suitable instrument is readily available.

There has been no safety functional requirement identified to fit a backflow HEPA filter (or other backflow protection device) to each Process Station bypass leg or the building area extract leg and as such none is included in the design. This requirement will be reviewed during the hazard analysis to be completed on the revised ventilation design recorded in this BoD as part of the design change request.

HEPA filter inserts will be tested at the manufacturer’s works and will have individual serial numbers and test certificates.

DOP testing will be performed on the filter installed to verify that the filter insert has not been damaged subsequent to leaving the manufacturers works and that the filter seals, housing and ductwork are functioning correctly. The ductwork, dampers and filters, together with the aerosol sample and injection points will be arranged to enable this to be efficiently and reliably carried out. The DOP testing points and equipment will be in accordance with ES_1_1707_1.

The MFU will be installed inside the building and will have the filter section tented out if the insert requires replacement. The tent will be ventilated by another MFU for the duration of the change. This is required to cover the fault condition of a dropped safe change bag.

The stub stack is the only Process Extract plant item to be located externally, which protrudes 3m above the roof level.

6.2 Building Ventilation

6.2.1 BRK & HPA

The BRK & HPA Building Ventilation system comprises of a Supply Air System and an Extract System that can be operated as a recirculation system during cooler months and a once through system when the external conditions are warmer than the design requirements. In recirculation mode, fresh air is supplied to balance with the Process Extract discharge volume to atmosphere, which is also required to provide suitable treated fresh air to the facility for occupancy.

The MILWEP Building Supply System will distribute air to the Unclassified MILWEP Building and it comprises of the following:

- Triple Bank louvre,
- 1 x 100% AHU (manufacturers standard – commercial grade), each including the following components:
    - Mixing Chamber,
    - Panel filter to filter incoming air and provide protection to the heating coil,
    - Bag filter with same function as above,
    - Space in the AHU for an Electrically Generated Steam Humidifier (EGSH - to maintain a minimum supply air humidity of 30%RH if retrofitted at a later date),
    - Electric main heater battery to heat the supply warm air to the building (with a temperature control setpoint of 15°C).
    - Commercial grade fan designed to deliver required airflow to the building with variable speed control.
- AID located on the discharge from the AHU, to facilitate plant start up and shutdown sequences.
- Supply ductwork system be to DW/144 including all necessary balancing dampers (BDs) and supply air grilles suitably located to ensure adequate air distribution. External ductwork will be insulated.
- Ductwork supports to the standard shall be required and tertiary steelwork may be required where the standard ductwork supports cannot be used in isolation.

The MILWEP Building Extract System will remove air from the Unclassified MILWEP Building and it comprises of the following:

- 1 x 100% Extract Fan (manufacturers standard – commercial grade).
- Manual ID upstream of the fan to support maintenance activities.
- AIDs located on the AHU after the discharge from the fan, to facilitate mode control, plant start up and shutdown sequences and maintenance activities.
- Extract ductwork system to DW/144 including all necessary BDs and extract grilles suitably located to ensure adequate air distribution. External ductwork will be insulated.
- Ductwork supports to the standard shall be required and tertiary steelwork may be required where the standard ductwork supports cannot be used in isolation.

- Triple Bank louvre on the discharge, as it has no airflow through it when in the recirculation mode.

A duct and associated AID will be installed to link the supply AHU mixing chamber with the Extract Fan discharge to facilitate the recirculation mode of operation.

The Building Ventilation P&E will be installed externally for BRK and HPA and as such shall be specified for an external location. The ductwork distribution system will be installed internally. Only external ductwork will be insulated and will include appropriate weather sealing, wildlife protection and drain points (e.g. fan scroll) as required.

The Control Room air conditioning will be provided by a proprietary stand-alone heat pump, with condenser outside on a plinth and a ceiling mounted unit inside to condition the air. The system shall have a fresh air inbleed sized to provide adequate fresh air for the number of occupants.

There is an additional requirement to provide heating and fresh air to the HPA change room. This shall be achieved using a similar system as for the control room.

6.2.2 CHX

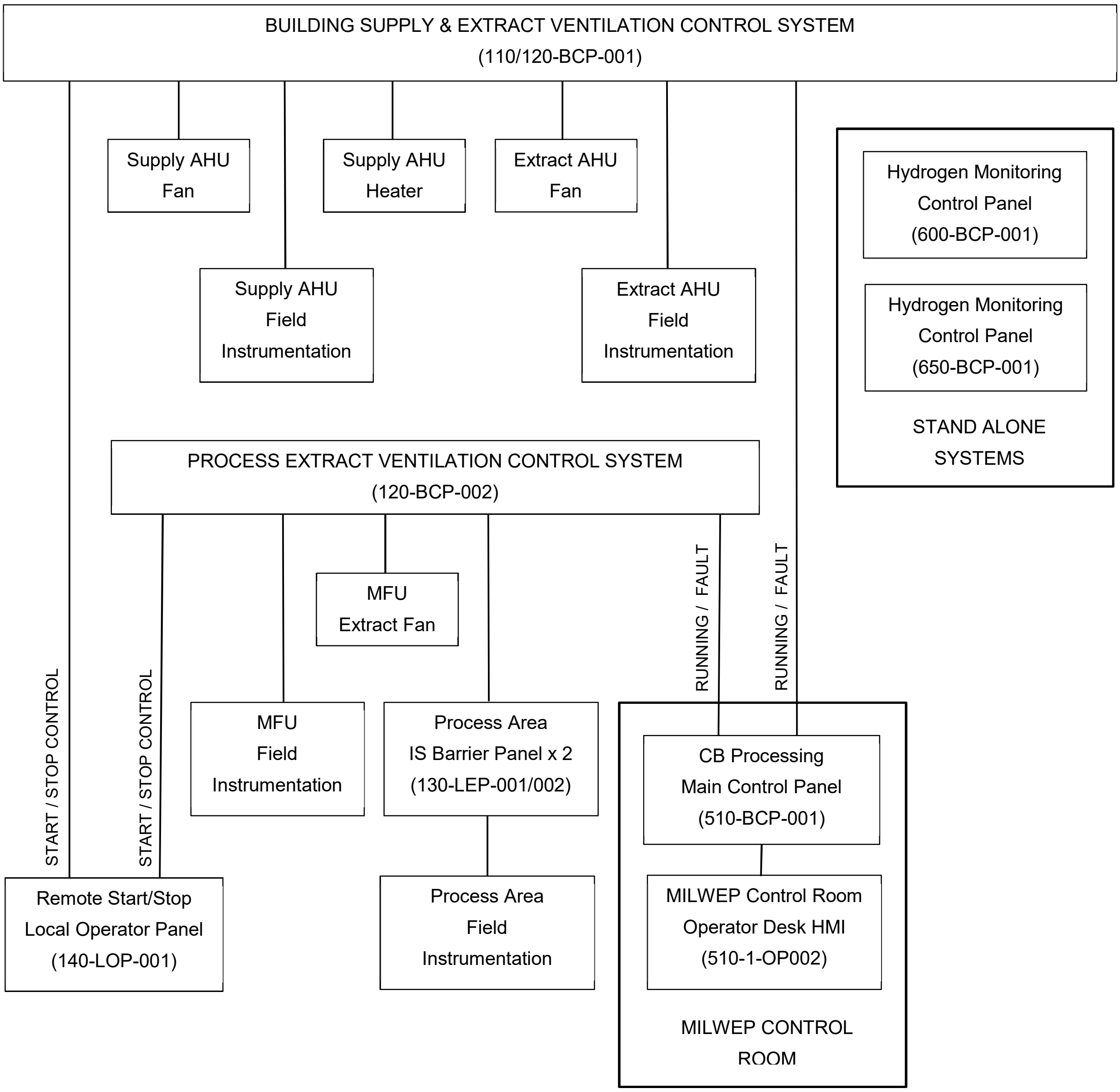
No Building Ventilation system is being provided as a part of the MILWEP Project and it is assumed that the existing FHB ventilation is adequate.

7. Control Philosophy

This section provides a general overview of the control requirements for the various ventilation systems which serve MILWEP on all three sites.

For a more detailed description of the ventilation system control requirements, refer to the MILWEP Ventilation Control Philosophy / Function Design Specification document [Ref. 20].

7.1 Ventilation Control System Architecture



7.2 Ventilation Philosophy

The Building Ventilation Supply and Extract systems shall operate on a 24 hours 7 day per week basis. Both systems shall operate concurrently in normal operation. The Building Ventilation system shall utilise two modes of operation which will be dependent upon the building external temperature;

- ‘Recirculation’ – During periods when Building External temperature is < 15°c.
- ‘Once through’ – During periods when Building External temperature is > 20°c.

An independent Process Extract System in the form of an MFU shall provide normal containment management during periods when air needs to be extracted from the CB’s when they are being processed at specific stations within the facility. The Process Extract System shall comply with the DSEAR requirements in both normal and fault conditions as defined in the Berkley & Hinkley DSEAR Assessments [5 & 6].

There are no interlocks between the Building Ventilation Supply/Extract systems and the Process Extract system.

Remote status and alarm signals shall be relayed to the MILWEP Control Room Human Machine Interface (HMI) as follows;

- Building Ventilation system running and common fault
- Process Extract MFU system running and common fault

7.3 BRK, HPA & CHX Process Extract Ventilation

The Process Extract System shall provide nominal containment of possible radiological particulate from within Concrete Box ullage and local environment and shall also manage the dilution of hydrogen evolved from the curing process.

The Process Extract System which will serve the BRK and HPA facilities shall include a standalone MFU installed within the Process Plant area which comprises of an Extract fan, HEPA filter, manual inlet/outlet dampers and local instrumentation.

The operation of the MFU extract fan and associated instrumentation shall be controlled and monitored via a Local Control Panel (120-BCP-002), located on the MFU. The MFU LCP shall house the extract fan VSD with its own a proprietary control HMI located on the panel fascia.

The fan motor shall include high temperature thermistor monitoring and the motor VSD shall be tripped on high temperature detection. An emergency stop push-button located on the LCP fascia shall facilitate an emergency shutdown of the fan (if determined by the Designer’s Risk Assessment).

The MFU extract fan running condition shall be monitored by two instruments; a differential pressure transmitter and a flow element monitoring system flow rate. The two instrument signals will be displayed on the LCP fascia and can be utilised by the operator to determine whether a system fault is real, as two or three alarms will indicate system failure and a single alarm may only indicate a faulty instrument.

The operating speed of the fan motor will be automatically adjusted by the VSD to provide the desired extract airflow from the Process Plant area. An automatic closed loop PID controller within the VSD shall alter the fan speed as the HEPA filter blinds to maintain design airflow.

There are no interlocks between the Process Extract and the Building Ventilation Supply or Extract systems.

System Running and fault signals shall be relayed to the MILWEP Control Room HMI to indicate the system running/stopped status and a common alarm condition on the MFU LCP.

Local flowmeters shall also be fitted in each Concrete Box flexible ductwork connection line (6 off in total) in the Curing and Filling Areas.

The Process Extract System shall comply with the DSEAR/ATEX requirements in both normal and fault conditions as defined in the Berkley & Hinkley DSEAR Assessments [5 & 6].

7.4 BRK & HPA Building Ventilation

7.4.1 General Philosophy

The Building Ventilation System comprises of a Supply Ventilation system provided from a single fan Air Handling Unit (AHU) and a single fan Extract System, which operate in tandem to ensure that a balanced ventilation air supply and extract is maintained at all times.

Both the building supply and extract systems shall be controlled from the Building Ventilation Control Panel (110/120-BCP-001) which will be located inside the building. The Ventilation Control Panel shall be a combined Motor Control Centre (MCC)/Programmable Logic Controller (PLC) panel with some operator controls mounted on the panel fascia. The combined VCP is split into dedicated MCC and PLC sections providing isolation between the motor starters and the sensitive PLC and control equipment. Operator control of the building ventilation equipment will be via a HMI display located on the VCP fascia and this will interface directly to the PLC via a communication link. The PLC software will provide the logic to control all ventilation operating sequences and process parameters including start-up, shutdown and alarm handling.

The VCP shall also include local VSD keypad controllers on the MCC panel fascia to enable configuration and control of the supply and extract fans during commissioning and maintenance activities or during a failure of the HMI/PLC. Access to these local manual controls will be password controlled on the keypad.

Three operating modes shall be manually selectable from the VCP fascia using a key switch; Automatic mode, Manual Recirculation mode or Manual Once Through mode. The key will be held under procedural control and only released by the Team Leader/Supervisor for the facility.

In Automatic (Normal) operating mode, the system will automatically select the system operating mode based on the external temperature of the building;

- ‘Recirculation’ – During periods when Building External temperature is < 15°c.
- ‘Once through’ – During periods when Building External temperature is > 20°c.

The mode of operation will also instigate the positioning of the AIDs to complete the operation as follows;

- ‘Recirculation’ - AID in recirculation duct open; AID in Extract Fan discharge closed.
- ‘Once Through’ - AID in Extract Fan discharge open; AID in recirculation duct closed.

During system power-up in Automatic mode, the system shall initially default to the ‘Recirculation’ mode.

The operator shall have the facility (via the VCP key switch) to select the ‘Manual Recirculation’ or ‘Manual Once through’ modes to run the Building Ventilation during maintenance or fault recovery conditions.

Under normal operations the air supply/extract shall be controlled, started and stopped as a ‘Building Ventilation System’ via a start push button on the VCP. Similarly, a ‘Building

Ventilation System' stop pushbutton will stop both the AHU and Extract fan in a controlled shutdown sequence.

The desired building temperature will have a control setpoint of 15°c. A PID temperature controller will be used to modulate the power to the AHU Main Heater to maintain this desired building temperature. A temperature transmitter installed within the return extract duct will provide the process variable to the temperature controller to modulate the power applied to the AHU heating coil (110-1-HTR001).

In the event of a Building Ventilation system trip condition (either supply AHU or extract fan), all of the AIDs will be spring closed effectively closing off the ductwork from outside the facility and preventing the internal air conditions from changing quickly.

There are no interlocks between the Building Ventilation system and the process plant and equipment or Process Extract.

7.4.2 Supply Ventilation Description

The Supply Ventilation system shall provide air to the building to provide an internal environment that is suitable for plant operations and to provide make-up air to the Process Extract Ventilation system.

The supply air is provided from an externally located Air Handing Unit, consisting of an inlet louvre, panel filter, bag filter, electric heater and a single fan unit. The AHU equipment shall be controlled from the Building Ventilation VCP.

The supply AHU shall include independent fan differential pressure monitoring and bag filter differential pressure monitoring instrumentation. In addition, an in-built flow measuring device with differential pressure monitoring across the supply fan will be used to measure the volumetric flow rate of the fan.

The supply fan will be a Variable Speed Drive (VSD) driven unit which will be speed modulated via closed loop PID control to maintain the desired set supply airflow into the building.

The supply fan shall include a thermistor fitted into the motor windings and connected into the VSD to provide motor over-temperature protection.

The supply fan motor 400vac supply shall be fed via an electrical isolator mounted adjacent to the main access doors of the fan compartment. The supply fan motor shall also include an Emergency stop push-button on the AHU exterior. The Emergency stop circuit shall interface to the VSD to stop the drive in the case of danger.

The AHU main heater shall be controlled via a PID temperature controller which will measure the temperature in the return extract duct and then modulate the power applied to the heater to maintain the desired building setpoint control temperature of 15°C.

The supply AHU will include an outlet AID which will automatically open during fan start-up. The open/closed position status of the outlet AID will be indicated on the VCP HMI.

An externally mounted temperature transmitter shall be mounted onto the exterior to measure the external building temperature. This temperature transmitter will be used to determine the system operating mode (Recirculation or Once through) whilst the system is in Automatic mode.

7.4.3 Extract Ventilation description

The Extract Ventilation system shall remove air from the building (Once through mode) or recirculate air back to the Supply AHU (Recirculation mode).

The extracted air is removed by an externally located Fan Unit, which includes a manual inlet damper (Locked Open) and an Automatic Outlet Damper which is opened during ‘Once through’ mode and closed during ‘Recirculation’ mode.

The Extract system shall include an independent fan differential pressure monitoring instrument. In addition, an in-built flow measuring device with differential pressure monitoring across the extract fan will be used to measure the volumetric flow rate of the fan.

The extract fan will be a Variable Speed Drive (VSD) driven unit which will be fixed to a set speed during commissioning to maintain the desired set extract airflow from the building.

The extract fan shall include a thermistor fitted into the motor windings and connected into the VSD to provide motor over-temperature protection.

The extract fan motor 400vac supply shall be fed via an electrical isolator mounted adjacent to the main access doors of the fan compartment. The supply fan motor shall also include an Emergency stop push-button on the AHU exterior. The Emergency stop circuit shall interface to the VSD to stop the drive in the case of danger.

7.5 BRK & HPA Ventilation System Remote Start Local Operator Panel

A separate Local Operator Panel (140-LOP-001) will be located outside the MILWEP building mounted adjacent to the Building Ventilation System equipment. This external panel shall have a beacon/klaxon to warn of a ventilation system fault or stoppage. This panel shall only be used in the event of a building evacuation due to building power failure and subsequent stopping of the Process Extract and Building Ventilation Systems.

The remote starting of the Process Extract and Building Ventilation Systems is to allow any hydrogen that may have accumulated while the MILWEP building has been unmanned to be extracted before people re-enter the building.

The ability to re-start both the Process Extract and Building Ventilation systems will be included on this remote panel using a remote start enable key switch (key under Team Leader/Supervisor control) and reset/start/stop pushbuttons to allow the quick dilution and dissipation of any hydrogen from the facility.

7.6 BRK & HPA Ventilation Remote Alarms to the MILWEP Control Room

System running and fault signals shall be relayed to the MILWEP Control Room HMI (510-BCP-001) for plant status/alarm messaging, including;

- Process Extract MFU system running and common fault,
- Building Ventilation system running and common fault,

The operator shall investigate a common fault locally on the specific control panel to aid diagnosis. The Process Extract common fault alarm shall invoke a software interlock to prevent CB fill operations from the HMI. If the fault occurs during CB filling operations, a supervisory decision will be made to continue or cease the process.

8. Safety Considerations

8.1 Fault Identification

The project is required to adequately address all aspects of safety - radiological, environmental and conventional. A key part of this process is identifying faults that can affect safety and implementing hazard management strategies to adequately address these faults. This is an ongoing process that shall carry through from early design through to plant operation and shall include:

- HAZOP studies to determine credible faults.
- Hazard Analysis on areas identified in the HAZOP.
- Recording the Safety Functional Requirements concluded from the above and what the Structures, Systems and Components performance requirements are to meet the requirements in the Engineering Schedule.
- Design Justification Report at the end of the design process to document how the design meets the Engineering Schedule requirements.

The following activities are to be undertaken to ensure regulatory compliance in the non-nuclear areas. These techniques are:

- Conventional Fire Safety reviews by the competent person for the facility.
- Environment, Health & Safety (EH&S) Reviews (including Construction, Design & Management Designers Risk Assessments) – may be covered by Design Review.
- Constructability / Hazard of Construction Reviews – may be covered by Design Review.

8.1.1 Engineering Schedule

Three Engineering Schedules (ESs) have been produced; one for each Site [Ref's 16 to 18].

The BRK & HPA ESs are very similar in that they place claims on the ventilation system to manage hydrogen evolution from the curing CBs whilst in the Process Stations and during transfer (using the travelling extract) and to utilise ATEX rated instruments where appropriate. Claims are also made on containment velocities whilst the temporary lid is in place on the CBs to prevent contamination release and a release fraction claim on the HEPA filtration on the Process Extract.

The design described in this BoD satisfies all of these claims made on the ventilation system.

There is one discrepancy between the safety claims made and the current Process Extract design in that a duty/standby arrangement is required, which has been removed during Value Engineering. The ESs for BRK & HPA require updating to remove this claim, as the design cannot be substantiated against this requirement.

The ES for CHX is simpler in the claims made; containment velocities are required whilst the temporary lid is in place on the CBs to prevent contamination release and there is a release fraction claim on the HEPA filtration on the Process Extract. Both claims can be substantiated.

Claims have also been made on the stack sampling (tritium, carbon-14 and isokinetic particulate sampling) for all three Sites that can be substantiated by employing the specified stack sampling systems on the Process Extract Stack.

Please see the individual ESs for more details.

8.2 Smoke & Fire Safety

No fire dampers and signals from the fire alarm to control any ventilation P&E are currently included in the design, as no requirements have been identified.

8.3 Seismic Qualification

There is no seismic requirement on the Process Extract or Building Ventilation systems.

8.4 Extreme Weather

The Building Ventilation system may be operational during extreme weather (conditions outside the design parameters described in Section 5.1) which will mean that internal design conditions will not be maintained during these periods.

9. Relevant Legislation and Standards

9.1 Statutory requirements

The following is a list of the main areas of UK legislation, which need to be considered in the design of the ventilation systems for MILWEP.

Ionising Radiations Regulations (IRR) 2017

The Ionising Radiations Regulations 2017 contain requirements relating to radioactive materials and the ventilation systems associated with their management. A summary of regulations and how the Process Extract will satisfy them is given below;

- Regulation 9(2): Work with unsealed radioactive materials; employers should give priority to the containment of radioactive substances as a means of preventing dispersal or contamination. Where containment alone is not sufficient to give the required protection, ventilation should be provided. *Section 4.1 explains how the MILWEP Process Extract complies.*
- Regulation 9(2): The radiation employer should aim to select, as appropriate, fume cupboards, sterile cabinets, gloveboxes, ducting, fan assemblies, filtration units and other components of the ventilation system which have been designed and constructed specifically for radioactively contaminated atmospheres. *The Process Extract will be designed in accordance with ES_0_1738 and associated Engineering Standards to ensure compliance with this requirement; please see Section 5 for details.*
- Regulation 9(2): Good design and construction will ensure that such equipment is constructed to facilitate maintenance, cleaning and decontamination; disposal of filter media and other such contaminated parts of the system should be achieved with minimum personal exposure to radiation. *The ventilation systems in contact with any contamination have been designed correctly to nuclear standards, as stated above.*
- Regulation 9(2): The design and operation of the ventilation system will need to satisfy any discharge authorisation requirements of the ***Radioactive Substances Act 1993***. *The extract stack will have an isokinetic particulate sampling system and a tritium sampling system to accurately collect samples from the discharged air if deemed necessary by the Site. The ventilation system design includes sampling.*
- Regulation 11(1): Active engineering controls and design features should be subjected to a regime of examination and test at suitable intervals. *The Process Extract has suitable monitoring (see Control Philosophy for details) and will be put on the routine maintenance schedule and operations inspection schedule, subject to Site agreement.*

DSEAR 2002

Please see Section 4.2 for compliance details.

The Health and Safety at Work etc Act 1974

The Act is concerned with health, safety and welfare in connection with work and the control of dangerous substances and certain emissions to the public. The Act places broad, general duties on employers, employees, manufacturers, designers and suppliers of work equipment and materials in the Workplace. The design shall be such that it allows the duties of the HSW Act 1974 to be met in terms of minimum temperatures and fresh air supplies. To assist in achieving this requirement, the following UK Regulations will be addressed in the design.

Management of Health and Safety at Work Regulations 1999 SI 1999/3242, amended by Management of Health & Safety at Work and Fire Precautions (Workplace) (Amendment) Regulations 2003 SI 2003/2457 (Made under the Health and Safety at Work etc Act 1974)

These Regulations require employers to assess risks to health and safety and record findings. They must then implement measures to control risks, appoint competent people, set up emergency procedures and provide information and training for employees and anyone else who needs to know. To comply with these regulations Design Risk Assessments and Registers of post design residual risks will be produced as part of the Ventilation design, which also covers CDM Regulations. In addition, the ventilation equipment procurement specifications will request that the equipment supplier provides appropriate operating and maintenance instructions and Technical file.

Workplace (Health, Safety and Welfare) Regulations 1992 SI 1992/3004 & amended SI 2002/2174 (Made under the Health and Safety at Work etc Act 1974, implementing EC Workplace Directive ECDIR 89/6547)

These Regulations state requirements for all places of work, regarding working environment, safety, facilities and housekeeping. Regulation 5 states that mechanical ventilation systems shall be maintained (including cleaned where appropriate) in an efficient state, in efficient working order and in good repair. To comply with this regulation the ventilation equipment will be located to allow sufficient maintenance space.

Manual Handling Operations regulations 1992 SI 1992/2793 & amended SI 2002/2174 (Made under the Health and Safety at Work etc Act 1974)

These regulations apply to any manual handling operations, which may cause injury at work. The regulations place a duty on the employer to avoid the need for his employees to undertake any manual handling operations at work, which involve a risk of their being injured. Where this cannot be avoided, a risk assessment shall be carried out and the risks reduced. To comply with these regulations lifting equipment will be specified where practicable to reduce the requirement for manual handling. Design Risk Assessments and Registers of post design residual risks produced as part of the Ventilation design which covers CDM Regulations (and carried out under Management of Health and Safety at Work Regulations 1999) will address manual handling operations which cannot be reasonably avoided; e.g. changing of HEPA filters.

Electricity at Work Regulations 1989 SI 1989/635 & Amended 1996/192 & 1997/1993 (Made under the Health and Safety at Work etc Act 1974)

These regulations impose health and safety requirements with respect to electricity at work. They impose requirements as to systems, work activities and protective equipment. Compliance with the current IEE wiring regulations (BS 7671:2001) is likely to achieve compliance with these regulations as far as design and construction is concerned. To comply with these regulations, the procurement specifications, for any Ventilation plant containing electrical equipment (e.g. motors), will request that the equipment meets the current IEE wiring regulations.

Electrical Equipment (Safety) Regulations 1994 SI 1994/3260 (Made under European Communities Act 1974 and Consumer Protection Act 1987 implementing Council Directive ECDIR 73/23)

These regulations apply to all electrical equipment for use between 50 and 1000V and require manufacturers of electrical equipment to place on the market only equipment, which does not jeopardise the safety of people, domestic animals and property. To comply with these regulations, the procurement specifications, for any Ventilation plant containing electrical equipment (e.g. motors), will request that the equipment meets these Regulations and carries a CE marking.

Electromagnetic Compatibility Regulations 1992 SI 1992/2372 & Amended 1994/3080, 1995/3180 (Made under European Communities Act 1972 implementing Council Directives ECDIR 89/336 & 92/31)

These regulations apply to all electrical and electronic appliances and associated equipment to ensure that they are constructed so as not to cause excessive electromagnetic interference or are not unduly affected by electromagnetic interference. To comply with these regulations, the procurement specifications, for any Ventilation plant containing electrical equipment (e.g. motors, variable speed drives), will request that the equipment meets these Regulations and carries a CE marking.

Construction (Design and Management) Regulations 2000 SI 2000/2380 & Amended 2015 (Made under the Health and Safety at Work etc Act 1974)

These regulations place duties on clients, planning supervisors, principal contractors, designers and contractors to plan and manage health and safety at construction sites. To comply with these regulations, under the role of the designer, Design Risk Assessments, Registers of post design residual risks and Design Reviews will be produced as part of the design process.

Provision and Use of Work Equipment Regulations (PUWER) 1998 SI 1998/2306 & amended SI 2002/2174 (Made under the Health and Safety at Work etc Act 1974)

These regulations give a general duty to an employer to supply safe equipment and give adequate information, instruction and training on its use. There are requirements under PUWER that equipment is constructed so as to be suitable for the purpose for which it is to be used and that clear instructions and information for the safe operation and maintenance of the equipment is provided. To comply with this, the procurement specifications for the Ventilation plant shall request that the equipment supplier provide appropriate operating and maintenance instructions and/or Technical file.

Supply of Machinery (Safety) Regulations 1992 SI 1992/3073 & Amended 1994/2063 (Made under the Health and Safety at Work etc Act 1974 implementing Council Machinery Directives 89/392, 91/368, 93/44 & 93/86)

These regulations apply to relevant machinery, which must be supplied safe and shown to be so and must be capable of being erected and put into service safely. To comply with these regulations Risk Assessment Forms and Risk Reduction Forms will be produced as part of the Ventilation design, the extent of the machinery shall be specified for procurement. The procurement specifications, for any Ventilation plant, which constitutes machinery or an assembly of machinery under these regulations, will request that the equipment meets these Regulations and carries a CE marking. For such machines the supplier of the machine shall maintain the Technical File and affix the CE mark, and a copy of the Declaration of Conformity shall be requested from the machine supplier.

Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 SI 1998/2307 & amended SI 2002/2174 (Made under the Health and Safety at Work etc Act 1974 implementing EC Directive 95/63)

These regulations require that the risks from lifting equipment and lifting operations be managed safely. The ventilation design does not include lifting operations in its use or lifting equipment in its design.

Control of Noise at Work Regulations 2005 SI 2005/1643 (Made under the European Communities Act 1972)

These regulations place duties on the employer to control an employee's exposure to noise, reduce noise risks, carry out assessments of noise levels, maintain equipment and provide information and training. To comply with these regulations, during the ventilation design, noise levels likely to be generated by operating equipment will be requested from equipment suppliers. These will be checked against the levels set in the regulations and measures will be included in the design to mitigate exposure. These shall be tested and verified during works testing and commissioning.

The Construction Products Regulation 1991 SI 1991/1620 & Amended 1994/3051 (Made under the European Communities Act 1972)

These regulations place requirements on the suppliers of a construction product (meaning an item which is incorporated in a permanent manner in works) to ensure that the product meets essential requirements when placed into the European market. The essential requirements relate to mechanical resistance and stability, safety in case of fire, hygiene, health and the environment, safety in use, protection against noise and energy economy and heat retention. If the product obtains a CE mark this is taken to mean that it meets the essential requirements. To comply with these regulations the Ventilation procurement specifications will request that the relevant products meet these Regulations and carry a CE marking.

9.2 Engineering Standards

The Process Extract design will be produced in accordance with ES_0_1738_1 [Ref. 1] and the following associated Engineering Standards:

- EG_0_1720_1 Issue 1 Design Guide for low and high integrity ventilation ductwork.
- ES_0_1723_2 Issue 4 Procurement Specification for high integrity stainless steel ventilation Ductwork.
- EG_0_1711_1 Issue 1 Design Guide for Filter Housings for 470l/s and 950l/s Circular Plug in HEPA filters.
- ES_0_1711_2 Issue 2 Manufacture of Safe Change HEPA Filter Housings for Use in Building Ventilation Systems.
- ES_0_1705_2 Issue 4 Type Testing and Approval of High Efficiency Particulate Air HEPA Filters.
- EG_1_1707 Issue 1 In-situ testing of HEPA filters design of duct mounted test points.
- ES_0_1737_2 Issue 4 Procurement Specification for circular plug-in 470 and 950l/s capacity HEPA filter inserts.

The building ventilation systems will be designed using CIBSE guidance where applicable;

- CIBSE Guide A – Environmental Design
- CIBSE Guide C – Reference Data

- CIBSE Guide M - Maintenance Engineering & Management

All Plant and equipment will be to commercial standards, such as;

- BS EN 1886: 2007: Ventilation for buildings - Air Handling Units - Mechanical Performance.
- BS EN 13053: 2006 +A1: 2011: Ventilation for buildings - Air Handling Units – Rating and Performance for units, components and sections.
- BS EN 378-1: 2016: Refrigerating systems and heat pumps. Safety and environmental requirements. Basic requirements, definitions, classification and selection criteria.
- BS EN 378-2: 2016: Refrigerating systems and heat pumps. Safety and environmental requirements. Design, construction, testing, marking and documentation.
- BS EN 378-3:2016. Refrigerating systems and heat pumps. Safety and environmental requirements. Installation site and personal protection.
- BS EN 378-4:2016. Refrigerating systems and heat pumps. Safety and environmental requirements. Operation, maintenance, repair and recovery.
- DW/144 (second Edition, 2013): Building & Engineering Services Association: Specification for Sheet Metal Ductwork.
- IEC EN 60204-1: Safety of Machinery – Electrical equipment of machines
- IEC 61508: Functional Safety of Electrical/Electronic/PES Related Systems
- IEC 61511: Safety Instrumented Systems for the Process Industry Sector

This ensures that a cost-effective design solution that satisfies the building ventilation system objectives is achieved.

10. System Interfaces and Service Requirements

A summary of the HVAC interfaces with others is stated below:

- Low Active Effluent Collection: Local collection from the stack drain.
- Non-Active Effluent Drain: collected water from the louvres on the AHUs.
- CB Temporary Lid: Flexible connection required between the Process Extract ductwork and the CB Temporary Lid (including travelling hose connection).
- 400V Power Distribution & Cable Racking: Power cables to feed the MFU Control Panel and the Building Ventilation Control Panel.
- Radiometric (Environmental Monitoring): The Process Extract ductwork will have suitable ports for stack sampling connection. The Building Ventilation system may require connections (to be confirmed).
- Hydrogen Monitoring System: The Process Extract ductwork will have suitable ports for hydrogen monitoring equipment connection
- Building Ventilation System Local Control Panel: 400vac Supply to local Main Distribution Board.
- Process Extract System Local Control Panel: 400vac Supply to local Main Distribution Board.

- Building Ventilation System Local Control Panel: Fault signal interface to the MILWEP Control Room HMI.
- Process Extract System Local Control Panel: Fault signal interface to the MILWEP Control Room HMI.
- Condensate drain from the heat pump in the Control Room: to surface water drain.
- Civil, Structural & Architectural (CS&A): Tertiary support steelwork is designed and supplied by CS&A to facilitate the ductwork design and installation.
- CS&A: builders work around ductwork passing through the building fabric is designed and made good by CS&A.
- CS&A: Plinths for the external P&E shall be designed by CS&A.