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01	Integration of technical and co-applicant review comments	30-04-2008
02	PCSR June 2009 update including: - Text clarifications - Addition of references - Technical updates to account for December 2008 design freeze notably classification upgrade of some JPV valves (section 1.3), JAC-JPI function in PCC-3 events (section 1.3), and protection of several pumps (section 1.3).	30-06-2009
03	Consolidated Step 4 PCSR update: - Minor editorial changes - Clarification of text - Clarification of PCSR cross-references - Update and addition of references - New §1.6 “Door Control Measures” added - Information added regarding diesel protection and sequences associated with emergency and SBO diesel generators (§2) - Information added regarding alarms (§4.2.1)	31-03-2011
04	Consolidated PCSR update: - References listed under each numbered section or sub-section heading numbered [Ref-1], [Ref-2], [Ref-3], etc - Minor editorial changes - Update and addition of references - Sections 2.1 and 2.2 renumbered to start at sub-section 2.1.0 and 2.2.0	21-11-2012

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REVISION HISTORY (Cont'd)

Issue	Description	Date
04 cont'd	Consolidated PCSR update (cont'd): - Clarification of text: (§1.2, §1.2.0.3.3, §1.2.2, §1.2.4.2, §1.2.6, Section 9.5.1.2 – Table 1, §1.3, §1.4.0.3.1, §2.1.0.3.1, §2.2.0.3.1, §5.2.2, §5.2.4, §6.2, §6.2.3, §6.4, §6.7.1) - Correction of RCC-E reference (§2.1.0.2) - Update to reflect that SGH system is also seismically classified (§6.1.1.6, §6.6.3.6) - Correction of design pressure for SGN high pressure part (§6.4) - Summary of design changes to be implemented for the JAC/JPI systems added, with cross-reference to Sub-chapter 16.4 (§1.3)	

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SUB-CHAPTER 9.5 – OTHER SUPPORTING SYSTEMS

1. FIRE PROTECTION SYSTEMS AND EQUIPMENT

1.1. GENERAL COMMENTS

This section describes the active methods of fire control, detection and extinguishing together with the corresponding sub-chapters for other related systems such as the ventilation, smoke and heat extraction systems.

The concept of fire protection follows a 3-level principle of defence-in-depth:

- fire prevention (see Sub-chapter 13.2),
- fire zoning (see Sub-chapter 13.2),
- fire control.

1.2. FIRE DETECTION [REF-1] TO [REF-5]

The French identifier for the plant Fire Detection System [FDS] is JDT.

1.2.0. Safety requirements

1.2.0.1. Safety functions

The JDT [FDS] system is a support system. It does not directly perform safety functions, but it is linked to safety function.

In the event of a fire, the JDT [FDS] system is necessary to protect the classified systems, by detecting the start of a fire from its first indication and by signalling the location of the fire to the central fire control and detection panels. In certain cases the JDT [FDS] system sends out signals to activate automatic fire protection measures (fire dampers, anti-smoke doors, fire-fighting measures, etc.), so that fire-fighting may be implemented before serious damage is caused.

1.2.0.2. Functional criteria

The JDT [FDS] system must detect a fire as soon as there are any signs and inform a central unit.

The JDT [FDS] system must be capable of indicating where the fire started as well as identifying any smoke-filled zones (fire monitoring).

The JDT [FDS] system must be capable of initiating automatic actions when the analysis shows this is to be necessary.

The fire detection system must be arranged in detection zones compatible with the plant fire sectors.

1.2.0.3. Design requirements

1.2.0.3.1. Requirements resulting from safety classification

Safety classification

The JDT [FDS] system must be safety classified in conformance with the classification principles given in Sub-chapter 3.2. It is classified F2.

Single failure criterion

The single failure criterion is applied to active components supplying an F1 function in order to ensure a sufficient degree of redundancy.

Emergency electrical power supplies

The fire detection system must be connected to a backed-up electrical power supply.

Qualification under operating conditions

The equipment in the JDT [FDS] system must be qualified for its required functions.

Mechanical, electrical, instrumentation and control classifications

The mechanical, electrical and instrumentation and control classifications of the fire detection system must conform to the classification principles described in Sub-chapter 3.2.

Seismic classification

The seismic classification of the fire detection system must be in conformance with the classification principles described in Sub-chapter 3.2.

Periodic tests

Systems performing F2 classified functions, which do not operate continuously (such as a detection system which changes state when an alarm occurs), must be subjected to periodic testing in order to ensure a sufficient level of confidence in their availability.

1.2.0.3.2. Other regulatory requirements

The JDT [FDS] system must be designed in conformance with the EPR Technical Code for Fire Protection (ETC-F).

1.2.0.3.3. Hazards

Internal hazards

The Fire Detection System must be protected against the internal hazards specified in Sub-chapter 13.2.

External hazards

The Fire Detection System must be protected against the external hazards specified in Sub-chapter 13.1.

1.2.0.4. Tests

1.2.0.4.1. Pre-operational tests

The JDT [FDS] system is subjected to a test program after construction, and prior to fuel loading.

1.2.0.4.2. Monitoring during plant operation

The JDT [FDS] system must be subjected to a monitoring programme after construction.

The permanent auto control of the system must enable system malfunctions to be indicated and corrected.

1.2.0.4.3. Periodic tests

The classified sections of the system must be designed so that periodic tests can be carried out.

1.2.1. Role of the system

The JDT [FDS] system groups the equipment designed to continuously monitor the environment of the different locations in the plant, in order to automatically warn plant operators of the start of a fire as soon as possible.

1.2.2. Design basis

The fire detection system is composed of:

a) Fire detectors

The fire detectors are linked to detection centres and automatic alarms.

All fire detectors are permanently auto-controlled and any anomaly is shown in the fire detection centre.

b) Detection zones

The fire detection system is organised into detection zones. The detection zones are superimposed on the fire sectors or fire zones and, where they are installed, on smoke control sectors and sprinkler sectors fitted with a "flood” type manual or automatic installation controlled by the detection system.

c) Detection lines or detection loops

The detectors are linked electrically in such a way as to form electrical lines or loops, covering geographically designated zones.

d) Detection centres

The detection lines are linked to processing cabinets which create visual and audible alarms in the Control Room as well as providing the information required for the logical processing of the fire alarms by the plant instrumentation and control system.

An objective of the design of the fire detection system is to monitor the progress of the fire. The detection centres must be able to store and retrieve this information.

Each detection centre is fitted with its own backed up electrical power supply.

e) Operating Panels

The state of all detectors fitted with an automatic control device (fire alarms, malfunction alarms, etc.) and the control of the fire dampers and the automatic fire-fighting equipment are displayed on the fire processing panels and on the information and assistance system located in the Control Room.

1.2.3. Description of the system and characteristics of the equipment

Fire detectors

The type of detector at each location must be chosen with regard to the particular fire phenomena applicable to the equipment or location being monitored (temperature, flame, smoke, combustion gas, etc.) and to the specific conditions of its installation (accessibility, atmosphere: humidity, temperature, ionising radiation, corrosive or explosive gases and pressure at the location).

In general, smoke detectors are especially adapted to provide rapid detection.

Flame heat detectors or other special detectors are also used depending on the specific risks in the monitored location.

Manual fire warning provisions (push buttons alarms, telephones) must be specified on a case-by-case basis.

1.2.4. Operating conditions

1.2.4.1. Permanent operation

The fire detection system is operational on a continuous basis in order to detect a fire or to control it as quickly as possible.

Fire alarms are always available in the Control Room.

1.2.4.2. Transient operation

- Failure of the electrical power supply

If the main power supply fails, the fire detection system is backed up automatically by an auxiliary source. The unavailability of each power supply is indicated by an alarm in the Main Control Room.

- Loss of E2 and non-safety classified (NC) instrumentation and control

Measurements, functional alarms and orders sent to the Control Room via the instrumentation and the E2 and NC instrumentation and control system are unavailable. The alarms remain available on the operating panels in the Control Room.

1.2.5. Preliminary safety analysis

1.2.5.1. Conformance to the regulations

The JDT [FDS] system is designed and constructed in accordance with the regulations in force (see Sub-chapter 1.4).

1.2.5.2. Compliance with the functional criteria

The functional criteria given in sub-section 1.2.0.2 are identical to those applying to existing PWRs. There is therefore no design risk associated with special technological features.

In order to validate the installation, compliance with the criteria is demonstrated by “actual fire” tests in the various possible configurations of ventilation.

1.2.5.3. Compliance with the design requirements

1.2.5.3.1. Safety classification

The design and production of systems and equipment conforms to the requirements of the classification rules given in Sub-chapter 3.2.

1.2.5.3.2. Single Failure Criterion [SFC]

The single failure criterion is applied to active components supplying an F1 function in order to ensure a sufficient degree of redundancy.

1.2.5.3.3. Qualification

The equipment will be qualified for the design basis earthquake.

1.2.5.3.4. Instrumentation and control

The design of the instrumentation and control equipment conforms to the requirements of the classification rules given in Sub-chapter 3.2.

1.2.5.3.5. Back-up electrical power supplies

The equipment has, as its main source, a continuous back-up electrical supply, supplemented by an auxiliary source dedicated to the fire detection system.

1.2.5.3.6. Hazards

See Section 9.5.1.2 – Table 1.

1.2.6. Tests, inspection and maintenance

Periodic testing enables the following functions to be checked:

- transmission of the fire alarm signal,
- storage of the fire alarm signal,
- transmission of a malfunction alarm in the system.

The state of the system (alarms, malfunctions, etc.) is displayed on the fire detection panels in the detection centres and on the operating panels.

SECTION 9.5.1.2 - TABLE 1

Hazards Summary Table for the JDT [FDS] System

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
B Rupture of piping Failure of tanks, pumps and valves Internal missiles Dropped loads Internal explosion	No (except detection stations and operational fire panels)	Detection stations and operational fire panels installed in the electrical buildings	In the case of the loss of a division, the loss does not put the rest of the detection system in other divisions out of action
Fire	Yes	Fire zones	The outgoing and incoming runs of the detection loops use different fire zones or sectors (or use of cable CR1-C1 if installation is impossible)
Internal flooding	No (except detection stations and operational fire panels)	Detection stations and operational fire panels installed in the electrical buildings	In the case of the loss of a division, the loss does not put the rest of the detection system in other divisions out of action

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	-	Seismic qualification of the equipment
Aircraft crash	No (except operational fire panels)	Installation of operational fire panels in the protected electrical buildings	In the case of the loss of a division, the loss does not put the rest of the detection system in other divisions out of action
External explosion External flooding Snow and wind	No (except detection stations and operational fire panels)	Detection stations and operational fire panels installed in the electrical buildings	In the case of the loss of a division, the loss does not put the rest of the detection system in other divisions out of action
Extreme cold	Yes	Installation of equipment monitoring safety classified plant in adequately heated locations	-
Electromagnetic wave	No (except detection stations and operational fire panels)	Detection stations and operational fire panels installed in the electrical buildings	In the case of the loss of a division, the loss does not put the rest of the detection system in other divisions out of action

1.3. FIRE FIGHTING SYSTEMS [REF-1] TO [REF-21]

The systems involved in fire extinguishing are:

- the JAC : Classified system for the supply of fire-fighting water
- the JPD : Classified system for extinguishing fires in the non-classified electrical building, the turbine hall, the pumping station, the Operation Building and the site tunnels
- the JPH : System for extinguishing fires in the turbine hall oil tank
- the JPI [NIFPS] : Classified system for protection and distribution of fire-fighting water in the Nuclear Island, the safety classified site tunnels and the access building.
- the 8_JPI [NIFPS] : System for fire protection of the effluent treatment building
- the JPS : System for the distribution of fire-fighting water for the site
- the JPT : System for fire protection of the transformers
- the JPV : Classified system for fire protection for the diesels building.

This chapter deals only with the following safety classified systems, defined as support functions for fire protection of the Nuclear Island: JAC, JPI [NIFPS], JPV; as well as the JPD in the pumping station and JAC building for fire protection of the Conventional Island

Several design changes will be implemented for the JAC/JPI [NIFPS] systems as follows. In order to ensure water make-up in the event of gross failure of penetrations in the pools connected to the Spent Fuel Pool (SFP), the safety features performing the spent fuel pool make-up function will be upgraded from class 2 to class 1. In addition, the spent fuel pool make-up function and the ASG [EFWS] tank replenishing function of the fire fighting water building and JAC system will be redesigned with more redundant components. The safety features performing the spent fuel pool make up function will be segregated from the safety features providing the fire fighting function.

These design changes are not included in the description of the JAC/JPI [NIFPS] fire fighting water systems provided in this section. The incorporation of these design changes into the fuel pool safety case is described in Sub-chapter 16.4, and the design changes will be fully incorporated into this sub-chapter as part of the detailed design during the site licensing phase.

1.3.0. Safety requirements

This sub-section gives the general safety requirements for classified systems of fire extinguishing and supply of fire-fighting water (JAC, JPI [NIFPS], JPV, JPD).

1.3.0.1. Safety functions

The JAC, JPI [NIFPS] JPV and JPD fire-fighting systems are defined as support systems: they do not contribute directly to the three basic safety functions. However they must enable the three functions to be carried out (no single fire will make all the systems providing a safety function unavailable).

The JPI [NIFPS] must also provide the function of basic safety “containment of radioactive substances” via containment isolation valves. It contributes to the function of: “ensuring the integrity of the containment”.

The JAC contributes to the decay heat removal function by its capacity for storage for the re-supply of the ASG [EFWS] tanks.

In addition, the JAC and JPI [NIFPS] systems contribute to the decay heat removal function in case of the following situations:

- PCC-3 event “isolable piping failure on a system connected to the spent fuel pool” (see Sub-chapter 14.4). In this event, capacity for storage and pumping function of the JAC system are used for achieving water makeup to the fuel pool, through JPI [NIFPS] circuit.
- Hypothetical loss of the PTR [FPPS/FPCS] cooling system. In this case, the loss of water by evaporation or boiling in the spent fuel pool may be mitigated by water makeup from the JAC system through the JPI [NIFPS] circuit.

1.3.0.2. Functional criteria

The fire protection systems are designed so that in the event of a fire, the following requirements are met:

- a fire must not cause more than one set of redundant equipment in an F1 system to be lost,
- a fire must not compromise the habitability of the main Control Room. If the Main Control Room is inaccessible, access to the Remote Shutdown Station must be assured. Accessibility for local actions must also be ensured. This is applicable in case of a break in pipework carrying inflammable liquids or gas, only case where simultaneously there is a combustible material and an ignition source.

In addition, the containment isolation valves are in compliance with the requirements given in Sub-chapter 6.2.

The JAC and JPI [NIFPS] systems are designed so that in the PCC-3 and PCC-4 event “isolable piping failure on a system connected to the spent fuel pool”, the flow rate of the water supply to the pool allows restoration of the cooling system before reaching the maximum fuel pool water temperature considered in the studies (see Sub-chapter 14.4).

1.3.0.3. Design requirements

1.3.0.3.1. Requirements resulting from the safety classifications

Safety classifications

The JAC, JPI [NIFPS] JPV and JPD systems are safety classified in compliance with the classification given in Sub-chapter 3.2.

The function of maintenance of pressure in the JAC system is not classified since it is not part of the classified function of production and distribution of water.

Single failure criterion (active and passive)

Only the following components, which are classified F1 meet the single failure criterion:

- JPI [NIFPS] containment penetrations,
- Pumps, pipes and valves of the JAC and JPI [NIFPS] systems which provide water makeup to the spent fuel pool.

Emergency electrical power supplies

The power supply to components with an F1 function are backed up so that they continue to function if external electrical power is lost.

Qualification under operating conditions

The components of the JAC, JPI [NIFPS] JPV and JPD systems are qualified to satisfy their classified role in the environmental conditions to which they are subjected.

Mechanical, electrical and Instrument and Control classifications

These conform to the requirements of Sub-chapter 3.2.

Seismic classification

These conform to the requirements of Sub-chapter 3.2.

Periodic tests

It must be possible to carry out periodic tests on the classified parts of the system.

The periodic tests and checks must be carried out in conformance with the operational boundary conditions given in the Operational Technical Specifications.

The periodic tests must enable checks to be made that the data used in the safety studies are consistent with the installed performance of the systems.

The layout and design of the equipment in the safety classified fire-fighting system must enable easy access in order to carry out periodic tests.

1.3.0.3.2. Other regulatory requirements

Technical Guidelines:

Conformance to the Technical Guidelines is specified in Sub-chapter 3.1.

In particular, the JAC, JPI [NIFPS] JPV and JPD systems are in conformance with guideline 6.1.2.3.

1.3.0.3.3. Hazards

Internal hazards

The equipment of the JAC, JPI [NIFPS], JPV and JPD systems must be protected in accordance with the specific rules for each hazard, against the internal hazards specified in Sub-chapter 13.2 and in Section 9.5.1.3 - Tables 1, 2, 3 and 4.

The JAC, JPI [NIFPS], JPV and JPD systems contribute to the protection of the installation against fire.

External hazards

The equipment of the JAC, JPI [NIFPS], JPV and JPD systems must be protected in accordance with the specific rules for each hazard, against the external hazards specified in Sub-chapter 13.1 and in Section 9.5.1.3 - Tables 1, 2, 3 and 4.

1.3.1. Role of the systems

The JAC, JPI [NIFPS], JPV and JPD systems do not have an operational role during normal operation of the reactor.

The fire-fighting systems manage the equipment involved in fire protection such as:

- the production of water,
- the distribution of water,
- the extinguishing of fires.

The fire water tanks also participate in the function of re-supplying the ASG [ESWS] tanks: see Sub-chapter 6.6 and sub-section 1.3.3.1 within this sub-chapter below.

The fire water tanks, the pumps and pipes connected to the spent fuel pool also participate in the function of water makeup, in case of drainage of the spent fuel pool.

1.3.2. Design basis

<u>General design assumption</u>

Overall, the fire-fighting water systems comprise:

- water reserves and fire pumps (integral parts of the Conventional Island),
- fire-fighting water supply (integral part of the Conventional Island),
- pressurisation equipment which maintains the pressure in the fire-fighting systems in the standby state when the system is operational,
- the main underground distribution network (integral part of the Conventional Island),
- the external fire points (integral part of the Conventional Island),

- the Fire Hose Stations (integral part of the Conventional or Nuclear Island),
- The standpipes.

Assumptions in the mechanical diagram

The storage, pumping and pressurisation of the fire-fighting water are provided by the JAC system which is not part of the Nuclear Island.

The fire-fighting system in the Nuclear Island buildings comprises standpipes including fire hose stations as well as valve units required for the different fixed sprinkler systems.

The JPI [NIFPS] and JPV systems are not strictly redundant and are made up of a single train. However, the interconnections and the existence of numerous sectioning valves must enable any point in the fire circuit to be supplied by at least two different routes (see Section 9.5.1.3 - Figure 1)

The JPI [NIFPS] system supplies the following buildings with fire-fighting water:

- the reactor building,
- the fuel building,
- the nuclear auxiliary building,
- the safeguard buildings (divisions 1 to 4),
- the access building.

Because of the presence of electrical safety links, the SEC [ESWS] tunnels and diesels (safety classified tunnels) are also protected by the JPI [NIFPS].

The diesel buildings are provided with fire-fighting water by the JPV system.

1.3.3. Description and characteristics of the equipment

1.3.3.1. General Description of the Systems

Circuits for the production of water

The JAC circuit produces and distributes fire-fighting water to JPI [NIFPS] and JPV at a pressure of 12 barg at the site platform. The JPI [NIFPS] supplies the JPV with fire-fighting water at Divisions 2 and 3 of the diesel buildings from the safeguard buildings 2 and 3.

The JAC circuit is composed of two redundant reserves of demineralised water and four fire pumps each supplying 100% of the requirement for the most demanding fire in the Nuclear Island. Note: two pumps are necessary for the most demanding requirement of the site which is located outside the Nuclear Island (site reference fire).

The pumps can use either of the water reserves and discharge into a common collector which can be isolated into two parts and assures the supply to the safeguard buildings 1 and 4 as well as diesels D1 and D4, thus providing a looped supply for the Nuclear Island and the diesels. Each pump is fed from a different electrical train.

The capacity of the first demineralised water tank (1000 m^3) provides fire-fighting water in the following two situations:

- sprinkling for 2 hours during the most demanding fire on site, together with two fire nozzles connected to the site fire hydrants.
- sprinkling for 2 hours during the most demanding fire in the Nuclear Island together with two fire nozzles connected to fire hose stations, associated with water make-up of the spent fuel pool requiring a volume of 330 m^3 (water supply to the fuel pool during more than 2 hours with a flow rate of 150 m^3/h).

The capacity of the second water tank (approximately 2600 m^3) enables the quantity of water needed for the function of re-supplying the ASG [ESWS] tanks to be ensured (volume much higher than the needed volume of fire-fighting water). The pumping and distribution for this function are carried out by the ASG [EFWS] function (Sub-chapter 6.6). The use of this reserve by the ASG [EFWS] is assumed only in a Risk Reduction Category (RRC) accident. The second tank is used for fire-fighting water when the first is not available.

The JAC pumps are started automatically on a reduction of pressure in the network or from the Main Control Room or locally.

The JPI [NIFPS] and JPV circuits are maintained permanently under pressure (stand-by pressure) by the pressurisation system of the JAC circuit (this pressurisation system is currently being developed). Since this function does not participate directly in fire-fighting, it is not classified.

Since the JAC system also supplies the conventional part of installations not classified for earthquakes, this part can be isolated from the classified part F2 – SC1 by two seismically designed valves (random failure criterion).

Circuits for the distribution of water

The circuits for the distribution of water are composed of:

- the headers for the main network,
- the standpipes,
- the fire points.

Components of fire extinguishing

In accordance with the requirements (section 7 of Sub-chapter 13.2), the components for extinguishing fires are made up of:

- fire hose stations,
- water pipes (“sprinkler” type),
- dry pipes (“flood” type”).

The Fire Hose Stations

The Fire Hose Stations (FHS) are, in addition to the mobile equipment, fixed first line installations for fire fighting.

All levels of the buildings in the Nuclear Island (NI) and in the pumping station must be equipped with a sufficient number of FHS linked to the internal water distribution circuit such that it is possible to reach any equipment in any room with a water nozzle, even if the room is fitted with sprinkler pipes. The area of each zone or sector must be reachable by an FHS (Sub-chapter 3.1).

The water pipes (sprinkler type),

Water pipes fitted with fusible heads known as “sprinklers”, activated by a rise in temperature, provide fixed and automatic protection. The sprinklers are activated by a temperature at least 28°C higher than the maximum ambient temperature of the protected rooms. This fire protection is used for:

- The safeguard building / electrical building cable decks (JPI [NIFPS]),
- The cable trays or cable concentrations in Nuclear Island locations (outside the containment) (JPI [NIFPS]),
- The SEC [ESWS] and diesels cable tunnels (JPI [NIFPS]).

Downstream of each isolation valve in these sprinkler pipes is a flow detector for inadvertent operation or a system leak. The sensitivity of the detectors matches the use of at least one sprinkler.

The dry pipes (flood type),

These pipes are empty of water and fitted with open sprayers, with a glass bulb or fusible link.

Using a remote control valve, they enable the primary and RBS [EBS] pumps to be sprinkled (JPI [NIFPS]).

Using a manual valve or a solenoid, they enable sprinkling:

- of the diesel generators (JPV)
- of the fuel tank rooms (JPV)

The JPI [NIFPS] system

This system plays a part in the protection of the Nuclear Island buildings against fire (sub-section 1.3.2).

This system also contributes to the fuel pool water makeup via the JAC system.

The reactor building

Protection of the annulus is provided by column mounted fire hose stations supplied with water by the JPI [NIFPS] and is capable of being isolated by a manual valve located outside the reactor building.

A second level of protection of the annulus is provided by water pipes fitted with sprinklers to enable the main electrical cabling axes to be sprinkled.

Fire protection for each primary pump is provided by a fixed spray-water extinguishing system of the flood type.

The iodine filters in the reactor building ventilation system (EVF) are protected by a connection from the sprinkler pipe to the fire hose station located close by. The containment is protected by a network of fire hose stations connected to dry risers, which can be connected to the water supply of the JPI [NIFPS] via two redundant lines (application of the single failure criterion in fire verification studies).

Each of these lines contains two motorised valves and a check valve connected in series. One valve is located inside the containment and the other outside, both as close to the containment as possible.

The fuel building,

Protection of the fuel building is ensured by fire hose stations mounted on water risers supplied by the JPI [NIFPS].

The RBS [EBS] pumps are fire protected by a fixed spray-water extinguishing system of the flood type.

The iodine filters in the Nuclear Auxiliary Building Ventilation System (DWL [CSBVS]), Annulus Ventilation System (EDE [AVS]) and Containment Sweep Ventilation System (EBA [CSVS]) ventilation systems are protected by a connection of the sprinkler pipe to the fire hose station located close by.

The fuel pool is comprised of water made up by two JPI [NIFPS] pipes coming from safeguard buildings 1 and 4. The motorised valves used for the function are set in safeguard buildings 1 and 4.

The nuclear auxiliary building

Protection of the nuclear auxiliary building is provided by fire hose stations on standpipes linked to the JPI [NIFPS] network. The fire hose stations are located on all levels and are easily visible from the main accesses. They enable all points of the nuclear auxiliary building to be reached.

The iodine filters in the DWN [NABVS] ventilation system are protected by connection of the sprinkler pipe to the fire hose station located close by.

The safeguard buildings

Protection of the four safeguard building / electrical building divisions is provided by fire hose stations mounted on water risers supplied by JPI [NIFPS]. The iodine filters in the Control Room Air Conditioning System (DCL [CRACS]) are protected by a connection of the sprinkler pipe to the fire hose station located close by. These pipes are activated manually.

A fixed type protection sprinkler enables the safeguard building / electrical building - nuclear auxiliary building, safeguard building/ electrical building - pumping station, safeguard building/ electrical building - diesels cable routes as well as the electrical equipment maintaining safety functions to be sprinkled.

Two pipes (set in safeguard buildings 1 and 4) are used for the fuel pool water makeup function. A motorised valve that is opened if it is needed equips each line. Otherwise, a motorised valve is also set on the main JPI [NIFPS] pipes at the entrance of safeguard buildings 1 and 4 to separate the fire fighting and the water makeup functions.

In case of accidental draining of the spent fuel pool, one side (safeguard building 1 for example) is used to ensure the fuel pool water makeup and the other side (safeguard building 4 for example) is used to achieve the fire fighting protection.

The access building

Protection of the access building is ensured by fire hose stations on standpipes linked to the JPI [NIFPS] network. The fire hose stations are located on all levels and are easily visible from the main accesses. They enable all points of the access building to be reached.

SEC [ESWS] and diesels tunnels

The SEC [ESWS] and diesels tunnels are fitted with sprinkler pipes to protect the cabling axes.

All locations

Portable CO2, powder or water extinguishers can be used according to the location.

Protection of the pumps (except primary pumps) will be carried out if the heat potential is judged to be too high. At the current stage of studies, nothing has been decided.

The JPV system

The diesel generators (diesel hall and day supply tank)

Protection for these locations is provided by a fixed installation with spray water containing 1% Floating Film Forming Agent (FFFA) with sprinklers using glass bulbs or fusible links.

The fuel tank room

Protection of the fuel tanks is provided by a network fitted with flood type open sprayers. The sprayed water contains 1% FFFA.

The electrical rooms

Protection is primarily provided by extinguishers. If necessary, the fire hose station located in the stair well of the diesel building is also used.

The diesel buildings are also protected by fire hose stations mounted on water risers.

The two isolation valves between the JAC and the JPV pipes contribute to the spent fuel pool water makeup function because these valves must be closed if the JAC is used to realise this mission. Only one side is isolated (JAC 1 or 4).

The JPD system

The pumping station

Protection for the four divisions is provided by water pipes associated with Fire Hose Stations. Areas with specific risks (cables, lubrication device for the CRF pumps) are protected by “sprinklers”.

The JAC building :

Protection for these locations is provided by water pipes associated with Fire Hose Stations.

1.3.4. Operating conditions

1.3.4.1. Permanent operation

The JAC, JPI [NIFPS] JPV and JPD systems are on standby. The containment isolation valves are closed. The JPI [NIFPS] network is filled with water and maintained under pressure (except for the part inside the containment) as well as the JPD network. The sprinkler pipe connections for spray to the iodine filters are empty of water.

The JPV system contains no water at the level of deluge and sprinkler sprays.

1.3.4.2. Transient operation

A fire may occur during power operation or shutdown states:

- **On equipment or in common locations in the Nuclear Island (JPI [NIFPS])**

An alarm occurs in the Main Control Room and the operator calls out the response team. As a general rule the fire can be fought by the use of one or several fire hose stations.

- **On the ducting of the cables of the Nuclear Island (except inside containment) (JPI [NIFPS])**

In standby mode, these pipes contain water. The operation of sprinkling is automatic: system shutdown is performed by closing the isolation valve locally.

- **Inside the containment except primary pumps (JPI [NIFPS])**

The network on standby does not contain water. The JPI [NIFPS] network is activated by remote control of the containment isolation valves.

- **At the level of primary pumps (JPI [NIFPS])**

A fixed spray water extinguishing system of flood type controlled from the Main Control Room or locally, provides fire protection for each pump.

The water supply is then activated by remote control of the containment isolation valves.

- **At the level of RBS [EBS] pumps (JPI [NIFPS])**

A fixed spray water extinguishing system of flood type controlled from the Main Control Room or locally, provides fire protection for each pump.

The water supply is then activated by remote control of the containment isolation valves.

- **In the diesel buildings (JPV)**

Protection of the diesel rooms and day tanks is provided by flood type pipes with fusible glass bulbs (the temperature must be at least 28°C higher than the maximum ambient temperature of the protected rooms).

Protection of the fuel tank is ensured by flood type pipes with open sprayers.

The pipes do not contain water during standby. The water is supplied by opening the flood valve either automatically when a fire is detected, or manually. Spraying is stopped manually by closing one of the isolation valves.

In every case, the fall in pressure in the fire-fighting network caused by a protective system being opened automatically or manually, causes the fire pumps to start automatically.

- **In the pumping station (JPD)**

Protection of the area with specific risks (cables, lubrication device for the CRF pumps) is provided by flood type pipes with fusible glass bulbs (the temperature must be at least 28°C higher than the maximum ambient temperature of the protected rooms).

1.3.4.2.1. In case of drainage of the spent fuel pool

Water makeup is realised by the JAC via the JPI [NIFPS] system: on a spent fuel pool low-level signal, the JAC pumps are started manually and one part of the JPI [NIFPS] is used for the water makeup (for example, the valve JPI1505VD is manually opened, the valve JPI1401VD at the entrance of safeguard building 1 and the valve JPV7210VD at the entrance of the diesel 1 are manually closed).

The other parts of the JPI [NIFPS] and JPV are required for fire protection (valve JPI4505VD stays closed and valves JPI4433VD and JPV8210VD remain open)

1.3.4.2.2. In case of an earthquake

That part of the JPI [NIFPS] which is not seismically classified is isolated from the main control room: the JPI [NIFPS] valves set on the connection with the access building and the Nuclear Auxiliary Building are manually closed.

1.3.5. Preliminary safety analysis

1.3.5.1. Conformance to the regulations

The systems are designed and constructed in accordance with the regulations in force (see Sub-chapter 1.4).

1.3.5.2. Compliance with the operating criteria

The JPI [NIFPS] JPV and JPD systems play a part in protecting the plant against fire. This protection is provided by the distribution of fire-fighting water inside the buildings of the Nuclear Island, the diesel buildings and the pumping station and the JAC building.

If a fire damper fails, common mode protection is provided by the fire protection systems sprinkling in the buildings protected by these JPI [NIFPS] and JPV systems. Nevertheless, the safety functions should be ensured by passive measures as compartmentalization (safety compartments).The JPI [NIFPS] also provides the function of basic safety “containment of radioactive substances” via containment isolation valves. The containment isolation function and its requirements are described in Sub-chapter 6.2.

Otherwise, the JAC and the JPI [NIFPS] contribute to the decay heat removal function in case of the PCC-3 event “isolable piping failure on a system connected to the spent fuel pool” (see Sub-chapter 14.4). In this event, the water makeup of the spent fuel pool by JAC/JPI [NIFPS] allows restoration of the cooling system before reaching the maximum fuel pool water temperature considered in the studies.

1.3.5.3. Compliance with the design requirements

1.3.5.3.1. Safety classification

The conformance of the design and production of systems and equipment to the requirements resulting from the classification rules is given in Sub-chapter 3.2.

1.3.5.3.2. Single Failure Criterion (SFC) or “Redundancy”

The JAC fire pumps that contribute to the spent fuel pool water makeup are supplied with power from four different electrical trains.

The JPI [NIFPS] containment isolation valves and the JPI [NIFPS] and JPV valves that contribute to the spent fuel pool water makeup are supplied with power from two different electrical trains.

The production of classified fire-fighting water is provided by redundant tanks and pumping systems (sub-section 1.3.3.1) and the supply for the Nuclear Island is provided by redundant supply pipes.

1.3.5.3.3. Qualification

The equipment is qualified in conformance with the requirements described in Sub-chapter 3.7.

1.3.5.3.4. Instrumentation and control

The conformance of the design and production of instrumentation and control to the requirements resulting from the classification rules is given in Sub-chapter 3.2.

1.3.5.3.5. Emergency power supplies

The JPI [NIFPS] containment isolation valves and the JPI [NIFPS] and JPV valves that participate in the spent fuel pool water makeup are F1 classified. Consequently, they have an emergency electrical supply. The actuators on these valves are backed up by the main diesels.

The power supplies to the fire-fighting pumps are backed up by the main diesels in order to ensure the availability of the system for producing fire-fighting water if external power supplies are lost.

1.3.5.3.6. Hazards

Section 9.5.1.3 - Tables 1 to 4 take into account the inclusion of hazards for the JPI [NIFPS], JPV JAC and JPD systems. The containment isolation valves are not discussed here (see Sub-chapter 6.2).

Summary charts for the JPI [NIFPS]: see Section 9.5.1.3 - Table 1

Summary charts for the JPV: see Section 9.5.1.3 - Table 2

Summary charts for the JAC: see Section 9.5.1.3 - Table 3

Summary charts for the JPD: see Section 9.5.1.3 - Table 4

1.3.5.4. Tests

1.3.5.4.1. Periodic tests

The JAC, JPI [NIFPS], JPV and JPD systems are the subject of periodic tests in order to check the operation of equipment. The fire-fighting equipment subject to controls or periodic tests are the fire hose stations, the fixed systems for extinguishing fires and the fire-fighting water production and networks (section 7 of Sub-chapter 13.2).

The minimal flow rate used to provide the fuel pool water makeup by the JAC-JPI [NIFPS] must be controlled.

1.3.5.4.2. Test, inspection and maintenance

<u>Test and inspection</u>

The start-up tests demonstrate that the functional characteristics of the system correspond to the design.

<u>Maintenance</u>

The JAC network is capable of being maintained while the plant is in operation; it must be operational in the plant shutdown states as well as when the plant is operating. However, taking into account the use of the fire-fighting water reserves and for re-supplying the ASG [EFWS], they can only be maintained during shut-down when the ASG [EFWS] is not required.

The JPI [NIFPS] outside the containment can be maintained during plant operation.

The JPV and JPD are accessible during all plant operating states in order to carry out maintenance.

1.3.6. Functional diagrams for the JPI [NIFPS] and JPV systems

See Section 9.5.1.3 - Figure 1 to Figure 12.

SECTION 9.5.1.3 - TABLE 1

Hazards summary table for the JPI [NIFPS] system

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Rupture of piping	Yes. Only one building must be affected.	Installation in the safeguard /electrical buildings and the reactor building	Isolation valves between each building
Failure of tanks, pumps and valves			
Internal missiles			
Dropped loads			
Internal explosion			
Fire	Yes	Installation in the safeguard /electrical buildings and the reactor building Fire sectors	Designed to function in case of a fire
Internal flooding	Yes. Only one building must be affected.	Installation in the safeguard /electrical buildings and the reactor building	Isolation valves between each building

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes (excepted for the part in the Nuclear Auxiliary Building and the Access Building = seismic NC)	Installation in the safeguard /electrical buildings and the reactor building	Seismic design Isolation valves between each building
Aircraft crash			Isolation valves between each building
External explosion			Isolation valves between each building
External flooding			Isolation valves between each building
Snow and wind			-
Extreme cold			-
Electromagnetic wave			-

SECTION 9.5.1.3 - TABLE 2

Hazards summary table for the JPV system

Internal hazards	**Protection requirement**	**General protection**	**Specific protection introduced in the design of the system**
Rupture of piping	NA	-	-
Failure of tanks, pumps and valves	NA	-	-
Internal missiles	Yes. Only one diesel division must be affected.	Installation in the diesel buildings	Isolation valves between each of the diesel divisions
Dropped loads	NA	-	-
Internal explosion	NA	-	-
Fire	Yes	Installation in the diesel buildings Fire sectors	Designed to function in case of fire
Internal flooding	Yes. Only one diesel division must be affected.	Installation in the diesel buildings	Isolation valves between each of the diesel divisions

External hazards	**Protection requirement**	**General protection**	**Specific protection introduced in the design of the system**
Earthquake	Yes	Installation in the diesel buildings	-
Aircraft crash			-
External explosion			-
External flooding			-
Snow and wind			-
Extreme cold			-
Electromagnetic wave			-

SECTION 9.5.1.3 - TABLE 3

Hazards summary table for the JAC system

Internal hazards	Protection requirement	General protection	Specific protection introduced in the design of the system
Rupture of piping	Yes	Mechanical classification of the equipment	No
Failure of tanks, pumps and valves	Yes		
Internal missiles	Yes	Installation in protected civil engineering structures	
Dropped loads	Yes		
Internal explosion	Yes		
Fire	Yes	Fire Sectors	Designed to operate in case of fire
Internal flooding	Yes	-	-Only one train must be affected

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	Yes. SC1 classification and installation in seismic civil engineering structure	No
Aircraft crash	Yes	Yes. Installation in protected or physically separated civil engineering structures	No
External explosion	NA	-	-
External flooding	Yes	Yes. Installation in protected civil engineering structures	No
Snow and wind	NA	-	-
Extreme cold	Yes	Yes. Installation in protected civil engineering structures	No (*:to be confirmed)
Electromagnetic wave	NA	-	-

SECTION 9.5.1.3 - TABLE 4

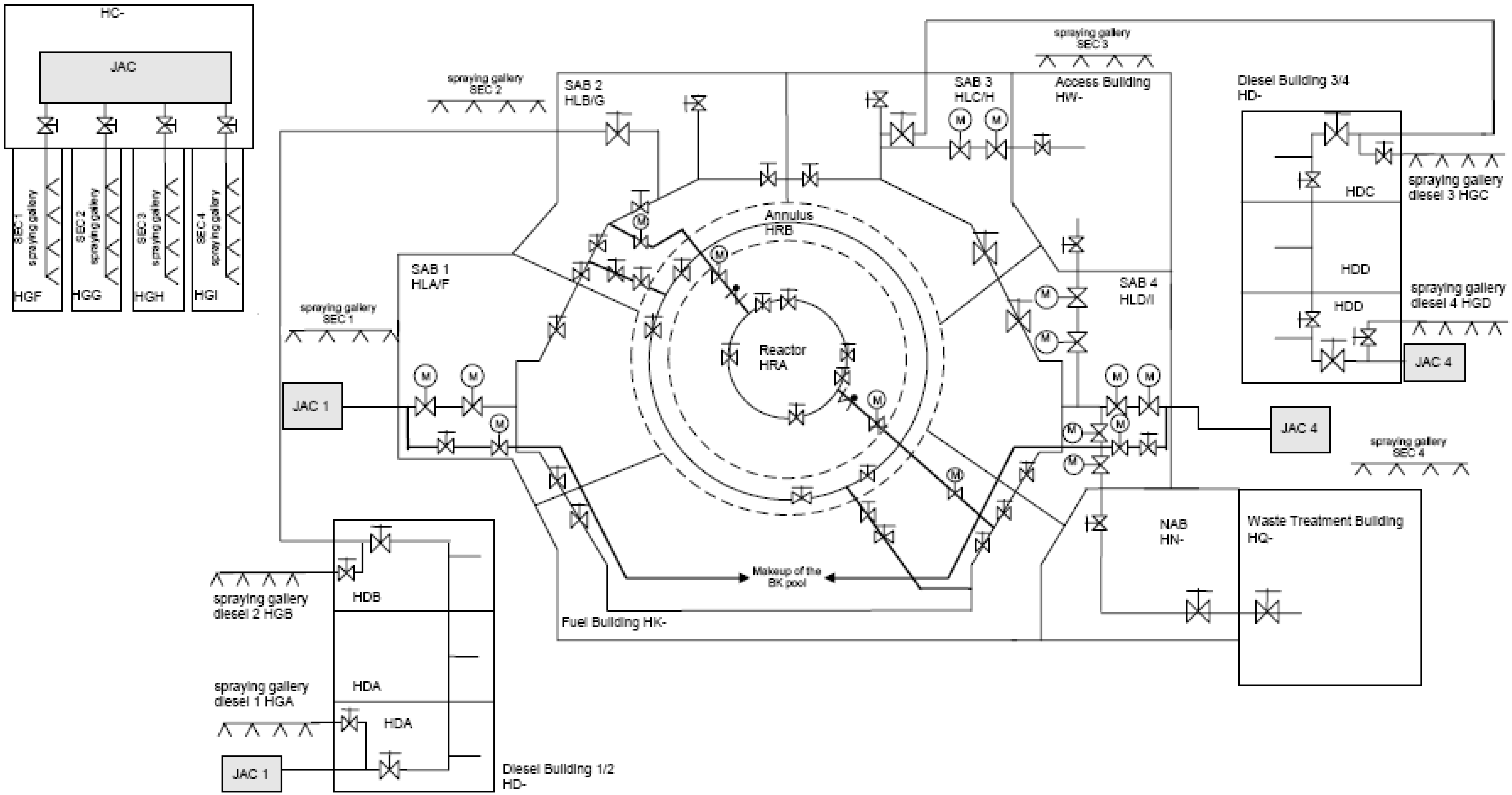
Hazards summary table for the JPD system

Internal hazards	Protection requirement	General protection	Specific protection introduced in the design of the system
Rupture of piping	NA	-	-
Failure of tanks, pumps and valves	NA	-	-
Internal missiles	NA	-	-
Dropped loads	NA	-	-
Internal explosion	NA	-	-
Fire	Yes	Fire sectors	Designed to function in case of fire
Internal flooding	NA.	-	-

External hazards	Protection requirement	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	Installation in protected civil engineering structures	-
Aircraft crash			-
External explosion			-
External flooding			-
Snow and wind			-
Extreme cold			-
Electromagnetic wave			-

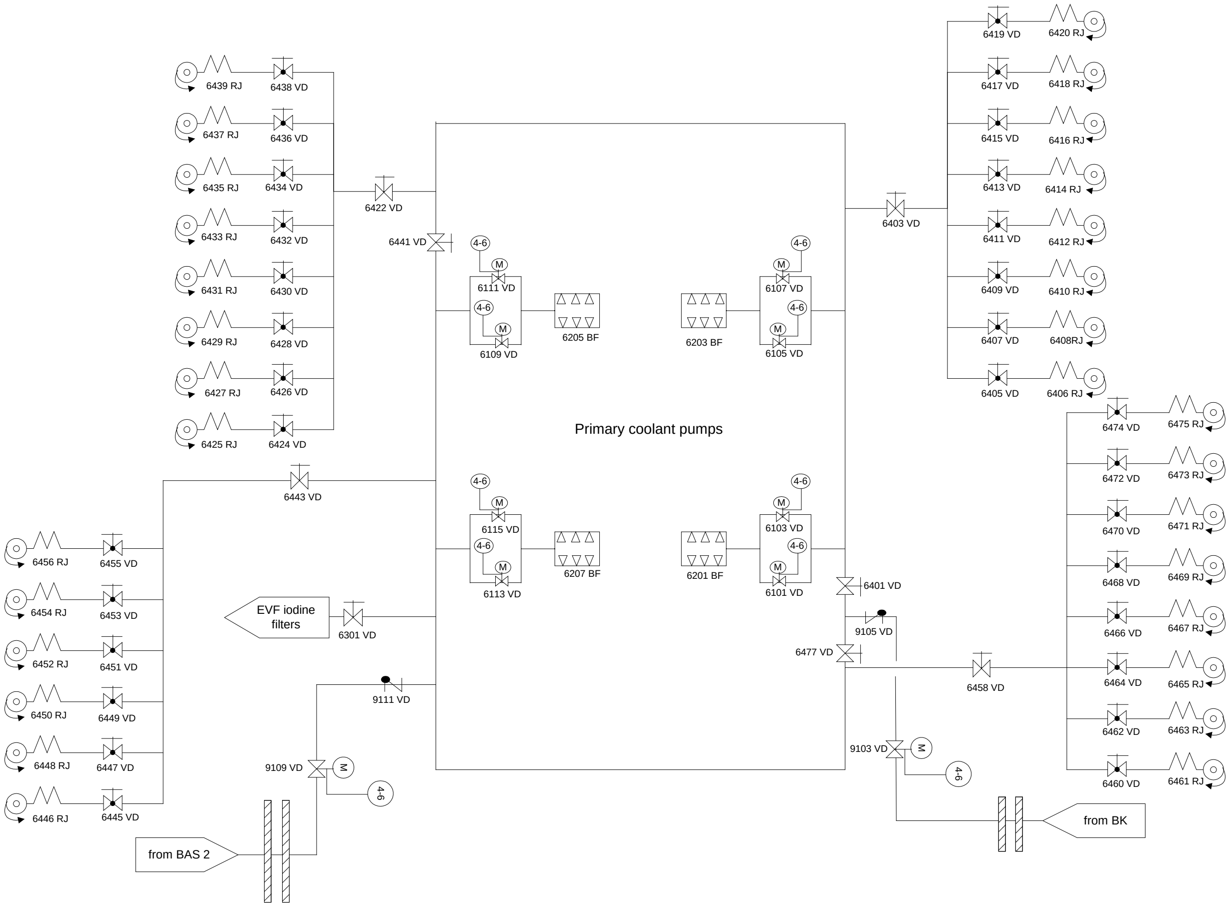
SECTION 9.5.1.3 - FIGURE 1 [REF-1]

General JPI [NIFPS]/JPV diagram



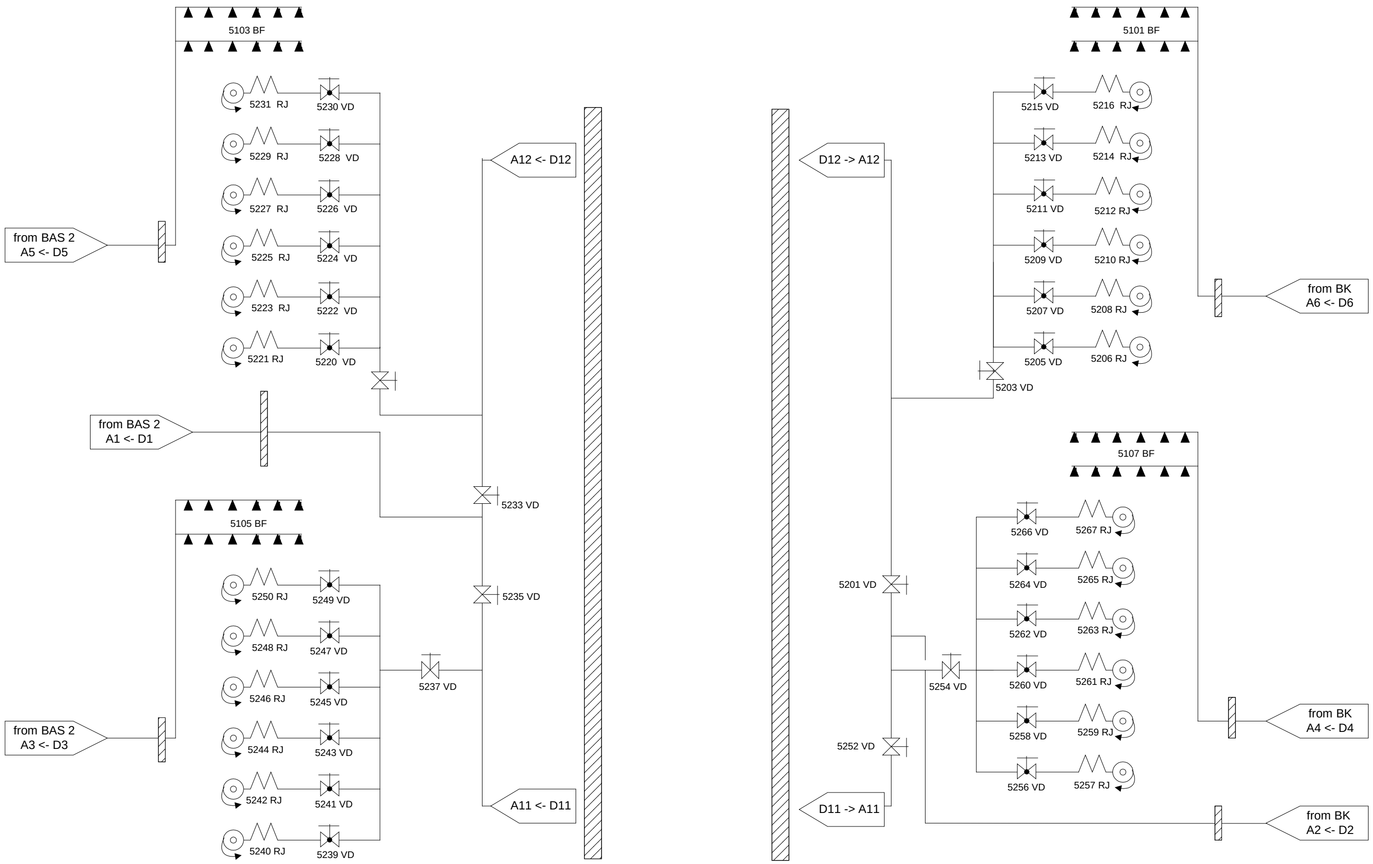
SECTION 9.5.1.3 - FIGURE 2 [REF-1] [REF-2]

Functional diagram for the containment volume of the reactor building



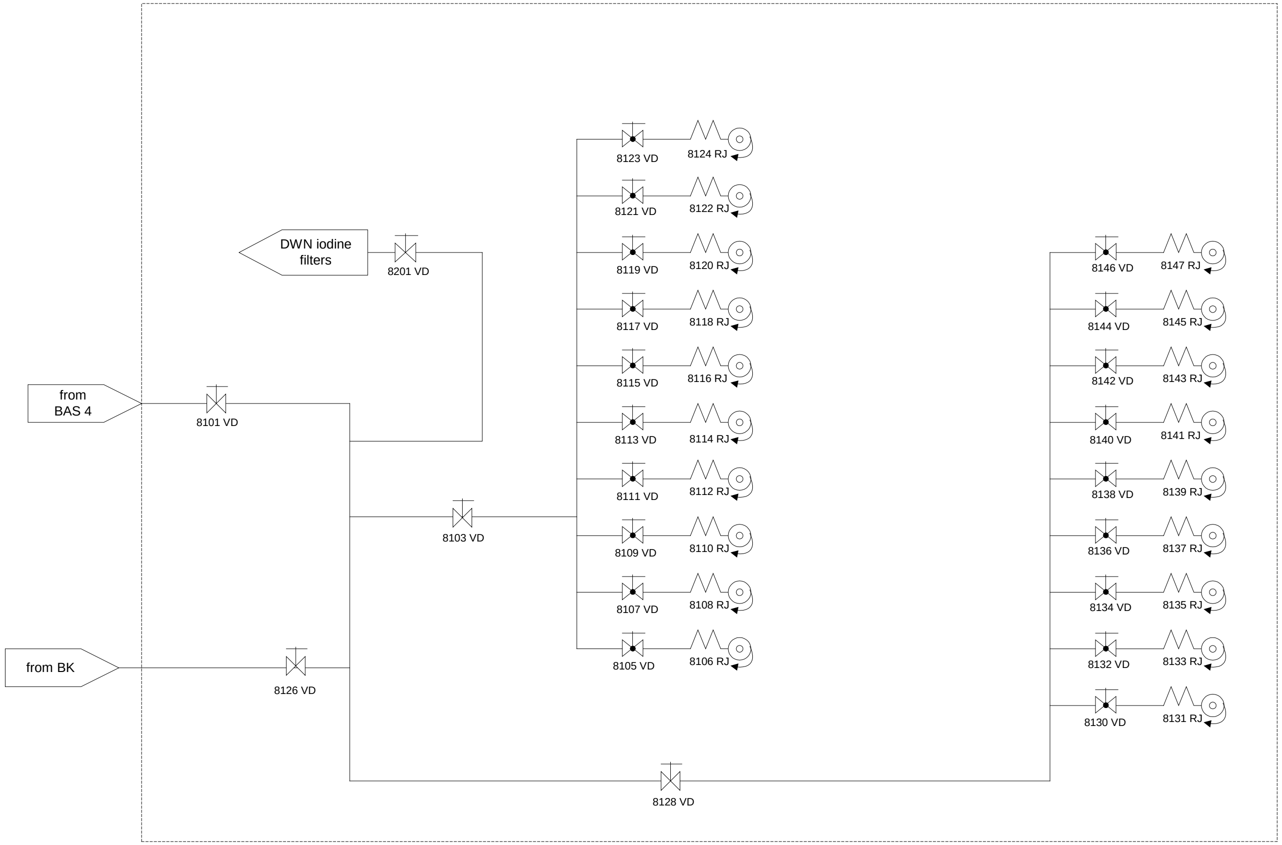
SECTION 9.5.1.3 - FIGURE 3 [REF-1] [REF-2]

Functional diagram of the JPI [NIFPS] for the space between reactor building enclosures



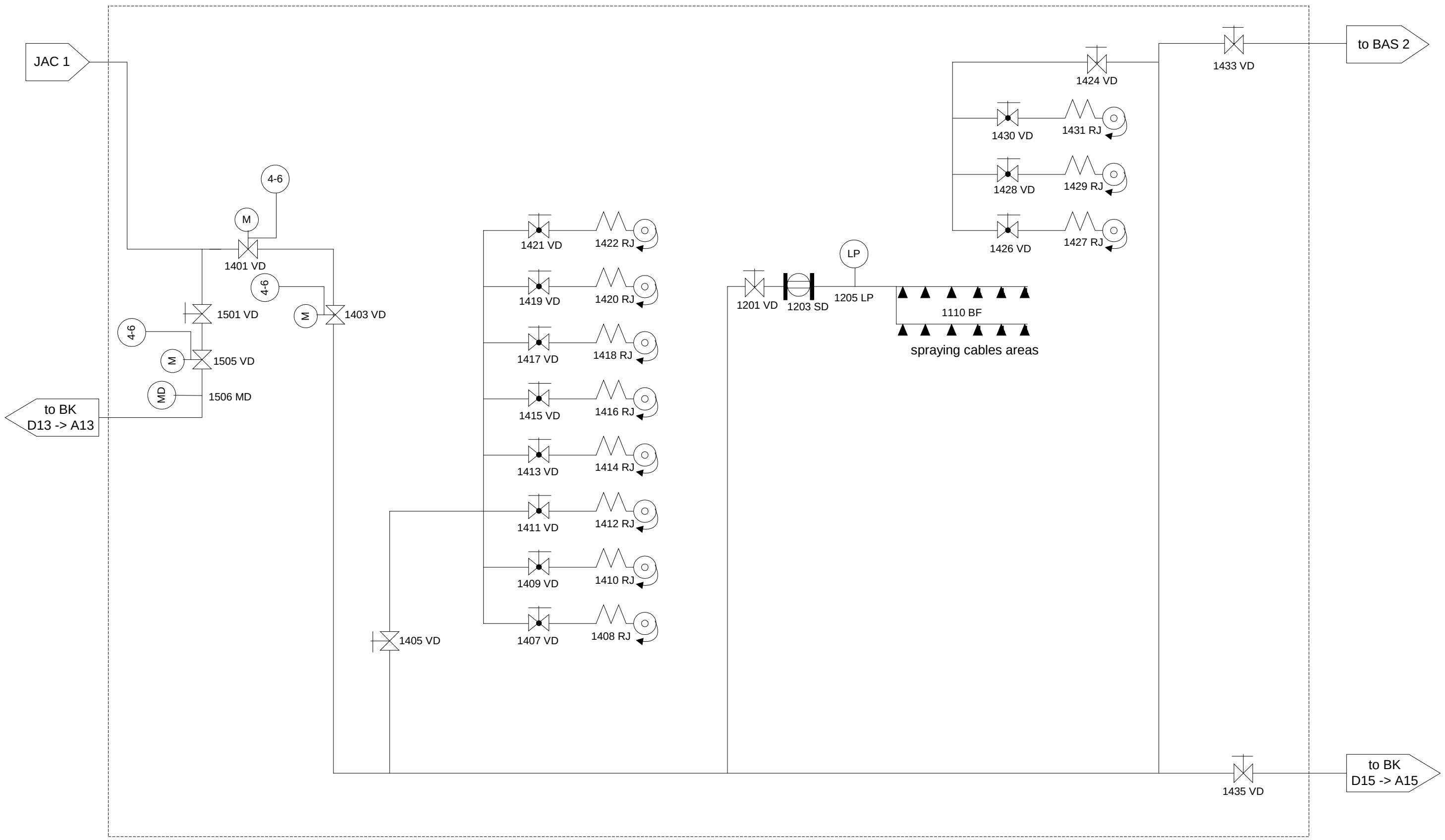
SECTION 9.5.1.3 - FIGURE 4 [REF-1] [REF-2]

Functional diagram of the JPI [NIFPS] for the nuclear auxiliary building



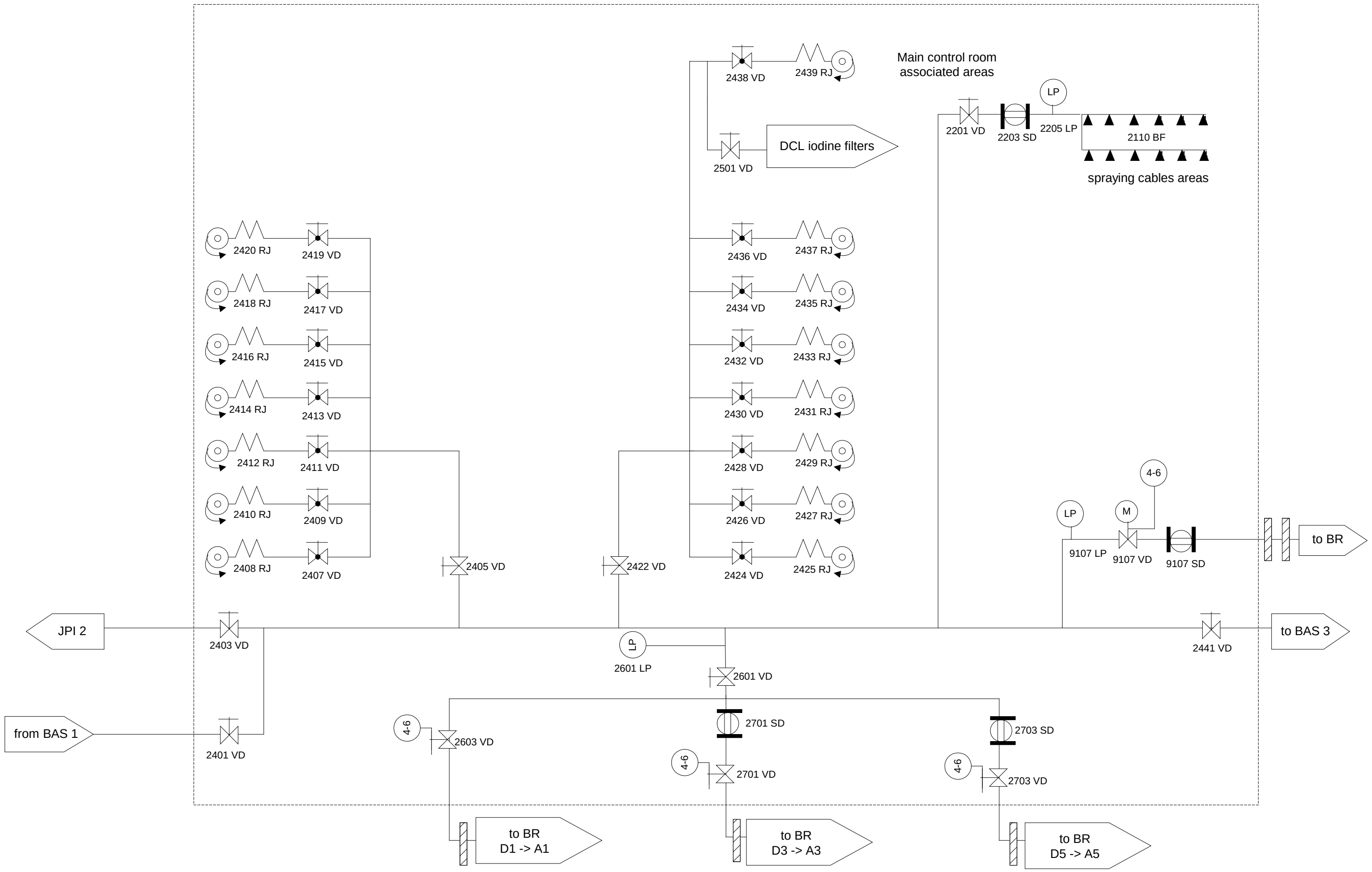
SECTION 9.5.1.3 - FIGURE 5 [REF-1] [REF-2]

Functional diagram of the JPI [NIFPS] for the Safeguard/ Electrical Buildings 1



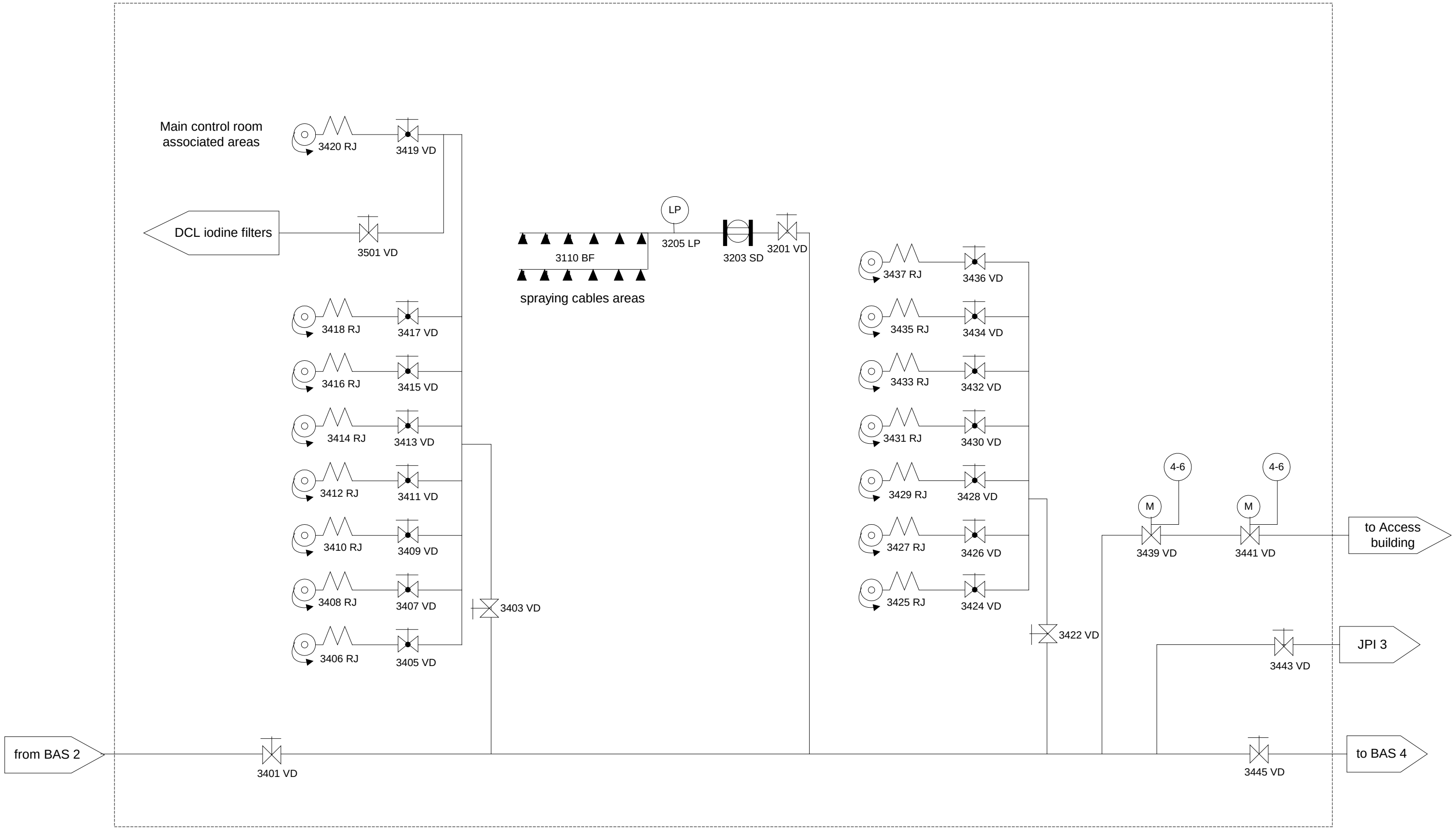
SECTION 9.5.1.3 - FIGURE 6 [REF-1] [REF-2]

Functional diagram of the JPI [NIFPS] for the Safeguard/ Electrical Buildings 2



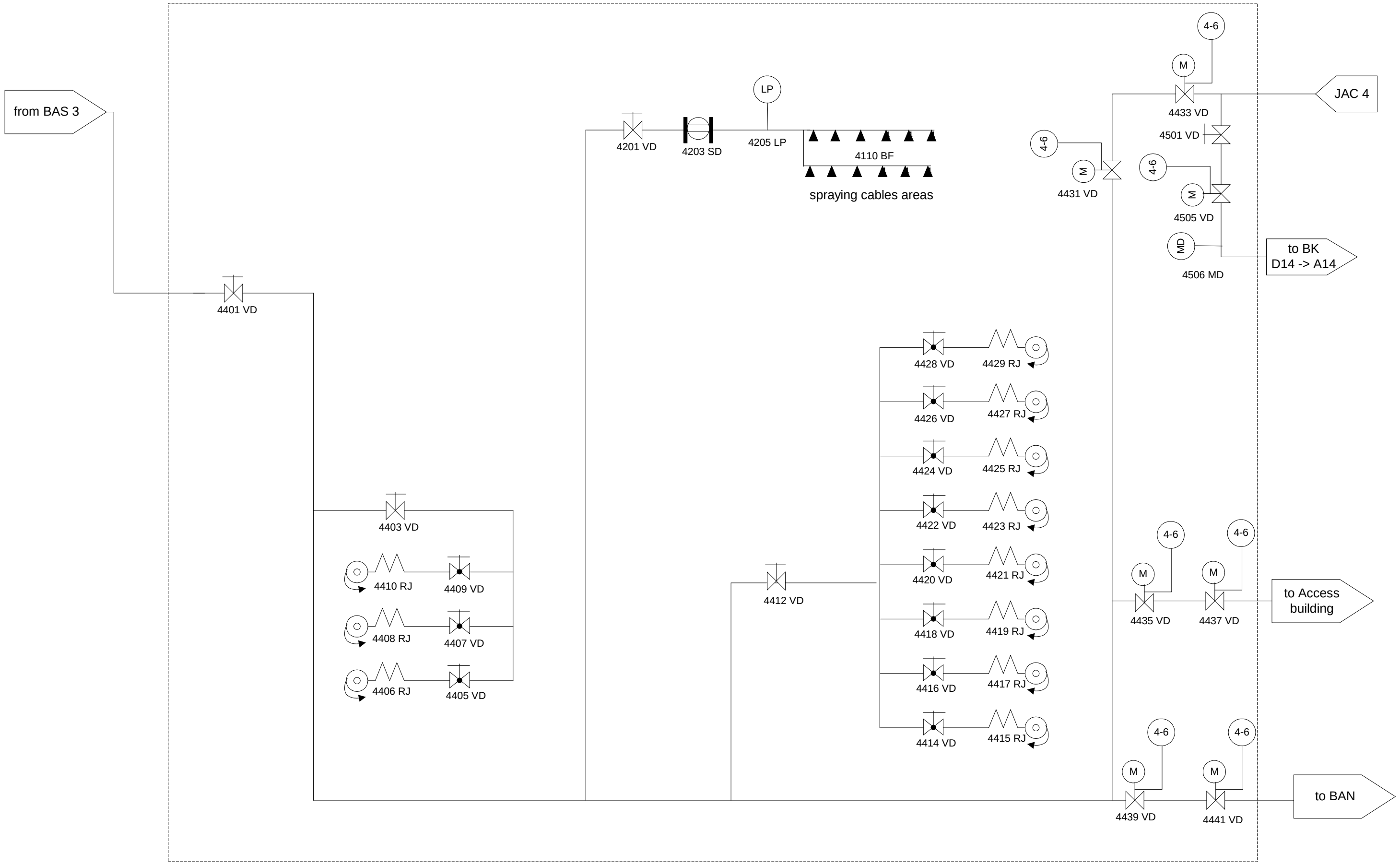
SECTION 9.5.1.3 - FIGURE 7 [REF-1] [REF-2]

Functional diagram of the JPI [NIFPS] for the Safeguard/ Electrical Buildings 3



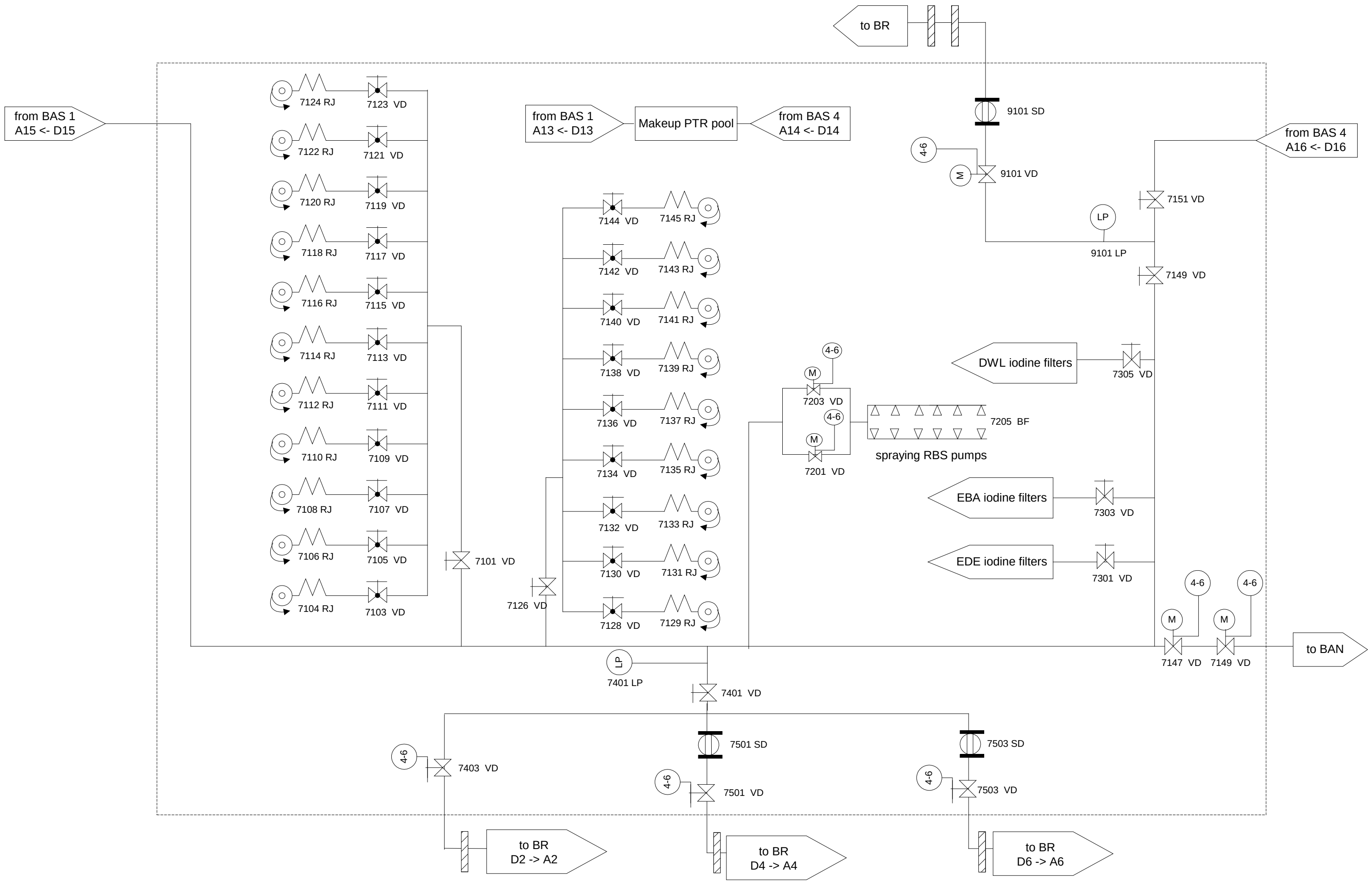
SECTION 9.5.1.3 - FIGURE 8 [REF-1] [REF-2]

Functional diagram of the JPI [NIFPS] for the Safeguard/ Electrical Buildings 4



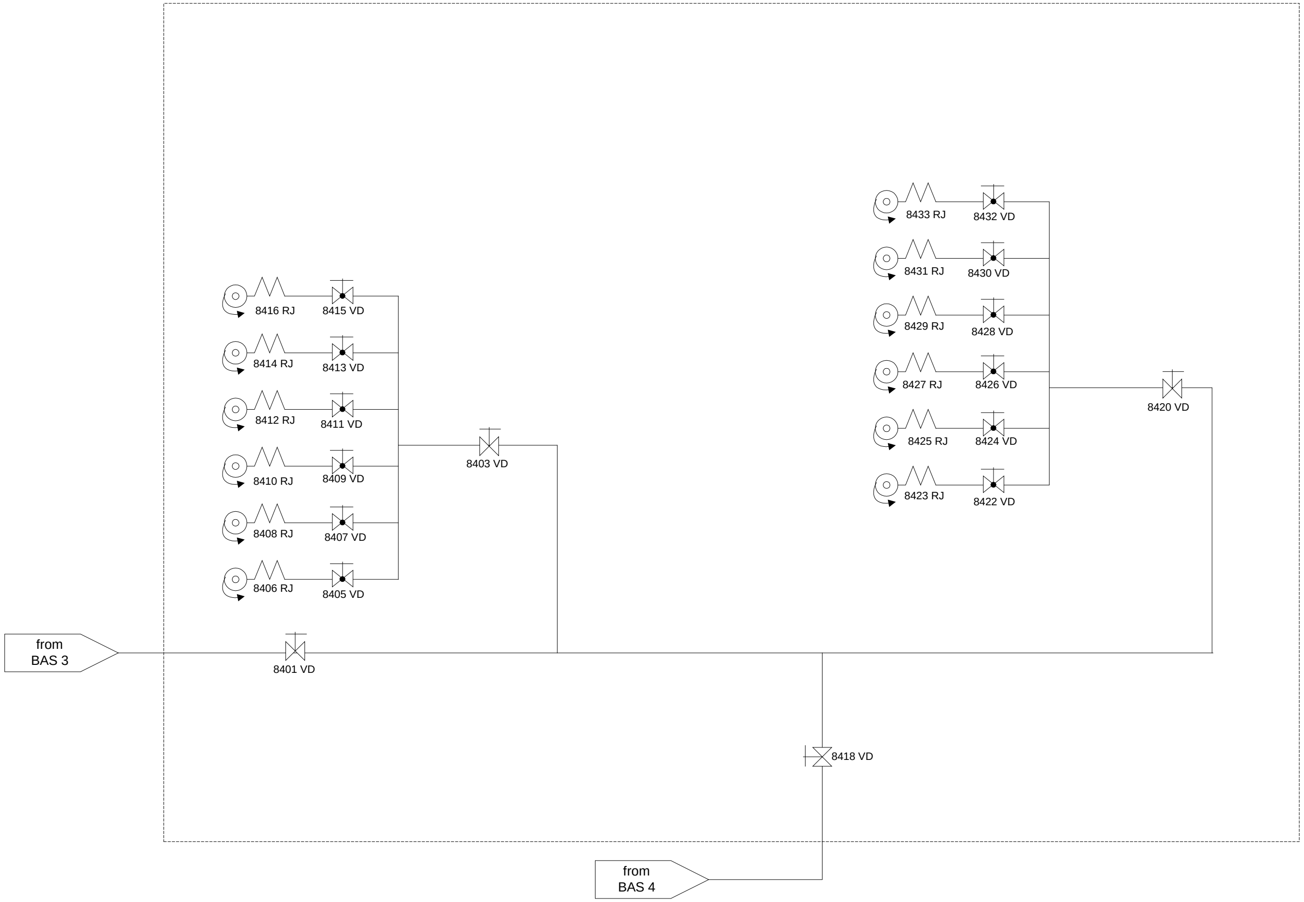
SECTION 9.5.1.3 - FIGURE 9 [REF-1] [REF-2]

Functional diagram of the JPI [NIFPS] for the Fuel Building



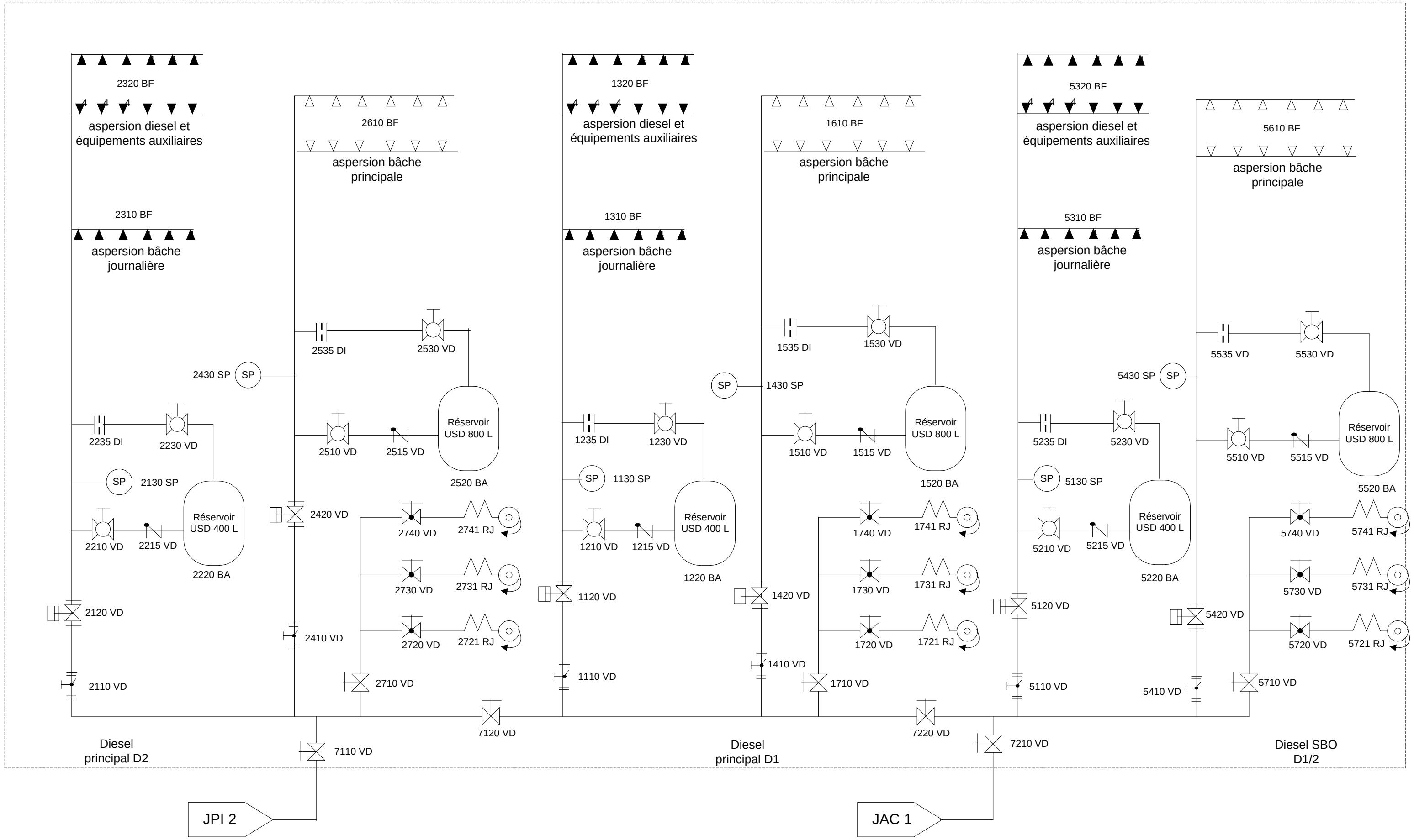
SECTION 9.5.1.3 - FIGURE 10 [REF-1] [REF-2]

Functional diagram of the JPI [NIFPS] for the access building



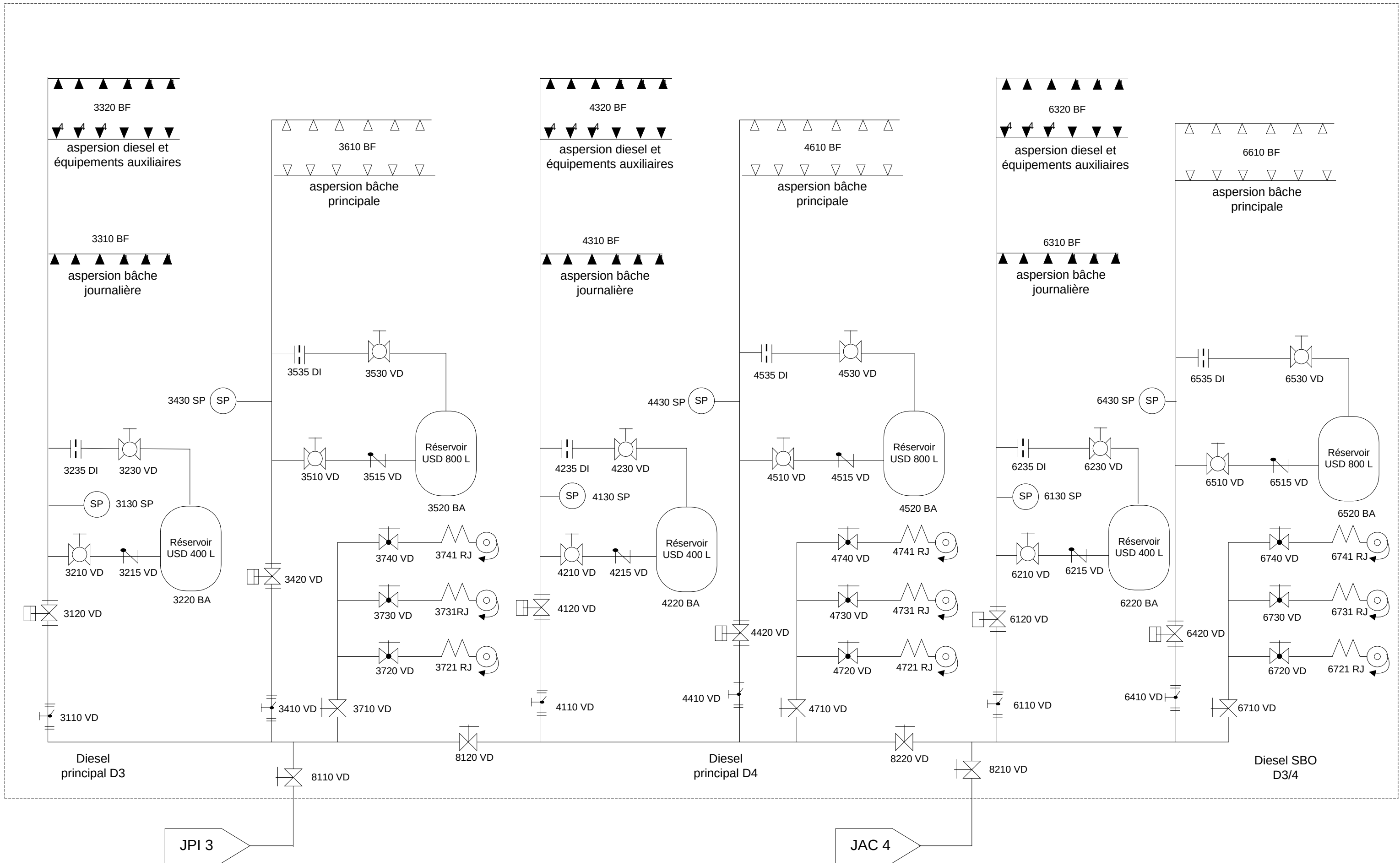
SECTION 9.5.1.3 - FIGURE 11 [REF-3]

Functional diagram of the JPV for the diesel divisions 1 and 2



SECTION 9.5.1.3 - FIGURE 12 [REF-3]

Functional diagram of the JPV for the diesel divisions 3 and 4



1.4. SMOKE CONTROL SYSTEM [REF-1] TO [REF-7]

The Smoke Control System of the Nuclear Island is the DFL for Nuclear Auxiliary Building, Safeguard Buildings, Fuel Building, Diesel Buildings and Access Tower and 8DFL for the Effluent Treatment Building.

1.4.0. Safety requirements

1.4.0.1. Safety functions

The Smoke Control System (DFL) plays a part in the safety function of fire containment which is enabled through the use of fire sectors. The DFL contributes to this fire sectorisation, as several of the rooms are connected together via a common smoke extraction duct equipped with smoke dampers as fire barriers.

The system is also used to control the spread of smoke and to enable a rapid response to a fire within the Nuclear Island.

1.4.0.2. Functional criteria

In each non-controlled zone of the four safeguard buildings, diesel buildings and access tower, the functional criteria of the Smoke Control System (DFL) are:

- to protect the safety exits and protected stairways from smoke;
- to contain the smoke within the fire sector;
- to ensure a negative pressure in the fire location following system start up;

In each mechanical controlled zone in the four safeguard buildings, in the fuel building, in the nuclear auxiliary building, in the effluent treatment building and in the access tower the functional criteria of the DFL are:

- to contain the smoke (the smoke extraction function is limited by radiological considerations);
- to protect the safety exits and protected stairways against smoke;
- to ensure a negative pressure in the effluent treatment building

1.4.0.3. Design requirements

1.4.0.3.1. Requirements resulting from safety classification

Safety classifications

The DFL Smoke Control System is not classified in general (only radiological containment, geographical separation and fire sectorisation when necessary), in conformance with Sub-chapter 3.2.

Single failure criterion (active and passive)

The system for smoke containment is not subject to the single failure criterion.

Back-up power supplies

The power supply of the smoke control system and its associated signals are backed up, except during a station blackout.

Qualification under operating conditions

The smoke containment system is qualified in the ambient conditions to which it is subjected whilst in operation.

Mechanical, electrical, instrument and control classifications

Mechanical classification: not applicable

Electrical classification: electrical equipment is classified, in conformance with Sub-chapter 3.2,

Instrumentation and Control Classification: instrumentation and control equipment is classified in conformance with Sub-chapter 3.2,

Seismic classification

Ventilation ducts, dampers and smoke control fans are classified in conformance with Sub-chapter 3.2.

Periodic tests

The system must be designed to enable periodic tests to be carried out on the F2 classified components.

1.4.0.3.2. Other regulatory requirements

Technical Guidelines: not applicable to the smoke control system.

The smoke control system meets the requirements of the EPR Technical code for fire protection (ETC-F) revision F.

1.4.0.3.3. Hazards

The hazards taken into account for the DFL system are given in Sub-chapter 13.1 for external hazards and Sub-chapter 13.2 for internal hazards.

1.4.1. Role of the system

There are two separate sub-systems within the smoke control system, each of which has specific roles.

1.4.1.1. The smoke extraction sub-system

In each non-controlled zone of the four safeguard buildings, diesel buildings and effluent treatment building, the DFL/8DFL smoke extraction sub-system is designed:

- to extract the smoke from one of the fire sectors, which is already isolated from the normal ventilation system by fire dampers.

In each controlled zone of the safeguard buildings, in the fuel building and the nuclear auxiliary building, the function of smoke extraction is restricted by radiological considerations. All smoke from the controlled zone, with the exception of the access tower, is extracted to the stack.

1.4.1.2. The over-pressure sub-system

In all Nuclear Island buildings (controlled and non-controlled area), the DFL overpressure sub-system is designed:

- to create a slight over-pressure in the stairways, landings and emergency exits, in order to prevent any smoke entering from the affected fire sectors.

1.4.2. Description and characteristics of equipment

Smoke control for the Nuclear Island is performed by an independent sub-system for each division of the safeguard buildings (non-controlled zone) and for each stairway and protected exit in the Nuclear Island buildings.

The smoke extraction circuits are made up of:

- One or more smoke extraction dampers valves,
- One extractor fan per circuit, whose capacity is regulated (by a motorised control damper) 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 zone of the safeguard buildings, diesel buildings and effluent treatment building are:

- The instrumentation and control cabinet rooms.
- The switchboards rooms.
- The Main Control Room (MCR) (only in the safeguard buildings division 2 and 3)

The over-pressure circuits consist of:

- One blower fan per fire safety sector,
- One weighted check-damper which opens according to the over-pressure achieved.

The fire safety sectors provided with an over-pressure circuit to ensure protection against smoke are:

- In the electrical part of the safeguard building:
  - The stairway of division 2 and division 3
  - The stairways and landings of each division (1 to 4).
  - The stairway between divisions 1 and 2.
  - The stairway between divisions 3 and 4.
  - The protected emergency exits.
- In the mechanical part of the safeguard building
  - The tower staircases in division 2 and division 3
- In the fuel building:
  - The passageway also used for access to the mechanical zone of the safeguard building.
- In the nuclear auxiliary building:
  - The stairways.
- In the nuclear auxiliary building, mechanical zones of the safeguard buildings and fuel building of the Nuclear Island:
  - The protected emergency exits and the stairways of the mechanical zones of two divisions of the safeguard buildings.
- In the diesels building:
  - The staircases and emergency exits
- In the access tower (controlled and non-controlled area)
  - The staircases and emergency exits

All these stairways and protected emergency exits are used to evacuate staff and to give access to the fire brigade. They must remain smoke-free.

1.4.3. Operating conditions

1.4.3.1. Normal state of the system

When the plant is operating and during shutdown states, the Smoke Control System (DFL) is on standby.

The normal state is the following:

- All the dampers and flaps of the DFL system are closed
- All the fans are stopped

1.4.3.2. Continuous loading of the system

The DFL system and corresponding sub-systems are on permanent load if a fire starts in a fire sector in the Nuclear Island buildings (safeguard buildings, nuclear auxiliary buildings, fuel building, diesel building, effluent treatment building, Access Tower).

If the affected sector is involved in smoke extraction (non-controlled zone of the safeguard buildings), additional measures are required.

The fire detection system (JDT [FDS]) enables fires and smoke to be detected in the Nuclear Island buildings.

- Fire in a fire sector with smoke extraction (safeguard buildings electrical rooms)

The JDT [FDS] 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 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 have been evacuated.

The stairways are over-pressurised, by opening a damper automatically and by starting the fan. This enables the fire sector to be approached or to be evacuated.

The fire team manually opens doors in continuous wide opening, located between the protected exit and the containment sector. This transfer of fresh air enables the fire to be reached and extinguished.

The pressure difference between the sector and the emergency exits (between 20 and 80 Pa) enables the exits to be protected from smoke whilst allowing the doors to be opened.

- Fire in a fire sector without fume extraction

The JDT [FDS] triggers the alarm in the Main Control Room. The fire dampers in the normal ventilation system of the sector involved are closed automatically.

The stairways are over-pressurised by opening a damper automatically and by starting the fan.

There is no fume extraction in the controlled zones (except for the Effluent Treatment Building 8DFL set to the stack).

- Main Control Room

The Main Control Room is protected against smoke regardless of the fire location. Thus if a fire breaks out within the Main Control Room, the pressure is reduced and the fumes are extracted. If the fire breaks out outside the Main Control Room, because the pressure in the Main Control Room is always higher than the surrounding rooms, (normal operating mode of DCL [CRACS]), smoke and fumes will not enter.

1.4.4. Preliminary safety analysis

1.4.4.1. Conformance with the regulations

The systems are designed and constructed in accordance with the regulations in force (see Sub-chapter 1.4).

1.4.4.2. Compliance with the design requirements

Safety classification

The design and production of systems and equipment will conform to the requirements of the classification rules given in Sub-chapter 3.2.

Single Failure Criterion or Redundancy

The DFL system is not required to meet the single failure criterion.

Qualification

The equipment will be qualified in accordance with the requirements described in Sub-chapter 3.6.

Instrumentation and Control

The instrumentation and control processing is located in the same electrical division as the actuators being controlled.

Emergency power supplies

The normal power supplies are crossed, i.e. equipment in SB division 1 is supplied from equipment in SB division 2. The power supply to the system is not backed up if a station blackout occurs. However, notification of the positions must remain operational.

Hazards

See Section 9.5.1.4 - Table 1.

1.4.5. Tests, inspection and maintenance

The DFL system is subject to periodic tests under fire protection. The tests may be carried out during normal plant operation.

1.4.6. Flow diagrams

The updated functional flow diagrams for the smoke control system have not yet been completed and will be included at a later date.

SECTION 9.5.1.4 - TABLE 1

Hazards summary table for the DFL system

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Rupture of piping	No	-	-
Failure of tanks, pumps and valves	No	-	-
Internal missiles	No	-	-
Dropped loads	No	-	-
Internal explosion	No	-	-
Fire	Yes		The system must function in case of fire
Internal flooding	No	-	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	-	SC1 integrity for - those intake and exhaust dampers and their ducts which are connected directly to the outside from the Controlled Zones. - Control Room Smoke Damper - Fire dampers in the interconnecting passageway
Aircraft crash	No	-	-
External explosion	Yes	-	Applies to isolation dampers which are directly connected to the outside-
External flooding	No	-	-
Snow and wind	No	-	-
Extreme cold	No	-	-
Electromagnetic interference	No	-	-

1.5. FIRE PROTECTION IN THE VENTILATION SYSTEMS

1.5.1. Containment of the Fire

The ventilation systems are required to be compatible with the plant fire containment arrangements.

This objective is met as follows:

- All the ventilation installations within each fire sector are fitted with fire dampers at the air inlet and outlets. The sector can therefore be completely isolated if a fire breaks out by closing these dampers automatically when a detection signal occurs or via the fused thermal link.

- Provision for random failure: there is general duplication of the fire dampers in the fire sector. Where duplication is not possible, alternative measures are taken (e.g. use of a sprinkler).

- Ventilation ducts crossing different fire sectors (including one attached to another division) are protected against fire.

1.5.2. Restriction of the fire

- The ventilation systems must be shut down or isolated from a sector containing a fire.

- Following a fire in an iodine filter, an alarm is sent to the Main Control Room and fire dampers upstream and downstream of the iodine trains or filters (EVF in Reactor Building) are automatically closed. The corresponding extraction line is automatically shut down. In addition, iodine filters are fitted with a fixed internal fire-extinguishing device (JPI [NIFPS]).

1.6. DOOR MONITORING SYSTEM

The section provides the principles of system to be installed for door monitoring [Ref-1].

1.6.0. Safety requirements

1.6.0.1. Safety functions

The purpose of this system is to monitor the position of fire doors which are installed within the boundaries of Safety Fire Compartments in the Nuclear Island and to contribute to the following safety functions:

- separation between buildings,
- divisional separation,
- segregation of safety trains.

The Door Monitoring System will detect if a relevant door is left open and will raise adequate alarms to alert the operator to an open door.

1.6.0.2. Functional criteria

The functional criteria of the Door Monitoring System are:

- to monitor the position of the relevant fire doors installed within the boundaries of Safety Fire Compartments in the Nuclear Island;
- to provide a signal to inform the operator that relevant doors are not closed.

1.6.0.3. Design requirements

1.6.0.3.1. Requirements resulting from safety classification

Safety classifications

All doors are considered to be closed in normal operation. The system is not required to ensure the integrity of the safety fire compartments of the plant. It is used in normal operation to prompt operational staff to close any doors that are left open.

Because the system does not have a nuclear safety duty, the system is neither functionally classified, nor electrically or I&C classified.

Single failure criterion (active and passive)

The Door Monitoring System is not subject to the single failure criterion.

Back-up power supplies

The power supply to the Door Monitoring System is not backed up.

Qualification under operating conditions

The Door Monitoring System is qualified in the ambient conditions to which it is subjected whilst in operation.

Mechanical, electrical, instrument and control classifications

Mechanical classification: not applicable

Electrical classification: electrical equipment is classified in conformance with Sub-chapter 3.2.

Instrumentation and Control Classification: instrumentation and control equipment is classified in conformance with Sub-chapter 3.2.

Because the system does not have a nuclear safety duty, the system is neither electrically or I&C classified.

Seismic classification

The Door Monitoring System is classified in conformance with Sub-chapter 3.2.

The system is not claimed in the safety demonstration of the fire hazard, so it is not SC1 classified. However, in order not to endanger SC1 classified equipment, the system is SC2 classified for Stability. For these reasons the system has specific qualification requirements to be applied.

Periodic tests

The system is designed to allow periodic tests in conformity with the general operating rules.

1.6.0.3.2. Other regulatory requirements

Technical Guidelines: not applicable to the Door Monitoring System.

The Door Monitoring System must be designed in conformance with the EPR Technical Code for Fire Protection (ETC-F).

1.6.0.3.3. Hazards

The hazards taken into account for the Door Monitoring System are given in Sub-chapter 13.1 for external hazards and Sub-chapter 13.2 for internal hazards.

1.6.1. Role of the system

The Door Monitoring System is designed to monitor the position of the relevant fire doors installed within the boundaries of Safety Fire Compartments in the Nuclear Island, and to provide a signal to inform the operator that relevant doors are not closed. The alarm of each relevant door is displayed on a central panel. In the event that an alarm is raised because a door is left open, the Main Control Room (or a control centre to be defined in the site-specific phase) personnel will send an auxiliary operator to close the door.

1.6.2. Description and characteristics of equipment

The Door Monitoring System will be specific to each plant unit.

The system for door monitoring will be comprised of:

- Detectors which supply information on the position of the doors;
- A master central unit: all the information will be compiled and analysed in the master central unit for detection (in case of a dedicated I&C);
- Alarms: these will be sent and displayed in the Main Control Room (MCR) (or a control centre to be defined in the site-specific phase);
- Connections between door contacts and the master central unit as well as cables used for the power supply of the system (in case of a dedicated I&C).

The detection of door position will be done by measurement based on magnetic or bold contacts.

1.6.3. Operating conditions

1.6.3.1. Permanent operation

The Door Monitoring System is operational on a continuous basis in order to detect whether any of the relevant doors have been left open. The detectors, installed in fixed positions, will monitor the position of the doors, and door alarms will always be available in the Control Room. The time period before an alarm is raised after a door being left open has to be long enough to avoid spurious alarms and disturb the normal operation of the plant.

It must be possible to disable the system for planned activities requiring doors to be open (e.g. maintenance activities).

1.6.3.2. Transient operation

If the main power supply fails, the unavailability of each power supply will be indicated by an alarm in the Main Control Room.

1.6.4. Preliminary safety analysis

1.6.4.1. Conformance with the regulations

The systems are designed and constructed in accordance with the regulations in force (see Sub-chapter 1.4).

1.6.4.2. Compliance with the design requirements

Safety classification

This system is not safety classified.

Single Failure Criterion or Redundancy

The Door Monitoring System is not required to meet the single failure criterion.

Qualification

The equipment will be qualified in accordance with the requirements described in Sub-chapter 3.6.

Emergency power supplies

The power supply to the system is not backed up. However, notification of the availability must remain operational.

Hazards

See Section 9.5.1.6 - Table 1.

1.6.5. Tests, inspection and maintenance

The Door Monitoring System is subject to regular maintenance and periodic tests. These may be carried out during normal plant operation.

SECTION 9.5.1.6 - TABLE 1

Hazards summary table for the Door Monitoring System

Internal hazards	Protection requirement	General protection	Specific protection introduced in the design of the system
Rupture of piping	NA	-	-
Failure of tanks, pumps and valves	NA	-	-
Internal missiles	NA	-	-
Dropped loads	NA	-	-
Internal explosion	NA	-	-
Fire	No	-	-
Internal flooding	NA	-	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	Yes. SC2 classification	SC2 – stability.
Aircraft crash	No	No	No
External explosion			
External flooding			
Snow and wind			
Extreme cold			
Electromagnetic wave			

2. DIESEL GENERATOR UNITS

2.1. EMERGENCY DIESEL GENERATORS [REF-1]

2.1.0. Safety requirements

2.1.0.1. Safety functions

The emergency diesel generators (also referred to as main diesel generators within the PCSR) do not contribute directly to the three basic safety functions.

However, if external electrical power is lost, the system must function in order to restore the power supply to the supported systems.

2.1.0.2. Functional criteria

The power of the diesel generators is based on the loading of equipment to the bus bars and the role of this equipment in each of the design basis accidents. The nominal power of the diesel engines is sized to the design basis accident having the greatest power demand, together with a safety margin.

In order to comply with the principle of segregation of the four electrical divisions, each division must be backed-up by an independent diesel.

The diesel reaches nominal speed (frequency) and voltage within 15 seconds from start-up signal.

In back-up mode, the diesel generator units provide electrical power with the voltage and frequency defined by the RCC-E (Chapter C 2400).

The diesel generator units can be started without any auxiliary source of electrical power.

The auxiliary diesel systems enable each diesel generator unit to function at full load for 72 hours. This period is compatible with the time taken to commission heavy equipment which could be used to provide a long term supply. In addition the 15 day Loss Of Offsite Power (LOOP) (following an earthquake) is taken into account in the design.

2.1.0.3. Design requirements

2.1.0.3.1. Requirements resulting from the safety classifications

Safety classifications of system

The diesel generator units are safety classified in accordance with the classification principles given in Sub-chapter 3.2.

Single failure criterion

The single failure criterion applies to the active components of the diesel generator units which provide F1 functions.

Emergency electrical supply

Not applicable since the diesel generator units are self-contained.

Qualification under operating conditions

The diesel generator units are subject to qualification ensuring that they will carry out their safety role in the ambient conditions in which they are required to function.

Classification of mechanical, electrical and instrumentation and control equipment

The emergency diesel generators are classified in accordance with the electrical and instrumentation and control classifications given in Sub-chapter 3.2.

Seismic classification

The emergency diesel generators are seismic classified in accordance with the classification given in Sub-chapter 3.2.

Periodic tests

The emergency diesel generators are tested periodically in order to ensure their availability.

2.1.0.3.2. Other regulatory requirements

Technical Guideline B.2.4.1 “Electrical supplies” states that the emergency diesel generators must be diverse from the two UDG (Ultimate Diesel Generators, also referred to as Station Black Out Diesel Generators, SBO-DG) in order to eliminate common mode failures between the two types of generators.

2.1.0.3.3. Hazards

See Sub-chapter 13.1 for external hazards and Sub-chapter 13.2 for internal hazards.

2.1.0.4. Tests

2.1.0.4.1. Preliminary tests

The system is subject to initial start-up tests in conformity with its safety function.

2.1.0.4.2. Monitoring during operation

Since the system is always on stand-by under normal plant operating conditions, and could be called on to start up at any time, the system parameters are monitored on a regular basis during operation.

The faults are indicated locally and on the Process Information and Control System (PICS), an alarm is triggered when an action is necessary.

2.1.0.4.3. Periodic tests

The system is designed to allow periodic tests in conformity with the general operating rules.

2.1.1. Role of the system

When the system is available, the emergency diesel generators are in stand-by mode, ready to start up at any time.

All the required auxiliaries are powered in order to ensure that the diesels can start up at any time.

2.1.2. Design basis

As a support system, the diesel generator unit is sized according to the equipment being supplied [Ref-1] [Ref-2]. The continuous nominal power of the diesel engine is designed to exceed the demands experienced during the design basis accident, in the external temperature and humidity conditions defined in Sub-chapter 13.1.

The design criteria depend on:

- the nature of the equipment to be supplied,
- the power requirements of the actuators,
- the requirement for the voltage and frequency to remain within the acceptable dynamic and static voltage and frequency range for the equipment in emergency mode, specifically during restarting in the course of the re-powering sequence.

2.1.3. Description of the system and characteristics of the equipment

Each of the 10 kV emergency diesel generator units forms a self-contained unit together with the following auxiliary systems:

- diesel fuel system,
- lubrication oil system,
- coolant system,
- start-up air system,
- air intake and extraction system,
- alternator, excitation and protection circuit,
- local instrumentation and control, control and alarm signalling network.

Diesel fuel system:

Each diesel generator unit is equipped with a “2 hour tank” fed from a storage tank (one “2 hour tank” and one storage tank per diesel).

The diesel fuel is pumped from the storage tank to the “2 hour tank” by a backed-up pump (two transfer pumps, both diesel backed) which is started at the same time as the diesel generator unit, thus ensuring that the “2 hour tank” remains full.

The contents of the “2 hour tank” enable the diesel generator unit to function for two hours at full load.

Lubrication oil system:

The diesel engine is provided with a self-contained lubrication system using a coupling booster pump.

A pre-lubrication device fitted with a re-circulating electrical pump reduces the time taken for the engine to run-up on a priority start-up signal.

Coolant system:

The cooling system is based on air coolers. The heat produced by the diesels is transferred to the cooling loop via a water/air heat exchanger.

Start-up air system:

Each diesel generator unit has a compressed air starter comprising:

- a compressor,
- one (or more) tank(s),
- two start-up air system trains,
- start-up valves.

A single air start-up train is necessary to start the engine for a priority start-up. The diesel is therefore considered as being available for its safety function when one of the two air start-up trains is available.

The capacity of the compressed air tank is sized so that several consecutive start-ups can be carried out on a single train without refilling.

Air intake and extraction system:

A sufficient supply of air is supplied for combustion and cooling.

The air intake and extraction systems are designed to avoid any flow recirculation.

The combustion air is taken from outside via air filters and air ducts and is delivered to the air chambers of the cylinders by a turbo-compressor driven by the exhaust gases.

The expanded exhaust gases leave the turbo-compressors through silencers and exhaust pipes to the outside.

Alternator, excitation and protection circuit:

The alternator is of the synchronous three-phase type.

It is air cooled, and fitted with a self excitation system with electronic voltage regulation.

Ventilation systems for the diesel buildings:

A ventilation system for each diesel building provides air renewal for the rooms. The values of all temperatures used in the design are given in Sub-chapter 9.4.

Local instrumentation and control network for control and signalling of alarms:

This equipment can be started from the local control panel in order to enable tests to be carried out. Measurements and information on the diesel are recorded on this panel.

The diesels can be started:

- either by operator action:
  - remotely via an electric signal coming from the Main Control Room,
  - locally.
- or automatically by a signal from the protection system.

A start-up without any external electrical source is also possible locally.

2.1.4. Operating conditions

2.1.4.1. Normal operation

During power operation, the diesel engine is available in stand-by mode. It can be started-up at any time. To achieve this, it is always pre-lubricated and pre-heated.

2.1.4.2. Steady operating mode

The engine achieves steady state operation after start-up and after the subsequent transients due to the re-powering of the backed-up actuators - following the predefined sequence of powering up.

In back-up mode, all switchboard loads are disconnected as part of a general load-shedding from the protection system except for the emergency diesel auxiliaries and a small number of consumers that are not affected by the load shedding (step 0). In order to respect the capability of the emergency diesel generator (EDG) and the RCC-E requirements, the EDG reloading sequence as programmed in the protection system is divided into 9 load restoration steps of 5 second duration.

This stable operating condition with power supply to the safety equipment continues until supply from the grid is restored.

The engine may be stopped:

- by operator action:
  - either remotely from the Main Control Room,
  - or locally using the emergency stop device.
- or by a priority protection action.

In case of the loss of voltage due to a short-circuit (typical electrical fault) on the busbar, the diesel can be disconnected because of the protection of the diesel circuit-breaker which will be activated.

N.B.: In a long-term Loss Of Offsite Power (LOOP), certain non-priority protections will be re-activated.

2.1.5. Tests, inspection and maintenance

a) Periodic tests

The periodic tests on the diesel generator unit and its auxiliaries must be capable of being carried out with the plant at power.

In order to avoid interruptions in the supply and to enable tests under full load to be carried out, it is possible to synchronise the diesel generator units to the network. If there is a loss of external electrical sources during this “linked-to-grid” operation, the diesel generator will switch automatically to “back-up” mode. This function is classified only if the diesel has to remain available in the terms of the “General Operating Rules” during “linked-to-grid” operation.

b) Maintenance

With the plant operating, it is possible to carry out maintenance operations on one diesel generator unit at a time. It is also possible to carry out preventive maintenance on the auxiliaries.

Checks on diesel fuel, lubrication oil and cooling water are carried out as part of the maintenance operations and inspections.

2.2. ULTIMATE DIESEL GENERATORS (UDG) [REF-1] TO [REF-3]

2.2.0. Safety requirements

2.2.0.1. Safety functions

The Ultimate Diesel Generators (UDG) do not contribute directly to the three basic safety functions.

However, if there is a total loss of electrical power, they function to restore power supplies to essential equipment.

2.2.0.2. Functional criteria

A single UDG with its auxiliaries is sufficient to provide the required electrical power following a total loss of the external electrical supplies and of the internal back-up power supplies.

The function of the system is to supply power to all required equipment at a voltage and a frequency within the dynamic and static limits allowed by the equipment.

The UDG must be available for operation within two hours after total loss of electrical supplies.

2.2.0.3. Design requirements

2.2.0.3.1. Requirements resulting from safety classifications

Safety classification of the system

The UDG units are safety classified in accordance with the classification given in Sub-chapter 3.2.

Single failure criterion

No single failure criterion is associated with the UDG in terms of the classifications in Sub-chapter 3.2.

Emergency electrical supply

Not applicable since the UDG units are self-contained.

Qualification under operating conditions

The UDG units are qualified in order to ensure their ability to fulfil their safety role under the most unfavourable operating conditions.

Classification of mechanical, electrical and instrumentation and control equipment

The UDG are classified in accordance with the electrical and instrumentation and control classifications in Sub-chapter 3.2.

Seismic classification

The UDG units are classified in conformity with the classification given in Sub-chapter 3.2.

Periodic tests

The UDG will be tested periodically in order to ensure their availability.

2.2.0.3.2. Other regulatory requirements

Consequence of the Technical Guidelines Section B.2.4.1 “Electrical supply”:

The UDG are diverse from the four emergency diesel generator units in order to eliminate common mode failures between the two types of diesel generators.

2.2.0.3.3. Hazards

Sub-chapter 13.1 describes the external hazards and Sub-chapter 13.2 describes the internal hazards.

2.2.0.4. Tests

2.2.0.4.1. Preliminary tests

The system is subject to initial start-up tests in conformity with its safety function.

2.2.0.4.2. Monitoring during operation

Since the system is always on stand-by under normal plant operating conditions, and could be called on to start up at any time, the major parameters of the system are monitored on a regular basis during plant operation.

The faults are indicated locally and on the Process Information and Control System (PICS), an alarm is triggered when an action is necessary.

2.2.0.4.3. Periodic tests

The system is designed to enable periodic tests in conformity with the general operating rules.

2.2.1. Role of the system

The UDG are available in standby mode. If there is a total loss of external electrical supplies and of internal back-up supplies, the UDG and their auxiliaries will be capable of being started and brought to power, following a predefined sequence, by the operator from the Main Control Room.

2.2.2. Design basis

As a support system, the UDG are designed according to the equipment they have to supply. The nominal steady power of the diesel engine is sized according to the total loss of power accident with the greatest power demand, together with a safety margin.

The design criteria are:

- the nature of the equipment to be supplied,
- the power of these actuators,
- the voltage must be within the limits of the dynamic and static voltage requirements of the equipment needed in backup mode.

2.2.3. Description of the system and characteristics of the equipment

Each of the UDG forms a self-contained unit with the following auxiliary systems:

- diesel fuel system,

- lubrication oil system,
- coolant system,
- start-up air system,
- system for air intake and extraction,
- alternator, excitation and protection circuit,
- local instrumentation and control, control and alarm signalling network.

Diesel fuel system:

Each diesel generator is fitted with a “2 hour tank” fed from a main storage tank (one “2 hour tank” and one main storage tank per diesel).

The main storage tank can operate independently for 24 hours at full load.

The “2 hour tank” is sized to permit at least two hours operation at full load.

Lubrication oil system:

Continuous pre-lubrication is not necessary.

Coolant system:

Continuous pre-heating is not necessary.

Start-up air system:

Each diesel generator has a complete compressed air start-up unit comprising a compressor, one (or more) tank(s), two start-up air lines and start-up valves

The capacity of the compressed air tank is such that several start-ups can be carried out without refilling.

System for air intake and extraction:

The description is given in section 2.1.4 of this sub-chapter.

Alternator, excitation and protection circuit

The description is given in section 2.1.4 of this sub-chapter.

Local instrumentation and control system for control and signalling of alarms:

The equipment can be brought into operation in back-up mode or to enable tests to be carried out from a local control panel. Operational data for the diesel are recorded on this panel.

The local control panel also displays analogue measurements and on-off status as well as individual alarms.

The UDG auxiliaries are supplied from a local distribution sub-switchboard.

2.2.4. Operating conditions

2.2.4.1. Normal operation

During normal plant operation, the engine is in stand-by mode and ready to start under full load at any time.

The start-up commands may come from:

- the Main Control Room, or
- a local control panel.

Start-up without any electrical supplies is also possible locally.

2.2.4.2. Steady operation

Steady operation of the engine is reached after a start-up initiated following total loss of external electrical supplies and of internal back-up supplies and sequenced re-powering of the various supported equipment.

The load restoration of the actuators is a manual action carried out according to the state of the plant. Loading of the consumers supplied by the back-up switchboard is carried out by group commands provided to the operator in the main control room.

When in steady mode, the diesel generator supplies electrical power to the terminals of its bus bar.

It is possible to shut down the diesel generator:

- by operator action,
    - o either remotely from the Main Control Room,
    - o or locally using the emergency stop device.
- or by a protection action.

2.2.5. Tests, inspection and maintenance

a) Periodic tests

The periodic tests on the UDG and their auxiliaries may be carried out with the plant in normal operation. The aim is to verify that the power delivered by the UDG satisfies the demands of the required loads.

During this testing, the UDG is coupled to the grid. In order to couple to the grid during periodic testing, it is necessary to be able to synchronise the UDG with the grid. For this reason, a synchro-coupler is incorporated in the UDG design.

The UDG can be connected to the grid via the systems LJA or LJK (division 1: LJA or LJK, division 4: LJD or LJN division 4), as soon as the voltages are equal and synchronised.

At the end of testing, an end of coupling signal is directed to the systems LJA or LJK (division 1: LJA or LJK, division 4: LJD or LJN), which opens the corresponding diesel generator circuit breaker. The operator can then shut down the diesel generator.

b) Maintenance of equipment

With the plant at power, maintenance operations will only be performed on one set at a time. It will be possible to carry out preventive maintenance on the auxiliaries with the plant at power.

Checks on diesel fuel, lubrication oil and cooling water will be carried out during maintenance operations and inspections.

3. COMPRESSED AIR SYSTEMS [REF-1] TO [REF-6]

The compressed air systems are:

SAP: the compressed air production system,

SAR: the control compressed air distribution system,

SAT: the working compressed air distribution system,

This section uses the term compressed air system to represent this group of systems.

3.0. SAFETY REQUIREMENTS

This section gives the general safety requirements for the classified parts of the compressed air system.

3.0.1. Safety functions

The compressed air system is a support system. It does not directly carry out any safety functions. The SAP is not safety classified. The SAR and general parts of the SAT are not safety classified.

The safety function of the safety classified parts of the compressed air system is linked to the containment of radioactive substances safety function through its contribution to containment isolation.

The function of containment isolation and the associated requirements are described in Sub-chapter 6.2.

3.0.1.1. Functional criteria

The functional criteria related to the safety function of the SAT are covered by Sub-chapter 6.2.

3.0.1.2. Design criteria

3.0.1.2.1. Requirements related to the safety classification

Safety classification of the system:

The compressed air system is classified in conformity with the classification principles given in Sub-chapter 3.2.

Single failure criterion

The single failure criterion is applicable to the active components of the part of the compressed air system which fulfils the F1 function.

Emergency power supplies

The F1 components of the SAT system are manually operated and therefore not supplied from backed-up electrical cabinets.

Qualification under operating conditions

This is discussed in Sub-chapter 3.6.

The compressed air equipment is qualified in the ambient conditions to which it is subject while in operation.

Mechanical, electrical, instrumentation and control classifications

These requirements are in conformance with Sub-chapter 3.2.

Seismic classification

Seismic requirements are presented in Sub-chapter 3.2.

Periodic tests

Periodic tests are carried out on the classified functions of the system to provide sufficient confidence in its availability.

3.0.1.2.2. Other regulatory requirements

Technical Directives

There are no specific requirements concerning the compressed air system in the Technical Directives.

3.0.1.2.3. Hazards

The external and internal hazards taken into account in the design are given in Chapter 13.

3.0.1.3. Tests

3.0.1.3.1. Preliminary tests

The relevant system undergoes a test programme after installation to confirm its safety functions.

3.0.1.3.2. Monitoring in operation

The compressed air system is subject to a programme of monitoring whilst in service.

The continuous monitoring enables malfunctions in the system to be indicated and corrected.

3.0.1.3.3. Periodic tests

The system is designed to enable periodic tests to be carried out in accordance with the Technical Specifications

3.1. ROLE OF THE SYSTEM

The compressed air production system supplies air of a quality suited to two systems:

- the control compressed air distribution system which supplies the pneumatic valves and pneumatic control valves (SAR).
- the working compressed air distribution system which supplies pneumatic tools and other pneumatic equipment (SAT).

3.2. BASIS OF DESIGN

The compressed air system comprises:

- the system for production of compressed air supplying air of a suitable quality,
- the control compressed air distribution system,
- the working compressed air distribution system.

3.3. DESCRIPTION OF THE SYSTEM AND CHARACTERISTICS OF THE EQUIPMENT

The control compressed air distribution system (SAR) receives air from the SAP through different interconnected networks:

- one network for use in the Nuclear Island,
- one network for use in the Conventional Island,
- one network for use in the rest of the site.

These networks are composed of headers, valves, desiccators, compressors, driers and local buffer tanks.

3.4. PHYSICAL PHENOMENA DETERMINING OPERATION

3.4.1. Normal operation

The SAR system is used for:

- Supplying control compressed air to the main feedwater control valves of the ARE [MFWS],

- Supplying control compressed air to the pneumatic valves of the RRI [CCWS].

All users supplied with control compressed air are on-off consumers.

The compressed air is produced by the SAP system (located in the turbine hall) and it is distributed by the SAR and SAT systems to the various users.

3.4.2. Operation in degraded conditions

If there is a loss of air pressure in the compressed air distribution network, automatic valves successively isolate the distribution to the working compressed air distribution system (SAT) and the distribution to the control compressed air distribution system (SAR) of the Conventional Island to prioritise the compressed air production for the SAR network within the Nuclear Island. As a last reserve, the local buffer tanks of the (SAR) enable the safety classified pneumatic valves to operate.

The local safety classified buffer tanks are designed to allow two movements per supplied valve, taking into account system leakages during 24 hours. The pneumatic valves have a fail-safe position following air loss. The fail-safe position of the pneumatic valves contributes to the safety function that enables its system safety function.

3.5. TESTS, INSPECTION AND MAINTENANCE

The layout and design of the safety classified compressed air system parts enables easy access in order to carry out periodic in-service inspections.

The periodic tests involve isolation linked to F1 functions.

The type C leaktightness tests are not necessary for the containment isolation valves.

4. COMMUNICATION SYSTEMS

4.1. INTRODUCTION

This section covers requirements relating to the plant communication systems, including the alarm systems, paging and internal and external telephone communication systems.

The communication systems are designed to provide safe communications within the plant. They play an important role regarding safety since certain functions are linked to the Internal Emergency Plan.

The communication systems are designed for the normal operational needs of the plant as well as for incidents and accidents.

4.2. PLANT COMMUNICATION SYSTEMS

The following communication systems are provided:

- The alarm system
- The paging system
- The telephone communication systems

4.2.1. Alarm system

The alarm system shares two codes:

- The site alarm: for an incident or accident which affects the whole site.

It is broadcast to all locations on the site.

- The local plant alarm: for an incident or accident whose impact is limited to one part of the plant equipment.

An audible and visual alarm system is used:

- The sound level of the sirens is higher than the station background noise.
- In extremely noisy places, an illuminated alarm signal is used.

The alarm system is continuously self-monitoring in order to detect failures.

Alarms are capable of being triggered manually from at least one of the following points:

- the Main Control Room,
- the back-up station,
- the central protection station of the Safety Block

Both the site and local plant alarms are part of the CNA sub-system (part of the DTV communication system). The site alarm cannot be triggered automatically. The local plant alarm can be triggered automatically to evacuate the reactor or fuel buildings in case of a number of events which require a rapid response. Some of the triggers associated with these events are built within the RPR [PS] plant system. The RPR [PS] plant system is an F1A classified safety system, whereas the CNA is an unclassified sub-plant system. The connection from the RPR [PS] to the CNA sub-system is a uni-directional electrical hardwired link from the RPR [PS] to the CNA system such that the RPR [PS] cannot be affected by the actions of, or faults in, the lower class CNA system.

Each time the alarm is triggered, the time and location are recorded.

In the case of an incident or accident, correct broadcast of the alarm is required and consequently a back-up power supply is provided.

4.2.2. Paging

To contact the staff responsible for managing and supervising plant operations within the station or in the immediate vicinity, two independent systems are provided:

- a loud-speaker system,
- a dedicated paging system.

The reception cover of the system extends over the whole site, both inside and outside the buildings.

It is possible to use the systems from the Main Control Room, the Main Control Room having priority over other available control points.

The fixed parts of the system have a backed-up power supply.

4.2.3. Telephone communications

Several telephone systems are provided and the design of the systems ensures that for all the plant operating states, at least one communication system provides the required level of communication.

<u>Main telephone system</u>

For general communications, a main telephone system is installed with the necessary number of access locations to respond to operational requirements.

Its capacity is sufficient to cover the needs of all the staff involved in work on the plant.

Secondary telephone system

A back-up telephone system provides a certain number of telephone links between all sensitive plant zones.

4.3. EXTERNAL COMMUNICATION SYSTEMS

The following external telephone links are provided:

To the public telephone system:

The public telephone exchange is linked to the main telephone system.

To the telecommunication systems of the electricity grid:

A telephone network provides easy and safe communications between the operational staff and those operating the electricity grid.

To standby staff:

In an accident, standby staff are mobilised and are operational within one hour after the Internal Emergency Plan is triggered.

The standby staff can be contacted through two independent routes from the Main Control Room.

To the radiological monitoring teams:

The radiological monitoring teams deployed outside the plant can be contacted.

To outside organisations:

The following safe, permanent, acoustic, and two-way voice links are provided:

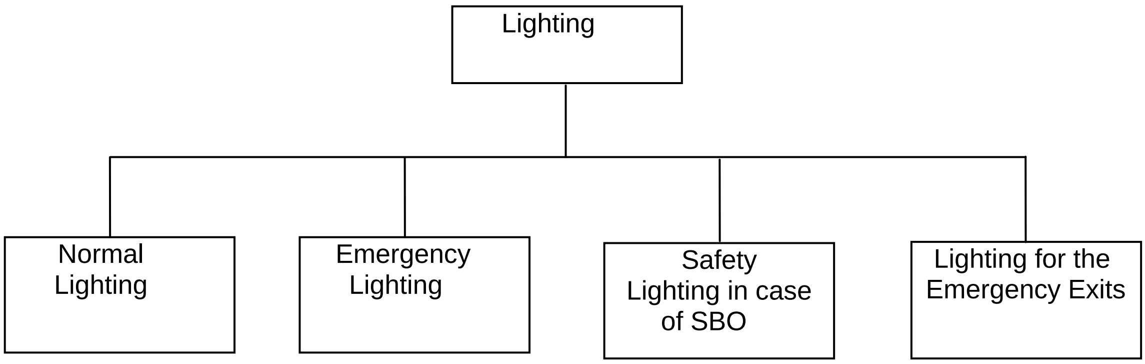
- with the public authorities: These are direct “station to station” telephone links since no dialling is necessary.
- with the Main Emergency Centre (fire-fighters): These are direct “station to station” telephone links since no dialling is necessary.
- with the police: These are direct “station to station” telephone links since no dialling is necessary..

5. LIGHTING [REF-1]

5.1. GENERAL DESIGN

Lighting is provided appropriate to the requirements of individual rooms and work places in all buildings.

The system is designed so that it provides maximum safety for property and staff and facilitates the safe working of operational staff during normal tasks or following an incident or accident. The lighting system architecture is as follows:



The plant must not be without lighting following a loss of offsite power in the network. Therefore as an addition to non backed-up “normal lighting”, three other systems, each of which has a back-up power supply, are provided:

- Emergency lighting: after starting the diesels, this supplies a level of lighting sufficient to enable work in progress to be continued and/or finished.
- Lighting provided if there is a total loss of internal and external electrical power (Station Black-Out, SBO): this supplies a sufficient level of visibility in the Main Control Room, back-up station and in the crisis management room.
- Lighting for the emergency exits: this provides a minimum level of lighting necessary to enable staff to exit the rooms and buildings in safety.

The system of normal lighting has no safety requirements, whereas the emergency lighting, lighting in case of total loss of internal and external electrical power, and lighting for the emergency exits, contribute to performing safety functions and so are classified.

The architecture of the electrical system is such that a sufficient level of lighting is ensured during plant maintenance work.

5.2. NUCLEAR ISLAND BUILDING

The total lighting in the Main Control Room, the back-up station and the crisis management room is comprised of:

- the emergency lighting,
- the lighting if there is a total loss of internal and external electrical power,
- the lighting for the emergency exits (low level).

The total lighting for the other buildings on the nuclear island is comprised of:

- the normal lighting,
- the emergency lighting,
- the lighting for the emergency exits (low contribution).

5.2.1. Normal lighting

Normal lighting is supplied by the four normal electrical distribution trains, not backed-up.

If there is a power loss in one normal electrical supply train, normal lighting ceases.

This network provides 3/4 of the lighting in the rooms (except the main Control Room, back-up station and crisis management room which are not fed by this network).

5.2.2. Emergency lighting

Emergency lighting is fed by the four plant trains. If there is a loss of external electrical power, the supply to the emergency lighting is taken over automatically by the main diesel generators.

This network provides 2/3 of the lighting in the Main Control Room, the back-up station and crisis management room and 1/4 of the lighting to other locations. The emergency lighting provides, if the normal lighting fails, a level of lighting which is enough to enable the plant to continue working by assuring the safety of all the circuits. To do this, the lights in the emergency lighting system are alternated with the equipments providing the normal lighting.

5.2.3. Emergency lighting in the event of total loss of internal power supplies

If there is a total loss of internal electrical power, the lighting network is supplied by two electrical divisions and is backed-up by the main diesels. If there is a loss of the electrical power supply and the main diesels, the supply to the back-up lighting network is taken over by the back-up diesels and the 12 hours batteries.

It provides 1/3 of the lighting in the Main Control Room, the back-up station and the crisis management room. In these locations, the back-up lighting provides a level of lighting which is enough to enable the plant to continue operating whilst assuring the safety of all the circuits. To do this, the lights in the back-up lighting system are alternated with the equipments providing the back-up lighting.

5.2.4. Lighting for emergency exits

This network lights the emergency exits and the evacuation routes (corridors, stairways, etc.) in each building and room. Lighting at workplaces with special hazards is part of the escape route lighting; it lights the locations of telecommunications points and those locations where local operation is required for the normal operation of equipment.

If there is a loss of external electrical power, the supply to the emergency exits lighting is taken over automatically by the main diesel generators. Batteries integrated in the fixtures provide a 2-hour supply if the main diesel generators fail.

This network functions continuously.

5.3. CONVENTIONAL ISLAND BUILDING

The total lighting for the other buildings on the conventional island (including the effluent treatment building and operational service centre) is comprised of:

- the normal lighting,
- the emergency lighting,
- the lighting for the emergency exits (low level).

5.3.1. Normal and emergency lighting

The total lighting of the rooms consists of normal lighting and the emergency lighting. The lamps of the normal lighting system and the emergency lighting supply the necessary level of lighting for each location.

Normal lighting and emergency lighting are supplied by distinct electrical distribution sectors of the Conventional Island. In the conventional island, at least 1/3 of the total lighting is supplied by the emergency lighting with the rest being supplied by the normal lighting.

In non-safety classified rooms of conventional island building, the power supply of the emergency lighting system is not backed up.

5.3.2. Lighting for the emergency exits

Refer to section 5.2.4

6. GAS DISTRIBUTION AND STORAGE

6.0. SAFETY REQUIREMENTS

6.0.1. Safety functions

The gas distribution and storage systems do not fulfil any safety function except for the Nitrogen Distribution System (SGN) for containment penetration isolation.

6.0.2. Functional criteria

The functional criteria related to the safety function of the SGN containment isolation valves are covered by Sub-chapter 6.2.

6.1. DESIGN REQUIREMENTS

6.1.1. Requirements from safety classifications

6.1.1.1. Safety classification

The SGN system is classified in accordance with the classification given in Sub-chapter 3.2.

6.1.1.2. Single failure criterion (active and passive)

F1 classified components satisfy the single failure criterion.

6.1.1.3. Emergency power supply

Supplies to F1 classified equipment are backed up by emergency power supplies.

6.1.1.4. Qualification for operating conditions

The system components are qualified depending on their safety role under the ambient conditions to which they are subjected when fulfilling their safety duty.

6.1.1.5. Mechanical, electrical and instrumentation and control classifications

Mechanical, electrical and instrumentation and control classifications are covered by Sub-chapter 3.2.

6.1.1.6. Seismic classification

The SGN and SGH system are classified in accordance with the seismic classification indicated in Sub-chapter 3.2.

6.1.1.7. Operational surveillance

It is possible to conduct operational surveillance and testing on the classified parts of the system.

6.1.2. Other regulatory requirements

Basic Safety Rules:

Application of Basic Safety Rules is specified in Sub-chapter 1.4.

Technical Guidelines:

Compliance with the Technical Guidelines is specified in Sub-chapter 3.1.

6.1.3. Hazards

See Sub-chapter 3.1 and Chapter 13 which present the list of hazards to be considered in system design.

6.2. SYSTEM ROLE

Plant systems SGN ([Ref-1] to [Ref-5]), SGO ([Ref-6] to [Ref-10]) and SGH ([Ref-11] to [Ref-14]) manage gas distribution in the nuclear island for nitrogen, oxygen and hydrogen respectively. The systems SGC and GRV manage the distribution in the conventional island of carbon dioxide and hydrogen respectively. The gas is produced in central supply units which are not part of the distribution systems.

(The gas is supplied by the gas storage system SKZ to the interface of the nuclear island. There is a minimum distance of the gas storage system to the nuclear auxiliary building. So the interface is arranged close to the outside wall of the nuclear auxiliary building.)

These networks are composed of main pipelines, valves and pressure reducers connected to the systems and components requiring gas in the various buildings in the nuclear and conventional islands.

6.2.1. Oxygen distribution system (SGO)

This system is used to supply oxygen to the recombiner for the Gaseous Waste Processing System (TEG [GWPS]) in the nuclear island.

6.2.2. Hydrogen distribution system (SGH)

This system is used to supply hydrogen:

- to the TEG [GWPS]: to the recombiner for oxygen treatment
- to the RCV [CVCS]: for hydrogen content control in the Reactor Coolant System

6.2.3. Nitrogen distribution system (SGN)

This system is used to supply nitrogen:

- as a carrier gas (TEG [GWPS], "aeroball" core internal measuring system RIC)
- to maintain the various tanks under pressure (RIS [SIS] accumulators)
- to vent ("inerting") the atmosphere of tanks and components which should not come into contact with oxygen (RCV [CVCS], REA [RBWMS], RCP [RCS], RPE [NVDS], TEP [CSTS])
- to sweep the reactor coolant system (via reactor coolant pumps and reactor vessel venting RCP [RCS])
- to maintain an inert atmosphere in the steam generators and for the mixing of chemical reagents (APG [SGBS]).
- for the reactor coolant pump sealing system during shutdown (DEA [SSSS] standstill seal system)
- to maintain an inert atmosphere in the pressuriser during plant shutdowns (RCP [RCS])
- for sampling of dissolved gases with degassing of liquid samples (REN [NSS])

6.2.4. Carbon dioxide and hydrogen distribution system (SGC & GRV)

These systems are used to supply carbon dioxide and hydrogen to the conventional island, mainly to the main generator (if applicable).

6.3. DESIGN BASIS

The quantities of gas stored are calculated so as to fulfil maximum needs for each gas during normal operations for a month (with a reserve for contingencies).

The gases are received in central supply units and channelled to individual consumers by the associated networks of distribution systems.

A hydrogen detection system (KRH system [Ref-1], [Ref-2]) is systematically installed in the rooms where components and flanges of the hydrogen system are installed.

6.4. EQUIPMENT DESCRIPTION AND CHARACTERISTICS

The layout of the SGN is shown in Section 9.5.6 - Figure 1, and the layout of the SGO and SGH in Section 9.5.6 - Figure 2. The distribution systems are composed of pipes, valves and pressure reducers. In the SGN system, safety valves are installed for pressure protection (risk of back pressure / risk of overpressurisation of connected systems). All the distribution systems, including the valves and safety valves are made of stainless steel. The safety valves as well as the pressure reducers are connected by flanges, the rest of the system is welded. Diaphragm valves (at the low pressure part) and globe valves (at the high pressure part) are typically used so as to limit leakage.

The following table indicates system design data:

Systems	Description	Building name	Design data
SGO	**Oxygen Distribution System** Pressure –TEG [GWPS] supply Temperature	 NAB	 13 bar 50 - 100 °C
SGN	**Nitrogen distribution system** Pressure – RIS [SIS] supply Pressure – REA [RBWMS] supply Pressure – RCV [CVCS] supply Pressure – TEP [CSTS], TEG [GWPS], REN [NSS] supply Pressure – RIC "aeroball" supply Pressure – RCP [RCS] supply Pressure – APG [SGBS] supply Pressure – RPE [NVDS] supply Temperature Temperature – Containment isolation	 RB FB- FB- NAB NAB RB RB RB NAB, SAB, FB, RB	 51 bar 13 bar 13 bar 13 bar 13 bar 51 bar 13 bar 13 bar 13 bar 50 - 100 °C 170 °C
SGH	**Hydrogen Distribution System** Pressure – TEG [GWPS], RCV [CVCS] supply Temperature	 NAB, FB-	 13 bar 50 - 100 °C

All pressure values are absolute.

6.5. OPERATING CONDITIONS

The gas distribution systems are permanently in operation.

6.6. PRELIMINARY SAFETY ANALYSIS

6.6.1. Compliance with regulations

Compliance with the general regulations in force is dealt with in Sub-chapter 1.4.

6.6.2. Compliance with functional criteria

The SGN contributes to the fundamental safety function of "containment of radioactive substances" by isolation of containment penetrations.

The containment isolation functions and functional criteria are described in Sub-chapter 6.2.

6.6.3. Compliance with design requirements

6.6.3.1. Safety classifications

Compliance of design and construction of materials and equipment with requirements derived from the classification rules is detailed in Sub-chapter 3.2.

6.6.3.2. Single failure criterion and redundancy

The single failure criterion is applicable to F1 classified components.

Containment penetrations in the SGN system are F1A classified. The isolation valves are redundant.

6.6.3.3. Qualification

The equipment is qualified in accordance with the requirements in Sub-chapter 3.6.

6.6.3.4. Instrumentation and control

Compliance of the design and construction of instrumentation and control systems with requirements derived from the classification rules is detailed in Sub-chapter 3.2.

6.6.3.5. Emergency power supply

Electrical supplies to the containment penetration isolation valves are backed up by emergency power supplies.

6.6.3.6. Hazards

The gas distribution and storage systems are not designed to withstand internal and external hazards except the seismically classified components of the SGN and SGH systems (see also Sub-chapter 3.1 and Chapter 13).

6.7. TESTING, INSPECTION AND MAINTENANCE

6.7.1. Preliminary tests

The start-up tests must demonstrate that system functional characteristics match the design, especially for pressure and also for flow rates.

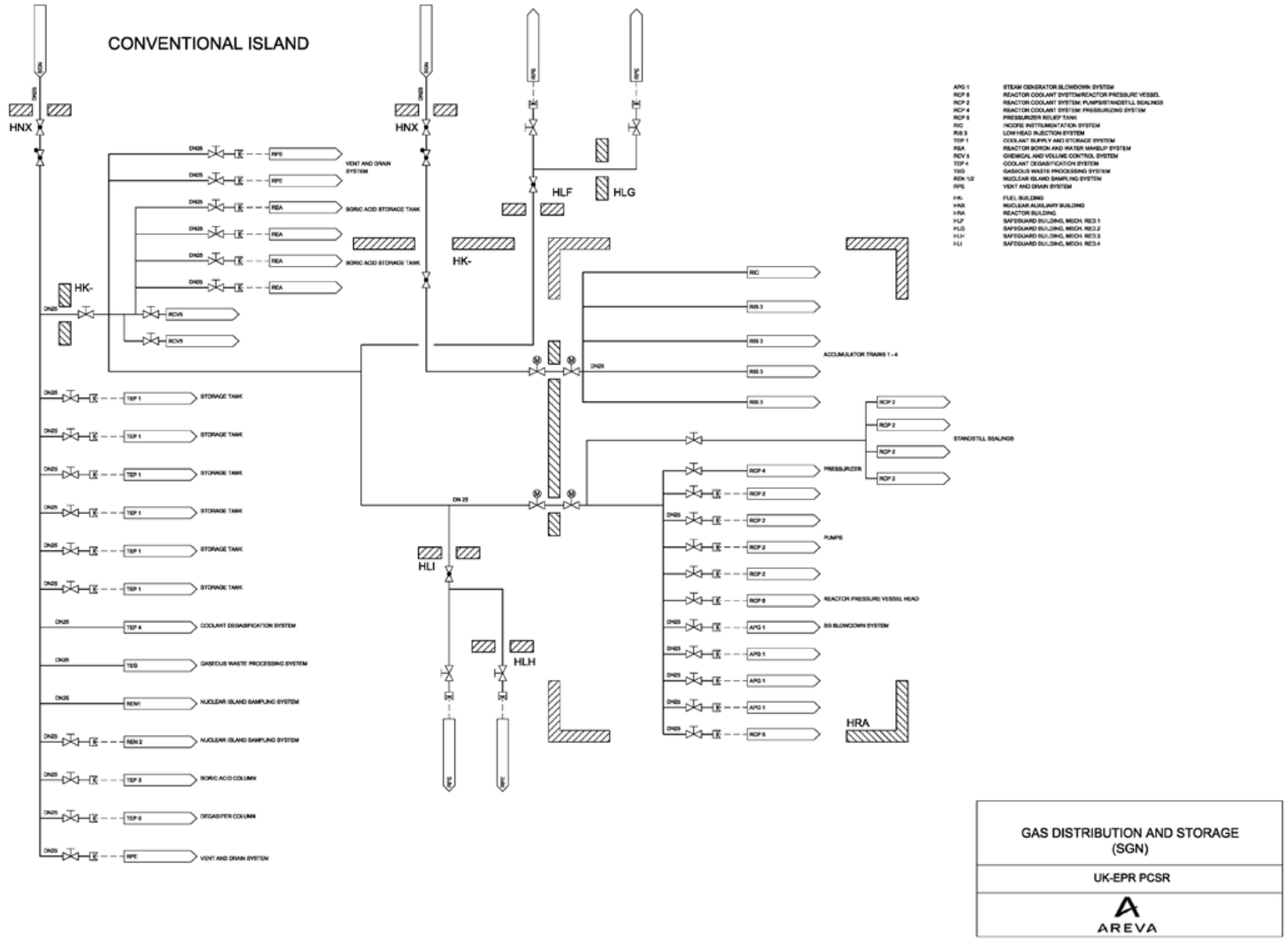
6.7.2. In-service inspection

Design and layout of the gas distribution system equipment must enable in-service inspection to be performed.

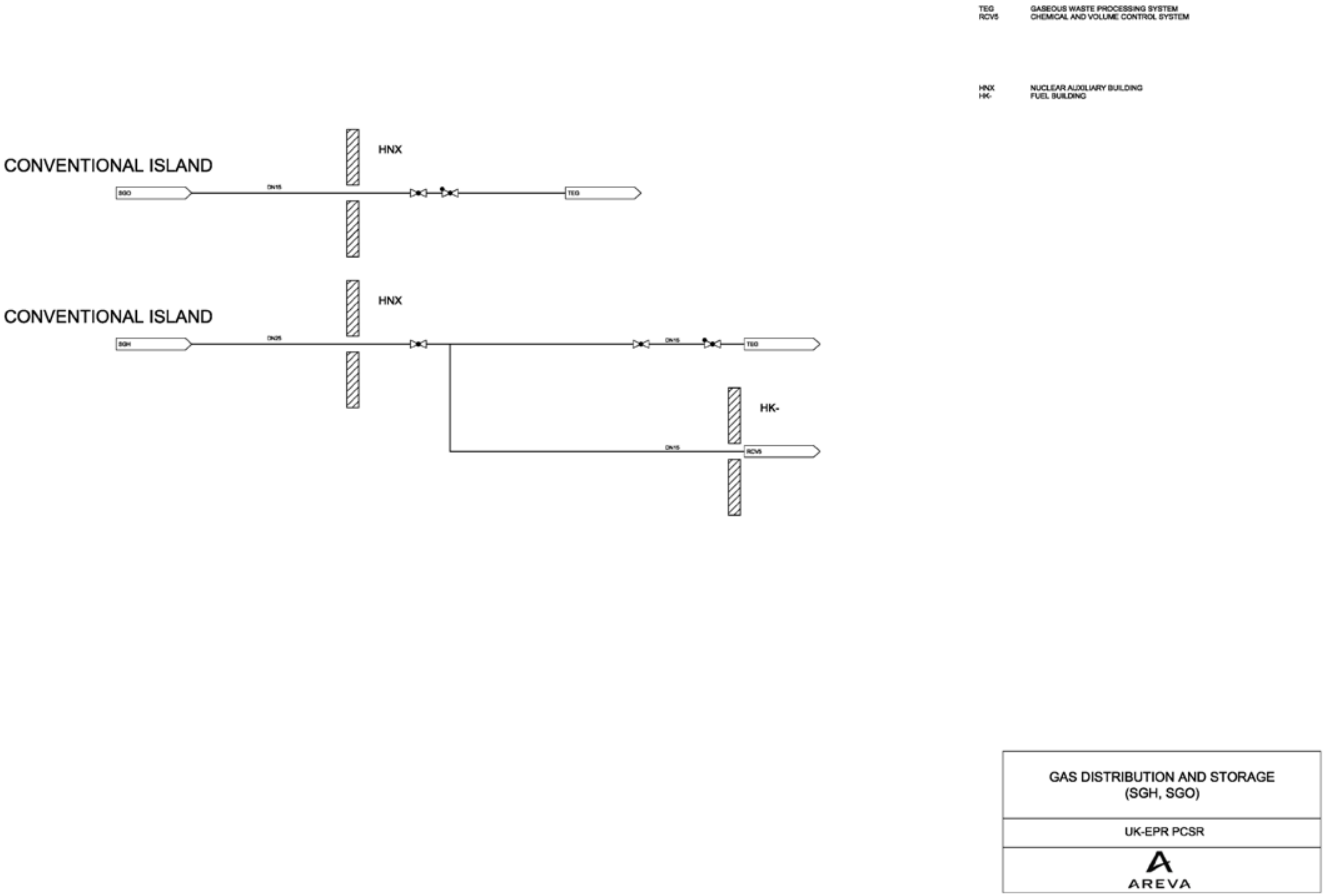
6.7.3. Surveillance tests

The safety classified systems (SGN) must enable surveillance tests to be performed.

SECTION 9.5.6 - FIGURE 1 - GAS DISTRIBUTION (SGN) [REF-1]



SECTION 9.5.6 - FIGURE 2 - GAS DISTRIBUTION (SGO, SGH) [REF-2] [REF-3]



SUB-CHAPTER 9.5 – REFERENCES

External references are identified within this sub-chapter by the text [Ref-1], [Ref-2], etc at the appropriate point within the sub-chapter. These references are listed here under the heading of the section or sub-section in which they are quoted.

1. FIRE PROTECTION SYSTEMS AND EQUIPMENT

1.2. FIRE DETECTION

[Ref-1] EPR FA3 JDT [FDS] System Specifications. ECEMA061374 Revision A1. EDF. January 2011. (E)

[Ref-2] System Design Manual - Fire Detection System (JDT [FDS]), Part 2 – System operation. EYTE/2008/fr/0104 Revision A1. SOFINEL. September 2009. (E)

[Ref-3] System Design Manual - Fire Detection System (JDT [FDS]), Part 3 – System sizing. EYTE/2008/fr/0107 Revision A1. SOFINEL. September 2009. (E)

[Ref-4] System Design Manual - Fire Detection System (JDT [FDS]), Part 4 – Flow diagrams. EYTE/2008/fr/0106 Revision A1. SOFINEL. September 2009. (E)

[Ref-5] System Design Manual - Fire Detection System (JDT [FDS]), Part 5 – Instrumentation and Control. EYTE/2008/fr/0105 Revision A1. SOFINEL. September 2009. (E)

1.3. FIRE FIGHTING SYSTEMS

[Ref-1] System Design Manual - Fire Fighting Water System of the Nuclear Island (JPI), Part 1. EZH/2007/en/0005 Revision C. EDF. September 2008. (E)

[Ref-2] System Design Manual - Fire Fighting Water System of the Nuclear Island (JPI), Part 2 – System operation. EZH/2007/en/0006 Revision D. EDF. July 2008. (E)

[Ref-3] System Design Manual - Fire Fighting Water System of the Nuclear Island (JPI), Part 3 – System sizing. EZH/2007/en/0007 Revision E. EDF. July 2008. (E)

[Ref-4] System Design Manual - Fire Fighting Water System of the Nuclear Island (JPI), Part 4 – Flow diagrams. EZH/2007/en/0009 Revision D. EDF. May 2008. (E)

[Ref-5] System Design Manual - Fire Fighting Water System of the Nuclear Island (JPI), Part 4.2 – Process and Instrumentation diagrams. EZH/2007/en/0010 Revision D. EDF. July 2008. (E)

[Ref-6] System Design Manual - Fire Fighting Water System of the Nuclear Island (JPI), Part 5 – Instrumentation and Control. SFL-EZH/2007/en/0021 Revision B. EDF. January 2008. (E)

[Ref-7] System Design Manual - Effluent Treatment Building Protection and Fire Fighting Water Distribution System (8JPI), Part 2 – System operation.
EYTF/2007/fr/0036 Revision D1. SOFINEL. September 2009. (E)

[Ref-8] System Design Manual - Effluent Treatment Building Protection and Fire Fighting Water Distribution System (8JPI), Part 3 – System sizing.
EYTF/2007/fr/0045 Revision C. EDF. July 2008 (E)

[Ref-9] System Design Manual - Effluent Treatment Building Protection and Fire Fighting Water Distribution System (8JPI), Part 4 – Flow Diagrams.
EYTF/2007/fr/0057 Revision C1. SOFINEL. September 2009. (E)

[Ref-10] Dossier de Système Elémentaire – Protection Incendie du BTE (8JPI), P4.2 – Schéma mécanique détaillé.
[System Design Manual – Effluent Treatment Building Protection and Fire Fighting Water Distribution System (8JPI), Part 4.2 – Detailed flow diagram.]
EYTF/2007/fr/0056 Revision C. EDF. July 2008.

[Ref-11] System Design Manual - Effluent Treatment Building Protection and Fire Fighting Water Distribution System (8JPI), Part 5 – Instrumentation and Control.
EYTF/2007/fr/0077 Revision C1. SOFINEL. September 2009. (E)

[Ref-12] System Design Manual - JAC: Classified Fire-Fighting Water Supply System Part 1: Plant System File Evolution. ETDOIG080014 Revision A1. EDF. August 2009. (E)

[Ref-13] System Design Manual - JAC: Flamanville 3 Classified Fire-Fighting Water Supply System Part 2: System operation. ETDOIG080015 Revision A1. EDF. August 2009. (E)

[Ref-14] System Design Manual - JAC: Flamanville 3 Classified Fire-Fighting Water Supply System Part 3: System and component design. ETDOIG080016 Revision A1. EDF. August 2009. (E)

[Ref-15] System Design Manual - JAC: Flamanville 3 Classified Fire-Fighting Water Supply System Part 4: Flow diagrams. ETDOIG080017 Revision A1. EDF. August 2009. (E)

[Ref-16] System Design Manual - JAC: Flamanville 3 Classified Fire-Fighting Water Supply System Part 5: Instrumentation and Control. ETDOFC080059 Revision A1. EDF. August 2009. (E)

[Ref-17] System Design Manual - Diesel Generator Protection and Fire-Fighting Water Distribution System (JPV), Part 1.
EYTF/2008/fr/0078 Revision B1. SOFINEL. September 2009. (E)

[Ref-18] System Design Manual - Diesel Generator Protection and Fire-Fighting Water Distribution System (JPV), Part 2 – System operation.
EYTF/2007/fr/0028 Revision C1. SOFINEL. September 2009. (E)

[Ref-19] System Design Manual - Diesel Generator Protection and Fire-Fighting Water Distribution System (JPV), Part 4 – Flow Diagrams.
EYTF/2007/fr/0035 Revision C1. SOFINEL. September 2009. (E)

[Ref-20] Dossier de Système Elémentaire – Protection et Distribution Eau Incendie Diesels (JPV), P4.2 – Schéma mécanique détaillé.
[System Design Manual – Diesel Generator Protection and Fire-Fighting Water Distribution System (JPV), Part 4.2 – Detailed flow diagram.]
EYTF/2007/fr/0033 Revision C. EDF. July 2008.

[Ref-21] System Design Manual - Diesel Generator Protection and Fire-Fighting Water Distribution System (JPV), Part 5 – Instrumentation and Control. EYTF/2007/fr/0054 Revision E1. SOFINEL. September 2009. (E)

SECTION 9.5.1.3 - FIGURES 1 TO 12

[Ref-1] System Design Manual - Fire Fighting Water System of the Nuclear Island (JPI), Part 2 – System operation. EZH/2007/en/0006 Revision D. EDF. July 2008. (E)

[Ref] System Design Manual - Fire Fighting Water System of the Nuclear Island (JPI), Part 3 – System sizing. EZH/2007/en/0007 Revision E. EDF. July 2008. (E)

[Ref-3] System Design Manual - Diesel Generator Protection and Fire-Fighting Water Distribution System (JPV), Part 2 – System operation. EYTF/2007/fr/0028 Revision C1. SOFINEL. September 2009. (E)

1.4. SMOKE CONTROL SYSTEM

[Ref-1] System Design Manual – Electrical Building Smoke Extraction System (DFL), Part 1. EZH/2008/en/0041 Revision C. EDF. November 2008. (E)

[Ref-2] System Design Manual – Electrical Building Smoke Extraction System (DFL), Part 2 – System operation. EZH/2007/en/0012 Revision F. EDF. October 2008. (E)

[Ref-3] System Design Manual – Electrical Building Smoke Extraction System (DFL), Part 3 – System sizing. EZH/2007/en/0153 Revision E. EDF. October 2008. (E)

[Ref-4] System Design Manual – Electrical Building Smoke Extraction System (DFL), Part 4 – Flow diagrams. EZH/2007/en/0140 Revision F. EDF. October 2008. (E)

[Ref-5] Dossier de Système Elémentaire – Système de Contrôle des Fumées (DFL), P4.1 – Schéma mécanique fonctionnel.
[System Design Manual – Smoke Control System (DFL), Part 4.1 – Detailed flow diagram.]
ECEF081218 Revision A. EDF. July 2008.

[Ref-6] System Design Manual – Electrical Building Smoke Extraction System (DFL), P4.2 - SMD. EZH/2007/en/0150 Revision F1. EDF. October 2008. (E)

[Ref-7] System Design Manual – Electrical Building Smoke Extraction System (DFL), Part 5 Instrumentation and Control. EZH/2007/en/0111 Revision D. EDF. October 2008. (E)

1.6. DOOR CONTROL MEASURES

[Ref-1] UK EPR – Specification of the Door Monitoring System. ECUK100261 Revision A. EDF. June 2010. (E)

2. DIESEL GENERATOR UNITS

2.1. EMERGENCY DIESEL GENERATORS

[Ref-1] System Design Manual - 10 kV Diesel Generator Set Division 1/2/3./4 (LHP/Q/R/S), Part 2 – System operation (Stage 2). EYTS/2007/fr/0002 Revision B1. Sofinel. October 2009. (E)

2.1.2. Design basis

[Ref-1] System Design Manual - 10 kV Diesel Generator Set Division 1/2/3/4 (LHP/Q/R/S), Part 3 – System sizing (Stage 2). EYTS/2008/fr/0041 Revision A1. Sofinel. October 2009. (E)

[Ref-2] System Design Manual - 10 kV Diesel Generator Set Division 1/2/3/4 (LHP/Q/R/S), Part 5 - Instrumentation and Control (Stage 2).EYTS/2007/fr/0164 Revision B1. Sofinel. October 2009. (E)

2.2. ULTIMATE DIESEL GENERATORS (UDG)

[Ref-1] System Design Manual - 690V Emergency Diesel Generators (LJP/S), Part 3 – System sizing (Stage 2). EYTS/2008/fr/0068 Revision B1. Sofinel. October 2009. (E)

[Ref-2] Functional justification of SBO diesel generator design basis. ECEF060964 Revision B1. EDF. April 2010. (E)

[Ref-3] System Design Manual - 690 V Emergency Diesel Generators (LJP/S), Part 5 – Instrumentation and Control (Stage 2). EYTS/2008/fr/0034 Revision B1. Sofinel. October 2009. (E)

3. COMPRESSED AIR SYSTEMS

[Ref-1] System Design Manual - Compressed Air System (SAR), Part 1. EZS/2007/en/0080 Revision B. August 2008. (E)

[Ref-2] System Design Manual - Compressed Air System (SAR), Part 2 – System operation. EZS/2007/en/0024 Revision C. August 2008. (E)

[Ref-3] System Design Manual - Compressed Air System (SAR), Part 3 – System design. EZS/2007/en/0049 Revision C. August 2008. (E)

[Ref-4] System Design Manual - Compressed Air System (SAR), Part 4 – Flow Diagrams. EZS/2007/en/0050 Revision B. August 2008. (E)

[Ref-5] System Design Manual - Compressed Air System (SAR), Part 4.2 – Detailed Flow Diagrams.
EZS/2007/en/0069 Revision C. August 2008. (E)

[Ref-6] System Design Manual - Compressed Air System (SAR), Part 5 – Instrumentation & Control
EZS/2007/en/0115 Revision B. August 2008. (E)

5. LIGHTING

[Ref-1] System Design Manual - Specifications for DN./ DS. Systems: “Lighting of EPR rooms”. ECEIG061187 Revision A1. June 2009. EDF. (E).

6. GAS DISTRIBUTION AND STORAGE

6.2. SYSTEM ROLE

[Ref-1] Stoehr S., Kokemueller D. Nitrogen Gas Distribution System (SGN) P2 - System Operation. SFL-EZS-030063 Revision D PREL. SOFINEL. November 2008. (E)

[Ref-2] Stoehr S., Kokemueller D. Nitrogen Gas Distribution System (SGN) P3 – Sizing of the system and its components. SFL-EZS030066 Revision D PREL SOFINEL. November 2008. (E)

[Ref-3] Stoehr S., Kokemueller D. Nitrogen Gas Distribution System (SGN) P4 - Flow diagrams. SFL-EZS-030056 Revision D PREL. SOFINEL. October 2008. (E)

[Ref-4] Stoehr S., Kokemueller D. Nitrogen Gas Distribution System (SGN) P5 – Instrumentation and Control (I&C). EZS/2007/en/0010 Revision C BPE. SOFINEL. November 2008. (E)

[Ref-5] Stoehr S., Kokemueller D. Nitrogen Gas Distribution System (SGN) P1. SFL-EZS-030069 Revision E PREL. SOFINEL. December 2008. (E)

[Ref-6] Stoehr S., Kokemueller D. System Design Manual - Oxygen Gas Distribution System (SGO) P1 - History of the System Manual. SFL-EZS-030068 Revision E PREL. Sofinel. October 2008. (E)

[Ref-7] Stoehr S., Kokemueller D. Oxygen Gas Distribution System (SGO) P2 - System Operation. SFL-EZS-030062 Revision D BPE. SOFINEL. December 2008. (E)

[Ref-8] Stoehr S., Kokemueller D. Oxygen Gas Distribution System (SGO) P3 – Sizing of the system and its components. SFL-EZS030065 Revision D BPE. SOFINEL. December 2008. (E)

[Ref-9] Stoehr S., Kokemueller D. Oxygen Gas Distribution System SGO P4 - Flow diagrams. SFL-EZS 030057 Revision E BPE. SOFINEL. December 2008. (E)

[Ref-10] Stoehr S., Kokemueller D. Oxygen Gas Distribution System (SGO) P5 - Instrumentation and Control. EZS/2007/en/0011 Revision C BPE. SOFINEL. October 2008. (E)

[Ref-11] Stoehr S., Kokemueller D. Hydrogen Gas Distribution System (SGH) P2 - System Operation. SFL-EZS-030061 Revision D PREL. SOFINEL. December 2008. (E)

[Ref-12] Stoehr S., Kokemueller D. Hydrogen Gas Distribution System (SGH) P3 – Sizing of the system and its components. SFL-EZS030064 Revision D PREL. SOFINEL. December 2008. (E)

[Ref-13] Stoehr S., Kokemueller D. Hydrogen Gas Distribution System (SGH) P4 - Flow diagrams. SFL-EZS 030058 Revision D PREL. SOFINEL. December 2008. (E)

[Ref-14] Stoehr S., Kokemueller D. Hydrogen Gas Distribution System (SGH) P5 – Instrumentation and Control. EZS/2007/en/0009 Revision C BPE. SOFINEL. October 2008. (E)

6.3. DESIGN BASIS

[Ref-1] System Design Manual - Nuclear Island Hydrogen Detection System (KRH), Part 2 – System Operation, SFL-EZS-030075 Revision A. SOFINEL. September 2006. (E)

[Ref-2] System Design Manual - Nuclear Island Hydrogen Detection System (KRH), Part 3 – Sizing of the System and its Components, SFL-EZS-030076 Revision A. SOFINEL. September 2006. (E)

SECTION 9.5.6 - FIGURES 1 AND 2

[Ref-1] Stoehr S., Kokemueller D. Nitrogen Gas Distribution System (SGN) P4 - Flow diagrams. SFL-EZS-030056 Revision D PREL. SOFINEL. October 2008. (E)

[Ref-2] Stoehr S., Kokemueller D. Hydrogen Gas Distribution System (SGH) P4 - Flow diagrams. SFL-EZS 030058 Revision D PREL. SOFINEL. December 2008. (E)

[Ref-3] Stoehr S., Kokemueller D. Oxygen Gas Distribution System (SGO) P4 - Flow diagrams. SFL-EZS 030057 Revision E BPE. SOFINEL. December 2008. (E)