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00	First issue	30.04.08
01	PCSR June 2009 update: – Clarification of text – Integration of reference mapping – Technical update of system description to account for December 2008 design freeze.	30-06-09
02	Consolidated Step 4 PCSR update: – Minor editorial changes – Clarification of text – Clarification of cross-references – References updated (English translation), corrected or added – Inclusion of information regarding corrosion resistant HVAC components under atmospheric conditions.(§1.1) – Addition of information regarding components of HVAC and regarding single failure criterion and iodine filter lines (§8.5.3.2)	28-03-11
03	Consolidated PCSR update: - References listed under each numbered section or sub-section heading numbered [Ref-1], [Ref-2], [Ref-3], etc - Minor editorial changes - System names and acronyms updated - Update of references: system design drawings added - Clarification of text (§9.4.1) Continued on next page	23-11-2012

REVISION HISTORY (Cont'd)

Issue	Description	Date
03 Cont'd	Consolidated PCSR update: - Description of static and dynamic containment of the Fuel Building and Reactor Building, metallic pre-filter upstream of the iodine lines and isolation dampers in the EBA [CSVS], and operation in accident conditions, added (§2.1.2, §2.3, §2.4.2, Section 9.4.2 – Figures 1 and 5, §5.1.2, §5.3.1, §5.3.2, §5.4.2, §5.5.3, Section 9.4.5 – Figure 1, § 6.3, §6.4.3 and Section 9.4.6 – Figure 1) - Addition of introductory text outlining the proposed design changes (or design options) to be implemented for the ventilation systems - DVL, DCL, DEL and DVP (§7, §8, §10, §11, §12).	

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SUB-CHAPTER 9.4 - HEATING, VENTILATION AND AIR-CONDITIONING SYSTEMS

0. GENERAL SAFETY REQUIREMENTS

This section presents the general safety requirements for the heating, ventilation and air-conditioning systems and for the cooling systems described in this chapter. The detailed requirements are provided for each system in the corresponding section.

0.1. SAFETY FUNCTIONS

- The ventilation systems play a direct role in supporting the third basic safety function: containment of radioactive substances. The systems reduce radioactive discharges into the environment in PCC, RRC-A or RRC-B events.
- In their capacity as support systems, the ventilation and cooling systems maintain ambient conditions within acceptable limits (temperature and intake of fresh air) for staff and equipment, supporting the correct operation of safety-classified systems.

The ventilation and cooling systems are organised into three groups:

a) systems or parts of systems which contribute to reducing radioactive discharges:

- DWN [NABVS]: Nuclear Auxiliary Building Ventilation System
- DWK [FBVS]: Fuel Building Ventilation System
- EBA [CSVS]: Containment Sweep Ventilation System
- DWL [CSBVS]: Safeguard Building Controlled Area Ventilation System
- DWB: ventilation of the controlled area of the Operational Service Centre
- DWQ [ETBVS]: Effluent Treatment Building Ventilation System
- DWW [ABVS]: Access Building Controlled Area Ventilation System

b) systems that maintain the ambient conditions required for the safety and habitability of the Main Control Room:

- EVR [CCVS]: Containment Cooling Ventilation System for continuous ventilation of the containment (in the event of station blackout, ventilation of the vessel pit only)
- DCL [CRACS]: Main Control Room Air Conditioning System
- DVL [SBVSE]: Safeguard Building Uncontrolled Area Ventilation System
- DVD: ventilation of the Diesel Buildings

- DVP: ventilation of the pumping station
- DWK [FBVS] (partially: heating of boron rooms, local air conditioning units of RBS [EBS] rooms)
- DWL [CSBVS] (partially: local air conditioning units are situated in RIS [SIS] / RRA [RHR] exchanger and valve rooms, ASG [EFWS] and RRI [CCWS] valve rooms, EVU [CHRS] pump and valve rooms and 3rd PTR [FPC(P)S] train room).

c) the support cooling systems for the safety-classified ventilation systems:

- DEL [SCWS]: chilled safety water production

Functions and requirements related to containment isolation are described in Sub-chapter 6.2. The relevant systems are the EBA [CSVS] and DER (reactor building chilled water production).

Specific requirements for the annulus ventilation (EDE [AVS]) system are given in Sub-chapter 6.2.

The safety functions of each system are described in the corresponding sections of this sub-chapter.

0.2. FUNCTIONAL CRITERIA

a) Systems that contribute to reducing radioactive discharges must perform the following:

- filtration of the extraction flow using High Efficiency Particulate Air (HEPA) filters and, if necessary, iodine filters. The Decontamination Factors (DFs) required are as follows:
    - o 1000 for HEPA filters
    - o 100 (methyl iodide) for the iodine filters needed in accident conditions
    - o 10 (methyl iodide) for the iodine filters used in normal operating conditions
- extraction and discharge of the flow to the vent stack

b) Systems that maintain ambient conditions required for the operational safety and habitability of the main control room must perform the following:

- maintenance of ambient conditions within acceptable limits (temperature, fresh air, remove waste heat of equipment, contamination and cleanliness) to enable staff access and the correct operation of equipment, noting the outside temperatures defined in Sub-chapter 13.1, repeated in section 1 of this sub-chapter and the heat losses of equipment.

c) Cooling support systems for the safety-classified ventilation systems must perform the following:

- maintain circulation of chilled water in the cooling coils of the ventilation systems

0.3. DESIGN REQUIREMENTS

0.3.1. Requirements arising from safety classification

- Classification: the ventilation systems are safety-classified in accordance with principles in Sub-chapter 3.2.
- Single failure criterion: the design of F1-classified systems must meet the single failure criterion.
- Backed up electrical supplies:
  - F1 components must be powered by the main emergency diesel generators.
  - The safety related components of the HVAC system must be powered by the ultimate emergency diesel generators, as follows:
    - Elements contributing to the containment of radioactivity during Severe Accident
    - Supporting systems
- Qualification to operating conditions: elements of the ventilation and cooling systems must be qualified to accomplish their safety function at the ambient conditions to which they are subject while fulfilling their function.

Mechanical, electrical and instrumentation and control classifications: these classifications are given in Sub-chapter 3.2.

- Seismic classification: this classification is given in Sub-chapter 3.2.
- Periodic tests: the availability of safety-classified systems must be confirmed periodically to a satisfactory degree of confidence.

0.3.2. Other regulatory requirements

- Technical Guidelines: general compliance with Technical Guidelines is specified in Sub-chapter 3.1. In particular, a list of iodine rooms and related requirements must be defined.

0.3.3. Hazards

The general requirements for consideration of hazards are defined for external hazards and internal hazards in Sub-chapter 3.1.

In particular, for ventilation systems:

- The ventilation systems must be designed to maintain specified ambient conditions in extreme cold and extreme hot.

- Fire: the ventilation systems must be designed in accordance with fire protection rules: in the event of fire, fire dampers or fire-proof ducts are required to isolate the affected compartment.

- External explosion: where necessary to protect against external explosion, explosion-proof dampers are installed in air-intakes and air exhaust in buildings when it is necessary.

0.4. TESTS

0.4.1. Pre-operational testing

The commissioning tests must demonstrate that the system functional characteristics correspond to the design, specifically with regard to flow rates, temperatures and automatic sequences.

The efficiency of HEPA filters and iodine filters is confirmed by tests. The efficiency required for new filters is detailed in section 1 of this sub-chapter.

0.4.2. Periodic tests

Safety-classified systems must be designed to allow periodic tests to be performed.

1. GENERAL DESIGN CRITERIA

The heating, ventilation air-conditioning and cooling systems are described in section 2 of this sub-chapter and subsequent sections [Ref-1]. Their general design objectives and a description of the equipment and the inspection and testing requirements are described below.

1.1. GENERAL DESIGN OBJECTIVES

The purpose of the ventilation systems is as follows:

- to maintain ambient conditions within acceptable limits (temperature, humidity and contamination) for staff and equipment
- to protect staff and materials against specific risks from the inside of the buildings (suffocation, explosion, fire) and from outside (see Sub-chapter 3.1).
- to monitor and limit radioactive discharges during normal operation and in accident conditions (containment function).

The following conditions are assumed in designing the ventilation systems:

To ensure no corrosion phenomena occur due to climatic or weather conditions, the following equipment is made of stainless steel:

- The air intake and exhaust grids.
- The first exchangers and heaters on the air supply trains.
- All the isolation, control or back draft dampers.
- All the ducts before the first heat exchangers of the fresh air supply files.

Atmospheric conditions

Summer conditions:

The average 12 hour maximum temperature is distinguished from the instantaneous maximum temperature.

- The average 12 hour temperature is considered for buildings with high thermal inertia, ventilated by systems including air cooling; this is the case for most of the nuclear island buildings: safeguard auxiliary building including electrical rooms, nuclear auxiliary building, fuel building.
- The instantaneous temperature is considered for external equipment and for buildings without significant thermal inertia: this is the case for the diesel generator building (fresh air ventilation, without cooling).

In Sub-chapter 13.1, temperatures are given for the standard and for the cold seafront conditions.

Systems in the nuclear island are designed for cold seafront temperatures as follows (The figures are given for information – these references will be replaced by site-specific figures once these are known):

- DEL [SCWS], the units of trains 1 and 4 are cooled by air: 42°C, relative humidity 29%
- DCL [CRACS], DVL [SBVSE], DWN [NABVS], DWK [FBVS], DWL [CSBVS], EDE [AVS], DWQ [ETBVS]: 36°C, relative humidity 40%
- DVD: 42°C, relative humidity 29%

Systems associated with site buildings are designed using site specific conditions:

- Administration offices (DVB), DWB, DVP: 32.4°C, relative humidity 49%

Moreover, an average 24 hour temperature is defined to calculate the solar heat loads on the walls. This temperature is:

- 33.2°C for the cold seafront conditions

Winter conditions:

The assumed minimum design temperature values and the related durations are given below (French standard references – these references will be replaced by site-specific figures once these are known):

- -15°C in permanent operation; this corresponds to the basic design
- -25°C for 7 days (“extreme cold” design, operation referred to as short-term)
- -35°C for 6 hours (“extreme cold” design, operation referred to as instantaneous)

The associated relative humidity is 100%.

The short term temperature is used to design the heating systems for components required to be protected during extreme cold events.

<u>Interior conditions</u>

In PCC-1 and PCC-2 conditions, for basic atmospheric conditions, the temperature in the various rooms is defined in Section 9.4.1 - Table 1.

Exceptional ambient conditions to be maintained in rooms are given in Section 9.4.1 - Table 2 and Table 3.

Maintaining these temperatures ensures proper operation of safety classified components. In particular:

- The minimum temperatures to be maintained in extreme cold are given in Section 9.4.1 - Table 2.
- The maximum temperatures to be maintained in RRC-A conditions for electrical rooms are given in Section 9.4.1 - Table 3.

The ventilation systems are designed for basic atmospheric conditions and to maintain the temperatures presented in Section 9.4.1 - Table 1. It is important to check that the (less restrictive) temperatures given in Section 9.4.1 - Table 2 and Section 9.4.1 - Table 3 are met under corresponding conditions.

Auxiliary fluids

- DER:

Supply temperature: 5°C; return temperature: 10°C.

- DEL [SCWS]:

Supply temperature: 5°C; return temperature: 10°C.

- RRI [CCWS]:

In PCC-1: Max. supply temperature: 35°C.

In PCC-2 to PCC-4: Max. supply temperature: 45°C

- SEL hot water system:

Supply temperature: 90°C; return temperature: 70°C.

- Water systems to feed the humidifiers:
  - SEP (drinking water) in none controlled areas
  - SED (demineralised water) in controlled areas

1.2. GENERAL DESIGN CHARACTERISTICS

1.2.1. Characteristics of controlled areas

General Characteristics:

In controlled areas the extraction flow rate is higher than the air supply flow in order to maintain sub-atmospheric pressure and hence containment of radioactivity. This containment is ensured by monitoring the supply flow rate in relation to the sub-atmospheric pressure in a pilot room.

The new air is generally distributed in the corridors. It is then transferred to those rooms with a higher risk of contamination.

The general exhaust from each system is collected and discharged so as to minimise the possibility of it being drawn into the air inlets.

All the air extracted from a controlled area is filtered and directed to the stack, where it is checked before discharge into the environment.

In the controlled areas, the minimum air renewal rate depends on the radiological risk associated with the room:

- rooms with iodine risk: 4 air changes/hr
- rooms with aerosol or non-fixed atmospheric contamination risk: 2 air changes/hr
- rooms without aerosol or non-fixed atmospheric contamination risk: 1 air changes/hr
- laboratories: 8 air changes/hr

<u>Characteristics of rooms with iodine risk:</u>

The extraction flow rates of lines containing iodine filters are minimised in order to:

- reduce the radwaste consequences of periodic replacement of iodine filters
- limit electrical power consumption of heaters upstream of the iodine filters.

A room must be considered a room with iodine risk if:

- the presence of gaseous iodine is possible
- <u>or</u> it contains pipework containing fluid with the following features:
    - its specific activity is greater than 1% of that of the primary coolant in normal operation
    - its temperature in normal operation is higher than 60°C

For these “iodine risk rooms”, the following design measures are applied:

- minimum air renewal rate must be 4 air changes/hour
- differential pressure between the iodine room (or groups of rooms) and adjacent rooms is maintained at 20 Pa minimum.

For the EPR facility, these criteria and design measures are applicable in normal operating conditions to the iodine risk rooms in the Fuel Building, Nuclear Auxiliary Building, the controlled area of Safeguard Buildings and the Effluent Treatment Building.

For other operating conditions, these design criteria and measures are adjusted. The main requirement is to limit the flow up the stack in order to limit offsite discharge, in the event of accidents (LOCA in the Safeguard Building and fuel handling accidents in the FB). The 20 Pa limit is not required to achieve this objective, but an appropriate transfer of air must be ensured.

A major design improvement of the EPR is that the extraction from every room in the Reactor Building, Fuel Building, Nuclear Auxiliary Building, controlled area of Safeguard Building, and the controlled area of the Effluent Treatment Building can be directed to an iodine filter if necessary.

More specifically for the DWN [NABVS] system:

- When contamination is localised, extraction from each room of the Fuel Building, Safeguard Building and Nuclear Auxiliary Building (at most three of the six cells at the same time) may be directed to an iodine filter and the above criteria are met.

- In the event of non-localised contamination, the overall extraction flow rate is reduced and the above criteria are not met, but potentially contaminated room are kept sub-atmospheric.

- During plant shutdown, the gas purging the Reactor Building (EBA [CSVS]) is continuously filtered by an iodine filter.

1.2.2. Characteristics of uncontrolled areas

The ventilation system can operate in recycling mode. The required air renewal rate depends on occupancy, with a minimum of 0.5 air changes/hour.

The discharged air is vented to the atmosphere without filtering.

1.2.3. Specific case of rooms with risk of explosive atmosphere

(See Sub-chapter 13.2).

Areas presenting a risk of explosive atmosphere, other than the reactor building, are ventilated with a minimum air change rate of 4 air changes/hr. Measures are taken to avoid local accumulation of an explosive atmosphere (e.g. no dead air pocket in the rooms). The transfer of air from an area at risk to an area not at risk is prohibited.

The battery rooms must have a ventilation system that limits the hydrogen content to below the Lower Explosive Limit. If there is a risk of an explosive atmosphere being produced (e.g. due to failure of the ventilation system), an alarm is sent to the control room.

The extraction flow rate from battery rooms is determined according to the following formula [Ref-1]:

$$\mathbf{Q = 0.05\ N\ I}$$

Where: Q: air flow (m^3/hr)

N: number of cells in the battery

I: maximum charging current (A)

When the battery characteristics are not known, a renewal rate of 10 air changes/hour is applied.

1.2.4. Equipment used in ventilation systems

Equipment requiring seismic qualification and supports, foundations, etc., will be given specific attention.

The equipment is installed according to rules that facilitate operation and maintenance.

a) Air inlet pre-filters

The filters used at air inlets are used to filter atmospheric dust. These filters normally have a relatively low efficiency but a higher efficiency filter may be used depending on site specific conditions such as a lot of dust due to an industrial or agricultural environment.

b) Extraction pre-filters

The pre-filters used for extraction, upstream of the HEPA filters, are designed to lengthen the service life of HEPA filters by filtering large particles from the air flow.

c) High Efficiency Particulate Air filters (HEPA)

When new, these filters have a Decontamination factor of at least 3000, corresponding to 99.97% efficiency.

Safety-classified filters have an efficiency of 1000 in operation.

Efficiency levels are measured using the NF X 44011 standard [Ref-1].

d) Iodine filters

Iodine filters are used in the various ventilation systems to absorb radioactive iodine suspended in the air flow. When new, these filters have a decontamination factor of at least 1000 (methyl iodide). In operation, they have minimum decontamination factor of 100 in safety-classified systems (filters required in the event of accidents) and 10 for other systems (operational filters).

e) Iodine filter heaters

Iodine filter heaters are located upstream of the iodine filters to limit relative humidity to 40% maximum.

f) Cooling coils

The ventilation systems use cooling coils constructed of finned tubes in the air-conditioning cycle. Droplet separators and drain funnels are provided to collect and remove the condensates. The coils are cooled by chilled water (from the DEL [SCWS] or DER) and/or by the component cooling system (RRI [CCWS]) in the reactor building.

g) Air supply/recycling/extraction fans

Fans used in the ventilation systems are supply, recycling or extraction fans. They are centrifugal or axial, depending on the system flow rate and head loss. They are electrically driven.

h) Heating methods

The ventilation systems use electrical heaters or heating coils (heated by a hot water system). In areas carrying the risk of an explosive atmosphere (battery rooms, etc.) the heaters or heating coils are explosion-proof.

i) Humidifiers

Humidifiers are installed to ensure the required ambient humidity where necessary.

1.3. GENERAL DESCRIPTION OF EQUIPMENT

The design characteristics of the main mechanical equipment used in the ventilation systems are described below:

a) Centrifugal fans

These are non-overloading direct-drive fans (the motor power is sufficient over the entire power curve of the fan), with backward curved blades and static and dynamic balancing. Some fans (DWN [NABVS] for example) have a variable-speed motor.

b) Axial fan

These fans are a direct drive, non-overloading fan, with static and dynamic balancing.

c) Coils

The coils are constructed from continuous copper tube with fins. They are formed to ensure a continuous and uninterrupted flow of water in each tube.

d) Electrical heating

The heaters comprise reinforced tubular elements in a sheet metal box.

e) Filters

The filters are made from cells with standard dimensions. The filtering medium is disposable. The filtering layer is made from fibreglass, unless stipulated otherwise. The cells are mounted on painted carbon steel platforms or in airtight filter boxes.

f) Iodine filters

The iodine filters are refilled and are placed all together into an airtight box.

g) Fan coil units

These units provide heating (when they are known as ‘unit heaters’) or cooling (i.e. local air-conditioning units) in a room.

A unit heater comprises a fan section and a heating section. The casing is made from thick steel. A direct drive axial fan is used. The heating device is either electrical or has a hot water supply.

A local air-conditioning unit is equipped with a fan and a cooling coil supplied with chilled water.

h) Independent air-conditioning units

The independent air-conditioning units are equipped with a filter, a fan and a cooling coil supplied by a cooling system built into the unit. The cooling system is associated with an air condenser (separate element) or a water condenser (built in).

An independent air-conditioning unit can also house an electrical or hot water coil as well as a humidifier as required.

All the equipment is housed in a compact metal chassis with double-walled insulated panels.

i) Humidifiers

The humidifiers are independent units that inject steam at the required rate directly into the ducts.

j) Fresh air intakes

The air inlets are fitted with a bird-proof grid and a rain shield. They are designed to prevent the formation of frost. They may be fitted with soundproofing devices as required.

Where necessary to meet safety requirements, external air inlets of classified buildings are designed with explosion-proof protection to protect the system against external explosions defined in Sub-chapter 13.1.

SECTION 9.4.1 - TABLE 1

Environmental Conditions for PCC-1 and PCC-2

For PCC-1 and PCC-2 events under basic atmospheric conditions, with the unit in operation or at shutdown, the ventilation systems maintain the following environmental conditions:

Areas	Minimum Temperature	Maximum Temperature	Relative Humidity
Reactor building			
• Service area (during access)	15°C	30°C	< 45%
• Equipment compartment			
- average value	15°C	53°C	
- maximum local admissible value		60°C	Not controlled
• reactor pit		75°C	
Annulus (presence of piping containing 2000 ppm boric acid)	7°C	45°C	Not controlled
Electrical areas of Safeguard Buildings			
• Main control room	20°C	26°C	Not controlled
• Offices, kitchen	20°C	26°C	30%<RH<70%★★★
• Bathrooms, cloakrooms	20°C	26°C	Not controlled
• Computer instrumentation and control remote shutdown station	15° C	30°C	Not controlled
• Electrical rooms	15°C	30°C ★	Not controlled
• Cable trays	5°C	35°C	Not controlled
• Battery rooms	18°C	25°C	Not controlled
• Ventilation equipment rooms	10°C	35°C	Not controlled
Nuclear Auxiliary Building, Fuel Building, mechanical areas of Safeguard Buildings, Effluent Treatment Building:			
• Laboratory	18°C	26°C	Not controlled
• Frequent and long occupation (green zone)	15°C	33°C	Not controlled
• Frequent and short or infrequent and long occupation (yellow zone)	10°C	38°C	Not controlled
• Infrequent and short occupation (orange and red zones)	10°C	45°C	Not controlled
• Exceptions			
- fuel handling hall	20°C	33°C	Not controlled
- "Boron" rooms (Bo1, Bo2, Bo3)	20°C ★★	depends on occupation	Not controlled
• HVAC technical room	10°C	35°C	Not controlled
Diesel Generator Buildings			
• diesel hall	10°C	50°C	Not controlled
• diesel electrical rooms	10°C	35°C	Not controlled
Main steam valve rooms	10°C	40°C	Not controlled
Pumping station:			
• electrical rooms	15°C	30°C	Not controlled
• other rooms	5°C	40°C	Not controlled

★ The specific authorised outlet temperature for transformer, rectifier and inverter hoods is 45°C.

★★ For “Boron” rooms, the temperature must always be kept above 20°C in order to avoid any possible crystallisation.

There are three main types of “Boron” room:

- Bo1 (7000 ppm and safety-classified):
    - The minimum temperature must be ensured in all cases.
- Bo2 (7000 ppm but not safety-classified)
    - The minimum temperature need only be ensured when the ventilation system is operating normally.
- Bo3 (2000 ppm and safety-classified)
    - The minimum temperature must also be ensured when the ventilation system is shutdown.

The minimum temperature must be ensured during maintenance of ventilation systems.

★★★ In the main control room, humidity is controlled for the operator comfort.

SECTION 9.4.1 - TABLE 2

Exceptional Minimum Temperatures to be maintained in Equipment Rooms

Equipment	Min. Temperature
Pure water system	> 0°C
Fire detection equipment	> 0°C
2200 ppm borated water system (without margin)	5°C
2200 ppm borated water system (with margin)	7°C
7000 ppm borated water system	18°C★
Pump with oil tank	8°C
Main control room	10°C
Instrumentation and control equipment	5°C
Electrical rooms – transformers – rectifiers – inverters	5°C
Computer rooms and adjacent rooms	10°C
Battery rooms	18°C

★ 18°C is the minimum temperature required to prevent crystallisation of 7700 ppm borated water (A10% boron concentration margin is included).

SECTION 9.4.1 - TABLE 3

Maximum Exceptional Temperatures

Equipment	Max. temperature
Main Control Room	32°C
Instrumentation and control equipment	40°C
Electrical rooms – transformers – rectifiers - inverters	40°C★
Computer rooms and adjacent rooms	40°C
Battery rooms	35°C
Room ventilated by a non-classified HVAC system and including safety related electrical component(s)	60°C★★

★ The maximum authorised outlet temperature for transformer, rectifier and inverter hoods is 50°C.

★★ This is a general case. Higher values can be used where a specific justification is made. This may be restricted to particular components following identified events.

SECTION 9.4.1 - TABLE 4

Airtightness requirements for HVAC components

Airtight component	Internal leakage rate	Leakage to the environment
Isolating damper or check damper M2	0.1 $m^3/h/m^2$ at 1 bar, 20°C, ΔP of 2000 Pa	0.01 $m^3/h/m^2$ external area ★★ under 1 bar, 20°C, ΔP of 2000 Pa
Isolating damper M3★	10 $m^3/h/m^2$ at 1 bar, 20°C, ΔP of 2000 Pa	1.5 $m^3/h/m^2$ external area ★★ under 1 bar, 20°C, ΔP of 20000 Pa
Check damper M3★	200 $m^3/h/m^2$ at 1 bar ΔP of 2000 Pa	1.5 $m^3/h/m^2$ external area ★★ under 1 bar, 20°C, ΔP of 2000 Pa
Filter or iodine trap housing M2 or M3★	3 10^{-5} of nominal flow rate ΔP of 2000 Pa	0.1 Number of air changes/hr
Duct, fans, cooling or heating coils M2	-	0.01 $m^3/h/m^2$ external area ★★ at 1 bar, 20°C, ΔP of 2000 Pa
Duct, fans, cooling or heating coils M3*	-	1.5 $m^3/h/m^2$ external area ★★ at 1 bar, 20°C, ΔP of 2000 Pa

★ M3 in the case of prevention of contamination outside

★★ External area is defined in accordance with EN1751 standard.

2. NUCLEAR AUXILIARY BUILDING AND FUEL BUILDING VENTILATION SYSTEMS (DWN [NABVS] AND DWK [FBVS])

2.1. ROLE OF THE SYSTEMS

2.1.1. Functional role of the systems

The Nuclear Auxiliary Building Ventilation System (DWN [NABVS]) and its extension, the Fuel Building Ventilation System (DWK [FBVS]) operate continuously. They are designed for the following purposes:

- to keep the ambient conditions within limits prescribed for correct operation of equipment and/or staff in normal operation (air supply and filtering, heating/refrigeration/humidity),
- to ensure during normal operation that contamination is contained at source to avoid its spreading from potentially contaminated areas to potentially less contaminated areas,
- to reduce the concentration of aerosols and radioactive gases in the atmosphere,
- to keep a negative pressure in the Nuclear Auxiliary Building and the Fuel Building compared to the outside pressure using an automatic control damper in the air supply trains.

Furthermore, the DWN [NABVS] system is designed for the following:

- to ensure the conditioning, extraction and filtering of air supplied and exhaust by DWK [FBVS],
- to ensure the operational extraction and filtering of the air exhaust by DWL [CSBVS] (see section 6 of this sub-chapter),
- to ensure during plant outages, the conditioning, extraction and filtering of the air from the purging ventilation system of the containment: high-capacity EBA [CSVS] (see section 5 of this sub-chapter),
- during the operation of the plant, to ensure the conditioning of the air from the purging ventilation system of the containment: low-capacity EBA [CSVS] (see section 5 of this sub-chapter),
- to reduce the radioactivity of the air discharged to the stack during normal operation,
- to isolate the air intake and the extraction from the Nuclear Auxiliary Building in the event of an earthquake.

In addition, the DWK [FBVS] system prevents condensation on the walls of the rooms that are in contact with the outside and more specifically on the walls of the fuel handling hall.

2.1.2. Safety role of the systems

The general safety requirements are given in section 0 of this sub-chapter and the specific requirements are given below:

The safety roles of the DWN [NABVS] system are as follows:

- to isolate the air inlet and extraction to and from the Nuclear Auxiliary Building in the event of an earthquake
- to extract air (HEPA and iodine filtration included) to reduce radioactivity of the air discharged to the stack
- to maintain a negative pressure in the Nuclear Auxiliary Building.

The safety roles of the DWK [FBVS] system are as follows:

- to automatically isolate the fuel pool hall air supply and extraction in the event of a fuel handling accident in this hall (PCC-4). In this case, the fuel pool hall dynamic containment is ensured by DWL [CSBVS] extraction system
- to preventively isolate the air supply and extraction in front of the equipment hatch when it is open, in the event of a fuel handling accident in the Reactor Building (PCC-4)
- to automatically isolate the air supply system and to preventively isolate the extraction system in front of the emergency airlock in the event of a fuel handling accident in the Reactor Building (PCC-4)
- to automatically isolate the fuel pool hall air supply and extraction in the event of failure of the two main lines of the fuel pool cooling system (RRC-A)
- to ensure the static containment of the Fuel Building in the event of a LOCA (PCC-4), or loss of the four main diesels and the two SBO diesels. The dynamic containment of the leaks from the Reactor Building to the Fuel Building is provided by the low-capacity EBA [CSVS]
- to maintain temperature in rooms for correct operation of classified equipment and more precisely cooling in RBS [EBS] pump rooms, heating in RBS [EBS], RCV [CVCS] rooms , REA [RBWMS] and in PTR [FPC(P)S] boron rooms
- to maintain a negative pressure in the Fuel Building.

N.B. for fuel handling accidents in the Reactor Building, containment is achieved by the low-capacity EBA [CSVS] system.

2.2. DESIGN BASES

<u>Air-supply conditions</u>

The air-supply characteristics of the DWN [NABVS] system in design conditions are as follows:

- Summer: 18°C

- Winter : 18°C

The design conditions (temperature and humidity) are defined in section 1 of this sub-chapter.

Auxiliary fluids

During the summer, the blown air is cooled by cooling coils supplied by the DER chilled water system (see section 11 of this sub-chapter).

During the winter, the blown air is heated by heating coils supplied by the SEL electrically-produced hot water system.

Conditions in rooms:

Air flows in the rooms are calculated taking account of both the minimum air change rate and the use of equipment and lighting.

Temperatures to be maintained in the rooms are given in Section 9.4.1 - Table 1.

The minimum temperatures are only guaranteed when the ventilation system is operating normally.

Minimum air change rates:

Air change rates are given in section 1 of this sub-chapter.

2.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

A diagram of all ventilation systems in the Nuclear Auxiliary Building, Fuel Building, Safeguard Building and Reactor Building is provided in Section 9.4.2 - Figure 1.

The flow rates are given for information only and remain to be validated by detailed studies.

DWN [NABVS] (See Section 9.4.2 - Figure 2 to Figure 4):

The DWN [NABVS] ([Ref-1] to [Ref-6]) comprises an air supply plant, an extraction plant with permanent filtering by HEPA filter, an iodine extraction plant, an air supply duct network, an extraction duct network and a vent stack.

The air supply plant includes the following:

- an external air inlet on the wall of the Nuclear Auxiliary Building with a protective grid and a rain barrier
- a concrete air intake plenum
- three trains of 33% capacity, mounted in parallel, each equipped with the following:
    - an automatic isolation damper
    - a pre-heating coil supplied by the hot water system (SEL)
    - a 2-stage filtering system

- a cooling coil supplied with chilled water (DER)
- droplet eliminator connected to the Nuclear Island Vent and Drain System (RPE [NVDS])
- a heating coil supplied by the hot water system (SEL)
- a silencer with sound attenuating baffles
- a manual isolation damper

- a concrete plenum,
- four redundant, 50%-capacity fans installed in parallel
- a supply air silencer with sound attenuating baffles
- an automatic control damper in the supply air for keeping sub-atmospheric in the Nuclear Auxiliary Building.

The extraction network comprises seven independent sub-networks:

- One for each of the six cells of the Nuclear Auxiliary Building, Fuel Building and Safeguard Building: cells no.1, 2 and 3 for the Nuclear Auxiliary Building, cells no. 4 and 5 for the Fuel Building and cell no. 6 for the mechanical parts of the four Safeguard Buildings
- One for the High-capacity EBA [CSVS] in the Reactor Building

The continuous extraction plant equipped with HEPA filters includes the following components:

- seven metal chambers mounted in parallel, each including a pre-filter and a HEPA filter with automatic control damper to keep a constant flow rate, inlet and outlet isolation damper
- a concrete plenum
- four redundant fans installed in parallel, each providing 50% capacity
- a shared concrete duct to the vent stack
- a silencer (pressure side) in a common concrete duct, with sound attenuation baffles

The iodine filtering includes the following elements:

- a concrete plenum
- trains mounted in parallel, each equipped with the following:
    - inlet and outlet automatic isolation dampers
    - inlet and outlet fire dampers
    - an electric heater

  - o an iodine trap

- a concrete plenum
- four redundant “booster” fans mounted in parallel each providing 25% capacity

The vent stack is installed on the reinforced structure of the Balance of Nuclear Island area, at the connection between the Fuel Building and the Nuclear Auxiliary Building. Other ventilation systems are directly connected to the stack. These are the low-capacity EBA [CSVS], the DWL [CSBVS], the DWB, the DWW [ABVS], the DWQ [ETBVS] and the EDE [AVS].

Recirculation cooling units are installed in the three vapour compressor rooms, in switchgear rooms and transformer rooms, and in the exhaust air fan room.

Local electrical heaters are installed in several rooms to maintain ambient conditions during the winter period and more particularly in Bo2-classified rooms to maintain a temperature of 20°C and to avoid boron precipitation.

<u>DWK [FBVS] (see Section 9.4.2 - Figure 5):</u>

The DWK [FBVS] ([Ref-7] to [Ref-12]) comprises an air supply duct network and an extraction duct network.

The air supply duct network is connected to the DWN [NABVS] main air-supply duct.

The extraction duct network comprises two separate networks that correspond to cells no. 4 and 5. These two networks are connected to the DWN [NABVS] extraction plant upstream of the filtering chambers.

The static containment of the Fuel Building is ensured by isolation dampers located at the air supply and at the extraction.

The dynamic containment in the Fuel Building is ensured by the difference between the air supply and exhaust flow rate. The regulation is by means of an air supply motor driven damper.

Local cooling units are installed in the PTR [FPC(P)S] (purification pumps), RCV [CVCS] (motors of the high pressure charging pumps), REA [RBWMS] (boric acid makeup pumps, transfer from storage tank pump) and RBS [EBS] rooms and in the loading area monitoring room to maintain temperature in accordance with equipment requirements. The chilled water for the local cooling units is provided by the DEL [SCWS] system in the RBS [EBS], RCV [CVCS] and REA [RBWMS] boric acid makeup pumps rooms and by the DER system in the PTR (FPC(P)S], REA [RBWMS] transfer from storage tank pump rooms and in the loading area monitoring room.

<u>Characteristics shared by the DWN [NABVS] and the DWK [FBVS]:</u>

Electrical convection heaters are installed in “boron” rooms when detailed studies demonstrate their usefulness; fan coil heaters are used to heat large volume rooms.

The fume chambers and the sampling glove boxes are filtered by specific REN [NSS] iodine filters (see section 1 of Sub-chapter 9.3). The specific REN [NSS] extraction fans are connected to the DWN [NABVS] (or the DWK [FBVS]) extraction ducts.

The thermal flow rates and heat exchange rates will be confirmed by detailed studies.

2.4. OPERATING CONDITIONS

2.4.1. Normal operation of the plant

The systems are used when the plant is in operation or shutdown.

Plant operation

The DWN [NABVS] [Ref-1] system operates continuously. No air is recirculated because of the potential for the presence of airborne contamination in certain areas. The pressure differential of 100 Pa inside the Nuclear Auxiliary Building with respect to the outside is maintained automatically.

The air supply rate is constant and distributed:

- to the Nuclear Auxiliary Building
- to the Fuel Building

When the air supply of the small-capacity system EBA [CSVS] of the Reactor Building is open, the air supply rate increases.

The extraction concerns:

- the Nuclear Auxiliary Building
- the Fuel Building
- the entire controlled area of the four Safeguard Buildings

The DWN [NABVS] fan flow rate is adjusted by variable fan speed.

Plant outages

During outages of the plant, the air-supply and extraction plants provide the ventilation described above, simultaneously with a purging air supply in the Reactor Building (provided by high-capacity EBA [CSVS] + low-capacity EBA [CSVS]), and extraction provided by high-capacity EBA [CSVS] and by the DWK [FBVS] for the material lock.

When the equipment hatch and the two airlocks are open, dampers located at the level of the air extraction from the emergency airlock and the personal airlock are closed and extraction is performed by the Reactor Building ventilation system.

The DWN [NABVS] fan flow rate is adjusted by frequency variation.

Presence of iodine in the rooms in the Nuclear Auxiliary Building, the Fuel Building or the Safeguard Building in normal operation.

In this situation, the air in the affected cells is processed by iodine filtering. A maximum of four cells can be switched automatically to iodine filtration but only three if the high-capacity EBA [CSVS] system is in use.

This state may be preceded, if the affected cell is not identified, by a transient start-up of iodine filtering (see section 2.4.3), the main consequence of which is to cause filtering at half-flow in all rooms (six cells) (only one of the main extraction and air supply fans remains in operation) until the affected cell has been identified. The unaffected cells are then directed to normal extraction.

The DWN [NABVS] fan flow rate is adjusted by frequency variation.

2.4.2. Accident conditions

Fuel handling accident in the Fuel Building

In this case, the air supply in the zone to be contained is isolated by closing the airtight dampers. The extraction via the DWK [FBVS] is isolated and directed to the DWL [CSBVS] system, equipped with a HEPA and iodine filter, which extracts only from the zones subject to potential leaks.

Fuel handling accident in the Reactor Building

The air supply and the extraction used during plant outages (high-capacity EBA [CSVS] system), and the low-capacity EBA [CSVS] system air supply, are isolated. The air supply and extraction (DWK [FBVS]), for the equipment area of the Fuel Building in front of the equipment hatch, are automatically isolated.

The air supply in the areas facing the emergency airlock and the personal airlock are automatically isolated.

Containment is ensured by the EBA [CSVS] low-capacity system equipped with a HEPA filter and iodine filter.

Loss Of Coolant Accident (LOCA)

In the event of LOCA, static containment of the Fuel Building is achieved by closing the isolation dampers located at the air supply and at the extraction of the normal ventilation of the Fuel Building. The static containment of the Fuel Building is carried out on a phase 1 containment isolation signal.

Moreover, the dynamic containment of the Fuel Building ensures collection and filtering before the release of any leak from the Reactor Building to the Fuel Building. The dynamic containment is ensured by the low-capacity EBA [CSVS], which is equipped with iodine filtration lines.

Station blackout (SBO)

In the event of SBO, static containment of the Fuel Building is achieved: The isolation dampers located at the air supply and at the extraction of the normal ventilation of the Fuel Building have a fail-safe closed position in the event of a loss of power supply.

Severe accident initiated by a LOCA

For this severe accident type, the phase 1 containment isolation signal leads to the same actions as for the LOCA (see Loss Of Coolant Accident above). These actions are performed before entry into severe accident management.

Loss of the 4 main diesels and the 2 SBO diesels

In the event of loss of the four main diesels and the two SBO diesels, static containment of the Fuel Building is achieved: The isolation dampers located at the air supply and the isolation dampers located at the extraction of the Fuel Building normal ventilation are closed (fail-safe closed position in the event of a loss of power).

Following recovery of the power supply, the Fuel Building is dynamically contained by the low-capacity EBA [CSVS]. For this, the EBA [CSVS] dampers connected to the accident extraction are opened and an iodine line is manually started.

Use of the RIS [SIS] in the Safeguard Building in the event of a LOCA

In this case, RIS [SIS] leaks may lead to an iodine activity level that is incompatible with discharge through the iodine filters in the DWN [NABVS] system. Discharge is thus performed using the DWL [CSBVS] system filters.

The DVL [SBVSE] normal air supply (see section 7) and extraction (DWN [NABVS]) to/from the mechanical Safeguard Building controlled areas are automatically shut off.

2.4.3. Transient states of the systems

Transient start-up of iodine filtration

In the event of iodine being released in the rooms of the Nuclear Auxiliary Building, the Fuel Building or the controlled areas of the Safeguard Building, and if the affected cell is not identified, extraction from the six cells is directed automatically to iodine filtering. This is achieved by start-up of two iodine extraction fans at full capacity and shutdown of one of the two operating extraction and air-supply fans.

In this configuration, extraction from all rooms is processed with iodine filtering. The air supply and extraction is operated at half capacity.

2.4.4. Other operating conditions of the systems

Loss of the hot water system (SEL)

When a signal is generated indicating that the air temperature is too low downstream of the pre-heating coils, the fans are automatically stopped and the dampers at the air inlet are automatically closed to prevent freezing of equipment.

Failure of the two main fuel pool cooling trains (Fuel Building)

The DWK [FBVS] isolating dampers in the fuel handling hall are closed.

Fire in an iodine filter

When a fire is detected, the operator is informed, the dampers located upstream and downstream of the iodine filter (which are flame arresters and designed to prevent smoke from spreading) are closed and the fan is automatically stopped.

2.5. PRELIMINARY SAFETY ANALYSIS

2.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

2.5.2. Compliance with functional criteria

The DWN [NABVS] and DWK [FBVS] contribute to limiting radioactive releases.

The air extracted is filtered by HEPA filters and iodine traps (in the event of iodine detection) before being discharged to the stack, in compliance with the requirements of section 0.2.

2.5.3. Compliance with design requirements

2.5.3.1. Safety classification

The design and production of materials and equipment complies with the requirements of the classification rules detailed in Sub-chapter 3.2.

2.5.3.2. Redundancy

The DWN [NABVS] and DWK [FBVS] systems are not required to meet the single failure criteria.

Only the dampers of the F1A-classified DWK [FBVS] system meet the single failure criterion and therefore have redundancy.

2.5.3.3. Qualification

Equipment is qualified in accordance with the requirements described in Sub-chapter 3.6.

2.5.3.4. Instrumentation and control

In general, the instrumentation and process control equipment is installed in the same electrical division as the controlled actuators.

2.5.3.5. Emergency electrical supplies

<u>Loss Of Offsite Power (LOOP)</u>

The fans are shut down on LOOP.

The DWN [NABVS] system is not backed up, except for the heating ensuring the minimum temperature given in section 1 above, which is backed up by power from the main diesel generators. In particular, the heating in the Boron Bo2 rooms (7000 ppm borated water non-safety system) has a powered back-up.

The DWN [NABVS] isolation dampers used in the event of a fuel handling accident in the Fuel Building or in the Reactor Building are automatically closed in the event of LOOP. Stable containment conditions are ensured.

The heaters units in the Boron Bo1 rooms and RBS [EBS] pump rooms are backed up by power from the main diesel generators.

The DWK [FBVS] local air-conditioning units in the RBS [EBS], RCV [CVCS] and REA [RBWMS] boric acid makeup pump rooms are backed up by power from the main diesel generators.

<u>Station blackout</u>

Systems are not provided with power in the event of station blackout.

2.5.3.6. Hazards

See Section 9.4.2 - Table 1 and Table 2

2.6. TESTS, INSPECTIONS AND MAINTENANCE

2.6.1. Tests

The safety functions are subject to periodic tests.

2.6.2. Inspections and maintenance

For the DWN [NABVS] system:

- In general maintenance is carried out preferentially during periods when the EBA [CSVS] system is not in use.

- The inspection and maintenance of supply and exhaust air fans can be performed during plant operations as well as during plant shut down since these components are designed with a 4 x 50% capacity. Only one supply fan and one exhaust fan would be inspected and maintained at the same time.

For the DWK [FBVS] system:

- Maintenance must be performed when fuel handling is not taking place.

2.7. FLOW DIAGRAMS

See Section 9.4.2 - Figure 1 to Figure 5

SECTION 9.4.2 - TABLE 1

Summary table for the protection of the DWN [NABVS] system against hazards

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Rupture of piping	No	-	-
Failures of tanks, pumps and valves		-	-
Internal missiles		-	-
Dropped Loads		-	-
Internal explosion		-	-
Fire		-	Fire dampers around the iodine traps (to limit the spread of the fire)
Internal flooding		-	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	No, except for dampers on the air inlets and exhaust	-	SC1 for dampers on the air inlets and exhaust
Aircraft crash	no	-	-
External explosion	no	-	-
External flooding	no	-	-
Snow and wind	no	-	-
Extreme cold	no	-	Heating for protection of systems of the Nuclear Auxiliary Building
Electromagnetic interference	no	-	-

SECTION 9.4.2 - TABLE 2

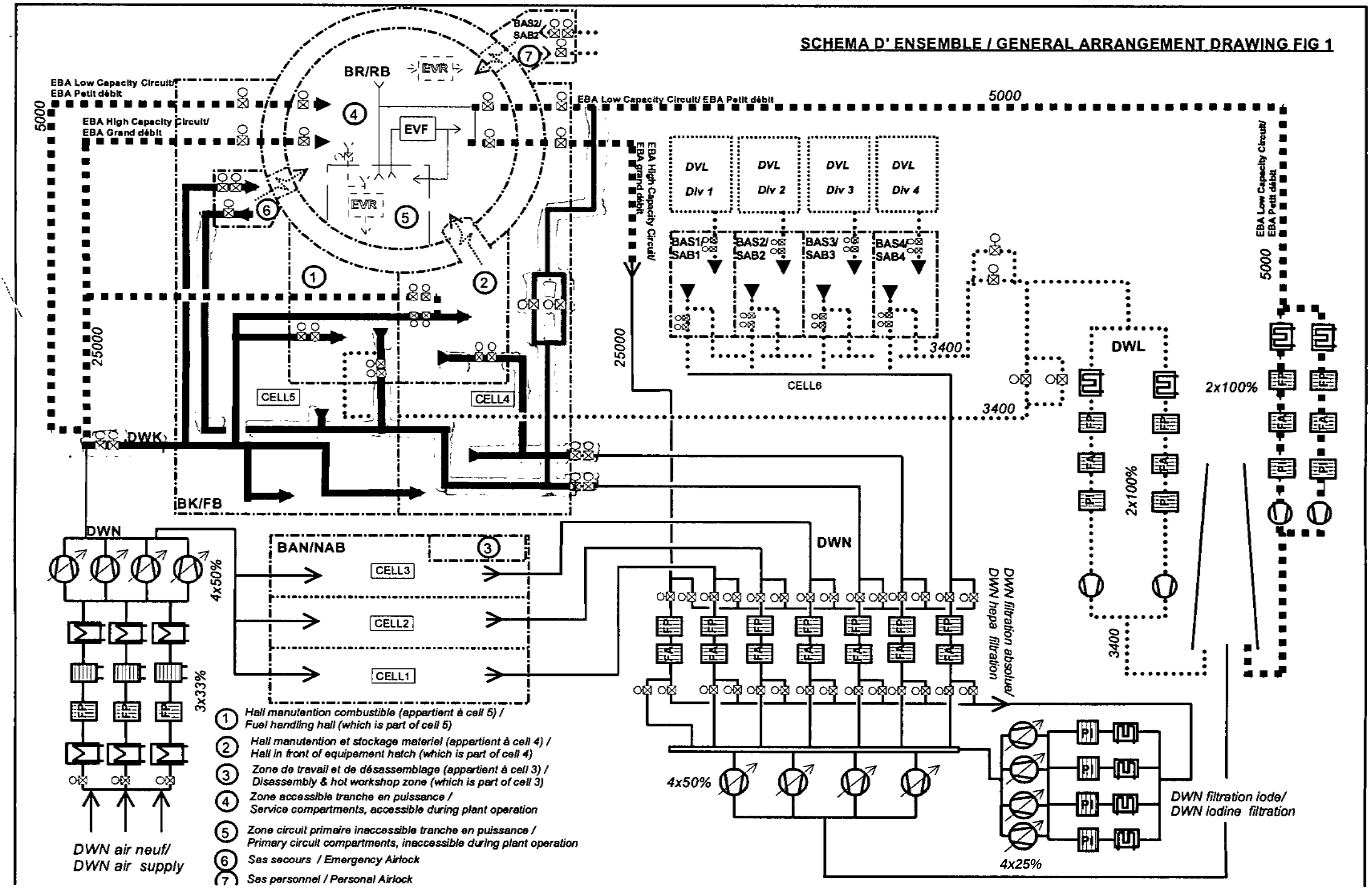
Summary table for the protection of the DWK [FBVS] system against hazards

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Rupture of piping	No loss of more than one train of the isolation dampers	Physical separation of redundant equipment	-
Failures of tanks, pumps and valves		Physical separation of redundant equipment	-
Internal missiles		Physical separation of redundant equipment	-
Dropped Loads		Physical separation of redundant equipment	-
Internal explosion		Physical separation of redundant equipment	-
Fire		Fire sectorisation in the Fuel Building	-
Internal flooding		Physical separation of redundant equipment	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	No loss of more than one train of the isolation dampers	Installation in the Fuel Building	SC1 for the classified parts
Aircraft crash		Installation in the Fuel Building	-
External explosion		Installation in the Fuel Building	No (no air inlet)
External flooding		Installation in the Fuel Building	-
Snow and wind		Installation in the Fuel Building	-
Extreme cold		Installation in the Fuel Building	Heating for protection of systems of the Fuel Building
Electromagnetic interference		Installation in the Fuel Building	-

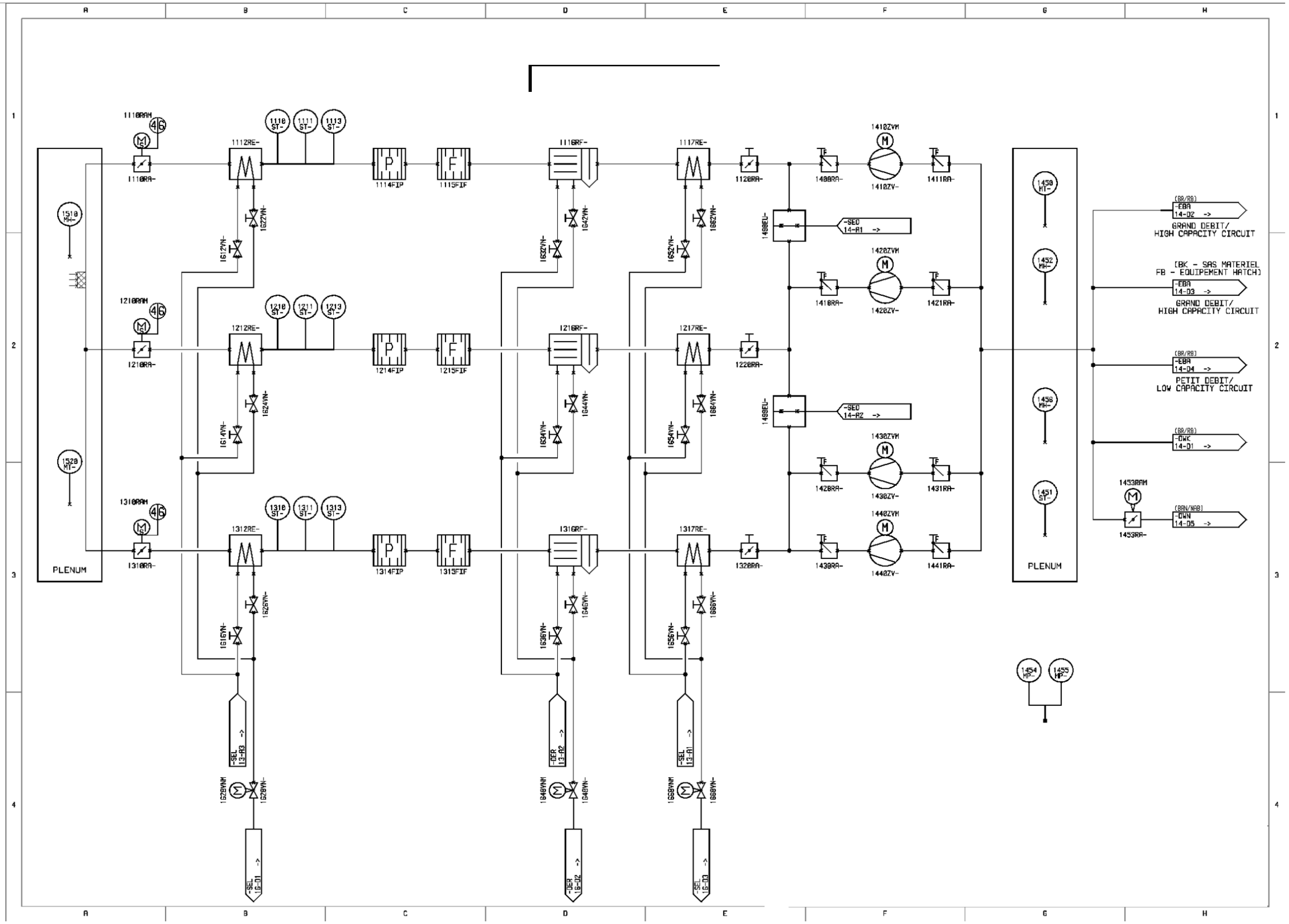
SECTION 9.4.2 - FIGURE 1

General Arrangement



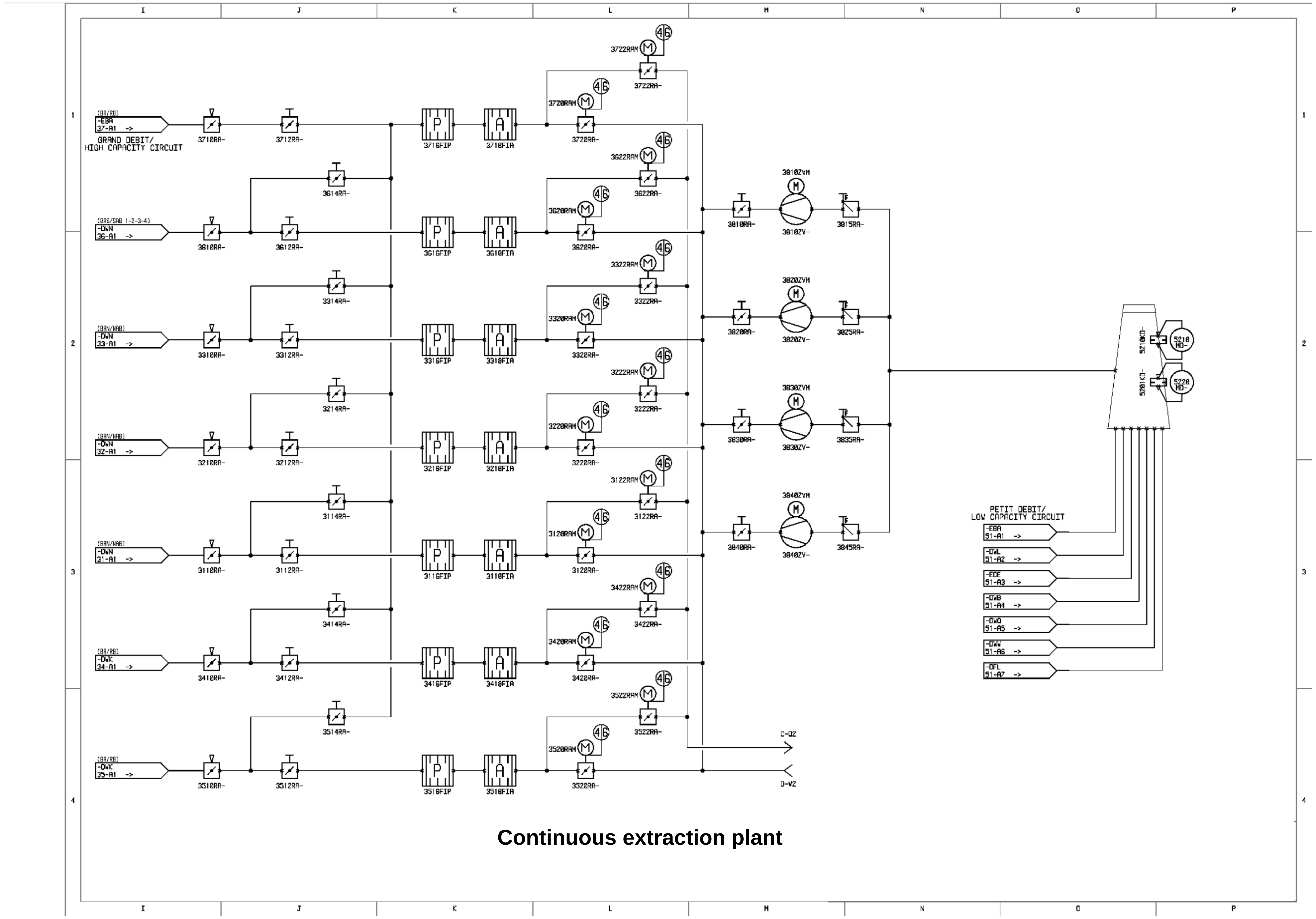
SECTION 9.4.2 - FIGURE 2

DWN [NABVS] Functional Flow Diagram



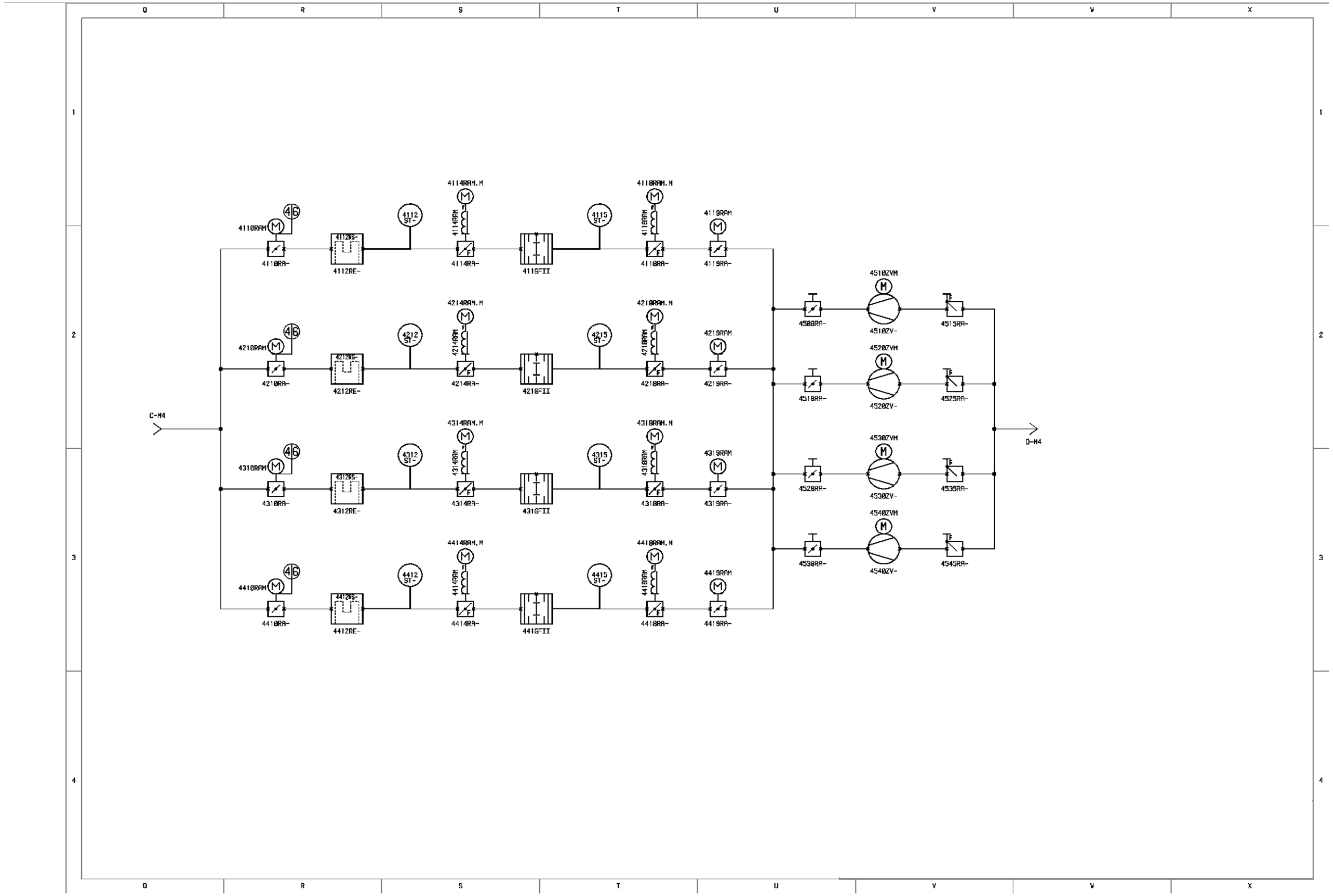
SECTION 9.4.2 - FIGURE 3

DWN [NABVS] Functional Flow Diagram



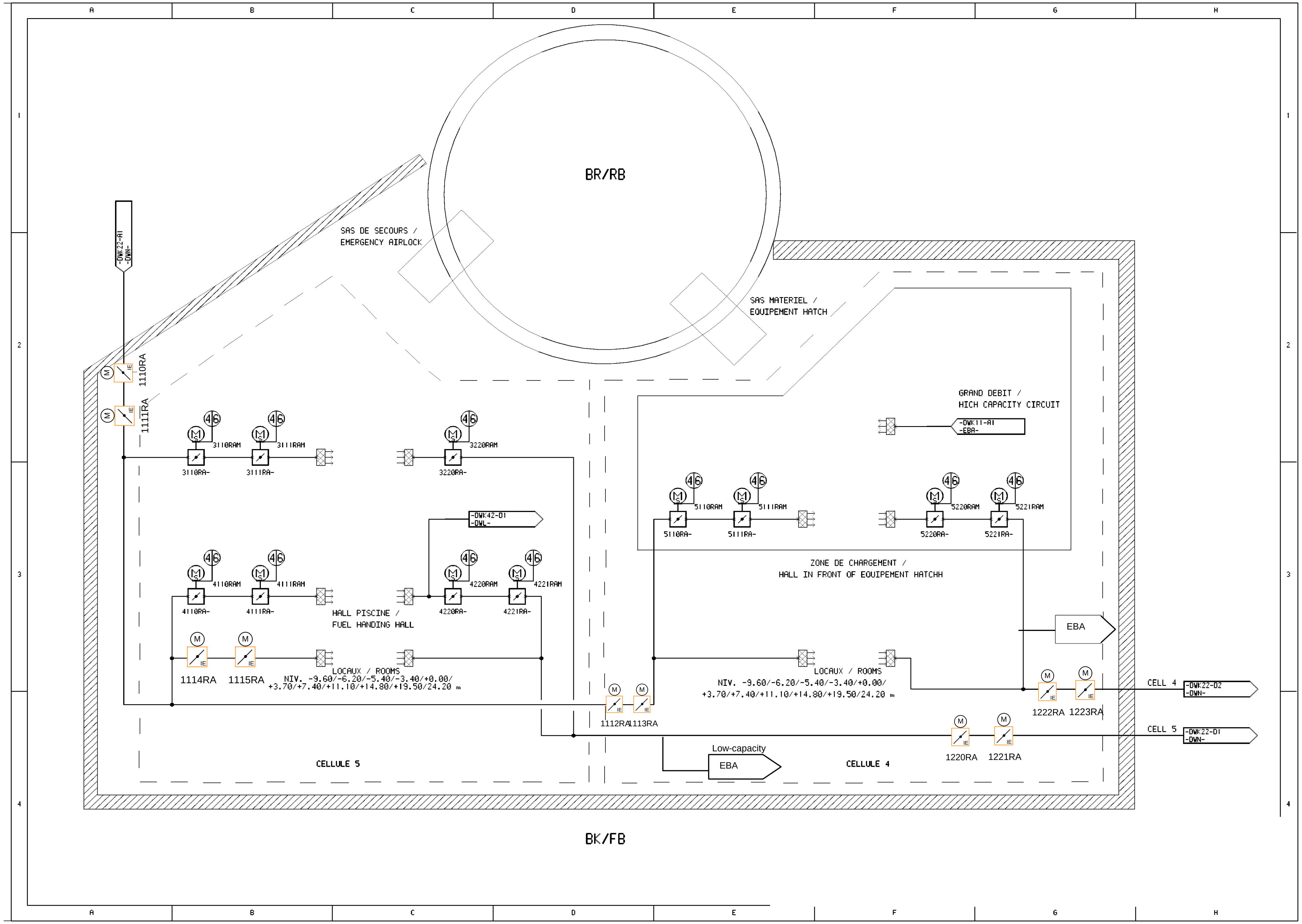
SECTION 9.4.2 - FIGURE 4

DWN [NABVS] Functional Flow Diagram



SECTION 9.4.2 - FIGURE 5

DWK [FBVS] Functional Flow Diagram



3. CONTAINMENT COOLING VENTILATION SYSTEM (EVR [CCVS]) [REF-1] TO [REF-7]

The paragraph below deals with the three Reactor Building ventilation systems that are the EVR [CCVS] (in this section), the EVF (in section 4) and the EBA [CSVS] (in section 5)

GENERAL DESIGN OF THE REACTOR BUILDING VENTILATION SYSTEMS

Access into the Reactor Building is permitted during plant operation:

- between seven days before and three days after a shutdown
- for planned maintenance operations
- for contingent maintenance operations

To enable access during power operation and to reduce the risk of radiological effects on staff, the containment is divided into two separate areas (see Section 9.4.3 - Figure 1):

- a service area, which is accessible during plant operation
- an equipment compartment

The equipment compartment of the Reactor Building is made up primarily of the following areas:

- rooms containing the primary circuit
- rooms containing primary circuit Chemical and Volume Control System (RCV [CVCS]) equipment
- the IRWST (RIS [SIS]) pool and the corium-spreading area

An airtight structure around the equipment compartment encloses the primary circuit components and systems that may cause radioactive leaks.

The Reactor Building ventilation systems maintain dynamic containment between the equipment compartment and the service area. A pressure barrier is created and uncontrolled transfer of activity from the equipment compartment to the service area is not possible (for operation of the plant without access, see section 4; in the case of access, see section 5).

The Containment Cooling Ventilation System (EVR [CCVS]) is divided into two separate systems:

- a system for continuous ventilation of the service area (EVR [CCVS] – service area)
- a system for continuous ventilation of the equipment compartment (EVR [CCVS] – equipment compartment)

3.1. ROLE OF THE SYSTEM

3.1.1. Functional role of the system

3.1.1.1. EVR [CCVS] – Service area

The functional role of the EVR [CCVS] – service area is as follows:

- to maintain ambient conditions acceptable for staff working in the Reactor Building service area
- to maintain ambient conditions needed to ensure correct operation of instrumentation and equipment

3.1.1.2. EVR [CCVS] equipment compartment

The functional role of the EVR [CCVS] equipment compartment is as follows:

- to maintain the ambient conditions necessary to ensure correct operation of the equipment
- to ventilate and cool the control rod mechanisms
- to ventilate and cool the reactor pit
- to produce environmental conditions acceptable for staff working in the Reactor Building equipment compartment during cold shutdown

3.1.2. The system safety role

The general safety requirements are given in section 0.

The only safety function of the EVR [CCVS] is the cooling of the reactor pit during a LOOP and an SBO [station blackout].

3.2. DESIGN BASES

3.2.1. EVR [CCVS] – service area

With the plant in operation, during hot and cold shutdown, the EVR [CCVS] extracts the heat discharged by the Reactor Building service area equipment and the walls and airtight structures of the equipment compartment.

The interior temperatures and humidity are defined in section 1; they allow staff to access the service area when the plant is in operation.

The cooling function is fulfilled by the local air-conditioning plants; the cooling coils are fed by the DER (chilled water) system.

3.2.2. EVR [CCVS] equipment compartment

With the plant in operation or during hot shutdown, the EVR [CCVS] equipment compartment removes the heat produced by the equipment, including the control rod drive mechanisms (the four primary pump motors are not included here as they are cooled directly by the RRI [CCWS]).

The interior temperatures are defined in section 1.

The cooling function is performed as follows:

- by cooling coils supplied by the RRI [CCWS], operating continuously
- by cooling coils supplied by the DER (chilled water) system, operating if necessary, i.e. if the outlet temperature of air supply fans is above 30°C.

Staff access, for the temperature conditions given in section 1, is permitted only during cold shutdown.

3.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

See Section 9.4.3 - Figure 1 to Figure 3

3.3.1. EVR [CCVS] – Service area

The EVR [CCVS] – service area operates in a closed circuit mode with local air-conditioning units. Each air-conditioning unit is equipped with a cooling coil connected to the DER (chilled water) system and a fan that blows cold air into the zones to which staff access is provided for systematic activities.

The system operates continuously and the air-conditioning capacity needed is provided by several units, serving the following:

- operating floor
- annular space
- penetration area
- core instrumentation (2 x 100%)
- RIS [SIS] valves rooms
- APG [SGBS] rooms

Two of the operating floor local air-conditioning units are connected by a duct to the Reactor Building dome to avoid hot spots.

3.3.2. EVR [CCVS] equipment compartment

The EVR [CCVS] – equipment compartment system operates in a closed circuit only for the primary circuit component rooms and the adjacent rooms where the auxiliary systems containing radioactivity are located. Atmospheric contamination resulting from leaks from these systems is contained by this ventilation system.

It comprises two trains, each featuring:

- two fans (2 x 50%) known as “main fans”
- two cooling coils (2 x 25%) fed by the RRI [CCWS]
- two cooling coils (2 x 25%) fed by the DER (chilled water) system
- two fans (2 x 50%) known as “reactor pit fans”

This system operates continuously with two main fans (one fan operating per train and the other as back-up).

Each train blows fresh air into a semi-circular concrete header located above the RIS [SIS] valve room. Different branches are connected to the semi-circular header to provide the air supply in the various zones:

- the four primary coolant pumps
- the four steam generators
- the RCV [CVCS] rooms
- the RPE [NVDS] rooms
- the reactor pit; the reactor pit is ventilated by two trains each associated with an air supply branch and equipped with two fans (2 x 50%)

Certain air supplies are tapped off upstream of the headers and supply the air to:

- the control rod drive mechanism area
- the pressuriser area
- the area under the steam generator compartment ceiling

3.4. OPERATING CONDITIONS

3.4.1. Normal state of the system

This state corresponds to conditions during plant operation or hot shutdown.

3.4.1.1. EVR [CCVS] – Service area

All local air-conditioning units operate continuously and maintain the specified environmental temperatures. In the instrumentation room, one of the two air-conditioning units is backed-up in the event of failure of the unit in operation.

3.4.1.2. EVR [CCVS] equipment compartment

On each of the two trains, a main fan and a reactor pit fan operate. The total air flow of the EVR [CCVS] equipment compartment is 220,000 m^3/hr at 30°C.

The cooling coils are fed by the RRI [CCWS]. If the outlet temperature of the air supply fans reaches 30°C the cooling coils fed by the DER (chilled water) are operated to the cool the air. The condensate is extracted by the RPE [NVDS].

3.4.2. Permanent system loads

<u>Staff access before/after shutdown</u>

Access to the Reactor Building is allowed when the reactor is in operation, for maintenance operation between seven days before and three days after shutdown. In the accessible area, defined as the service area, the EVR [CCVS] – service area, maintains environmental conditions acceptable for staff. These conditions are given in Section 9.4.1 – Table 1.

Before and during man access, fresh air is brought in by the EBA [CSVS] low flow rate system, for purging purposes (see section 5).

<u>Shutdown</u>

During cold shutdown, the Reactor Building is ventilated by the EBA [CSVS] (high and low flow rate EBA [CSVS]).

The fresh air brought in by the EBA [CSVS] is distributed through the service area of the Reactor Building then in the equipment compartment via the EBA [CSVS] 1120RA damper (see section 5) and the EVR [CCVS] 1101 and 1201RA dampers. The air is then distributed by the fans and ducts of the EVR [CCVS] equipment compartment, to all rooms. The system operates using the EVR [CCVS] cooling coils until a temperature below 33°C is reached.

3.4.3. Transient system states

<u>Partial or total loss of cooling water</u>

When the RRI [CCWS] and DER (chilled water) cooling coils are no longer available, the fans continue to operate to prevent hot spots and to provide pit cooling.

<u>Loss of Primary Coolant Accident (LOCA)</u>

During and after this type of accident, the containment continuous ventilation systems are not required.

Fuel handling accident in the Reactor Building

In the event of a fuel handling accident (although this is not a safety requirement) the EVR [CCVS] can be used to remove heat released.

Loss Of Offsite Power (LOOP)

In the event of LOOP, EVR [CCVS] main fans and pit cooling fan supply is backed up by the main diesel generator. For the RRI [CCWS] and DER systems, only the RRI [CCWS] system has back up power supply. Only the coils fed by RRI [CCWS] system will ensure the air cooling, thus, Reactor Building temperatures are going to rise.

Generalised Voltage Loss (SBO [station blackout])

In the event of a station blackout, only the fans associated with the reactor pit have power supplies that are backed up by the ultimate emergency diesel generator. These help to maintain the temperature below 75°C at the top of the pit, i.e. the maximum allowable temperature 24 hours following an SBO.

3.5. PRELIMINARY SAFETY ANALYSIS

3.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

3.5.2. Compliance with functional criteria

In the event of a blackout, the EVR [CCVS] is designed to meet the objective of maintaining acceptable temperature conditions in the reactor pit.

3.5.3. Compliance with design requirements

3.5.3.1. Safety classifications

The compliance of the equipment design and manufacture with requirements derived from the classification rules is detailed in Sub-chapter 3.2.

3.5.3.2. Single Failure Criterion and redundancy

The reactor pit ventilation system comprises two trains each equipped with two 2 x 50% fans, making a global redundancy of 4 x 50%.

One of the fans in each EVR [CCVS] ventilation system train is supplied by a division 1 electrical train and the other fan in each system is supplied by a division 2 electrical train.

3.5.3.3. Qualification

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

3.5.3.4. Instrumentation and control

The compliance of the equipment design and manufacture with requirements derived from the classification rules is detailed in Sub-chapter 3.2.

3.5.3.5. Uninterruptible power supplies

Loss Of Offsite Power (LOOP)

In the event of LOOP:

- The reactor pit fans are backed up.
- The main fans of the EVR [CCVS] – equipment compartment are backed up by the diesel generators. This is not a safety requirement, but it helps avoid damage to equipment.

Generalised Voltage Loss (SBO [station blackout])

In the event of SBO the fans associated with the reactor pit are provided with a back up electrical supply.

3.5.3.6. Hazards

See Section 9.4.3 - Table 1.

3.5.3.7. Materials

Pit reactor ducts are foreseen as watertight and resistant to high pressure (around 20 bars).

3.6. TESTS, INSPECTIONS AND MAINTENANCE

3.6.1. Periodic tests

The safety functions are subject to periodic tests.

3.6.2. Inspection and maintenance

Maintenance of the EVR [CCVS] is performed during plant shutdown, when access to the entire Reactor Building is possible and the environmental conditions in the Reactor Building are ensured by the EBA [CSVS].

3.7. MECHANICAL DIAGRAM

See Section 9.4.3 - Figure 2 and Figure 3

SECTION 9.4.3 - TABLE 1

Summary Table of the inclusion of hazards for the EVR [CCVS] 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		-	-
Internal missiles		-	-
Load fall		-	-
Internal explosion		-	-
Fire		-	-
Internal flooding		-	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	No loss of more than one 2 x 50% vessel pit ventilation train	Implantation in Reactor Building	SC1 for ventilation of vessel pit SC2 for the rest (not to damage F1 components) (to be confirmed in detailed studies)
Aircraft crash	No	-	-
External explosion	No	-	-
External flooding	No	-	-
Snow and wind	No	-	-
Extreme cold	No	-	-
Electromagnetic interference	No	-	-

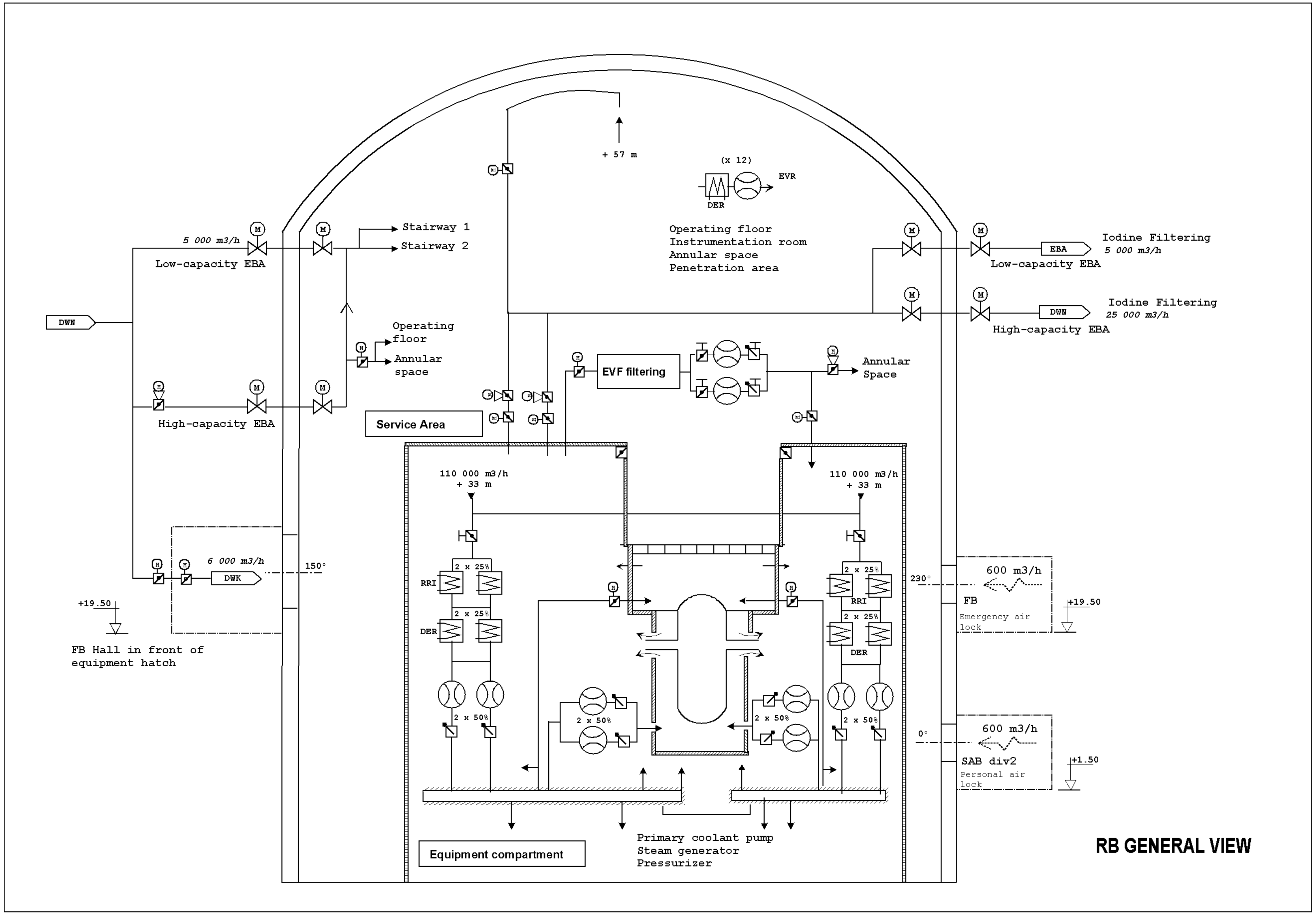
SECTION 9.4.3 - TABLE 2

EVR [CCVS] Functional Flow diagram Glossary

French	English
Espace de service	Service area
Compartiment équipement	Equipment compartment
Plancher de service	Operating floor
Local instrumentation	Instrumentation room
Bâche de détente	Expansion tank
Echangeur	Heat exchanger
Vannes RIS boucle i	Loop i RIS valves

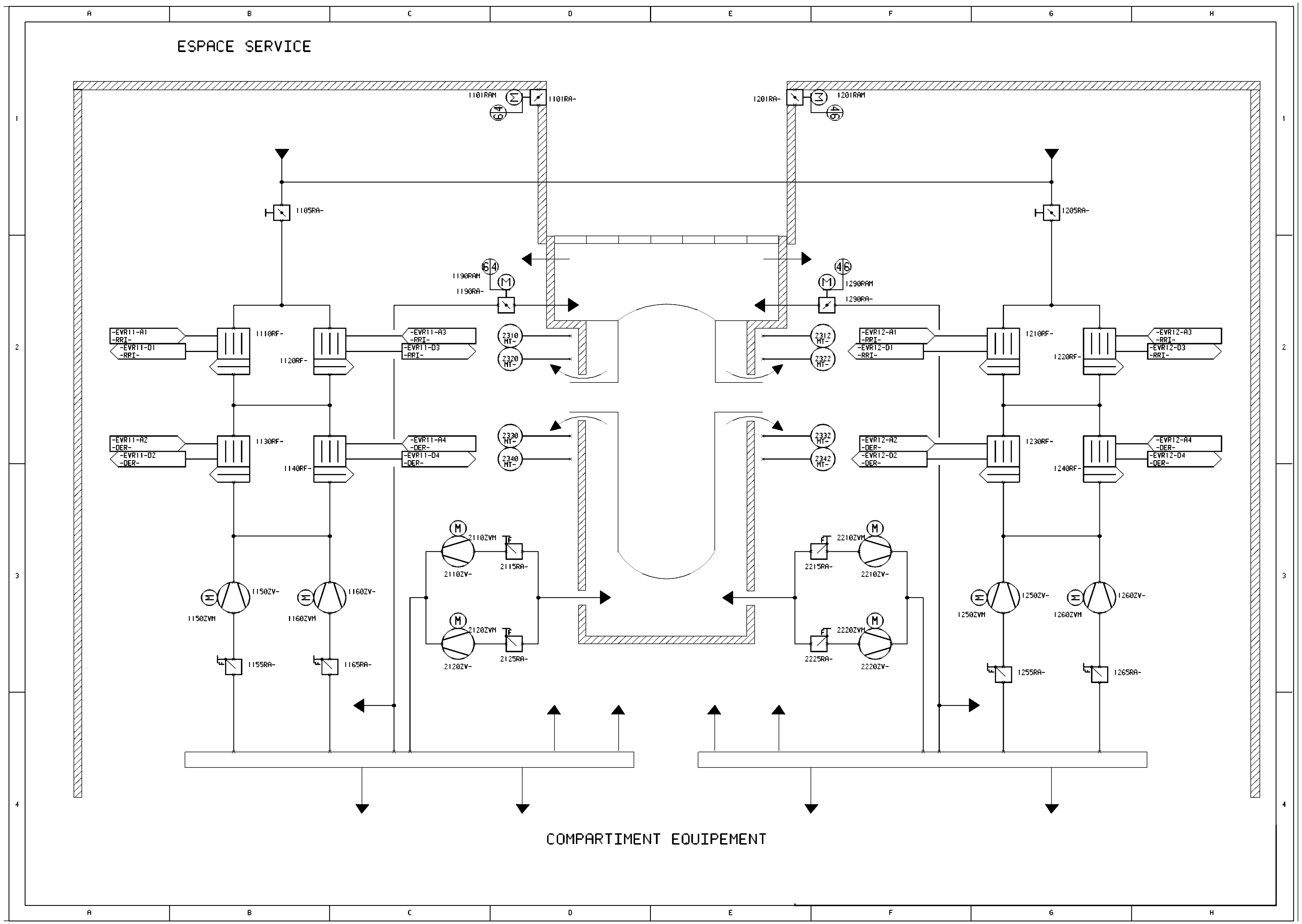
SECTION 9.4.3 - FIGURE 1 [REF-1]

Reactor Building ventilation: General Diagram



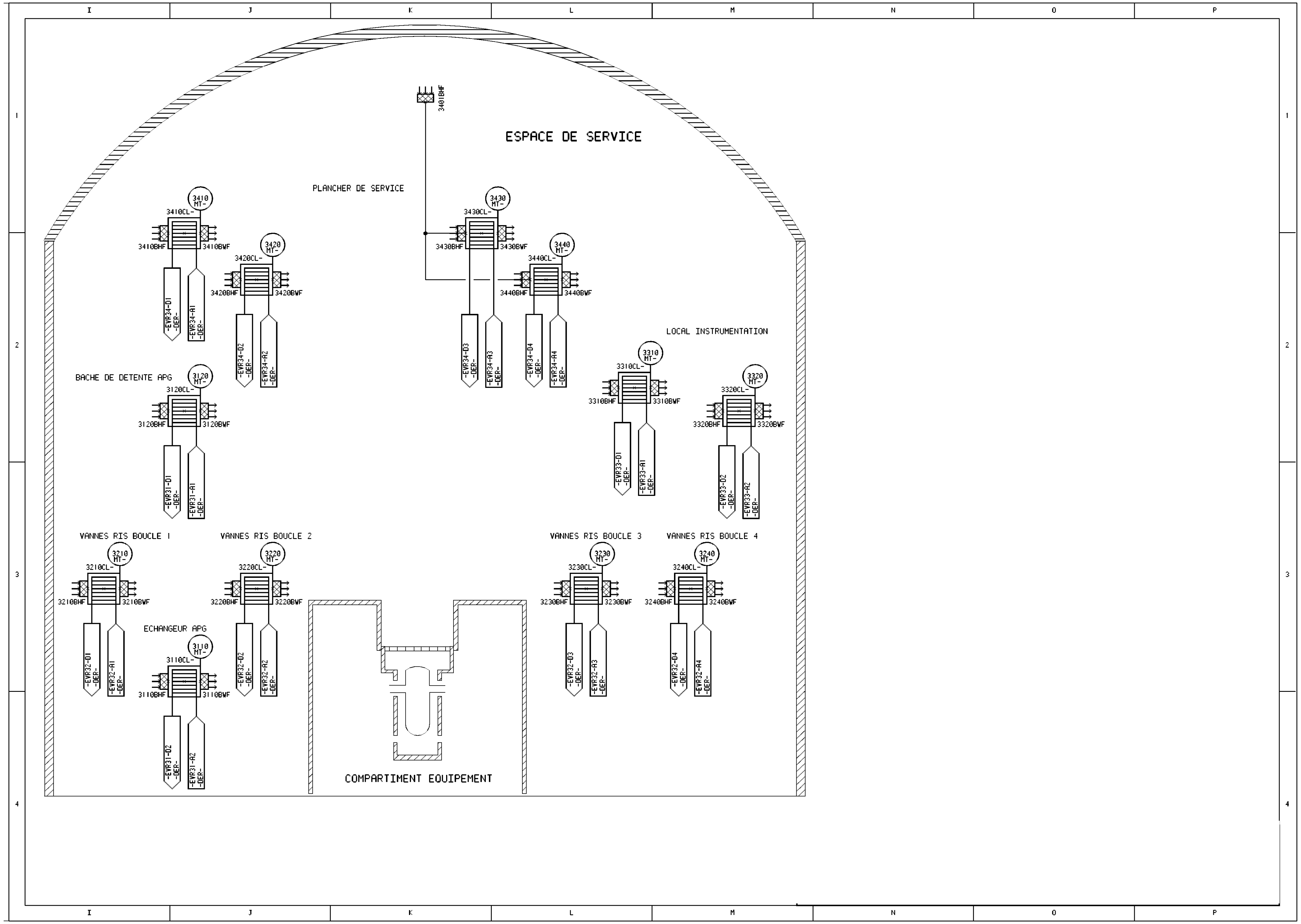
SECTION 9.4.3 - FIGURE 2 [REF-2]

EVR [CCVS] – Containment Cooling Ventilation System – Equipment Compartment



SECTION 9.4.3 - FIGURE 3 [REF-2]

EVR [CCVS] – Containment Cooling Ventilation System – Service Area



4. REACTOR BUILDING INTERNAL FILTRATION SYSTEM (EVF) [REF-1] TO [REF-7]

4.1. ROLE OF THE SYSTEM

4.1.1. Functional role of the system

The EVF operates during operation of the plant, in order to:

- reduce the concentration of radioactive iodine and aerosols in the reactor building,
- maintain dynamic containment between the service area and the equipment compartment when there is no access to the Reactor Building (if there is access, dynamic containment is provided by the EBA [CSVS], see section 5).

4.1.2. The system safety role

Iodine filter fire dampers which help avoid fire spreading in the Reactor Building are safety classified. The rest of EVF has no safety function.

4.2. DESIGN BASIS

In the two-room concept, the equipment compartment and service area, that constitute the Reactor Building, are physically separated during plant power operation.

<u>Reactor in operation or hot shutdown</u>

The EVF operates continuously and ensures the dynamic containment of the equipment compartment when the low-capacity EBA [CSVS] is not in operation.

<u>Cold shutdown</u>

The internal filtering system is not required at cold shutdown (the high-flow EBA [CSVS] extraction filtering function is ensured by a filtering line of the DWN [NABVS] system, see section 5).

<u>Fuel handling</u>

The internal filtering system is not required during fuel handling.

<u>LOCA (Loss of Cooling Accident) situation</u>

The internal filtering system is not required during a LOCA situation.

<u>Ventilation flow</u>

The EVF operates for the Reactor Building during plant power operation; the minimum ventilation flow rate is 7,000 m³/hr.

4.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

See Section 9.4.4 - Figure 1.

From upstream to downstream, the system comprises:

- a duct which extracts air from the equipment compartment through a motor-driven damper
- a filtering train (1 x 100%) with an electrical heater, a pre-filter, a HEPA filter and an iodine filter between two fire dampers. Each component is installed in an airtight metallic housing
- two fans (2 x 100%)
- a duct with a motor-driven damper re-injecting air into the equipment compartment
- a duct with a motor-driven regulating damper blowing air into the service area

4.4. OPERATING CONDITIONS

4.4.1. Normal state of the system

Normal state

With the plant at power, the internal filtering system operates continuously in the Reactor Building. The air flow is 7,000 m³/hr. The air is extracted from the equipment compartment and filtered by a HEPA filter and iodine filter.

Part of the flow is diverted to the service area so that the equipment compartment is at negative pressure, while the service area is subjected to a relative excess pressure. The air flow to maintain this dynamic containment is controlled by the differential pressure required between the two zones. The air flow will not exceed 2,000 m³/hr.

The rest of the flow is used to purge the equipment compartment in recirculation mode.

4.4.2. Other system states

4.4.2.1. Shutdown

During outages, the EVF is not required.

4.4.2.2. Fuel handling accident in the Reactor Building

In the event of a fuel handling accident, the EVF is not required.

4.4.2.3. Primary Loss of Coolant Accident (LOCA)

The EVF is not required during or after this accident.

4.4.2.4. Fire

In the event of fire detection, the iodine filter is isolated by fire dampers and the EVF fan stops.

Moreover, the EVF iodine filter is protected against fire by the JPI system (fire fighting water system).

4.5. PRELIMINARY SAFETY EVALUATION

Only fire dampers are F2-classified. The rest of EVF is not classified; power supplies are not backed up in the event of LOOP.

The system is not designed to withstand an earthquake, however, the integrity of certain equipment items (SC2 classification) may be required to ensure that hazards are not posed to any classified equipment.

4.6. TESTS, INSPECTION AND MAINTENANCE

4.6.1. Periodic tests

The safety functions are subject to periodic tests.

4.6.2. Inspection and maintenance

Tests, inspections and maintenance may be performed during plant outages and during cold shutdown phase when the EVF is not required.

4.7. MECHANICAL DIAGRAM

See Section 9.4.4 - Figure 1.

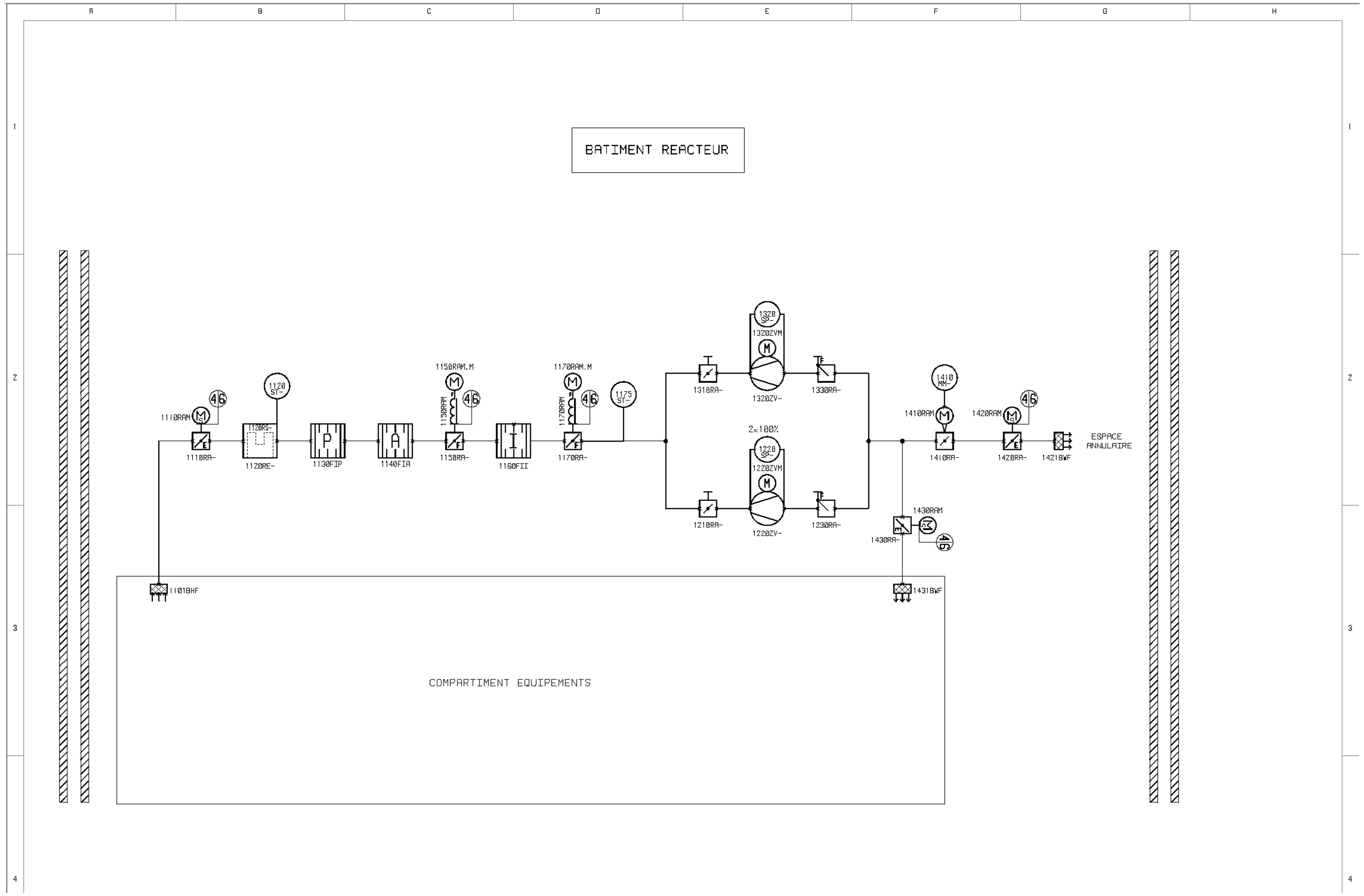
SECTION 9.4.4 - TABLE 1

EVF Functional Flow diagram Glossary

French	English
Bâtiment réacteur	Reactor Building
Espace annulaire	Annular space
Compartiment équipement	Equipment compartment

SECTION 9.4.4 - FIGURE 1 [REF-1]

EVF Functional Flow Diagram



5. CONTAINMENT SWEEP VENTILATION SYSTEM (EBA [CSVS]) [REF-1] TO [REF-7]

The Containment Sweep Ventilation System comprises the following:

- a high-capacity EBA system [CSVS] [main purging]
- a low-capacity EBA system [CSVS] [mini-purging]

5.1. ROLE OF THE SYSTEM

5.1.1. Functional role of the system

5.1.1.1. Low-capacity EBA [CSVS]

Normal operating conditions:

Whenever necessary during normal plant operation, the low-capacity EBA [CSVS] operates in open circuit mini-purging mode to ventilate the service area of the Reactor Building; this enables the following:

- reduction in the activity of the atmosphere in the service area due to the presence of noble gases (Krypton 85 and Xenon 133 in particular) and tritium (tritiated steam)
- oxygenation of the atmosphere in the service area
- creation of excess pressure in the stairways, thus protecting the stairways from smoke in the event of fire
- ensuring dynamic containment between the two areas of the Reactor Building by extraction of the air from the equipment and filtering compartment (HEPA filter and iodine filter) before discharge to the stack.

During an outage, the low-capacity EBA [CSVS] acts to complement the high-capacity EBA [CSVS].

Air conditioning and blowing are performed by the DWN [NABVS] system (see section 2).

Function in the event of a fuel handling accident in the Reactor Building:

Extraction using the low-capacity system EBA [CSVS] with a HEPA filter and iodine filter maintains the containment function of the Reactor Building.

5.1.1.2. High-capacity EBA [CSVS]

Operation in normal operating conditions:

The high-capacity EBA [CSVS] is used during outages for the following purposes:

- to reduce the concentration of fission or activation products in the Reactor Building atmosphere (service area and equipment compartment) to allow permanent access in optimum safe conditions as soon as possible at cold shutdown.

- to oxygenate the atmosphere of the equipment compartment

- to keep the ambient temperature and relative humidity acceptable for staff working in the Reactor Building during cold shutdown periods

Air conditioning, blowing, filtering and extraction are performed by the DWN [NABVS] system (see section 2).

5.1.2. Safety role of the system

The general safety requirements for the ventilation systems are given in section 0 and the specific requirements for the EBA [CSVS] are detailed below.

The safety function of the EBA [CSVS] is to contribute to limiting radioactive releases. A breakdown is as follows:

- In normal operation, when operating, the low-capacity EBA [CSVS] helps to limit discharges via filtering.

- If an event leading to release of activity in the containment (PCC-3, PCC-4, RRC-A, RRC-B) or if a more general increase in radioactivity occurs, the containment isolation valves in the low-capacity and high-capacity EBA [CSVS] must be closed. The normal Fuel Building Ventilation System (DWK [FBVS]) is isolated. The Fuel Building is confined through the low-capacity EBA [CSVS] extraction via the DWK [FBVS] extraction network.

- In the event of a fuel handling accident in the Reactor Building, or a LOCA from the RIS/RRA [SIS/RHRS] with an open equipment hatch:

  - the containment isolation valves of the high-capacity EBA [CSVS] and those for air supply of the low-capacity EBA [CSVS] are closed

  - the air supply in front of the equipment hatch is isolated

  - the extraction of the low-capacity EBA [CSVS] ensures dynamic containment of the Reactor Building; the air is filtered through a HEPA filter and iodine filter before discharge to the stack

- Moreover, in the event of an accident leading to a radiological release, the low-capacity EBA [CSVS] collects and filters the containment penetration leaks from the EBA [CSVS] and TEG [GWPS].

5.2. DESIGN BASIS

5.2.1. Low-capacity EBA [CSVS]

Mini-purging system in operation

The system is designed to limit radioactive discharges. It comprises a supply train and an exhaust filtering train operating at 5,000 m^3/hr. The system must enable air change in the service area of the Reactor Building during plant operation, and must maintain dynamic containment of the equipment compartment.

Fuel handling accident in the Reactor Building

In the event of a fuel handling accident in the Reactor Building, the low-capacity EBA [CSVS] is used to maintain a dynamic containment and filter the extracted air before discharging it to the stack.

5.2.2. High-capacity EBA [CSVS]

The high-capacity EBA [CSVS] is sized to perform ventilation of the Reactor Building at cold shutdown.

The Reactor Building (free volume: 80,000 m3) is ventilated as an open system.

The air supply to and the extraction from the Reactor Building are performed using the DWN [NABVS] ventilation system of the Nuclear Auxiliaries Building: the supply air is filtered and conditioned by the DWN [NABVS]; the extracted air is filtered by the DWN [NABVS] filtering system, the HEPA filter and iodine filter, before being discharged to the stack.

The design data of the EBA [CSVS] in normal operation is given below (the low-capacity EBA [CSVS] operates in parallel with the high-capacity EBA [CSVS]):

Air-supply rate:	25,000 m^3/hr	(high-capacity EBA [CSVS])
	5,000 m^3/hr	(low-capacity EBA [CSVS])
total	30,000 m^3/hr	

This flow rate ensures a fresh air supply sufficient for 600 people (50 m^3/hr per person).

Acceptable temperature and humidity conditions in the Reactor Building are defined in section 1.

5.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

See Section 9.4.5 - Figure 1.

5.3.1. Low-capacity EBA [CSVS]

This sub-system comprises:

- For air supply: a duct from the DWN [NABVS] system via the high-capacity EBA [CSVS]. The air is blown into the two stairways and to the service floor.
- For extraction (from upstream to downstream):
    - a duct taking air from the dome in the service area and the equipment compartment
    - a common low and high-capacity EBA [CSVS] duct located in the Reactor Building
    - a duct connecting the common low and high-capacity EBA [CSVS] duct to Fuel Building
    - two EBA [CSVS] filtering sub-systems (2 x 100%) comprising: electric heater, pre-filter, HEPA filter, iodine filter enclosed by fire dampers and fans
    - a duct for discharge to the DWN [NABVS] stack
    - two ducts connecting the low-capacity EBA [CSVS] extraction to the DWK [FBVS] extraction cells
- Outlets enabling recovery of the leaks from the containment isolation valves
- On the air supply and exhaust ducts, two containment isolation valves are installed on both sides of the reactor building containment
- A metallic pre-filter, located upstream of the iodine lines, minimises radiological releases in the event of a severe accident. For other situations, this equipment is by-passed.

5.3.2. High-capacity EBA [CSVS]

This sub-system comprises:

- Outlets enabling recovery of the leaks from the containment isolation valves.
- For air supply:
    - a duct (from the DWN [NABVS]) to the Reactor Building where it is connected to a shared air distribution header and to the air supply of the low-capacity EBA [CSVS]. This duct is equipped with two containment isolation valves.
    - a duct system ensuring the air supply distribution to the stairway, the service floor and annular space. The duct to the service floor is equipped with a motor-driven sealing damper.

- a duct (from the DWN [NABVS]) to the Fuel Building. This duct is equipped with two motor-driven dampers and is used to blow air from the setdown area into the Reactor Building when the equipment hatch is open.

- For extraction:
  - an extraction duct from the Reactor Building connected to the filters of the DWN [NABVS] system. Ventilation or purge nozzles in the areas where work is carried out during plant outage are also provided, which are connected from mobile filtering devices when it is possible.
  - a duct connecting the extraction duct common to the low and high-capacity EBA [CSVS] to the Fuel Building. This duct is connected to the DWN [NABVS] filters.
  - an extraction duct system ensuring air extraction from the equipment compartment and service area rooms. It is connected to the low and high-capacity EBA [CSVS] duct. This duct is equipped with two containment isolation valves.

5.4. OPERATING CONDITIONS

5.4.1. Normal State of the System

5.4.1.1. Plant in operation

5.4.1.1.1. Mini-purging of the containment

When the plant is in operation, there is no continuous ventilation of the atmosphere in the Reactor Building service area. All the containment isolation valves are closed.

Dynamic containment is ensured by the EVF system (see section 4).

In preparation for access to the Reactor Building during plant operation and during the access period, the low-capacity EBA [CSVS] is started two days before the access. Fresh air is brought from outside to the Reactor Building service area; the extraction part of the low-capacity EBA [CSVS] maintains dynamic containment between the equipment compartment and the service area in an open circuit. The EBA [CSVS] air flow rate is 5,000 m^3/hr. The air extracted is discharged to the Nuclear Auxiliary Building stack after being filtered by an EBA [CSVS] filtering sub-system.

5.4.1.1.2. Control of containment pressure – depressurisation of the containment

When the plant is in operation, there is no continuous pressure control in the Reactor Building service area.

If necessary, depressurisation of the service area may be achieved using the extraction portion of the mini-purging system (low-capacity EBA [CSVS]).

5.4.1.2. Plant outage

During cold shutdown, with no atmospheric contamination, the ventilation of the containment is performed by EBA [CSVS] operating in open-circuit mode (high-capacity EBA [CSVS] and low-capacity EBA [CSVS]). The air supply rate is 30,000 m^3/hr.

The high-capacity EBA [CSVS] may be started as soon as the RIS [SIS] is operating in residual heat removal mode (RIS/RRA [SIS/RHRS]), provided that the activity of the primary coolant, in stable operation during the period preceding the outage, is lower than a defined value [Ref-1].

At the start of the outage period, dynamic containment is maintained between the service area and the equipment compartment to purify the air in the equipment compartment and to prepare for staff access to the equipment compartment (purge phase). When all the rooms have been swept and the risk of atmospheric contamination is limited, maintenance of containment of the equipment compartment is no longer necessary.

Air supply (Equipment hatch closed):

Fresh air is blown into the stairways, the service floor and then the equipment compartment via the motor-driven dampers EBA [CSVS] 1120RA, EVR [CCVS] 1101RA and 1201RA.

Air supply (Equipment hatch open):

A flow rate of 6,000 m^3/hr is taken from the total flow of 30,000 m^3/hr and directed to the front of the equipment hatch via the connection to the DWK [FBVS]. From this location, the air flows to the service floor through the open equipment hatch.

Extraction:

The EBA [CSVS] extracts the air from the equipment compartment and the dome of the service area.

In the event of a temperature increase in the Reactor Building beyond the design value of the EBA [CSVS], one of the cooling sub-systems of the EVR [CCVS] is put back into operation on instructions from the operator (see section 3).

5.4.2. Transient state of the system (accident operating conditions)

High level of activity in the Reactor Building (equipment hatch open)

In the event of detection of the following:

- activity in the Reactor Building atmosphere following a fuel handling accident during cold shutdown of the reactor
- a rupture in the primary system while it is at a temperature lower than 90°C

The high-capacity EBA [CSVS] and the low-capacity EBA [CSVS] air supply systems are automatically shut down. The corresponding containment isolation valves are closed. The air supply to the front of the equipment hatch is isolated. The extraction part of the low-capacity EBA [CSVS] remains in operation to avoid spreading contamination by maintaining negative pressure in the Reactor Building and thus a flow into the Reactor Building at the equipment hatch and airlocks. The extracted air is filtered by a HEPA filter and iodine filter before being discharged to the stack.

The purge/ventilation of the containment is operated again when the activity level in the Reactor Building is compatible with the defined level of gaseous discharge.

Loss of Coolant Accident (LOCA)

Outlets used to recover the leaks coming from the Reactor Building and to direct them into the EBA [CSVS] iodine trains are positioned on the EBA [CSVS] high-capacity and low-capacity supply lines and the EBA [CSVS] high-capacity extraction line.

The dampers located in the Fuel Building, connecting the low-capacity extraction network of the DWK [FBVS] system are opened. A low-capacity EBA [CSVS] fan is started up. The air is extracted through a HEPA filter and an iodine trap before being discharged into the stack.

High pressure in the Reactor Building or safety injection signal

In the event of high pressure in the Reactor Building or a safety injection signal, the mini-purge function of the low-capacity EBA [CSVS] is shut down (if it is operating) and all the containment isolation valves are closed.

Loss Of Offsite Power (LOOP)

In the event of LOOP, the electrical supply to the DWN [NABVS] system fans is not backed up. Thus, the air supply is not distributed in Reactor Building and the high capacity EBA [CSVS] does not extract air. The supply to the low-capacity EBA [CSVS] iodine trains is backed up in order to enable dynamic containment of the Reactor Building or the Fuel Building to be preserved.

Station blackout (SBO)

The iodine trains of the low-capacity EBA [CSVS] are emergency-supplied and enable dynamic containment in the Fuel Building to be preserved. Thus, the dampers connecting the low-capacity extraction and the DWK [FBVS] extraction network are backed-up by SBO diesel generator sets.

Severe Accident

Outlets used to recover the leaks coming from the Reactor Building and to direct them into the EBA [CSVS] iodine trains are opened.

The dampers located in the Fuel Building, connecting the low-capacity extraction network of the DWK [FBVS] system are opened. A low-capacity EBA [CSVS] fan is started up. The air is extracted through a HEPA filter and an iodine trap before being discharged into the stack.

In the event of a severe accident, minimisation of radiological releases is ensured by the metallic pre-filter, upstream of each iodine line.

5.4.3. Other operating conditions of the system

5.4.3.1. Fire

In the event of fire detection in an iodine filter of the low-capacity EBA [CSVS], the filter is isolated by fire dampers. The filtering train affected is thus unavailable; the system continues to operate on the other filtering train.

5.5. PRELIMINARY SAFETY EVALUATION

5.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

5.5.2. Compliance with functional criteria

The design of the EBA [CSVS] meets the objective of limiting radioactive discharge in the event of an accident, specifically as follows:

- by providing containment isolation
- by providing efficient HEPA filtering and iodine filtering

5.5.3. Compliance with design requirements

5.5.3.1. Safety classifications

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

5.5.3.2. Single failure criterion or redundancy

The containment isolation consists of two valves, one either side of the reactor building.

The iodine filtering trains used in the event of accident and the dampers controlling air supply in front of the equipment hatch are 2 x 100% redundant.

Two EBA [CSVS] dampers are installed in parallel on each connection line between the low-capacity EBA [CSVS] extraction and the DWK [FBVS] extraction network.

5.5.3.3. Qualification

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

5.5.3.4. Instrumentation and control

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

5.5.3.5. Emergency electrical supplies

For the containment isolation valves, see section 3 of Sub-chapter 6.2.

Loss of Offsite Power (LOOP)

The two iodine extraction trains and the dampers controlling air supply in front of the equipment hatch are supplied by emergency switchboards dedicated to the nuclear island as follows: one train on a switchboard of division 1 and one train on a switchboard of division 4.

The two air supply dampers at the equipment hatch do not need to be supplied from the emergency switchboard of division 1 as the fail-safe position of these dampers is the closed position.

For the purpose of maintaining these switchboards, electrical cross-connections are provided with a switchboard of division 2 for the train supplied by division 1 and with a switchboard of division 3 for the train supplied by division 4.

The connection dampers between the low-capacity extraction and the DWK [FBVS] extraction network are supplied by emergency-supplied switchboards. The two dampers on the same connection train are supplied by different divisions 1 and 4.

Station blackout (SBO)

The two iodine extraction trains and the connection dampers between the low-capacity extraction and the DWK [FBVS] extraction network are supplied by the ultimate emergency diesel generators.

5.5.3.6. Hazards

See Section 9.4.5 - Table 1.

5.6. TESTS, INSPECTIONS AND MAINTENANCE

5.6.1. Periodic tests

The safety functions are subject to periodic tests.

5.6.2. Inspection and maintenance

Maintenance of the iodine trains of the EBA [CSVS] and air-supply isolation dampers for the Equipment hatches is performed during plant operation when the low-capacity EBA [CSVS] is not in operation.

Maintenance of the low-capacity EBA [CSVS] containment isolation valves is performed only when the plant core is completely unloaded.

Maintenance of the high-capacity EBA [CSVS] containment isolation valves may be performed during plant operation.

5.7. FLOW DIAGRAM

See Section 9.4.5 - Figure 1

SECTION 9.4.5 - TABLE 1

Summary table of the hazards protection for the EBA [CSVS] (containment isolation is addressed elsewhere)

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Rupture of piping	No loss of more than one low-capacity EBA [CSVS] iodine extraction train	Physical separation of redundant equipment	-
Failures of tanks, pumps and valves		Physical separation of redundant equipment	-
Internal missiles		Physical separation of redundant equipment	-
Dropped Loads		Physical separation of redundant equipment	-
Internal explosion		Physical separation of redundant equipment	-
Fire		Fire zoning in the Fuel Building	fire dampers around the iodine filters (to limit the spread of the fire)
Internal flooding		Physical separation of redundant equipment	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	No loss of more than one low-capacity EBA [CSVS] iodine extraction train	Installation in the Fuel Building and the Reactor Building	SC1 for the classified parts
Aircraft crash		Installation in the Fuel Building and the Reactor Building	SC1 for the classified parts
External explosion		Installation in the Fuel Building and the Reactor Building	No (no air inlet)
External flooding		Installation in the Fuel Building and the Reactor Building	-
Snow and wind		Installation in the Fuel Building and the Reactor Building	-
Extreme cold		Installation in the Fuel Building and the Reactor Building	-
Electromagnetic interference		Installation in the Fuel Building and the Reactor Building	-

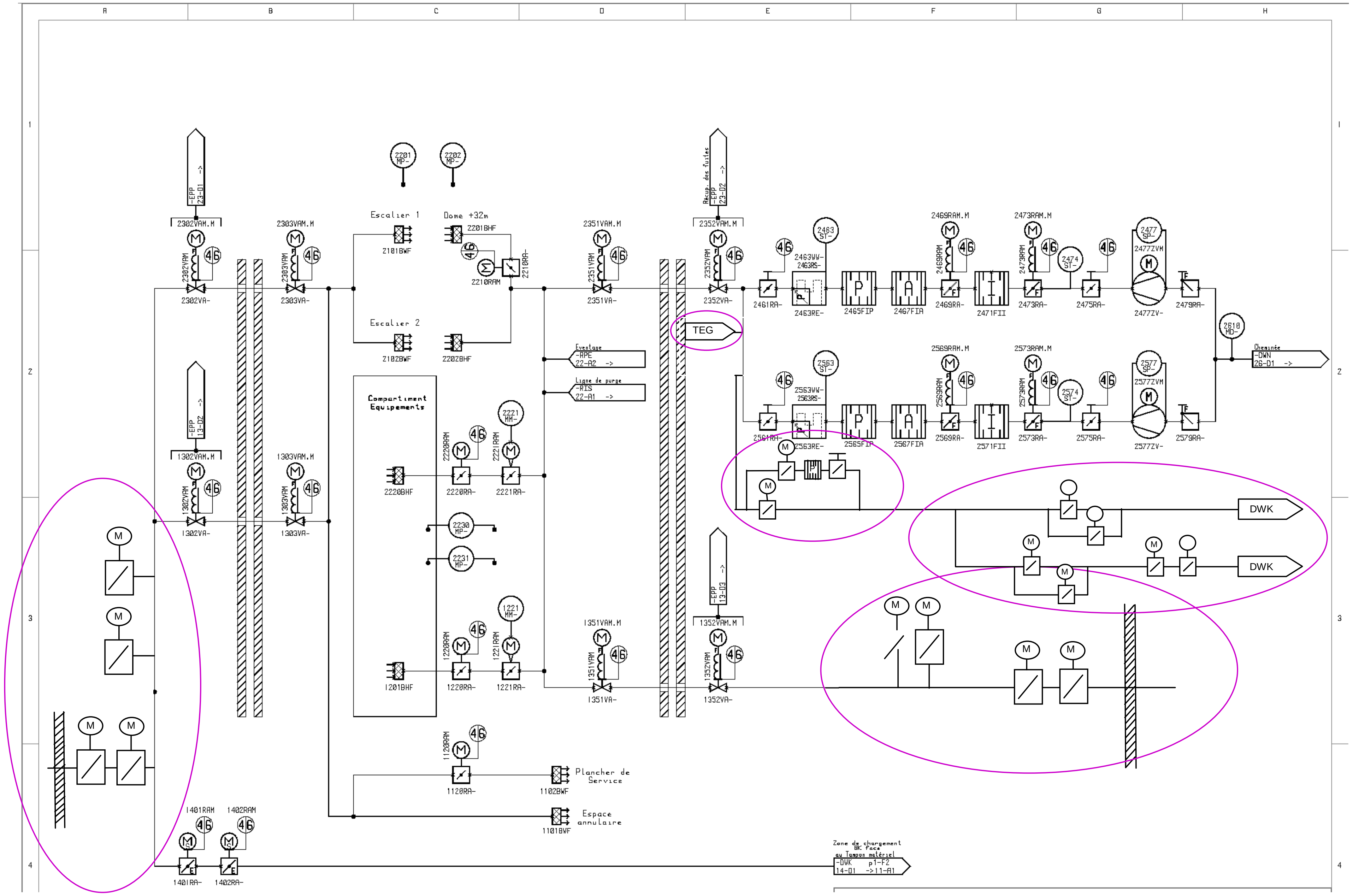
SECTION 9.4.5 - TABLE 2

EBA [CSVS] Functional Flow Diagram Glossary

French	English
Zone de chargement	Loading area
Tampon matériel	Equipment hatch
Cheminée	Stack
Ventil. de soufflage	Air-supply plant
Recup. Des fuites	Drip recovery
Plancher de service	Operating floor
Espace annulaire	Annular space
Compartiment équipement	Equipment compartment
Escalier	Stairway
Eventage	Venting
Ligne de purge	Blowdown line

SECTION 9.4.5 - FIGURE 1 [REF-1]

EBA [CSVS] Functional Flow Diagram



6. SAFEGUARD BUILDING CONTROLLED AREA VENTILATION SYSTEM (DWL [CSBVS])

6.1. ROLE OF THE SYSTEM [REF-1] TO [REF-7]

6.1.1. Functional role of the system

In relation to the controlled area of the mechanical part of the Safeguard Buildings, the DWL [CSBVS] system has four roles:

- Under normal operation: ventilation of rooms is provided by DWL [CSBVS] ducts connected to the air supply of the DVL [SBVSE] system, with extraction and filtering connected to the DWN [NABVS] system.

- In the event of an accident: the DWL [CSBVS] isolates the controlled mechanical area of the Safeguard Building when the RIS [SIS] is used after an accident in the Reactor Building. It isolates this volume of air and extracts from it any iodine which may have been released, using the dedicated iodine filtration lines filters and fans of the DWL [CSBVS]. The DWL [CSBVS] also isolates the volume of air potentially contaminated by the EVU [CHRS] when this system is used after a severe accident. The containment of the controlled mechanical area of the Safeguard Building is performed by the DWL [CSBVS] extraction trains (filters and fans) as described previously.

- To maintain a negative pressure in the controlled areas in normal operation below the outside pressure.

- In safeguard building rooms which have high internal heat loads (such as large pumps motors), local recirculation cooling units are installed to maintain temperatures compatible with equipment operation.

In the Fuel Building:

- The filters and the extraction fans of the DWL [CSBVS] ensure containment of the fuel pool hall and extract iodine in the event of a fuel handling accident in the Fuel Building.

In the Reactor Building:

- The DWL [CSBVS] provides the air supply to the front of the personal airlock and provides isolation in the event of a fuel handling accident in the Reactor Building with the airlock open.

6.1.2. Safety role of the system

The safety roles of the DWL [CSBVS] are as follows:

- To establish dynamic containment of the controlled mechanical area of the Safeguard Building and RIS [SIS] rooms, on receipt of a safety injection signal, to prevent RIS [SIS] leaks outside of the containment.

- To establish dynamic containment of the controlled mechanical area of the Safeguard Buildings on the receipt of a containment isolation signal, to collect and filters the leakages from Reactor Building in case of accident inside the Reactor Building.

- To establish static containment of RIS [SIS] rooms (division 1 and 4), when the RIS-BP [LHSI] is in RRA [RHRS] mode at temperatures over 100°C, to prevent spreading of RIS [SIS] room contaminants to other parts of the building.

- To establish dynamic containment of one Safeguard Building and the RIS [SIS] rooms in the event of RIS [SIS] leakage when in RRA [RHRS] mode at temperatures lower than 100°C.

- To isolate the air supply to the EVU [CHRS] rooms if this system is in operation.

- To extract air and filter iodine that may be released in the Fuel Building fuel pool hall in the event of a fuel handling accident. The normal ventilation of the Fuel Building fuel pool hall, provided by DWK [FBVS], is isolated in these circumstances.

- Automatic isolation of the air supply to the front of the personal airlock in the event of a fuel handling accident in the Reactor Building. The air supply to the front of the equipment hatch (provided by the high-capacity EBA [CSVS]) and the air supply to the front of the emergency airlock (provided by DWK [FBVS]) are automatically isolated. Extraction of the Reactor Building air and filtering of iodine is taken over by the Low-capacity EBA [CSVS].

- To maintain the required temperature in rooms containing fuel pool cooling system components (only applicable to Division 1), EVU [CHRS] system, RIS [SIS] system, RRI [CCWS] and ASG [EFWS] valves.

6.2. BASIS OF THE DESIGN

The air supply in the Safeguard Building is provided by the DVL [SBVSE].

Under design conditions, the DVL [SBVSE] supplies air with the following characteristics:

- Summer: 18°C

- Winter: 18°C

The design temperatures conditions are defined in section 1.

<u>Conditions in rooms</u>

The air flows and the capacity of the local recirculation cooling unit in the rooms are calculated taking account of both the minimum air change rate and the heat loads of equipment (excluding the main motors which are water cooled) and lighting.

The temperatures maintained in these rooms are given in section 1.

<u>Minimum air change rate:</u>

The air change rates for normal operation are given in section 1.

In an accident, dynamic containment is maintained using one of the extraction fans. With the air supply shut down, the correct flow direction is ensured.

During accident conditions, DWL [CSBVS] local cooling units are used to provide the required temperature for operation of the safety systems (RIS [SIS], PTR [FPC(P)S], EVU [CHRS], RRI [CCWS], ASG [EFWS]). These cooling units are also used to fulfil the normal operation temperatures requirements.

6.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

The system comprises four networks, each allocated to the mechanical part of a division of the Safeguard Building and an iodine extraction system used in case of accidents. Each part is described below:

- Each network allocated to the mechanical part of a division of the Safeguard Building comprises a set of air supply ducts connected to the air supply network of the DVL [SBVSE], that includes a volume control damper, two isolation dampers and a fire damper arranged in a series configuration, and a set of extraction ducts that includes the following:
    - Two isolation dampers arranged in a series configuration connected to the extraction trains of the DWN [NABVS] system located in the Nuclear Auxiliary Building in case of normal ventilation isolation. Additionally, two fire dampers arranged in a series configuration are installed on the exhaust line.
    - Two isolation dampers arranged in parallel configuration connected to the iodine extraction trains of the DWL [CSBVS] system, used in the event of an accident, located in the Fuel Building. Additionally, two fire dampers arranged in a series configuration are installed on the exhaust line.
- The iodine filtering device located in the Fuel Building comprises 2 x 100% trains connected in parallel, each with a flow rate of 3400 m^3/hr. Each train is installed in a separate room and comprises the following:
    - an electric heater
    - a HEPA filtering plant
    - an iodine filter
    - a fan
    - fire dampers
- A metallic pre-filter, located upstream of each iodine line, minimises radiological releases in the event of a severe accident. For other situations, this equipment is by-passed.
- The DWL [CSBVS] system also provides local recirculation cooling units in rooms having high heat loads (RIS [SIS], PTR [FPC(P)S], EVU [CHRS], RRI [CCWS], ASG [EFWS] rooms). Each recirculation cooling unit starts automatically at the required temperature setpoint or on a start-up of an associated pump.

- The fuel pool hall DWK [FBVS] extraction ducts are connected upstream of the iodine extraction trains of the DWL [CSBVS] systems with two isolation dampers arranged in parallel configuration.

6.4. OPERATING CONDITIONS [REF-1]

6.4.1. Normal state of the system

The system is used when the plant is in operation or shutdown.

The flow rates given below are for information only and need to be validated by detailed studies by the contractor [Ref-1].

6.4.1.1. Plant in operation

The four air supply and extraction systems for the four divisions are in operation.

In each division, the DVL [SBVSE] supplies a continuous flow rate ranging from 6,400 m^3/hr to 6,800 m^3/hr to the DWL [CSBVS] air supply network, according to the division.

The DWN [NABVS] system extracts a flow rate ranging from 6,600 m^3/hr to 7,000 m^3/hr from each division in the controlled areas, according to the division.

The DWL [CSBVS] iodine trains extraction fans are normally shut down and dampers are closed.

6.4.1.2. Plant at shutdown

The configuration of the system is the same as during normal operation.

If maintenance operations, that are to be carried out on equipment or systems, lead to a risk of delayed release of iodine the division extraction system may, as a precautionary measure, be aligned in iodine filtering mode by appropriate setting the DWN [NABVS] system extraction dampers.

In both cases, the nominal air supply rate is supplied by the DVL [SBVSE].

6.4.2. Other permanent operating conditions of the system

6.4.2.1. Operation of the RIS [SIS] during a LOCA

In the case of a LOCA, a leak from the RIS [SIS] may lead to an iodine activity level that is incompatible with extraction via the iodine filtering trains of the DWN [NBAVS] system. As a preventive measure, the air supply (DVL [SBVSE]) and extraction (DWN [NABVS]) to and from the Safeguard Building are isolated. Extraction is carried out using the iodine filtering trains of the DWL [CSBVS].

Recirculation cooling unit fans, for the rooms containing RIS [SIS] components, will start if a RIS [SIS] pump is started. Recirculation cooling unit fans for the rooms containing RRI [CCWS] components continue to operate automatically.

6.4.2.2. Operation of the RIS [SIS] in RRA [RHRS] mode

- RIS [SIS] leak in RRA [RHRS] mode, T > 100°C

The RIS/RRA [SIS/RHRS] rooms of divisions 1 and 4 are isolated as a preventive measure.

A depressurisation mechanism (burst pressure opening vents type) opens if the pressure rises to too high a level in the RIS [SIS] rooms.

When the venting has relieved the excess pressure, the outlet has been closed and the steam has condensed, containment of the RIS [SIS] rooms by DWL [CSBVS] is resumed.

- RRA [RHRS], T< 100°C

Normal ventilation is maintained.

In the case of leak detection by RIS [SIS] system, the normal air supply and exhaust, and the RIS [SIS] room air supply are isolated. The DWL [CSBVS] iodine filtration is then automatically started.

6.4.2.3. Sweeping of Safeguard Building rooms (only one division at a time)

In the event of a leak in a division, it may be necessary to purify the air in that division before carrying out repairs.

In this configuration, supply and exhaust air flow in the affected division is increased to sweep the potentially contaminated rooms. The supply and exhaust air flow of the remaining three divisions is decreased in order to ensure that the maximum exhaust air flow rate of the DWN [NABVS] system is not exceeded.

6.4.2.4. Operation of the EVU [CHRS] in the event of a severe accident

In the event of a severe accident, all the EVU [CHRS] rooms are isolated from other rooms by closing the air supply dampers located on each room supply ductwork prior to EVU pump start. A local cooling unit will start and stop according to the temperature measurements in EVU rooms.

6.4.2.5. Fuel handling accident in the Fuel Building

These conditions do not affect the ventilation of the Safeguard Building.

In these conditions, one of the iodine extraction trains of the DWL [CSBVS] is used and provides an extraction flow rate ranging up to 3,400 m^3/hr to achieve containment in the concerned area [Ref-1].

6.4.2.6. Fuel handling accident in the Reactor Building

These conditions do not affect the general ventilation of the Safeguard Building. Only personal airlock neighbouring room ventilation is modified.

Reactor Building containment is ensured by closing the two redundant air supply isolation dampers in front of the personal airlock. The exhaust isolation damper closure is confirmed if necessary, as it shall have been closed to ensure that airflow through the personal airlock is directed towards the Reactor Building.

6.4.3. Transient states of the system

Partial or Total Loss of Ultimate Heat Sink (LUHS)

For the DWL [CSBVS] system, the recirculation cooling units are cooled by chilled water provided by DEL [SCWS]. A LUHS could result in the loss of circulation cooling water needed for the DEL [SCWS] chiller condensers. To protect against a total loss of DWL [CSBVS] recirculation cooling units, chiller condensers in division 1 and 4 are cooled by air. Therefore the DWL [CSBVS] recirculation cooling units in division 1 and 4 remain available.

Severe Accident

In the event of a severe accident, minimisation of radiological releases is ensured by the metallic pre-filter, located upstream of each iodine line.

6.5. PRELIMINARY SAFETY ANALYSIS

6.5.1. Compliance with regulations

The system complies with regulations in force (see Sub-chapter 1.4).

6.5.2. Compliance with functional criteria

The DWL [CSBVS] contributes to reducing the release of radioactivity.

The extracted air is filtered by HEPA filters and by iodine filters (in the event of iodine detection) before being discharged to the stack, in compliance with section 0.2.

6.5.3. Compliance with design requirements

6.5.3.1. Safety classification

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

6.5.3.2. Single Failure Criterion and redundancy

The DWL [CSBVS] extraction (F1B) meets the single failure criterion being comprised of 2 x 100% trains.

The F1A/F1B classified dampers are provided with redundancy.

The F2 classified dampers are not provided with redundancy.

6.5.3.3. Qualification

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

6.5.3.4. Instrumentation and control

In general, the instrumentation and control processing equipment is installed in the same electrical division as the controlled actuators.

6.5.3.5. Emergency electrical supplies

<u>Loss of Offsite Power (LOOP)</u>

The power for the F1A/F1B classified dampers is backed-up by the main diesel generators. The F2 classified dampers are not provided with backed-up power supplies.

In the event of LOOP, the fans and others actuators of the DWL [CSBVS] iodine filtration trains, RIS rooms supply isolation dampers, normal supply air and exhaust isolation dampers, Fuel Building emergency exhaust isolation dampers and recirculation cooling unit fans of RRI [CCWS] and ASG [EFWS], RIS [SIS], PTR [FPC(P)S] and EVU [CHRS] rooms are provided with backed-up power supplies.

<u>Station Blackout (SBO)</u>

In the event of SBO, the DWL [CSBVS] iodine filtration unit components, the emergency exhaust dampers and recirculation cooling units of RRI [CCWS], RIS [SIS], ASG [EFWS], PTR [FPC(P)S] and EVU [CHRS] rooms are provided with back up power supplies (only in division 1 and division 4).

6.5.3.6. Hazards

See Section 9.4.6 - Table 1.

6.6. TESTS, INSPECTIONS AND MAINTENANCE

6.6.1. Tests

The safety functions are subject to periodic tests.

6.6.2. Inspections and maintenance

DWL [CSBVS] is required to be available during every power plant configuration including shutdown conditions and especially during fuel handling in the Fuel Building. The only remaining state is the state F when the core is unloaded.

6.7. FLOW DIAGRAM

See Section 9.4.6 - Figure 1

SECTION 9.4.6 - TABLE 1

Summary Table of hazards protection for the DWL [CSBVS]

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Rupture of piping	No loss of more than one train	Physical separation of redundant equipment	-
Failures of tanks, pumps and valves		Physical separation of redundant equipment	-
Internal missiles		Physical separation of redundant equipment	-
Dropped Loads		Physical separation of redundant equipment	-
Internal explosion		Physical separation of redundant equipment	-
Fire		Fire zoning in the Fuel Building Fire zoning in the Safeguard Buildings	In particular, fire dampers around the iodine filtration trains (to limit the fire spreading to the other train)
Internal flooding		Physical separation of redundant equipment	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	Installation in the Fuel Building and the Safeguard Buildings	SC1
Aircraft crash	Yes	Installation in the Fuel Building and the Safeguard Buildings	Divisions 2&3 and Fuel Building are bunkerised buildings. Divisions 1&4 are physically separated
External explosion	Yes	Installation in the Fuel Building and the Safeguard Buildings	No – Air intake from the DVL [SBVSE] system
External flooding	Yes	Installation in the Fuel Building and the Safeguard Buildings	-
Snow and wind	Yes	Installation in the Fuel Building and the Safeguard Buildings	-
Extreme cold	Yes	Installation in the Fuel Building and the Safeguard Buildings	Heating to protect the systems in the controlled areas of the Safeguard Building
Electromagnetic interference	Yes	Installation in the Fuel Building and the Safeguard Buildings	-

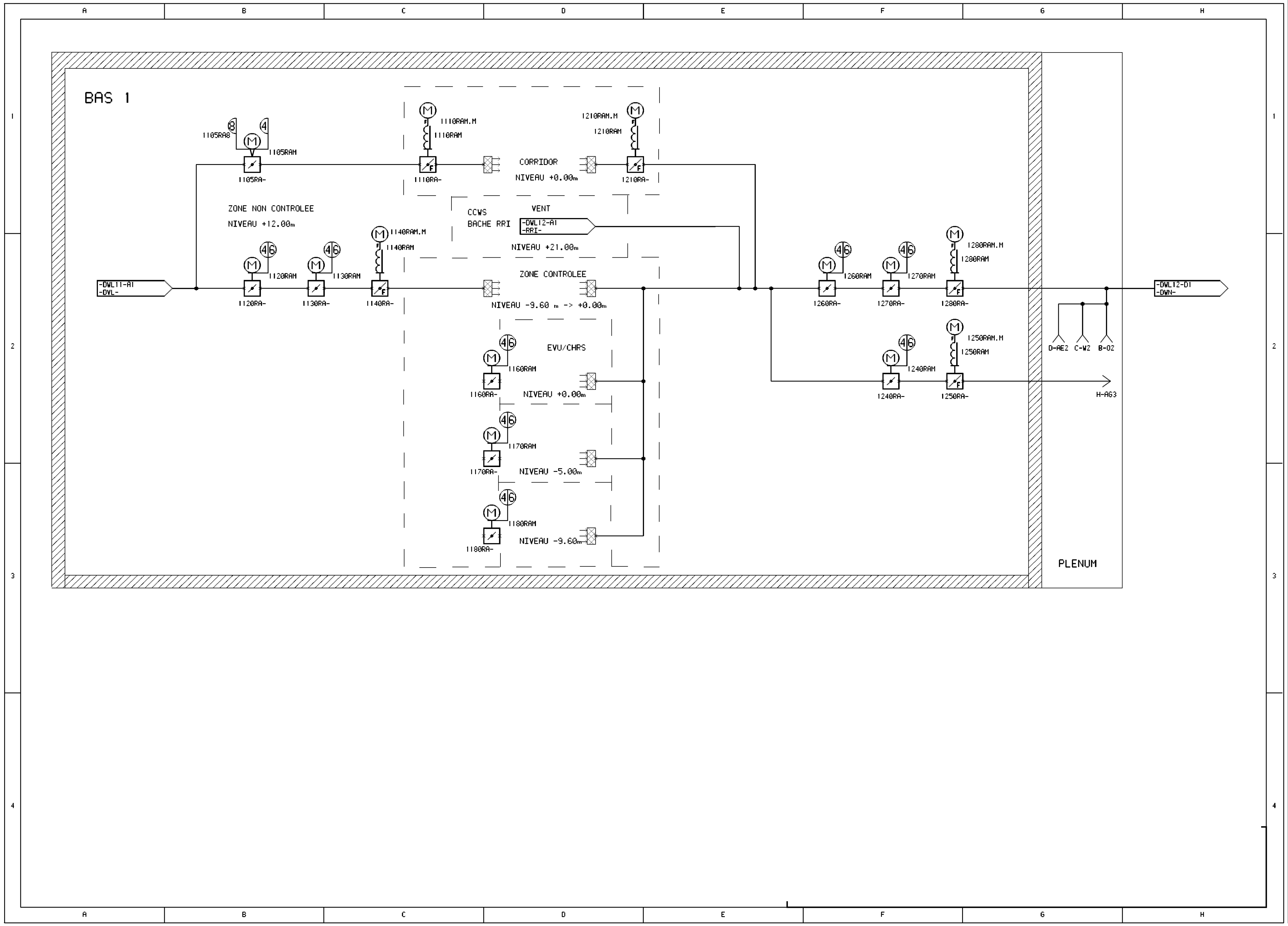
SECTION 9.4.6 - TABLE 2

DWL [CSBVS] Functional Flow diagram Glossary

French	English
Zone non contrôlée	Uncontrolled area
Zone contrôlée	Controlled area
Niveau	Level
Hall manutention combustible	Fuel pool handling hall
Bâche	Tank

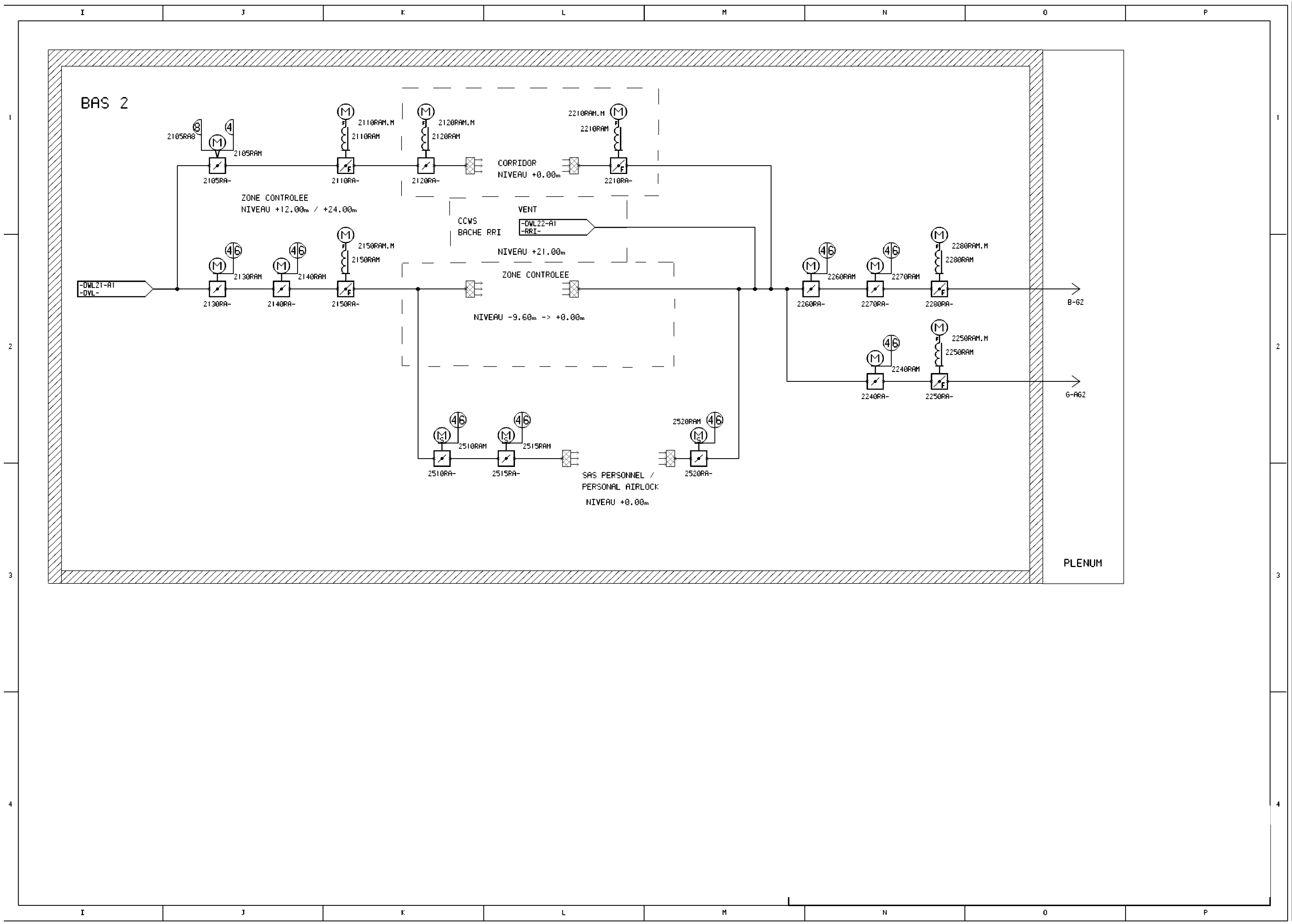
SECTION 9.4.6 - FIGURE 1

DWL [CSBVS] Functional Flow Diagram (SHEET 1/5)



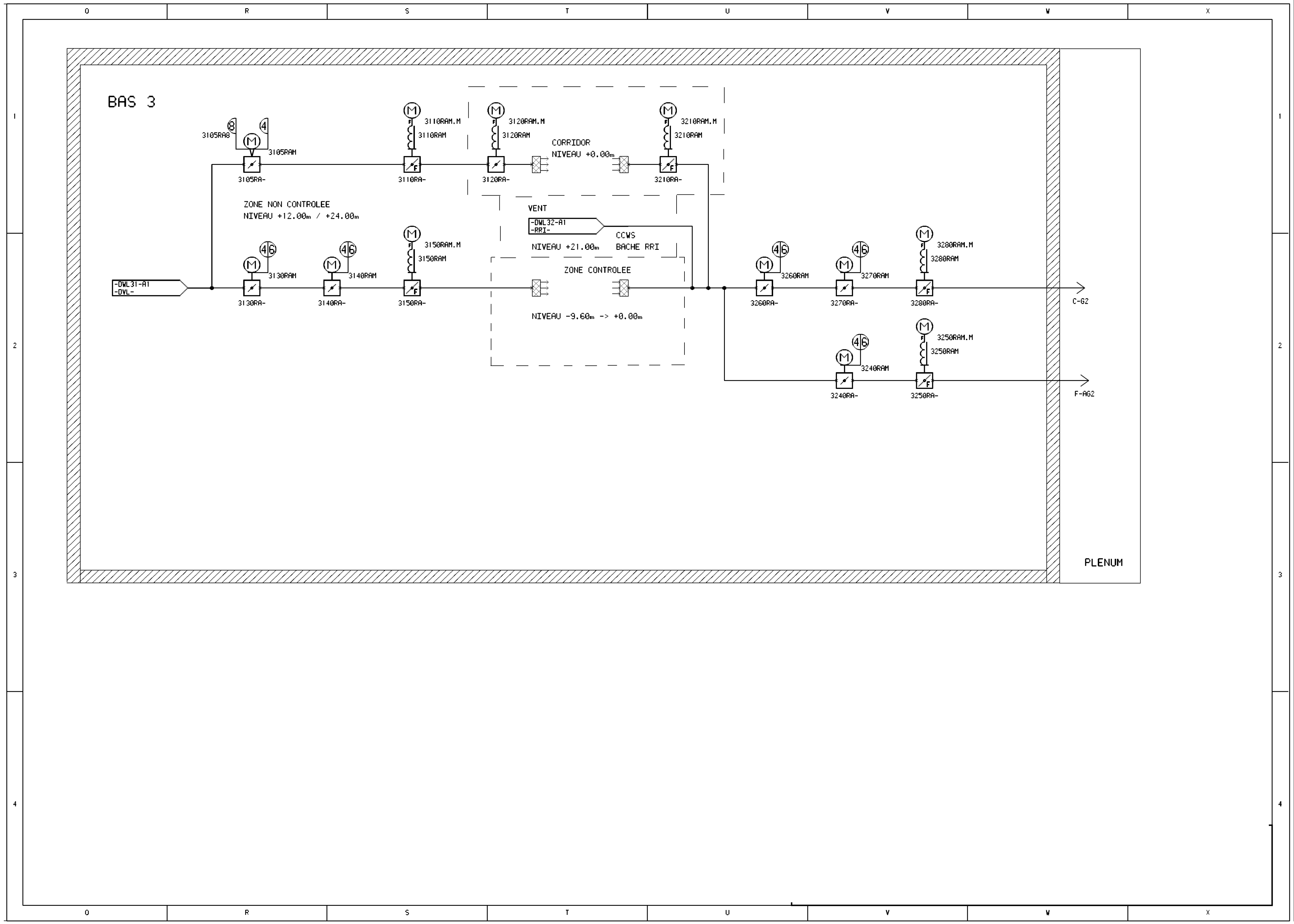
SECTION 9.4.6 - FIGURE 1

DWL [CSBVS] Functional Flow Diagram (SHEET 2/5)



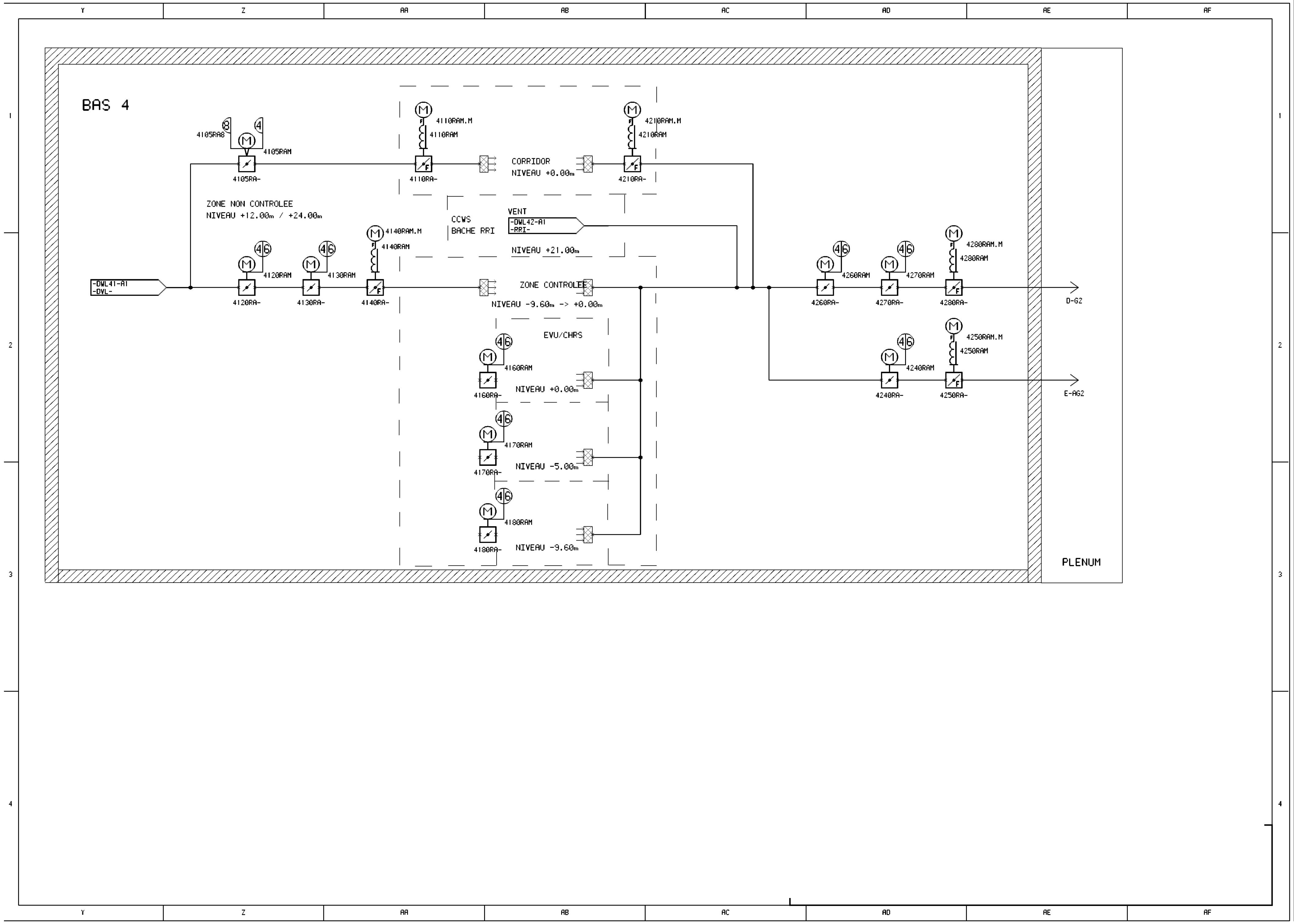
SECTION 9.4.6 - FIGURE 1

DWL [CSBVS] Functional Flow Diagram (SHEET 3/5)



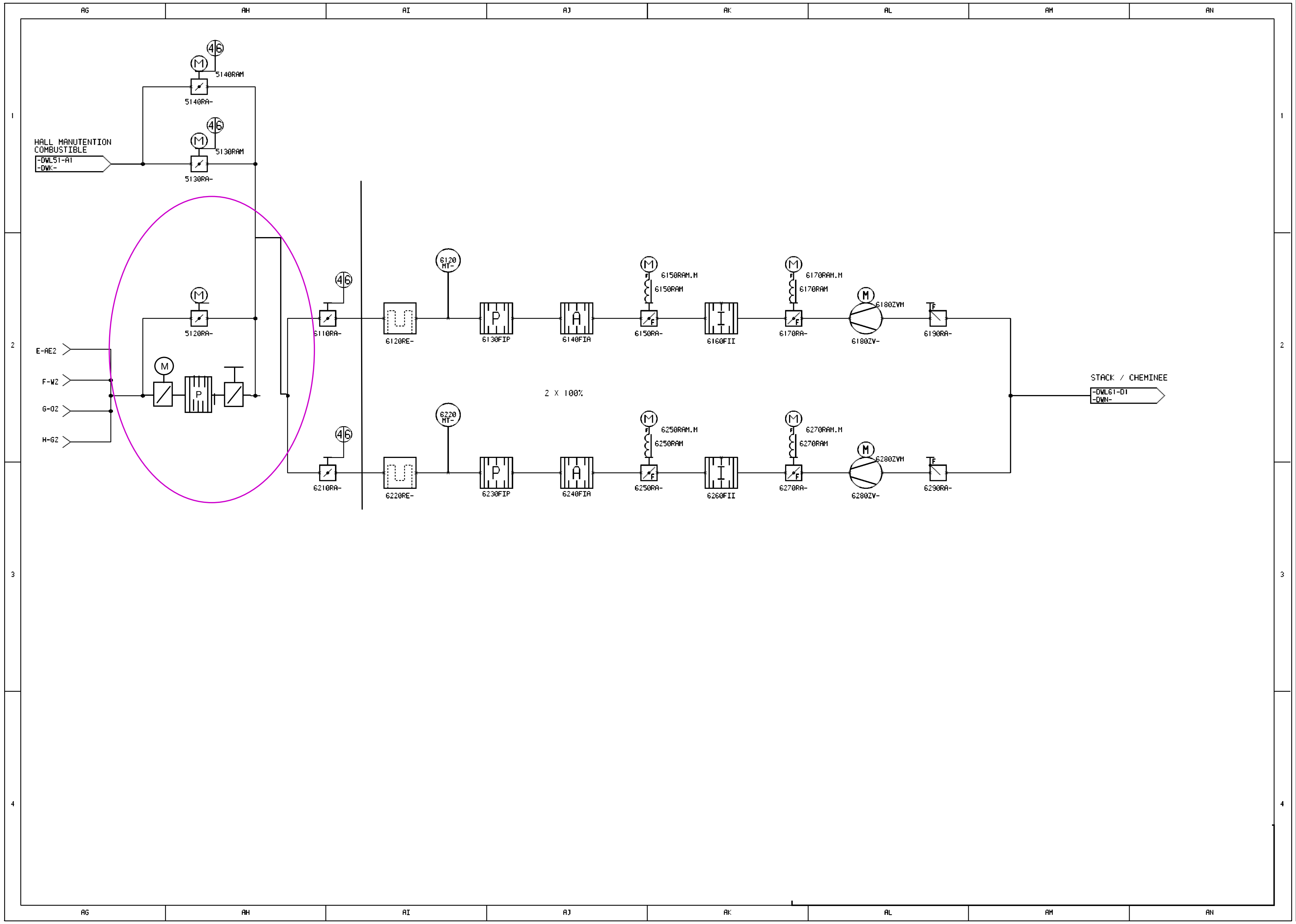
SECTION 9.4.6 - FIGURE 1

DWL [CSBVS] Functional Flow Diagram (SHEET 4/5)



SECTION 9.4.6 - FIGURE 1

DWL [CSBVS] Functional Flow Diagram (SHEET 5/5)



7. SAFEGUARD BUILDING UNCONTROLLED AREA VENTILATION SYSTEM (DVL [SBVSE])

A number of design changes will be implemented for the DVL [SBVSE] system to address the issues arising from fault studies in relation to the cooling of essential electrical and Instrumentation and Control equipment (I&C) within the four safeguard buildings:

- The two maintenance trains will be renamed DVLnew-1 and DVLnew-4. Each of the two DVLnew trains will provide back-up for the two main DVL trains: DVLnew-1 will provide back-up for the main DVL [SBVSE] trains 1 and 2 and DVLnew-4 will provide back-up for the main DVL [SBVSE] trains 3 and 4.

- Failure of a main DVL [SBVSE] train will result in automatic switchover to its associated back-up DVLnew train.

- Maintenance on a main DVL [SBVSE] train will only be allowed if the outside temperature is below a defined temperature limit (around 25°C), in order to avoid the use of a back-up DELnew train (see section 10 of this sub-chapter) during maintenance.

- If a loss of the main DVL [SBVSE] train occurs in division 1 while DVLnew1 and DELnew1 are being used for maintenance operation in division 2, DVLnew1 is automatically switched to ventilate the essential EC&I rooms of the Safeguard Building in division 1.

- If a loss of the main DVL [SBVSE] train occurs in division 4 while DVLnew4 and DELnew4 are being used for maintenance operation in division 3, DVLnew4 is automatically switched to ventilate the essential EC&I rooms of the Safeguard Building in division 4.

Diversity will be applied between the four main DVL [SBVSE] trains and the two DVLnew back-up trains to mitigate frequent faults and to achieve the dose bands targets.

Failure of the control system supporting the four main DVL [SBVSE] trains will result in automatic switchover to the two DVLnew back-up trains.

The start-up of the DVLnew train will lead to automatic start-up of the DELnew train.

These design changes are not included in the description of the DVL [SBVSE] provided in this section. The incorporation of these design changes into the loss of support systems safety case is described in section 9 of 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.

A more detailed description of the changes can be found in the conceptual design document [Ref-1].

7.1. ROLE OF THE SYSTEM [REF-1] TO [REF-7]

7.1.1. Functional role of the system

The functional roles of the DVL [SBVSE] system which operates in the four Safeguard Buildings are as follows:

- to maintain acceptable temperature ambient conditions and air renewal conditions for staff and for equipment in the uncontrolled area of the Safeguard Buildings (in particular in the electrical, electronic and mechanical rooms)
- to supply air to the DWL [CSBVS] system

7.1.2. Safety role of the system

The general safety requirements are given in section 0 and the specific requirements are given below:

The safety function of the DVL [SBVSE] system is to maintain the temperature of the air in the uncontrolled area in the safeguard building within a range compatible with the satisfactory operation of the electrical and mechanical safety equipment.

The DVL [SBVSE] ventilation system is a support system for instrumentation and control equipment, for the electrical switchboards and mechanical equipment.

7.2. DESIGN BASIS

The DVL [SBVSE] system is designed to:

- remove heat released by:
  - operating equipment (lighting and heat from equipment, with the exception of the main motors which are cooled separately), the exterior supplies and the supplies from neighbouring rooms in the uncontrolled area of the Safeguard Building, in order to ensure that the maximum authorised temperatures are not exceeded
- ensure minimum temperature in the various rooms
- supply a fresh air change rate of at least 0.5 air changes/hr in rooms where equipment is located and 10 air changes/hr in battery rooms
- prevent accumulation of specific gases (mainly toxic and explosive gases)
- supply air to the DWL [CSBVS] system

The air supply temperatures assumed for designing the DVL [SBVSE] system air-conditioning trains are as follows:

- Summer: 18.0°C
- Winter: 18.0°C

The basic atmospheric conditions (temperature and humidity) are defined in section 1.

7.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

For each Electrical Division of the Safeguard Buildings (1 to 4), heating, ventilation and air-conditioning are provided by separate and independent elements of the DVL [SBVSE] system.

In normal operation of the system, heating, ventilation and air conditioning are provided by 100% F1B trains.

During maintenance of one 100% F1B train at a time (see section 7.4), heating, ventilation and air conditioning are provided by a non-classified, 100% train shared by two divisions (1/2 and 3/4).

In each division, extraction from rooms subject to specific risks (battery rooms and rooms of the DEL [SCWS] chilled water system for instance), is ensured by two 100% trains: one F1B and the other non-classified.

The DVL [SBVSE] system comprises an air-supply/extraction system which may operate in recycling mode using a fresh air supply.

Note: The RSS, designed for use in case of unavailability of the Main Control Room, is located in Division 3 of the Safeguard Building; its ventilation may be provided by the DVL [SBVSE] system of either Division 2 or Division 3.

For each division, the DVL [SBVSE] system comprises the following elements:

- a single air intake equipped with explosion-proof dampers; in Divisions 2 and 3: the air intake is shared by the DCL [CRACS] system of the same division; in Divisions 1 and 4: there is a single air intake for the F1B and non classified trains of each division
- a 100% F1B air-conditioning train (filtering, heating, cooling and air supply) and an associated extraction fan
- a connection to a non-classified, 100% air-conditioning supply and exhaust trains whose elements are located in Division 1 (Division 4)
- connections for the air supply to the controlled area of the mechanical rooms (interface with the DWL [CSBVS] system)
- a network of ducts distributing air to the electrical rooms and mechanical rooms
- two independent extraction duct networks :
    - one provided for rooms subject to specific risks (battery rooms, mechanical rooms and rooms of the DEL [SCWS] chilled water system); for these rooms air is directly discharged to the outside by one of the two extraction fans (in each division: a 100% F1B-classified extraction train, a non classified 100% extraction train)

  - o a network provided for the other rooms in the uncontrolled area of the Safeguard Building. This network is connected to the main extraction trains with 100% capacity (the F1B fan is located in the same division; the non classified fan shared by Divisions 1/2 (3/4) is located in Division 1 (Division 4), some fraction of which can be recycled to optimise the power consumption of the air conditioning train.

- a single air outlet equipped with explosion-proof dampers (shared for the air extractions of the non-classified ventilation systems).

Each air-conditioning train comprises the following:

- a set of regulating dampers
- a pre-filter
- an electric heater
- a cooling coil with droplet separator (for the F1B train, the chilled water is supplied by the DEL [SCWS] system of the same division; the non-classified train is supplied with chilled water by the DER system)
- an air-supply fan with 100% capacity
- a high-efficiency fine filter (HEPA)

The ducting is made from galvanised steel.

For each division (1 to 4), the F1B train is supplied with electricity by its own F1B electrical train.

In Division 1 (the principle is identical in Division 4):

- a non classified train shared by Divisions 1 and 2 (4 and 3) operates during maintenance of a division, Division 1 or Division 2 (Division 4 or Division 3 respectively). It is supplied with electricity by a non-classified switchboard of the same division. A cross-connection with the neighbouring electrical train is however possible during electrical maintenance on the train. For extraction from the battery rooms, each division has its own F1B and non-classified trains and for this reason no connection of inter-division ducts is required
- manual isolation dampers, equipped with open and closed position switches, are installed on the inter-division ducts (air-supply and extraction ducts for Division 1/2 (3/4)).

7.4. OPERATING CONDITIONS

The DVL [SBVSE] system in each division operates in all operating modes of the plant as well as during plant outages or during maintenance of one electrical division.

7.4.1. Normal state of the system

Definition:

The system is used in its normal state when the plant is operating and during plant outages.

Description:

Normal operation is defined as follows for each division:

- the F1B train (filtering, heating and cooling) is in operation
- the non-classified train is shut down (it may be restarted if the F1B train is unavailable for maintenance or due to an incident)
- the air is distributed in all uncontrolled rooms of the Safeguard Buildings (with the exception of those that are air-conditioned by the DCL [CRACS] Division 2 – Division 3 system). A flow rate ranging from 6,400 to 6,800 m^3/hr [Ref-1] is supplied to the controlled mechanical area (air distributed by the DWL [CSBVS] system)
- the air is extracted from all rooms (of the uncontrolled area)
- the air is extracted from all rooms where there is a specific risk (hydrogen, freon: battery rooms and DEL [SCWS] system room) and from cold mechanical rooms to the outside using a specific extraction routing
- the ventilation functions of the RSS located in division 3 are provided by the DVL [SBVSE] system located in division 2 or in division 3 according to their availability
- in summer, since the exterior temperature is lower than the temperature of the extracted air, the DVL [SBVSE] system operates in an open circuit (fresh air) mode. Otherwise, the DVL [SBVSE] system operates in recycling mode with a fresh air contribution.
- in winter and depending on ambient conditions (see section 1), the air-conditioning system operates in recycling mode with fresh air injection.

7.4.2. Other permanent operating conditions of the system

7.4.2.1. Operation during maintenance of the EE1 electrical switchboards of the division or for availability testing

The following cases are considered: maintenance of one of the two electrical divisions, maintenance on the F1B trains and loss of an active F1B element.

Whatever the situation, the four DVL [SBVSE] system trains are required. Consequently, in case of maintenance on one F1B classified train, the function (supply and exhaust) is fulfilled by a non classified 100% train shared by two divisions (1/2 and 3/4). The exhaust of specific rooms (mechanical area, battery rooms) is provided with a train designed for maintenance in each division.

7.4.3. Transient states of the system

7.4.3.1. Partial or total loss of the ultimate heat sink (LUHS) – Partial or total loss of the RRI-SEC [CCWS-ESWS] cooling chain (LOCC)

For the DVL [SBVSE] system, the air flow of the F1B train is cooled by chilled water supplied by the DEL [SCWS] system: in two divisions (division 2 and division 3), two water-cooled chilling units connected to the RRI [CCWS] and in the two other divisions (division 1 and division 4), two air-cooled chilling units. In the case of LUHS, the DEL [SCWS] classified chilled water system fulfils the cooling function for only two divisions (divisions 1&4).

7.4.3.2. Loss of Offsite Power (LOOP)

In the event of LOOP, the fans and other actuators of the 100% F1B trains of the DVL [SBVSE] system are supplied with backup power by the corresponding main diesel generators.

7.4.3.3. Station Blackout (SBO)

During station blackout, only two of the four Safeguard Building divisions (division 1 and 4) are supplied with power back-up by the corresponding SBO (Station BlackOut) diesel generators. The principles of emergency supply are as follows:

- The power supply for the F1B 100% train (extraction air-supply fans and other actuators) in Division 1 is backed up by the SBO diesel generator of the same division.

- The power supply for the F1B 100% train (extraction air-supply fans and other actuators) in Division 4 is backed up by the SBO diesel generator of the same division.

7.5. PRELIMINARY SAFETY ANALYSIS

7.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

7.5.2. Compliance with functional criteria

The DVL [SBVSE] system is designed to comply with the temperatures given in section 1.

7.5.3. Compliance with design requirements

7.5.3.1. Safety classification

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

7.5.3.2. Single Failure Criterion or redundancy

The DVL [SBVSE] system must meet the single failure criterion. In the event of the unavailability of an active or passive component, the 4 x 100% structure of the F1B trains ensures that the three other F1B trains are available. Since the F1B trains are not connected to each other, the failure will not affect another train.

7.5.3.3. Qualification

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

7.5.3.4. Instrumentation and control

Instrumentation and control processing equipment is installed in the same electrical division as the actuators they control.

7.5.3.5. Emergency electrical supplies

The equipment that performs the F1B functions is powered by the backed up switchboards in the four divisions.

7.5.3.6. Hazards

See Section 9.4.7 - Table 1.

7.6. TESTS, INSPECTIONS AND MAINTENANCE

7.6.1. Periodic tests

The safety functions are subject to periodic testing.

7.6.2. Inspection and maintenance

Maintenance may be performed with the plant in operation.

7.7. FLOW DIAGRAMS

See Section 9.4.7 - Figure 1

SECTION 9.4.7 - TABLE 1

Hazards Protection

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Rupture of piping	No loss of more than one train	Geographical separation of redundant equipment	-
Failures of tanks, pumps and valves		Geographical separation of redundant equipment	-
Internal missiles		Geographical separation of redundant equipment	-
Dropped Loads		Geographical separation of redundant equipment	-
Internal explosion		Geographical separation of redundant equipment	-
Fire		Fire sectorisation	-
Internal flooding		Geographical separation of redundant equipment	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	Installation in the Safeguard Building	Seismic design
Aircraft crash	Yes	Installation in the Safeguard Building	Divisions 2 and 3 bunkered and geographical separation for Divisions 1 and 4
External explosion	Yes	Installation in the Safeguard Building	Explosion-proof dampers
External flooding	Yes	Installation in the Safeguard Building	Rooms located in the upper levels
Snow and wind	Yes	Installation in the Safeguard Building	-
Extreme cold	Yes	Installation in the Safeguard Building	Electric heaters allowing the correct operation of the other systems
Electromagnetic interference	Yes	Installation in the Safeguard Building	-

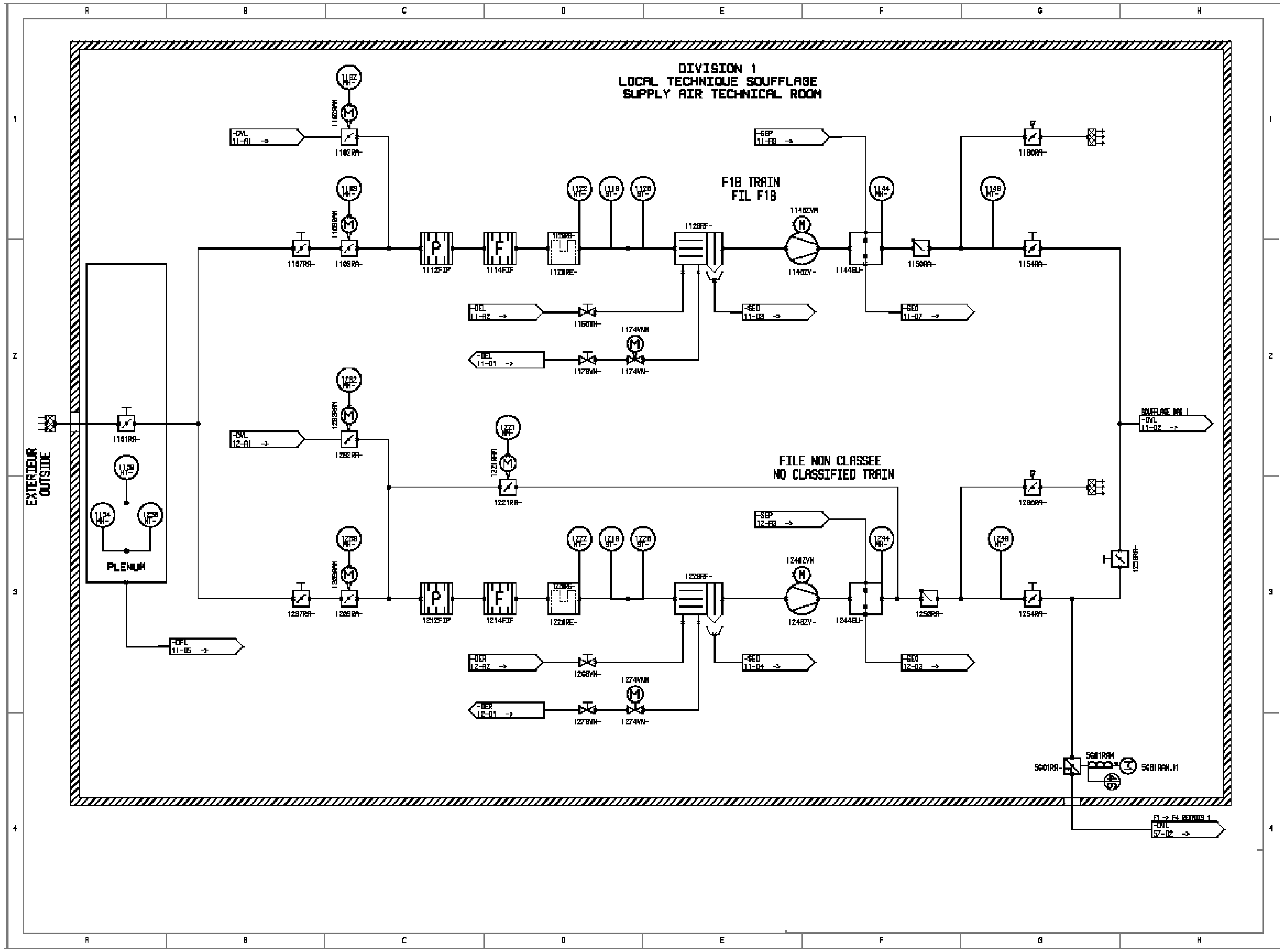
SECTION 9.4.7 - TABLE 2

DVL [SBVSE] Functional Flow diagram Glossary

French	English
Partie électrique	Electrical part
Locaux batteries	Battery room
Locaux pompes RRI	RRI pump rooms
Echangeur	Heat exchanger
Soufflage	Air supply
Extraction	Exhaust
BAS	SAB
SdR	RSS

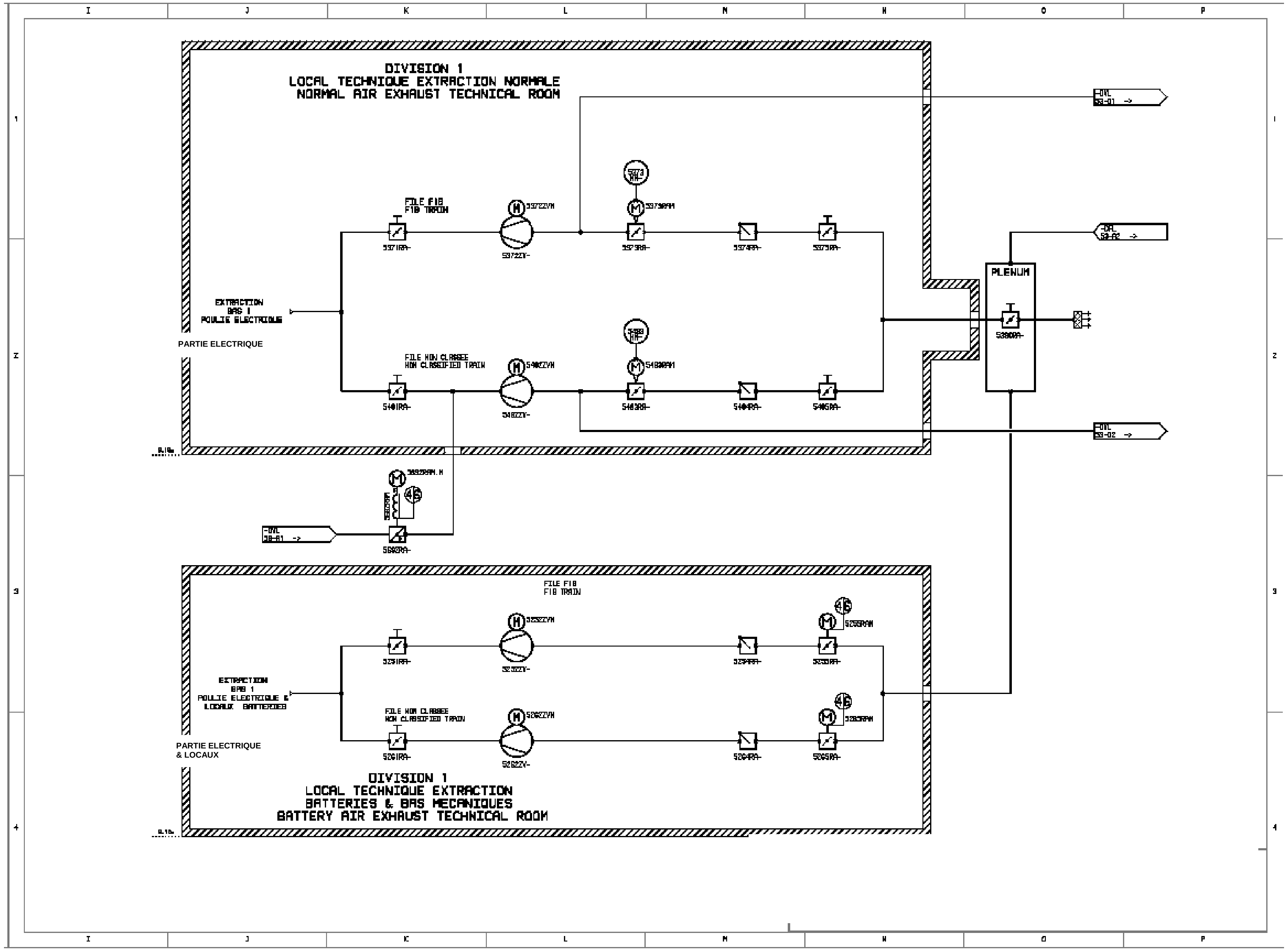
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 1/12)



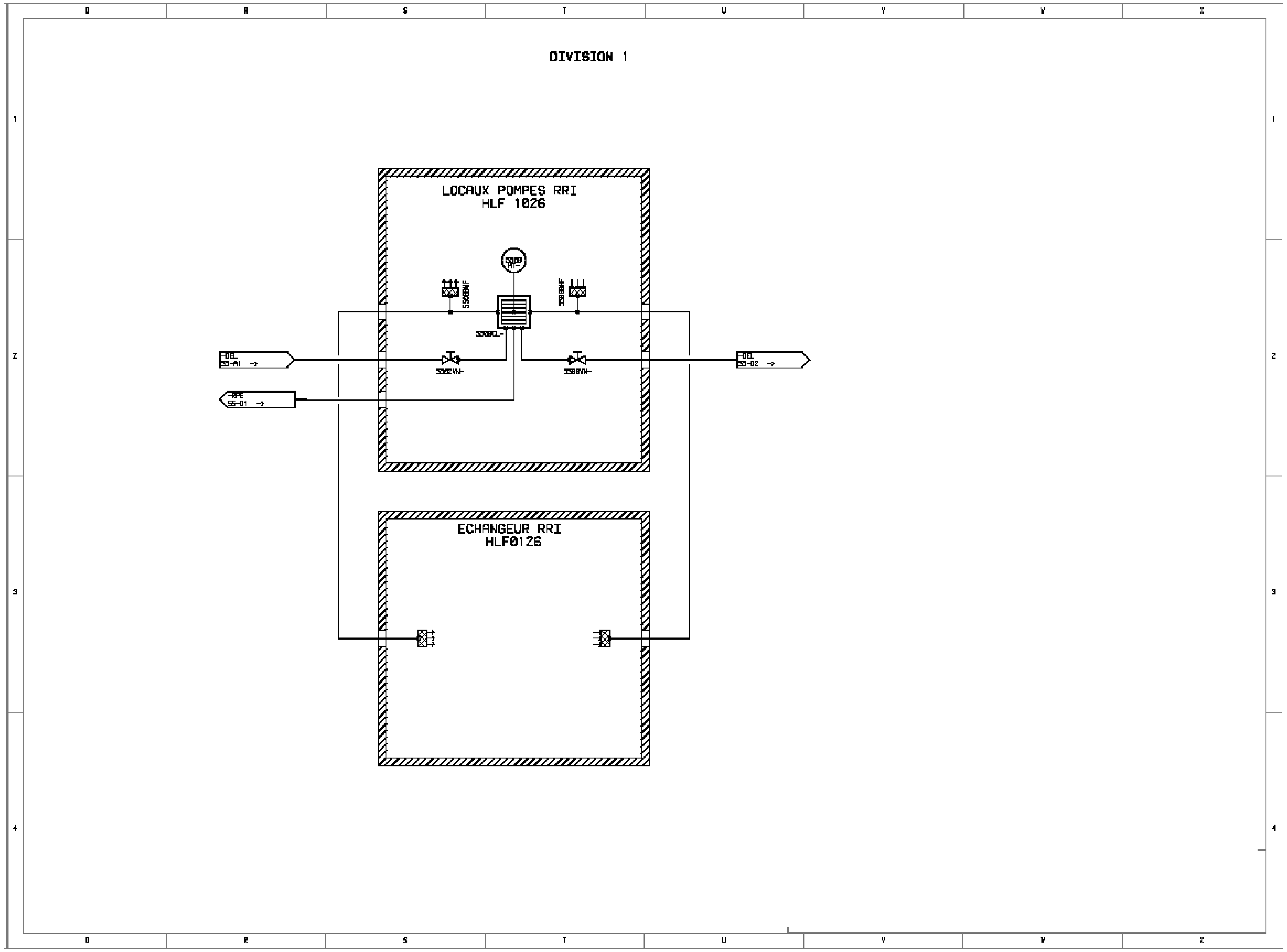
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 2/12)



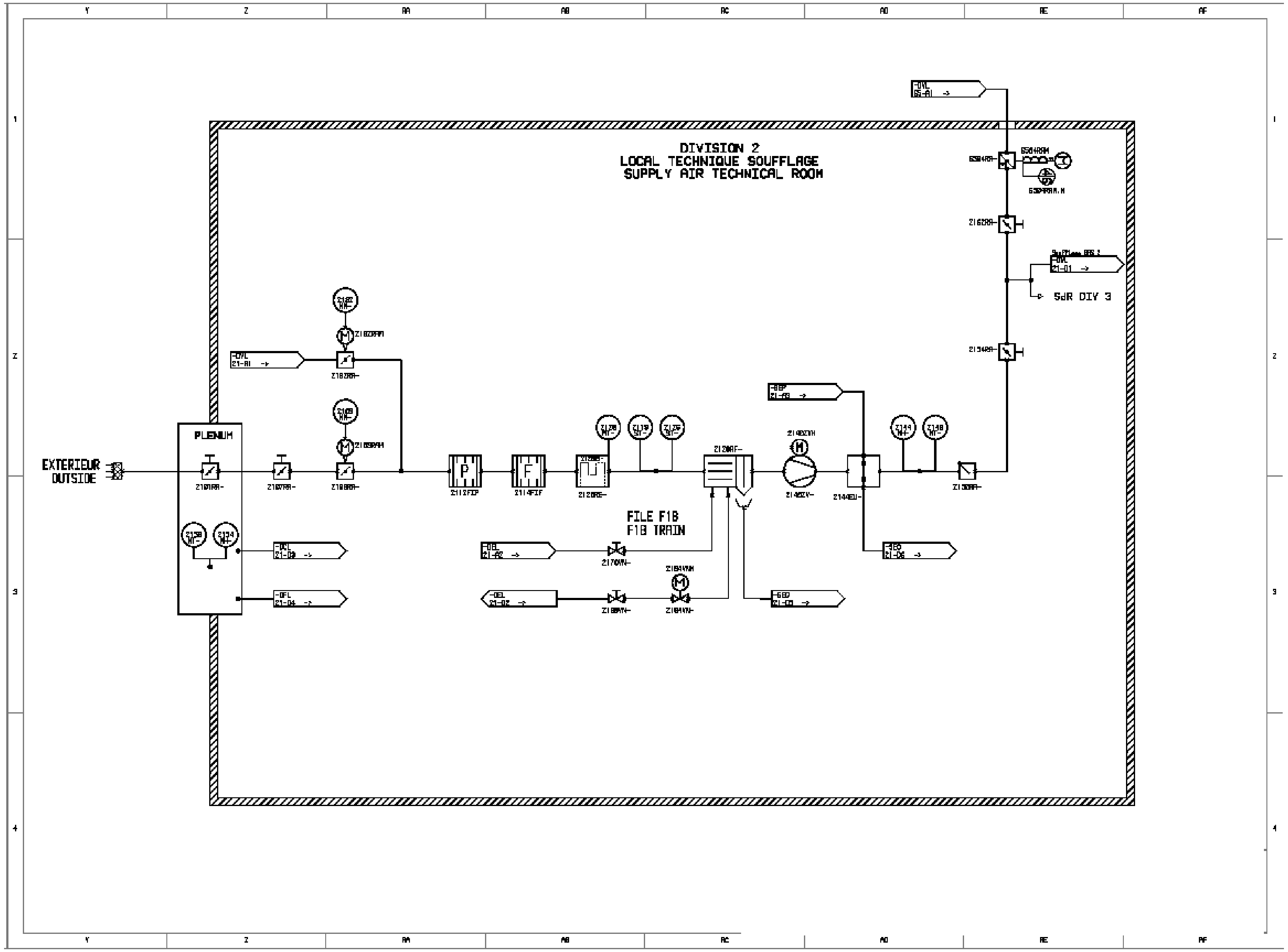
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 3/12)



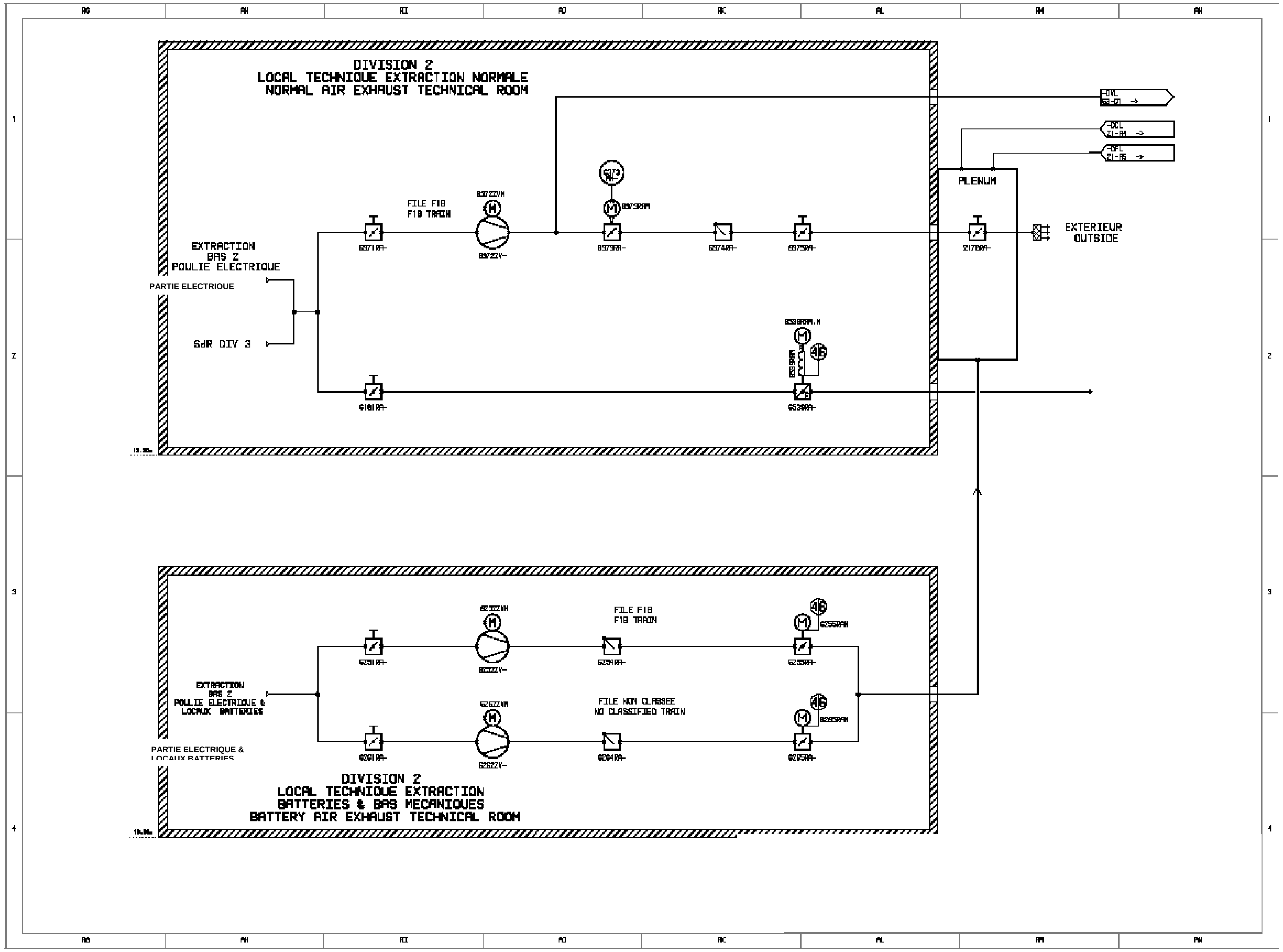
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 4/12) [Ref-1]



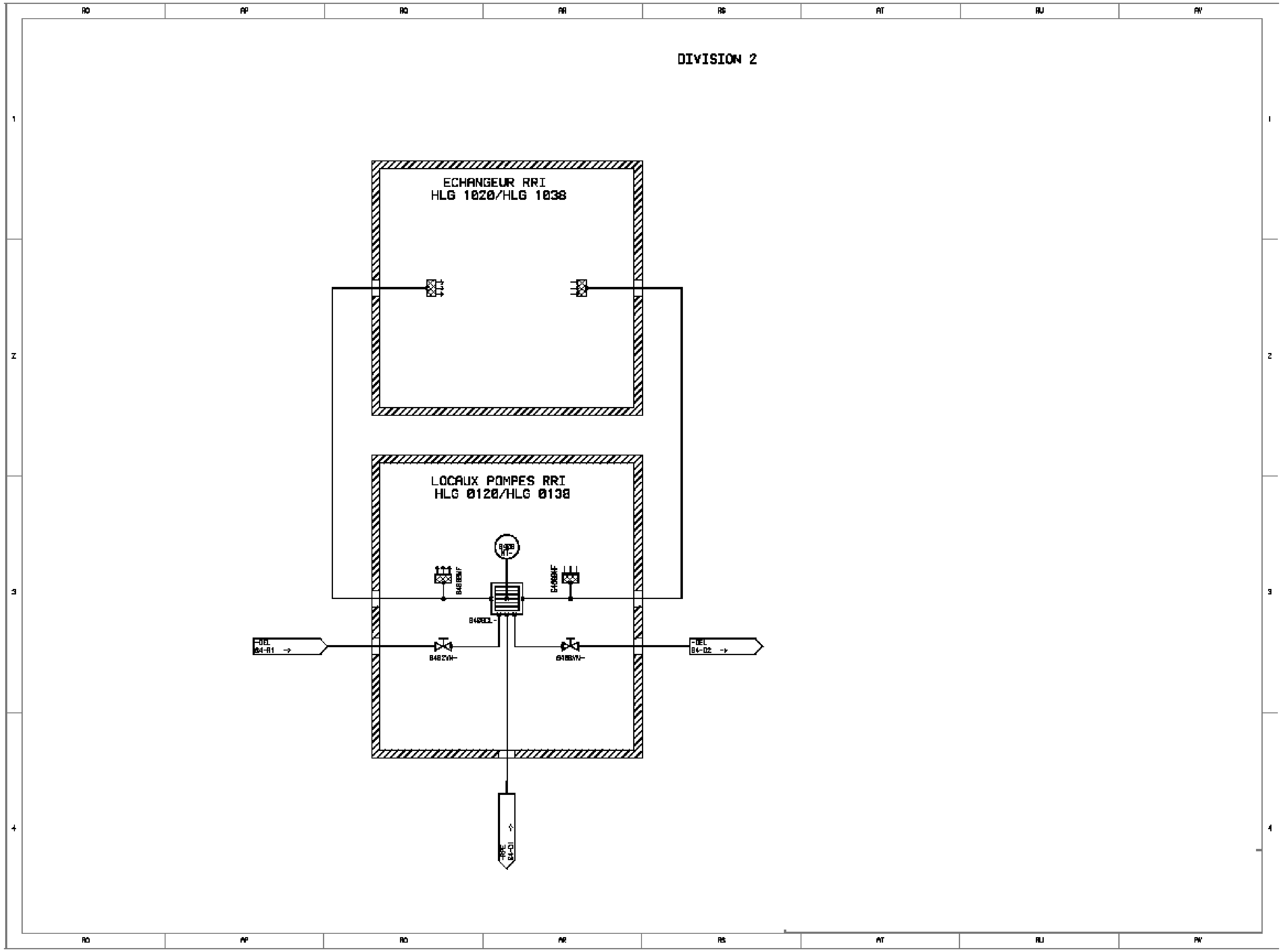
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 5/12) [Ref-1]



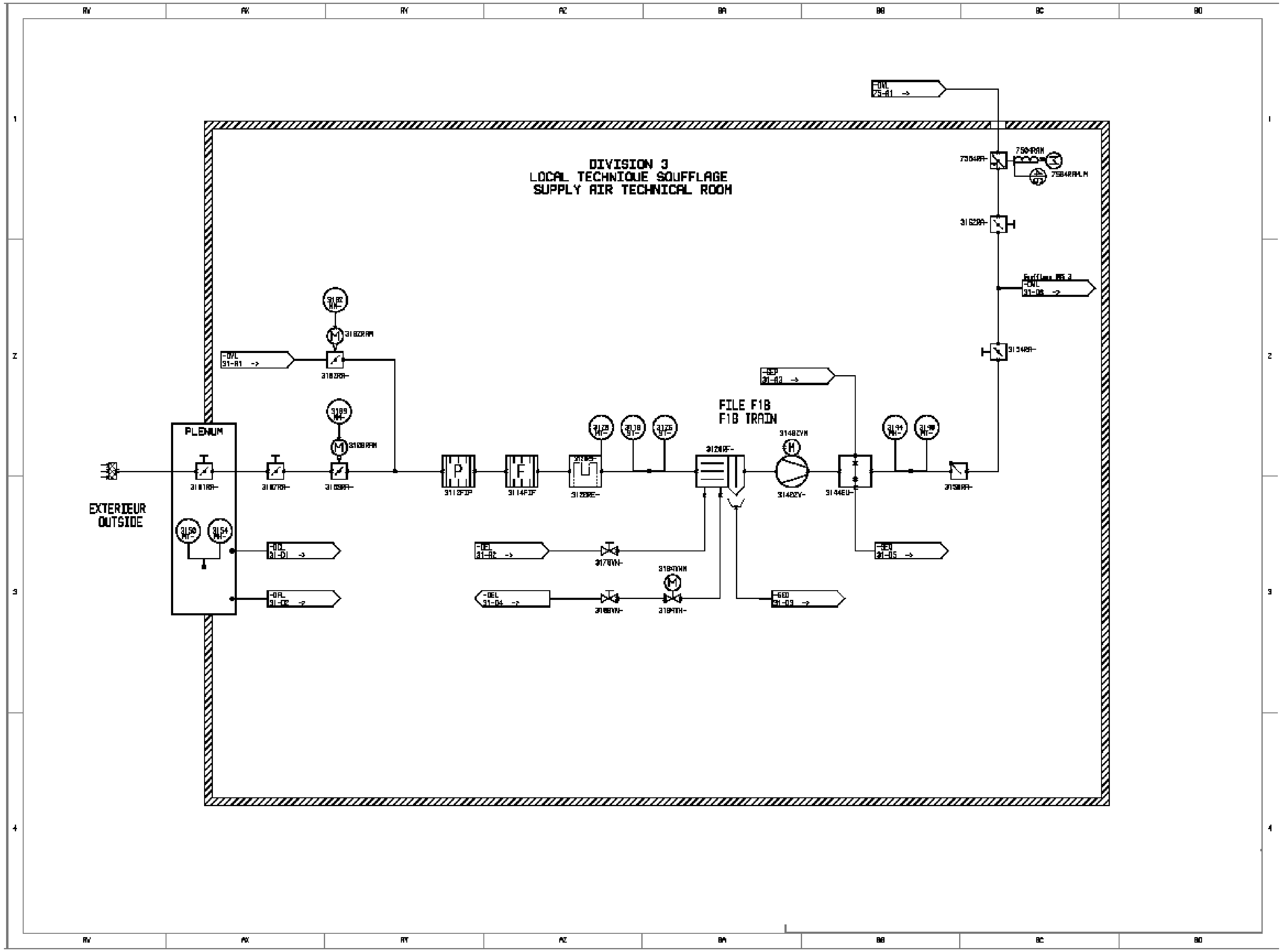
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 6/12)



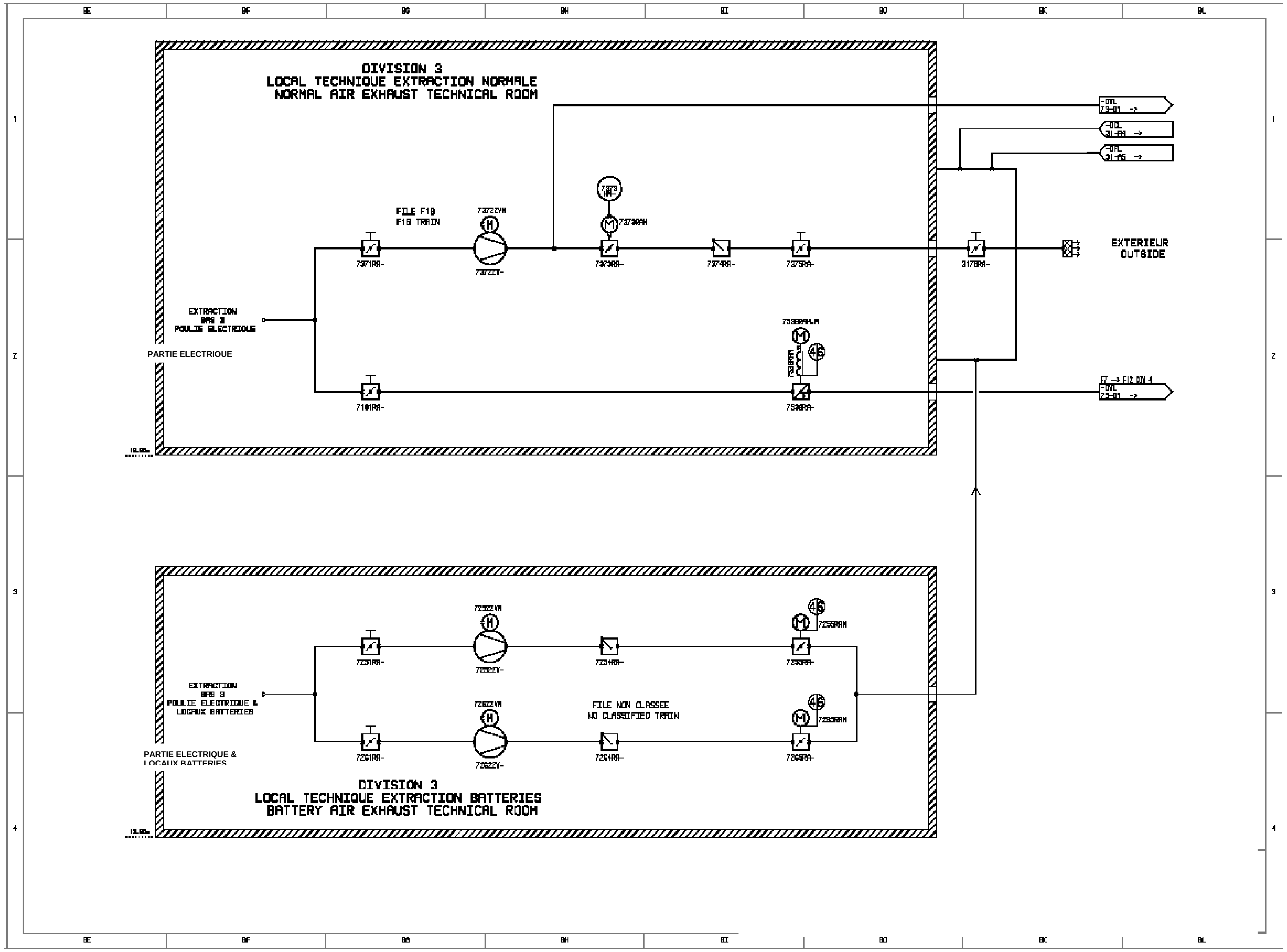
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 7/12)



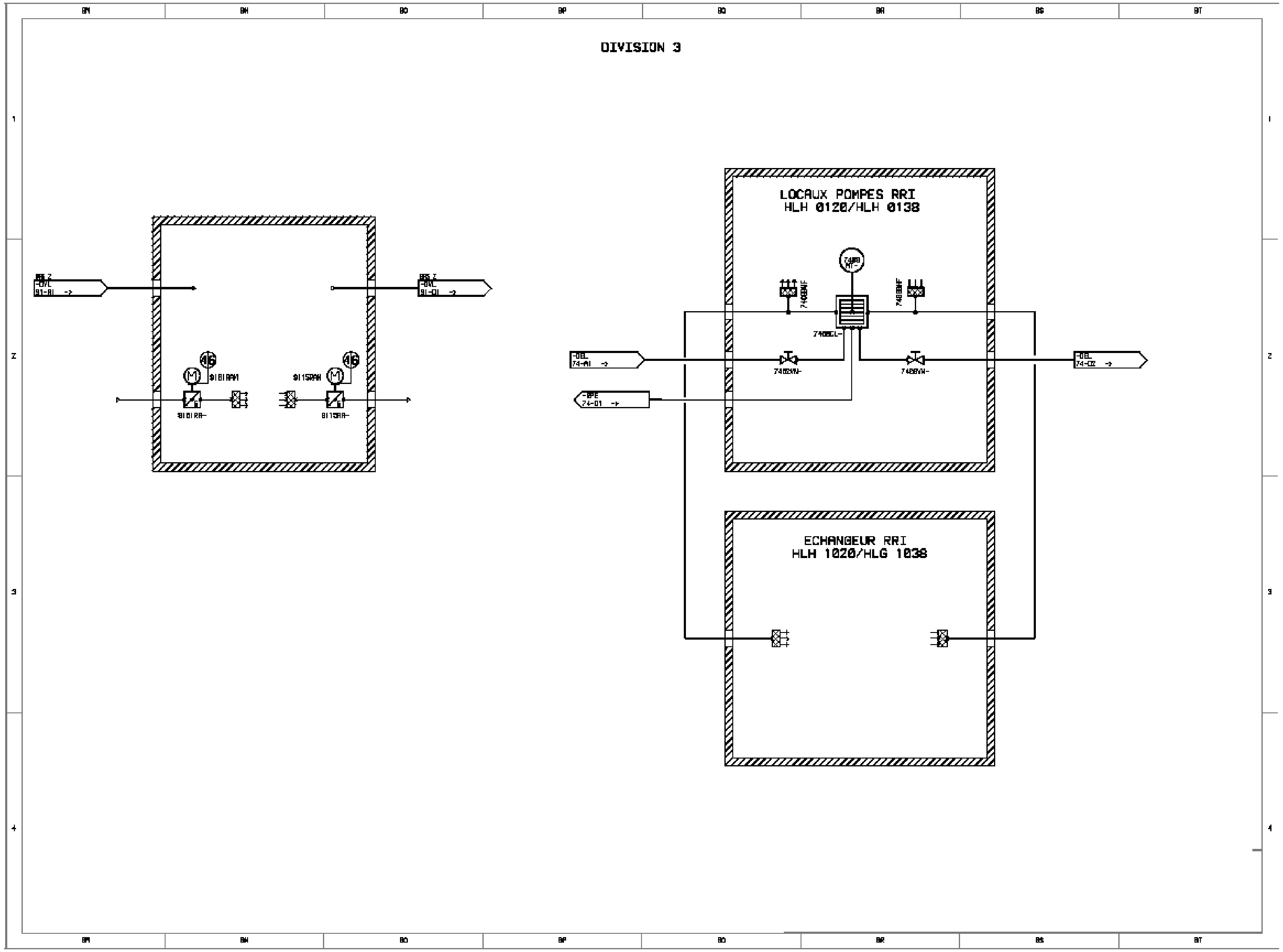
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 8/12)



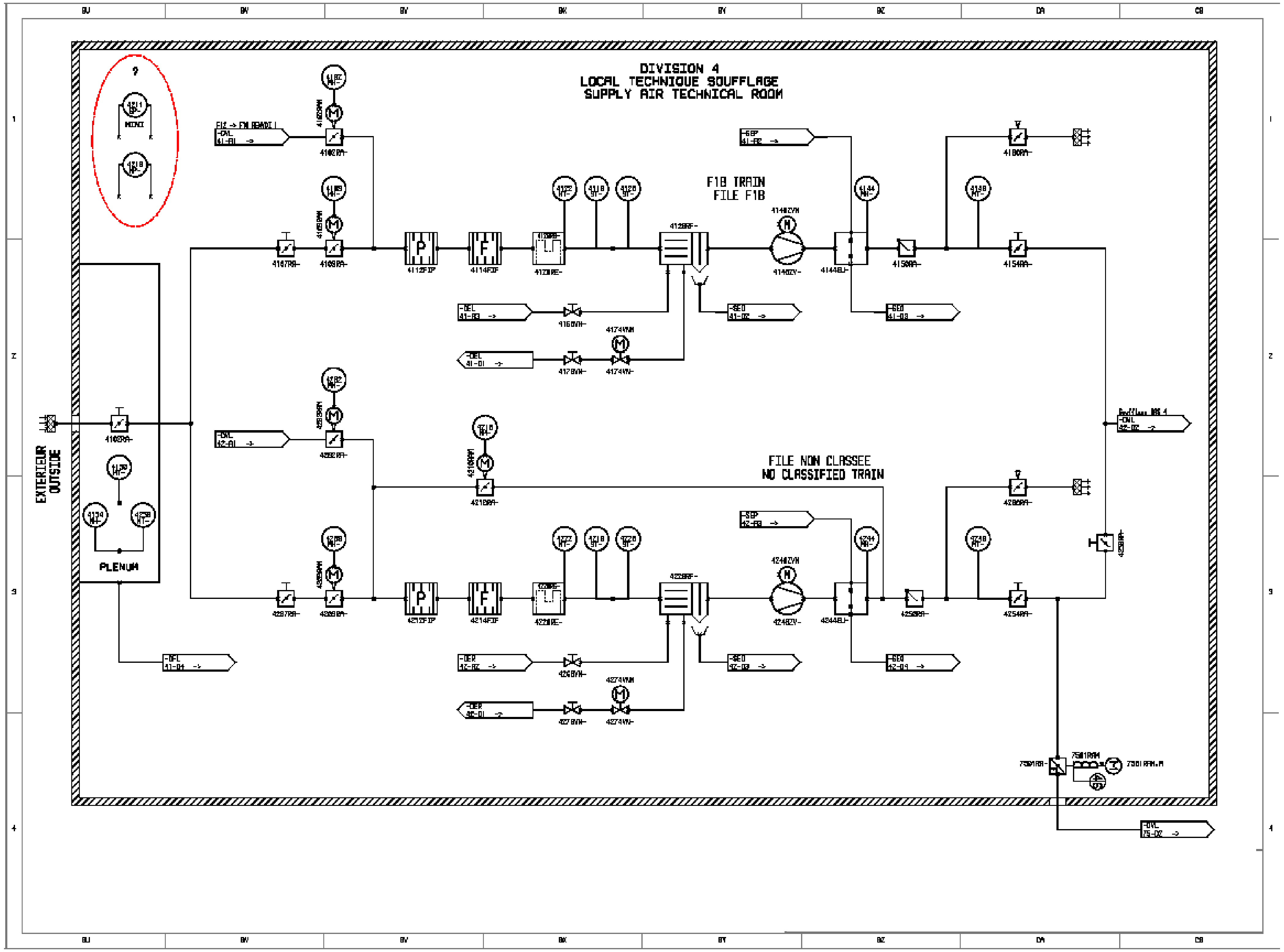
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 9/12)



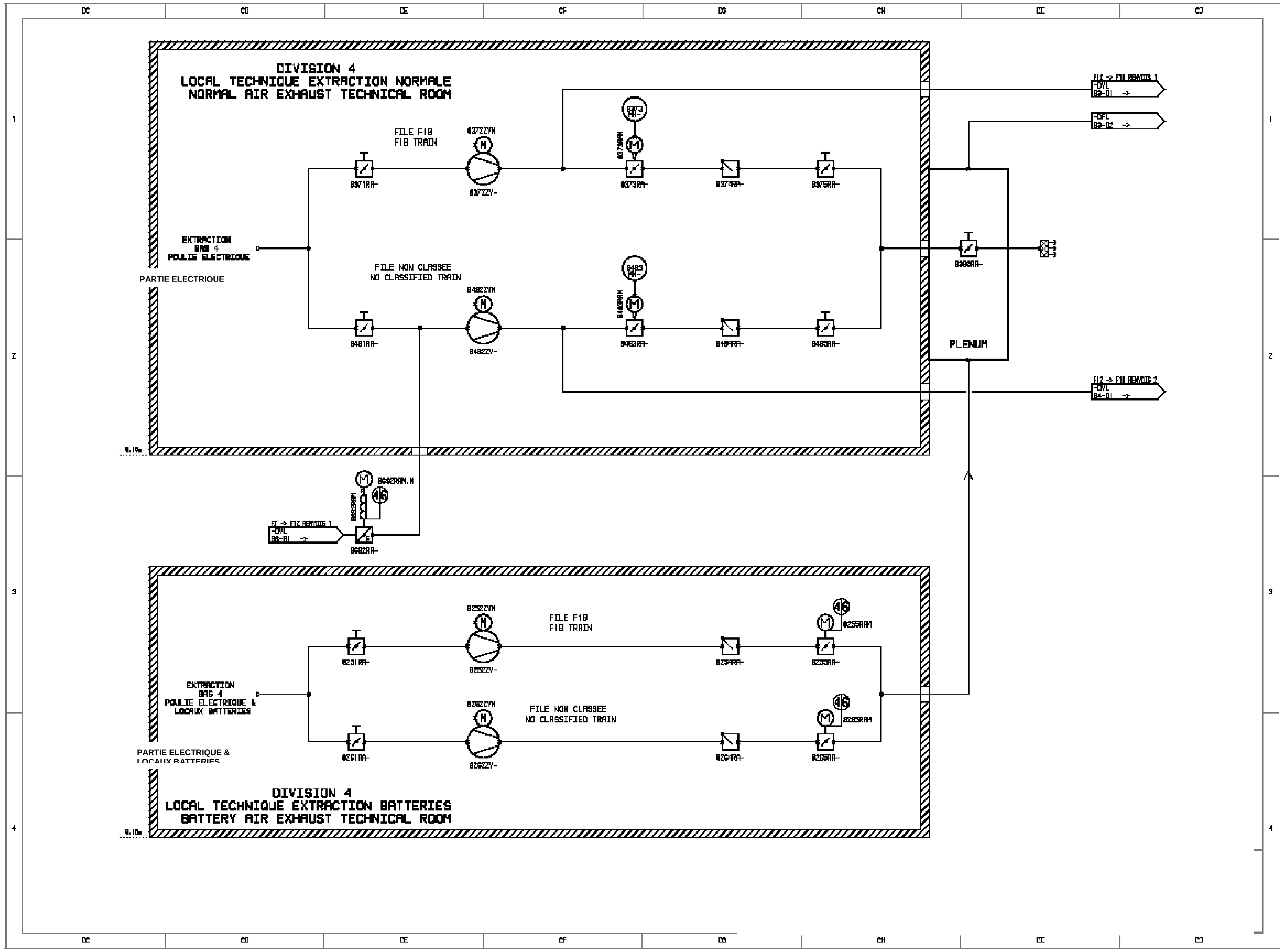
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 10/12)



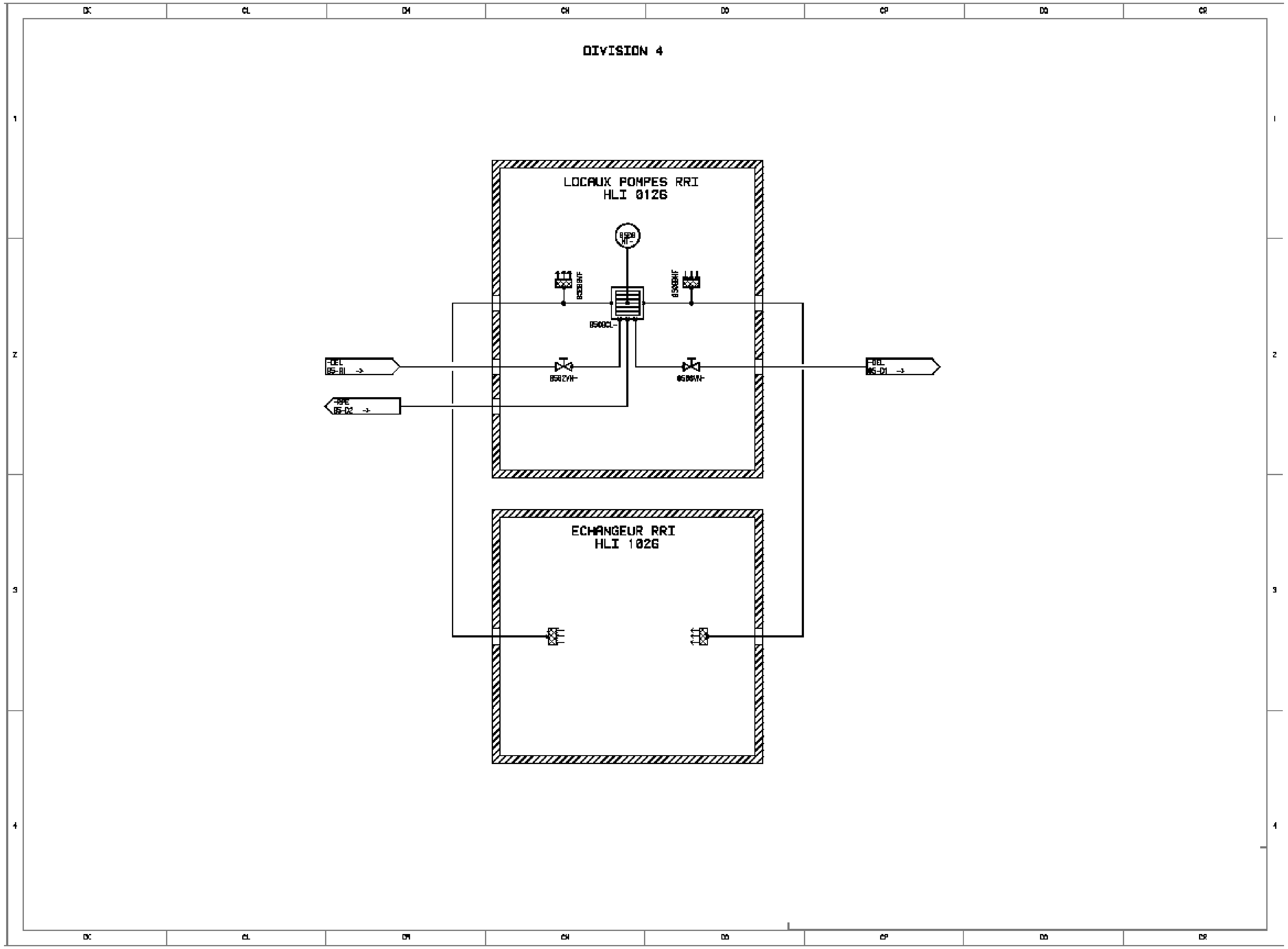
SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 11/12)



SECTION 9.4.7 - FIGURE 1

DVL [SBVSE] Functional Flow Diagram (Sheet 12/12)



8. MAIN CONTROL ROOM AIR CONDITIONING SYSTEM (DCL [CRACS])

A number of design changes will be implemented for the DCL [CRACS] system to address the issues arising from fault studies in relation to the cooling of essential electrical and Instrumentation and Control equipment (I&C) within the four safeguard buildings.

In the event of a Loss Of Off-site power (LOOP), consideration of single failure and preventive maintenance may result in some configurations with only one DEL [SCWS] train available to support the DCL [CRACS]. There is then a risk that the air supply temperature to the Main Control Room (MCR) and associated rooms is not maintained within an adequate temperature range, leading to the potential loss of operability of the MCR electrical and I&C equipment due to overheating, which could affect the safe operation of the plant. Currently, the Remote Shutdown Station (RSS) is used to bring the plant to a safe shutdown state in these conditions.

A number of DCL [CRACS] design options, involving introduction of a level of diversity to the use of the RSS, either at the system or at the component level, are being considered. The impact of these potential design options on the loss of support systems safety case is described in section 9 of Sub-chapter 16.4. The design options will be fully developed and incorporated into the design described in this sub-chapter as part of the detailed design during the site licensing phase.

8.1. ROLE OF THE SYSTEM [REF-1] TO [REF-7]

8.1.1. Functional role of the system

The functional role of the Main Control Room Air Conditioning System (DCL [CRACS]) is as follows:

- to maintain acceptable ambient conditions (temperature and humidity) for staff and equipment in the Main Control Room
- to ensure habitability of the Main Control Room, the Technical Support Centre and associated rooms, even in the event of radioactive contamination of the environment.

8.1.2. Safety role of the system

The general safety requirements are provided in section 0 and the specific requirements are given below:

The safety functions of the system are as follows:

- to maintain the temperature of the air within a range compatible with the correct operation of the Instrumentation and Control safety equipment
- to heat and ventilate the Main Control Room and the adjoining rooms

The other safety functions of the system are as follows:

- isolation function (damper in the fresh air intake ducts and in the air exhaust ducts)

- filtering the air supplying the Main Control Room and the adjoining rooms
- prevention of contaminated air from the outside from entering the rooms where staff are located so as to ensure habitability of the Main Control Room and adjoining rooms

8.2. DESIGN BASES

The DCL [CRACS] system is designed for the following:

- to remove heat produced by operating equipment, staff, from outside air and from neighbouring rooms to ensure that maximum authorised temperatures are not exceeded
- to ensure minimum temperature in the rooms are not reduced
- to control and maintain relative humidity, especially in the Main Control Room, at 50% ±10%
- to supply a fresh air change flow rate of at least 0.5 air changes/hour to all areas served by DCL [CRACS] (i.e. Main Control Room, Technical Support Centre and adjoining rooms)
- to maintain the Main Control Room and the adjoining rooms at a pressure greater than the pressures in peripheral rooms in order to ensure habitability in the event of radioactive contamination of the environment

The basic exterior atmospheric conditions and interior conditions (temperature and humidity) are defined in section 1.

8.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

The ventilation system of the Main Control Room operates in recycling mode plus a fresh air contribution. It supplies the Main Control Room and the adjacent rooms (instrumentation and control maintenance room, meeting rooms, the technical support centre, kitchen and washrooms).

The system comprises the following:

- two separate air inlets equipped with anti-shock wave check valves which are common with DVL [SBVSE] system (division 2 and 3)
- four 50% air-conditioning trains comprising:
    - two 50% identical and physically separated trains with an iodine filtering line
    - two 50% identical and physically separated trains without an iodine filtering line
- four steam humidifiers (one for each air-conditioning train)
- a single 100% network of ducts distributing air in the rooms

The four trains are installed 2 by 2. One train with an iodine filtering line and one train without an iodine filtering line are allocated to division 2 and the two others are allocated to division 3.

In each train, the fresh air is taken from the outside through the air inlet and then mixed with recycled air.

In the event of site contamination, the fresh air line without iodine filtering is isolated and the fresh air line with iodine filtering is started. The iodine filtering line is equipped with a heater, a pre-filter, an iodine filter, HEPA filters and a fan. A motor-driven damper is provided for switching the flow.

The recycling element of each train comprises a pre-filter, a cooling coil with droplet separator (supplied with chilled water by the DEL [SCWS] system), a fan, a high-efficiency filter and an electric powered humidifier. An electric powered heater is used to control the temperature in the Main Control Room. The kitchen and the washrooms have a separate air extraction system.

The main ducting network (air-conditioning trains) is made from galvanised steel. The iodine filtering train is made from steel with decontaminable surfaces.

8.4. OPERATING CONDITIONS

The DCL [CRACS] system operates in all power plant operating modes.

8.4.1. Normal state of the system

Definition:

The system is used in a normal state when the plant is operating and during plant outages, except in the case of external contamination.

Description:

Normal operation is defined by the following:

- two 50% air-conditioning trains (the choice of active trains is made by the operators according to availability of trains and to ensure an equal operating time for all trains)
- the two iodine filtering trains (50%) are bypassed, and for each train the motor-driven damper located upstream of the “iodine fan” is in the closed position
- the air in the Electrical Building at the level of the control room is recycled, with the exception of the air in the kitchen and the washrooms, which is discharged to the outside
- for each train, the extra air is taken from outside (fresh air) through the air inlet electrical heater and the sealed motor-driven damper (in the “open auto position”)
- individual electric air heaters, located in supply air ducts, which operate automatically in an ON/OFF mode and are controlled by temperature sensors in the relevant rooms.

8.4.2. Other continuous operating conditions of the system

8.4.2.1. Operation in the event of site contamination

Definition:

This continuous state corresponds to a contaminated environment following an accident on or close to the site. Contamination of the site (radiological contamination) is detected by the external contamination detection system (KRT [PRMS]).

Description:

This continuous operating state is defined by the following:

- the operation of two iodine filtering trains (fans and electrical heaters)
- the automatic closure of the sealed motor-driven dampers located on the 50% trains without iodine filtering line
- automatic opening of the motor-driven dampers located on the fans in the trains with iodine filters
- two corresponding 50% air-conditioning trains, in operation
- the air in the rooms is recycled in accordance with normal operating state, but with the addition of the kitchen and washroom air flow rate. The air passes through the motor-driven dampers in the automatic open position (the kitchen and washroom exhaust fan is stopped and outside isolation dampers are closed)
- DCL [CRACS] system operation creates a slight overpressure condition in the Main Control Room and associated rooms to prevent unfiltered in-leakage into these spaces

8.4.2.2. Operation during maintenance or unavailability of the ventilation equipment

Definition:

The system is used in this continuous state during maintenance of a train (unit in operation) or during maintenance of two divisions (unit in outage) or during unavailability of one or more ventilation elements or functions.

Description:

For this continuous state, the operation of the DCL [CRACS] system is the same as in normal operation; two of the four 50% ventilation trains are needed.

8.4.3. Transient states of the system

8.4.3.1. Partial or total loss of the ultimate heat sink

For the DCL [CRACS] system, the air flow is cooled by chilled water from the chilled water system (DEL [SCWS]).

In division 2 and 3, the chilled water is supplied by the water-cooled chilling units connected to the RRI [CCWS] and in the two others (division 1 and 4), is supplied by two air-cooled chilling units. In the case of LUHS, only the two air-cooled cooling plants remain available, the chilled water system (DEL [SCWS]) only fulfils the function of cooling two trains.

8.4.3.2. Loss of Offsite Power (LOOP)

The power supplies to the four 50% trains are backed up by the main diesel generators. During a LOOP and in normal operation, only two of the four trains operate continuously. This is a safety requirement for the Main Control Room. The principles of emergency power supply are as follows:

- in Division 2, one 50% train is backed up by Division 2 and the other by Division 1
- in Division 3, one 50% train is backed up by Division 3 and the other by Division 4.

8.4.3.3. Station Blackout (SBO)

The power supplies to two of the four 50% air-conditioning trains are backed up by the SBO diesel generators. The principles of emergency supply are as follows:

- the 50% train installed in Division 2 powered by Division 1 is backed up by an SBO diesel generator
- the 50% train installed in Division 3 powered by Division 4 is backed up by an SBO diesel generator

8.5. PRELIMINARY SAFETY ANALYSIS

8.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

8.5.2. Compliance with functional criteria

The DCL [CRACS] system is designed to comply with the temperatures given in section 1.

8.5.3. Compliance with design requirements

8.5.3.1. Safety classification

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

8.5.3.2. Single Failure Criterion or redundancy

The DCL [CRACS] system is required to meet the single failure criterion. In the event of unavailability of an active or passive component, the 4 train architecture (4 x 50%) of the F1B trains ensures that the other three F1B trains are available. Since the F1B trains are not connected to each other, the failure will not affect another division. Additionally, the four F1B trains are inside bunkered division 2 and 3 and are installed in separate rooms to ensure their physical separation. Although the DCL [CRACS] system is required to meet the single failure criterion, the iodine filter line operation is only required in the case of an RRC-B situation and/or external hazard. As a result, single failure and maintenance are not taken into account and it is therefore possible to carry out maintenance on the iodine filter lines.

8.5.3.3. Qualification

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

8.5.3.4. Instrumentation and control

The instrumentation and control processing is installed in the same electrical division as the actuators they control.

8.5.3.5. Emergency electrical supplies

The four DCL [CRACS] air-conditioning trains are electrically independent; each of the trains is powered from a different electrical division, i.e.:

- one of the two trains installed in safeguard building 2 is powered by electrical train 1 and the other by train 2
- one of the two trains installed in safeguard building 3 is powered by electrical train 3 and the other by train 4

This provision ensures the availability of the air-conditioning function in the event of failure of an electrical train or in the event of preventive maintenance.

In plant outage, during simultaneous maintenance of two electrical trains, two 50% air-conditioning trains remain available.

The two iodine filtering trains are electrically independent, each of the trains is powered from a different electrical train, i.e.:

- the train installed in safeguard building 2 is powered by electrical train 1
- the train installed in safeguard building 3 is powered by electrical train 4

In the event of failure of the electrical trains, power supplies for the iodine filtering trains are backed up by the SBO diesel generators.

8.5.3.6. Hazards

See Section 9.4.8 - Table 1.

8.6. TESTS, INSPECTIONS AND MAINTENANCE

8.6.1. Periodic tests

The safety functions are subject to periodic testing.

8.6.2. Inspection and maintenance

Maintenance may be performed with the plant in operation. In this case, maintenance of only one train is authorised.

8.7. FLOW DIAGRAMS

See Section 9.4.8 - Figure 1.

SECTION 9.4.8 - TABLE 1

Hazards

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Rupture of piping	No loss of more than one train	Geographical separation of redundant equipment	-
Failures of tanks, pumps and valves		Geographical separation of redundant equipment	-
Internal missiles		Geographical separation of redundant equipment	-
Dropped Loads		Geographical separation of redundant equipment	-
Internal explosion		Geographical separation of redundant equipment	-
Fire		Fire zoning	Fire dampers
Internal flooding		Geographical separation of redundant equipment	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	Installation in the Safeguard Building	Seismic design
Aircraft crash	Yes	Installation in the Safeguard Building division 2 and 3	-
External explosion	Yes	Installation in the Safeguard Building	Anti-shock wave check valves (DVL [SBVSE] system)
External flooding	Yes	Installation in the Safeguard Building	Rooms located in the upper levels
Snow and wind	Yes	Installation in the Safeguard Building	-
Extreme cold	Yes	Installation in the Safeguard Building	Electric heaters allowing the correct operation of the other systems
Electromagnetic interference	Yes	Installation in the Safeguard Building	-

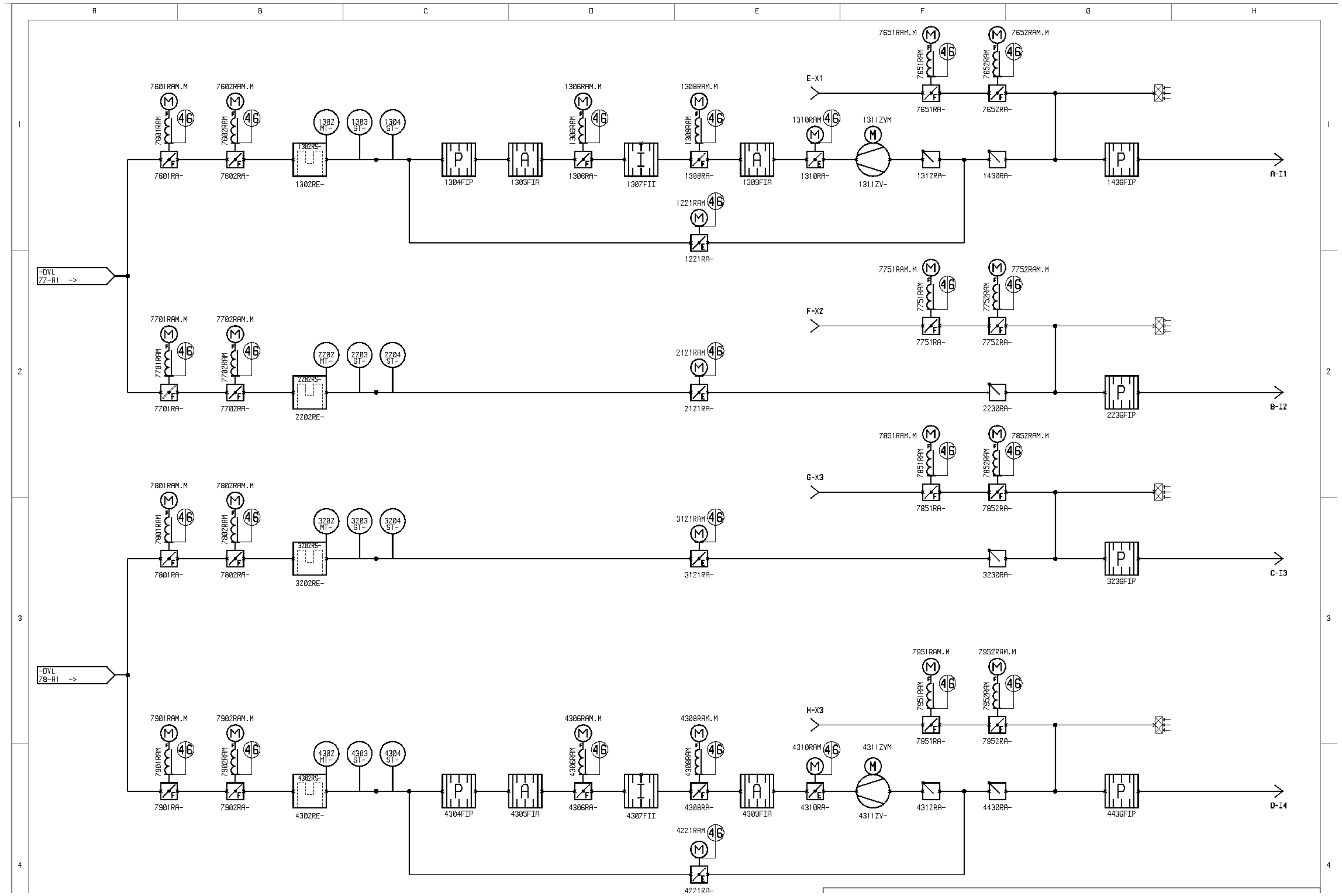
SECTION 9.4.8 - TABLE 2

DCL [CRACS] Functional Flow diagram Glossary

French	English
Plenum de soufflage	Air-supply plenum
Ventilation salle de commande	Main Control Room Ventilation
Sanitaires	Sanitary facilities
Cuisines	Kitchens
Locaux annexes	Adjoining rooms

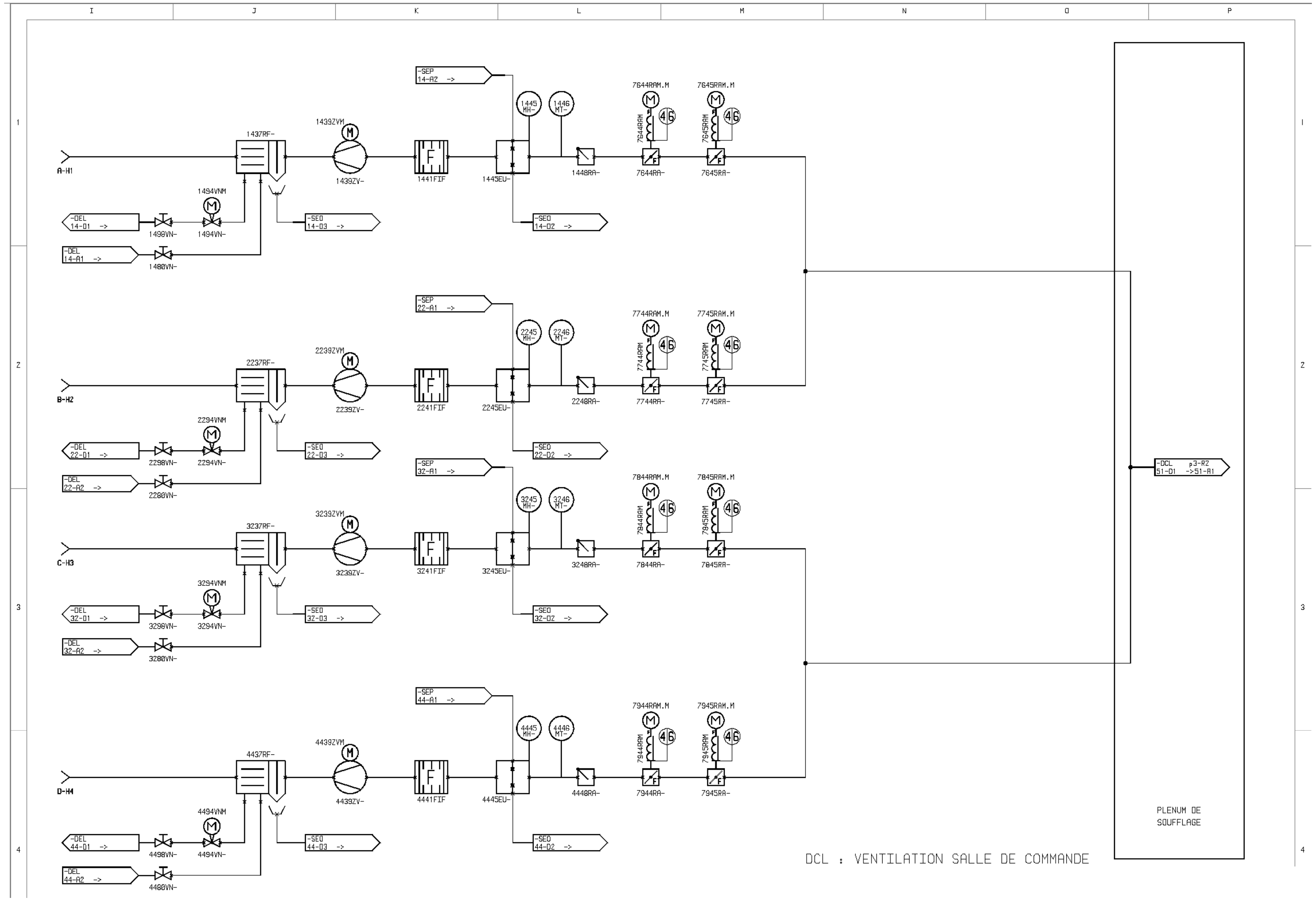
SECTION 9.4.8 - FIGURE 1

Functional Flow Diagram – DCL [CRACS] (Sheet 1/3)



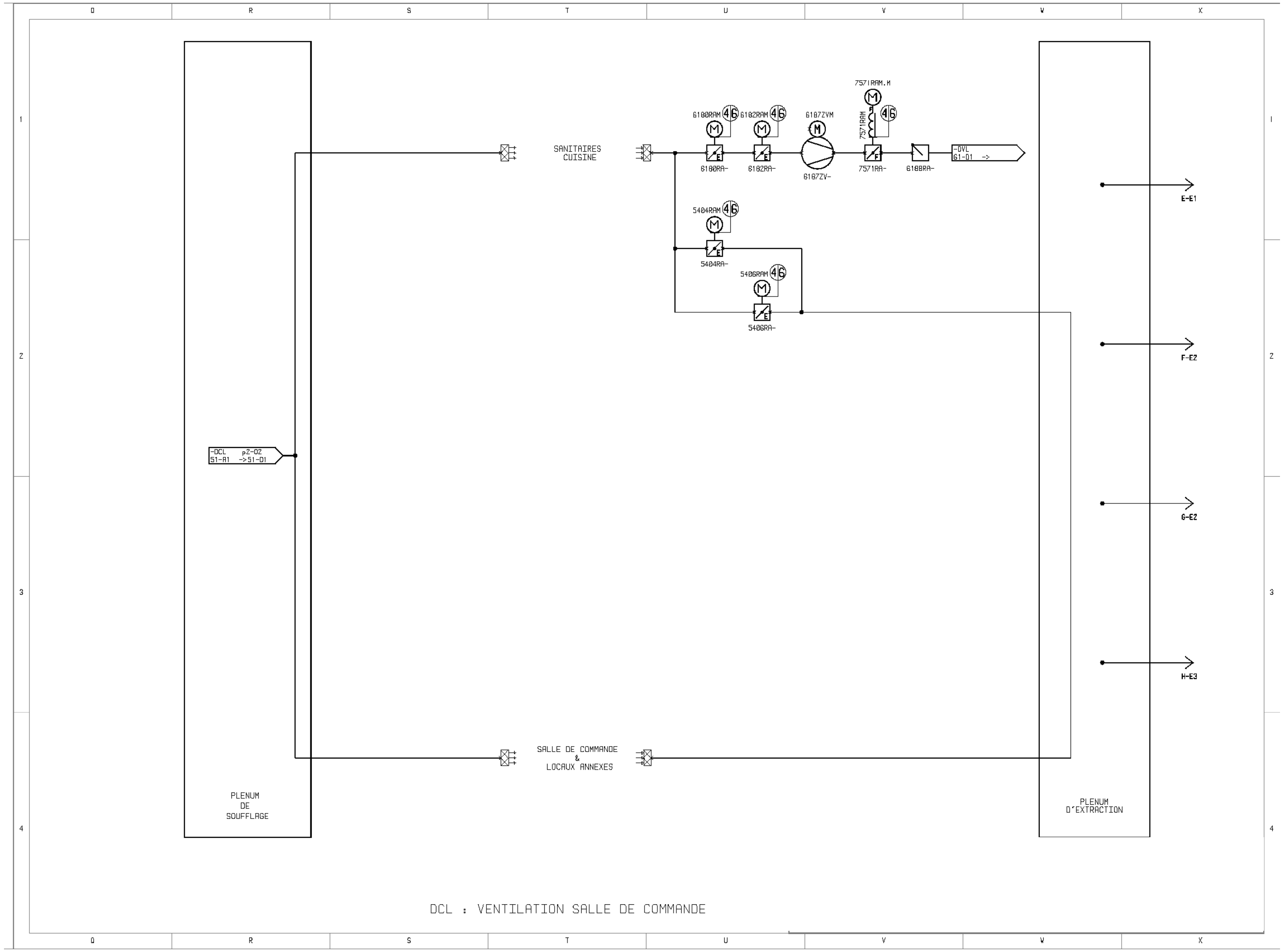
SECTION 9.4.8 - FIGURE 1

Functional Flow Diagram – DCL [CRACS] (Sheet 2/3)



SECTION 9.4.8 - FIGURE 1

Functional Flow Diagram – DCL [CRACS] (Sheet 3/3)



9. DIESEL ROOM VENTILATION SYSTEM (DVD)

9.1. ROLE OF THE SYSTEM [REF-1] TO [REF-5]

9.1.1. Functional role of the system

The role of the DVD system is to ventilate the diesel rooms (the main diesel rooms and the SBO diesel rooms). The specific duties are as follows:

- to remove heat released by the diesel (the diesel generator itself is cooled independently of the ventilation system) and the heat generated by electrical equipment
- to maintain acceptable ambient conditions for staff and for equipment
- to purge air for staff

9.1.2. Safety role of the system

General safety requirements are given in section 0 of this sub-chapter and specific requirements are given below.

For the main diesel rooms and the SBO diesel rooms, the safety roles of the DVD system are as follows:

- to maintain an ambient temperature below a specified maximum by removal of the heat released during operation of the diesel and of electrical components
- to maintain an ambient temperature above a specified minimum in tank rooms, I&C rooms, battery and electrical rooms

9.2. DESIGN BASIS

The DVD system is designed to provide heating and ventilation to ensure correct operation of the diesel generators and associated equipment.

Basic external atmospheric conditions and interior conditions (temperature) are defined in section 1 of this sub-chapter.

9.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

The ventilation systems of the diesel rooms ventilate the rooms containing the four main diesel generators (one per division) and the two SBO diesel generators.

Each division has its own separate and independent ventilation system with no connection to the other divisions.

For each diesel generator, the DVD system contains several independent sub-systems as follows:

- ventilation and heating of the diesel hall are provided by:
  - a single air intake with 4 motor-driven isolation dampers with a silencer and dust filter
  - an explosion-proof damper
  - two air supply fans with 50% capacity
  - two extraction fans with 50% capacity
  - unit heaters
  - recirculation loop with an isolation damper
  - an air outlet with a silencer
- the 100% air-conditioning system for the electrical rooms contains the following:
  - an air intake with a silencer and dust filter
  - a set of isolation dampers (explosion-proof and protected against other external hazards)
  - a pre-filter
  - a fine high-efficiency filter
  - an electric heater
  - a cooling coil with independent cooling
  - a 100% air-supply fan
  - a distribution duct
  - the air conditioning system operates in recycling mode with a fresh air intake. Part of air supplied in electrical rooms is diverted to the diesel generator hall.
- ventilation of the fuel tank rooms (main diesel building) is performed by:
  - an air intake from the diesel hall for the main fuel tank room
  - an air intake from the diesel hall for the service fuel tank room
  - an extraction fan
  - an extraction duct system with isolation dampers (explosion proof and protected against other external hazards)

- ventilation of the fuel tank rooms and battery rooms (SBO diesel buildings) is performed by:
  - an air supply from the air-conditioning system of the electrical rooms for the main fuel tank and battery
  - an in duct heater unit for the battery rooms
  - an air intake from the diesel hall for the service fuel tank room
  - two 100% extraction fans

9.4. OPERATING CONDITIONS

9.4.1. Normal state of the system

Note: in the normal state of the DVD system, the diesel generators are switched off. For the electrical rooms, the air is conditioned continuously in recycling mode with a fresh air supply.

The unit heaters in the diesel generator hall are controlled by thermostats located in the hall.

The power supplies for the ventilation sub-system for the electrical rooms, the air supply and extraction fans in the diesel hall are backed up by the diesel generator in the building. The power supplies for the unit heaters are not backed up (the heat is mainly that generated by the operating equipment).

9.4.2. Other continuous operating conditions of the system

The ventilation of the fuel tank rooms in the main diesel buildings operates continuously.

Ventilation of the battery rooms and the fuel tank rooms in the SBO diesel buildings operates continuously.

9.4.3. Transient states of the system

9.4.3.1. Partial or total loss of the ultimate heat sink (LUHS) – Partial or total loss of the RRI-SEC [CCWS-ESWS] cooling chain (LOCC)

For the DVD system, the total or partial loss of the ultimate heat sink has no impact (as there are no cooling coils supplied with chilled water).

9.4.3.2. Loss of Offsite Power (LOOP)

In the event of LOOP, the power supplies for each main diesel, the air supply isolation dampers, the two 50% air supply fans and the two 50% extraction fans in the diesel hall, the air-supply fan and the cooling system in the electrical rooms, are backed up by the corresponding main diesel generator.

The power supplies for each SBO diesel generator, heater units in the diesel hall and auxiliary room, the air supply fan, the cooling system and heaters units in the electrical rooms, the air extraction fans and heater units in the fuel tank rooms and the battery rooms are backed up by the corresponding main diesel generator.

9.4.3.3. Station Blackout (SBO)

During a postulated SBO, only the SBO diesel generators are operational. The power supplies for the air supply isolation dampers, the two 50% air supply fans and the two 50% extraction fans in the diesel hall, the extraction fans and heater units in the fuel tank rooms and the battery rooms, the cooling system and the air-supply fan in the electrical rooms are backed up by the corresponding SBO diesel generator.

9.5. PRELIMINARY SAFETY ANALYSIS

9.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

9.5.2. Compliance with functional criteria

The DVD system is designed to comply with the temperatures given in section 1 of this sub-chapter.

9.5.3. Compliance with design requirements

9.5.3.1. Safety classification

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

9.5.3.2. Single Failure Criterion or redundancy

The 4 x 100% trains of the F1A and F1B elements of the DVD system in the main diesel rooms meet the single failure criterion. For each main diesel, the rooms have their own ventilation system (DVD system). There is no connection between the ventilation systems of the different divisions of the main diesel rooms. Thus a failure in one division cannot affect another division.

For the SBO diesel generator and their service systems, the single failure criterion does not apply.

9.5.3.3. Qualification

The equipment is qualified in accordance with the general principles described in Sub-chapter 3.6.

9.5.3.4. Instrumentation and control

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

The ventilation systems response on voltage loss is as follows:

- Electrical room ventilation system is disconnected in the event of loss of the programmable logic controller (PLC), voltage power loss and loss of command voltage.
- Diesel generator hall ventilation system remains in its existing operating mode in the event of a PLC loss. In the case of power loss and no control voltage, the ventilation system remains at normal/back-up conditions (the back-up train takes over from the normal train) if only one air supply and exhaust fan is in operation.
- The main diesel generator fuel tank room ventilation system is disconnected on loss of control voltage and power loss and remains in its existing operating mode on PLC loss.
- The SBO diesel generator fuel tank room ventilation system is maintained at Normal/Back-up mode on loss of control voltage and power loss or remains in its existing operating mode on PLC loss.
- Heat units are isolated on loss of control voltage, PLC loss and power loss.

9.5.3.5. Emergency electrical supplies

- For the main diesel rooms:

Components that fulfil F1 functions in the main diesel rooms and F2 functions which are powered by switchboards backed up by the SBO diesel generator are also powered by switchboards backed up by the main diesel in the same division.

- For the SBO diesel rooms:

Components that fulfil F2 functions are powered by switchboards backed up by the SBO diesel in the same division.

9.5.3.6. Hazards

See Section 9.4.9 - Table 1.

9.6. TESTS, INSPECTIONS AND MAINTENANCE

9.6.1. Periodic tests

The safety functions are subject to periodic testing.

9.6.2. Inspection and maintenance

Maintenance may be performed with the power plant in operation.

9.7. FLOW DIAGRAMS

See Section 9.4.9 - Figure 1.

SECTION 9.4.9 - TABLE 1

Hazards

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Ruptures of piping	No loss of more than one train	Geographical separation of redundant equipment	-
Failures of tanks, pumps and valves		Geographical separation of redundant equipment	-
Internal missiles		Geographical separation of redundant equipment	-
Dropped Loads		Geographical separation of redundant equipment	-
Internal explosion		Geographical separation of redundant equipment	-
Fire		Fire zoning	-
Internal flooding		Geographical separation of redundant equipment	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	Installation in the Diesel Buildings	Seismic design
Aircraft crash	Yes	Installation in the Diesel Buildings	Geographical separation
External explosion	Yes	Installation in the Diesel Buildings	Anti-shock wave check valves
External flooding	Yes	Installation in the Diesel Buildings	Rooms located in the upper levels
Snow and wind	Yes	Installation in the Diesel Buildings	-
Extreme cold	Yes	Installation in the Diesel Buildings	Electric heaters and heater banks allowing the correct operation of the other systems
Electromagnetic interference	Yes	Installation in the Diesel Buildings	-

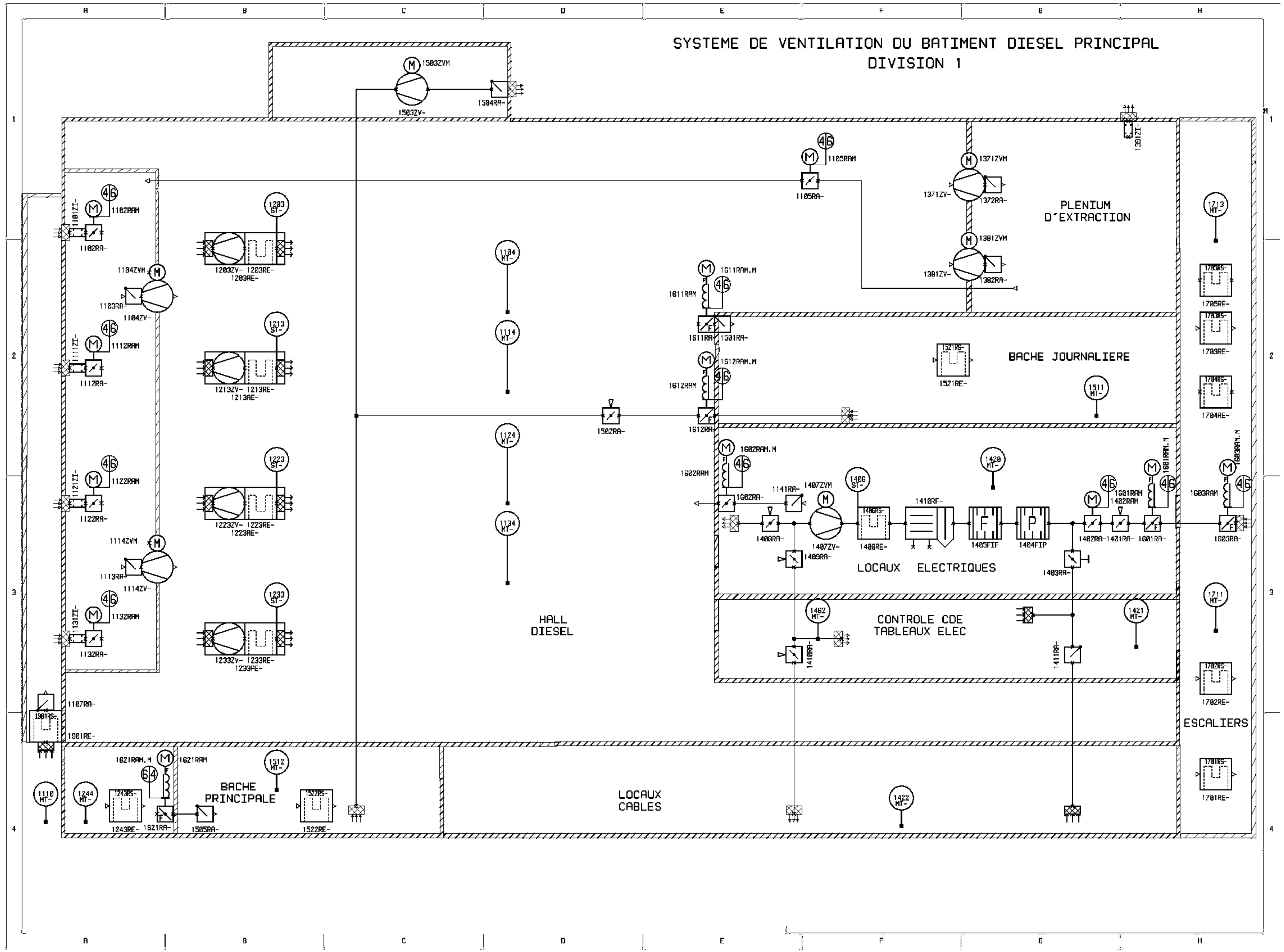
SECTION 9.4.9 - TABLE 2

DVD Functional Flow diagram Glossary

French	English
Système de ventilation du bâtiment des diesels principaux	Ventilation system of main diesel generator building
Plenum d'extraction	Extraction plenum
Bâche journalière	Daily tank
Locaux électriques	Electrical room
Contrôle commande	Control
Tableaux élect. (électriques)	Switchboard
Locaux câbles	Cable rooms
Escaliers	Stairway
Hall diesel	Diesel Generator hall
Local batteries	Battery room
Bâche principale	Main tank
Equipement auxiliaire du diesel	Diesel auxiliary equipment

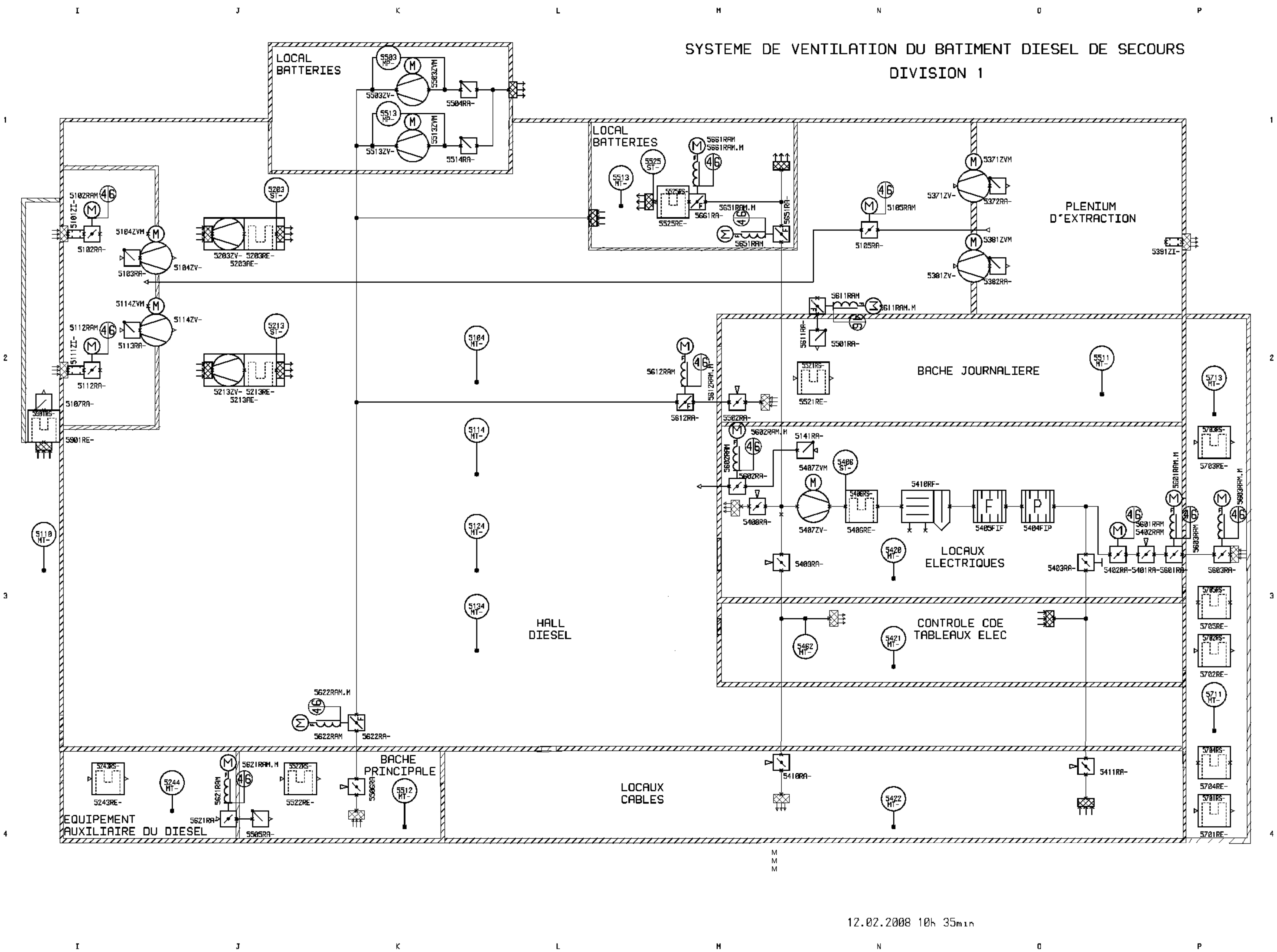
SECTION 9.4.9 - FIGURE 1

DVD Functional Flow Diagram (Sheet 1/6)



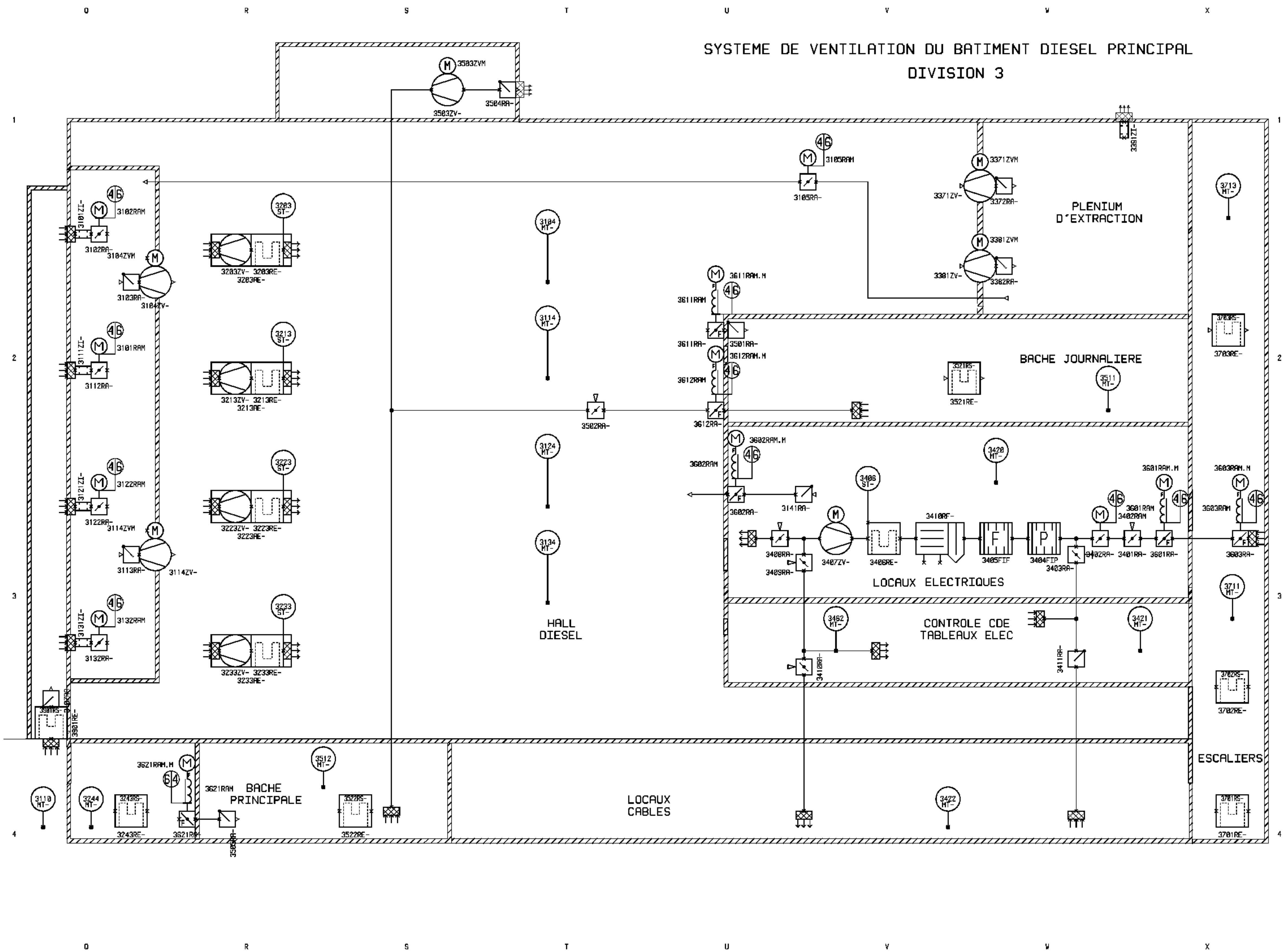
SECTION 9.4.9 - FIGURE 1

DVD Functional Flow Diagram (Sheet 2/6)



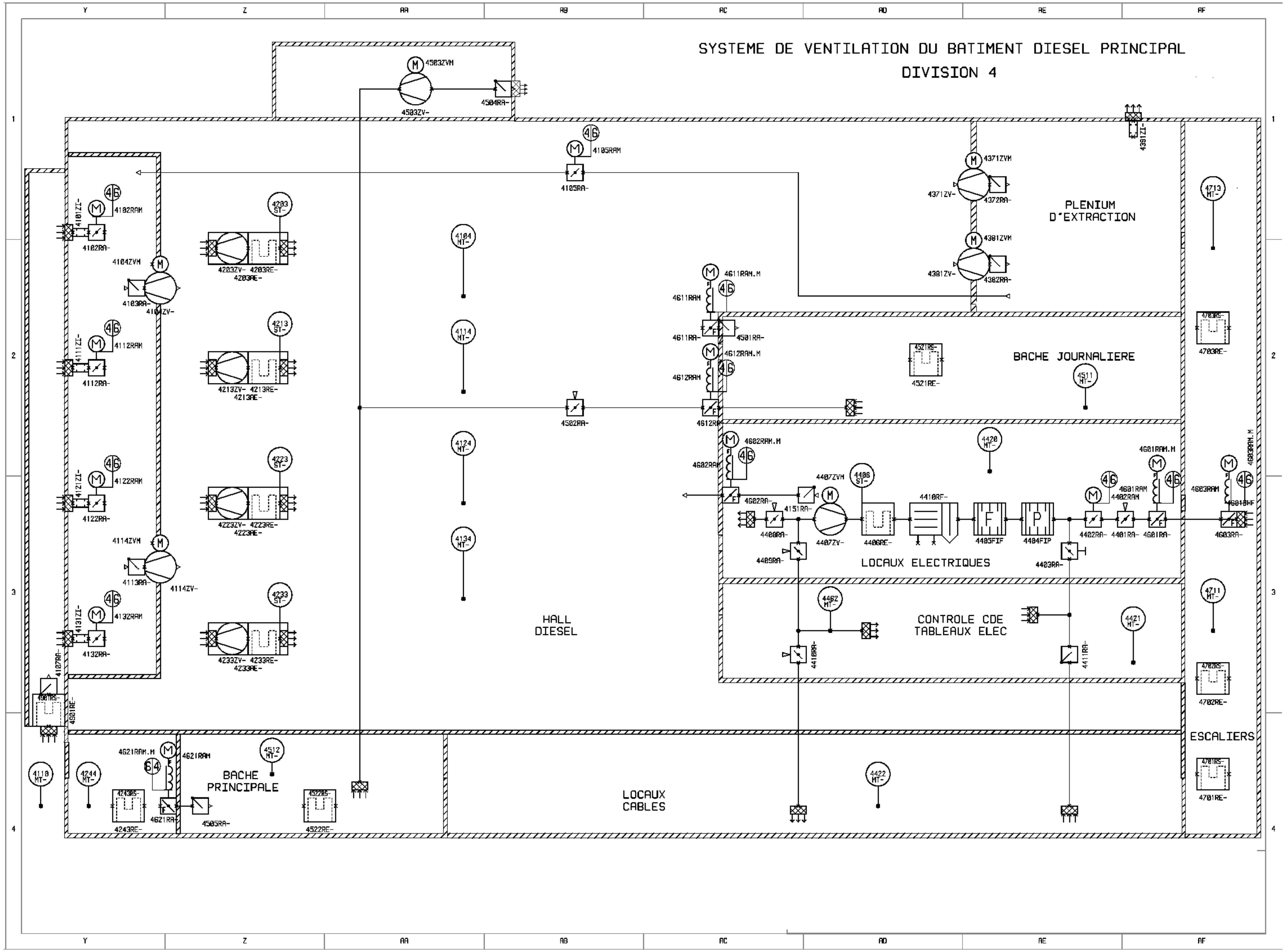
SECTION 9.4.9 - FIGURE 1

DVD Functional Flow Diagram (Sheet 3/6)



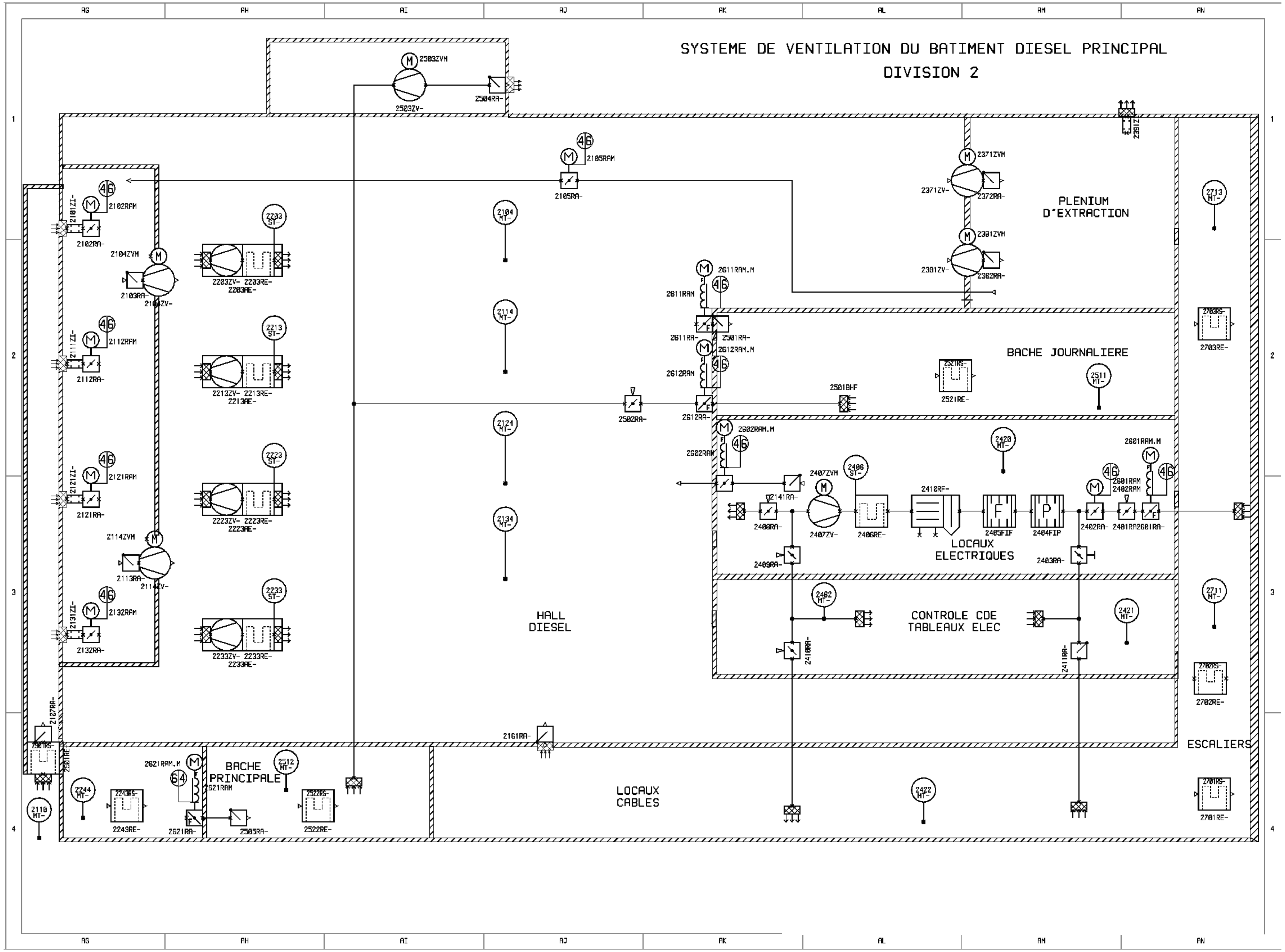
SECTION 9.4.9 - FIGURE 1

DVD Functional Flow Diagram (Sheet 4/6)



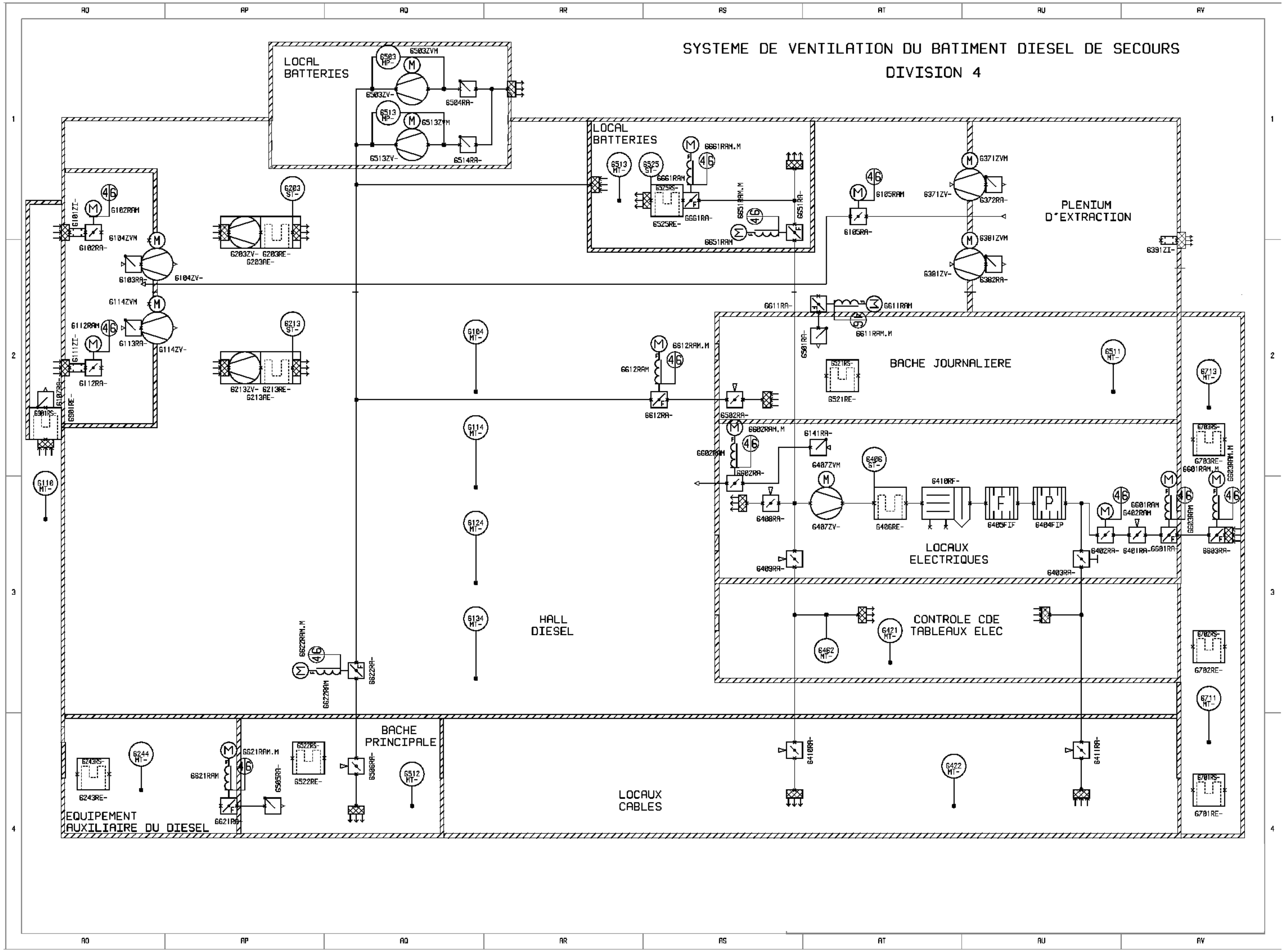
SECTION 9.4.9 - FIGURE 1

DVD Functional Flow Diagram (Sheet 5/6)



SECTION 9.4.9 - FIGURE 1

DVD Functional Flow Diagram (Sheet 6/6)



10. SAFETY CHILLED WATER SYSTEM (DEL [SCWS])

A number of changes will be implemented for the DEL [SCWS] to address the issues arising from fault studies in relation to the cooling of essential electrical and Instrumentation and Control (I&C) equipment within the four safeguard buildings:

- The chilled water system (DER) serving the DVL [SBVSE] maintenance trains, renamed DVLnew trains (see section 7 of this sub-chapter), will be replaced by two new air-cooled DEL [SCWS] trains (designated DELnew-1 and DELnew-4).
- The two back-up DELnew trains will be located in plant rooms at roof level in safeguard buildings 1 and 4. DELnew-1 in division 1 will provide back-up for divisions 1 and 2. DELnew-4 in division 4 will provide back-up for divisions 3 and 4.
- Maintenance on a main DEL [SCWS] train will only be allowed if the outside temperature is below a defined temperature limit (around 25°C), in order to avoid the use of a back-up DELnew train during maintenance.
- If a loss of the main DVL [SBVSE] train occurs in division 1 while DVLnew1 and DELnew1 are being used for maintenance operation in division 2, DVLnew1 is automatically switched to ventilate the essential EC&I rooms of the Safeguard Building in division 1.
- If a loss of the main DVL [SBVSE] train occurs in division 4 while DVLnew4 and DELnew4 are being used for maintenance operation in division 3, DVLnew4 is automatically switched to ventilate the essential EC&I rooms of the Safeguard Building in division 4.

Diversity will be applied between the four main DEL [SCWS] trains and the two DELnew back-up trains to mitigate frequent faults and to achieve dose bands targets.

In the event of loss of ventilation and cooling, failure of a main DEL [SCWS] train will result in automatic switchover to the associated back-up DVLnew and DELnew train.

Failure of the control system supporting the four main DEL [SCWS] trains will result in automatic switchover to the two DELnew back-up trains.

Furthermore, in order to be able to withstand Common Cause Failure (CCF) of the electrical supplies, the voltage level of the electrical supply to the four main DEL [SCWS] trains will be diverse from that of the two DELnew back-up trains.

These design changes are not included in the description of the DEL [SCWS] provided in this section. The incorporation of these design changes into the loss of support systems safety case is described in section 9 of 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.

A more detailed description of the modifications is given in the conceptual design document [Ref-1].

10.1. ROLE OF THE SYSTEM [REF-1] TO [REF-7]

10.1.1. Functional role of the system

The DEL [SCWS] contributes to the general operation of the plant by producing and distributing chilled water which provides the heat sink for the following ventilation systems: electrical buildings (DVL [SBVSE]) and Main Control Room (DCL [CRACS]).

10.1.2. Safety role of the system

The general safety requirements are given in section 0 of this sub-chapter.

The DEL [SCWS] function includes the cooling of the two RIS [SIS] low head injection pumps, in the event of failure of the RRI [CCWS] heat sink, and ensuring the correct operation of equipment in the electrical rooms.

10.2. DESIGN BASIS

The cooling units produce chilled water at 5°C with a nominal return temperature of 10°C.

The design of the DEL [SCWS] and the installation of the equipment take into account the constraints of accessibility, in-service inspection and periodic tests.

Necessary measures are taken to avoid any risk of freezing and corrosion of the systems.

The DEL [SCWS] system is controlled centrally from the Main Control Room.

All equipment is made from carbon steel. Stainless steel materials are used for the equipment installed outside the buildings (e.g. seafront).

10.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

10.3.1. General description

The DEL [SCWS] comprises four independent trains that are geographically separate (one train in each safeguard building). Each train supplies one cooling coil of a 100% DVL [SBVSE] classified train, one cooling coil of a 50% DCL [CRACS], one DVL [SBVSE] cooling coil in the RRI [CCWS] pump room, one DWL [CSBVS] cooling coil in the RRI [CCWS] valve room, one DWL [CSBVS] cooling coil in the RIS [SIS] valve room and a DWK [FBVS] cooling coil in the RBS [EBS] pump room. Two trains also provide back-up to the RRI [CCWS] for cooling the RIS [SIS] pumps.

Each 100% train comprises a cooling unit, a circulation pump and an expansion tank with a nitrogen blanket. A by-pass line ensures a constant flow of chilled water in the cooling unit while the variable flow rate in the DVL [SBVSE] or DCL [CRACS] cooling coils is controlled by a motor-driven control valve. The cooling units of two trains are cooled by the outside air.

The cooling units of the other two trains are cooled by two different RRI [CCWS] trains to minimise the consequences of unavailability of the heat sink in the production of chilled water: one unit is on the 1b common train and the other unit is on the 2b common train.

Trains 1 to 4 are powered by different electrical trains.

10.3.2. Main equipment data

Main data of chillers trains 1/4

- Chiller refrigerating capacity — approx. 1100 kW
- Inlet/outlet chilled water temperature — 10°C/5°C
- Refrigerant — R134a
- Cooling medium — Air
- Maximal air temperature (inlet condenser) — 42°C

Main data of chillers trains 2/3

- Chiller refrigerating capacity — approx. 1000 kW
- Inlet/outlet chilled water temperature — 10°C/5°C
- Refrigerant — R134a
- Cooling medium — Demineralised water RRI [CCWS]
- Maximal water temperature (inlet condenser) — 45°C

Main data of the DEL [SCWS] pumps

- Normal flow rate: — approx. 200 m^3/h

10.4. OPERATING CONDITIONS

10.4.1. Normal state of the system

The four DEL [SCWS] trains operate regardless of the plant operating conditions. The cooling capacity supplied depends on the demand of the ventilation systems.

Supply of chilled water to the DCL [CRACS] lines (4 x 50%) of Divisions 2/3

Each DEL [SCWS] train supplies the 50% DCL [CRACS] line of Division 2/3 corresponding to its division. Thus in normal operation, only two DEL [SCWS] trains contribute to cooling of the Main Control Room.

Supply of chilled water to the DVL [SBVSE] lines (4 x 100%) of Divisions 1 to 4

Each DEL [SCWS] train supplies the 100% DVL [SBVSE] line of its own division.

10.4.2. Other permanent operating condition of the system

The only cases where there is a change to the operating conditions are those involving shutdown of the DEL [SCWS] following failure of the system, a decrease in cooling demand or maintenance.

10.4.3. Transient states of the system

10.4.3.1. Partial or total loss of the ultimate heat sink (LOCC)

The two trains cooled by the RRI [CCWS] are lost. The other two trains are cooled by the outside air and are thus not affected.

10.4.3.2. Loss of Offsite Power (LOOP)

The power supplies for the trains are backed up in the event of LOOP by the main diesel generator of their division.

10.4.3.3. Station Blackout (SBO)

The power supplies for the two trains are backed up in the event of SBO by the corresponding ultimate emergency diesel generator. The other two trains are lost.

10.4.3.4. Loss of one or two DEL [SCWS] trains

In the event of loss of one or two DEL [SCWS] trains (pumps or cooling unit), the supply of chilled water to the DCL [CRACS] may be provided by the other available DEL [SCWS] trains in the corresponding trains. The back-up to the DVL [SBVSE] may be provided by the two non-classified DVL [SBVSE] lines of Divisions 1 and 4, supplied with chilled water by DER.

10.5. PRELIMINARY SAFETY ANALYSIS

10.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

10.5.2. Compliance with functional criteria

The system maintains production and circulation of chilled water in the cooling coils of the ventilation systems.

10.5.3. Compliance with design requirements

10.5.3.1. Safety classification

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

10.5.3.2. Single Failure Criterion or Redundancy

The DEL [SCWS] system must meet the single failure criterion. In the event of failure of a component, the four trains of the system ensure that three trains are available.

There is a connection between DEL [SCWS] division 2 and DEL [SCWS] division 1 (resp. DEL [SCWS] division 3 and DEL [SCWS] division 4) in order to be able to cool permanently the RBS [EBS] pump rooms in case of maintenance of division 1 (resp. DEL [SCWS] division 4). However, to keep the independence of the divisions, there are two redundant isolation valves installed in two different buildings on the corresponding lines.

Diversity of the heat sink is provided by the choice of condensers of the cooling units (two cooled by air and two cooled by water).

10.5.3.3. Qualification

The elements of the system are qualified to fulfil their safety function and adapt to the ambient conditions to which they are subjected during fulfilment of their function.

10.5.3.4. Instrumentation and control

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

10.5.3.5. Emergency electrical supplies

The equipment is powered by the emergency switchboards in the four divisions.

In two divisions, power supplies to this equipment are also backed up in the event of station blackout.

10.5.3.6. Hazards

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Ruptures of piping	No loss more than one train.	Physical separation	-
Failures of tanks, pumps and valves		Physical separation	-
Internal missiles		Physical separation	-
Dropped Loads		Physical separation	-
Internal explosion		Physical separation	-
Fire		Physical separation	-
Internal flooding		Physical separation	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes	Installation in the Safeguard Building	Seismic design
Aircraft crash	No loss more than one train	Installation in the Safeguard Building	Geographical separation
External explosion	Yes	Installation in the Safeguard Building	Design of equipment located outside
External flooding	Yes	Installation in the Safeguard Building	-
Snow and wind	Yes	Installation in the Safeguard Building	Equipment located outside to be protected from snow and sized to withstand wind
Extreme cold	Yes	Installation in the Safeguard Building	Measures taken to avoid freezing of the systems
Lightning	Yes	Installation in the Safeguard Building	Equipment located outside to be protected from lightning.

10.6. TESTS, INSPECTIONS AND MAINTENANCE

10.6.1. Inspection and maintenance

During preventive maintenance, one train is considered unavailable. For short-term maintenance however, such as replacement of the lubrication oil load or replacement of filters upstream of the pumps, the train is considered to be available. Maintenance of a train may be performed during shutdown or operation of the plant. Simultaneous maintenance of two trains is only authorised when the DER system supplies chilled water to the non-classified DVL [SBVSE] lines and provided that the two trains in maintenance are not cooled by the same heat sink (air for trains 1 and 4, RRI [CCWS] water for trains 2 and 3).

10.6.2. Periodic tests

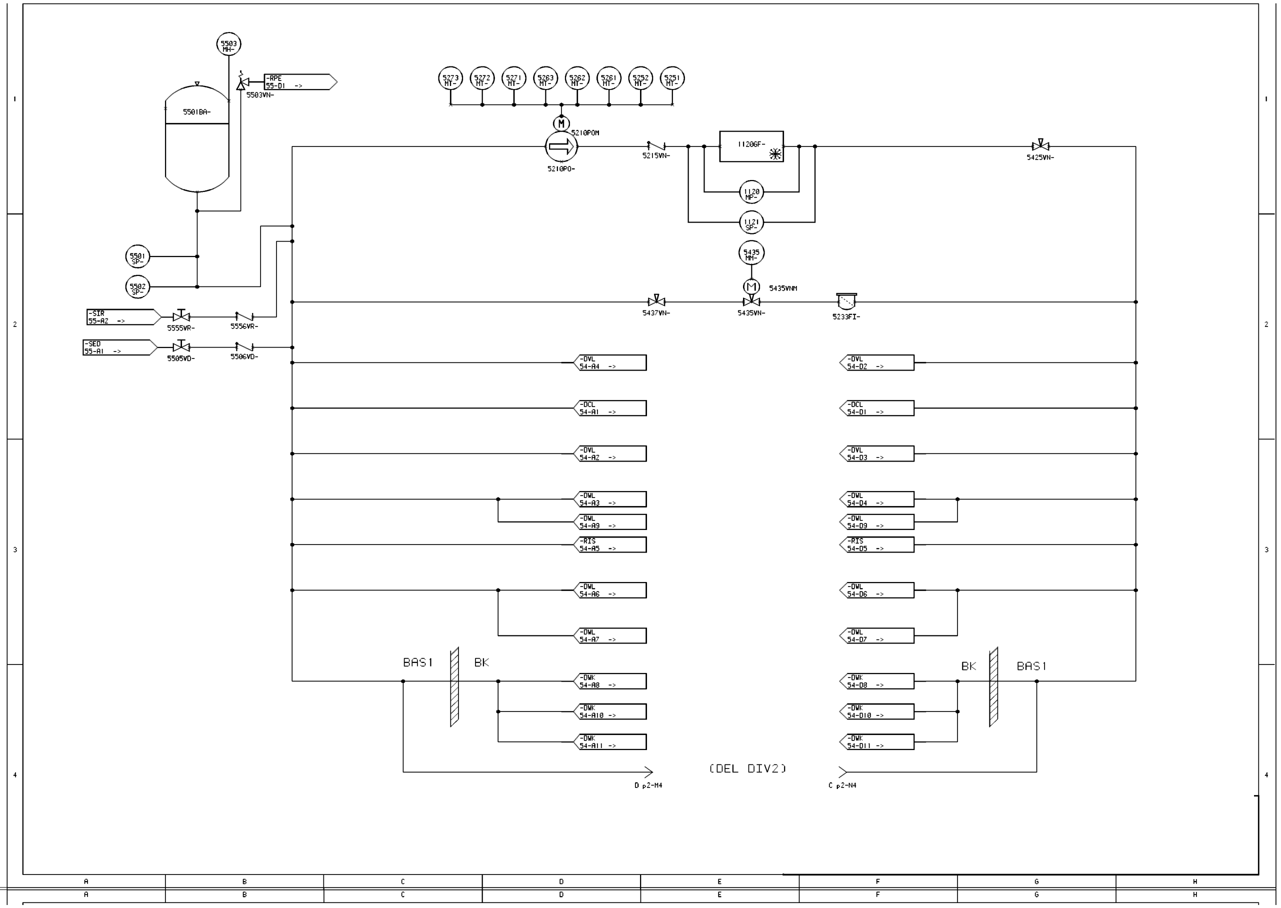
The safety functions are subject to periodic testing.

10.7. FLOW DIAGRAM

See Section 9.4.10 - Figure 1, Figure 2, Figure 3 and Figure 4.

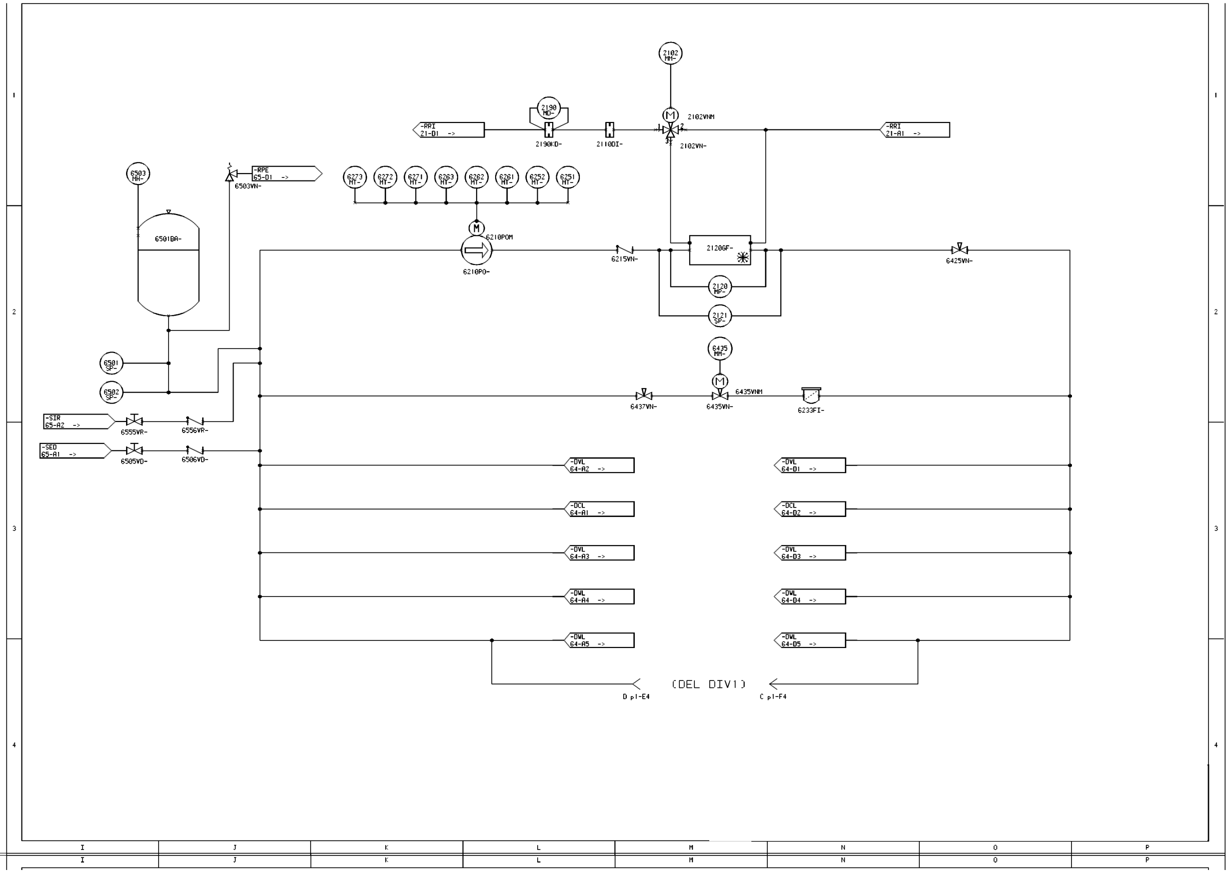
SECTION 9.4.10 - FIGURE 1 [REF-1]

DEL [SCWS] Functional Flow Diagram (TRAIN 1)



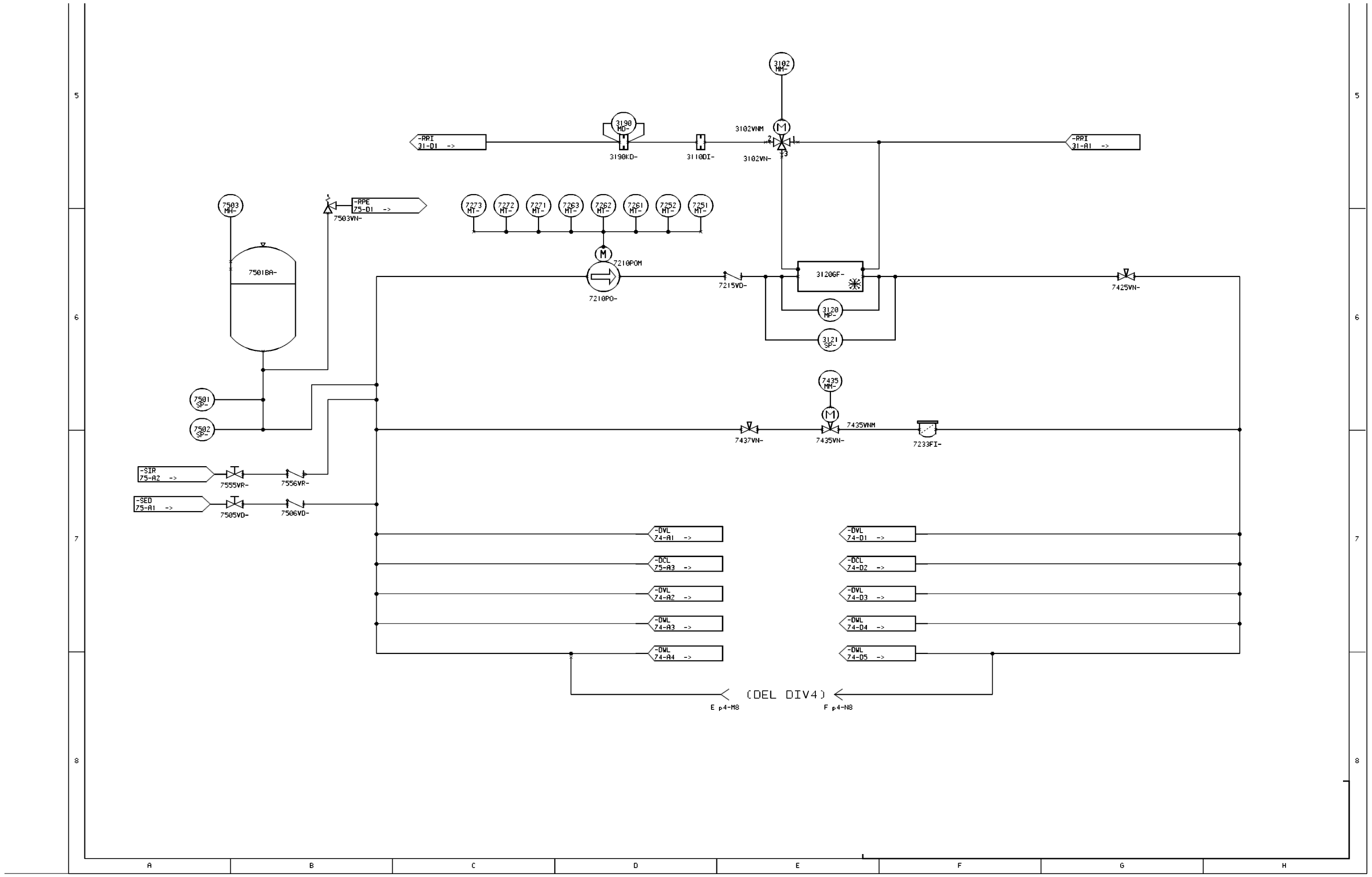
SECTION 9.4.10 - FIGURE 2 [REF-1]

DEL [SCWS] Functional Flow Diagram (TRAIN 2)



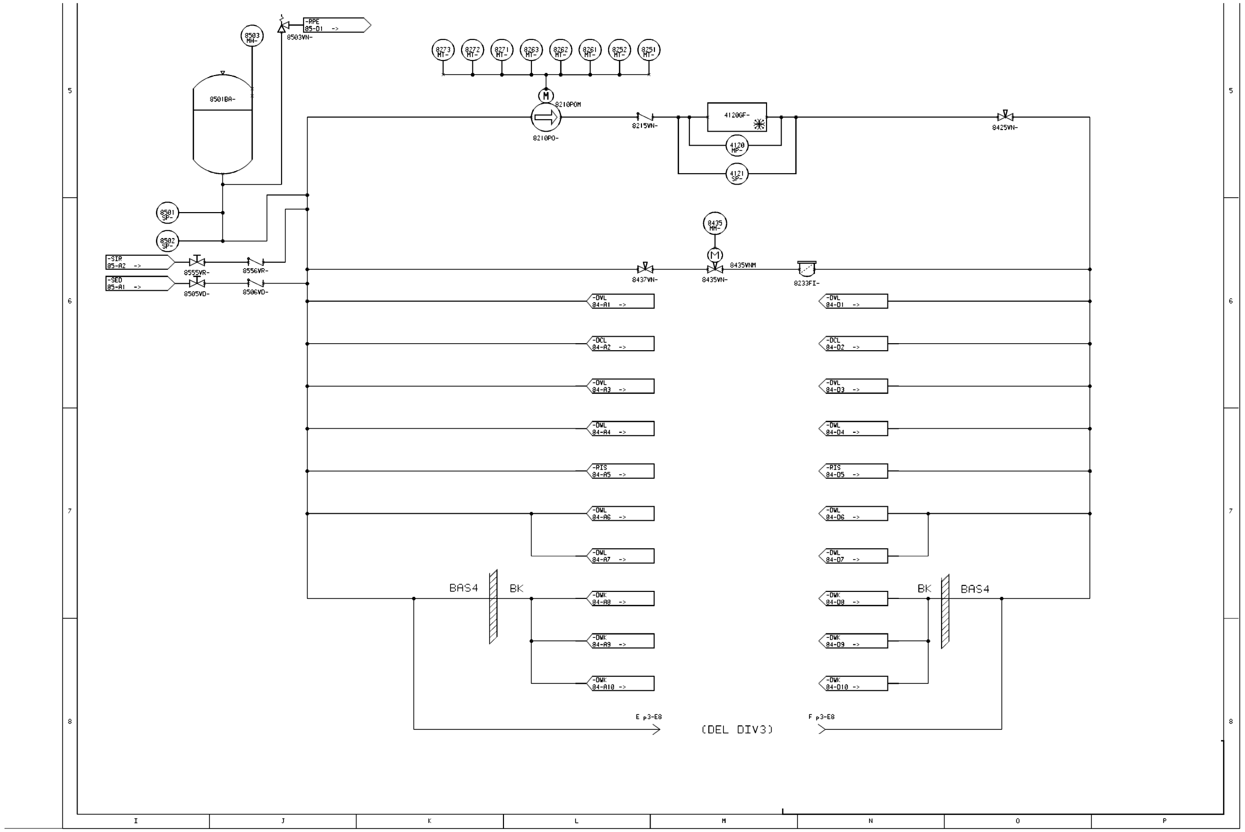
SECTION 9.4.10 - FIGURE 3 [REF-1]

DEL [SCWS] Functional Flow Diagram (Train 3)



SECTION 9.4.10 - FIGURE 4 [REF-1]

DEL [SCWS] Functional Flow Diagram (Train 4)



11. OPERATIONAL CHILLED WATER SYSTEM (DER)

The design changes to be implemented for the DVL [SBVSE] and DEL [SCWS] systems (see sections 7 and 10 above) in order to address the issues arising from fault studies in relation to the cooling of essential electrical and Instrumentation and Control equipment (I&C) within the four safeguard buildings, will have an impact on the DER system.

The DVL [SBVSE] maintenance trains will be replaced by DVLnew trains (see section 7), which will not be cooled by DER; they will now be cooled by new dedicated DEL [SCWS] systems DELnew-1 and DELnew-4.

This design change is not included in the description of the DER system provided below. The incorporation of this design change into the loss of support systems safety case is described in section 9 of Sub-chapter 16.4, and the design change will be fully incorporated into this sub-chapter as part of the detailed design during the site licensing phase.

A more detailed description of the changes can be found in the conceptual design document [Ref-1].

11.1. ROLE OF THE SYSTEM [REF-1] TO [REF-7]

11.1.1. Functional role of the system

In normal operation of the plant (PCC-1), the DER fulfils the following functions:

- DER sub-system A, namely DERA, produces chilled water for:
  - Containment Cooling Ventilation System EVR [CCVS],
  - Nuclear Auxiliary Building Ventilation System DWN [NABVS],
  - Non classified trains of the Safeguard Building Uncontrolled Area Ventilation System DVL [SBVSE],
  - Access Building Controlled Area Ventilation System DWW [ABVS],
  - Fuel Building Ventilation System DWK [FBVS],
  - Ventilation System for Main Steam System, Feedwater Flow Control System and Steam Generator Blowdown System bunkers and DER rooms (DVE).
- DER sub-system B, namely DERB produces chilled water for:
  - Gaseous Waste Processing System TEG [GWPS],
  - Coolant Storage and Treatment System TEP [CSTS],
  - Nuclear Sampling System REN [NSS],
  - Secondary Sampling System RES.

11.1.2. Safety role of the system

The DER system contributes to the control of the containment safety function due to its containment penetrations which must be closed by the DERA sub–system containment isolation valves in case of radioactivity releases inside the containment.

11.2. DESIGN BASES

The cooling plants produce chilled water:

- for sub-system A: at a temperature of 5°C with a nominal return temperature of 10°C
- for sub-system B: at a temperature of 6°C with a nominal return temperature of 12°C.

The design of the DER and the installation of the equipment take into account constraints regarding accessibility, in-service inspection and periodic tests.

Suitable measures are taken to avoid any risk of freezing and corrosion of the system.

The DER is controlled centrally from the Main Control Room.

All equipment is made from carbon steel.

The operating pressure in sub-system B is higher than that of the TEG [GWPS].

11.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

The system is illustrated in Section 9.4.11 – Figure 1.

Sub-system A:

This sub-system supplies, principally, three DWN [NABVS] cooling coils in the Nuclear Auxiliary Building, 16 EVR [CCVS] cooling coils in the Reactor Building (four cooling coils in the equipment compartment and 12 cooling coils in the service area) and, as back-up, two cooling coils of the non-classified 100% DVL [SBVSE] trains of Divisions 1 and 4 (shared with divisions 2 and 3).

The sub-system consist of 2 x 50% chilled water production trains and 2 x 50% circulation pumps, distributing chilled water to the cooling coils. Each train comprises a cooling unit and a circulation pump. A by-pass line ensures an almost constant flow of chilled water in each cooling unit while the variable flow rate in the DVL [SBVSE] or DWN [NABVS] cooling coils is controlled by a motor-driven regulating valve. The system is equipped with an expansion tank with a nitrogen blanket.

The cooling units are cooled by two different RRI [CCWS] trains to minimise the risk of unavailability of the heat sink in the production of chilled water. One unit is on the 1b common auxiliaries and the other unit is on the 2b common auxiliaries.

Each train is powered by a different electrical train and may be powered by a neighbouring train during maintenance of electrical switchboards. The same is true for each circulation pump.

Sub-system B:

This sub-system permanently supplies two compressors, one pre-dryer, one dryer and one TEG [GWPS] gas cooler as well as one TEP [CSTS] liquid heat exchanger.

It consists of 2 x 100% trains in parallel. Each train comprises a cooling unit and a circulation pump. The system is equipped with an expansion tank with a nitrogen blanket. The chilled water flow rate is constant.

The two cooling units are cooled by two different RRI [CCWS] trains in order to ensure a permanent supply of chilled water to the TEG [GWPS]. One unit is on the common 1b auxiliaries and the other unit is on the common 2b auxiliaries.

Each train (comprising a cooling unit and a circulation pump) is powered by a different electrical train and power supplies are backed up by a main diesel generator from Division 1 or 4, on the same switchboard as the TEG [GWPS] compressors. Note that this design provision enhances system availability and is not safety related, since the sub-system is not classified.

11.4. OPERATING CONDITIONS

11.4.1. Normal state of the system

Sub-system A:

The cooling capacity supplied depends on the demand made by the ventilation system.

The sub-system primarily fulfils the following functions:

- Supplying chilled water to the DWN [NABVS].
- Supplying chilled water to the EVR [CCVS]:
    - cooling the EVR [CCVS] – equipment compartment if the outlet temperature of EVR [CCVS] air supply fans is above 30°C
    - cooling the EVR [CCVS] – service area continuously (plant at power or hot shutdown).
- Supply of chilled water to the two non-classified DVL [SBVSE] trains of Divisions 1 and 4 in the event of loss or maintenance of one of the two DVL [SBVSE] safety trains and in order to ensure cooling of a Safeguard Building following an accident.
- Supply of chilled water to the Access Building Controlled Area Ventilation System DWW [ABVS].
- Supply of chilled water to the DWK [FBVS].
- Supply of chilled water to the ventilation system for Main Steam System, Feedwater Flow Control System and Steam Generator Blowdown System bunkers and DER rooms (DVE).

Sub-system B:

The sub-system permanently cools the TEG [GWPS], TEP [CSTS], REN [NSS] and RES Secondary Sampling System equipment.

11.4.2. Other continuous operating conditions of the system

Sub-system A:

Whether one or two trains (each comprising a cooling unit and a circulation pump) and one or two circulation pumps is used depends on the demand made by the ventilation systems.

In the event of failure of a train or circulation pump, the second train or second circulation pump is automatically started as back-up.

Sub-system B:

One train (comprising a cooling unit and a circulation pump) is continuously operating.

In the event of failure of this train, the second train is automatically started as a back-up.

11.4.3. Transient states of the system

11.4.3.1. Partial or total loss of heat sink (LOCC)

Both sub-systems are lost.

11.4.3.2. Loss of offsite power (LOOP)

The power supplies to the motor-driven containment isolation valves (sub-system A), and the sub-system B trains are backed up by a diesel generator.

11.4.3.3. Station blackout (SBO)

Both sub-systems are lost.

11.5. PRELIMINARY SAFETY ANALYSIS

The requirements relating to the containment isolation valves are detailed in Sub-chapter 6.2. The following five aspects are integrated in the design of these valves:

- Safety classification
- Single failure criterion (active and passive)
- Emergency electricity supply
- Qualification for operating conditions
- Mechanical, electrical and instrumentation and control classification

- Seismic classification
- Protection against events
- Other statutory requirements

11.6. TESTS, INSPECTIONS AND MAINTENANCE

11.6.1. Inspection and maintenance

Simultaneous maintenance of the two trains of either sub-system (A or B) is not authorised. Maintenance is performed on one train at a time, regardless of the state of the plant.

For short-term maintenance such as replacement of an oil valve or replacement of a filter upstream of the pumps, the system is considered to be available.

11.6.2. Periodic tests

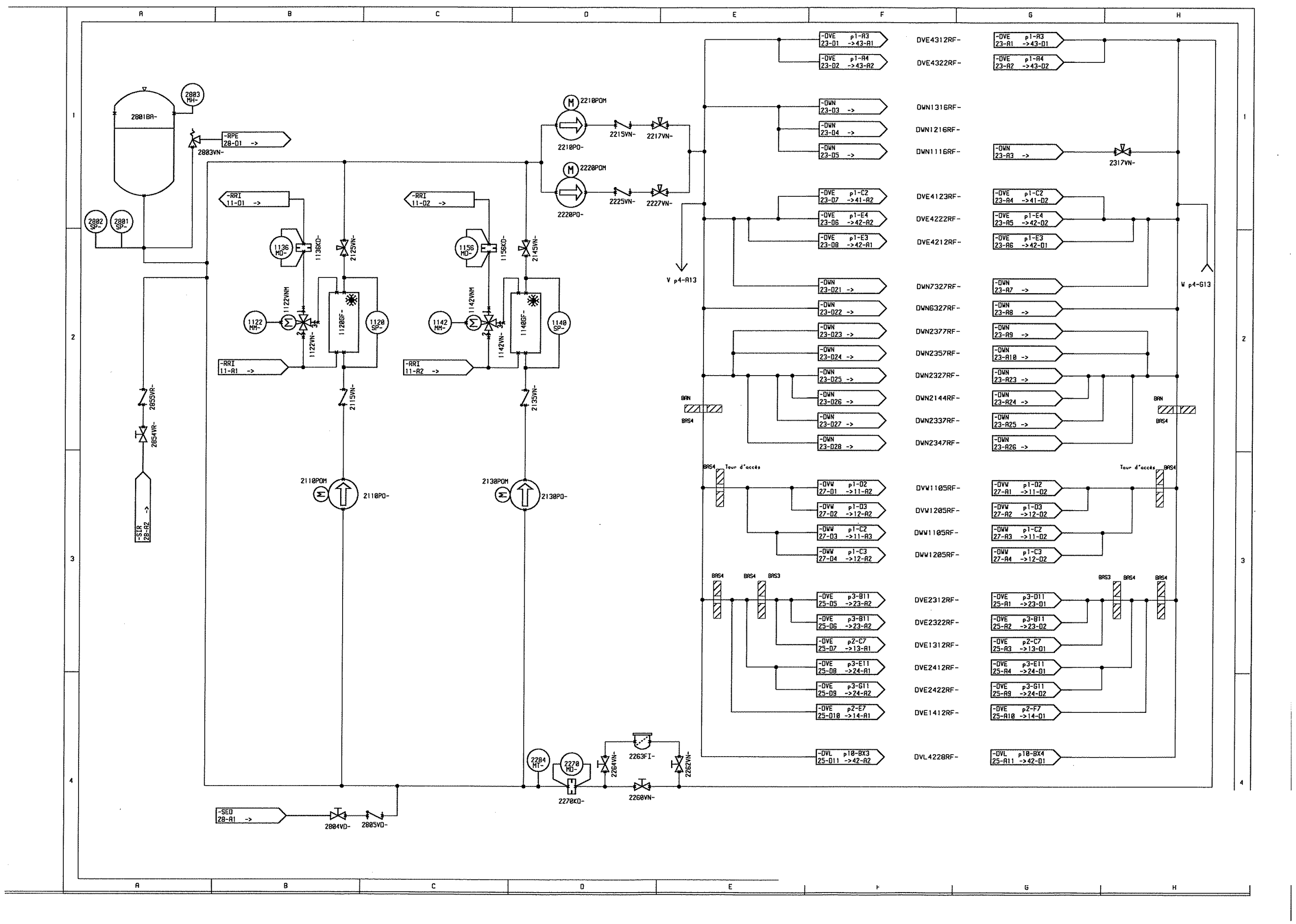
The safety functions are subject to periodic testing.

11.7. FUNCTIONAL FLOW DIAGRAM

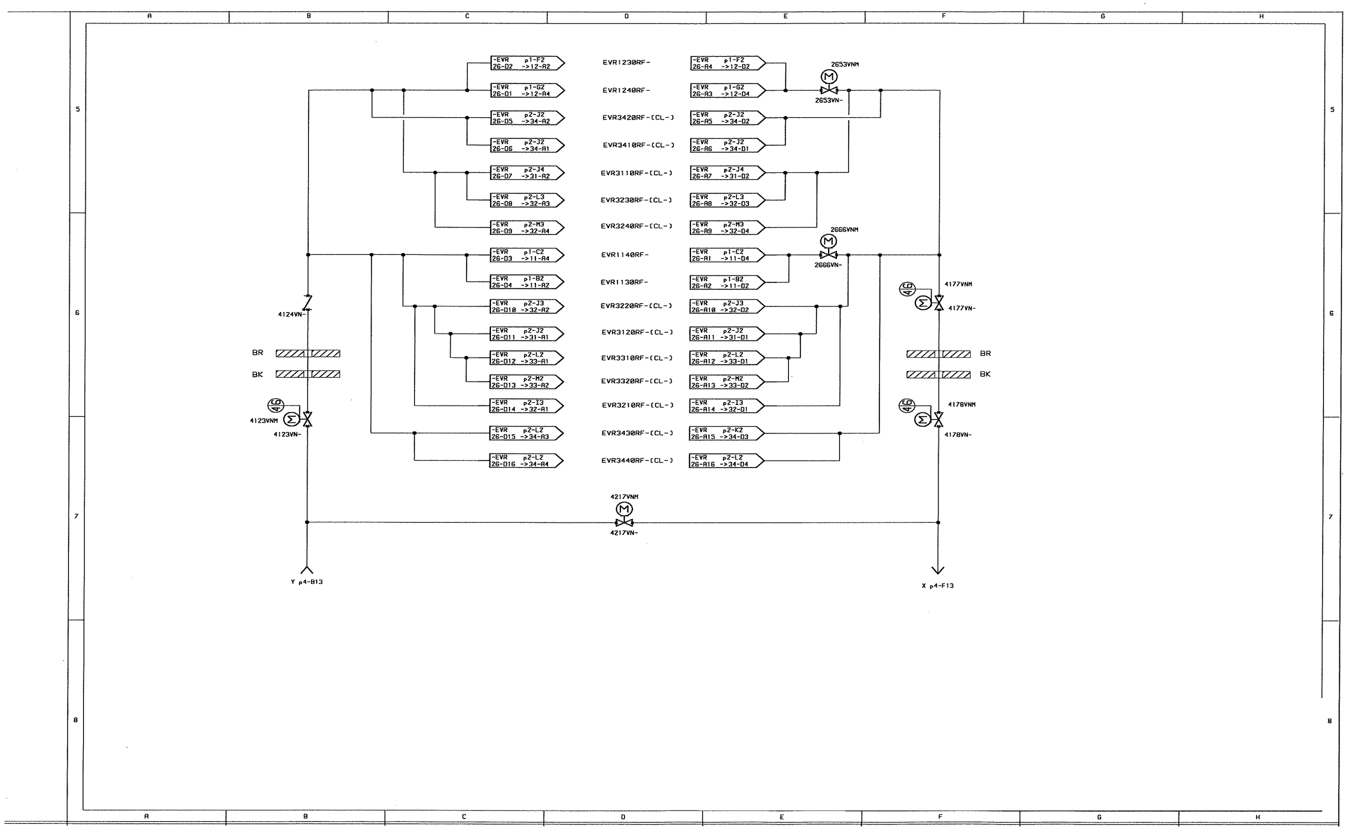
See Section 9.4.11 – Figure 1.

SECTION 9.4.11 - FIGURE 1 (1/4) [REF-1]

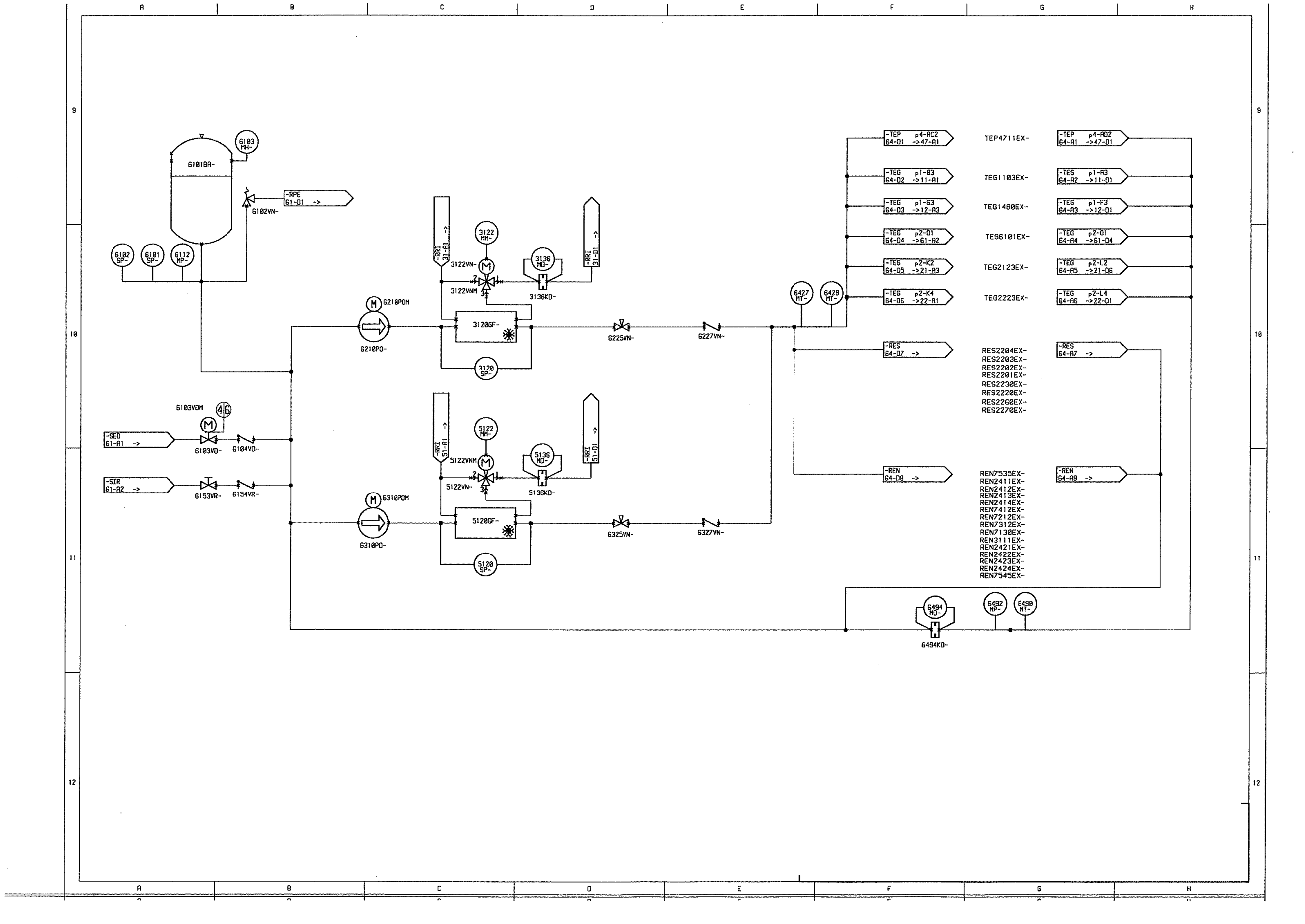
DER flow diagrams



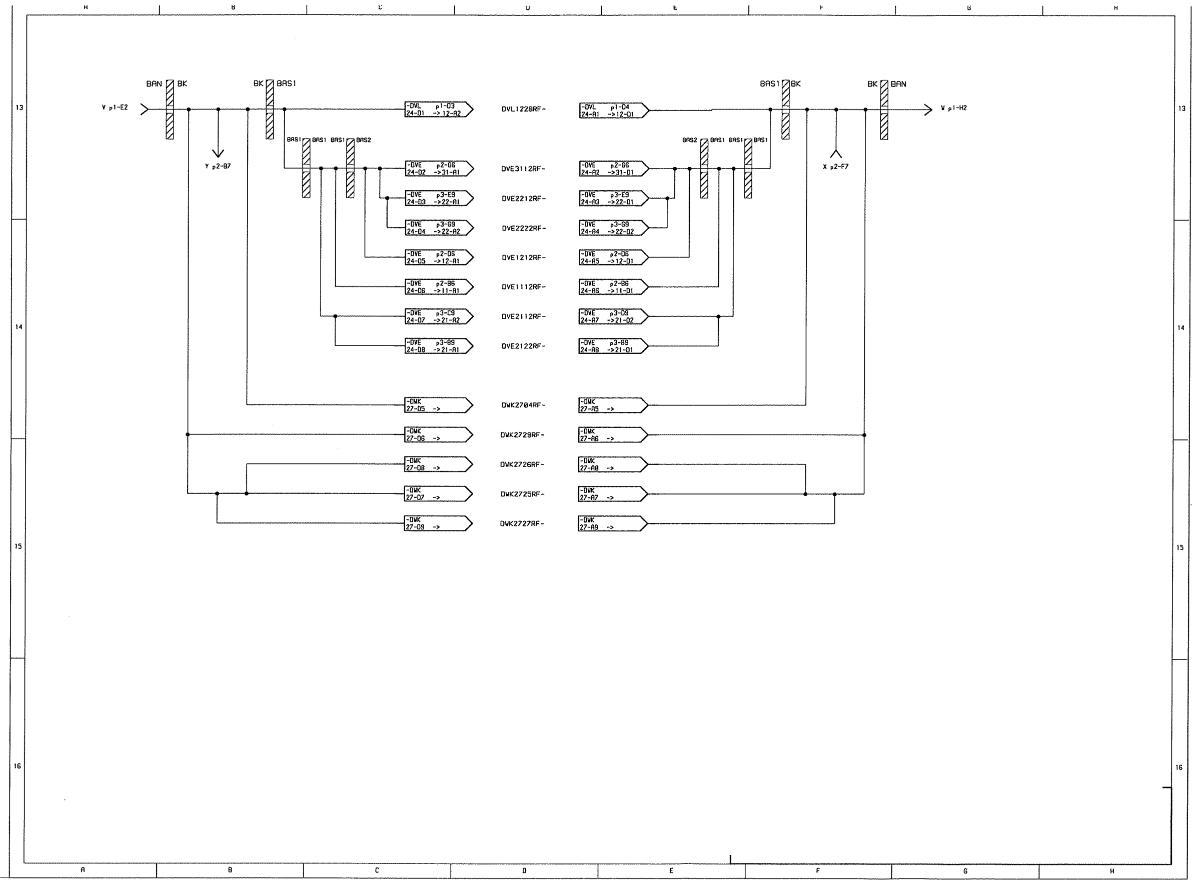
SECTION 9.4.11 - FIGURE 1 (2/4) [REF-1]



SECTION 9.4.11 - FIGURE 1 (3/4) [REF-1]



SECTION 9.4.11 - FIGURE 1 (4/4) [REF-1]



12. VENTILATION OF THE PUMPING STATION (DVP)

A number of changes will be implemented for the DVP system to address the issues arising from fault studies in relation to the cooling of the safety classified SEC [ESWS] pumps.

In order to reduce the frequency of a potential Total Loss Of Cooling Chain (TLOCC) event arising from Common Cause Failure (CCF) of the DVP ventilation function, I&C associated with the ventilation function start-up or I&C sensors associated with the temperature monitoring (to be defined depending on the grace period) will be duplicated on the Class 1 TXS platform, providing appropriate diversity with the SPPA T2000 platform.

In addition, current probabilistic considerations show that there might be an additional need to introduce 2 by 2 manufacturing diversity on sensitive DVP components (mainly the fans) in order to prevent consequential mechanical CCF on those components. This might form part of a strategy to ensure that the frequency of a TLOCC event initiated by CCF on the SEC [ESWS] or RRI [CCWS] pumps is not significantly increased when considering TLOCC events initiated by CCF on the DVP system.

These design changes are not included in the description of the DVP system provided in this section. The incorporation of these design changes into the loss of support systems safety case is described in Sub-chapter 16.4, and the design changes will be fully developed and incorporated into this sub-chapter as part of the detailed design during the site licensing phase.

12.1. ROLE OF THE SYSTEM [REF-1]

The role of the DVP system is to recycle the air and maintain ambient conditions compatible with the satisfactory operation of equipment within the pumping station, the SEC [ESWS] tunnels and the fire pump room (beneath the pre-discharge structure).

It also contributes to the containment of fires and ensures that smoke is extracted from the rooms after a fire.

12.2. DESIGN BASES

The safety requirements are given in section 0.

The safety role of the DVP system is to maintain the ambient conditions compatible with the satisfactory operation of the safety classified SEC [ESWS] pumps and CFI [CFWS] (or SFI) equipment.

It has two main functions:

- Cooling of the CFI [CFWS] (or SFI) filtering system, the SEC [ESWS] pumps, "low speed" motors and "low pressure" washing pumps.

- Heating the rooms housing classified equipment.

The safety classification is given in Sub-chapter 3.2.

Design assumptions:

- The air change rate for rooms subjected to non-specific pollution is 0.5 changes/hr.
- The external temperatures and humidity conditions and the ambient conditions to be maintained in the rooms are given in section 1. The rooms housing classified SEC [ESWS] and CFI (or SFI) [CWFS] equipment are maintained at a temperature of between 5°C and 40°C to ensure the availability of these systems.

Air recycling:

- The air in the pumping station rooms, the SEC [ESWS] tunnels and the fire fighting system building is constantly recycled.
- Outside air enters through transfers between the rooms, except in the electrical rooms for which the air is filtered (to remove salt) and supplied (maintaining an overpressure) to protect the equipment.
- The "polluted" air is removed by extraction.

Heating:

- Heating is provided by unit heaters and heating elements.
- The heat released by the motors of the main pumps, when in operation, help to heat the halls and the rooms during winter.
- During periods of extreme cold, the minimum temperatures in the pumping station rooms and the SEC [ESWS] tunnels are maintained so that no classified equipment fails to operate or is damaged.

Cooling:

- The rooms are cooled using ventilation and air conditioning units.
- In order to limit the increase in temperature of the SEC [ESWS] wells, the heat dissipated by the SEC [ESWS] motors during the summer is transferred to the outside.

Fire protection and smoke extraction:

- In the event of a fire, the stairwells providing access to the SEC [ESWS] wells are kept in a state of overpressure by a ventilation system that is open to the outside.
- The extractor fans are automatically shut down in the event of a fire; however, they can be individually restarted to help extract smoke.

12.3. DESCRIPTION OF THE INSTALLATION

The ventilation systems of each module of the pumping station and the associated SEC [ESWS] tunnel are separate. Each module consists of an open system with partial recycling in winter.

Each pumping station module includes:

For air recycling:

- An air intake,
- Air transfer grids to let fresh air into the rooms (except for the electrical rooms),
- A blower and a filter to let fresh air into and pressurise the electrical rooms,
- A network of extraction ducts leading from each ventilated room that converge towards an extraction fan in the ventilation room (the air is then discharged from the roof through a duct),
- Two extractor fans at either end of the SEC [ESWS] tunnel (safeguard building, diesel generator room side)

For the heating of rooms housing classified equipment:

- Unit heaters, controlled by thermostats, distributed in the rooms,
- A CFI (or SFI) [CWFS] filter heating device: heating elements for chain filters and supply of hot air for the drum screen compartment,
- Low temperature monitoring thermostats in the SEC [ESWS] well and around the "low speed" motor in the CFI (or SFI) [CWFS] filtering system,

For the heating of the various rooms:

- Unit heaters, controlled by thermostats, are distributed in the rooms,
- Recycled heat dissipated by the main motors,

For the cooling of the CFI (or SFI) [CWFS] filtering system, the SEC [ESWS] pump, the "low speed" motor and the "low pressure" washing pump:

- A two position (winter/summer) air recycling device between the SEC [ESWS] well, the hall and the outside. The circulation of air is ensured by the SEC [ESWS] motor fan,
- A high temperature monitoring thermostat in the SEC [ESWS] well,
- An air treatment unit in the CRF (water circulation) motor room (Divisions 2 and 3 only)*,
- A high temperature monitoring thermostat on the "low speed" motor in the CFI (or SFI) [CWFS] filtering system,

* In the case of an open circuit for condenser cooling, CRF pumps are located in the pumping station. In the case of a closed circuit with atmospheric cooler, CRF pumps may be located in turbine hall.

For the cooling of the various rooms:

- Air treatment units in the electrical rooms and the electrochlorination rooms,

For the extracting of smoke from the rooms:

- A stairway overpressure system (external air intake duct, blower and discharge duct).

The fire pump room ventilation system is separate. It operates as an open system.

The fire pump room includes:

- An air intake,
- An extractor fan (designed to recycle air and cool the pump motors),
- A heater.

12.4. OPERATING PRINCIPLE

12.4.1. Normal permanent loads

The ventilation system is always in operation:

There are two normal continuous load scenarios during which the ventilation system automatically operates in each train:

- Winter:
  - Air recycling is provided.
  - The heating equipment is in operation and controlled by temperature sensors.
  - The heat recycling devices meet in the hall; their operation is effected by operation of the pump motors.
  - The system for recycling the air in the CRF motor room, the hall and the CRF pump room is in operation (fan running).
  - The air treatment units remain in operation.
- Summer:
  - Air recycling is provided.
  - The heating equipment is shut down.
  - The recycling devices join outside.
  - The air treatment units remain in operation and operate independently.

12.4.2. Special continuous loads

- Extreme cold:
  - The heating equipment in operation during "winter" load conditions is designed for extreme cold.
- External undervoltage (LOOP):
  - The power supply for the heating equipment, or the air treatment units, required to maintain temperatures (so that classified equipment does not fail or become damaged) is backed up by the main diesel generators.

12.5. PRELIMINARY SAFETY ANALYSIS

12.5.1. Compliance with regulations

Not applicable.

12.5.2. Conformance with functional criteria

The system is designed to maintain ambient conditions compatible with the satisfactory operation of the safety classified equipment installed in the pumping station. It has been verified that, using the assumptions defined in Sub-chapter 13.1, these ambient conditions are met for extreme climatic conditions for the pumping station rooms containing classified equipment belonging to the SEC [ESWS] and CFI [CWFS] systems.

12.5.3. Compliance with design requirements

12.5.3.1. Safety classification

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

12.5.3.2. Single failure criterion

The physical separation of the ventilation system for the four pumping station divisions allows the single failure criterion to be met.

12.5.3.3. Qualification

The system components will be qualified to perform their safety function and to adapt to the safety conditions to which they are subjected during the performance of their role.

12.5.3.4. Instrumentation and control

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

12.5.3.5. Uninterruptible power supplies

The power supplies for the heating or cooling equipment required to maintain ambient conditions in the event of a LOOP are backed up by the main diesel generators.

12.5.3.6. Hazards

External hazards

The classified equipment is protected against the external hazards presented in Sub-chapter 13.1 by the general or specific measures described in the table below:

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	Yes for F1B parts	Installed in SC1 pump house	SC1 design for F1B equipment SC2 design for F2 or non-classified equipment (on a case-by-case basis)
Aircraft crash	Yes for F1B parts	pump house: geographic separation and in bunker	-
External explosion	Yes for F1B parts	Installed in protected pump house	Dampers on the air inlets and discharge
External flooding	Yes for F1B parts	pump house design	Equipment setting
Snow and wind	Yes	Installed in protected pump house	-
Extreme cold	Yes		Design input data
Electromagnetic interferences	Yes for F1B parts	Installed in protected pump house	-

Internal hazards

The physical and electrical separation of the ventilation system of each of the pumping station divisions meets the need for protection against internal hazards as described in Sub-chapter 13.2.

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Ruptures of piping	No loss of more than one train for F1B parts	Not applicable	-
Failures of tanks, pumps and valves		installation in the 4 separate pump house divisions	-
Internal missiles		installation in the 4 separate pump house divisions	-

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Dropped loads		installation in the 4 separate pump house divisions	-
Internal explosion		installation in the 4 separate pump house divisions	-
Fire		installation in the 4 separate pump house divisions	-
Internal flooding		installation in the 4 separate pump house divisions	-

12.6. TESTS AND MAINTENANCE

All the classified electrical equipment within the DVP system is subject to periodic tests.

The tests are carried out during plant operation. They are conducted on each train successively, rather than simultaneously.

Blinding of the filters is regularly checked.

The preventive maintenance of the heating equipment and air treatment units is carried out during "summer" load conditions and "winter" load conditions respectively. Maintenance of other ventilation equipment in the system is carried out at the same time as the maintenance of the associated SEC [ESWS] train.

The air treatment units are serviced in accordance with the manufacturer's guidelines.

12.7. FUNCTIONAL FLOW DIAGRAM

To be given during the detailed design phase.

13. VENTILATION OF THE CONTROLLED AREA OF THE OPERATING SERVICE CENTRE (DWB)

13.1. ROLE OF THE SYSTEM [REF-1] TO [REF-7]

13.1.1. Functional role of the system

The functional role of the ventilation system (DWB) for the controlled areas of the Operational Service Centre (OSC) is to:

- maintain acceptable ambient conditions (temperature, humidity) for equipment and staff,
- ensure the containment of radioactive products if an operator becomes contaminated.

13.1.2. Safety role of the system

The general safety requirements are given in section 0 of this sub-chapter. Specific requirements are given below.

The role of the safety system is:

- to prevent radioactive releases from the hot laboratories in the Operational Service Centre (OSC)

13.2. DESIGN BASES

The DWB system is designed to:

- maintain acceptable ambient conditions for equipment and staff at various locations,
- ensure that any contamination carried by operators returning from controlled areas is contained,
- ensure that contamination from the least contaminated areas is transferred to the most contaminated (hot laboratories, hot changing rooms),
- maintain the tunnels at a positive pressure compared to the Access Tower. In order to ensure a continuous flow of air from the controlled area of the operating service centre towards the controlled area of the access building, the introduction of new air is carried out by system 8DWB and is recirculated by system DWW [ABVS].
- provide a minimum air change rate of 1 air change/hour (8 air changes/hour for the laboratories).

The basic external atmospheric conditions and the internal conditions (temperature, humidity) are given in section 1 of this sub-chapter.

13.3. DESCRIPTION AND CHARACTERISTICS OF THE SYSTEMS

See Section 9.4.13 - Figure 1.

The system operates with a completely fresh air supply. It serves the laboratories, hot changing rooms and entrance/exit tunnels to and from the Access Tower.

This system comprises:

- an air inlet,
- two 100% identical trains which provide air conditioning to rooms, each comprising:
  - an automatic isolation damper,
  - a preheating coil (SEL),
  - two-stage filtering,
  - a cooling coil supplied with chilled water (internally produced in the OSC),
  - a heating coil (SEL),
  - a 100% fan,
- a 100% humidifier
- a 100% network of ducts providing air to the areas,
- extraction ductwork
- two 100% extraction plants, each comprising:
  - a pre-filter,
  - a HEPA filter,
  - a 100% fan,
- The air is discharged by one of the two 100% fans, into the vent stack of the Nuclear Auxiliary Building.

13.4. OPERATING CONDITIONS

The DWB system operates in all plant operating states.

13.4.1. Normal state of the system

<u>Definition:</u>

The system is used in a normal state when the plant is operating and during shutdowns.

Description:

Normal operation is characterised by:

- a 100% air conditioning train (the choice of active trains is made by the operators in accordance with train availability and taking into account equal operating duration for both trains),
- the air is distributed in all the rooms of the Operational Service Centre (OSC),
- the air from all the rooms is then extracted and discharged through the stack of the Nuclear Auxiliary Building.

13.4.2. Transient states of the system

13.4.2.1. Loss Of Offsite Power (LOOP)

The power supply to the system is not backed up in the event that LOOP occurs.

13.4.2.2. General undervoltage (SBO [station blackout])

The power supply to the system is not backed up in the event that SBO [station blackout] occurs.

13.5. PRELIMINARY SAFETY ANALYSIS

13.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

13.5.2. Compliance with the operating criteria

The DWB system design complies with the temperatures given in section 1 of this sub-chapter.

13.5.3. Compliance with the design requirements

13.5.3.1. Safety classification

Compliance of the equipment with requirements of the safety classification rules is given in Sub-chapter 3.2.

The extraction and filtration train of the controlled area is F2-classified.

The air-supply fan is also F2-classified as if provides the radioactive material containment in the OSC.

13.5.3.2. Single Failure Criterion or redundancy

The single failure criterion does not apply to the DWB system. But, active components are designed with 2 x 100% trains to ensure a good availability.

13.5.3.3. Qualification

Not applicable

13.5.3.4. Instrumentation and control

As a general rule, the processing of the instrumentation and control is located in the same electrical division as the actuators being controlled.

13.5.3.5. Emergency electrical supplies

The power supply to this system is not backed up.

13.5.3.6. Hazards

See Section 9.4.13 - Table 1.

13.6. TESTS, INSPECTION AND MAINTENANCE

13.6.1. Periodic tests

The safety functions are tested periodically

13.6.2. Inspection and maintenance

It will be possible to carry out maintenance with the unit at power.

13.7. MECHANICAL DRAWINGS

See Section 9.4.13 - Figure 1

SECTION 9.4.13 - TABLE 1

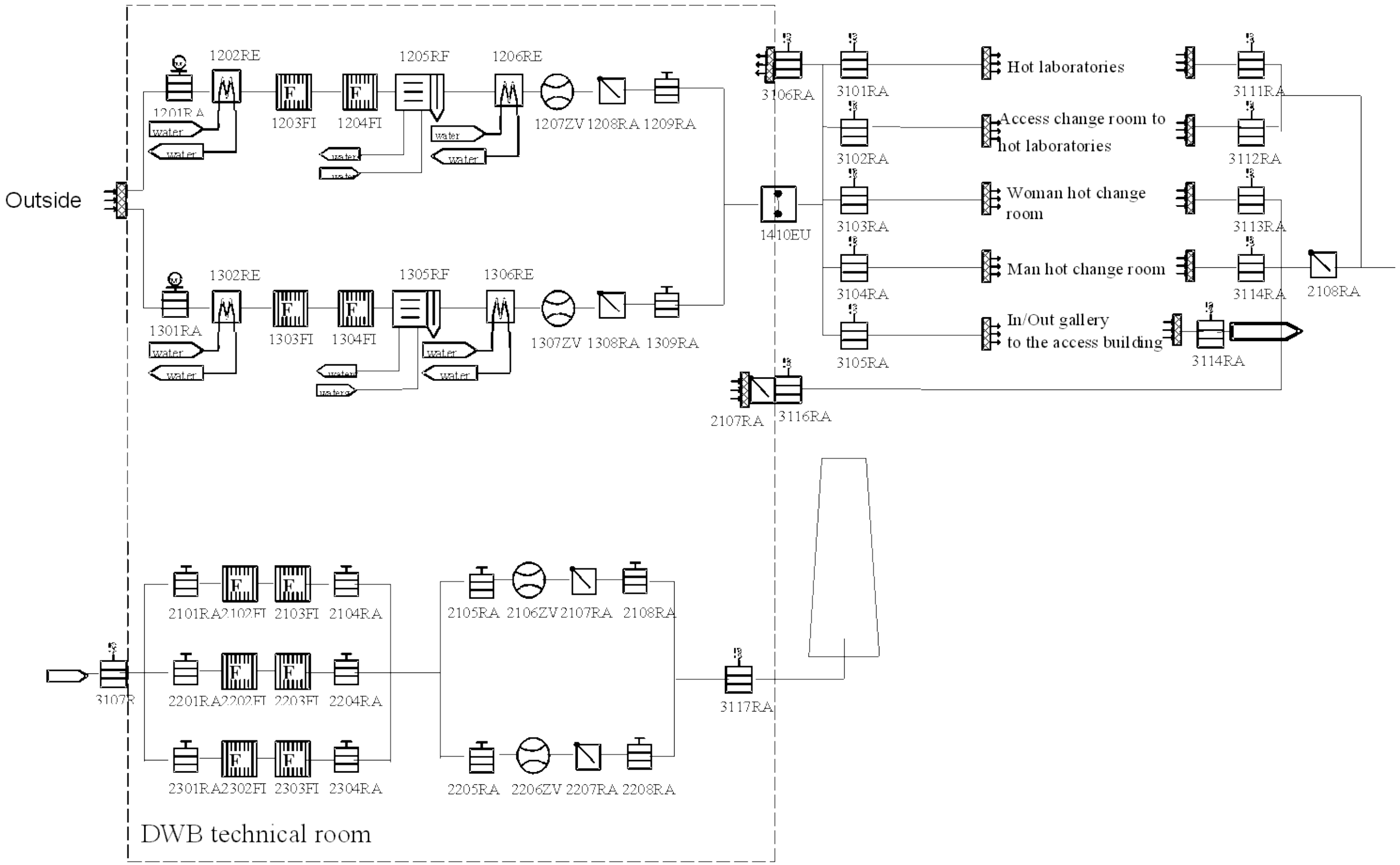
Hazards

Internal hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Rupture of piping	No	-	-
Failures of tanks, pumps and valves	No	-	-
Internal missiles	No	-	-
Dropped Loads	No	-	-
Internal explosion	Yes	-	-
Fire	Yes	Fire sectorisation in the OCS [Operational Service Centre]	-
Internal flooding	Yes	-	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	No	-	-
Aircraft crash	No	-	-
External explosion	No	-	-
External flooding	No	-	-
Snow and wind	No	-	-
Extreme cold	No	-	-
Electromagnetic interference	No	-	-

SECTION 9.4.13 - FIGURE 1

DWB Functional Flow Diagram



14. VENTILATION OF THE CONTROLLED AREA OF THE EFFLUENT TREATMENT BUILDING (DWQ [ETBVS])

14.1. ROLE OF THE SYSTEM [REF-1] TO [REF-6]

14.1.1. Functional role of the system

The DWQ [ETBVS] system for the Effluent Treatment Building is a ventilation system which operates on a continuous basis. It is designed:

- to keep the ambient conditions within the limits prescribed for the correct operation of equipment and/or staff in normal operation (blowing and filtration, heating/cooling)
- to ensure during normal operation that contamination is contained at source in order to avoid its spreading from potentially contaminated areas to potentially less contaminated areas.
- to reduce the concentrations of aerosols and radioactive gases in the atmosphere of rooms,
- to maintain the pressure in the effluent treatment building below that outside.
- to reduce the radioactivity in the air released to the stack during normal operation.

14.1.2. Safety Role of System

The general safety requirements are given in section 0 of this sub-chapter: specific requirements are given below.

The DWQ [ETBVS] system contributes to reducing radioactive releases during normal operation.

The safety role of the DWQ [ETBVS] is to extract air (HEPA and iodine filtration included).

14.2. DESIGN BASIS

<u>Supply conditions</u>

Design conditions, the air supply characteristics of the DWQ [ETBVS] system are as follows:

- summer: 18°C
- winter: 22°C or 30°C for the specific TEU [LWPS] system.
- design conditions (temperature, humidity) are given in section 1 of this sub-chapter.

Auxiliary fluids

In summer, the air is cooled by cooling coils of the chilled water system (DEQ) (see section 11 of this sub-chapter).

In winter, it is heated by heating coils of the SEL system (electric heating).

Conditions in the rooms

The flow rates of air in the rooms are calculated taking into account both the minimum rate of air renewal and heat contributions from equipment and lighting.

The internal conditions (temperature, humidity) are given in section 1 of this sub-chapter.

Minimum flow rates for air renewal:

The air change rates are given in section 1 of this sub-chapter.

14.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

See section 9.4.14 – Figure 1

The DWQ [ETBVS] system supplies air to three parts of the Effluent treatment Buildings: a controlled area, an uncontrolled area and a storage area.

The controlled area DWQ [ETBVS] system part is made up of an air supply plant, an extraction plant with permanent filtration via a HEPA filter, an iodine filtration plant, a network of air supply and extraction ducts.

The air supply plant is made up of the following elements:

- an external air inlet with a protective grid and a rain barrier,
- a concrete air intake plenum
- parallel conditioning trains (2 x 100%), each comprising:
  - a preheating coil supplied by the hot water circuit (SEL),
  - two-stage filtering,
  - a chilling coil supplied with chilled water (DEQ)
  - a heating coil supplied by the hot water circuit (SEL),
  - an air supply fan
- a concrete plenum

The continuous extraction plant with the HEPA filters comprises the following components (2 x 100%):

- compartments located in parallel, each made up of a pre-filter and a HEPA filter,

- a concrete plenum,
- redundant fans installed in parallel (installed in the Nuclear Auxiliary Building)
- a common concrete duct to the stack (DWN [NABVS]).

The iodine filtration comprises the following elements (2 x 50%):

- a concrete plenum,
- parallel trains, each fitted with:
    - an automatically closing damper,
    - an electric heater,
    - an iodine filter fitted with fire dampers,
    - a concrete plenum,
    - booster fans.

In the controlled area rooms, local convectors or fan heaters may be used to supplement heating. Local cooling units in controlled area rooms may be used to supplement the supply, in order to reduce the flow.

The uncontrolled area DWQ [ETBVS] system element is made up of an air supply plant, an extraction fan, a network of air supply and extraction ducts.

The air supply plant is made up of the following elements:

- an external air inlet with a protective grid and a rain barrier,
- a conditioning train comprising the following elements:
    - two-stage filtering,
    - a chilling coil supplied with chilled water (DEQ),
    - an electric heater,
    - an air supply fan.

The storage area DWQ [ETBVS] system element is made up of an air supply plant, an extraction fan, a network of air supply and extraction ducts.

The air supply plant is made up of the following elements:

- an external air inlet with a protective grid and a rain barrier,
- a conditioning train comprising the following elements:
    - two-stage filtering,

- o a chilling coil supplied with chilled water (DEQ),
- o an electric heater,
- o an air supply fan.

14.4. OPERATING CONDITIONS

14.4.1. Normal operation of the unit

Unit in operation or during shutdown

The controlled area of system DWQ [ETBVS] operates on a continuous basis and maintains the Effluent treatment Building at negative pressure.

Both of the extraction trains ensured half flow rate but in the event of one train unavailable, each one can operate at full flow rate.

The iodine filtration is bypassed.

The uncontrolled area of system DWQ [ETBVS] operates on a continuous basis and in recirculation mode with fresh air makeup.

The storage area of system DWQ [ETBVS] operates on a continuous basis.

Identification of iodine in the Effluent Treatment Building

On detection of iodine by KRT [PRMS], the exhaust is directed from 1 to 2 trains.

14.4.2. Other system modes

Loss of the hot water system (SEL)

When a signal is generated, indicating that the air temperature is too low after the preheating coils, the fans are automatically shut down and the air dampers are automatically closed, to avoid the equipment freezing.

Loss of the cold water system (DEQ)

This unavailability results in a cooling capacity decrease but air supply is not automatically stopped. Only a high temperature signal is generated.

Fire in the iodine filter

When a fire is detected, the operator is alerted, the fire dampers located upstream and downstream of the iodine filter (which are flame arresters and designed to prevent the spread of smoke) are closed and the fan is shut down automatically.

14.5. PRELIMINARY SAFETY ANALYSIS

14.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

14.5.2. Compliance with the operating criteria

The DWQ [ETBVS] contributes to reducing radioactive releases.

The extracted air is filtered by HEPA filters and the iodine filter (if iodine is detected), before being released to the stack, in conformance with section 0.2 of this sub-chapter.

14.5.3. Compliance with the design requirements

14.5.3.1. Safety classification

Conformance of the design and manufacture of systems and equipments to the requirements of the safety classification rules is given in Sub-chapter 3.2.

14.5.3.2. Single Failure Criterion and redundancy

The DWQ [ETBVS] is not required to meet the single failure criterion.

14.5.3.3. Qualification

Not applicable

14.5.3.4. Instrumentation and control

As a general rule, the instrumentation and process control is located in the same electrical division as the actuators being controlled.

14.5.3.5. Emergency power supplies

<u>Loss of Offsite Power (LOOP)</u>

The power supply for the system is not backed up.

<u>Station Blackout (SBO)</u>

The power supply for the system is not backed up.

14.5.3.6. Hazards

See Section 9.4.14 - Table 1.

14.6. TESTS, INSPECTIONS AND MAINTENANCE

14.6.1. Tests

The safety functions are tested periodically.

14.6.2. Inspections and maintenance

Maintenance may be performed with the plant in operation.

Maintenance on the electrical room cooling coil must preferably be carried out in winter, to avoid exceeding maximum temperature limits in PCC-1 and PCC-2 transient conditions.

14.7. MECHANICAL DRAWINGS

See Section 9.4.14. - Figure 1

SECTION 9.4.14 - TABLE 1

Hazards

Internal hazard	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		-	-
Internal missiles		-	-
Dropped Loads		-	-
Internal explosion		-	-
Fire		-	Fire dampers around the iodine traps (to limit the spread of fire)
Internal flooding		-	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	No	-	Air supply and extraction of the controlled area are isolated by dampers
Aircraft crash	No	-	-
External explosion	No	-	-
External flooding	No	-	-
Snow and wind	No	-	-
Extreme cold	No	-	-
Electromagnetic interference	No	-	-

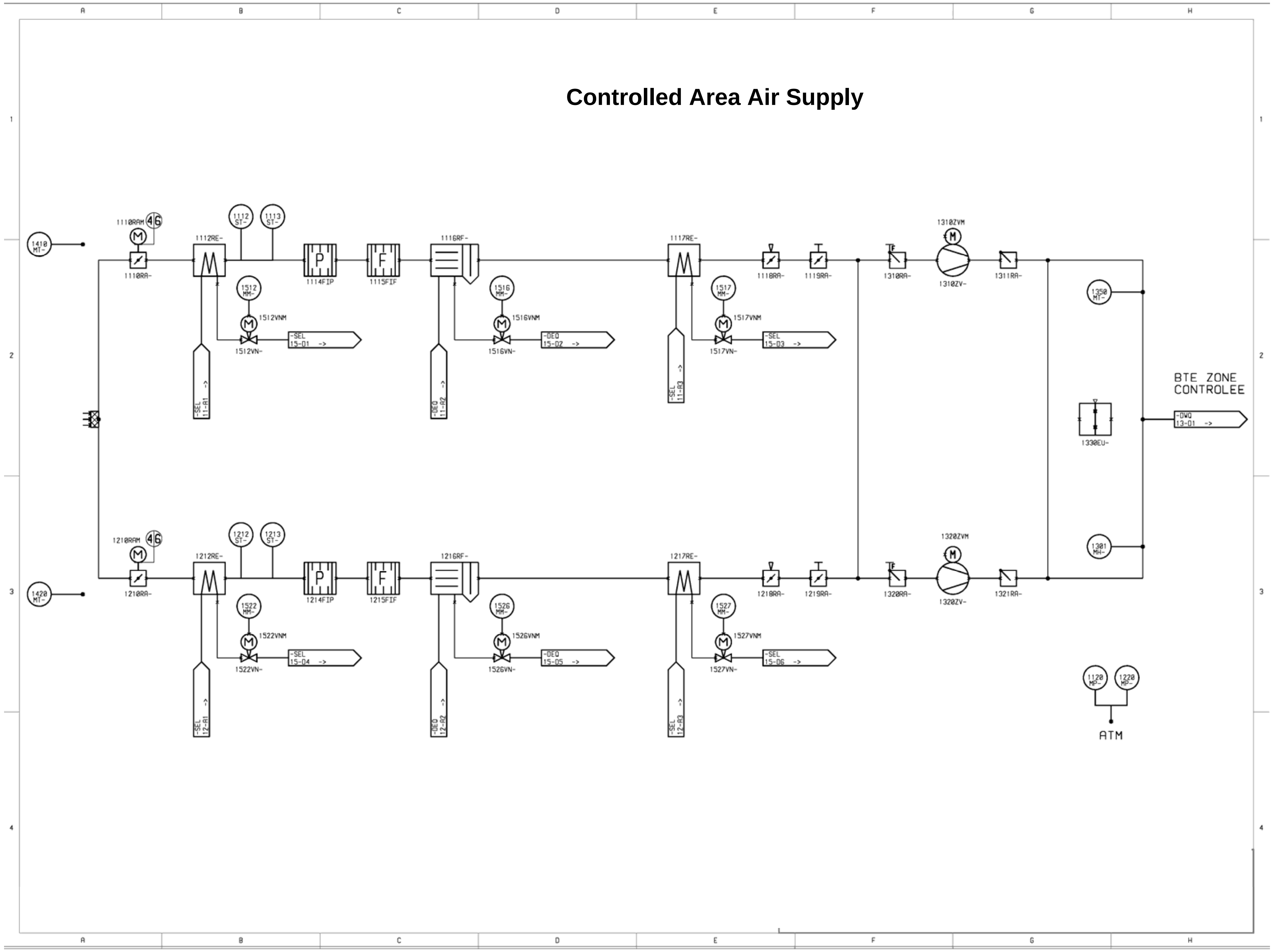
SECTION 9.4.14 - TABLE 2

DWQ [ETBVS] Functional Flow Diagram Glossary

French	**English**
BTE	Effluent treatment Building
Zone contrôlée	Controlled area
Zone non contrôlée	Uncontrolled area
Zone d’entreposage	Storage area
Cheminée	Stack

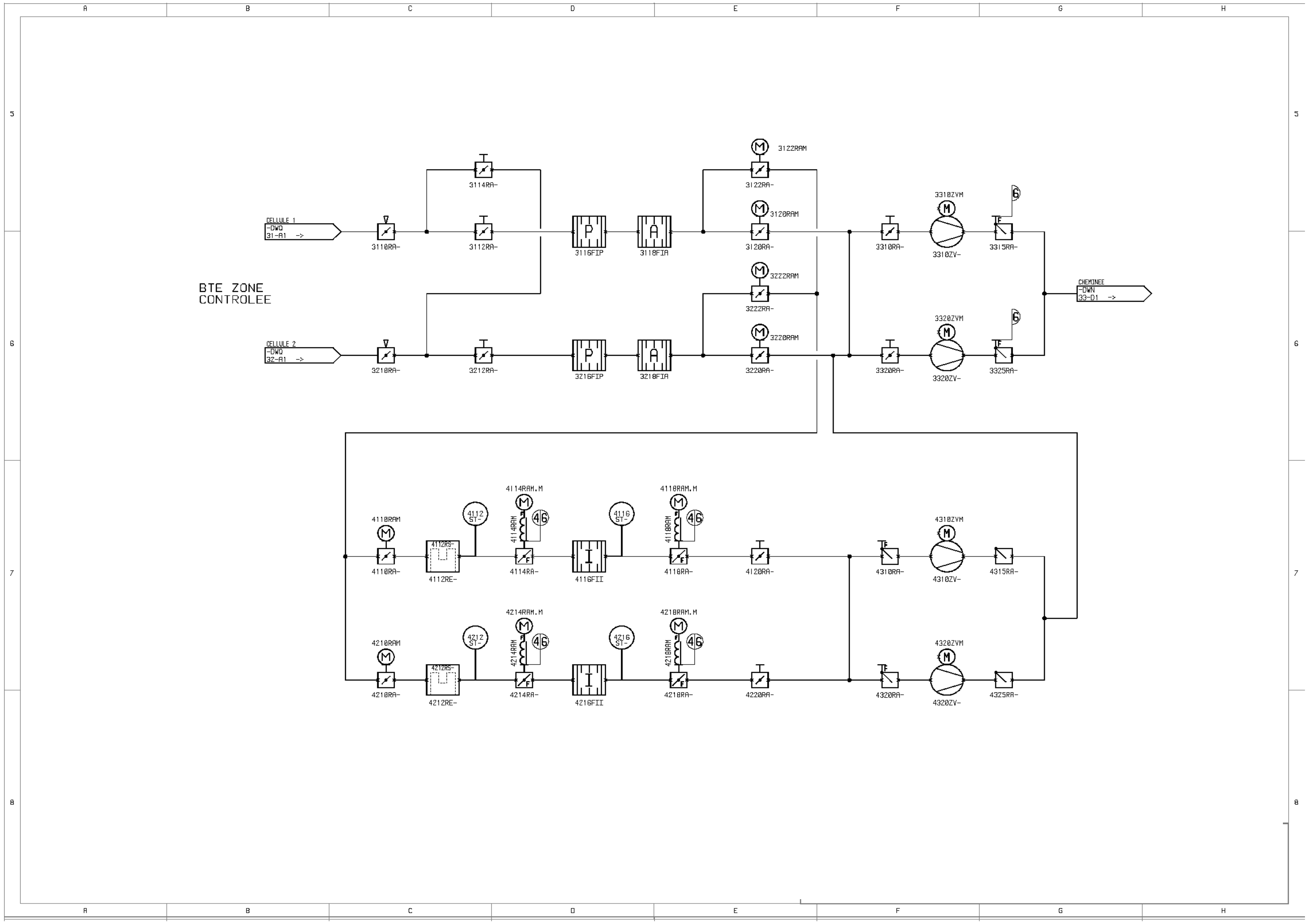
SECTION 9.4.14 - FIGURE 1

DWQ [ETBVS] Functional Flow Diagram (Sheet 1/4)



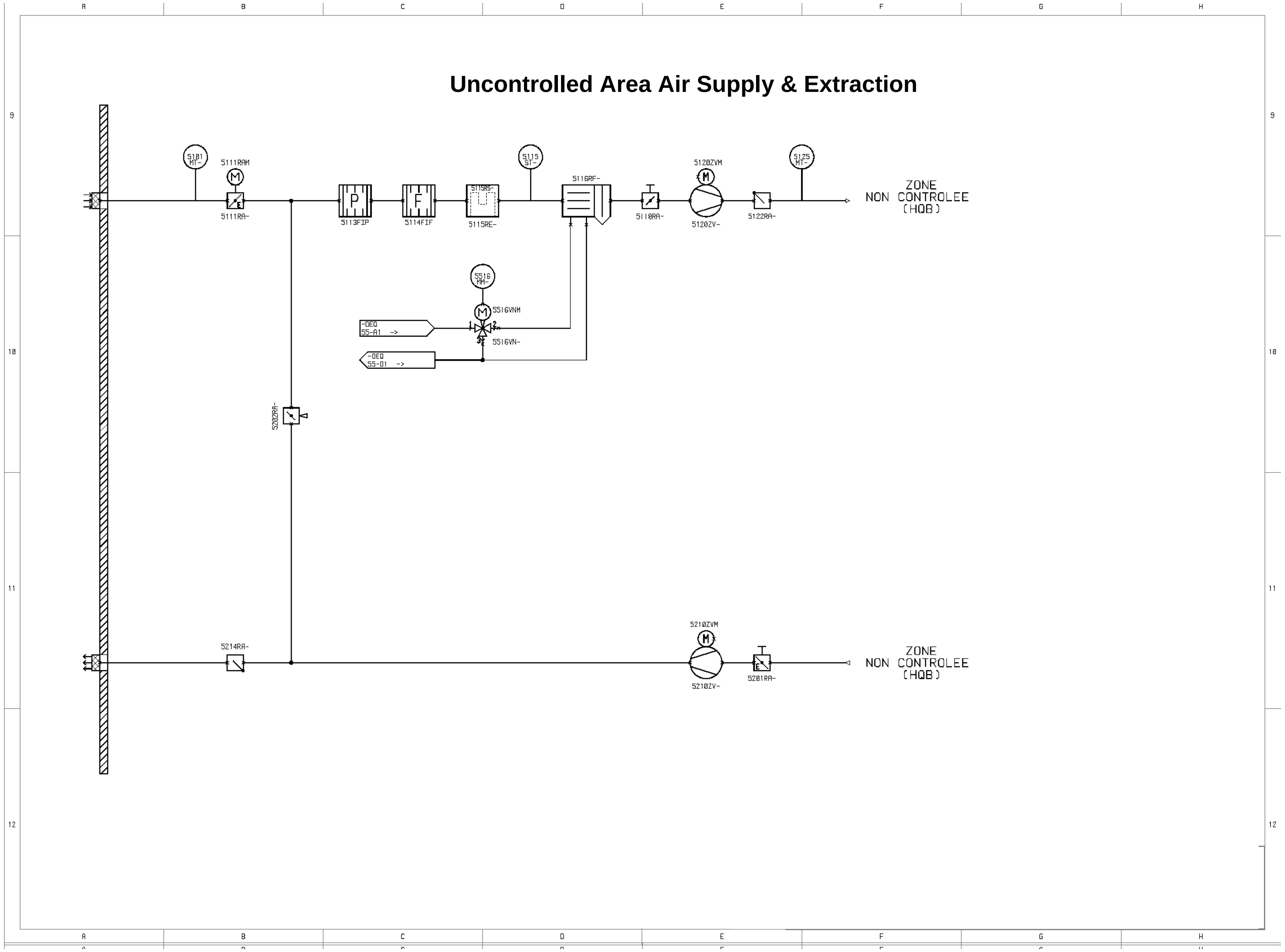
SECTION 9.4.14 - FIGURE 1

DWQ [ETBVS] Functional Flow Diagram (Sheet 2/4)



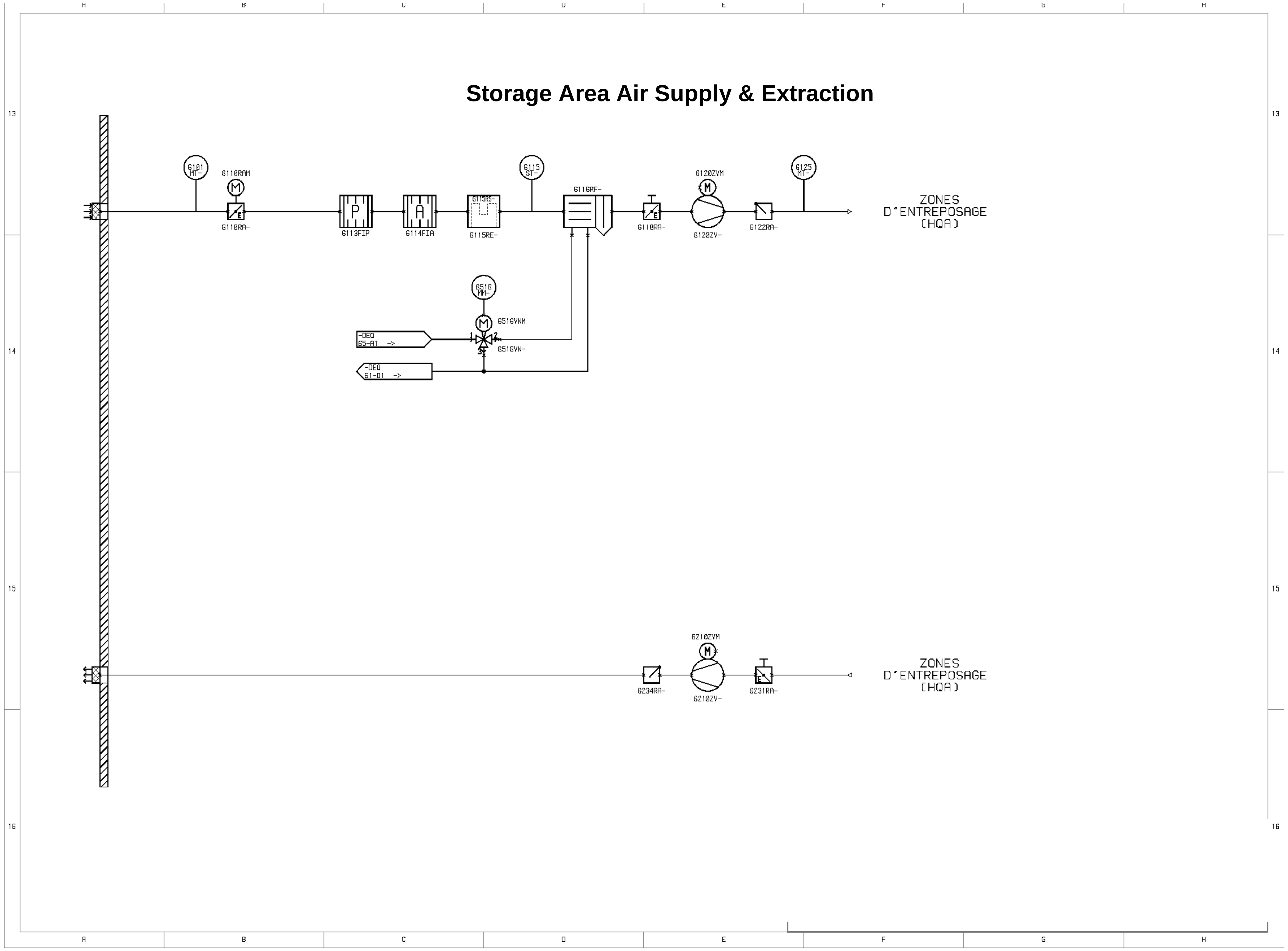
SECTION 9.4.14 - FIGURE 1

DWQ [ETBVS] Functional Flow Diagram (Sheet 3/4)



SECTION 9.4.14 - FIGURE 1

DWQ [ETBVS] Functional Flow Diagram (Sheet 4/4)



15. ACCESS BUILDING CONTROLLED AREA VENTILATION SYSTEM (DWW [ABVS])

15.1. ROLE OF THE SYSTEM [REF-1] TO [REF-7]

15.1.1. Functional role of the system

The functional role of the Access Building Controlled Area Ventilation System (DWW [ABVS]) is to:

- maintain acceptable ambient conditions (temperature, humidity) for equipment and staff,
- ensure the containment of radioactive material if a room becomes contaminated.

15.1.2. Safety role of the system

The general safety requirements are given in section 0 of this sub-chapter.

15.2. DESIGN BASES

The DWW [ABVS] system is designed for:

- maintaining acceptable ambient conditions in the various rooms for equipment and staff,
- ensuring that any possible contamination carried by operators is contained,
- ensuring that contamination from the least contaminated room is transferred to the most contaminated room,
- providing a minimum air change rate of 1 air change/hour

The basic external atmospheric conditions and the internal conditions (temperature, humidity) are given in section 1 of this sub-chapter.

15.3. DESCRIPTION AND CHARACTERISTICS OF THE SYSTEM

See Section 9.4.15 - Figure 1.

The system operates with an all fresh air supply. It supplies all rooms in the controlled area of the Access Tower (changing rooms, ventilation plant room etc.).

This system comprises:

- an air inlet,

- two identical 100% trains for providing air conditioning to rooms, each comprising:
  - an automatic isolation damper,
  - a preheating coil (SEL),
  - two-stage filtering,
  - a chilling coil supplied with chilled water,
  - a heating coil (SEL)
  - a 100% fan,
  - an manual isolation damper
- a 100% network of ducts providing air to the premises,
- extraction ductwork
- two identical 100% extraction trains, each comprising:
  - a pre-filter,
  - a HEPA filter,
  - a 100% fan,

The air is discharged by one of the two 100% fans, into the stack of the Nuclear Auxiliary Building.

15.4. OPERATING CONDITIONS

The DWW [ABVS] system operates in all operating modes of the power plant.

15.4.1. Normal state of the system

Definition:

The system is used in a normal state when the plant is operating and during shutdown.

Description:

Normal operation is characterised by:

- operation of one 100% air conditioning train (the choice of active train is made by the operators according to train availability and to ensure equal operating times for both the trains),
- distribution of air throughout all the rooms of the Access building,
- exhaust air filtering is ensured by extraction train start-up,

- extraction and discharge air from all the locations through the stack of the Nuclear Auxiliary Building.

15.4.2. Transient states of the system

15.4.2.1. Loss Of Offsite Power (LOOP)

The power supply to the system is not backed up against LOOP.

15.4.2.2. General undervoltage SBO [station blackout])

The power supply to the system is not backed up against SBO [station blackout].

15.5. PRELIMINARY SAFETY ANALYSIS

15.5.1. Compliance with regulations

The system complies with general regulations in force (see Sub-chapter 1.4).

15.5.2. Compliance with operating criteria

The DWW [ABVS] system is designed to meet the temperatures given in section 1 of this sub-chapter.

The efficiency of the HEPA filtration conforms to the criteria given in section 0 of this sub-chapter.

15.5.3. Compliance with design requirements

15.5.3.1. Safety classification

The design and manufacture of systems and equipment meets the requirements of the classification rules is given in Sub-chapter 3.2.

The extraction and filtration train in the controlled area is F2-classified.

The air-supply fan is also F2-classified as it provides radioactive material containment in the Access building.

15.5.3.2. Safety Failure Criterion or redundancy

The single failure criterion does not apply to the DWW [ABVS] system, but active components are designed with 2 x 100% trains to ensure a good availability during maintenance operations.

15.5.3.3. Qualification

Not applicable.

15.5.3.4. Instrumentation and control

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

In accordance of the safety requirement of the system, the failsafe position is defined individually for each actuator in the event that instrumentation and control is lost.

15.5.3.5. Emergency power supplies

The power supply to this system is not backed up.

15.5.3.6. Hazards

See Section 9.4.15 - Table 1.

15.6. TESTS, INSPECTION AND MAINTENANCE

15.6.1. Periodic tests

The safety functions are tested periodically.

15.6.2. Inspection and maintenance

It will be possible to carry out maintenance with the plant at power.

15.7. MECHANICAL DRAWINGS

See Section 9.4.15 - Figure 1

SECTION 9.4.15 - TABLE 1

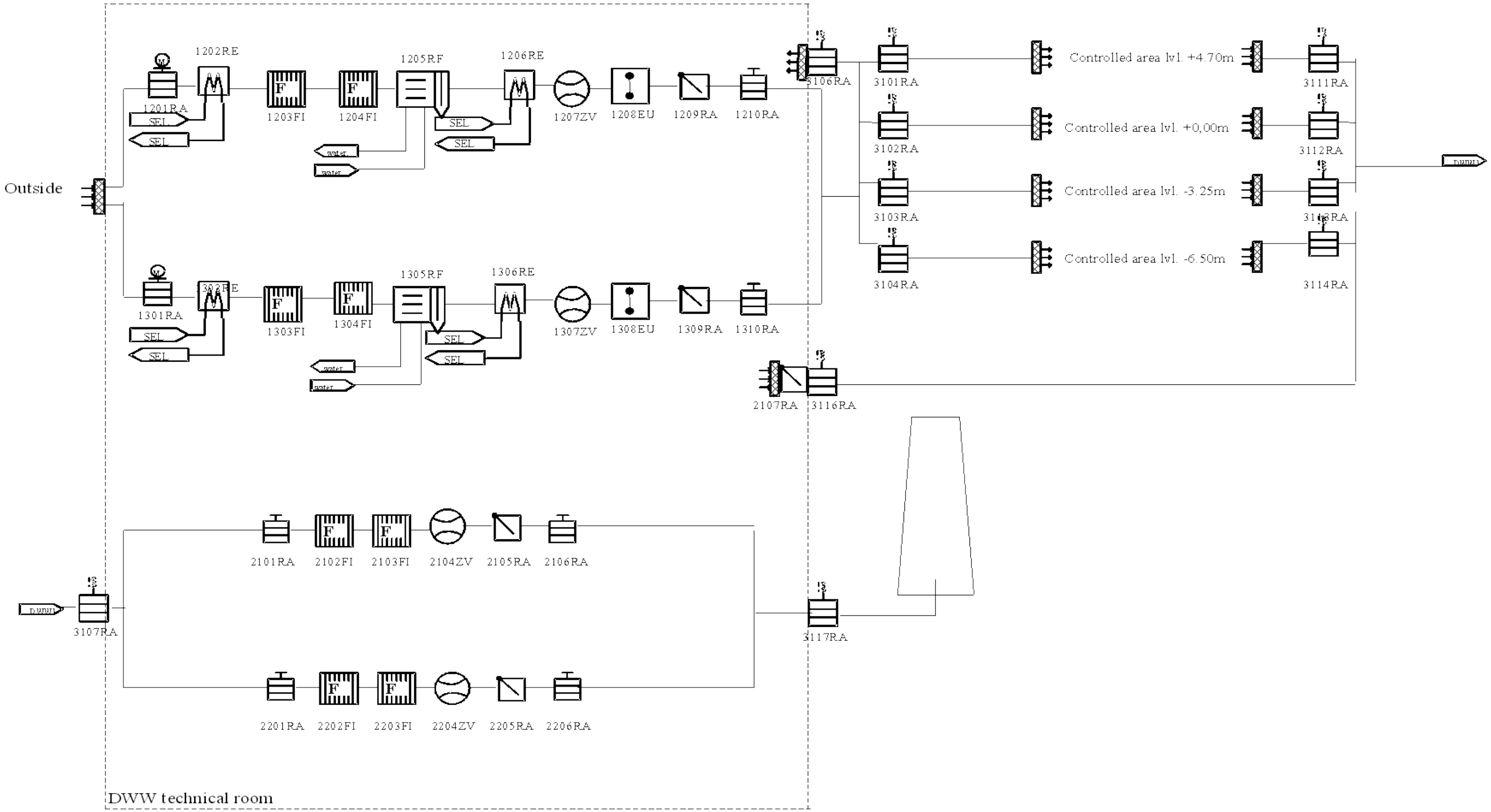
Hazards

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	No	Fire zoning in the Access Tower	-
Internal flooding	No	-	-

External hazards	Protection required in principle	General protection	Specific protection introduced in the design of the system
Earthquake	No	-	-
Aircraft crash	No	-	-
External explosion	No	-	-
External flooding	No	-	-
Snow and wind	No	-	-
Extreme cold	No	-	-
Electromagnetic wave	No	-	-

SECTION 9.4.15 - FIGURE 1

DWW [ABVS] Functional Flow Diagram



SUB-CHAPTER 9.4 – 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. GENERAL DESIGN CRITERIA

[Ref-1] Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactor. NF ISO 17873. April 2006. (E)

1.2. GENERAL DESIGN CHARACTERISTICS

1.2.3. Specific case of rooms with risk of explosive atmosphere

[Ref-1] Installations électriques à basse tension – Règles.
[Low voltage electrical installations – Rules.]
AFNOR. NF C 15-100. December 2005.

1.2.4. Equipment used in ventilation systems

c) High Efficiency Particulate Air filters (HEPA)

[Ref-1] NF X 44011 Air Cleaning Devices, Method of measuring filter efficiency using uramine (fluorescent) aerosol. May 1972. (E)

2. NUCLEAR AUXILIARY BUILDING AND FUEL BUILDING VENTILATION SYSTEMS (DWN [NABVS] AND DWK [FBVS])

2.3. DESCRIPTION AND CHARACTERISTICS OF EQUIPMENT

DWN [NABVS] (See Section 9.4.2 - Figure 2 to Figure 4):

[Ref-1] System Design Manual – Nuclear Auxiliary Building Ventilation System (DWN [NABVS]), P1 - History of the System Manual.
EZH/2008/EN/0031 Revision C. EDF. November 2008. (E)

[Ref-2] System Design Manual – Nuclear Auxiliary Building Ventilation System (DWN [NABVS]), P2 – System operation (Stage 2).
EZL2006/en/0093 Revision E. EDF. November 2008. (E)

[Ref-3] System Design Manual – Nuclear Auxiliary Building Ventilation System (DWN [NABVS]), P4 – Flow diagrams.
EZL2007/en/0069 Revision F. EDF. November 2008. (E)

[Ref-4] Dossier de Système Elémentaire – Ventilation du Bâtiment des Auxiliaires Nucléaires (DWN [NABVS]), P4.1 – Schéma mécanique fonctionnel.
[System Design Manual – Nuclear Auxiliary Building Ventilation System (DWN [NABVS]), P4.1 – Functional flow diagrams. ECEF081212 Revision A. EDF. July 2008.

[Ref-5] System Design Manual – Nuclear Auxiliary Building Ventilation System (DWN [NABVS]), P4.2 – Detailed flow diagrams. EZH2007/en/0056 Revision E. EDF. November 2008. (E)

[Ref-6] System Design Manual – Nuclear Auxiliary Building Ventilation System (DWN [NABVS]), P5 – Instrumentation and Control.
EZL2007/en/0149 Revision E. EDF. November 2008. (E)

DWK [FBVS] (see Section 9.4.2 - Figure 5):

[Ref-7] System Design Manual – Fuel Building Ventilation System (DWK [FBVS]) P1 - Plant System File History. EYTS/2008/fr/0032 Revision B1. EDF. October 2009. (E)

[Ref-8] System Design Manual – Fuel Building Ventilation System (DWK [FBVS]) P2 - System Operation (Stage 2). SFL-EF MF 2006.164 Revision D1. SOFINEL. October 2009. (E)

[Ref-9] System Design Manual – Fuel Building Ventilation System (DWK [FBVS]) P3 - System and Component Design Basis. EYTS 2007/fr/0043 Revision B1. EDF. September 2009. (E)

[Ref-10] System Design Manual – Fuel Building Ventilation System (DWK [FBVS]), P4 – Flow diagrams. EYTS 2007/fr/0173 Revision B1. SOFINEL. October 2009. (E)

[Ref-11] Dossier de Système Elémentaire – Système de Ventilation du Bâtiment Combustible (DWK [FBVS]), P4.2 – Schéma mécanique détaille.
[System Design Manual – Fuel Building Ventilation System (DWK [FBVS]), P4.2 – Detailed flow diagram.]
EYTS 2007/fr/0172 Revision B. SOFINEL. April 2008.

[Ref-12] System Design Manual – Fuel Building Ventilation System (DWK [FBVS]), P5 - Instrumentation and Control. EYTS 2007/fr/0191 Revision C1. SOFINEL. October 2009. (E)

2.4. OPERATING CONDITIONS

2.4.1. Normal operation of the plant

[Ref-1] System Design Manual – Nuclear Auxiliary Building Ventilation System (DWN [NABVS]), P3 Sizing Report (Stage 2).
EZL2006/en/0092 Revision F. EDF. November 2008. (E)

3. CONTAINMENT COOLING VENTILATION SYSTEM (EVR [CCVS])

[Ref-1] System Design Manual – Containment Cooling Ventilation System (EVR [CCVS]) P1 - System Description Records.
EYTS/2007/fr/0129 Revision B1. Sofinel. August 2009. (E)

[Ref-2] System Design Manual – Containment Cooling Ventilation System (EVR [CCVS]), P2 - System Operation (Stage 1).
EYTS 2007/fr/0132 Revision B1. SOFINEL. August 2009. (E)

[Ref-3] System Design Manual – Containment Cooling Ventilation System (EVR [CCVS]), P3 - System Sizing.
SFL-EFMF2006.451 Revision D1. SOFINEL. August 2009. (E)

[Ref-4] System Design Manual - Containment Cooling Ventilation System (EVR [CCVS]), P4 - Mechanical diagrams.
SFL-EFMF 2006.1189 Revision B1. August 2009. SOFINEL. (E)

[Ref-5] Dossier de Système Elémentaire - EVR [CCVS], P4.1 – Schéma mécanique fonctionnel.
[System Design Manual – Containment Cooling Ventilation System (EVR [CCVS]), P4.1 – Functional flow diagram.]
SFL-EFMF 2006.1186 Revision A. SOFINEL. July 2006.

[Ref-6] Dossier de Système Elémentaire – Ventilation Continue Enceinte System (EVR [CCVS]), P4.2 – Schéma mécanique détaille.
[System Design Manual – Containment Cooling Ventilation System (EVR [CCVS]), P4.2 – Detailed flow diagram.]
SFL-EFMF 2006.1187 Revision B. SOFINEL. June 2007.

[Ref-7] System Design Manual – Containment Cooling Ventilation System (EVR [CCVS]), P5 - Instrumentation and Control.
EYTS 2006/fr/0017 Revision D1. EDF. August 2010. (E)

SECTION 9.4.3 - FIGURES 1 TO 3

[Ref-1] System Design Manual – Containment Cooling Ventilation System (EVR [CCVS]), P2 - System Operation (Stage 1).
EYTS 2007/fr/0132 Revision B1. SOFINEL. August 2009. (E)

[Ref-2] Dossier de Système Elémentaire – EVR [CCVS], P4.1 – Schémas mécaniques fonctionnel (Stage 1).
[System Design Manual – Containment Cooling Ventilation System (EVR [CCVS]), P4.1 – Functional flow Diagrams (Stage 1)].
SFL-EF-MF-2006.1186 Revision A. SOFINEL. July 2006.

4. REACTOR BUILDING INTERNAL FILTRATION SYSTEM (EVF)

[Ref-1] System Design Manual – Reactor Building Internal Filtration System (EVF) P1 - Plant System History File. EYTS/2007/fr/0141 Revision B1. Sofinel. October 2009. (E)

[Ref-2] System Design Manual – Reactor Building Internal Filtration System (EVF), P2 - System Operation (Stage 1). SFL-EFMF2006.166 Revision C1 PREL. SOFINEL. October 2009. (E)

[Ref-3] System Design Manual – Reactor Building Internal Filtration System (EVF), P3 - System Sizing. SFL-EFMF2006.165 Revision C1. SOFINEL. October 2009. (E)

[Ref-4] System Design Manual – Reactor Building Internal Filtration System (EVF), P4 - Flow diagrams. EYTS 2007/fr/0118 Revision B1. SOFINEL. October 2009. (E)

[Ref-5] Dossier de Système Elémentaire – EVF, P4.1 – Schéma mécanique fonctionnel (Stage 1 PREL).
[System Design Manual – Reactor Building Internal Filtration System (EVF), P4.1 – Functional flow diagrams (Stage 1)].
SFL-EFMF2006.516 Revision A. SOFINEL. July 2006.

[Ref-6] Dossier de Système Elémentaire – Filtration Interne (EVF), P4.2 – Schéma mécanique détaille.
[System Design Manual – Reactor Building Internal Filtration System (EVF), P4.2 – Detailed flow diagrams].
SFL-EFMF2006.1141 Revision D. SOFINEL. December 2008.

[Ref-7] System Design Manual – Reactor Building Internal Filtration System (EVF), P5 - Instrumentation and Control. EYTS 2006/fr/0012 Revision D1. SOFINEL. November 2009. (E)

SECTION 9.4.4 - FIGURE 1

[Ref-1] Dossier de Système Elémentaire – EVF, P4.1 – Schéma mécanique fonctionnel (Stage 1 PREL).
[System Design Manual – Reactor Building Internal Filtration System (EVF), P4.1 – Functional flow diagrams (Stage 1)].
SFL-EFMF2006.516 Revision A. SOFINEL. July 2006.

5. CONTAINMENT SWEEP VENTILATION SYSTEM (EBA [CSVS])

[Ref-1] System Design Manual – Containment Sweep Ventilation System (EBA [CSVS]) P1 - System Description Records. EYTS/2007/fr/0128 Revision B1. Sofinel. November 2009. (E)

[Ref-2] System Design Manual – Containment Sweep Ventilation System (EBA [CSVS]), P2 - System Operation (Stage 1). EYTS/2007/fr/0131 Revision B1. SOFINEL. November 2009. (E)

[Ref-3] System Design Manual – Containment Sweep Ventilation System (EBA [CSVS]), P3 - System Sizing. SFL-EFMF2006.502 Revision B1. SOFINEL. March 2009. (E)

[Ref-4] System Design Manual – Containment Sweep Ventilation System (EBA [CSVS]), P4 – Flow diagrams. SFL-EFMF2006.1188 Revision C1. SOFINEL. November 2009. (E)

[Ref-5] Dossier de Système Elémentaire – EBA, P4.1 – Schéma mécanique fonctionnel (Stage 1 PREL).
[System Design Manual – Containment Sweep Ventilation System (EBA [CSVS]), P4.1 – Functional flow diagrams (Stage 1)].
SFL-EF MF-2006.1184 Revision A. SOFINEL. July 2006.

[Ref-6] Dossier de Système Elémentaire – Ventilation Balayage Enceinte Système (EBA [CSVS]), P4.2 –Schéma mécanique détaille.
[System Design Manual – Containment Sweep Ventilation System (EBA [CSVS]), P4.2 – Detailed flow diagrams].
SFL-EF MF-2006.1185 Revision C. SOFINEL. September 2007.

[Ref-7] System Design Manual – Containment Sweep Ventilation System (EBA [CSVS]), P5 - Instrumentation and Control. EYTS/2006/fr/0016 Revision D1. SOFINEL. November 2009. (E)

5.4. OPERATING CONDITIONS

5.4.1. Normal State of the System

5.4.1.2. Plant outage

[Ref-1] System Design Manual – Containment Sweep Ventilation System (EBA [CSVS]), P2 - System Operation (Stage 1). EYTS/2007/fr/0131 Revision B1. EDF. November 2009. (E)

SECTION 9.4.5 - FIGURE 1

[Ref-1] Dossier de Système Elémentaire – EBA, P4.1 – Schéma mécanique fonctionnel (Stage 1 PREL).
[System Design Manual – Containment Sweep Ventilation System (EBA [CSVS]), P4.1 – Functional flow diagrams (Stage 1)]. SFL-EF MF-2006.1184 Revision A. SOFINEL. July 2006.

6. SAFEGUARD BUILDING CONTROLLED AREA VENTILATION SYSTEM (DWL [CSBVS])

6.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual – Safeguard Building Controlled Area Ventilation System (DWL [CSBVS)], P1 - History of the System.
EZH/2008/en/0044 Revision C. EDF. November 2008. (E)

[Ref-2] System Design Manual – Safeguard Building Controlled Area Ventilation System (DWL [CSBVS]), P2 – System operation (Stage 2).
SFL-EZL-030008 Revision G. EDF. November 2008. (E)

[Ref-3] System Design Manual – Safeguard Building Controlled Area Ventilation System (DWL [CSBVS]), P3 – Design Report (Stage 2).
EZH/2007/en/0033 Revision E. EDF. November 2008. (E)

[Ref-4] System Design Manual – Safeguard Building Controlled Area Ventilation System (DWL [CSBVS]), P4 - Flow diagrams.
EZL/2007/en/0122 Revision F. EDF. November 2008. (E)

[Ref-5] Dossier de Système Elémentaire – Ventilation de la Zone Contrôlée des Bâtiments des Auxiliaires de Sauvegarde (DWL), P4.1 – Schéma mécanique fonctionnel.
[System Design Manual – Ventilation System of the Controlled Area of the Safeguard Buildings (DWL [CSBVS]), P4.1 – Functional flow diagrams.]
ECEF081213 Revision A. EDF. July 2008.

[Ref-6] System Design Manual – Safeguard Building Controlled Area Ventilation System (DWL [CSBVS]), P4.2 – Detailed flow diagrams.
EZH/2007/en/0048 Revision E. EDF. November 2008. (E)

[Ref-7] System Design Manual – Safeguard Building Controlled Area Ventilation System (DWL [CSBVS]), P5 – Instrumentation and Control.
EZH/2007/en/0107 Revision D. EDF. November 2008. (E)

6.4. OPERATING CONDITIONS

[Ref-1] System Design Manual – Safeguard Building Controlled Area Ventilation System (DWL [CSBVS]), P3 – Design Report (Stage 2).
EZH/2007/en/0033 Revision E. EDF. November 2008. (E)

6.4.1. Normal state of the system

[Ref-1] System Design Manual – Safeguard Building Controlled Area Ventilation System (DWL [CSBVS]), P3 – Design Report (Stage 2).
EZH/2007/en/0033 Revision E. EDF. November 2008. (E)

6.4.2. Other permanent operating conditions of the system

6.4.2.5. Fuel handling accident in the Fuel Building

[Ref-1] System Design Manual – Safeguard Building Controlled Area Ventilation System (DWL [CSBVS]), P3 – Design Report (Stage 2).
EZH/2007/en/0033 Revision E. EDF. November 2008. (E)

7. SAFEGUARD BUILDING UNCONTROLLED AREA VENTILATION SYSTEM (DVL [SBVSE])

[Ref-1] GDA - DEL / DVL - Conceptual Design Note. ECES121567 Revision A. EDF. November 2012. (E)

7.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual – Safeguard Building Non-Controlled Area Ventilation System (DVL [SBVSE], P1 - History of the System Manual. EZH/2008/en/0045 Revision C. EDF. November 2008. (E)

[Ref-2] System Design Manual – Safeguard Building Non-Controlled Area Ventilation System (DVL [SBVSE], P2 – System operation (Stage 2) EZL/2007/en/0077 Revision F. EDF. November 2008. (E)

[Ref-3] System Design Manual – Safeguard Building Non-Controlled Area Ventilation System (DVL [SBVSE]), P3 – Design Report (Stage 2). EZH/2007/en/0035 Revision F. EDF. November 2008. (E)

[Ref-4] System Design Manual – Safeguard Building Non-Controlled Area Ventilation System (DVL [SBVSE]), P4 - Flow diagrams (Stage 2) EZL/2007/en/0072 Revision F. EDF. November 2008. (E)

[Ref-5] Dossier de Système Elémentaire – Ventilation de la Zone Non-contrôlée des Bâtiments des Auxiliaires de Sauvegarde (DVL), P4.1 – Schéma mécanique fonctionnel.
[System Design Manual – Safeguard Building Non-Controlled Area Ventilation System (DVL [SBVSE]), P4.1 – Functional flow diagrams.]
ECEF081214 Revision A. EDF. July 2008.

[Ref-6] System Design Manual – Safeguard Building Non-Controlled Area Ventilation System (DVL [SBVSE]), P4.2 – Detailed flow diagrams.
EZH/2007/en/0049 Revision E. EDF. November 2008. (E)

[Ref-7] System Design Manual – Safeguard Building Non-Controlled Area Ventilation System (DVL [SBVSE]), P5 - Instrumentation and Control (Stage 2) EZH/2007/en/0025 Revision D. EDF. November 2008. (E)

7.4. OPERATING CONDITIONS

7.4.1. Normal state of the system

[Ref-1] System Design Manual – Safeguard Building Non-Controlled Area Ventilation System (DVL [SBVSE]), P3 – Design Report (Stage 2). EZH/2007/en/0035 Revision F. EDF. November 2008. (E)

SECTION 9.4.7 - FIGURE 1

[Ref-1] System Design Manual – Safeguard Building Non-Controlled Area Ventilation System (DVL [SBVSE]), P4 - Flow diagrams (Stage 2) EZL/2007/en/0072 Revision F. EDF. November 2008. (E)

8. MAIN CONTROL ROOM AIR CONDITIONING SYSTEM (DCL [CRACS])

8.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual – Main Control Room Air Conditioning System (DCL [CRACS], P1 - History of the System Manual. EZH/2008/en/0042 Revision C. EDF. November 2008. (E)

[Ref-2] System Design Manual – Main Control Room Air Conditioning System (DCL [CRACS]), P2 – System operation (Stage 1). EZL/2006/en/0077 Revision F. EDF. November 2008. (E)

[Ref-3] System Design Manual – Main Control Room Air Conditioning System (DCL [CRACS]), P3 - System Sizing. EZH/2007/en/0036 Revision F. EDF. November 2008. (E)

[Ref-4] System Design Manual – Main Control Room Air Conditioning System (DCL [CRACS]), P4 - Flow diagrams. EZH/2007/en/0051 Revision F. EDF. November 2008. (E)

[Ref-5] Dossier de Système Elémentaire – Ventilation de la Salle de Commande (DCL), P4.1 – Schéma mécanique fonctionnel.
[System Design Manual – Main Control Room Air Conditioning System (DCL [CRACS]), P4.1 – Functional flow diagrams.]
ECEF081239 Revision A. EDF. April 2008.

[Ref-6] System Design Manual – Main Control Room Air Conditioning System (DCL [CRACS]), P4.2 – Detailed flow diagrams.
EZH/2007/en/0052 Revision F. EDF. November 2008. (E)

[Ref-7] System Design Manual – Main Control Room Air Conditioning System (DCL [CRACS]), P5 - Instrumentation and Control. EZH/2007/en/0011 Revision E. EDF. October 2008. (E)

9. DIESEL ROOM VENTILATION SYSTEM (DVD)

9.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual – Main Diesel and SBO Diesel Building Ventilation System (DVD), P2 - System Operation (Stage 2).
SFL-EF MF 2006.430 Revision E1 PREL. SOFINEL. October 2009. (E)

[Ref-2] System Design Manual – Main Diesel and SBO Diesel Building Ventilation System (DVD), P3 - System Sizing (Stage 2).
SFL-EF MF 2006.431 Revision D1. SOFINEL. October 2009. (E)

[Ref-3] System Design Manual – Main Diesel and SBO Diesel Building Ventilation System (DVD), P4 - Flow diagrams (Stage 2).
EYTS2007/fr/0135 Revision C1 PREL. SOFINEL. July 2009. (E)

[Ref-4] Dossier de Système Elémentaire – Système de Ventilation des Bâtiments Diesel (DVD), P4.1 – Schéma mécanique fonctionnel.
[System Design Manual – Main Diesel and SBO Diesel Building Ventilation System (DVD), P4.1 – Functional flow diagrams.]
ECEF071412 Revision A. SOFINEL. April 2008.

[Ref-5] System Design Manual – Main Diesel and SBO Diesel Building Ventilation System (DVD), P5 - Instrumentation and Control (Stage 2).
SFL-EF MF 2006.1650 Revision F1. SOFINEL. October 2009. (E)

10. SAFETY CHILLED WATER SYSTEM (DEL)

[Ref-1] GDA - DEL / DVL - Conceptual Design Note. ECES121567 Revision A. EDF. November 2012. (E)

10.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual – Safety Chilled Water System (DEL), P1 - History of System Manual. EZH2007EN0142 Revision D. EDF. November 2008. (E)

[Ref-2] System Design Manual – Safety Chilled Water System (DEL), P2 - System Operation. SFL-EZL-030004 Revision H. EDF. November 2008. (E)

[Ref-3] System Design Manual – Safety Chilled Water System (DEL), P3 - System and component design. EZH/2007/en/0001 Revision F. EDF. November 2008. (E)

[Ref-4] System Design Manual – Safety Chilled Water System (DEL), P4 - Flow diagrams. EZL/2007/en/0067 Revision F. EDF. November 2008. (E)

[Ref-5] Dossier de Système Elémentaire – Eau Réfrigérée de Sureté (DEL), P4.1 - Schéma mécanique fonctionnel (Stage 1).
[System Design Manual – Safety Chilled Water System (DEL), P4.1 – Functional flow diagrams (Stage 1)].
ECEF072079 Revision A. EDF. December 2007.

[Ref-6] Dossier de Système Elémentaire – Système d'Eau Réfrigérée de Sureté (DEL), P4.2 - Schéma mécanique détaillé.
[System Design Manual – Safety Chilled Water System (DEL), P4.2 – Detailed flow diagrams].
SFL-EZL-030015 Revision A. EDF. September 2006.

[Ref-7] System Design Manual – Safety Chilled Water System (DEL), P5 - Instrumentation and Control. SFL-EZL-030023 Revision H. EDF. October 2008. (E)

SECTION 9.4.10 - FIGURES 1 TO 4

[Ref-1] Dossier de Système Elémentaire – Eau Réfrigérée de Sureté (DEL), P4.1 - Schéma mécanique fonctionnel (Stage 1).
[System Design Manual – Safety Chilled Water System (DEL), P4.1 – Functional flow diagrams (Stage 1)].
ECEF072079 Revision A. EDF. December 2007.

11. OPERATIONAL CHILLED WATER SYSTEM (DER)

[Ref-1] GDA - DEL / DVL - Conceptual Design Note. ECES121567 Revision A. EDF. November 2012. (E)

11.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual – Operational Chilled Water System (DER),
P1 - History of System Manual.
EZH/2008EN0043 Revision C. EDF. November 2008. (E)

[Ref-2] System Design Manual – Operational Chilled Water System (DER),
P2 - System Operation.
EZL/2007/en/0078 Revision F. EDF. November 2008. (E)

[Ref-3] System Design Manual – Operational Chilled Water System (DER),
P3 - System and component design.
EZH/2007/en/0002 Revision F. EDF. November 2008. (E)

[Ref-4] System Design Manual – Operational Chilled Water System (DER),
P4 - Flow diagrams.
EZL/2007/en/0080 Revision F. EDF. November 2008. (E)

[Ref-5] Dossier de Système Elémentaire – DER, P4.1 - Schéma mécanique fonctionnel (Stage 1).
[System Design Manual – Operational Chilled Water System (DER),
P4.1 – Functional flow diagrams (Stage 1)].
ECEF080980 Revision A. EDF. May 2008.

[Ref-6] System Design Manual – Operational Chilled Water System (DER),
P4.2 – Detailed flow diagrams.
SFL-EZL-030013 Revision F. EDF. November 2008. (E)

[Ref-7] System Design Manual – Operational Chilled Water System (DER), P5 - Instrumentation and Control.
EZH/2007/en/0044 Revision F. EDF. October 2008. (E)

SECTION 9.4.11 - FIGURE 1

[Ref-1] Dossier de Système Elémentaire – DER, P4.1 - Schéma mécanique fonctionnel (Stage 1).
[System Design Manual – Operational Chilled Water System (DER), P4.1 – Functional flow diagrams (Stage 1)].
ECEF080980 Revision A. EDF. May 2008.

12. VENTILATION OF THE PUMPING STATION (DVP)

12.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual – Circulating Water Pumping Station Ventilation System (DVP).
ETDOFC060066 Revision A1. EDF. December 2009. (E)

13. VENTILATION OF THE CONTROLLED AREA OF THE OPERATING SERVICE CENTRE (DWB)

13.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual – Operating Building Contaminable Room Ventilation System (8DWB) P1 -DSE History. EYTS/2007/fr/0138 Revision A1. Sofinel. August 2009. (E)

[Ref-2] System Design Manual – Operating Building Contaminable Room Ventilation System (8DWB), P2 - System Operation (Stage 2).]
SFL-EF MF 2006.131 Revision D1. SOFINEL. August 2009. (E)

[Ref-3] System Design Manual – Operating Building Contaminable Room Ventilation System (8DWB), P3 - System and component design (Stage 2).
SFL-EF MF 2006.132 Revision E1. SOFINEL. August 2009. (E)

[Ref-4] System Design Manual – Operating Building Contaminable Room Ventilation System (8DWB), P4 - Flow diagrams (Stage 2).
EYTS/2006/fr/0001 Revision B1. SOFINEL. August 2009. (E)

[Ref-5] Dossier de Système Elémentaire – 8DWB, P4.1 - Schémas mécaniques fonctionnels.
[System Design Manual – Operating Building Contaminable Room Ventilation System (8DWB), P4.1 – Functional flow diagrams].
EYTS/2006/fr/0013 Revision A. SOFINEL. September 2006.

[Ref-6] Dossier de Système Elémentaire – Système de Ventilation de la Zone Contrôlée du POE (8DWB), P4.2 - Schéma mécanique détaillé.
[System Design Manual – Operating Building Contaminable Room Ventilation System (8DWB), P4.2 – Detailed flow diagrams].
EYTS/2006/fr/0003 Revision C. SOFINEL. February 2008.

[Ref-7] System Design Manual – Operating Building Contaminable Room Ventilation System (8DWB), P5 - Instrumentation and Control (Stage 2).
EYTS2006/fr/0006 Revision B1. SOFINEL. August 2009. (E)

14. VENTILATION OF THE CONTROLLED AREA OF THE EFFLUENT TREATMENT BUILDING (DWQ [ETBVS])

14.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual – Effluent Treatment Building Ventilation System (8DWQ) P1 - History. EYTS/2008/fr/0038 Revision B1. Sofinel. November 2009. (E)

[Ref-2] System Design Manual – Effluent Treatment Building Ventilation System (8DWQ), P2 - System Operation (Stage 1).
EYTS2007/fr/0108 Revision B1. SOFINEL. November 2009. (E)

[Ref-3] System Design Manual – Effluent Treatment Building Ventilation System (8DWQ), P3 - System and component design (Stage 1).
EYTS2007/fr/0109 Revision B1. SOFINEL. November 2009. (E)

[Ref-4] System Design Manual – Effluent Treatment Building Ventilation System (8DWQ), P4 - Flow diagrams.
EYTS2007/fr/0189 Revision B1. SOFINEL. November 2009. (E)

[Ref-5] Dossier de Système Elémentaire – Système de Ventilation du BTE (8DWQ), P4.2 - Schéma mécanique détaillé.
[System Design Manual – Effluent Treatment Building Ventilation System (8DWQ), P4.2 – Detailed flow diagrams].
EYTS2007/fr/0188 Revision B. SOFINEL. May 2008.

[Ref-6] System Design Manual – Effluent Treatment Building Ventilation System (8DWQ), P5 - Instrumentation and Control.
EYTS2007/fr/0184 Revision C1. SOFINEL. November 2009. (E)

15. VENTILATION OF THE CONTROLLED AREA OF THE ACCESS BUILDING (DWW) [ABVS])

15.1. ROLE OF THE SYSTEM

[Ref-1] System Design Manual –Ventilation of Contaminable Rooms in the Access Tower (DWW [ABVS]) P1 - History. EYTS/2008/fr/0009 Revision B1. Sofinel. November 2009. (E)

[Ref-2] System Design Manual –Ventilation of Contaminable Rooms in the Access Tower (DWW [ABVS]), P2 - System Operation (Stage 2).
EYTS/2007/fr/0187 Revision D1 BPE. SOFINEL. November 2009. (E)

[Ref-3] System Design Manual – Ventilation of Contaminable Rooms in the Access Tower (DWW [ABVS]), P3 - System Sizing (Stage 2).
EYTS/2007/fr/0087 Revision B1 BPE. SOFINEL. November 2009. (E)

[Ref-4] System Design Manual – Ventilation of Contaminable Rooms in the Access Tower (DWW [ABVS]), P4 - Flow diagrams (Stage 2).
EYTS/2008/fr/0023 Revision B1 BPE. SOFINEL. November 2009. (E)

[Ref-5] Dossier de Système Elémentaire – Système de Ventilation de la Zone (DWW), P4.1 - Schéma mécanique fonctionnel.
[System Design Manual – Access Building Controlled Area Ventilation System (DWW [ABVS]), P4.1 – Functional flow diagrams].
ECEF081184 Revision A. SOFINEL. September 2008.

[Ref-6] Dossier de Système Elémentaire – Ventilation de Zone Contrôlée de la Tour d'Accès (DWW), P4.2 - Schéma mécanique détaillé.
[System Design Manual – Access Building Controlled Area Ventilation System (DWW [ABVS]), P4.2 – Detailed flow diagrams].
EYTS/2007/fr/0148 Revision C. SOFINEL. September 2008.

[Ref-7] System Design Manual – Access Building Controlled Area Ventilation System (DWW [ABVS]), P5 - Instrumentation and Control (Stage 2)].
EYTS/2007/fr/0165 Revision C1 BPE. SOFINEL. November 2009. (E)