SUB-CHAPTER B.2 - GENERAL DESCRIPTION OF UNIT

1. GENERAL OVERVIEW

1.1. OVERVIEW OF THE SITE

To follow.

1.2. GENERAL DESCRIPTION OF THE SITE

1.2.1. Overall description

To follow.

1.2.2. Description of units in operation

Not applicable.

1.2.3. Description of the EPR Unit

1.2.3.1. Layout plan of the EPR unit

To follow.

1.2.3.2. Location of Unit

To follow.

1.2.3.3. List of structures essential for the Balance of Nuclear Island (BNI)

These structures are as follows:

- Reactor building (HR or BR), used principally to house the nuclear steam-supply system,
- Auxiliary safeguards building and the electrical building are split into four divisions, (trains) each containing a series of emergency systems with electrical support systems (HLA/HLF, HLB/HLG, HLH/HLC, HLI/HLD or BAS-BL divisions 1 to 4),
- Fuel building (HK or BK),
- Nuclear auxiliary building (HN or BAN),
- Diesel-generator buildings (HDA, HDB, HDC, HDD or BD),
- Effluent-treatment building (HQ or BTE)

- Turbine hall (HM or SDM) containing the turbine generator, the condenser and the feedwater plant,
- Conventional island electrical building also known as the unclassified electrical building (HF or BLNC),
- Power-transmission (HT or TP-TS) and subsidiary feed (HJ) platform,
- Access tower (HW),
- Pumping station (HP or SDP) and the pre-discharge (HCB) and discharge (HCA) ponds,
- Operational service centre (HB or POE),
- Gas storage (HZ),
- Building for collecting and processing the site's water (HX).

2. GENERAL DESCRIPTION OF THE UNIT

2.1. GENERAL ASSUMPTIONS

General remarks

To follow.

2.1.1. Platform level

To follow.

2.1.2. 2.1.2 Access roads and transport networks

To follow.

2.1.3. Other facilities

To follow.

2.2. LOCATION OF STRUCTURES

2.2.1. Nuclear island

2.2.1.1. Structures on shared foundation raft

The buildings of the nuclear island which are located on the shared foundation raft are:

- the reactor building,

- the 4 safeguard auxiliary buildings,
- the fuel building.

The foundation raft is shaped approximately like a cross, with the reactor building at its centre and the fuel building and the electrical and safeguard buildings at its edges.

The reactor building is cylindrical in shape. The containment is of a "double enclosure" type with a pre-stressed concrete inner enclosure and a reinforced concrete outer enclosure. The fuel building is in the shape of a rectangle extended in a trapezoidal form up to the edge of the reactor building.

The three groups of electrical and safeguards buildings are similar in shape. Each division includes an individual safety train of the safeguards and electrical equipment. A tensioning gallery is installed on the underside of the reactor building to enable the tensioning of the vertical pre-stressing cables of the internal containment enclosure.

2.2.1.2. Other structures on the nuclear island

The nuclear island also includes:

- the nuclear auxiliaries building,
- the access tower,
- the diesel buildings,
- the effluent-treatment building (BTE).

The nuclear safeguard building is built on an independent foundation raft next to the fuel building.

The two diesel buildings each house 2 main diesel generator sets and 1 emergency plant cool-down system diesel generator set. The diesel buildings are constructed from reinforced concrete, and are built on an independent foundation raft. The effluent treatment building, which is also made of reinforced concrete, is subdivided into 2 sections:

- a storage section (HQA),
- an effluent treatment section (HQB).

The effluent treatment building adjoins the nuclear auxiliary building and is designed to serve two units.

2.2.2. Conventional Island

The conventional island mainly comprises the following structures:

- the turbine hall,
- the unclassified electrical building.

The unclassified electrical building (BLNC or HF) houses all the unclassified electrical equipment serving the conventional island and the other unit structures apart from the nuclear island. The building adjoins the turbine hall and is near the power-transmission platform.

2.2.3. Other site structures

Other site structures comprise:

- Water circulation structures:
  - pumping station
  - supply channel,
  - discharge structure.
- The power-transmission platform (main transformers, high-voltage pylon, aero-underground substation and the corresponding connections).
- The operational service centre (POE)
- The gas and chemical products storage building,
- The building which collects and processes the site's effluent water (HX) which includes:
  - a containment tank,
  - a settler / oil-separator.
- The desalination unit (HYS),
- The Nuclear island demineralised water tank (SED),
- The effluent-storage reservoirs (HC).

2.2.3.1. Structures positioned along the seawater supply channel

The pumping station and the discharge structure divided into a discharge and pre-discharge section are positioned along the supply channel.

2.2.3.2. The power-transmission platform

The power-transmission platform is located adjacent to the turbine hall and houses the following plant items:

- The poles of the main transformer,
- The step-down transformers,
- A substation under a metallic envelope (PSEM),
- An auxiliary transformer platform (HJ).

2.2.3.3. The operational service centre

The operational service centre provides:

- administrative building functions located within its superstructure,

- cold store/workshop functions on the ground floor (which may be shared with the other site units),
- “controlled area” access functions in the basement (locker rooms, access controls and dosimeter operations).

The Operational Service Centre is on 9 levels, 3 of which are below ground, the 5 upper levels being arranged in 3 parallel buildings. The ground floor and lower floors constitute a one-piece whole. The Operational Service Centre is located as close as possible to the turbine hall and nuclear island in order to minimize times for movement of staff. Tunnels and walkways provide connection with the access towers and turbine hall.

2.2.3.4. The gas-storage platform

To follow.

2.2.3.5. Effluent water treatment building

The building for the collection and treatment of effluent water (HX) includes:

- a containment tank,
- a settler / oil-separator.

3. DESCRIPTION OF STRUCTURES

3.1. CRITERIA FOR LOCATION AND INSTALLATION OF STRUCTURES

The following factors have been taken into account in determining the location and design of the site civil structures:

- nuclear safety requirements,
- design criteria with regard to internal and external hazards,
- compliance with technical and environmental constraints (e.g. requirements on cooling of effluent discharge, requirements on redundancy and geographical separation, etc.),
- dependence of equipment housed within the structure on auxiliary equipment and services (supply of auxiliary steam, compressed air, gas, etc.),
- statutory industrial safety requirements, covering fire (fire sectorization, fire fighting systems, provision of emergency exits, provision of evacuation routes, etc.)
- radiological protection criteria, including requirements on the separation of controlled and uncontrolled areas.

The design criteria are described in Chapter C.5.

3.1.1. Location and installation requirements related to access and maintenance

3.1.1.1. Criteria for location and installation relating to fire

The location of buildings must enable fire and emergency services to provide an effective response in the event of a site emergency.

For this purpose, the location of buildings has been chosen to enable:

- the creation of roads enabling access for emergency equipment:
- the creation of ladder tracks (sections of roads usable for positioning aerial ladders)

Access to safety buildings must be ensured by two independent routes.

Risks due to fires are controlled by sub-dividing buildings into fire segregation zones applying principles of physical or geographical separation, and by applying security rules which specify the provision of emergency exits and protected zones.

Evacuation routes are defined in all parts of the buildings enabling the prompt evacuation of occupants in the event of fires (including emergency exits, stairwells, etc.). These routes are of two types:

- “protected” evacuation routes, which are transit routes protected from the effects of fires,
- “normal” or “unprotected” evacuation routes which lead to a protected evacuation route.

A maximum routing distance to an emergency exit is specified, defined as the distance between any point in a building and a protected emergency corridor, staircase or stairwell or to the outside. For FA3 EPR, the maximum routing distance is specified by French regulations (French labour laws) as follows:

- The routing distance to an emergency exit must not exceed 40 m, unless specific provisions are made. All areas where this distance is exceeded in the FA3 design have been identified. Only a few such zones exist (such as access to the polar crane or to certain technical tunnels where access is not normally required). Exceptions are examined on a case-by-case basis, taking into account the arrangements in place for reaching a safe location.
- no dead-end route (cul-de-sac) must be over 10 m long
- the landing of a staircase at ground floor level must be less than 20 m from an outside exit.

Required minimum passage dimensions are calculated based on the number of people expected to pass through the passage in an emergency and the emergency measures likely to be deployed within it.

Protected emergency exits are maintained at a positive over-pressure in relation to areas likely to be damaged and are separated from unprotected zones by smoke-sealed fire break doors.

Emergency exits in the access tower pass through protected stairwells and/or protected passages to the outside.

Protected stairwells representing a main evacuation route are designed in accordance with the following requirements:

- stairwell and landing widths must allow a standard stretcher to pass,
- up-down circulation routes are separated except in the case of tunnels.

Secondary emergency exits are provided:

- in the form of stairwells,
- in the form of ladders, if that is acceptable in terms of the number of people expected to be in the zone or on the floor concerned.

3.1.1.2. Maintenance, in-service inspection and maintenance conditions for equipment

3.1.1.2.1. Safety clearances for cranes

In order to avoid risk of collision, the safety clearance between external mobile items of stationary handling equipment or that on rails and structures or objects located around them, except for lifting gear and loading attachments, is at least 0.60 m vertically and horizontally.

3.1.1.2.2. Handling conditions

At locations where equipment handling is necessary for operation or maintenance, hoisting equipment is supplied, unless the lifting load is under 20 kg and the equipment is positioned below chest height and is easily accessible.

Initial assembly of mechanical equipment (heat exchangers, pumps, ventilators, etc.) is facilitated by use of brackets in Phase 2 concrete and/or by the use of removable partitions or slabs.

Removable partitions or slabs are also used to enable certain items of equipment to be accessed and maintained in routine maintenance situations,

Special provisions are made for the replacement of equipment such as accumulators, pressurizer discharge tanks, etc. Replacement of these large components is achieved by dismantling and re-assembling the equipment at the site.

Unless otherwise indicated in the specific rules for locating a component, a minimum clearance of 0.60 m is specified around all components that may be subject to in-service inspection or maintenance.

3.1.1.2.3. Circulation zones

As a general rule, a minimum free passage of 1.10 x 2.20 m is specified except in tunnels, where the minimum passage width is 0.90 m.

3.1.2. Criteria for location and installation relating to internal hazards

The design requirement is that internal hazards (see Chapter C.4) must not propagate from one safety train to another or from the spent fuel storage pool to a safety train. Geographical and/or physical separation criteria are applied to prevent propagation of hazards.

For example, the spread of internal fire or flood is prevented by construction provisions such as separation walls, fire barriers and sealing devices applied to openings between rooms.

Design provisions prevent the propagation of hazards from the conventional island to the nuclear island (particularly missile propagation).

3.1.3. Criteria for location and installation relating to external hazards

The requirements, design bases and safety analysis associated with external hazards are described in Chapter C.3. They are summarised as follows in relation to the design of buildings:

- Earthquake and explosion:
  - o Protection against earthquakes and external explosions is provided for the reactor building, safeguard buildings 1 to 4, the nuclear auxiliary buildings, the pumping station, the fuel building and the effluent treatment building.
  - o The turbine hall and the conventional electrical building are not protected against earthquakes as their design ensures that these buildings cannot threaten the nuclear island in the case of earthquake.
- Aircraft crash:
  - o Protection against aircraft crash is provided as follows:
    - ❖ total protection is provided for buildings that could contain nuclear fuel. These buildings are protected by an "aircraft shell”. This applies to the reactor building and the fuel building,
    - ❖ protection is provided for buildings containing essential safety equipment, either by protecting them with an aircraft shell, or by ensuring sufficient geographical separation between redundant systems.

The design of the aircraft shell covers all of aircraft types.

- Flooding
  - o in certain accident scenarios, high-capacity tanks could overflow. External flooding is avoided either by appropriate location of the tanks or by installation of retention barriers,
  - o the level of the foundation platform is designed to be higher than the highest flood level anticipated for the site.

3.1.4. Criteria for location and installation relating to radiological protection

The objective of radiological protection requirements is to minimise the exposure of personnel during in-service inspection and maintenance operations. Chapter L.4 describes the EPR design features developed to achieve this objective. The objective gives rise to the following criteria which affect the internal layout of the buildings:

- Equipment is positioned according to the need for it to be accessible and to the radiation levels in separate compartments (reservoirs/heat exchangers – pumps – valves),

- The routing of personnel is done from zones with lower radiation to zones with a higher level of radiation.

3.1.5. Location and installation criteria related to primary circuits and spent fuel storage pool

The location and design of the circuits is determined the following criteria:

- Requirement to minimise lengths of connecting pipework,
- Ciruit pressurisation requirements (e.g. NPSH),
- Requirement to minimise operator dose.

The location of the spent fuel pool is a determining factor in the design of the reactor building and the fuel building.

The location must be chosen to:

- enable the loading of fuel containers,
- enable the inspection and repair of spent fuel assemblies,
- enable the storage of spent fuel outside the reactor building.

3.2. CHARACTERISTICS OF BUILDINGS

3.2.1. List of standard and site structures

3.2.1.1. List of standard structures

The list of standard structures is as follows:

- The reactor building,
- The safeguard building and the electrical building,
- The fuel building,
- The nuclear auxiliaries building,
- The access tower,
- The diesel buildings,
- The effluent-treatment building,
- The turbine hall which contains the turbine generator, the condenser and the feedwater plant,
- The unclassified electrical building.

These structures are part of the nuclear island, apart from the last two above-mentioned structures, which are part of the conventional island.

3.2.1.2. List of the site structures

The list of site structures is as follows:

- The pumping station with the pre-discharge and discharge ponds,
- The power-transmission and auxiliaries supply platform,
- The operational service centre,
- The gas storage facility,
- The building for collecting and processing the site's water,
- The desalination unit,
- The demineralised water tank,
- The effluent storage reservoirs,
- The tunnels,
- The storage centre for weakly-active waste (TFA).

3.2.2. Standard buildings within the Nuclear Island

Access by personnel to the radiologically-controlled areas in the nuclear island buildings is via an access tunnel, from the operational service centre or, or via the access tower for control room staff.

3.2.2.1.1. Reactor building

The containment consists of a cylindrical internal pre-stressed concrete wall and an exterior wall constructed from reinforced concrete, separated by an inter-space called the "inter-containment annulus". The internal surface of the interior containment is covered by a metallic leaktight skin.

3.2.2.1.2. Provisions for mitigating the consequences of severe accidents

The lower part of the reactor building includes a corium recovery area incorporating an integral cooling mechanism whose purpose is to prevent the degradation of the reactor building's foundation raft in a severe (core melt) accident. This "corium spreading zone", which has a surface area of 170 m^2, is positioned beside the bottom of the vessel cavity (pit). The corium recovery area is described in more detail below in Section 4.5.4. of Chapter B.2.

3.2.2.1.3. Installation of the primary system

The EPR primary circuit is characterized by the following features:

- the hot leg and the cold leg nozzles on the reactor vessel are positioned symmetrically,

- The pressurizer is installed in a dedicated area,

- Vertical supports are provided for the primary pumps and steam generators,

- Concrete walls are positioned between the primary system loops and between the hot and cold legs of each loop to protect against common mode failure mechanisms,

- A concrete wall (secondary protection wall) is constructed around the primary circuit to protect the containment from missiles from the disruption of pipework and to reduce radiation from the primary loops towards the inter-containment annular area.

3.2.2.1.4. Pool-water storage reservoir (IRWST)

The pool-water storage reservoir, which also serves as a reserve water supply in an accident, is situated at the back of the building, between the vessel pit and the wall enclosing the lower level internal structures. The area between this reservoir and the containment wall is largely filled with concrete in order to avoid deadspaces.

The main data taken into account in locating the IRWST are as follows:

- Required volume of water in normal operation: 1,940 m^3,

- Required water capacity during unit shutdown: 2,080 m^3.

3.2.2.1.5. Area for the chemical and volume control system (RCV)[CVCS]

This RCV [CVCS] area is adjacent to the fuel building, above the corium-spreading area and underneath the compartments of the reactor pool. The RCV [CVCS] area extends from the reactor cavity to the wall surrounding the internal structures.

3.2.2.1.6. Steam-generator blowdown system (APG)[SGBS]

The blowdown spalling tank and the regenerative heat exchanger are located adjacent to two of the divisions of the safeguard building.

3.2.2.1.7. Main steam lines and main feedwater lines

The main steam lines (VVP) [MSS] and main feedwater lines (ARE) [MFWS] emerge from the roof above two of the divisions of the electrical buildings and run along the gable walls of the other two divisions.

3.2.2.1.8. The inter-containment annulus

The annulus is essentially a circulation area for personnel. It enables access to the various equipment rooms in the reactor building. It is also used to distribute pipework and cable runs from the periphery to the interior of the reactor building.

3.2.2.1.9. Access during reactor operation

The radiological impact on staff during reactor operation is limited by a dividing the inner containment into two areas (“two-zone concept”):

- a service area which is accessible when the unit is operational,
- an equipment area, which is inaccessible, or to which access is restricted, while the reactor is operating.

3.2.2.1.10. Access to the reactor building

The reactor building has air locks for the personnel access at different levels in the reactor building.

An equipment access hatch (TAM), which is located on the operating floor, is open during unit shutdowns and may be used as an access route for personnel during these periods.

3.2.2.1.11. Access to the containment inter-space

It is possible to access to the inter-space between the containment walls from the peripheral buildings. Access points are located in such a way as to facilitate access to equipment (cross-members, cable runs, etc.) and to meet fire protection requirements.

3.2.2.2. The safeguard auxiliary buildings

These buildings house classified safety systems. The safety systems are generally designed with quadruple redundancy, each train being located in a physically separate division of the building.

3.2.2.2.1. Mechanical area

Each division of the building contains a mechanical section dedicated to the safeguard systems (e.g. IRWST, ASG [EFWS] and their support systems). Divisions 1 and 4 of the safeguards building house the containment ultimate cooling system (EVU) [CHRS]. The third PTR [FPCS/FPPS] train is located in one of the four divisions.

3.2.2.2.2. Electrical area, Control and Heating, Ventilation and Air Conditioning

The electrical safety systems, control and instrumentation systems (CC) [CI], the control room, and the systems for heating, ventilation and air conditioning of the divisions are located in the uncontrolled area (ZNC).

The control room and some of the operations/technical rooms are located above and below the ventilation plants. The main control room is installed in one of the four divisions.

The remote shutdown station (SDR) [RSS] is located in different division and on a different level from the main control room.

The heating, ventilation and air conditioning systems for the main control room and adjoining rooms are shared between two electrical buildings.

3.2.2.2.3. VVP[MSS] and ARE[MFW] bunkers

These bunkers are constructed from thick reinforced concrete walls, to protect the VVP[MSS] and ARE[MFW] lines against external hazards.

3.2.2.2.4. Access to electrical and safeguard buildings

Separate access for personnel is provided to the two different radiological zones:

- a radiologically controlled area,
- a radiologically uncontrolled area.

Access to the radiologically controlled zone of the safeguard building is made through a separate, safe passageway. Upper levels are accessed by a safe staircase.

The main access to the radiologically uncontrolled area of the electrical buildings, is made from the access tower and from the main control room. For each building division, the safe passageway is linked to all the radiologically uncontrolled areas by staircases and lifts.

3.2.2.3. The fuel building

The fuel building is located on the same foundation raft as the reactor building and the electrical and safeguard buildings.

Protection against aircraft crash is provided by the aircraft shell. The building's internal structures are physically separated from the external protection wall to protect them from vibrations and displacements produced by the impact.

The fuel building houses:

- The two main pool-water cooling system trains (PTR)[FPCS],
- The emergency boration control system (RBS)[EBS],
- The chemical and volume control system (RCV)[CVCS].

The redundant trains of these systems are physically separated by a wall which divides the building into two sections.

The fuel building houses:

- the spent fuel pool,
- the loading pit for casks,
- the transfer station,
- the storage and inspection compartments of new fuel assemblies,
- the filtering units for filtration of air escaping in an accident,
- the ventilation systems for the inter-containment annulus,
- part of the ventilation system which is used to purge the containment;
- the RCV[CVCS] volume control reservoir and the boric acid storage reservoirs.

The roof of the fuel building supports the evacuation stack for discharge of gaseous effluent from the nuclear auxiliary building.

Access to the various levels of the fuel building is made by one or other of the two secure stairwells.

3.2.2.4. The nuclear auxiliaries building

The nuclear auxiliaries building houses the nuclear operation systems and the maintenance areas.

The main systems installed in the nuclear auxiliaries building are the following:

- The treatment system for primary effluents (TEP / coolant and demineralised water storage, coolant treatment and purification plant),
- The pool-water treatment system (PTR) [FPPS],
- The gaseous effluent treatment system (TEG),
- Part of the steam-generator blowdown treatment and cooling system (APG) [SGBS]
- The operational ventilation and chilled water systems of the nuclear auxiliaries building.

A section of the building is designed as a radiological uncontrolled area, and part of the chilled-water system is within this area. The special systems sampling laboratories are on the building's lowest level.

All air discharged by ventilating radiologically-controlled areas in the nuclear island buildings is channelled to the nuclear auxiliaries building where it is collected and checked before being discharged to atmosphere via the stack.

3.2.2.5. The access tower

The main function of the access tower is to control access to the nuclear island, specifically:

- Access to the controlled area via the service duct,
- Access to the uncontrolled areas from a higher level.

The building contains the following rooms:

- the room for maintaining and decontaminating minor equipment,
- operational rooms,
- technical rooms.

3.2.2.6. The diesel buildings

The two diesel buildings are geographically separated in order to meet the requirements for protection against aircraft crash. Their positions are determined by maintenance imperatives and to enable the easy movement of diesel motors in and out of the building.

Each diesel building houses two main diesel generator sets each of which supplies a safety train within a division of the safeguard building, as well as an emergency back-up unit. The two redundant generators and the emergency generator with their auxiliaries are protected against internal hazards by a separating wall.

Both diesel buildings are designed to withstand earthquake and explosions.

3.2.2.7. The effluent-treatment building (BTE)

This structure is divided into 2 sections, one for the storage of solid waste (HQA), the other for liquid effluent treatment (HQB).

The design plan of the effluent treatment building has been determined so as to take up as little room as possible.

3.2.2.7.1. Storage section (HQA)

The Storage Section is made up of:

- a heavy-duty section acting as a reception room mobile equipment for resin treatment. It includes a level used for the control and maintenance of the overhead crane and the baler used for packaging low-activity waste,

- A light-duty section consisting of the room for storing drums and containers of TES with access to road convoys, rooms for controlling drums before disposal and rooms for the storage of APG resins.

3.2.2.7.2. Effluent treatment section (HQB)

The Effluent Treatment section consists of a heavy-duty area that houses mainly the TEU facility (for head storage, processing) and the TES facility (for resin storage, concentrates, bay for encapsulating filters). The heavy-duty area also houses a plant for producing concrete and storing aggregates and the rooms containing the component cooling system of the BTE (TRI), .electrical rooms and the BTE control room.

3.2.3. Structures in the conventional block

3.2.3.1. The turbine hall

The location of the turbine hall in relation to the nuclear island is set by requirements for routing VVP [MSS] pipework and inter-unit tunnels and the need to leave sufficient space for the air intakes of the nuclear island.

The turbine hall houses the turbine-generator set (GTA set), the moisture separator/reheaters (GSS), the condenser and the feedwater plant, and the associated support systems.

The building has two sections:

- a lower section containing the GTA installations in the central area, with other equipment and pipeline systems on various intermediate floors on the periphery,

- an upper section above the turbine floor, containing the heavy handling equipment necessary for the assembly and maintenance of equipment.

The turbine hall is designed so as not to present any threat to buildings in the nuclear island.

The turbine hall floor is organized to enable storage of main turbine components during maintenance outages, and to allow access to equipment at lower levels through openings. A main 350/70 tonne gantry and an auxiliary 20 tonnes gantry enable handling of turbine components during assembly and maintenance.

3.2.3.2. Electrical building within the Conventional Island

The conventional island's electrical building houses the normal and secured electrical distribution panels, which supply the Conventional Island systems, together with the instrumentation and control system which manages and monitors these systems.

The 10kV electrical supply comes from stepdown transformers and from the auxiliary transformer. The connecting cables run in separate tunnels.

The conventional island's electrical building delivers the permanent 10kV supply to each of the nuclear island's 4 electrical buildings.

The Conventional Island's electrical building has two fire areas to minimize the risks of loss of power from external sources.

The premises are equipped with mechanical ventilation or are air-conditioned in accordance with technical requirements.

3.2.4. Other site structures

Some buildings are neither part of the conventional island nor the nuclear island, irrespective of whether or not their function is technical.

3.2.4.1. Structures along the channel

3.2.4.1.1. The pumping station

The pumping station which is situated near the intake channel, contains equipment supplying cooling water for:

- the nuclear and conventional islands' auxiliaries,
- the secondary (condenser) cooling system.

It is a solid structure designed to resist earthquakes.

The Pumping Station has four separate drainage channels:

- two central channels each including four waterways (narrow passages), fitted with filter drums, which mainly supply the essential service-water systems (SEC) [ESWS] and provide the condenser cooling water (CRF).
- two lateral channels each including a single waterway, fitted with a chain filter, which mainly supply the essential service-water systems (SEC) [ESWS] and the conventional auxiliaries systems (SEN).

Each waterway has a fixed grid with a trash rake which performs a preliminary filtering function. Sluice gates may be used to isolate the extracted water.

The rotational drive system of the drum and chain filters enables marine debris and organisms trapped on the filter panels to be separated and discharged. The drive speed is increased if the pressure loss in the filter increases. Filtering capacity is maintained by a washing system which removes debris accumulated on the filter panels.

A pontoon with anti-hydrocarbon booms is installed in front of the pumping station.

The four SEC [ESWS] lines are independent and geographically separate.

The supply of seawater to the SEC [ESWS] pumps and the final cooling circuit (SRU) is designed so that if a drum or chain filter stops working, the pumps continue to be supplied.

The water-intake and raw water filtering systems are described in Part I of Vol. 2.

3.2.4.1.2. Discharge structure

The discharge plant is positioned alongside the intake channel, next to the pumping station. It consists of a pre-discharge section and a discharge pond.

The pre-discharge section runs between the pumping station and the discharge pond, alongside the intake channel and is designed to receive marine debris discharged from the pumping station. A skip with a perforated base is used to collect the marine debris, which is then removed by lorry. The water is returned to the discharge pond using an Archimedean screw, then discharged to sea.

The discharge pond is within a pit constructed from concrete, which is connected to a submarine tunnel which discharges to the sea.

The pond is divided into two sections:

- one section receives discharge from the SEC and SRU pumps and contains a weir,
- the second section receives downcomer water from the CRF and SEN pumps.

3.2.4.2. The power-transmission platform

The power transmission platform adjoins the turbine hall, and is near the electrical building within the conventional island. It houses the main transformer (TP) and the two step-down transformers (TS).

Another platform, adjoining the HT platform, houses the auxiliary transformer (TA), which is always live during reactor operation.

The configuration makes it possible to provide physical separation of the TS and the TA power supply sources for the EPR unit. The distribution of electrical energy from the TA is also split into two systems, for compatibility with the design of the conventional island’s electrical system.

3.2.4.3. The operational service centre (POE)

This building provides various operational functions for the EPR unit. Specifically, it contains the following:

- rooms for access to the controlled area (changing rooms),
- workshops and storerooms,
- offices (for administration and technical services),
- laboratories,
- a computer room,

- the plant documentation centre.

The POE is not safety-classified. It contains neither safety-classified installations, nor safety-classified equipment. It is nevertheless designed so as not to cause hazards to the nearby diesel building in the event of an earthquake.

3.2.4.4. Gas storage platform

The gas storage platform is an independent platform which is used to store and supply the gases required to operate the unit. The installation complies with current security regulations.

3.2.4.5. Building for collecting and processing the site’s water (HX).

The HX building includes a containment tank, a settler and an oil separator.

French environmental regulations require that polluted effluent is not discharged into the environment, including following fires or accidental spillage on to roads. The containment tank ensures the buffer retention of effluents in the event of such incidents to allow time for analyzing effluent to define the suitable treatment before discharge. It is connected to the effluent water discharge system (SEO).

The purpose of the settler-oil separator is to separate and isolate water oil-contaminated water collected by the SEH network following an incident such as an explosion of a main transformer, or a spillage, with the aim of only discharging purified water into the SEO network.

3.2.4.6. Demineralised feedwater plant

A demineralised feedwater plant, will produce demineralised water requirement for the unit.

The various distribution systems and equipment are described in Part I.

3.2.4.7. The tunnels

The buildings on the site are linked by various tunnels.

Access to the tunnels is defined on a case-by-case basis and is arranged so as to avoid connections between zones of different types (hot/cold, controlled/uncontrolled).

4. DESCRIPTION OF MAIN SYSTEMS

4.1. DESCRIPTION OF NUCLEAR STEAM SUPPLY SYSTEM (NSSS)

The nuclear steam-supply system is a pressurized-water reactor with a thermal power rating of 4,500 MW, designed for a 60-year lifetime.

The plant can operate at base load, or is able to load-follow within the range 25 -100 % of nominal full power. It is designed to change load at most twice per day.

The nuclear steam-supply system is composed of:

- a core, which contains 241 fuel assemblies. Fuel assembly is in a 17 x 17 square array comprising 265 fuel rods. The fuel is in the form of UO_2 pellets. It is also possible to use MOX (Mixed Oxide) pellets. The pellets are enclosed in a zirconium alloy tube to form fuel rods.

- 4 cooling circuits, containing water at a pressure of 155 bar abs. Each circuit comprises a primary pump, a steam generator and the connecting pipework. The steam is produced in the secondary side of the steam generators, at a pressure of around 78 bar abs at full power;

- a pressurizer whose function is to maintain the water in the primary circuit at a steady pressure.

- instrumentation enabling control of the various operational parameters of the nuclear steam supply system and the automatic activation of measures which prevent normal operating limits being exceeded.

- 89 control rod cluster assemblies. The control rod cluster assemblies, together with diluted boron in the water of the main cooling circuit, are used to control the core reactivity.

- several auxiliary systems required for the controlling the reactor and maintaining it in a safe state.

4.2. DESCRIPTION OF MAIN AUXILIARY SYSTEMS

4.2.1. Safety injection system / reactor residual heat removal system (IRWST/RRA) [SIS/RHRS]

The IRWST/RRA system is a combined system providing safety injection and removal of residual heat from the reactor.

A detailed description of the IRWST system is given in Chapter F.3.

The IRWST/RRA [SIS/RHRS] system consists of 4 separate, independent trains, each of these trains being able to inject borated water into the primary circuit by means of an accumulator, a medium-pressure safety injection pump (ISMP) [MHSI] and a low-pressure safety injection pump (ISBP) [LHSI] with a heat exchanger at its outlet. The system also provides controlled heat extraction from the primary circuit, chiefly the residual power in the core, through the ISBP [LHSI] pump and heat exchanger and the heat exchanger's bypass line.

The accumulators inject into the cold leg of the primary loops. The ISMP [MHSI] and ISBP [LHSI] pumps discharge into the IRWST and also into the cold legs of the RCP [RCS], via shared injection nozzles (the ISBP [LHSI] lines can be manually configured to inject simultaneously into hot and cold legs). The suction of the ISBP [LHSI] lines can also be taken from the hot legs in residual heat removal mode (suction and discharge from the same loop). The ISMP [MHSI] and the ISBP [LHSI] pumps are cooled by the reactor's intermediate cooling system (RRI) [CCWS]. Diverse air cooling of the BP [LP] pumps is available in two of the safety trains should the RRI [CCWS] fail.

The accumulators are located within the reactor's containment. The ISMP [MHSI] and ISBP [LHSI] pumps are sited in the controlled area of the safeguard buildings. The ISBP [LHSI] heat exchangers are also installed in the safeguard buildings. The electrical power supply is provided by independent electrical trains, backed up by the main diesel generators.

4.2.2. Primary coolant reserve water in the containment (IRWST pool - IRWST)

A detailed description of the IRWST system is given in Chapter F.3.

The IRWST pool is a reservoir containing a large quantity of borated water. It serves to collect water which is discharged into the reactor containment in the event of an accident. The IRWST pool also acts as a water reserve for the IRWST system, the EVU [CHRS] containment heat removal system, and possibly the RCV (CVCS) (reactor chemical and volume control system). It also ensures that the area of the containment floor provided for corium spreading and cooling, is flooded in the event of a severe accident.

Filters and anti-clogging devices protect the IRWST and EVU [CHRS] pumps from transport of debris during postulated accident conditions.

4.2.3. Extra boration system (RBS)[EBS]

A detailed description of the RBS [EBS] system is given in Chapter F.7.

The RBS [EBS] system which consists two separate, independent trains, is able to inject borated water into the primary circuit at high pressure. Each of the RBS trains consists of a borated water tank, a positive displacement pump and two lines of injection into cold legs, via the safety injection penetrations.

The RBS [EBS] pumps and tanks are in located the fuel building.

The electrical power supply is provided by independent trains, backed up by the main diesel generators. Each pump may be supplied by two electrical power trains.

4.2.4. Steam generator emergency feed system (ASG) [EFWS]

A detailed description of the ASG [EFWS] system is given in Chapter F.6.

The ASG [EFWS] system consists of 4 independent trains, each supplying feedwater to a steam generator from an ASG [EFWS] tank by means of a pump. The ASG [EFWS] tanks contain demineralised water. The headers installed between the four tanks, normally shut, enable reserve water from any ASG [EFWS] tank to be supplied to any of the four trains. Headers installed between the injection lines, normally shut, enable the feed to be supplied to all the steam generators in the event of a failure of an ASG [EFWS] pump.

The electrical power supply to the ASG [EFWS] pumps is provided by independent trains, backed up by the main diesel generators. Also, in order to recover from situations of a total loss of electrical power supply, two of the four electrical trains are also backed up by two final emergency diesel generator sets, which are started manually and are of a diverse design from the four emergency diesel generator sets.

4.2.5. Component cooling system (RRI) [CCWS]

A detailed description of the RRI [CCW] system is given in Chapter I.2.

The RRI [CCW] system consists of 4 separate, independent trains, each train providing cooling to the heat exchangers of the 4 RIS/RRA [SIS/RHRS] trains via a closed cooling loop consisting of a pump and a heat exchanger (at the outlet of the pump). The RRI [CCW] system is cooled by the SEC [ESW] system (emergency service water).

The RRI loops which cool the RIS/RRA [SIS/RHRS] are independent. Two separate independent RRI loops, called common 1 and common 2 provide cooling to other consumer circuits such as PTR [FPCS/FPPS] (treatment and cooling of pool-water) and RCV [CVCS] (chemical and volume control for the reactor). Common 1 is cooled by RRI train 1 or 2; common 2 is cooled by RRI train 3 or 4. The independence of the RRI [CCWS] trains is ensured by the shutoff valves: the configuration of the valves enables the common loops to be normally connected with one of the two trains and shut off from the other.

The RRI [CCWS] pumps and heat exchangers are sited in the safeguard buildings, outside the controlled area. The RRI [CCWS] pumps are themselves cooled by water from the RRI [CCWS].

The electrical power supply to the RRI [CCW] system is provided by independent trains, backed up by the main diesel generators.

4.2.6. Essential service-water system (SEC) [ESWS]

A detailed description of the SEC [ESWS] system is given in Chapter I.2 of Vol. 2.

The SEC [ESWS] system is composed of 4 separate, independent trains, each performing the role of extracting heat from the RRI exchangers by means of a pump.

The SEC [ESWS] pumps are installed in the pumping station. The electrical power supply is provided by independent electrical trains, backed up by the main diesel generators.

4.2.7. Spent fuel pool-water treatment and cooling system (PTR)

A detailed description of the PTR system is given in Vol. 2 Chapter I.1.

The PTR system is divided into two sub-systems: the cooling system for pool water and the pool-water treatment system.

This pool water cooling system consists of two main trains which are independent of one another, which extract heat from the spent-fuel pool. Each train contains two pumps and a heat exchanger.

The pool-water cooling system also has a third train that provides backup in the event of loss of the two main trains. This third train is comprised of a pump and a heat exchanger.

The pool water cooling system extracts water from and returns water to the spent-fuel-pool.

The main pumps and exchangers of the PTR are located in the fuel building (the heat exchanger is cooled by the RRI [CWCS] system). Each main train is assigned to a shared RRI, and so can be cooled by two RRI [CWCS] trains.

The heat exchanger associated with the third train is cooled by a component cooling loop within the EVU [CHRS] system, connected to the emergency cooling water (SRU).

The electrical power supply is provided by independent trains. Each pump may be supplied by two electrical power trains. The main trains are backed up by the main diesel generators. When the unit is in shutdown states D and F the third train is also backed up by the emergency plant cooldown diesel generator sets.

Pool-water treatment system comprises one purification circuit for the spent-fuel pool (BK pool), one purification circuit for the reactor building pool (BR pool) and the IRWST pool, and skimming circuits for the spent-fuel and reactor building pools (one skimming circuit per pool). The system comprises two cartridge filters, a demineralizer and a filter (for trapping resins) used to purify the pool water. There is an additional cartridge filter in the skimming circuit for the spent-fuel pool.

The transfer of water between the IRWST system, the reactor building pool and the compartments for BK transfer and the loading of lead-lined casks, is carried out by the PTR system.

4.2.8. Chemical and volume control system (RCV) [CVCS]

A detailed description of the RCV [CVCS] system is given in Chapter I.3.

The RCV [CVCS] system provides chemical control (e.g. boration) and volume control (e.g. make-up) for the primary system, carrying out the following functions: letdown, containment of leaks from GMPP [RCP] seals, make-up, and GMPP [RCP] seal injection.

The RCV [CVCS] extracts water from the primary circuit which it then passes through a regenerative heat exchanger into two parallel trains, each of which contains a high-pressure heat exchanger and a high-pressure throttling device.

The GMPP [RCP] seal leakage containment system consists of a header which collects leakages from the seals of all four pumps, connected to the RCV [CVCS] tank.

The RCV [CVCS] make-up system comprises two charging pumps which draw from RCV [CVCS] tank or IRWST system, and inject into two hot legs and into the pressurizer (auxiliary spraying function).

Injection at the GMPP [RCP] seals is done through a header feeding the seals of the four pumps. The injected water is taken from the RCV [CVCS] injection line and passed through one of two filters arranged in parallel (both filters are not used simultaneously).

The chemical and volume control system consists of an RCV [CVCS] tank, connections to the primary coolant purification system, the coolant degassing system, the primary fluid storage and treatment system (TEP) and the water and boron make-up system (REA).

The regenerative heat exchanger is cooled by the makeup supply and heated by the let-down supply and is located in the reactor building. The high-pressure heat exchangers are also located in the reactor building and are associated with different shared RRI [CWCS] circuits. Consequently two RRI [CWCS] trains are available for cooling each heat exchanger. The RCV [CVCS] charging pumps are located in the fuel building and are cooled by RRI [CWCS]. The RCV [CVCS] tank is also located in the fuel building.

The system’s electrical power is supplied by two different electrical trains. Most of the RCV [CVCS] actuators are backed up by the main diesel generators.

4.2.9. Steam and energy conversion systems

A detailed description of the steam and energy conversion system is given in Vol 2 Part J.

Turbine generator set

The purpose of the turbine generator set (GTA) is to convert the energy from the steam received from the steam generators into electrical energy. It is not a safety system. However, it is designed to trip automatically if certain reactor protection systems are actuated.

Main Steam System (VVP) / System for atmospheric dump (VDA).

The function of the VVP / VDA systems is:

- to provide the main steam to the turbine and the other devices that use the main steam supply in the turbine hall during normal operation,
- to remove decay heat by discharging steam to condenser (if it is available) or to the atmosphere (if not) in a normal reactor shutdown or in incident or accident situations.
- to ensure that the steam generators are protected against over-pressurisation by venting steam in incident or accident situations,
- to cool the primary circuit until it reaches the injection pressure for the medium-pressure IRWST system in a small APRP breach [SBLOCA] or RTGV [SGTR] by discharging steam into the atmosphere or into the condenser (if it is available),
- to isolate the secondary side of the steam generators in the event of accidents resulting in an excessive steam demand,
- to contain the activity releases if there is an RTGV [SGTR], by shutting off steam lines.

The VVP [MSSS] has four identical classified trains (one per GV [SGU]). Each train is composed of:

- a main steam shutoff valve,
- a train for discharge into the atmosphere, comprising one pressure-relief valve and one shutoff valve (VDA system),
- two safety valves,
- pipework between the GV [SG] flow limiter and the outlet of the main steam-valve cubicles,
- safety classified valves and pipework for the conditioning line,
- safety classified valves for the system for recovering condensed steam.

Main condenser

The main condenser receives the steam exhausted from the low pressure turbine and cools it using the unit's cooling system. It also provides the heat sink for the primary system during reactor shutdown and start-up.

The condenser is also used to remove live steam in the case of certain transients such as a house load operation (loss of off-site power) or following a turbine trip.

Turbine to condenser bypass system

This system is not designed primarily as a safety system. Its main purposes are to :

- avoid loading the atmospheric venting system (VDA) and the pressurizer relief valves during transients like house load operation (loss of off-site power), turbine trips or automatic reactor shutdown,
- avoid the opening of the VVP relief valves [MSRVs] and avoid excessive heating of the primary system after automatic reactor shutdown,
- extract the primary system's stored energy and residual heat in a controlled manner during cooling phases of the primary system until the conditions are obtained for connection of the RRA [RHRS],
- Facilitate the control of secondary pressure during turbine start-up and in particular during grid synchronisation.

4.3. DESCRIPTION OF THE TURBINE GENERATOR UNIT AND THE FEEDWATER PLANT

Detailed descriptions of the turbine-generator unit and the feedwater plant are given in Part J.

The secondary system is designed for a boiler thermal load of 4,524 MW (including the heat load due to the primary pumps).

The secondary system comprises:

- the secondary side of the steam generators, where secondary cooling water is converted to steam,
- the turbine generator unit, consisting of a turbine and a three-phase AC generator. The purpose of the turbine generator unit is to convert the thermal energy in the steam emanating from the steam generators into electrical energy. The turbine converts the energy in the steam into mechanical energy. It has two shafts with one high-pressure turbine cylinder (HP) and three low-pressure turbine cylinders (BP), and two vertical moisture separators / reheaters to separate out moisture when the steam expands. Residual energy is transferred to the heat sink via the condenser. The turbine's nominal rotation speed is 1500 rpm. The AC generator is cooled by hydrogen and pressurized water.
- a condensate plant comprising:
    - a set of condensate extraction pumps,
    - a set of low- and high-pressure feed heaters,
    - a deaerator tank, which is also used for degassing and heating the water from the low-pressure feed heaters,
    - four motorized feed pumps, each designed to supply 33% of the required nominal feedwater flow (APA),
    - a normal feedwater supply system for the steam generators (ARE) [MFWS] including a low-flow line and a high-flow line for each of the GVs [SGUs],
    - a specific pump (AAD) for supplying feedwater to the steam generators during the unit start-up and shutdown phases (powers < 4% Pn).

4.4. DESCRIPTION OF POWER SUPPLY SUBSTATION

A detailed description of the power supply substation is given in Chapter H.

The purpose of the power supply substation is to supply electrical power required by all the auxiliary systems in the unit's various operational phases. It is comprise of two sections:

- External power supply sources:
    - The main supply source (400 kV), used to export the electrical power produced by the unit, and to provide electrical power to the unit in start-up, normal shutdowns and as a back-up during accident conditions,
    - The auxiliary supply source, used to supply the unit in the event of simultaneous loss of the main supply source and the main generator.
- Internal supply sources: four main 10kV diesel generators and two 690 V diesel generators for emergency plant cooldown.

The unit is connected to the main network by a line breaker. When the power station is linked to the grid, the energy supply is connected via the main transformer (20kV/400kV), the main generator breaker and the line breaker.

The electrical supply for the unit's auxiliary devices is connected via two step-down transformers with three sets of windings (400 kV / 2 x 10 kV each). The power is derived from the grid network or from the AC generator under normal operating conditions. Each secondary winding on the step-down transformers supplies a different 10kV switchboard. These 4 x 10 kV switchboards form the heads of the 4 electrical trains.

The electrical supply for the unit's auxiliary devices can also be obtained via an auxiliary transformer.

When it is necessary to use the auxiliary network, there is a switchover between the step-down transformers and the auxiliary transformer.

4.5. DESCRIPTION OF SYSTEMS FOR MITIGATION OF SERIOUS ACCIDENTS

4.5.1. Ventilation system for the inter-space between the containment walls (EDE)

A detailed description of the EDE system is given in Chapter F.2.

The functions of the containment inter-space ventilation system are:

- to maintain a negative (sub-atmospheric) pressure the inter-space between the containment walls in accident situations, in order to collect leakages across the interior wall, including those from the system for collecting leakages of radioactive fluids from inside the pipelines in the case of certain penetrations,

- to discharge air from the inter-space to the stack after passing through high-efficiency particle and iodine filters ,

- to delay the release of radioactive substances in order to take maximum advantage from the decay of fission products.

The ventilation system for the containment inter-space comprises:

- two 100% safety trains, physically separated, equipped with very high efficiency particle and iodine filters,

- one 100% train used in normal operation, without an iodine filter but with high-efficiency particle filters. In the event of a serious accident, this train is isolated by motorized dampers and ventilation is provided by the EDE safety trains.

4.5.2. Ultimate containment heat removal system (EVU) [CHRS]

A detailed description of the EVU [CHRS] system is given in Chapter F.2.

The EVU [CHRS] system is a last-resort system designed to limit the pressure in the containment and to ensure heat extraction from the containment and the IRWST system on failure of safeguard systems leading to a core meltdown accident (RRC-B), or in the event of a loss of coolant accident (APRP) [LOCA] with the loss of the low pressure injection pumps (ISBP) [LHSI].

The system consists of two physically separate trains (2 x 50% trains for short term use/ 2 x 100 % trains for long term use).

In a severe accident, the EVU [CHRS] is only required to operate at 100% capacity during the short-term phase (which can last up to 15 days with a MOX core) in order to reducing the pressure within the containment. In the long-term accident phase, a single EVU [CHRS] train is sufficient to extract the residual heat and maintain the containment pressure close to atmospheric pressure.

Each containment EVU [CHRS] train consists of:

- a dedicated suction line from the IRWST system,
- a pump and a heat exchanger
- a dome spraying system discharging to a circular manifold equipped with spray nozzles whose purpose is to reduce the pressure and the temperature inside the containment,
- a cooling system for the foundation raft consisting of :
    - a passive quenching mechanism, located in separate compartments between the corium spreading area and the IRWST system, which ensures passive quenching of the spreading area by the IRWST system on the arrival of the hot corium.
    - a recirculation line enabling the direction of the EVU [CHRS] flow towards the IRWST system, and towards the cooling line of the spreading area and the corium area when the passive quenching mechanism is open,
    - a cooling function to extract the residual heat from the containment via the EVU [CHRS] heat exchangers. This function is provided by two component cooling loops each dedicated to an EVU [CHRS] train between the intermediate heat exchanger and the EVU [CHRS] heat exchanger, each of which contains a pump and an expansion tank. These intermediate cooling systems are cooled by the SRU system (last-resort heat sink).

The EVU [CHRS] trains and their dedicated cooling systems receive their electrical power from independent electrical trains backed up by the emergency plant cooldown diesel generator sets.

4.5.3. Hydrogen control system

The hydrogen control system is based on the use of passive catalytic recombiner units distributed in the reactor building. Their operation promotes overall convection within the containment.

The passive catalytic recombiner units operate spontaneously when the hydrogen concentration on the catalytic surfaces exceeds a minimum threshold level.

Shutters and rupture disks are provided to automatically connect the service compartment with the equipment compartment if the pressure increases in the equipment compartment, in order to reduce the hydrogen concentration in the latter.

4.5.4. Foundation raft cooling system

A detailed description of the EDE system is given in Chapter F.2. The foundation raft cooling system is dedicated to the passive quenching of the corium released in a hypothetical core melt accident. During the corium quenching phase, the water first passes through cooling channels. The cooling structure is composed of blocks of solid steel, the lower part of which form the cooling channels, which are of rectangular cross section.

Water is brought to the cooling channels by a central piping system, which connects the two symmetrical cavities enclosing the corium quenching mechanism. The channels empty into a free volume at the periphery of the piping system.

After the arrival of the corium in the spreading area and the operation of the quenching mechanism, water from the IRWST floods the central piping system under gravity. It then passes through the cooling channels and finally into the free volume.

Passive natural circulation cooling is established until there is a balance in the columns of water in the spreading area and the IRWST system. Eventually the corium quenching water begins to boil, the steam produced being released into the containment. Spray water from the EVU system is necessary to reduce the pressure in the containment to prevent containment failure.

When the EVU [CHRS] pumps are unavailable or out of service, the design allows sufficient heat to be removed by evaporation in the cooling channels for an extended period.

4.5.5. Depressurization system for serious accident situations

A detailed description is given in Vol 2 Chapter E.4.

This system includes two relief valves which enabling the primary system to be depressurized in the event of a serious accident. These valves are installed on a line connected to the pressurizer steam space by a dedicated penetration.

The two valves in series are connected between the pressurizer penetration upstream of the relief line leading to the pressurizer discharge tank. The valves are closed in normal operation.

4.6. DESCRIPTION OF THE PUMPING STATION

The pumping station consists of four separate filtration channels:

- 2 central channels, each equipped with four prefiltration waterways and a filter drum, filtering both the SEC [ESWS] and the CRF,

- 2 side channels, each equipped with a prefiltration waterway and a chain filter, filtering both the SEC [ESWS]and the SEN.

Each waterway has a fixed grid with a trash rake. Sluice gates may be used to isolate the extracted water.

A pontoon with anti-hydrocarbon booms is installed in front of the pumping station.

The filtration system (CFI) mainly supplies water to:

- the SEC [ESWS]system for cooling the RRI [CWCS],
- the CRF system for cooling the condenser,
- The SEN system for cooling the turbine hall auxiliaries,
- The SRU system for cooling the two EVU [CHRS] trains and the third PTR train. The SRU pumps may draw from two different filtration channels, and as a last resort, from the unit's discharge pool.

The water-intake and sea water filtering systems are described in Part I of Vol. 2.

4.7. DESCRIPTION OF EFFLUENT TREATMENT

Effluent that is radioactive or that could be contaminated is collected separately, depending on its state (gas, liquid or solid) and quality (reusable or spent) by different systems, and sent to processing plants for liquid, gaseous and solid effluent. Liquids are stored, if necessary, before being reused within the power station or discharged outside. Gases are discharged outside after being passed through retardant filters to allow radioactive decay. Solid waste is treated before disposal off site.

Primary reusable effluent, originating from discharged primary water associated with plant operation and emanating from the primary cooling and RCV [CVCS] systems, is collected without being contaminated with oxygen, and sent to the primary effluent treatment system (TEP), and subsequently recycled as supplementary water and boric acid for use in the primary circuit. This category also includes most of the controlled leakoffs and bleeds from equipment in the circuits carrying the primary coolant, which are collected by RPE [NVDS] and sent to the TEP system.

Waste effluent from the nuclear installations that cannot be recycled is collected by the RPE [NVDS] system and sent to the spent effluent treatment system (TEU), situated in the EPR BTE. To make it easier to process and to avoid spreading contamination, it is sorted according to its degree of chemical and radioactive pollution. To carry out the sorting, the collection of waste effluent is organized into 4 categories:

- process drainage (primary-quality aerated water that cannot be recycled),
- floor drainage (water form circuit leaks and from the floors of nuclear buildings),
- chemical effluent (chemically-polluted water containing primary coolant),
- service effluent (laundry, showers).

After processing, spent liquid effluent is sent to the existing on-site systems (the system for controlling and discharging liquid effluent (KER), the system of additional "hygiene" tanks (TER) and the system that receives, manages and discharges effluent drained from the turbine hall (SEK).

Various different systems are used to process different gaseous effluent, including the RPE (gaseous effluent for some material from the drain and vent system), the TEG (for hydrogen recombination and radioactive decay of noble gases) and some ventilation systems, including DWN, EBA, and DWL.

Processing of solid waste is split between the TES system in the unit and the part of the TES system installed in the EPR BTE, which contains storage and conditioning facilities.

The normal pattern of waste disposal is preferred but when disposal is difficult, TFA waste can be stored in the TFA area.

5. GENERAL OPERATING PRINCIPLES

5.1. POWER ADJUSTMENT

The EPR is designed to operate in load follow mode and also to participate in power adjustments to respond to grid frequency variations and secondary control (remote control), depending on the requirements of the grid network and the reactor’s adjustment capacity, as set down in the Technical Operation Specifications.

The unit is designed to move between nominal power and the technical minimum. Load follow enables foreseeable developments in energy demand to be followed. It can be activated between 25% Pn and 100% Pn. Two load follow profiles are provided:

- Light load follow, between 60% Pn and 100% Pn, at a maximum speed of 5% Pn/min[1],
- Deep load follow, between 25% Pn and 60% Pn, at a maximum speed of 2.5% Pn/min[2],

The unit can supply between the technical minimum and nominal power:

- a reserve pf +/- 2.5 % Pn to the network for primary frequency control with a maximum speed of 1 % Pn/s,
- a reserve pf +/- 4.5 % Pn to the network between the technical minimum and 60% Pn for secondary frequency control with a maximum speed of 1 % Pn/mn,
- a reserve pf +/- 10 % Pn to the network between 60% Pn and 100% Pn for secondary frequency control with a maximum speed of 2 % Pn/mn,

Higher variation speeds are acceptable during major network disturbance (e.g. 5 % Pn/min on remote control).

[1] For a burnup rate < 80% The maximum variation speed is not yet defined for a burnup rate > 80%.
[2] For a burnup rate < 80% The maximum variation speed is not yet defined for a burnup rate > 80%.

5.2. PREVENTIVE MAINTENANCE

As the EPR design has four backup trains, partial preventive maintenance can be performed with the unit at power (with one train at a time being taken out for maintenance, as described in Chapter M.2). At unit shutdown, the design allows preventive maintenance to be carried out on only one backup train at a time in state E (reactor cavity full), and on two trains at the same time in state F (reactor completely discharged).

For certain lower safety category systems and for unclassified systems, preventive maintenance is in general allowed at any time. However, some restrictions will be necessary due to constraints relating to the availability of the unit and to the requirements of Technical Operation Specifications (STE).

A probabilistic safety analysis (EPS) [PSA] has been carried out for the EPR allowing for preventive maintenance with the unit both at power and shutdown. Results have demonstrated the acceptability of the maintenance strategy and have shown that the risk of core meltdown remains within the safety targets (see Chapter M.2 and Chapter Q).

Re-qualification tests are performed at the end of every preventive maintenance activity on an item of equipment in order to verify that it has maintained its performance capacity. The re-qualification tests include intrinsic re-qualification and functional re-qualification. They are sufficient for demonstrating the availability of the equipment, and consequently they remove the need for periodic tests following a maintenance action.

The maintenance strategy implemented for the EPR complies with that already in force on operational French CNPEs, but has been integrated within the design stage. The reliability-based maintenance optimisation method (OMF) has been widely used, and implemented at the design stage on most systems at risk.

The principles of preventive maintenance are described in detail in Chapter M.