Form10/00

UK ABWR

Document ID	:	GA91-9101-0101-16000
Document Number	:	XE-GD-0649
Revision Number	:	C

UK ABWR Generic Design Assessment

Generic PCSR Chapter 16 : Auxiliary Systems

Hitachi-GE Nuclear Energy, Ltd.

DISCLAIMERS

Proprietary Information

This document contains proprietary information of Hitachi-GE Nuclear Energy, Ltd. (Hitachi-GE), its suppliers and subcontractors. This document and the information it contains shall not, in whole or in part, be used for any purpose other than for the Generic Design Assessment (GDA) of Hitachi-GE's UK ABWR. This notice shall be included on any complete or partial reproduction of this document or the information it contains.

Copyright

Table of Contents

Executive Summary

This chapter describes the safety case for the UK ABWR plant auxiliary systems and severe accident mechanical systems. It lists the high level Safety Functional Claims (SFCs) that are made on these systems, together with the Safety Properties Claims (SPCs) that come from the Nuclear Safety and Environmental Design Principles (NSEDPs).

Plant Auxiliary Systems include water systems; process auxiliary systems; Heating, Ventilation and Air Conditioning (HVAC) systems; the Emergency Diesel Generators (EDGs) and the severe accident mechanical Systems. The information provided for these includes: system design; functionality in normal operation and during faults; safety functional categorisation and system classification; important support systems; safety case Assumptions, Limits and Conditions for Operation (LCOs) and compliance with the As Low as Reasonably Practicable (ALARP) principle.

The overall Pre-Construction Safety Report (PCSR) justification that the UK ABWR is safe and satisfies the ALARP principle is underpinned by hazards assessments, design basis analysis, probabilistic safety analysis, beyond design basis analysis, and human factors analysis (described in PCSR Chapters 6, 7 and 24 to 27 respectively), which demonstrate that the design of the auxiliary systems covered by this chapter are fault tolerant. In addition, severe accident analysis in PCSR Chapter 26: Beyond Design Basis and Severe Accident Analysis demonstrates the effectiveness of the severe accident systems covered in this chapter in preventing or mitigating the impact of severe accidents. These analysis chapters specify the high level safety functional claims but do not specify requirements for design parameters on individual auxiliary systems or severe accident mechanical systems. Instead they apply analysis conditions and assumptions that are based on, and fully consistent with, the design information and safety claims for the systems that are presented in this chapter, in order to substantiate those claims.

The designs of Safety Class 1 and 2 sub-systems and components within the auxiliary systems are well advanced for GDA, being largely based on proven technology from the Japanese ABWR reference design. Additional risk reduction measures have been introduced (with reference to the J-ABWR design) in response to safety assessments undertaken in GDA. These include relocation of the EDGs from inside the Reactor Building (R/B) to separate buildings and the minimisation of the use of embedded pipework within the active drains systems.
Other specific issues that have been considered in the assessments to demonstrate that risks are ALARP. For example this work includes the design optioneering for the addition of a Reserve Ultimate Heat Sink (RUHS). GDA assessments assume there will be a RUHS, but detailed design of this facility will be required in post GDA phase.

This chapter demonstrates that the risks associated with the design and operation of the auxiliary systems and severe accident mechanical systems for the UK ABWR are ALARP. It is acknowledged that further work will be required in post GDA phase to develop the design and fully incorporate site specific stage. This work will be the responsibility of any future licensee.

16.1 Introduction

Chapter 16 of this PCSR presents a high level summary of the safety case for the UK ABWR plant auxiliary systems, including water systems, process auxiliary systems, HVAC and other auxiliary systems including the EDGs. The chapter also includes severe accident mechanical systems.
It presents an overview of each of the auxiliary systems and identifies the applicable design and safety requirements. It goes on to demonstrate how these requirements have been met and how the auxiliary systems contribute to the overall safety of UK ABWR.

16.1.1 Background

Auxiliary systems cover a broad category that includes those systems that are necessary to support the safe operation of the UK ABWR, but which do not fit naturally within other chapters of the PCSR. They contribute to nuclear safety by either supporting the operation of other Systems, Structures and Components (SSCs) that are important to safety (e.g. providing compressed gas to instruments or cooling water to core flooder pumps) or by delivering a safety function directly (e.g. filtration provided by the HVAC system prior to discharge). Auxiliary systems also include mechanical systems which are designed to prevent or mitigate the impact of severe accidents (e.g. core flooding via temporary connections, mobile heat exchanger facility, filtered containment venting).

16.1.2 Document Structure

This chapter includes the following sections:

Section 16.2 Purpose and Scope:
This section sets out the purpose of the chapter and identifies what is included in the scope of the chapter and what is excluded.

Section 16.3 Water Systems:
This section covers the following systems:
- Heat Sink (Ultimate Heat Sink (UHS)),
- Reactor Building Cooling Water Systems (Reactor Building Service Water System (RSW), Reactor Building Cooling Water System (RCW)),
- Turbine Building Cooling Water Systems (Turbine Building Cooling Water System (TCW), Turbine Building Service Water System (TSW)),
- Makeup Water Systems (Makeup Water Condensate System (MUWC)),
- HVAC Cooling Water Systems (HVAC Emergency Cooling Water System (HECW), Normal Cooling Water System (HNCW)), HVAC Backup Building Cooling Water System (HBCW)), and
- Emergency Equipment Cooling Water System (EECW).

Section 16.4 Process Auxiliary Systems:
This section covers the following systems:
- Compressed Gas Systems (Instrument Air System (IA), Station Service Air System (SA), High Pressure Nitrogen Gas Supply System (HPIN)),
- Drain System (Plumbing and Drainage System, Miscellaneous Non-Radioactive Drain Transfer System (MSC), Radioactive Drain Transfer System (RD)),
- Process Sampling System (SAM) and Outer Secondary Containment Grab Sampler (OSCGS),
- Chemical Injection Systems, and

- Steam Supply System (including House Boiler).

Section 16.5 Heating Ventilating and Air Conditioning System:
This section covers the following HVAC systems:
- Reactor Area (R/A) HVAC,
- Reactor Building Emergency Electrical Equipment Zone (RBEEE/Z) HVAC,
- Emergency D/G Electrical Equipment Zone (DGEE/Z) HVAC,
- Turbine Building (T/B) HVAC,
- Heat Exchanger Building Normal and Emergency (Hx/B-N and Hx/B-E) HVAC,
- Control Building Emergency Electrical Equipment Zone (CBEEE/Z) HVAC,
- Control Building Class 2 Electrical Equipment Zone (CBC2EE/Z) HVAC,
- Main Control Room (MCR) HVAC,
- Radwaste Building (Rw/B) HVAC,
- Service Building (S/B) HVAC,
- Backup Building Electrical Equipment Zone (BBEE/Z) HVAC, and
- Backup Building Emergency Control Room (BBECR) HVAC.

Section 16.6 Other Auxiliary Systems:
This section covers:
- Fire Protection Systems (FP) (including fire detection, alarm, firefighting and smoke control systems),
- Emergency Power Supply Systems (including EDG, Back-up Building Generator (BBG) and Diverse Additional Generator (DAG)), and
- Suppression Pool Clean-up System (SPCU).

Section 16.7 Severe Accident Mechanical Systems:
This section covers:
- Flooder System of Specific Safety Facility (FLSS),
- Flooder System of Reactor Building (FLSR),
- Filtered Containment Venting System (FCVS),
- Lower Drywell Flooder System (LDF),
- Alternate Heat Exchanger Facility (AHEF),
- Reactor Depressurisation Control Facility (RDCF), and
- Alternative Nitrogen Injection System (ANI).

Section 16.8 Assumptions, Limits and Conditions for Operation:
This section summarises the limits and conditions for operation that are specified in greater detail in the Basis of Safety Case (BSC) documents for the SSCs in the scope of this Chapter. Assumptions are not covered in this chapter because there are no fundamental assumptions.

Section 16.9 Summary of ALARP Justification:
This section presents a summary of how auxiliary systems contribute to reducing risks to As Low As Reasonably Practicable (ALARP).

Other relevant information is captured in Appendices as follows:
Appendix A – Safety Functional Claims Tables:
The claim tree for the SSCs in this chapter shown in Appendix A is a simplified version of the detailed claim tree contained in the BSC or Topic Report (TR) of the related SSC.

Appendix B – Safety Properties Claims Tables:
The nine generic SPCs for all Mechanical Engineering (ME) SSCs that define the design requirements applicable to the SSCs scope of this chapter are presented in Appendix B tables as ME SPCs. These tables of SPCs were derived for the ME SSCs based on the 'guide word' approach specified in Hitachi-GE's Safety Case Development Manual (SCDM) (Ref-16.1-5). Having derived the SPCs, a mapping exercise was undertaken to ensure that the SPCs fully cover the relevant NSEDPs applicable to the ME area. More information on the development of SPCs, and the coverage, at the more detailed level in the safety case, to demonstrate full compliance with the relevant NSDEPs is presented in Chapter 5, Section 5.3 and the Topic Report on Safety Requirements for Mechanical SSCs (Ref-16.1-3). Fulfilment of the requirements from the SPCs is justified in the BSC or TR of the related SSC as well as the Topic Report on Mechanical SSCs Architecture (Ref-16.1-4).

Appendix C – Document Map:
The document map showing Level 2 documents that support this chapter is provided in Appendix C.

The main links of this chapter with other GDA PCSR chapters are as follows:

- For links to Generic Environmental Permit (GEP) and Conceptual Security Arrangements (CSA) documentation, please see Chapter 1: Introduction. For GEP, where specific references are required, for example in Radioactive Waste Management, Radiation Protection, Decommissioning, these are included in the specific sections within the Generic PCSR.
- The general principles for the identification of LCOs related to the systems within this chapter scope are described in Chapter 4: Safety Management throughout Plant Lifecycle.
- The categorisation of safety functions and safety classification of SSC in this chapter conform with the methodology described in Chapter 5: General Design Aspects. The general requirements for equipment qualification, Examination Inspection Maintenance and Testing (EMIT) and codes and standards that come from this safety categorisation and classification are also described in Chapter 5. Further details can be found in the section related to EMIT of the BSC document of the systems within scope of this chapter.
- Hazard assessments (e.g. flooding, fire, rotating equipment related hazards, etc.) to demonstrate adequate performance of systems within this chapter scope are included in Chapters 6 and 7 (External and Internal Hazards respectively).
- The design of the function of auxiliary systems to confine radioactive material within the primary containment are described in Chapter 13: Engineered Safety Features).
- Control and instrumentation functions to support the SSCs in Chapter 16 is described and justified in Chapter 14: Control and Instrumentation (C&I).
- The supplies to provide electrical power to the SSCs in Chapter 16 is described in Chapter 15: Electrical Power Supplies.
- The chemistry of the fluids of the Chapter 16 systems is described and justified in Chapter 23: Reactor Chemistry.
- The performance of systems within Chapter 16 scope during design basis events is assessed and the conclusions reported in Chapter 24: Design Basis Analysis.
- Probabilistic analysis to demonstrate adequate performance of systems within Chapter 16 scope during accident conditions is included in Chapter 25: Probabilistic Safety Assessment.
- The contribution of Chapter 16 systems to severe and beyond design basis accidents is assessed and the conclusions reported in Chapter 26: Beyond Design Basis and Severe Accident Analysis.
- Substantiation of Human Based Safety Claims related to human interactions with systems within this chapter scope is described in Chapter 27: Human Factors.
- An overview of how the UK ABWR design has evolved, and how this evolution contributes to the overall ALARP case is described in Chapter 28: ALARP evaluation.

- Claims on the availability of the SSCs covered by this chapter to contribute to safe decommissioning operations and general requirements for decommissioning of these SSCs are described in Chapter 31: Decommissioning.

This chapter is supported by a set of reference documents, primarily BSCs (Level 2 documents) and their associated Level 3 documents, including System Design Descriptions (SDDs). Each BSC describes a specific system within the scope of Chapter 16, explaining where the arguments and evidence that substantiate the safety claims for those systems are presented. A full list of the Level 2 documents is provided within the document map in Appendix C.

16.2 Purpose and Scope

16.2.1 Purpose

The purpose of this chapter is to present a high level summary of the safety case for the UK ABWR auxiliary systems, and a route map to where the more detailed evidence can be found. This chapter supports the overall conclusion of the PCSR that risks associated with the UK ABWR are demonstrably ALARP.

The aim of the chapter is also to provide a link to the supporting documents that substantiate that all required safety functions can be delivered by the auxiliary systems, and to confirm that there is an adequate level of confidence in the substantiation to support the GDA process.

Specific objectives of Chapter 16 are to:

(1) Identify and describe the systems within the scope of the auxiliary systems.
(2) Identify the support systems required for all systems in the scope of Chapter 16, and describe where the arguments and evidence that substantiate all relevant safety claims on these are presented in supporting documents (or in other chapters of the GDA PCSR).
(3) Describe the various modes of operation of the systems within the Chapter scope (in normal operation and fault conditions).
(4) Identify and describe the safety functions of the SSCs within the scope of the Chapter, and to specify the safety categorisation of those functions.
(5) Specify the safety classification of the SSCs within the scope of the Chapter.
(6) Specify all claims relevant to auxiliary systems (SFCs and SPCs) and provide links to the associated BSCs and TRs which set out the supporting arguments and evidence.
(7) Identify all links to other chapters of the GDA PCSR to ensure consistency across the whole safety case
(8) Describe or provide links to where the detailed arguments and evidence can be found in the supporting BSCs, TRs and the detailed Level 3 design information.
(9) Provide links to evidence that demonstrate that the risks associated with the SSCs within the scope of the chapter are ALARP.

16.2.2 Scope

The scope of this chapter covers the following auxiliary systems, at a level of detail appropriate for GDA:

- Water Systems,
- Process Auxiliary Systems,
- Heating Ventilating and Air Conditioning Systems,
- Other Auxiliary Systems, and
- Severe Accident Mechanical Systems.

For each of the systems (listed above), the chapter covers:

- Safety claim(s), safety function(s),
- System description,
- System configuration(s),
- System operating mode(s),

- System design specification(s) (i.e. design codes and standards, environmental qualification, safety category and classification, seismic categorisation, SFC and SPC),
- Support systems (i.e. power supply, C&I, air systems, cooling systems, HVAC systems), and
- A description of where the arguments and evidence that substantiate all relevant safety case claims are presented in supporting documents.

16.3 Water Systems

16.3.1 Ultimate Heat Sink

Design Bases

This section describes the design basis for the Ultimate Heat Sink (UHS).
The UHS has been designed to meet the following Safety Functional Claims (SFCs). The relation between the SFCs put on this system and the high level claims is shown in Appendix-A.

Normal and Faults Conditions
The UHS is the principal means to provide sufficient cooling water to the RSW to dissipate the heat from the plant auxiliaries required for power operation, shutdown operation, hot standby with Off-site power and main condenser available, hot standby under Loss of Off-site Power (LOOP) and main condenser unavailable, and main design basis fault scenarios (LOCA).
This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. [UHS SFC 5-2.1]

System Summary Description

(1) Functions Delivered

The UHS ensures that an adequate source of cooling water is available at all times for reactor operation, shutdown cooling and accident mitigation. The RSW receives the cooling water from the UHS and returns the water to it.

(2) Basic Configuration

The conceptual configuration of the SSCs related to the UHS is summarised as follows:

(a) UHS
(b) Heat Exchanger Building (Hx/B)
The Hx/B is the structure housing the RSW Pumps, associated piping and valves. Refer to Chapter 10: Civil Works and Structures for the design description of the Hx/B.
(c) Reactor Building Service Water System (RSW)
The RSW is divided into 3 independent and separated divisions A, B and C each one provided with the following main components:
(i) Three RSW Pumps per division
(ii) Piping and valves
(iii) Instruments and controllers
(d) Reactor Building Cooling Water System (RCW)
The RCW is divided into 3 independent and separated divisions A, B and C each one provided with the following main components :
(i) Three RCW Pumps per division
(ii) Three RCW Heat Exchangers per division
(iii) Piping and valves
(iv) Instruments and controllers

Figure 16.3-1 shows an outline of the RCW/RSW basic configuration.

(3) Modes of Operation

The UHS is designed to operate in conjunction with the RSW and RCW for the following principal modes:
The UHS provides cooling water to the RSW and accepts the heatload sent from the RSW as a result of the heat removal from the R/B auxiliaries operating during the modes indicated below by the RCW, which transfers the heat to the RSW through the RCW Heat Exchangers:

(a) Power Operation Mode
(b) Shutdown Operation Mode
(c) Hot Standby Mode (Off-site Power and Main Condenser Available)
(d) Hot Standby Mode (Off-site Power and Main Condenser Unavailable)
(e) Main Design Basis Fault Scenarios (LOCA) Mode

(4) Reserved Ultimate Heat Sink

The role of Reserved Ultimate Heat Sink (RUHS) is to maintain stable condition under the Loss of Ultimate Heat Sink (LUHS) event such as intake blockage due to seaweed. The frequency of LUHS and the detailed design of the RUHS are site specific, however, LUHS is regarded as frequent fault in UK-ABWR, and it is considered that RUHS could be connected to RCW or RSW from the point of view of safety and rationality. RUHS is designed to start automatically upon LUHS signal. The design requirement for RUHS is equivalent to the UHS [Ref-16.3-1].

Figure 16.3-2 shows an outline of the RUHS connected to the RCW basic configuration.
Figure 16.3-3 shows an outline of the RUHS connected to the RSW basic configuration.

Assumptions, Limits and Conditions for Operation

In order to ensure that the UHS is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs and surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is described in the generic technical specifications [Ref-16.3-37].

- Three divisions of UHS shall be operable during start-up, power operation, hot shutdown, cold shutdown and refuelling for the delivery of the SFCs claimed when required.

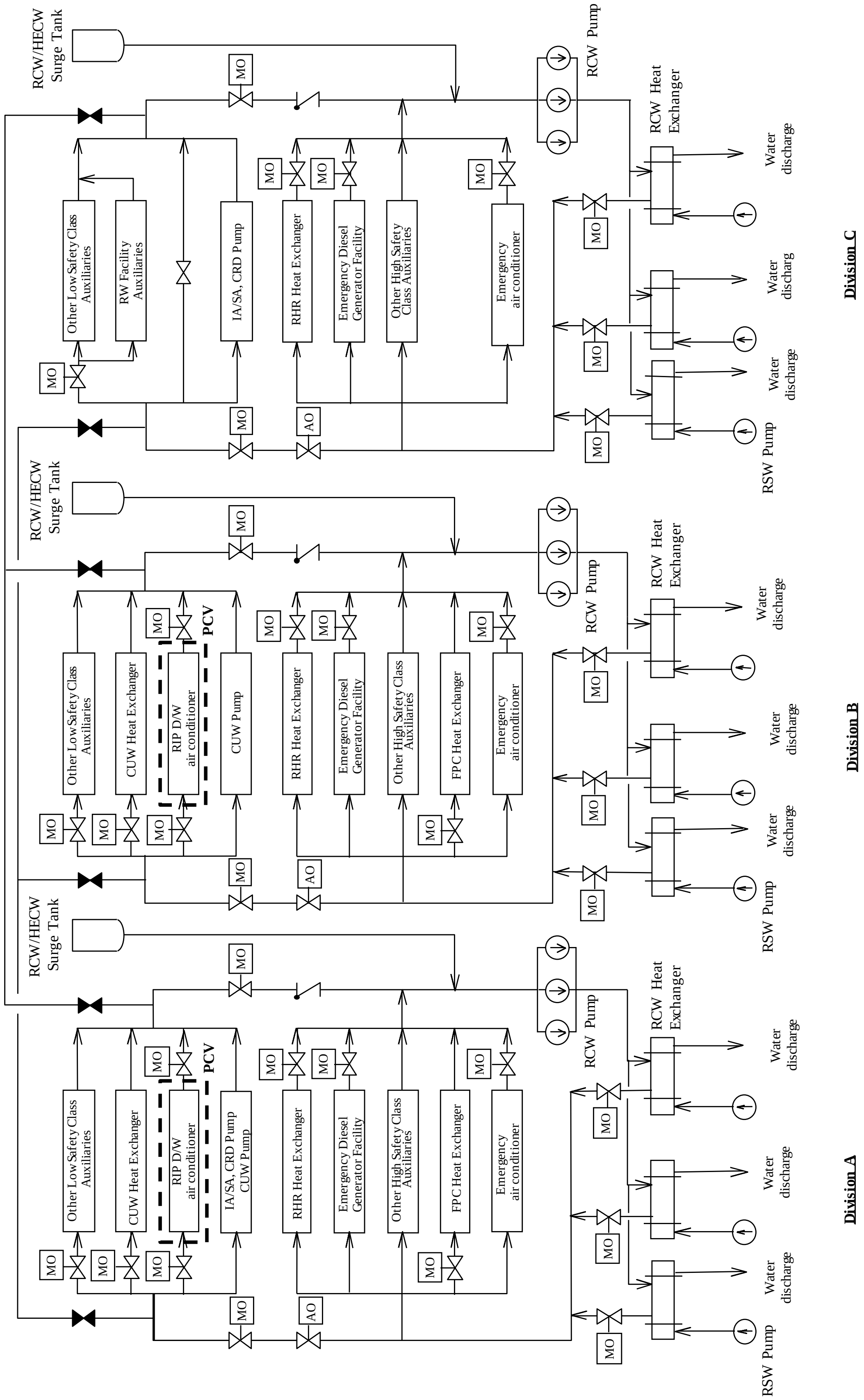


Figure 16.3-1 Outline of the RCW/RSW basic configration

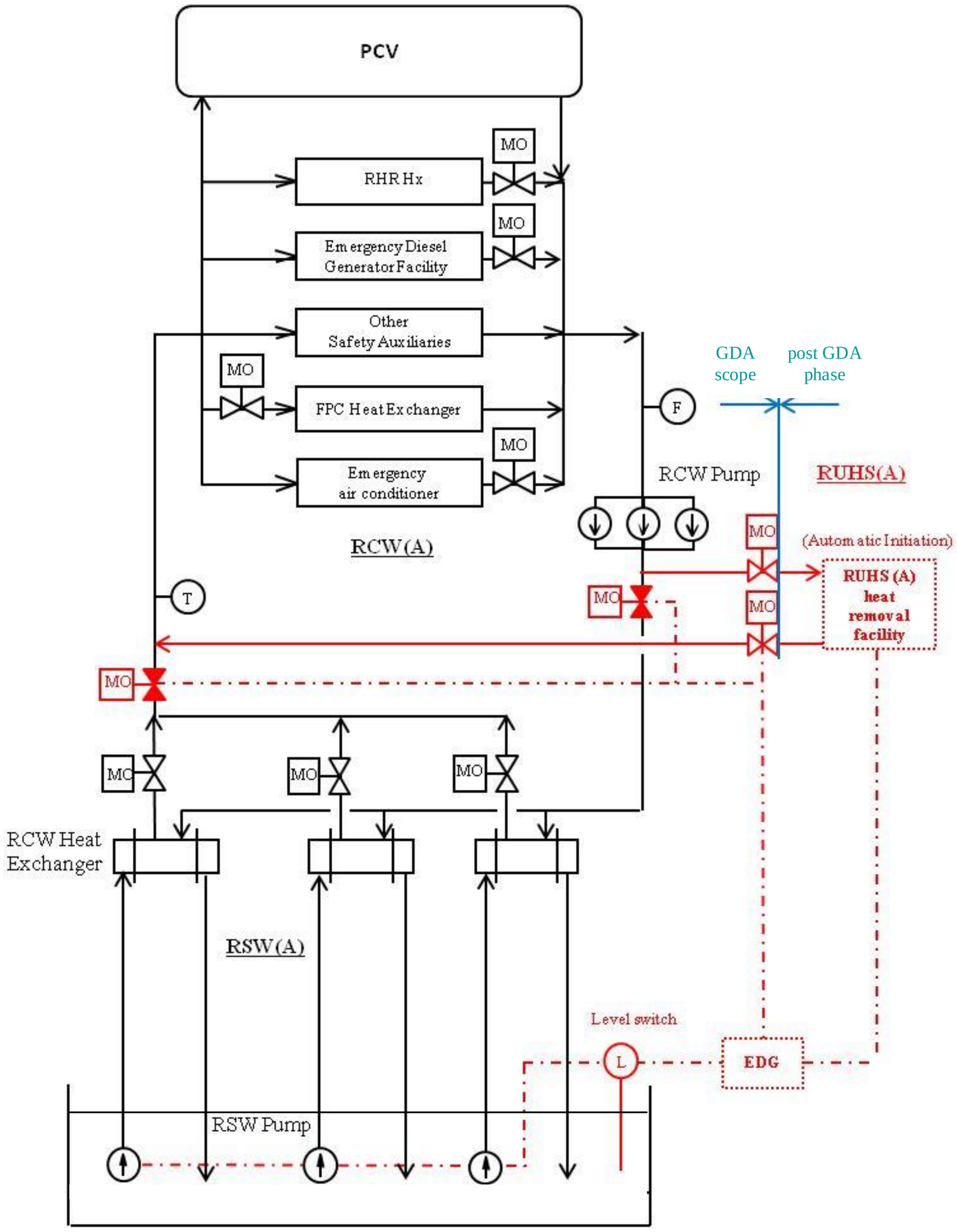


Figure 16.3-2 outline of the RUHS connected to the RCW basic configuration

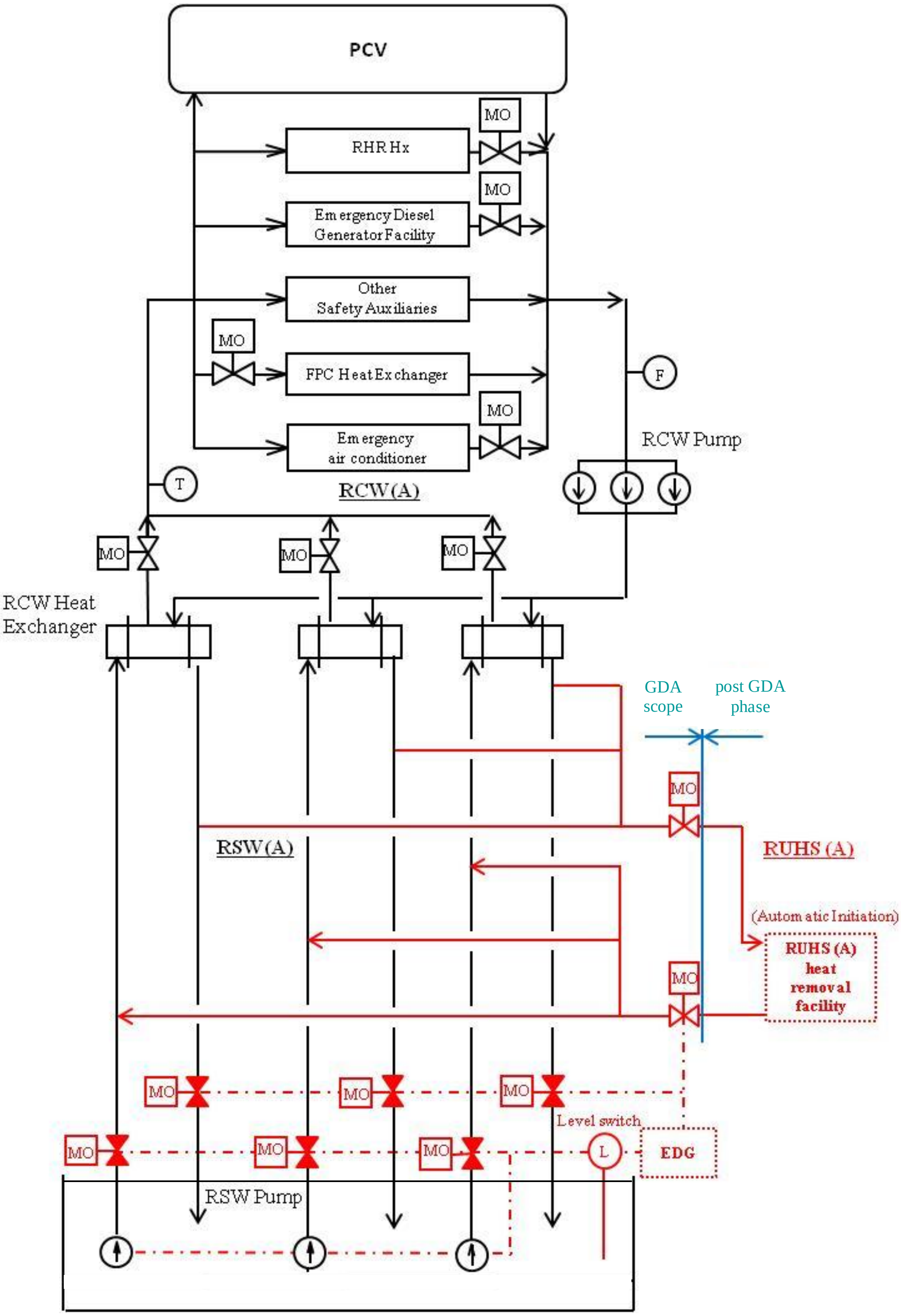


Figure 16.3-3 outline of the RUHS connected to the RSW basic configuration

16.3.2 Reactor Building Cooling Water Systems

16.3.2.1 Reactor Building Cooling Water System

System Summary Description

This section is a general introduction to the Reactor Building Cooling Water System (RCW) where the systems roles, systems functions, systems configuration and modes of operation are briefly described. The RCW safety case is justified in the Reactor Building Cooling Water System Basis of Safety Cases (BSC) [Ref-16.3-2]. The RCW is described in detail in the system specifications [Ref-16.3-3] and the Piping and Instrumentation Diagrams [Ref-16.3-4] [Ref-16.3-5] [Ref-16.3-6] [Ref-16.3-7] [Ref-16.3-8] [Ref-16.3-9] [Ref-16.3-10] [Ref-16.3-11] [Ref-16.3-12].

(1) System Roles

The main role of the RCW is to supply RCW water to the plant auxiliaries in order to preserve the specified functions. Plant auxiliaries consist of the equipment of low safety significance and the equipment of high safety significance (reactor auxiliaries, the emergency heating ventilation and air conditioning auxiliaries and etc.).

(2) Functions Delivered

The RCW is designed to perform the following safety functions:

(a) The RCW recirculates cooling water through the closed loop comprising the RCW Heat Exchanger and the equipment of low safety significance by the RCW Pump to remove the heat from each piece of equipment during normal plant operation, shutdown or hot standby (Off-site power available) and transfer it to the RSW.

(b) The RCW recirculates cooling water through the closed loop comprising the RCW Heat Exchanger and the equipment of high safety significance by the RCW Pump to remove the heat from each piece of equipment after automatic initiation during plant abnormal conditions such as Loss of Off-site Power (LOOP) or Loss of Coolant Accident (LOCA) and transfer it to the RSW.

(c) With regard to the Fuel Pool Cooling and Clean-up System (FPC), the RSW and the HVAC Emergency Cooling Water System (HECW) auxiliaries, the RCW recirculates cooling water through the closed loop comprising the RCW Heat Exchanger and their auxiliaries by the RCW Pump to remove the heat from each one of their auxiliaries regardless of the plant operation conditions and transfer it to the RSW.

(3) Basic Configuration

The RCW consists of three independent divisions for cooling of all safety auxiliaries (RCW (A), RCW (B) and RCW (C)) provided with three RCW Pumps and three RCW Heat Exchangers each. In addition, each division is provided with one RCW Surge Tank to ensure the RCW Pump intake pressure and time delay against leakage of cooling water from the system. The RCW is provided with two RCW Chemical Addition Tanks (one tank is shared by two divisions, and another tank is shared by the other division of RCW and the Turbine Building Cooling Water System (TCW)) to inject corrosion inhibitor into the cooling water when necessary.

The main components are summarised as follows:

(a) Three RCW Pumps per division (A, B, C),
(b) Three RCW Heat Exchangers per division (A, B, C),
(c) One RCW Surge Tank per division (A, B, C),
(d) Two RCW Chemical Addition Tanks in the system (Division B and C share the one tank, and division A of RCW and TCW share another tank),
(e) Piping and valves, and
(f) Instruments and controllers.

(4) Modes of Operation

The RCW can deliver the following operation modes:

(a) Power Operation Mode
The RCW distributes cooling water to remove heat from the plant auxiliaries during power operation, and transfers it to the RSW through the heat exchangers, which remove heat from the RCW and transfer it to the UHS.
This mode is initiated and controlled by remote manual operation from the Main Control Room (MCR). Two RCW Pumps and two Heat Exchangers are in service at each division during this mode while the remaining components are on Standby.

(b) Shutdown Operation Mode
The RCW destributes cooling water to remove decay heat from the RHR Heat Exchanger as well as the heat from the plant auxiliaries during normal reactor shutdown, and transfers it to the RSW through the heat exchangers, which remove heat from the RCW and transfer it to the UHS.
This mode is initiated and controlled by remote manual operation from the MCR and, three RCW Pumps and three RCW Heat Exchangers are in service in each division during this mode.

(c) Hot Standby Mode (Off-site Power and Main Condenser Available)
The RCW distributes cooling water to remove heat from the plant auxiliaries during Hot Standby (Off-site Power and Main Condenser Available), and transfers it to the RSW through the heat exchangers, which remove heat from the RCW and transfer it to the UHS.
This mode is manually operated from the MCR in conjunction with the Hot Standby Mode of the Turbine System to remove the heat from the plant auxiliaries. During Hot Standby (Off-site Power and Main Condenser Available) mode, two RCW Pumps and two RCW Heat Exchangers per division are in service with the rest on Standby.

(d) Off-site Power or Main Condenser Unvailable
The RCW distributes cooling water to remove heat from the plant auxiliaries when Off-site power or Main Condenser are unavailable, and transfers it to the RSW through the heat exchangers, which remove heat from the RCW and transfer it to the UHS.
This mode is initiated automatically upon LOOP signal to remove decay heat from the RHR Heat Exchangers as well as the plant auxiliaries (Emergency Diesel Generator Facility, etc.) by operating the three RCW pumps and the three RCW Heat Exchangers of each division. Power supply for this mode is supplied by the Emergency Diesel Generator System.

(e) Main Design Basis Fault Scenarios Mode
The RCW distributes cooling water to remove heat from the plant auxiliaries during Design Basis Fault, and transfers it to the RSW through the heat exchangers, which remove heat from the RCW and transfer it to the UHS.
This mode is initiated automatically upon LOCA signal or Suppression Pool Cooling automatic initiation signal to remove decay heat from the RHR Heat Exchangers as well as the heat from plant auxiliaries (Emergency Diesel Generator Facility, etc.). The three RCW Pumps and three RCW Heat Exchangers of each division are operated for this mode.

Design Bases

This section describes the design bases for the RCW.
The RCW has been designed to meet the following SFCs. The linkage between the SFCs of the RCW with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

<u>Decay Heat Removal Function</u>

Normal Conditions

(a) The RCW is a principal means together with the RHR to remove residual heat from the reactor by transferring residual heat from the RHR process water to the RSW process water after normal reactor shutdown to reach reactor cold shutdown.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. [RCW SFC 3-1.1]

Fault Conditions

(b) The RCW is a principal means together with the RHR to deliver long term containment heat removal by transferring the decay heat of fission products from the RHR process water to the RSW process water in the event of frequent faults such as LOOP and infrequent faults such as LOCA.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. [RCW SFC 3-1.2]

Normal and Fault Conditions

(c) The RCW is a principal means together with the FPC and the RHR to maintain the SFP water temperature within the design values by transferring decay heat from the RHR and FPC process water to the RSW process water.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. [RCW SFC 2-4.1]

<u>Class 1 Auxiliaries Cooling Function</u>

Fault Conditions

(a) The RCW is an essential system for supporting HPCF operation by removing heat from the main HPCF components (HPCF Pumps) and transferring it to RSW process water whenever HPCF operation is required.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This function is an essential service for the ECCS described in the BSC on Emergency Core Cooling system. [RCW SFC 5-2.1]

(b) The RCW is an essential system for supporting EDG operation by removing heat from the RCW Heat Exchanger and transferring it to RSW process water whenever EDG operation is required.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This function is an essential service for the EDG described in the BSC on Emergency Power Supply System.[RCW SFC 5-2.2]

Normal and Fault Conditions

(c) The RCW is an essential system for supporting RHR operation by removing heat from the main RHR components (RHR Pumps) and transferring it to RSW process water whenever RHR operation is required.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This function is an essential service for ECCS described in the BSC on Emergency Core Cooling system.[RCW SFC 5-2.3]

(d) The RCW is an essential system for supporting Safety Class 1 HVAC operation by removing heat from HVAC components (Safety Class 1 LCUs and HECW Chillers) and transferring it to RSW process water whenever HVAC is operating.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This function is an essential service for HVAC described in the BSC on Heating, Ventilating and Air Conditioning system.[RCW SFC 5-2.4]

<u>Class 2 Auxiliaries Cooling Function</u>

Fault Conditions

The RCW is an essential system for supporting Safety Class 2 HVAC operation by removing heat from HVAC components (Safety Class 2 LCUs) and transferring it to RSW process water whenever HVAC is operating.
This function is categorized as Category B and the components to deliver it are designed to meet Class 2 requirements.
This function is an essential service for HVAC described in the BSC on Heating, Ventilating and Air Conditioning system.[RCW SFC 5-2.5]

<u>Other Auxiliaries Cooling Function</u>

Normal and Fault Conditions

The RCW supports the operations of Safety Class 3 auxiliaries (RIP motors, RIP MG Sets, DWC cooling units, CUW Pumps and Heat Exchangers, CRD Pumps, IA and SA Compressors, etc.) by removing heat from them and transferring it to RSW process water.
This function is categorized as Safety Category B and the components to deliver it are designed to meet Safety Class 3 requirements. [RCW SFC 5-11.1]

<u>PCV Isolation Function</u>

Fault Conditions

The RCW components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. This function is categorised as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This function is an essential service for PCV isolation. [RCW SFC 4-7.11]

System Design Description

This section describes the design of the RCW to support and justify the delivery of [RCW SFC 3-1.1], [RCW SFC 3-1.2], [RCW SFC 2-4.1], [RCW SFC 5-2.1], [RCW SFC 5-2.2], [RCW SFC 5-2.3], [RCW SFC 5-2.4], [RCW SFC 5-2.5] and [RCW SFC 5-11.1]. Additional design description can be found in [Ref-16.3-2] [Ref-16.3-3] [Ref-16.3-4] [Ref-16.3-5] [Ref-16.3-6] [Ref-16.3-7] [Ref-16.3-8] [Ref-16.3-9] [Ref-16.3-10] [Ref-16.3-11] [Ref-16.3-12].

(1) Overall System Design and Operation

The RCW is composed of three electrical and mechanical independent divisions designated A, B, and C. Each division contains the necessary piping, pumps, valves and heat exchangers.

The RCW distributes cooling water to remove heat from the plant auxiliaries during power operation, shut down operation, hot standby (Off-site Power and Main Condenser Available), hot standby (Off-site Power and Main Condenser Unavailable) and Main Design Basis Fault Scenarios, and transfer it to the RSW through the heat exchangers, which removes heat from the RCW and transfer it to the UHS.

The auxiliaries to be supplied cooling water by RCW are assigned to the three divisions by considering equipment arrangement, heat loads, flow balance and the distribution of power supply to the loads.

During Power Operation Mode and Hot Standby Mode (Off-site Power and Main Condenser Available), two RCW Pumps and two RCW Heat Exchangers continuously operate in one division in each of the divisions (A, B and C).

The RCW is provided with isolation valves to automatically separate the safety auxiliaries required during LOOP and LOCA from those non-safety auxiliaries, in order to ensure the integrity and safety functions of the system during LOOP and LOCA.

The RCW is configured as a closed loop and designed such that it automatically fills up with cooling water to prevent cooling water insufficiency through the surge tanks. Makeup water is automatically added to the surge tanks from the MUWP.

There are interconnecting tie lines between the divisions, which are be used to supply cooling water to auxiliaries of the RCW division isolated for maintenance during refuelling outages. During refuelling outage backup mode, the auxiliaries supplied cooling water are limited so that the capacities of the RCW Pumps and heat exchangers in the supplying divisions are not exceeded. The tie lines are closed during the rest of operating modes.

(2) Equipment Design and Operation

(a) RCW Pump

(i) Purpose

The purpose of the RCW pump is to send cooling water to the plant auxiliaries and remove the heat from them in order to deliver [RCW SFC 3-1.1], [RCW SFC 3-1.2], [RCW SFC 2-4.1], [RCW SFC 5-2.1], [RCW SFC 5-2.2], [RCW SFC 5-2.3], [RCW SFC 5-2.4], [RCW SFC 5-2.5] and [RCW SFC 5-11.1].

(ii) Configuration and Operation

Divisions A and B of the RCW are designed to supply approximately 3,900 m^3/h of cooling water and division C of the RCW is designed to supply approximately 3,300 m^3/h of cooling water to satisfy the required flow of cooling water for all operating modes. Based on this, divisions A and B are provided with three pumps of approx. 1,300 m^3/h of design flow rate per pump for each division, and division C is provided with three pumps of approx. 1,100 m^3/h of design flow rate per pump.

(iii) Performance

The RCW Pump is designed to perform as follows in order to ensure the delivery of [RCW SFC 3-1.1], [RCW SFC 3-1.2], [RCW SFC 2-4.1], [RCW SFC 5-2.1], [RCW SFC 5-2.2], [RCW SFC 5-2.3], [RCW SFC 5-2.4], [RCW SFC 5-2.5] and [RCW SFC 5-11.1]:

Table 16.3-1 : RCW Pump Capacity

	RCW (A/B)	RCW(C)
Number	3 units/division (2 divisions)	3 units/division (1 division)
Rated Flow	1,300m^3/h (per unit)	1,100m^3/h (per unit)

(b) RCW Heat Exchanger

(i) Purpose

The RCW heat exchangers cool the plant auxiliaries in order to preserve the specified functions by transferring heat energy from the RCW circulating water to the RSW service water supplied from the Ultimate Heat Sink in order to deliver [RCW SFC 3-1.1], [RCW SFC 3-1.2], [RCW SFC 2-4.1], [RCW SFC 5-2.1], [RCW SFC 5-2.2], [RCW SFC 5-2.3], [RCW SFC 5-2.4], [RCW SFC 5-2.5] and [RCW SFC 5-11.1].

(ii) Configuration and Operation

The RCW is provided with three plate type heat exchangers per division for heat removal from the RCW during all operating modes per division. Divisions A and B are provided with three heat exchangers of approximately 19.3 MW/unit each and division C is provided with three heat exchangers of approximately 17.3 MW/unit. One side water is RSW water circulated by the RSW, whereas the other side (RCW) is RCW water.

(iii) Performance

The RCW Heat Exchanger is designed to perform as follows in order to ensure the delivery of [RCW SFC 3-1.1], [RCW SFC 3-1.2], [RCW SFC 2-4.1], [RCW SFC 5-2.1], [RCW SFC 5-2.2], [RCW SFC 5-2.3], [RCW SFC 5-2.4], [RCW SFC 5-2.5] and [RCW SFC 5-11.1]:

Table 16.3-2 : RCW Heat Exchanger Capacity (Divisions A and B)

RCW Heat Exchanger (A)/(B)		
	Primary side	Secondary side
Fluid	RCW water	RSW water
Flow rate (m^3/h per unit)	1,300	1,500
Capacity (MW/unit)	Approx.19.3	

Table 16.3-3 : RCW Heat Exchanger Capacity (Division C)

RCW Heat Exchanger (C)		
	Primary side	Secondary side
Fluid	RCW water	RSW water
Flow rate (m^3/h per unit)	1,100	1,500
Capacity (MW/unit)	Approx.17.3	

(3) Main Support Systems

(a) Instrumentation and Control System

Instrumentation
Instrumentation is provided to measure and monitor the operating conditions of the RCW components necessary for the delivery of the safety functions. The main provisions for instrumentation are described as follows:

(i) All instruments are arranged so that monitoring and control of process variables (flow rate, pressure, etc.) and operation are performed from the Main Control Room (MCR).

(ii) Sampling points for determining RCW water quality and detecting any leakage of radioactive fluids from the auxiliaries (such as the RHR Heat Exchangers, the CUW Heat Exchangers, etc.) are provided.

(iii) The position of all motor-operated and pneumatic valves is indicated on the MCR.

Control
The main control provisions related to the delivery of the safety functions by the RCW are summarised as follows:

(iv) All the RCW Pumps and the RCW Heat Exchangers are designed to start automatically upon the LOOP, the LOCA or the Suppression Pool Cooling automatic initiation signals.

(v) The isolation valves separating non-safety loads from safety loads during LOOP and LOCA are designed to close automatically upon the LOOP or the LOCA signal. These valves fully close if the control signal to the valve is lost.

(b) Power Supply System

(i) The normal AC power supply to the RCW electrical components is provided by an independent and Off-site source (external grid). In addition, RCW Class 1 components, valves, instruments and controllers are provided with emergency AC power supply and DC power supply.

(ii) Each of the RCW divisions A, B and C is supplied power by independent divisions 1, 2 and 3 of the emergency power supply system respectively.

(4) System Architecture

(a) Redundancy
The RCW consists of three redundant divisions A, B, and C with their respective pumps, heat exchangers, strainers, piping, valves, and instrumentation such that single failure of any dynamic component does not prevent the delivery of the safety functions.

(b) Independence
The components forming the three divisions of the RCW are independent and separately arranged in different locations within the Heat Exchanger Building (Hx/B) to prevent failure of a component in one of the divisions from leading to a common cause failure of all divisions.

Assumptions, Limits and Conditions for Operation

In order to ensure that the RCW is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs and surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is described in the Basis of Safety Cases on Reactor Building Cooling Water System [Ref-16.3-2].

- Three divisions of RCW shall be operable during start-up, power operation and hot shutdown for the delivery of the SFCs claimed when required.

- Three divisions of RCW shall be operable during cold shutdown and refuelling for the delivery of the SFCs claimed when required (one RCW division may be inoperable after a number of hours from initial entry into hot shutdown in the process to shut down the reactor).

16.3.2.2 Reactor Building Service Water System

System Summary Description

This section is a general introduction to the Reactor Building Service Water System (RSW) where the systems roles, systems functions, systems configuration and modes of operation are briefly described. The RSW safety case is justified in the Reactor Building Cooling Water Systems Basis of Safety Cases (BSC) [Ref-16.3-2]. The RSW is described in detail in the system specifications [Ref-16.3-13] and the Piping and Instrumentation Diagrams [Ref-16.3-14] [Ref-16.3-15] [Ref-16.3-16].

(1) System Roles

The main role of the RSW is to cool and remove the heat from the RCW by supplying RSW water from the UHS.

(2) Functions Delivered

The RSW is designed to perform the following safety functions:
The RSW provides RSW water to the RCW Heat Exchangers from the water intake pit in order to remove the heat from RCW and discharge it into the water discharge pit. (Intake and discharge pit will be designed post GDA phase.)

(3) Basic Configuration

The RSW consists of three independent divisions A, B and C corresponding to the RCW divisions. Each division consists of three RSW Pumps, three RSW Strainers, piping, etc.

The main components are summarised as follows:
(a) Three RSW Pumps per division (A, B, C),
(b) Three RSW Strainers per division (A, B, C),
(c) Piping and valves, and
(d) Instruments and controllers.

(4) Modes of Operation

The RSW can deliver the following operation modes:

(a) Power Operation Mode
The RSW removes the heat from the RCW Heat Exchanger during plant normal operation. This mode is initiated and controlled by remote manual operation from the Main Control Room (MCR). Two RSW Pumps are in service at each division during this mode while the remaining components are on standby.

(b) Shutdown Operation Mode
The RSW removes the heat from the RCW Heat Exchanger during the plant shutdown. This mode is initiated and controlled by remote manual operation from the MCR and, three RSW Pumps are in service in each division during this mode.

(c) Hot Standby Mode (Off-site Power and Main Condenser Available)
This mode is manually operated from the MCR in conjunction with the Hot Standby Mode of the Turbine System to remove the heat from the RCW Heat Exchanger. Two RSW Pumps per division are in service with the rest on standby.

(d) Hot Standby Mode (Off-site Power and Main Condenser Unavailable)
This mode is initiated automatically upon LOOP signal or Suppression Pool Cooling automatic initiation signal to remove the heat from the RCW Heat Exchanger by operating the three RSW Pumps of each division. Power supply for this mode is supplied by the Emergency Diesel Generator System.

(e) Main Design Basis Fault Scenarios Mode
This mode is initiated automatically upon LOCA signal or Suppression Pool Cooling automatic initiation signal to remove the heat from the RCW Heat Exchanger. Three RSW Pumps of each division are operated for this mode.

Design Bases

This section describes the design bases for the RSW.
The RSW has been designed to meet the following SFCs. The linkage between the SFCs of the RSW with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

<u>Decay Heat Removal After Shutdown Function</u>

Normal Conditions

(a) The RSW is a principal means together with the RHR to remove residual heat from the reactor by transferring residual heat from the RCW process water to the UHS after normal reactor shutdown to reach reactor cold shutdown.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. [RSW SFC 3-1.1]

Fault Conditions

(b) The RSW is a principal means together with the RHR to deliver long term containment heat removal by transferring the decay heat of fission products from the RCW process water to the UHS in the event of frequent faults such as LOOP and infrequent faults such as LOCA.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. [RSW SFC 3-1.2]

Normal and Fault Conditions

(c) The RSW is a principal means together with the FPC and the RHR to maintain the SFP water temperature within the design values by transferring decay heat from the RCW process water to the UHS.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. [RSW SFC 2-4.1]

<u>Class 1 Auxiliaries Cooling Function</u>

Fault Conditions

(a) The RSW is an essential system for supporting HPCF operation by removing heat from the RCW process water and transferring it to the UHS whenever HPCF operation is required.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This function is an essential service for the ECCS described in the BSC on Emergency Core Cooling system. [RCW SFC 5-2.1]

(b) The RSW is an essential system for supporting EDG operation by removing heat from the RCW process water and transferring it to the UHS whenever EDG operation is required.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This function is an essential service for the EDG described in the BSC on Emergency Power Supply System. [RSW SFC 5-2.2]

Normal and Fault Conditions

(c) The RSW is an essential system for supporting RHR operation by removing heat from the RCW process water and transferring it to the UHS whenever RHR operation is required.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This function is an essential service for ECCS described in the BSC on Emergency Core Cooling system. [RSW SFC 5-2.3]

(d) The RSW is an essential system for supporting Safety Class 1 HVAC operation by removing heat from RCW process water and transferring it to the UHS whenever HVAC is operating.
This function is categorized as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This function is an essential service for HVAC described in the BSC on Heating, Ventilating and Air Conditioning system. [RSW SFC 5-2.4]

<u>Class 2 Auxiliaries Cooling Function</u>

Fault Conditions

The RSW is an essential system for supporting Safety Class 2 HVAC operation by removing heat from RCW process water and transferring it to the UHS whenever HVAC is operating.
This function is categorized as Safety Category B and the components to deliver it are designed to meet Safety Class 2 requirements. This function is an essential service for HVAC described in the BSC on Heating, Ventilating and Air Conditioning system. [RSW SFC 5-2.5]

<u>Other Auxiliaries Cooling Function</u>

Normal and Fault Conditions

The RSW supports the operations of Safety Class 3 auxiliaries (RIP motors, RIP MG Sets, DWC cooling units, CUW Pumps and Heat Exchangers, CRD Pumps, IA and SA Compressors, etc.) by removing heat from the RCW process water and transferring it to the UHS.
This function is categorized as Safety Category Band the components to deliver it are designed to meet Safety Class 3 requirements. [RSW SFC 5-11.1]

System Design Description

This section describes the design of the RCW and RSW to support and justify the delivery of [RSW SFC 3-1.1], [RSW SFC 3-1.2], [RSW SFC 2-4.1], [RSW SFC 5-2.1], [RSW SFC 5-2.2], [RSW SFC 5-2.3], [RSW SFC 5-2.4], [RSW SFC 5-2.5] and [RSW SFC 5-11.1]. Additional design description can be found in [Ref-16.3-2] [Ref-16.3-13] [Ref-16.3-14] [Ref-16.3-15] [Ref-16.3-16].

(1) Overall System Design and Operation

The RSW is composed of three electrical and mechanical independent divisions designated A, B, and C. Each division contains the necessary piping, pumps, valves and heat exchangers.

The RSW distributes cooling water to remove heat from the RCW Heat Exchanger during power operation, shutdown operation, hot standby (Off-site Power and Main Condenser Available), hot standby (Off-site Power and Main Condenser Unavailable) and Main Design Basis Fault Scenarios, and transfer it to the UHS.

During Power Operation Mode and Hot Standby Mode (Off-site Power and Main Condenser Available), two RCW Pumps and two RCW Heat Exchangers continuously operate in one division in each of the division.

(2) Equipment Design and Operation

RSW Pump

(i) Purpose

The main purpose of the RSW Pump is to supply RSW water to the RCW Heat Exchanger in order to remove the heat from the RCW water by heat transfer in order to deliver [RSW SFC 3-1.1], [RSW SFC 3-1.2], [RSW SFC 2-4.1], [RSW SFC 5-2.1], [RSW SFC 5-2.2], [RSW SFC 5-2.3], [RSW SFC 5-2.4], [RSW SFC 5-2.5] and [RSW SFC 5-11.1].

(ii) Configuration and Operation

Each division of the RSW is designed to supply approximately 4,500 m^3/h of RSW water to satisfy the required flow of cooling water for all operating modes. Based on this, each division is provided with three pumps of approx. 1500 m^3/h of design flow rate per pump with a total of nine pumps.

(iii) Performance

The RSW Pump is designed to perform as follows in order to ensure the delivery of [RSW SFC 3-1.1], [RSW SFC 3-1.2], [RSW SFC 2-4.1], [RSW SFC 5-2.1], [RSW SFC 5-2.2], [RSW SFC 5-2.3], [RSW SFC 5-2.4], [RSW SFC 5-2.5] and [RSW SFC 5-11.1]:

Table 16.3-4 : RSW Pump Capacity

RSW (A/B/C)	
Number	3 units/division (3 divisions)
Rated Flow	1,500m^3/h (per unit)

(3) Main Support Systems

(a) Instrumentation and Control System

Instrumentation

Instrumentation is provided to measure and monitor the operating conditions of the RSW components necessary for the delivery of the safety functions. The main provisions for instrumentation are described as follows:

(i) All instruments are arranged so that monitoring and control of process variables (flow rate, pressure, etc.) as well as operation are performed from the Main Control Room (MCR).
(ii) The position of all motor-operated valves are indicated on the MCR.

Control
The main control provisions related to the delivery of the safety functions by the RSW are summarised as follows:

(i) All RSW Pumps are designed to start automatically upon the LOOP, the LOCA, or the Suppression Pool Cooling automatic initiation signals.
(ii) All RSW Pumps are designed to stop automatically upon the low water level in RSW water intake pit, and RUHS system is initiated.

(b) Power Supply System

(i) The normal AC power supply to the RSW electrical components is provided by an independent and Off-site source (external grid). In addition, RSW Class 1 components, valves, instruments and controllers are provided with emergency AC power supply and DC power supply.
(ii) Each of the RSW divisions A, B and C is supplied power by independent divisions 1, 2 and 3 of the emergency power supply system respectively.

(4) System Architecture

(a) Redundancy
The RSW consists of three redundant divisions A, B, and C with their respective pumps, heat exchangers, strainers, piping, valves, and instrumentation such that, single failure of any dynamic component does not prevent the delivery of the safety functions.

(b) Independence
The components forming the three divisions of the RCW are independent and separately arranged in different locations within the Heat Exchanger Building (Hx/B) to prevent failure of a component in one of the divisions from leading to a common cause failure of all divisions.

Assumptions, Limits and Conditions for Operation

In order to ensure that the RSW is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs and surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is described in the Basis of Safety Cases on Reactor Building Cooling Water System [Ref-16.3-2]..

- Three divisions of RSW shall be operable during start-up, power operation and hot shutdown for the delivery of the SFCs claimed when required.

- Three divisions of RSW shall be operable during cold shutdown and refuelling for the delivery of the SFCs claimed when required (one RSW division may be inoperable after a number of hours from initial entry into hot shutdown in the process to shut down the reactor).

16.3.3 Turbine Building Cooling Water Systems

16.3.3.1 Turbine Building Cooling Water System

System Summary Description

This section is a general introduction to the Turbine Building Cooling Water System (TCW) where the system roles, system functions, system configuration and modes of operation are briefly described [Ref-16.3-17].

(1) System Roles

The purpose of The TCW is to supply cooling water to turbine auxiliary equipment to ensure their functions.

(2) Functions Delivered

The TCW supplies cooling water to turbine auxiliary equipment, such as oil coolers, motor coolers, shaft bearings, and HVAC Normal Cooling Water System (HNCW) chillers.

(3) Basic Configuration

The TCW consists of the following main components:

Turbine Building Cooling Water Pump	3 units (1 unit as standby)
Turbine Building Cooling Water Heat Exchanger	3 units (1 unit as standby)
TCW surge tank	1 unit

(4) Modes of Operation

The modes of operation of the TCW are summarised as follows:

(a) Normal Operation

During normal operation, the TCW Pumps circulate the cooling water through the TCW Heat Exchangers. The TCW Pump and TCW Heat Exchanger are composed of 3 × 50 percent capacity with 1 unit as standby.
The TCW Pump suction is connected to the TCW surge tank to ensure the required Net Positive Suction Head (NPSH).
The TCW surge tank is provided as a reservoir for small amounts of leakage from the TCW and for the expansion and contraction of the cooling water when the system temperature changes.
When the nitrite concentration or pH in the cooling water drops below a low limit, an anti-corrosion chemical is injected to the TCW Pump suction from the RCW chemical addition tank where the anti-corrosion chemical is added manually.
In this injection system, the cooling water circulates from TCW Pump discharge header to TCW Pump suction header via the RCW chemical addition tank by the TCW Pump head.
The Temperature Control Valve (TCV) is located at the oil cooler inlet to reduce the cooling water pressure in the oil cooler and minimise the possibility of cooling water leaking into oil in case of tube leak.

In addition, regarding the Turbine Electro Hydraulic Control System (EHC) oil cooler, titanium tube and double tube plate are adopted to prevent leakage.
To protect the TCW surge tank downcomer against corrosion, a recirculation line is connected between the TCW Heat Exchanger outlet and the TCW surge tank to supply the anti-corrosion chemical.

(b) Refuelling Outage

A small bypass valve is provided at the TCW Heat Exchanger outlet to fill it with cooling water for recovery after cleaning the unit.
The cooling water drain is discharged to the Miscellaneous Non-radioactive Drain Transfer System (MSC).

(c) Transient Conditions

The TCW surge tank hydrostatic head provides suction pressure for the TCW Pump. In case the TCW surge tank water level drops below the preset level, all TCW Pumps are stopped to prevent pump cavitation.

Design Bases

This section describes the design bases for the TCW.

(1) Safety Functions

The TCW has been designed to meet the following Safety Function. The linkage between the SFC of the TCW with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

The TCW supplies cooling water to turbine auxiliary equipment. The TCW delivers a Safety Category B function, and the components necessary to deliver this function are classified as Safety Class 3 according to the safety categorisation and classification of UK ABWR. [TCW SFC 5-11.1]

(2) Design Bases for Power Generation

From the power generation perspective, the TCW meets the following design basis:
The TCW supplies cooling water to turbine auxiliary equipment, such as oil coolers, motor coolers, shaft bearings, and HVAC Normal Cooling Water System (HNCW) chillers.

System Design

This section describes the design of the TCW from the power generation perspective.

(1) Overall Design and Operation

The TCW is a closed system that circulates cooling water with chemical additives by the TCW Pump to cool turbine auxiliary equipment.
In case of cooling water insufficiency, it is supplied from MUWP to the TCW surge tank.
An anti-corrosion chemical is injected to the TCW Pump suction via the RCW chemical addition tank to protect piping and equipment in the system against corrosion.
The TCW supplies cooling water to the turbine auxiliary equipment, such as oil coolers,

motor coolers, shaft bearings, refrigerators.
The TCW supplies cooling water to only non-radioactive equipment to prevent radioactive pollution.

(2) Equipment Design

(a) TCW Pump

Configuration
(i) 3 TCW Pumps (50 percent × 3) are installed (1 unit as standby).
(ii) The shaft sealing is of a mechanical seal type to reduce leakage.

Performance
The TCW Pump is designed to perform as follows:

TCW Pump	Number:	3 units (1 unit as standby)
	Capacity:	Up to 3,700 m^3/h/unit

(b) TCW Heat Exchanger

Configuration
(i) 3 TCW plate type Heat Exchangers (50 percent × 3) are installed (1 unit as standby).
(ii) If one of the active TCW Heat Exchangers fails to operate, the standby unit is placed in service manually.

Performance
The TCW Heat Exchanger is designed to perform as follows:

TCW Heat Exchanger	Number:	3 units (1 unit as standby)
	Design heat duty:	Up to 22 MW/unit

(3) Support Systems

The main systems supporting mechanical SSCs for the delivery of cooling water supply to turbine auxiliary equipments are described as follows:

(a) Control and Instrumentation Systems

Control
- The air-operated TCV is locked at the Fail As Is position in case of a loss of air supply, to prevent an extreme rise or drop in the temperature of the fluid being cooled (such as water, oil, air and hydrogen gas), except that the air-operated valve for supplying water to the TCW surge tank is fully open (Fail Open).
- The cooling water temperature at the TCW Heat Exchanger outlet is maintained constant by controlling the TCW Heat Exchanger water flow rate and the bypass flow rate by using the air-operated TCW-TCV at its outlet.
- The performance of the main turbine and the RFP-T are affected by the oil temperature variation, therefore, the TCVs are installed at the main turbine oil cooler and the RFP-T oil cooler supply lines respectively to regulate the cooling water flow rate in order to keep the oil temperature at the required value. The preset turbine oil temperature is changed in accordance with the turbine operation condition.
- The cooling water flow rate to the EHC fluid cooler and the hydrogen coolers

is regulated by TCV to keep the oil or hydrogen temperature at cooler outlet constant.

- The cooling water flow rate to all of the other coolers is manually regulated by individual throttling valves located at cooler outlet.

Interlocks
The TCW Pump has the following interlocks:

- In case of a drop in the TCW Pump discharge pressure, the alarms are transmitted to the Main Control Room (MCR) and the standby pump starts automatically. After TCW Pump flow rate decreases and its discharge pressure is recovered, 1 TCW Pump is shutdown manually from the MCR.
- In case of the TCW surge tank water level "Low Low Low", all TCW Pumps trip automatically.

(b) Power Supply System

The TCW components are connected to a safety class 3 AC.

(c) Turbine Building Service Water System (TSW)

The TSW supplies service water to the TCW Heat Exchanger to cool the TCW water.

(d) Makeup Water Purified System (MUWP)

The MUWP supplies makeup water to the TCW surge tank.

16.3.3.2 Turbine Building Service Water System

System Summary Description

This section is a general introduction to the Turbine Building Service Water System (TSW) where the system roles, system functions, system configuration and modes of operation are briefly described.

(1) System Roles

The purpose of the TSW is to supply sea water (site dependent) as cooling water to the Turbine Building Cooling Water Heat Exchanger and remove heat from the Turbine Building Cooling Water System (TCW).

(2) Basic Configuration

The TSW consists of the following main components:

TSW Pump	3 units (1 unit as standby)
TSW strainer	3 units (1 unit as standby)

(3) Modes of Operation

Modes of operation of the TSW are summarised as follows:

(a) Normal Operation

The TSW is equipped with 3 TSW Pumps of 50 percent capacity (1 unit as standby) to ensure normal plant operation and startup/shutdown operations.
A TSW strainer is provided on each TCW Heat Exchanger inlet to protect the TCW Heat Exchanger and TSW piping by removing debris and aquatic organisms from the sea water.
The TSW strainer is able to perform self cleaning, changeover to the standby strainer and overhaul while the TSW is in service.
The TSW strainer self-cleaning starts automatically and periodically or in the event of high differential pressure.

(b) Refuelling Outage

The residual air in the piping and the TCW Heat Exchanger during the TSW water filling is discharged by the discharge pressure of TSW Pump.

(c) Transient Conditions

The standby TSW Pump starts automatically in the event that a normally operating pump trips or the discharge pressure drops below a preset limit.

Design Bases

This section describes the design bases for the TSW.

(1) Safety Functions

The TSW has been designed to meet the following Safety Function. The linkage between the SFC of the TSW with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

The TSW supplies service water to the TCW Heat Exchanger and removes heat from the TCW. The TSW delivers a Safety Category B function, and the components necessary to deliver this function are classified as Safety Class 3 according to the safety categorisation and classification of UK ABWR. [TSW SFC 5-11.1]

(2) Design Bases for Power Generation

From the power generation perspective, the TSW meets the following design basis:
The TSW supplies the sea water (site dependent) from intake pool to the TCW Heat Exchanger via the TSW strainer and draws off the water to the discharge pool by Turbine Building Service Water pump.

System Design

This section describes the design of the TSW from the power generation perspective.

(1) Overall Design and Operation

The TSW supplies the sea water (site dependent) from the intake pool to the TCW Heat Exchanger via the TSW strainer and draws off the water to the discharge pool by TSW Pump.
The TSW operating pressure is lower than the TCW to prevent sea water (site dependent) from leaking into the TCW.

(2) Equipment Design

TSW Pump

Configuration
(i) 3 TSW Pumps (50 percent × 3) are installed (1unit as standby).
(ii) The TSW Pump is a vertical type.

Performance
The TSW Pump is designed to perform as follows.

TSW Pump	Number:	3 units (1 unit as standby)
	Capacity:	Up to 3,800 m^3/h/unit

(3) Support Systems

The main systems supporting mechanical SSCs for the delivery of service water supply to TCW Heat Exchangers are described as follows:

(a) Control and Instrumentation Systems

When 2 TSW Pumps are in operation, a low outlet pressure signal or a pump trip causes the standby pump start automatically.
The TSW strainer self-cleaning starts automatically and periodically or in the event of high differential pressure.

(b) Power Supply System

The TSW components are connected to a safety Class 3 AC.

(c) Turbine Building Cooling Water System (TCW)

The TSW supplies sea water (site dependent) as service water to the TCW Heat Exchanger and removes heat from the TCW.

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.3-38]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.3.4 Makeup Water Systems

16.3.4.1 Makeup Water Condensate System

System Summary Description

This section is a general introduction to the Makeup Water Condensate System (MUWC) where the system roles, system functions, system configuration and modes of operation are briefly described.

(1) System Roles

The purpose of the MUWC is to supply condensate required for each component.

(2) Functions Delivered

The MUWC supplies required water such as filling water and water for washing purpose during the Refuelling outage.

(3) Basic Configuration

The MUWC consists of the following main components:

Condensate Storage Tank (CST)	1 unit
Makeup Water Condensate Pump	3 units

(4) Modes of Operation

The modes of operation of the MUWC are summarised as follows:

(a) Normal Operation

At least 1 of 3 MUWC Pumps is in operation. A minimum flow pipe is provided to continuously supply even when the makeup water flow rate is very low.
A pressure transmitter is provided at the pump discharge header to detect drops in pressure and automatically start the standby pump.
The MUWC supplies purging, scramming and filling water to the CRD from the condensate spillover line at the normal operation, and the excess water is recovered to the CST. When the condensate spillover line is not available, the makeup water for CRD is supplied from the CST.
The Makeup Water Purified System (MUWP) supplied purified makeup water to the CST, and the makeup water valve is remotely operated in the Main Control Room (MCR).

(b) Startup and System shutdown

The returned water to the condenser at System shutdown is recovered to the CST via the condensate spillover line.

(c) Refuelling Outage

The water stored for emergency in the CST is able to be used as a part of the water required for such as the fuel pool filling in the reactor building during the Refuelling outage.

Design Bases

This section describes the design bases for the MUWC.

(1) Safety Functions

The MUWC has been designed to meet the following Safety Function. The linkage between the SFCs of the MUWC with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal Conditions

(a) The MUWC supplies the required condensate to each component. [MUWC SFC 5-11.1]
The MUWC delivers a Safety Category B function, and the components necessary to deliver this function are classified as Safety Class 3 according to the safety categorisation and classification of UK ABWR.

Normal and Fault Conditions

(b) The MUWC piping and components outside the Reactor Coolant Pressure Boundary (RCPB) contains radioactive material. Rupture of this piping could lead to a release of radioactive material of dose consequences that are relatively low.. [MUWC SFC 4-4.1]
The MUWC delivers a Safety Category C function, and the components necessary to deliver this function are classified as Safety Class 3 according to the safety categorisation and classification of UK ABWR.

Fault Conditions

(c) The CST is used as a water source for the Reactor Core Isolation Cooling System (RCIC) and High Pressure Core Flooding System (HPCF) in the event of frequent and infrequent faults such as LOCA. [MUWC SFC 2-1.1]
The MUWC delivers a Safety Category A function, and the components necessary to deliver this function are classified as Safety Class 2 according to the safety categorisation and classification of UK ABWR.

(d) The MUWC components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [MUWC SFC 4-7.1]
(This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. This safety function is developed and justified in Chapter 13: Engineered Safety Features, Section 13.3.3.1 related to the Primary Containment Facility.

(e) The MUWC, which is a system for normal operation, will be utilised to supply coolant water for reactor core cooling, if available, in the event of beyond design basis faults or severe accidents. [MUWC SFC 2-3.1]
This function is categorised as Safety Category C and the components to deliver it are designed to meet Safety Class 3 requirements.

(2) Design Bases for Power Generation

From the power generation perspective, the MUWC meets the following design basis:
The MUWC supplies required water such as filling water and water for washing purpose during the Refuelling outage.

System Design

This section describes the design of the MUWC.

(1) Overall Design and Operation

The MUWC supplies required condensate at Startup, System shutdown and Power operation to each component which may potentially have radioactive contamination.
The MUWC is used as a water source for the Reactor core isolation cooling system (RCIC), High Pressure Core Flooder System (HPCF), Suppression Pool Clean-up System (SPCU) and Control Rod Drive System (CRD) and also receives cleaned water from the LCW.
The CST retains the quantity of condensate required by the HPCF or RCIC to deliver the safety functions required of these systems following faults during plant operation. Accordingly, the suction nozzles for the HPCF and RCIC are installed lower in the tank than the nozzles for the other systems to ensure supply to these systems.
The CST is equipped with a level switch to use the suppression pool water for supplying to the HPCF and RCIC in case the CST water level drops below a preset level.

(2) Equipment Design

(a) CST

Configuration

(i) The CST stores condensate as a water source for the HPCF, RCIC, SPCU and CRD. The CST usually stores the water from the LCW.

(ii) The CST stores the water for the Emergency Core Cooling System (ECCS) and the water used for makeup, filling, sealing, washing of equipment and decontamination. Since a water source for the ECCS must always be reserved, its suction nozzle is installed lower than the nozzles for the other systems to ensure supply to these systems.

(iii) A vacuum relief valve and a pressure relief valve are provided on the CST.

(iv) To detect leaks from the CST as early as possible, leaking water is collected into a pit equipped with a leak detector.

(v) The drain pipes and overflow pipes of the CST are connected to the LCW collection tank. To prevent the air in the LCW collection tank from flowing into the MUWC through the overflow pipe, the pipe end will be below the level of water in the LCW collection tank, or a similar countermeasure, such as a U-seal will be installed.

Performance
The CST is designed to perform as follows.

CST	Number:	1 unit
	Nominal Capacity:	Up to 2,400 m^3

(b) MUWC Pump

Configuration

(i) This pump transfers condensate water from the CST to equipment.

(ii) The MUWC Pumps receive power from a Motor Control Centre (MCC) which can be supplied from an Emergency Diesel Generator (ED/G) to ensure the water supply even during a loss of power incident.

(iii) 3 MUWC Pumps are installed, however during Power operation, a single pump is sufficient to supply the usual requirements.

(iv) All 3 pumps are used to supply a large amount of condensate water, such as for filling of the reactor well during a Refuelling outage.

Performance
The MUWC Pump is designed to perform as follows:

MUWC Pump	Number:	3 units
	Capacity:	Up to 130 m^3/h/unit

(3) Support Systems

The main systems supporting mechanical SSCs for the delivery of makeup water supply are described as follows:

(a) Control and Instrumentation Systems

The purified water is automatically supplied to the CST by an automatic interlock which controls the makeup valve according to the CST water level High/Low switch. Water level High/Low alarms are set to alert operators to CST abnormal water levels.
The CST makeup can also be manually opened/closed from the MCR.
In case of a MUWC Pump discharge pressure "Low", 1 standby pump starts automatically.
The standby MUWC Pump is stopped manually when pump discharge pressure and system flow rate conditions allow.
The CST is equipped with a water level transmitter to detect water levels, to run and stop the MUWC Pump and to control the Level Control Valve (LCV) for the purified water makeup. These operations can be controlled manually.
To prevent the MUWC Pump cavitation due to lower water level of the CST, interlocks are provided to automatically trip the pump at a preset level for normal operation and for outage respectively.
To prevent the MUWC Pump from frequent start and stop, interlocks are provided to prevent standby pump startup in case the CST water level is below preset levels for normal operation and for outage respectively.

(b) Power Supply System

The MUWC Pump components are not required to be connected to emergency power from a nuclear safety perspective.

(c) Reactor Core Isolation Cooling System (RCIC)

The MUWC is one of the water sources for makeup water through the RCIC to the Reactor Pressure Vessel (RPV).

(d) High Pressure Core Flooder System (HPCF)

The MUWC is one of the water sources for makeup water through the HPCF to the Reactor Pressure Vessel (RPV).

(e) Suppression Pool Clean-up System (SPCU)

The MUWC is one of the water sources for makeup water through the SPCU to the spent fuel storage pool.

(f) Control Rod Drive System (CRD)

The MUWC supplies purge water through the CRD to the Fine Motion Control Rod Drive (FMCRD), Reactor Internal Pumps (RIPs) and the Reactor Water Clean-up System (CUW) when the condensate spillover line is not available.

(g) Low Conductivity Waste System (LCW)

The MUWC receives water from LCW. The drain pipes and overflow pipes of the CST are connected to the LCW collection tank.

(h) Turbine Gland Steam System (TGS)

The MUWC supplies the makeup water for steam generation in the Gland Steam Evaporator (GSE).

(i) Condenser

The MUWC supplies makeup water to the condenser to control the condenser hotwell water level.

(j) Makeup Water Purified System (MUWP)

The MUWP supplies purified makeup water to the CST.

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.3-38]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.3.5 HVAC Cooling Water Systems

16.3.5.1 HVAC Emergency Cooling Water System

System Summary Description

This section is a general introduction to the HECW where the system roles, system functions, system configuration and modes of operation are briefly described. The HECW is described in detail in the system specifications [Ref-16.3-18] and the Piping and Instrumentation Diagrams [Ref-16.3-19] [Ref-16.3-20] [Ref-16.3-21].

(1) System Roles

The HECW is designed to achieve the following purpose:

Providing chilled water as a cooling medium to the following cooling coils of the Normal/Emergency Heating Ventilating Air Conditioning System (HVAC) Supply Air Treatment Facilities and Local Cooling Units during normal operation, shutdown, refuelling outage and fault conditions such as LOCA and LOOP.

Table 16.3-5 : HVAC Sub-system associated with HECW

No.	Bldg.	HVAC Sub-system	Safety Division
1	R/B	Reactor Building Emergency Electrical Equipment Zone [RBEEE (A), (B) and (C)/Z] HVAC	Normal/Emergency
2	EDG/B	Emergency Diesel Generator Electrical Equipment Zone [DGEE (A), (B) and (C)/Z] HVAC	Normal/Emergency
		Emergency Diesel Generator Room [EDG (A), (B) and (C)] Local Cooling Units	Emergency
3	C/B	Control Building Emergency Electrical Equipment Zone [CBEEE (A), (B) and (C)/Z] HVAC	Normal/Emergency
4	C/B	Main Control Room [MCR (A) and (B)] HVAC	Normal/Emergency
5	Hx/B	Heat Exchanger Building Emergency [Hx/B-Emergency (A), (B) and (C)] Local Cooling Units	Emergency

(2) Function Delivered

The HECW is designed to provide the cooling function for the Normal/Emergency HVAC during normal operation, shutdown, refuelling outage and fault conditions to ensure equipment operation in these areas are maintained.

(3) Basic Configuration

The HECW consists of three separate but non-identical divisions A, B and C. The system main components are summarised as follows:

(a) HECW Chillers (hereinafter termed Chiller)
  (i) Divisions A and B of Normal/Emergency

  3 units [per division] (divisions A and B shares one standby unit)
  (ii) Divisions A and B of Emergency
  1 unit [per division]

(iii) Division C of Normal/Emergency
3 units (one standby unit)

(iv) Division C of Emergency
1 unit

(b) HECW Chilled Water Pumps (hereinafter termed Chilled Water Pump)

(i) Divisions A and B of Normal/Emergency
3 units [per division] (divisions A and B shares single standby unit)

(ii) Divisions A and B of Emergency
1 unit [per division]

(iii) Division C of Normal/Emergency
3 units (one standby unit)

(iv) Division C of Emergency
1 unit

(c) HECW Chemical Addition Tank (hereinafter termed Chemical Addition Tank)
1 unit [per division A, B and C each]

(d) Surge Tank [Shared with Reactor Building Cooling Water System (RCW)]

(e) Piping and Valves
1 set with divisional segregation.

(f) Instrumentation and Control Devices
1 set with divisional segregation.

Figure 16.3-4 to 16.3-6 show an outline of the HECW.

.

(4) Modes of Operation

(a) Normal Conditions

(i) Divisions A and B

During normal operation, shutdown and refuelling outage, the HECW of normal/emergency supplies chilled water to the cooling coils of the RBEEE (A), (B)/Z HVAC, DGEE (A), (B)/Z HVAC and CBEEE(A), (B)/Z HVAC Supply Air Treatment Facilities. Two Chiller / Chilled Water Pump sets per division can achieve this, but three Chiller / Chilled Water Pump sets per division are required if the MCR (A) or (B) HVAC Supply Air Treatment Facilities are also required.

(ii) Division C

Division C of the HECW of normal/emergency supplies chilled water to the cooling coils of the RBEEE (C)/Z HVAC, DGEE (C)/Z HVAC and CBEEE (C)/Z HVAC Supply Air Treatment Facilities. Two Chiller / Chilled Water Pump sets are operated during normal operation, shutdown and refuelling outage. All Chiller / Chilled Water Pump set not in operation are available in standby availability determined by lowest run time or manually as determined by the plant operator.

(b) Emergency Operations
In the event of faults such as LOCA and LOOP, the HECW of normal/emergency operation is operated in the same manner as Normal Operation. The HECW of emergency supplies chilled water to the cooling coils of the Hx/B-Emergency (A), (B), (C) Local Cooling Units and the EDG (A), (B), (C) Local Cooling Units. The HECW of emergency is only operated during fault conditions such as LOCA and LOOP.

Design Bases

This section describes the design bases for the HECW [Ref-16.3-18].
The linkage between the Safety Functional Claims of HECW with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix−A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal Conditions
(a) The HECW provides chilled water for the Normal/Emergency HVAC during normal operation, shutdown and refuelling outage. [HECW SFC 5-18.1]

This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

Fault Conditions
(b) The HECW provides chilled water for Normal/Emergency and Emergency HVAC during fault conditions such as LOCA and LOOP. [HECW SFC 5-18.2]

This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

System Design Description

This section describes the design of the HECW to support and justify the delivery of HECW SFC 5-18.1 and HECW SFC 5-18.2. Additional design description can be found in [Ref-16.3-18] [Ref-16.3-19] [Ref-16.3-20] [Ref-16.3-21].

(1) System Design and Operation

The HECW is a closed loop chilled water system. The system comprises three electrical and mechanical independent divisions designated A, B and C in accordance with three divisions of the Normal/Emergency and Emergency HVAC. Each HECW division contains chillers, chilled water pumps, valves, piping, chemical addition tanks, instrumentation and controls. Cooling water for the chiller condensers is supplied by the RCW.

During normal operation, shutdown, refuelling outage and fault conditions, the HECW is provided for keeping each Normal/Emergency and Emergency HVAC cooling function to specified capacity by supplying chilled water to the cooling coils of the MCR HVAC, RBEEE/Z HVAC, DGEE/Z HVAC, CBEEE/Z HVAC Supply Air Treatment Facilities and Hx/B-Emergency Local Cooling Units , EDG Local Cooling Units.

The HECW continuous operation is ensured by receiving the power supply provided by EDG in the event of LOOP.

(2) Equipment Design and Operation

(a) Chiller

(i) Purpose

The purpose of the Chiller is to provide chilled water for the cooling coils of the Normal/Emergency HVAC Supply Air Treatment Facilities and Emergency Local Cooling Units.

(ii) Configuration and Operation

Divisions A and B of the HECW of normal/emergency each contains three partial capacity chillers which provide chilled water to respective cooling coils serving the MCR (A) or (B) HVAC, RBEEE (A), (B)/Z HVAC, DGEE (A), (B)/Z HVAC and CBEEE (A), (B)/Z HVAC Supply Air Treatment Facilities.
Divisions A and B of the HECW of emergency each contain a single capacity chiller which provide chilled water to respective cooling coils serving the Hx/B-Emergency (A), (B) and the EDG (A), (B) Local Cooling Units.
During normal operation, shutdown, refuelling outage and fault conditions, the HECW supplies chilled water to the cooling coils of the RBEEE (A), (B)/Z HVAC, DGEE (A), (B)/Z HVAC, CBEEE (A), (B)/Z HVAC and the Hx/B-Emergency (A), (B) Local Cooling Units, the EDG (A), (B) Local Cooling Units. Two Chiller / Chilled Water Pump sets per division can achieve this, but three Chiller / Chilled Water Pump sets per division are required if the MCR (A) or (B) HVAC Supply Air Treatment Facilities are also required.
Division C of the HECW of normal/emergency contains three 50 percent capacity chillers which provide chilled water to respective cooling coils serving the RBEEE (C)/Z HVAC, DGEE (C)/Z HVAC and CBEEE (C)/Z HVAC Supply Air Treatment Facilities.
Divisions C of the HECW of emergency contain a single capacity chiller which provides chilled water to respective cooling coils serving the Hx/B-Emergency (C) Local Cooling Unit and the EDG (C) Local Cooling Unit. (HECW SFC 5-18.1 and HECW SFC 5-18.2)

(iii) Performance

The Chiller is designed to perform as follows in order to deliver cooling function for the Normal/Emergency and Emergency HVAC. (HECW SFC 5-18.1 and HECW SFC 5-18.2)

Divisions A and B Chiller of normal/emergency

· Number: 6 units [3 units per division] (divisions A and B shares one standby unit)
· Cooling Capacity: 493 kW [per unit]
· Chilled Water Flow: 43 m^3/h [per unit]

Divisions A and B Chiller of emergency

· Number: 2 units [1 unit per division]
· Cooling Capacity: 856 kW [per unit]
· Chilled Water Flow: 74 m^3/h [per unit]

Division C Chiller of normal/emergency
- Number: 3 units (one standby unit)
- Cooling Capacity: 428 kW [per unit]
- Chilled Water Flow: 37 m^3/h [per unit]

Division C Chiller of emergency
- Number: 1 unit
- Cooling Capacity: 863 kW
- Chilled Water Flow: 75 m^3/h

(b) Chilled Water Pump

(i) Purpose

The purpose of the Chilled Water Pump is to supply chilled water for the cooling coils of the Normal/Emergency and Emergency HVAC Supply Air Treatment Facilities.

(ii) Configuration and Operation

Divisions A and B of the HECW of normal/emergency each contain three partial capacity pumps which supply chilled water to respective cooling coils serving the MCR (A) or (B) HVAC, RBEEE (A), (B)/Z HVAC, DGEE (A), (B)/Z HVAC and CBEEE (A), (B)/Z HVAC Supply Air Treatment Facilities.

Divisions A and B of the HECW of emergency each contain a single capacity pump which supplies chilled water to respective cooling coils serving the Hx/B-Emergency (A), (B) Local Cooling Units and the EDG (A), (B) Local Cooling Units.

During normal operation, shutdown, refuelling outage and fault conditions, the HECW supplies chilled water to the cooling coils of the RBEEE (A), (B)/Z HVAC, DGEE (A), (B)/Z HVAC, CBEEE (A), (B)/Z HVAC and the Hx/B-Emergency (A), (B) Local Cooling Units, the EDG (A), (B) Local Cooling Units. Two Chiller / Chilled Water Pump sets per division can achieve this, but three Chiller / Chilled Water Pump sets per division are required if the MCR (A) or (B) HVAC Supply Air Treatment Facilities are also required.

Division C of the HECW of normal/emergency contains three 50 percent capacity pumps which supply chilled water to respective cooling coils serving the RBEEE (C)/Z HVAC, DGEE (C)/Z HVAC and CBEEE (C)/Z HVAC Supply Air Treatment Facilities.

Divisions C of the HECW of emergency contain a single capacity pump which supply chilled water to respective cooling coils serving the Hx/B-Emergency (C) Local Cooling Unit and the EDG (C) Local Cooling Unit. (HECW SFC 5-18.1 and HECW SFC 5-18.2)

(iii) Performance

The Chilled Water Pump is designed to perform as follows in order to deliver cooling function for the Normal/Emergency and Emergency HVAC (HECW SFC 5-18.1 and HECW SFC 5-18.2).

Divisions A and B Pump of normal/emergency
- Number: 6 units [3 units per division] (divisions A and B shares one standby unit)
- Rated Flow: 43 m^3/h [per unit]

Divisions A and B Pump of emergency
- Number: 2 units [1 unit per division]
- Rated Flow: 74 m^3/h [per unit]

Division C Pump of normal/emergency
- Number: 3 units (one standby unit)
- Rated Flow: 37 m^3/h [per unit]

Division C Pump of emergency
- Number: 1 unit
- Rated Flow: 75 m^3/h

(3) Main Support Systems

The major support system related to delivery of the HECW safety functions are briefly described as follows.

(a) Instrumentation and Control Systems

(i) Instrumentation

Instrumentation is provided to measure and monitor the operating conditions of the HECW components necessary for the delivery of the safety functions. The main provisions for instrumentation are described as follows.
- Chilled water supply temperature from the evaporator
- Return header temperature of the Chiller
- Inlet and outlet pressure of the Chilled Water Pump
- Pressure between supply and return header of the Chilled Water Pump

(ii) Control

The main control provisions related to the delivery of the safety functions are described as follows.
- The Chillers and the Chilled Water Pumps are operated from the Main Control Room and the local control panel.
- HECW starts to operate provided that one or more RCW pumps operate. If all RCW pumps per one division stop, the corresponded HECW division also stops to protect the Chillers.
- The appropriate system flow is maintained by constantly keeping the differential pressure between supply and return headers of Chilled Water Pump constant if the required cooling load is low.

(b) Power Supply System

(i) The normal AC power supply to the HECW electrical components is provided by an independent and Off-site source (external grid). In addition, the HECW components, instruments and controllers are provided with emergency AC power supply and DC power supply.

(ii) Each of the HECW divisions A, B and C is supplied power by independent divisions I, II and III of the emergency power supply system.

(c) Reactor Building Cooling Water System (RCW)

The RCW supplies cooling water to the chiller condensers. The RCW is also divisionalised (A, B and C divisions) to ensure delivery of required safety functions.

Assumptions, Limits and Conditions for Operations

In order to ensure that the HECW is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs and surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is ultimately reflected in the generic technical specifications [Ref-16.3-37].

- Three divisions of HECW shall be operable during start-up, power operation and hot shutdown for the delivery of the SFCs claimed when required.
- Three divisions of HECW shall be operable during cold shutdown and refuelling for the delivery of the SFCs claimed when required (one HECW division may be inoperable when electrical power distribution subsystems of the same division are allowed to be inoperable.).

Division A

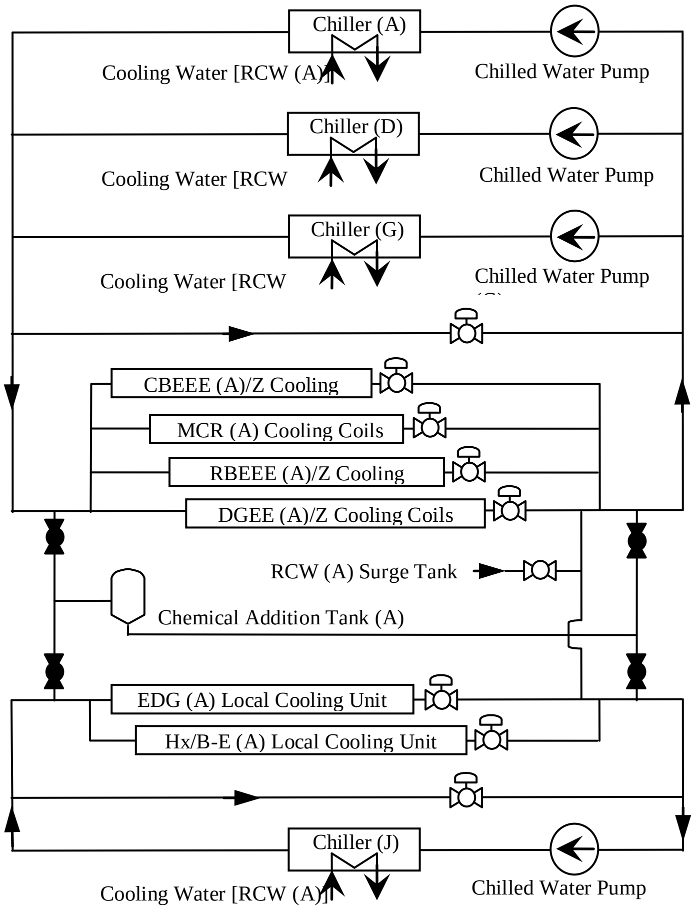
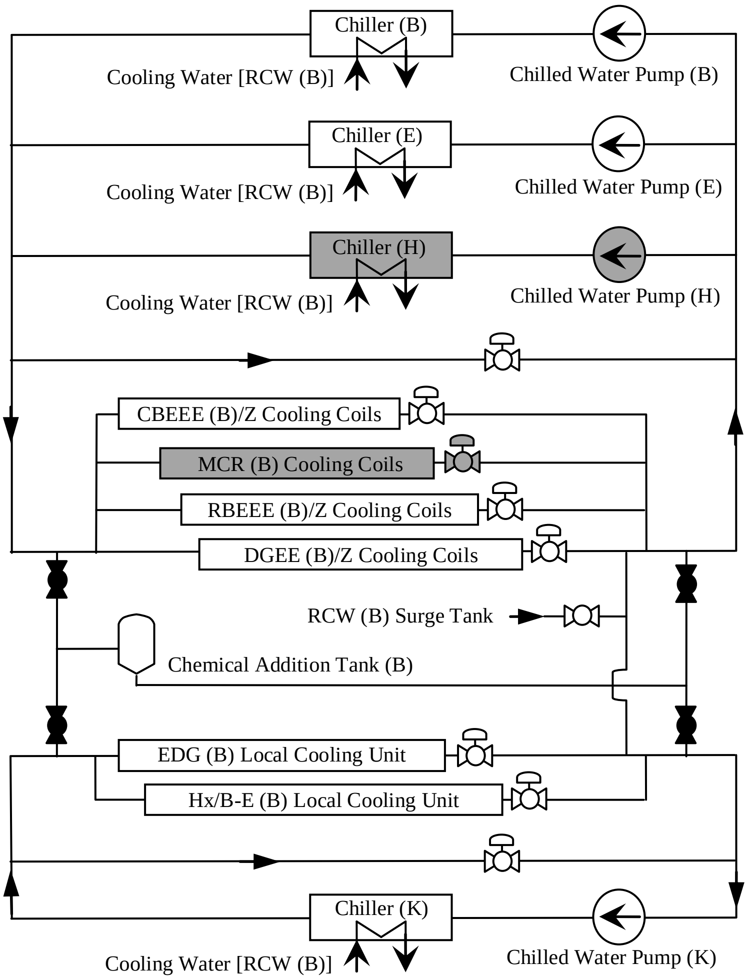


Figure 16.3-4 : Outline of the HECW (Division A)

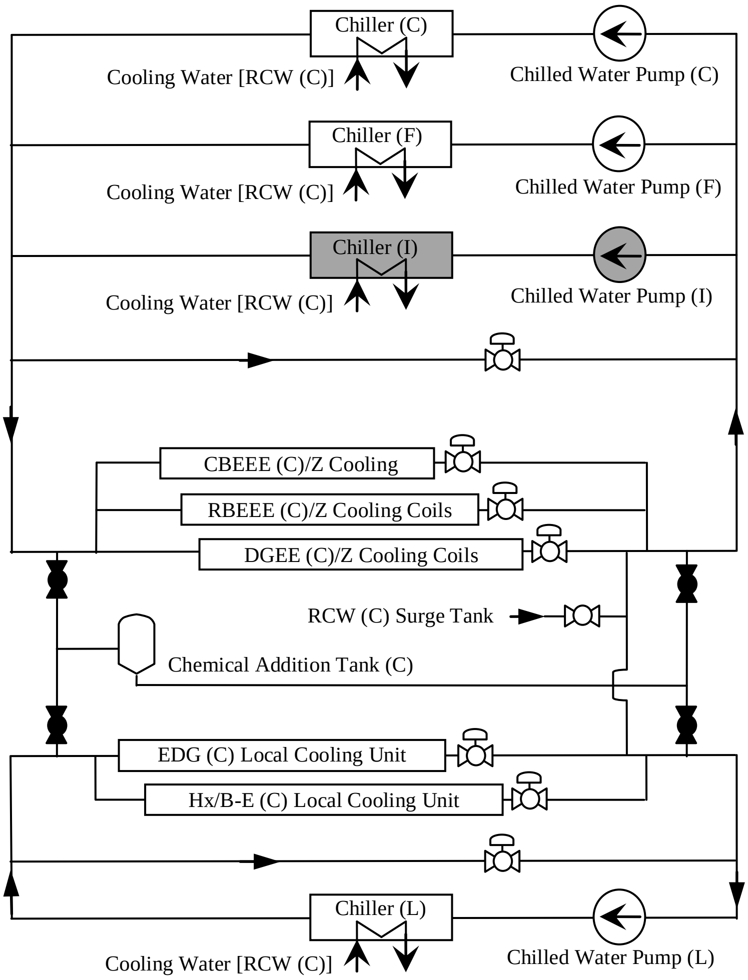
Division B



Note: This drawing shows a condition that Chiller (H) and Chilled Water Pump (H) are in standby.

Figure 16.3-5 : Outline of the HECW (Division B)

Division C



Note: This drawing shows a condition that Chiller (I) and Chilled Water Pump (I) are in standby.

Figure 16.3-6 : Outline of the HECW (Division C)

16.3.5.2 HVAC Normal Cooling Water System

System Summary Description

This section is a general introduction to the HNCW where the system roles, system functions, system configuration and modes of operation are briefly described. The HNCW is described in detail in the system specifications [Ref-16.3-22] and the Piping and Instrumentation Diagrams [Ref-16.3-23] [Ref-16.3-24] [Ref-16.3-25] [Ref-16.3-26] [Ref-16.3-27] .

(1) System Roles

HNCW is designed to provide chilled water as a cooling medium to each cooling coil of the Drywell Cooling System (DWC) Dehumidifiers, the various Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in each building.
The HNCW consists of following three sub-systems.
(a) HNCW,
(b) Rw/B HNCW, and
(c) S/B HNCW.

The HNCW supplies cooling water to the DWC, the Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in the Reactor Building (R/B), Control Building (C/B), Turbine Building (T/B), Heat Exchanger Building (Hx/B) and Filter Vent Building (FV/B). The Radwaste Building (Rw/B) HNCW supplies cooling water to the Rw/B. The Service Building (S/B) HNCW supplies cooling water to the S/B. The HNCW, Rw/B HNCW and S/B HNCW are operated during normal operation, shutdown and refuelling outage.

(2) Function Delivered

The HNCW, Rw/B HNCW and S/B HNCW are designed to achieve the following function:
The HNCW supports the cooling function for the DWC Dehumidifiers, the various Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in the R/B, C/B, T/B, Hx/B and FV/B during normal operation, shutdown and refuelling outage, by removing heat from these systems.
The Rw/B HNCW supports the cooling function for the various Normal HVAC Supply Air Treatment Facilities in Rw/B during normal operation, shutdown and refuelling outage, by removing heat from these systems.
The S/B HNCW supports the cooling function for the various Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in S/B during normal operation, shutdown and refuelling outage, by removing heat from these systems.

(3) Basic Configuration

(a) The HNCW main components are summarised as follows:
- (i) HNCW Chiller
  5 units - 25 percent each (1 unit standby)
- (ii) HNCW Chilled Water Pump
  5 units - 25 percent each (1 unit standby)
- (iii) HNCW Chemical Addition Tank
  1 set
- (iv) Surge Tank [Sharing with Turbine Building Cooling Water System (TCW)]

(v) Piping and Valves
1 set
(vi) Instrumentation and Control Devices
1 set

Figure 16.3-7 shows an outline of the HNCW.

(b) The Rw/B HNCW main components are summarised as follows:
(i) Rw/B HNCW Chiller
2 units - 100 percent each (1 unit standby)
(ii) Rw/B HNCW Chilled Water Pump
2 units - 100 percent each (1 unit standby)
(iii) Rw/B HNCW Chemical Addition Tank
1 set
(iv) Rw/B HNCW Surge Tank
1 set
(v) Piping and Valves
1 set
(vi) Instrumentation and Control Devices
1 set

Figure 16.3-8 shows an outline of the Rw/B HNCW.

(c) The S/B HNCW main components are summarised as follows:
(i) S/B HNCW Chiller
3 units - 50 percent each (1 unit standby)
(ii) S/B HNCW Chilled Water Pump
3 units - 50 percent each (1 unit standby)
(iii) S/B HNCW Chemical Addition Tank
1 set
(iv) S/B HNCW Surge Tank
1 set
(v) Piping and Valves
1 set
(vi) Instrumentation and Control Devices
1 set

Figure 16.3-9 shows an outline of the S/B HNCW.

(4) Modes of Operation

The HNCW, Rw/B HNCW, and S/B HNCW can deliver the following operation modes.

(a) Normal Conditions

(i) Up to four of the five HNCW Chiller / Chilled Water Pump sets are operated in plant normal operation, shutdown and refuelling outage based on the cooling load demand. One HNCW Chiller / Chilled Water Pump set is always available in standby.

(ii) One of the two Rw/B HNCW Chiller / Chilled Water Pump sets are operated in plant normal operation, shutdown and refuelling outage based on the cooling load demand. One Rw/B HNCW Chiller / Chilled Water Pump set is always available in standby.

(iii) Up to two of the three S/B HNCW Chiller / Chilled Water Pump sets are operated in plant normal operation, shutdown and refuelling outage based on the cooling load demand. One S/B HNCW Chiller / Chilled Water Pump set is always available in standby.

(b) Emergency Operations

(i) In the event of faults such as LOCA and LOOP, the HNCW is inoperable. Supply and return chilled water pipelines which penetrate the Primary Containment Vessel (PCV) incorporate isolation valves which are automatically closed by a LOCA signal to achieve Containment isolation.

(ii) In the event of faults such as LOCA and LOOP, the Rw/B and S/B HNCW are inoperable.

Design Bases

This section describes the design bases for the HNCW, Rw/B HNCW, and S/B HNCW [Ref-16.3-22] .
The linkage between the Safety Functional Claims of the HNCW, Rw/B HNCW, and S/B HNCW with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix−A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal and Fault Conditions

(a) HNCW provides chilled water for the DWC Dehumidifiers and the cooling coils of the various Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in the R/B, C/B, T/B, Hx/B and FV/B. [HNCW SFC 5-18.1]
This function is classified as Category C and the components to deliver it are designed to meet Class 3 requirements.

(b) Rw/B HNCW provides chilled water for the cooling coils of the various Normal HVAC Supply Air Treatment Facilities in the Rw/B. [HNCW SFC 5-18.2]
This function is classified as Category C and the components to deliver it are designed to meet Class 3 requirements.

(c) S/B HNCW provides chilled water for the cooling coils of the various Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in the S/B. [HNCW SFC 5-18.3]
This function is classified as Category C and the components to deliver it are designed to meet Class 3 requirements.

In the event of faults such as LOCA and LOOP, the HNCW, Rw/B HNCW and S/B HNCW are inoperable.

Fault Conditions

(d) The HNCW components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [HNCW SFC 4-7.1]
This safety function is developed and justified in the section related to the Primary Containment Facility in Chapter 13: Engineered Safety Features.

System Design Description

This section describes the design of the HNCW, Rw/B HNCW, and S/B HNCW to support and justify the delivery of HNCW SFC 5-18.1, HNCW SFC 5-18.2, HNCW SFC 5-18.3 and HNCW SFC 4-7.1. Additional design description can be found in [Ref-16.3-22] [Ref-16.3-23] [Ref-16.3-24] [Ref-16.3-25] [Ref-16.3-26] [Ref-16.3-27] .

(1) System Design and Operation

(a) The HNCW is a closed loop chilled water system. The system is comprised of five chillers, five pumps, valves, piping, chemical addition tank, instrumentation and controls. Cooling water for the chiller condensers is supplied by the TCW.
During the plant normal operation, shutdown and refuelling outage, the HNCW supports the delivery of cooling and dehumidification within the drywell (via DWC) and to other parts of the plant by the Normal HVACs cooling function. The HNCW is designed to achieve the specified capacity of cooling by supplying chilled water to the DWC Cooling Dehumidifiers, the cooling coils of the various Normal HVAC Air Supply Treatment Facilities and the Normal Local Cooling Units in the R/B, C/B, T/B, Hx/B and FV/B.

In the event of faults such as LOCA and LOOP, the HNCW components are inoperable. Supply and return chilled water pipelines which penetrate the Primary Containment Vessel (PCV) incorporate isolation valves which are automatically closed by the LOCA signal to isolate Containment.

(b) The Rw/B HNCW is a closed loop chilled water system. The system is comprised of two chillers, two pumps, valves, piping, chemical addition tank, surge tank, instrumentation and controls. Cooling water for the chiller condensers is supplied by the TCW.
During the plant normal operation, shutdown and refuelling outage, the Rw/B HNCW supports the delivery of cooling to other parts of the plant by the Normal HVACs cooling function. The Rw/B HNCW is designed to achieve the specified capacity of cooling by supplying chilled water to the cooling coils of the Normal HVAC Air Supply Treatment Facilities in the Rw/B.

In the event of faults such as LOCA and LOOP, the Rw/B HNCW components are inoperable.

(c) The S/B HNCW is a closed loop chilled water system. The system is comprised of three chillers, three pumps, valves, piping, chemical addition tank, surge tank, instrumentation and controls. Cooling water for the chiller condensers is supplied by the TCW.
During the plant normal operation, shutdown and refuelling outage, the S/B HNCW supports the delivery of cooling by the Normal HVACs cooling function. The S/B HNCW is designed to achieve the specified capacity of cooling to other parts of the plant by supplying chilled water to the cooling coils of the Normal HVAC Air Supply Treatment Facilities and the Normal Local Cooling Units in the S/B.

In the event of faults such as LOCA and LOOP, the S/B HNCW components are inoperable.

(2) Equipment Design and Operation

(a) HNCW Chiller

(i) Purpose
The purpose of the HNCW Chiller is to provide chilled water for the DWC Dehumidifiers, the cooling coils of the Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in the R/B, C/B, T/B, Hx/B and FV/B.

(ii) Configuration and Operation
The HNCW contains five 25percent capacity Chillers which provide chilled water to respective cooling coils serving the Normal HVACs and the DWC Dehumidifiers in the R/B, C/B, T/B, Hx/B and FV/B. (HNCW SFC 5-18.1)

(iii) Performance
The HNCW Chiller is designed to perform as follows in order to deliver cooling and dehumidification within the drywell and the cooling function for the Normal HVACs in the R/B, C/B, T/B, Hx/B and FV/B. (HNCW SFC 5-18.1)

- Number: 5 units [1 unit standby]
- Cooling Capacity: 3290 kW [per unit]
- Chilled Water Flow: 570 m^3/h [per unit]

(b) Rw/B HNCW Chiller

(i) Purpose
The purpose of the Rw/B HNCW Chiller is to provide chilled water for the cooling coils of the Normal HVAC Supply Air Treatment Facilities in the Rw/B.

(ii) Configuration and Operation
The Rw/B HNCW contains two 100percent capacity Chillers which provide chilled water to respective cooling coils serving the Normal HVACs in the Rw/B. (HNCW SFC 5-18.2)

(iii) Performance
The Rw/B HNCW Chiller is designed to perform as follows in order to deliver cooling within the cooling function for the Normal HVACs in the Rw/B. (HNCW SFC 5-18.2)

- Number: 2 units [1 unit standby]
- Cooling Capacity: 1160 kW [per unit]
- Chilled Water Flow: 200 m^3/h [per unit]

(c) S/B HNCW Chiller

(i) Purpose
The purpose of the S/B HNCW Chiller is to provide chilled water for the cooling coils of the Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in the S/B.

(ii) Configuration and Operation
The S/B HNCW contains three 50percent capacity Chillers which provide chilled water to respective cooling coils serving the Normal HVACs in the S/B. (HNCW SFC 5-18.3)

(iii) Performance
The S/B HNCW Chiller is designed to perform as follows in order to deliver cooling within the cooling function for the Normal HVACs in the S/B. (HNCW SFC 5-18.3)

- Number: 3 units [1 unit standby]
- Cooling Capacity: 596 kW [per unit]
- Chilled Water Flow: 105 m^3/h [per unit]

(d) HNCW Chilled Water Pump

(i) Purpose
The purpose of the HNCW Chilled Water Pump is to supply chilled water for the DWC Dehumidifiers, the cooling coils of the Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in the R/B, C/B, T/B, Hx/B and FV/B.

(ii) Configuration and Operation
The HNCW contains five 25percent capacity Chilled Water Pumps which supply chilled water to respective cooling coils serving the Normal HVACs and the DWC Dehumidifiers. (HNCW SFC 5-18.1)

(iii) Performance
The HNCW Chilled Water Pump is designed to perform as follows in order to deliver cooling and dehumidification within the drywell and the cooling function for the Normal HVACs in the R/B, C/B, T/B, Hx/B and FV/B. (HNCW SFC 5-18.1)

- Number: 5 units [1 unit standby]
- Rated Flow: 570 m^3/h [per unit]

(e) Rw/B HNCW Chilled Water Pump

(i) Purpose
The purpose of the Rw/B HNCW Chilled Water Pump is to supply chilled water for the Normal HVAC Supply Air Treatment Facilities in the Rw/B.

(ii) Configuration and Operation
The Rw/B HNCW contains two 100percent capacity Chilled Water Pumps which supply chilled water to respective cooling coils serving the Normal HVACs in the Rw/B. (HNCW SFC 5-18.2)

(iii) Performance
The Rw/B HNCW Chilled Water Pump is designed to perform as follows in order to deliver cooling within the cooling function for the Normal HVACs in the Rw/B. (HNCW SFC 5-18.2)
- Number: 2 units [1 unit standby]
- Rated Flow: 200 m^3/h [per unit]

(f) S/B HNCW Chilled Water Pump

(i) Purpose
The purpose of the S/B HNCW Chilled Water Pump is to supply chilled water for the cooling coils of the Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in the S/B.

(ii) Configuration and Operation
The S/B HNCW contains three 50percent capacity Chilled Water Pumps which supply chilled water to respective cooling coils serving the Normal HVACs in the S/B. (HNCW SFC 5-18.3)

(iii) Performance
The S/B HNCW Chilled Water Pump is designed to perform as follows in order to deliver cooling within the cooling function for the Normal HVACs in the S/B. (HNCW SFC 5-18.3)
- Number: 3 units [1 unit standby]
- Rated Flow: 105 m^3/h [per unit]

(3) Main Support Systems

The major support systems related to delivery of the HNCW, Rw/B HNCW and S/B HNCW safety functions are briefly described as follows.

(a) Instrumentation and Control Systems
(i) Instrumentation
Instrumentation is provided to measure and monitor the operating conditions of the HNCW, Rw/B HNCW and S/B HNCW components necessary for the delivery of the safety functions. The main provisions for instrumentation are described as follows.
- Return header temperature of the Chiller
- Inlet and outlet pressure of the Chilled Water Pump
- Pressure between supply and return header of the Chilled Water Pump

(ii) Control

The main control provisions related to the delivery of the safety functions are described as follows.

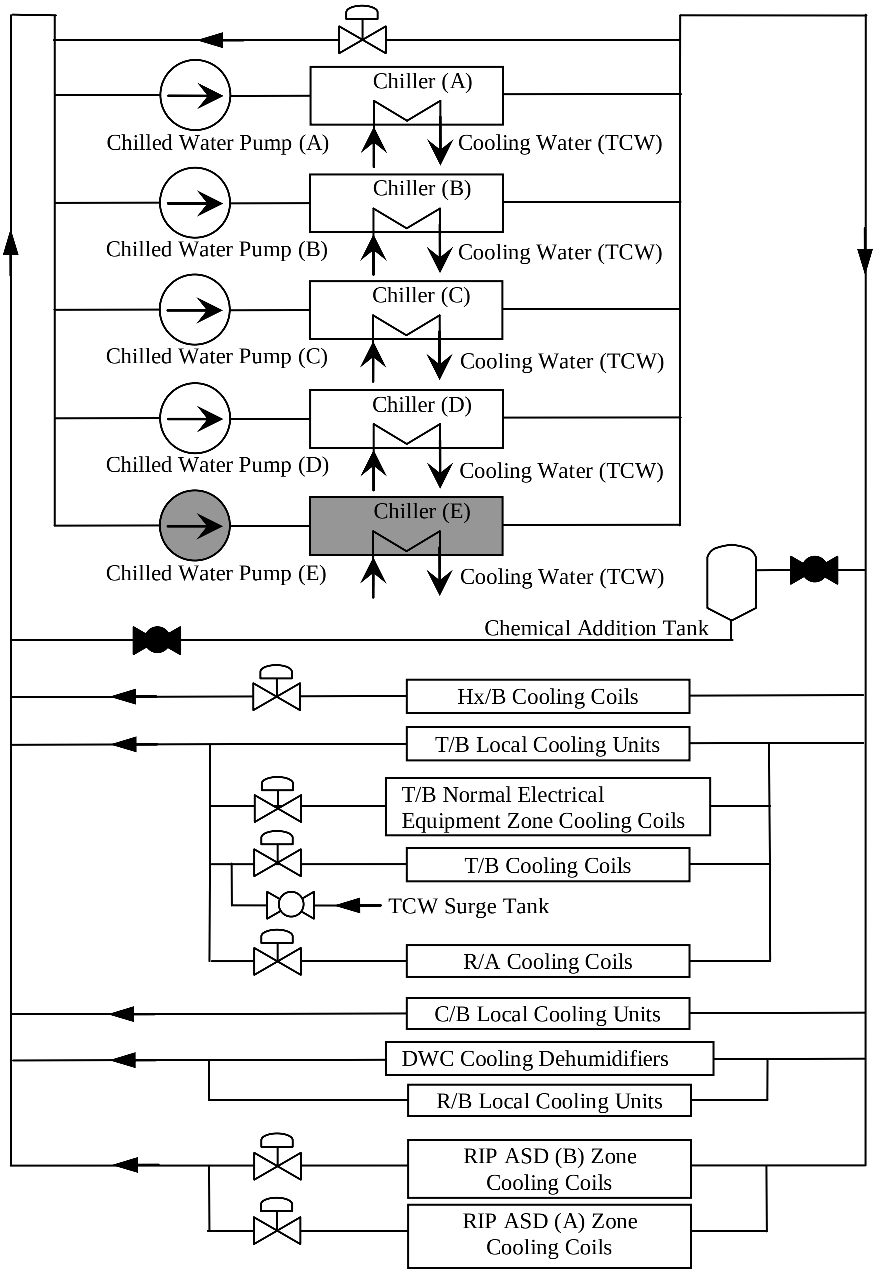
- The HNCW Chillers and the Chilled Water Pumps are operated from the Main Control Room and the local control panel.
- The Rw/B HNCW Chillers and the Chilled Water Pumps are operated from the Rw/B Main Control Room and the local control panel.
- The S/B HNCW Chillers and the Chilled Water Pumps are operated from the local control panel.
- HNCW, Rw/B HNCW and S/B HNCW start to operate provided that one or more TCW pumps operate. If all TCW pumps stop, HNCW, Rw/B HNCW and S/B HNCW also stop to protect the Chillers.
- The appropriate system flow is maintained by constantly keeping the differential pressure between supply and return headers of Chilled Water Pump constant if the required cooling load is low.

(b) Power Supply Systems

The HNCW, Rw/B HNCW and S/B HNCW components are connected to a safety class 3 AC.

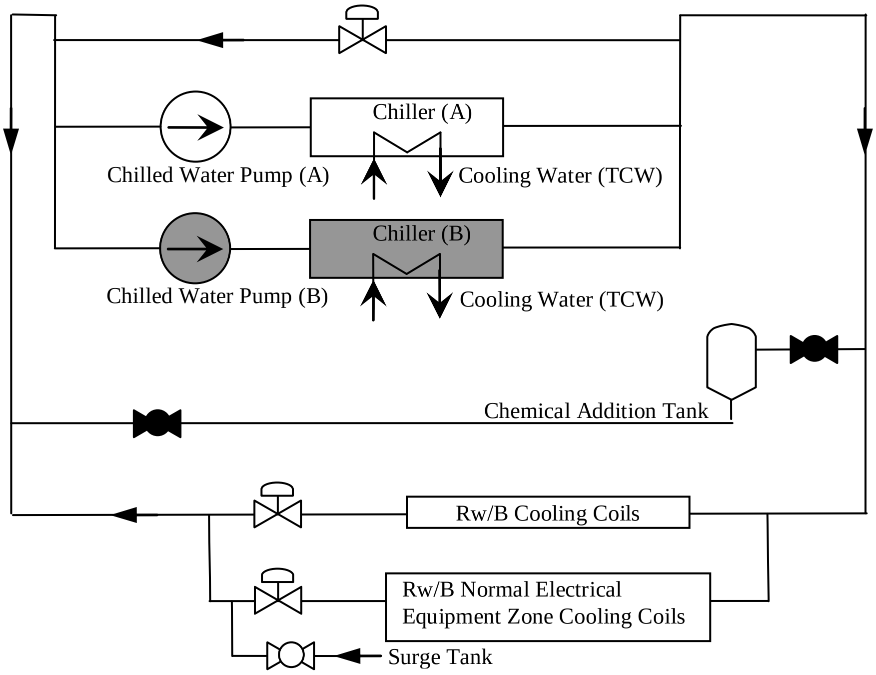
(c) Turbine Building Cooling Water System (TCW)

The TCW supplies cooling water to the chiller condensers.



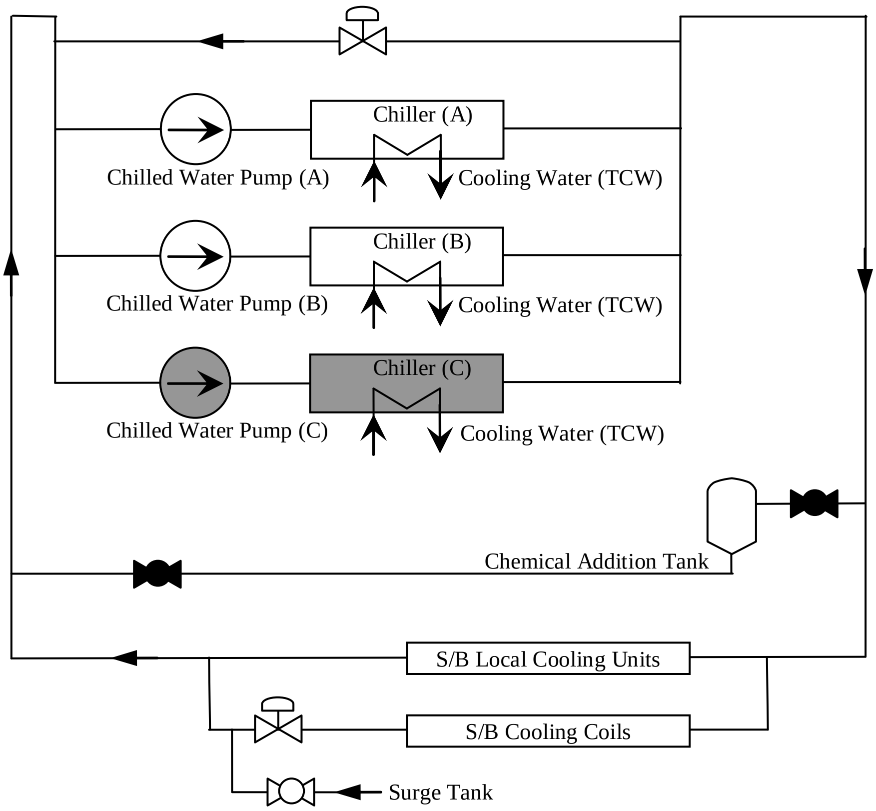
Note: This drawing shows a condition that Chiller (E) and Chilled Water Pump (E) are in standby.

Figure 16.3-7 : Outline of the HNCW



Note: This drawing shows a condition that Chiller (B) and Chilled Water Pump (B) are in standby.

Figure 16.3-8 : Outline of the Rw/B HNCW



Note: This drawing shows a condition that Chiller (C) and Chilled Water Pump (C) are in standby.

Figure 16.3-9 : Outline of the S/B HNCW

16.3.5.3 HVAC Backup Building Cooling Water System

System Summary Description

This section is a general introduction to the HBCW where the system roles, system functions, system configuration and modes of operation are briefly described. The HBCW is described in detail in the system specifications [Ref-16.3-28] and the Piping and Instrumentation Diagrams [Ref-16.3-29] [Ref-16.3-30].

(1) System Roles

The HBCW is designed for the following purpose.

Providing chilled water as a cooling medium to the following cooling coils of the Normal/Emergency Heating Ventilating Air Conditioning System (HVAC) Supply Air Treatment Facilities and Local Cooling Units during normal operation, shutdown, refuelling outage and fault conditions such as frequent design basis faults, beyond design basis faults and severe accidents.

Table 16.3-6: HVAC Sub-system associated with HBCW

No.	Bldg.	HVAC Sub-system	Safety Division
1	C/B	Control Building Class 2 Electrical Equipment Zone [CBC2EE/Z] HVAC	Normal/Emergency
2	B/B	Backup Building Electrical Equipment Zone [BBEE (A) and (B)/Z] HVAC	Normal/Emergency
		Backup Building Generator Room [BBG (A) and (B)] Local Cooling Units	Emergency
3	B/B	Backup Building Emergency Control Room [BBECR (A) and (B)] HVAC	Normal/Emergency
4	FV/B	Filter Vent Building [FV/B] HVAC	Normal/Emergency

(2) Function Delivered

The HBCW is designed to provide the cooling function for the Normal/Emergency HVAC during normal operation, shutdown, refuelling outage and fault conditions to ensure equipment operation in these areas are maintained.

(3) Basic Configuration

The HBCW consists of two separate but non-identical divisions A and B. The system main components are summarised as follows:

(a) HBCW Chillers (hereinafter termed Chiller)
  (i) Divisions A and B of Normal/Emergency
  2 units [per division] (divisions A and B shares one standby unit)
  (ii) Divisions A and B of Emergency
  1 unit [per division]

(b) HBCW Chilled Water Pumps (hereinafter termed Chilled Water Pump)
   (i) Divisions A and B of Normal/Emergency
      2 units [per division] (divisions A and B shares one standby unit)
   (ii) Divisions A and B of Emergency
      1 unit [per division]
(c) HBCW Chemical Addition Tank (hereinafter termed Chemical Addition Tank)
   1 unit [per division A and B each]
(d) HBCW Surge Tank (hereinafter termed Surge Tank)
   1 unit [per division A and B each]
(e) Piping and Valves
   1 set with divisional segregation.
(f) Instrumentation and Control Devices
   1 set with divisional segregation.

Figure 16.3-10 and 16.3-11 show an outline of the HBCW.

(4) Modes of Operation

(a) Normal Conditions
During normal operation, shutdown and refuelling outage, the HBCW of normal/emergency supplies chilled water to the cooling coils of the CBC2EE/Z HVAC, BBEE (A), (B)/Z HVAC and FV/B HVAC Supply Air Treatment Facilities. One Chiller / Chilled Water Pump set per division can achieve this, but two Chiller / Chilled Water Pump sets per division are required if the BBECR (A) or (B) HVAC Supply Air Treatment Facilities are also required. In addition, chilled water for the cooling coils of CBC2EE/Z HVAC and FV/B HVAC Supply Air Treatment Facilities is supplied from Division B of the Normal/Emergency HBCW Chillers through the interconnecting tie lines if Division A of Normal/Emergency HBCW Chillers fails.

(b) Emergency Operations
In the event of frequent design basis faults, beyond design basis faults and severe accidents, the HBCW of normal/emergency is operated in the same manner as Normal Operation. The HBCW of emergency supplies chilled water to the cooling coils of the BBG (A) and (B) Local Cooling Units. The HBCW of emergency is only operated during fault conditions such as LOCA and LOOP with failure of Class 1 system.

Design Bases

This section describes the design bases for the HBCW [Ref-16.3-28].
The linkage between the Safety Functional Claims of HBCW with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix−A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal Conditions
(a) The HBCW provides chilled water for the Normal/Emergency HVAC that is related to the nuclear supporting functions especially important to safety during normal operation, shutdown and refuelling outage. [HBCW SFC 5-18.1]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

Fault Conditions

(b) The HBCW provides chilled water for the Normal/Emergency and the Emergency HVAC that is related to the nuclear supporting functions especially important to safety during fault conditions. [HBCW SFC 5-18.2]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

System Design Description

This section describes the design of the HBCW to support and justify the delivery of HBCW SFC 5-18.1 and HBCW SFC 5-18.2. Additional design description can be found in [Ref-16.3-28] [Ref-16.3-29] [Ref-16.3-30].

(1) System Design and Operation

The HBCW is a closed loop chilled water system. The system comprises two electrical and mechanical independent divisions designated A and B in accordance with two divisions of the Normal/Emergency and the Emergency HVAC. Each HBCW division contains chillers, chilled water pumps, valves, piping, chemical addition tanks, surge tanks, instrumentation and controls.

During normal operation, shutdown, refuelling outage and fault conditions, the HBCW is provided for keeping each Normal/Emergency and Emergency HVAC cooling function to specified capacity by supplying chilled water to the cooling coils of the BBECR HVAC, BBEE/Z HVAC, CBC2EE/Z HVAC, FV/B HVAC Supply Air Treatment Facilities and BBG Local Cooling Units.

The HBCW continuous operation is ensured by receiving the power supply provided by BBG in the event of LOOP.

There are interconnecting tie lines between the divisions, which are used to supply chilled water to the cooling coils of CBC2EE/Z HVAC and FV/B HVAC Supply Air Treatment Facilities from Division B of the Normal/Emergency HBCW Chillers if Division A of the Normal/Emergency HBCW Chillers fail.

(2) Equipment Design and Operation

(a) Chiller
  (i) Purpose
  The purpose of the Chiller is to provide chilled water for the cooling coils of the Normal/Emergency HVAC Supply Air Treatment Facilities and the Emergency Local Cooling Units.
  (ii) Configuration and Operation
  Divisions A and B of the HBCW of normal/emergency each contains two partial capacity chillers which provide chilled water to respective cooling coils serving the BBECR (A) or (B) HVAC, BBEE (A), (B)/Z HVAC, CBC2EE/Z HVAC and FV/B HVAC Supply Air Treatment Facilities.
  Divisions A and B of the HBCW of emergency each contain a single capacity chiller which provide chilled water to respective cooling coils serving the BBG (A) and (B) Local Cooling Units.
  During normal operation, shutdown, refuelling outage and fault conditions, the HBCW supplies chilled water to the cooling coils of the BBEE (A), (B)/Z

HVAC, CBC2EE/Z HVAC, FV/B HVAC and the BBG (A), (B) Local Cooling Units. One Chiller / Chilled Water Pump set per division can achieve this, but two Chiller / Chilled Water Pump sets per division are required if the BBECR (A) or (B) HVAC Supply Air Treatment Facilities are also required. (HBCW SFC 5-18.1 and HBCW SFC 5-18.2)

(iii) Performance

The Chiller is designed to perform as follows in order to deliver cooling function for the Normal/Emergency and the Emergency HVAC. (HBCW SFC 5-18.1 and HBCW SFC 5-18.2)

Divisions A and B Chiller of normal/emergency

- Number: 4 units [2 units per division] (divisions A and B shares one standby unit)
- Type: Air cooled chiller
- Cooling Capacity: 754 kW [per unit]
- Chilled Water Flow: 130 m^3/h [per unit]

Divisions A and B Chiller of emergency

- Number: 2 units [1 unit per division]
- Type: Air cooled chiller
- Cooling Capacity: 368 kW [per unit]
- Chilled Water Flow: 64 m^3/h [per unit]

(b) Chilled Water Pump

(i) Purpose

The purpose of the Chilled Water Pump is to supply chilled water for the cooling coils of the Normal/Emergency and Emergency HVAC Supply Air Treatment Facilities.

(ii) Configuration and Operation

Divisions A and B of the HBCW of normal/emergency each contain two partial capacity pumps which supply chilled water to respective cooling coils serving the BBECR (A) or (B) HVAC, BBEE (A), (B)/Z HVAC, CBC2EE/Z HVAC and FV/B HVAC Supply Air Treatment Facilities.

Divisions A and B of the HBCW of emergency each contain a single capacity pump which supply chilled water to the respective cooling coils serving the BBG (A) and (B) Local Cooling Units.

During normal operation, shutdown, refuelling outage and fault conditions, the HBCW supplies chilled water to the cooling coils of the BBEE (A), (B)/Z HVAC, CBC2EE/Z HVAC, FV/B HVAC and the BBG (A), (B) Local Cooling Units. One Chiller / Chilled Water Pump set per division can achieve this, but two Chiller / Chilled Water Pump sets per division are required if the BBECR (A) or (B) HVAC Supply Air Treatment Facilities are also required. (HBCW SFC 5-18.1 and HBCW SFC 5-18.2)

(iii) Performance

The Chilled Water Pump is designed to perform as follows in order to deliver cooling function for the Normal/Emergency and the Emergency HVAC (HBCW SFC 5-18.1 and HBCW SFC 5-18.2).

Divisions A and B Pump of normal/emergency

- Number: 4 units [2 units per division] (divisions A and B shares one standby unit)
- Rated Flow: 130 m^3/h [per unit]

Divisions A and B Pump of emergency

- Number: 2 units [1 unit per division]
- Rated Flow: 64 m^3/h [per unit]

(3) Main Support Systems

The major support system related to delivery of the HBCW safety functions are briefly described as follows.

(a) Instrumentation and Control Systems

(i) Instrumentation

Instrumentation is provided to measure and monitor the operating conditions of the HBCW components necessary for the delivery of the safety functions. The main provisions for instrumentation are as follows.

- Chilled water outlet temperature of the Chiller
- Return header temperature of the Chiller
- Inlet and outlet pressure of the Chilled Water Pump
- Pressure between supply and return header of the Chilled Water Pump

(ii) Control

The main control provisions related to the delivery of the safety functions are as follows.

- The Chillers and the Chilled Water Pumps are operated from the local control panel and the Emergency Control Room.
- The appropriate system flow is maintained by constantly keeping the differential pressure between supply and return headers of Chilled Water Pump constant if the required cooling load is low.
- The valves for interconnecting tie lines are manually actuated.

(b) Power Supply System

(i) The normal AC power supply to the HBCW electrical components is provided by an independent and Off-site source (external grid).

(ii) In the event of LOOP and startup of the BBGs, power is supplied by the BBGs installed in the B/B. The BBG is a source distinct from the Emergency Diesel Generators which provide power to the emergency systems installed in the R/B.

Assumptions, Limits and Conditions for Operations

In order to ensure that the HBCW is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs and surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is ultimately reflected in the generic technical specifications [Ref-16.3-37].

- Two divisions of HBCW shall be operable during start-up, power operation and hot shutdown for the delivery of the SFCs claimed when required.

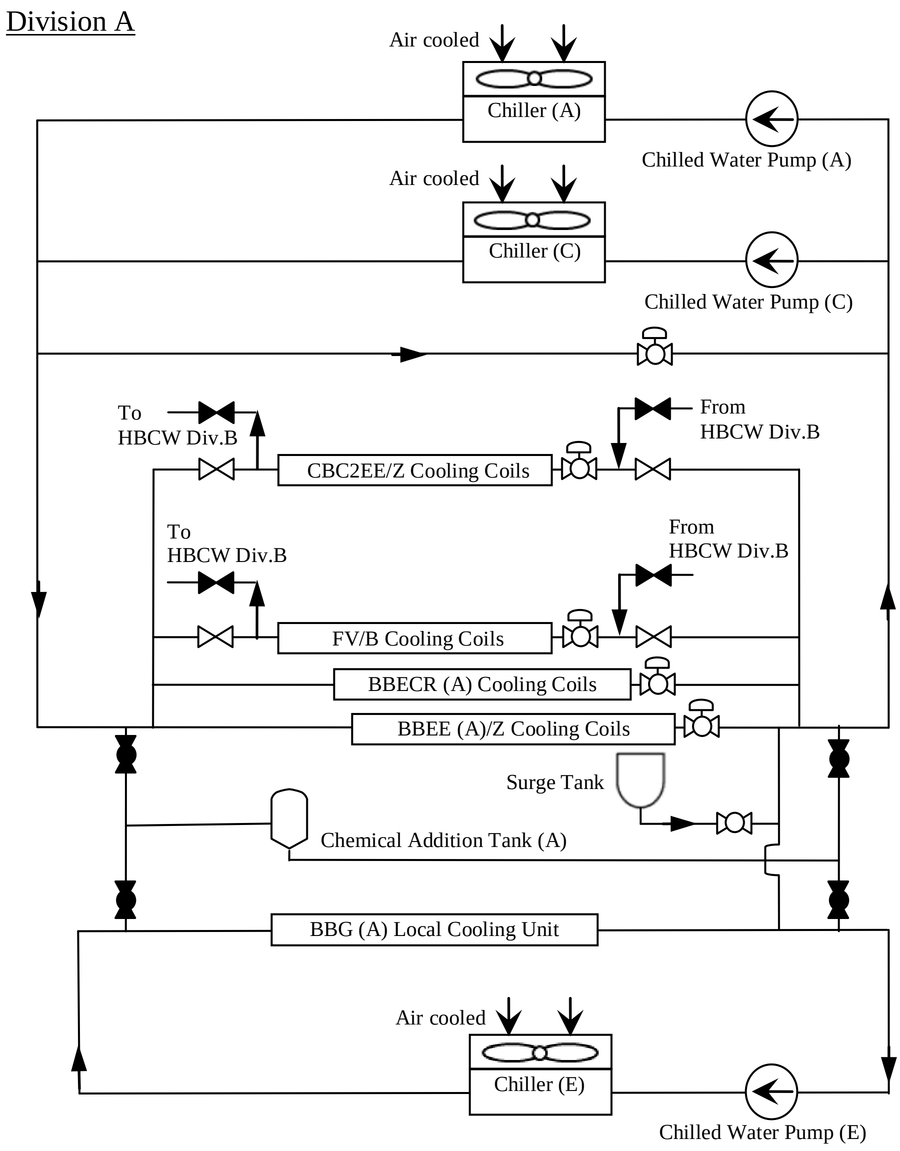
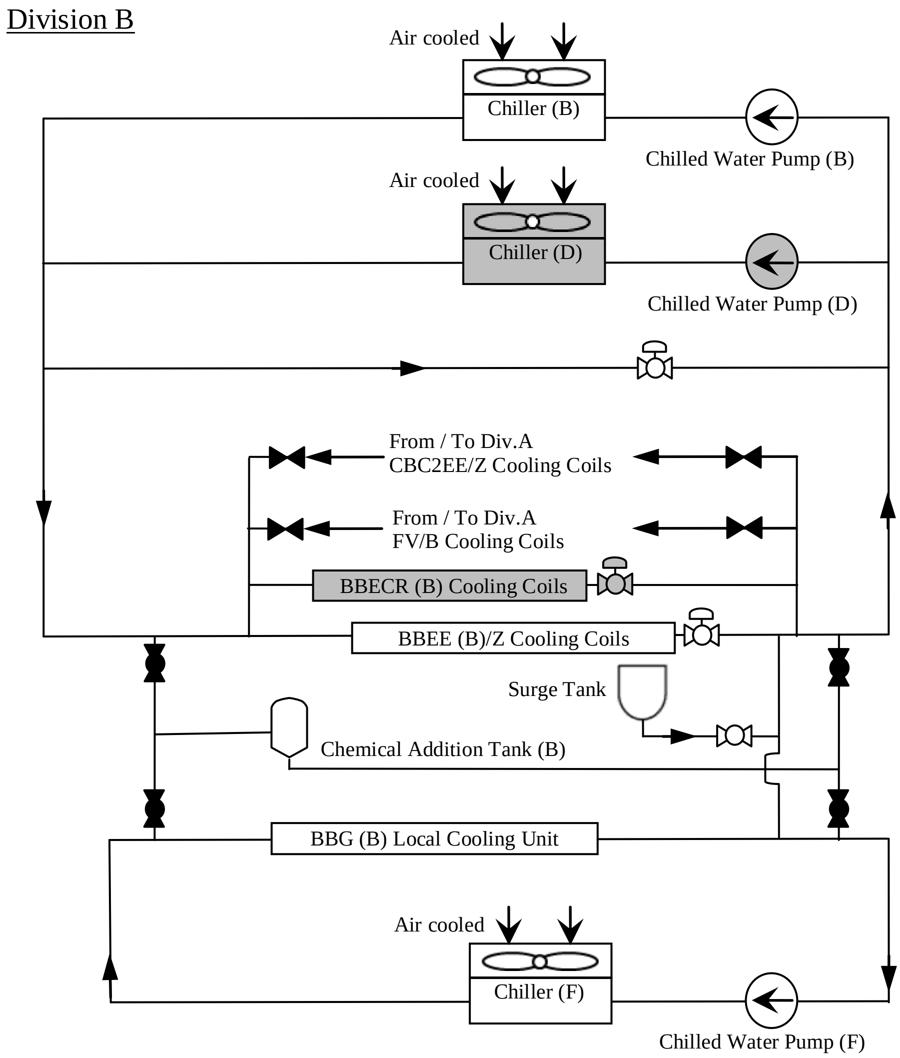


Figure 16.3-10 : Outline of the HBCW (Division A)



Note: This drawing shows a condition that Chiller (D) and Chilled Water Pump (D) are in standby.

Figure 16.3-11 : Outline of the HBCW (Division B)

16.3.6 Emergency Equipment Cooling Water System

Summary Description

This section is a general introduction to the Emergency Equipment Cooling Water System (EECW) where the systems roles, systems functions, systems configuration and modes of operation are briefly described. The EECW safety case is justified in the Backup Building Cooling Water System Basis of Safety Cases (BSC) [Ref-16.3-31].The EECW is described in detail in the system specifications [Ref-16.3-32] and the Piping and Instrumentation Diagrams. [Ref-16.3-33] [Ref-16.3-34]

(1) System Role

The main role of the EECW is to supply recirculation cooling water to the Backup Building Generators (BBG) in order to ensure power supply to the BBG loads in the event of frequent design basis faults with failure of the Class 1 core cooling systems, and in the event of beyond design basis faults and severe accidents.

(2) Functions Delivered

The EECW recirculates cooling water through a closed loop to remove heat from the BBG auxiliaries and transfers it to the Air Fin Coolers (AFCs) which cool down the water by transferring heat to the ambient air.

(3) Basic Configuration

The EECW has two independent divisions, each of them supplying the necessary cooling water to its respective BBG. Each division consists of two pumps mounted in parallel and one AFC unit. The components are arranged on a closed piping loop connected to the BBG auxiliaries that are required to be cooled. A surge tank is connected to the pump suction of each division to maintain the system under pressure and secure sufficient pump suction head. The necessary valves, controls and instrumentation are also provided.

(4) Modes of Operation

The EECW can deliver the following operation modes:

(a) Standby Mode, Freezing Prevention Operation
The EECW is in standby during plant normal operation. Since the AFCs and the nearby piping are located outdoors, there is a risk of freezing inside the piping when temperature falls below zero. In that case, one of the two EECW pumps is continuously running to circulate water heated by a heater in order to maintain temperatures in the outdoor piping and the AFC above the freezing point.

(b) BBG Cooling Mode
When a BBG division is operating, the pumps of the corresponding division of the EECW force cooling water circulation through the closed loop to remove heat from the BBG auxiliaries and transfer it to outside air through the AFCs.

Design Bases

This section describes the design bases for the EECW. [Ref-16.3-31]
The EECW has been designed to meet the following SFCs. The linkage between the SFCs of the EECW with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Fault Conditions

(a) The EECW is the principal means to remove heat from the Backup Building Generator (BBG) auxiliaries so that power can be supplied to the BBG loads in the event of frequent design basis faults where BBG loads operation is required. [EECW SFC 5-3.1]

The EECW supports the delivery of a Category A safety function and the components necessary to deliver heat removal are designed to meet Class 2 requirements.

(b) The EECW is the principal means to remove heat from the Backup Building Generator (BBG) auxiliaries so that power can be supplied to the BBG loads in the event of beyond design basis faults and severe accidents. [EECW SFC 5-3.2]

The EECW supports the delivery of a Category B safety function and the components necessary to deliver heat removal are designed to meet Class 2 requirements.

System Design Description

This section describes the design of the EECW to support and justify the delivery of EECW SFC 5-3.1 and EECW SFC 5-3.2. [Ref-16.3-23][Ref-16.3-24][Ref-16.3-25][Ref-16.3-26][Ref-16.3-27]

(1) System Design and Operation

The EECW is on standby during plant normal condition, and no component is operating, except that one pump is functioning to prevent pipe freezing.

Upon start-up of the Backup Building Generator, the corresponding EECW division is started up to supply cooling water for the BBG. A signal is sent to the two pumps and the AFC of the division to initiate them automatically. The two pumps provide cooling water circulation through the BBG auxiliaries and the AFC, while the AFC transfers heat from the circulating water to the outside air. The EECW has sufficient cooling capacity to remove all the heat generated by the BBG when it functions at the rated operation.

(2) Equipment Design and Operation

(a) EECW Pump

(i) Purpose

The EECW pumps send cooling water to the BBG auxiliaries and remove heat from them in order to deliver [EECW SFC 5-3.1] and [EECW SFC 5-3.2].

(ii) Configuration and Operation

Each division of the EECW is provided with two 50 percent capacity pumps. One division of the EECW provides sufficient cooling water for one BBG division when BBG is operating at rated power.

(iii) Performance

The EECW Pump is designed to perform as follows in order to ensure the delivery of the safety functions:

Number: 2 units/division x 2 divisions
Flow Rate: 150 m^3/h/unit

(b) Air Fin Cooler

(i) Purpose

The AFCs cool the BBGs in order to preserve their power supply function by transferring heat energy from the EECW circulating water to the atmosphere in order to deliver [EECW SFC 5-3.1] and [EECW SFC 5-3.2].

(ii) Configuration and Operation

One AFC unit is provided for each division.
One AFC unit is capable of removing the heat generated by one BBG when operating at rated power under design air pressure condition.

(iii) Performance

The AFC is designed to perform as follows in order to ensure the delivery of the safety functions:

Number: 1 unit/division x 2 divisions
Flow Rate: 300 m^3/unit

(3) Main Support Systems

(a) Instrumentation and Control System

The systems supporting the EECW with instrumentation and control is the Safety Class 2 Hardwired Backup System (HWBS) and the Severe Accident C&I System (SA C&I). The design and the claims on the HWBS and the SA C&I are addressed in Chapter 14: Control and Instrumentation.

(i) Instrumentation

Instrumentation is provided to measure and monitor the operating conditions of the system components necessary for the delivery of the safety functions. The main provisions for instrumentation are described as follows.

- A pressure gauge is provided at the discharge of the EECW pump. An alarm is activated upon low discharge pressure.
- Temperature is locally indicated downstream of the AFC for monitoring.
- An alarm is actuated on surge tank low and high water level.

(ii) Control

- Automatic operation of the EECW Pumps and the AFC is actuated by the logic of the HWBS on a 1-out-of-2 twice voting logic if available. Nonetheless, remote switches for manual actuation from the Backup Building Control Panel (BBCP) or the Hardwired Backup Panel (HWBP) in the MCR via the HWBS are provided, with an interlock that prevents operation from both places at a time.
- Manual operation of the EECW for beyond design basis faults (including severe accidents) is monitored and controlled remotely from the BBCP in the B/B control room through the SA C&I logic (the actuators are shared with the HWBS).

(b) Power Supply System

Power supply for the EECW electrical components, valves, and the related instrumentation and controllers are provided by the B/B Class 2 EPS. The detailed design and the claims on the EPS are addressed in Chapter 15: Electrical Power Supplies.

(i) The EECW divisions are connected to separated systems of the B/B Class 2 AC and DC EPS, supplying the required power to all electrical components in each division (EECW Division A and B are connected B/B Class 2 EPS system 1 and 2, respectively).

(ii) The normal AC and DC power supply to the EECW electrical components, valves, instrumentation and controllers is provided by the external grid. In addition, the Safety Class 2 B/B Generators 1 and 2 provide power for EECW division A and B components respectively in the event of LOOP or Station Blackout (SBO).

Assumptions, Limits and Conditions for Operation

In order to ensure that the EECW is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs and surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is described in the Basis of Safety Cases on Backup Building Cooling Water System ([Ref-16.3-31]) and ultimately reflected in the “Generic Technical Specifications” ([Ref-16.3-37]).

- The EECW (Division 1 and/or 2) shall be operable when associate BBG (System 1 and/or 2) is required to be operable.

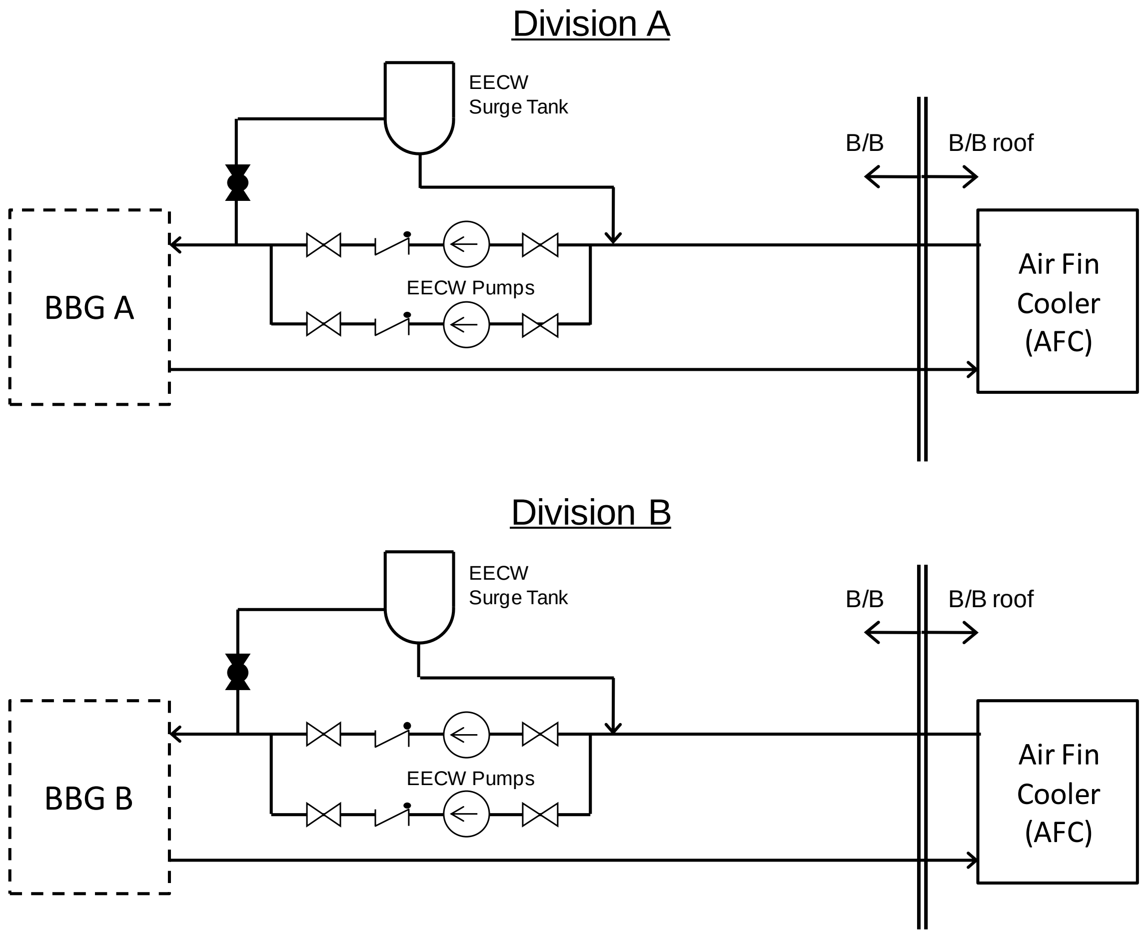


Figure 16.3-12 Outline of the EECW

16.4 Process Auxiliary Systems

16.4.1 Compressed Gas Systems

16.4.1.1 Instrument Air System

System Summary Description

This section is a general introduction to the Instrument Air System (IA) where the system roles, system functions, system configuration and modes of operation are briefly described. The IA is described in detail in the system specifications [Ref-16.4-1] and the Piping and Instrumentation Diagram (P&ID). [Ref-16.4-2]

(1) System Roles

The IA is designed to supply clean, dry and oil-free compressed air to the plant instrumentation, control components and air operated valves.

(2) Functions Delivered

The IA supplies compressed air to satisfy the requirements of plant instruments, controllers, pneumatic valves, etc. The main users of compressed air are shown in Table 16.4-1. The list of systems consuming air from the IA is included in [Ref-16.4-1].

Table 16.4-1: Main users of Instrument Air

Facility	Main users
Reactor Building	Instrumentation
	Control valves
	Air-operated valves
Turbine Building	Instrumentation
	Control valves
	Air-operated valves
Radwaste Building	Instrumentation
	Control valves
	Air-operated valves
Control Building	Instrumentation
	Control valves
	Air-operated valves
Heat Exchanger Building	Instrumentation
	Control valves
	Air-operated valves

The IA is not an essential supporting system for safety systems and components such as the RPS MSIV, because all SSCs served by the IA having a nuclear safety role are designed with the ‘fail safe’ concept. For example, RPS is held in stand-by position and MSIV are maintained opened by supplying air from the IA, and if the IA fails, these functions are initiated automatically (the reactor is scrammed and MSIV is closed).

(3) Basic Configuration

(a) The supply of compressed air for plant instrumentation and controls is provided by a compressed air system with two parallel trains. The system has two compressors arranged in parallel (one duty, one standby). Compressed air from the compressors is transferred to the air reservoir, then through one of two parallel dryer trains (one unit as backup), and finally is supplied to the respective pneumatic components.

(b) Normal operation of the IA is independent from the Station Service Air System (SA). However, in case of failure or abnormal pressure drop, the SA is capable of automatic operation to back up the IA through the piping and the valve connecting the two systems.

(c) Piping connecting to the High Pressure Nitrogen Gas Supply System (HPIN) is provided upstream of the valve isolating the IA since the instrumentation, controllers and devices for driving pneumatic valves inside the Primary Containment Vessel (PCV) are normally operated by nitrogen gas during normal plant operation.

(d) The IA consists of the following equipment. The outline of IA configuration is shown in Figure 16.4-1.

- IA Compressor 2 units (1 as a backup)
- IA Air Reservoir 1 unit
- IA Dryer Pre Filter 2 units (1 as a backup)
- IA Dryer Tower 2 sets/unit x 2units (1 as a backup)
- IA Dryer After Filter 2 units (1 as a backup)

(4) Modes of Operation

The IA can deliver the following operation modes by switching the position of the valves.

(a) Normal Operation Mode

Compressed air is supplied by one of the IA Compressors which is selected as the driving unit to operate during normal conditions.
Nitrogen gas to be supplied to instruments and valves inside the PCV is provided by the Nitrogen Gas Supply Machine from the Atmospheric Control System (AC) after pressure reduction through the HPIN.

(b) Backup Operation Mode

The standby compressor automatically starts if a pressure drop is detected in the IA Air Reservoir due to a failure in the driving compressor or insufficient air supply to satisfy an increase in air consumption with just one unit.

Furthermore, in the event the gas pressure decreases further, the isolation valve on the line connecting with the SA automatically opens to receive compressed air from the SA.
In addition, the IA supplies air to the pneumatic components inside the PCV in the event that capability of supplying nitrogen decreases or a failure occurs.

(c) Plant Periodic Inspection Mode

The IA provides compressed air to the pneumatic components inside the PCV instead of nitrogen gas during periodic inspections by a manually-operated switch.

Design Bases

This section describes the design bases for the IA.
The IA has been designed to meet the following SFCs. The linkage between the SFCs of IA with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal Conditions

(a) The IA continuously supplies compressed air to prevent inoperability of the pneumatic components within systems required for plant continuous operation. [IA SFC 5-13.1]
(This function is categorised as Category C and the components to deliver it are to meet Class 3 requirements)

(b) The IA supplies the air required to maintain the normal operation of Class 3 systems that contribute to reducing radiation exposure from radioactive material. [IA SFC 5-13.2]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

Fault Conditions

(a) The IA backs up the HPIN by automatically supplying compressed air to drive the instruments, controllers and pneumatics valves that are normally supplied with nitrogen gas by the HPIN, in the event that the HPIN supply is interrupted. [IA SFC 5-13.3]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

(b) The IA components penetrating the primary containment form a barrier to confine the radioactive material within the primary containment boundary and prevent its dispersion to the environment in the event of faults. [IA SFC 4-7.1]
(This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. This safety function is developed and justified in Chapter 13: Engineered Safety Features, Section 13.3.3.1 related to the Primary Containment Facility)

System Design Description

This section describes the design of the IA to support and justify the delivery of [IA SFC 5-13.1], [IA SFC 5-13.2] and [IA SFC 5-13.3]. The IA is described in detail [Ref-16.4-1] and [Ref-16.4-2].

(1) Overall System Design and Operation

The IA provides a reliable supply of dry, clean, oil-free compressed air for plant instrumentation and controls. Compressed air from two compressors arranged in parallel (one as backup) is transferred to the air reservoir, then through one of two parallel dryer trains (one train as backup), which each have a dryer pre-filter, two parallel dryer towers (one in service and one stand-by) and a dryer post-filter. Finally compressed air is directed to the respective pneumatic components.

(a) Normal Operation Mode

Compressed air is supplied by one of the IA Compressors which is selected as the driving unit to operate during normal conditions.
Nitrogen gas to be supplied to instruments and valves inside the PCV is provided by the Nitrogen Gas Supply Machine from the Atmospheric Control System (AC) after pressure reduction through the HPIN.

(b) Backup Operation Mode

The standby compressor automatically starts if a pressure drop is detected in the IA Air Reservoir due to a failure in the driving compressor or insufficient air supply to satisfy an increase in the air consumption with just one unit.
Furthermore, in the event the gas pressure decreases more, the isolation valve on the line connecting with the SA automatically opens to receive compressed air from the SA.
In addition, the IA supplies air to the pneumatic components inside the PCV in the event that the capability of supplying nitrogen decreases or a failure occurs.

The IA is designed to satisfy the following general conditions. Actual values for the specification can only be determined when the specification of the pneumatic equipment and instrumentation supplied is known in more detail.

Table 16.4-2: General Requirements for IA Design

Item	Contents
Air flow rate	The adequate flow to sufficiently supply the total air consumption of the devices which require it.
Air pressure	The adequate pressure to satisfy the maximum necessary pressure among all pneumatic components and not to cause damage or inoperability to pneumatic components through excess pressure
Air quality	The adequate quality to not cause any impediment to the pneumatic components
Air humidity	The adequate humidity to not cause any impediment to instruments and controllers to achievement of required operating life and maintenance interval

Item	Contents
Air temperature	The adequate temperature to not cause any impediment to the dryer
Dust particles size	The adequate diameter to not cause any impediment to instruments and controllers

(2) Equipment Design and Operation

(a) IA Compressor

(i) Purpose
The IA Compressor supplies air at the highest pressure required among all of its loads in order to deliver [IA SFC 5-13.1], [IA SFC 5-13.2] and [IA SFC 5-13.3]. Where necessary, any components which have a lower maximum pressure rating will be suitably protected.

(ii) Configuration and Operation
Two 100 percent-capacity IA Compressors are provided and supply oil-free air to the components in order to maintain their performance. One compressor is sufficient for supplying the required consumption of compressed air, therefore one compressor is in operation and the other is in stand-by.

(iii) Performance
The specification of IA Compressor required for the delivery of [IA SFC 5-13.1], [IA SFC 5-13.2] and [IA SFC 5-13.3] is shown below.

- Number 2 units (1 driving unit, 1 stand-by unit)
- Capacity(suction air flow) Approx. 16 m^3/min/unit[normal]

(b) IA Air Reservoir

(i) Purpose
The IA Air Reservoir is designed to absorb and mitigate the pulsations caused by the discharge of compressed air and provide a stable supply. In addition, it is capable of supplying compressed air for 10 minutes at the required pressure after failure of all systems supplying air (IA and SA) in the event of loss of power supply.

(ii) Performance
The specification of IA Air Reservoir is shown below.

- Number 1 unit
- Capacity Approx.40m^3

(c) IA Dryer

(i) Purpose
The IA dryer is capable of drying the air up to the dew point, at a sufficiently low temperature to not interfere with the operating conditions of instruments and controllers, including allowance if necessary for expansion of air at the equipment.

(ii) Configuration and Operation
The IA dryer consists of two 100 percent-capacity trains, in each one of which one set of two IA Dryer Tower units are installed. In each set one unit operates while the other is regenerating. One set operates as the driving set and the other is in stand-by. If the driving unit fails, operation is switched to the standby units automatically to continue supplying air at the same conditions.

(d) IA Dryer Pre Filter

(i) Purpose
The IA Dryer Pre Filter removes dust particles contained in the compressed air to prevent adhesion to the desiccant and thus preserve desiccant performance.

(ii) Configuration and Operation
The IA Dryer Pre Filters are installed at the inlet of the IA Dryer Towers sets. Two 100 percent-capacity switchable units are installed.

(e) IA Dryer After Filter

(i) Purpose
The IA Dryer After Filter removes desiccant particles and other dust substances that might be in the dried air and thus protect the pneumatic components.

(ii) Configuration and Operation
The IA Dryer After Filters are installed at the outlet of the IA Dryer Towers. Two 100 percent-capacity switchable units are installed.

(3) Main Support Systems

(a) Instrumentation and Control Systems

(i) The IA Compressors are continuously switching between loaded operation and unloaded operation depending on the pressure in the IA Air Reservoir to control and maintain it within the determined range. If the pressure in the IA Air Reservoir drops below the specified value, the standby IA Compressor automatically starts and operates in parallel with the driving unit. Once the standby compressor has been initiated, shutoff can be implemented by the operation switch.
(ii) Nitrogen gas supply is automatically switched to compressed air supply if the nitrogen gas supply pressure to the components within the PCV drops.
(iii) The isolation valve connecting the SA to the IA automatically opens to initiate the backup operation if the pressure in the IA Air Reservoir drops.

(b) Power Supply System

During normal conditions, the IA is supplied with power by the external grid. The Emergency Power Supply System is capable of supplying AC power to the IA Compressors and the IA dryer units and DC power to the controls and instrumentation in the event of loss of offsite power supply.

(c) Reactor Building Cooling Water System (RCW)

The cooling water for the compressors comes from the RCW. The cooling water for the driving and standby compressors comes from different divisions of the RCW system to minimise risk of simultaneous loss of cooling water supply.

Assumptions, Limits and Conditions for Operations

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.4-11]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

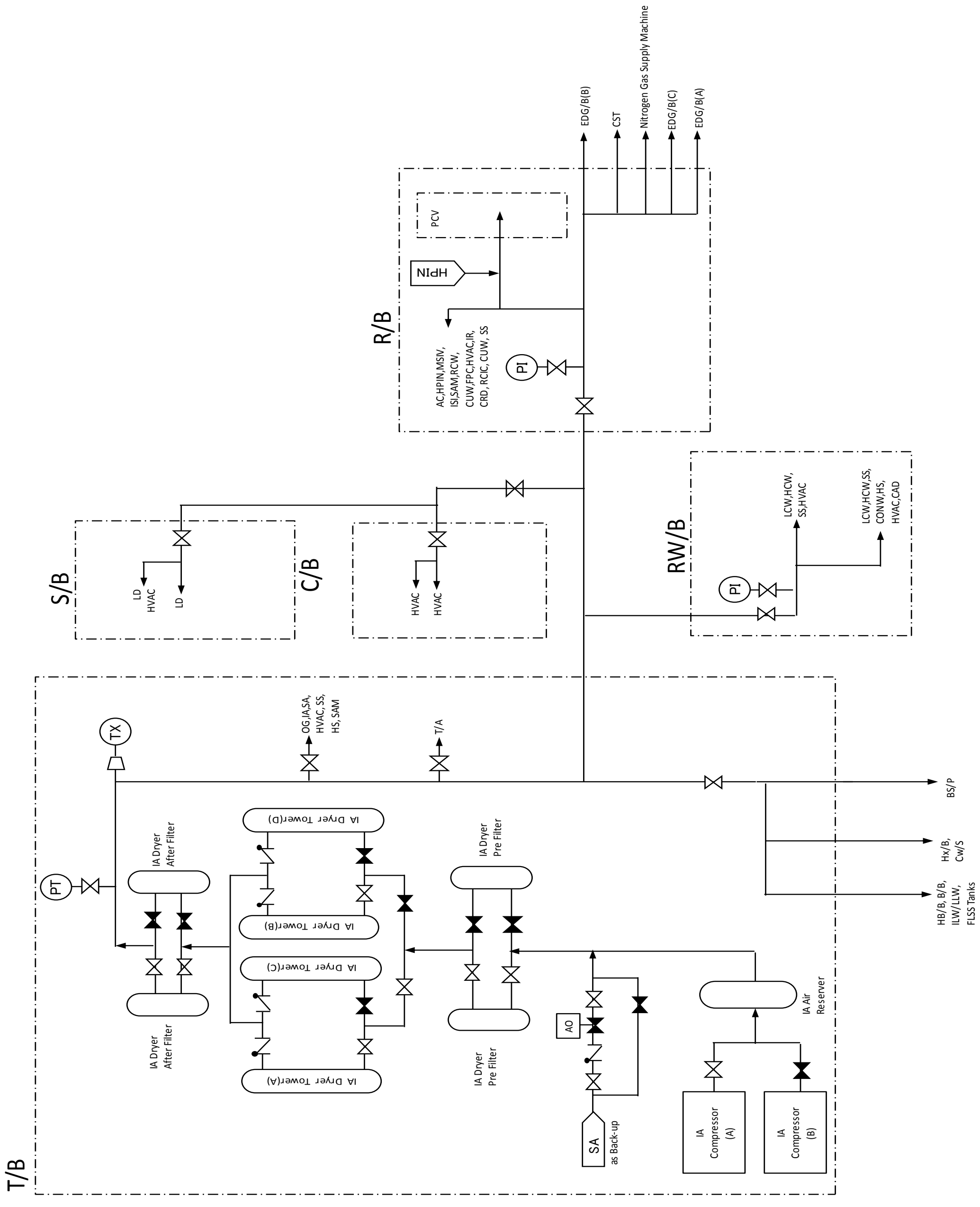


Figure 16.4-1: Outline of IA configuration

16.4.1.2 Station Service Air System

System Summary Description

This section is a general introduction to the Station Service Air System (SA) where the system roles, system functions, system configuration and modes of operation are briefly described. The SA is described in detail in the system specifications [Ref-16.4-4] and the P&IDs [Ref-16.4-5], [Ref-16.4-6], [Ref-16.4-7] and [Ref-16.4-1].

(1) System Roles

The SA is designed to supply compressed air for equipment purging, filter backwashing and fluid agitation as well as compressed air for pneumatic components and tools. The SA is a source of compressed air for miscellaneous purposes and is independent from the Instrument Air System (IA) except for the tie-line on the IA to enable supply from the SA to the IA as backup measure to loss of the IA.

(2) Functions Delivered

The SA supplies compressed air for equipment purging, filter backwashing, fluid agitation and operation of pneumatic components and tools. The main users of compressed air are shown in Table 16.4-3.

Table 16.4-3: Main users of Service Air

Main user	Purpose
Standby Liquid Control Tank	Mixing
CUW Filter/Demineraliser	Backwashing
FPC Filter/Demineraliser	Backwashing
Condensate Filter	Backwashing
Condensate Demineraliser	Mixing
LCW Filter	Backwashing
LCW Demineraliser	Transfer
HCW Demineraliser	Transfer
Instrument Air System	Backup

(3) Basic Configuration

The SA is composed of two parallel compressors. Compressed air from each compressor is collected and flows through the SA Air Reservoir to the respective air supply points.
The SA normally operates separately from the IA. However, if the supply pressure of the IA abnormally drops, the SA is actuated as a backup of the IA. Connecting piping and valves are provided to automatically back up the IA.
The SA consists of the following components. The outline of SA configuration is shown in Figure 16.4-2.

·	SA Compressor	2 units (50 percent-capacity/unit)
·	SA Air Reservoir	1 unit
·	Piping and Valves	1 set
·	Instruments and Controllers	1 set
·	Hose Connections and Fittings	1 set

(4) Modes of Operation

The SA can deliver the following operation modes by switching the position of the valves.

(a) Normal Operation Mode

This is the basic operation mode of the SA which supplies compressed air to the different equipment requiring it.

(b) IA Back-up Operation Mode

The valve on the line connecting the SA with the IA automatically opens and the supply of compressed air from the SA to the IA is initiated, in the event that the pressure in the IA drops.

Design Bases

This section describes the design bases for the SA.
The SA has been designed to meet the following SFCs. The linkage between the SFCs of SA with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal Conditions

(a) The SA continuously supplies compressed air to prevent inoperability of the pneumatic components within systems required for plant continuous operation. [SA SFC 5-13.1]
(This function is categorised as Category C and the components to deliver it are to meet Class 3 requirements.)

(b) The SA supplies air to the air required to maintain the normal operation of Class 3 systems that contribute to reducing radiation exposure from radioactive material. [SA SFC 5-13.2]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

Fault Conditions

(c) The SA initiates supply of compressed air to the IA as a back-up of the IA in the event that the pressure in the IA drops abnormally. [SA SFC 5-13.3]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

(d) The SA components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [SA SFC 4-7.1]
(This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. This safety function is developed and justified in Chapter 13: Engineered Safety Features, Section 13.3.3.1 related to the Primary Containment Facility.

System Design Description

This section describes the design of the SA to support and justify the delivery of [SA SFC 5-13.1] and [SA SFC 5-13.2]. The SA is described in detail in [Ref-16.4-4], [Ref-16.4-5], [Ref-16.4-6], [Ref-16.4-7] and [Ref-16.4-8].

(1) Overall System Design and Operation

The SA consists of two parallel compressors. Compressed air from each compressor is collected and flows through the SA Air Reservoir to the respective air supply points.
The SA normally operates separately from the IA. However, if the supply pressure of the IA drops, the SA is actuated as a backup of the IA. Connecting piping and valves are provided to automatically back up the IA.

(a) Normal Operation Mode

This mode is the basic operation mode of the SA which supplies compressed air to the different equipment requiring it.
One compressor is normally operating loaded or unloaded repeatedly as the driving unit.
The other compressor is on standby condition during normal conditions. In the event the air consumption exceeds the capacity of the driving unit or the operating compressor cannot maintain the required pressure due to any failure, the standby compressor is initiated automatically and operated loaded or unloaded as the auxiliary unit.

(b) IA Backup Operation Mode

The valve on the line connecting the SA with the IA automatically opens and the supply of compressed air from the SA to the IA is initiated in the event the pressure in the IA drops.

The SA is designed to satisfy the following general conditions. Actual values for the specification can only be determined when the specification of the equipment supplied is known in more detail.

Table 16.4-4: General Requirements for Air Supply

Item	Requirement
Air flow rate	Sufficient to satisfy the supply to all components.
Air pressure	Sufficient to satisfy the highest pressure among all components requiring air supply.
Air quality	The necessary quality to supply to the components without hindrance.

(2) Equipment Design and Operation

(a) SA Compressor

(i) Purpose
The SA compressors supply the required continuous consumption of air to the components, and are capable of sufficiently covering the cumulative consumption of the maximum intermittent loads in order to deliver [SA SFC 5-13.1] and [SA SFC 5-13.2].

(ii) Configuration and Operation
Two compressors with 50 percent-capacity per unit are provided. They supply oil-free air in order to satisfy the consumption of the different loads without affecting their performance. One compressor is normally operating and the standby compressor initiates when the capacity of the driving compressor is exceeded due to the cumulative consumption from the intermittent loads to ensure the necessary supply.

(iii) Performance
The specification of the SA Compressor required for the delivery of [SA SFC 5-13.1] and [SA SFC 5-13.2] is shown below:

- Number 2 units
- Suction Air Flow Approx.12m^3/min /unit [normal]
- Discharge pressure 0.72MPa

(b) SA Air Reservoir

(i) Purpose
The SA Air Reservoir is designed to mitigate pulsations and prevent rapid pressure drops during load variations, and supply compressed air in a stable way.

(ii) Performance
The specification of the SA Air Reservoir is shown below.

- Number 1 unit
- Capacity Approx.11m^3

(3) Main Support Systems

Instrumentation and Control Systems

(i) The driving compressor is switched from load operation to unload operation depending on the pressure in the SA Air Reservoir so that the pressure is maintained within the determined range. The stand-by compressor is automatically initiated and operated in parallel with the driving compressor if the pressure in the SA Air Reservoir drops to a pre-determined low value. A timer is provided to prevent frequent initiation/shutoff of the stand-by compressor.

(ii) The connection valve between the SA and the IA opens automatically to initiate air supply from the SA to the IA if the pressure in the IA Air Reservoir drops.

Assumptions, Limits and Conditions for Operations

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.4-11]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

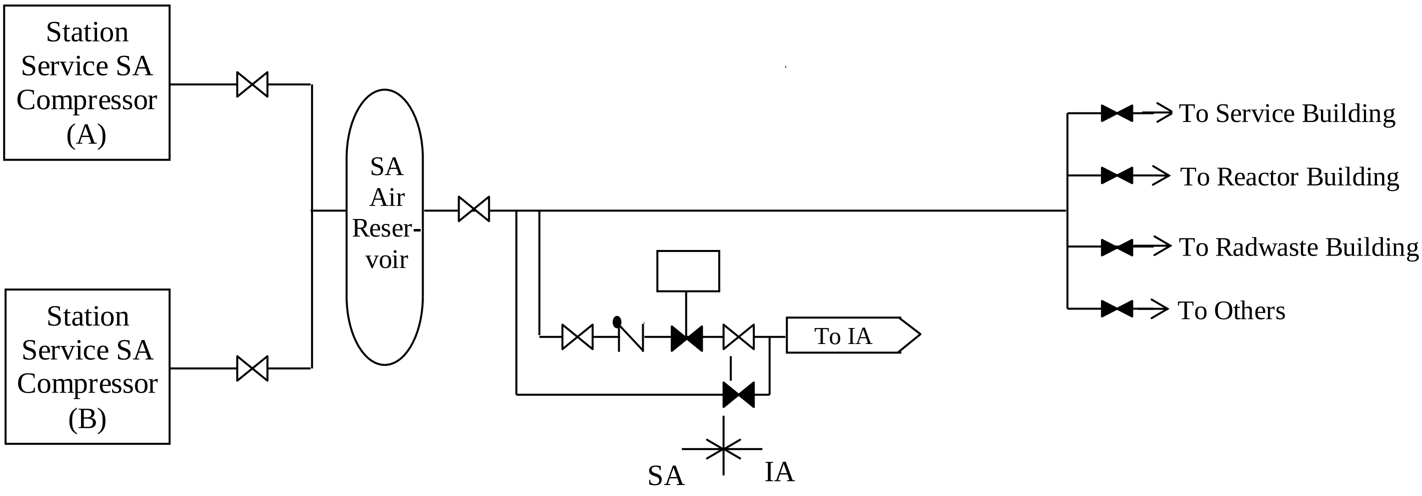


Figure 16.4-2: Outline of SA configuration

16.4.1.3 High Pressure Nitrogen Gas Supply System

System Summary Description

This section is a general introduction to the High Pressure Nitrogen Gas Supply System (HPIN) where the system roles, system functions, system configuration and modes of operation are briefly described. The HPIN design is described in detail in the system specifications [Ref-16.4-9] and the P&ID [Ref-16.4-10].

(1) System Roles

The purpose of the HPIN is to supply clean, dry and oil-free nitrogen gas to all the accumulators of the Main Steam Safety Relief Valves (SRVs) and other pneumatic valve actuators which need high pressure nitrogen gas.

(2) Functions Delivered

(a) The HPIN supplies nitrogen gas to the following components from the nitrogen gas supply machine via the Atmospheric Control System (AC) during plant normal conditions.

(i) SRV Accumulators for the relief valve function, the Automatic Depressurisation System (ADS) function and the Reactor Depressurisation Control Facility (RDCF) function of the Safety Relief Valves (SRV)
(ii) Instrumentation and pneumatic valves in the Primary Containment Vessel (PCV) including inboard containment isolation valves (e.g. inboard MSIVs)
(iii) Equipment requiring nitrogen gas supply in the Reactor Building (R/B)

(b) The HPIN is capable of supplying nitrogen gas from the nitrogen gas supply machine to the SRV Accumulators for the ADS and the RDCF functions of the SRVs in the event of design basis faults such as LOCA if this is available. Furthermore, nitrogen cylinders are provided to ensure the supply in the case of loss of the normal nitrogen supply.

(c) The HPIN can also supply nitrogen gas through the nitrogen cylinders for the actuation of the SRVs in the event of beyond design basis faults if available.

(3) Basic Configuration

The HPIN consists of one high pressure nitrogen gas supply division to provide nitrogen from the nitrogen gas supply machine via the AC during plant normal conditions, and two high pressure nitrogen gas supply divisions (emergency gas supply lines A and B) to provide nitrogen from the HPIN nitrogen cylinders in case of loss of the normal supply. The basic components are as follows. The outline of the HPIN configuration is shown on Figure 16.4-3.

· Nitrogen Gas Cylinder Rack	2 racks (5 cylinders per rack)
· Piping and Valves	1 Set
· Instruments and Controllers	1 Set
· Control Panels	1 Set

(4) Modes of Operation

The HPIN can deliver the following operation modes by switching the position of the valves.

(a) Normal Operation Mode

All nitrogen-operated components are provided with nitrogen gas during plant normal conditions. The nitrogen is supplied through the IA except for the SRV Accumulators which are directly supplied by the HPIN.

(b) Emergency Operation Mode

The HPIN is capable of supplying nitrogen gas from the nitrogen gas supply machine to the SRV Accumulators for the ADS and RDCF functions of the SRVs in the event of design basis faults such as LOCA if this is available. In addition, the motor-operated valves at the outlet of the nitrogen gas cylinders are automatically opened to supply nitrogen gas to the SRV Accumulators for the ADS and RDCF functions if the normal supply is lost or the pressure at the inlet line to the accumulators drops below the determined pressure.

(c) Beyond Design Basis Faults Operation Mode

The motor-operated valves at the outlet of the nitrogen gas cylinders can be manually opened to supply nitrogen gas to the SRVs required for depressurisation in the event of beyond design basis faults if available.

Design Bases

This section describes the design bases for the HPIN.
The HPIN has been designed to meet the following SFCs. The linkage between the SFCs of HPIN with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal Conditions

(a) The HPIN supplies nitrogen gas to fill and maintain pressure in the SRV accumulators for relief, ADS and RDCF functions during normal conditions. [HPIN SFC 5-13.1]
(This function is categorised as Safety Category C and the components to deliver it are designed to meet Safety Class 3 requirements)

(b) The HPIN supplies nitrogen gas to the nitrogen operated equipment installed in the reactor building and the PCV (including inboard MSIV) during normal conditions. [HPIN SFC 5-13.2]
(This function is categorised as Safety Category C and the components to deliver it are designed to meet Safety Class 3 requirements)

Fault Conditions

(c) The HPIN backs up reactor depressurisation by the SRVs in the event of design basis faults if available. [HPIN SFC 5-3.1]
(This defence in depth function is categorised as Safety Category C and the components to deliver it are designed to meet Safety Class 3 requirements).

(d) The HPIN through its nitrogen gas cylinders supports SRV operation for reactor depressurisation in the event of beyond design basis faults if available. [HPIN SFC 5-3.2]
(This defence in depth function is categorised as Safety Category B and the components to deliver it are designed to meet Safety Class 3 requirements).

(e) The HPIN components penetrating the primary containment form a barrier to confine radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [HPIN SFC 4-7.1]
(This function is categorised as Safety Category A and the components to deliver it are designed to meet Safety Class 1 requirements. This safety function is developed and justified in Chapter 13: Engineered Safety Features, Section 13.3.3.1 related to the Primary Containment Facility.

System Design Description

This section describes the design of the HPIN to support and justify the delivery of [HPIN SFC 5-13.1], [HPIN SFC 5-13.2], [HPIN SFC 5-3.1] and [HPIN SFC 5-3.2]. The HPIN is described in detail in [Ref-16.4-9] and [Ref-16.4-10]

(1) Overall System Design and Operation

(a) Normal Operation Mode

The system supplies nitrogen gas to the equipment described below from the nitrogen gas supplying machine via the AC.

(i) SRV Accumulator (for the ADS, RDCF and relief functions),
(ii) The inboard MSIV,
(iii) The nitrogen gas-operated equipment used in PCV, and
(iv) The nitrogen gas-operated equipment used in R/B.

(iii) and (iv) equipment is supplied nitrogen via the Instrument Air System (IA)

The nitrogen gas to be supplied to each unit of equipment is supplied after reducing its pressure by the pressure control device set up on the supply line.

In the case the pressure in the supply line drops below the determined value, the supply of the nitrogen gas to the equipment within the R/B and the PCV automatically switches to the IA.

(b) Emergency Operation Mode

While normally supplying nitrogen gas from the nitrogen gas supply machine via the AC, the HPIN is designed to supply nitrogen gas to the SRV Accumulator for the ADS and the RDCF functions from the HPIN nitrogen gas cylinders if the normal nitrogen gas supply stops or the nitrogen gas pressure is less than the determined value in the supply piping. The motor-operated valves at the outlet of the nitrogen gas cylinders are automatically opened and the isolation valves installed at the nitrogen supply connection line between emergency gas supply line A and B and normal gas supply line are automatically closed. The supply from the cylinders can be maintained for 7 days without replacement following an accident.
The supply piping from the nitrogen gas cylinders to the SRV Accumulators is divided into two independent lines that are directed to 3 or 4 of the SRVs with the ADS function and to 3 or 4 SRVs with the RDCF function so that seven SRVs (combination of ADS and RDCF valves of the same HPIN line) with depressurisation function can be operated even if a single nitrogen gas supply pipe is blocked or broken.
The nitrogen gas to be supplied to the SRV Accumulators is supplied after reducing its pressure by the pressure control device which is set up on the supply line.

(c) Beyond Design Basis Faults Operation Mode

The HPIN valve line-up can be manually changed to provide nitrogen gas supply to the SRVs that form part of the ADS or the SRVs that form part of the RDCF as necessary in the event of beyond design basis faults. The nitrogen gas supply comes from the emergency nitrogen gas cylinders described in (b).

The HPIN is designed to satisfy the following general conditions. Actual values for the specification can only be determined when the specifications of the equipment and instrumentation supplied are known in more detail.

Table 16.2-5: General Requirements for Air Supply

Item	Requirement
Nitrogen gas Pressure	Sufficient to satisfy the highest pressure among all components requiring nitrogen gas supply.
Cylinder capacity	Sufficient to ensure supply for 7 days without replacement.

(2) Equipment Design and Operation

HPIN Nitrogen Gas Cylinder

(i) Purpose
Nitrogen cylinders are provided to assure the supply in case of loss of the nitrogen supply from the AC in order to deliver [HPIN SFC 5-3.1] and [HPIN SFC 5-3.2].

(ii) Configuration and Operation
The nitrogen gas cylinders are divided into two cylinder racks A and B. Each rack of cylinders supplies nitrogen to 3 or 4 of the SRVs with the ADS function and to 3 or 4 SRVs with RDCF function so that seven SRVs with depressurisation function can be operated even if one of the nitrogen gas supply pipes is blocked or broken.

(iii) Performance
The specifications of the nitrogen gas cylinder required for the delivery of [HPIN SFC 5-3.1] and [HPIN SFC 5-3.2] is shown below:

- Number 5 units/rack × 2 racks
- Capacity 46.7L per cylinder

(3) Main Support Systems

(a) Instrumentation and Control Systems

(i) The valves are operated and their position monitored from the Main Control Room (MCR).

(ii) While normally supplying nitrogen gas from the nitrogen gas supply machine via the AC, the HPIN is also designed to supply nitrogen gas to the SRV Accumulator for the ADS and RDCF functions from the HPIN nitrogen gas cylinders if the normal nitrogen gas supply stops or the nitrogen gas pressure is less than the determined value in the supply piping by automatically changing the position of the valves.

(iii) The instrumentation and control requirements are as indicated in Table 16.4-6.

Table 16.4-6: List of HPIN Monitored Items

<table>
<tr><td>Monitored Item</td><td>Signal</td><td>Application</td></tr>
<tr><td>Pressure at HPIN nitrogen gas cylinder outlet</td><td>Low pressure</td><td>Alarm</td></tr>
<tr><td rowspan="3">Pressure at HPIN ADS accumulator inlet</td><td rowspan="2">Low pressure</td><td>Alarm</td></tr>
<tr><td>Interlock</td></tr>
<tr><td>High pressure</td><td>Interlock</td></tr>
</table>

(b) Power Supply System

The power to emergency lines A and B is supplied from different divisions of emergency power sources.

<u>Assumptions and Limit Conditions of Operation</u>

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.4-11]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

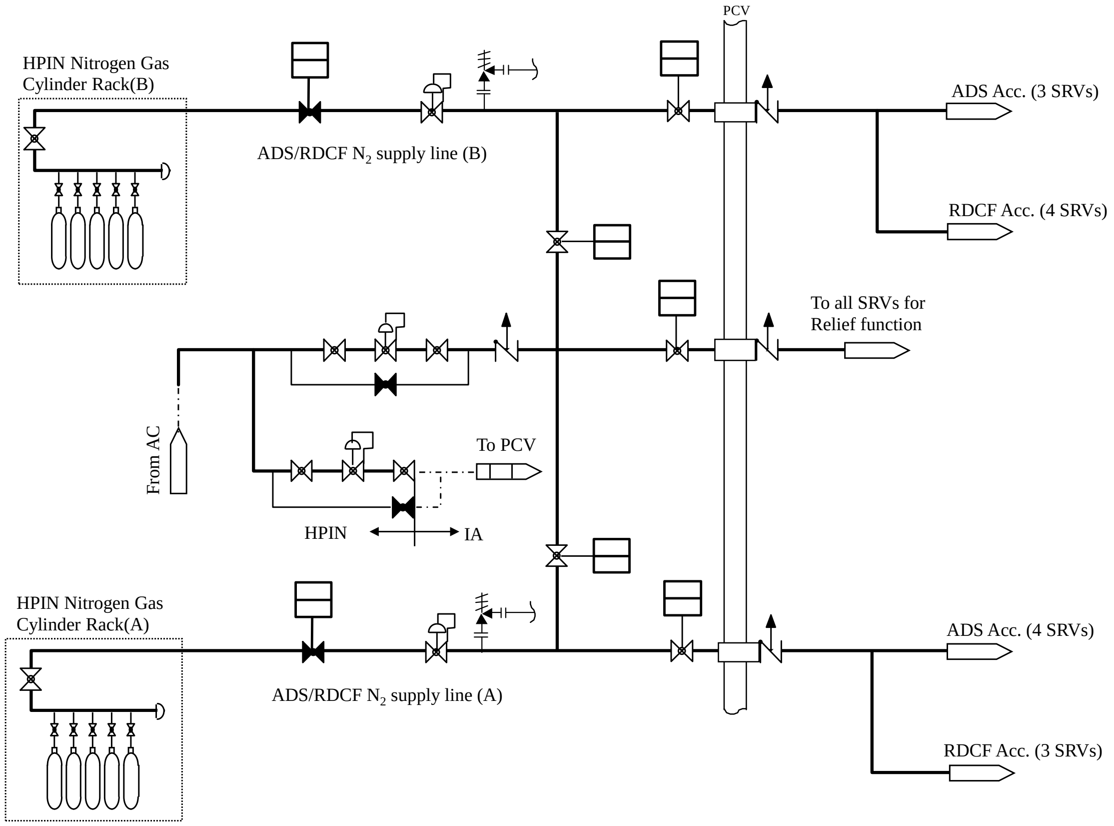


Figure 16.4-3: Outline of HPIN configuration

16.4.2 Drain System

16.4.2.1 Plumbing and Drainage System

System Summary Description

This section is a general introduction to the Plumbing and Drainage System (P&D) where the system roles, system functions, system configuration and modes of operation are briefly described. The P&D is described in detail in the system specifications [Ref-16.4-12].

(1) System Roles

The system role of P&D is to collect and transfer the drain generated from each areas in the building.

(2) Functions Delivered

The drain generated from each area in the building is classified and collected corresponding to its property and divisional area, and transferred to the drain sump of the Radioactive Drain Transfer System (RD), the Miscellaneous Non-Radioactive Drain Transfer System (MSC) or outside the system (intake seal pit and discharge seal pit).

(3) Drain Categories

The drains of the nuclear power plant are basically divided into three categories, the drains for radioactive liquid waste (waste generated in controlled areas with possibility of radioactive contamination), the drains for non-radioactive liquid waste and the drains for special liquid waste.

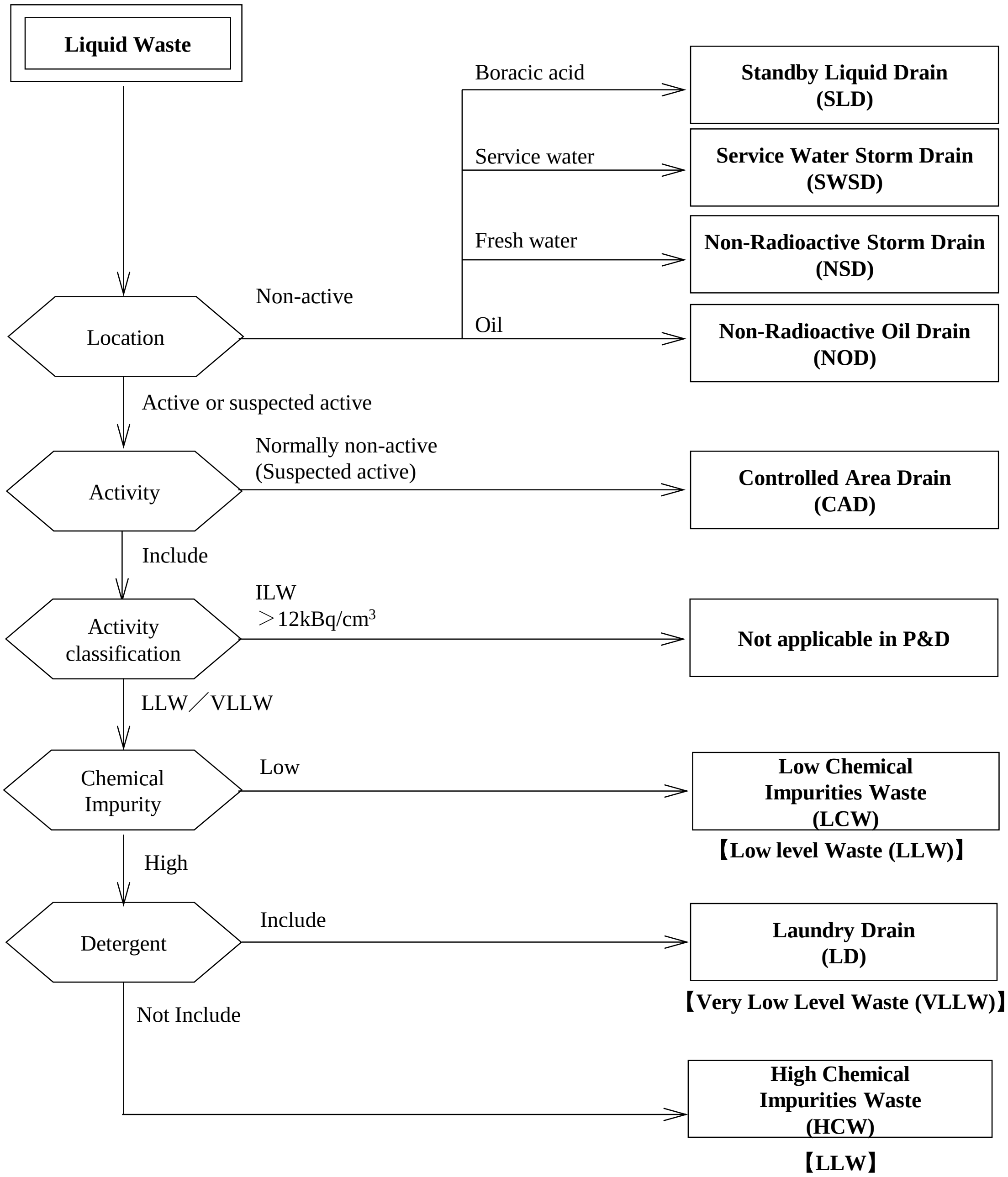


Figure 16.4-4: Methodology for Classifying Liquid Waste [Ref-16.4-12].

(a) Radioactive Liquid Waste
- (i) Low Chemical Impurities Waste (LCW),
- (ii) High Chemical Impurities Waste (HCW),
- (iii) Laundry Drain (LD),
- (iv) Hot Shower Drain (HSD), and
- (v) Controlled Area Drain (CAD).

(b) Non-Radioactive Liquid Waste
- (i) Non-Radioactive Storm Drain (NSD) and
- (ii) Service Water Storm Drain (SWSD).

(c) Special Liquid Waste
- (i) Standby Liquid Drain (SLD),
- (ii) Decontamination Drain (DD), and
- (iii) Non-Radioactive Oil Drain (NOD).

Liquid waste is divided into subcategories, collected in the corresponding sumps or sump tanks and appropriately treated in the Liquid Waste Management System (LWMS) in accordance with the flow diagram shown in Figure 16.4-4 based on the liquid properties.

Design Bases

This section describes the design bases for the P&D.
The P&D has been designed to meet the following SFC. The linkage between the SFCs of P&D with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal Conditions

The P&D segregates liquid waste into subcategories, collecting, containing and directing it in the corresponding sumps or sump tanks so that they are treated based on their liquid properties in the LWMS. [P&D SFC 4-12.1]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

System Design Description

This section describes the design of the P&D to support and justify the delivery of P&D [SFC 4-12.1]. The P&D is described in detail in [Ref-16.4-12].

(1) Overall System Design and Operation

Treatment principles depending on drain properties

The different range of collected drained waste is treated in accordance with the following principles.

(a) Radioactive Liquid Waste
The waste is collected by the sump or sump tanks through the drain funnel or directly transferred to the appropriate collection tank in the LWMS. After treatment at the LWMS, the waste is sent to the Condensate Storage Tank as recycled water for plant operation or transferred out of the system as plant extra water after verifying the water quality.

(b) Non-Radioactive Liquid Waste
(i) Non-Radioactive Storm Drain
The Waste is collected by the NSD sumps for fresh water in the non-controlled areas and discharged outside the system. If water which does not meet the water quality requirements for discharge outside is collected by the sump, the drains are appropriately treated according to the property of drains as follows
1. Diluted by water and discharged outside after confirming the drains meet the water quality requirement
2. Treated by the Radioactive facilities
3. Collected and treated at the location where it is generated

(ii) Service Water Storm Drain
The Waste is collected at the SWSD sumps in the non-controlled areas and drained outside the system.

(c) Special Liquid Waste
(i) Standby Liquid Drain
Drained boric-acid solution is completely separated from the other waste and collected by exclusive containers to avoid need for treatment in the LWMS.
(ii) Decontamination Drain
Several equipment, components and operation tools are decontaminated to reduce personnel exposure during maintenance and inspection. The decontamination liquid waste is collected through the P&D piping or the Decontamination System piping depending on its properties.
(iii) Non-Radioactive Oil Drain
The non-radioactive oil liquid waste is collected and treated at the location where it is generated.

(2) Collection Principles Depending on the Area

The collection principles of the waste generated in each building and the connecting trenches is as follows:

(a) Drains in the Drywell (Primary Containment Vessel)
Drains inside the drywell are connected to the following sumps;
(i) HCW sump: Drain including fault drain in the Drywell Cooling System (DWC), Reactor Building Cooling Water System (RCW), HVAC Normal Cooling Water System (HNCW) system
(ii) LCW sump: Equipment drains in other systems

(b) Drains in the Secondary Containment
Drains in the secondary containment within the R/B are collected by the different sump tanks set up in the secondary containment to ensure the air tightness in containment.

(c) Drains in the Emergency Equipment Rooms
Drains are collected through the drainage piping of the independent divisions of the Emergency Core Cooling System (ECCS) depending on the area where the leak occurred to prevent simultaneous overflow in several ECCS divisions.
Area Divisions:
(i) Division I: Room of the Reactor Core Isolation Cooling System (RCIC), pump room of the Residual Heat Removal System (RHR) (A)
(ii) Division II: Room of the High Pressure Core Flooder System (HPCF) (B), pump room of the RHR (B)
(iii) Division III: Room of the HPCF (C), pump room of the RHR (C)

The drain generated in the Hx/B is divided into NSD and SWSD according to the collection division.

Sumps and drainage piping of non-controlled areas and controlled areas are separated to prevent contamination of the atmosphere in clean areas by the drainage piping.

(3) Equipment Design and Operation

(a) The standard diameter of the main transfer piping is designed considering the flow rate of the drainage funnels.

(b) The drains and vents of components and piping are connected to component drain funnels.

(c) As a general rule, overflow from the tanks storing radioactive fluid waste is directly transferred to the corresponding sump tank according to the collection division.

(d) Piping from the process side to component drain funnels are arranged with a continuous inclination downwards and routed so that there is no obstruction to access and transportation into components, piping, etc. The piping from the component floor drain funnels to the respective sumps or sump tanks is arranged with a continuous inclination downwards as well.

Assumptions, Limits and Conditions for Operations

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.4-11]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.4.2.2 Miscellaneous Non-Radioactive Drain Transfer System

System Summary Description

This section is a general introduction to the Miscellaneous Non-Radioactive Drain Transfer System (MSC) where the system roles, system functions, system configuration and modes of operation are briefly described. The MSC is described in detail in the system specifications [Ref-16.4-13] and the P&IDs [Ref-16.4-14][Ref-16.4-15][Ref-16.4-16]

(1) System Roles

The objective of the MSC is to collect and transfer the non-radioactive liquid waste (Non-Radioactive Storm Drain (NSD) and Service Water Storm Drain (SWSD)) generated in the radiation non-controlled areas during reactor operation and plant shutdown.

(2) Functions Delivered

(a) The NSD and the SWSD are collected in the storm drain sump and transferred outside the system using the sump pumps.

(b) If water which does not meet the water quality requirements for discharge outside it is collected by the sump and the drains are appropriately treated according to the property of drains as follows
  (i) Diluted by water and discharged outside after confirming the drains meet the water quality requirement
  (ii) Treated by the Radioactive facilities
  (iii) Collected and treated at the location where it is generated

(c) The NSD and the SWSD generated in each building are to be transferred as indicated as follows:
  (i) Reactor Building (R/B)
  The NSD in the sump pit is transferred to the Seal Pit. If water which does not meet the water quality requirements for discharge outside it is collected by the sump and the drains are appropriately treated according to the property of drains as described above.

  (ii) Turbine Building (T/B)
  The NSD in the sump pit is transferred to the Seal Pit. If water which does not meet the water quality requirements for discharge outside it is collected by the sump and the drains are appropriately treated according to the property of drains as described above.

  (iii) Radwaste Building (Rw/B)
  The NSD generated in the Rw/B is collected into the NSD sump pit of the Control Building (C/B).

  (iv) Control Building (C/B)
  The NSD in the sump pit is transferred to the Seal Pit. If water which does not meet the water quality requirements for discharge outside it is collected by the sump and the drains are appropriately treated according to the property of drains as described above.

(v) Heat Exchanger Building (Hx/B)
The NSD in the sump pit is transferred to the Seal Pit. If water which does not meet the water quality requirements for discharge outside it is collected by the sump and the drains are appropriately treated according to the property of drains as described above.

(vi) Emergency Diesel Generator Building (EDG/B)
The NSD in the sump is transferred to the Seal Pit. If water which does not meet the water quality requirements for discharge outside is collected by the sump, the drains are appropriately treated according to the property of drains as described above.

(vii) Backup Building (B/B)
The NSD in the sump is transferred to the Seal Pit. If water which does not meet the water quality requirements for discharge outside is collected by the sump, the drains are appropriately treated according to the property of drains as described above.

(viii) Service Building (S/B)
The NSD in the sump is transferred to the Seal Pit. If water which does not meet the water quality requirements for discharge outside is collected by the sump, the drains are appropriately treated according to the property of drains as described above.

(3) Basic Configuration

(a) Each sump pit is provided with one sump pump with sufficient capacity to transfer the determined drains. A sump pit is provided with two sump pumps:
If a sump pit continuously receives drainage such as condensate water from the HVACs in the non-controlled areas.

(b) Each sump is provided with level switches in order to automatically transfer the drains by automatic initiation and shutoff of the pumps.

(c) The materials of the sump pump, transfer piping and valves for the SWSD are selected with resistance to the service water.

(d) The sump pits are located in the non-controlled areas since there is normally no risk of collecting drain water with radioactivity.

(4) Modes of Operation

The sump pumps are automatically initiated and shut off by level switches depending on the water level of the sump pit. The pumps start operation upon increase of water level and when the water level of the sump pit sufficiently drops, automatic shutoff is implemented.

Design Bases

This section describes the design bases for the MSC.
The MSC collects and transfers the non-radioactive liquid wastes. The function of the MSC is not safety-categorised according to the safety categorisation and classification of the UK ABWR.

Assumptions, Limits and Conditions for Operations

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.4-11]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.4.2.3 Radioactive Drain Transfer System

System Summary Description

Radioactive drain (RD) transfer system shall transfer drains generated in controlled areas to collection tanks in individual subsystems installed in the Radwaste building. Laundry drains and radioactive shower drains are transferred to laundry drain collection tanks, which are installed in the Service building. RD transfer system is comprised of sump tanks, sump pumps, piping, valves, and instrumentation devices. The schematic drawing of RD transfer system in R/B is given in Figure 16.4-4. The RD is described in detail in the system specifications [Ref-16.4-27].

Design Bases

This section describes the design bases for the RD.
The RD transfer system is designed to meet the following safety functions. The linkage between the SFCs of RD with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects

Normal Conditions

(a) The RD transfer system provides sufficient capacity to transfer liquid waste to the Liquid Waste Management System for normal conditions including startup, shutdown and outage. [RD SFC 4-12.1]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

Fault Conditions

(b) The RD components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [RD SFC 4-7.1]
(This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements)

(c) In the event of a fault condition which resulted in excessive inflow rate of liquid waste into the drywell sump, an alarm is actuated. [RD SFC 5-4.1]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

System Design Description

(1) System Design for Normal Conditions

This section describes the system design for normal conditions.

(a) All sumps which receive radioactive wastes are equipped with two pumps. The pump is sized to handle the maximum anticipated flow into the sump. When one pump is operating, another pump is on stand-by.

(b) High and low water level switches are provided on each sump to start and stop the sump pump automatically.

(c) A separate high-high water level switch is installed to start the second pump and to actuate an alarm in the main control room simultaneously.

(2) System Design for Faults

This section describes the system design for faults.

(a) In the event of a LOCA signals, all drywell sump pumps are automatically stopped and the isolation valves are automatically closed.

(b) The isolation valves are motor operated valves supplied by emergency power.

(c) The inflow rate into drywell sump is monitored by checking the rise rate of water level, and the frequency and duration of pump runs.

(d) A leak detector is installed within the sump pit in each building where the sump tanks are installed. When leakage from sump tanks is detected, an alarm is actuated.

Assumptions, Limits and Conditions for Operations

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.4-11]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

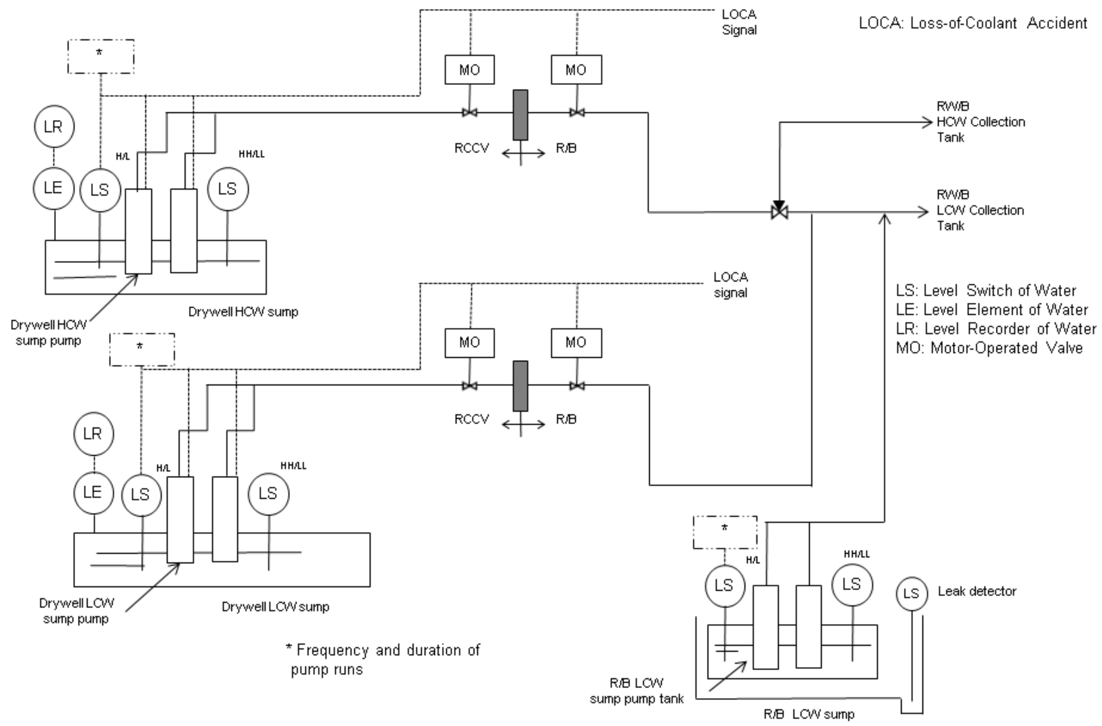


Figure 16.4-5: Outline of Radioactive Drain Transfer System in R/B

16.4.3 Sampling Systems

The Sampling Systems consists of the Sampling System (SAM) and the Outer Secondary Containment Grab Sampling. A detailed description of the sampling and monitoring philosophy is provided in Chapter 23: Reactor Chemistry.

16.4.3.1 Sampling System

System Summary Description

This section is a general introduction to the Sampling System where the system roles, system functions and system configuration are briefly described. The SAM is described in detail in the system specifications [Ref-16.4-17].

(1) System Roles

The roles of the SAM is to collect and analyse fluid process streams associated with plant operation for providing the analytical information of each system and component to be monitored and maintained during normal conditions or transient condition.

(2) Functions Delivered

The SAM is designed to safely collect principal fluid process streams under the operational conditions during normal conditions and transient conditions, and to directly measure parameters of the fluid process streams such as conductivity, hydrogen ion concentration and dissolved oxygen.

(3) Basic Configuration

The SAM consists of the following components:

- Sampling coolers,
- Sampling nozzle,
- Instrumentation,
- Sampling racks,
- Sampling hoods,
- Local Panels,
- Sample extraction sink, and
- Piping and valves.

(4) Modes of Operation

Process fluid and other items requiring continuous monitoring are continuously sampled and measured by process analysis instruments such as conductivity meters, pH meters, dissolved oxygen and hydrogen meters, etc. Samples of process fluids subjected to intermittent water quality monitoring are extracted from the process line and analysed by grab sampling.
Process instrumentation or grab sampling is determined based on the necessary sampling frequency and the importance of the data.

Grab samples are manipulated in sampling hoods or sampling sinks after cooling or reducing the pressure as necessary.
Samples are drained to the radioactive waste systems for treatment after analysis and measuring. However, if reasonably practicable, samples requiring continuous extraction are returned to the process systems to limit the generation of waste, provided that the operating conditions of the instruments and components are not exceeded.

Design Bases

This section describes the design bases for the SAM.
The SAM has been designed to meet the following SFC. The linkage between the SFCs of SAM with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal and Fault Conditions

(a) The SAM collects representative fluid process streams for analysis and provides the analytical data required to monitor plant and equipment performance and change in operating parameters under the environmental and operational conditions during normal conditions and transient conditions. [SAM SFC 5-4.1]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

Fault Conditions

(b) The SAM components penetrating the primary containment form barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [SAM SFC 4-7.1]
(This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. This safety function is developed and justified in the Chapter 13: Engineered Safety Features, Section 13.3.3.1 related to the Primary Containment Facility.

System Design Description

This section describes the design of the SAM to support and justify the delivery of [SAM SFC 5-14.1]. The SAM is described in detailed in [Ref-16.4-17].

(1) Overall System Design and Operation

(a) Sampled Process Streams and Analysed Parameters

Table 16.4-6 provides a list of main samples, their locations and purposes. In addition to those, on-line monitoring of parameters (temperature, pressure, radiation) is carried out but does not require sampling of process fluids and so is not part of the SAM.

Table 16.4-7: Summary of Main Samples

Item	Sampling point	Purpose
Reactor water	Reactor Pressure Vessel (RPV) bottom	Monitoring of reactor cooling water quality when the CUW is isolated
Reactor Water Clean-up System Filter Demineraliser (CUW F/D) inlet and outlet water	F/D inlet F/D outlet	Monitoring of reactor cooling water quality Monitoring of F/D performance
Suppression Pool (S/P) water	RHR Heat Exchanger outlet	Monitoring of corrosion and radioactivity
Sodium pentaborate solution	Standby Liquid Control (SLC) Storage Tank	Monitoring of boron concentration
Residual Heat Removal System (RHR) water	RHR Heat Exchanger outlet	Monitoring of water quality
Main Condenser	Hotwell outlet Condensate Demineraliser inlet Condensate Demineraliser outlet	Detection of leakage from condenser tubes Monitoring of water quality Monitoring of demineraliser performance

(b) Sampling methodology

Sampling methods are divided into the following three types depending on the required sampling frequencies and impacts of the obtained data on plant operation safety.

(i) Process stream collection with recycling line
A line to recirculate part of the process fluid from piping or components via a pump or blower is configured with instrumental detectors mounted on it to continuously obtain data.

(ii) Process stream collection with a sampling line
Samples are continuously taken from the process line through a sampling pipe with instrumental detectors mounted on it to continuously obtain data.

(iii) Local grab sampling
Process samples are intermittently taken from the process piping through the sampling pipes and analysed in the laboratory where data is obtained.

(2) Equipment Design and Operation

(a) Sampling Piping

(i) Piping for grab sampling is provided with depressurisation valves and stop valves. However low pressure piping is provided with stop valves only.

(ii) Piping for extraction of high temperature or high pressure samples is provided with coolers or depressurisation devices to cool and reduce the pressure when sampling.

(iii) Samples which require to be continuously extracted are returned to the process line after measuring through the sampling collection pipes connected to the process lines. Sampling is automatically shut off when the process system operations are not operating (process side pumps shut off).

(b) Sampling Nozzle

In principal, sampling nozzles are mounted on the pipe side surface of horizontal and straight sections of process piping. Samples of fluids containing crud should not be taken from the bottom of horizontal pipes.

(c) Sampling Hoods

(i) Frequently sampled radioactive fluids of each system are collected and transferred to one sampling hood.
(ii) Sampling hoods are applied to sample the high radioactive fluids for manual sampling.
(iii) The exhaust lines of the sampling hoods are connected to the HVAC in order to always maintain the hood at negative pressure inside and to prevent exposure to radioactive material generated during sampling.
(iv) Components installed inside the hoods are limited to a minimum quantity in order to reduce the sources of radiation exposure.

(d) Sampling Sink

Sampling sinks are provided near grab sampling points for auxiliary cooling water etc. in the following conditions:
(i) Sampling points located in high radioactivity areas with high radioactivity levels.
(ii) Sampling points for samples such as cooling water which require a periodic and relatively high frequent analysis (more than once a month (provisional)).

(e) Filter Sampling Rack

Filter sampling racks are provided to sampling points when it is necessary to measure the concentration of metal elements in the water.
(i) Filters are mounted upstream of the depressurisation devices in order to improve the precision of the measured concentration of indissoluble crud.
(ii) Integral flow meters are mounted on the outlet of the filters in order to check the total volume of samples through the filter.

(3) Main Support Systems

Instrumentation and Control Systems

(i) Conductivity meters, pH meters and humidity meters are constantly monitoring the process status. The measurements are monitored in the Main Control Room (MCR) where alarms are initiated if the predetermined values are exceeded. However, the data necessary for local operation is locally monitored and also monitored in the MCR if necessary.
(ii) Process sampling, including alarms, is displayed in the MCR and the data recorded as necessary.
(iii) As a general rule, parameters in the water quality specification are transmitted to the Process Computer System.

(4) System Interfaces

Sampling lines branching from the respective systems and components are provided with separation valves. The design conditions of the SAM conform to the process systems into which they are connected.

Assumptions, Limits and Conditions for Operations

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.4-11]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.4.3.2 Outer Secondary Containment Grab Sampling

This section is a general introduction of the grab sampling at the outside of the secondary containment.

The UK ABWR is designed as the fault can be basically managed and controlled by continuous monitoring system (process instrumentations) as described in Chapter 14: Control and Instrumentation. The plant can maintain the safety states with the continuous monitoring system for post-accident middle and long terms as well. Prior to Severe Accident (SA) recovery or decommissioning activities, grab sample analysis to measure the nuclide specific activities, if possible, may provide supportive information for planning of decommissioning. Required sample and sampling configuration strongly depend on the plant situation and there remains large uncertainties (e.g. accessibility, availability of utility) whilst enough time margin is acceptable. Therefore consideration to provide mobile type sampling equipment is reasonable and expected in the generic design stage. The mobile equipment will be connected to the plant system where available and it can collect the sample. It is preferable to remotely collect the sample at the outside of the secondary containment to provide safe access for the operator who transports the samples to the radiochemistry laboratory. In addition, the system described in Section 16.4.3.1 will be used, if available.

The decommissioning programme is the responsibility of the future licensee. Dependent on the decommissioning procedure, an installed grab sampler may be an ALARP option although the installed equipment may not be available in the post-SA condition due to some design constraints; for example environmental conditions, mechanical integrity, utilities (e.g. power supply, cooling water), and accessibility. In addition, the system has a disadvantage of contamination through functional testing and training during normal conditions. The final grab sampling programme and system design will be determined in the site specific stage together with the decommissioning procedure. In the generic design stage, sampling points and ports are assumed and provided for the potential future design change. Expected samples are;

- Liquid sample from RPV,
- Liquid sample from S/P,
- Gaseous sample from Drywell (D/W), and
- Gaseous sample from Wetwell (W/W).

The sampling lines and PCV isolation valves are included in the generic design. Space for the installed sample collection rack (or the mobile equipment) is provided in the R/B radiation controlled area at the outside of the secondary containment.

Since the analysed data are used for the decommissioning planning, the grab sampling function as well as the nuclide analysis function does not fall into any HLSFs in Chapter 5: General Design Aspects, Section 5.6. Therefore Safety Category is not defined (non-category) whilst a part of the configuration comprises the primary containment boundary and it is categorised and classified as Safety Category A and Class 1. The primary containment boundary design is described in Chapter 13: Engineered Safety Features, Section 13.3.

16.4.4 Chemical Injection Systems

A detailed description of the Chemical Injection Systems is provided in Chapter 23: Reactor Chemistry.

16.4.4.1 Hydrogen and Oxygen Injection System

For the contribution to maintain the structural integrity by providing a mitigation of potential corrosion of SSCs by the recombination reaction between Oxygen (O_2) and Hydrogen (H_2), the Hydrogen and Oxygen Injection System (HOIS) injects H2 into the Condensate & Feedwater system (CFDW) during normal plant operation. The HOIS injects also O_2 at the inlet of the off-gas recombiner in order to recombine the residual hydrogen injected.

16.4.4.2 Noble Metal Injection System

The Noble Metal Injection System (NMIS) injects a Platinum (Pt) solution into the FDW line to improve the effect of the H_2 injected by the HOIS by catalysing the reaction of recombination between H_2 and O_2 on the surface of SSCs.

16.4.4.3 Zinc Injection System

The Zinc Injection System (ZNIS) injects zinc into the CFDW lines in order to mitigate an increase of the dose rate from deposited ^{60}Co and ^{58}Co at the surface of SSCs due to the hydrogen injection of HOIS.

16.4.4.4 Oxygen Injection System

The Oxygen Injection System (OI) injects O_2 into the main condensate pipeline in order to improve the anti-corrosion effect on pipelines by forming stable protective iron oxide films on the inner wall surfaces of equipment and pipes that constitute the CFDW.

16.4.5 Steam Supply System

16.4.5.1 House Boiler System

System Summary Description

This section is a general introduction to the House Boiler System where the system roles, system functions, system configuration and modes of operation are briefly described. The House Boiler System is described in detail in the system specifications [Ref-16.4-18] and the P&IDs [Ref-16.4-19], [Ref-16.4-20], [Ref-16.4-21], [Ref-16.4-22], [Ref-16.4-23], [Ref-16.4-24], [Ref-16.4-25] and [Ref-16.4-26].

(1) System Roles

The House Boiler System is designed to supply clean steam generated by the House Boiler to the equipment operating with house steam and collect the condensed water from the steam usage equipment and return it to the House Boiler Facility.

(2) Functions Delivered

The House Boiler System consists of the House Boiler Facility, the Heating Steam System (HS) and the Heating Steam Condensate Water Return System (HSCR).

(a) The HS supplies clean steam with the necessary volume at the required pressure (saturated steam) to the components operating with steam within the power plant.

(b) The HSCR collects the condensed water from each component and pipe and returns it to the House Boiler facility. The HSCR recovers as much condensed water as possible from the respective loads and the piping to recycle it as feed-water for the House Boiler.

(3) Basic Configuration

(a) The House Boiler facility consists of the House Boiler, feed water system, instrumentation, etc.

(b) The steam generated by the House Boiler is transferred to the respective components using steam in the power plant through the HS piping.

(c) The Condensed Water Recovery Facility, which is installed in HSCR, consists of a Heating Steam Receiver Tank, a Heating Steam Condenser and Heating Steam Drain Recovery Pumps through which the condensed water is returned to the water supply tank in the House Boiler Facility.

(d) The House Boiler System consists of the following components equipment:
  (i) House Boiler Facility
    ・House Boiler: 2 units
  (ii) Condensed Water Recovery Facility
    ・Heating Steam Receiver Tank: 1 unit
    ・Heating Steam Condenser: 1 unit
    ・Heating Steam Drain Recovery Pump: 2 units
  (iii) Piping and Valves: 1 set
  (iv) Instrument and Controllers: 1 set

(4) Modes of Operation

This system supplies clean steam generated by the House Boiler to the equipment operating with house steam during normal conditions, start-up, shutdown and inspection.

Design Bases

This section describes the design bases for the HS/HSCR.
The HS/HSCR has been designed to meet the following SFCs. The linkage between the SFCs of HS/HSCR with the FSFs and the HLSFs is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Normal Conditions

(a) The HS/HSCR during plant normal conditions supplies the steam required to maintain the normal operation of safety class 3 systems which contributes to reducing radiation exposure from radioactive materials. [HS/HSCR SFC 5-13.1]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

(b) The HS/HSCR during plant normal conditions supplies the steam required to heat the plant and maintain its condition during winter. [HS/HSCR SFC 5-13.2]
(This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements)

System Design Description

This section describes the design of the HS/HSCR to support and justify the delivery of [HS/HSCR SFC 5-13.1] and [HS/HSCR SFC 5-13.2]. The HS/HSCR is described in detail in [Ref-16.4-18] and the P&IDs [Ref-16.4-19], [Ref-16.4-20], [Ref-16.4-21], [Ref-16.4-22], [Ref-16.4-23], [Ref-16.4-24], [Ref-16.4-25] and [Ref-16.4-26].

(1) Overall System Design and Operation

The steam generated by the House Boiler is transferred to the respective components which use steam in the power plant through the HS piping. The steam is condensed into water by the heat exchanged with the steam loads. Most of the condensed water is returned to the water supply tank in the House Boiler Facility through the Condensed Water Recovery Facility in the HSCR, and finally is returned to the House Boiler, where it is converted into the steam again to repeat the cycle.

The HS/HSCR is designed to satisfy the following condition.
Steam Capacity Approx.50 t/h

(2) Equipment Design and Operation

(a) House Boiler Facility

(i) Purpose
The House Boiler facility is designed to deliver steam at the required pressure and flow rate to satisfy demands for non-reactor steam and start-up / stand-by steam requirements of the power plant in order to deliver [HS/HSCR SFC 5-13.1] and [HS/HSCR SFC 5-13.2].

(ii) Configuration and Operation
The House Boiler facility will be oil-fuelled boiler and located in the House Boiler Building (HB/B) in the Power Plant. The number of boiler units has been selected considering the variable steam demand on the system depending on plant status (e.g. power operation, outage, start-up).

(iii) Performance
The specification of the House Boilers required for the delivery of [HS/HSCR SFC 5-13.1] and [HS/HSCR SFC 5-13.2] is shown below:
· Number 2 units
· Capacity Approx.25t/h /unit

(b) Condensed Water Recovery Equipment

(i) Purpose
The condensed water recovery equipment collect the drains and condensed steam from the HS after use by the equipment, and send them back to the House Boiler Building for recovery in order to deliver [HS/HSCR SFC 5-13.1] and [HS/HSCR SFC 5-13.2].

(ii) Configuration and Operation
The condensed water recovery equipment consist of a Heating Steam Receiver Tank, a Heating Steam Condenser and Heating Steam Drain Recovery Pumps.

(iii) Heating Steam Receiver Tank
The Heating Steam Receiver Tank is provided with the necessary gaseous space for gas-liquid separation of the in-flow of condensed water and for prevention of steam suction by the Heating Steam Drain Recovery Pumps. Moreover, the Heating Steam Receiver Tank is employed as a water reservoir for the control operation of the Heating Steam Drain Recovery Pumps.

(iv) Heating Steam Condenser
The Heating Steam Condenser is capable of condensing all the re-flushed steam flowing into the Heating Steam Receiver Tank by cooling water. The Heating Steam Condenser condenses the re-evaporated steam to maintain the temperature below 100 °C (water boiling point at atmospheric pressure) and prevent re-evaporation.

(v) Heating Steam Drain Recovery Pump
The Heating Steam Drain Recovery Pump transfers the condensed water from the Heating Steam Receiver Tank to the water supply tank in the House Boiler Facility. HSCR is equipped with two 100 percent-capacity Heating Steam Drain Recovery Pumps.

(c) Steam Trap

(i) The HS line will be equipped with steam traps to allow drainage of condensed steam. The appropriate design of steam trap will be selected for each individual location based on likely steam conditions, layout, maintainability and other relevant factors.

(ii) A bypass line is provided for trap maintainability.

(d) Piping and Valves

As a general rule, the piping of the HS and the HSCR is arranged downwards with inclinations to ensure no drain accumulation on the piping routes.

The HS piping will be provided with drain traps for draining water accumulated at the bottom of rising pipes and drain pots, the inlet of control valves and other points.

(3) Main Support Systems

Instrumentation and Control Systems

(i) The House Boiler Facility is provided with monitoring to measure the operation conditions and appropriate protective devices to shut down the House Boiler safely in an emergency.

(ii) The water level in the Heating Steam Receiver Tank is controlled by the level switch installed inside it, which sends signals to initiate and shut off the Heating Steam Drain Recovery Pumps to ensure adequate net pressure suction head for the pumps to avoid cavitation.

Assumptions, Limits and Conditions for Operations

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.4-11]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.5 Heating Ventilating and Air Conditioning System

System Summary Description

This section is a general introduction to the Heating Ventilating and Air Conditioning System (HVAC) where the system roles, system functions, system configuration and modes of operation are briefly described. The HVAC safety case is justified in the HVAC BSC [Ref-16.5-1]. The HVAC is described in detail in the system specifications [Ref-16.5-2] and the Duct and Instrumentation Diagrams (D&IDs) [Ref-16.5-3] to [Ref-16.5-29].

(1) System Roles

The HVAC is designed to achieve the following purposes:

(a) The HVAC maintains a negative pressure within the Reactor Building, the Turbine Building, the Radwaste Building, and the Service Building contamination controlled areas to ensure contaminants do not escape to the environment and provides dilution of the contaminants when they are generated by ensuring sufficient ventilation rate. In addition, exhaust air is treated with the filter before discharging from the area.

(b) The HVAC removes heat and humidity from the atmosphere within the building which may be generated by equipment such as electric panels, mechanical facilities and piping with high temperature.

(c) The HVAC for operating during plant emergency condition has the capability of maintaining a performance under the extreme ambient condition (external hazard).

(d) The HVAC has a role in demonstrating compliance with discharge limits under the Environmental Permitting Regulations 2016 (EPR16).

(e) The HVAC provides outside fresh air for operators and occupants.

(f) The HVAC has a role in controlling airborne contamination to ensure the safety of operators within the control room during accident conditions.

(g) The HVAC discharges smoke after a fire is extinguished and supplies fresh air in exchange. It also prevents smoke from moving into other areas thus ensuring egress routes for operators. However, on the basis that the main functional requirement of ventilation systems serving radiation controlled areas within UK is to provide containment, smoke purge systems serving the controlled areas are not provided.

(2) Function Delivered

The HVAC is designed to achieve the roles discussed above while also delivering the following functional requirements:

(a) Exhaust
Exhaust air from the potential contaminated area is discharged from the main exhaust stack. High Efficiency Particulate Air (HEPA) filters are installed in the Exhaust Air Treatment Facilities (Multiple Safe Change HEPA Filter units) of the systems that discharge exhaust air through main exhaust stack in accordance with Chapter 20: Radiation Protection.
The HVAC for areas which are outside the radiologically controlled areas discharge air directly to the atmosphere locally to the area ventilated without any treatment by filters.

(b) Ventilation
Ventilation method is determined by consideration of the system's required functions from the following Type-1, Type-2 or Type-3:

(i) Type-1 ventilation method
This ventilation method uses Supply Fans for supplying air and Exhaust Fans for discharging air. There are two methods for this ventilation type. One is "Once-through ventilation method" which discharges the whole air volume that is supplied, and another method is "Partial Recirculation Method" which involves mixing fresh outside air with a portion of the exhaust air which is recirculated.

- Once-through ventilation
  Supply Fans supply air from outside and the same amount of air is discharged by Exhaust Fans.
- Partial recirculation ventilation
  Air from a particular area is recirculated with a proportion of fresh air introduced by Supply Fans and an equal proportion removed from the area by Exhaust fans. This method is mainly used for HVAC within contamination non-controlled (herein termed non- controlled) areas.

(ii) Type-2 ventilation method
This is a "forced draught" ventilation method whereby air is supplied by means of the Supply Fans and exhaust air is allowed to pass through openings. Since the pressure within the building is positive, this method is used for the ventilation of radiation non-controlled areas only.

(iii) Type-3 ventilation method
This is an "induced draught" method where outside air is supplied via intakes or openings in buildings and the ventilation flow is induced by means of the Exhaust Fans which draw air through the area and exhaust it to outside the building. This method is used for the local ventilation.

(c) Cooling and heating
Outside air is cooled by the chilled water from the Chillers supplied to the HVAC cooling coil. The HVAC Normal Cooling Water System (HNCW) is used for the normal system whereas the HVAC Emergency Cooling Water System (HECW) and HVAC Backup Building Cooling Water System (HBCW) are used for the emergency system. Local Cooling Units, which recirculate and cool air within rooms, are either Normal Local Cooling Units or Emergency Local Cooling Units. Chilled or cooling water is used for the following:

- Local Cooling Units for normal use; cooling provided by HNCW
- Local Cooling Units for emergency use; cooling provided by any of the Reactor Building Cooling Water System (RCW), HECW and HBCW.

Heating is carried out by the Heating Steam system (HS) through the HVAC heating coil. It should be noted that there is a case when cooling/heating is carried out by Fan Coil Unit (FCU) or Multi-Split Air Conditioning Unit (ACU) when there is a necessity to control room temperature individually for each room such as the general habitable area located within radiation non-controlled area.

(d) Dust removal from the outside air
A middle efficiency air filter is used when supplying outside air to minimise the amount of dust etc. that could infiltrate into the building.

(e) Airflow control and ensuring negative pressure
Airflow direction within the building is directed from less contaminated areas to more contaminated areas and the contamination is prevented from spreading to other areas. As for the HVAC sub-system servicing the radiation controlled area, differential pressure between the inside and outside of the building is adjustable so the pressure of the whole area is ensured to be negative.

(f) Smoke purging and control function
Smoke purging is necessary for the human access by means of the Smoke Purge Fan specifically made for discharging smoke while supplying outside fresh air by means of the Supply Fan. The smoke generated within each fire zone designated as safety zone is not allowed to infiltrate into adjacent clean area. Smoke control is provided to fire-fighting stairwells via a pressure differential ventilation system by means of HVAC system as necessary.

(3) Basic Configuration

The basic configuration of the HVAC for each building is as follows:

(a) Reactor Building (R/B)

The HVAC for the R/B consists of the following sub-systems.

(i) Reactor Area (R/A) HVAC

The summary of the main components are as follows:

- Supply Fan 3 units - 50 % each
- Exhaust Fan 3 units - 50 % each
- Supply Air Treatment Facility single unit - 100 % (Cooling coils, heating coils and filters are included)
- Exhaust Air Treatment Facility 1 set - 100 % (Multiple Safe Change HEPA Filter units are provided, and one standby housing is installed.)
- R/A Supply Air Isolation Damper and Accumulator Tank 2 units each (Mounted on the Supply Duct of the R/A HVAC)
- R/A Exhaust Air Isolation Damper and Accumulator Tank 2 units each (Mounted on the Exhaust Duct of the R/A HVAC)
- Normal Local Cooling Unit (LCU) 4 units
- Emergency LCU 10 units
  - Residual Heat Removal System (RHR) Pump Room LCU;
    3 units [1 unit per division (A, B, C)] – 100 % each [per division]
  - Reactor Core Isolation Cooling System (RCIC) Pump Room LCU;
    single unit – 100 %
  - High Pressure Core Flooder System (HPCF) Pump Room LCU;
    2 units [1 unit per division (B, C)] – 100 % each [per division]
  - Fuel Pool cooling and Clean-up System (FPC) Pump Room LCU;
    2 units [1 unit per division (A, B)] – 100 % each [per division]
  - Standby Gas Treatment System (SGTS) Room LCU;
    2 units [1 unit per division (A, B)] – 100 % each [per division]

- PCV Purge Exhaust Fan single unit - 100 %
- PCV Purge Supply Filter Unit single unit - 100 % (Filters are included)
- Duct, damper and accessory 1 set

(ii) Reactor Building Emergency Electrical Equipment Zone (RBEEE/Z) HVAC

This system consists of the divisions A, B and C.

The summary of the main components are as follows:
- Supply Fan 2 units [per division] - 100 % each [per division]
  (Used both for exchanging with outside air and discharging smoke)
- Exhaust Fan 2 units [per division] - 100 % each [per division]
- Smoke Purge Fan single unit [per division] - 100 % [per division]
- Supply Air Treatment Facility single unit [per division] - 100 % [per division] (Cooling coils and filters are included)
- Duct, damper and accessory 1 set

(b) Emergency Diesel Generator Building (EDG/B)

Emergency D/G Electrical Equipment Zone (DGEE/Z) HVAC

This system consists of the divisions A, B and C.

The summary of the main components are as follows:
- Supply Fan 2 units [per division] - 100 % each [per division]
  (Used both for exchanging with outside air and discharging smoke)
- Exhaust Fan 2 units [per division] - 100 % each [per division]
- Smoke Purge Fan single unit [per division] - 100 % [per division]
- Supply Air Treatment Facility single unit [per division] - 100 % [per division] (Cooling coils, heating coils and filters are included)
- Emergency Diesel Generator (EDG) Room Emergency Supply Fan 2 units [per division] – 50 % each [per division]
- EDG Room Emergency Supply Air Treatment Facility single unit [per division] -100 % [per division] (Filters are included)
- EDG Room LCU 2 units [per division] - 50 % each [per division]
- Duct, damper and accessory 1 set

(c) Turbine Building (T/B)

T/B HVAC

The summary of the main components are as follows:
- Supply Fan 3 units - 50 % each
- Exhaust Fan 3 units - 50 % each
- Supply Air Treatment Facility single unit – 100 % (Cooling coils, heating coils and filters are included)
- Exhaust Air Treatment Facility 1 set - 100 % (Multiple Safe Change HEPA Filter units are provided, and one standby housing is installed.)
- Normal LCU 7 units
- Duct, damper and accessory 1 set

(d) Heat Exchanger Building (Hx/B)

The HVAC for the Hx/B HVAC consists of the following sub-systems.

(i) Hx/B-Normal (N) HVAC

The summary of the main components are as follows:

- Supply Fan 2 units - 100 % each (Used both for exchanging with outside air and discharging smoke)
- Supply Air Treatment Facility single unit – 100 % (Cooling coils, heating coils and filters are included)
- Duct, damper and accessory 1 set

(ii) Hx/B-Emergency (E) HVAC

This system consists of the divisions A, B and C.

The summary of the main components are as follows:

- Supply Fan single unit [per division] - 100 % each [per division]
- Supply Air Treatment Facility single unit [per division] – 100 % [per division] (Filters are included)
- Emergency LCU single unit [per division] - 100 % [per division]
- Duct, damper and accessory 1 set

(e) Control Building (C/B)

The HVAC for the C/B consists of the following sub-systems.

(i) Control Building Emergency Electrical Equipment Zone (CBEEE/Z) HVAC

This system consists of the divisions A, B and C.

The summary of the main components are as follows:

- Supply Fan 2 units [per division] - 100 % each [per division]
  (Used both for exchanging with outside air and discharging smoke)
- Exhaust Fan 2 units [per division] - 100 % each [per division]
- Smoke Purge Fan single unit [per division] - 100 % [per division]
- Supply Air Treatment Facility single unit [per division] - 100 % [per division] (Cooling coils and filters are included)
- Normal LCU 2 units
- Duct, damper and accessory 1 set

(ii) Main Control Room (MCR) HVAC

This system consists of the divisions A and B one of which is provided as a redundancy.

The summary of the main components are as follows:

- Supply Fan single unit [per division] - 100 % [per division]
- Exhaust Fan single unit [per division] - 100 % [per division]
- Recirculation Supply Fan single unit [per division] - 100 % [per division]

- Supply Air Treatment Facility single unit [per division] - 100 % [per division] (Cooling coil and filters are included)
- Emergency Filter Train single unit [per division] - 100 % [per division] (Charcoal adsorbers are included)
- Humidifier 1 set [per division] - 100 % [per division]
- Duct, damper (Including the motor operated MCR Isolation Dampers) and accessory 1 set

(iii) Control Building Class 2 Electrical Equipment Zone (CBC2EE/Z) HVAC

The summary of the main components are as follows:

- Supply Fan 2 units - 100 % each (Used both for exchanging with outside air and discharging smoke)
- Exhaust Fan 2 units - 100 % each
- Smoke Purge Fan single unit - 100 %
- Supply Air Treatment Facility single unit - 100 % (Cooling coils and filters are included)
- Duct, damper and accessory 1 set

(f) Radwaste Building (Rw/B)

Rw/B HVAC

The summary of the main components are as follows:

- Supply Fan 2 units - 100 % each
- Exhaust Fan 2 units - 100 % each
- Supply Air Treatment Facility single unit - 100 % (Cooling coils, heating coils and filters are included)
- Exhaust Air Treatment Facility 1 set - 100 % (Multiple Safe Change HEPA Filter units are provided, and one standby housing is installed.)
- Local Exhaust Unit single unit (as necessary)
- Duct, damper and accessory 1 set

(g) Service Building (S/B)

S/B HVAC

The summary of the main components are as follows:

- Controlled Area Supply Fan 2 units - 100 % each
- Controlled Area Exhaust Fan 2 units - 100 % each
- Non-Controlled Area Supply Fan 2 units - 100 % each
- Non-Controlled Area Exhaust Fan 2 units – 100% each
- Controlled Area Supply Air Treatment Facility single unit - 100 % (Cooling coils, heating coils and filters are included)
- Non-Controlled Area Supply Air Treatment Facility single unit – 100 % (Cooling coils, heating coils and filters are included)
- Controlled Area Exhaust Air Treatment Facility 1 set - 100 % (Multiple Safe Change HEPA Filter units are provided, and one standby housing is installed.)
- FCU or Multi-Split ACU 1 set – 100 % each
- Non- Controlled Area Humidifier 1 set – 100 %
- Duct, damper and accessory 1 set

(h) Backup Building (B/B)

The HVAC for the B/B consists of the following sub-systems.

(i) B/B Electrical Equipment Zone (BBEE/Z) HVAC

This system consists of the divisions A and B.

The summary of the main components are as follows:

- Supply Fan 2 units [per division] - 100 % each [per division] (Both used for exchanging with outside air and discharging smoke)
- Exhaust Fan 2 units [per division] - 100 % each [per division]
- Smoke Purge Fan single unit [per division] – 100% [per division]
- Supply Air Treatment Facility single unit [per division] - 100 % [per division] (Cooling coil, heating coils and filters are included)
- Backup Building Generator (BBG) Room Emergency Supply Fan 2 units [per division] – 50 % each [per division]
- BBG Room Emergency Supply Air Treatment Facility single unit [per division] -100 % [per division] (Filters are included)
- BBG Room LCU 2 units [per division] - 50 % each [per division]
- Humidifier 1 set [per division] - 100 % [per division]
- Duct, Damper and accessory 1 set

(ii) Backup Building Emergency Control Room (BBECR) HVAC

This system consists of the divisions A and B one of which is provided as a redundancy.

The summary of the main structural components are as follows:

- Supply Fan single unit [per division] - 100 % [per division]
- Exhaust Fan single unit [per division] - 100 % [per division]
- Recirculation Supply Fan single unit [per division] - 100 % [per division]
- Supply Air Treatment Facility single unit [per division] - 100 % [per division] (Cooling coil and filters are included)
- Emergency Filter Train single unit [per division] - 100 % [per division] (Charcoal adsorbers are included)
- Humidifier 1 set [per division] - 100 % [per division]
- Duct, damper (Including the motor operated BBECR Isolation Dampers) and accessory 1 set

(i) Filter Vent Building (FV/B)

Filter Vent Building (FV/B) HVAC

The summary of the main components are as follows:

- Supply Fan 2 units - 100 % each (Used both for exchanging with outside air and discharging smoke)
- Exhaust Fan 2 units - 100 % each
- Smoke Purge Fan single unit - 100 %

- Supply Air Treatment Facility single unit - 100 % (Cooling coils and filters are included)
- Duct, damper and accessory 1 set

System outlines of each HVAC sub-system are shown in the Figure 16.5-1 to 16.5-21.

(4) Modes of Operation

(a) R/A HVAC

This system is in operation during the plant normal operations and fault conditions, or when smoke purging is required.

Operation modes of the system are as follows:

(i) Normal operation mode

- Except for the Emergency LCUs (the RCIC Pump Room, HPCF Pump Room, FPC Pump Room and SGTS Room LCUs), all equipment is operated in during the plant normal operation and the plant normal shutdown. During the plant normal shutdown, the RHR pumps are operated in order to remove residual heat load from the reactor. The RHR Pump Room LCUs are initiated by the start signal of the RHR pumps.
- The PCV Purge Supply Filter Unit and Exhaust Fan remove inert atmosphere and provide air for the Primary Containment Vessel (PCV) prior to personnel entry during the plant normal shutdown.
- The protected stair case pressurisation function is provided as support for firefighting and safety evacuation by the R/A HVAC.

(ii) Emergency operation mode

Upon receipt of any emergency isolation signals (“high radioactivity of the HVAC exhaust gas in the R/A”, “high radioactivity in fuel handling area”, “drywell high pressure” or “reactor water low level”) in the event of Loss of Coolant Accident (LOCA), the R/A HVAC is automatically shutdown and the R/A Isolation Dampers mounted on the Supply/Exhaust duct are automatically closed to isolate R/A and prevent exfiltration of the radioactive gas to outside by switching into the SGTS.

In the event of Loss of Offsite Power (LOOP), the R/A HVAC is shutdown. However, the Emergency LCUs can be operated with the power supply provided by the EDG in order to maintain a temperature environment in the safety component [e.g. Emergency Core Cooling System (ECCS) pumps] areas.

(iii) Smoke purge operation mode

On the basis that the main functional requirement of ventilation systems serving radiation controlled areas within UK is to provide containment, smoke purge systems serving the R/B controlled areas are not provided.

(b) RBEEE/Z HVAC

This system is in operation during the plant normal operations and fault conditions, or when smoke purging is required.

Operation modes of the system are as follows:

(i) Normal operation mode

- Except for the Smoke Purge Fan, all equipment is operated during the plant normal operation and the plant normal shutdown.
- The protected stair case pressurisation function is provided to support for firefighting and safety evacuation by the RBEEE/Z HVAC.

(ii) Emergency operation mode
Continuous operation is ensured by connection to the power supply provided by the EDG in the event of LOOP.

(iii) Smoke purge operation mode
"Once-through ventilation method" is used for supplying air by the Supply Fan, and the Exhaust Fan is shutdown. The Smoke Purge Fan is operated for discharging cold smoke after the fire is extinguished.

(c) DGEE/Z HVAC

This system is in operation during the plant normal operations and fault conditions, or when smoke purging is required.

Operation modes of the system are as follows:

(i) Normal operation mode
- Except for the EDG Room LCUs, Emergency Supply Fans and the Smoke Purge Fan, all equipment is operated during the plant normal operation and the plant normal shutdown.
- The protected stair case pressurisation function is provided as support for firefighting and safety evacuation by the DGEE/Z HVAC.

(ii) Emergency operation mode
Continuous operation is ensured by connection to the power supply provided by the EDG in the event of LOOP. The EDG Room LCUs and Emergency Supply Fans are operated after the EDG is activated.

(iii) Smoke purge operation mode
"Once-through ventilation method" is used for supplying air by the Supply Fan, and the Exhaust Fan is shutdown. The Smoke Purge Fan is operated for discharging cold smoke after the fire is extinguished.

(d) Hx/B (Hx/B-N and Hx/B-E) HVAC

This system is operated during the plant normal operations and when smoke purging is required. However, the Emergency LCUs and Emergency Supply Fans are in operation only for fault conditions.

Operation modes of the system are as follows:

(i) Normal operation mode
- Except for the Hx/B Emergency LCUs and the Emergency Supply Fans, all equipment is operated during the plant normal operation and the plant normal shutdown.
- The protected stair case pressurisation function is provided as support for firefighting and safety evacuation by the Hx/B-N HVAC.

(ii) Emergency operation mode
The Hx/B-N HVAC is shutdown in the event of LOOP. The Emergency LCUs and Hx/B-E Supply Fans are in operation by means of the power supply provided by the EDG.

(iii) Smoke purge operation mode

During the plant normal operations, the Hx/B-N Supply Fan is used for supplying outside air and discharging cold smoke by the once-through ventilation method after the fire is extinguished.

(e) CBEEE/Z HVAC

This system is in operation during the plant normal operations and fault conditions, or when smoke purging is required.

Operation modes of the system are as follows:

(i) Normal operation mode
- Except the Smoke Purge Fan, all equipment is operated during normal operation and normal shutdown.
- The protected stair case pressurisation function is provided as support for firefighting and safety evacuation by the CBEEE/Z HVAC.

(ii) Emergency operation mode
Continuous operation is ensured by connection to the power supply provided by the EDG in the event of the LOOP.

(iii) Smoke purge operation mode
"Once-through ventilation method" is used for supplying air by means of the Supply Fan, and the Exhaust Fan is shutdown. The Smoke Purge Fan is operated for discharging cold smoke after the fire is extinguished.

(f) MCR HVAC

This system is in operation during the plant normal operations and fault conditions, or when smoke purging is required.

Operation modes of the system are as follows:

(i) Normal operation mode
Except for the MCR Recirculation Supply Fan, the MCR Emergency Filter Train and the Smoke Purge Fan, all equipment is operated during normal operation and normal shutdown.

(ii) Emergency operation mode
When isolating the MCR in fault conditions, the MCR normal operation mode Air Intake Isolation Damper is closed, and the Recirculation Supply Fan is operated, the Emergency operation mode Air Intake Isolation Damper and the Emergency Filter Train Inlet Damper are opened. All outside air is filtered by the MCR Emergency Filter Train. The Exhaust Fan is stopped and the Exhaust Air Isolation Damper is closed. Continuous operation is assured by connection to the power supply provided by the EDG in the event of LOOP.

(iii) Smoke purge operation mode
The Smoke Purge Fan which is part of fire protection system is operated for discharging cold smoke after the fire is extinguished.

(g) CBC2EE/Z HVAC

This system is in operation during the plant normal operations and fault conditions, or when smoke purging is required.

Operation modes of the system are as follows:

(i) Normal operation mode
Except the Smoke Purge Fan, all equipment is operated during the plant normal operation and the plant normal shutdown.

(ii) Emergency operation mode
Continuous operation is ensured by connection to the power supply provided by the BBG in the event of the LOOP.

(iii) Smoke purge operation mode
"Once-through ventilation method" is used for supplying air by means of the Supply Fan, and the Exhaust Fan is shutdown. The Smoke Purge Fan is operated for discharging cold smoke after the fire is extinguished.

(h) BBEE/Z HVAC

This system is in operation during the plant normal operations and fault conditions, or when smoke purging is required.

Operation modes of the system are as follows:

(i) Normal operation mode
- Except for the BBG LCUs, Emergency Supply Fans and the Smoke Purge Fan, all equipment is operated during the plant normal operation and the plant normal shutdown.
- The protected stair case pressurisation function is provided as support for firefighting and safety evacuation by the BBEE/Z HVAC.

(ii) Emergency operation mode
Continuous operation is ensured by connection to the BBG in the event of LOOP. The BBG Room LCUs and Emergency Supply Fans are operated after the BBG is activated.

(iii) Smoke purge operation mode
"Once-through ventilation method" is used for supplying outside air and discharging cold smoke by means of the Supply Fan and the Exhaust Fan after the fire is extinguished.

(i) BBECR HVAC

This system is in operation during the plant normal/emergency operation, or when smoke purging is required.

Operation modes of the system are as follows:

(i) Normal operation mode
Except for the BBECR Recirculation Supply Fan, the BBECR Emergency Filter Train and the Smoke Purge Fan, all equipment is operated during the plant normal operation and the plant normal shutdown.

(ii) Emergency operation mode
When isolating the BBECR in fault conditions, the BBECR normal operation mode Air Intake Isolation Damper is closed, and the Recirculation Supply Fan is operated, the Emergency operation mode Air Intake Isolation Damper and the Emergency Filter Train Inlet Damper are opened. All outside air is filtered by the BBECR Emergency Filter Train. The exhaust fan is stopped and the exhaust air isolation damper is closed. Continuous operation is

assured by connection to the power supply provided by the BBG in the event of LOOP.

(iii) Smoke purge operation mode
The Smoke Purge Fan which is part of fire protection system is operated for discharging cold smoke after the fire is extinguished.

(j) FV/B HVAC

This system is in operation during the plant normal operations and fault conditions, or when smoke purging is required.

Operation modes of the system are as follows:

(i) Normal operation mode
- Except the Smoke Purge Fan, all equipment is operated during the plant normal operation and the plant normal shutdown.
- The protected stair case pressurisation function is provided as support for firefighting and safety evacuation by the FV/B HVAC.

(ii) Emergency operation mode
Continuous operation is ensured by connection to the power supply provided by the BBG in the event of the LOOP.

(iii) Smoke purge operation mode
"Once-through ventilation method" is used for supplying air by means of the Supply Fan, and the Exhaust Fan is shutdown. The Smoke Purge Fan is operated for discharging cold smoke after the fire is extinguished.

(k) Other HVACs

The following systems are operated during the plant normal operations and/or when smoke purging is required but these systems are shutdown in the event of LOOP:

(i) T/B HVAC,
(ii) Rw/B HVAC, and
(iii) S/B HVAC.

Design Bases

This section describes the design basis for HVAC.
The linkage between the Safety Functional Claims of HVAC with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

(1) Safety Functions

The HVAC is classified into the three safety divisions as follows.

(a) Emergency HVAC
The Emergency HVAC is in operation during fault conditions.
(b) Normal/Emergency HVAC
The Normal/Emergency HVAC is in operation during normal conditions and fault conditions.
(c) Normal HVAC
The Normal HVAC is in operation during normal conditions.

The HVAC has been designed to meet the following Safety Functional Claims (SFCs).
Table 16.5-1 shows the key SSCs and safety category/class for HVACs.

(a) Emergency HVAC
Normal Conditions
The R/A HVAC controls the design environmental parameters inside the served areas. [R/A HVAC SFC 5-18.1]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

Fault Conditions
(i) The R/A HVAC system is designed to reduce the release and spread of airborne contamination from the reactor building during design basis and beyond design basis fault conditions. [R/A HVAC SFC 4-7.2]
This function is classified as Category B and components to deliver it are designed to meet Class 2 requirements.

(ii) The R/A HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions. [R/A HVAC SFC 5-18.2]
This function is classified as Category A and components to deliver it are designed to meet Class 1 requirements.

(iii) The DGEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions. [DGEE/Z HVAC SFC 5-18.2]
This function is classified as Category A and components to deliver it are designed to meet Class 1 requirements.
(iv) The Hx/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can

deliver the fundamental safety functions in fault conditions. [Hx/B HVAC SFC 5-18.2]

This function is classified as Category A and components to deliver it are designed to meet Class 1 requirements.

(v) The MCR HVAC system is designed to reduce the ingress of gaseous or airborne radioactive material and the exposure of operators during fault conditions. [MCR HVAC SFC 4-7.3]

This function is classified as Category A and components to deliver it are designed to meet Class 1 requirements.

(vi) The BBEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions. [BBEE/Z HVAC SFC 5-18.2]

This function is classified as Category A and components to deliver it are designed to meet Class 2 requirements.

(vii) The BBECR HVAC system is designed to reduce the ingress of gaseous or airborne radioactive material and the exposure of operators during fault conditions. [BBECR HVAC SFC 4-7.3]

This function is classified as Category A and components to deliver it are designed to meet Class 2 requirements.

(b) Normal/Emergency HVAC

Normal Conditions

(i) The RBEEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation. [RBEEE/Z HVAC SFC 5-18.1]

This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(ii) The RBEEE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation. [RBEEE/Z HVAC SFC 5-18.3]

This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(iii) The RBEEE/Z HVAC system is designed to support smoke management for conventional fire safety. [RBEEE/Z HVAC SFC 5-18.4]

This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(iv) The DGEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation. [DGEE/Z HVAC SFC 5-18.1]

This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(v) The DGEE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation. [DGEE/Z HVAC SFC 5-18.3]

This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(vi) The DGEE/Z HVAC system is designed to support smoke management for conventional fire safety. [DGEE/Z HVAC SFC 5-18.4]

This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(vii) The CBEEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation. [CBEEE/Z HVAC SFC 5-18.1]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(viii) The CBEEE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation. [CBEEE/Z HVAC SFC 5-18.3]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(ix) The CBEEE/Z HVAC system is designed to support smoke management for conventional fire safety. [CBEEE/Z HVAC SFC 5-18.4]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(x) The CBC2EE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation. [CBC2EE/Z HVAC SFC 5-18.1]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(xi) The CBC2EE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation. [CBC2EE/Z HVAC SFC 5-18.3]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(xii) The MCR HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation. [MCR HVAC SFC 5-18.1]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(xiii) The MCR HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation. [MCR HVAC SFC 5-18.3]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(xiv) The BBEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation. [BBEE/Z HVAC SFC 5-18.1]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(xv) The BBEE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation. [BBEE/Z HVAC SFC 5-18.3]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(xvi) The BBEE/Z HVAC system is designed to support smoke management for conventional fire safety. [BBEE/Z HVAC SFC 5-18.4]

This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(xvii) The BBECR HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation. [BBECR HVAC SFC 5-18.1]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(xviii) The BBECR HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation. [BBECR HVAC SFC 5-18.3]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(xix) The FV/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation. [FV/B HVAC SFC 5-18.1]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(xx) The FV/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation. [FV/B HVAC SFC 5-18.3]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(xxi) FV/B HVAC system is designed to support smoke management for conventional fire safety. [FV/B HVAC SFC 5-18.4]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

Fault Conditions

(i) The RBEEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions. [RBEEE/Z HVAC SFC 5-18.2]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(ii) The CBEEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions. [CBEEE/Z HVAC SFC 5-18.2]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(iii) The CBC2EE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions. [CBC2EE/Z HVAC SFC 5-18.2]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(iv) The MCR HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions. [MCR HVAC SFC 5-18.2]

This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(v) The MCR HVAC systems ensure the adequate environmental parameters are maintained for working conditions during fault conditions. [MCR HVAC SFC 5-18.5]
This function is classified as Category A and the components to deliver it are designed to meet Class 1 requirements.

(vi) The BBECR HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions. [BBECR HVAC SFC 5-18.2]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(vii) The BBECR HVAC systems ensure the adequate environmental parameters are maintained for working conditions during fault conditions. [BBECR HVAC SFC 5-18.5]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

(viii) The FV/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions. [FV/B HVAC SFC 5-18.2]
This function is classified as Category A and the components to deliver it are designed to meet Class 2 requirements.

Table 16.5-1: Safety Category and Class for HVAC

HVAC sub-system/components	Object SSCs	HVAC safety division	Category	Class
RHR Pump Room LCUs	RHR	Emergency	A	1
RCIC Pump Room LCU	RCIC	Emergency	A	1
HPCF Pump Room LCUs	HPCF	Emergency	A	1
FPC Pump Room LCUs	FPC (Emergency makeup water system)	Emergency	A	1
SGTS Room LCUs	SGTS	Emergency	B	2
R/A Isolation Dampers and Accumulator Tanks	R/B (secondary containment)	Emergency	B	2
RBEEE/Z HVAC	Emergency on-site power system	Normal/Emergency	A	1
DGEE/Z HVAC	Emergency on-site power system	Normal/Emergency	A	1
EDG Room LCUs and Emergency Supply Fans		Emergency	A	1
Hx/B-E Local Cooling Units and Emergency Supply Fans	Emergency component cooling water system (RCW and RSW)	Emergency	A	1
CBEEE/Z HVAC	Direct current power supply system	Normal/Emergency	A	1
MCR HVAC	Main control room and its shielding (C/B)	Normal/Emergency	A	1
CBC2EE/Z HVAC	Class 2 Control Panel	Normal/Emergency	A	2

Table 16.5-1: Safety Category and Class for HVAC (Continued)

HVAC sub-system/components	Object SSCs	HVAC safety division	Category	Class
BBEE/Z HVAC	Emergency on-site power system	Normal/Emergency	A	2
BBG Room LCUs and Emergency Supply Fans		Emergency	A	2
BBECR HVAC	Emergency control room and its shielding (B/B)	Normal/Emergency	A	2
FV/B HVAC	Filtered Containment Venting System	Normal/Emergency	A	2

(c) Normal HVAC

Normal Conditions

(i) The R/A HVAC system is designed to reduce the release and spread of airborne contamination during normal operation.
[R/A HVAC SFC 4-7.1]

(ii) The R/A HVAC system ensures comfort during maintenance in the accessible areas.
[R/A HVAC SFC 5-18.3]

(iii) The R/A HVAC system is designed to support smoke management for conventional fire safety.
[R/A HVAC SFC 5-18.4]

(iv) The T/B HVAC system is designed to reduce the release and spread of airborne contamination during normal operation
[T/B HAVC SFC 4-7.1]

(v) The T/B HVAC ensures adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.
[T/B HVAC SFC 5-18.1]

(vi) The T/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.
[T/B HVAC SFC 5-18.3]

(vii) The T/B HVAC system is designed to support smoke management for conventional fire safety.
[T/B HVAC SFC 5-18.4]

(viii) The Hx/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.
[Hx/B HVAC SFC 5-18.1]

(ix) The Hx/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.
[Hx/B HVAC SFC 5-18.3]

(x) The Hx/B HVAC system is designed to support smoke management for conventional fire safety.
[Hx/B HVAC SFC 5-18.4]

(xi) The CBC2EE/Z HVAC system is designed to support smoke management for conventional fire safety.
[CBC2EE/Z HVAC SFC 5-18.4]
(xii) The MCR HVAC system is designed to support smoke management for conventional fire safety.
[MCR HVAC SFC 5-18.4]
(xiii) The Rw/B HVAC system is designed to reduce the release and spread of airborne contamination during normal operation.
[Rw/B HVAC SFC 4-7.1]
(xiv) The Rw/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.
[Rw/B HVAC SFC 5-18.1]
(xv) The Rw/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.
[Rw/B HVAC SFC 5-18.3]
(xvi) The Rw/B HVAC system is designed to support smoke management for conventional fire safety.
[Rw/B HVAC SFC 5-18.4]
(xvii) The S/B HVAC system is designed to reduce the release and spread of airborne contamination during normal operation.
[S/B HVAC SFC 4-7.1]
(xviii) The S/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.
[S/B HVAC SFC 5-18.1]
(xix) The S/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.
[S/B HVAC SFC 5-18.3]
(xx) The S/B HVAC system is designed to support smoke management for conventional fire safety.
[S/B HVAC SFC 5-18.4]
(xxi) The BBECR HVAC system is designed to support smoke management for conventional fire safety.
[BBECR HVAC SFC 5-18.4]

These functions are classified as Category C and the components to deliver it are designed to meet Class 3 requirements.

Fault Conditions
In the event of LOOP, following HVACs are inoperable.

(i) R/A HVAC
(Except for the Emergency LCUs, the R/A Isolation Dampers/ and Accumulator Tanks)
(ii) T/B HVAC
(iii) Hx/B-N HVAC
(iv) CBC2EE/Z HVAC
(Except for the Normal / Emergency HVAC)
(v) MCR HVAC
(Except for the Normal / Emergency HVAC)
(vi) Rw/B HVAC
(vii) S/B HVAC

(viii) BBECR HVAC
(Except for the Normal / Emergency HVAC)

System Design Description

This section describes the design of the HVAC to support and justify the delivery of HVAC SFCs. Additional design description can be found in [Ref-16.5-1], [Ref-16.5-2], and [Ref-16.5-3] to [Ref-16.5-29].

(1) System Design and Operation

(a) R/A HVAC

The R/A HVAC is categorised for following two functions:

(i) Normal function (R/A HVAC SFC 4-7.1, R/A HVAC SFC 5-18.1, R/A HVAC SFC 5-18.3 and R/A HVAC SFC 5-18.4)
This system provides ventilation and air conditioning function for the R/A by the once-through ventilation method and maintains a negative pressure within the R/A with respect to atmosphere during the plant normal operations. In addition, exhaust air is treated with the HEPA filters before discharging to the main exhaust stack.

The Normal LCUs supplement the R/A HVAC to maintain a controlled temperature environment in certain high heat load areas.

During the plant normal shutdown, the RHR is operated in order to remove residual heat from the reactor. The RHR Pump Room LCUs are automatically started upon the RHR pump initiation signals and provide cooling to remove heat load from the RHR pumps. In addition, the nitrogen gas is exchanged with air within the Primary Containment Vessel (PCV) to provide access for operators and workers. To do so, HVAC supply air for the R/A is partially directed to the Atmospheric Control system (AC) via the PCV Purge Supply Filter Unit. Consequently, air is returned to the R/A HVAC exhaust system by means of the PCV Purge Exhaust Fan.

A local Safe Change HEPA filter unit will be provided for high potentially airborne contamination areas as necessary.

(ii) Emergency function

- Cooling function for emergency SSCs room (R/A HVAC SFC 5-18.2)
  The emergency LCUs of the R/A HVAC are designed to provide suitable indoor environmental conditions to ensure the continued operation of the emergency SSCs during fault conditions. Heat load from the emergency SSCs is removed by the RCW passing through the LCU.
  - RHR Pump Room LCU
    The RHR [Low Pressure Flooder System (LPFL)] is composed of three independent divisions designated A, B and C. Therefore, the LCU is provided with three units according to division of the RHR. The LCUs are automatically started upon RHR pump initiation signals.
  - RCIC Pump Room LCU

The RCIC consists of a single pump. Therefore, the LCU is provided with one unit according to the RCIC. The LCU is automatically started upon RCIC turbine stop valve open signal.

- The HPCF Pump Room LCU
  The HPCF is composed of two independent divisions designated B and C. Therefore, the LCU is provided with two units according to division of the HPCF. The LCUs are automatically started upon HPCF pump initiation signals.
- The FPC Pump Room LCU
  The FPC is composed of two independent divisions designated A and B. Therefore, the LCU is provided with two units according to division of the FPC. The LCUs are automatically started upon FPC pump initiation signals and R/A isolation damper closing signals.
- The SGTS Room LCU
  The SGTS is composed of two independent divisions designated A and B. Therefore, the LCU is provided with two units according to division of the SGTS. The LCUs are automatically started upon SGTS initiation signals.

- R/A isolation function (R/A HVAC SFC 4-7.2)
  Upon receipt of any emergency isolation signals ("high radioactivity of the HVAC exhaust gas in the R/A", "high radioactivity in fuel handling area", "drywell high pressure" or "reactor water low level"), the R/A HVAC is automatically shutdown and the R/A Isolation Dampers mounted on the supply/exhaust duct of the R/A HVAC are automatically closed to isolate R/A while preventing exfiltration of the radioactive gas to outside by switching in the SGTS.

System outline of the R/A HVAC is shown in the Figure 16.5-1.

(b) RBEEE/Z HVAC (RBEEE/Z HVAC SFC 5-18.1, RBEEE/Z HVAC SFC 5-18.2, RBEEE/Z HVAC SFC 5-18.3 and RBEEE/Z HVAC SFC 5-18.4)

The RBEEE/Z HVAC provides ventilation and air conditioning function for the RBEEE/Z by the partial recirculation ventilation method during the plant normal operations and fault conditions. The RBEEE/Z HVAC composed of three divisions designated A, B and C systems. Each system serves one divisional RBEEE/Z. The divisional HECW provides chilled water for the RBEEE/Z HVAC.
After a fire event, in case cold smoke is generated within fire area, the ventilation method is changed from partial recirculation to the once-through for smoke purging.

System outline of the RBEEE/Z HVACs are shown in the Figure 16.5-2 to 16.5-4.

(c) DGEE/Z HVAC (DGEE/Z HVAC SFC 5-18.1, DGEE/Z HVAC SFC 5-18.2, DGEE/Z HVAC SFC 5-18.3 and HVAC SFC 5-18.4)

(i) HVAC and Smoke Purge Function for the DGEE/Z

- The DGEE/Z HVAC provides ventilation and air conditioning for the DGEE/Z by the partial recirculation ventilation method during the plant normal operations and fault conditions. The DGEE/Z HVAC is composed of three divisions designated A, B and C systems. Each system serves one divisional DGEE/Z. The divisional HECW provides chilled water for the DGEE/Z HVAC.

- After a fire event, in case cold smoke is generated within fire area, the ventilation method is changed from partial recirculation to once-through for smoke purging.

(ii) Cooling Function for the EDG room

The EDG is the power supply system for supporting core cooling function in the event of design basis faults. Therefore, the cooling function for the EDG room is required to have a higher reliability than other HVAC sub-systems in accordance with Probabilistic Safety Assessment [Ref. 16-5.30].

The cooling configuration for the EDG room is as follows.

- EDG Room LCU (Primary Cooling Function)
  The EDG Room LCU is designed to provide suitable indoor environmental conditions to ensure the continued operation of the EDG during fault conditions. The LCU is supplied with chilled water by the divisional HECW.
- EDG Room Emergency Supply Fan (Secondary Cooling Function)
  The EDG Room Emergency Supply Fan provides filtered outside air cooling. The role of the Emergency Supply Fan is to maintain suitable environmental conditions under the loss of cooling by the EDG Room LCU due to failure of the HECW Chiller.

The EDG is composed of three independent divisions designated A, B and C. Therefore, the LCU and Emergency Supply Fan are each provided with two units per division. The LCUs and Emergency Supply Fans are automatically started upon EDG initiation signals.

System outline of the DGEE/Z HVACs are shown in the Figure 16.5-5 to 16.5-7.

(d) T/B HVAC (T/B HVAC SFC 4-7.1, T/B HVAC SFC 5-18.1, T/B HVAC SFC 5-18.3 and T/B HVAC SFC 5-18.4)

The T/B HVAC provides ventilation and air conditioning function for the controlled area within the T/B by the once-through ventilation method and maintains a negative pressure within the controlled areas with respect to atmosphere during the plant normal operations. In addition, exhaust air is treated with the HEPA filters before discharging to main exhaust stack.

The LCUs supplement the T/B HVAC to maintain a controlled temperature environment in certain high heat load areas.

Local Safe Change HEPA filter unit will be provided for high potentially airborne contamination areas as necessary.

In the event of LOOP, the T/B HAVC is inoperable.

System outline of the T/B HVAC is shown in the Figure 16.5-8.

(e) Hx/B (Hx/B-N and Hx/B-E) HVAC (Hx/B HVAC SFC 5-18.1, Hx/B HVAC SFC 5-18.2, Hx/B HVAC SFC 5-18.3 and Hx/B HVAC SFC 5-18.4)

(i) Hx/B-N HVAC
The Hx/B-N HVAC provides ventilation and air conditioning function for the Hx/B by the type-2 ventilation method during the plant normal operations. After a fire event, in case cold smoke is generated within fire area, the smoke purging function is carried out by the once-through ventilation method.

System outline of the Hx/B-N HVAC is shown in the Figure 16.5-9.

(ii) Hx/B-E HVAC
The RCW and RSW within the Hx/B are essential systems for supporting core cooling function in the event of design basis faults. Therefore, the cooling function for the RCW and RSW room are required to have higher reliability than other HVAC sub-systems in according to PSA [Ref. 16-5.30]. The cooling configuration for the RCW and RSW room is as follows:

- Emergency LCU (Primary Cooling Function)
  The Emergency LCU is designed to provide suitable indoor environmental conditions to ensure the continued operation of the RCW and RSW in the Hx/B during fault conditions. The LCU is supplied with chilled water by the divisional HECW.
- Hx/B-E Supply Fan (Secondary Cooling Function)
  The Hx/B-E Supply Fan provides filtered outside air cooling. The role of the Emergency Supply Fan is to maintain suitable environmental conditions during the loss of cooling by the Emergency LCU due to failure of the HECW Chiller.

The RCW and RSW are each composed of three independent divisions designated A, B and C. Therefore, the LCU and Emergency Supply Fan are each provided with one unit per division. The LCUs and Emergency Supply Fans are automatically started upon RCW pump initiation signals.

System outline of the Hx/B-E HVAC is shown in the Figure 16.5-10.

(f) CBEEE/Z HVAC (CBEEE/Z HVAC SFC 5-18.1, CBEEE/Z HVAC SFC 5-18.2, CBEEE/Z HVAC SFC 5-18.3 and CBEEE/Z HVAC SFC 5-18.4)

The CBEEE/Z HVAC provides ventilation and air conditioning function for the CBEEE/Z by the partial recirculation ventilation method during the plant normal operations and fault conditions. After a fire event, in case cold smoke is generated within fire area, the ventilation method is changed from partial recirculation to once-through ventilation for smoke purging.

The CBEEE/Z HVAC is composed of three divisions and redundant cooling is provided to each of the CBEEE/Z divisions I through IV.

The objective of the selected configuration as described below is to ensure HVAC function is provided with sufficient redundancy by incorporating various system combinations.

The HVAC division A (Ventilation area: CBEEE/Z division I and division IV), the HVAC division B (CBEEE/Z division II and division IV), and the HVAC division C (CBEEE/Z division III and division IV).

Thus, divisions I through IV for CBEEE/Z are provided with their own HVAC even in the event of loss of one HVAC division.
The Normal LCUs supplement the CBEEE/Z HVAC to maintain a controlled temperature environment in certain high heat load areas.

The exhaust air from battery room for each division is discharged to outside directly through exhaust duct and openings by the Exhaust Fans.

System outline of the CBEEE/Z HVACs are shown in the Figure 16.5-11 to 16.5-13.

(g) MCR HVAC (MCR HVAC SFC 4-7.3, MCR HVAC SFC 5-18.1, MCR HVAC SFC 5-18.2, MCR HVAC SFC 5-18.3, MCR HVAC SFC 5-18.4 and MCR HVAC SFC 5-18.5)

During the plant normal operations and fault conditions, the MCR HVAC is designed to maintain a habitable environment and to ensure the operability of nuclear safety components within the MCR by the partial recirculation ventilation method. The MCR is composed of two divisions designated A and B systems. The redundant divisional system is on standby. After a fire event, in case cold smoke is generated within fire area it is discharged to outside by the smoke purge fan which is a part of fire protection system.

Upon receipt of any emergency isolation signals (“high radioactivity of the HVAC exhaust gas in the R/A” and “high radioactivity in fuel handling area”), the Normal Operation Mode Air Intake Dampers close, the Exhaust Air Isolation Dampers close, the Exhaust Fan stops, the Emergency Mode Air Intake Dampers open, the Emergency Filter Train Inlet Damper opens and Recirculation Supply Fan starts. This initiates emergency operation mode. In emergency mode, a positive pressure is maintained in the MCR with respect to the outside atmosphere. The Emergency Filter Train treats a mixture of the MCR recirculated air and outside air to maintain a positive pressure with appropriate air flow rates.

The Emergency Filter Train is capable to filtering and eliminating radiological contamination and hazardous substances within the MCR.

System outline of the MCR HVACs are shown in the Figure 16.5-14.

(h) CBC2EE/Z HVAC (CBC2EE/Z HVAC SFC 5-18.1, CBC2EE/Z HVAC SFC 5-18.2, CBC2EE/Z HVAC SFC 5-18.3 and CBC2EE/Z HVAC SFC 5-18.4)

The CBC2EE/Z HVAC provides ventilation and air conditioning function for the CBC2EE/Z by the partial recirculation ventilation method during the plant normal operations and fault conditions. After a fire event, in case cold smoke is generated within fire area, the ventilation method is changed from partial recirculation to once-through ventilation for smoke purging.

System outline of the CBC2EE/Z HVAC is shown in the Figure 16.5-15.

System Configuration of the C/B HVAC sub-system including the CBEEE/Z, MCR and CBC2EE/Z HVAC is shown in the Figure 16.5.

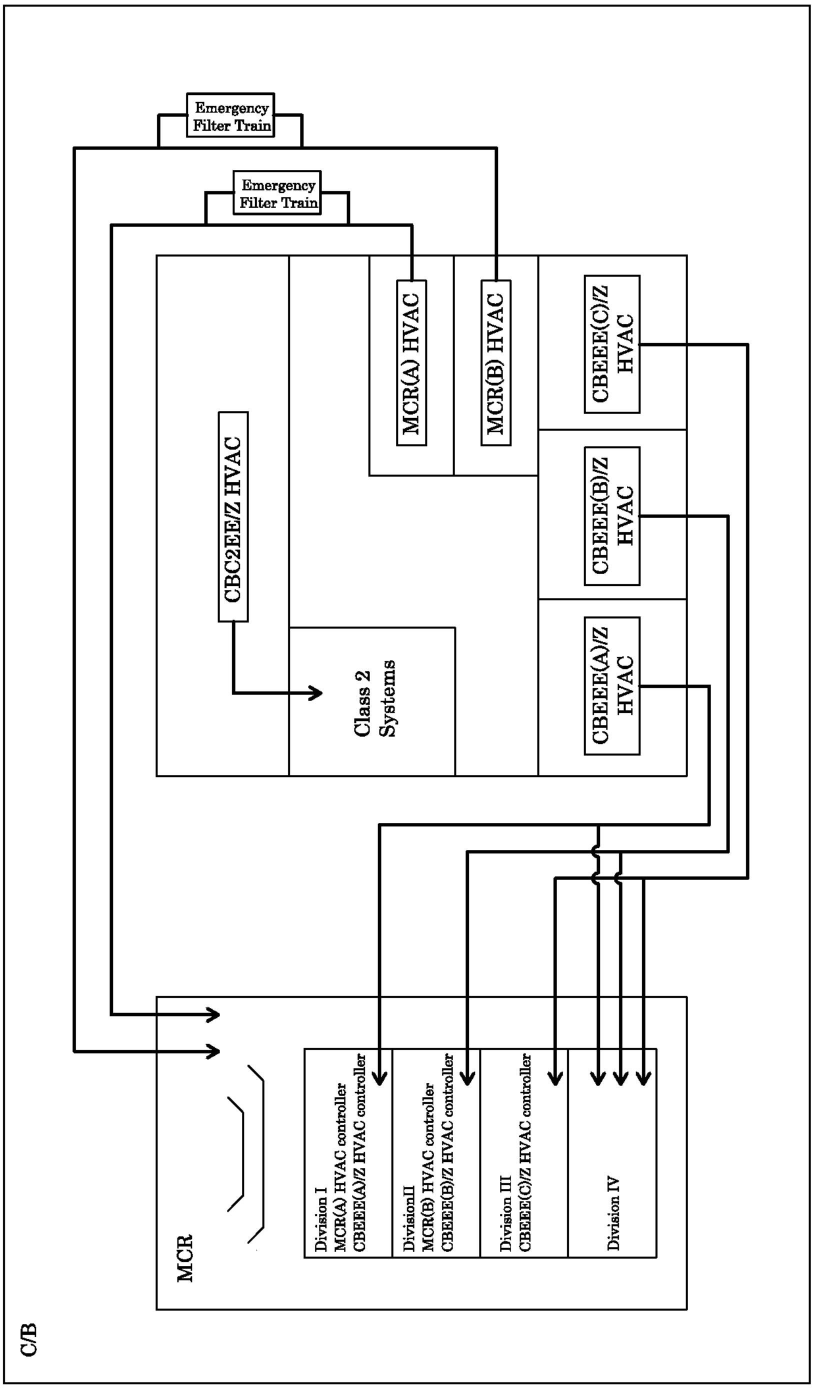


Figure 16.5: System Configuration of the C/B HVAC

(i) Rw/B HVAC (Rw/B HVAC SFC 4-7.1, Rw/B HVAC SFC 5-18.1, Rw/B HVAC SFC 5.18.3 and Rw/B HVAC SFC 5-18.4)

The Rw/B HVAC provides ventilation and air conditioning function for the Rw/B by the once-through ventilation method and maintains a negative pressure within the controlled areas with respect to atmosphere during the plant normal operations. In addition, exhaust air is treated with the HEPA filters before discharging to the main exhaust stack.

Local Safe Change HEPA filter unit will be provided for potentially high airborne contamination areas as necessary.

In the event of LOOP, the Rw/B HAVC is inoperable.

System outline of the Rw/B HVAC is shown in the Figure 16.5-16.

(j) S/B HVAC (S/B HVAC SFC 4-7.1, S/B HVAC SFC 5-18.1, S/B HVAC SFC 5-18.3 and S/B HVAC SFC 5-18.4)

The S/B Controlled Area HVAC provides ventilation and air conditioning function for the S/B by the once-through ventilation method and maintains a negative pressure within the controlled area with respect to atmosphere during the plant normal operations. In addition, exhaust air is treated with the HEPA filters before discharging to atmosphere.
The LCU supplement the S/B Controlled Area HVAC to maintain a controlled temperature environment in certain high heat load areas.

The S/B Non-Controlled Area HVAC provides ventilation and air conditioning function for the S/B by partial recirculation ventilation method during the plant normal operations.
The LCUs supplement the S/B Non-Controlled Area HVAC to maintain a controlled temperature environment in certain high heat load areas.

As for the general habitable area, the FCU or Multi-Split ACU is used individually for cooling and heating, to maintain the habitability of the occupants if needed.

In the event of LOOP, the S/B HAVC is inoperable.

System outline of the S/B HVAC is shown in the Figure 16.5-17.

(k) BBEE/Z HVAC (BBEE/Z HVAC SFC 5-18.1, BBEE/Z HVAC SFC 5-18.2, BBEE/Z HVAC SFC 5-18.3 and HVAC SFC 5-18.4)

(i) HVAC and Smoke Purge Function for the BBEE/Z

- The BBEE/Z HVAC provides ventilation and air conditioning function for the B/B by the partial recirculation ventilation method during the plant normal operations and fault conditions. The BBEE/Z HVAC is composed of two divisions designated A and B systems. Each system serves the divisional BBEE/Z.
- After a fire event, in case cold smoke is generated within fire area, the ventilation method is changed from partial recirculation ventilation to once-through for smoke purging.

(ii) Cooling Function for the BBG room
The BBG is the power supply system for supporting core cooling function in the event of beyond design basis faults and severe accidents. Therefore, the cooling function for the BBG room is required to have higher reliability than other HVAC sub-systems in accordance with PSA [Ref. 16-5.30].
The cooling configuration for the BBG room is as follows:
- BBG Room LCU (Primary Cooling Function)
The BBG Room LCU is designed to provide suitable indoor environmental conditions to ensure the continued operation of the BBG during fault conditions. The LCU are supplied with chilled water by the divisional HBCW.
- BBG Room Emergency Supply Fan (Secondary Cooling Function)
The BBG Room Emergency Supply Fan provides filtered outside air cooling. The role of the Emergency Supply Fan is to maintain suitable environmental conditions during the loss of cooling by the BBG Room LCU due to failure of the HBCW Chiller.

The BBG is designated A and B. Therefore, the LCU and Emergency Supply Fan are provided with two units per division. The LCUs and Emergency Supply Fans are automatically started upon BBG initiation signals.

System outline of the BBEE/Z HVACs are shown in the Figure 16.5-18 and 16.5-19.

(l) BBECR HVAC (BBECR HVAC SFC 4-7.3, BBECR HVAC SFC 5-18.1, BBECR HVAC SFC 5-18.2, BBECR HVAC SFC 5-18.3, BBECR HVAC SFC 5-18.4 and HVAC SFC 5-18.5)

During the plant normal operations and fault conditions, the BBECR HVAC is designed to maintain a habitable environment and to ensure the operability of nuclear safety components within the BBECR by the partial recirculation ventilation method. The BBECR HVAC is composed of two divisions designated A and B systems. The redundant divisional system is on standby. After a fire event, in case cold smoke is generated within fire area it is discharged to outside by the smoke purge fan which is part of fire protection system.

Upon receipt of any emergency isolation signals, the Normal Operation Mode Air Intake Dampers close, the Exhaust Air Isolation Dampers close, the Exhaust Fan stops, the Emergency Mode Air Intake Dampers open, the Emergency Filter Train Inlet Damper opens and Recirculation Supply Fan starts. This initiates emergency operation mode. In emergency mode, a positive pressure is maintained in the BBECR with respect to the outside atmosphere. The Emergency Filter Train treats a mixture of the BBECR recirculated air and outside air to maintain a positive pressure with appropriate air flow rates.

The Emergency Filter Train is capable to filtering and eliminating radiological contaminants and hazardous substances within the BBECR.

System outline of the BBECR HVACs are shown in the Figure 16.5-20.

(m) FV/B HVAC (FV/B HVAC SFC 5-18.1, FV/B HVAC SFC 5-18.2, FV/B HVAC SFC 5-18.3 and HVAC SFC 5-18.4)

The FV/B HVAC provides ventilation and air conditioning function for the FV/B by the partial recirculation ventilation method during the plant normal operations and fault conditions. After a fire event, in case cold smoke is generated within fire area, the ventilation method is changed from partial recirculation to once-through ventilation for smoke purging.

System outline of the FV/B HVAC is shown in the Figure 16.5-21.

(2) Equipment Design and Operation

(a) HVAC System Airflow Rate

Table 16.5-2 shows the system airflow rate provided for each HVAC sub-system in order to ventilate and remove heat from each building and area.

Table 16.5-2: HVAC System Airflow Rate (1/2)

Bldg.	System	HVAC safety division	System Airflow Rate	Remarks
R/B	R/A HVAC	Normal	245000 m^3/h	
	RBEEE (A)/Z HVAC	Normal/Emergency	33000 m^3/h	
	RBEEE (B)/Z HVAC	Normal/Emergency	48000 m^3/h	
	RBEEE (C)/Z HVAC	Normal/Emergency	40000 m^3/h	
EDG/B	DGEE (A)/Z HVAC	Normal/Emergency	44500 m^3/h	
	DGEE (B)/Z HVAC	Normal/Emergency	44500 m^3/h	
	DGEE (C)/Z HVAC	Normal/Emergency	44500 m^3/h	
T/B	T/B HVAC	Normal	379000 m^3/h	
Hx/B	Hx/B-N HVAC	Normal	180000 m^3/h	
C/B	CBEEE (A)/Z HVAC	Normal/Emergency	42500 m^3/h	
	CBEEE (B)/Z HVAC	Normal/Emergency	34500 m^3/h	
	CBEEE (C)/Z HVAC	Normal/Emergency	31000 m^3/h	
	MCR (A) HVAC	Normal/Emergency	100000 m^3/h	
	MCR (B) HVAC	Normal/Emergency	100000 m^3/h	
	CBC2EE/Z HVAC	Normal/Emergency	5000 m^3/h	

Table 16.5-2: HVAC System Airflow Rate (2/2) (Continued)

Bldg.	System	HVAC safety division	System Airflow Rate	Remarks
Rw/B	Rw/B HVAC	Normal	157000m^3/h	
S/B	S/B controlled area HVAC	Normal	58000 m^3/h	
	S/B non- controlled area HVAC	Normal	39000 m^3/h	
B/B	BBEE (A)/Z HVAC	Normal/Emergency	40000 m^3/h	
	BBEE (B)/Z HVAC	Normal/Emergency	40000 m^3/h	
	BBECR (A) HVAC	Normal/Emergency	52000 m^3/h	
	BBECR (B) HVAC	Normal/Emergency	52000 m^3/h	
FV/B	FV/B HVAC	Normal/Emergency	30000 m^3/h	

(b) Supply, Exhaust, PCV Purge Exhaust Fan and Smoke Purge Fan

(i) Purpose

The Supply, Exhaust and PCV Purge Exhaust Fan provide a sufficient air flow rate to ensure the HVAC function in order to deliver R/A HVAC SFC 4-7.1, R/A HVAC SFC 4-7.2, R/A HVAC SFC 5-18.1, R/A HVAC SFC 5-18.3, R/A HVAC SFC 5-18.4, RBEEE/Z HVAC SFC 5-18.1, RBEEE/Z HVAC SFC 5-18.2, RBEEE/Z HVAC SFC 5-18.3, RBEEE/Z HVAC SFC 5-18.4, DGEE/Z HVAC SFC 5-18.1, DGEE/Z HVAC SFC 5-18.2, DGEE/Z HVAC SFC 5-18.3, DGEE/Z HVAC SFC 5-18.4, T/B HVAC SFC 4-7.1, T/B HVAC SFC 5-18.1, T/B HVAC SFC 5-18.3, T/B HVAC SFC 5-18.4, Hx/B HVAC SFC 5-18.1, Hx/B HVAC SFC 5-18.2, Hx/B HVAC SFC 5-18.3, Hx/B HVAC SFC 5-18.4, CBEEE/Z HVAC SFC 5-18.1, CBEEE/Z HVAC SFC 5-18.2, CBEEE/Z HVAC SFC 5-18.3, CBEEE/Z HVAC SFC 5-18.4, CBC2EE/Z HVAC SFC 5-18.1, CBC2EE/Z HVAC SFC 5-18.2, CBC2EE/Z HVAC SFC 5-18.3, CBC2EE/Z HVAC SFC 5-18.4, MCR HVAC SFC 4-7.3, MCR HVAC SFC 5-18.1, MCR HVAC SFC 5-18.2, MCR HVAC SFC 5-18.3, MCR HVAC SFC 5-18.5, Rw/B HVAC SFC 4-7.1, Rw/B HVAC SFC 5-18.1, Rw/B HVAC SFC 5-18.3, Rw/B HVAC SFC 5-18.4, S/B HVAC SFC 4-7.1, S/B HVAC SFC 5-18.1, S/B HVAC SFC 5-18.3, S/B HVAC SFC 5-18.4, BBEE/Z HVAC SFC 5-18.1, BBEE/Z HVAC SFC 5-18.2, BBEE/Z HVAC SFC 5-18.3, BBEE/Z HVAC SFC 5-18.4, BBECR HVAC SFC 4-7.3, BBECR HVAC SFC 5-18.1, BBECR HVAC SFC 5-18.2, BBECR HVAC SFC 5-18.3, BBECR HVAC SFC 5-18.5, FV/B HVAC SFC 5-18.1, FV/B HVAC SFC 5-18.2, FV/B HVAC SFC 5-18.3 and FV/B HVAC SFC 5-18.4.

The Smoke Purge Fan of each HVAC sub-system removes cold smoke from fire area after a fire is extinguished in order to deliver RBEEE/Z HVAC SFC 5-18.4, DGEE/Z HVAC SFC 5-18.4, Hx/B HVAC SFC 5-18.4, CBEEE/Z HVAC SFC 5-18.4, CBC2EE/Z HVAC SFC 5-18.4, RBEEE/Z HVAC SFC 5-18.4, MCR HVAC SFC 5-18.4, S/B HVAC SFC 5-18.4, BBECR HVAC SFC 5-18.4, BBEE/Z HVAC SFC 5-18.4 and FV/B HVAC SFC 5-18.4.

(ii) Configuration and Operation

- R/A HVAC Supply, Exhaust and PCV Purge Exhaust Fan
  - The R/A HVAC is provided with three 50-percent capacity centrifugal Supply and Exhaust Fans mounted in parallel.
  - Two Supply Fans and Exhaust Fans operate during all normal operations.
  - The Supply and Exhaust Fan on standby are designed to automatically start-up upon failure signals of the operating Supply and Exhaust Fans.
  - Pneumatic operated dampers are mounted on the discharge side of the Supply Fans to prevent reverse flow and manual balancing dampers are mounted on the suction side of the fans in order to adjust the rated air flow rate during commissioning.
  - Pneumatic operated dampers are mounted on the discharge side and suction side of the Exhaust Fans. Pneumatic operated dampers of the discharge side prevent reverse flow and the dampers on the suction side are automatically adjusted and controlled to maintain a negative pressure within the R/A with respect to atmosphere. In addition manual balancing dampers are mounted on the upstream

side of the suction side pneumatic operated dampers in order to adjust the rated air flow rate during commissioning.
- Discharge air flow sensor, rotation speed sensor and inlet/outlet differential pressure sensor are provided each fan to detect fan failure.
- The PCV Purge Exhaust Fan exhausts the nitrogen from the PCV and supplies the air to the PCV in order to allow personnel entry during shutdown and refuelling outages (de-inerting operation of the AC). In addition, the PCV Purge Exhaust Fan exhausts the air from the PCV during start-up (inerting operation of the AC).

- RBEEE/Z, DGEE/Z, CBEEE/Z, BBEE/Z HVAC Supply, Exhaust and Smoke Purge Fan
  Each division of RBEEE/Z, DGEE/Z, CBEEE/Z and BBEE/Z HVAC is provided with two 100-percent capacity centrifugal Supply/Exhaust Fans mounted in parallel and one 100-percent Smoke Purge Fan. Each division of the DGEE/Z and BBEE/Z HVAC are provided with two 50-percent axial Emergency Supply Fans for the EDG and BBG room. The main configuration aspects regarding the Supply, Exhaust and Smoke Purge Fan are described as follows:
  - One Supply Fan and Exhaust Fan operate during all modes of plant operation.
  - The Supply and Exhaust Fan on standby are designed to automatically start-up upon failure signals of the operating Supply and Exhaust Fan.
  - Motor operated dampers are mounted on the discharge side of the fans to prevent reverse flow and manual balancing dampers are mounted on the suction side of the fans in order to adjust air flow rate.
  - Discharge air flow sensor, rotation speed sensor and inlet/outlet differential pressure sensor are provided each fan to detect fan failure.
  - The Smoke Purge Fan removes cold smoke from fire area after a fire is extinguished.
  - The Emergency Supply Fans are initiated automatically upon activation signal of the EDGs and BBGs in the event of faults and are stopped by the operator.

- CBC2EE/Z, FV/B HVAC Supply, Exhaust and Smoke Purge Fan
  CBC2EE/Z and FV/B HVAC is provided with two 100-percent capacity centrifugal Supply/Exhaust Fans mounted in parallel and one 100-percent Smoke Purge Fan. The main configuration aspects regarding the Supply, Exhaust and Smoke Purge Fan are describes as follows:
  - One Supply Fan and Exhaust Fan operate during all modes of plant operation.
  - The Supply and Exhaust Fan on standby are designed to automatically start-up upon failure signals of the operating Supply and Exhaust Fan.

- Motor operated dampers are mounted on the discharge side of the fans to prevent reverse flow and manual balancing dampers are mounted on the suction side of the fans in order to adjust air flow rate.
- Discharge air flow sensor, rotation speed sensor and inlet/outlet differential pressure sensor are provided each fan to detect the fan failure.
- The Smoke Purge Fan removes cold smoke from fire area after a fire is extinguished.

- T/B HVAC Supply and Exhaust Fan
  - The T/B HVAC is provided with three 50-percent capacity centrifugal Supply and Exhaust Fans mounted in parallel.
  - Two Supply Fans and Exhaust Fans operate during all normal operations.
  - The Supply and Exhaust Fan on standby are designed to automatically start-up upon failure signals of the operating Supply and Exhaust Fans.
  - Pneumatic operated dampers are mounted on the discharge side of the Supply Fans to prevent reverse flow and manual balancing dampers are mounted suction side of the fans in order to adjust the air flow rate during commissioning.
  - Pneumatic operated dampers are mounted on the discharge side and suction side of the Exhaust Fans. Pneumatic operated dampers of the discharge side prevent reverse flow and the dampers of the suction side are manually adjusted and controlled to maintain a negative pressure within the T/B controlled areas with respect to atmosphere. In addition manual balancing dampers are mounted on the upstream side of the suction side pneumatic operated dampers in order to adjust the air flow rate during commissioning.
  - Discharge air flow sensor, rotation speed sensor and inlet/outlet differential pressure sensor are provided each fan to detect fan failure.

- Hx/B (Hx/B-N and Hx/B-E) HVAC Supply Fan
  Hx/B-N HVAC is provided with two 100-percent capacity centrifugal Supply Fans mounted in parallel. Each division of the Hx/B-E HVAC is provided with one 100-percent capacity centrifugal Supply Fan. The main configuration aspects regarding the Supply Fan are describes as follows:
  - One Supply Fan of the Hx/B-N HVAC operates during all normal operations.
  - The Supply Fan of Hx/B-N HVAC on standby is designed to automatically start-up upon failure signals of the operating Supply Fan.
  - Pneumatic operated dampers are mounted on the discharge side of the Supply Fans of Hx/B-N HVAC to prevent reverse flow and manual balancing dampers are mounted suction side of the fans in order to adjust the air flow rate during commissioning.
  - Motor operated dampers are mounted on the discharge side of the Supply Fans of Hx/B-E HVAC to prevent reverse flow and manual

balancing dampers are mounted on the suction side of the fans in order to adjust air flow rate.
- The Hx/B-E Supply Fans are initiated automatically upon activation signal of RCW pumps in the event of faults and are stopped by the operator.

- MCR and BBECR HVAC Supply, Exhaust and Recirculation Supply Fan
  Each division of the MCR and BBECR HVAC is provided with one 100-percent capacity centrifugal Supply, Exhaust and Recirculation Supply Fans.
  - One Supply Fan and Exhaust Fan operate during all modes of plant operations.
  - The divisional redundant system on standby is designed to automatically change over upon failure signals of the operating Supply and Exhaust Fan.
  - The Recirculation Supply Fan is on standby during normal operations mode and is initiated automatically upon start-up signal.
  - Motor operated dampers are mounted on the discharge side of the fans to prevent reverse flow and manual balancing dampers are mounted on the suction side of the fans in order to adjust air flow rate.
  - Discharge air flow sensor, rotation speed sensor and inlet/outlet differential pressure sensor are provided each fan to detect fan failure.

- Rw/B HVAC Supply and Exhaust Fan
  - The Rw/B HVAC is provided with two 100-percent capacity centrifugal Supply and Exhaust Fans mounted in parallel.
  - One Supply Fan and Exhaust Fan operate during all normal operations.
  - The Supply and Exhaust Fan on standby are designed to automatically start-up upon failure signals of the operating Supply and Exhaust Fans.
  - Pneumatic operated dampers are mounted on the discharge side of the Supply Fans to prevent reverse flow and manual balancing dampers are mounted suction side of the fans in order to adjust the air flow rate during commissioning.
  - Pneumatic operated dampers are mounted on the discharge side and suction side of the Exhaust Fans. Pneumatic operated dampers of the discharge side prevent reverse flow and the dampers of the suction side are manually adjusted and controlled to maintain a negative pressure within the Rw/B controlled areas with respect to atmosphere. In addition manual balancing dampers are mounted on upstream side of the suction side pneumatic operated dampers in order to adjust the air flow rate during commissioning.
  - Discharge air flow sensor, rotation speed sensor and inlet/outlet differential pressure sensor are provided for each fan to detect fan failure.

- S/B HVAC Supply, Exhaust and Smoke Purge Fan
  The S/B Non-Controlled Area and Controlled Area HVAC are each provided with two 100-percent capacity centrifugal Supply and Exhaust Fans mounted in parallel. The main configuration aspects regarding the Supply and Exhaust Fan are described as follows.
  - One Supply Fan and Exhaust Fan operate during all normal operations.
  - The Supply and Exhaust Fan on standby are designed to automatically start-up upon failure signals of the operating Supply and Exhaust Fan.
  - Pneumatic operated dampers are mounted on the discharge side of the fans to prevent reverse flow and manual balancing dampers are mounted on the suction side of the fans in order to adjust air flow rate.
  - Pneumatic operated dampers are mounted on the discharge side of the Exhaust Fans. The dampers prevent reverse flow.
  - Pneumatic operated dampers are mounted on the suction side of the S/B Controlled Area Exhaust Fans. The dampers are manually adjusted and controlled to maintain a negative pressure within the S/B controlled areas with respect to atmosphere.
  - The manual balancing dampers are mounted on suction side in order to adjust the air flow rate during commissioning.
  - As for the S/B Controlled Area HVAC, discharge air flow sensor, rotation speed sensor and inlet/outlet differential pressure sensor are provided each fan to detect fan failure.
  - The Smoke Purge Fan removes cold smoke from the fire area after a fire is extinguished.

The Supply/Exhaust Fan and Smoke Purge Fan of HVAC are designed to perform as the following specifications shown in Table 16.5-3.

Table 16.5-3: HVAC Fan and Smoke Purge Fan Design Specifications (1/4)

Bldg.	Equipment Name	Quantity	Rated Airflow Rate (per unit)
R/B	R/A Supply Fan	3 (1 standby)	122500 m^3/h
	R/A Exhaust Fan	3 (1 standby)	122500 m^3/h
	PCV Purge Exhaust Fan	1	22000 m^3/h
	RBEEE (A)/Z Supply Fan	2 (1 standby)	33000 m^3/h
	RBEEE (B)/Z Supply Fan	2 (1 standby)	48000 m^3/h
	RBEEE (C)/Z Supply Fan	2 (1 standby)	40000 m^3/h
	RBEEE (A)/Z Exhaust Fan	2 (1 standby)	3000 m^3/h
	RBEEE (B)/Z Exhaust Fan	2 (1 standby)	4200 m^3/h
	RBEEE (C)/Z Exhaust Fan	2 (1 standby)	4200 m^3/h
	RBEEE (A)/Z Smoke Purge Fan	1	33000 m^3/h
	RBEEE (B)/Z Smoke Purge Fan	1	48000 m^3/h
	RBEEE (C)/Z Smoke Purge Fan	1	40000 m^3/h
EDG/B	DGEE (A)/Z Supply Fan	2 (1 standby)	44500 m^3/h
	DGEE (B)/Z Supply Fan	2 (1 standby)	44500 m^3/h
	DGEE (C)/Z Supply Fan	2 (1 standby)	44500 m^3/h
	DGEE (A)/Z Exhaust Fan	2 (1 standby)	14000 m^3/h
	DGEE (B)/Z Exhaust Fan	2 (1 standby)	14000 m^3/h
	DGEE (C)/Z Exhaust Fan	2 (1 standby)	14000 m^3/h
	EDG (A) Room Emergency Supply Fan	2	79500 m^3/h
	EDG (B) Room Emergency Supply Fan	2	79500 m^3/h

Table 16.5-3: HVAC Fan and Smoke Purge Fan Design Specifications (2/4) (Continued)

Bldg.	Equipment Name	Quantity	Rated Airflow Rate (per unit)
EDG/B	EDG (C) Room Emergency Supply Fan	2	79500 m^3/h
	DGEE (A)/Z Smoke Purge Fan	1	44500 m^3/h
	DGEE (B)/Z Smoke Purge Fan	1	44500 m^3/h
	DGEE (C)/Z Smoke Purge Fan	1	44500 m^3/h
T/B	T/B Supply Fan	3 (1 standby)	189500 m^3/h
	T/B Exhaust Fan	3 (1 standby)	189500 m^3/h
Hx/B	Hx/B-N Supply Fan	2 (1 standby)	180000 m^3/h
	Hx/B-E (A) Supply Fan	1	100000 m^3/h
	Hx/B-E (B) Supply Fan	1	100000 m^3/h
	Hx/B-E (C) Supply Fan	1	100000 m^3/h
C/B	CBEEE (A)/Z Supply Fan	2 (1 standby)	42500 m^3/h
	CBEEE (B)/Z Supply Fan	2 (1 standby)	34500 m^3/h
	CBEEE (C)/Z Supply Fan	2 (1 standby)	31000 m^3/h
	CBEEE (A)/Z Exhaust Fan	2 (1 standby)	8000 m^3/h
	CBEEE (B)/Z Exhaust Fan	2 (1 standby)	9000 m^3/h
	CBEEE (C)/Z Exhaust Fan	2 (1 standby)	5500 m^3/h
	CBEEE (A)/Z Smoke Purge Fan	1	42500 m^3/h
	CBEEE (B)/Z Smoke Purge Fan	1	34500 m^3/h
	CBEEE (C)/Z Smoke Purge Fan	1	31000 m^3/h

Table 16.5-3: HVAC Fan and Smoke Purge Fan Design Specifications (3/4) (Continued)

Bldg.	Equipment Name	Quantity	Rated Airflow Rate (per unit)
C/B	MCR (A) Supply Fan	1*	100000 m^3/h
	MCR (B) Supply Fan	1*	100000 m^3/h
	MCR (A) Exhaust Fan	1*	5000 m^3/h
	MCR (B) Exhaust Fan	1*	5000 m^3/h
	MCR (A) Recirculation Supply Fan	1*	8000 m^3/h
	MCR (B) Recirculation Supply Fan	1*	8000 m^3/h
	CBC2EE/Z Supply Fan	2 (1 standby)	5000 m^3/h
	CBC2EE/Z Exhaust Fan	2 (1 standby)	1000 m^3/h
	CBC2EE/Z Smoke Purge Fan	1	5000 m^3/h
Rw/B	Rw/B Supply Fan	2 (1 standby)	157000 m^3/h
	Rw/B Exhaust Fan	2 (1 standby)	157000 m^3/h
S/B	S/B controlled area Supply Fan	2 (1 standby)	58000 m^3/h
	S/B controlled area Exhaust Fan	2 (1 standby)	66000 m^3/h
	S/B non-controlled area Supply Fan	2 (1 standby)	39000 m^3/h
	S/B non-controlled area Exhaust Fan	2 (1 standby)	19000 m^3/h
B/B	BBEE (A)/Z Supply Fan	2 (1 standby)	40000 m^3/h
	BBEE (B)/Z Supply Fan	2 (1 standby)	40000 m^3/h
	BBEE (A)/Z Exhaust Fan	2 (1 standby)	2000 m^3/h
	BBEE (B)/Z Exhaust Fan	2 (1 standby)	2000 m^3/h
	BBG (A) Room Emergency Supply Fan	2	47500 m^3/h
	BBG (B) Room Emergency Supply Fan	2	47500 m^3/h

Table 16.5-3: HVAC Fan and Smoke Purge Fan Design Specifications (4/4) (Continued)

Bldg.	Equipment Name	Quantity	Rated Airflow Rate (per unit)
B/B	BBEE (A)/Z Smoke Purge Fan	1	40000 m^3/h
	BBEE (B)/Z Smoke Purge Fan	1	40000 m^3/h
	BBECR (A) Supply Fan	1*	52000 m^3/h
	BBECR (B) Supply Fan	1*	52000 m^3/h
	BBECR (A) Exhaust Fan	1*	4500 m^3/h
	BBECR (B) Exhaust Fan	1*	4500 m^3/h
	BBECR (A) Recirculation Supply Fan	1*	8000 m^3/h
	BBECR (B) Recirculation Supply Fan	1*	8000 m^3/h
FV/B	FV/B Supply Fan	2 (1 standby)	30000 m^3/h
	FV/B Exhaust Fan	2 (1 standby)	5000 m^3/h
	FV/B Smoke Purge Fan	1	30000 m^3/h

Notes: * MCR HVAC and BBECR HVAC have a redundancy and operate on either division (A) or (B).

(c) Supply Air Treatment Facility (SATF) and Exhaust Air Treatment Facility (EATF)

(i) Purpose

The SATF provides a sufficient filter efficiency and cooling/heating capacity to ensure the HVAC function in order for R/A HVAC SFC 4-7.1, R/A HVAC SFC 5-18.1, R/A HVAC SFC 5-18.3, RBEEE/Z HVAC SFC 5-18.1, RBEEE/Z HVAC SFC 5-18.2, RBEEE/Z HVAC SFC 5-18.3, DGEE/Z HVAC SFC 5-18.1, DGEE/Z HVAC SFC 5-18.2, DGEE/Z HVAC SFC 5-18.3, T/B HVAC SFC 4-7.1, T/B HVAC SFC 5-18.1, T/B HVAC SFC 5-18.3, Hx/B HVAC SFC 5-18.1, Hx/B HVAC SFC 5-18.2, Hx/B HVAC SFC 5-18.3, CBEEE/Z HVAC SFC 5-18.1, CBEEE/Z HVAC SFC 5-18.2, CBEEE/Z HVAC SFC 5-18.3, CBC2EE/Z HVAC SFC 5-18.1, CBC2EE/Z HVAC SFC 5-18.2, CBC2EE/Z HVAC SFC 5-18.3, MCR HVAC SFC 5-18.1, MCR HVAC SFC 5-18.2, MCR HVAC SFC 5-18.3, MCR HVAC SFC 5-18.5, Rw/B HVAC SFC 4-7.1, Rw/B HVAC SFC 5-18.1, Rw/B HVAC SFC 5-18.3, S/B HVAC SFC 4-7.1, S/B HVAC SFC 5-18.1, S/B HVAC SFC 5-18.3, BBEE/Z HVAC SFC 5-18.1, BBEE/Z HVAC SFC 5-18.2, BBEE/Z HVAC SFC 5-18.3, BBECR HVAC SFC 5-18.1, BBECR HVAC SFC 5-18.2, BBECR HVAC SFC 5-18.3, BBECR HVAC SFC 5-18.5, FV/B HVAC SFC 5-18.1, FV/B HVAC SFC 5-18.2 and FV/B HVAC SFC 5-18.3.

The EATF provides a sufficient filter efficiency to reduce the release of radiological substances to atmospheric environment in order for R/A HVAC SFC 4-7.1, T/B HVAC SFC 4-7.1, Rw/B HVAC SFC 4-7.1 and S/B HVAC SFC 4-7.1.

(ii) Configuration and Operation

- R/A, T/B, Hx/B-N, Rw/B, S/B Controlled Area HVAC SATF and EATF
  - The R/A, T/B, Hx/B-N, Rw/B and S/B Controlled Area HVAC are each provided with one 100-percent SATF. Each SATF consists of filters, cooling/heating coils, reinforced concrete housings and instrumentation. The SATF is installed upstream of the Supply Fan in order to remove general atmospheric dust and particle by filtration and control the required supply (fan discharge) air temperature by the cooling coils and heating coils.
  - The coalescer filter mounted on the uppermost side in the SATF to remove outside air moisture to reduce the potential for downstream corrosion. The filter efficiency is 85-percent and above.
  - The frost protection coil is plate-fin type mounted upstream side of the filter to prevent freezing of the filter. The heating medium for R/A, T/B, Rw/B and S/B Controlled Area HVAC is the heating steam drawn from the HS and HSCR and the electric heater is provided for the Hx/B-N HVAC.
  - The filter is a middle efficiency bag type mounted downstream side of the frost protection coil. The filter is provided to prevent the ingress of general atmospheric dust or particles into the buildings. The filter efficiency is 80-percent and above.
  - The main heating coil of R/A, T/B, Rw/B and S/B Controlled Area HVAC is a plate-fin type mounted downstream side of the filter. The heating medium is the heating steam is drawn from the HS and HSCR in winter.
  - The main heating coil of Hx/B-N HVAC is an electric heater mounted downstream side of the filter.
  - The cooling coil is a plate-fin type mounted downstream side of the main heating coil. The cooling medium is chilled water drawn from the HNCW.
  - The SATF is provided with appropriate quantity of the filter, coalesce filter, main heating coil and cooling coil in accordance with the system air flow rate and the required cooling/heating capacity.
  - The R/A, T/B, Rw/B and S/B Controlled Area HVAC EATFs are mounted in upstream side of each Exhaust Fans. The EATFs consist of the multiple safe change HEPA filter units and instrumentation. The EATF is capable of filtering and eliminating the contamination particles with the Decontamination Factor of 10000 (efficiency; 99.99-percent) and above. Single stage EATF is provided for the exhaust air from C2 areas and double stage EATF is provided for the exhaust air from C3 areas. The overall DF of single or double EATF is 1000 (efficiency; 99.9-percent) and above.

  The main configuration aspects regarding the EATF are described as follows.

- The R/A HVAC is provided with two 100-percent (primary and secondary) EATFs for the exhaust air from C2 and C3 areas. Each EATF consists of thirteen safe change HEPA filter units which includes one standby unit.
- The T/B HVAC is provided with two 100-percent (primary and secondary) EATFs for the exhaust air from C3 areas and the one 100-percent EATF for the exhaust air from the C2 areas. Each EATF for C3 areas consist of eleven safe change HEPA filter units which includes one standby unit and EATF for C2 areas consist of eight safe change HEPA filter units which also includes one standby unit.
- The Rw/B HVAC is provided with two 100-percent (primary and secondary) EATFs for the exhaust air from C2 and C3 areas. Each EATF consists of ten safe change HEPA filter units which includes one standby unit.
- The S/B Controlled Area HVAC is provided with two 100-percent (primary and secondary) EATFs for the exhaust air from C3 areas and the one 100-percent EATF for the exhaust air from the C2 areas. Each EATF for C3 areas consists of three safe change HEPA filter units which includes one standby unit and EATF for C2 areas consist of four safe change HEPA filter units which also includes one standby unit.

- PCV Purge Supply Filter Unit
  - The PCV Purge Supply Filter Unit is provided with one 100-percent supply filter unit. Supply Filter Unit consists of filter, filter housing and instrumentation.

- RBEEE/Z, DGEE/Z, CBEEE/Z, MCR, CBC2EE/Z, S/B Non-Controlled Area, BBEE/Z and BBECR, HVAC SATF
  - Each division of the RBEEE/Z, DGEE/Z, CBEEE/Z, MCR, CBC2EE/Z, S/B Non-Controlled Area, BBEE/Z and BBECR HVAC is provided with one 100-percent SATF. Each SATF consists of filters, cooling/heating coils, reinforced concrete housings and instrumentation. The SATF is installed upstream of the Supply Fan in order to remove general atmospheric dust and particles by the filters and control the required supply (fan discharge) air temperature by cooling coils or heating coils.
  - The filter is middle efficiency bag type mounted on the uppermost side in the SATF. The filter is provided to prevent the ingress of general atmospheric dust or particles into the buildings. The filter efficiency is 80-percent and above.
  - The cooling coil is a plate-fin type mounted downstream side of the filter. The cooling medium is chilled water drawn from the HECW, the HNCW or the HBCW.
  - Each division of the DGEE/Z and BBEE/Z HVAC SATF is provided with a heating coil. The heating coil is an electric type mounted between the filter and the cooling coil.
  - The SATF is provided with appropriate quantity of the filter and cooling/heating coils in accordance with the system air flow rate and the required cooling/heating capacity.

- EDG Room, Hx/B-E and BBG Room Emergency SATF
  - Each division of the EDG Room, Hx/B-E and BBG Room Emergency Supply Fans is provided with one 100-percent SATF. Each SATF consists of filters, reinforced concrete housings and instrumentation. The SATF is installed upstream of the Supply Fan in order to remove general atmospheric dust and particles by the filters.
  - The filter is a middle efficiency bag type mounted on the uppermost side in the SATF. The filter is provided to prevent the ingress of general atmospheric dust or particles into the buildings. The filter efficiency is 80-percent.

The Supply Air Treatment Facility and Exhaust Air Treatment Facility are designed to perform as the following specifications shown in Table 16.5-4 and Table 16.5-5.

Table 16.5-4: Supply Air Treatment Facility Design Specifications (1/3)

Bldg.	Equipment Name	Quantity	Airflow Rate (per unit)	Coils	
R/B	R/A Supply Air Treatment Facility	1	245000 m^3/h	Cooling coil	
				Cooling medium	HNCW
				Heating coil	
				Heating medium	HS
	PCV Purge Supply Filter Unit	1	22000 m^3/h	-	
	RBEEE (A)/Z Supply Air Treatment Facility	1	33000 m^3/h	Cooling coil	
				Cooling medium	HECW
	RBEEE (B)/Z Supply Air Treatment Facility	1	48000 m^3/h	Cooling coil	
				Cooling medium	HECW
	RBEEE (C)/Z Supply Air Treatment Facility	1	40000 m^3/h	Cooling coil	
				Cooling medium	HECW
EDG/B	DGEE (A)/Z Supply Air Treatment Facility	1	44500 m^3/h	Cooling coil	
				Cooling medium	HECW
				Heating coil	
				Heating medium	Electricity
	DGEE (B)/Z Supply Air Treatment Facility	1	44500 m^3/h	Cooling coil	
				Cooling medium	HECW
				Heating coil	
				Heating medium	Electricity
	DGEE (C)/Z Supply Air Treatment Facility	1	44500 m^3/h	Cooling coil	
				Cooling medium	HECW
				Heating coil	
				Heating medium	Electricity
	EDG (A) Room Emergency Supply Air Treatment Facility	1	79500 m^3/h	-	
	EDG (B) Room Emergency Supply Air Treatment Facility	1	79500 m^3/h	-	
	EDG (C) Room Emergency Supply Air Treatment Facility	1	79500 m^3/h	-	
T/B	T/B Supply Air Treatment Facility	1	379000 m^3/h	Cooling coil	
				Cooling medium	HNCW
				Heating coil	
				Heating medium	HS

Table 16.5-4: Supply Air Treatment Facility Design Specifications (2/3) (Continued)

Bldg.	Equipment Name	Quantity	Airflow Rate (per unit)	Coils	
Hx/B	Hx/B-N Supply Air Treatment Facility	1	180000 m^3/h	Cooling coil	
				Cooling medium	HNCW
				Heating coil	
				Heating medium	Electricity
	Hx/B-E (A) Supply Air Treatment Facility	1	100000 m^3/h	-	
	Hx/B-E (B) Supply Air Treatment Facility	1	100000 m^3/h	-	
	Hx/B-E (C) Supply Air Treatment Facility	1	100000 m^3/h	-	
Rw/B	Rw/B Supply Air Treatment Facility	1	157000 m^3/h	Cooling coil	
				Cooling medium	HNCW
				Heating coil	
				Heating medium	HS
C/B	CBEEE (A)/Z Supply Air Treatment Facility	1	42500 m^3/h	Cooling coil	
				Cooling medium	HECW
	CBEEE (B)/Z Supply Air Treatment Facility	1	34500 m^3/h	Cooling coil	
				Cooling medium	HECW
	CBEEE (C)/Z Supply Air Treatment Facility	1	31000 m^3/h	Cooling coil	
				Cooling medium	HECW
	MCR (A) Supply Air Treatment Facility	1*	100000 m^3/h	Cooling coil	
				Cooling medium	HECW
	MCR (B) Supply Air Treatment Facility	1*	100000 m^3/h	Cooling coil	
				Cooling medium	HECW
	CBC2EE/Z Supply Air Treatment Facility	1	5000 m^3/h	Cooling coil	
				Cooling medium	HBCW
S/B	S/B controlled area Supply Air Treatment Facility	1	58000 m^3/h	Cooling coil	
				Cooling medium	HNCW
				Heating coil	
				Heating medium	HS
	S/B non-controlled area Supply Air Treatment Facility	1	39000 m^3/h	Cooling coil	
				Cooling medium	HNCW
				Heating coil	
				Heating medium	HS

Table 16.5-4: Supply Air Treatment Facility Design Specifications (3/3) (Continued)

Bldg.	Equipment Name	Quantity	Airflow Rate (per unit)	Coils	
B/B	BBEE (A)/Z Supply Air Treatment Facility	1	40000 m^3/h	Cooling coil	
				Cooling medium	HBCW
				Heating coil	
				Heating medium	Electricity
	BBEE (B)/Z Supply Air Treatment Facility	1	40000 m^3/h	Cooling coil	
				Cooling medium	HBCW
				Heating coil	
				Heating medium	Electricity
	BBG (A) Room Emergency Supply Air Treatment Facility	1	47500 m^3/h	-	
	BBG (B) Room Emergency Supply Air Treatment Facility	1	47500 m^3/h	-	
	BBECR (A) Supply Air Treatment Facility	1*	52000 m^3/h	Cooling coil	
				Cooling medium	HBCW
	BBECR (B) Supply Air Treatment Facility	1*	52000 m^3/h	Cooling coil	
				Cooling medium	HBCW
FV/B	FV/B Supply Air Treatment Facility	1	30000 m^3/h	Cooling coil	
				Cooling medium	HBCW

Notes: * MCR HVAC and BBECR HVAC have a redundancy and operate on either division (A) or (B).

Table 16.5-5: Exhaust Air Treatment Facility Design Specifications

Bldg.	Equipment Name	Quantity	Airflow Rate (per unit)	Coils
R/B	R/A Exhaust Air Treatment Facility	1 (Set)	245000 m^3/h (per total unit)	Safe Change HEPA Filter Unit (2 banks)
T/B	T/B Exhaust Air Treatment Facility for high contaminated area	1 (Set)	279500 m^3/h (per total unit)	Safe Change HEPA Filter Unit (2 banks)
	T/B Exhaust Air Treatment Facility for low contaminated area	1 (Set)	99500 m^3/h (per total unit)	Safe Change HEPA Filter Unit (1 bank)
Rw/B	Rw/B Exhaust Air Treatment Facility	1 (Set)	157000 m^3/h (per total unit)	Safe Change HEPA Filter Unit (2 banks)
S/B	S/B Exhaust Air Treatment Facility for high contaminated area	1 (Set)	12800 m^3/h (per total unit)	Safe Change HEPA Filter Unit (2 banks)
	S/B Exhaust Air Treatment Facility for low contaminated area	1 (Set)	53200 m^3/h (per total unit)	Safe Change HEPA Filter Unit (1 bank)

(d) Local Cooling Unit (LCU)

(i) Purpose

The LCU provides a sufficient air flow rate and a sufficient cooling capacity to remove heat load from related SSCs in order to R/A HVAC SFC 5-18.1, R/A HVAC SFC 5-18.2, DGEE/Z HVAC SFC 5-18.2, T/B HVAC SFC 5-18.1, Hx/B HVAC SFC 5-18.2, S/B HVAC SFC 5-18.1 and BBEE/Z HVAC SFC 5-18.2.

(ii) Configuration and Operation

The main configuration aspects regarding the LCU are described as follows.

- Normal and Emergency LCUs of the R/A HVAC
  - The Normal LCUs are provided with one 100-percent centrifugal fan and cooling coil chamber per unit.
  - The Normal LCU is provided with two 100-percent centrifugal fans and one 100-percent cooling coil chamber per unit.
  - The Emergency LCUs are provided with one 100-percent centrifugal fan and cooling coil chamber.
  - The Normal and Emergency LCUs are running to provide sufficient air flow rate and cooling capacity to remove heat from the emergency SSCs.
  - The Normal LCUs are actuated using manual start-up from the MCR during the plant normal operations.
  - The Emergency LCUs are actuated automatically upon start-up signal (initiation signal of the ECCS pumps etc.) in the event of faults.

- EDG Room LCU of the DGEE/Z HVAC
  - The EDG Room LCUs are provided with two 50-percent centrifugal fans and cooling coil chambers.
  - The EDG Room LCUs are running to provide sufficient air flow rate and cooling capacity to remove heat from the EDG components.
  - The LCUs are actuated automatically upon start-up signal of EDGs in the event of faults.

- Normal LCU of the T/B HVAC
  - The Normal LCUs are provided with two 100-percent centrifugal fans and one 100-percent cooling coil chamber per unit.
  - The Normal LCUs are running to provide sufficient air flow rate and cooling capacity to remove heat from the related SSCs.
  - The Normal LCUs are actuated using manual start-up from the MCR during the plant normal operations.

- Hx/B Emergency LCU of the Hx/B HVAC
  - The Hx/B-E LCUs are provided with one 100-percent centrifugal fans and cooling coil chambers.
  - The Hx/B-E LCUs are running to provide sufficient air flow rate and cooling capacity to remove heat from the RCW and RSW components.
  - The Hx/B-E LCUs are actuated automatically upon start-up signal of RCW pumps in the event of faults.

- Normal LCU of the CBEEE/Z HVAC
  - The Normal LCUs are provided with two 100-percent centrifugal fans and one 100-percent cooling coil chamber.
  - The Normal LCUs are running to provide sufficient air flow rate and cooling capacity to remove heat from the related SSCs.
  - The Normal LCUs are actuated using manual start-up from the MCR during the plant normal operations.

- BBG Room LCU of the BBEE/Z HVAC
  - The BBG Room LCUs are provided with two 50-percent centrifugal fans and cooling coil chambers.
  - The BBG Room LCUs are running to provide sufficient air flow rate and cooling capacity to remove heat from the BBG components.
  - The LCUs are actuated automatically upon start-up signal of BBGs in the event of faults.

- Normal LCU of the S/B HVAC
  - The Normal LCU is provided with two 100-percent centrifugal fans and one 100-percent cooling coil chamber.
  - The Normal LCU is running to provide sufficient air flow rate and cooling capacity to remove heat from the related SSCs.
  - The Normal LCU is actuated using manual start-up from the S/B local control panel during the plant normal operations.

Table 16.5-6 shows the design specifications of the Local Cooling Unit.

Table 16.5-6: Local Cooling Unit Design Specifications (1/3)

Bldg.	Equipment Name	Unit Quantity	Fan Quantity	Airflow Rate (per unit)	Cooling Medium
R/B	RHR Pump (A) Room Local Cooling Unit	1	1	10000 m^3/h	RCW
	RHR Pump (B) Room Local Cooling Unit	1	1	10000 m^3/h	RCW
	RHR Pump (C) Room Local Cooling Unit	1	1	10000 m^3/h	RCW
	HPCF Pump (B) Room Local Cooling Unit	1	1	15100 m^3/h	RCW
	HPCF Pump (C) Room Local Cooling Unit	1	1	15100 m^3/h	RCW
	RCIC Pump Room Local Cooling Unit	1	1	2300 m^3/h	RCW
	FPC Pump (A) Room Local Cooling Unit	1	1	1300 m^3/h	RCW
	FPC Pump (B) Room Local Cooling Unit	1	1	1300 m^3/h	RCW

Table 16.5-6: Local Cooling Unit Design Specifications (2/3) (Continued)

Bldg.	Equipment Name	Unit Quantity	Fan Quantity	Airflow Rate (per unit)	Cooling Medium
R/B	SGTS (A) Room Local Cooling Unit	1	1	600 m^3/h	RCW
	SGTS (B) Room Local Cooling Unit	1	1	600 m^3/h	RCW
	R/B MS Tunnel Room Local Cooling Unit	1	2 (1 standby)	7500 m^3/h	HNCW
	Refuelling Machine Control Room Local Cooling Unit	1	1	5400 m^3/h	HNCW
	ISI Room Local Cooling Unit	1	1	3700 m^3/h	HNCW
	RIP FMCRD Handling Tool Control Room Local Cooling Unit	1	1	2220 m^3/h	HNCW
EDG/B	EDG (A) Room Local Cooling Unit	2	2	25100 m^3/h	HECW
	EDG (B) Room Local Cooling Unit	2	2	25100 m^3/h	HECW
	EDG (C) Room Local Cooling Unit	2	2	25100 m^3/h	HECW
T/B	MSR (A) Room Local Cooling Unit	1	2 (1 standby)	18200 m^3/h	HNCW
	MSR (B) Room Local Cooling Unit	1	2 (1 standby)	18200 m^3/h	HNCW
	T/D-RFP Room Local Cooling Unit	1	2 (1 standby)	14400 m^3/h	HNCW
	IPB/Z Local Cooling Unit	1	2 (1 standby)	37300 m^3/h	HNCW

Table 16.5-6: Local Cooling Unit Design Specifications (3/3) (Continued)

Bldg.	Equipment Name	Unit Quantity	Fan Quantity	Airflow Rate (per unit)	Cooling Medium
T/B	T/B Supply Fan Room Local Cooling Unit	1	2 (1 standby)	13500 m^3/h	HNCW
	R/A, T/B Exhaust Fan Room Local Cooling Unit	1	2 (1 standby)	18300 m^3/h	HNCW
	R/A Supply Fan Room Local Cooling Unit	1	2 (1 standby)	13500 m^3/h	HNCW
Hx/B	Hx/B-E (A) Local Cooling Unit	1	1	39000 m^3/h	HECW
	Hx/B-E (B) Local Cooling Unit	1	1	38000 m^3/h	HECW
	Hx/B-E (C) Local Cooling Unit	1	1	40000 m^3/h	HECW
C/B	MG Set A Room Local Cooling Unit	1	2 (1 standby)	9200 m^3/h	HNCW
	MG Set B Room Local Cooling Unit	1	2 (1 standby)	9200 m^3/h	HNCW
B/B	BBG (A) Room Local Cooling Units	2	2	15100 m^3/h	HBCW
	BBG (B) Room Local Cooling Units	2	2	15100 m^3/h	HBCW
S/B	S/B Electrical Equipment Room Local Cooling Unit	1	2 (1 standby)	8200 m^3/h	HNCW

(e) MCR and BBECR HVAC Emergency Filter Train

(i) Purpose

The Emergency Filter Train provides a sufficient filter efficiency to eliminate the radiological contaminants and hazardous substances within the MCR and the BBECR in order to MCR HVAC SFC 5-18.2, MCR HVAC SFC 5-18.5, BBECR HVAC SFC 5-18.2 and BBECR HVAC SFC 5-18.5.

(ii) Configuration and Operation

Each division of the MCR and BBECR HVAC are provided with one 100-percent Emergency Filter Train. Each Emergency Filter Train consists of filter, filter housing and instrumentation. The four filters installed within Emergency Filter Train are arranged on the upstream side as follows: a pre-filter, a primary HEPA filter, charcoal adsorber, and the secondary HEPA filter. The filter housing are welded structures for preventing leaks. The main configuration aspects of the Emergency Filter Train are described as follows.

- Pre-filter
  The pre-filter is a middle efficiency unit type. The pre-filter is provided to prevent efficiency drop of the HEPA filter due to a clogging. The filter efficiency is 80-percent and above.
- HEPA filter
  The HEPA filter is located on the upstream side of the charcoal adsorber and prevents degradation of the charcoal adsorber performance by adhesion of radioactive particles in the event of faults.
- The HEPA filter is located on the downstream side of the charcoal adsorber and captures charcoal particles that adsorb radioactive iodine.
- Efficiency of the HEPA filter in laboratory performance test is 99.97-percent and above and the efficiency in-situ performance test is 99.9-percent and above.
- Charcoal adsorber
  The charcoal adsorber removes radioactive iodine with an efficiency of 91-percent and above for inorganic and organic iodine with a relative humidity below 70-percent. Bed depth of adsorber is 5 cm (2 inches).

Table 16.5-7 and Table 16.5-8 shows the design specifications of the MCR and BBECR Emergency Filter Train.

Table 16.5-7: MCR HVAC Emergency Filter Train Design Specifications

Bldg.	Equipment Name	Quantity	Airflow Rate (per unit)	Charcoal Filter	
C/B	MCR (A) HVAC Emergency Filter Train	1*	8000 m^3/h	Type	Bag type filter
				Efficiency	80 % and above
				Type	HEPA filter
				Efficiency	99.97% by Factory test (ASME AG-1 (2009))
					99.9% by In-situ performance test
				Type	Iodine removal charcoal adsorber (Bed depth of 50 mm)
				Efficiency	91 % by Factory test *Relative humidity at less than or equal 70 %
					90 % by In-situ performance test *Relative humidity at less than or equal 70 %
	MCR (B) HVAC Emergency Filter Train	1*	8000 m^3/h	Type	Bag type filter
				Efficiency	80 % and above
				Type	HEPA filter
				Efficiency	99.97% by Factory test (ASME AG-1 (2009))
					99.9% by In-situ performance test
				Type	Iodine removal charcoal adsorber (Bed depth of 50 mm)
				Efficiency	91 % by Factory test *Relative humidity at less than or equal 70 %
					90 % by In-situ performance test *Relative humidity at less than or equal 70 %

Notes: * MCR HVAC has a redundancy and operates on either division (A) or (B).

Table 16.5-8: BBECR HVAC Emergency Filter Train Design Specifications

Bldg.	Equipment Name	Quantity	Airflow Rate (per unit)	Charcoal Filter	
B/B	BBECR (A) HVAC Emergency Filter Train	1*	8000 m^3/h	Type	Bag type filter
				Efficiency	80 % and above
				Type	HEPA filter
				Efficiency	99.97% by Factory test (ASME AG-1 (2009))
					99.9% by In-situ performance test
				Type	Iodine removal charcoal adsorber (Bed depth of 50 mm)
				Efficiency	91 % by Factory test *Relative humidity at less than or equal 70 %
					90 % by In-situ performance test *Relative humidity at less than or equal 70 %
	BBECR (B) HVAC Emergency Filter Train	1*	8000 m^3/h	Type	Bag type filter
				Efficiency	80 % and above
				Type	HEPA filter
				Efficiency	99.97% by Factory test (ASME AG-1 (2009))
					99.9% by In-situ performance test
				Type	Iodine removal charcoal adsorber (Bed depth of 50 mm)
				Efficiency	91 % by Factory test *Relative humidity at less than or equal 70 %
					90 % by In-situ performance test *Relative humidity at less than or equal 70 %

Notes: * BBECR HVAC has a redundancy and operates on either division (A) or (B).

(f) R/A Isolation Damper

(i) Purpose

- R/A Isolation Damper
  The R/A Isolation Dampers automatically isolate the R/A to confine the radioactive material within the R/A boundary and prevent its dispersion to atmosphere in order to R/A HVAC SFC 4-7.2.

(ii) Configuration and Operation

- R/A Isolation Damper
  The two R/A Isolation Dampers are installed in series on the main supply and exhaust duct of the R/A HVAC. The Isolation Dampers are pneumatic operated butterfly dampers that are remotely actuated by the emergency isolation signal in order to close the main supply and exhaust duct and thus form a barrier.

(iii) Performance

- R/A Isolation Damper
  The R/A Isolation Dampers are designed to quickly and automatically close within 5 seconds or less under fault conditions by pneumatic actuation when air in the piston compartment is vented, by the support springs.

(3) **Main Support System**

The main support systems supporting mechanical SSCs for the delivery of the HVAC Emergency, Normal/Emergency and Normal functions are described as follows.

(a) Control and Instrumentation (C&I) Systems

The main instrumentation and control provisions related to the HVAC operation from a performance and reliability point of view are summarised as follows. The design of the Instrumentation and Control is addressed in Chapter 14: Control and Instrumentation.

(i) R/A HVAC

- Instrumentation
  The following status is measured and/or indicated in the MCR or locally:
  - Supply air temperature,
  - Filter differential pressure,
  - Differential pressure between the R/A and atmosphere,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of this system is carried out from the MCR.
  - The system operation is carried out by activating the system operation switch. It should be noted that two Exhaust Fans simultaneously start up. Two Supply Fans start up after a certain interval in order to maintain a negative pressure within the R/A.
  - The R/A Differential Pressure Control Dampers located at the inlet of the Exhaust Fans are automatically controlled in order to maintain a negative pressure within the R/A with respect to atmosphere.
  - The Emergency LCUs automatically start up upon receiving activation signals from the ECCS pumps and other emergency SSCs.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.
  - Upon receipt of any of the following emergency isolation signals, the Supply and Exhaust Fans stop automatically in order to ensure the SGTS function. It should be noted that the closing signal of the Isolation Dampers issued from the R/A also make them stop automatically to protect the HVAC.
    - High radioactivity of the HVAC exhaust gas in the R/A
    - High radioactivity in the fuel handling area
    - Drywell high pressure
    - Reactor water low level

(ii) RBEEE/Z HVAC

- Instrumentation
  The following status is measured and/or indicated in the MCR or locally:
  - Supply air temperature,
  - Filter differential pressure,

- Fan airflow rate,
- Fan rotation speed, and
- Fan inlet/outlet differential pressure.

- Control
  - Operation of each HVAC (divisions A, B and C) is carried out from the MCR.
  - The Exhaust Fan is activated automatically when the Supply Fan is manually activated in order to maintain a positive pressure within each divisional area.
  - When the Supply or Exhaust Fan trips, the standby fan provided for each of them starts up automatically.
  - The supply temperature of each HVAC is controlled to be at a constant temperature.
  - In the event of LOOP, Supply and Exhaust Fan will stop, and after emergency power is activated by the EDG, the Supply and Exhaust Fan are restarted.

(iii) DGEE/Z HVAC

- Instrumentation

  The following status is measured and/or indicates in the MCR or locally:
  - Supply air temperature,
  - Filter differential pressure,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of each HVAC (divisions A, B and C) is carried out from the MCR.
  - The Exhaust Fan is activated automatically when the Supply Fan is manually activated in order to maintain a positive pressure within each divisional area.
  - When the Supply or Exhaust Fan trips, the standby fan provided for each of them starts up automatically.
  - The supply temperature of each HVAC is controlled to be at a constant temperature.
  - In the event of LOOP, Supply and Exhaust Fan stop, and after emergency power is activated by the EDG, the Supply and Exhaust Fan are restarted.
  - The EDG Room LCUs and Emergency Supply Fans (divisions A, B and C) automatically start up upon receiving the activation signal from the EDGs.

(iv) T/B HVAC

- Instrumentation

  The following status is measured and/or indicated in the MCR or locally:
  - Supply air temperature,
  - Filter differential pressure,
  - Differential pressure between the T/B and atmosphere,
  - Fan airflow rate,
  - Fan rotation speed, and

  - Fan inlet/outlet differential pressure.
- Control
  - Operation of this system is carried out from the MCR.
  - The system operation is carried out by activating the system operation switch. It should be noted that two Exhaust Fans simultaneously start up. Two Supply Fans start up after a certain interval in order to maintain a negative pressure within the T/B.
  - The T/B Differential Pressure Control Dampers located at the inlet of the Exhaust Fans are manually controlled in order to maintain a negative pressure within the T/B with respect to atmosphere.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.

(v) Hx/B (Hx/B-N and Hx/B-E) HVAC

- Instrumentation
  The following status is measured and indication is given to the MCR or locally:
  - Supply air temperature (only for Hx/B-N HVAC)
  - Filter differential pressure (only for Hx/B-N HVAC)
- Control
  - Operation of this system is carried out from the MCR.
  - Operation of the Hx/B-N HVAC is carried out by manually operating the Supply Fan.
  - When the Supply Fan of Hx/B-N HVAC trip, the standby fan starts up automatically.
  - The Hx/B Emergency LCUs and Emergency Supply Fans (divisions A, B and C) automatically start up when receiving activation signals from the RCW pumps.

(vi) CBEEE/Z HVAC

- Instrumentation
  The following status is measured and/or indicated in the MCR or locally:
  - Supply air temperature,
  - Filter differential pressure,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of each HVAC (divisions A, B and C) is carried out from the MCR.
  - The Exhaust Fan is activated automatically when the Supply Fan is manually activated in order to maintain a positive pressure within each divisional area.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.
  - The supply temperature of each HVAC is controlled to be at a constant temperature.
  - In the event of LOOP, Supply and Exhaust Fan stop, and after emergency power is activated by the EDG, the Supply and Exhaust Fan are restarted.

(vii) MCR HVAC

- Instrumentation
  The following status is measured and/or indicated in the MCR or locally:
  - MCR indoor temperature,
  - MCR indoor humidity,
  - Filter differential pressure,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of this system is carried out from the MCR.
  - Switching to the standby unit for the system divisions A and B is done manually after shutting down the system division that is in operation.
  - The Exhaust Fan is activated automatically when the Supply Fan is manually activated in order to maintain a positive pressure within each divisional area.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.
  - Temperature control of supply air is provided on detecting the temperature within the MCR.
  - The Humidifier detects and controls relative humidity within the MCR.
  - The emergency operation mode is automatically initiated upon receipt of any the following emergency isolation signals:
    - High radioactivity of the exhaust gas in the R/A
    - High radioactivity in the fuel handling area
  - In the event of LOOP, Supply and Exhaust Fan stop, and after emergency power is activated by the EDG, the Supply and Exhaust Fan are restarted.

(viii) CBC2EE/Z HVAC

- Instrumentation
  The following status is measured and/or indicated in the BBECR:
  - Supply air temperature,
  - Filter differential pressure,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of this system is carried out in the BBECR.
  - The Exhaust Fan is activated automatically when the Supply Fan is manually activated in order to maintain a positive pressure within each divisional area.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.
  - The supply temperature of each HVAC is controlled to be at a constant temperature.
  - In the event of LOOP, Supply and Exhaust Fan stop, and after emergency power is activated by the BBG, the Supply and Exhaust Fan are restarted.

(ix) Rw/B HVAC

- Instrumentation
  The following status is measured and/or indicated to the Rw/B Control Room (RWCR) or locally:
  - Supply air temperature,
  - Filter differential pressure,
  - Differential pressure between the Rw/B and atmosphere,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of this system is carried out from the RWCR.
  - The system operation is carried out by activating the system operation switch. It should be noted that the Exhaust Fan simultaneously start up. The Supply Fan starts up after a certain interval in order to maintain a negative pressure within the Rw/B.
  - The Rw/B Differential Pressure Control Dampers located at the outlet of the Exhaust Fans are manually controlled in order to maintain a negative pressure within the Rw/B with respect to atmosphere.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.

(x) S/B HVAC

- Instrumentation
  The following status is measured and/or indicated locally:
  - Supply air temperature,
  - Filter differential pressure,
  - Differential pressure between the S/B and atmosphere,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of this system is carried out from the HVAC control panel installed within the S/B.
  - The system operation is carried out by activating the system operation switch. It should be noted that the Exhaust Fan simultaneously start up. The Supply Fan starts up after a certain interval in order to maintain a negative pressure within the S/B.
  - The S/B Differential Pressure Control Dampers located at the outlet of the Exhaust Fans are manually controlled in order to maintain a negative pressure within the S/B with respect to atmosphere.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.
  - The Humidifier detects and controls relative humidity within the S/B.
  - Operation of the FCUs and Multi-Split ACUs are carried out from the local control panel.

(xi) BBEE/Z HVAC

- Instrumentation
  The following status is measured and/or indication is given in the BBECR:
  - Supply air temperature,
  - Filter differential pressure,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of each HVAC (divisions A and B) is carried out from the BBECR.
  - The Exhaust Fan is activated automatically when the Supply Fan is manually activated in order to maintain a positive pressure within each divisional area.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.
  - The supply temperature of each HVAC is controlled to be at a constant temperature.
  - In the event of LOOP, Supply and Exhaust Fan stop, and after emergency power is activated by the BBG, the Supply and Exhaust Fan are restarted.
  - The BBG Room LCUs and Emergency Supply Fans (divisions A and B) automatically start up upon receiving activation signals from the BBG.

(xii) BBECR HVAC

- Instrumentation
  The following status is measured and/or indication is given to the BBECR or locally:
  - BBECR indoor temperature,
  - BBECR indoor humidity,
  - Filter differential pressure,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of this system is carried out from the BBECR.
  - Switching to the standby unit for the system divisions A and B is done manually after shutting down the system division that is in operation.
  - The Exhaust Fan is activated automatically when the Supply Fan is manually activated in order to maintain a positive pressure within each divisional area.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.
  - Temperature control of supply air is given upon detecting the temperature within the BBECR.
  - The Humidifier detects and controls relative humidity within the BBECR.

- The emergency operation mode is automatically initiated upon receipt of any emergency isolation signals.
- In the event of LOOP, Supply and Exhaust Fan stop, and after emergency power is activated by the BBG, the Supply and Exhaust Fan are restarted.

(xiii) FV/B HVAC

- Instrumentation
  The following status is measured and/or indication is given to the BBECR:
  - Supply air temperature,
  - Filter differential pressure,
  - Fan airflow rate,
  - Fan rotation speed, and
  - Fan inlet/outlet differential pressure.
- Control
  - Operation of this system is carried out from the BBECR.
  - The Exhaust Fan is activated automatically when the Supply Fan is manually activated in order to maintain a positive pressure within each divisional area.
  - When the Supply or Exhaust Fan trip, the standby fan provided for each of them starts up automatically.
  - The supply temperature of each HVAC is controlled to be at a constant temperature.
  - In the event of LOOP, Supply and Exhaust Fan stop, and after emergency power is activated by the BBG, the Supply and Exhaust Fan are restarted.

(b) Power Supply Systems

The summary of the main power supply systems are shown below. For further details on the design refer to Chapter 15: Electrical Power Supplies.

(i) The Normal HVAC
The Normal HVACs components are not required to be connected to the emergency power from a nuclear safety perspective.

(ii) The Normal/Emergency and Emergency HVAC

- The normal AC power supply to the Normal/Emergency and Emergency HVACs electrical components are provided by an independent and reliable offsite source (external grid). In addition, the HVACs components, instruments and controllers are provided with emergency AC power supply and DC power supply.
- The Normal/Emergency and Emergency HVACs are supplied power by emergency bus from the divisions A, B and C, which are backed up by EDG or BBG for those divisions in the event of LOOP.

(c) HVAC Normal Cooling Water System (HNCW)

The HNCW consists of three sub-systems.
The HNCW provides chilled water to the cooling coils within the Normal HVAC SATFs and Normal LCUs. The chilled water is supplied from each HVAC as follows:

(i) HNCW
- R/A HVAC,
- T/B HVAC,
- Hx/B-N HVAC, and
- Normal LCUs of the CBEEE/Z HVAC.

(ii) Rw/B HNCW
- Rw/B HVAC

(iii) S/B HNCW
- S/B HVAC

For further details refer to Chapter 16: Auxiliary Systems, Section 16.3.

(d) HVAC Emergency Cooling Water System (HECW)

The HECW provides chilled water to the cooling coils within the Normal/Emergency SATFs and Emergency LCUs. They consist of three divisions (divisions A, B and C). The chilled water is supplied from each HVAC division as follows:

(i) Chilled water for HVAC supplied by HECW(A), (B) and (C)
- RBEEE (A), (B), (C) /Z HVAC,
- DGEE (A), (B), (C) /Z HVAC,
- EDG Room (A), (B), (C) LCUs,
- CBEEE (A), (B), (C) /Z HVAC, and
- Hx/B (A), (B), (C) Emergency LCUs.

(ii) Chilled water for HVAC supplied by HECW(A) and (B)
- MCR (A), (B) HVAC

For further details refer to Chapter 16: Auxiliary Systems, Section 16.3.

(e) HVAC Backup Building Cooling Water System (HBCW)

The HBCW provides chilled water to the cooling coils within the Normal/Emergency SATFs and Emergency LCUs. They consist of two divisions (divisions A and B). The chilled water is supplied from each HVAC division as follows.

Chilled water for HVAC supplied by HBCW
- CBC2EE/Z HVAC,
- BBEE (A), (B) /Z HVAC,
- BBG Room (A), (B) LCUs, and

- FV/B HVAC.

For further details refer to Chapter 16: Auxiliary Systems, Section 16.3.

(f) Heating Steam System and Heating Steam Condensate Return System (HS and HSCR)

The HS (and HSCR) provides steam to the steam coils within the normal Supply Air Treatment Facilities as follows:

(i) R/A HVAC,
(ii) T/B HVAC,
(iii) Rw/B HVAC, and
(iv) S/B HVAC.

For further details refer to Chapter 16: Auxiliary Systems, Section 16.4.5.

(g) Reactor Building Cooling Water System (RCW)

The RCW provides cooling water to the Emergency LCUs of the R/A HVAC.

For further details refer to Chapter 16: Auxiliary Systems, Section 16.3.

Assumptions, Limits and Conditions for Operations

In order to ensure that the HVAC is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs and surveillance requiremnents to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is ultimately reflected in the generic technical specifications [Ref-16.5-31].

(1) R/A HVAC

- All number of R/A Supply and Exhaust Air Isolation Dampers are operable.
- All number of Local Cooling Units are operable.

(2) Reactor Building Emergency Electrical Equipment Zone (RBEEE/Z) HVAC

- Required RBEEE/Z HVAC divisions are operable.

(3) Emergency D/G Electrical Equipment Zone (DGEE/Z) HVAC

- Required DGEE/Z HVAC divisions are operable.
- All number of LCUs are operable.

(4) Hx/B-Emergency (E) HVAC

- All number of LCUs are operable.
- All number of Supply Fans are operable.

(5) Control Building Emergency Electrical Equipment Zone (CBEEE/Z) HVAC

- Required CBEEE/Z HVAC divisions are operable.

(6) Main Control Room (MCR) HVAC
- Required MCR HVAC divisions are operable.

(7) Control Building Class 2 Electrical Equipment Zone (CBC2EE/Z) HVAC
- Required CBC2EE/Z HVAC divisions are operable.

(8) B/B Electrical Equipment Zone (BBEE/Z) HVAC
- Required BBEE/Z HVAC divisions are operable.
- All number of LCUs are operable.

(9) Backup Building Emergency Control Room (BBECR) HVAC
- Required BBECR HVAC divisions are operable.

(10) Filter Vent Building (FV/B) HVAC
- Required FV/B HVAC divisions are operable.

Decomissioning

The specification of the HVAC system will ensure a design life that is appropriate for decommissioning, taking into consideration the phase in which it is required to be operable, all risks to personnel safety and the environment throughout plant life, and impact to the building and systems layout and size. The design life of the HVAC system is appropriate for decommissioning.

The HVAC system will be available during decommissioning and will be used to control temperature and humidity working conditions during decommissioning operations [Ref-16.5-32], and is put in place or modified to ensure leaks are detected early and gaseous releases are filtered [Ref-16.5-33].

The HVAC system may require replacement during generation or prior to decommissioning to ensure functional needs of decommissioning are met. This was undertaken at ISAR-1 and may also be adopted for the UK ABWR, although suitability of the HVAC system throughout its design life will be decided by the future licensee [Ref-16.5-32].

The installation of local containment and filtration systems will be required at the work place which will be connected to the existing building HVAC system where practicable. To manage the gaseous discharge, local containment and ventilation will be installed and connected to the HVAC system where practicable [Ref-16.5-34].

Waste arising immediately after EoG is HVAC HEPA filters. Further information on radioactive waste can be found in the Topic Report on Decommissioning Waste Management [Ref-16.5-34].

Information on removal of the HVAC system can be found in the Chapter 31: Decommissioning.

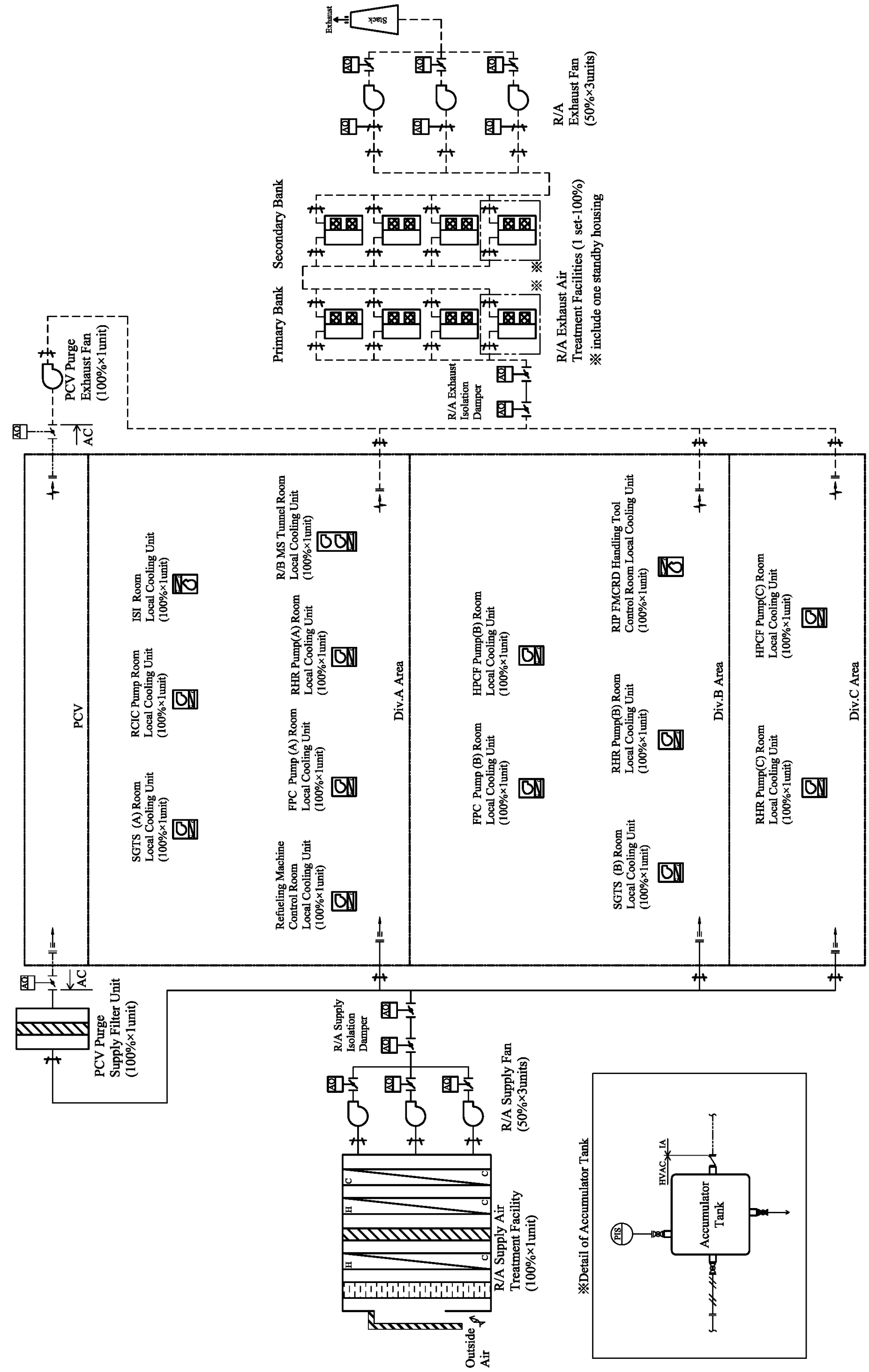


Figure 16.5-1:Outline of the R/A HVAC

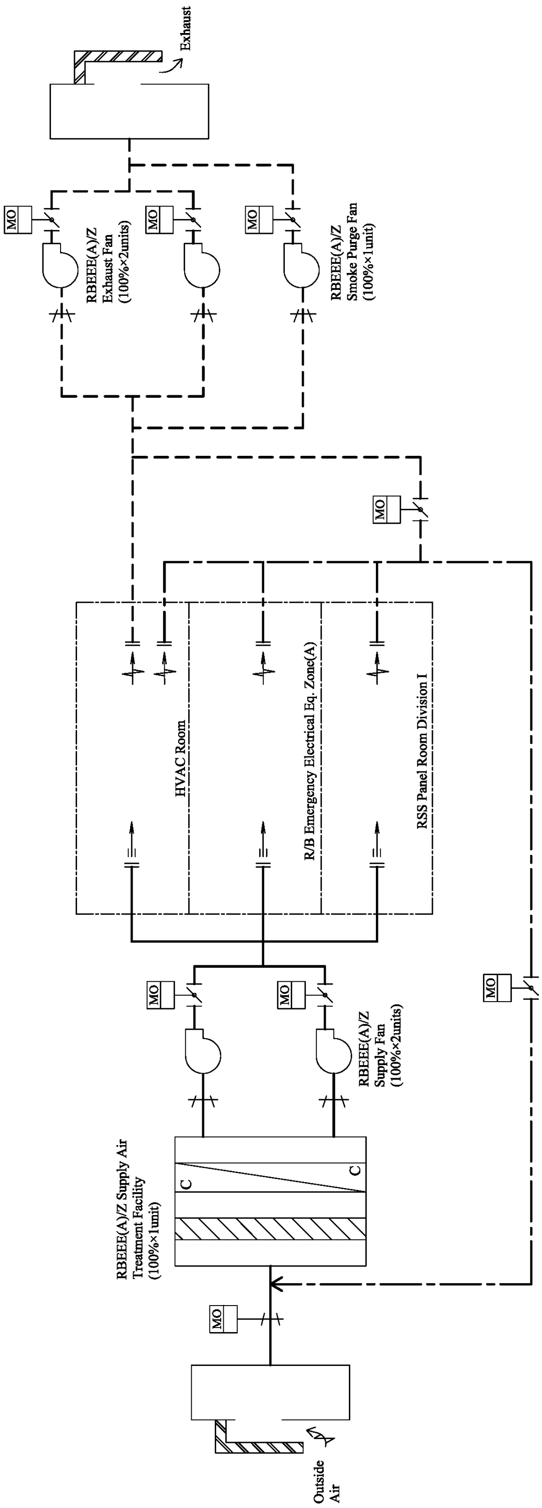


Figure 16.5-2:Outline of the RBEEE (A)/Z HVAC

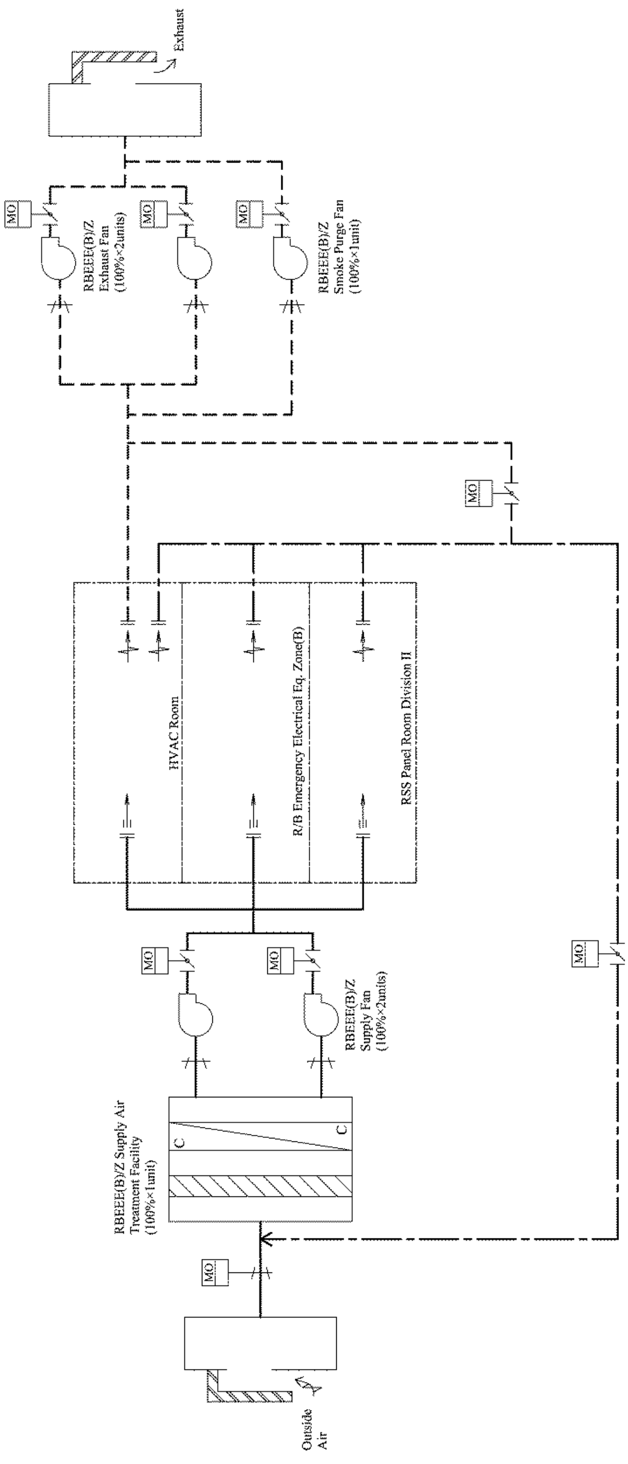


Figure 16.5-3:Outline of the RBEEE (B)/Z HVAC

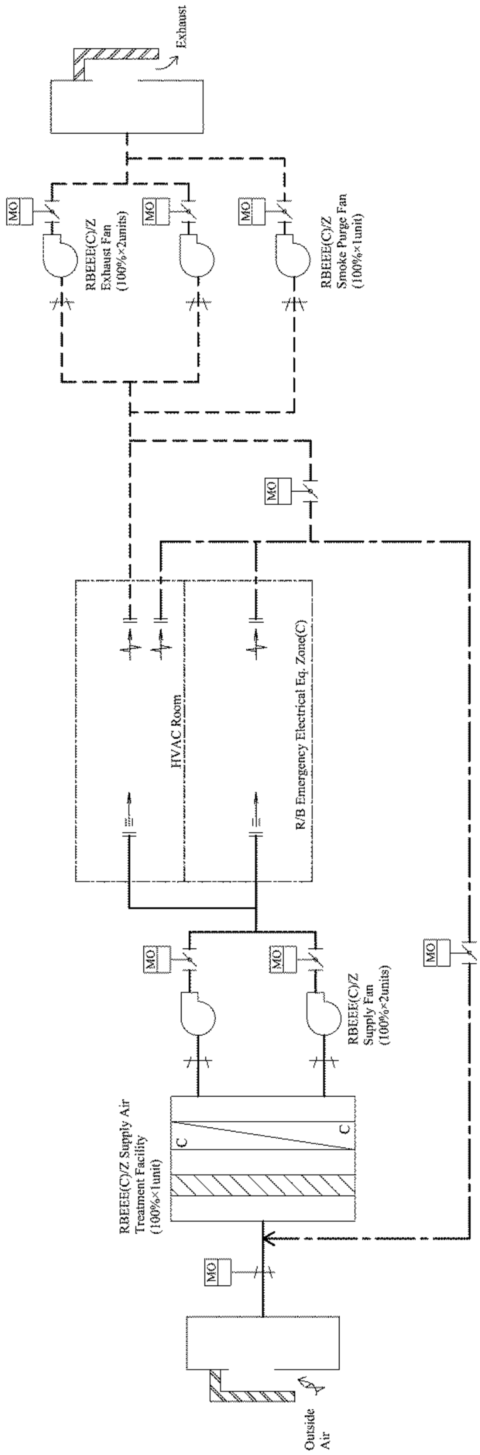


Figure 16.5-4:Outline of the RBEEE (C)/Z HVAC

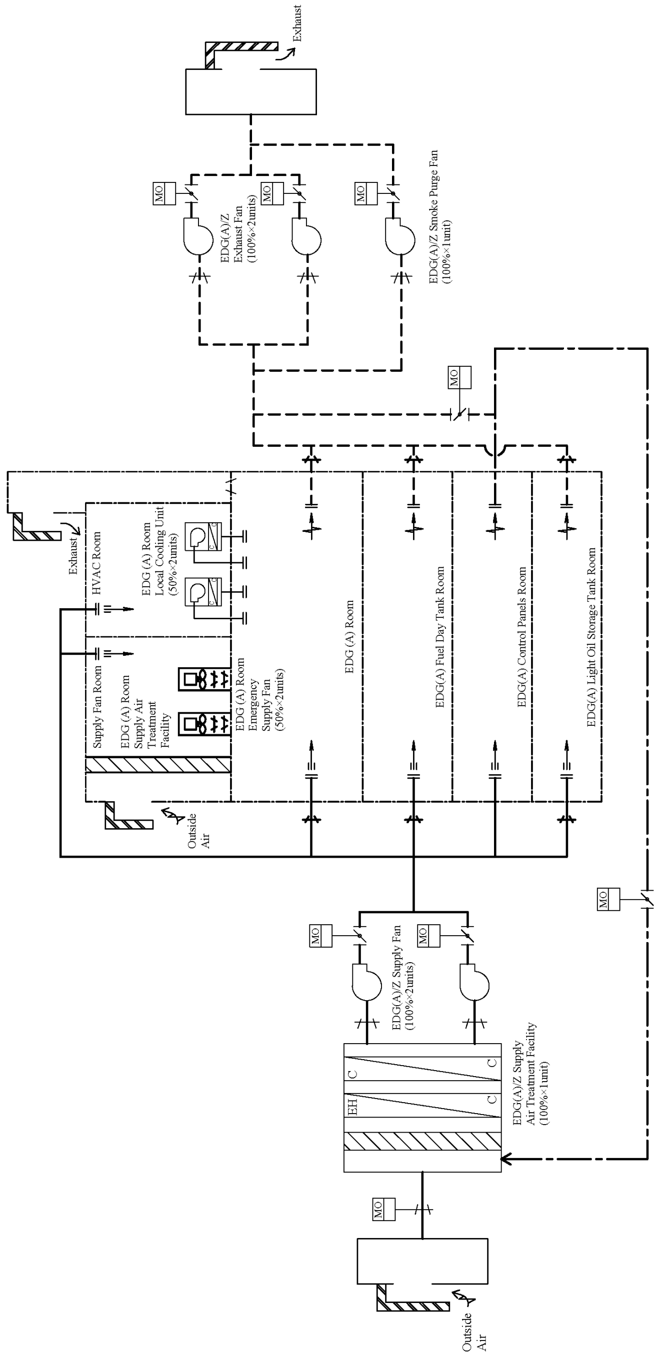


Figure 16.5-5:Outline of the DGEE (A)/Z HVAC

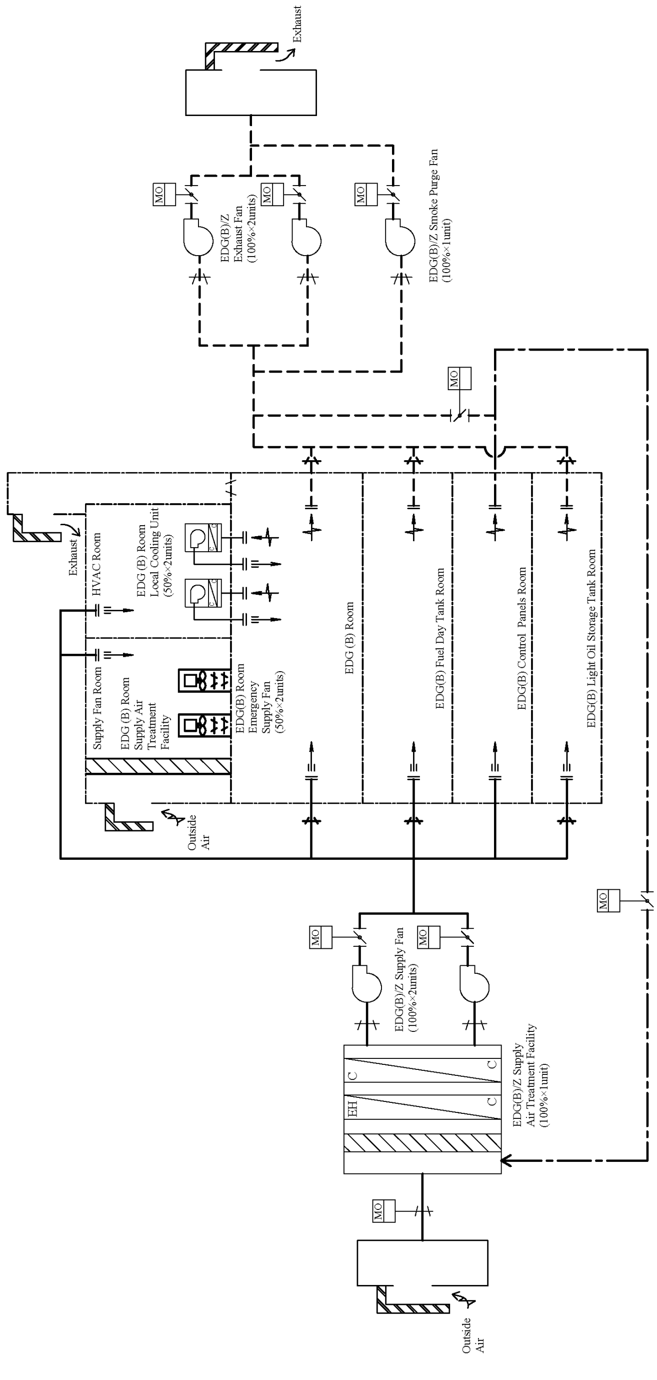


Figure 16.5-6:Outline of the DGEE (B)/Z HVAC

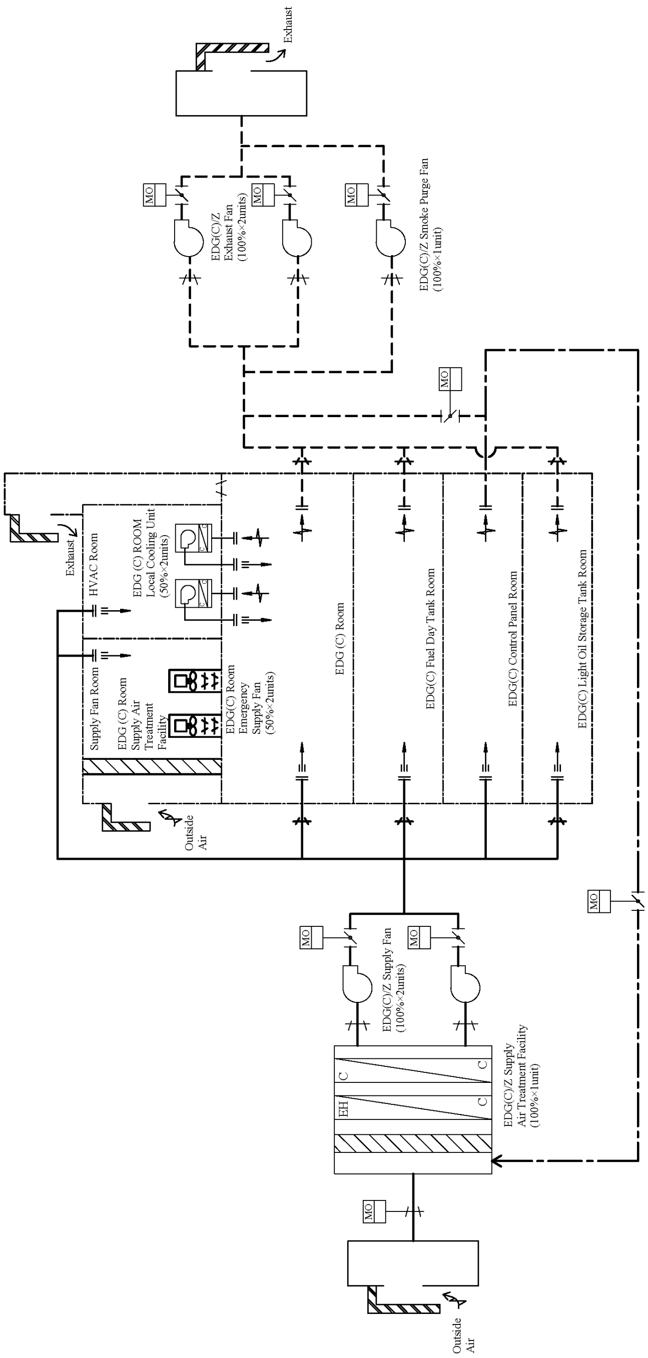


Figure 16.5-7:Outline of the DGEE (C)/Z HVAC

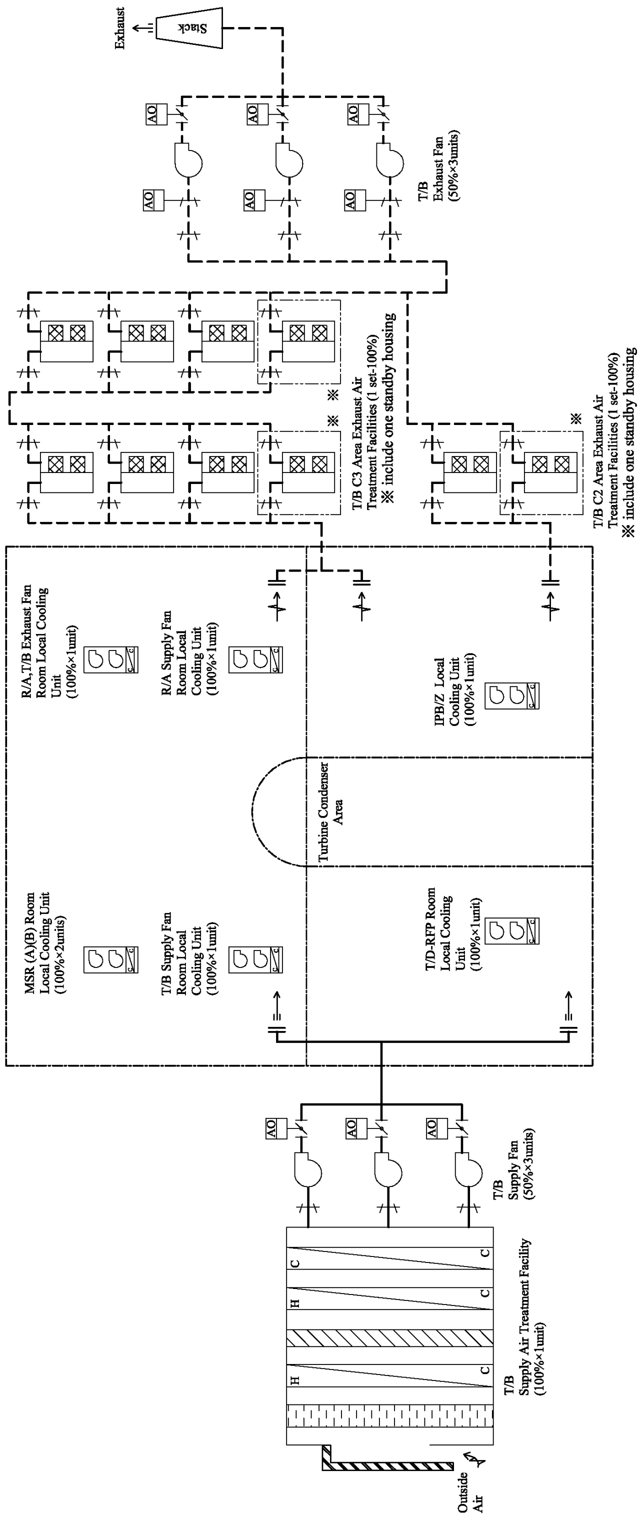


Figure 16.5-8:Outline of the T/B HVAC

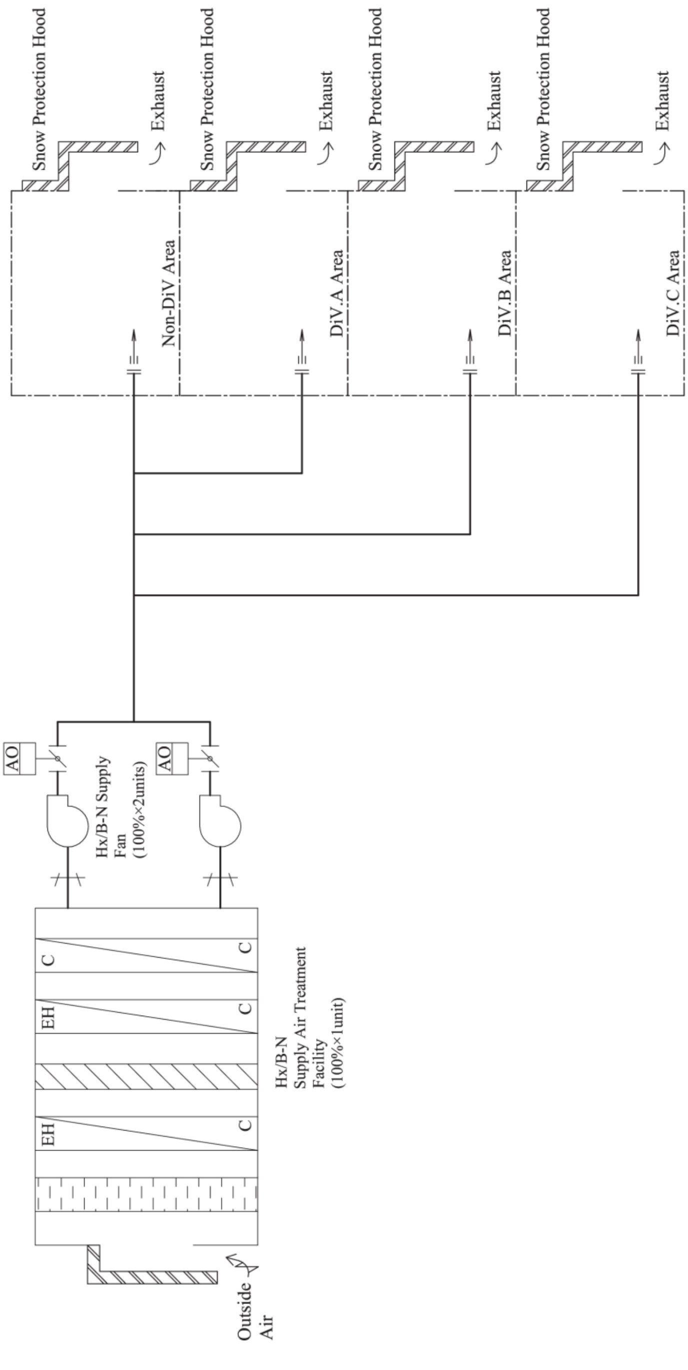


Figure 16.5-9:Outline of the Hx/B-N HVAC

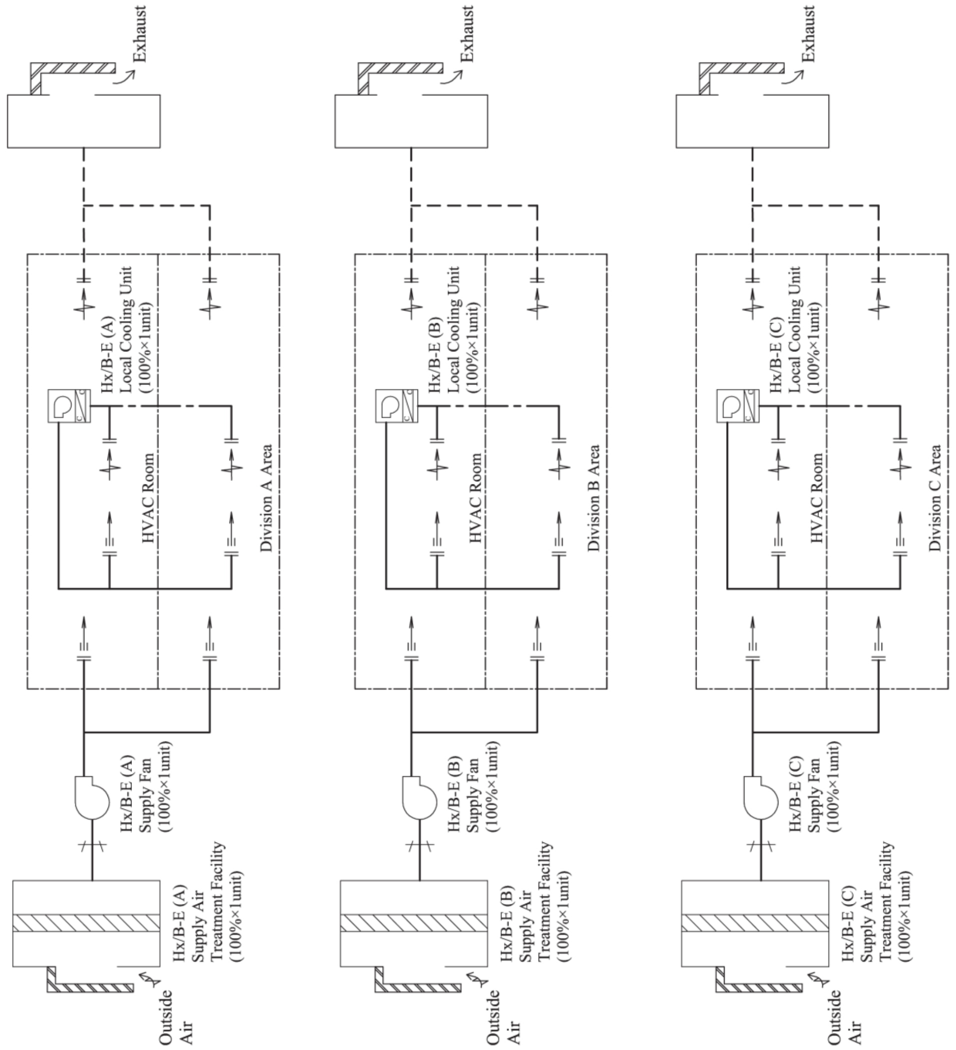


Figure 16.5-10:Outline of the Hx/B-E HVAC

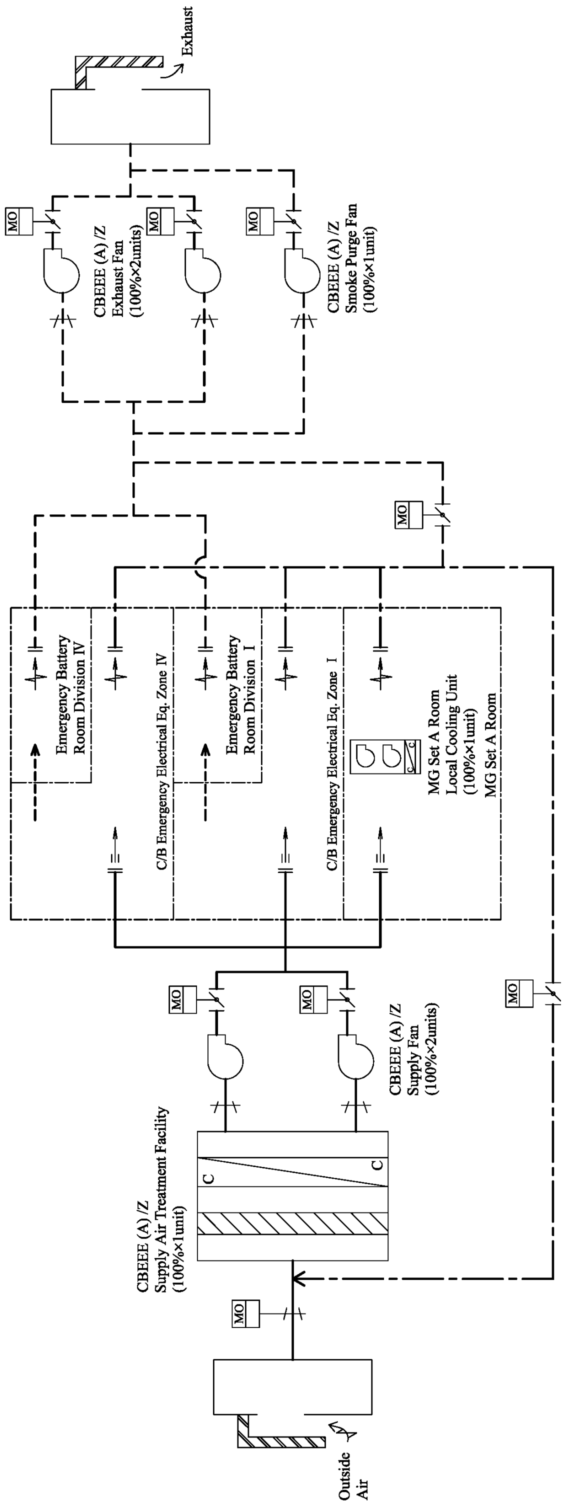


Figure 16.5-11:Outline of the CBEEE (A)/Z HVAC

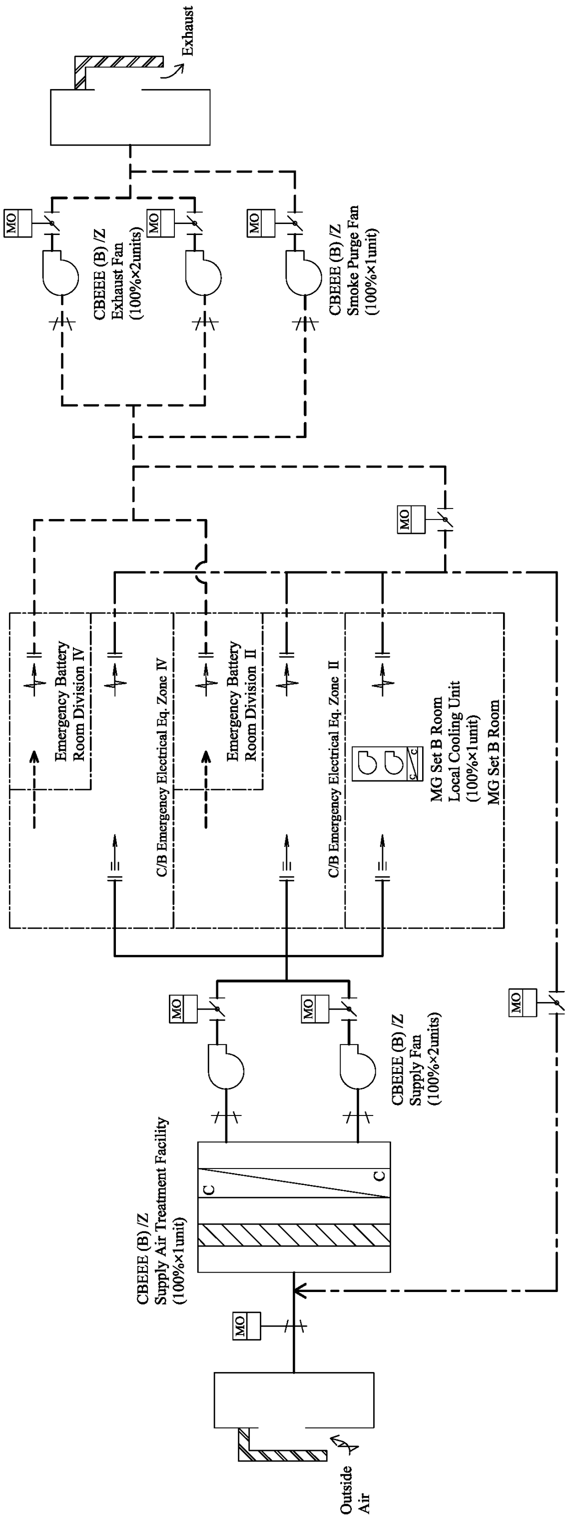


Figure 16.5-12:Outline of the CBEEE (B)/Z HVAC

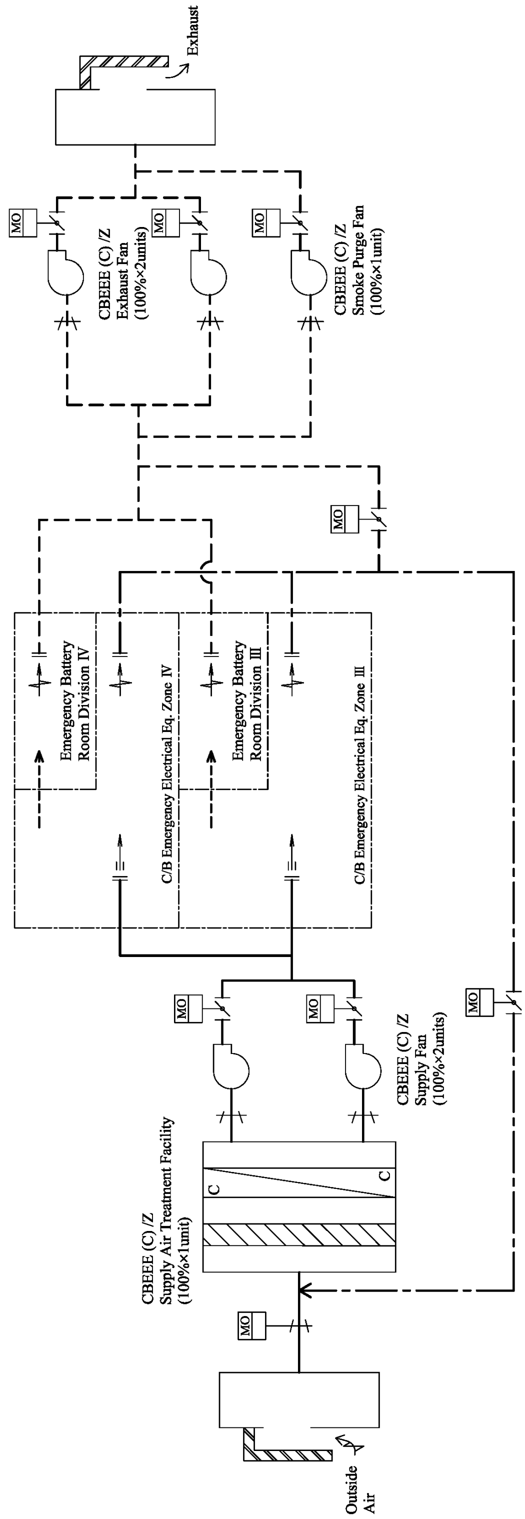


Figure 16.5-13:Outline of the CBEEE (C)/Z HVAC

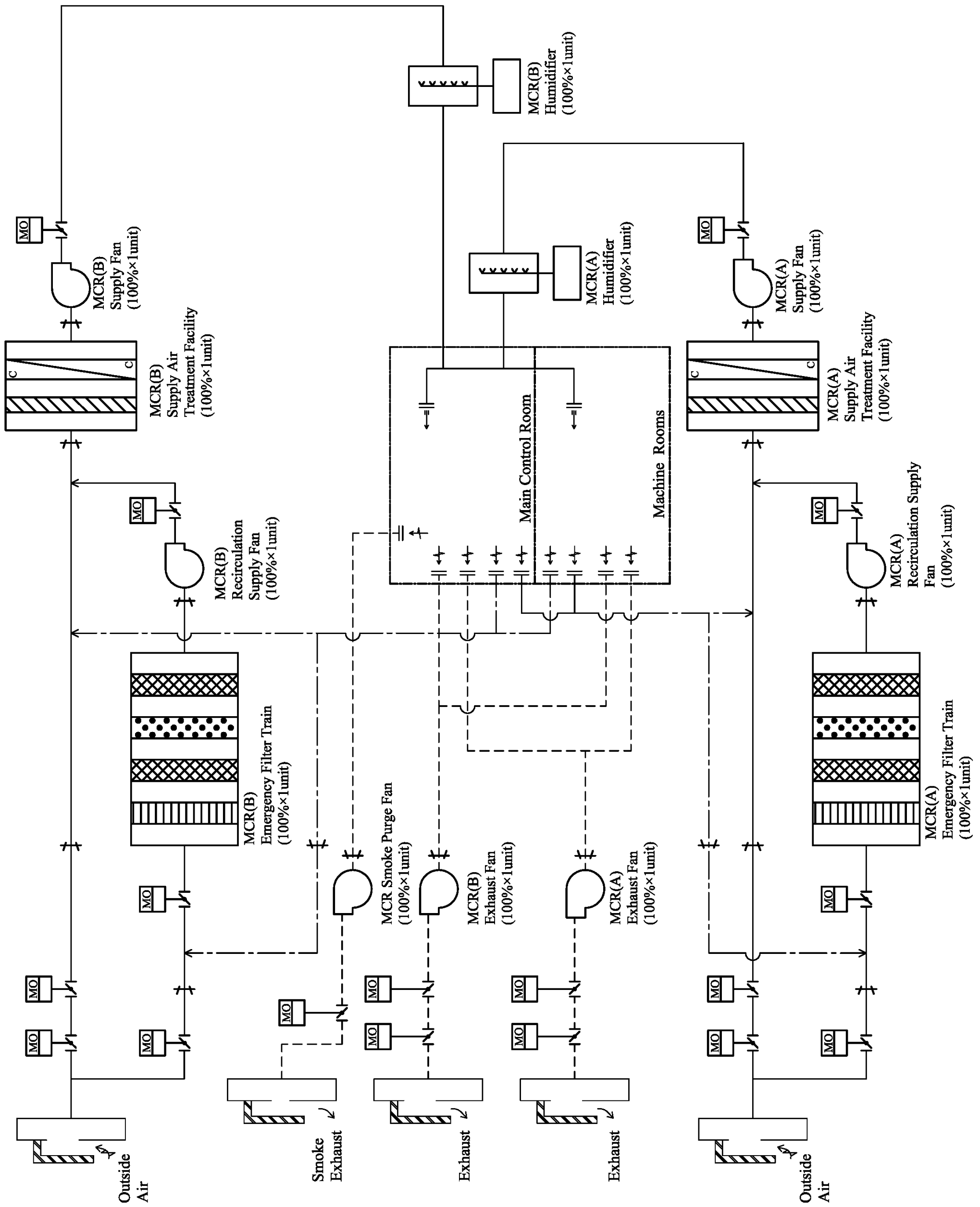


Figure 16.5-14:Outline of the MCR (A), (B) HVAC

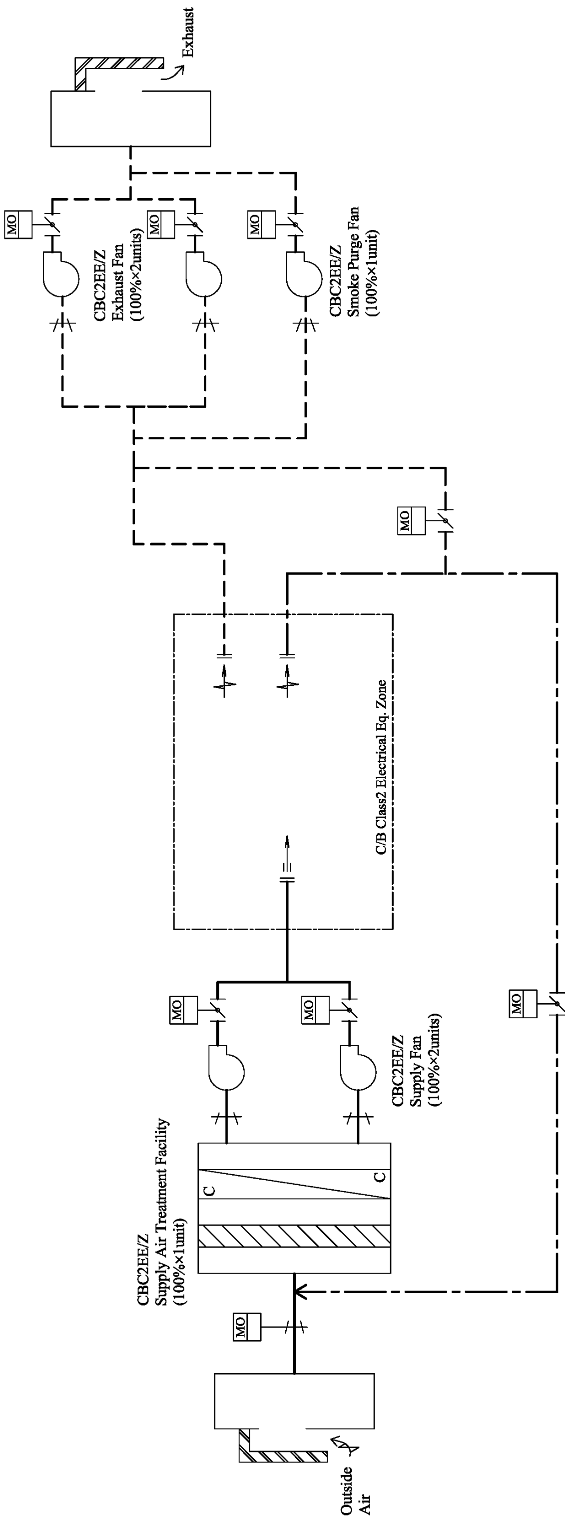


Figure 16.5-15:Outline of the CBC2EE/Z HVAC

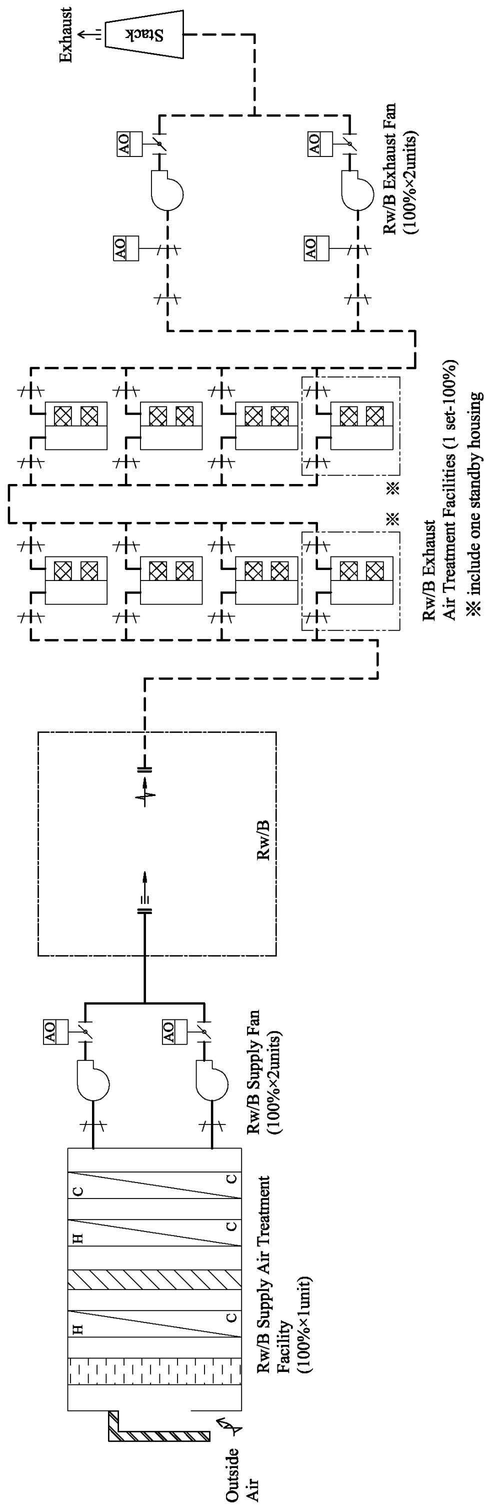


Figure 16.5-16:Outline of the Rw/B HVAC

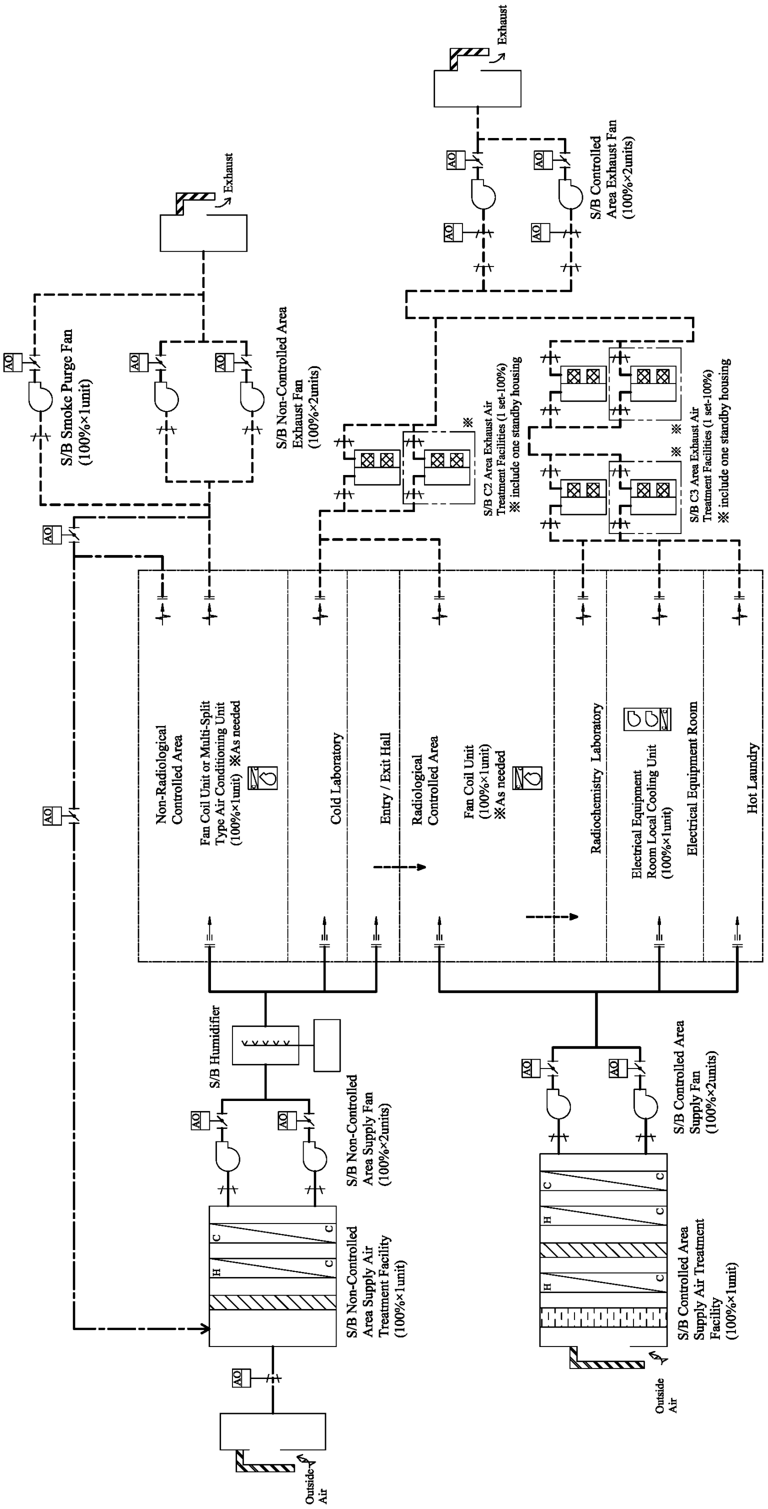


Figure 16.5-17:Outline of the S/B HVAC

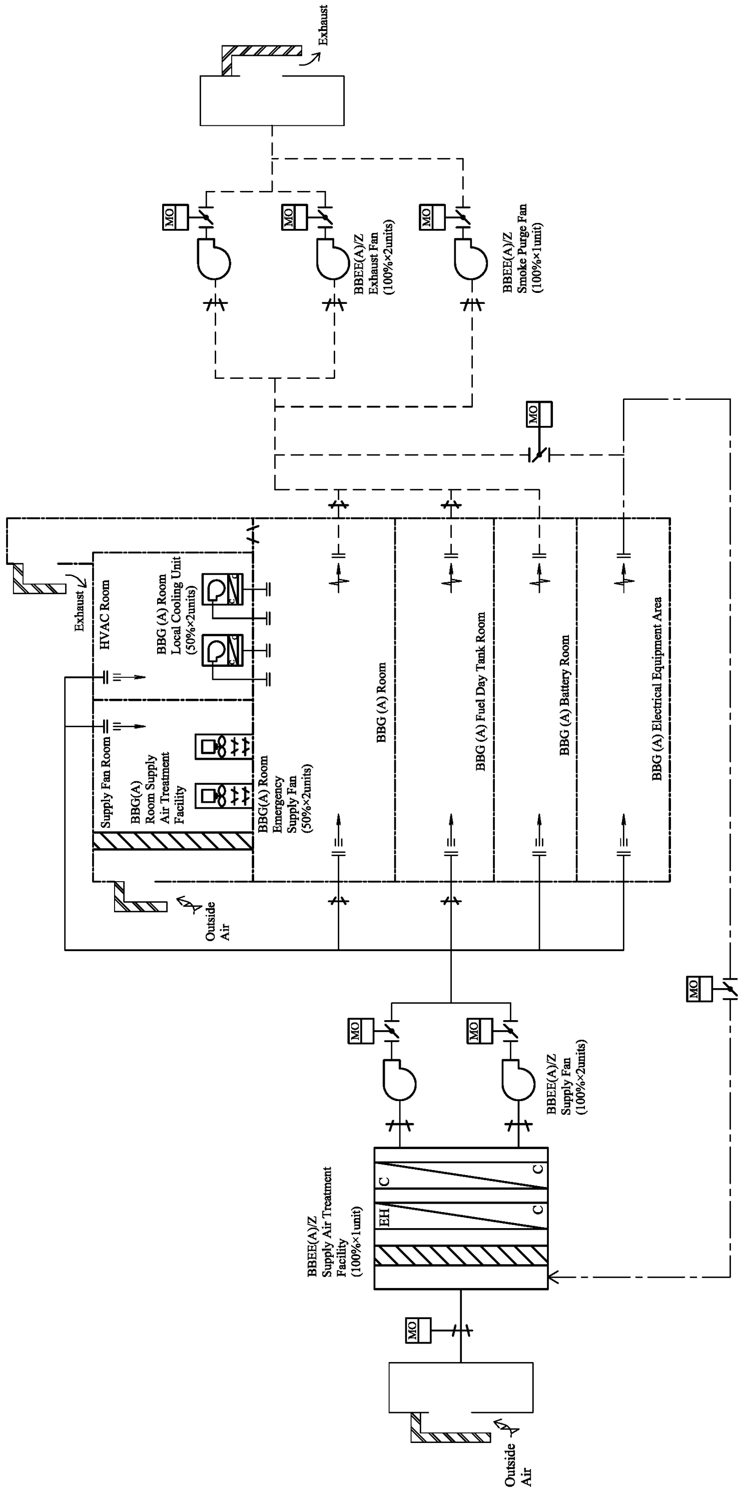


Figure 16.5-18:Outline of the BBEE (A)/Z HVAC

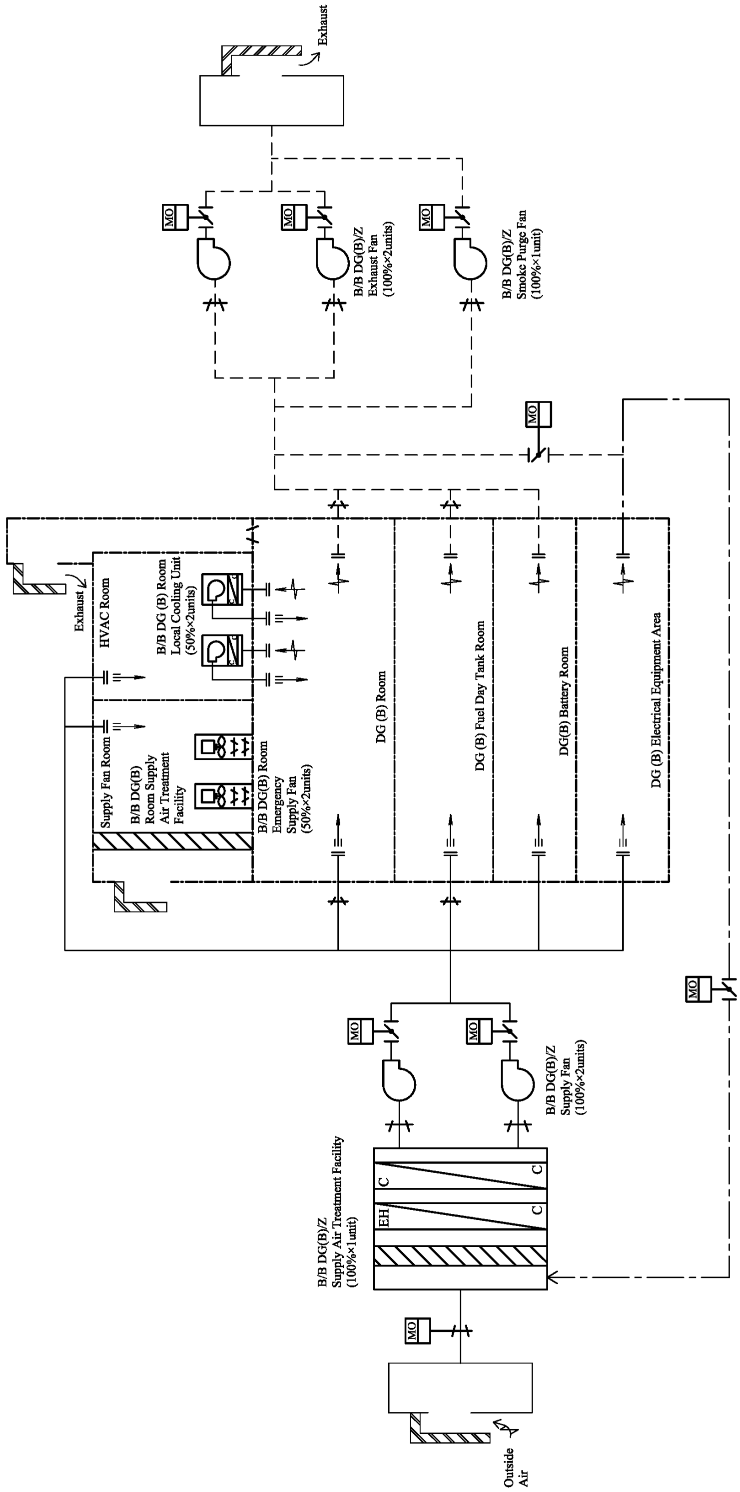


Figure 16.5-19:Outline of the BBEE (B)/Z HVAC

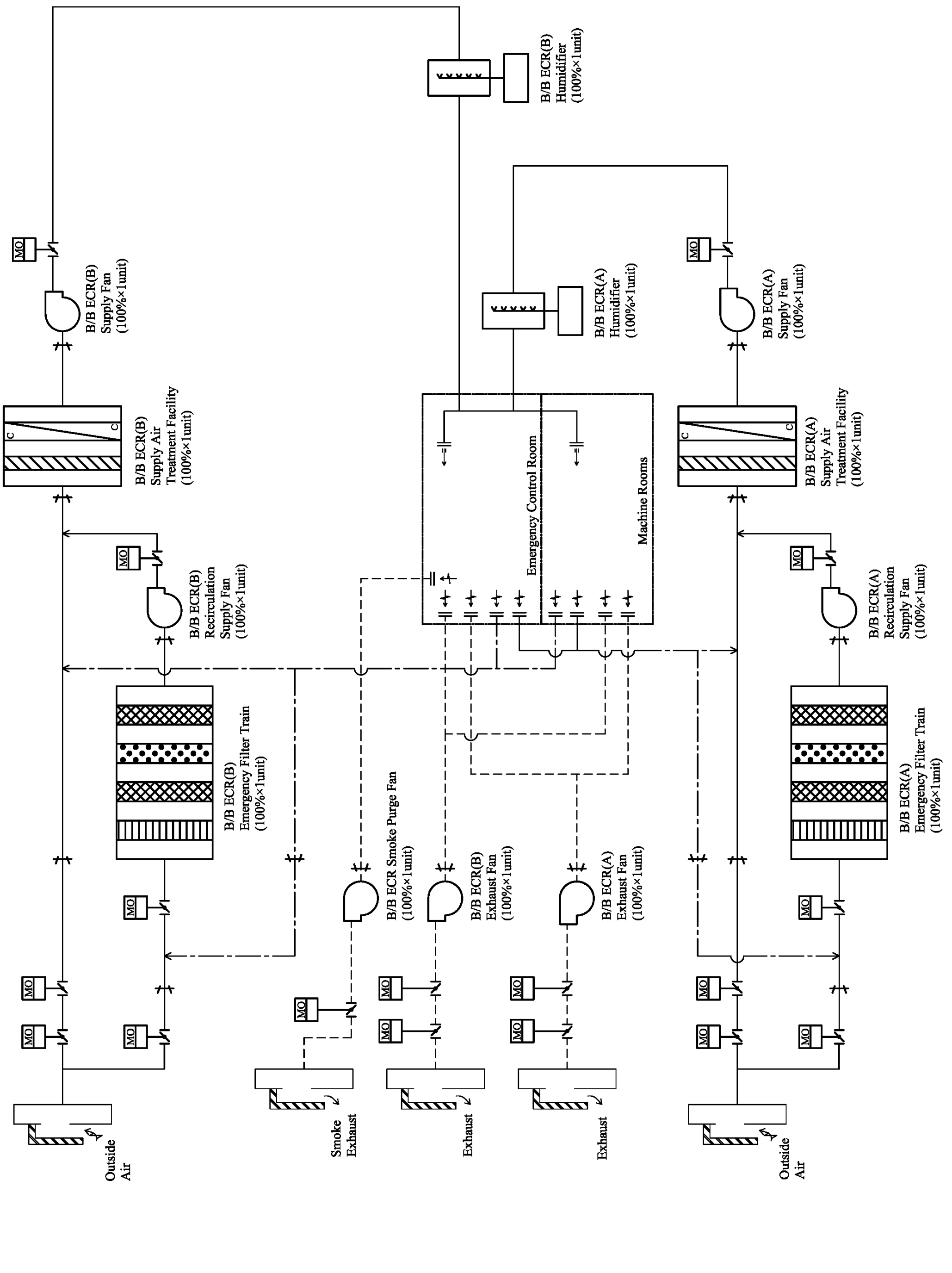


Figure 16.5-20:Outline of BBECR (A), (B) HVAC

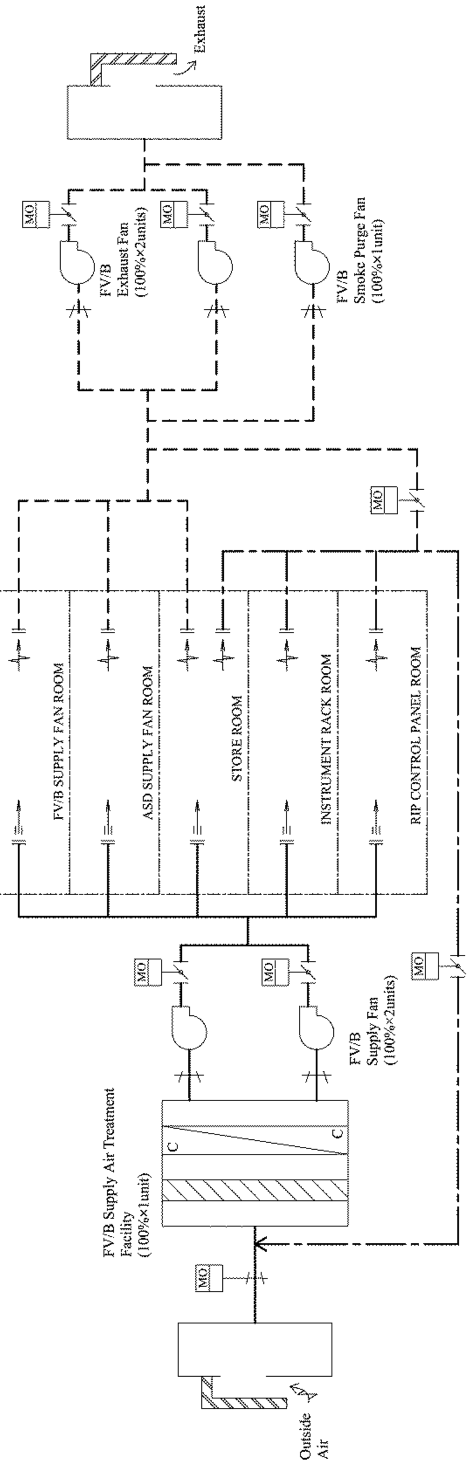


Figure 16.5-21:Outline of the FV/B HVAC

16.6 Other Auxiliary Systems

16.6.1 Fire Protection Systems

The fire protection system is not the principle means of protecting the plant against the internal fire effect, but this system is installed as a defence-in depth measure.

16.6.1.1 Fire Detection and Alarm Systems

System Summary Description

This section is a general introduction to the fire detection and alarm systems where the system roles, system functions, system configuration are briefly described.

(1) **System Roles**

Fire detection and alarm systems serve to detect a fire and provide warning to occupants in the vicinity of a fire and the main control room (MCR). Detection and notification of a fire in an area containing important equipment that performs a safety function allow operators to take actions to mitigate the effects of fire.

The detection system is designed to continuously monitor the environment across locations as appropriate in the plant, early detection and alerting of a fire can ensure safe evacuation of personnel, suppression systems to operate and other measures to operate, such as fire dampers to protect people and safety functions of UK ABWR.

(2) **Functions Delivered**

The functions of the fire detection and alarm system are to detect a fire and send signals to the fire alarm main control panel. The detection system is analogue addressable, allowing the location of each detector operating to be identified at the fire alarm panel. This then leads the fire alarm sounders in the appropriate area and other fire protection measures including fixed suppression systems to be activated, as required.

The fire detection system provides audible and/or visual alarms in the MCR.

(3) **Basic Configuration**

The fire detection and alarm system consists of detectors and manual call point in appropriate detection zone, local fire alarm panels on each floor of the building, main fire alarm main control panel in main control room and a local sounder.

Design Basis

Fire detector and alarm systems serve to detect a fire and provide warning to occupants in the vicinity of a fire and the MCR. [Safety Function reference: FPS SFC 5-14.1]
This safety function is a Category C function, and the components necessary to deliver this function are classified as Class 3 safety components according to the safety categorisation and classification of UK ABWR. The linkage between the Safety Functional Claims of Fire Detection and Alarm

System with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix A. The FSFs and HLSFs are defined in Generic PCSR Chapter 5 “General Design Aspects”.

System Design Description

This section describes the design of the Fire Detection and Alarm Systems to support the safety functions described in “Design Basis” of Section 16.6.1.2.

(1) **Overall Design and Operation**

This system consists of fire detector, local sounding system, fire alarm panel and cables. Signals from detectors are sent to the local alarm panel. The local alarm panel displays the location of fire, transmits the signal to the fire alarm main control panel and actuates main/local sounders. The local fire alarm panel actuates the operation of the fixed fire suppression system. The fire alarm main control panel displays the location of fire alarm.

(2) **Equipment Design**

(a) Fire alarm main control panel

(i) Alarm area map is displayed on the colour monitor.
(ii) Alarm from the interlocking fire door and damper is displayed on the colour monitor.
(iii) The status of fixed suppression system is displayed on the colour monitor.
(iv) Failure signal from detectors is displayed on the colour monitor.

The fire alarm main control panel is positioned to maintain constant monitoring in the main control room.

(b) Local fire alarm panel

The relevant alarm area map is displayed on the monitor.

(c) Manual call points

Manual call points are located as appropriate and have a function to send a fire alarm signal by pushing buttons.

(d) Local sounders

Local sounders are initiated by either a fire signal from the fire detector or from the manual call point.

(e) Fire detectors

The type of detector at each location is chosen with regard to the particular fire phenomena applicable to the equipment or location being monitored (heat, flame, smoke, product of combustion, etc.) and to the specific conditions of its installation (accessibility, atmosphere: humidity, temperature, radiation, corrosive or explosive gases and pressure at the location).

(3) **Main Support Systems**

The fire detection and alarm system is supplied from the Class 3 electrical supply system.

Instrumentation and Control Systems

(i) Fire indication:
When fire signal is received from a fire detector or a manual call point, the indication lamps on the fire alarm main control panel and local fire control panel are turned on, and the detection zone of fire incidence is indicated.

(ii) Indication functions of fixed fire extinguishing system:
A signal indicating actuation of a fixed fire extinguishing system or actuation of a push button of the local control panels is sent to the fire alarm main control panel.

(iii) Indication functions of fire damper:
The fire alarm main control panel indicates the status of fire dampers.

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.6-1]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.6.1.2 Fire Fighting Water Supply System

System Summary Description

This section is a general introduction to the fire fighting water supply system where the system roles, system functions, system configuration are briefly described.

(1) **System Roles**

The main role of the fire fighting water supply system is to minimise the damage caused by fire by providing a dedicated supply to the Fire Fighting system. The fire fighting water supply is to both provide the appropriate system pressure and water volume.
The fire fighting water supply system also has the role of providing water to the reactor in the event of fault or severe accident and to the SFP if available.

(2) **Functions Delivered**

The fire fighting water supply system is designed to function in the case of a fire and in the event of fault or severe accident and provides supply of pressurised water to the fire fighting systems across the site for an extended period of time.

(3) **Basic Configuration**

The fire fighting water supply system provides dedicated fire fighting water. Water for the system is stored in outdoor water tanks and fire pumps connect them to a looped fire mains. This allows water to be provided from two directions, which provides redundancy against failure in a part of the looped fire mains.

Design Basis

The fire fighting water supply system provides the water to the fire fighting systems and provides the water to the reactor and the SFP through fire main and makeup water condensate system. [Safety function reference: FPS SFC 5-14.2, SFC 2-2.1, SFC 2-3.1, SFC 2-5.1]
This safety function is a Category A function and the components necessary to deliver this function are categorised as Class 3 safety components according to the safety categorisation and classification of UK ABWR.
The linkage between the Safety Functional Claims of Fire Fighting Water Supply System with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix A. The FSFs and HLSFs are defined in Generic PCSR Chapter 5 “General Design Aspects”.

System Design

This section describes the design of the Fire Fighting Water Supply System to support the safety functions described in “Design Basis” of Section 16.6.1.2.

(1) **Overall Design and Operation**

The fire pumps, fire water and fire main piping are dedicated to the fire water supply.
Fire water system consists of a fire main loop and is supplied by dedicated pumps and connected to water tanks, as shown in Figure 16.6 -1.
Fire water for the main loop is supplied by four fire pumps each having 50 percent flow capacity.

Two fire water tanks for the main loop have 100 percent capacity each. The capacity for the water supply system is determined as the maximum water consumption rate of the most demanding fixed suppression system added to the manual suppression requirement.

(2) **Equipment Design**

(a) Water Distribution Network

(i) Configuration:
The fire water distribution network consists of a fire main loop.
It supplies water to:
· Outdoor hydrant system and indoor wet hydrant system in the reactor building
· Foam extinguishing system
· Fixed water spray systems in the buildings
Isolation valves are located throughout the fire mains.
(ii) Performance:
Water flow rate of fire pumps and capacity of fire water tanks are determined by the maximum water consumption of the most demanding fixed extinguishing system plus the manual suppression requirement.

(b) Fire Pump

(i) Configuration:
One fire pump can supply 50 percent of the water requirement for the most demanding fixed suppression system and the hydrant.
A pair of electrically driven fire pumps is provided as the primary pumps and a pair of secondary diesel driven pumps provides diversity. Fire pump discharge header piping is pressurised by one jockey pump to maintain appropriate pressure.
(ii) Performance:
Water head pressure is determined by the pressure required at the farthest nozzle of the most demanding extinguishing system.

(c) Fire Water Tank

(i) Configuration:
The fire water tanks are filled through a connection from the towns water system. The capacity of fire water is dedicated to supplying water to the fire fighting systems.
(ii) Performance:

The fire water tanks capacities are based on the flow requirements of the most demanding fixed extinguishing system plus the manual suppression requirements.

(3) **Main Support Systems**

The major support systems related to the delivery of the fire fighting water supply system safety functions are briefly described as follows.

(a) Control:
In the normal operating condition of the power station, a jockey pump maintains the required system pressure, and fire pumps are in standby condition. The fire pumps can be started either automatically by detecting low pressure in fire pump discharge header piping, manually in the MCR or by the local pump control panel.
If the fire pump cannot operate due to loss of power, the secondary fire pump automatically starts.

(b) Interlock:
To prevent cavitation occurring in the jockey pump and fire pumps due to the lowering of water level in fire protection water tanks, water level in the tanks is monitored and a low level causes each fire pump to trip.

(c) Power source:
The primary pumps on the fire main loop are a pair of motor driven pumps. The secondary pumps are a pair of diesel driven pumps.
Measurement:
The following items are measured and monitored in the fire water supply system:
(i) Water level at fire water tank, and
(ii) Water pressure of water supply (fire pump discharge header pressure).

(d) Alarm:
In order to maintain this system's functions, the following alarms are provided:
(i) High level of fire water tank (before overflowing),
(ii) Low level of fire water tank (before pump trips),
(iii) Low pressure of water supply header piping,
(iv) Fire pump operation,
(v) Fire pump failure, and
(vi) Fire detection in fire pump house.

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.6-1]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

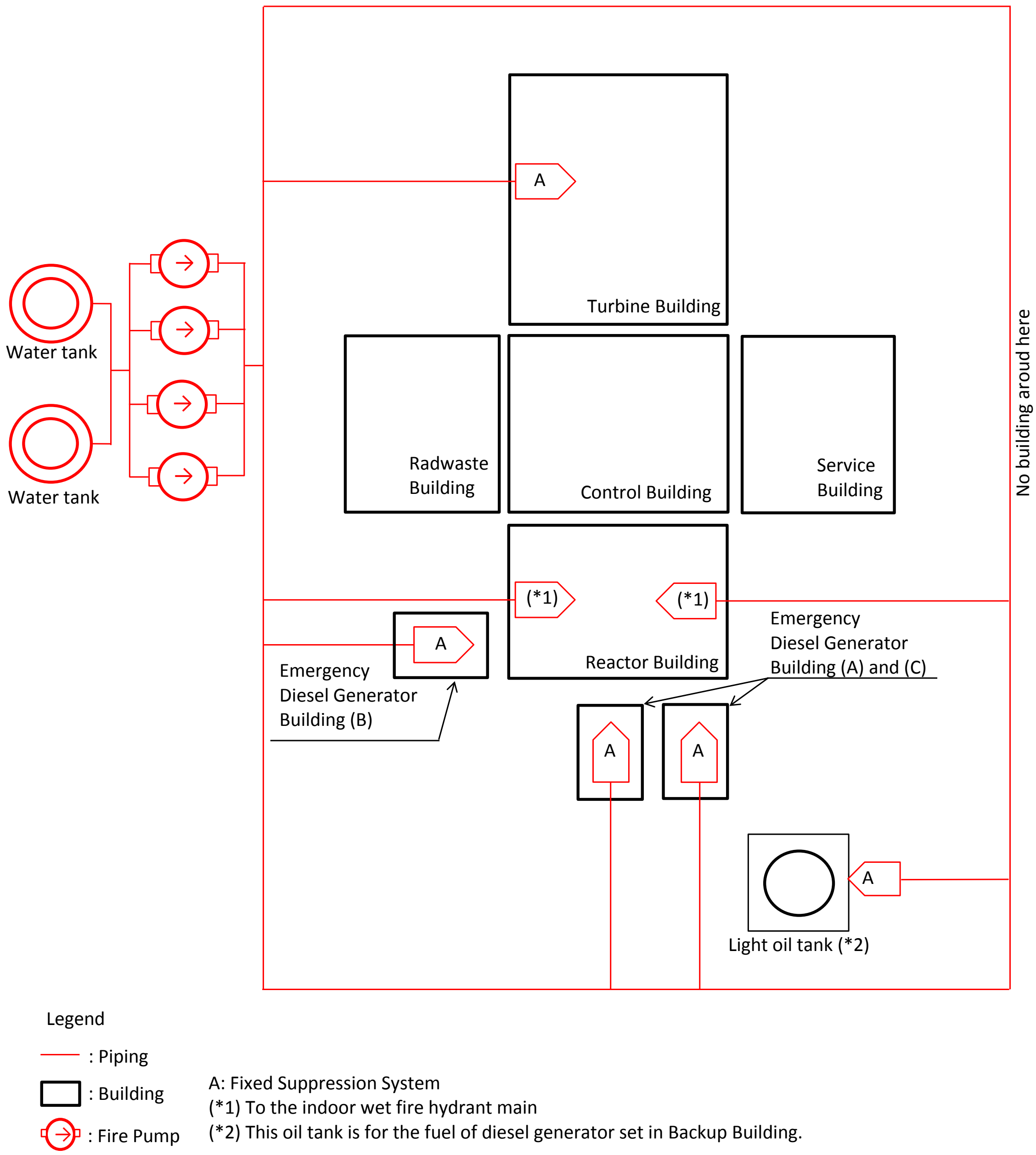


Figure 16.6-1 : Outline of the Fire Fighting Water Supply System

16.6.1.3 Fixed Fire Suppression Systems

System Summary Description

This section is a general introduction to the fixed fire suppression systems where the system roles, system functions and system configuration are briefly described.

(1) **System Roles**

The main role of the fixed fire suppression systems is to operate in the case of a fire to limit its growth and spread following ignition.

(2) **Functions Delivered**

The fixed fire suppression systems are designed to function in the case of a fire and provide fire suppression in areas of high fire risk.

(3) **Basic Configuration**

Fixed suppression systems are provided in areas of high fire risk and are supplied water from the fire fighting water supply system.

Design Basis

The fixed fire suppression systems limit fire growth and spread following ignition. [Safety Function reference: FPS SFC 5-14.3]
This safety function is a Category C function, and the components necessary to deliver this function are categorised as Class 3 safety components according to the safety categorisation and classification of UK ABWR. The linkage between the Safety Functional Claims of Fixed Fire Suppression Systems with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix A. The FSFs and HLSFs are defined in Generic PCSR Chapter 5 "General Design Aspects".

System Design

This section describes the design of the fixed fire suppression systems to support the safety functions described in the "Design Basis" of Section 16.6.1.3.

(1) **Overall Design and Operation**

Water spray extinguishing systems and foam extinguishing systems are designed to extinguish fires in areas of where there is the potential for oil fire.

Each fixed fire suppression system has a separate direct connection to the fire main loop.
Fixed fire suppression system actuation decreases the pressure in the fire fighting water supply system and causes the fire pumps to operate.

(2) **Equipment Design**

For all pipe work associated with the fixed fire suppression systems, isolating valves are installed to enable individual systems to be isolated and repairs to be carried out. Each of the fixed fire suppression systems has a fire main connecting it to the water supply distribution network. The fixed fire suppression systems are made up of the following:

(a) Water Spray Extinguishing System

(i) Configuration:
Water spray systems are designed to extinguish fires in areas where there is the potential for an oil fire. The piping network contains water spray nozzles open to atmosphere. The water is held back by deluge valves. The deluge valves are opened by two different types of detectors (such as heat and smoke) allowing water to flow into the piping network. The deluge valves can also be operated manually.

(ii) Performance:
The system is designed to suppress oil pool fires and the performance is calculated based on a nominal application rate and duration based on appropriate standard.

(b) Foam Extinguishing System

(i) Configuration:
The foam extinguishing systems are designed to extinguish fires in areas of where there is the potential for an oil fire. They are actuated by different types of detectors allowing water to the piping network connected to the foam concentrate tank. The foam extinguishing system is also designed for the bunded area to extinguish the fire.

(ii) Performance:
The system is designed to suppress oil pool fires and the performance is calculated based on a nominal application rate and duration based on appropriate standard.

(3) **Main Support Systems**

(a) Water Spray Extinguishing System

Water spray systems are supplied water from fire fighting water supply system and fire detectors are provided to detect fire that may occur in protected rooms. Fire detectors are connected to the local control panel of the water spray system in order to activate the system operation automatically.

(b) Foam Extinguishing System

The foam extinguishing system is supplied with water from fire fighting water supply system and fire detectors are provided to detect fire may that occur in protected rooms. The power source is supplied from normal power supply system.

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.6-1]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.6.1.4 Fire Brigade Equipment

System Summary Description

This section is a general introduction to the fire brigade equipment where the system roles, system functions, system configuration are briefly described.

(1) **System Roles**

The main role of the fire brigade equipment is to provide the fire brigade with the necessary equipment to manage a fire in order to limit its growth and spread following ignition. The Fire Brigade Equipment also has the role of providing water to the reactor in the event of fault or severe accident and to the SFP if available.

(2) **Functions Delivered**

The fire brigade equipment is designed to be available in case of a fire and provides:

(a) Access to outdoor hydrants on;

(b) Indoor piping network and outlets with hoses for fire water to reach any room

The fire brigade equipment is also designed to be available in the event of fault or severe accident and supply water to the reactor and the SFP through makeup water condensate system.

(3) **Basic Configuration**

The fire brigade equipment consists of fire mains (internal and external) and fire hydrants (internal and external).

Design Basis

The fire brigade equipment limits fire growth and spread following ignition and supply water to the reactor and the SFP. [Safety Function reference: FPS SFC 5-14.4, SFC 2-2.1, SFC 2-3.1, SFC 2-5.1]. This safety function is a Category C function and the components necessary to deliver this function are categorised as Class 3 safety components according to the safety categorisation and classification of UK ABWR. For the components within the range from the interface with fire fighting water supply system to the interface with makeup water condensate system which are necessary for core cooling in the event primary and secondary means for core cooling are failed or unavailable, the safety function is a Category A.
The linkage between the Safety Functional Claims of Fire Brigade Equipment with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix A. The FSFs and HLSFs are defined in Generic PCSR Chapter 5 “General Design Aspects”.

System Design

This section describes the design of the fire brigade equipment to support the safety functions described in the “Design Basis” of Section 16.6.1.4.

(1) **Overall Design and Operation**

Primary suppression coverage for the inside of buildings is provided by dry fire mains to which water is supplied from connections on outside building wall and hydrants except in the secondary containment area of reactor building where wet fire main loop and hydrants are provided.

The suppression coverage for the outside of buildings and their surroundings is provided by outdoor fire hydrants.
Both inside and outside fire hydrants can be used by the fire brigade.

(2) **Equipment Design**

(a) Outdoor Fire Hydrants

(i) Configuration:
Fire hydrants are placed adequately in order for the fire brigade to attempt to suppress fires. Water is supplied by external fire mains.
(ii) Performance design:
A fire hydrant outlet is capable of providing a minimum of 750 L/min.

(b) Indoor Fire Mains and Hydrants

(i) Configuration:
The dry indoor fire mains and hydrants are placed in all fire fighting shafts and other locations in order to suppress any fire which may occur inside of buildings except in the secondary containment of reactor building where wet indoor fire main loop and hydrants are provided.
(ii) Performance Design:
A fire hydrant outlet is capable of providing a minimum of 750 L/min.

(3) **Main Support Systems**

Water for the indoor fire mains are designed to be supplied from the outdoor fire mains. The indoor fire mains of other than secondary containment of reactor building are connected to the outdoor fire mains indirectly.

Assumptions, Limits and Conditions for Operation
Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.6-1]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.6.1.5 Smoke Control Systems

System Summary Description

This section is a general introduction to the smoke control system where the roles, functions, configuration and modes of operation are briefly described.

(1) **System Roles**

The roles of the smoke control systems as described in the fire strategy report [Ref-16.6-5] are as follows:

- Protect personnel and SSCs,
- Prevent the spread of smoke when a fire has initiated in one plant room,
- Remove smoke from a plant room through ventilation,
- Ensure basement areas are sufficiently ventilated and any smoke can be vented out,
- Prevent spread of airborne radiological contamination,
- Allow occupants to escape, and
- Allow manual fire fighting and rescue activities to take place.

There is also a requirement for emergency stairways to be isolated from smoke and ventilated, to provide personnel a safe means to escape.

(2) **Functions Delivered**

The smoke control system provides two functions: smoke extraction and overpressure.

For the non-controlled areas in the safety divisions, smoke extraction is required to extract smoke from one of the fire sectors, which is already isolated from the ventilation system by fire dampers. In controlled areas, such as reactor building, turbine building, on the basis that main functional requirement of ventilation systems serving radiation controlled areas within UK is to provide containment, smoke extraction serving the controlled areas is not provided. [Ref-16.6-6]

A pressure differential system is used to minimise the spread of smoke in the staircase during means of egress and fire fighting operation.

(3) **Basic Configuration**

A pressurised system for every fire safety sector emergency stairway is provided by means of existing HVAC systems.

Smoke extractor fan circuits with vents are provided for all non-controlled areas.

Every fire barrier with ventilation across it has fire dampers to prevent the spread of smoke.

Design Bases

This section describes the design bases for the Smoke Control Systems.
The linkage between the Safety Functional Claims of Smoke Control Systems with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

The smoke control system is designed to meet the following safety function claim (SFC). The relation between the SFC put on this system and the high level claims is shown in Appendix A.

The smoke control system contributes fire containment by controlling the spread of smoke, enabling a rapid response to a fire. [FPS SFC 5-14.5]
Plant rooms are compartmentalised to prevent spread of fire and smoke, and this is further mitigated by the use of smoke dampers as fire barriers. Several plant rooms are connected together via a common smoke extraction duct equipped with smoke dampers.

Excluding the smoke control across the controlled areas in the safety divisions, which have radiological containment significance, there are no nuclear safety claims on the smoke control system.
This safety function is a Category C function, and the components necessary to deliver this function are categorized as Class 3 safety components according to the safety categorization and classification of UK ABWR.

System Design Description

This section describes the design of the Smoke Control Systems to support and justify the delivery of FPS SFC 5-14.5.

(1) **System Design and Operation**

All of the safety division train has connections to the smoke ducts that vent the smoke out in the event of a fire. Overpressure is provided through existing HVAC systems in the emergency stairways and exits. The HVAC system is also available to purge cold smoke from logged and non-radiological areas after fires have been extinguished as described in the fire strategy report.

Fire fighting shafts are also provided with smoke control to assist in fire brigade operations, by preventing them becoming completely smoke logged. However, the smoke control design has to take into account the need for radiological containment, the degree of internal separation in the buildings, the configuration of all elements of the SSCs and the interaction of the systems.

Generally, smoke extract systems are designed in accordance with BS EN 12101.

(a) System Operation Conditions

Fire dampers automatically close upon alarms received by the main control panel.

(b) Design Features of the Smoke Control System

Each division of the non-controlled safety division train, and each stairway and protected exit in the Power Block has smoke control provided by an independent sub-system. Each smoke extraction circuit is made up of:

- One or more smoke extraction dampers.
- One extractor fan per circuit, whose capacity is regulated according to the under-pressure achieved in the sector from which the smokes have been extracted.

The fire zones involved in fume extraction in the non-controlled areas of the safety divisions are:

- The instrumentation and control cabinet rooms,
- The switchboards rooms, and
- The Main Control Room.

All these stairways and protected emergency exits are used to evacuate staff and to give access for the fire brigade. They remain smoke-free.

The smoke control system and corresponding sub-systems are activated if a fire starts in a fire sector in the Power Block buildings.

If the affected sector is involved in smoke extraction (non-controlled area of the safety divisions), additional measures are required as follows.

- Fire in a fire sector with smoke extraction (safety divisions electrical rooms)

  When the fire detection system gives the alarm in the Main Control Room, the fire dampers in the normal ventilation of the sector involved are closed automatically.

  The smoke extraction dampers flaps in the affected sector open automatically. The smoke extractor fan in the sector is started manually from the Main Control Room or locally, after the existence of a fire has been established together with confirmation that all staff in the sector has been evacuated.
  The stairways are over-pressurised, by means of existing HVAC systems. This enables the fire sector to be approached or to be evacuated.

- Fire in a fire sector without fume extraction

  The fire detection system triggers the alarm in the Main Control Room. The fire dampers in the normal ventilation system of the sector involved are closed automatically.

(2) Equipment Design and Operation

The smoke control system is designed as part of the HVAC systems, for the dual purpose of HVAC requirements and fire protection. The major plant features of the equipment design are:

- Venting of fire areas to prevent undue build-up of pressure due to a fire.
- Pressure control across the fire barriers to assure that any leakage is into the fire area experiencing the fire.

- Pressure control and purge air supply to prevent back-flow of smoke and hot gases when fire barrier doors are maintained open for access for manual fire suppression activities.
- Augmented and directed clean air supply to provide a clean air path to the fire for fire suppression personnel.
- Smoke control by fans and systems external to the fire area experiencing the fire.
- Removal of smoke and heat from the fire by smoke extractor fans and operating supply fans to provide clean, cool air.
- Manually reset position of fire dampers in the smoke removal path.

(3) **Main Support Systems**

Instrumentation and Control Systems

The instrumentation and control processing is located in the same electrical division as the actuators being controlled.

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.6-1]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

16.6.2 Emergency Power Supply System

16.6.2.1 Emergency Diesel Generator

System Summary Description

This section is a general introduction to the Emergency Diesel Generator (EDG) where the system roles, system functions, system configuration and modes of operation are briefly described. The EDG Safety Case is justified in the Basis of Safety Cases on Emergency Power Supply System [Ref-16.6-2].

(1) **System Roles**

The role of the EDGs is to supply power needed to shut down the reactor safely when the offsite power is lost and to supply power to the electrical systems supporting the delivery of safety functions if a Loss of Coolant Accident (LOCA) should occur simultaneously.

(2) **Functions Delivered**

The EDGs are designed to perform the following main function:

The EDGs supply power to loads necessary to safety shut down the reactor in the event of Loss of Offsite Power (LOOP) and any Loss of Coolant Accident (LOCA) associated with LOOP.

(3) **Basic Configuration**

The EDGs consist of three independent divisions, A, B, and C. Each division consists of the following main components.

- Engine,
- Generator,
- DG Fuel Oil System,
- DG Cooling Water System,
- DG Lubricant Oil System,
- DG Compressed Air System, and
- DG Air Intake and Exhaust Gas System.

(4) **Modes of Operation**

Modes of operation of the EDGs are summarised as follows.

(a) Emergency operating mode

The EDGs supply power to loads necessary to safely shut down the reactor in the event of LOOP and LOCA associated with LOOP.

(b) Stand-by mode

During stand-by mode, it can be started-up immediately by a start-up signal at any time. To achieve this, the engine is pre-lubricated and pre-heated by the DG Lubricant Oil System and DG Cooling Water System.

Design Bases

This section describes the design basis for the EDGs.
The linkage between the Safety Functional Claims of EDG with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

The EDGs have been designed to meet the following Safety Functional Claims (SFC).

The EDGs supply power to loads necessary to secure functions of engineering safety facilities and necessary to safety shut down the reactor in the event of LOOP and LOCA associated with LOOP. [Safety Function reference: EPS SFC 5-2.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements.
The main loads connected to each of EDGs are described in Chapter 15, Section 15.5: Electrical Equipment and systems.

System Design Description

This section describes the design of the EDGs to support and justify the delivery of EPS SFC 5-2.1. [Ref-16.6-2]

(1) **System Design and Operation**

The EDGs are composed of three electrical and mechanical independent divisions designated A, B and C. Each division contains the necessary equipment for EDG operation.

(2) **Equipment Design and Operation**

(a) Engine

(i) Purpose:
The engine supplies drive power to the generator.

(ii) Configuration and Operation:
EDGs are provided with an exhaust turbocharged engine. The engine is designed to be started by compressed air automatically. The engine is able to be started up and shut down by remote manual operation from the main control panel or at the local control panel [EPS SFC 5-2.1].

(iii) Performance:
The engine is designed to be able to continuously operate at rated power under the specified operating condition. The rate of engine speed variance is lower than specified value [EPS SFC 5-2.1].

(b) DG Fuel Oil System

(i) Purpose:
The DG Fuel Oil System (DGFO) is intended to supply fuel oil to the engine for it to generate the electrical power.

(ii) Configuration and Operation:
Each engine is supplied with fuel oil from an independent DGFO. One DGFO consists of Light Oil Tanks (LOT), a fuel oil transfer pump, and the required piping and valves. A fuel oil day tank, providing fuel oil to the engine through gravity, is installed in each DGFO and holds enough fuel for eight hours of engine operation. Fuel oil is transferred from the LOTs to the fuel oil day tank by the pump when it is detected that the fuel oil level falls below the specified level [EPS SFC 5-2.1].

(iii) Performance:
The storage capacity of the LOTs of each DGFO is sufficient for continuously operating each engine for seven days at rated power [EPS SFC 5-2.1].

(c) DG Cooling Water System

(i) Purpose:
The DG Cooling Water System (DGCW) is configured to perform cooling and warming around the diesel engine cylinder for shortening the start-up time and efficient operation of the EDGs.

(ii) Configuration and Operation:
Each engine is supplied cooling water from an independent DGCW. The DGCW consists of tanks, pumps, heat exchanger, piping and valves. The water consumption of the DGCW is supplied automatically from the Makeup Water Purified System (MUWP). The DGCW is cooled by Reactor Building Cooling Water System (RCW) [EPS SFC 5-2.1].

(iii) Performance:
The cooling capacity of the DGCW is sufficient for operation at rated power. In order to facilitate the rapid starting of the engine, the engine is pre-heated [EPS SFC 5-2.1].

(d) DG Lubricant Oil System

(i) Purpose:
The DG Lubricant Oil System (DGLO) lubricates the parts requiring lubrication and cooling such as the main bearing of diesel engine and pre-lubricates and warms up the system to reduce the start-up time of the EDGs.

(ii) Configuration and Operation:
Each engine is supplied with lubricant oil from an independent DGLO. The DGLO consists of tanks, pumps, heat exchanger, piping and valves [EPS SFC 5-2.1].

(iii) Performance:
The lubricating capacity of the DGLO is sufficient for continuous operation at rated power. In order to facilitate the rapid starting of the engine, the engine is pre-heated and pre-lubricated [EPS SFC 5-2.1].

(e) DG Compressed Air System

(i) Purpose:
The DG Compressed Air System (DGCA) is intended to store the compressed air required to start-up the engine.

(ii) Configuration and Operation:
The DGCA provides a supply of compressed air for starting the engine without external power. The DGCA consists of starting air receiver, air compressor, piping and valves. The DGCA has two lines from the starting air receiver to the engine [EPS SFC 5-2.1].

(iii) Performance:
Each compressed air system has enough air storage capacity for 5 starts. The EDGs shall be able to achieve the prescribed values of frequency within specified times until a specified number of engine starts. The capacity of air compressor shall be sufficient to recharge the storage of air receiver within specified times [EPS SFC 5-2.1].

(f) DG Air Intake and Exhaust Gas System

(i) Purpose:
The DG Air Intake and Exhaust Gas System (DGAE) intakes the combustion air from outside of EDG Building (EDG/B) and exhausts the combustion gas to outside.

(ii) Configuration and Operation:
Each engine is supplied with combustion air and discharge exhaust gas by the independent DGAE. The DGAE consists of an expansion joint, an exhaust silencer, piping and valves. The exhaust gas drives the turbocharger to increase amount of intake air [EPS SFC 5-2.1].

(iii) Performance:
The air intake is from the piping through the outside of EDG/B, and exhaust gases are released atmosphere via exhaust silencer on the EDG/B roof [EPS SFC 5-2.1].

(g) Generator

(i) Purpose:
Generator generated electricity is needed to safely shut down reactor in the event of LOOP and LOCA associated with LOOP.

(ii) Configuration and Operation:
The generator is a synchronous generator and is directly coupled to the engine [EPS SFC 5-2.1].

(iii) Performance:
The generator shall be able to continuously operate with rated load. The capacity of generator is sufficient to supply power to necessary load (such as a load for fuel cooling) in the event LOOP or LOCA associated with LOOP. Rate of generator voltage variance is lower than specified value [EPS SFC 5-2.1].

(3) **Main Support Systems**

The main systems supporting SSCs for the delivery of the safety functions are briefly described as follows:

(a) Reactor Building Cooling Water System (RCW)

The RCW supplies cooling water to the Heat Exchangers of the EDGs. In these heat exchangers, the heat of DGCW is removed. The EDGs are connected to independent and separated RCW divisions.

(b) Makeup Water Purified System (MUWP)

The MUWP supplies cooling water to the cooling water expansion tank of the DGCW. The liquid level of tank is monitored and cooling water is automatically supplied by MUWP when the liquid level is lower than specified value.

Assumptions, Limits and Conditions for Operation

In order to ensure that the EDG is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs, surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is described in the Basis of Safety Cases on the Emergency Power Supply System [Ref-16.6-2].

- The diesel fuel oil, lube oil, starting air sub-system shall be within limits.

16.6.2.2 Back-up Building Generator

System Summary Description

This section is a general introduction to Back-up Building Generator (BBG) where the system roles, system functions, system configuration and modes of operation are briefly described. The BBG Safety Case is justified in the Basis of Safety Cases on Emergency Power Supply System [Ref-16.6-2].

(1) **System Roles**

The role of the BBGs is to supply power to diverse provisions which are necessary for reactor safety in the event of LOOP and LOCA associated with LOOP.
The BBGs also have a role as the source of electricity at the situation of severe accident.

(2) **Functions Delivered**

The BBGs are designed to perform the following main functions:

(a) The BBGs supply power to diverse provisions which are necessary for reactor safety in the event of LOOP and LOCA associated with LOOP.

(b) The BBGs become the power supply equipment in the event of severe accidents.

(3) **Basic Configuration**

The BBGs consist of two independent divisions, system 1 and system 2. Each division consists of the following main components:

- Engine,
- Generator,
- BBG Fuel Oil System,
- BBG Cooling Water System,
- BBG Lubricant Oil System,
- BBG Compressed Air System, and
- BBG Air Intake and Exhaust Gas System.

(4) **Modes of Operation**

Modes of operation of the BBGs are summarised as follows:

(a) Emergency operating mode

The BBGs supply power to diverse provisions which are necessary for reactor safety in the event of LOOP and LOCA associated with LOOP.

(b) Stand-by mode

During stand-by mode, it can be started up immediately by start-up signal at any time. To achieve this, the engine is pre-lubricated and pre-heated by BBG Lubricant System and BBG Cooling Water System.

Design Bases

This section describes the design basis for the BBGs.
The linkage between the Safety Functional Claims of BBG with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

The BBGs have been designed to meet the following SFC:

(a) The BBGs supply power to diverse provisions which are necessary for reactor safety in the event of a LOOP and a LOCA associated with a LOOP. [EPS SFC 5-3.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 2 requirements.
The main loads connected to each of BBGs are described in Chapter 15, Section 15.5: Electrical Equipment and Systems.

(b) The BBGs supply power in the event of severe accidents. [EPS SFC 5-3.2] This function is categorised as Category B and the components to deliver it are designed to meet Class 2 requirements.

System Design Description

This section describes the design of the BBGs to support and justify the delivery of EPS SFC 5-3.1 and EPS SFC 5-3.2. [Ref-16.6-2]

(1) **System Design and Operation**

The BBGs are composed of two electrical and mechanical independent divisions designated system 1 and system 2. Each division contains the necessary equipment for operation.

(2) **Equipment Design and Operation**

(a) Engine

(i) Purpose:
The engine supplies drive power to the generator.

(ii) Configuration and Operation:
BBGs are provided with an exhaust turbocharged engine. The engine is designed to be started by compressed air automatically. The engine is able to be started up and shut down by remote manual operation from the main control panel or at the local control panel [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(iii) Performance:
The engine is designed to be able to continuously operate at rated power under the specified operating condition. The rate of engine speed variance is lower than specified value [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(b) BBG Fuel Oil System

(i) Purpose:
The BBG Fuel Oil System (BBGFO) is intended to supply fuel oil to the engine for it to generate the electrical power.

(ii) Configuration and Operation:
Each engine is supplied with fuel oil from the BBGFO. The BBGFO consists of a Light Oil Tank (LOT) and two trains of fuel transfer pumps with the required piping and valves. A fuel oil day tank, providing fuel oil to the engine through gravity, is installed in each BBGFO train and holds enough fuel for eight hours of engine operation. Fuel oil is transferred from the LOT to the fuel oil day tanks by the pumps when it is detected that the fuel oil level falls below the specified level [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(iii) Performance:
The storage capacity of the BBG LOT is sufficient for continuously operating one engine for seven days at rated power [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(c) BBG Cooling Water System

(i) Purpose:
The BBG Cooling Water System (BBGCW) is configured to perform cooling and warming around the diesel engine cylinder for reduced start-up time and efficient operation of the BBGs.

(ii) Configuration and Operation:
Each engine is supplied with cooling water from an independent BBGCW. The BBGCW consists of tanks, pumps, heat exchanger, piping and valves. The BBGCW is cooled by Emergency Equipment Cooling Water System (EECW) [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(iii) Performance:
The cooling capacity of the BBGCW is sufficient for continuous operation at rated power. In order to facilitate the rapid starting of the engine, the engine is pre-heated [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(d) BBG Lubricant Oil System

(i) Purpose:
The BBG Lubricant Oil System (BBGLO) lubricates the parts requiring lubrication and cooling such as the main bearing of diesel engine and pre-lubricates and warms up the system to reduce the start-up time of the BBGs.

(ii) Configuration and Operation:
Each engine is supplied with lubricant oil from an independent BBGLO. The BBGLO consists of tanks, pumps, heat exchanger, piping and valves [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(iii) Performance:
The lubricating capacity of the BBGLO is sufficient for continuous operation at rated power. In order to facilitate the rapid starting of the engine, the engine is pre-heated and pre-lubricated [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(e) BBG Compressed Air System

(i) Purpose:
The BBG Compressed Air System (BBGCA) is intended to store the compressed air required to start up the engine.

(ii) Configuration and Operation:
The BBGCA provides a supply of compressed air for starting the engine without external power. The BBGCA consists of starting air receiver, air compressor, piping and valves. The BBGCA has two lines from the starting air receiver to the engine [EPS SFC 5.3-1 and EPS SFC 5.3-2].

(iii) Performance:
Each compressed air system has enough air storage capacity for 5 starts. The BBGs shall be able to achieve the prescribed values of frequency within specified times until specified number of times engine starts. The capacity of air compressor is sufficient to recharge the air receiver within specified times [EPS SFC 5.3-1 and EPS SFC 5.3-2].

(f) BBG Air Intake and Exhaust Gas System

(i) Purpose:
The BBG Air Intake and Exhaust Gas System (BBGAE) intakes the combustion air from outside of the Backup Building (B/B) and exhausts the combustion gas to outside.

(ii) Configuration and Operation:
Each engine is supplied with combustion air, and discharges exhaust gas by an independent BBGAE. The BBGAE consists of an expansion joint, an exhaust silencer, piping and valves. The exhaust gas drives the turbocharger to increase amount of intake air [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(iii) Performance:
The air intake is from the piping through the outside of the B/B, and exhaust gases are released atmosphere via exhaust silencer on the B/B roof [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(g) Generator

(i) Purpose:
Generator generates the electricity needed to safely shut down reactor in the event of LOOP and LOCA associated with LOOP.

(ii) Configuration and Operation:
The generator is a synchronous generator and is directly coupled to the engine [EPS SFC 5-3.1 and EPS SFC 5.3-2].

(iii) Performance:
The generator shall be able to continuously operate with rated load. The capacity of generator is sufficient to supply power to the necessary load (such as a load for fuel cooling) in the event LOOP or LOCA associated with LOOP. Rate of generator voltage variance is lower than the specified value [EPS SFC 5-3.1 and EPS SFC 5-3.2].

(3) **Main Support Systems**

The main systems supporting SSCs for the delivery of the safety functions are briefly described as follows:

Emergency Equipment Cooling Water System (EECW)

The EECW supplies water to the Heat Exchanger of BBG. In these Heat Exchangers, the heat of BBGCW is removed. The BBGs are connected to independent and separated EECW divisions.

Assumptions, Limits and Conditions for Operation

In order to ensure that the BBG is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs, surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is described in the Basis of Safety Cases on the Emergency Power Supply System [Ref-16.6-2].

- The diesel fuel oil, lube oil, starting air sub-system shall be within limits.

16.6.2.3 Diverse Additional Generator

System Summary Description

This section is a general introduction to the Diverse Additional generator (DAG) where the system roles, system functions, system configuration and modes of operation are briefly described. [Ref-16.6-2]

(1) **System Roles**

The role of the DAG is to supply power needed to shut down the reactor safely when the off-site power is lost and to supply power to the electrical systems supporting the delivery of safety functions in the event of the simultaneous occurrence of LOOP and Common Cause Failure (CCF) of the EDGs.

(2) **Functions Delivered**

The DAG is designed to perform the following main function:
The DAG supplies power to loads necessary in the event of the simultaneous occurrence of LOOP and CCF of the EDGs to safely shut down the reactor.

(3) **Basic Configuration**

The DAG consists of the following main components.

- Prime Mover,
- Generator,
- DAG Fuel Oil System,
- DAG Lubricant Oil System, and
- DAG Air Intake and Exhaust Gas System.

(4) **Modes of Operation**

Modes of operation of the DAG are summarised as follows.

(a) Emergency operating mode

The DAG supplies power to loads necessary to safety shut down the reactor in the event of the simultaneous occurrence of LOOP and CCF of the EDGs.

(b) Stand-by mode

During stand-by mode, the DAG can be started-up by start-up signal at any time. To achieve this, the prime mover is pre-lubricated by the DAG Lubricant Oil System.

Design Bases

This section describes the design bases for the DAG.

The DAG has been designed to meet the following SFC:
The DAG supplies power to loads necessary to secure functions of engineering safety facilities and necessary to safely shut down the reactor in the event of the simultaneous occurrence of LOOP and CCF of EDGs. [EPS SFC 5-3.3]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

System Design Description

This section describes the design of the DAG to support and justify the delivery of EPS SFC 5-3.3. [Ref-16.6-2]

(1) **System Design and Operation**

The DAG contains the necessary equipment as follows.

(2) **Equipment Design and Operation**

(a) Prime Mover

(i) Purpose:
The prime mover supplies drive power to the generator.

(ii) Configuration and Operation
The DAG is a different device from EDG and BBG. The prime mover is designed to be started by an electrical signal automatically. The engine is able to be started up and shut down by remote manual operation from the main control panel or at a local control panel [EPS SFC 5-3.3].

(iii) Performance:
The prime mover is designed to be able to continuously operate at rated power under the specified operating condition. The rate of engine speed variance is lower than specified value [EPS SFC 5-3.3].

(b) DAG Fuel Oil System

(i) Purpose:
The DAG Fuel Oil System (DAGFO) is intended to supply fuel oil to the prime mover for generating the electrical power.

(ii) Configuration and Operation:
The prime mover is supplied with fuel oil from the DAGFO. The DAGFO consists of tanks, pumps, piping and valves. The fuel oil day tank, which holds enough fuel for eight hours of engine operation, will be installed at the outlet of the DAGFO. Fuel oil will be filled to the fuel oil day tank from the light oil

tank when it is detected that the fuel oil level falls below the specified level [EPS SFC 5-3.3].

(iii) Performance:
The storage capacity of DAGFO is sufficient for operation of the engine for seven days at rated power [EPS SFC 5-3.3].

(c) DAG Lubricant Oil System

(i) Purpose:
The DAG Lubricant Oil System (DAGLO) lubricates the parts requiring lubrication and cooling such as main bearing of prime mover and pre-lubricates and warms up the system to reduce the start-up time of the DAG.

(ii) Configuration and Operation:
The engine is supplied with lubricant oil from the DAGLO. The DAGLO consists of tanks, pumps, heat exchanger, piping and valves [EPS SFC 5-3.3].

(iii) Performance:
The lubricating capacity of the DAGLO is sufficient for continuous operation at rated power. In order to facilitate the rapid starting of the engine, the engine is pre-heated and pre-lubricated [EPS SFC 5-3.3].

(d) DAG Air Intake and Exhaust Gas System

(i) Purpose:
The DAG Air Intake and Exhaust Gas System (DAGAE) intakes the combustion air from outside of DAG Building (DAG/B) and exhausts the combustion gas to outside.

(ii) Configuration and Operation:
The prime mover is supplied with combustion air and discharge exhaust gas by the DAGAE. The DAGAE consists of an expansion joint, an exhaust silencer, piping and valves [EPS SFC 5-3.3].

(iii) Performance:
The air intake is from the piping through the outside of DAG/B, and exhaust gases are released atmosphere via exhaust silencer on the DAG/B roof [EPS SFC 5-3.3].

(e) Generator

(i) Purpose
Generator generates electricity needed to safely shut down reactor in the event of the simultaneous occurrence of LOOP and CCF of the EDGs.

(ii) Configuration and Operation
The generator is a synchronous generator and is directly coupled to the engine [EPS SFC 5-3.3].

(iii) Performance
The generator shall be able to continuously operate with rated load. The capacity of generator is sufficient to supply power to necessary load (such as a load for fuel cooling) in the event of the simultaneous occurrence of LOOP and CCF of the EDGs.
Rate of generator voltage variance is lower than specified value [EPS SFC 5-3.3].

Assumptions, Limits and Conditions for Operation

In order to ensure that the DAG is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs, surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information is transferred to the future licensee to operate the plant as designed in the safety case.

- The diesel fuel oil and lube oil sub-system shall be within limits.

16.6.3 Suppression Pool Clean-up System

System Summary Description

This section is a general introduction to the Suppression Pool Clean-up System (SPCU) where the system roles, system functions, system configuration and modes of operation are briefly described. Further detail design information is shown in related supporting documents. [Ref-16.6-6][Ref-16.6-7] For detail of chemistry aspect, see Chapter 23: Reactor Chemistry, Section 23.6.

(1) **System Roles**

The purpose of the SPCU is to clean the water in the Suppression Pool (S/P) by transferring the pool water through the Fuel Pool Cooling and Clean-up System Filter Demineraliser (FPC F/D) div. B and returning it back to the S/P. The treated water can be used for water-filling of the upper pools as well (Reactor Well and Steam Dryer, Steam Separator Pit (D/S Pit)) during preparation for re-fuelling outage.
Moreover, the SPCU is capable of drawing water from the Condensate Storage Tank (CST) or the S/P to supply water to the Spent Fuel Storage Pool (SFP) as required.

(2) **Functions Delivered**

(a) The primary function of the SPCU is to provide purifying water treatment for the S/P. The SPCU removes miscellaneous impurities by filtration, adsorption, and ion exchange processes. Moreover, it maintains the S/P water quality within the specification.

(b) The SPCU provides water-filling to the upper pools prior to refuelling.

(c) The SPCU provides makeup water to the Spent Fuel Storage Pool (SFP) from the Condensate Storage Tank (CST) or the S/P, if available, in the loss of coolant event in the SFP and regular makeup water system is failed or the capacity is insufficient to makeup the pool.

(3) **Basic Configuration**

The SPCU consists of the following components:

- SPCU Pump,
- FPC F/D (B) (installed on the FPC),
- Piping and Valves, and
- Instrumentation and Controllers.

Figure 16.6-2 shows an outline of the SPCU.

(4) **Modes of Operation**

The SPCU can deliver the following operation modes by switching the position of the valves.

(a) Suppression Pool Water Clean-up Mode

Water from the S/P is drawn by the SPCU Pump, treated by the FPC F/D (B), and returned to the S/P. The operation is initiated and stopped by the operator. Since this operation mode is not a continuous operation mode, only one of the two F/D units (F/D (B)) is designed to be utilized, and is capable of operating in parallel with F/D unit B performing clean-up of the SFP.
This mode is operated sufficiently to satisfy the specified water quality requirements before refuelling outage.

(b) SFP Water-Filling and Drainage Mode

Water from the S/P is transferred to the upper pools prior to fuel replacement on this mode to fill up the pools for shielding during fuel and components handling. The outlet valve on the water supply line to the Dryer/Separator (D/S) Pit (from downstream of the F/D (B)) is opened and the valve on the return piping to the S/P is closed to transfer water. The flow rate is equal to that of the S/P Water Clean-up Mode to facilitate operation of the F/D. This operating mode is initiated and stopped by the operator.

This operation mode is also to drain water in the SFP after fuel replacement operation. Water is cleaned up by the FPC F/D and directly drained through the SPCU return line to the S/P. This operation mode can perform clean-up with one FPC F/D or both FPC F/Ds.

(c) SFP Makeup Mode

Feed-water to the SFP is performed by initiating the SPCU Pump and opening each inlet valve. Water can be drawn from the CST or the S/P by the SPCU Pump, and is directly transferred to the SFP without passing through the FPC F/D. The S/P is used as a backup water source instead of the CST. However, The S/P water is supplied only during events that do not involve Loss of Coolant Accident (LOCA). This operating mode is initiated and stopped by the operator.

Design Bases

This section describes the design bases for the SPCU. [Ref-16.6-6]
The linkage between the Safety Functional Claims of SPCU with the Fundamental Safety Functions (FSF) and the High Level Safety Functions (HLSF) is shown in the Appendix A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

The SPCU has been designed to meet the following SFCs. The relation between the SFCs put on this system and the high level claims is shown on Appendix A.

Normal Operations

(a) The SPCU provides purifying water treatment for the S/P in plant normal operation. It removes various impurities by filtration, adsorption, and ion exchange processes. [SPCU SFC 5-9.1]
This function is categorized as Category C and the components to deliver it are designed to meet Class 3 requirements.

(b) The SPCU piping outside the PCV boundary contains radioactive material. Rupture of this piping could lead to a release of radioactive material of dose consequences relatively low. [SPCU SFC 4-4.1]
This function is categorised as Category C and the components to deliver it are designed to meet Class 3 requirements.

Fault Conditions

(a) The SPCU provides makeup water to the SFP at loss of SFP coolant condition. [SPCU SFC 2-5.1]
This function is categorized as Category C and the components to deliver it are designed to meet Class 3 requirements.
This safety function is developed and justified in the section related to the Spent Fuel Pool Cooling in Chapter 19: Fuel Storage and Handling.

(b) The SPCU components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [SPCU SFC 4-7.1]
This function is categorized as Category A and the components to deliver it are designed to meet Class 1 requirements.
This safety function is developed and justified in the section related to the Primary Containment Facility in Chapter 13, Section 13.3: Containment System.

System Design Description

This section describes the design of the SPCU to support and justify the delivery of SPCU SFC 5-9.1. Additional design description can be found in [Ref-16.6-6][Ref-16.6-7].

(1) **Overall System Design and Operation**

FPC F/D unit B is separated from the SFP clean-up mode and used for S/P Water clean-up mode. Water from the S/P is drawn by the SPCU Pump, treated by the FPC F/D (B), and returned to the S/P. The operation is initiated and stopped by the operator. However, this operation mode is automatically shut off to isolate systems from the S/P upon Primary Containment Vessel (PCV) isolation signal. Since this operation mode is not a normal operation mode, only one of the two F/D units (F/D (B)) is designed to be utilized, and is capable of operating in parallel with F/D unit D performing clean-up of the SFP. Therefore, in the event that F/D (B) was operating as a SFP clean-up filter, it is switched to the F/D (D) and F/D (B) is used on S/P clean-up mode. This mode is sufficiently operated to satisfy the specified water quality requirements before refuelling outage.

(2) **Equipment Design and Operation**

(a) SPCU Pump

(i) Purpose
The SPCU pump provides flow of the water from the S/P to circulate it through the FPC F/D (B) in order to deliver SPCU SFC 5-9.1.

(ii) Configuration
One SPCU Pump capable of continuous operation is provided. The SPCU Pump is located on the bottom floor of the reactor building and close to the S/P so that adequate suction head is assured during all the operating modes and the pump suction line remains flooded.

(iii) Performance
The flow rate of the SPCU Pump is the same as the FPC F/D flow. The SPCU Pump total head is such that the pump is capable of drawing water from the S/P and transferring it to the upper pools passing through the FPC F/D (B). The SPCU Pump is designed to have sufficient suction head under the most demanding conditions during all operation modes. The Specification of SPCU Pump required for the delivery of SPCU SFC 5-9.1 is shown as follows:

- Number 1 unit
- Pump type Turbo
- Rated Flow approx.250 m^3/h
- Design Pressure 1.57 MPa[gauge]

(b) FPC Filter-demineraliser (B)

(i) Purpose
The FPC F/D (B) purifies the water from the S/P by removing the various impurities through filtration, adsorption and ion exchange processes in order to deliver SPCU SFC 5-9.1.

(ii) Configuration
During normal plant operation, the SPCU is designed to recirculate approximately 250m^3/h of suppression pool water through one of the FPC Filter-demineraliser (B).

(iii) Performance

- Number 1 unit
- Capacity approx. 250m^3/h

(3) **Main Support Systems**

(a) Instrumentation and Control Systems

Instrumentation

(i) A flow element and a flow transmitter are provided on the SPCU Pump discharge line in order to measure the flow and inform the main control room. A switch is provided with an interlock to protect the SPCU Pump and warn the main control room that the discharge flow is low.
(ii) A pressure switch is provided on the suction side of the SPCU Pump, to protect the pump with an interlock and warn the main control room that the suction pressure is low.
(iii) The statuses of all motor operated valves are indicated in the main control room.

(b) Interlock
   (i) The SPCU Pump is not operable unless the suction valve, on the S/P or the CST side, is fully opened.
   (ii) The SPCU Pump is tripped upon low suction pressure or low discharge flow signals. In addition, the pump is tripped upon Low Water Level in the S/P.

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.6-1]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

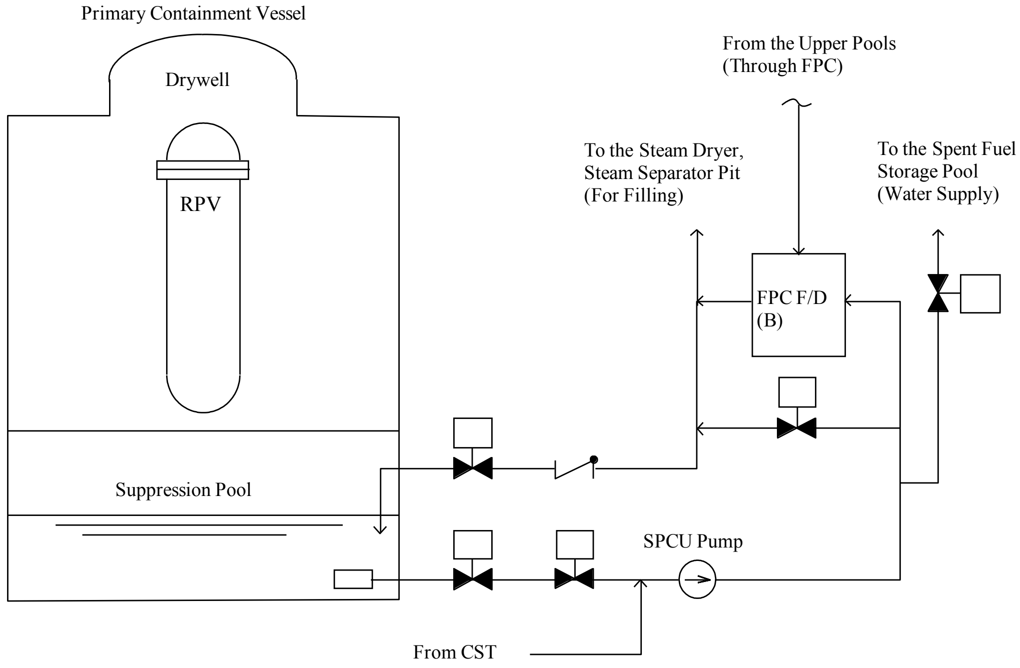


Figure 16.6-2 : Outline of SPCU Configuration

16.7 Severe Accident Mechanical Systems

16.7.1 Summary of Description

This section summarises the Severe Accident Mechanical Systems in consideration of beyond design basis faults. Beyond design basis faults, that potentially lead to multiple losses of the safety facilities due to the CCF in safety systems or terrible external hazard (e.g. earthquake, flooding, aircraft crash, tornado, terror attacks and so on), are defined as the fault which satisfies both following two conditions:

(1) Frequency of initiating fault < 10^{-5} /y and
(2) Frequency of fault sequence < 10^{-7} /y.

Severe accidents are defined as those fault sequences that could lead either to consequences exceeding the highest offsite radiological doses given in the BSL of Numerical Target 4, or to an unintended relocation of a substantial quantity of radioactive material within the facility which places a demand of remaining physical barriers.

Severe Accident Mechanical Systems are general terms for the following systems which are provided as a backup of safety functions for design basis faults in the event of beyond design basis faults or severe accidents:

- Flooder System of Specific Safety Facility (FLSS),
- Flooder System of Reactor Building (FLSR),
- Reactor Depressurisation Control Facility (RDCF),
- Lower Drywell Flooder System (LDF),
- Filtered Containment Venting System (FCVS),
- Alternate Heat Exchange Facility (AHEF), and
- Alternative Nitrogen Injection System (ANI).

The FLSR, AHEF and the ANI include mobile facilities; therefore these systems need manual deployment before initiation.

16.7.2 Design Basis

16.7.2.1 Safety Functions

The Severe Accident Mechanical Systems are designed to provide alternative and additional means to deliver the key safety functions of cooling the core and maintaining containment. The Severe Accident Mechanical Systems meet the following safety functions:

(1) The FLSS and FLSR provide coolant to the reactor core in order to prevent significant reactor core damage and to maintain reactor core cooling in the event of the Emergency Core Cooling System (ECCS) failure.
(2) The FLSS and FLSR supply coolant to the Primary Containment Vessel (PCV) spray header to provide direct cooling of the upper drywell atmosphere.
(3) The FLSS and FLSR provide coolant to the reactor well to prevent Dry well (D/W) head flange failure due to excess over-temperature.
(4) The FLSS and FLSR provide coolant to the Spent Fuel Storage Pool (SFP) to cool the spent fuel and to maintain the pool water level in the event of Loss of Coolant Accident (LOCA) or loss of the makeup/cooling function of the SFP.
(5) The RDCF provides reactor vessel depressurisation by controlling the target SRVs in order to enhance the water injection to the reactor core at low pressure for core cooling or long-term heat removal.
(6) The LDF provides water to the lower D/W under the severe accident condition of the vessel failure to cool the molten core and to prevent PCV failure due to the pedestal failure.
(7) The FCVS releases PCV gas though vent pipes to deliver containment overpressure protection and long-term PCV heat removal with water injection system such as the FLSS and the FLSR.
(8) The FCVS reduces the release of large quantities of radioactive iodine and long half-life fission products contained in venting gas through the FCVS Vent Filter under the severe accident condition.
(9) The AHEF removes heats from the Residual Heat Removal System (RHR) Heat Exchanger by supplying cooling water to the Reactor Building Cooling Water System (RCW) circuit from the mobile AHEF cooling unit in the event of the RCW function failure.
(10) The ANI supplies nitrogen gas to the both sides of the Wet well (W/W) and the D/W in order to inert the PCV atmosphere in the terminating phase after severe accident where PCV venting is operated.

16.7.3 System Design Description

16.7.3.1 Flooder System of Specific Safety Facility

System Summary Description

This section is a general introduction to the Flooder System of Specific Safety Facility (FLSS) where the system roles, system functions, system configuration and modes of operation are briefly described. The FLSS safety case is justified in the Basis of Safety Cases (BSC) on Severe Accident Mechanical Systems [Ref-16.7-1]. The FLSS design is described in the system specifications [Ref-16.7-2] and the piping and instrumentation diagrams [Ref-16.7-3][Ref-16.7-4].

(1) System Roles

The main role of the FLSS is to supply cooling water by the FLSS pumps installed in the Backup Building (B/B) to prevent core damage as a backup to the ECCS low-pressure core injection function. The FLSS is also initiated to mitigate serious core damage, Reactor Pressure Vessel (RPV) breakage and PCV breakage.
Furthermore, the FLSS provides cooling and makeup water for the SFP to maintain the water level in the event that the water supply and cooling function to the SFP fails.

(2) Functions Delivered

The FLSS is designed to perform the following functions:
(a) The FLSS provides cooling water to the reactor core.
(b) The FLSS provides cooling water to the PCV spray header.
(c) The FLSS provides cooling water to the Lower D/W
(d) The FLSS provides cooling water to the reactor well.
(e) The FLSS provides cooling water to the SFP.

The FLSS initiates automatically as a backup of the ECCS low-pressure core injection function for design basis faults and is designed to be operated manually from either the Main Control Room (MCR) or the B/B for beyond design basis faults.

(3) Basic Configuration

The FLSS consists of the FLSS Water Storage Tanks, FLSS Pumps, piping, valves, instrumentation and controllers. Injection lines are provided for each destination described in above, as shown in Figure 16.7-1. The main components are summarised as follows:
(a) The FLSS Pumps installed in the B/B which is totally independent from the Reactor Building (R/B)
(b) Piping and valves connecting to the feed water line of the RHR
(c) Piping and valves connecting to the PCV spray line of the RHR
(d) Piping and valves connecting to the Lower D/W supply line of the Makeup Water Condensate System (MUWC)
(e) Piping and valves connecting to the reactor well supply line of the Fuel Pool Cooling and Clean-up System (FPC)
(f) Piping and valves connecting to the SFP makeup water supply line of the FPC

(4) Modes of Operation

The FLSS can deliver the following operation modes by switching the position of the valves:

(a) Standby Mode

The FLSS is on standby during plant normal operation.

(b) RPV Injection Mode before Core Damage

The FLSS provides cooling water to the reactor core as a backup of the ECCS low-pressure core injection function in the event of design basis faults. Also the FLSS provides cooling water to the reactor core in the event of beyond design basis faults.

(c) Multiple Injection Mode before RPV Failure

The FLSS provides cooling water to the reactor core, the lower D/W and the reactor well in the event of severe accidents.

(d) Multiple Injection Mode after RPV Failure

The FLSS provides cooling water to the reactor core, the PCV spray header and the lower D/W in the event of severe accidents.

(e) SFP Injection Mode

The FLSS provides cooling water to the SFP in the event of design basis faults or beyond design basis faults.

(f) Test Mode

Functional tests of the FLSS are performed to confirm that the FLSS pumps deliver the required flow rate. In the test mode, water is taken from the FLSS water storage tanks by FLSS pumps and returned via the test piping.

Design Bases

This section describes the design bases for the FLSS.

Provisions for installing permanent and mobile safety facilities are put in place as countermeasures against the events that potentially lead to multiple losses of the safety facilities including the ECCS. The FLSS is designed as a permanent safety facility of UK ABWR and is designed to meet the following SFCs. The relation between the SFCs put on this system and the high level claims is shown in Appendix-A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Fault Conditions

(a) The FLSS is the secondary means to provide reactor core cooling so that significant damage to the fuel is prevented and the reaction between the fuel cladding and the reactor coolant is sufficiently minimised in the event of a fault where all the primary reactor core cooling means (ECCS) have failed. [FLSS SFC 2-2.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 2 requirements.

(b) In the eventuality that the cooling function for the SFP is unavailable or small leakage from the SFP occurs, the FLSS supplies sufficient water to maintain the water level of the SFP as a secondary means of cooling the spent fuel stored in the SFP. [FLSS SFC 2-5.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 2 requirements.

(c) The FLSS is the principal means to provide reactor core cooling in order to prevent significant damage to the fuel and minimise the reaction between the fuel cladding and the reactor coolant sufficiently in the event of beyond design basis faults and severe accidents. [FLSS SFC 2-2.2]
This function is categorised as Category B and the components to deliver it are designed to meet Class 2 requirements.

(d) The FLSS is the principal means to provide PCV cooling with PCV spray in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents. [FLSS SFC 4-9.1]
This function is categorised as Category B and the components to deliver it are designed to meet Class 2 requirements.

(e) The FLSS is the principal means to provide molten core cooling with lower D/W injection in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents. [FLSS SFC 4-9.2]
This function is categorised as Category B and the components to deliver it are designed to meet Class 2 requirements.

(f) The FLSS is the principal means to provide PCV head flange cooling in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents. [FLSS SFC 4-9.3]
This function is categorised as Category B and the components to deliver it are designed to meet Class 2 requirements.

(g) The FLSS is the principal means to provide SFP with makeup water to mitigate significant damage to the spent fuel due to potential long term SBO and subsequent loss of SFP cooling function in the event of beyond design basis faults or severe accidents. [FLSS SFC 2-5.2]
This function is categorised as Category B and the components to deliver it are designed to meet Class 2 requirements.

(h) The FLSS is the principal means to provide SFP with spray water to mitigate significant damage to the spent fuel due to loss of the fuel pool water resulting from loss of makeup water or a large leakage from the SFP in the event of beyond design basis faults or severe accidents. [FLSS SFC 2-5.3]

This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(i) The FLSS components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [FLSS SFC 4-7.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. This safety function is developed and justified in Chapter 13: Engineered Safety Features, Section 13.3.3.2 related to the Primary Containment Isolation System.

System Design Description

This section describes the design of the FLSS to support and justify the delivery of FLSS SFCs. Additional design description can be found in [Ref-16.7-1], [Ref-16.7-2], [Ref-16.7-3] and [Ref-16.7-4].

(1) Overall System Design and Operation

(a) RPV Injection Mode before Core Damage

The FLSS provides cooling water to the RPV as a backup of the ECCS low-pressure core injection function to prevent core damage in the event of design basis faults. In this case FLSS pumps are initiated automatically upon detection of reactor low water level, and water injection is started after RPV depressurisation by the RDCF.
Also the FLSS provides cooling water to the RPV to prevent core damage in the event of beyond design basis faults. In this case the FLSS is initiated manually from either the MCR or the B/B.

(b) Multiple Injection Mode before RPV Failure

In the case of reactor core damage, the FLSS provides cooling water to the RPV to cool reactor core for prevention of the RPV failure. In parallel the FLSS provides cooling water to the lower D/W to make a pool at lower D/W in preparation for the drop of the molten corium in case of RPV failure. Also the FLSS provides cooling water to the reactor well to prevent a breach of the PCV head due to high temperature. In this case the FLSS is initiated manually from either the MCR or the B/B. The flow rate to each destination is controlled with the flow control valves mounted on each injection line inside the B/B.

(c) Multiple Injection Mode after RPV Failure

In the case of RPV failure, the FLSS provides cooling water to the RPV and the lower D/W to cool the molten corium for prevention of the PCV failure. In parallel the FLSS provides cooling water to the PCV spray line to prevent PCV breach due to high temperature. In this case the FLSS is initiated manually from either the MCR or the B/B. The flow rate to each destination is controlled with the flow control valves mounted on each injection line inside the B/B.

(d) SFP Injection Mode

The FLSS provides cooling water to the SFP as a backup to the FPC to maintain SFP water level in the event of design basis faults where the SFP small leakage occurs. Also the FLSS provides cooling water to the SFP with sprays, to mitigate significant damage to the spent fuel in the event of beyond design basis faults and severe accidents where a large leakage occurs. In both case the FLSS is initiated manually from either the MCR or the B/B.

(e) Test Mode

Functional tests of the FLSS are performed to confirm that the FLSS Pumps deliver the required flow rate. In the test mode, water is taken from the FLSS Water Storage Tanks by FLSS Pumps and returned via the test piping.

(2) Equipment Design and Operation

(a) FLSS Pump

(i) Purpose
The purpose of the FLSS Pumps is to provide cooling water for the FLSS operation modes described in section (4) in order to deliver FLSS SFC 2-2.1, FLSS SFC 2-5.1, FLSS SFC 2-2.2, FLSS SFC 4-9.1, FLSS SFC 4-9.2, FLSS SFC 4-9.3 and FLSS SFC 2-5.2.

(ii) Configuration and Operation
Four pumps are provided in the FLSS. Two pumps are installed on each division, and the FLSS has two separate divisions.

(iii) Performance
The pump capacity is designed to satisfy the highest flow rate among the required flow rates of the FLSS operation modes described in section (4) “Modes of Operation” in order to deliver related FLSS SFCs.
The main specifications of the FLSS Pump are described below:

Number:	2 units / division (2 divisions)
Rated flow:	Approx. 330m^3/h/unit
Head	165 m

(b) FLSS Water Storage Tank

(i) Purpose
The FLSS Water Storage Tanks provide a sufficient source of water for the FLSS all injection modes in order to deliver FLSS SFC 2-2.1, FLSS SFC 2-5.1, FLSS SFC 2-2.2, FLSS SFC 4-9.1, FLSS SFC 4-9.2, FLSS SFC 4-9.3 and FLSS SFC 2-5.2, FLSS SFC 2-5.3.

(ii) Configuration and Operation
The FLSS is provided with ten vertical FLSS Water Storage Tanks, and the FLSS Pump suction line and minimum flow return line connect to all tanks. Water supply line and drain line are provided with each tank.

(iii) Performance

The tank capacity is designed to satisfy the all required FLSS injection functions for seven days, and considers:

- The amount of water supply for removal of the decay heat in case the RPV damage occurs, including the amount of water for the RPV injection and the lower D/W injection,
- The amount of water supply to the PCV spray line,
- The amount of water supply to the reactor well, and
- The amount of water supply to the SFP.

The main specifications of the FLSS Pump are described below:

Number:	10 units
Effective Volume:	approximately 1120m^3/unit

(3) Main Support Systems

(a) Instrumentation and Control Systems

The main instrumentation and control provisions related to the FLSS operations are summarised from the performance and reliability points of view:

(i) Instrumentation

Instrumentation is provided to measure and monitor the operating conditions of the FLSS components necessary for the delivery of the safety functions. The main provisions for instrumentation are described as follows:

The following values are measured and displayed in both the Backup Building Control Panel (BBCP) and the MCR.

- FLSS Pump discharge/suction pressure
- FLSS Pump discharge flow rate
- FLSS Water Storage Tank water level

The following alarms are implemented.

- Low FLSS Pump inlet pressure
- Low FLSS Water Storage Tank water level

(ii) Control

The main control provisions related to the delivery of the FLSS safety functions are summarised as follows.

The FLSS is automatically actuated and controlled by the logic of the Hardwired Backup System (HWBS), in the event of design basis fault where all divisions of the ECCS fail to initiate.
For further details of the HWBS see Chapter 14: Control and Instrumentation, Section 14.6.3.

The FLSS is also actuated and controlled remotely from the BBCP of SA C&I system or the HWBP in the MCR.
For further details of the SA C&I system see Chapter 14: Control and Instrumentation, Section 14.6.6.

(b) Power Supply System

The configuration of the power supply system necessary to deliver the FLSS safety functions is summarised as follows.

(i) In the event of accident where the offsite power source and all divisions of Emergency Diesel Generator (EDG) are unavailable, the FLSS Pumps and other active components are supplied Alternating Current (AC) power by the Backup Building Generator (BBG) which is located in the B/B.
For further details of the BBG see Chapter 15: Electrical Power Supplies, Section 15.4.6.

(ii) FLSS Pump (A), (C) and related motor-operated valves are connected to BBG division A, FLSS Pump (B), (D) and related motor-operated valves are connected to BBG division B.

Assumptions, Limits and Conditions for Operation

In order to ensure that the FLSS is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs, surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is described in the Basis of Safety Cases on Severe Accident Mechanical Systems [Ref-16.7-1]

- Two trains of the FLSS shall be operable during power operation, start-up, hot shutdown, cold shutdown and refuelling for the delivery of the SFCs claimed when required.

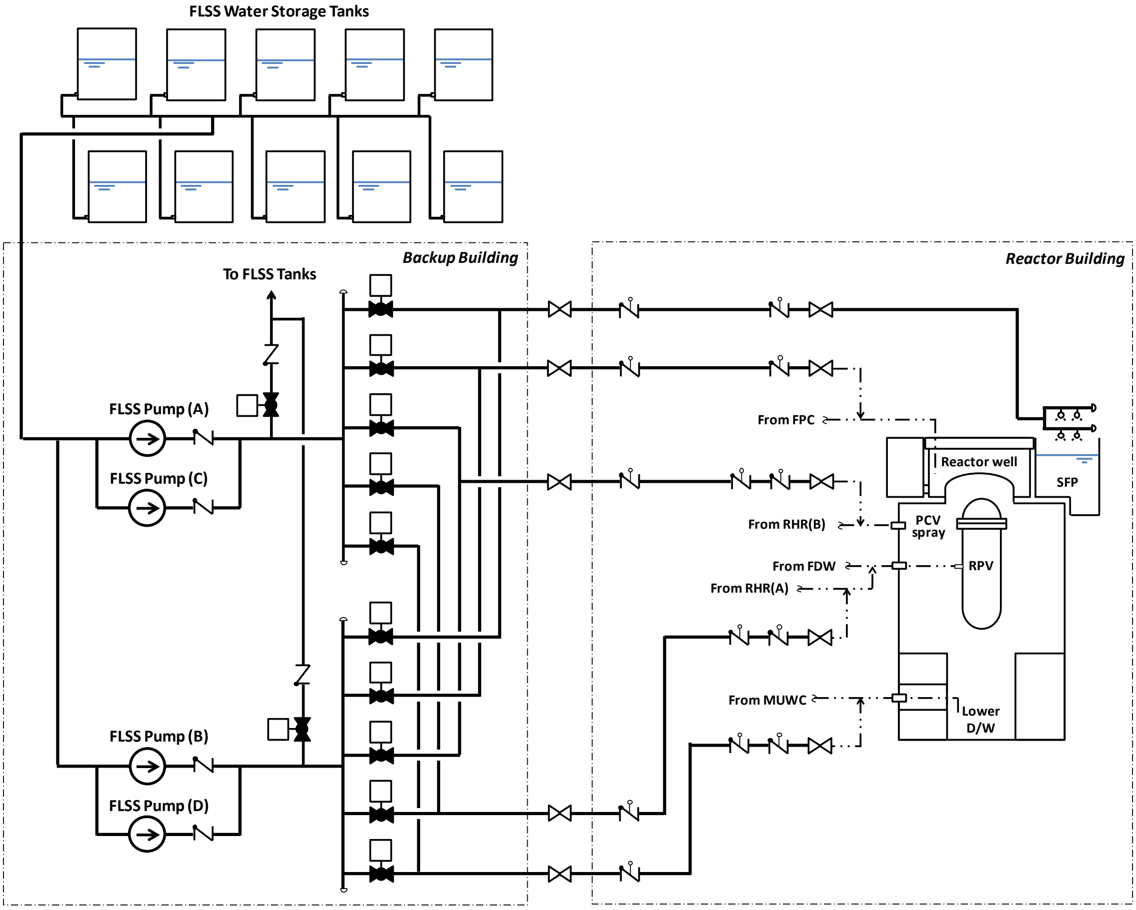


Figure 16.7-1 : Outline of the Flooder System of Specific Safety Facility

16.7.3.2 Flooder System of Reactor Building

System Summary Description

This section is a general introduction to the Flooder System of Reactor Building (FLSR) where the system roles, system functions, system configuration and modes of operation are briefly described. The FLSR safety case is justified in the Basis of Safety Cases on Severe Accident Mechanical Systems [Ref-16.7-1]. The FLSR design is described in the system specifications [Ref-16.7-5] and the piping and instrumentation diagrams [Ref-16.7-6].

(1) System Roles

The main role of the FLSR is to supply cooling water by FLSR Mobile Pumps to mitigate serious damage to the core fuel and to mitigate PCV breakage in the event where the core cooling function fails. The FLSR also has the role of maintaining the SFP water level in the event of severe accidents where the water supply and cooling functions to the SFP fails.

(2) Functions Delivered

The FLSR is designed to perform the following functions:
(a) The FLSR provides cooling water to the reactor core.
(b) The FLSR provides cooling water to the PCV spray header.
(c) The FLSR provides cooling water to the Lower D/W.
(d) The FLSR provides cooling water to the reactor well.
(e) The FLSR provides cooling water to the SFP.

(3) Basic Configuration

The FLSR consists of FLSR Mobile Pumps, the necessary piping, valves and instrumentation. The FLSR has its own water source but can use any water source on site. Two individual hose connections are provided for each destination and mounted separately on outside of the R/B as shown in Figure 16.7-2. The FLSR supplies cooling water by connecting the FLSR Mobile Pumps to any water source on-site and to the FLSR injection piping.

(4) Modes of Operation

The FLSR needs to be manually arranged using the FLSR mobile equipment before initiating. Once installed, the FLSR can deliver the following operation modes by switching the position of the valves.

(a) Standby Mode

The FLSR is not expected to be activated during normal plant operation. The components are at the designated standby storage locations and are ready to be moved to the predefined place for operation. Regular testing of the FLSR equipment is carried out by the operator during normal plant operation.

(b) Multiple Injection Mode before RPV Failure

Once the FLSR equipment is deployed, the FLSR provides coolant to the RPV by adjusting control valve. In parallel, the FLSR supplies coolant to the lower D/W to prepare a pool for the molten corium in the case of core melt and failure of the RPV and it also provides coolant to the reactor well to prevent a breach of the PCV due to high temperature.

(c) Multiple Injection Mode after RPV Failure

In the accident condition of vessel failure, the FLSR provides coolant to the RPV and the lower D/W line and in parallel supplies water to the PCV spray line to cool down the PCV and prevent its breach due to high temperature. The supply flow rate is adjusted based on any pressure decrease or increase.

(d) SFP Injection Mode

In the event of beyond design basis faults where the cooling function of the SFP is unavailable or leakage occurs, the FLSR can be initiated as a backup of the FLSS to provide makeup water to the SFP.

Design Bases

This section describes the design bases for the FLSR.
Provisions for installing permanent and mobile safety facilities are put in place as countermeasures against the events that potentially lead to multiple losses of the safety facilities including ECCS. The FLSR is designed as a mobile safety facility of UK ABWR and designed to meet the following SFCs. The relation between the SFCs put on this system and the high level claims is shown in Appendix-A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Fault Conditions

(a) The FLSR is a secondary means to provide reactor core cooling in order to prevent significant damage to the fuel and minimise the reaction between the fuel cladding and the reactor coolant sufficiently in the event of beyond design basis faults and severe accidents. [FLSR SFC 2-2.1]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(b) The FLSR is a secondary means to provide PCV cooling with PCV spray in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents where the primary PCV cooling means (FLSS) have failed. [FLSR SFC 4-9.1]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(c) The FLSR is a secondary means to provide molten core cooling with lower D/W injection in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents where the primary molten core cooling means (FLSS) have failed. [FLSR SFC 4-9.2]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(d) The FLSR is a secondary means to provide PCV head flange cooling in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents where the primary PCV head flange cooling means (FLSS) have failed. [FLSR SFC 4.9-3]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(e) The FLSR is a secondary means to provide SFP with makeup water as a backup of the FLSS in the event of design basis faults and beyond design basis faults or severe accidents [FLSR SFC 2-5.1]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(f) The FLSR is a secondary means to provide SFP with spray water to mitigate significant damage to the spent fuel due to loss of the fuel pool water resulting from loss of makeup water or a large leakage from the SFP as a backup of the FLSS in the event of beyond design basis faults or severe accidents. [FLSR SFC 2-5.2]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(g) The FLSR is a secondary means to provide reactor core cooling during outage in order to prevent significant damage to the fuel in the event of design basis fault where the primary (ECCS) and secondary (FLSS) means for core cooling are failed or unavailable. [FLSR SFC 2-2.2]
This function is categorised as Category A and the components to deliver it are designed to meet Class 3 requirements.

(h) The FLSR components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [FLSR SFC 4-7.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. This safety function is developed and justified in Chapter 13: Engineered Safety Features, Section 13.3.3.2 related to the Primary Containment Isolation System.

System Design Description

This section describes the design of the FLSR to support and justify the delivery of FLSR SFCs. Additional design description can be found in [Ref-16.7-1], [Ref-16.7-5] and [Ref-16.7-6].

(5) Overall System Design and Operation

The purpose of FLSR is to supply cooling water to the RPV, PCV, the SFP and the reactor well to prevent serious damage from occurring to the fuel in the RPV and in the SFP in the event of beyond design basis faults and to prevent PCV breakage by removing heat from the containment. Before initiating the FLSR, the FLSR needs to be manually arranged using the FLSR mobile equipment. The mobile pumps are connected to a water source inside the plant site boundary. The mobile pumps are also connected to the connection points installed on the FLSS injection piping. Once the FLSR equipment is arranged, the FLSR is able to supply cooling water to each destination through the FLSS injection lines.

(a) Multiple Injection Mode before RPV Failure

In the event of a beyond design basis fault where all the divisions of the ECCS are unavailable, the FLSR mobile pumps can be manually arranged, connected to a water source and to the injection piping and initiated as a backup of the FLSS. Once the FLSR equipment is arranged, the FLSR provides injection water to the RPV by adjusting a control valve after depressurisation of the RPV by the SRVs. In parallel, it also supplies water to the lower D/W to prepare a pool for the molten corium in the case of core melt and failure of the RPV and also to the reactor well to prevent a breakage of the PCV due to high temperature.

(b) Multiple Injection Mode after RPV Failure

In the accident condition of vessel failure, the FLSR provides injection water to the RPV and the lower D/W line and in parallel supplies water to the PCV spray line to cool down the PCV and prevent its breach due to high temperature. The supply flow rate is adjusted based on any pressure decrease or increase.

(c) SFP Injection Mode

In the event of beyond design basis faults where the cooling function of the Spent Fuel Pool (SFP) is unavailable or leakage occurs, the FLSR can be initiated as a backup of the FLSS to provide makeup water to the SFP.

(6) Equipment Design and Operation

FLSR Mobile Pump

(i) Purpose
The purpose of the FLSR Mobile Pumps is to provide a water flow to supply water for the several operation modes of the FLSR in order to deliver FLSR SFC 2-2.1, FLSR SFC 2-2.2, FLSR SFC 4-9.1, FLSR SFC 4-9.2, FLSR SFC 4.9-3, FLSR SFC 2-5.1 and FLSR SFC 2-5.2.

(ii) Configuration, Operation and Performance
The FLSR Mobile Pumps are provided with sufficient flowrate to ensure the FLSR SFCs are delivered. The number and type of pump will be specified by the future licensee to allow flexibility and use of standard available equipment (e.g. fire pumps).

(7) Main Support Systems

(a) Instrumentation and Control Systems

The main instrumentation and control provisions related to FLSR operation from the performance and reliability points of view are summarised as follows.

(i) Instrumentation
A flowmeter is installed on the mobile facility to confirm the pump discharge flow rate.

(ii) Control

The active components of FLSR are mounted on the mobile facility. Therefore the FLSR is actuated and controlled manually from mobile unit.

(b) Power Supply System

- The FLSR Mobile Pump and related instrumentations are powered by the mobile facility itself.
- Apart from mobile facility, the FLSR does not have any active components in the R/B (piping and check valves).

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.7-7]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

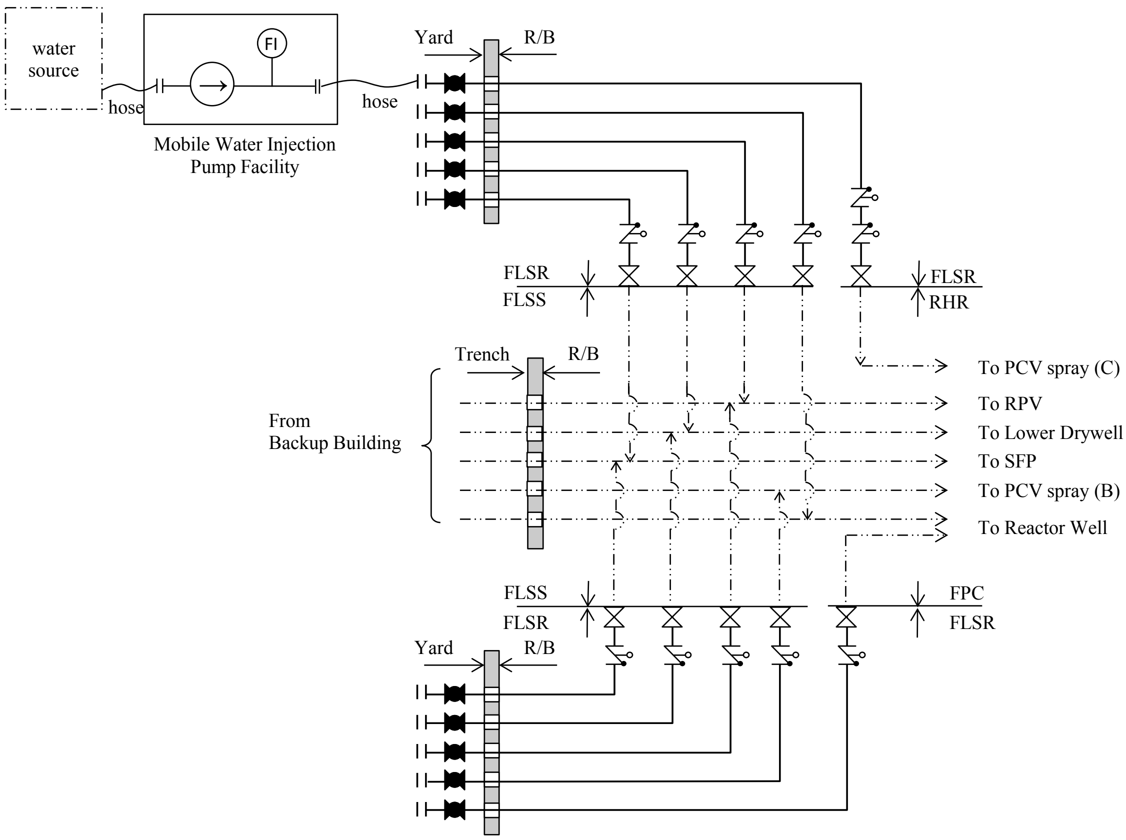


Figure 16.7-2: Outline of the Flooder System of Reactor Building

16.7.3.3 Reactor Depressurisation Control Facility

System Summary Description

This section is a general introduction to the Reactor Depressurisation Control Facility (RDCF) where the system roles, system functions, system configuration and modes of operation are briefly described. The RDCF safety case is justified in the Basis of Safety Cases on Emergency Core Cooling System [Ref-16.7-19] and the Basis of Safety Cases on Severe Accident Mechanical Systems [Ref-16.7-1]. The RDCF is described in detail in the system specifications [Ref-16.7-8] and the Piping and Instrumentation Diagrams (P&IDs) [Ref-16.7-9], [Ref-16.7-10].

(1) System Roles

The main role of the RDCF is to depressurise the RPV and thus enable reactor core cooling at low pressure state as an alternative means in the event of faults where the principal reactor core cooling means formed by the ECCS are not available.

(2) Functions Delivered

The RDCF controls the SRVs of the Nuclear Boiler System (NB) in order to depressurise the RPV and thus enable reactor core cooling function under fault conditions in which core cooling by the principal means is not available (ECCS or its support systems are not available). The RDCF controls the SRVs to provide depressurisation of the RPV so that cooling water can be supplied into the RPV by the FLSS or the FLSR at low pressure state.

The RDCF is designed to remotely depressurise the reactor by automatic or manual actuation for design basis faults. The RDCF is also designed to be locally operated to ultimately depressurise the reactor for some beyond design basis faults.

(3) Basic Configuration

The RDCF controls seven out of the nine SRVs mounted on the MS lines which are not provided with the ADS function. The SRVs with RDCF function depressurise the RPV by relieving high pressure steam to the S/P where it is condensed. The SRVs with the RDCF function are provided with one dedicated RDCF Accumulator (in addition to the conventional SRV Accumulator for relief operation), and two additional solenoid valves dedicated for the RDCF operation, which together form an integral assembly that is a part of the NB.

In addition, four out of the seven SRVs valves with RDCF function are provided with an additional switching valve integrated in the SRV solenoid valve assembly, which is operated by the nitrogen gas stored in dedicated cylinders provided for the RDCF. The RDCF is configured into two divisions to supply nitrogen gas to these four SRVs through the dedicated nitrogen gas cylinders.

(4) Modes of Operation

The RDCF can deliver the following operation modes. :

(a) Plant Normal Operation Condition

The RDCF is on standby during normal plant operation. The RDCF Accumulators are kept charged by the HPIN. The RDCF nitrogen gas cylinders are isolated from the RDCF nitrogen gas supply header to the SRVs actuated by switching valve.

(b) RPV Depressurisation Mode

In the event of design basis faults as an alternative to the ECCS, or in the event of beyond design basis faults such as long-term SBOs, the RDCF is initiated to depressurise the RPV through the SRVs with the control of the dedicated solenoid valves or switching valves and nitrogen gas supply sources (accumulators or cylinders) to enable water supply into the RPV with the low-pressure RPV injection mode of the FLSS or the FLSR.

Design Bases

This section describes the design bases for the RDCF.
Provisions for installing permanent and mobile safety facilities are put in place as countermeasures against the events that potentially lead to multiple losses of the safety facilities including ECCS. The RDCF is designed as a permanent safety facility of UK ABWR and designed to meet the following SFCs. The relation between the SFCs put on this system and the high level claims is shown on Appendix-A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Fault Conditions

(a) The RDCF is an alternative means to depressurise the RPV in order to provide reactor core cooling in low pressure state with the FLSS in the event of design basis faults where the primary means (ECCS) are not available. [RDCF SFC 2-2.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 2 requirements.

(b) The RDCF is the principal means to depressurise the RPV in order to provide reactor core cooling in low pressure state with the FLSS after RCIC operation for the first 24 hours in the event of design basis faults such as SBO or Class 1 CCF. [RDCF SFC 2-2.2]
This function is categorised as Category A and the components to deliver it are designed to meet Class 2 requirements.

(c) The RDCF with switching valves is the principal means to maintain RPV depressurisation in order to provide reactor core cooling in low pressure state with the FLSS in the event of design basis faults such as SBO or Class 1 CCF after the first 24 hours. [RDCF SFC 2-2.3]
This function is categorised as Category A and the components to deliver it are designed to meet Class 3 requirements.

(d) The RDCF is an alternative means to depressurise the RPV in order to provide reactor core cooling in low pressure state with the FLSS or FLSR in the event of beyond design basis faults with RDCF Accumulator available. [RDCF SFC 2-2.4]

This function is categorised as Category B and the components to deliver it are designed to meet Class 2 requirements.

(e) The RDCF with switching valves is the principal means to depressurise the RPV in order to provide reactor core cooling in low pressure state with the FLSR after RCIC operation for the first 24hrs in the event of beyond design basis faults without RDCF Accumulator available. [RDCF SFC 2-2.5]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(f) The RDCF with switching valves is the principal means to maintain RPV depressurisation in the event of beyond design basis faults without RDCF Accumulator available after the first 24 hours. [RDCF SFC 2-2.6]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(g) The RDCF components penetrating the primary containment form a barrier to confine radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [RDCF SFC 4-7.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. This safety function is developed and justified in Chapter 13: Engineered Safety Features, Section 13.3.3.2 related to Primary Containment Isolation System.

System Design Description

This section describes the design of the RDCF to support and justify the delivery of RDCF SFC 2-2.1, RDCF SFC 2-2.2, RDCF SFC 2-2.3, RDCF SFC 2-2.4 RDCF SFC 2-2.5 and RDCF SFC 2-2.6. Additional design description can be found in [Ref-16.7-1], [Ref-16.7-19], [Ref-16.7-8], [Ref-16.7-9] and [Ref-16.7-10].

(1) Overall System Design and Operation

(a) Design Basis Fault Scenarios
In the event frequent design basis faults the RDCF operates as the secondary means to deliver reactor core cooling in the event delivery of this function by the ECCS was unavailable. Sufficient reactor depressurisation to allow cooling water injection into the RPV at low pressure by the FLSS for the delivery of reactor core cooling is fulfilled by the seven SRVs forming part of the RDCF. The signal initiating automatic depressurisation is sent on simultaneous reactor water level L1, confirmation that the RPV is not already depressurised, and that at least one FLSS Pump is running. In addition, a timer delays the signal so that it is not sent if the ECCS succeeded to recover reactor water level above L1, or if depressurisation has already been performed by the ADS or Transient ADS.
The RDCF actuation signal switches the position of the two solenoid valves dedicated for this function to open a flow path for the nitrogen gas stored in the RDCF Accumulators to the SRVs in order to force the seven valves to open and perform RPV depressurisation.

In the event of infrequent faults the RDCF automatically actuates the same way as for frequent faults when the automatic initiation conditions are met in the event of unavailability of the ECCS. In the case of design basis SBO or CCF

scenarios where reactor core cooling is only available by the RCIC, the RDCF is manually operated after 8hrs in order to allow continuation of the reactor core cooling by the FLSS (ex. medium-term SBO or Class 1 CCF events).
The RDCF Accumulators have capacity to maintain the SRVs open for 24hrs without relying on any external nitrogen gas supply. Therefore, for design basis scenarios requiring RDCF operation beyond 24hrs, the nitrogen gas supply source is switched to the RDCF nitrogen gas cylinders via the switching valve, and thus RDCF operation is maintained by the SRVs actuated by switching valve.

(b) Beyond Design Basis Fault Scenarios
In the event of design basis faults with Class 2 control and power supply support systems available the RDCF operates the same way as for design basis faults by automatic or manual actuation in case of failure of Class 1 reactor core cooling means provided that the design pressure of the drywell is not exceeded.

In the event of beyond design basis faults with Class 2 control or power supply support systems unavailable or drywell pressure beyond design basis conditions such as 168hrs SBO with CCF of the EDG and the BBG (total loss of power supply), the RDCF can be used as the ultimate means to depressurise the RPV for the delivery of reactor core cooling by the FLSR and maintain it for seven days.
In this scenario, any two valves out of the four SRVs provided with switching valves are opened by manually supplying nitrogen gas to actuate the switching valve. By supplying nitrogen gas to the inlet port of the switching valve, the position of this valve changes due to the pressure on the seat and thereby the flow path for the nitrogen gas to the SRVs is opened to force actuation of the SRVs and decrease RPV pressure. The nitrogen gas supply comes from the RDCF dedicated supply of nitrogen gas cylinders in the operation area from either of the two trains to open the SRVs.

(2) Equipment Design and Operation

The design and operation of the SRVs controlled by the RDCF in order to deliver RDCF SFC 2-2.1, RDCF SFC 2-2.2 RDCF SFC 2-2.3, RDCF SFC 2-2.4, RDCF SFC 2-2.5 and RDCF SFC 2-2.6 is described in Chapter 12: Reactor Coolant Systems, Reactivity Control Systems and Associated Systems, Section 12.3.5.2 about the NB.

(3) Main Support Systems

(a) Instrumentation and Control Systems

The systems supporting the RDCF with instrumentation and control are the safety class 2 Hardwired Backup System (HWBS) and the Severe Accident C&I System. The design and the claims on these systems are addressed in Chapter 14: Control and Instrumentation.

(i) Automatic operation of the SRVs forming part of the RDCF is actuated by the logic of the HWBS on a 1-out-of-2-twice voting logic if available. Nonetheless, remote switches for manual actuation from the Backup Building Control Panel (BBCP) or the Hardwired Backup Panel (HWBP) in the MCR via the HWBS are provided, with an interlock that prevents operation from both places at a time.

(ii) Manual operation of the RDCF to deliver RPV depressurisation for beyond design basis faults (including severe accidents) with control and power supply available is monitored and controlled remotely from the BBCP in the B/B control room through the SA C&I logic (the actuators are shared with the HWBS) after transferring control from the HWBP if this is not available.

(iii) The RDCF, as ultimate means for reactor depressurisation through the switching valve in the event of beyond design basis faults without RDCF Accumulators available, is locally operated by manual action and does not require C&I logic to control it.

(iv) The RDCF nitrogen gas cylinder standby pressure and the supply pressure are only displayed in local meters.

(v) Once the SRVs are opened, they are interlocked so as to not re-close even if the pressure drops below the re-seat set pressure of the valves. The valves remain open unless manually closed from the MCR or the B/B.

(vi) The main parameters for monitoring and controlling the proper operation of the RDCF are the position of the SRVs, the temperature of the SRV discharge line and the nitrogen supply pressure from the cylinders.

(b) Power Supply System

Power supply for RDCF components, instrumentation and controllers comes from the Safety Class 2 Electrical Power Distribution System (EPS). The detailed design and the claims on the EPS are dressed in Chapter 15: Electrical Power Supplies.

(i) The solenoid valves for the SRVs of the RDCF are supplied power by the B/B Class 2 DC Power Supply System.

(ii) Power supply is not required for the delivery of reactor depressurisation by the switching valve.

Assumptions, Limits and Conditions for Operation

In order to ensure that the RDCF is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCO, surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is described in the Basis of Safety Cases on Emergency Core Cooling System [Ref-16.7-19] and the Basis of Safety Cases on Severe Accident Mechanical Systems [Ref-16.7-1].

- Seven RDCF valves shall be operable during power operation, start-up and hot shutdown for the delivery of the SFCs claimed when required.

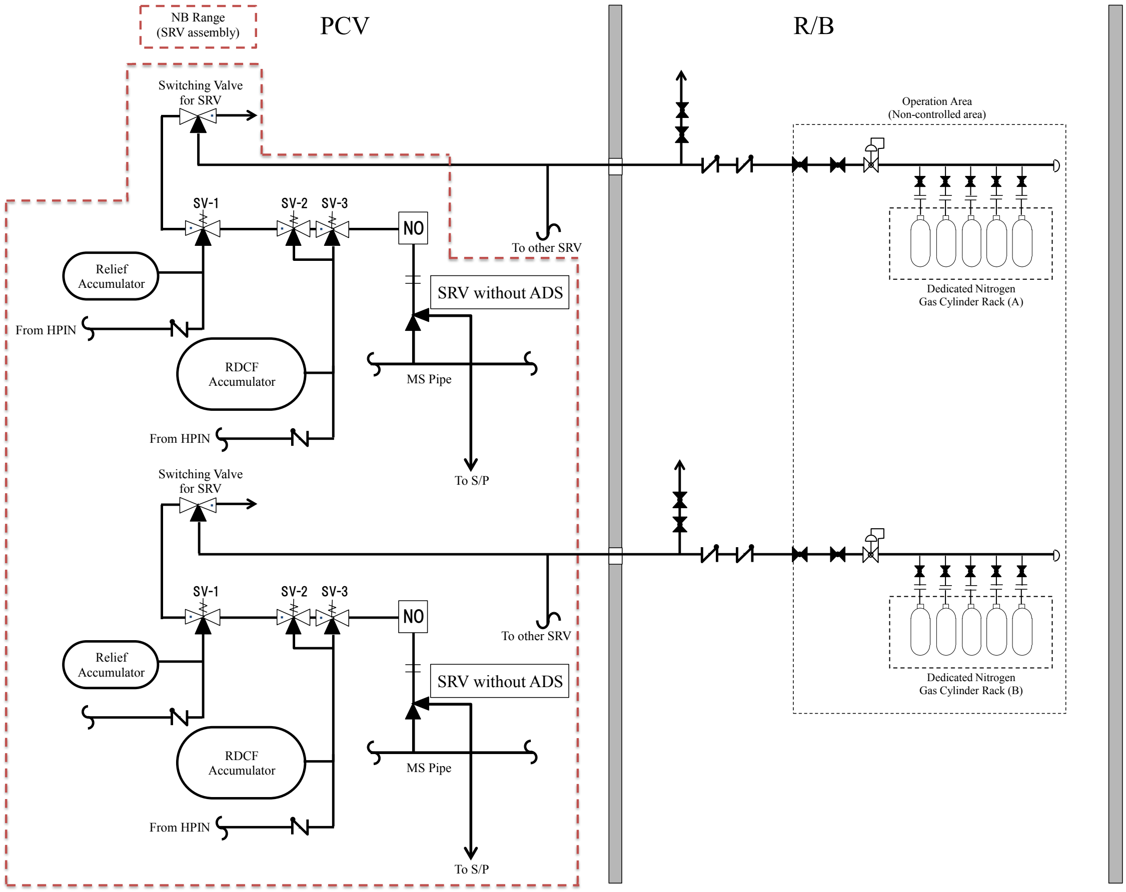


Figure 16.7-3: Outline of the Reactor Depressurisation Control Facility

16.7.3.4 Lower Drywell Flooder System

System Summary Description

This section is a general introduction to the Lower Drywell Flooder System (LDF) where the system roles, system functions, system configuration and modes of operation are briefly described. The LDF safety case is justified in the Basis of Safety Cases on Severe Accident Mechanical Systems [Ref-16.7-1]. The LDF design is described in the system specifications [Ref-16.7-11] and the piping and instrumentation diagrams [Ref-16.7-12].

(1) System Roles

The main roles of the LDF is to flood the lower D/W with water from the Suppression Pool (S/P) in the unlikely event of a severe accident where the core melts and causes a subsequent vessel failure to occur, and deposition of molten corium (a molten mixture of fuel, reactor internals, the vessel bottom head and control rod drive components) on the lower D/W floor. The LDF covers molten corium with water for cooling and scrubbing of any fission products released from the debris.

(2) Functions Delivered

The LDF provides water to the Lower D/W to remove the decay heat from molten corium and provide cooling and scrubbing of any fission products released from the debris.

(3) Basic Configuration

The LDF consists of a water source (S/P), 10 sets of piping and fusible plugs (FPLGs) shown in Figure 16.7-4. The LDF has no pumps, no instrumentation and no controllers as it operates automatically in a passive manner.

(4) Modes of Operation

The LDF delivers the following operation modes.

(a) Standby Mode

The LDF is on standby during normal plant operation and postulated design basis faults. The valves are kept at their normal positions: the stop valves are open, and the FPLGs are closed.
The LDF is never expected to be necessary for safety reasons because of the extensive array of water injection systems available to maintain core cooling. It is not expected to become a cooling flow path from the S/P to the lower D/W during normal plant operation and postulated design basis faults such as LOCA.

(b) Lower Drywell Flooder Mode

In the event of postulated beyond design basis fault that leads to core meltdown, vessel failure and deposition of molten corium on the lower D/W floor, the LDF provides a flow path for the water from the S/P into the lower D/W area. The flow path into the lower D/W is activated when the lower D/W airspace temperature reaches 260°C, by melting of the fusible metal inside a FPLG, which enables the S/P water to flow into the lower D/W with hydrostatic head.

Design Bases

This section describes the design bases for the LDF.

Provisions for installing permanent and mobile safety facilities are put in place as countermeasures against the events that potentially lead to multiple losses of the safety facilities including ECCS. The beyond design basis fault where the LDF activates is a very unlikely event however the LDF is installed to provide additional mitigation over and above what is strictly required.
The LDF is designed as a permanent safety facility of UK ABWR and is designed to meet the following SFCs. The relation between the SFCs put on this system and the high level claims is shown in Appendix-A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Fault Conditions

(a) The LDF is an alternative means to provide molten core cooling with lower D/W injection in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents where all the primary molten core cooling means (FLSS and FLSR) have failed. [LDF SFC 4-9.1]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(b) The LDF forms a part of S/P boundary in order to secure the water source of the ECCS. [LDF SFC 2-1.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements.

System Design Description

This section describes the design of the LDF to support and justify the delivery of LDF SFC 4-9.1. Additional design description can be found in [Ref-16.7-1], [Ref-16.7-11] and [Ref-16.7-12].

(1) Overall System Design and Operation

The purpose of LDF is to flood the debris by supplying cooling water to Lower D/W in the event of postulated beyond design basis fault which leads to core meltdown, vessel failure and deposition of molten corium on the lower D/W floor. During the plant normal operation, the flow path is closed by a FPLG and it also maintains this closed position until the temperature at the lower D/W exceeds its design value of 260±10°C. Since the temperature of the lower D/W is controlled below the PCV design temperature of 171°C during the design basis faults (e.g. LOCA), the design of FPLG avoids unexpected melting in these faults.
The flow path into the lower D/W is activated when the lower D/W airspace temperature reaches 260±10°C, by melting of the fusible metal inside a FPLG, which enables the S/P water to flow into the lower D/W with hydrostatic head.
The flow of S/P water to the lower D/W through LDF forms a pool of water above the core debris. This pool cools the molten corium and subsequently removes the corium decay heat. Interaction between the corium and the concrete floor is also suppressed by this pool of water. When PCV spray is available, the steam generated by the corium heat is condensed by the PCV sprays and drained back into the S/P. On the other hand, even when PCV spray is unavailable, containment venting system prevents containment failure due to overpressure by the generated steam.
The flow path is shut when water level in the vertical vent pipe is lower than LDF inlet level and then there is no water flow through the flooder pipe.

(2) Equipment Design and Operation

LDF Fusible Plug (FPLG)

(i) Purpose
The LDF FPLGs provides flow paths from the S/P to the lower D/W to cool the molten core in the event of severe accidents where the RPV has failed, in order to deliver LDF SFC 4-9.1.

(ii) Configuration and Operation
The LDF is provided with ten flow paths connecting the S/P and the D/W, and the LDF FPLGs are mounted at the end of the LDF piping.

(iii) Performance
The LDF FPLGs are designed to perform following specification to deliver LDF SFC 4-9.1.

Number:	10 units
Operation temperature:	260±10 °C
Capacity:	11 L/s/unit

(3) Main Support Systems

(a) Instrumentation and Control Systems

(i) Instrumentation
The operation of the LDF is confirmed by the D/W temperature reduction and the lowering of S/P water level. These values can be monitored from the emergency control room in the B/B and the MCR.

(ii) Control
Control provisions related to the delivery of the safety function are not necessary because the LDF operates in a totally automatic and passive manner.

(b) Power Supply System

There is no active component thus no electric supply is required for the LDF.

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.7-7]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

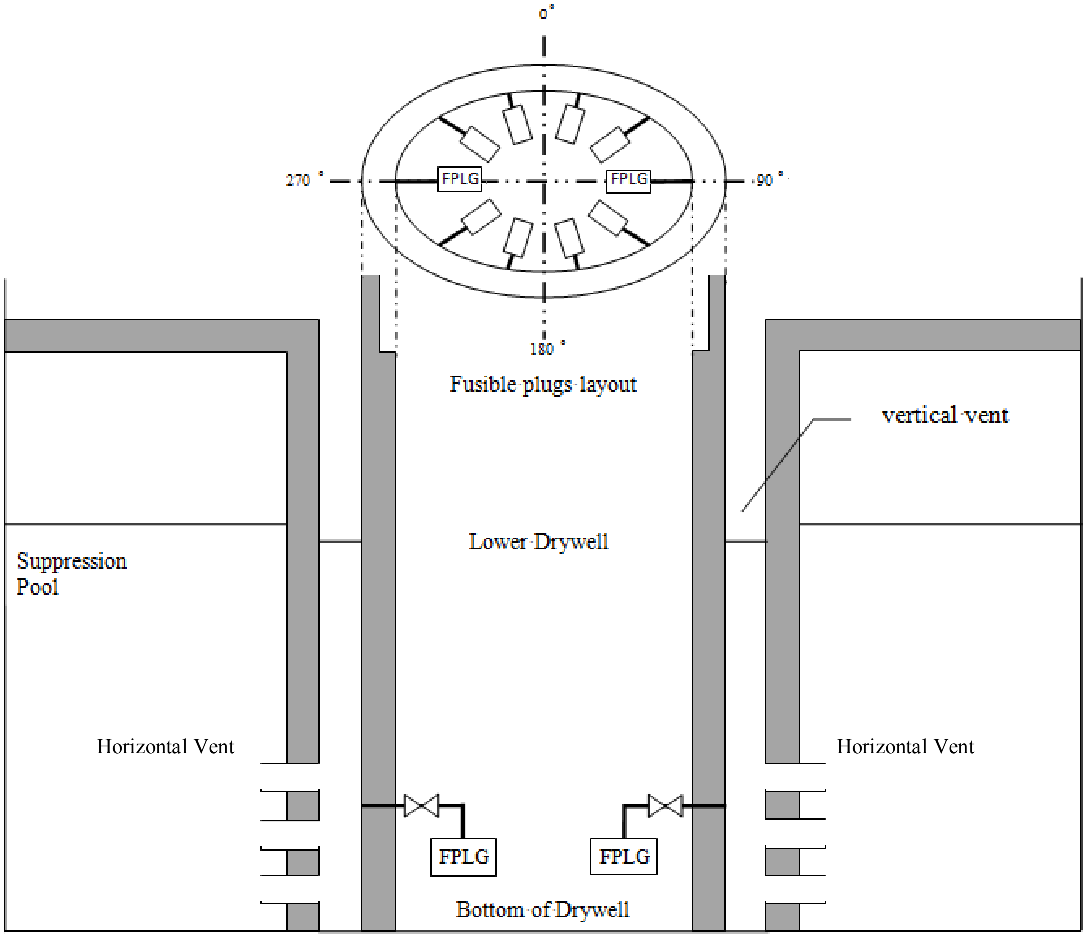


Figure 16.7-4: Outline of the Lower Drywell Flooder

16.7.3.5 Filtered Containment Venting System

System Summary Description

This section is a general introduction to the Filtered Containment Venting System (FCVS) where the system roles, system functions, system configuration and modes of operation are briefly described. The FCVS safety case is justified in the Basis of Safety Cases on Severe Accident Mechanical Systems [Ref-16.7-1]. The FCVS design is described in the system specifications [Ref-16.7-13] and the piping and instrumentation diagrams [Ref-16.7-14].

(1) System Roles

The main roles of the FCVS are to release PCV gas in order to prevent PCV failure due to overpressure and to remove decay heat from the PCV. Also filtering the venting gas to reduce amount of emission of radioactive iodine and long half-life fission products to the environment is part of the role of the FCVS.
UK ABWR containment venting system consists of this FCVS and the hardened venting line of the Atmospheric Control System (AC).

(2) Functions Delivered

The FCVS is designed to perform the following functions:
(a) The FCVS releases PCV gas to deliver containment overpressure protection and long-term PCV heat removal during design basis faults, beyond design basis faults and severe accidents.
(b) The FCVS reduces amount of emission of radioactive iodine and long-half-life fission products contained in venting gas to the environment through the Vent Filter in the event of severe accidents.

(3) Basic Configuration

The FCVS consists of the following main components. Figure 16.7-5 shows an outline of the FCVS configuration.

- FCVS Vent Filter	1 unit
- Piping, Valves and Rupture Disks	1 set
- Instrumentation and Controllers	1 set
- Nitrogen Gas Purging Facility (mobile)	1 unit

(4) Modes of Operation

The FCVS can deliver the following operation modes by switching the position of the venting valves.

(a) Standby Mode

The FCVS is maintained on standby during the plant normal operation. During standby, the FCVS is isolated from the PCV by normally closed motor-operated valves and the Containment Overpressure Protection System (COPS) rupture disc, and is maintained in an inert condition by the nitrogen substitution. Therefore oxygen concentration in the FCVS is kept under the lower flammability limit to prevent hydrogen combustion caused by a potentially large amount of radiolytic gas inflow at the beginning of venting.

(b) PCV Venting Mode

The FCVS releases PCV gas to the environment for containment overpressure protection and long-term PCV heat removal. At this time, radioactive iodine and long-half-life fission products contained in PCV gas are reduced through the Vent Filter before exhausting.
The FCVS is initiated manually by opening the FCVS vent valves in the event that the PCV pressure exceeds the design value. Valve actuation is controlled in both the MCR and the emergency control room in the B/B. Also the FCVS provides extended spindle valve for the FCVS vent valves to actuate the valves even in the event of loss of BBG power supply.
In addition to this, the FCVS provides the COPS to initiate venting operation automatically without operators' actions. The COPS included as part of the FCVS, consists of only the rupture disk mounted on downstream of PCV isolation valves from W/W. This rupture disk is burst automatically in case of PCV pressure reaches twice the design value.

(c) Post-venting Mode

After the PCV is depressurised and the heat removal system is prepared, FCVS isolation valves are closed. Furthermore, after accident converged, a large amount of fission products are contained in the water inside of the Vent Filter and becomes a radiation source. Thus the contaminated water is returned to the PCV or transferred to the mobile treatment system as soon as possible in order to reduce exposure and management tasks.

Design Bases

This section describes the design bases for the FCVS.
Provisions for installing permanent and mobile safety facilities are put in place as countermeasures against the events that potentially lead to multiple losses of the safety facilities including the ECCS. The FCVS is designed as a permanent safety facility of UK ABWR and designed to meet the following SFCs. The relation between the SFCs put on this system and the high level claims is shown in Appendix-A. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Fault Conditions

(a) The FCVS is a secondary means to deliver long-term PCV heat removal and overpressure protection in the event of design basis faults where all the primary PCV heat removal means (RHR) have failed. [FCVS SFC 3-2.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 2 requirements.

(b) The FCVS is a principal means to deliver and long-term PCV heat removal and overpressure protection in the event of beyond design basis faults and severe accidents. [FCVS SFC 3-2.2]
This function is categorised as Category B and the components to deliver it are designed to meet Class 2 requirements.

(c) The FCVS is a secondary means to deliver PCV overpressure protection in the event of severe accidents. [FCVS SFC 4-9.1]

This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(d) The FCVS is a principal means to reduce the release of radioactive material from the PCV in the event of beyond design basis faults and severe accidents. [FCVS SFC 4-8.1] This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(e) The FCVS components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [FCVS SFC 4-7.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. This safety function is developed and justified in Chapter 13: Engineered Safety Features, Section 13.3.3.2 related to the Primary Containment Isolation System.

System Design Description

This section describes the design of the FCVS to support and justify the delivery of FCVS SFCs. Additional design description can be found in [Ref-16.7-1], [Ref-16.7-13] and [Ref-16.7-14].

(1) Equipment Design and Operation

(a) FCVS Vent Filter

(i) Purpose
The main purpose of the FCVS Vent Filter is to reduce the amount of emission of radioactive aerosols (particles) and elemental iodine contained in the venting gas prior to discharge to the environment in order to deliver FCVS SFC 4-8.1.

(ii) Configuration and Operation
The FCVS Vent Filter consists of a water scrubbing section and metal filter section to secure required Decontamination Factor (DF) performance. Since the FCVS Vent Filter is a static component, generally no manual operation is required. However in the case that the scrubbing solution level is decreased due to decay heat and superheated vent gas, additional solution needs to be added manually.

(iii) Performance
The specification required for the FCVS Vent Filter to ensure the delivery of related FCVS SFCs is shown below:

- The Vent Filter is designed to perform following DF:
  Aerosol: DF $\geq$ 1000
  Iodine Element: DF $\geq$ 100
- The Vent Filter is designed considering the operating conditions during severe accident and to be capable of preserving the pressure boundary up to twice the PCV design pressure at 200°C.
- The Vent Filter is designed to be capable of maintaining the necessary water level inside the Vent Filter without operator action for 24 hours after vent initiation even considering the heat exchange between the decay heat from the particles caught and the gases flowing in.

(b) Containment Overpressure Protection System (COPS) Rupture Disc

(i) Purpose
The main purpose of the COPS Rupture Disc is to force PCV depressurisation when the PCV pressure reaches twice of PCV design pressure in order to prevent PCV failure due to overpressure. Also it delivers the PCV heat removal function FCVS SFC 4-9.1 with PCV venting.

(ii) Configuration and Operation
The COPS Rupture Disc consists of rupture part and holder. Since the COPS Rupture Disc is static component, no manual operation is required.

(iii) Performance
The COPS Rupture Disc is designed to perform following specification to deliver FCVS SFC 4-9.1.

Number:	1 unit
Bursting Pressure:	620 kPa

(2) Main Support Systems

(a) Instrumentation and Control Systems

The main instrumentation and control provisions related to FCVS operation from the performance and reliability points of view are summarised as follows.
For further details of the SA C&I see Chapter 14: Control and Instrumentation, Section 14.6.6.

(i) Instrumentation
Instrumentation is provided to measure and monitor the operating conditions of the FCVS components necessary for the delivery of the safety functions and thus ensure their performance and reliability. The status, measurements and alarms of the components and valves to be remotely operated are displayed in both the Backup Building Control Panel (BBCP) and the MCR.
The parameters to be monitored are as follows:

- Vent Filter water level
- Vent Filter pressure
- Vent Filter temperature
- Vent Filter outlet pressure
- Radioactivity concentration of the discharge gases from the Vent Filter

(ii) Control
The FCVS is actuated and controlled remotely from the emergency control room in the BBCP of SA C&I system or the HWBP in the MCR..

(b) Power Supply System
The configuration of the power supply system necessary to deliver the safety functions claimed is summarised as follows.
For further details of the BBG see Chapter 15: Electrical Power Supplies, Section 15.4.6.

The FCVS motor-operated valves and related instrumentation are powered by one division of the BBG which is different from the one for active components of the vent system (AC).

Assumptions, Limits and Conditions for Operation

In order to ensure that the FCVS is operated within safety limits and the design requirements from the safety case are met during the operating regime, appropriate LCOs, surveillance requirements to ensure the LCOs are met as well as corrective actions (measures) to follow when the LCOs are not met are defined. This information which is shown below is described in the Basis of Safety Cases on Severe Accident Mechanical Systems [Ref-16.7-1].

- Two containment venting system shall be operable during power operation, start-up and hot shutdown for the delivery of the SFCs claimed when required.

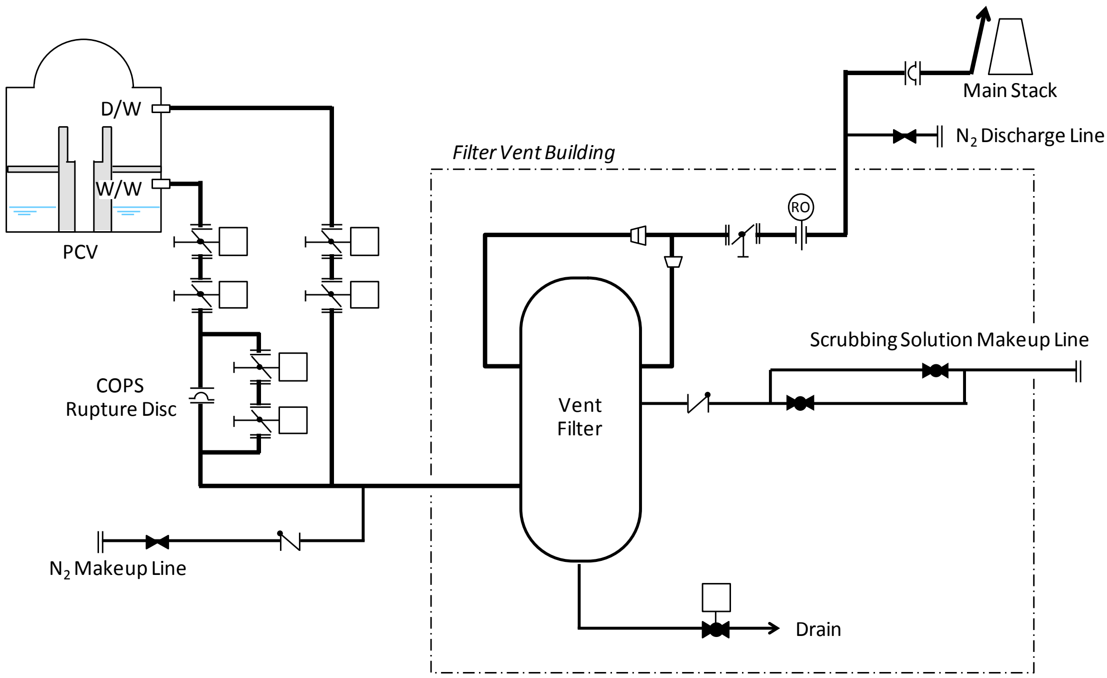


Figure 16.7-5: Outline of the Filtered Containment Venting System

16.7.3.6 Alternate Heat Exchange Facility

System Summary Description

This section is a general introduction to the Alternate Heat Exchange Facility (AHEF) where the system roles, system functions, system configuration and modes of operation are briefly described. The AHEF safety case is justified in the Severe Accident Basis of Safety Cases [Ref-16.7-1]. The AHEF is described in detail in the system specifications [Ref-16.7-15] and the Piping and Instrumentation Diagrams (P&IDs) [Ref-16.7-16].

(1) System Roles

The main purpose of the AHEF is to recover cooling capacity of any one division of the Residual Heat Removal System (RHR) by connecting the mobile equipment to the Reactor Building Cooling Water System (RCW), in case that the functions of RCW or Reactor Building Service Water System (RSW) are lost.

(2) Functions Delivered

The AHEF removes heat from the RHR Heat Exchanger by supplying it with cooling water via the RCW circuit with the mobile AHEF cooling unit, which consists of AHEF Cooling Water Pumps and AHEF Heat Exchanger. In order to remove the heat from the PCV, the AHEF Heat Exchangers are cooled with service water driven by mobile AHEF Service Water Pumps.

(3) Basic Configuration

The AHEF consists of the following main components. Figure 16.7-6 provides an outline of the AHEF configuration.

(a) One set of AHEF components consists of a Mobile AHEF Cooling Unit and AHEF Service Water Pumps.

(b) The Mobile AHEF Cooling Unit consists of the following components:

- AHEF Cooling Water Pump: 1 unit (100%-capacity/unit)
- AHEF Heat Exchangers: 2 units (50%-capacity/unit)
- AHEF RSW Strainers: 1unit (100%-capacity/unit)
- Piping and Valves: 1 set
- Instruments and Controllers: 1 set

(c) The AHEF RSW Pumps and accompanied components are as follows:

- AHEF RSW Pumps: 2 units (50%-capacity/unit)
- Piping and Valves: 1 set
- Hoses: 1 set

(4) Modes of Operation

The AHEF mobile cooling unit needs to be manually connected to the RCW before initiating. The AHEF can deliver the following operation modes:

(a) Standby Mode
The AHEF is not expected to be activated during normal plant operation and design basis faults conditions. The components are at the designated storage locations and are ready to be carried on a trailer vehicle to be moved to the predefined place operation. Regular testing of the AHEF equipment will be undertaken on RCW circuit standby equipment by the operator in order not to compromise normal plant operation.

(b) AHEF Operation
The AHEF components are moved and set up to supply cooling water to one of the RHR Heat Exchangers to maintain the cooling function of the RHR in the case that the functions of the RCW or the RSW are lost.

Design Bases

This section describes the design bases for the AHEF.
Provisions for installing permanent and mobile safety facilities are put in place as countermeasures against the events that potentially lead to multiple losses of the safety facilities including the ECCS. The AHEF is designed as a mobile safety facility of UK ABWR and designed to meet the following SFCs. The relation between the SFCs put on this system and the high level claims is shown in Appendix-5. The FSFs and HLSFs are defined in Chapter 5: General Design Aspects.

Fault Conditions

The AHEF is an alternative means to provide the cooling water for one division of RHR Heat Exchangers and associated auxiliaries via RCW in terms of long-term PCV heat removal in the event of beyond design faults and severe accidents where the functions of RCW or RSW are lost. [AHEF SFC 3-2.1]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

System Design Description

This section describes the design of the AHEF to support and justify the delivery of AHEF SFC 3-2.1. Additional design description can be found in [Ref-16.7-1], [Ref-16.7-15] and [Ref-16.7-16].

(1) Overall System Design and Operation

The AHEF supplies cooling water to one of the RHR Heat Exchangers and the associated auxiliaries via the RCW to maintain the cooling function of RHR in case that the functions of RCW or RSW are lost.

The Mobile AHEF Cooling Unit comprises the AHEF Cooling Water Pump, the AHEF Heat Exchangers and other related components and are mounted a trailer vehicle. The Cooling Water components are at the designated storage locations when the AHEF is not in use. They can be moved to the predefined place to be operated before activating the AHEF.

To put the AHEF in operation, the primary side (fresh water side) of the AHEF Heat Exchangers is connected to the connection points installed on the RCW piping and the secondary side (service water side) of the AHEF Heat Exchangers is connected with the

AHEF Service Water Pumps in the predefined area outside of buildings and the AHEF Service Water Pumps suction line connect to the water source. Then the AHEF Water Cooling Pump and the Service Water Pump are initiated to remove the heat from the RPV via the RHR.

(2) Equipment Design and Operation

(a) AHEF Cooling Water Pump

(i) Purpose
The AHEF Cooling Water Pump provides circulation of the water cooled down by the AHEF heat exchangers to one RHR heat exchanger to remove heat from the reactor coolant in order to deliver [AHEF SFC 3-2.1].

(ii) Configuration and Operation
The AHEF Cooling Water Pump is activated when the AHEF is in use. The AHEF Cooling Water Pump is designed to satisfy the required flow rate and discharge head. The AHEF Cooling Water Pump is carried on a trailer vehicle carrying the Mobile AHEF Cooling Unit.

(iii) Performance
The specification required for the AHEF Cooling Water Pump to ensure the delivery of [AHEF SFC 3-2.1] is shown below:

- Number: 1 unit
- Rated flow: 600m^3/h/unit

(b) AHEF Heat Exchanger

(i) Purpose
The AHEF heat exchanger is designed to remove the heat from the cooling water with service water and thus remove heat from the RHR instead of the RCW in order to deliver [AHEF SFC 3-2.1].

(ii) Configuration and Operation
The AHEF Heat Exchangers are designed to remove decay heat of the reactor core. The AHEF Heat Exchangers are mounted on a trailer vehicle composing the Mobile AHEF Cooling Unit.

(iii) Performance
The specification required for the AHEF Heat Exchanger to ensure the delivery of [AHEF SFC 3-2.1] is shown below:

Table 16.7-1: AHEF Heat Exchanger Capacity

AHEF Heat Exchanger		
	Primary side	Secondary side
Fluid	Fresh water	Service water
Flow rate (m^3/h per unit)	Approx. 300	Approx. 420
Capacity (MW/unit)	11.5	
Number (unit)	2	

(c) AHEF RSW Pump

(i) Purpose
The AHEF RSW pumps provide service water to the AHEF heat exchangers to cool down the cooling water in order to deliver [AHEF SFC 3-2.1].

(ii) Configuration and Operation
The AHEF Service Water Pumps are mobile submersible pumps. Two AHEF Service Water Pumps are activated when the AHEF is in use. The AHEF Service Water Pumps are designed to satisfy the required flow rate and discharge head. The AHEF Service Water Pumps are carried on a trailer vehicle with the Mobile AHEF Cooling Unit when the AHEF is in use.

(iii) Performance
The specification required for the AHEF Service Water Pump to ensure the delivery of [AHEF SFC 3-2.1] is shown below:
- Number: 2 units
- Flow rate: 420 m^3/h /unit

(d) AHEF RSW Strainer

(i) Purpose
The purpose of the AHEF is to prevent introduction of foreign material such as shellfish into the heat transfer piping, which causes plugging of the piping in order to deliver [AHEF SFC 3-2.1].

(ii) Configuration and Operation
The AHEF Strainers are mounted on the inlet of the AHEF Heat Exchangers.

(iii) Performance
The specification required for the AHEF Strainer to ensure the delivery of AHEF SFC 3-2.1 is shown below:
- Number: 1 unit
- Flow rate: 840 m3/h/unit

(3) Main Support Systems

(a) Instrumentation and Control Systems

The main instrumentation and control provisions related to AHEF operation from the performance and reliability points of view are summarised as follows:

(i) Instrumentation
- The AHEF is locally operated with monitoring and local indicators.
- Detection of leakage on AHEF is performed by monitoring the water level in the surge tank of the RCW.
- Monitoring of AHEF exposure to radioactivity is performed by regular sampling of the cooling water.

(ii) Control
All the operations of the AHEF are manual.

(b) Power Supply System
The Mobile Pumps are designed to be powered by mobile power source facilities.

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.7-7]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

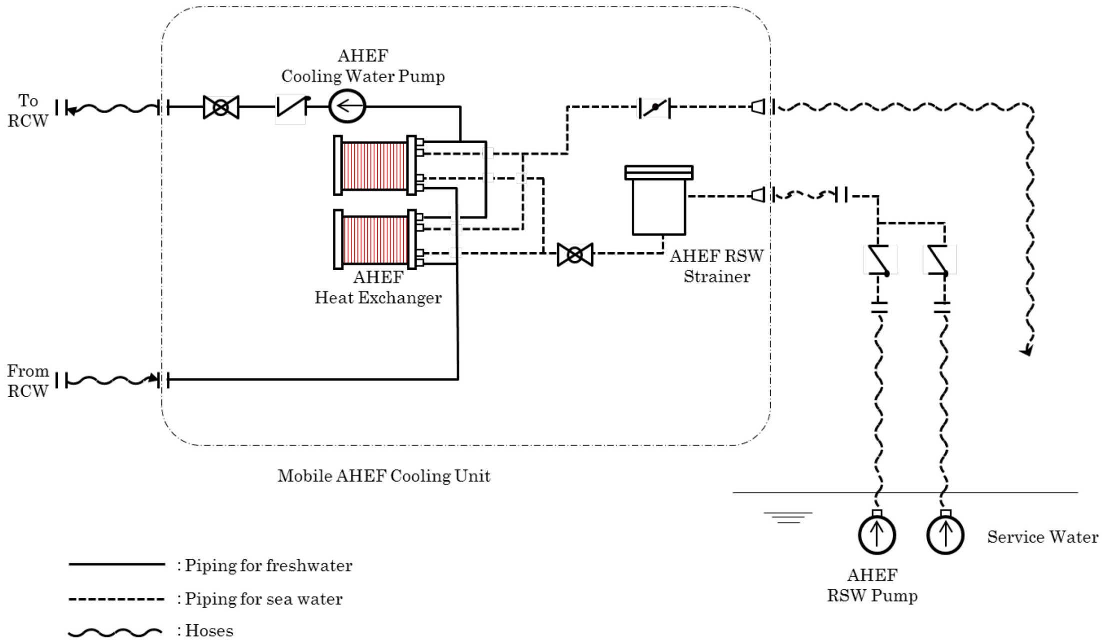


Figure 16.7-6: Outline of the Alternate Heat Exchange Facility

16.7.3.7 Alternative Nitrogen Injection System

System Summary Description

This section is a general introduction to the Alternative Nitrogen Injection System (ANI) where the system roles, system functions, system configuration and modes of operation are briefly described. The ANI safety case is justified in the Basis of Safety Cases on Severe Accident Mechanical Systems [Ref-16.7-1]. The ANI design is described in the system specifications [Ref-16.7-17] and the piping and instrumentation diagrams [Ref-16.7-18].

(1) System Roles

The main role of the ANI is to keep the hydrogen concentration inside the PCV below the lower flammability limit by supplying nitrogen gas into the PCV and to prevent PCV breach due to negative pressure caused by restarting of PCV cooling by the RHR.

(2) Functions Delivered

The ANI is designed to perform the following functions:

(a) The ANI, as a post severe accident management system, supplies nitrogen gas to the both sides of the W/W and the D/W in order to inert the PCV atmosphere in the terminating phase after severe accident where PCV venting is operated.

(b) Nitrogen injection is carried out by the mobile nitrogen gas supply facility.

(3) Basic Configuration

The ANI consists of a Mobile nitrogen gas supply facility and the necessary piping and valves. Two individual connections are provided and mounted separately on the outside of the R/B as shown in Figure 16.7-7.

(4) Modes of Operation

The ANI can deliver the following operation modes by switching the position of the valves.

(a) Standby Mode

The ANI is not expected to be activated during normal plant operation. The nitrogen gas supply facilities are at the designated standby storage locations and are ready to be moved to the predefined place for being operated.

(b) Nitrogen Injection Mode

In the event of severe accident where PCV venting is initiated, PCV venting generally continues until the RHR is recovered. The mobile nitrogen gas supply facility is deployed and supplies nitrogen gas into the PCV before the RHR is recovered.
Nitrogen injection is started by the opening injection valves after the mobile nitrogen gas supply facility connection.

The conditions of nitrogen injection inside the PCV are monitored. Supply pressure and flow rate are monitored by the mobile nitrogen gas supply facility, the pressure and the H_2 concentration inside the PCV are monitored by the Severe Accident C&I System (SA C&I).
The ANI continues to operate until the Atmospheric Control system (AC) is recovered or the accident is completely terminated, i.e. hydrogen generation is stopped.

Design Bases

This section describes the design bases for the ANI.
Provisions for installing permanent and mobile safety facilities are put in place as countermeasures against the events that potentially lead to multiple losses of the safety facilities including the ECCS. The ANI is designed as a mobile safety facility of UK ABWR and designed to meet the following SFCs. The relation between the SFCs put on this system and the high level claims is shown in Appendix-A. The FSFs and HLSFs are defined in Chapter: General Design Aspects.

Fault Conditions

(a) The ANI is an alternative means to supply nitrogen gas into the PCV in order to keep the hydrogen concentration inside the PCV below the lower flammability limit and to prevent PCV break due to negative pressure caused by restarting of PCV cooling, after an accident where PCV venting is operated. [ANI SFC 4-17.1]
This function is categorised as Category B and the components to deliver it are designed to meet Class 3 requirements.

(b) The ANI components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults. [ANI SFC 4-7.1]
This function is categorised as Category A and the components to deliver it are designed to meet Class 1 requirements. This function is developed and justified in Chapter 13: Engineered Safety Features, Section 13.3.3.2 related to the Primary Containment Isolation System.

System Design Description

This section describes the design of the ANI to support and justify the delivery of ANI SFCs. Additional design description can be found in [Ref-16.7-1], [Ref-16.7-17] and [Ref-16.7-18].

(1) Overall System Design and Operation

The ANI supplies nitrogen gas into the PCV in order to keep the hydrogen concentration inside the PCV below the lower flammability limit and to prevent PCV break due to negative pressure caused by restarting of PCV cooling, after an accident where PCV venting is operated.

The ANI Mobile Nitrogen gas Supply Facility and other related components are mounted a trailer vehicle. It is at the designated storage locations when the ANI is not in use and can be moved to the predefined place to be operated before activating the ANI.

(2) Equipment Design and Operation

(a) ANI Mobile Nitrogen gas Supply Facility

(i) Purpose
The purpose of the ANI mobile nitrogen gas supply facility is to provide nitrogen into the PCV in order to deliver ANI SFC 4-9.1

(ii) Configuration and Operation
The ANI mobile nitrogen gas supply facility can generate nitrogen from the air thus no further additional nitrogen source is required.

(iii) Performance
The nitrogen generator capacity of the ANI mobile nitrogen gas supply facility is designed to satisfy the required flow rate against the assumed PCV pressure during the accident condition in order to deliver related ANI SFC.
The main specifications of the nitrogen generator are described below:

Flow rate:	200 Nm^3/h
Supply pressure:	0.5 MPa

(3) Main Support Systems

(a) Instrumentation and Control Systems

The main instrumentation and control provisions related to ANI operation from the performance and reliability points of view are summarised as follows:

(i) Instrumentation
Flowmeter and pressure indicator are installed on the mobile facility to confirm the nitrogen supply conditions.

(ii) Control
The active components of ANI are mounted on the mobile facility. Therefore the ANI is actuated and controlled manually from mobile side.

(b) Power Supply System

- The ANI nitrogen generator and related instrumentations are powered by the mobile facility itself.
- Apart from mobile facility, the ANI does not have any active components in the R/B (piping and check valves).

Assumptions, Limits and Conditions for Operation

Based on the general principles for the identification of Assumptions and LCOs described in Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation ([Ref-16.7-7]), limits directly related to operational aspects, e.g. Operation Control, will be determined in the site specific phase and the details will be commensurate with the maturity of the design. For this reason there are no applicable LCOs on this system within the scope of the GDA.

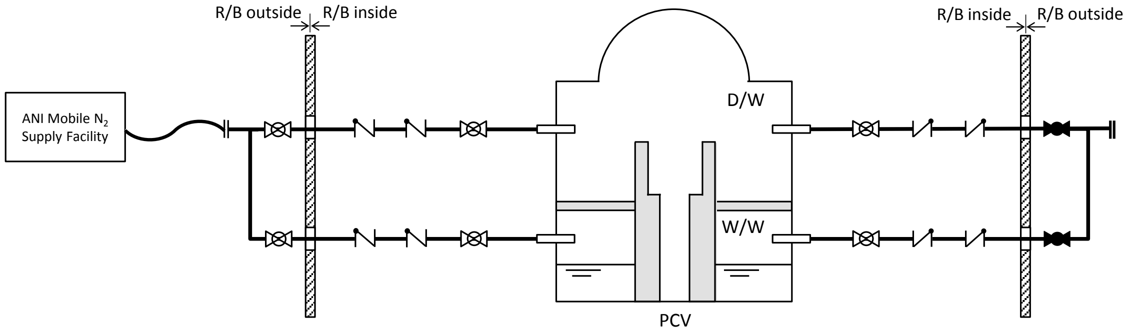


Figure 16.7-7: Outline of the Alternative Nitrogen Injection System

16.8 Assumptions, Limits and Conditions for Operation

16.8.1 Purpose

This section considers the LCOs that apply specifically to the Auxiliary Systems of the generic UK ABWR design reference.
The context, definition and process for identification of assumptions are described in Chapter 4: Safety Management throughout Plant Lifecycle.
The details are in the corresponding section of the BSC or TR of the related systems:

Description of Water Systems:
- RUHS: [Ref-16.3-37],
- RCW: [Ref-16.3-2],
- RSW: [Ref-16.3-2],
- HECW: [Ref-16.3-37],
- HBCW: [Ref-16.3-37], and
- EECW: [Ref-16.3-31].

Description of Other Auxiliary Systems:
- EDG: [Ref-16.6-2],
- BBG: [Ref-16.6-2], and
- DAG: [future licensee].

Description of Heating Ventilating and Air Conditioning System:
- HVAC: [Ref-16.5-31].

Description of Severe Accident Mechanical Systems:
- FLSS: [Ref-16.7-1],
- RDCF: [Ref-16.7-19] and [Ref-16.7-1], and
- FCVS: [Ref-16.7-1].

16.8.2 LCOs specified for Auxiliary Systems

The LCOs that apply to the Auxiliary Systems are identified under each individual system within the chapter.

16.8.3 Assumptions for Auxiliary Systems

The Assumptions that apply to the Auxiliary Systems are identified under each individual system within the chapter.

16.9 Summary of ALARP Justification

This section presents a high level overview of how the ALARP principle has been applied for the Auxiliary Systems and Severe Accident Mechanical Systems covered by Chapter 16, and how this contributes to the overall ALARP argument for the UK ABWR.
Chapter 28: ALARP Evaluation presents an overview of how the UK ABWR design has evolved, and how this evolution contributes to the overall ALARP case. The approach to ALARP during GDA is further described in the GDA ALARP Methodology (Ref-16.9-1) and the Safety Case Development Manual (Ref-16.1-5).
For the mechanical systems which make up this chapter, this ALARP methodology has been embedded within the design process (Ref-16.9-2). This places requirements on designers to consider ALARP through a comprehensive check which includes such elements as the identification of Relevant Good Practice (RGP) and Operational Experience (OPEX), gap analysis, risk assessment, optioneering and design review throughout the design process.

The most significant nuclear safety risks associated specifically with the Auxiliary Systems and severe accident mechanical systems of the UK ABWR are:

Auxiliary Systems:

- Inability to provide sufficient heat removal in normal or fault conditions, due to common cause failure of cooling water supplies (i.e. Loss of the Ultimate Heat Sink (LUHS));
- Inability to provide sufficient contamination control in normal or fault conditions, due to loss of the HVAC;
- Unacceptably high dose rates associated with normal operation and maintenance of the SSCs in these systems.

Severe Accident Mechanical Systems:

- Breach of the FLSS components within the Reactor Coolant Pressure Boundary (RCPB), allowing leakage of radioactive reactor coolant into either the primary or secondary containment;
- Inability to provide sufficient long term cooling of the core in severe accident conditions, due to low core flow rate;
- Inability to maintain integrity of the primary containment in severe accident conditions that result in unabated release of radioactivity to the environment;
- Unacceptably high dose rates associated with normal operation and maintenance of these SSCs.

The safety of the Japanese ABWR reference design of the systems described in this chapter is well understood, using proven technology. Hence a significant aspect of demonstrating the application of RGP in the design of the Auxiliary Systems of the UK ABWR is to generally adopt the Japanese reference design, with only limited modifications to reduce the risk So far As is Reasonably Practicable (SFAIRP) where it is reasonably practicable to do so as required by UK regulations. Thus, the UK ABWR design of these systems is mainly the same as for the operating ABWRs in Japan that is based in the previous BWRs designs, which together have provided many years of operating experience. Some design evolution including installation of the severe accident mechanical systems that was introduced into the latest Japanese ABWR designs that are not yet operating has been incorporated into the reference design. These design evolutions are based on the earlier

Japanese designs for which operating experience has been assessed, and also take account of relevant worldwide operating experience.

The discussion on ALARP is generally included within each of the BSCs that support this chapter. Each BSC also contains a section which discusses following;

- With regard to design input, the safety functions that the SSCs have to deliver are derived linked to the fundamental safety functions, high level safety functions and fault schedule and Safety Functional Claims (SFCs) are set at a system level. Moreover, with regard to the performance required for the SSCs to deliver these safety functions, design requirements from the safety analysis, etc. are set as well.
- With regard to the compliance with regulations, RGP and OPEX, the requirements have been identified through collaboration with the UK experts such as the future licensee. The mature reference design with operational experience that the previous ABWR represents have been subjected to a gap analysis to make sure it is in line with UK practice.
- With regard to the gaps found between the reference ABWR design and UK regulations, RGP, etc., the UK ABWR SSCs design has gone through an optioneering and design review process to determine which options are the most reasonably practicable to close the gaps. Finally, the design was modified if appropriate.
- Hence, UK ABWR concept design specifications are set. Finally, the UK ABWR design that results from this process (modified reference design) is subjected to a risk assessment to make sure the design reduces the risks (nuclear safety, worker safety and environmental impact) SFAIRP and is ALARP.

For the systems covered by Chapter 16, specific areas where RGP has been identified and applied include:

- ASME codes and standards,
- IAEA Safety Standards,
- WENRA Safety Objectives,
- Compliance with UK guidance on the design of safe isolation of plant and equipment for EMIT (ISBN 978 0 7176 6171 8 (Ref-16.9-3)),
- Compliance with UK guidance on the design of ventilation systems for radioactive areas (NVF/DG001 (Ref-16.9-4)),
- Relevant good practice examples of other nuclear power plants, and
- Operational experience of other nuclear power plants.

For the systems covered by Chapter 16, specific areas where ALARP assessments have been used to inform the design and propose changes on the reference design include the following relevant examples:

- The reference design of the ME SSCs was subjected to a thorough assessment in order to demonstrate that their design life and replacement frequency are in line with RGP and reduce the risk as low as reasonably practicable. According to the design review process established, depending on the operational period and profile under which the SSCs are required to work for UK ABWR (construction and/or commercial operation and/or decommissioning) it is judged whether the SSC is provided with a design life of 60 years or longer, or periodically replaced whichever the most reasonably practicable approach is to ensure continued availability of the SSC for the required conditions. This assessment is still ongoing and the design life and replacement frequency of several SSCs have already been modified. For further details refer to section 5 of the 'Hitachi-GE Strategy on the Design Life of ME SSCs'

(Ref-16.9-5).
Specifically, for those SSCs that their availability is expected for operation during decommissioning, this safety demonstration must cover both commercial operation and decommissioning operational profiles showing that safety and environmental performance can be maintained based on a component/subsystem replacement policy. Where it is not reasonably practicable to replace a major structure or component then the future safety case and specification of requirements for an SSC must cover a full design life longer than 60 years and the differing operational profiles required for different phases of the overall lifecycle of the structure or component. See Chapter 31: Decommissioning, Section 31.5.2.4 for a list of the systems supporting decommissioning.

- Auxiliary Systems:
  - Common cause failure of cooling water supplies has been identified as a potential threat to nuclear safety. Loss of the Ultimate Heat Sink (LUHS) (for instance due to blockage of the intakes by seaweed or algae) has been subject to extensive optioneering and ALARP study. This has resulted in a design change to include a RUHS as a risk reduction measure for the UK ABWR as part of GDA. This work is still ongoing, and further work will be required in post GDA phase to define the exact requirements, preferred technology, etc. The ALARP evaluation carried out to date is presented in (Ref-16.9-6) and summarised in Section 16.3.1.
  - The HVAC system (R/A, T/B, Rw/B, S/B) design is based upon the assumption that the possibility of airborne contamination has been minimised at source by an appropriate design, operating procedures, and maintenance procedures. In addition to multiple SFCs for the control of radioactive material and waste, the design ensures, so far as is reasonably practicable, that radioactive material and radioactive waste on the site is at all times adequately contained so that it cannot leak or otherwise escape. This is supported by design features to minimise the potential for leakage of containment, which are described in detail in relevant PCSR chapters against Fundamental Safety Function (FSF) 4: confinement / containment of radioactive materials. Specifically, a number of design features are claimed against High Level Safety Functions (HLSFs): 4-7: Functions to confine radioactive materials, shield radiation, and reduce radioactive release, 4-8: Functions to minimise the release of radioactive gases, 4-11: Functions to store the radioactive materials as gaseous waste, 4-12: Functions to store the radioactive materials as liquid wastes, 4-13: Functions to store the radioactive materials as solid wastes.
  - Notwithstanding this, there remains a potential risk associated with radioactive material being present within the facilities and therefore airborne radioactive materials (e.g. gases or contamination) need to be appropriately managed. This ALARP assessment is presented in a Topic Report (Ref-16.9-7) that supports the Basis of Safety Case for the HVAC systems (Ref-16.9-8).
  - The reference design for the EDGs followed Japanese practice of locating the EDGs within the R/B. While this offers advantages in terms of seismic withstand and aircraft impact resistance, the potential fire risk due to large fuel tanks being located inside the R/B prompted the search for potential risk reduction measures. Relocation of the EDGs was extensively optioneered by a multi-disciplinary team, taking into account such factors as internal hazards, external hazards, overall nuclear safety, reliability, maintainability and constructability. The identified options were ranked and rated, and a conclusion reached

on the optimum location i.e. the location that reduces risk to ALARP. Further detail is presented in a Topic Report on EDG Relocation (Ref-16.9-9).

- The use of embedded pipework is integral to the proposed UK ABWR design, and whilst it provides some benefits such as shielding, reduction of pipe length and increase of the access space. It also introduces the potential for undetected leakage into concrete during plant operation, and increased complexity during decommissioning. UK ABWR pipework has undergone extensive review and ALARP assessment to reduce, as far as practicable (Ref-16.9-10). UK ABWR pipework has undergone extensive review and ALARP assessment to reduce, as far as practicable. Minimisation of embedded pipework will facilitate and allow for a more efficient deplanting process of plant systems in decommissioning and ensure that the risks to operators are ALARP (see Chapter 31: Decommissioning). Where embedded pipework has been retained in the design, this has been fully assessed and justified in line with the ALARP principle.

- Severe Accident Mechanical Systems:
  - The severe accident mechanical systems (e.g. FLSS, FCVS, etc.) are fitted to the UK ABWR as countermeasures against beyond design basis faults and severe accidents as part of the lessons learnt from Fukushima Daiichi Accident. Since these systems are required in the event where the principal safety means would be lost, key SSCs are installed in the B/B and independent C&I and power supply are provided to prevent common cause failure.
  - In addition, the following defence in depth considerations have been implemented against unpredictable severe accident conditions:
    - The FLSR provides mobile injection facilities to backup coolant injection in the event where the FLSS is failed in the severe accident;
    - The RDCF provides local actuation with the switching valve, which does not rely on support systems, in addition to the automatic and manual actuation from the MCR and the B/B;
    - The LDF is provided as a passive core cooling system for the event of complete loss of other injection systems;
    - The FCVS provides the Containment Overpressure Protection System (COPS) (i.e. rupture disc) to achieve primary containment venting without operator’s action.
  - The FLSS is designed to supply cooling water from the B/B in order to prevent significant core damage in the event of design basis fault and severe accident. It was identified that the two trains of FLSS Pumps share one injection line thus potential failure of the associated check valve would result in loss of FLSS injection function. Therefore, the connecting point from FLSS has been subject to detailed ALARP evaluation, in line with the GDA ALARP methodology. This assessment took into account the nuclear safety, the worker safety, the impact on the environment. This ALARP assessment is presented in an assessment report (Ref-16.9-11) that supports the Basis of Safety Case for the severe accident mechanical systems (Ref-16.9-12).

In summary, it is concluded that all reasonably practicable risk reduction measures have been implemented, through the application UK and international good practice and a systematic and comprehensive ALARP evaluation process. The risks from the Auxiliary Systems covered by Chapter 16 are therefore considered to be ALARP.

16.10 Conclusions

This Chapter describes the safety case for the UK ABWR plant auxiliary systems and severe accident mechanical systems.

The Water Systems described in this chapter and its supporting references provide essential support to the SSCs described in Chapters 10-15, 17 and 19 of this PCSR. Essential support systems described in this chapter have been designed to the same safety standards as the SSCs that they support. A good example is the RCW described in 16.3.2. As this system provides essential cooling support to a wide range of other Safety Class 1 SSCs it is classified as Safety Class 1. The RCW is a three divisional system with each division capable of providing all the cooling necessary to keep the SSCs within the division it is supporting fully operational. Each division also has some internal redundancy allowing greater fault tolerance and flexibility in undertaking planned maintenance of this safety critical system. This chapter and its supporting references shows that all of the other cooling Water Systems are designed using the same approach as the RCW. The key principle adopted is to design each cooling Water System so that it performs identically in response to hazards and failures as the SSCs that they support. This means that for matters such as defence-in-depth, fault tolerance and reliability, each Water System covered by this chapter has the same integrity requirements as the SSCs it is supporting in overall safety train of equipment required to deliver a safety function.

Process Auxiliary Systems described in this chapter are provided to cover a wide range of safety support roles. One of many examples described in this chapter is the HPIN. This system provides nitrogen gas to the accumulators of the 16 SRVs and, for example, supports the ADS safety function and the PCV isolation valves and many other functions. This chapter describes the safety classification of this system and how it operates in both normal and under fault conditions. All other Process Auxiliary Systems have identical coverage as the HPIN in this chapter with descriptions providing a demonstration that while these systems provide important supporting roles their failures do not prohibit any SSC from performing its safety functional role. This means that for all of their failure modes all Safety Class 1 and Safety Class 2 SSCs they support can operate safely to ensure that any failures within these systems will not cause a safety problem.

The approach to the design of HVAC is identical in this chapter to the approach described for Water Systems covered briefly above. For example this means that where HVAC SSCs are Safety Class 1 (R/B, C/B, MCR etc.) these systems are designed to the same standards as the Safety Class 1 SSCs they support. It also means that all Safety Class 1 HVAC SSCs are designed with considerable defence-in-depth and have to meet high reliability targets. This chapter shows that each Safety Class 1 HVAC SSC is also itself supported by other Safety Class 1 systems such as C&I (chapter 14), Water Systems (this chapter) and the Electrical Power Supply System (Chapter 15) etc. An identical approach is applied to the Safety Class 2 diverse HVAC and the Safety Class 3 HVAC. For example each safety Class 2 HVAC has two by 100% divisions and is supported by Safety Class 2 C&I (Chapter 14), Safety Class 2 Water Systems (this chapter) and Safety Class 2 EPS (Chapter 15) all supported by the remotely located Back-up building.

Although an important focus of this chapter is to provide a safety justification of the design of the reactor support systems to reduce the risk of accidents to a level that is as low as reasonably practicable provision has been made for severe accident mechanical engineering systems. This chapter shows that the UK ABWR has been provided with a wide range of fixed installations and remotely and securely located mobile facilities. A good example of the fixed installation described in this chapter is the LDF System and an example of a mobile facility is the FLSR. The LDF's role is to provide a very robust and simple method of providing cooling to molten corium debris by flooding the Lower Drywell with water from the S/P. As described in section 16.7.3.4 of this chapter the LDF consists of piping, fusible plugs and the S/P as a source of water. It requires no complex instrumentation or controllers to operate effectively thereby ensuring that even with a severe accident leading to a core melt the integrity of the PCV can be maintained to minimise the release of radioactivity. Similarly, section 16.7.3.2 of this chapter shows that the FLSR is a simple mobile system providing effective cooling in the event of the total failure of the Safety Class 1 ECCS and the Safety Class 2 FLSS. Section 16.7 provides an overview of the totality of the severe accident mechanical systems and how they can be used to ensure the minimisation of the release of radioactivity in the highly unlikely event of a severe accident occurring.

16.11 References

Ref-16.1-1 Hitachi-GE Nuclear Energy, Ltd., "*Topic Report on Fault Assessment*", GA91-9201-0001-00022 (UE-GD-0071), Rev.6, July 2017

Ref-16.1-2 Hitachi-GE Nuclear Energy, Ltd. "*List of Safety Category and Class for UK ABWR*", GA91-9201-0003-00266 (AE-GD-0224) Rev.4, August 2017

Ref-16.1-3 Hitachi-GE Nuclear Energy, Ltd. "*Topic Report on Safety Requirements for Mechanical SSCs*", GA91-9201-0001-00117 (SE-GD-0308) Rev.2, May 2017

Ref-16.1-4 Hitachi-GE Nuclear Energy, Ltd. "*Topic Report on Mechanical SSCs Architecture*", GA91-9201-0001-00210 (SE-GD-0425) Rev.1, July 2017

Ref-16.1-5 Hitachi-GE Nuclear Energy, Ltd. "*GDA Safety Case Development Manual*", GA10-0511-0006-00001 (XD-GD-0036) Rev.3, May 2017

Ref-16.3-1 Hitachi-GE Nuclear Energy, Ltd., "*Topic Report on RUHS*", GA91-9201-0001-00233 (AE-GD-0812), Rev.0, October 2016

Ref-16.3-2 Hitachi-GE Nuclear Energy, Ltd., "*Basis of Safety Cases on Reactor Building Cooling Water Systems*", GA91-9201-0002-00035 (SE-GD-0059) Rev.3, June 2017

Ref-16.3-3 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System System Design Description*", GP25-1001-0001-00001 (SD-GD-0016) Rev.2, June 2017

Ref-16.3-4 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System P&ID (1/9)*", GP25-1001-0001-00001 (310QC98-333) Rev.2,June 2017

Ref-16.3-5 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System P&ID (2/9)*", GP25-1001-0001-00002 (310QC98-334) Rev.2, June 2017

Ref-16.3-6 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System P&ID (3/9)*", GP25-1001-0001-00003 (310QC98-335) Rev.2, June 2017

Ref-16.3-7 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System P&ID (4/9)*", GP25-1001-0001-00004 (310QC98-336) Rev.2, June 2017

Ref-16.3-8 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System P&ID (5/9)*", GP25-1001-0001-00005 (310QC98-337) Rev.2, June 2017

Ref-16.3-9 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System P&ID (6/9)*", GP25-1001-0001-00006 (310QC98-338) Rev.2, June 2017

Ref-16.3-10 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System P&ID (7/9)*", GP25-1001-0001-00007 (310QC98-339) Rev.2, June 2017

Ref-16.3-11 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System P&ID (8/9)*", GP25-1001-0001-00008 (310QC98-340) Rev.2, June 2017

Ref-16.3-12 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Cooling Water System P&ID (9/9)*", GP25-1001-0001-00009 (310QC98-341) Rev.2, June 2017

Ref-16.3-13 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Service Water System System Design Description*", GP25-1001-0001-00001 (SD-GD-0017) Rev.2, June 2017

Ref-16.3-14 Hitachi-GE Nuclear Energy, Ltd., *"Reactor Building Service Water System P&ID (1/3)*", GP25-1001-0001-00001 (310QC98-343) Rev.2, June 2017

Ref-16.3-15 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Service Water System P&ID (2/3)*", GP25-1001-0001-00002 (310QC98-344) Rev.2, June 2017

Ref-16.3-16 Hitachi-GE Nuclear Energy, Ltd., "*Reactor Building Service Water System P&ID (3/3)*", GP25-1001-0001-00003 (310QC98-345) Rev.2, June 2017

Ref-16.3-17 Hitachi-GE Nuclear Energy, Ltd., "*Basis of Safety Cases on Turbine Building Cooling Water Systems*", GA91-9201-0002-00036 (SBE-GD-0014), Rev.2, June 2017

Ref-16.3-18 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Emergency Cooling Water System System Design Description*", GP25-1001-0001-00001 (HPD-GD-H002) Rev.2, June 2017

Ref-16.3-19 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Emergency Cooling Water System P&ID (1/3)*", GP25-2101-0001-00001 (310QC67-568) Rev.0 , October 2015

Ref-16.3-20 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Emergency Cooling Water System P&ID (2/3)*", GP25-2101-0001-00002 (310QC67-569) Rev.0, October 2015

Ref-16.3-21 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Emergency Cooling Water System P&ID (3/3)*", GP25-2101-0001-00003 (310QC67-585) Rev.0, October 2015

Ref-16.3-22 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Normal Cooling Water System System Design Description*", GP24-1001-0001-00001 (HPD-GD-H003) Rev.2, June 2017

Ref-16.3-23 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Normal Cooling Water Stystem P&ID (1/5)*", GP24-2101-0001-00001 (310QC67-570) Rev.2, June 2017

Ref-16.3-24 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Normal Cooling Water Stystem P&ID (2/5)*", GP24-2101-0001-00002 (310PB50-272) Rev.2, June 2017

Ref-16.3-25 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Normal Cooling Water Stystem P&ID (3/5)*", GP24-2101-0001-00003 (310QC67-572) Rev.2, June 2017

Ref-16.3-26 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Normal Cooling Water Stystem P&ID (4/5)*", GP24-2101-0001-00004 (310QC67-588) Rev.0, June 2017

Ref-16.3-27 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Normal Cooling Water Stystem P&ID (5/5)*", GP24-2101-0001-00005 (310QC67-589) Rev.0, June 2017

Ref-16.3-28 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Backup Building Cooling Water System System Design Description*", GP26-1001-0001-00001 (HPD-GD-H010) Rev.0, June 2017

Ref-16.3-29 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Backup Building Cooling Water System P&ID (1/2)*", GP26-2101-0001-00001 (310QC67-586) Rev.0, June 2017

Ref-16.3-30 Hitachi-GE Nuclear Energy, Ltd., "*HVAC Backup Building Cooling Water System P&ID (2/2)*", GP26-2101-00001-00002 (310QC67-587) Rev.0, June 2017

Ref-16.3-31 Hitachi-GE Nuclear Energy, Ltd., "*Basis of Safety Cases on Backup Building Cooling Water System*", GA91-9201-0002-00035 (SE-GD-0358) Rev.1, June 2017

Ref-16.3-32 Hitachi-GE Nuclear Energy, Ltd., "*Emergency Equipment Cooling Water System System Design Description*", GP27-1001-0001-00001 (SD-GD-0040) Rev.2, June 2017

Ref-16.3-33 Hitachi-GE Nuclear Energy, Ltd., "*Emergency Equipment Cooling Water System P&ID (1/2)*", GP27-2101-0001-00001 (310QC98-342) Rev.2, June 2017

Ref-16.3-34 Hitachi-GE Nuclear Energy, Ltd., "*Emergency Equipment Cooling Water System P&ID (2/2)*", GP27-2101-0001-00002 (310QC98-361) Rev.2, June 2017

Ref-16.3-35 Hitachi-GE Nuclear Energy, Ltd. "*Topic Report on Fault Assessment*", GA91-9201-0001-00022 (UE-GD-0071) Rev. 6, July 2017

Ref-16.3-36 Hitachi-GE Nuclear Energy, Ltd. "*List of Safety Category and Class for UK ABWR*" GA91-9201-0003-00266 (AE-GD-0224) Rev. 3, April 2016

Ref-16.3-37 Hitachi-GE Nuclear Energy, Ltd. "*Generic Technical Specifications*" GA80-1502-0002-00001 (SE-GD-0378) Rev. 3, August 2017

Ref-16.3-38 Hitachi-GE Nuclear Energy, Ltd., "*Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation*", GA91-0512-0010-00001 (XD-GD-0042) Rev.2, March 2017

Ref-16.4-1 Hitachi-GE Nuclear Energy, Ltd., "Instrument Air System System Design Description", GP52-1001-0001-00001 (SD-GD-0020) Rev. 1, August 2016

Ref-16.4-2 Hitachi-GE Nuclear Energy, Ltd., *"Instrument Air System P&ID"*, GP52-2101-0001-00001 (310QC98-349) Rev.2, June 2017

Ref-16.4-3 Hitachi-GE Nuclear Energy, Ltd., *"High Pressure Nitrogen Gas Supply System and Instrument Air system Safety Case (Response to RQ-ABWR-0901)"*, GA91-9201-0003-01465 (SE-GD-0482) Rev.0, July 2016

Ref-16.4-4 Hitachi-GE Nuclear Energy, Ltd., *"Station Service Air System System Design Description"*, GP51-1001-0001-00001 (SD-GD-0019) Rev. 0, September 2013

Ref-16.4-5 Hitachi-GE Nuclear Energy, Ltd., *"Station Service Air System P&ID (1/4)"*, GP51-2101-0001-00001 (310QC98-446) Rev. 1, September 2016

Ref-16.4-6 Hitachi-GE Nuclear Energy, Ltd., *"Station Service Air System P&ID (2/4)"*, GP51-2101-0001-00002 (310QC98-447) Rev. 1, September 2016

Ref-16.4-7 Hitachi-GE Nuclear Energy, Ltd., *"Station Service Air System P&ID (3/4)"*, GP51-2101-0001-00003 (310QC98-448) Rev. 1, September 2016

Ref-16.4-8 Hitachi-GE Nuclear Energy, Ltd., *"Station Service Air System P&ID (4/4)"*, GP51-2101-0001-00004 (310QC98-364) Rev. 1, June 2017

Ref-16.4-9 Hitachi-GE Nuclear Energy, Ltd., *"High Pressure Nitrogen Gas Supply System System Design Description"*, GP54-1001-0001-00001 (SD-GD-0021) Rev. 2, June 2017

Ref-16.4-10 Hitachi-GE Nuclear Energy, Ltd., *"High Pressure Nitrogen Gas Supply System P&ID"*, GP54-2101-0001-00001 (310QC98-450) Rev. 1, September 2016

Ref-16.4-11 Hitachi-GE Nuclear Energy, Ltd., "*Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation.*", GA91-0512-0010-00001 (XD-GD-0042) Rev.2, March 2017

Ref-16.4-12 Hitachi-GE Nuclear Energy, Ltd., *"Plumbing and Drainage System System Design Description"*, GU45-1001-0001-00001 (SD-GD-0031) Rev. 1, June 2017

Ref-16.4-13 Hitachi-GE Nuclear Energy, Ltd., *"Miscellaneous Non-Radioactive Drain Transfer System System Design Description"*, GU63-1001-0001-00001 (SD-GD-0034) Rev. 1, June 2017

Ref-16.4-14 Hitachi-GE Nuclear Energy, Ltd., *"Miscellaneous Non-Radioactive Drain Transfer System P&ID (1/3)"*, GU63-2101-0001-00001 (310QC98-490) Rev. 1, August 2016

Ref-16.4-15 Hitachi-GE Nuclear Energy, Ltd., *"Miscellaneous Non-Radioactive Drain Transfer System P&ID (2/3) (T/B)"*, GU63-2101-0001-00002 (310QD02-030) Rev. 2, June 2017

Ref-16.4-16 Hitachi-GE Nuclear Energy, Ltd., *"Miscellaneous Non-Radioactive Drain Transfer System P&ID (3/3)"*, GU63-2101-0001-00003 (310QC98-491) Rev. 1, August 2016

Ref-16.4-17 Hitachi-GE Nuclear Energy, Ltd., *"Sampling System System Design Description"*, GP91-1001-0001-00001 (SD-GD-0024) Rev. 2, June 2017

Ref-16.4-18 Hitachi-GE Nuclear Energy, Ltd., *"Heating Steam System and Heating Steam Condensate Water Return System System Design Description"*, GP61-1001-0001-00001 (SD-GD-0022) Rev. 0, September 2013

Ref-16.4-19 Hitachi-GE Nuclear Energy, Ltd., *"HS and HSCR P&ID (1/8)"*, GP61-2101-0001-00001 (310QC98-351) Rev. 1, November 2016

Ref-16.4-20 Hitachi-GE Nuclear Energy, Ltd., *"HS and HSCR P&ID (2/8)"*, GP61-2101-0001-00002 (310QC98-352) Rev. 1, November 2016

Ref-16.4-21 Hitachi-GE Nuclear Energy, Ltd., *"HS and HSCR P&ID (3/8)"*, GP61-2101-0001-00003 (310QC98-353) Rev. 1, November 2016

Ref-16.4-22 Hitachi-GE Nuclear Energy, Ltd., *"HS and HSCR P&ID (4/8)"*, GP61-2101-0001-00004 (310QC98-354) Rev. 1, November 2016

Ref-16.4-23 Hitachi-GE Nuclear Energy, Ltd., *"HS and HSCR P&ID (5/8)"*, GP61-2101-0001-00005 (310QC67-541) Rev. 0, October 2015

Ref-16.4-24 Hitachi-GE Nuclear Energy, Ltd., *"HS and HSCR P&ID (6/8)"*, GP61-2101-0001-00006 (310QC67-542) Rev. 0, October 2015

Ref-16.4-25 Hitachi-GE Nuclear Energy, Ltd., *"HS and HSCR P&ID (7/8)"*, GP61-2101-0001-00007 (310QC67-583) Rev. 0,October 2015

Ref-16.4-26 Hitachi-GE Nuclear Energy, Ltd., *"HS and HSCR P&ID (8/8)"*, GP61-2101-0001-00008 (310QC67-584) Rev. 0,October 2015

Ref-16.4-27 Hitachi-GE Nuclear Energy, Ltd. *"List of Safety Category and Class for UK ABWR"* GA91-9201-0003-00266 (AE-GD-0224) Rev. 4, August 2017

Ref-16.4-28 Hitachi-GE Nuclear Energy, Ltd. *"Liquid Waste Management System System Design Description "* GK10-1001-0001-00001 (WD-GD-0001) Rev. 0, Mar 2017

Ref-16.5-1 Hitachi-GE Nuclear Energy, Ltd., *"Basis of Safety Cases on Heating Ventilating and Air Conditioning System"*, GA91-9201-0002-00041(HPE-GD-H006) Rev.4, June 2017.

Ref-16.5-2 Hitachi-GE Nuclear Energy, Ltd., *"Heating Ventilating and Air Conditioning System System Design Description"*, GU41-1001-0001-00001(HPD-GD-H001), Rev.1, June 2017.

Ref-16.5-3 Hitachi-GE Nuclear Energy, Ltd., *"R/A HVAC System D&ID (1/5)"*, GU41-2101-0001-00001 (310PB50-270), Rev.0, October 2015.

Ref-16.5-4 Hitachi-GE Nuclear Energy, Ltd., *"R/A HVAC System D&ID (2/5) (ECCS Local Cooling Units)"*, GU41-2101-0001-00002 (310QC67-544), Rev.1, October 2015.

Ref-16.5-5 Hitachi-GE Nuclear Energy, Ltd., *"R/A HVAC System D&ID (3/5) (Emergency Local Cooling Units)"*, GU41-2101-0001-00003 (310QC67-545), Rev.1, October 2015.

Ref-16.5-6 Hitachi-GE Nuclear Energy, Ltd., *"R/A HVAC System D&ID (4/5) (Local Cooling Units)"*, GU41-2101-0001-00004 (310QC67-567), Rev.1, June 2017.

Ref-16.5-7 Hitachi-GE Nuclear Energy, Ltd., *"R/A HVAC System D&ID (5/5) (Local Cooling Units)"*, GU41-2101-0001-00005 (310QC67-546), Rev.0, October 2015.

Ref-16.5-8 Hitachi-GE Nuclear Energy, Ltd., *"R/B Emergency Electrical Equipment (A) Zone HVAC System D&ID"*, GU41-2101-0003-00001 (310QC67-550), Rev.1, June 2017.

Ref-16.5-9 Hitachi-GE Nuclear Energy, Ltd., *"R/B Emergency Electrical Equipment (B) Zone HVAC System D&ID"*, GU41-2101-0003-00002 (310QC67-551), Rev.1, June 2017.

Ref-16.5-10 Hitachi-GE Nuclear Energy, Ltd., *"R/B Emergency Electrical Equipment (C) Zone HVAC System D&ID"*, GU41-2101-0003-00003 (310QC67-552), Rev.1, June 2017.

Ref-16.5-11 Hitachi-GE Nuclear Energy, Ltd., *"ED/G (A) Electrical Equipment Zone HVAC System D&ID"*, GU41-2101-0016-00001 (310QC67-580), Rev.1, June 2017.

Ref-16.5-12 Hitachi-GE Nuclear Energy, Ltd., *"ED/G (B) Electrical Equipment Zone HVAC System D&ID"*, GU41-2101-0016-00002 (310QC67-581), Rev.1, June 2017.

Ref-16.5-13 Hitachi-GE Nuclear Energy, Ltd., *"ED/G (C) Electrical Equipment Zone HVAC System D&ID"*, GU41-2101-0016-00003 (310QC67-582), Rev.1, June 2017.

Ref-16.5-14 Hitachi-GE Nuclear Energy, Ltd., *"T/B HVAC System D&ID (1/3)"*, GU41-2101-0002-00001 (310PB50-271), Rev.0, October 2015.

Ref-16.5-15 Hitachi-GE Nuclear Energy, Ltd., *"Hx/B Normal HVAC System D&ID"*, GU41-2101-0010-00001 (310QC67-563), Rev.0, October 2015.

Ref-16.5-16 Hitachi-GE Nuclear Energy, Ltd., *"Hx/B Emergency HVAC System D&ID"*, GU41-2101-0011-00001 (310QC67-564), Rev.1, June 2017.

Ref-16.5-17 Hitachi-GE Nuclear Energy, Ltd., *"C/B Emergency Electrical Equipment (A) Zone HVAC System D&ID"*, GU41-2101-0005-00001 (310QC67-555), Rev.1, June 2017.

Ref-16.5-18 Hitachi-GE Nuclear Energy, Ltd., *"C/B Emergency Electrical Equipment (B) Zone HVAC System D&ID"*, GU41-2101-0005-00002 (310QC67-556), Rev.1, June 2017.

Ref-16.5-19 Hitachi-GE Nuclear Energy, Ltd., *"C/B Emergency Electrical Equipment (C) Zone HVAC System D&ID"*, GU41-2101-0005-00003 (310QC67-557), Rev.1, June 2017.

Ref-16.5-20 Hitachi-GE Nuclear Energy, Ltd., *"C/B Class 2 Electrical Equipment Zone HVAC System D&ID"*, GU41-2101-0015-00001 (310QC67-579), Rev.1, June 2017.

Ref-16.5-21 Hitachi-GE Nuclear Energy, Ltd., *"MCR HVAC System (A) D&ID"*, GU41-2101-0004-00001 (310QC67-553), Rev.0, October 2015.

Ref-16.5-22 Hitachi-GE Nuclear Energy, Ltd., *"MCR HVAC System (B) D&ID"*, GU41-2101-0004-00002 (310QC67-554), Rev.0, October 2015.

Ref-16.5-23 Hitachi-GE Nuclear Energy, Ltd., *"Rw/B HVAC System D&ID"*, GU41-2101-0006-00001 (310QC67-558), Rev.1, June 2017.

Ref-16.5-24 Hitachi-GE Nuclear Energy, Ltd., *"S/B HVAC System D&ID (1/2)"*, GU41-2101-0012-00001 (310QC67-565), Rev.1, June 2017.

Ref-16.5-25 Hitachi-GE Nuclear Energy, Ltd., *"B/B Electrical Equipment (A) Zone HVAC System D&ID"*, GU41-2101-0014-00001 (310QC67-577), Rev.1, June 2017.

Ref-16.5-26 Hitachi-GE Nuclear Energy, Ltd., *"B/B Electrical Equipment (B) Zone HVAC System D&ID"*, GU41-2101-0014-00002 (310QC67-578), Rev.1, June 2017.

Ref-16.5-27 Hitachi-GE Nuclear Energy, Ltd., *"B/B ECR HVAC System (A) D&ID"*, GU41-2101-0013-00001 (310QC67-575), Rev.1, June 2017.

Ref-16.5-28 Hitachi-GE Nuclear Energy, Ltd., *"B/B ECR HVAC System (B) D&ID"*, GU41-2101-0013-00002 (310QC67-576), Rev.1, June 2017.

Ref-16.5-29 Hitachi-GE Nuclear Energy, Ltd., *"FV/B HVAC System D&ID"*, GU41-2101-0017-00001 (310QC67-590), Rev.1, June 2017.

Ref-16.5-30 Hitachi-GE Nuclear Energy, Ltd., *"Topic Report on Internal Event at Power Level 1 PSA"*, GA-91-9201-0001-00102 (AE-GD-0257), Rev.4, June 2016

Ref-16.5-31 Hitachi-GE Nuclear Energy, Ltd. "*Generic Technical Specifications*" GA80-1502-0002-00001 (SE-GD-0378) Rev. 3, August 2017

Ref-16.5-32 Hitachi-GE Nuclear Energy, Ltd., "*Topic Report on Decommissioning: Design for Decommissioning*", GA91-9201-0001-00172 (DCE-GD-0065) Rev.3, June 2017.

Ref-16.5-33 Hitachi-GE Nuclear Energy, Ltd., "*Topic Report on Decommissioning: Decommissioning Plan*", GA91-9201-0001-00176 (DCE-GD-0066) Rev.3, July 2017.

Ref-16.5-34 Hitachi-GE Nuclear Energy, Ltd., "*Topic Report on Decommissioning: Decommissioning Waste Management*", GA91-9201-0001-00173 (DCE-GD-0069) Rev.6, July 2017.

Ref-16.6-1 Hitachi-GE Nuclear Energy, Ltd., "*Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation.*", GA91-0512-0010-00001 (XD-GD-0042) Rev.2, March 2017

Ref-16.6-2 Hitachi-GE Nuclear Energy, Ltd., *"Basis of Safety Cases on Emergency Power Supply System"*, GA91-9201-0002-00042 (VDE-GD-0001) Rev. 3, June 2017.

Ref-16.6-3 Hitachi-GE Nuclear Energy, Ltd., "*Fire Protection System Basic Design Plan*", GA26-1001-0002-00001 (BKD-GD-0002) Rev.0, March 2014.

Ref-16.6-4 Hitachi-GE Nuclear Energy, Ltd., "*Topic Report on Departures from Conventional Fire Regulation*", GA91-9201-0001-00001(BKE-GD-0004), Rev.6, March 2017.

Ref-16.6-5 Hitachi-GE Nuclear Energy, Ltd., "*Basis of Safety Cases on Heating Ventilating and Air Conditioning System*", GA91-9201-0002-00041(HPE-GD-H006) Rev.4, June 2017.

Ref-16.6-6 Hitachi-GE Nuclear Energy, Ltd., *"Suppression Pool Clean-up System System Design Description"*, GG51-1001-0001-00001 (SD-GD-0011) Rev. 1, April 2016.

Ref-16.6-7 Hitachi-GE Nuclear Energy, Ltd., *"Suppression Pool Clean-up System P&ID"*, GG51-2101-0001-00001 (310QC98-326) Rev.1, April 2016.

Ref-16.6-8 Hitachi-GE Nuclear Energy, Ltd., *"Topic Report on Fault Assessment"*, GA91-9201-0001-00022 (UE-GD-0071) Rev.6, July 2017.

Ref-16.6-9 Hitachi-GE Nuclear Energy, Ltd., "*Generic Technical Specifications*", GA80-1502-0002-00001 (SE-GD-0378) Rev.3, August 2017.

Ref-16.7-1 Hitachi-GE Nuclear Energy, Ltd., *"Basis of Safety Cases on Severe Accident Mechanical Systems"*, GA91-9201-0002-00021 (SE-GD-0219) Rev.2, June 2017.

Ref-16.7-2 Hitachi-GE Nuclear Energy, Ltd., *"Flooder System of Specific Safety Facility System Design Description"*, GE71-1001-0001-00001 (SD-GD-0042) Rev.3, June 2017.

Ref-16.7-3 Hitachi-GE Nuclear Energy, Ltd., *"Flooder System of Specific Safety Facility P&ID (1/2)"*, GE71-2101-0001-00001 (310PB35-982) Rev.1, February 2016.

Ref-16.7-4 Hitachi-GE Nuclear Energy, Ltd., *"Flooder System of Specific Safety Facility P&ID (2/2)"*, GE71-2101-0001-00002 (310QC88-455) Rev.1, June 2017.

Ref-16.7-5 Hitachi-GE Nuclear Energy, Ltd., *"Flooder System of Reactor Building System Design Description"*, GE72-1001-0001-00001 (SD-GD-0043) Rev.1, May 2017.

Ref-16.7-6 Hitachi-GE Nuclear Energy, Ltd., *"Flooder System of Reactor Building Facility P&ID"*, GE72-2101-0001-00001 (310QC98-421) Rev.1, February 2016.

Ref-16.7-7 Hitachi-GE Nuclear Energy, Ltd., "*Standard Control Procedure for Identification and Registration of Assumptions, Limits and Conditions for Operation.*", GA91-0512-0010-00001 (XD-GD-0042) Rev.2, March 2017

Ref-16.7-8 Hitachi-GE Nuclear Energy, Ltd., *"Reactor Depressurisation Control Facility System Design Description"*, GP56-1001-0001-00001 (SD-GD-0075) Rev.0, May 2017.

Ref-16.7-9 Hitachi-GE Nuclear Energy, Ltd., *"Reactor Depressurisation Control Facility P&ID"*, GP56-2101-0001-00001 (310QC98-362) Rev.0, May 2017.

Ref-16.7-10 Hitachi-GE Nuclear Energy, Ltd., *"Reactor Depressurisation Control Facility P&ID (Switching Valve for SRV)"*, GP56-2101-0001-00002 (310QC98-363) Rev.0, May 2017.

Ref-16.7-11 Hitachi-GE Nuclear Energy, Ltd., *"Lower Drywell Flooder System System Design Description"*, GT14-1001-0001-00001 (SD-GD-0036) Rev.1, May 2017

Ref-16.7-12 Hitachi-GE Nuclear Energy, Ltd., *"Lower Drywell Flooder System P&ID"*, GE14-2101-0001-00001 (310QC98-367) Rev. 2, June 2017.

Ref-16.7-13 Hitachi-GE Nuclear Energy, Ltd., *"Filter Containment Venting System System Design Description"*, GT61-1001-0001-00001 (SD-GD-0038) Rev.2, June 2017.

Ref-16.7-14 Hitachi-GE Nuclear Energy, Ltd., *"Filter Containment Venting System P&ID"*, GT61-2101-0001-00001 (310QC88-470) Rev.2 June 2017.

Ref-16.7-15 Hitachi-GE Nuclear Energy, Ltd., *"Alternative Heat Exchange Facility System Design Description"*, GP81-1001-0001-00001 (SD-GD-0045) Rev.2, June 2017.

Ref-16.7-16 Hitachi-GE Nuclear Energy, Ltd., *"Alternative Heat Exchange Facility P&ID"*, GP81-2101-0001-00001 (310RC03-256) Rev.2, June 2017.

Ref-16.7-17 Hitachi-GE Nuclear Energy, Ltd., *"Alternative Nitrogen Injection System System Design Description"*, GT72-1001-0001-00001 (SD-GD-0070) Rev.1, June 2017.

Ref-16.7-18 Hitachi-GE Nuclear Energy, Ltd., *"Alternative Nitrogen Injection System P&ID"*, GT72-2101-0001-00001 (310RC03-287) Rev.1, June 2017.

Ref-16.7-19 Hitachi-GE Nuclear Energy, Ltd., *"Basis of Safety Cases on Emergency Core Cooling System"*, GA91-9201-0002-00020 (SE-GD-0164) Rev.2, June 2017.

Ref-16.7-20 Hitachi-GE Nuclear Energy, Ltd., *"Topic Report on Beyond Design Basis Analysis"*, GP81-2101-0001-00001 (310RC03-256) Rev.2, June 2017.

Ref-16.7-21 Hitachi-GE Nuclear Energy, Ltd. "*Generic Technical Specifications*" GA80-1502-0002-00001 (SE-GD-0378) Rev. 3, August 2017

Ref-16.9-1 Hitachi-GE Nuclear Energy, Ltd. "*GDA ALARP Methodology*", GA10-0511-0004-00001 (XD-GD-0037) Rev. 1, November 2015.

Ref-16.9-2 Hitachi-GE Nuclear Energy, Ltd. "*General Design Process Approach for Mechanical Engineering SSCs*", GA91-9201-0003-00854 (SE-GD-0297) Rev 1, September 2016.

Ref-16.9-3 ISBN 978 0 7176 6171 8: '*The safe isolation of plant and equipment*', Issue 2, 2006.

Ref-16.9-4 NVF/DG001: '*Nuclear Ventilation Forum: Nuclear Industry guidance; An Aid to the Design of Ventilation of Radioactive Areas*', Issue 1, January 2009.

Ref-16.9-5 Hitachi-GE Nuclear Energy, Ltd., "Hitachi-GE Strategy on the Design Life of ME SSCs", GA91-9201-0003-00532 (SE-GD-0188) Rev.1, September 2016

Ref-16.9-6 WN002-S9-FD-REP-00002: '*Reserve Ultimate Heat Sink Strategic Optioneering Report*', Rev 1.0, March 2016.

Ref-16.9-7 Hitachi-GE Nuclear Energy, Ltd. "*Topic Report on ALARP Assessment for R/A, T/B, Rw/B and S/B HVAC Systems*" GA91-9201-0001-00196 (HPE-GD-H050), Rev 0, February 2016.

Ref-16.9-8 Hitachi-GE Nuclear Energy, Ltd. "*Basis of Safety Case for the Heating, Ventilating and Air Conditioning System (HVAC)*", GA91-9201-0002-00041 (HPE-GD-H006), Rev. 4, June 2017.

Ref-16.9-9 Hitachi-GE Nuclear Energy, Ltd. "*Topic Report of the Emergency Diesel Generator Locations Optioneering Study*", GA91-9201-0001-00170 (LE-GD-0192), Rev 0, December 2015.

Ref-16.9-10 Hitachi-GE Nuclear Energy, Ltd., "*Topic Report on ALARP Assessment for Embedded Pipework*", GA91-9201-0001-00258 (OPE-GD-0005) Rev.0, March 2017

Ref-16.9-11 Hitachi-GE Nuclear Energy, Ltd. "*FLSS Design Review and ALARP Report*", GA91-9201-0003-02078 (SE-GD-0595), Rev 0, April 2017.

Ref-16.9-12 Hitachi-GE Nuclear Energy, Ltd. "*Basis of Safety Case on Severe Accident Mechanical Systems*" GA91-9201-0002-00021 (SE-GD-0219), Rev 2, June 2017.

Appendix A: Safety Functional Claims Tables

The safety functional claims table of each system is provided in the following tables.

Ch.16.3

- SFC Table of UHS
- SFC Table of RCW
- SFC Table of RSW
- SFC Table of TCW
- SFC Table of TSW
- SFC Table of MUWC
- SFC Table of HECW
- SFC Table of HNCW
- SFC Table of HBCW
- SFC Table of EECW

Ch.16.4

- SFC Table of IA
- SFC Table of SA
- SFC Table of HPIN
- SFC Table of P&D
- SFC Table of RD
- SFC Table of SAM
- SFC Table of HS/HSCR

Ch.16.5

- SFC Table of HVAC

Ch.16.6

- SFC Table of FPS
- SFC Table of EDG, BBG and DAG
- SFC Table of SPCU

Ch.16.7

- SFC Table of FLSS
- SFC Table of FLSR
- SFC Table of RDCF
- SFC Table of LDF
- SFC Table of FCVS
- SFC Table of AHEF
- SFC Table of ANI

SFC Table of UHS

	Top Claim for Mechanical System					Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)	State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-2	Supporting functions especially important to safety	1.1 Generator load rejection 1.2 Partial loss of reactor flow (trip of 4 RIPs) 1.3 Loss of reactor flow (trip of all RIPs) 1.4 Feedwater controller failure - Maximum demand 1.5 Recirculation flow control failure (runout of all RIPs) 1.6 Loss of feedwater heating 1.7 Reactor pressure regulator failure in the closed direction 1.8 Inadvertent control valve closure 2.1 Inadvertent MSIV closure 2.2 Reactor pressure regulator failure in the open direction 2.3 Loss of main condenser vacuum 3.1 Loss of all feedwater flow 4.2 Control rod withdrawal error at power 4.4 Inadvertent reactor SCRAM (CRD pump trip) 4.5 SRNM or APRM sensor failure 4.6 Radiation Monitor Failure 5.1 Short term LOOP 5.2 Medium term LOOP 5.3 Long-term LOOP 6.1 Inadvertent opening of a SRV 7.1 LOCA - RPV bottom drain line break 7.2 LOCA - small line break 8.1 LOCA - HPCF line break 8.2 LOCA - LPFL line break 9.1 LOCA - FWD line 9.2 LOCA - MS line break 9.3 LOCA - RHR line break 10.1 LOCA outside PCV - MS line break 10.2 LOCA outside PCV - CUW line break 10.3 LOCA outside PCV - FWD line break 10.4 LOCA outside PCV - small line break 11.2 Inadvertent opening of all ADS 11.3 Inadvertent start up of all injection system 11.4 Inadvertent opening of all ADS (SSLC failure) 11.5 Inadvertent MSIV closure (SSLC failure) 11.8 M/C power supply failure on electrical CCF	Normal and Fault Conditions	UHS SFC 5-2.1	The UHS is the principal means to provide sufficient cooling water to the RSW to dissipate the heat from the plant auxiliaries required for power operation, shutdown operation, hot stand-by with off-site power and main condenser available, hot stand-by under Loss of Off-site Power (LOOP) and main condenser unavailable, and main design basis fault scenarios (LOCA).	A	1

	Top Claim for Mechanical System					Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)	High Level Safety Function (HLSF)	Fault Schedule (Bounding Fault)							
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
			11.9	D/C power supply failure on electrical CCF					
			11.10	Loss of all RCW					
			11.11	Loss of all RSW					
			11.12	Loss of Class 1 HVAC					
			13.3	SD - Loss of operating RHR and the same ECCS div.					
			13.4	SD – Loss of operating RHR (Class 1 controller CCF)					
			13.5.1	SD - Short LOOP					
			13.5.2	SD - Medium LOOP					
			13.5.3	SD - Long LOOP					
			13.6.1	SD - Short SBO					
			13.6.2	SD - Medium SBO					
			13.6.3	SD - Long SBO					
			13.7	SD - Draindown due to operating RHR valve failure					
			13.8	SD - LOCA inside PCV – FWD line					
			13.9	SD - LOCA inside PCV – RHR suction line					
			13.10	SD - LOCA inside PCV – LPFL injection line					
			13.11	SD - LOCA below TAF					
			13.12	SD - RPV draindown by CUW					
			13.13	SD - Leakage during FMCRD inspection					
			13.14	SD - Leakage during IMC nozzle replacement					
			13.15	SD - Leakage during RIP inspection					
			13.16	SD - Refuelling bellow perforation					
			17.1	Internal fire in R/B					
			17.2	Internal fire in Hx/B					
			17.3	Internal fire in C/B					
			17.4	Internal fire in MCR					
			17.5	Internal missile in MCR					
			17.6	Turbine missile					
			18.1	Loss of UHS					
			18.2	10-3/y earthquake					
			18.3	DB earthquake					

SFC Table of RCW

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	3	Long term heat removal	3-1	Functions to remove residual heat after shutdown	-	No corresponding fault	Normal Conditions	[RCW SFC 3-1.1]	The RCW is a principal means together with the RHR to remove residual heat from the reactor by transferring residual heat from the RHR process water to the RSW process water after normal reactor shutdown to reach reactor cold shutdown.	A	1
2	3	Long term heat removal	3-1	Functions to remove residual heat after shutdown	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 3.1 4.2 4.4 4.5 4.6 5.1 5.2 5.3 6.1 7.1 7.2 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3 10.4	Generator load rejection Partial loss of reactor flow (trip of 4 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) SRNM or APRM sensor failure Radiation Monitor Failure Short term LOOP Medium term LOOP Long-term LOOP Inadvertent opening of a SRV LOCA - RPV bottom drain line break LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line break LOCA outside PCV - small line break	Fault Conditions	[RCW SFC 3-1.2]	The RCW is a principal means together with the RHR to deliver long term containment heat removal by transferring the decay heat of fission products from the RHR process water to the RSW process water in the event of frequent faults such as LOOP and infrequent faults such as LOCA.	A	1

	Top Claim for Mechanical System					Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)	State	Claim ID	Claim Contents	Cat.	Class
					11.2 Inadvertent opening of all ADS 11.3 Inadvertent start up of all injection system 11.4 Inadvertent opening of all ADS (SSLC failure) 11.5 Inadvertent MSIV closure (SSLC failure) 11.8 M/C power supply failure on electrical CCF 11.9 D/C power supply failure on electrical CCF 11.10 Loss of all RCW 11.11 Loss of all RSW 11.12 Loss of Class 1 HVAC 13.3 SD - Loss of operating RHR and the same ECCS div. 13.4 SD – Loss of operating RHR (Class 1 controller CCF) 13.5.1 SD - Short LOOP 13.5.2 SD - Medium LOOP 13.5.3 SD - Long LOOP 13.6.1 SD - Short SBO 13.6.2 SD - Medium SBO 13.6.3 SD - Long SBO 13.7 SD - Draindown due to operating RHR valve failure 13.8 SD - LOCA inside PCV – FWD line 13.9 SD - LOCA inside PCV – RHR suction line 13.10 SD - LOCA inside PCV – LPFL injection line 13.11 SD - LOCA below TAF 13.12 SD - RPV draindown by CUW 13.13 SD - Leakage during FMCRD inspection 13.14 SD - Leakage during IMC nozzle replacement 13.15 SD - Leakage during RIP inspection 13.16 SD - Refuelling bellow perforation 17.1 Internal fire in R/B 17.2 Internal fire in Hx/B 17.3 Internal fire in C/B 17.4 Internal fire in MCR 17.5 Internal missile in MCR 17.6 Turbine missile 18.1 Loss of UHS 18.2 10-3/y earthquake 18.3 DB earthquake					

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
3	2	Fuel Cooling	2-4	Function to cool spent fuel outside the reactor coolant system	-	No corresponding fault	Normal and Fault Conditions	[RCW SFC 2-4.1]	The RCW is a principal means together with the FPC and the RHR to maintain the SFP water temperature within the design values by transferring decay heat from the RHR and FPC process water to the RSW process water.	A	1
4	5	Others	5-2	Supporting functions especially important to safety	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 3.1 4.2 4.4 4.5 4.6 5.1 5.2 5.3 6.1 7.2 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3 10.4 11.3 13.3 13.5	Generator load rejection Partial loss of reactor flow (trip of 3 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) SRNM or APRM sensor failure Radiation monitor failure Short LOOP Medium LOOP Long LOOP Inadvertent opening of a SRV LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break LOCA outside PCV – small line break Inadvertent startup of all injection system SD - Loss of operating RHR and the same ECCS div. SD - LOOP	Fault Conditions	[RCW SFC 5-2.1]	The RCW is an essential system for supporting HPCF operation by removing heat from the main HPCF components (HPCF Pumps) and transferring it to RSW process water whenever HPCF operation is required.	A	1

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
					13.7 13.8 13.9 13.10 13.11 13.12 13.13 13.14 13.15 13.16 17.1 17.2 17.3 17.4 17.5 17.6 18.1 18.2 18.3	SD - Draindown due to operating RHR valve failure SD - LOCA - feedwater line inside PCV SD - LOCA - RHR suction line inside PCV SD - LOCA - LPFL return line inside PCV SD - LOCA - mechanical below TAF SD - RPV draindown by CUW SD - Leakage during FMCRD inspection SD - Leakage during replacement of ICM nozzle SD - Leakage during RIP inspection SD - Refuelling bellow perforation Internal fire in R/B Internal fire in Hx/B Internal fire in C/B Internal fire in MCR Internal missile in MCR Turbine missile Loss of UHS 10-3/y earthquake DB earthquake					
5	5	Others	5-2	Supporting functions especially important to safety	5.1 5.2 5.3	Short LOOP Medium LOOP Long LOOP	Fault Conditions	[RCW SFC 5-2.2]	The RCW is an essential system for supporting EDG operation by removing heat from the EDGs and transferring it to RSW process water whenever EDG operation is required.	A	1
6	5	Others	5-2	Supporting functions especially important to safety	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 3.1 4.2 4.4 4.5	Generator load rejection Partial loss of reactor flow (trip of 4 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) SRNM or APRM sensor failure	Normal and Fault Conditions	[RCW SFC 5-2.3]	The RCW is an essential system for supporting RHR operation by removing heat from the main RHR components (RHR Pumps) and transferring it to RSW process water whenever RHR operation is required.	A	1

	Top Claim for Mechanical System			Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)	High Level Safety Function (HLSF)	Fault Schedule (Bounding Fault)					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)	State	Claim ID	Claim Contents	Cat.	Class
			4.6 Radiation Monitor Failure 5.1 Short term LOOP 5.2 Medium term LOOP 5.3 Long-term LOOP 6.1 Inadvertent opening of a SRV 7.1 LOCA - RPV bottom drain line break 7.2 LOCA - small line break 8.1 LOCA - HPCF line break 8.2 LOCA - LPFL line break 9.1 LOCA - FWD line 9.2 LOCA - MS line break 9.3 LOCA - RHR line break 10.1 LOCA outside PCV - MS line break 10.2 LOCA outside PCV - CUW line break 10.3 LOCA outside PCV - FWD line break 10.4 LOCA outside PCV - small line break 11.2 Inadvertent opening of all ADS 11.3 Inadvertent start up of all injection system 11.4 Inadvertent opening of all ADS (SSLC failure) 11.5 Inadvertent MSIV closure (SSLC failure) 11.8 M/C power supply failure on electrical CCF 11.9 D/C power supply failure on electrical CCF 11.10 Loss of all RCW 11.11 Loss of all RSW 11.12 Loss of Class 1 HVAC 13.3 SD - Loss of operating RHR and the same ECCS div. 13.4 SD – Loss of operating RHR (Class 1 controller CCF) 13.5.1 SD - Short LOOP 13.5.2 SD - Medium LOOP 13.5.3 SD - Long LOOP 13.6.1 SD - Short SBO 13.6.2 SD - Medium SBO 13.6.3 SD - Long SBO 13.7 SD - Draindown due to operating RHR valve failure 13.8 SD - LOCA inside PCV – FWD line 13.9 SD - LOCA inside PCV – RHR suction line 13.10 SD - LOCA inside PCV – LPFL injection line 13.11 SD - LOCA below TAF 13.12 SD - RPV draindown by CUW 13.13 SD - Leakage during FMCRD inspection					

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
					13.14 13.15 13.16 17.1 17.2 17.3 17.4 17.5 17.6 18.1 18.2 18.3	SD - Leakage during IMC nozzle replacement SD - Leakage during RIP inspection SD - Refuelling bellow perforation Internal fire in R/B Internal fire in Hx/B Internal fire in C/B Internal fire in MCR Internal missile in MCR Turbine missile Loss of UHS 10-3/y earthquake DB earthquake					
7	5	Others	5-2	Supporting functions especially important to safety	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 3.1 4.2 4.4 4.5 4.6 5.1 5.2 5.3 6.1 7.1 7.2 8.1 8.2 9.1 9.2 9.3 10.1	Generator load rejection Partial loss of reactor flow (trip of 4 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) SRNM or APRM sensor failure Radiation Monitor Failure Short term LOOP Medium term LOOP Long-term LOOP Inadvertent opening of a SRV LOCA - RPV bottom drain line break LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break	Normal and Fault Conditions	[RCW SFC 5-2.4]	The RCW is an essential system for supporting Safety Class 1 HVAC operation by removing heat from HVAC components (Safety Class 1 LCUs and HECW Chillers) and transferring it to RSW process water whenever HVAC is operating.	A	1

	Top Claim for Mechanical System			Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)	High Level Safety Function (HLSF)	Fault Schedule (Bounding Fault)					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)	State	Claim ID	Claim Contents	Cat.	Class
			10.2 LOCA outside PCV - CUW line break 10.3 LOCA outside PCV - FWD line break 10.4 LOCA outside PCV - small line break 11.2 Inadvertent opening of all ADS 11.3 Inadvertent start up of all injection system 11.4 Inadvertent opening of all ADS (SSLC failure) 11.5 Inadvertent MSIV closure (SSLC failure) 11.8 M/C power supply failure on electrical CCF 11.9 D/C power supply failure on electrical CCF 11.10 Loss of all RCW 11.11 Loss of all RSW 11.12 Loss of Class 1 HVAC 13.3 SD - Loss of operating RHR and the same ECCS div. 13.4 SD – Loss of operating RHR (Class 1 controller CCF) 13.5.1 SD - Short LOOP 13.5.2 SD - Medium LOOP 13.5.3 SD - Long LOOP 13.6.1 SD - Short SBO 13.6.2 SD - Medium SBO 13.6.3 SD - Long SBO 13.7 SD - Draindown due to operating RHR valve failure 13.8 SD - LOCA inside PCV – FWD line 13.9 SD - LOCA inside PCV – RHR suction line 13.10 SD - LOCA inside PCV – LPFL injection line 13.11 SD - LOCA below TAF 13.12 SD - RPV draindown by CUW 13.13 SD - Leakage during FMCRD inspection 13.14 SD - Leakage during IMC nozzle replacement 13.15 SD - Leakage during RIP inspection 13.16 SD - Refuelling bellow perforation 17.1 Internal fire in R/B 17.2 Internal fire in Hx/B 17.3 Internal fire in C/B 17.4 Internal fire in MCR 17.5 Internal missile in MCR 17.6 Turbine missile 18.1 Loss of UHS 18.2 10-3/y earthquake 18.3 DB earthquake					

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
8	5	Others	5-2	Supporting functions especially important to safety	 2.1 2.2 2.3 3.1 4.6 5.1 7.1 7.2 8.1 8.2 9.1 9.2 9.3 10.4 11.2 11.6 11.7 11.8 13.5 13.5 13.5 13.5 13.16 17.6 18.1 18.2 18.3	(Not claimed for the design basis) Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Radiation monitor failure Short term Loss of off-site power LOCA - RPV bottom drain line break LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line LOCA - MS line break LOCA -RHR Outlet line break Small line break LOCA outside the PCV Inadvertent start-up all injection system Loss of all RCW Loss of all RSW Loss of Class 1 HVAC SD- Short LOOP SD - Medium LOOP SD - Long LOOP Long term LOOP Refuelling bellows perforation Turbine missile Loss of Ultimate Heat Sink 10-3/year Earthquake Design Basis Earthquake (DBE)	Fault Conditions	[RCW SFC 5-2.5]	The RCW is an essential system for supporting Safety Class 2 HVAC operation by removing heat from HVAC components (Safety Class 2 LCUs) and transferring it to RSW process water whenever HVAC is operating.	B	2
9	5	Others	5-11	Supporting functions to supply power (except for emergency supply)	-	No corresponding fault	Normal and Fault Conditions	[RCW SFC 5-11.1]	The RCW supports the operations of Safety Class 3 auxiliaries (RIP motors, RIP MG Sets, DWC cooling units, CUW Pumps and Heat Exchangers, CRD Pumps, IA and SA Compressors, etc.) by removing heat from them and transferring it to RSW process water.	B	3

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
10	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	7.1 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3	LOCA - RPV bottom drain line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (9.1.1, 9.1.2) LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break	Fault Conditions	[RCW SFC 4-7.1]	The RCW components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of RSW

	Top Claim for mechanical system						Top Claim for mechanical system				
	Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		State	Claim ID	Claim Contents	Cat.	Class
1	3	Long term heat removal	3-1	Functions to remove residual heat after shutdown	-	No corresponding fault	Normal Conditions	[RSW SFC 3-1.1]	The RSW is a principal means together with the RHR to remove residual heat from the reactor by transferring residual heat from the RCW process water to the UHS after normal reactor shutdown to reach reactor cold shutdown.	A	1
2	3	Long term heat removal	3-1	Functions to remove residual heat after shutdown	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 3.1 4.2 4.4 4.5 4.6 5.1 5.2 5.3 6.1 7.1 7.2 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3 10.4	Generator load rejection Partial loss of reactor flow (trip of 4 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) SRNM or APRM sensor failure Radiation Monitor Failure Short term LOOP Medium term LOOP Long-term LOOP Inadvertent opening of a SRV LOCA - RPV bottom drain line break LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line break LOCA outside PCV - small line break	Fault Conditions	[RSW SFC 3-1.2]	The RSW is a principal means together with the RHR to deliver long term containment heat removal by transferring the decay heat of fission products from the RCW process water to the UHS in the event of frequent faults such as LOOP and infrequent faults such as LOCA.	A	1

	Top Claim for mechanical system										
	Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)		Top Claim for mechanical system				
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		State	Claim ID	Claim Contents	Cat.	Class
					11.2	Inadvertent opening of all ADS					
					11.3	Inadvertent start-up of all injection system					
					11.4	Inadvertent opening of all ADS (SSLC failure)					
					11.5	Inadvertent MSIV closure (SSLC failure)					
					11.8	M/C power supply failure on electrical CCF					
					11.9	D/C power supply failure on electrical CCF					
					11.10	Loss of all RCW					
					11.11	Loss of all RSW					
					11.12	Loss of Class 1 HVAC					
					13.3	SD - Loss of operating RHR and the same ECCS div.					
					13.4	SD – Loss of operating RHR (Class 1 controller CCF)					
					13.5.1	SD - Short LOOP					
					13.5.2	SD - Medium LOOP					
					13.5.3	SD - Long LOOP					
					13.6.1	SD - Short SBO					
					13.6.2	SD - Medium SBO					
					13.6.3	SD - Long SBO					
					13.7	SD - Draindown due to operating RHR valve failure					
					13.8	SD - LOCA inside PCV – FWD line					
					13.9	SD - LOCA inside PCV – RHR suction line					
					13.10	SD - LOCA inside PCV – LPFL injection line					
					13.11	SD - LOCA below TAF					
					13.12	SD - RPV draindown by CUW					
					13.13	SD - Leakage during FMCRD inspection					
					13.14	SD - Leakage during IMC nozzle replacement					
					13.15	SD - Leakage during RIP inspection					
					13.16	SD - Refuelling bellow perforation					
					17.1	Internal fire in R/B					
					17.2	Internal fire in Hx/B					
					17.3	Internal fire in C/B					
					17.4	Internal fire in MCR					
					17.5	Internal missile in MCR					
					17.6	Turbine missile					
					18.1	Loss of UHS					
					18.2	10-3/y earthquake					
					18.3	DB earthquake					

	Top Claim for mechanical system						Top Claim for mechanical system				
	Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		State	Claim ID	Claim Contents	Cat.	Class
3	2	Fuel Cooling	2-4	Function to cool spent fuel outside the reactor coolant system	-	No corresponding fault	Normal and Fault Conditions	[RSW SFC 2-4.1]	The RSW is a principal means together with the FPC and the RHR to maintain the SFP water temperature within the design values by transferring decay heat from the RCW process water to the UHS.	A	1
4	5	Others	5-2	Supporting functions especially important to safety	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 3.1 4.2 4.4 4.5 4.6 5.1 5.2 5.3 6.1 7.2 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3 10.4 11.3 13.3 13.5	Generator load rejection Partial loss of reactor flow (trip of 3 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) SRNM or APRM sensor failure Radiation monitor failure Short LOOP Medium LOOP Long LOOP Inadvertent opening of a SRV LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break LOCA outside PCV – small line break Inadvertent startup of all injection system SD - Loss of operating RHR and the same ECCS div. SD - LOOP	Fault Conditions	[RSW SFC 5-2.1]	The RSW is an essential system for supporting HPCF operation by removing heat from the RCW process water and transferring it to the UHS whenever HPCF operation is required.	A	1

	Top Claim for mechanical system						Top Claim for mechanical system				
	Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		State	Claim ID	Claim Contents	Cat.	Class
					13.7 13.8 13.9 13.10 13.11 13.12 13.13 13.14 13.15 13.16 17.1 17.2 17.3 17.4 17.5 17.6 18.1 18.2 18.3	SD - Draindown due to operating RHR valve failure SD - LOCA - feedwater line inside PCV SD - LOCA - RHR suction line inside PCV SD - LOCA - LPFL return line inside PCV SD - LOCA - mechanical below TAF SD - RPV draindown by CUW SD - Leakage during FMCRD inspection SD - Leakage during replacement of ICM nozzle SD - Leakage during RIP inspection SD - Refuelling bellow perforation Internal fire in R/B Internal fire in Hx/B Internal fire in C/B Internal fire in MCR Internal missile in MCR Turbine missile Loss of UHS 10-3/y earthquake DB earthquake					
5	5	Others	5-2	Supporting functions especially important to safety	5.1 5.2 5.3	Short LOOP Medium LOOP Long LOOP	Fault Conditions	[RSW SFC 5-2.2]	The RSW is an essential system for supporting EDG operation by removing heat from the RCW process water and transferring it to the UHS whenever EDG operation is required.	A	1
6	5	Others	5-2	Supporting functions especially important to safety	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 3.1 4.2 4.4 4.5	Generator load rejection Partial loss of reactor flow (trip of 4 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) SRNM or APRM sensor failure	Normal and Fault Conditions	[RSW SFC 5-2.3]	The RSW is an essential system for supporting RHR operation by removing heat from the RCW process water and transferring it to the UHS whenever RHR operation is required.	A	1

	Top Claim for mechanical system									
	Fundamental Safety Function (FSF)	Fundamental Safety Function (FSF)	Fundamental Safety Function (FSF)		Top Claim for mechanical system					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		State	Claim ID	Claim Contents	Cat.	Class
			4.6	Radiation Monitor Failure					
			5.1	Short term LOOP					
			5.2	Medium term LOOP					
			5.3	Long-term LOOP					
			6.1	Inadvertent opening of a SRV					
			7.1	LOCA - RPV bottom drain line break					
			7.2	LOCA - small line break					
			8.1	LOCA - HPCF line break					
			8.2	LOCA - LPFL line break					
			9.1	LOCA - FWD line					
			9.2	LOCA - MS line break					
			9.3	LOCA - RHR line break					
			10.1	LOCA outside PCV - MS line break					
			10.2	LOCA outside PCV - CUW line break					
			10.3	LOCA outside PCV - FWD line break					
			10.4	LOCA outside PCV - small line break					
			11.2	Inadvertent opening of all ADS					
			11.3	Inadvertent start up of all injection system					
			11.4	Inadvertent opening of all ADS (SSLC failure)					
			11.5	Inadvertent MSIV closure (SSLC failure)					
			11.8	M/C power supply failure on electrical CCF					
			11.9	D/C power supply failure on electrical CCF					
			11.10	Loss of all RCW					
			11.11	Loss of all RSW					
			11.12	Loss of Class 1 HVAC					
			13.3	SD - Loss of operating RHR and the same ECCS div.					
			13.4	SD – Loss of operating RHR (Class 1 controller CCF)					
			13.5.1	SD - Short LOOP					
			13.5.2	SD - Medium LOOP					
			13.5.3	SD - Long LOOP					
			13.6.1	SD - Short SBO					
			13.6.2	SD - Medium SBO					
			13.6.3	SD - Long SBO					
			13.7	SD - Draindown due to operating RHR valve failure					
			13.8	SD - LOCA inside PCV – FWD line					
			13.9	SD - LOCA inside PCV – RHR suction line					
			13.10	SD - LOCA inside PCV – LPFL injection line					
			13.11	SD - LOCA below TAF					
			13.12	SD - RPV draindown by CUW					
			13.13	SD - Leakage during FMCRD inspection					

	Top Claim for mechanical system						Top Claim for mechanical system				
	Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		State	Claim ID	Claim Contents	Cat.	Class
					13.14 13.15 13.16 17.1 17.2 17.3 17.4 17.5 17.6 18.1 18.2 18.3	SD - Leakage during IMC nozzle replacement SD - Leakage during RIP inspection SD - Refuelling bellow perforation Internal fire in R/B Internal fire in Hx/B Internal fire in C/B Internal fire in MCR Internal missile in MCR Turbine missile Loss of UHS 10-3/y earthquake DB earthquake					
7	5	Others	5-2	Supporting functions especially important to safety	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 3.1 4.2 4.4 4.5 4.6 5.1 5.2 5.3 6.1 7.1 7.2 8.1 8.2 9.1 9.2 9.3 10.1	Generator load rejection Partial loss of reactor flow (trip of 4 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) SRNM or APRM sensor failure Radiation Monitor Failure Short term LOOP Medium term LOOP Long-term LOOP Inadvertent opening of a SRV LOCA - RPV bottom drain line break LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break	Normal and Fault Conditions	[RSW SFC 5-2.4]	The RSW is an essential system for supporting Safety Class 1 HVAC operation by removing heat from RCW process water and transferring it to the UHS whenever HVAC is operating.	A	1

	Top Claim for mechanical system			Top Claim for mechanical system				
	Fundamental Safety Function (FSF)	Fundamental Safety Function (FSF)	Fundamental Safety Function (FSF)					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	State	Claim ID	Claim Contents	Cat.	Class
			10.2 LOCA outside PCV - CUW line break 10.3 LOCA outside PCV - FWD line break 10.4 LOCA outside PCV - small line break 11.2 Inadvertent opening of all ADS 11.3 Inadvertent start-up of all injection system 11.4 Inadvertent opening of all ADS (SSLC failure) 11.5 Inadvertent MSIV closure (SSLC failure) 11.8 M/C power supply failure on electrical CCF 11.9 D/C power supply failure on electrical CCF 11.10 Loss of all RCW 11.11 Loss of all RSW 11.12 Loss of Class 1 HVAC 13.3 SD - Loss of operating RHR and the same ECCS div. 13.4 SD – Loss of operating RHR (Class 1 controller CCF) 13.5.1 SD - Short LOOP 13.5.2 SD - Medium LOOP 13.5.3 SD - Long LOOP 13.6.1 SD - Short SBO 13.6.2 SD - Medium SBO 13.6.3 SD - Long SBO 13.7 SD - Draindown due to operating RHR valve failure 13.8 SD - LOCA inside PCV – FWD line 13.9 SD - LOCA inside PCV – RHR suction line 13.10 SD - LOCA inside PCV – LPFL injection line 13.11 SD - LOCA below TAF 13.12 SD - RPV draindown by CUW 13.13 SD - Leakage during FMCRD inspection 13.14 SD - Leakage during IMC nozzle replacement 13.15 SD - Leakage during RIP inspection 13.16 SD - Refuelling bellow perforation 17.1 Internal fire in R/B 17.2 Internal fire in Hx/B 17.3 Internal fire in C/B 17.4 Internal fire in MCR 17.5 Internal missile in MCR 17.6 Turbine missile 18.1 Loss of UHS 18.2 10-3/y earthquake 18.3 DB earthquake					

	Top Claim for mechanical system						Top Claim for mechanical system				
	Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		State	Claim ID	Claim Contents	Cat.	Class
8	5	Others	5-2	Supporting functions especially important to safety	 2.1 2.2 2.3 3.1 4.6 5.1 7.1 7.2 8.1 8.2 9.1 9.2 9.3 10.4 11.2 11.6 11.7 11.8 13.5 13.5 13.5 13.5 13.16 17.6 18.1 18.2 18.3	(Not claimed for the design basis) Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Radiation monitor failure Short term Loss of off-site power LOCA - RPV bottom drain line break LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line LOCA - MS line break LOCA -RHR Outlet line break Small line break LOCA outside the PCV Inadvent start-up all injection system Loss of all RCW Loss of all RSW Loss of Class 1 HVAC SD- Short LOOP SD - Medium LOOP SD - Long LOOP Long term LOOP Refuelling bellows perforation Turbine missile Loss of Ultimate Heat Sink 10-3/year Earthquake Design Basis Earthquake (DBE)	Fault Conditions	[RSW SFC 5-2.5]	The RSW is an essential system for supporting Safety Class 2 HVAC operation by removing heat from RCW process water and transferring it to the UHS whenever HVAC is operating.	B	2
9	5	Others	5-11	Supporting functions to supply power (except for emergency supply)	-	No corresponding fault	Normal and Fault Conditions	[RSW SFC 5-11.1]	The RSW supports the operations of Safety Class 3 auxiliaries (RIP motors, RIP MG Sets, DWC cooling units, CUW Pumps and Heat Exchangers, CRD Pumps, IA and SA Compressors, etc.) by removing heat from the RCW process water and transferring it to the UHS.	B	3

SFC Table of TCW/TSW

<table>
<tr><td rowspan="3"></td><td colspan="6">Top Claim for Mechanical System</td><td colspan="5" rowspan="2">Top Claim for Mechanical System and Components</td></tr>
<tr><td colspan="2">Fundamental Safety Function
(FSF)</td><td colspan="2">High Level Safety Function
(HLSF)</td><td colspan="2">Fault Schedule
(Bounding Fault)</td></tr>
<tr><td colspan="2">PCSR Ch.5 Section 6
Table 5.6-1: High level safety functions in UK ABWR</td><td colspan="2">PCSR Ch.5 Section 6
Table 5.6-1: High level safety functions in UK ABWR</td><td colspan="2">Topic Report on Fault Assessment
Table.4.2-1 Fault Schedule
(Ref 12.1-1)</td><td>State</td><td>Claim ID</td><td>Claim Contents</td><td>Cat.</td><td>Class</td></tr>
<tr><td>1</td><td>5</td><td>Others</td><td>5-11</td><td>Supporting functions to supply power (except for emergency supply)</td><td>-</td><td>No corresponding fault</td><td>Normal Conditions</td><td>TCW SFC 5-11.1</td><td>The TCW supplies cooling water to turbine auxiliary equipment.</td><td>B</td><td>3</td></tr>
<tr><td>2</td><td>5</td><td>Others</td><td>5-11</td><td>Supporting functions to supply power (except for emergency supply)</td><td>-</td><td>No corresponding fault</td><td>Normal Conditions</td><td>TSW SFC 5-11.1</td><td>The TSW supplies service water to the TCW Heat Exchanger and removes heat from the TCW.</td><td>B</td><td>3</td></tr>
</table>

SFC Table of MUWC

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-11	Supporting functions to supply power (except for emergency supply)	-	No corresponding fault	Normal Conditions	MUWC SFC 5-11.1	The MUWC supplies the required to condensate to each component.	B	3
2	2	Fuel Cooling	2-1	Functions to cool reactor core	5.1 5.2 11.8 11.9 11.10 11.11 11.12 18.1	Short LOOP & CCF of EDGs Medium LOOP & CCF of EDGs M/C power supply failure (electrical CCF) D/C power supply failure (electrical CCF) Loss of all RCW Loss of all RSW Loss of Class 1 HVAC Loss of UHS	Fault Conditions	MUWC SFC 2-1.1	The CST is used as a water source for the Reactor Core Isolation Cooling System (RCIC) and High Pressure Core Flooding System (HPCF) in the event of frequent and infrequent faults such as SBO.	A	2
3	4	Confinement / Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	7.1 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3	LOCA - RPV bottom drain line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (9.1.1, 9.1.2) LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break	Fault Conditions	MUWC SFC 4-7.1	The MUWC components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
4	4	Confinement / Containment of radioactive materials	4-4	Functions to contain radioactive material	-	No corresponding fault	Normal and Fault Conditions	MUWC SFC 4-4.1	The MUWC piping and components outside the Reactor Coolant Pressure Boundary (RCPB) contains radioactive material. Rupture of this piping could lead to a release of radioactive material of dose consequences that are relatively low.	C	3
5	2	Fuel Cooling	2-3	Function to make up reactor coolant with other system	-	Not claimed in the design basis.	Fault Conditions	MUWC SFC 2-3.1	The MUWC, which is a system for normal operation, will be utilised to supply coolant water for reactor core cooling, if available, in the event of beyond design basis faults or severe accidents.	C	3

SFC Table of HECW

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-18	Function to maintain internal building environment appropriate for SSCs	-	No corresponding fault	Normal Conditions	HECW SFC 5-18.1	The HECW provides chilled water for the Normal/Emergency HVAC during normal operation, shutdown and refuelling outage.	A	1
2	5	Others	5-18	Function to maintain internal building environment appropriate for SSCs	5.1 5.1.2 5.1.3 5.2 5.2.2 5.2.3 5.3 5.3.2 5.3.3 7.1 7.2 8.1 8.2 9.1.1	Short term LOOP Short-term LOOP with CCF of initiation signal Short-term LOOP with digital CCF Medium term LOOP Medium term LOOP with CCF of initiation signal Medium term LOOP with digital CCF Long term LOOP Long term LOOP with CCF of initiation signal Long term LOOP with digital CCF LOCA - RPV bottom drain line break Small line break LOCA LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (LPFL connected) break	Fault Conditions	HECW SFC 5-18.2	The HECW provides chilled water for the Normal/Emergency and the Emergency HVAC during fault conditions such as LOCA and LOOP.	A	1

	Top Claim for Mechanical System					Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)	State	Claim ID	Claim Contents	Cat.	Class
					9.1.2 LOCA - FWD line (RCIC connected) break 9.2 LOCA - MS line break 9.3 LOCA - RHR line break 10.1 LOCA outside PCV - MS line break 10.2 LOCA outside PCV - CUW line break 10.3 LOCA outside PCV - FWD line (RCIC connected) break 13.5.1 SD – Short term LOOP 13.5.2 SD – Medium term LOOP 13.5.3 SD – Long term LOOP 13.9 SD - LOCA at RHR suction line inside PCV 13.10 SD - LOCA at LPFL return line inside PCV 13.11 SD – LOCA (mechanical) below TAF 13.12 SD – RPV draindown by CUW 13.13 SD – Leakage during FMCRD inspection 13.14 SD – Leakage during replacement ICM nozzle 13.15 SD – Leakage during RIP inspection					

SFC Table of HNCW

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-18	Function to maintain internal building environment appropriate for SSCs	-	No corresponding fault	Normal and Fault Conditions	HNCW SFC 5-18.1	The HNCW provides chilled water for the DWC Dehumidifiers and the cooling coils of the Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in R/B, C/B, T/B, Hx/B and FV/B.	C	3
2	5	Others	5-18	Function to maintain internal building environment appropriate for SSCs	-	No corresponding fault	Normal and Fault Conditions	HNCW SFC 5-18.2	The Rw/B HNCW provides chilled water for the cooling coils of the Normal HVAC Supply Air Treatment Facilities in Rw/B.	C	3
3	5	Others	5-18	Function to maintain internal building environment appropriate for SSCs	-	No corresponding fault	Normal and Fault Conditions	HNCW SFC 5-18.3	The S/B HNCW provides chilled water for the cooling coils of the Normal HVAC Supply Air Treatment Facilities and the Normal Local Cooling Units in S/B.	C	3
4	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	7.1 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3	LOCA - RPV bottom drain line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (9.1.1, 9.1.2) LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break	Fault Conditions	HNCW SFC 4-7.1	The HNCW components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of HBCW

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-18	Function to maintain internal building environment appropriate for SSCs	-	No corresponding fault	Normal Conditions	HBCW SFC 5-18.1	The HBCW provides chilled water for the Normal/Emergency HVAC that is related to the nuclear supporting functions especially important to safety during normal operation, shutdown and refuelling outage.	A	2
2	5	Others	5-18	Function to maintain internal building environment appropriate for SSCs	FS-2 FS-3 FS-4 FS-5 FS-12 FS-15 -	Reactivity Control Reactivity Control Reactivity Control Reactivity Control Reactor Core Cooling Long-term Heat Removal Severe Accidents	Fault Conditions	HBCW SFC 5-18.2	The HBCW provides chilled water for Normal/Emergency and the Emergency HVAC that is related to the nuclear supporting functions especially important to safety during fault conditions.	A	2

SFC Table of EECW

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-3	Function of alternative supporting system	5.1 5.2 5.1.1 5.2.1 13.5.1 13.5.2 13.6.1 13.6.2	Short LOOP Medium LOOP Short- LOOP with CCF of EDGs (short SBO) Medium LOOP with CCF of EDGs (medium SBO) Short LOOP Medium LOOP Short- LOOP with CCF of EDGs (short SBO) Medium LOOP with CCF of EDGs (medium SBO)	Fault Conditions	EECW SFC 5-3.1	The EECW is the principal means to remove heat from the Backup Building Generator System (BBG) auxiliaries so that power can be supplied to the BBG loads in the event of frequent design basis faults where BBG loads operation is required.	A	2
2	5	Others	5-3	Function of alternative supporting system	-	-	Fault Conditions	EECW SFC 5-3.2	The EECW is the principal means to remove heat from the Backup Building Generator System (BBG) auxiliaries so that power can be supplied to the BBG loads in the event of beyond design basis faults and severe accidents.	B	2

SFC Table of IA

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-13	Auxiliary functions for plant operation	-	No corresponding fault	Normal Conditions	IA SFC 5-13.1	The IA continuously supplies compressed air to prevent inoperability of the pneumatic components within systems required for plant continuous operation.	C	3
2	5	Others	5-13	Auxiliary functions for plant operation	-	No corresponding fault	Normal Conditions	IA SFC 5-13.2	The IA supplies the air required to maintain the normal operation of Class 3 systems that contribute to reducing radiation exposure from radioactive material.	C	3
3	5	Others	5-13	Auxiliary functions for plant operation	-	Not claimed in the design basis	Fault Conditions	IA SFC 5-13.3	The IA backs up the HPIN by automatically supplying compressed air to drive the instruments, controllers and pneumatics valves that are normally supplied with nitrogen gas by the HPIN, in the event that the HPIN supply is interrupted.	C	3
4	4	Confinement/ Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding fault	Fault Conditions	IA SFC 4-7.1	The IA components penetrating the primary containment form barrier to confine the radioactive material within the primary containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of SA

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-13	Auxiliary functions for plant operation	-	No corresponding fault	Normal Conditions	SA SFC 5-13.1	The SA continuously supplies compressed air to prevent inoperability of the pneumatic components within systems required for plant continuous operation.	C	3
2	5	Others	5-13	Auxiliary functions for plant operation	-	No corresponding fault	Normal Conditions	SA SFC 5-13.2	The SA supplies air to the air required to maintain the normal operation of Class 3 systems that contribute to reducing radiation exposure from radioactive material.	C	3
3	5	Others	5-13	Auxiliary functions for plant operation	-	Not claimed in the design basis	Fault Conditions	SA SFC 5-13.3	The SA initiates supply of compressed air to the IA as a back-up of the IA in the event that the pressure in the IA drops abnormally.	C	3
4	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	7.1 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3	LOCA - RPV bottom drain line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (9.1.1, 9.1.2) LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break	Fault Conditions	SA SFC 4-7.1	The SA components penetrating the primary containment form barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of HPIN

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-13	Auxiliary functions for plant operation	-	Not claimed for the design basis	Normal Conditions	HPIN SFC 5-13.1	The HPIN supplies nitrogen gas to fill and maintain pressure in the SRV accumulators for relief, ADS and RDCF functions during normal conditions.	C	3
2	5	Others	5-13	Auxiliary functions for plant operation	-	Not claimed for the design basis	Normal Conditions	HPIN SFC 5-13.2	The HPIN supplies nitrogen gas to the nitrogen operated equipment installed in the reactor building and the PCV (including inboard MSIV) during normal conditions.	C	3
3	5	Others	5-3	Function of alternative supporting system	-	Not claimed for the design basis	Fault Conditions	HPIN SFC 5-3.1	The HPIN backs up reactor depressurisation by the SRVs in the event of design basis faults if available.	C	3
4	5	Others	5-3	Function of alternative supporting system	-	Not claimed for the design basis	Fault Conditions	HPIN SFC 5-3.2	The HPIN through its nitrogen gas cylinders supports SRV operation for reactor depressurisation in the event of beyond design basis faults if available.	B	3
5	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding fault	Fault Conditions	HPIN SFC 4-7.1	The HPIN components penetrating the primary containment form a barrier to confine radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of P&D

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	4	Confinement/Containment of radioactive materials	4-12	Functions to store the radioactive materials as liquid waste	-	No corresponding fault	Normal Conditions	P&D SFC 4-12.1	The P&D segregates liquid waste into subcategories, collecting, containing and directing it in the corresponding sumps or sump tanks so that they are treated based on their liquid properties in the Liquid Waste Management System (LWMS).	C	3

SFC Table of RD

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	4	Confinement/Containment of radioactive materials	4-12	Functions to store the radioactive materials as liquid wastes	-	No corresponding fault	Normal Conditions	RD SFC 4-12.1	The RD transfer system provides sufficient capacity to transfer liquid waste to the Liquid Waste Management System for normal conditions including start-up, shutdown, and outage.	C	3
2	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	7.1 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3	LOCA - RPV bottom drain line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (9.1.1, 9.1.2) LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break	Fault Conditions	RD SFC 4-7.1	The RD components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1
3	5	Others	5-4	Monitoring functions of plant conditions to support operator actions	-	Not claimed in the design basis	Fault Conditions	RD SFC 5-4.1	In the event of a fault condition which resulted in excessive inflow rate of liquid waste into drywell sump, an alarm is actuated.	C	3

SFC Table of SAM

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-4	Monitoring functions of plant conditions to support operator actions	-	No corresponding fault	Normal and Fault Conditions	SAM SFC 5-4.1	The SAM collects representative fluid process streams for analysis and provides the analytical data required to monitor plant and equipment performance and change in operating parameters under the environmental and operational conditions during normal conditions and transient conditions.	C	3
2	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	7.1 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3	LOCA - RPV bottom drain line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (9.1.1, 9.1.2) LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break	Fault Conditions	SAM SFC 4-7.1	The SAM components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of HS/HSCR

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-13	Auxiliary functions for plant operation	-	No corresponding fault	Normal Conditions	HS/HSCR SFC 5-13.1	The HS/HSCR in plant normal conditions supplies the steam required to maintain the normal operation of safety class 3 systems which contributes to reducing radiation exposure from radioactive materials.	C	3
2	5	Others	5-13	Auxiliary functions for plant operation	-	No corresponding fault	Normal Conditions	HS/HSCR SFC 5-13.2	The HS/HSCR in plant normal conditions supplies the steam required to heat the plant and maintain its condition during winter.	C	3

SFC Table of HVAC

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	4	Confinement /Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding event	Normal Conditions	[R/A HVAC SFC 4-7.1]	The R/A HVAC system is designed to reduce the release and spread of airborne contamination during normal operation.	C	3
2	4	Confinement /Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	2.1 2.2 2.3 3.1 4.6 5.1 7.1 7.2 9.1.1 9.1.2 9.2 9.3 14.5 14.6 14.7	Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of feedwater flow Radiation monitor failure Short term LOOP LOCA – PCV bottom drain line break LOCA – Small line break LOCA - FWD line (LPFL connected) break LOCA - FWD line (RCIC connected) break LOCA - MS line break LOCA - RHR line break Fuel drop Fuel collision Drop of heavy equipment into core	Fault Conditions	[R/A HVAC SFC 4-7.2]	The R/A HVAC system is designed to reduce the release and spread of airborne contamination during basis design and beyond design basis fault conditions.	B	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
3	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[R/A HVAC SFC 5-18.1]	The R/A HVAC controls the design environmental parameters inside the served areas.	A	1
4	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.10 2.1	Generator load rejection [ECCS LCUs] Partial loss of reactor flow (trip of 4 RIPs) [ECCS LCUs] Loss of reactor flow (trip of all RIPs) [ECCS LCUs] Feedwater controller failure - Maximum demand [ECCS LCUs] Recirculation flow control failure (runout of all RIPs) [ECCS LCUs] Loss of feedwater heating [ECCS LCUs] Reactor pressure regulator failure in the closed direction [ECCS LCUs] Inadvertent control valve closure [ECCS LCUs] Inadvertent opening of all ADS [ECCS LCUs] Inadvertent MSIV closure [ECCS, SGTS & CAMS	Fault Conditions	[R/A HVAC SFC 5-18.2]	The R/A HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	1

	Top Claim for Mechanical System			Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)	High Level Safety Function (HLSF)	Fault Schedule (Bounding Fault)					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)	State	Claim ID	Claim Contents	Cat.	Class
			LCUs]					
			2.2 Reactor pressure regulator failure in the open direction [ECCS, SGTS & CAMS LCUs]					
			2.3 Loss of main condenser vacuum [SGTS & CAMS LCUs]					
			2.4 Radiation monitor failure [ECCS LCUs]					
			3.1 Loss of all feedwater flow [ECCS & CAMS LCUs]					
			3.2 Inadvertent start-up of all injection system [ECCS LCUs]					
			4.2 Control rod withdrawal error at power [ECCS LCUs]					
			4.4 Inadvertent reactor SCRAM (CRD pump trip) [ECCS LCUs]					
			4.6 SRNM or APRM sensor failure [ECCS & CAMS LCUs]					
			5.1 Short term LOOP [EECS, FPC & CAMS LCUs]					
			5.2 Medium term LOOP [ECCS & FPC LCUs]					

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
					5.3	Long-term LOOP [ECCS & FPC LCUs]					
					6.1	Inadvertent opening of a SRV [ECCS LCUs]					
					7.1	LOCA – RPV bottom drain line break [ECCS, SGTS & CAMS LCUs]					
					7.2	LOCA - small line break [ECCS, SGTS & CAMS LCUs]					
					8.1	LOCA - HPCF line break [ECCS & SGTS LCUs]					
					8.2	LOCA - LPFL line break [ECCS & SGTS LCUs]					
					9.1	LOCA - FWD line break [ECCS, SGTS & CAMS LCUs]					
					9.2	LOCA - MS line break [ECCS, SGTS & CAMS LCUs]					
					9.3	LOCA - RHR line break [ECCS, SGTS & CAMS LCUs]					
					10.1	LOCA outside PCV - MS line break [ECCS LCUs]					
					10.2	LOCA outside PCV - CUW line break [ECCS LCUs]					

Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
				10.3	LOCA outside PCV - FWD line (RCIC connected) break [ECCS LCUs]					
				13.3	SD – Loss of operating RHR and the same ECCS div. [ECCS LCUs]					
				13.4	SD – Loss of operating RHR (CCF of Class 1 C&I) [ECCS LCUs]					
				13.7	SD – Draindown due to operating RHR valve failure [ECCS LCUs]					
				13.12	SD – RPV draindown by CUW [ECCS LCUs]					
				13.13	SD – Leakage during FMCRD inspection [ECCS LCUs]					
				13.14	SD – Leakage during replacement of ICM nozzle [ECCS LCUs]					
				13.15	SD – Leakage during RIP inspection [ECCS LCUs]					
				14.5	Fuel drop [SGTS & CAMS LCUs]					
				14.6	Fuel collision [SGTS & CAMS LCUs]					
					Drop of heavy equipment					

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
					14.7	into core [SGTS & CAMS LCUs]					
5	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[R/A HVAC SFC 5-18.3]	The R/A HVAC system ensures comfort during maintenance in the accessible areas	C	3
6	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[R/A HVAC SFC 5-18.4]	The R/A HVAC system is designed to support smoke management for conventional fire safety.	C	3
7	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[RBEEE/Z HVAC SFC 5-18.1]	The RBEEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	A	1
8	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	5.1 5.1.2 5.1.3 5.2 5.2.1 5.2.3 5.3 5.3.2	Short term LOOP Short term LOOP with CCF of initiation signal Short term LOOP with digital CCF Medium term LOOP Medium term LOOP with CCF of initiation signal Medium term LOOP with digital CCF Long-term LOOP Long term LOOP with CCF of initiation signal	Fault Conditions	[RBEEE/Z HVAC SFC 5-18.2]	The RBEEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	1

	Top Claim for Mechanical System					Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
					5.3.3 7.1 7.2 8.1 8.2 9.1.1 9.1.2 9.2 9.3 10.1 10.2 10.3 13.5.1 13.5.2 13.5.3 13.9 13.10 	Long term LOOP with digital CCF LOCA - RPV bottom drain line break LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (LPFL connected) break LOCA - FWD line (RCIC connected) break LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break SD – Short term LOOP SD – Medium term LOOP SD – Long term LOOP SD - LOCA at RHR suction line inside PCV SD - LOCA at LPFL return line inside PCV SD – LOCA (mechanical)					

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
					13.11 13.12 13.13 13.14 13.15	below TAF SD – RPV draindown by CUW SD – Leakage during FMCRD inspection SD – Leakage during replacement ICM nozzle SD – Leakage during RIP inspection					
9	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[RBEEE/Z HVAC SFC 5-18.3]	The RBEEE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	A	1
10	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[RBEEE/Z HVAC SFC 5-18.4]	The RBEEE/Z HVAC system is designed to support smoke management for conventional fire safety	A	1
11	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[DGEE/Z HVAC SFC 5-18.1]	The DGEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	A	1

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
12	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	5.1 5.1.2 5.1.3 5.2 5.2.1 5.2.3 5.3 5.3.2 5.3.3 7.1 7.2 8.1 8.2 9.1.1 9.1.2 9.2 9.3 10.1	Short term LOOP Short term LOOP with CCF of initiation signal Short term LOOP with digital CCF Medium term LOOP Medium term LOOP with CCF of initiation signal Medium term LOOP with digital CCF Long-term LOOP Long term LOOP with CCF of initiation signal Long term LOOP with digital CCF LOCA - RPV bottom drain line break LOCA - small line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (LPFL connected) break LOCA - FWD line (RCIC connected) break LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS	Fault Conditions	[DGEE/Z HVAC SFC 5-18.2]	The DGEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	1

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
						line break					
					10.2	LOCA outside PCV - CUW line break					
					10.3	LOCA outside PCV - FWD line (RCIC connected) break					
					13.5.1	SD – Short term LOOP					
					13.5.2	SD – Medium term LOOP					
					13.5.3	SD – Long term LOOP					
					13.9	SD - LOCA at RHR suction line inside PCV					
					13.10	SD - LOCA at LPFL return line inside PCV					
					13.11	SD – LOCA (mechanical) below TAF					
					13.12	SD – RPV draindown by CUW					
					13.13	SD – Leakage during FMCRD inspection					
					13.14	SD – Leakage during replacement ICM nozzle					
					13.15	SD – Leakage during RIP inspection					
13	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[DGEE/Z HVAC SFC 5-18.3]	The DGEE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	A	1

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
14	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[DGEE/Z HVAC SFC 5-18.4]	The DGEE/Z HVAC system is designed to support smoke management for conventional fire safety.	A	1
15	4	Confinement /Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding event	Normal Conditions	[T/B HVAC SFC 4-7.1]	The T/B HVAC system is designed to reduce the release and spread of gaseous and airborne contamination during normal operation.	C	3
16	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[T/B HVAC SFC 5-18.1]	The T/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	C	3
17	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[T/B HVAC SFC 5-18.3]	The T/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	C	3
18	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[T/B HVAC SFC 5-18.4]	The T/B HVAC system is designed to support smoke management for conventional fire safety.	C	3
19	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[Hx/B HVAC SFC 5-18.1]	The Hx/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	C	3
20	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	FS-6 FS-7 FS-10 FS-14	Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal	Fault Conditions	[Hx/B HVAC SFC 5-18.2]	The Hx/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	1

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
21	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[Hx/B HVAC SFC 5-18.3]	The Hx/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	C	3
22	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[Hx/B HVAC SFC 5-18.4]	The Hx/B HVAC system is designed to support smoke management for conventional fire safety.	C	3
23	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[CBEEE/Z HVAC SFC 5-18.1]	The CBEEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	A	1
24	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	FS-1 FS-6 FS-7 FS-10 FS-13 FS-14 FS-17	Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal Long-term Heat Removal Confinement/Containment of radioactive materials	Fault Conditions	[CBEEE/Z HVAC SFC 5-18.2]	The CBEEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	1
25	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[CBEEE/Z HVAC SFC 5-18.3]	The CBEEE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	A	1

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
26	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[CBEEE/Z HVAC SFC 5-18.4]	The CBEEE/Z HVAC system is designed to support smoke management for conventional fire safety.	A	1
27	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[CBC2EE/Z HVAC SFC 5-18.1]	The CBC2EE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	A	2
28	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	FS-2 FS-3 FS-4 FS-5 FS-12 FS-15 -	Reactivity Control Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal Severe Accidents	Fault Conditions	[CBC2EE/Z HVAC SFC 5-18.2]	The CBC2EE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	2
29	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[CBC2EE/Z HVAC SFC 5-18.3]	The CBC2EE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	A	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
30	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[CBC2EE/Z HVAC SFC 5-18.4]	The CBC2EE/Z HVAC system is designed to support smoke management for conventional fire safety.	C	3
31	4	Confinement /Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	FS-1 FS-6 FS-7 FS-10 FS-13 FS-14 FS-17	Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal Long-term Heat Removal Confinement/Containment of radioactive materials	Fault Conditions	[MCR HVAC SFC 4-7.3]	The MCR HVAC system is designed to reduce the ingress of gaseous or airborne radioactive material and the exposure of operators during fault conditions.	A	1
32	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[MCR HVAC SFC 5-18.1]	The MCR HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	A	1
33	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	FS-1 FS-6 FS-7 FS-10 FS-13 FS-14 FS-17	Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal Long-term Heat Removal Confinement/Containment of radioactive materials	Fault Conditions	[MCR HVAC SFC 5-18.2]	The MCR HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	1
34	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[MCR HVAC SFC 5-18.3]	The MCR HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	A	1

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
35	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[MCR HVAC SFC 5-18.4]	The MCR HVAC system is designed to support smoke management for conventional fire safety.	C	3
36	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	FS-1 FS-6 FS-7 FS-10 FS-13 FS-14 FS-17	Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal Long-term Heat Removal Confinement/Containment of radioactive materials	Fault Conditions	[MCR HVAC SFC 5-18.5]	The MCR HVAC systems ensure the adequate environmental parameters are maintained for working conditions during fault conditions.	A	1
37	4	Confinement /Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding event	Normal Conditions	[Rw/B HVAC SFC 4-7.1]	The Rw/B HVAC system is designed to prevent the release and spread of radioactive material during normal operation.	C	3
38	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[Rw/B HVAC SFC 5-18.1]	The Rw/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	C	3
39	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[Rw/B HVAC SFC 5-18.3]	The Rw/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	C	3
40	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[Rw/B HVAC SFC 5-18.4]	The Rw/B HVAC system is designed to support smoke management for conventional fire safety.	C	3
41	4	Confinement /Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding event	Normal Conditions	[S/B HVAC SFC 4-7.1]	The S/B HVAC system is designed to reduce the release and spread of gaseous or airborne contamination during normal operation.	C	3

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
42	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[S/B HVAC SFC 5-18.1]	The S/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	C	3
43	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[S/B HVAC SFC 5-18.3]	The S/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	C	3
44	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[S/B HVAC SFC 5-18.4]	The S/B HVAC system is designed to support smoke management for conventional fire safety.	C	3
45	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[BBEE/Z HVAC SFC 5-18.1]	The BBEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	A	2
46	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	FS-2 FS-3 FS-4 FS-5 FS-12 FS-15 -	Reactivity Control Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal Severe Accidents	Fault Conditions	[BBEE/Z HVAC SFC 5-18.2]	The BBEE/Z HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	2
47	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[BBEE/Z HVAC SFC 5-18.3]	The BBEE/Z HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	A	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
48	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[BBEE/Z HVAC SFC 5-18.4]	The BBEE/Z HVAC system is designed to support smoke management for conventional fire safety.	A	2
49	4	Confinement /Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	FS-2 FS-3 FS-4 FS-5 FS-12 FS-15 -	Reactivity Control Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal Severe Accidents	Fault Conditions	[BBECR HVAC SFC 4-7.3]	The BBECR HVAC system is designed to reduce the ingress of gaseous or airborne radioactive material and the exposure of operators during fault conditions.	A	2
50	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[BBECR HVAC SFC 5-18.1]	The BBECR HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	A	2
51	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	FS-2 FS-3 FS-4 FS-5 FS-12 FS-15 -	Reactivity Control Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal Severe Accidents	Fault Conditions	[BBECR HVAC SFC 5-18.2]	The BBECR HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	2
52	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[BBECR HVAC SFC 5-18.3]	The BBECR HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	A	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
53	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[BBECR HVAC SFC 5-18.4]	The BBECR HVAC system is designed to support smoke management for conventional fire safety.	C	3
54	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	FS-2 FS-3 FS-4 FS-5 FS-12 FS-15 -	Reactivity Control Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal Severe Accidents	Fault Conditions	[BBECR HVAC SFC 5-18.5]	The BBECR HVAC systems ensure the adequate environmental parameters are maintained for working conditions during fault conditions.	A	2
55	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[FV/B HVAC SFC 5-18.1]	The FV/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in normal operation.	A	2
56	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	FS-2 FS-3 FS-4 FS-5 FS-12 FS-15	Reactivity Control Reactivity Control Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Reactor Core Cooling Long-term Heat Removal	Fault Conditions	[FV/B HVAC SFC 5-18.2]	The FV/B HVAC ensures the adequate environmental parameters are maintained so that the relevant SSCs can function appropriately and can deliver the fundamental safety functions in fault conditions.	A	2
57	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[FV/B HVAC SFC 5-18.3]	The FV/B HVAC systems ensure the adequate environmental parameters are maintained for working conditions during normal operation.	A	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
58	5	Others	5-18	Functions to maintain internal building environment appropriate for SSCs	-	No corresponding event	Normal Conditions	[FV/B HVAC SFC 5-18.4]	FV/B HVAC system is designed to support smoke management for conventional fire safety.	A	2

SFC Table of FPS

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-14	Supporting functions for on-site emergency preparedness	-	Not claimed in the design basis	Fault Conditions	FPS SFC 5-14.1	Fire detector and alarm systems serve to detect a fire and provide warning to occupants in the vicinity of a fire and the MCR.	C	3
2	5	Others	5-14	Supporting functions for on-site emergency preparedness	-	Not claimed in the design basis	Fault Conditions	FPS SFC 5-14.2	The fire fighting water supply system provides the water to the fire fighting systems.	C	3
3	5	Others	5-14	Supporting functions for on-site emergency preparedness	-	Not claimed in the design basis	Fault Conditions	FPS SFC 5-14.3	The fixed fire suppression systems limit fire growth and spread following ignition.	C	3
4	5	Others	5-14	Supporting functions for on-site emergency preparedness	-	Not claimed in the design basis	Fault Conditions	FPS SFC 5-14.4	The fire brigade equipments limit fire growth and spread following ignition.	C	3
5	5	Others	5-14	Supporting functions for on-site emergency preparedness	-	Not claimed in the design basis	Fault Conditions	FPS SFC 5-14.5	The smoke control system contributes fire containment by controlling the spread of smoke, enabling a rapid response to a fire.	C	3

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
6	2	Fuel Cooling	2-2	Function of alternative fuel cooling	11.6 11.7 11.8.2 11.10.2 11.11.2 11.12.2	Inadvertent start-up A1 (RHR, HPCF) injection system in shutdown modes Inadvertent start-up A2 (FLSS) injection system in shutdown modes M/C power supply failure on electrical CCF Loss of all RCW Loss of all RSW Loss of Class 1 HVAC	Fault Conditions	FPS SFC 2-2.1	The Fire Protection System (FP), which is a system for fire fighting, will be utilised to supply coolant water for reactor core cooling in the event the primary (ECCS) and secondary (FLSS) means for core cooling are failed or unavailable.	A	3
7	2	Fuel Cooling	2-3	Function to make up reactor coolant with other system	11.4.2 11.6 11.7 11.8.2 11.10.2 11.11.2 11.12.2 13.3 13.4 13.5.2 13.5.3	Inadvertent opening of all ADS due to spurious failure of Class 1 SSLC Inadvertent start-up A1 (RHR, HPCF) injection system in shutdown modes Inadvertent start-up A2 (FLSS) injection system in shutdown modes M/C power supply failure on electrical CCF Loss of all RCW Loss of all RSW Loss of Class 1 HVAC Loss of operating RHR with loss of the same division of ECCS Loss of operating RHR due to CCF of Class 1 controller Medium term Loss of off-site power (Medium term < 24hr) Long term Loss of off-site power (Long	Fault Conditions	FPS SFC 2-3.1	The Fire Protection System (FP), which is a system for fire fighting, will be utilised to supply coolant water for reactor core cooling, if available, in the event of beyond design basis faults or severe accidents.	C	3

	Top Claim for Mechanical System				Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)	High Level Safety Function (HLSF)	Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
				term < 168hr)					
			13.6.2	Medium term SBO (Medium term < 24hr)					
			13.6.3	Long term SBO (Long term < 168hr)					
			13.7	Draindown due to valve failure within the operating RHR (Spurious opening due to human error)					
			13.8.1	LOCA at feedwater line (A) inside PCV					
			13.8.2	LOCA at feedwater line (B) inside PCV					
			13.9	LOCA at RHR suction line inside PCV					
			13.10	LOCA at LPFL return line inside PCV					
			13.11	LOCA(mechanical) below TAF					
			13.12	RPV draindown by CUW					
			13.13	Leakage during FMCRD inspection					
			13.14	Leakage during replacement ICM nozzle					
			13.15	Leakage during RIP inspection					
			13.16	Refueling Bellows Perforation caused by an Irradiated Fuel Drop					
			13.17	LOCA at CUW system line outside PCV					
			13.18	LOCA at RHR system line outside PCV					
			17.1.2	Internal Fire in Reactor Building					
			17.2.2	Internal Fire in Heat Exchanger Building					
			17.3.2	Internal Fire in Control Building					
			17.4.2	Internal Fire in Main Control Room					
			17.5.2	Internal Missile in Main Control Room					
			18.1.2	Loss of Ultimate Heat Sink					
			18.2.2	10^{-3}/year Earthquake					
			18.3.2	Design Basis Earthquake (DBE)					

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
8	2	Fuel Cooling	2-5	Function to make up water for spent fuel pool	11.4.2	Inadvertent opening of all ADS due to spurious failure of Class 1 SSLC	Fault Conditions	FPC SFC 2-5.1	The SPCU, MUWC or FP, which systems are for normal operating function, will be utilised to supply water to the SFP, if available.	C	3
					11.6	Inadvertent start-up A1 (RHR, HPCF) injection system in shutdown modes					
					11.7	Inadvertent start-up A2 (FLSS) injection system in shutdown modes					
					11.8.2	M/C power supply failure on electrical CCF					
					11.10.2	Loss of all RCW					
					11.11.2	Loss of all RSW					
					11.12.2	Loss of Class 1 HVAC					
					13.3	Loss of operating RHR with loss of the same division of ECCS					
					13.4	Loss of operating RHR due to CCF of Class 1 controller					
					13.5.2	Medium term Loss of off-site power (Medium term < 24hr)					
					13.5.3	Long term Loss of off-site power (Long term < 168hr)					
					13.6.2	Medium term SBO (Medium term < 24hr)					
					13.6.3	Long term SBO (Long term < 168hr)					
					13.7	Draindown due to valve failure within the operating RHR (Spurious opening due to human error)					
					13.8.1	LOCA at feedwater line (A) inside PCV					
					13.8.2	LOCA at feedwater line (B) inside PCV					
					13.9	LOCA at RHR suction line inside PCV					
					13.10	LOCA at LPFL return line inside PCV					

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
					13.11	LOCA(mechanical) below TAF					
					13.13	Leakage during FMCRD inspection					
					13.14	Leakage during replacement ICM nozzle					
					13.15	Leakage during RIP inspection					
					13.16	Refueling Bellows Perforation caused by an Irradiated Fuel Drop					
					13.17	LOCA at CUW system line outside PCV					
					13.18	LOCA at RHR system line outside PCV					
					17.1.2	Internal Fire in Reactor Building					
					17.2.2	Internal Fire in Heat Exchanger Building					
					17.3.2	Internal Fire in Control Building					
					17.4.2	Internal Fire in Main Control Room					
					17.5.2	Internal Missile in Main Control Room					
					18.1.2	Loss of Ultimate Heat Sink					
					18.2.2	10^{-3}/year Earthquake					
					18.3.2-	Design Basis Earthquake (DBE)					

SFC Table of EDG, BBG and DAG

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat.	Class
1	5	Others	5-2	Supporting functions especially important to safety	-	See chapter 15.	Fault Conditions	EPS SFC 5-2.1	The EDGs supply power to loads necessary to secure functions of engineering safety facilities and necessary to safety shut down the reactor in the event of LOOP and LOCA associated with LOOP.	A	1
2	5	Others	5-3	Function of alternative supporting system	-	See chapter 15.	Fault Conditions	EPS SFC 5-3.1	The BBG supplies power to diverse provisions which are necessary for reactor safety in the event of a LOOP and a LOCA associated with LOOP.	A	2
3	5	Others	5-3	Function of alternative supporting system	-	See chapter 15.	Beyond Design Basis Fault Conditions	EPS SFC 5-3.2	The BBG supplies power in the event of severe accidents.	B	2
4	5	Others	5-3	Function of alternative supporting system	-	See chapter 15.	Fault Conditions	EPS SFC 5-3.3	The DAG supplies power to loads necessary to secure functions of engineering safety facilities and necessary to safety shut down the reactor in the event of the simultaneous occurrence of LOOP (Loss of Off-site Power) and CCF of the EDGs.	B	3

SFC Table of SPCU

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
1	5	Others	5-9	Functions to clean up water except for reactor coolant	-	No claim	Normal Operations	SPCU SFC 5-9.1	The SPCU provides purifying water treatment for the S/P in plant normal operation. It removes various impurities by filtration, adsorption, and ion exchange processes.	C	3
2	2	Fuel cooling	2-5	Functions to make up water for spent fuel pool	-	Not claimed in the design basis	Fault Conditions	SPCU SFC 2-5.1	The SPCU is capable of supplying makeup water to the SFP even if it is under the environmental conditions post LOCA.	C	3
3	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	7.1 8.1 8.2 9.1 9.2 9.3 10.1 10.2 10.3	LOCA - RPV bottom drain line break LOCA - HPCF line break LOCA - LPFL line break LOCA - FWD line (9.1.1, 9.1.2) LOCA - MS line break LOCA - RHR line break LOCA outside PCV - MS line break LOCA outside PCV - CUW line break LOCA outside PCV - FWD line (RCIC connected) break	Fault Conditions	SPCU SFC 4-7.1	The SPCU components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1
4	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding fault	Normal Operations	SPCU SFC 4-4.1	The SPCU piping outside the PCV boundary contains radioactive material. Rupture of this piping could lead to a release of radioactive material of relatively low dose consequences.	C	3
5	2	Fuel Cooling	2-5	Function to make up water for spent fuel pool	-	Not claimed in the design basis	Fault Conditions	FPC SFC 2-5.1	The SPCU, MUWC or FP, which systems are for normal operating function, will be utilised to supply water to the SFP, if available.	C	3

SFC Table of FLSS

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
1	2	Fuel cooling	2-2	Function of alternative fuel cooling	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 2.4 3.1 3.2 4.2 4.4 5.1 5.2 6.1 7.2 10.4	Generator load rejection Partial loss of reactor flow (trip of 3 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Radiation monitor failure Loss of all feedwater flow Inadvertent start-up of all injection system Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) Short LOOP Medium LOOP Inadvertent opening of a SRV LOCA - small line break LOCA Outside PCV – small line break	Fault Conditions	[FLSS SFC 2-2.1]	The FLSS is the secondary means to provide reactor core cooling so that significant damage to the fuel is prevented and the reaction between the fuel cladding and the reactor coolant is sufficiently minimised in the event of a fault where all the primary reactor core cooling means (ECCS) have failed.	A	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
					11.4 11.5 11.8 11.9 11.10 11.11 11.12 13.3 13.4 13.5 13.6 13.7 13.8 13.9 13.10 13.11 13.12 13.13 13.14 13.15 17.1 17.2 17.3 17.4 18.1 18.2	Inadvertent opening of all ADS (SSLC failure) Inadvertent MSIV closure (SSLC failure) M/C power supply failure (electrical CCF) D/C power supply failure (electrical CCF) Loss of all RCW Loss of all RSW Loss of Class 1 HVAC SD - Loss of operating RHR and same ECCS division SD - Loss of operating RHR (Class 1 controller CCF) SD - LOOP SD - SBO SD - Draindown due to operating RHR valve failure SD - LOCA inside PCV - FDW line SD - LOCA inside PCV - RHR suction line SD - LOCA inside PCV - LPFL return line SD - LOCA (mechanical below TAF) SD - RPV draindown by CUW SD - Leakage during FMCRD inspection SD - Leakage during replacement of ICM nozzle SD - Leakage during RIP inspection Internal fire in R/B Internal fire in Hx/B Internal fire in C/B Internal fire in MCR Loss of UHS 10-3/y earthquake					
2	2	Fuel cooling	2-5	Functions to make up water for spent fuel pool	1 2 3	Failure of two FPC pumps (loss of FPC cooling) Loss of off-site power Small leakage from SFP pool lining	Fault Conditions	[FLSS SFC 2-5.1]	In the eventuality that the cooling function for the SFP is unavailable or small leakage from the SFP occurs, the FLSS supplies sufficient water to maintain the water level of the SFP as a secondary means of cooling the spent fuel stored in the SFP.	A	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
3	2	Fuel cooling	2-2	Function of alternative fuel cooling	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSS SFC 2-2.2]	The FLSS is a principal means to provide reactor core cooling in order to prevent significant damage to the fuel and minimise the reaction between the fuel cladding and the reactor coolant sufficiently in the event of beyond design basis faults and severe accidents.	B	2
4	4	Confinement/Containment of radioactive materials	4-9	Functions to contain radioactive materials in the event of a severe accident	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSS SFC 4-9.1]	The FLSS is a principal means to provide PCV cooling with PCV spray in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents.	B	2
5	4	Confinement/Containment of radioactive materials	4-9	Functions to contain radioactive materials in the event of a severe accident	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSS SFC 4-9.2]	The FLSS is a principal means to provide molten core cooling with lower D/W injection in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents.	B	2
6	4	Confinement/Containment of radioactive materials	4-9	Functions to contain radioactive materials in the event of a severe accident	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSS SFC 4-9.3]	The FLSS is a principal means to provide PCV head flange cooling in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents.	B	2
7	2	Fuel cooling	2-5	Functions to make up water for spent fuel pool	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSS SFC 2-5.2]	The FLSS is the principal means to provide SFP with makeup water to mitigate significant damage to the spent fuel due to potential long term SBO and subsequent loss of SFP cooling function in the event of beyond design basis faults or severe accidents.	B	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
8	2	Fuel cooling	2-5	Functions to make up water for spent fuel pool	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSS SFC 2-5.3]	The FLSS is the principal means to provide SFP with spray water to mitigate significant damage to the spent fuel due to loss of the fuel pool water resulting from loss of makeup water or a large leakage from the SFP in the event of beyond design basis faults or severe accidents.	B	3
9	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding fault	Normal and Fault Conditions	[FLSS SFC 4-7.1]	The FLSS components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of FLSR

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
1	2	Fuel cooling	2-2	Function of alternative fuel cooling	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSR SFC 2-2.1]	The FLSR is a secondary means to provide reactor core cooling in order to prevent significant damage to the fuel and minimise the reaction between the fuel cladding and the reactor coolant sufficiently in the event of beyond design basis faults and severe accidents.	B	3
2	4	Confinement/Containment of radioactive materials	4-9	Functions to contain radioactive materials in the event of a severe accident	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSR SFC 4-9.1]	The FLSR is a secondary means to provide PCV cooling with PCV spray in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents where the primary PCV cooling means (FLSS) have failed.	B	3
3	4	Confinement/Containment of radioactive materials	4-9	Functions to contain radioactive materials in the event of a severe accident	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSR SFC 4-9.2]	The FLSR is a secondary means to provide molten core cooling with lower D/W injection in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents where the primary molten core cooling means (FLSS) have failed.	B	3
4	4	Confinement/Containment of radioactive materials	4-9	Functions to contain radioactive materials in the event of a severe accident	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSR SFC 4-9.3]	The FLSR is a secondary means to provide PCV head flange cooling in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents where the primary PCV head flange cooling means (FLSS) have failed.	B	3
5	2	Fuel cooling	2-5	Functions to make up water for spent fuel pool	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSR SFC 2-5.1]	The FLSR is a secondary means to provide SFP with makeup water as a backup of the FLSS in the event of design basis faults and beyond design basis faults or severe accidents.	B	3
6	2	Fuel cooling	2-5	Functions to make up water for spent fuel pool	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FLSR SFC 2-5.2]	The FLSR is a secondary means to provide SFP with spray water to mitigate significant damage to the spent fuel due to loss of the fuel pool water resulting from loss of makeup water or a large leakage from the SFP as a backup of the FLSS in the event of beyond design basis faults or severe accidents.	B	3

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
7	2	Fuel cooling	2-2	Function of alternative fuel cooling	11.6 11.7 11.8.2 11.10.2 11.11.2 11.12.2	Inadvertent start-up A1 (RHR, HPCF) injection system in shutdown modes Inadvertent start-up A2 (FLSS) injection system in shutdown modes M/C power supply failure on electrical CCF Loss of all RCW Loss of all RSW Loss of Class 1 HVAC	Design Basis Fault Conditions	[FLSR SFC 2-2.2]	The FLSR is a secondary means to provide reactor core cooling during outage in order to prevent significant damage to the fuel in the event of design basis fault where the primary (ECCS) and secondary (FLSS) means for core cooling are failed or unavailable.	A	3
8	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding fault	Normal and Fault Conditions	[FLSR SFC 4-7.1]	The FLSR components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of RDCF

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
1	2	Fuel cooling	2-2	Function of alternative fuel cooling	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 2.4 3.1 3.2 4.2 4.4 5.1 5.2 6.1 7.2 11.4 11.5 11.8 11.9 11.10	Generator load rejection Partial loss of reactor flow (trip of 3 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Radiation monitor failure Loss of all feedwater flow Inadvertent start-up of all injection system Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) Short LOOP Medium LOOP Inadvertent opening of a SRV LOCA - small line break Inadvertent opening of all ADS (SSLC failure) Inadvertent MSIV closure (SSLC failure) M/C power supply failure (electrical CCF) D/C power supply failure (electrical CCF) Loss of all RCW	Fault Conditions	[RDCF SFC 2-2.1]	The RDCF is an alternative means to depressurise the RPV in order to provide reactor core cooling in low pressure state with the FLSS in the event of design basis faults where the primary means (ECCS) are not available.	A	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
					11.11 11.12 17.1 18.1 18.2	Loss of all RSW Loss of Class 1 HVAC Internal fire in R/B Loss of Ultimate Heat Sink 10^{-3}/y earthquake					
2	2	Fuel cooling	2-2	Function of alternative fuel cooling	1.4 3.1 5.1 5.2 11.5 11.8 11.9 11.10 11.11 11.12 17.5	Feedwater controller failure - Maximum demand Loss of all feedwater flow Short LOOP with CCF Medium LOOP with CCF Inadvertent MSIV closure due to spurious failure of Class 1 SSLC M/C power supply failure on electrical CCF D/C power supply failure on electrical CCF Loss of all RCW Loss of all RSW Loss of Class 1 HVAC Internal Missile in the MCR	Fault Conditions	[RDCF SFC 2-2.2]	The RDCF is the principal means to depressurise the RPV in order to provide reactor core cooling in low pressure state with the FLSS after RCIC operation for the first 24 hours in the event of design basis faults such as SBO or Class 1 CCF.	A	2
3	2	Fuel cooling	2-2	Function of alternative fuel cooling	11.5 11.8 11.9 11.10 11.11 11.12	Inadvertent MSIV closure due to spurious failure of Class 1 SSLC M/C power supply failure on electrical CCF D/C power supply failure on electrical CCF Loss of all RCW Loss of all RSW Loss of Class 1 HVAC	Fault Conditions	[RDCF SFC 2-2.3]	The RDCF with switching valves is the principal means to maintain RPV depressurisation in order to provide reactor core cooling in low pressure state with the FLSS in the event of design basis faults such as SBO or Class 1 CCF after the first 24 hours.	A	3

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
4	2	Fuel cooling	2-2	Function of alternative fuel cooling		No corresponding event	Fault Conditions	[RDCF SFC 2-2.4]	The RDCF is an alternative means to depressurise the RPV in order to provide reactor core cooling in low pressure state with the FLSS or FLSR in the event of beyond design basis faults with RDCF Accumulator available.	B	2
5	2	Fuel cooling	2-2	Function of alternative fuel cooling		No corresponding event	Fault Conditions	[RDCF SFC 2-2.5]	The RDCF with switching valves is the principal means to depressurise the RPV in order to provide reactor core cooling in low pressure state with the FLSR after RCIC operation for the first 24hrs in the event of beyond design basis faults without RDCF Accumulator available.	B	3
6	2	Fuel cooling	2-2	Function of alternative fuel cooling		No corresponding event	Fault Conditions	[RDCF SFC 2-2.6]	The RDCF with switching valves is the principal means to maintain RPV depressurisation in the event of beyond design basis faults without RDCF Accumulator available after the first 24 hours.	B	3
7	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding fault	Normal and Fault Conditions	[RDCF SFC 4-7.1]	The RDCF components penetrating the primary containment form a barrier to confine radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of LDF

	Top Claim for mechanical system						Top Claim for mechanical system				
	Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		State	Claim ID	Claim Contents	Cat	Class
1	4	Confinement/Containment of radioactive materials	4-9	Functions to contain radioactive materials in the event of a severe accident	-	Severe Accidents	Beyond Design Basis Fault Conditions	[LDF SFC 4-9.1]	The LDF is an alternative means to provide molten core cooling with lower D/W injection in order to prevent the PCV failure in the event of beyond design basis faults and severe accidents where all the primary molten core cooling means (FLSS and FLSR) have failed.	B	3
2	2	Fuel cooling	2-1	Functions to cool reactor core	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.10 2.1 2.2 2.3 2.4 3.1 3.2 4.2 4.4 4.6 5.1 5.1.1 5.2 5.2.1 5.3 5.3.1 5.3.4 6.1 7.1 7.2	Generator load rejection Partial loss of reactor flow (trip of 4 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent opening of all ADS Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Radiation monitor failure Loss of all feedwater flow Inadvertent start-up of all injection system Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) SRNM or APRM sensor failure Short term LOOP Short-term LOOP with CCF of EDGs Medium term LOOP Medium term LOOP with CCF of EDGs Long-term LOOP Long-term LOOP with CCF of EDGs Long-term LOOP with CCF of EDGs and CCF of B/B DGs Inadvertent opening of a SRV LOCA - RPV bottom drain line break LOCA - small line break	Normal Operation and Fault Conditions	[LDF SFC 2-1.1]	The LDF forms a part of S/P boundary in order to secure the water source of the ECCS.	A	1

	Top Claim for mechanical system					Top Claim for mechanical system				
	Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)		Fundamental Safety Function (FSF)					
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR	State	Claim ID	Claim Contents	Cat	Class
					8.1 LOCA - HPCF line break 8.2 LOCA - LPFL line break 9.1.1 LOCA - FWD line (LPFL connected) break 9.1.2 LOCA - FWD line (RCIC connected) break 9.2 LOCA - MS line break 9.3 LOCA - RHR line break 10.1 LOCA outside PCV - MS line break 10.2 LOCA outside PCV - CUW line break 10.3 LOCA outside PCV - FWD line (RCIC connected) break					

SFC Table of FCVS

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
1	3	Long-term heat removal	3-2	Function of alternative containment cooling and decay heat removal	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 3.1 4.2 4.4 5.1 5.2 5.3 6.1 7.2 10.4 11.8 11.9 11.10 11.11 11.12 13.6 13.7 13.12 18.1 18.2 17.1 17.2 17.3	Generator load rejection Partial loss of reactor flow (trip of 3 RIPs) Loss of reactor flow (trip of all RIPs) Feedwater controller failure - Maximum demand Recirculation flow control failure (runout of all RIPs) Loss of feedwater heating Reactor pressure regulator failure in the closed direction Inadvertent control valve closure Inadvertent MSIV closure Reactor pressure regulator failure in the open direction Loss of main condenser vacuum Loss of all feedwater flow Control rod withdrawal error at power Inadvertent reactor SCRAM (CRD pump trip) Short LOOP Medium LOOP Long LOOP Inadvertent opening of a SRV LOCA - small line break Small line break LOCA outside PCV M/C power supply failure on electrical CCF D/C power supply failure on electrical CCF Loss of all RCW Loss of all RSW Loss of Class 1 HVAC Long-term SBO Draindown due to valve failure in RHR RPV draindown by CUW Loss of ultimate heat sink 10-3/y earthquake Internal fire in R/B Internal fire in Hx/B Internal fire in C/B	Fault Conditions	[FCVS SFC 3-2.1]	The FCVS is a secondary means to deliver long-term PCV heat removal and overpressure protection in the event of design basis faults where all the primary PCV heat removal means (RHR) have failed.	A	2

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
					17.4 17.5 17.6	Internal fire in MCR Internal missile in MCR Turbine missile					
2	3	Long-term heat removal	3-2	Function of alternative containment cooling and decay heat removal	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FCVS SFC 3-2.2]	The FCVS is a principal means to deliver and long-term PCV heat removal and overpressure protection in the event of beyond design basis faults and severe accidents.	B	2
3	4	Confinement/Containment of radioactive materials	4-9	Functions to contain radioactive materials in the event of a severe accident	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FCVS SFC 4-9.1]	The FCVS is a secondary means to deliver PCV overpressure protection in the event of severe accidents.	B	3
4	4	Confinement/Containment of radioactive materials	4-8	Functions to minimise the release of radioactive gases	-	Severe Accidents	Beyond Design Basis Fault Conditions	[FCVS SFC 4-8.1]	The FCVS is a principal means to reduce the release of radioactive material from the PCV in the event of beyond design basis faults and severe accidents.	B	3
5	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding fault	Normal and Fault Conditions	[FCVS SFC 4-7.1]	The FCVS components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

SFC Table of AHEF

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
1	3	Long-term heat removal	3-2	Function of alternative containment cooling and decay heat removal	-	Severe Accident	Fault Conditions	[AHEF SFC 3-2.1]	The AHEF is an alternative means to provide the cooling water for one division of RHR Heat Exchangers and associated auxiliaries via RCW in terms of long-term PCV heat removal in the event of beyond design faults and severe accidents where the functions of RCW or RSW are lost.	B	3

SFC Table of ANI

	Top Claim for Mechanical System						Top Claim for Mechanical System and Components				
	Fundamental Safety Function (FSF)		High Level Safety Function (HLSF)		Fault Schedule (Bounding Fault)						
	PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		PCSR Ch.5 Section 6 Table 5.6-1: High level safety functions in UK ABWR		Topic Report on Fault Assessment Table.4.2-1 Fault Schedule (Ref 12.1-1)		State	Claim ID	Claim Contents	Cat	Class
1	4	Confinement/Containment of radioactive materials	4-17	Functions to maintain PCV atmosphere in an inert state for preventing hydrogen combustion	-	Severe Accidents	Beyond Design Basis Fault Conditions	[ANI SFC 4-17.1]	The ANI is an alternative means to supply nitrogen gas into the PCV in order to keep the hydrogen concentration inside the PCV below the lower flammability limit and to prevent PCV break due to negative pressure caused by restarting of PCV cooling, after an accident where PCV venting is operated,	B	3
2	4	Confinement/Containment of radioactive materials	4-7	Functions to confine radioactive materials, shield radiation, and reduce radioactive release	-	No corresponding fault	Normal and Fault Conditions	[ANI SFC 4-7.1]	The ANI components penetrating the primary containment form a barrier to confine the radioactive material within the containment boundary and prevent its dispersion to the environment in the event of faults.	A	1

Appendix B: Safety Properties Claims Tables

The safety properties claims defined for mechanical systems are shown in the following table.

	SPC	Safety Properties Claims (SPC) Contents	SCDM SPC Guide word [Ref-16-1.5]
1	ME SPC1	Design provision against Single Failure Mechanical systems and their support systems are designed with redundancy against single failure of any dynamic component under the worst permissible system availability state so that single failure does not prevent the delivery of the corresponding safety functions.	• Fault Tolerance • Reliability
2	ME SPC2	Design provision against Common Cause Failure Mechanical systems are designed with independency between redundant components so that the failure of one dynamic component does not lead to a common cause failure that could prevent the delivery of the corresponding safety functions.	• Defence in Depth • Reliability
3	ME SPC3	Design provision against System Interfaces The mechanical interfaces between SSCs of different safety classes inside a mechanical system or between several systems are designed such that failure in a lower class item will not propagate to higher safety class items and jeopardise the delivery of the corresponding safety functions.	• Defence in Depth • Reliability
4	ME SPC4	Internal Hazards Protection Mechanical SSCs are protected or designed to withstand the effects of the following internal hazards so that they do not affect the delivery of the corresponding safety functions: (1) Internal flooding (2)Internal fire and explosion (3) Internal missiles (4)Dropped and collapsed loads (5) Pipe whip and jet impact (6)Internal blast (7) Electromagnetic Interference (EMI) (8)Miscellaneous hazards	• Fault Tolerance • Reliability
5	ME SPC5	External Hazards protection Mechanical SSCs are protected or designed to withstand the effects of the external hazards (Earthquakes, Loss of Offsite Power (LOOP)) so that they do not affect the delivery of the corresponding safety functions.	• Fault Tolerance • Reliability
6	ME SPC6	Actuation Provision Mechanical systems are designed so that no human intervention is necessary for approximately 30 minutes following the start of the requirement for the safety function.	• Human Factors • Reliability
7	ME SPC7	Qualification Provision Mechanical SSCs are capable to deliver their safety functions under the associated operational and environmental conditions throughout their operational life.	• Qualification • Life Cycle • Reliability
8	ME SPC8	EMIT(Examination, Maintenance, Inspection and Test) Mechanical SSCs are designed with the capability for being tested, maintained and monitored during power operation and/or refuelling outages in order to ensure the capability to deliver the safety functions claimed without compromising their availability throughout their operational life.	• Life Cycle • Reliability • Layout and Accessibility • Radiation Protection
9	ME SPC9	Codes and Standards Mechanical components are designed manufactured, constructed, installed, commissioned, quality assured, maintained, tested and inspected according to codes and standards commensurate to their Safety Class.	• Relevant Good Practice • Reliability

Note: the ME SPCs are derived based on the guide word approach as described in Generic PCSR Chapter 5 section 5.3 'General Safety Design Bases'.

The safety properties claims table of each system is provided in the following tables.

Ch.16.3 Water Systems

	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
RCW										
Water Circulation portion	A-1	X	X	X	X	X	X	X	X	X
PCV Boundary Portion	A-1	X	X	X	X	X	X	X	X	X
Other portion	B-3	-	-	X	-	X	-	X	X	X
RSW										
Water Service portion	A-1	X	X	X	X	X	X	X	X	X
TCW										
Water Circulation portion	B-3	-	-	X	-	X	-	X	X	X
TSW										
Water Service portion	B-3	-	-	X	-	X	-	X	X	X
MUWC										
CST portion	A-2	X	X	X	X	X	X	X	X	X

	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
Within PCVB portion	A-1	X	X	X	X	X	X	X	X	X
Other portion	B-3	-	-	X	-	X	-	X	X	X
HECW										
Chiller, Chilled Water Pump	A-1	X	X	X	X	X	X	X	X	X
Other portion	C-3	-	-	X	-	X	-	X	X	X
HNCW										
HNCW PCV isolation valve	A-1	X	X	X	X	X	X	X	X	X
HNCW Chiller, Chilled Water Pump	C-3	-	-	X	-	X	-	X	X	X
Rw/B HNCW Chiller, Chilled Water Pump	C-3	-	-	X	-	X	-	X	X	X
S/B HNCW Chiller, Chilled Water Pump	C-3	-	-	X	-	X	-	X	X	X
HBCW										
Chiller, Chilled Water Pump	A-2	X	X	X	X	X	X	X	X	X
Other portion	C-3	-	-	X	-	X	-	X	X	X
EECW										

	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
Circulation Loop portion	A-2/B-2	X	X	X	X	X	X	X	X	X
Other portion	C-3	-	-	X	-	X	-	X	X	X

Ch.16.4 Process Auxiliary Systems

SSCs	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
IA										
Air Supply portion	C-3	-	-	X	-	X	-	X	X	X
SA										
Air Supply portion	C-3	-	-	X	-	X	-	X	X	X
HPIN										
Nitrogen Gas Cylinder	B-3/C-3	-	-	X	-	X	-	X	X	X
Nitrogen Gas Cylinder Rack	B-3/C-3	-	-	X	-	X	-	X	X	X
P&D										
Drainage portion	C-3	-	-	X	-	X	-	X	X	X
RD										
Drywell isolation portion	A-1	X	X	X	X	X	X	X	X	X
Others	C-3	-	-	X	-	X	-	X	X	X
SAM										
Sampling Nozzle Sampling Hoods Sampling Sink Filter Sampling Rack	C-3	-	-	X	-	X	-	X	X	X

SSCs	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
HS/HSCR										
Steam Supply portion	C-3	-	-	X	-	X	-	X	X	X

Ch.16.5 Heating Ventilating and Air Conditioning Systems (HVAC)

SSCs	Safety Cat. & Class	ME SPC1	ME SPC2	ME SPC3	ME SPC4	ME SPC5	ME SPC6	ME SPC7	ME SPC8	ME SPC9
		Design provision against Single Failure	Design provision against Common Cause Failure	Design provision against System Interfaces	Internal Hazards Protection	External Hazards protection	Automation	Qualification Provision	EMIT	Codes and Standards
Cooling function for RHR pump room	A-1	X	X	X	X	X	X	X	X	X
Cooling function for RCIC pump room	A-1	X	X	X	X	X	X	X	X	X
Cooling function for HPCF pump room	A-1	X	X	X	X	X	X	X	X	X
Cooling function for FPC pump room	A-1	-	-	X	-	X	-	X	X	X
Cooling function for SGTS room	B-2	X	X	X	-	X	X	X	X	X
R/A isolation function	B-2	X	X	X	-	X	X	X	X	X
Cooling function for CAMS room	B-2	X	X	X	-	X	X	X	X	X
Cooling function for EDG room	A-1	X	X	X	X	X	X	X	X	X
Cooling function for RCW and RSW room	A-1	X	X	X	X	X	X	X	X	X

SSCs	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
Cooling function for BBG room	A-2	X	X	X	X	X	X	X	X	X
RBEEE/Z HVAC	A-1	X	X	X	X	X	X	X	X	X
Smoke purge function of RBEEE/Z HVAC	C-3	-	-	-	-	X	-	X	X	X
DGEE/Z HVAC	A-1	X	X	X	X	X	X	X	X	X
Smoke purge function of DGEE/Z HVAC	C-3	-	-	-	-	X	-	X	X	X
CBEEE/Z HVAC	A-1	X	X	X	X	X	X	X	X	X
Smoke purge function of CBEEE/Z HVAC	C-3	-	-	-	-	X	-	X	X	X
MCR HVAC	A-1	X	X	X	X	X	X	X	X	X
Humidifier of MCR HVAC	C-3	-	-	-	-	X	-	X	X	X
CBC2EE/Z HVAC	A-2	X	X	X	X	X	X	X	X	X

SSCs	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
Smoke purge function of CBC2EE/Z HVAC	C-3	-	-	-	-	X	-	X	X	X
BBEE/Z HVAC	A-2	X	X	X	X	X	X	X	X	X
Smoke purge function of BBEE/Z HVAC	C-3	-	-	-	-	X	-	X	X	X
BBECR HVAC	A-2	X	X	X	X	X	X	X	X	X
Humidifier of BBECR HVAC	C-3	-	-	-	-	X	-	X	X	X
FV/B HVAC	A-2	X	X	X	X	X	X	X	X	X
Smoke purge function of FV/B HVAC	C-3	-	-	-	-	X	-	X	X	X
R/A HVAC	C-3	-	-	-	-	X	-	X	X	X
T/B HVAC	C-3	-	-	-	-	X	-	X	X	X
Hx/B-N HVAC	C-3	-	-	-	-	X	-	X	X	X

SSCs	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
Rw/B HVAC	C-3	-	-	-	-	X	-	X	X	X
S/B HVAC	C-3	-	-	-	-	X	-	X	X	X

Ch.16.6 Other Auxiliary Systems

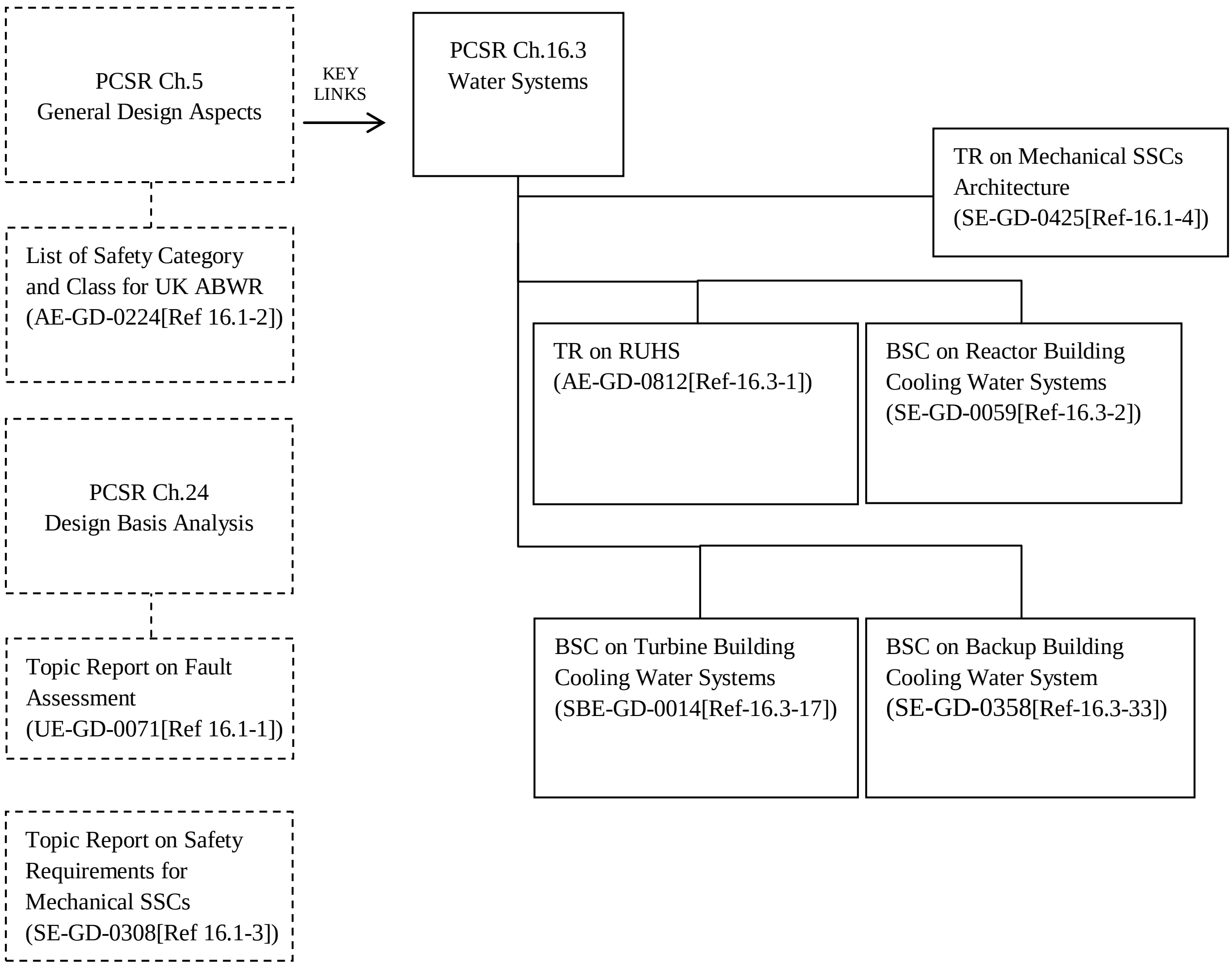
	Safety Cat. & Class	ME SPC1	ME SPC2	ME SPC3	ME SPC4	ME SPC5	ME SPC6	ME SPC7	ME SPC8	ME SPC9
		Design provision against Single Failure	Design provision against Common Cause Failure	Design provision against System Interfaces	Internal Hazards Protection	External Hazards protection	Automation	Qualification Provision	EMIT	Codes and Standards
FPS										
Fire Detection and Alarm System	**C-3**	X	-	-	-	X	X	X	X	X
Fire Fighting Water Supply System	**C-3**	X	X	X	X	X	X	X	X	X
Fixed Fire Water Suppression System	**C-3**	-	-	-	-	X	X	X	X	X
Fire Brigade Equipment	**C-3**	-	-	-	-	X	-	X	X	X
Smoke Control Systems	**C-3**	-	-	X	-	X	-	X	X	X
Smoke Control Systems	**C-3**	-	-	X	-	X	-	X	X	X
EDG, BBG and DAG										
EDG	A-1	X	X	X	X	X	X	X	X	X
BBG	A-2 B-2	X	X	X	X	X	X	X	X	X
DAG	B-3	-	-	X	X	X	-	X	X	X

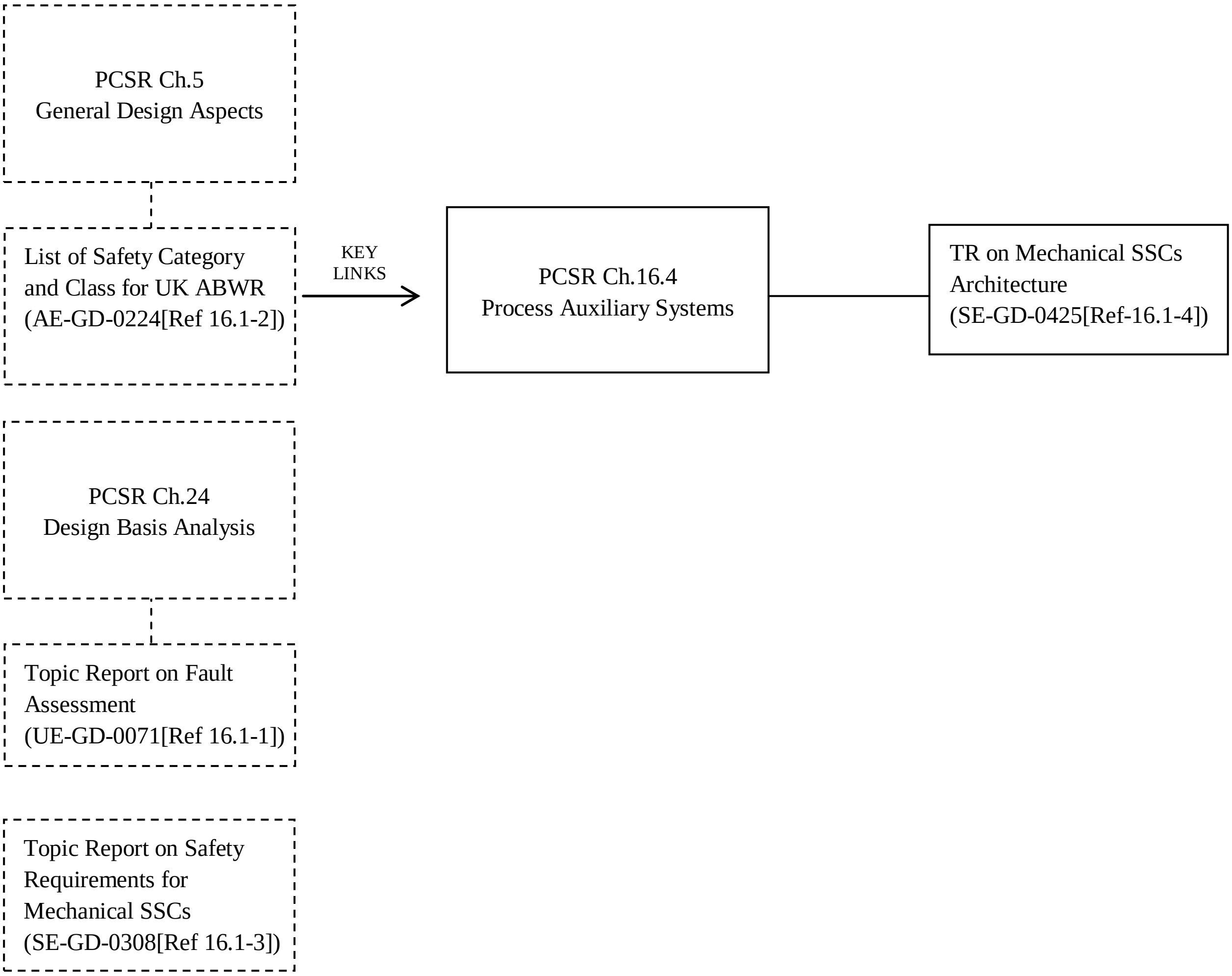
	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
SPCU										
Suppression Pool Water Clean-up portion	C-3	-	-	X	-	X	-	X	X	X
SFP Water Filling portion	C-3	-	-	X	-	X	-	X	X	X
SFP Makeup portion	C-3	-	-	X	-	X	-	X	X	X

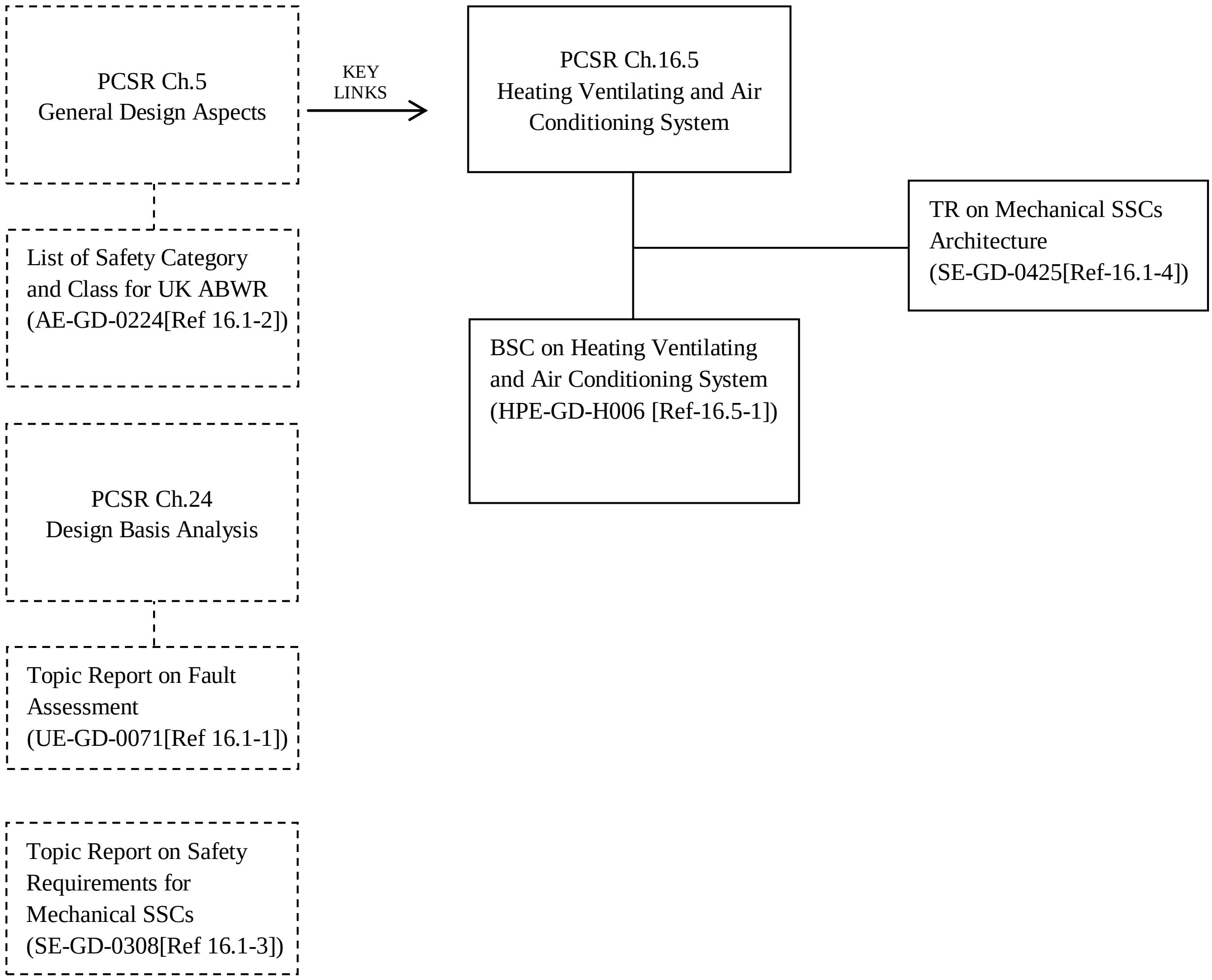
Ch.16.7 Severe Accident Mechanical Systems

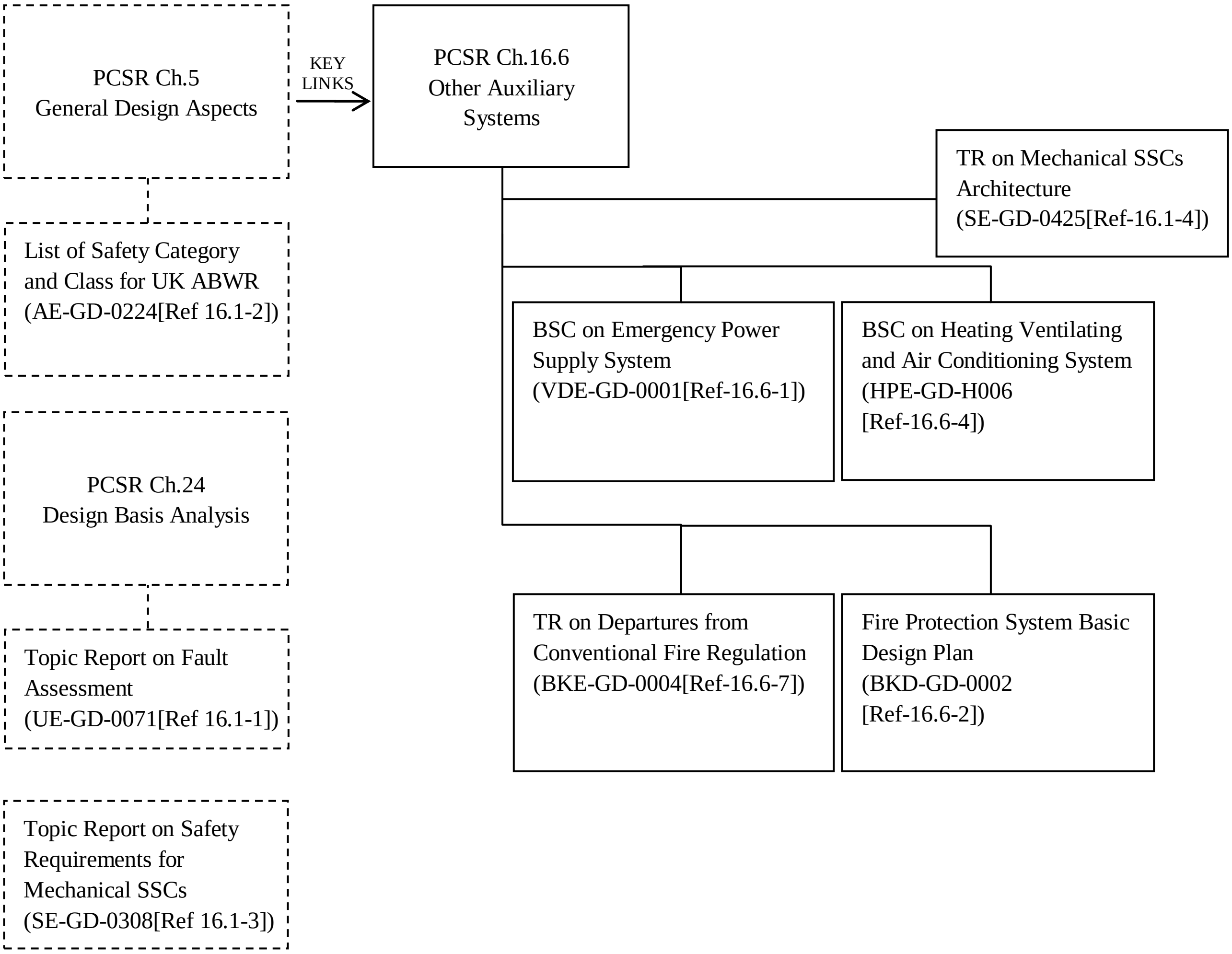
SSCs	Safety Cat. & Class	ME SPC1 Design provision against Single Failure	ME SPC2 Design provision against Common Cause Failure	ME SPC3 Design provision against System Interfaces	ME SPC4 Internal Hazards Protection	ME SPC5 External Hazards protection	ME SPC6 Automation	ME SPC7 Qualification Provision	ME SPC8 EMIT	ME SPC9 Codes and Standards
FLSS										
Pump	A-2/B-2	X	X	X	X	X	X	X	X	X
Water Storage Tank	A-2/B-2	X	X	X	X	X	X	X	X	X
FLSR										
Mobile Pump	B-3	-	-	X	-	X	-	X	X	X
RDCF										
SRV	A-2/B-2	X	X	X	X	X	X	X	X	X
Solenoid valves	A-2/B-2	X	X	X	X	X	X	X	X	X
Switching valve	B-3	-	-	X	-	X	-	X	X	X
Nitrogen gas cylinder rack	B-3	-	-	X	-	X	-	X	X	X
LDF										
Fusible Plug	B-3	-	-	X	-	X	-	X	X	X
FCVS										
Vent Line	A-2/B-2	X	X	X	X	X	X	X	X	X
Filter portion	B-3	-	-	X	-	X	-	X	X	X
AHEF										
Cooling Water Pump	B-3	-	-	X	-	X	-	X	X	X
Heat Exchanger	B-3	-	-	X	-	X	-	X	X	X
RSW Pump	B-3	-	-	X	-	X	-	X	X	X
ANI										
Mobile Nitrogen Generator	B-3	-	-	X	-	X	-	X	X	X

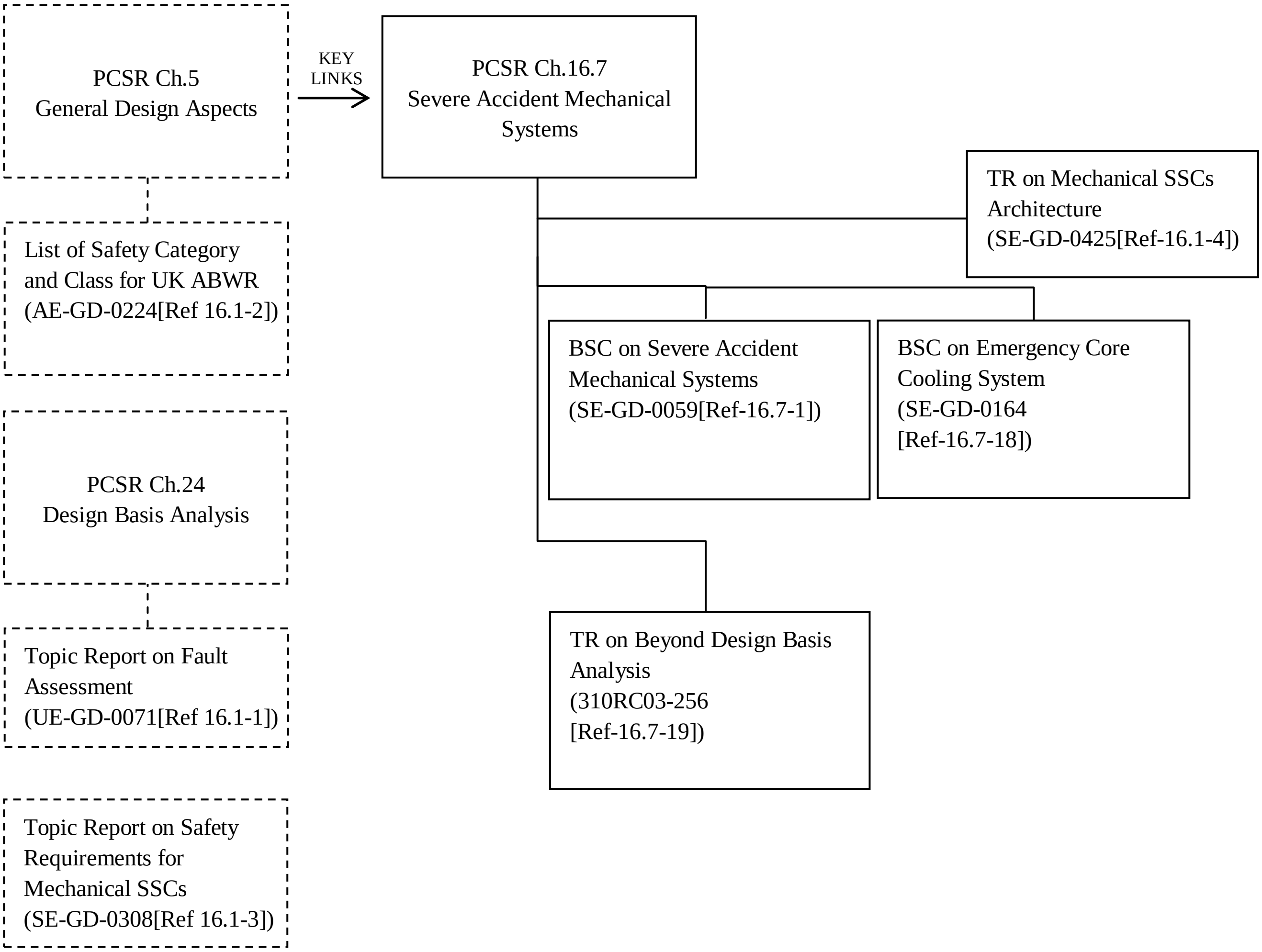
Appendix C: Document Map




PCSR Ch.5
General Design Aspects
List of Safety Category
and Class for UK ABWR
(AE-GD-0224[Ref 16.1-2])
KEY
LINKS
PCSR Ch.16.4
Process Auxiliary Systems
TR on Mechanical SSCs
Architecture
(SE-GD-0425[Ref-16.1-4])
PCSR Ch.24
Design Basis Analysis
Topic Report on Fault
Assessment
(UE-GD-0071[Ref 16.1-1])
Topic Report on Safety
Requirements for
Mechanical SSCs
(SE-GD-0308[Ref 16.1-3])


PCSR Ch.5
General Design Aspects
KEY
LINKS
PCSR Ch.16.5
Heating Ventilating and Air Conditioning System
TR on Mechanical SSCs Architecture (SE-GD-0425[Ref-16.1-4])
List of Safety Category and Class for UK ABWR (AE-GD-0224[Ref 16.1-2])
BSC on Heating Ventilating and Air Conditioning System (HPE-GD-H006 [Ref-16.5-1])
PCSR Ch.24
Design Basis Analysis
Topic Report on Fault Assessment (UE-GD-0071[Ref 16.1-1])
Topic Report on Safety Requirements for Mechanical SSCs (SE-GD-0308[Ref 16.1-3])


PCSR Ch.5
General Design Aspects
KEY LINKS
PCSR Ch.16.6
Other Auxiliary Systems
TR on Mechanical SSCs Architecture (SE-GD-0425[Ref-16.1-4])
List of Safety Category and Class for UK ABWR (AE-GD-0224[Ref 16.1-2])
BSC on Emergency Power Supply System (VDE-GD-0001[Ref-16.6-1])
BSC on Heating Ventilating and Air Conditioning System (HPE-GD-H006 [Ref-16.6-4])
PCSR Ch.24
Design Basis Analysis
Topic Report on Fault Assessment (UE-GD-0071[Ref 16.1-1])
TR on Departures from Conventional Fire Regulation (BKE-GD-0004[Ref-16.6-7])
Fire Protection System Basic Design Plan (BKD-GD-0002 [Ref-16.6-2])
Topic Report on Safety Requirements for Mechanical SSCs (SE-GD-0308[Ref 16.1-3])


PCSR Ch.5
General Design Aspects
KEY LINKS
PCSR Ch.16.7
Severe Accident Mechanical Systems
TR on Mechanical SSCs Architecture (SE-GD-0425[Ref-16.1-4])
List of Safety Category and Class for UK ABWR (AE-GD-0224[Ref 16.1-2])
BSC on Severe Accident Mechanical Systems (SE-GD-0059[Ref-16.7-1])
BSC on Emergency Core Cooling System (SE-GD-0164 [Ref-16.7-18])
PCSR Ch.24
Design Basis Analysis
Topic Report on Fault Assessment (UE-GD-0071[Ref 16.1-1])
TR on Beyond Design Basis Analysis (310RC03-256 [Ref-16.7-19])
Topic Report on Safety Requirements for Mechanical SSCs (SE-GD-0308[Ref 16.1-3])