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XC

The areas shall be proposed and designed in layout plan also with regard to:

- storage will be constructed by the Owner* after the start of operation of the Plant*,
- optimal transport distance from reactor building,
- no negative impact to the Plant* operation,
- transport infrastructure (road communications, parking and parking lots, railway siding, etc.),
- appropriate foundation conditions.

XCA

For fresh fuel, it is preferred to provide additional storage capacity in the Plant* fresh fuel storage (see Section 2.8.1.2.1.5).

For that purpose, the Supplier* shall evaluate possibility to increase the storage capacity of the Plant* fresh fuel storage (e.g. by locating additional fresh fuel containers within the Plant* fresh fuel storage or by enlarging the Plant* fresh fuel storage building to avoid outside transport of the fresh fuel).

XD

When designing the Plant*, the Supplier* shall consider, to the maximum extent practicable, the integration of the future spent fuel interim storage and fresh fuel storage into the Plant*, i.e. the Plant* shall be equipped with appropriate spare capacity in the Plant* technical infrastructure, such as electrical distribution, HVAC, radiation monitoring system and other systems, as applicable.

2.11.1.1.1.Y

The design of the structures shall be optimized to realize capital cost savings without sacrificing function and operability.

2.11.1.1.1.Z

General requirements for coordinate system shall be in line with Rules* (Gov. Order No. 430/2006 Coll., as amended, etc.).

ZA

Coordinates of any element included in Documents* shall reflect physical location defined by agreed global coordinate system described in Technical Requirements Document*, Section 5.2.13.

ZB

If reasonable (in case of simplification, etc.), Supplier* can define a one local coordinate system related to Site*.

ZC

If any local coordinate is mentioned in Documents* there shall be stated it's local. In such cases the Document* shall clarify the relation between local and global coordinate system.

ZD

Plot scale used in hard copy of any Document* related to layout shall ensure good readability and acceptance for all Authorities*.

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ZE

Any Document* related to layout shall contain, inter alia, legend, descriptions, references, dimensions (including representation of axes, clarification of the relation between local and global coordination system including elevations, clarification of the view orientation by compass rose, designation and description of the main civil structures/buildings/rooms, plant orientation sketch, etc.) that ensure good understanding of the Document*.

ZF

All measurable values mentioned in Documents* related to layout shall use SI (metric) system in accordance with Terms and Conditions*, Article 4.1.13 and Rules* (Act No. 505/1990 Coll., as amended, Decree No. 264/2000 Coll., as amended, etc.) .

2.11.1.1.2 NUCLEAR ISLAND

2.11.1.1.2.A

The Supplier* shall prepare the Plant* general arrangement drawing of all Nuclear Island* buildings and facilities and their connecting underground tunnels and galleries, bridges, passageways, etc. These general arrangement drawings shall show the elevation of each building and each longitudinal and transverse section. The drawing shall include the general dimensions and shape of the rooms, the location of mechanical, electrical and I&C equipment, and any other relevant aspects such as big structures, equipment hatches, maintenance areas, etc. The general drawings shall show the layout of relevant pipes (e.g., main steam, feedwater, Safety Systems*), electrical distribution areas, HVAC areas, etc.

2.11.1.1.2.B

The detailed layout of equipment, piping, HVAC ducts, cable trays, and other works described hereinafter shall be performed in a 3D electronic data model. Construction drawings such as piping drawings shall be obtained from the 3D electronic data model.

2.11.1.1.2.C

The 3D electronic mock-up shall also be used for equipment and components maintenance analysis.

2.11.1.1.2.D

The 3D electronic mock-up with all related database information shall be supplied to the Owner* as part of the Plant* documentation.

2.11.1.1.2.E

The following buildings or facilities, including the arrangement of piping and equipment within the buildings, shall be included in the NI:

- reactor building (Primary Containment*) and Secondary Containment* structure,
- nuclear auxiliary buildings,
- fuel building (this facility may be included in the reactor building),
- associated mechanical and electrical auxiliary buildings,
- radwaste building,
- control building,
- hot shop/outage maintenance building,
- on-site standby Alternating Current (AC) power supply facility,

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- radiological access control,
- emergency shutdown facility,
- safety related storage (tanks or pools [usually included in reactor building]).

2.11.1.1.3 POWER GENERATION PLANT AND OTHER BUILDINGS

2.11.1.1.3.A

The Supplier* shall prepare general arrangement drawings of all Plant* buildings and facilities as well as other facilities within the Owner's Scope of Supply*, which form part of the Plant* including their connecting underground tunnels and galleries, bridges, passageways, etc.

AA

The buildings and facilities shall be designed and located on the basis of the Site* specification information provided by the Owner*.

AB

These general arrangement drawings shall show the elevation of each building and longitudinal and transverse section. The drawing shall include the general dimensions and shape of the rooms, mechanical, electrical and I&C location, and other relevant aspects such as big structures, equipment hatches, maintenance areas, etc. The general drawing shall show the layout of relevant pipes (e.g., main steam, feedwater, Safety Systems*), electrical distribution areas, HVAC areas, etc.

The detailed layout of equipment, piping, HVAC ducts, cable trays and conduits, and other works of the PGP shall be performed (See Technical Requirements Document* Section 2.12.10.3).

2.11.1.1.3.B

The orientation of the turbine generators shall be positioned so to avoid missile risks to the NI unless other proven measures have been considered in the design of turbine buildings or systems. The possibility of damaging other Structures, Systems and Components* important to safety (i.e. emergency water and electricity supplies) shall also be considered.

BA

Strong preference shall be given to radial alignment of the turbine shaft (with respect to the centre of the reactor building). The Supplier* shall supply the Owner* with information about the probability of the turbine shedding missiles. The design of the turbine shall not contribute significantly to impairing the safety of any Unit* on the Site* according to the probabilistic objectives given in Technical Requirements Document* Section 2.1.3.5.

2.11.1.1.3.C

For the other components that may produce missiles (Turbine-Driven Feedwater Pumps, high pressure tanks, etc.) either their rupture shall be proven unlikely or the orientation of the component shall be such that damage to safety classified SSC is prevented. In particular, special attention shall be paid to the installation of the auxiliary feedwater storage tank, if any.

2.11.1.1.3.D

The Supplier* shall provide adequate barriers, if needed, to avoid any Plant* missile from jeopardising the safety of any Unit*.

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2.11.1.1.3.E

The turbine building structural design shall be integrated with the equipment design in such a way that the equipment can be accessed and maintained without resorting to structural modifications.

2.11.1.1.3.F

The Supplier* shall propose design and layout for ancillary buildings and facilities needed for the operation, maintenance and support of the PGP.

2.11.1.1.3.G

Sufficient lay-down space shall be provided on the operating floor to accommodate sectional maintenance of the turbine generator, with all the major paths lying within the crane travel. This shall assume full disassembly of the High Pressure (HP) turbine, one Low Pressure (LP) turbine, the turbine stop and control valves, and the generator rotor.

2.11.1.1.3.H

The designated floor laydown areas shall have floor loading capacity to support the storage of heavy equipment (e.g., turbine rotor, turbine cells, generator field, etc.).

2.11.1.1.3.I

Layout of the PGP equipment shall enable future implementation of district heating without major changes to existing SSC, see Section 2.2.2.

2.11.1.1.4 RELATION BETWEEN LAYOUT AND LIST PROJECT DOCUMENTS

2.11.1.1.4.A

All Documents* related to layout shall be listed in List of Project Documents*.

2.11.1.1.4.B

Any Document* related to layout shall contain the information that the Document* belongs to layout scope.

2.11.1.1.4.C

Documents* related to layout shall be prepared for any building, other structure and area of the Plant*. Organization of the Documents* related to layout shall be structured to be able to sort by building, batch, milestones, etc..

2.11.1.1.4.D

General requirements for documentation described in Technical Requirements Document*, Section 2.12.1.2 shall be applicable for all Documents* related to layout.

2.11.1.1.4.E

Documents* related to layout shall include following items (but not be limited to):

- 3D Information Model*
- General arrangement drawing (plant view for each level, sections)
- General plant layout
- Equipment introduction note
- Status report
- Civil works handover report
- Room Book

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- Hazard studies report
- Fire protection drawing (plant view for each level, sections)
- Fire zoning report
- Contamination zoning drawing (plant view for each level, sections)
- Contamination zoning report
- Radiological zoning drawing (plant view for each level, sections)
- Radiological zoning report
- Topographical benchmark drawing (plant view for each level, sections)
- Erection area drawing (plant view for each level, sections)
- Detail layout drawings (with detailed information regarding steelwork, equipment, etc.)
- Handling device report
- List of security devices (including description)
- Door and hatch list (including description)
- Load drawing (plant view for each level, sections)
- List of embedded parts - standard/special (including description)
- Steelwork handover note
- Coating book
- Building crane guide drawing
- Calculation report
- Loading description report
- General method statement
- Drawing of formwork and embedded parts (view for each civil works structure – floor, ceiling, wall)
- Drawing of anchoring (view for each civil works structure – floor, ceiling, wall)
- List of anchoring (including description)
- Detail drawings of openings closure
- Drawing of reinforcement (view for each civil works structure – floor, ceiling, wall)
- Interface list (including description)

2.11.1.1.5 BASIC LAYOUT CONSIDERATIONS

2.11.1.1.5.A

The Supplier* shall provide specific clarifications and information for:

- separation and segregation of the Plant* and its buildings to account for internal and external hazards,
- operational and maintenance access and personnel flow, including adequate escape provisions, particularly during refuelling,
- ALARA considerations (see the Technical Requirements Document* Section 2.11.2.5),
- ability of the design to accept several different component and equipment solutions from different Subcontractors*,
- waste management of the low and medium activity (amount of activity released, capacity of storage or other strategies),

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- the layout of the Plant* levels which shall be determined on the basis of potential flooding due to storms. (See also the Technical Requirements Document*, Section 2.4.1.2.5 and Volume 5).

2.11.1.1.5.B

The following shall be considered and demonstrated in the design:

- functional relationship between the main power block, ancillary buildings and circulating water flow routes,
- arranging cable and pipe runs to the minimum practicable length,
- architecture, landscaping and maintenance of the environment in the vicinity of the Site*,
- the connections to the overhead transmission lines serving the Site*,
- good construction access from all temporary works areas.

BA

In the layout, the Supplier* shall consider the routes from the Site* and their positions depending on the directions of the dominant winds.

2.11.1.1.5.C

Selection of the relative positions of the buildings within the Plant* shall include the following considerations:

- functional relationship of main buildings for power generation, auxiliary and ancillary buildings and circulating water flow paths,
- separation and alignment of the Plant* for reasons of nuclear safety,
- provision of adequate protection against hazards,
- personnel flow, operational access and maintenance,
- provision of the connection of the transmission lines serving the Site*,
- provision of adequate construction access,
- provision of facilities for connection of mobile equipment,
- flexibility for improvements of the general arrangement to take account of different external hazards or specific local requirements.

CA

This shall include:

- the ability to increase the capacity or extend the storage facilities for spent fuel and intermediate waste,
- the ability to implement additional systems and equipment in the future,
- underground communications,
- aesthetic appearance.

2.11.1.1.5.D

The Site* and building layout shall be designed on the basis of the information provided by the Owner*, taking into consideration the following requirements and economic aspects:

- ALARA consideration,
- architectural, landscaping and maintenance of the environment in the vicinity of the Site*,
- the connections of the transmission lines serving the Site*,

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- the economic balance between the length of main cooling water culverts and main cable routes,
- optimal technical and economical analysis of the circulating water flow rate and layout elevation,
- arranging cable and pipe runs to the minimum practicable length,
- operational and maintenance access and personnel flow, including adequate escape provisions, particularly during outages,
- Physical Separation* and Segregation* of systems and buildings of the PGP from the NI considering the internal and external hazards,
- restriction of the effects of potential blasts and/or missiles within acceptable limits,
- good construction access from all temporary works areas.

2.11.1.1.5.E

Equipment inside the turbine building shall be grouped to minimise major piping runs.

2.11.1.1.5.F

The following main Plant* design features shall be provided to facilitate equipment maintenance:

- a main access door located at ground level, with connection to road or railway, for access to and removal of equipment from the turbine building,
- access to all major equipment via the turbine building main crane (providing hatches as necessary) or access to monorails and hoists to remove the piece of equipment to the central communications corridor. In case of very heavy loads of rarely hoisted equipment such as turbine generator stator, a temporary hoisting equipment may be used,
- permanent platforms shall be provided where practical and necessary for personnel access to key equipment area to facilitate maintenance,
- an elevator shall be provided with access to all the building floors. The location shall be such as to provide access to main electrical areas. Use for freight as well as personnel shall be evaluated as part of the maintainability plan,
- stairways shall be provided at appropriate locations to facilitate personnel access to all levels and platforms for operation and maintenance of the equipment.

2.11.1.1.5.G

Special provisions shall be made for installation and maintenance of the condenser. Technical Requirements Document*, Section 4.2.7.4 requires the condenser tube bundle to be fabricated in modules including tube sheets, tubes and tube supports.

2.11.1.1.5.H

The Plant* arrangement shall include space, access ways, and lifting provisions which allow replacement of any feedwater heaters without requiring removal of any other major component (mechanical or structural) or large size piping.

2.11.1.1.5.I

The following arrangement requirements apply to the Moisture Separator and Reheaters:

- Each MSR shall be directly accessible by the turbine building crane. Lift capability and space shall be provided to permit removal and replacement of an entire MSR as well

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as a reheater tube bundle without requiring the removal of any other major component or large size piping.

- The Plant* arrangement shall facilitate the retubing of condensers and tube bundle replacements for feedwater heaters and the Moisture Separator and Reheaters*. The Plant* arrangement shall provide both tubing pull space and separate laydown areas required for the retubing or bundle replacement operations. Layout drawings, prepared by the Supplier*, shall identify spaces for tubing replacement, laydown areas and lifting provisions for retubing or bundle replacement.

2.11.1.1.5.J

The turbine building laydown area for turbine generator maintenance shall be in accordance with the turbine generator Inspection* and maintenance programme.

2.11.1.1.5.K

The minimum laydown area shall consist of sufficient space to store three of the largest turbine components or two of the largest turbine components plus the generator and exciter. This area shall include space for maintaining all turbine stop valves, control and intercept valves. Reserved space shall include maintenance equipment, maintenance personnel access, pull spaces and shielding, if required. All major load movement paths shall be in moving path. Provisions shall be made for vertical stacking and unstacking of turbine rotors if required by the design. Provisions shall be made for removal of all turbine generator major assemblies using the turbine building main crane. In case of turbine generator stator a temporary hoisting equipment may be used.

2.11.1.1.5.L

The Supplier* shall provide the Owner* with a turbine generator laydown area drawing and the criteria considered for the definition of laydown area during normal turbine generator maintenance works and in case of removal of all turbine generator major assemblies.

2.11.1.1.6 LAND USE

2.11.1.1.6.A

The Plant* design shall minimize the operational cost by to minimizing length of piping, channels and bridges, routes, etc.

2.11.1.1.6.B

The Plant* design shall offer the optimal connection to the existing infrastructure.

2.11.1.1.6.C

The Plant* design shall not negatively influent the utilization of the Site*.

2.11.1.1.6.D

The Plant* design shall be in compliance with the Rules*.

2.11.1.1.6.E

The Plant* design shall be in compliance with the valid territorial plan and principles of the territorial development.

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2.11.1.1.6.F

Architectural principles shall be defined early in the LWA Phase*. The architectural principles shall include exterior design (buildings arrangement including its dimensions and colours arrangement) of the Plant*.

Note:

The requirement for the architectural design of the Plant* to fit in the existing landscape (including the Existing Nuclear Power Plant*) is part of the EIA binding conditions (see the Licensing and Permitting, Safety and Quality Document*, Section 1.3.3).

2.11.1.1.6.G

Protective zones of each road, railway, civil structures and all network of technical infrastructure (underground and aboveground) shall be considered and respected. Protective zones are defined by Mandatory Law*, see Chapter 2.5.

2.11.1.1.6.H

The owner of the road, railway, civil structure or network of the technical infrastructure specifies the requirements on the Construction Works* within the protective zone of the road, railway, civil structure or network of the technical infrastructure. The Supplier* shall respect the requirements of owners in the design of the Plant* and during the Construction Phase*.

2.11.1.1.7 IMPACT OF THE PLANT ON THE ENVIRONMENT

2.11.1.1.7.A

The Plant* impact on the environment shall comply with the requirements of the Rules* (see the Technical Requirements Document* Chapter 2.5).

2.11.1.1.7.B

The Plant* design shall be adapted to meet the specific regulatory limits of the Czech Republic.

BA

The Plant* design shall be compliant with all standards, codes of practice, regulations and other requirements as specified by the Rules* regarding appearance, noise, emissions, effluents, drains, rivers or any other environmental aspects.

2.11.1.1.7.C

The Supplier* shall also show all necessary consequences of the said Rules*.

2.11.1.1.7.D

The Supplier* shall develop the design and arrangement of the equipment, buildings and structure, and other features on the Site*, within the environmental limits for all stages of construction, Commissioning*, operation, and Decommissioning*.

DA

Consideration shall be given to the protection against the leakage and emissions of dangerous substance to environment during equipment failure.

2.11.1.1.7.E

The Plant* levels shall be determined following an assessment of potential flooding due to storms. Accordingly, the embedment shall be limited as well as the stores below the critical level.

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2.11.1.1.8 BUILDINGS AND ROOMS IDENTIFICATION

2.11.1.1.8.A

Each building and each room of the Plant* shall have a unique identifier.

2.11.1.1.8.B

The Plant* identification shall be performed as a whole, taking into account the mechanical and electrical equipment identification as well.

2.11.1.1.9 MULTI-UNIT SITES

2.11.1.1.9.A

For a multi-Unit* Plant*, the arrangement of the NI and the PGP shall be such that the Units* duplicate each other while avoiding mirror image arrangements. If the mirror image layout arrangement cannot be eliminated, such layout arrangement shall not cause personnel confusion and possible working mistakes.

2.11.1.1.9.B

Sharing between Units* of system ensuring safety classified functions or related to Plant* availability is not favoured, and any such sharing shall be justified on a case by case basis.

2.11.1.1.9.C

Other systems, service and facilities (in particular BOP) can be shared if justified by cost taking into account operational and maintenance aspects.

2.11.1.2 ACCESS

2.11.1.2.1 SITE LAYOUT

2.11.1.2.1.A

The Plant* layout of buildings, paths and roadways on the Site* shall be such that:

- adequate access and escape routes are available on the Site* to areas which are normally or temporarily manned to facilitate the safe operation or shutdown of the Plant*,
- safe escape routes are provided from all Plant* areas and buildings,
- the layout shall provide for alternative access of the fire brigade and other emergency services to each building and facility in the shortest possible time.

2.11.1.2.1.B

The layout shall include designated access ways to all parts of the Site* and buildings.

2.11.1.2.1.C

The size and arrangement of such access ways shall take into account the frequency of access and the combustible materials present.

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2.11.1.2.2 PLANT ACCESS

2.11.1.2.2.A

The Plant* layout shall be such that any equipment can be readily and safely operated, inspected and maintained.

2.11.1.2.2.B

The Supplier* shall provide a main access door located at ground level or other levels, with connection to road or railway, for access to and removal of equipment from each building.

2.11.1.2.2.C

Unless otherwise specifically agreed with the Owner*, the provisions made shall also allow the equipment to be removed and replaced if necessary, without the need to dismantle any other part of the Plant*, including pipework and cables, or demolish any structural components.

2.11.1.2.2.D

Adequate facilities shall be provided for controlled personnel access to the Plant*. This entry facility shall have adequate space to prevent crowding and be designed to facilitate effective movement with separate paths for entry and exit.

2.11.1.2.2.E

Typical value is to enable 500 "badged" people, per Unit*, to pass through the personnel access portal in thirty minutes.

2.11.1.2.2.F

Consideration shall be given to the management of the increased number of personnel during a refuelling outage.

2.11.1.2.2.G

The goal is to provide adequate screening with a minimum of delay to avoid impact on operations and maintenance activities.

2.11.1.2.3 PERSONNEL MOVEMENT

2.11.1.2.3.A

Main corridors and hallways shall have adequate width and height as required by the Rules* and as necessary for operational and maintenance activities.

2.11.1.2.3.B

There shall be adequate headroom below/above equipment and services (e.g. piping, cable trays, lifting equipment etc.) as applicable.

2.11.1.2.3.1 ESCAPE ROUTES

2.11.1.2.3.1.A

Escape routes shall comply with the fire protection Rules* applicable in the Plant* design country of origin of the Reactor Technology (or an EU country where the reactor is licensed) and with Mandatory Law*, in particular fire protection regulations (see Technical Requirements Document* Chapter 2.5). The more restrictive requirements shall apply.

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AA

The width, height, length and numbers of escape routes and number of escape exits shall be defined depending on the number of personnel.

2.11.1.2.3.1.B

Existence of elevators or lifts shall not justify a reduction in the number or in the widths of the escape routes. In the case of fire elevators and/or lifts shall not be used (not applicable to evacuation elevators or lifts).

2.11.1.2.3.1.C

Escape routes shall be provided with emergency lighting and fluorescent signals.

2.11.1.2.3.2 DOORS

2.11.1.2.3.2.A

Engineering characteristics and construction of escape route doors shall comply with the fire protection Rules* applicable in the Plant* design country of origin of the Reactor Technology (or an EU country where the reactor is licensed) and with Mandatory Law*, in particular fire protection regulations (see Technical Requirements Document* Chapter 2.5). The more restrictive requirements shall apply.

2.11.1.2.3.2.B

All the staircase doors shall open in the evacuation direction.

2.11.1.2.3.2.C

Doorsteps and thresholds shall be easy to dismantle and thus facilitating the transportation of heavy equipment and objects during the lifetime of the Plant*.

2.11.1.2.3.2.D

Entrances to the switchgear rooms shall be high enough (e.g. thanks to the provision of a lintel) to allow easy transportation and replacement of the highest electrical cabinet housed therein.

2.11.1.2.3.2.E

Attention shall be paid to the doors between areas with separate and independent ventilation systems (potential staggered pressure to cope with) in order to facilitate the passage (even during some Accident Conditions* which cause higher differential pressure).

2.11.1.2.3.2.F

The design shall minimize the need for temporary cable and/or pipes laying through Fire Barriers* during outage and refuelling time. In cases where Fire Areas* can't be provided with all supplies needed during outage and refuelling time and is there a need to facilitate temporary cable and/or pipes through Fire Barriers*, penetrations (e.g. catholes), with rating consistent with the fire door beside, shall be located next to doors.

2.11.1.2.3.2.G

Sliding or lifting doors shall not be used for emergency exits.

GA

Lifting or sliding doors can be foreseen for equipment transportation.

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2.11.1.2.3.3 STAIRWELL

2.11.1.2.3.3.A

Stairwell and staircases shall be designed according to the Rules* applicable in the Plant* design country of origin of the Reactor Technology (or an EU country where the reactor is licensed) and valid Mandatory Law* (see Technical Requirements Document* Chapter 2.5). The more restrictive requirements shall apply.

2.11.1.2.3.3.B

Isolated steps shall be avoided in the main passageways (escape routes and main circulation areas).

2.11.1.2.3.3.C

The width of a landing shall take into account stretcher handling if necessary, allowing a stretcher to be handled horizontally.

2.11.1.2.3.3.D

All the steps in one flight shall be of the same height.

2.11.1.2.3.3.E

All the escape staircases shall continue up to the exit level of the building.

2.11.1.2.3.3.F

Separations shall be implemented between descending stairs and ascending stairs at the exit level of the building. There shall be no communication between the caging volumes for buildings with a bottom floor that is deeper than -8 m from the exit (surface) level.

2.11.1.2.3.4 GALLERIES

A

Galleries shall be designed according to the Rules* applicable in the Plant* design country of origin of the Reactor Technology (or an EU country where the reactor is licensed) and valid Mandatory Law* (see Technical Requirements Document* Chapter 2.5). The more restrictive requirements shall apply.

2.11.1.3 REQUIREMENTS ON THE DIGITAL FORM OF THE PLANT LAYOUT

2.11.1.3.A

The digital form of the Plant* layout shall be created and supported in the geographic information system (GIS) with complete database information.

AA

The digital form of the Plant* layout shall be possible to export in the AutoCAD dwg form.

2.11.1.3.B

The Plant* layout shall be accessible in the digital GIS form for the Owner* during the all phases of the design, Construction* and Commissioning* phase.

BA

The Supplier* shall provide the Owner* the final Plant* layout in GIS system.

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BB

The final Plant* layout shall include all design stage and geodetic survey stage of the Plant*.

BC

The final Plant* layout shall be in compliance with the Rules*.

2.11.1.3.C

Information Models* related to layout shall be in line with requirements described in Technical Requirements Document*, Section 2.12.10.3.

2.11.1.3.D

It shall be possible to generate specific Documents* related to layout from the 3-D comprehensive computer graphical-database information and data model of the Plant*.

2.11.1.3.E

3-D comprehensive computer graphical-database data model of the Plant* shall include layout of the Construction Site* including the underground infrastructure and buildings, geological survey and monitoring, with their geographical coordinates etc. and layout of all the buildings and each room.

2.11.1.3.F

Documents* related to layout shall define all-important characteristics of each room, such as fire cell or Fire Area* identification, Train* and Division* identification for rooms housing subdivided systems, radiation class, main components location and other environmental specifications or characteristics of each Plant* room.

2.11.1.3.G

All information and data used in Information Models* related to layout shall be based on valid design data and shall follow design manuals and procedures described in Technical Requirements Document*, Section 2.12.6.

GA

All entities responsible for layout shall be able to access the valid design data from searching tool described in Technical Requirements Document*, Section 2.12.9. and Section 2.12.10.3.

2.11.1.3.H

Status of layout including related design information for all plant elements (civil and steel structures, equipment, HVAC/piping/electrical/I&C components, etc.) shall be tracked to be able to identify reason of creation or any change.

2.11.1.3.I

In any Document* related to layout shall be used Project Identification System* in compliance with Technical Requirements, Section 2.12.7.

2.11.2 SAFETY AND HAZARD ASPECTS

2.11.2.1 INTRODUCTION

2.11.2.1.A

This Section addresses design requirements regarding Plant* layout to ensure that the consequence of accidents and Hazards* addressed in the design, or interactions between

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buildings, structures or components on the Site* will not lead to unacceptable failures in the Plant* safety features.

2.11.2.1.B

The Plant* shall be designed to allow operation and maintenance without unacceptable risks to the Operator* or the general public from any cause whatsoever, and to ensure that in case of an accident the reactor is able to be shutdown and the release of radioactive material minimised.

BA

Safety colour coding of areas, floors, equipment and piping shall be used.

2.11.2.1.C

The design compliance for the relative location of buildings, structures or components regarding protection requirements to withstand Internal and External Hazards* which may lead to loss of services necessary to ensure safety, (and which are identified in Section 2.1.2.6 and Sections 2.4.1 and 2.4.5), are also addressed.

2.11.2.1.D

Additionally, layout features which affect radiation and contamination requirements are discussed.

2.11.2.2 PHYSICAL SEPARATION

2.11.2.2.A

Redundant Safety Systems* and equipment shall be physically separated, according to the safety requirements set out in Section 2.1.6.3.2.1.

AA

The arrangement of the separated equipment shall take into account Internal Hazards* and External Hazards*.

2.11.2.2.B

This shall be achieved using barriers together with distance, however separation by distance only may be used on a case by case basis.

2.11.2.2.1 CABLES

2.11.2.2.1.A

Cables associated with safety Division* shall be located in separate cable routes, within the buildings and in separate tunnels or trenches between buildings.

AA

The separation of redundant cables and related electrical equipment by distance or separation by the barriers shall be adopted to ensure that the effects of hazards such as fire or other by fault progression are limited.

2.11.2.2.1.B

The Plant* design of cables and related electrical equipment shall ensure safe shutdown capability.

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BA

The redundant divisions of safe shutdown equipment (cables and related electrical equipment) shall be completely separated.

BB

Inside containment and in control rooms are exception, where fire protection shall be accomplished by Fire Zone* (NS-G-1.7 Fire Cell) i.e. spatial separation, limiting the combustible loading, combined with detection and suppression as properly justified by the fire hazard analysis.

2.11.2.2.1.C

See also the Technical Requirements Document*, Section 2.11.4.5 and 2.11.2.4.2.

2.11.2.2.2 PIPES

2.11.2.2.2.A

The ALARA principle shall be taken into account when determining the separation of active and non-active equipment.

2.11.2.2.2.B

The separation of redundant equipment (including pipework of different Trains*) by distance or segregation by barriers shall be adopted to ensure that the effects of Hazards* (e.g. fire) or the consequential effects of high energy line breaks (such as pipe whip or missiles) are limited.

2.11.2.2.2.C

Active or potentially active pipework shall be located in areas where there is no normal personnel access.

2.11.2.2.2.D

Where this is not practicable, it shall be shielded and separated from non-active pipework in order to reduce operational exposure of Plant* personnel.

2.11.2.2.2.E

The routing of high energy line pipework through areas containing safety classified equipment shall be avoided.

EA

In cases where this is not feasible, the safety classified equipment shall be adequately protected.

2.11.2.2.2.F

See also Section 2.11.4.3.

2.11.2.2.3 HVAC

2.11.2.2.3.A

The arrangement of Heating, Ventilation and Air Conditioning (HVAC) components and ductwork shall take into account safety Train* separation, Fire Areas* and Fire Zones*, and logical grouping of components within a system.

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AA

To meet the Single Failure Criterion* (SFC) also in the case of fire (and other Internal Hazards*) the separation requirement shall be applied in between redundant Safety Systems* which might cause initiating events.

2.11.2.2.3.B

The layout of equipment shall also be arranged to ensure that there is separation of the non-active and potentially active components, wherever practical.

BA

HVAC airflows shall be arranged so that the flow is from "clean" to "dirty" areas.

2.11.2.2.3.C

The relative location of HVAC and other intakes with the exhausts from HVAC, diesel engines, gas turbines or oil-fired boilers shall be arranged so that:

CA

- there is no recirculation of ventilation between buildings e.g. the intake of one adjacent to the exhaust of another,

CB

- exhaust gases shall not enter combustion air intakes and cause oxygen starvation,

CC

- exhaust gases shall not enter access ways or HVAC inlets, particularly the Main Control Room* (MCR), Emergency Control Room* (ECR); Technical Support Centre (TSC); Operational Support Centre (OSC) and Emergency Preparedness Centre* and shelters intakes,

CD

- consideration shall be given to the location of intakes that may introduce vapours or explosive gases (e.g. hydrogen) from nearby installations,

CE

- separation between intakes/exhaust of relative divisions shall be dealt with satisfactorily, to address the Hazards* concerns.

2.11.2.2.3.D

The Supplier* shall take measures to prevent the spread of smoke throughout the Plant*, especially in the personnel access areas and rescue routes which the fire brigades and emergency services may enter.

DA

A case-by-case evaluation shall be performed taking into account the specificity and designation of each area.

2.11.2.2.3.E

See Section 2.11.4.2.

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2.11.2.3 PENETRATIONS THROUGH BARRIERS

2.11.2.3.1 INTRODUCTION

2.11.2.3.1.A

The need for mixing of the atmosphere by natural circulation in the Primary Containment* and the Secondary Containment* shall be taken into account (See Technical Requirements Document* Section 2.9.3.1.9.1 and Section 2.9.3.2.2)

2.11.2.3.1.B

The choice of means of separation shall depend upon the accidents addressed in the design, e.g. fire, flooding, temperature, humidity etc., and the disposition of the Plant* concerned.

2.11.2.3.1.C

Principal Barrier* is defined as a Barriers* that segregates Safety Systems*. For instance, Divisions* shall be physically separated by Principal Barriers*, redundant Trains* shall follow the same principle according to the extent that they are division related. This provision will prevent common mode failure resulting from internal and external hazards.

2.11.2.3.1.D

Specific attention shall be paid to the provisions to be assumed for Division* related cables and cable routes prior to entering the MCR desks.

DA

For practical reasons the MCR, and redundant shutdown Safety Systems* inside the Containment System*, are excluded from the requirements for separation by Principal Barriers*. The separation is achieved by other means (e.g. distance).

DB

For this particular area, the Supplier* shall provide adequate clarification to demonstrate that the layout is satisfactorily implemented.

2.11.2.3.1.E

The Principal Barrier* shall be physically easy to identify and free from any distinctive feature.

2.11.2.3.1.F

The area enclosed by Principal Barrier* shall be segregated into separate zones by additional barriers to protect against specific hazards only, such as fire, in order to enhance safety, maintain operability and to protect the investment.

2.11.2.3.2 DESIGN OF BARRIERS

2.11.2.3.2.A

Penetrations through Principal Barriers* shall only exist where there is a clear functional need.

AA

On the Primary Containment* and the Secondary Containment* penetrations, see Technical Requirements Document* Section 2.9.4.1.6 and Section 2.9.4.2.2.

2.11.2.3.2.B

The number of penetrations through Principal Barriers* shall be strictly minimized.

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2.11.2.3.2.C

The penetrations shall be considered as part of the Principal Barrier* and their resistance time evaluated.

2.11.2.3.2.D

During the design process, drawings of those buildings housing equipment important to safety (mechanical, electrical, and I&C) shall be prepared to show their Physical Separation* and Segregation* into areas and zones, and to identify the location of Principal Barriers* and other barriers.

2.11.2.3.2.E

The role and rating of each of the barriers shall be determined and catalogued, together with a list of penetrations through those Barriers*, their justification and their individual design requirements.

2.11.2.3.2.F

Where the need for Principal Barrier* has been established, the penetrations which are required for system functionality shall meet the following requirements:

FA

Doors and hatches

There shall not be any doors or hatches (used for emergency exits, Normal Operation* or normal maintenance), which directly penetrate Principal Barriers*.

However, access hatches for maintenance only may be approved by the Owner*, but they will remain fully sealed except during the Plant* outages. See Technical Requirements Document* Section 2.9.2.5 for details concerning Containment System* accessibility.

If some doors or hatches are planned in an opening in the Principal Barriers*, for exceptional maintenance purpose, they shall be designed to maintain the level of protection in compliance with the characteristics and ratings of the corresponding Barrier*. Moreover, their status shall be monitored continuously.

Alarms and periodic checking on door or hatches positions shall be provided for such openings. In such a case, the Supplier* shall explain in which conditions this opening will be used and how the above requirements will be fulfilled. This shall also include a description of the required procedures for opening and closing such doors and hatches.

The Supplier* shall take cost aspects into consideration to minimise the number of doors and hatches which directly penetrate Principal Barriers*.

Where doors or hatches interconnect Fire Areas* it shall be possible to create a lobby.

A lobby is an ante-room which isolates the door or the airlock from the fire boundary to which it belongs. In principle, there is no way to deviate from a redundant means of isolation (doors, dampers, etc.) but the potential consequences shall be evaluated on a case by case basis.

FB

Ducts

Ducts which pass through, but do not serve, Principal Area*, shall possess the same ratings as the Principal Barriers* they pass through.

FC

Pipes

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Wherever practical, all pipes penetrations shall be located in areas which have low combustible loading and pipes carrying flammable or oxidizing fluids (including compressed air) shall only penetrate Principal Barrier* when directly serving equipment in the segregated areas. Wherever practical, pipes shall be anchored at such penetrations.

FD

Cables

Cables dedicated to one Division* shall not be routed through another Division* where cable segregation is required for nuclear safety.

The requirements for Segregation* in the control complex are covered in Technical Requirements Document* Section 2.11.2.4.2, and for cable routing in Section 2.11.4.5.

Cables shall, wherever practicable, remain routed in a single area surrounded by Principal Barrier* and:

- no power cable shall be run in more than one Principal Area* unless required to meet a functional need, in which case adequate protection shall be provided,
- power and instrumentation cables shall be separated by an appropriate distance to prevent induced currents,
- cables shall fulfil the appropriate requirements for fire retardant design.

2.11.2.4 MEASURES AGAINST HAZARDS

2.11.2.4.1 INTRODUCTION

2.11.2.4.1.A

For each possible hazard, an overall assessment shall be incorporated into the Plant* and building layout to prevent unacceptable consequences of hazards on safety equipment.

AA

The list of possible hazards to be considered in the design is given in the Technical Requirements Document* Section 2.1.2.6 and 2.1.9.3. The methodology is described in Section 2.4.1.

2.11.2.4.1.B

Provisions shall also be used to protect the investment.

BA

Building structures shall be suitably fire resistant. Non-combustible or fire retardant and heat resistant materials are required to be used as far as practicable throughout the Plant* and in particular in locations such as in the reactor containment and the control room.

BB

The main facilities and components of the oil system (tanks, pumps, filters, coolers) shall be placed in independent Fire Areas* (compartments) equipped with intercepting sumps and emergency sumps and a fixed fire extinguishing system. The other facilities and components, which are placed out of these Fire Areas* (pipelines, decantation stations, actuators), shall be designed so that an uncontrolled spread of firing liquid is eliminated (in case of release of liquid from technological equipment).

2.11.2.4.1.C

As part of the hazards analysis, a case by case evaluation shall be performed for each building important to safety anticipated to be involved in the overall assessment of hazards.

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2.11.2.4.1.D

Principal Barriers* shall be planned and easy to identify.

2.11.2.4.1.E

Openings and penetrations in these Principal Barriers* shall be minimised and shall be sealed with materials which provide an equivalent rating.

EA

The rating concerns the design assumptions values for the Principal Barrier* (fire, flooding, load drop, and other internal and external hazards addressed in the design).

2.11.2.4.1.F

The Plant* safe shutdown following postulated hazards shall be achievable in part through complete separation of redundant Divisions* of safe shutdown equipment and the associated electrical supplies and by allocation of Principal Barriers*.

2.11.2.4.1.G

Redundant switchgear safety Divisions* shall be separated from each other and from the remainder of the Plant* by allocation of Principal Barriers*.

2.11.2.4.1.H

Safety battery rooms shall be separated from each other, and other areas of Plant*, by allocation of Principal Barriers*.

2.11.2.4.1.I

DC switchgear and inverters shall not be located in these battery rooms.

2.11.2.4.1.J

Redundant shutdown systems inside the Containment System* shall be at least separated by distances aiming to reduce the risk induced by hazards.

2.11.2.4.1.K

The Supplier* shall provide drawings, showing all Fire Areas* and Fire Zones* based on the general arrangement drawing of each building, as well as the layout site plans. Additionally, the Supplier* shall provide drawings showing the escape routes for each building.

2.11.2.4.1.L

The Supplier* shall comply with Rules* specified in Technical Requirements Document*, Chapter 2.5 especially with the Rules* which relates to potential risk from explosive atmosphere (ATEX). The Supplier* shall develop ATEX studies and hazardous areas plant drawings based on the general arrangement of the buildings and layout to comply with applicable regulations.

2.11.2.4.2 FIRE AREAS AND ZONES

2.11.2.4.2.A

Fire Areas* and Fire Zones* shall be defined based on the fire hazard analyses.

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AA

Fire Areas* and Fire Zones* shall be incorporated into the overall layout and building layouts to restrict the impact of fire on equipment important to safety.

AB

These definitions correspond to those in IAEA Safety Guide NS-G-1.7 where "Fire Compartment" is equivalent to Fire Area*, and "Fire Cell" is equivalent to Fire Zone*.

2.11.2.4.2.B

As part of the fire hazard analysis, a case by case evaluation of the fire loading of equipment in the Plant* layout shall be carried out.

BA

Indicative principles for the treatment of the results of evaluation are as follows:

- space without fire hazard except protected escape routes: no possibility of Fire Zones*.
- other spaces: case by case evaluation to determine either the allocation of Fire Zone* or the implementation of Fire Area* with Barrier* of the appropriate fire resistance rating (preferred method).

2.11.2.4.2.C

Fire Areas* and Fire Zones* shall then be allocated taking into account the safety requirements of the operating staff, the equipment, the fire loading, the ignition sources, and the degree of separation required to be compatible with existing qualified equipment that is commercially available, i.e. the building arrangement shall suit the equipment that is available.

2.11.2.4.2.D

Exterior walls of buildings important to safety which may be exposed to fire hazards shall be designed as Fire Barriers*.

2.11.2.4.2.E

Openings and penetrations in the Fire Barrier* shall be minimised and shall be sealed with materials which provide an equivalent fire resistance rating (e.g. penetrations seals and cable wraps).

2.11.2.4.2.F

Personnel access routes and evacuation routes for each Fire Area* shall be included in the layout.

2.11.2.4.2.G

Such escape routes shall have the minimum impact on nuclear safety.

2.11.2.4.2.H

They shall be in accordance with the requirements of the Rules* including the Requirements of the Authorities* (see Chapter 2.5) and shall include:

- clearly marked escape routes and fire exits,
- emergency lighting,
- self closing fire doors,
- stairways outside the Primary Containment* serving as escape routes, access routes for fire-fighting, and access routes to areas containing equipment necessary for safe shutdown of the Plant* shall be enclosed in masonry or concrete towers with the

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appropriate fire resistance rating, and shall be provided with means to prevent the progression of smoke.

HA

Means to prevent the progression of smoke may be extraction or overpressurisation systems.

2.11.2.4.2.I

Wherever practical all Fire Barriers* shall be integrated into the civil structure to minimise bulk building quantities.

2.11.2.4.2.J

Rooms containing safety computer equipment that is not part of the control room complex shall be separated from their redundant backups and from other areas of the Plant* by allocation of Fire Areas*.

JA

The control complex includes the Main Control Room* (MCR) and the other rooms which support the MCR operations.

2.11.2.4.2.K

The control complex shall be separated from the remainder of the Plant* by Fire Barriers* on the walls, ceilings and floors.

2.11.2.4.2.L

Peripheral rooms in the control complex shall be separated from the MCR by the allocation of Fire Areas*.

2.11.2.4.2.M

In areas which have fixed water fire suppression systems installed, floor drains shall be sized to remove expected water flow without flooding equipment important to safety.

2.11.2.4.2.N

The separation of redundant systems inside the MCR shall be achieved by Fire Zones* and partial Barriers*.

NA

For practical reasons the MCR itself may be allocated as a Fire Area* and is therefore excluded from the requirements for separation by Fire Barriers*.

2.11.2.4.2.O

The Emergency Control Room* shall be located in separate Fire Zone*, which is separate from the control complex.

2.11.2.4.2.P

The fire fighting measures have three aims in the PGP:

- detection, extinguishing and prevention of fire propagation from the PGP to the equipment important to safety of the Nuclear Island* or to equipment containing radioactive materials,
- investment protection,
- protection of the operating staff.

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2.11.2.4.2.Q

Allocation of Fire Areas* for redundant shutdown systems inside the Containment System* shall be achieved by distance and the risk reduced by limiting the combustible loading and providing fire detection and suppression systems designed on the basis of fire hazards analysis.

2.11.2.4.2.R

Fire Barriers* shall not impede access to safety categorised equipment.

2.11.2.4.2.S

Partial Barriers* may also be used.

2.11.2.4.2.T

As a minimum, within the Power Generation Plant*, each individual building shall be a separate Fire Area*, i.e.:

- generator building,
- mechanical auxiliary building,
- electrical auxiliary building,
- non safety autonomy emergency power supply system,
- fuel oil storage tank,
- cable galleries,
- lubrication oil tank.

2.11.2.4.2.U

Inside each building, the following separation shall be provided:

- Generator building:
 - separate Fire Areas* in some cases also Fire Zones* (see Chapter 2.5):
 - the spaces located below and above the operating deck,
 - the turbine oil station,
 - Turbine - generator oil station,
 - if any, the feed water pump turbine oil stations,
 - areas, which are explicitly mentioned in the Rules* (see Chapter 2.5)
 - if it is located inside the generator building, the blowdown treatment system (and the polishing system if any), shall be a separate Fire Zone*. This system is potentially radioactive.
 - the hydrogen exhaust piping shall be directed to the outside of the building. The location of the exhaust shall preclude the risk of hydrogen entering into the building.
- Mechanical and electrical auxiliary buildings:
 - separate Fire Zones* or Fire Areas* for:
 - areas, which are explicitly mentioned in the Rules* (see Chapter 2.5)
 - the redundant equipment shall be housed in separate Fire Zones*.
- Non safety autonomy emergency power supply system:
 - the redundant equipment shall be housed in separate Fire Areas*,
- Inside each facility, the fuel and lubrication oil storage tank shall be housed in a separate Fire Zone*.
- Systems containing flammable liquids shall be protected against fire by means determined by fire hazard analysis. If the fixed fire extinguishing systems are determined the Owner* prefers automatic Light water or Water mist systems.

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2.11.2.5 ENVIRONMENTAL ZONES

2.11.2.5.1 INTRODUCTION

2.11.2.5.1.A

In addition to the requirements for separation and Segregation* to protect the equipment, the layout shall take into account the operability and maintainability of the Plant* by environmental zoning.

AA

For additional requirements see the Licensing and Permitting, Safety and Quality Document* Section 2.6

2.11.2.5.1.B

The zoning of the layout shall accommodate:

- the environment in terms of temperature, humidity, renewal of fresh air, for normal personnel access and habitation,
- the radiation levels,
- the potential contamination.

Note B

The objective is to achieve optimum working conditions for personnel while still providing effective control of personnel and equipment access, and to ensure that both the maximum and minimum of ambient parameters mentioned above for which the electrical and electronic equipment and components are designed to operate within are not exceeded. It is expected that three zoning schemes will be developed but they will encompass a number of common zones.

2.11.2.5.1.C

The Supplier* shall ensure that the environmental conditions and radiation levels associated with each room or area in each building are compatible with the equipment operating in that room and the extent of occupation by personnel for the purpose of Plant* operation, monitoring, maintenance, etc.

2.11.2.5.1.D

The assessment of temperature and humidity in each room and area (particularly, where the safety classified components may be jeopardized by temperature and humidity) shall encompass all conditions addressed in the design (e.g. taking into account the effect of loss of support systems and other potential hazards.)

2.11.2.5.1.E

The definition of environmental zones on this basis shall contribute to the design of the environmental support systems and support the environmental qualification work. The principles for allocation of zones on the basis of radiation levels and potential contamination are covered in the following sections.

2.11.2.5.1.F

Final Plant* documentation shall include drawings clearly indicating the environmental zones, zone identification designation and a listing of environmental conditions by zone identification.

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Zone identification shall be similar, preferably the same, as the one used in the Reference Plant*.

2.11.2.5.1.G

Workplaces shall be organized so they can be kept in a state that does not endanger people's safety and health for the whole operation period.

2.11.2.5.2 BASIC BREAKDOWN OF PLANT AREAS

A

The basic breakdown of the Plant* areas inside the main security checkpoint (the Plant* fence), shall be as follows:

AA

Non-supervised areas shall be areas with unrestricted access for personnel proceeding to non-active areas.

AB

Supervised areas shall be areas not designated as controlled areas but for which occupational exposure and working conditions are kept under review, but no specific protection measures or safety provisions are normally needed. This shall include, for example, reactor operations staff who are proceeding to the Main Control Room* and associated areas, but who may still be subject to a further security check.

ABA

The supervised areas shall be in accordance with requirements stipulated in the Mandatory Law*.

AC

Controlled areas are areas in which specific protection measures and safety provision are or could be required for controlling radiation exposure or preventing the spread of contamination during Normal Operation* or Design Basis Conditions 2*, and preventing or limiting the extent of potential radiation exposure.

ACA

The controlled areas shall be in accordance with requirements stipulated in the Mandatory Law* (particularly Decree No. 422/2016 Coll. as amended).

B

Based on above mentioned breakdown structure, the layout of the Plant* and/or Unit* shall be designed in compliance with the Mandatory Law* and the following general requirements:

BA

The guidance to proposed allocation of non-supervised, supervised, and controlled areas is shown in the figure in the Technical Requirements Document*, Section 2.11.2.5.2.2.1. and shall be considered by the Supplier*.

BB

The boundaries of these areas shall be protected against unauthorised entry, and all personnel access and minor equipment access shall occur via one access control area which is permanently controlled either by card access or a guardian.

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BC

Main access and exit point from controlled area shall be at same point of the Plant*. In close proximity of the main access point the radiation monitoring control room shall be placed (see Section 2.11.2.5.4.2).

BD

All personnel entering to the controlled area shall be issued with electronic dosimeters and monitored for radiation exposure. The access to the controlled area shall be equipped to monitor all personnel for radiation exposure. Stationary monitors (e.g. portal radiation monitors, hand and foot monitors) shall be provided at the main exit points from controlled areas and supervised areas to facilitate the monitoring of operating personnel and equipment.

BE

Alternative access routes shall be designed for emergency services.

BF

Certain equipment items, such as the fuel transport flasks, large spares, and maintenance equipment, shall enter and leave the controlled area by other routes but, in these cases, special precautions are required to prevent the passage of personnel and the spread of contamination.

BG

Separate emergency exits shall be designed in accordance with the Mandatory Law* and Requirements of the Authorities*.

BH

Wherever practical all non-radioactive equipment shall be located in uncontrolled areas. Rationales shall substantiate this specific arrangement.

BI

Within the controlled area, the design shall be such that it reduces the size and number of areas that may become contaminated and maintains the degree of contamination ALARA.

BJ

In areas where contamination may arise, the Plant* design and building layout shall allow adequate control of personnel and reduce ALARA the possibility of the spread of contamination to other areas by personnel, goods, vehicular traffic or the ventilation and drainage systems.

BK

Where a passage between zones of different contamination classification is required for operational or maintenance purposes, an area shall be set aside to control the spread of contamination.

BL

Permanent sub-changing rooms shall be provided at places where the frequency of personnel crossing from an uncontaminated area to a contaminated area is more frequent than required for tasks such as annual maintenance.

BLA

The floor area or space provision for a sub-changing room shall be based on the maximum expected usage.

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BLB

This area shall be designed to accommodate facilities to monitor personnel and allow protective clothing to be changed (sub-changing room).

BLC

The scope, required space and location of personnel contamination monitors and temporary facilities used during refuelling and maintenance periods shall be proposed by the Supplier* and shall be agreed with the Owner*.

BM

The MCR shall be located outside the controlled area.

Note BM:

It is recommended to locate MCR in supervised area.

BN

Radiation zones shall be defined and assigned to each room for power operation and shutdown states according to the design dose rate in the room for the particular operational state.

BO

A separated area provided with a system for the measurement of contamination by use of whole-body surface and tool contamination monitors (alfa and beta) shall be located on the boundary of the controlled area, with entrance in staff working clothes used for the controlled area.

2.11.2.5.2.1 RADIATION

2.11.2.5.2.1.A

The Supplier* shall design the equipment and its layout in such a way that the radiation exposure of personnel from potentially active items of the Plant* is minimised. Precise requirements (ALARA principle, dose targets etc.) are stated in the Technical Requirements Document*, Section 2.2.6 and Section 2.1.3.

2.11.2.5.2.1.B

On this basis, the Supplier* shall perform a permanent shielding analysis and present the areas in the design where specific efforts have been made (e.g. by installing special system architecture, shielding, robotics, material specification, etc.) and the benefits expected in the case of a possible breakdown in order to fulfil the above requirement.

Note B

The most preferable is the use of the permanent shielding when applicable.

2.11.2.5.2.1.C

The design shall comply with the targets for occupational radiation exposure as defined in the Technical Requirements Document*, Section 2.2.6 and Section 2.1.3.

CA

For this purpose, the Supplier* shall study planned maintenance task manning and time, and expected radiation levels in the work areas to confirm that the radiation exposure target is expected to be met. The study shall establish that no cost effective reduction in personnel

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exposure can be made by increased shielding or additional equipment maintenance design features, or other arrangements.

2.11.2.5.2.1.D

The following shall be considered for minimising the occupational radiation exposure:

- space for unimpeded access to rooms and around equipment,
- space for auxiliary temporary shields and load-bearing capacity of floors to install such shielding,
- provision of load lifting and carrying devices,
- intermediate storage for dismounted parts, including metallic insulation,
- space for special tools and equipment,
- preference for staircases in place of ladders,
- space for auxiliary ventilation and breathing equipment.

Note D

Adequate space for comfortable maintenance may imply larger buildings, resulting in additional costs. The Owner* will evaluate designs not only on minimum building space, but will consider demonstrations of ease of maintenance on a cost-benefit basis.

2.11.2.5.2.2 RADIATION ZONES

2.11.2.5.2.2.A

The layout shall be allocated into radiation zones, which, together with the established radiation source terms, shall provide the basis for:

- access control measures,
- building layout which provides access to high radiation areas from low radiation areas, in the Normal Operation* (including shutdown conditions),
- equipment design, selection, and layout to maintain assigned, or lower, radiation levels,
- separation of radioactive and non-radioactive pipe routing (incl. the sewage water pipes from the controlled area),
- radiation shielding and calculation of shielding thickness,
- administration of occupancy restriction throughout the facility.

AA

For guidance, see the figure in the Technical Requirements Document*, Section 2.11.2.5.2.2.1.

AB

Non-active drains shall not be located in active areas to avoid the possibility of active effluent or leakage being discharged down non-active drains.

Note A

Current typical breakdown of radiation zones of controlled area which are not restricted in the Existing Nuclear Power Plant* is as follows:

Zone	dose rate [$\mu\text{Sv/h}$]	volume activity of aerosols [Bq/m^3]	surface activity [Bq/cm^2]
green	up to 25	less or equal to 30	less or equal to 3
yellow	26 - 250	less or equal to 30	less or equal to 3
orange	251 – 1 000	more than 30	more than 3
red	more than 1 000	more than 3 000	more than 100

2.11.2.5.2.2.B

The Supplier* shall provide the Owner* with details of the allocation and classification of radiation zones used for development of the equipment layout.

2.11.2.5.2.2.C

The dose rate limit for areas with unlimited access, based on 2 000 working hours per year, shall be less than 10 $\mu\text{Sv/h}$. In case the dose rate limit is higher than 10 $\mu\text{Sv/h}$, the Supplier* shall justify the working hours per year in such area.

2.11.2.5.2.2.D

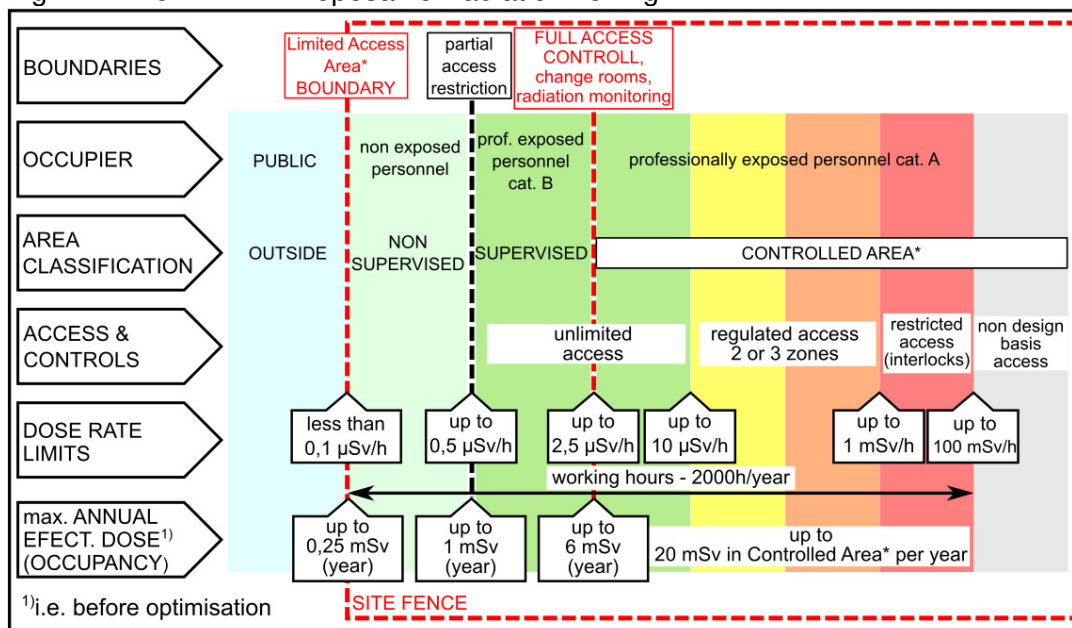
Suitability of the layout to allow maintenance in high radiation areas shall be demonstrated by detailed studies.

2.11.2.5.2.2.E

The Supplier* shall assess the impact on radiation zones as a result of the consequences of DBA and DEC.

2.11.2.5.2.2.1 PROPOSAL FOR RADIATION ZONING

Fig. 2.11.2.5.2.2.1-1: Proposal for radiation zoning



2.11.2.5.2.3 PROTECTION AGAINST RADIATION

2.11.2.5.2.3.A

Protection against radiation shall be provided by implementing measures to mitigate actual or anticipated exposure conditions.

2.11.2.5.2.3.B

Methods of achieving this aim shall include the consideration of operation and maintenance requirements, e.g. remote operation and the Redundancy*, together with the use of shielding, to reduce the dose rates to personnel working in the vicinity of the equipment (the most preferable is the use of shielding).

2.11.2.5.2.3.C

Shielding shall conform to the ALARA principle.

2.11.2.5.2.3.D

Provisions shall include the following:

DA

- to allow unlimited access, each corridor personnel access and amenity room shall remain at a dose rate lower than 10 µSv/h. Any deviations from this target value shall be substantiated by a sound base ALARA approach.

DB

- in particular, water coverage during routing handling of any Fuel Assembly* shall be such that the local dose rate on the operating floor does not exceed 10 µSv/h, taking into account all the relevant sources. Exceptions shall be justified by the Supplier* and shall be in accordance with ALARA principle. Standard operations shall be executable without attendance of the personal in the spent fuel pool proximity.

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DC

- the general shielding target shall be to keep the dose rate originating from the radiation from the components of the surrounding compartments within 20 % of the boundary dose rate corresponding to the classification of the compartment considered.

2.11.2.5.2.3.E

On this basis:

EA

- radioactive equipment such as tanks, heat exchangers, and filters, shall be located in shielded compartments, provided with localised shielding, or located so as to reduce the dose rate by distance, in order to meet the requirements of the radiation zones specified,

EB

- pumps and valves shall be located in a separate room from the tank that they serve,

EC

- redundant radioactive equipment requiring maintenance, whether safety-related or not, shall be located in separate shielded compartments or otherwise properly shielded,

ED

- shielding between equipment inside compartments shall be provided if studies show that the qualification radiation dose (dose level for which a particular equipment has been qualified) shall be exceeded,

2.11.2.5.2.3.F

The use of removable localised shielding shall be exceptional and facilities for its removal shall be provided as follows:

FA

- an alternative to shield walls shall be evaluated during the Plant* and/or Unit* layout design phase,

FAA

Design alternatives shall include relocation of equipment, localised higher density shielding on equipment, shielding by other non-radioactive equipment, etc.

FB

- space, support points, and handling facilities shall be provided for temporary shielding where it is part of the expected maintenance programme,

FC

- when a radioactive pipe is required to traverse a normally accessible space, a shielded chase shall be provided,

FD

- the Supplier* shall separate highly radioactive components from low or non-radioactive components by shielding or distance, or arrange to reduce personnel exposure during operation, testing and maintenance activities,

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FE

- building arrangements shall make maximum use of common shielding walls and floors, and wherever practical shield walls shall be integrated into the building structure,

FF

- access labyrinths shall be favoured over shielded doors, except where doors or physical barriers are required to prevent unnecessary access to high-radiation areas,

FG

- lead brick walls shall not be addressed in the design.

2.11.2.5.2.4 HIGH RADIATION AREAS

2.11.2.5.2.4.A

Means shall be provided to minimise or eliminate the need for the Plant* personnel to enter areas in which the radiation level is greater than 1 mSv/h to perform routine operations such as reading of gauges or adjustment of valves, or routine maintenance, e.g. more than 6 times per year.

AA

The Supplier* shall take into account the requirements of the Technical Requirements Document*, Section 2.2.6 on occupational radiation exposure targets and Section 2.1.3, and the allocation of radiation zones in the Technical Requirements Document*, Section 2.11.2.5.2.2.

2.11.2.5.2.4.B

The following design methods shall be considered to minimise radiation levels in the areas where operation and maintenance personnel are required to carry out their functions:

BA

- provide remote viewing devices for routine visual surveillance (unless the risk of equipment failure and thus worsening conditions proven to be negligible),

BB

- locate valve actuators in a low radiation zone,

BC

- locate instrumentation indicators, solenoid valves, control panels, and electro-pneumatic converters in a lower radiation zone,

BD

- for sensing elements in high radiation areas, locate transmitter readouts in a low radiation zone,

BE

- locate instrument isolation valves just beyond the penetration on the low radiation side of a shield wall to allow maintenance during the Power Operation Modes*,

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BF

- instruments and their isolation valves shall be located so that they are accessible for use, calibration, and repair without disassembly or removal of piping, grating or other structures,

BG

- design instrumentation for long service life and low frequency of maintenance and calibration,

BH

- provide features which permit periodic calibrations of radiation monitors in high radiation rooms from adjacent low level areas,

BI

- locate penetrations for piping, HVAC ducts, etc., through shield walls above personnel head height e.g. 2,0 - 2,2 m to minimise personnel exposure by streaming effects,

BJ

- penetrations shall not be located in the line of sight between radiation sources and occupied areas,

BK

- valves shall be located to enable maintenance to be carried out on the valves without significant radiation exposure,

BL

- piping layout shall minimise the existence of highly radioactive pass-through piping (for example, the header pipe of the branch pipe to the equipment within the cubicle being serviced) which could cause high radiation levels even when the cubicle equipment has been flushed,

BM

- reach rod shafts (rod gearing) and associated valves shall be such that the drive shaft does not block or cross access ways or corridors that are necessary for maintenance of equipment.

2.11.2.5.2.4.C

The Supplier* shall evaluate the areas where transient high radiation could be experienced (e.g. adjacent to fuel transfer tubes and at Reactor Cavity* sumps) and design with the aim of minimising the potential for large radiation doses (greater than 1 mSv/h) from such transient sources.

2.11.2.5.2.4.D

The Supplier* shall identify areas where, under DBC 1 and DBC 2, personnel could receive a radiation dose of 100 mSv or more in one hour.

Note D

These are the areas which are not expected to be accessible (see non design basis access in the Technical Requirements Document*, Section 2.11.2.5.2.2.1).

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2.11.2.5.2.4.E

The need for personnel to access these areas shall be avoided by design, or when elimination by design is not possible, physical Barriers* shall be provided to prevent unauthorised access.

2.11.2.5.3 CONTAMINATION

2.11.2.5.3.1 CONTAMINATION ZONES

2.11.2.5.3.1.A

For design purposes the classification of potential contamination areas within the controlled area shall be as specified below.

2.11.2.5.3.1.B

Equipment or systems that have the potential to become contaminated during operation and maintenance shall be grouped and/or located separately from non-active areas of the Plant* or systems, with controlled access to each active area, in order to minimise the potential for the spreading of contamination.

2.11.2.5.3.1.C

The equipment and components of a radioactive systems shall be in adjoining separate rooms graded in decreasing radiation level down to general access areas. Access to high-radiation rooms shall be from lower-radiation rooms, with easy access for essential parts and tools.

2.11.2.5.3.1.D

In classifying each contamination area, the extent to which the active HVAC systems control the extent of airborne contamination shall be taken into account, see the Technical Requirements Document*, Section 2.8.2.9.3

2.11.2.5.3.1.E

The design requirement for the HVAC system shall include the requirement to reduce ALARA the need for breathing air protection.

2.11.2.5.3.1.F

All potentially contaminated areas shall be served by a radioactive HVAC system.

2.11.2.5.3.1.G

At the design stage the contamination zoning and the airflow directions shall be designed to ensure flow from areas of low potential contamination to those with a higher contamination potential.

2.11.2.5.3.1.H

Filtered extracts from the active areas shall be discharged, via a specific and controlled stack.

Note H

It is expected there will normally be only one specific stack per Unit*, see the Technical Requirements Document*, Section 2.8.1.1.3.3 and Section 2.9.2.2.3.1.

2.11.2.5.3.1.I

It shall be ensured that zones with high contamination risks (e.g. iodine risk) remain permanently in depression compared to contiguous zones.

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2.11.2.5.3.2 CONTAMINATION PREVENTION

2.11.2.5.3.2.A

The equipment arrangement and building design shall have the following features to reduce the potential for spread of radioactive contamination and to facilitate clean-up:

AA

- efficient arrangement of each work area anticipating potential sources of radiation,

AB

- providing hoods or negative pressure sealed enclosures in work areas, where appropriate,

AC

- floor surfaces drained or equipped with a collecting system which shall be sized according to clean-up water flow rates. Whatever the means used, it shall be adaptable to local regulation,

Note AC

Sloped floors are highly recommended.

AD

- walls, curbs or bounds tested for liquid tightness shall be provided around tanks containing contaminated fluids and around areas where is a possibility of contaminated fluid leakage,

AE

- concrete and fireproofed surfaces with the potential for radioactive contamination shall be protected with a smooth surface coating.

Note AE

These surfaces include at least operating floor surfaces and surfaces in rooms which have the potential for leaks or for being flooded or sprayed with liquid containing radioactive contamination (such as the lower areas of containment concrete internals).

2.11.2.5.3.2.B

Contaminated radioactive systems and components shall be separated in different rooms from non-contaminated systems, and separated from one another.

2.11.2.5.3.2.C

Operational components, like valves or pumps, shall be separated from higher-radiation sources such as tanks or heat exchangers.

2.11.2.5.4 ACCESS FACILITIES

2.11.2.5.4.1 PERSONNEL

2.11.2.5.4.1.A

The layout shall be designed to facilitate the regulation of personnel and equipment entering into the Plant* and/or Unit*. The requirements to be fulfilled in order to achieve this aim, namely

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the provision of access points to the Site* via a security checkpoint/gatehouse are specified in the Section 2.11.6., Section 4.7.11 and Section 2.1.8.3.

AA

The restricted and unrestricted areas shall reflect the Plant* and/or Unit* security requirements, while the controlled, supervised and non-controlled areas enable radiation protection.

AB

Unauthorised access to, or interference with, the Safety Systems* and their reference data, and with other safety classified structures or equipment, shall be prevented as stipulated in the Rules*.

2.11.2.5.4.1.B

Waste collection areas/rooms with waste sacks and break areas/rooms where the personnel can rest shall be implemented in both controlled and uncontrolled areas.

BA

The break areas/rooms within the controlled area shall be located in the low radiation areas. Waste collection areas/rooms shall be located in areas that enable further waste processing (e.g. transport out of the controlled area).

2.11.2.5.4.1.C

The facility for access to supervised areas with separate paths for the entry and exit of personnel shall have adequate space to prevent crowding and be designed for straight-through flow.

2.11.2.5.4.2 CONTROLLED AREA

2.11.2.5.4.2.A

All staff, including Subcontractors*, shall enter and leave the controlled area at a single point which shall be at the entry/exit of the main changing room.

AA

A second access point shall be accepted for certain circumstances (e.g. maintenance).

2.11.2.5.4.2.B

The design shall provide entrance/exit facilities controlled by radiation monitoring system with turnstiles (dosimetry-operated for entrance and monitor-operated for exit).

BA

As part of personnel monitoring system, the main access point to the controlled area shall also be equipped with monitor for tentative examination of internal contamination of the personnel (not to be confused with whole-body counter for detailed analyses of internal contamination). See the Technical Requirements Document*, Section 2.8.2.14.3, and the Licensing and Permitting, Safety and Quality Document*, Section 2.6).

2.11.2.5.4.2.C

A guard-operated gate (for trolleys) shall also be provided.

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CA

As trolleys used for component transportation cannot pass through the control gate, a guardian shall ensure that uncontrolled contamination shall not be released.

2.11.2.5.4.2.D

Within the controlled area, the extent of contamination controlled areas shall be reduced ALARA and each contamination area shall be separated from adjacent contamination areas of different levels by the provision of a sub-changing room at the point of personnel entrance/exit.

DA

These sub-changing rooms shall define the boundary of each contamination area.

2.11.2.5.4.2.E

Access to the controlled area for fuel transport flasks, large items of the Plant* and/or Unit*, waste drums, etc., shall be via an "airlock" type plant handover arrangement which ensures that a contamination controlled area is never directly open to areas where access is uncontrolled. Other design solutions may be used for accesses to controlled area with unlimited access (see the Technical Requirements Document*, Section 2.11.2.5.2.2.1) when justified as long as the contamination spreading is precluded.

2.11.2.5.4.2.F

The access control and main changing area shall include entry turnstiles, exit monitors and turnstiles, accommodation for the access guardian, and clothing storage and locker/shower rooms for male and female staff including Subcontractors*.

FA

The capacity of these facilities shall be compatible with the numbers of staff and Subcontractor*s required during any outage, considering also capacity for conjunction of planned and unplanned outage on both Units*.

2.11.2.5.4.2.G

The layout shall provide space for offices and facilities for supervisory and health physics staff as required by the Owner*.

GA

In close proximity of the main access point to the controlled area the radiation monitoring control room shall be placed and shall be designed as follows or the Supplier* shall demonstrate another way of achieving the requirements below:

- capacity of radiation monitoring control room shall be compatible with the number of staff required to ensure radiation protection (this should include guardian to operate turnstiles, operator of radiation monitoring system, person to issue workers with protective equipment and help than in case of contamination etc. during any outage);
- include equipment/computers to operate and control radiation monitoring system, which shall also ensure availability, analysis and interpretation of all data related to radiation protection;
- enough space to store documentation;
- connection to internal communication system of supervised and controlled area to inform personnel in case of emergency situation.

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Note GA

It is typical for the Existing Nuclear Power Plant* to control and operate radiation monitoring system and ensure radiation protection of the whole plant from one central point which is placed at the main access/exit of controlled area, called central radiation monitoring control room. In this room computers to operate radiation monitoring system are placed. Radiation control room can be considered as something like Main Control Room, but from radiation point of view. This room also serves as storage of additional protective equipment (shield, masks etc.), autonomous measuring device, dosimeters, operational and maintenance documentation and also emergency decontamination loop is part of this room.

2.11.2.5.4.2.H

As design target, main corridors shall be uncontaminated and have low dose rates.

2.11.2.5.4.2.I

Where this is impractical the length of personnel routes through radiation and contamination areas shall be minimised to reduce the time spent in transit through such areas.

2.11.2.5.4.2.J

The design shall ensure that working times on active components will not be increased due to inaccessibility factors.

2.11.2.5.4.2.K

To control both the radiation dose incurred by Site* personnel working in the controlled area, and the spread of contamination, the layout of the controlled area shall be such that personnel shall not pass through areas of high radiation to gain access to an area of lower contamination.

KA

This design requirement is achieved by identifying (at the design stage) the access requirements and sources of radiation and contamination that will arise in the installation once it is operational.

2.11.2.5.4.2.L

It shall not be necessary to cross radiation/contamination-controlled areas to perform maintenance activities on equipment in non-controlled areas.

2.11.2.5.4.2.M

The Supplier* shall consider the requirements for escape routes.

2.11.2.5.4.2.N

As a basic principle, there shall be no emergency exits from non-controlled areas to controlled areas.

NA

Where necessary, emergency exits shall be permitted across control boundaries to corridors of the controlled area.

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2.11.2.5.4.3 AREA RADIATION MONITORING

2.11.2.5.4.3.A

The monitoring of radiation situation shall be in accordance with the requirements of the Mandatory Law* and the Requirements of the Authorities*, see the Technical Requirements Document*, Chapter 2.5 (in particular Decree no. 360/2016 Coll. on radiation monitoring).

2.11.2.5.4.3.B

The dose rate located within the controlled area shall be monitored by:

- permanently fixed equipment,
- periodic controls, and monitoring with mobile equipment prior to intervention.

2.11.2.5.4.3.C

Permanently fixed monitors shall be located in all low radiation areas and shall be considered in other radiation areas based on the need for personnel access. They shall have localised visible and audible alarms, which shall be adequately reflected in the MCR and radiation monitoring control room, if any.

CA

All the relevant online data related to radiation protection (e.g. data from radiation monitoring system, data from turnstiles, permanently fixed monitors, teledozimetric system, radiation protection data from the Existing Nuclear Power Plant* etc.) shall be accessible in radiation monitoring control room.

2.11.2.5.4.3.D

In particular, permanently installed monitors shall be provided:

- in the containment interior,
- at the personnel and equipment airlocks,
- in service compartments in which temporary dose rates in excess of 0,1 mSv/h are to be expected,
- in compartments in which rapid operational increases in dose rate of more than 3 mSv/h can occur.

DA

Portable monitors shall be provided in compartments where temporary dose rates may exceed 0,1 mSv/h.

2.11.2.5.4.3.E

Transport operations in the controlled area shall be monitored by mobile instrumentation and alarm systems.

2.11.2.5.4.3.F

Compartments in which radioactive equipment or sample work is carried out shall be provided with portable dose rate monitors during the duration of the work.

2.11.2.5.4.3.G

Permanently fixed iodine, gas and aerosol monitors shall be located in those zones and compartments which are considered to have a high iodine risk and where personnel intervention may be required.

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2.11.2.5.4.3.H

The final scope and location of permanently fixed and in particular portable radiation monitors shall be proposed by the Supplier* and shall be subject to the Owner's* approval.

2.11.2.5.5 NOISE AND ACOUSTIC DESIGN

2.11.2.5.5.A

The Supplier* shall ensure that the Plant* and its SSC meet the requirements of the applicable Rules* for noise and acoustic design and operation and maintenance noise level requirements as defined in Section 2.14.1.3.1.

AA

As regards the impact on the environment, existing noise sources shall be taken into account, in particular the switchyard Slavětice (incl. noise sources with low frequency and tonal noise).

2.11.2.5.5.B

The Supplier* shall be responsible for the acoustic design of the Plant*, including as minimum:

- compliance with overall Plant* noise level values,
- acoustic modelling and evaluation in accordance with Plant* layout and building general arrangements,
- individual equipment noise specifications,
- specific equipment acoustic designs for critical equipment (turbine generator, cooling towers, etc.),
- acoustic test procedures and compliance testing.

2.11.2.5.5.C

The Supplier* shall provide noise abatement for noise sources when required considering they shall:

- not impede the operational performance of the equipment,
- not create safety hazards,
- allow access for maintenance of the equipment,
- be easy to install, operate and maintain,
- assure comfortable operation to Plant* personnel particularly in control rooms and other working areas.

2.11.2.5.6 HAZARDS FROM EXPLOSIVE ATMOSPHERES

2.11.2.5.6.A

The Supplier* shall design the Plant* taking into account the potential Hazards* due to presence of flammable vapours, liquids, gas or combustible concentrations.

2.11.2.5.6.B

The Supplier* shall develop hazardous area maps and classification (ATEX) in accordance with the Rules*.

2.11.2.5.6.C

The hazardous area maps shall be defined by the Supplier* based on the Plant* layout and building general arrangement drawings.

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CA

This hazardous area maps shall include all hazardous media and items, including pipe vents and possible ignition sources.

2.11.2.5.6.D

The Supplier* shall review the potential impact for the equipment located in hazardous areas and address any non compliance issue.

DA

This may require relocating equipment that causes the Hazard* or upgrading the components to avoid the Hazard*.

2.11.2.5.7 IMPLEMENTATION OF THE GENERIC RULES IN THE PGP

2.11.2.5.7.1 TURBINE BUILDING

2.11.2.5.7.1.A

Although there is no contamination in Normal Operation* it shall be possible to provide temporary access control to potentially contaminated areas.

2.11.2.6 PGP AND BOP BUILDING STRUCTURES

2.11.2.6.A

No buildings of the Power Generation Plant* shall be required to be safety classified.

2.11.2.6.B

The design of the structure shall be optimised to realise capital cost savings without sacrificing function and operability.

2.11.2.6.C

Building structures shall be suitably fire resistant. Non-combustible or fire retardant and heat resistant materials are required to be used as far as practicable throughout the Plant*.

2.11.2.6.D

Inside the buildings, the design of the structure shall limit the propagation of effects from:

- earthquakes,
- flooding,
- fires,
- large high energy line breaks.

Underground tunnels or galleries connecting any PGP buildings or facility (e.g., the turbine building) with any Nuclear Island* building shall be designed such that flooding in a PGP building or facility does not affect any Nuclear Island* building or facility, even in the case of external or internal hazards (e.g., earthquake).

DA

Where appropriate, concrete may be used to prevent fire propagation or to provide shielding.

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2.11.2.6.E

Earthquake resistance for these buildings shall be in accordance with requirements specified in Eurocodes.

2.11.2.6.F

However damage to the building structures, or, the induced effects of high energy line breaks, flooding and fires, shall not jeopardise either the stability of the Nuclear Island* or any Safety Functions* or the accessibility to the NI.

2.11.3 EQUIPMENT ARRANGEMENT RULES

2.11.3.1 INTRODUCTION

2.11.3.1.A

This Section 2.11.3 include requirements to be fulfilled by the Supplier* when developing the equipment layout of the Plant*. The following Sections provide further guidance on layout, specific to equipment types.

AA

The Supplier* shall justify any deviation and develop more detailed rules in addition to those defined hereinafter.

AB

Layout requirements which are specific to the Containment System* are covered in Chapter 2.9.

2.11.3.1.B

The equipment shall be laid out to:

BA

- respect the requirements for system functional requirements, installation, operation (including ergonomics), In-Service Inspection (ISI), maintenance and replacement of the equipment,

BB

- provide a minimum free space of 600 mm around components which require maintenance or ISI, which takes account the thermal insulation still in place if any,

BC

- take into account required protection from Internal Hazards*, as outlined in Section 2.4.5.8.2.

BD

- take into account required protection from External Hazards*, particularly earthquakes, flooding,

2.11.3.1.C

The equipment shall be protected to meet the functional requirements by arrangement into Trains*, and Divisions* where required by the safety case as defined in Section 2.8.3.1.1.

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2.11.3.1.D

The Divisions* shall be totally independent and separated both mechanically and electrically by distance and physical barriers (as specified in Section 2.11.2.3) designed to consider:

DA

- seismic events, as outlined in Section 2.4.6. This shall include protection against the failure of seismically qualified equipment due to impact from adjacent non-seismic equipment following a seismic event as specified in Section 2.4.6 and Section 2.4.8.

DB

- the location of highly active components that require in-situ maintenance, such as pumps, in separately shielded compartments,

DC

- the retention of leakage close to the source and the prevention of leakage from controlled to non-controlled zones.

2.11.3.1.E

The layout shall be subject to interdisciplinary review as specified in Section 2.12.11.

2.11.3.1.F

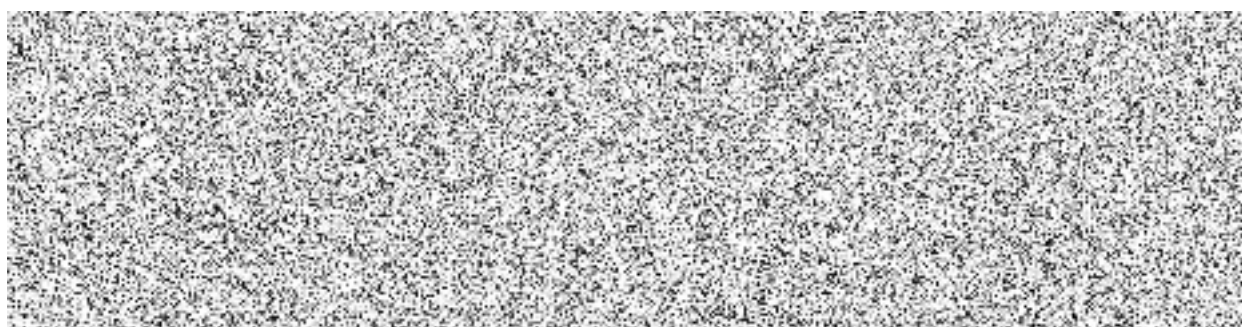
The layout shall be systematically assessed taking each Hazard*, or combination of Hazards*, into account and the reviews documented and maintained as part of the Plant* design record.

2.11.3.1.G

All Hazards* shall be taken into account in the review, including those outlined in Sections 2.1.2.6 and 2.1.9.3.

2.11.3.1.H

If the layout of Structures, Systems and Components* (SSC) performing Safety Functions* does not enable any testing, Inspection* or monitoring of these SSC to the extent desirable, then the following approach shall be applied:



2.11.3.1.I

Equipment which is likely to be removed shall incorporate the necessary fixed means for adequate removal, in particular appropriate handling and free space along the handling route.

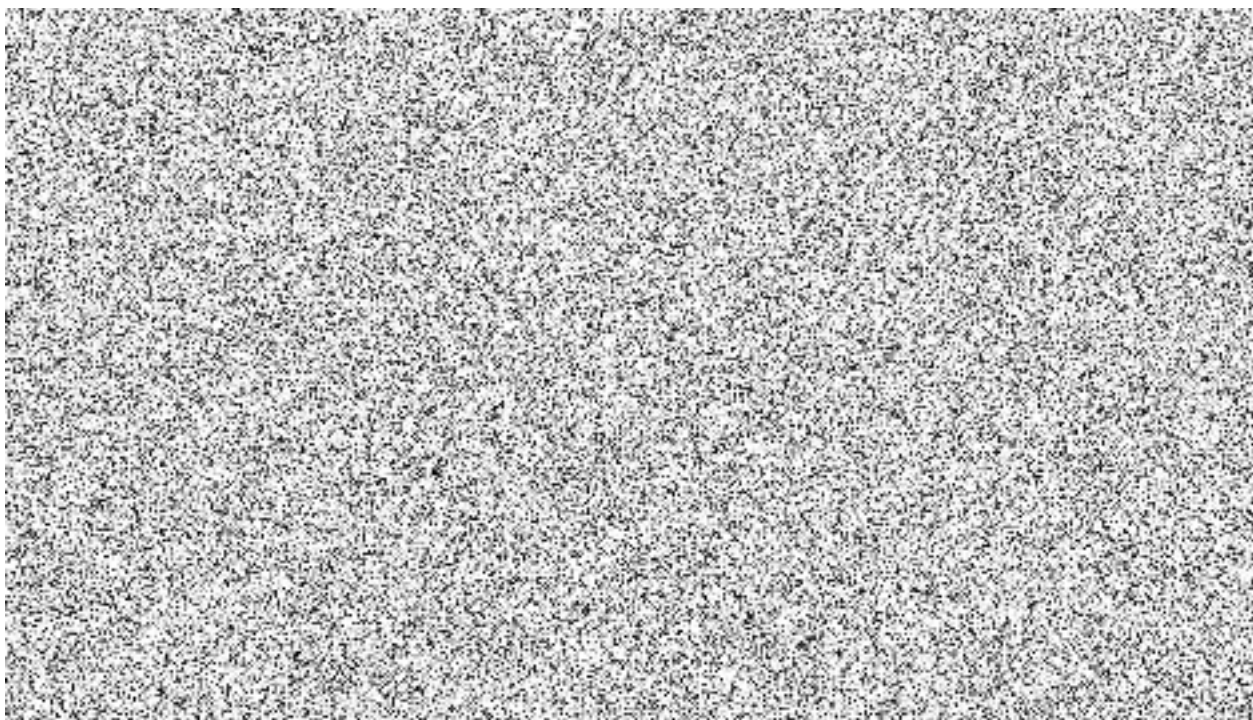
IA

The Supplier* shall provide the elements to address the protection of the safety features.

2.11.3.1.J

The following shall be considered for minimizing the occupational radiation exposure:

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2.11.3.2 ROBOTICS

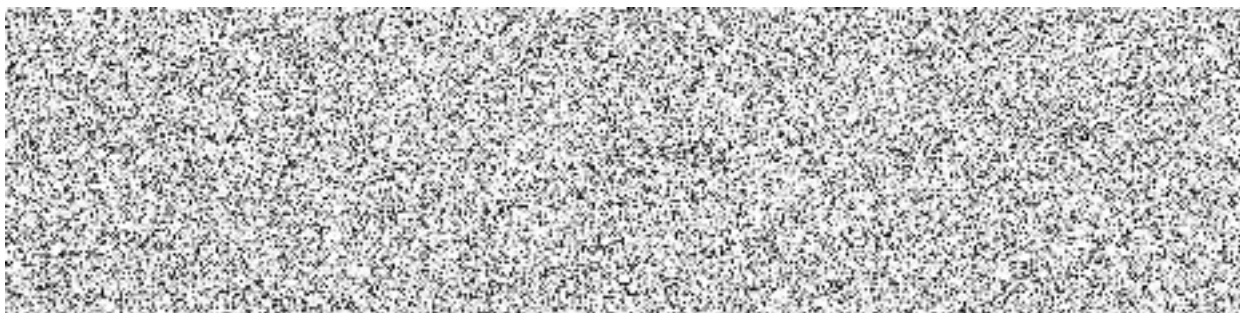
2.11.3.2.A

The Supplier* shall include a robotic applications analysis in conjunction with the Maintainability* evaluation and the In-Service Inspection considerations. See the Chapter 2.14 and Operation and Maintenance Document* Section 3.2.

2.11.3.2.B

This analysis shall consider designated storage spaces for robotic equipment, separate facilities for device decontamination, the placement of rails or tracks or the embedment of wires or other path determiners for automatic guided vehicles, distributed communication and broad band data highways, including containment penetrations dedicated for such purposes and the general application of orientation indicators.

2.11.3.3 TANKS



2.11.3.3.B

Ingress and egress for maintenance purposes in to and out of tanks shall be easy to achieve.

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2.11.3.3.C

Where manhole on top is not practicable, a lateral manhole with “sufficient spare place” in front of it and adequate permanent handling means (manhole tap, scaffolding, etc.) shall be provided.

2.11.3.3.D

If the tank is to contain radioactive fluid, a fluid collection system (retention pit, drainage system sumps, etc.) shall be planned.

2.11.3.3.E

In case of tanks containing non-radioactive fluids (in particular hazardous fluids), the decision to provide a retention pit shall be based on the applicable Rules* and, if not specified by the Rules* then it shall be based on an assessment which includes the following considerations:

- consequence of leakage,
- location of the tank,
- tank contents,
- localised drainage facilities,
- capacity of the retention pit required,
- use of a shared pit for several tanks.

EA

The assessment shall be provided to the Owner*.

2.11.3.4 PUMPS

2.11.3.4.A

Smaller pumps which are of the vertically mounted in line design shall be located such that they can be removed in one piece for replacement/overhaul.

2.11.3.4.B

To facilitate removal, a fixed lifting point shall be provided over each pump.

2.11.3.4.C

In case of larger, more sophisticated pumps, local laydown areas shall be provided and covered by fixed runway beam(s) which permit transfer to the plant removal route.

2.11.3.4.D

Care shall be taken to ensure that the siting and routing of suction pipework shall eliminate Net Positive Suction Head (NPSH) problems.

2.11.3.4.E

Any hatch and removal routes shall be large enough for the pump component movement to the decontamination /maintenance workshop.

2.11.3.4.F

The installation of the pumps conveying radioactive fluids shall be designed so as to facilitate the maintenance actions to reduce the radiation exposure of personnel (choice of location, Physical Separation*, means of handling, laydown areas, etc.).

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2.11.3.4.G

The installation shall make it possible to comply with rules of distance between elements of the circuits (elbow, etc.) and suction / discharge flanges so as to ensure stable flow regimes.

2.11.3.5 HEAT EXCHANGERS

2.11.3.5.A

Accessibility for maintenance shall be ensured over the entire circumference of the heat exchangers.

2.11.3.5.B

When siting both plate and tubular exchanger types, consideration shall be given to the "withdrawal" length and pipework connections.

BA

In case deviations from this requirement have been assumed on a sound economic basis, an easy replacement of the total component shall be assumed.

2.11.3.5.C

Plate exchangers shall have a retention pit to permit the plates to be washed down in the unclamped position. These heat exchangers shall include integral facilities for plate opening and cleaning.

CA

Floor drainage into sumps within a flood retaining room/area will meet this requirement.

2.11.3.5.D

Runway beams shall be provided for tube withdrawal on shell and tube heat exchangers unless design is provided with possibility of replacement of the whole tube bundle of the heat exchanger (when too many tubes are plugged).

2.11.3.6 FILTERS AND DEMINERALISERS

2.11.3.6.A

The design and layout of potentially radioactive filters shall allow remote replacement of the filter cartridge and handling of the spent filter cask.

2.11.3.6.B

Filters units shall be grouped in common areas and dimensions for handling equipment shall be standardised.

2.11.3.6.C

Provisions for demineralisers shall include, at least, gravity feed of the new resin charge from above and backflush discharge of active resin to the RWPS.

2.11.3.6.D

Buildings housing the demineralisers shall ensure the retention of the liquids in the event of rupture, in order to avoid the dispersion of the resins.

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2.11.3.6.F

All demineralisers of a specific system shall be located in the same general area to facilitate the filling and the draining of resins.

2.11.3.7 AIR FILTERS

2.11.3.7.A

Potentially radioactive filters shall be located in filter rooms that are segregated from other areas of the Plant*.

2.11.3.7.B

Space shall be provided adjacent to the filters for the replacement of elements, maintenance activities and testing. In the case of charcoal filter beds, provision shall be made for removal and replacement of charcoal.

2.11.3.8 EVAPORATORS

2.11.3.8.A

Evaporators to process boron or liquid radwaste shall be compartmented to segregate the more active parts from the components that may require regular Inspection* or servicing (such as the pumps).

2.11.3.8.B

Allowance shall also be made for the withdrawal of heater and cooler tube bundles. The ability of replacing the component as a whole shall be considered.

BA

If withdrawal of tube bundles or heaters is not possible, the tube bundles and heaters shall be accessible for cleaning, maintenance, repair or testing with the adequate measures to keep the doses ALARA and to assure radiation protection and the design shall be provided with possibility of replacement of the whole evaporators.

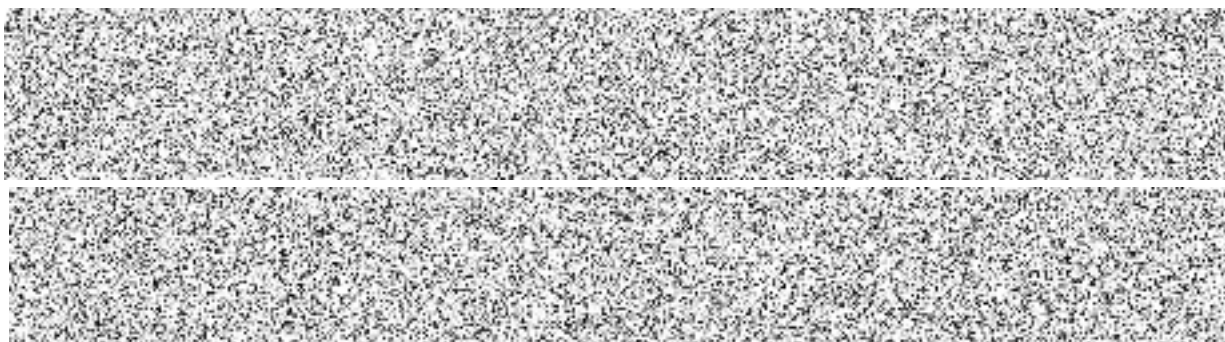
2.11.3.9 ELECTRICAL PANELS, SWITCHGEARS AND I&C ROOMS

2.11.3.9.A

The layout relationship of the Plant* shall be dictated by interconnections or requirements of segregation and separation, but minimum basic clearances are indicated as follows.

2.11.3.9.B

The electrical facilities shall be geographically located in areas free of potential water spray or flooding. If this is not possible, special layout provisions shall be taken to prevent any detrimental consequences.



CB

The arrangement of transformer stand shall enable transformer exchange, without disassembling another item of equipment, and also removing and placing transformer's cubicle during maintenance.



2.11.3.9.E

Special room provisions shall be taken and shown on the design drawings to anticipate the replacements and/or modifications likely to occur in the switchgear rooms.

2.11.3.9.F

For local layout within a room or given area, where a set of equipment is used for the same function, the same configuration (no mirror image) of each set there shall be to reduce the potential for operator error.

2.11.3.9.G

Electrical switchgears shall be separated from I&C rooms. The I&C shall be located in specific rooms.

2.11.3.9.H

All high and medium voltage switchboards shall be located in rooms specially reserved for switchgear. They shall not be located in other plant areas. This requirement shall also apply to low voltage switchboards and I&C where it's practical.



2.11.3.9.J

The electrical facilities shall be designed with special area provisions to anticipate replacements and/or layout modifications in the switchgear and other equipment rooms.

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2.11.3.10 TRANSFORMERS

2.11.3.10.A

Oil filled transformers are forbidden inside the Nuclear Island*, where only dry transformers (preferably cast resin isolated) shall be used.

AB

Oil filled transformers shall be located outside the turbine hall. Consideration shall be given to minimise connections lengths to the turbine hall.

2.11.3.10.B

The GT shall enable connection of the neutral on EHV side to the ground via low-value reactance in the future (it means especially insulation of neutral point, free space etc.).

2.11.3.10.C

Oil transformers shall be located on a raft in a compound dedicated for this purpose with secure fencing and gates provided.

CA

The transformer sump and controlled oil catchment tank shall be provided.

CB

The controlled oil catchment tank shall be sized for oil filling of the biggest transformer with fire extinguishing agents and rainwater. Rainwater from the controlled oil catchment tank shall be discharged into non-radioactive liquid waste system. See the Technical Requirements Document*, Section 4.6.5.

CC

Oil extraction devices with output to a cistern vehicle shall be provided.

2.11.3.10.D

The Fire Barrier* shall be provided between all oil filled adjacent transformers (entities), both single phase and three phase.

DA

The Fire Barrier* shall be at least 1 m above and 2 m beyond the oil containing parts, to prevent fire from spreading.

DB

The Fire Barrier* shall also be an effective "blast" resistant wall.

DC

The same Fire Barrier* shall be provided between the oil transformers and the turbine building where they are adjacent.

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2.11.3.10.E

Oil transformers stand (sitting) shall be fitted with a fixed automatic fire suppression system.

EA

An auto water spray deluge system shall be contained in a retention pit if required as a result of the safety analysis.



2.11.3.10.H

Cable distribution cubicles and cubicles with transformer auxiliaries, e.g. controllers, diagnostic, monitoring equipment, shall be located at accessible places without special equipment and precautions (ladders etc.).

2.11.3.10.I

Operation of SAPS shall not be affected by blast, fire and secondary effect (i.e. smoke and heat) of other oil transformers (GT, ANT and excitation transformer if any) and subsequent extinguishing operation and vice versa.

2.11.3.10.J

When transformer sitting is taking place, consideration shall be given to avoid disturbance to other transformers during installation or removal.

2.11.3.10.K

Transformers shall be equipped with lifting lugs for enabling movement of transformers during installation, removal and transport preparation works.

2.11.3.11 BATTERY ROOMS

2.11.3.11.A

Station batteries shall be located in a plant room dedicated for them and separate from associated distribution plant areas and cabling.

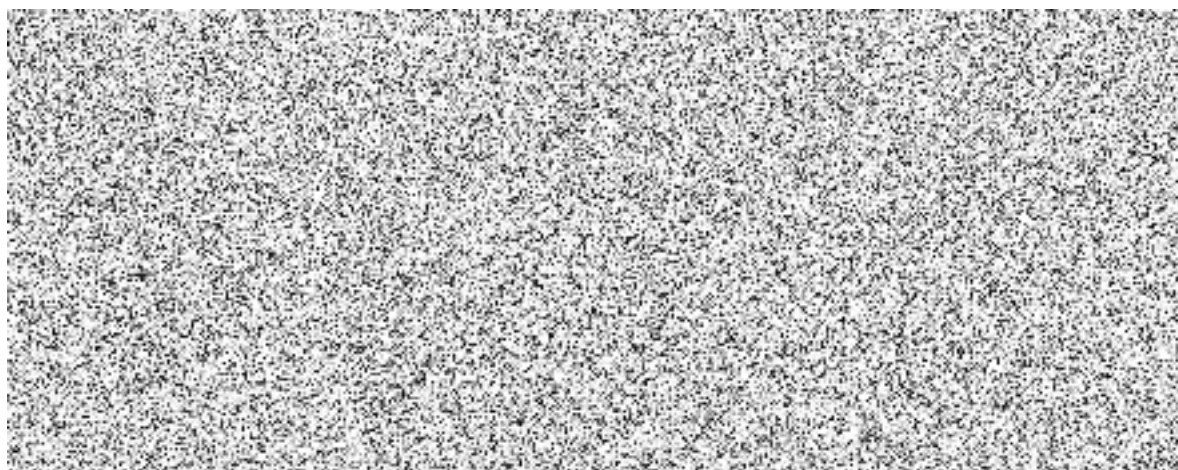


2.11.3.11.C

Ceiling configuration and ventilation shall be designed to avoid the build-up of hydrogen gas pockets.



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2.11.3.11.E

The battery room shall include running water in the event of accidents involving personnel.

EA

Battery room shall have a specific draining system in case of running water failure.

2.11.3.11.F

Battery racks and other auxiliaries in the battery room shall be acid resistant or protected against the acid influence.

2.11.3.11.G

The battery room shall be equipped by door opening towards outside with panic bar from inside of battery room and lock device from outside.

2.11.3.11.H

The passageways around the batteries shall be identified. Operation and maintenance gangways shall be in compliance with the Mandatory Law* and the Codes and Standards* in the Technical Requirements Document*, Chapter 2.5.

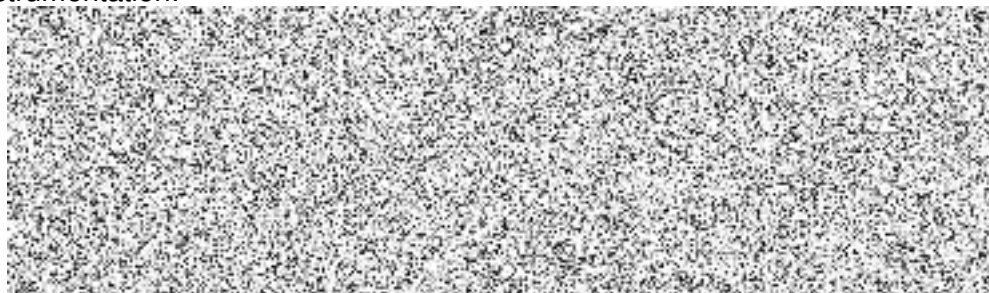
2.11.3.11.I

The battery room shall be provided with a hydrogen detection system and ventilation system sensors arranged to provide alarms in the Main Control Room to indicate hydrogen levels approaching the lower flammability limit and any failure of the ventilation system.

2.11.3.12 LOCALLY MOUNTED I&C INSTRUMENTATION

2.11.3.12.A

The following shall be taken into account when selecting the location for equipment mounted instrumentation:



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2.11.3.12.B

Instruments shall be located so that readings can be made from a readily accessible location but not all instruments within a room or area need to be routed to a single location.

2.11.3.12.C

The need for support of shielding weight and low background level shall also be considered.

2.11.3.12.D

Location of instrumentation shall be designed to minimize sample line lengths.

2.11.3.12.E

The location of flow restrictors shall not affect proper operation of measurement.

2.11.3.12.F

The layout and location of locally mounted instrumentation shall be designed to avoid its damage by maintenance work in the area.

2.11.3.12.G

Instrument lines containing radioactive fluids shall be planned in a way that they can be filled with deionised water and flushed from the isolation valves of the equipment in the direction of the system to keep their contamination as low as possible.

2.11.3.12.H

All local equipment such as transmitters, drives and actuators shall be equipped with electrical plug-socket connections to make easy and fast testing and replacement possible, where it is practical and suitable from maintenance and environmental conditions point of view.

2.11.3.13 DEGASIFIERS

A

Allowance shall be made for the withdrawal of tube bundles.

2.11.4 ROUTING OF SERVICES

2.11.4.1 GENERAL

2.11.4.1.A

This Section 2.11.4 includes requirements to be fulfilled by the Supplier* for routing of pipework and associated valves, ductwork and associated dampers, cables and trays.

AA

In addition, the seismic requirements and the need for Segregation* and Physical Separation* due to safety and radiation protection requirements shall be taken into account.

AB

The Supplier* shall justify any deviation and develop more detailed rules in addition to those defined hereinafter.

2.11.4.1.B

Routing of pipework and associated valves, ductwork and associated dampers, cables and trays shall be subject to the interdisciplinary design reviews as described in Section 2.12.11.

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2.11.4.1.C

Direct unobstructed access shall be provided to all equipment which:

- is operated frequently,
- requires frequent Inspection* and maintenance.

2.11.4.1.D

Each building and each room shall have a unique identifier.

2.11.4.1.E

Consideration shall also be given to access for normal maintenance and repair of all other equipment.

EA

Similar consideration shall be given to access requirements for snubbers, which, together with valves, will require removal space and platforms (permanent or temporary) for in service maintenance, testing and replacement.

2.11.4.1.F

Valves and dampers for systems in active areas, where frequent access is to be avoided, shall be sited or operated, where practicable, outside the shield wall.

FA

The ALARA approach shall be adopted e.g. any overall benefits of dose reduction shall be taken into account.

FB

The amount of maintenance necessary in terms of the operating mechanism shall be considered when locating this equipment.

2.11.4.1.G

Attention shall be given to the routing of the potentially dangerous Services* which, although necessary, are flammable / toxic / asphyxiating / carcinogenic, e.g. CO₂, N₂, NH₃, N₂H₄, H₂, and O₂.

GA

The use of hazardous and toxic chemicals in the Plant* shall be minimised as outlined in Section 2.14.7.

2.11.4.1.H

Each service route shall be examined individually to assess possible requirements for barriers/double containment, special venting provisions (including HVAC), avoidance of high combustible areas and Physical Separation*/Segregation*.

2.11.4.1.I

Special attention shall be given to the design and installation of components to avoid the possibility of leakage of combustible fluids, such as hydrogen, oil or hydraulic fluids, into areas where components or piping with high temperatures are located.

2.11.4.1.J

The design shall eliminate the use of buried piping carrying radioactive or potentially radioactive liquids.

2.11.4.2 HVAC

2.11.4.2.A

The arrangement of HVAC components and ductwork shall take into account safety Train* separation, Fire Areas* and Fire Zones*, and logical grouping of components within a system.

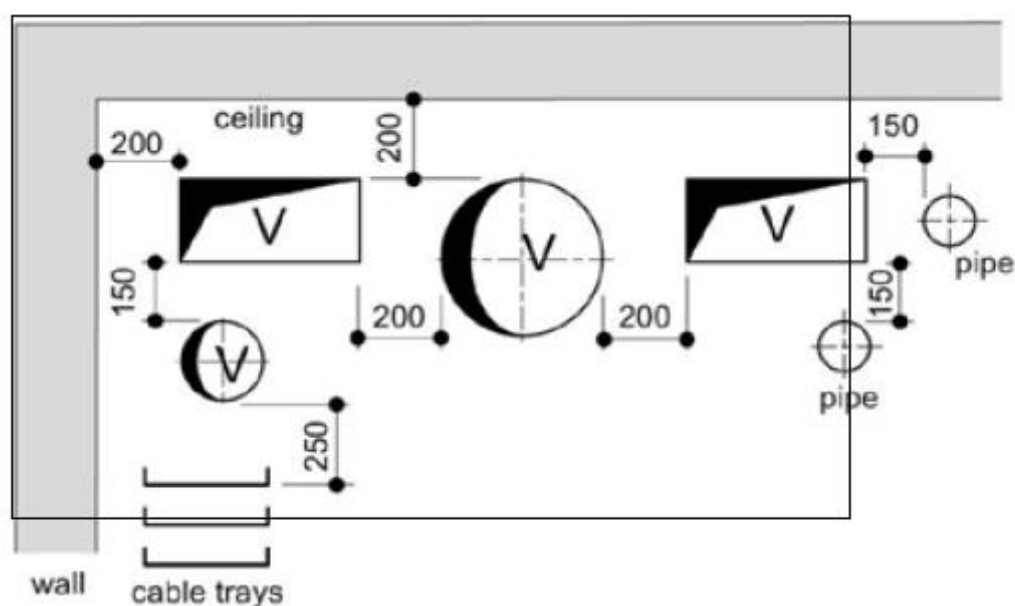
2.11.4.2.B

In addition to complying with Mandatory Law* and the Requirements of the Authorities* adequate space shall be provided for installation, insulation, operation, maintenance, and Decommissioning* and shall not adversely impact adjacent structures, cabling, or components.

BA

The minimum distances to be maintained between ventilation ducts and other equipment shall be as follows:

	Walls	HVAC	pipes	cables trays
HVAC	200 mm	150 mm vertically 200 mm horizontally	150 mm	250 mm

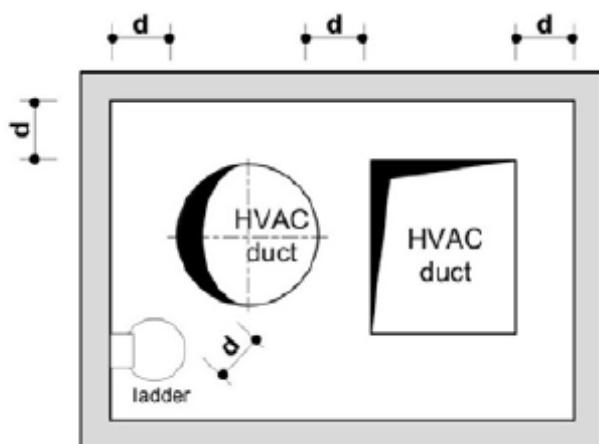


BB

Space for pipes and ducts inside shafts shall be as follows:

		Size of pipe / duct	
		D < 400 mm	D > 400 mm
bolted joining	A & B & C	150 mm	300 mm
welded joining in-situ	A & B & C	400 mm	400 mm

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BC

For Inspection*, service or replacement of online components and easy access work stations, space shall be available as shown below:

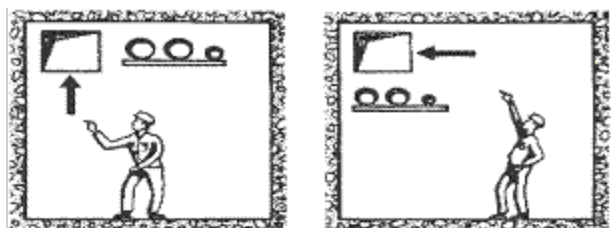


Fig 1-2 : Access on one side

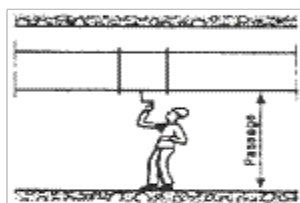


Fig 3 : Minimum headroom in the passageways

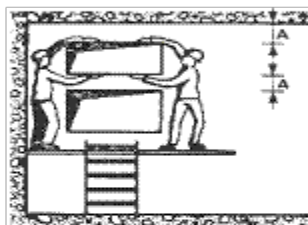


Fig 4 : Space for erection or replacement

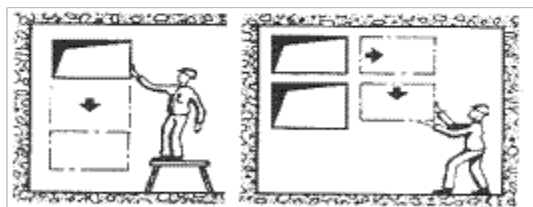
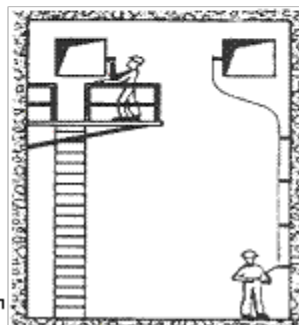


Fig 5-6 : Space and storage areas for replacement

Fig 7 : Access to be foreseen to equipment controls



BD

Deviations to above stipulated requirements are permissible as outlined in section 2.11.4.1.

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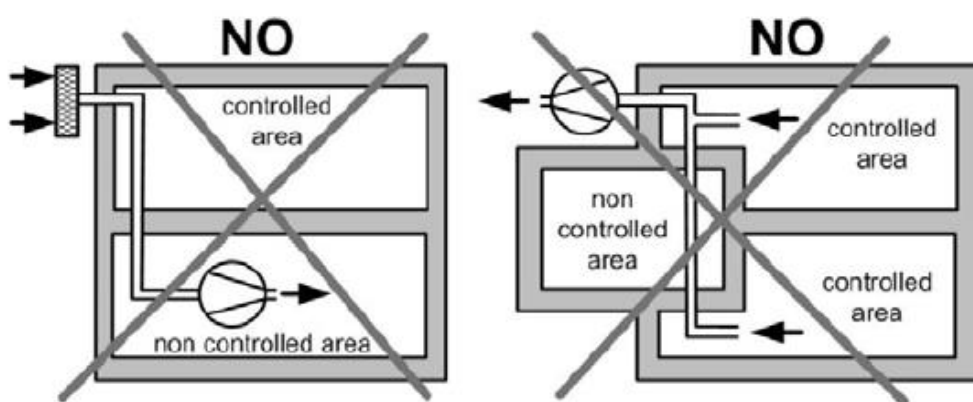
2.11.4.2.C

The layout of equipment shall also be arranged to ensure that there is separation between the non-active and potentially active components, wherever practical.

2.11.4.2.D

HVAC ductwork shall be routed such as:

- ductwork supplying air to non-controlled areas are not routed through controlled areas (especially if a supply air duct would be at a lower air pressure compared to controlled area); and
- ductwork extracting air from controlled areas are not routed through non-controlled areas.



2.11.4.3 PIPING LAYOUT

2.11.4.3.1 PIPEWORK GUIDELINES

2.11.4.3.1.A

Pipe length and the number of fittings shall be kept to a minimum with due consideration given to piping flexibility.

2.11.4.3.1.B

Permanent or temporary access shall be provided for maintenance and periodic inspection*.

2.11.4.3.1.C

Consideration shall be given to the separation of clean and radioactive piping. Pipework carrying radioactive fluids shall, as far as possible, only be routed through controlled areas, and shall be of minimum length.

2.11.4.3.1.D

High and moderate energy piping shall be separated from safety classified components, where required by the safety case.

2.11.4.3.1.E

Redundant safety divisions shall be protected adequately to meet pipe break hazard requirements. Within each Division* the equipment shall be arranged to minimise the consequences of such pipe breaks.

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2.11.4.3.1.F

Grating platforms shall be located at the optimum levels for access to valves, and to enable ISI and maintenance activities to be carried out.

FA

Pipe insulation parts shall be of the quick-disconnect type and of small size and weight to permit handling by a single person.

2.11.4.3.1.G

The use of flanged connections shall be restricted to those components which require regular maintenance, such as pumps, valves, orifices or piping, e.g. which is subject to biological growth. Flange connections shall preferably not be located above walkways and equipment, where leakage could hinder personnel access.

2.11.4.3.1.H

Piping shall be laid out in such a manner that it shall not impede access for operation or maintenance of other major components.

2.11.4.3.1.I

Elbows shall be used in preference.

2.11.4.3.1.J

Pipes carrying radioactive fluid shall be routed in pipe chases reserved for this purpose or behind structures or away from normal access areas, to minimise personnel exposure during Normal Operation* and maintenance, wherever practical.

2.11.4.3.1.K

Special attention shall be given to avoid high radiation crud traps (collection and build-up points) in the equipment and piping arrangements.

2.11.4.3.1.L

The location of flow restrictors shall accommodate any requirements for straight pipe lengths necessary for proper operation. The risk of piping damage due to cavitation shall be taken into account.

2.11.4.3.1.M

Local sampling points shall not be permitted in radioactive or potentially radioactive systems. Samples shall be routed to sampling stations.

MA

Sampling stations shall be shielded, and covered in a ventilation hood, with potential spills drained by closed piping.

2.11.4.3.1.N

Seismic piping shall not be routed directly below non-seismic piping, and shall, where possible, be routed separately. In any case, the seismic piping shall be designed to withstand loads resulting from failure of non-seismic piping and equipment.

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2.11.4.3.1.O

The pipelines shall be laid at the adequate slope so that every part of the line is possible to vent and drain. Where not feasible, venting/drainage of pipelines shall be provided by alternative means.

2.11.4.3.1.P

Relief and safety valve discharges in clean steam systems shall be piped to remote areas away from the Plant* personnel.

2.11.4.3.1.Q

Piping downstream of steam bypass or dump valves shall be as short as possible and arranged so that it does not trap condensate.

2.11.4.3.1.R

Piping shall be arranged to minimise occurrence of water hammer.

2.11.4.3.1.S

Piping that could induce damage to electrical equipment in event of leakage shall neither be routed above electrical panels or cabinets nor inside electrical and I&C rooms.

2.11.4.3.1.T

System and piping design shall minimise the potential for cavitation, high turbulence and two phase flow in valves.

2.11.4.3.1.U

The level of the vibrations shall be checked during the Commissioning* and the functional considerations shall be taken into account.

2.11.4.3.1.V

Chemical feeding system pipes that conduct aggressive fluids (i.e. sulphuric acid) shall be routed above ground or in pipe trenches so that piping leaks can be detected and controlled. The Inspection* shall be possible.

VA

The pipe with aggressive media in case of any leakage shall be designed to prevent leaks into the environment.

2.11.4.3.2 CRUD

2.11.4.3.2.A

The piping layout and construction of radioactive systems shall minimise dead legs and crud traps. The following design rules shall be used to minimise crud build-up:

AA

- instrument tapping points shall be taken off slightly below the parent pipeline midplane to avoid crud traps and gas entrapment

AB

- flow paths shall be as free as possible from abrupt changes in direction

AC

- the origin of branch process lines having little or no flow during the Normal Operation* shall be taken off above the horizontal midplane of the parent process pipe

AD

- thermal expansion loops shall be raised instead of depressed, wherever practicable

AE

- sloping piping shall be provided with low point drain and flush connections

2.11.4.3.2.B

Internal surfaces of liquid flow paths shall be smooth and as free from abrupt discontinuities in cross-section as is practicable.

2.11.4.3.2.C

Welding of piping shall not induce any accumulation of activated corrosion products. Types of weld which could give rise to discontinuities in the pipe bore shall be avoided, i.e. socket welds.

2.11.4.3.3 SPACE RESERVATION FOR INSULATION THICKNESS

A

Provisions shall be taken into account for the necessary insulation around pipes and its removal where needed.

2.11.4.3.4 SLOPES

2.11.4.3.4.A

Pipelines shall be laid with sufficient slope for the pipe to be drained. Where not feasible draining of pipelines shall be provided by alternative means.

AA

All pipes shall be sloped according to the type of fluid flowing therein:

pipes		minimum slope
for liquid	non-active active	5 mm/m 10 mm/m
for liquid (waste pipe)	non-active	15 mm/m
for resin (5 diameter radius bend)	filling pipe draining pipe	50 mm/m 10 mm/m
for steam		20 mm/m

Any deviation shall be justified.

2.11.4.3.4.B

For spent resin and radioactive slurries, pipes shall be continuously sloped, with backflushing to the tanks.

2.11.4.3.5 DISTANCES BETWEEN PIPES

A

In addition to complying with Mandatory Law* and the Requirements of the Authorities* minimum distances between pipes or between walls and pipes, insulated or not shall be

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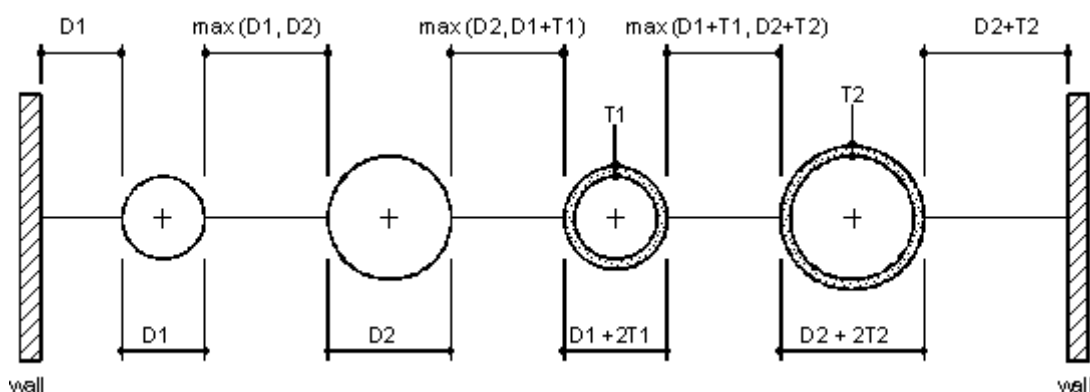
provided for installation, insulation, operation, maintenance, and Decommissioning* and shall not adversely impact adjacent structures, cabling, or components.

AA

For pipes submitted to ISI, see also Section 2.11.4.3.8.

AB

From the two figures proposed the minimum distance is the maximum external diameter of the pipes, whether they are insulated or not.



AC

For pipes less than 150 mm in diameter, the minimal distance between pipes or between walls and pipes shall be 150 mm.

AD

Deviations to above stipulated requirements are permissible as outlined in section 2.11.4.1.

2.11.4.3.6 HIGH AND LOW POINTS

2.11.4.3.6.A

In piping runs, the number of high and low points shall be kept to the absolute minimum.

2.11.4.3.6.B

High points in pump suction lines shall be avoided.

2.11.4.3.6.C

In case of high or low points, adequate vent or drain provisions have to be made.

2.11.4.3.7 VENTS AND DRAINS

2.11.4.3.7.A

Pipework shall be arranged in such a way as to ensure that adequate space exists for vents and drains where required.

2.11.4.3.7.B

Vent and drain terminal points shall be routed so that any leakage does not affect equipment or walkways.

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2.11.4.3.8 ACCESS FOR IN-SERVICE INSPECTION

2.11.4.3.8.A

Pipes submitted to Inspections* shall be as accessible as possible, with a minimum free space.

AA

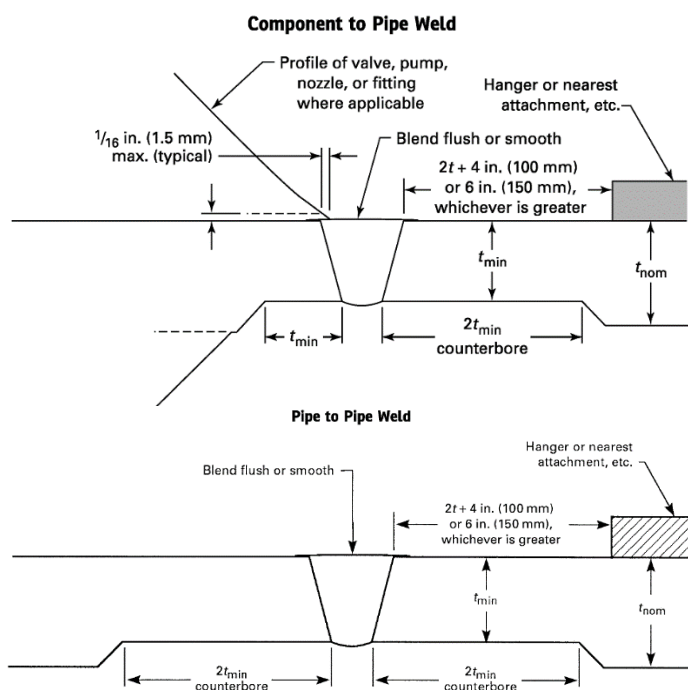
Pipes that form part of a layer and require Inspections* shall be located to the outside to ensure access without removing other piping.

AB

Pipes shall be arranged to provide access to all welds potentially subject to ISI and sufficient space between the welds.

AC

The distance between two welds potentially subject to ISI shall be at least two times the pipe wall thickness plus 100 mm or 150 mm, whichever is greater, according to the following figure.



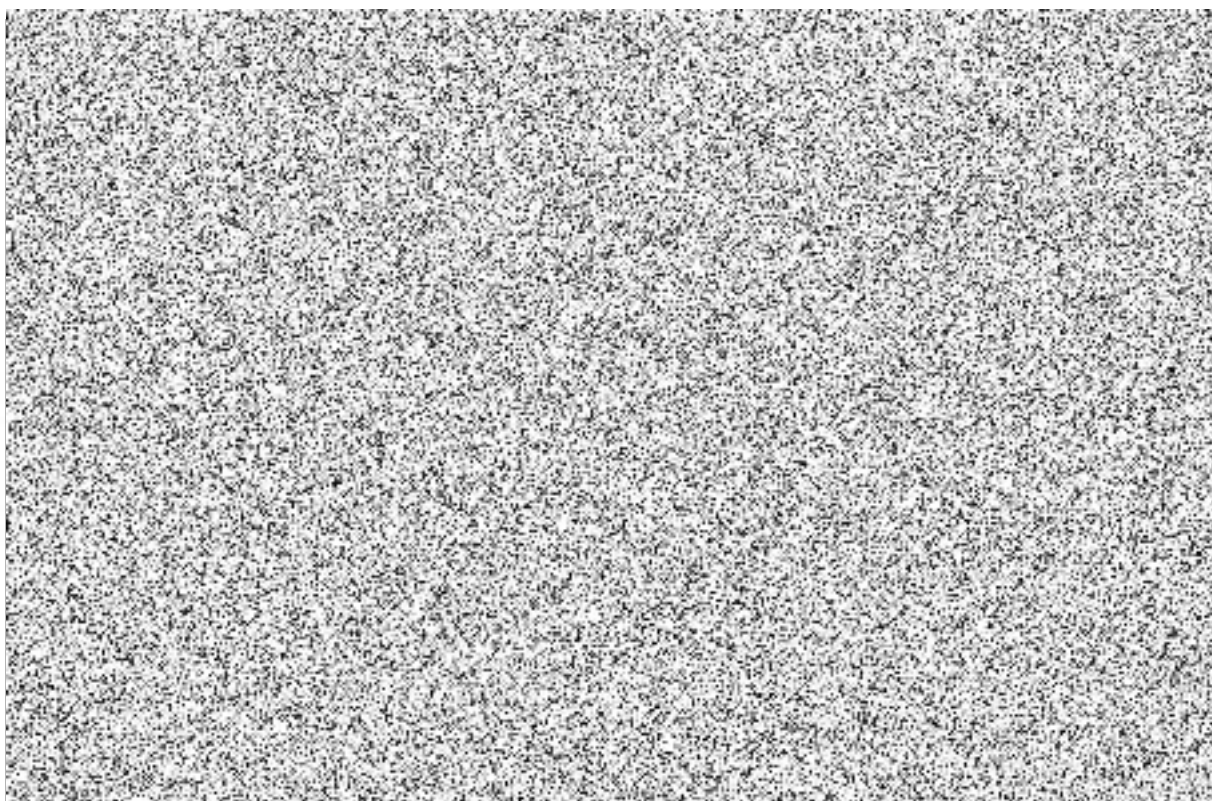
2.11.4.3.8.B

Permanent or temporary access shall be provided for maintenance and periodic Inspection*.

2.11.4.3.8.C

Minimum free space for pipes submitted to Inspections* shall be as shown below:

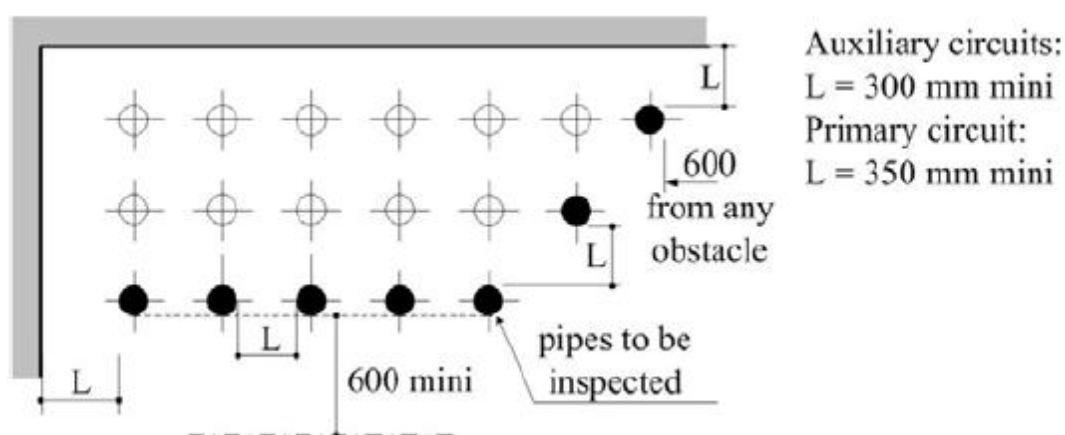




* A restriction may be a wall, a parallel pipe or other rigid obstruction that runs along the length of the pipe for a distance greater than 30 cm on either side of the weld.

+ Pipe does not include the thickness of insulation.

For commonly routed pipes:



2.11.4.3.8.D

Buried and underground piping systems shall be assessed by predictive computer codes and include provisions for inspection by indirect and/or direct technologies.

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2.11.4.4 VALVE LAYOUT

2.11.4.4.A

Where practical, all valves shall be located so that flow is horizontal and stem orientation is almost vertical while meeting the manufacturer's requirements for operation, maintenance and dismantling.

AA

The effects of stem orientation are less critical for valves of less than 100 mm in diameter. For valves >100 mm in diameter, where layout dictates that this requirement is not practicable, the following functional considerations shall be taken into account:

- whether the valve is horizontally located,
- the effects of possible stem leakage on the actuator,
- the effects of handling and maintenance,
- deposition of suspended or dissolved material, and wear upon gate valve discs,
- pressure drop and "valve slam" with swing disc check valves,
- actuator life and the need for increased maintenance,
- increase in valve stroking time.

2.11.4.4.B

Valves shall be located so that Normal Operation* and maintenance can be conveniently performed from normal platform or floor locations in a standing position.

2.11.4.4.C

Wherever possible, valves (especially manual valves) shall be located outside high radiation level areas.

CA

If not possible they shall be equipped with extended spindles or adequately shielded to ensure radiation protection.

CB

However, the use of extended spindles to facilitate valve operation shall, where practicable, be avoided for both manual and power actuated valves by ensuring adequate access to the valve for operation and maintenance.

CC

Where manual valves are situated behind radiation shield walls, suitably designed extended spindles shall be included to allow operation of the valves from the shielded side of the wall.

CD

Extended spindles shall not extend into areas required for personnel access to equipment.

2.11.4.4.D

Clearance for rising stems, rising actuators, handwheels etc. shall be provided on all valves as applicable.

DA

Rising stems, especially on motor operated valves, shall not extend into personnel access areas.

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2.11.4.4.E

Valves shall be arranged so that clearance exists for all maintenance operations.

2.11.4.4.F

In the case of lines containing a manual control valve with an associated localised instrument such as a flow indicator, the valve and instrument shall be located in close proximity so the valve can be adjusted while observing the indicator.

2.11.4.4.G

Valve actuators shall be supported so that the normal movement of the pipe can be accommodated without subjecting the actuator to excessive loads.

GA

Adequate space shall exist for maintenance, transport to the workshop and dismantling the actuators of all valves.

2.11.4.4.H

The number of seismic snubbers shall be minimised and shall be considered during the layout stage of the relevant piping/valve systems.

HA

Seismic snubbing of valve topworks may be necessary in certain cases, as dictated by the piping design.

HB

This shall be considered during the layout stage of the relevant piping/valve systems.

2.11.4.4.I

The layout and dimensions of connections to utilities (e.g. steam leak-off, compressed air, fluids, electrical power, etc.) shall be standardised.

2.11.4.4.J

Valve actuators in any building shall be located above the flooding level, e.g. in case of a LOCA.

2.11.4.4.K

Valves shall not be butt welded together or butt welded directly to other fittings.

2.11.4.4.L

Stem leak-off pipe diameters shall be standardised and may be designated non-safety classified.

2.11.4.4.M

Process valves shall not be located at low points in piping.

2.11.4.4.N

The containment isolation valves shall be located as close as to the containment boundary as practical.

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NA

Sufficient space shall be provided between the valves and containment boundary to ensure that testing and maintenance can be performed.

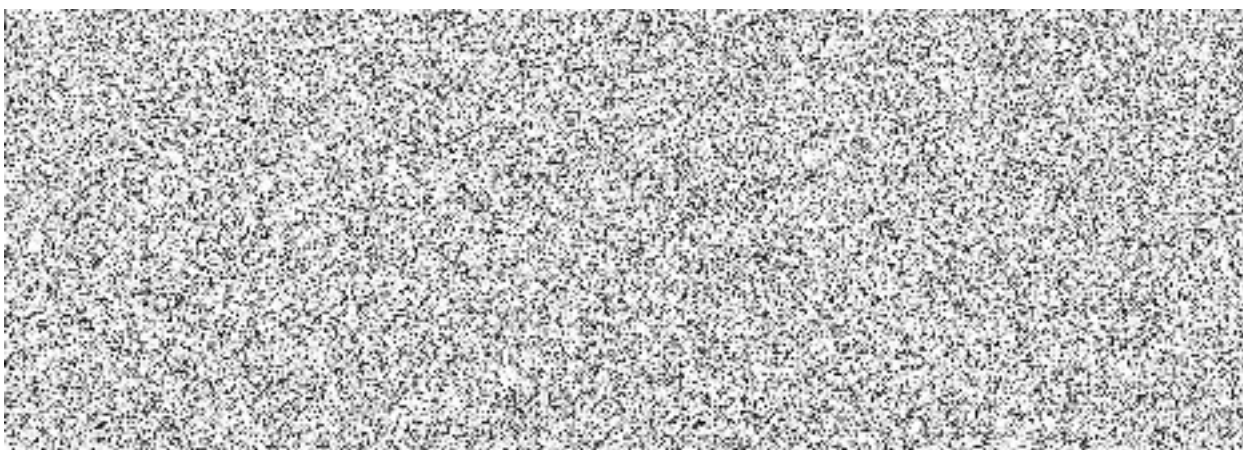
2.11.4.5 CABLE ROUTING

2.11.4.5.A

Cables shall be organized into and routed along principal routes in banks of multiple cable trays or ladder racks generally arranged with separation between several kinds of cables (e.g. power cables, low voltage, high voltage, and various types of I&C cables).

2.11.4.5.B

Cable routings shall meet the independence requirements of IAEA NS-G-1.7, SSG-34 and shall be in compliance with other Mandatory Law* specified in the Technical Requirements Document*, Chapter 2.5 and in accordance with the document "Principles of cabling" specified in the Technical Requirements Document*, Section 2.7.11.4.3.



CA

The arrangement of cable trays shall be in compliance with the Mandatory Law* and the Codes and Standards* specified in the Technical Requirements Document*, Chapter 2.5.

CB

The criteria for Physical Separation* of cables shall be implemented for cables provided different functions and designed for different voltages, including cables for mutually backed up technological systems.

CC

The criteria for installation of low voltage cables including I&C cables shall be implemented to ensure protection against induction and radio frequency/electromagnetic interference (RFI /EMI) sources disturbing signal.

CD

Cable trays shall be designed with reserve capacity at least 20% (equally spread for each group of cables) at the Final Takeover* date for possibility of future modifications and backfitting during Plant* operation.

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2.11.4.5.D

Principal cable tray routes shall be routed in cable areas dedicated to such tray routes connected by cable risers and tunnels. This requirement shall be strictly applied where is concentrated huge amount of cables e.g. close to control facilities, etc.

DA

Cables related to the Safety Systems* shall be physically separated between the Divisions* (exception is described in the requirement BB in the Technical Requirements Document*, Section 2.11.2.2.1 and requirement DB, Section 2.11.4.5 of this Technical Requirements Document*).

DB

Where cables from more than one Division* or Train* serve a common area (e.g. the MCR), these requirements above shall be applied up to the point where it is possible, after the point there shall be maximal possible Physical Separation* to reach adequate Independence*. In such cases the Supplier* shall conduct other supporting analysis to justify a solution early enough during the design process. This analysis shall be approved by the Owner* and/or by the Authorities*.

DC

All cables associated with the one safety Division* shall be separated from cables associated with other safety Divisions* by the Principal Barriers*.

DD

Special attention shall be paid to the geographical separation of the Division* related cable route.

DE

Within the Divisions*, each Train* shall be separated either spatially (the Fire Zone*) or by the barriers.

2.11.4.5.E

Cable trays shall be installed above piping routes. Any exception shall be well justified and countermeasures to protect cables shall be installed if needed.

2.11.4.5.F

As a design principle, cables shall not be routed through rooms unless they are serving equipment in that room. Any exception shall be well justified and countermeasures to protect cables shall be installed if needed.

2.11.4.5.G

The Supplier* shall provide to the Owner* software and data for cable routing.

2.11.4.5.H

Cables, cable trays and its systems, structures and components shall be treated and installed with respect to manufacturer's specifications in order to preclude deterioration or damage of particular components (especially cables) during installation. Detailed technological procedures shall also be elaborated, provided and followed.

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2.11.4.5.I

Cable areas shall be equipped by a fixed automatic or manual fire suppression system according to the fire hazard analysis.

2.11.5 SITE SUPPORT SYSTEMS

2.11.5.A

The Supplier* shall provide all necessary Site* support and service systems to ensure operation of the Plant* such as (but not limited to):

- drinking water supply,
- hot water supply,
- sewage water drains,
- heating water and HVAC,
- electrical power,
- lighting,
- fire protection,
- physical protection (incl. I&HAS),
- communication systems including non-process computer networks,
- service and demineralized water supply,
- compressed and breathing air and gas supply,
- stormwater drains,
- waste water drains.

AA

Use of SSC during the construction period shall be subject to the Owner's* approval.

AB

The Supplier* shall review the requirements of any additional service during construction to justify that it is compatible with the purchase and design requirements and is adequately reflected in the purchase specifications.

AC

The Supplier* shall refurbish the SSC as necessary so that when the SSC are turned over for permanent Plant* operation, they are in a "as good as new" condition.

AD

Site* support and service systems shall be designed with appropriate spare capacity (including, inter alia, space reserve) in order to provide a possibility for future (reasonable foreseeable) modification of the Plant* as well as facilities related to the Owner's Scope of Supply* located at the Site* and/or modification or addition of interconnection of such facilities with the Site* support and service systems.

AE

Such spare capacity shall also cover requirements of the Owner's* office building located at Owner's* construction area A2, with estimated capacities as follows:

- power supply: 1 MWe;
- heating water: 750 kW;

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- waste water drainage: piping design capacity 20,65 l/s, average daily amount 28,2 m³/d;
- stormwater drainage: piping design capacity 144 l/s, average annual amount 7161 m³/y;
- communication systems including non-process computer networks for approx. 470 persons;
- fire protection, physical protection (incl. I&HAS).

AF

The spare capacity shall include capacity for future spent fuel interim storage and fresh fuel storage as required in Section 2.11.1.1.1.

2.11.5.B

These systems, where additional requirements are not set in the Technical Requirements Document* and/or Rules*, shall be designed in accordance with standard industrial practice (in accordance with the Czech Codes and Standards*), and take into account the additional requirements referenced below.

2.11.5.C

Waste water drains systems shall be segregated as follows:

- active or potentially active:
 - low conductivity wastes,
 - high conductivity wastes,
 - chemical wastes,
 - detergent wastes,
 - mixed wastes,
- non-active:
 - equipment drains (clean),
 - floor drains (dirty).

2.11.5.D

Oily and potentially oily drains shall be segregated to prevent discharge of waste contaminated by oil, or contamination of the waste treatment processes by oil.

2.11.5.E

The chemical drain networks shall be independent to have the ability to neutralize the hazardous chemicals.

2.11.5.F

Non-active drains shall not be located in active areas to avoid the possibility of active fluid being discharged down non-active drains.

2.11.6 SECURITY

2.11.6.A

The Plant* design shall review the layout and identify the Structures, Systems and Components* that are to be protected and the Vital Areas* for construction and Normal Operation* (including refuelling and major outages).

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Note AA

See Chapter 2.1 Section 2.1.8.3.2

2.11.6.B

The plant arrangement and the design of buildings shall facilitate the control of personnel and movement of material with a minimum of security and radiological control points. It shall also facilitate surveillance and response of the security force.

2.11.6.C

These control points shall be sized to accommodate personnel for both normal and maintenance outages and to incur the minimum of delay in response.

2.11.6.D

The security areas of the exterior buildings shall be arranged to minimise irregular shapes which would require additional surveillance equipment and monitors.

2.11.6.E

The Plant* arrangement shall be consistent with the security system requirements and with the access control specified in Section 2.11.2.5.4 of Technical Requirements Document*.

2.11.6.F

The access routes to be used by personnel under emergency conditions shall be defined and shall provide guidance for access from the MCR, to the ECR and to the Emergency Response Facilities*.

2.11.6.G

The Supplier* shall provide means to prevent unauthorized access.

2.11.6.H

The security provisions shall not be capable of failing in a manner which would block necessary Operator* access during emergencies.

2.11.6.I

The Supplier* shall incorporate physical protection measures into the design of the Plant*, such as strengthening of the Vital Areas* boundary.

2.11.6.J

A selected area devoted to nursing staff dealing with injured persons in the controlled area shall be found close to the changing room. It shall be equipped with first aid means allowing the injured person to wait for their means of transportation to the hospital.

2.11.6.K

Additional provisions shall be provided, such as:

- room for processing visitors and personnel who do not have permanent badges,
- metal and explosive detectors,
- doors with controlled access,
- provisions for alcohol and drug testing,
- provisions and staff for work with classified information,
- offices and work space outside the protected areas.

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2.11.6.L

Access to the different areas shall be computer logged (i.e. time of day, date, area, etc.) for each exit and entry and controlled to allow access of specified individuals only.

Note LA

Logging of entry and exit will allow surveillance and review of access patterns of individuals and evaluation of appropriateness of access authorisation. In addition, alarms to indicate attempts at unauthorised access will permit expeditious response by the security force where appropriate.

2.11.6.M

Access to equipment important for security reasons shall require passage through at least two physical barriers.

2.11.6.N

The design of important area boundary doors or access shall be based upon penetration delay times which are compatible with the capabilities of the intrusion detection systems and the response capability of the NPP security force.

2.11.6.O

In order to allow access by individuals into the areas where Safety Systems* are located (e.g. MCR, electrical safety Divisions, etc.) means shall be provided for their identification.

Note OA

This can be accomplished by using video systems, card readers and/or hard key and lock controls as permit/concur devices.

2.11.6.1 ON SITE WIRELESS COMMUNICATION SYSTEM REQUIREMENTS

2.11.6.1.A

The Supplier* shall establish reliable a wireless electronic communication system to ensure effective communication for all activities connected with fire and physical protection.

2.11.6.1.B

The Supplier* shall design and supply such wireless communication system to meet following requirements:

- The communication system shall be independent from other communication systems with which is connected.
- The communication system shall not be affected by the failure of connected other connected communication system.
- The communication system shall be designed that failure of its component shall not affect the entire system.
- Signal coverage of all objects supplied by the Supplier*.
- Demand on emergency signal transmission.
- The possibility of selective calls (separately within the physical protection unit and fire protection unit) including the possibility of connection to telephone network.
- The possibility of group or individual communications.

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- The possibility of selective call between two basic modes - nominal operational and action mode (e.g. for fire rescue service in case of fire and for physical protection in case of intrusion).
- Sufficient number of handheld communications devices to secure fire and physical protection.
- Mechanical ruggedness accordant with long-term use in outdoor environment - e.g. an appropriate range of operating temperatures.
- Control panels with an output for monitoring of voice communication and with the possibility of identification of the terminal equipment.
- Rechargeable terminal facilities also in emergency control centres (e.g. Main Control Room*, Emergency Control Room*, Emergency Response Facilities*).
- The possibility of communication in the noisy operations (a sufficient pieces of headsets).
- The compatibility (the possibility of connection) with the joint rescue service and the fire rescue service, used for communication between on-site fire rescue service and state fire rescue service and with other joint rescue service units.

2.11.7 DECONTAMINATION FACILITIES

2.11.7.A

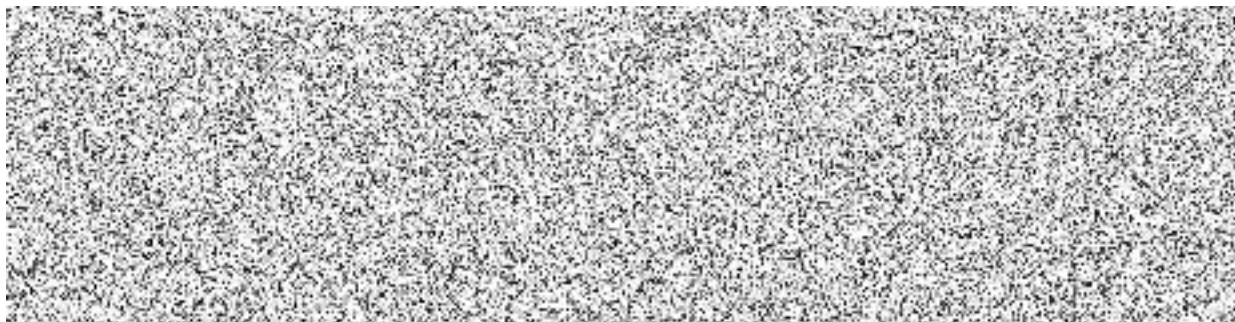
Areas and facilities shall be provided in the Plant* for the decontamination of active components prior to maintenance or repair in the Plant's* workshops, or prior to the transportation off-site.

AA

See further requirements in Section 2.14.4.3.

2.11.7.B

Connections shall be provided for decontamination flushing.



2.11.8 LABORATORIES

2.11.8.A

Laboratory facilities and equipment (including analytical instruments) shall be provided by the Supplier* to assure that on-site sampling and analysis capabilities can be performed to the required accuracy at the Plant*.

2.11.8.B

The Supplier* shall incorporate adequate sampling and analysis capacities for the Operation and Maintenance of the Plant* without need of outside facilities.

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BA

For more information see Section 2.8.2.14.6.

2.11.8.C

Instrumentation shall be state-of-the-art and shall follow the best practice in nuclear industry to ensure that analyses will be performed in accurate and efficient manner (e.g. inductively coupled plasma - optical emission spectrometer ICP - OES, inductively coupled plasma - mass-spectrometer ICP - MS).

CA

The final instrumentation equipment shall be selected in the future and shall be subject to the Owner's approval*.

CB

All equipment (analytical instruments, measurement standards, gauges, etc.) of the laboratories shall be certified in accordance with the Rules*, in particular Act No. 505/1990 Coll., as amended. The Supplier* shall ensure appropriate calibration for those measurement instruments which are not subject of certification according to the Rules*. The Supplier* shall provide to the Owner* any necessary documents and certificates associated with such equipment.

2.11.8.D

Laboratories shall be located so that, under post-accident conditions, they remain outside active areas and are accessible by personnel.

2.11.8.E

The radiation counting rooms, instrument calibration areas and checkout areas shall be located in low radiation zones of the Plant* and provided with a wall, or slab shielding, to reduce background radiation levels so that they do not influence the required measurement sensitivities.

EA

Shielding shall be constructed of material that has been screened for radioactivity prior to fabrication.

EB

The Supplier* shall ensure that the atmosphere in the radiation counting rooms, in the event of a reactor accident, does not become contaminated with airborne radioactivity which would invalidate the analysis of post-accident systems and work atmosphere samples.

2.11.8.F

A storage area shall be provided for laboratory chemicals and supplies and portable equipment.

2.11.8.G

Means shall be provided to facilitate the transfer of both chemical and radioactive wastes from the laboratories to the appropriate radwaste system, taking due account of ALARA requirements.

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2.11.8.H

Special laboratory chemicals that cannot be handled by the normal radwaste systems shall include their own method of handling and disposal of waste solutions.

2.11.8.I

All waste products generated shall be of a form which allows for ultimate disposal by an approved route.

2.11.8.J

Mixed wastes shall be avoided whenever possible.

2.11.8.K

Provisions shall be made for safe storage of the associated chemicals and the measures necessary for protection of personnel and environment shall be made.

2.11.8.L

The system shall include the safety devices for personnel in accordance with the Rules* to be applied.

2.11.9 LIFTING EQUIPMENT

2.11.9.1 GENERAL

2.11.9.1.A

A safe load path shall be provided and designated for moving all heavy or critical loads (all equipment, which if dropped, could affect the safe shutdown equipment) above and across various areas and shall be served by lifting equipment as necessary.

AA

The functional requirements associated with lifting equipment are outlined in Technical Requirements Document* Section 2.7.14.

2.11.9.1.B



2.11.9.1.C

Designated interim placement and storage areas shall be provided for all such heavy or critical loads (if any).

2.11.9.1.D

Lifting equipment located above Structures, Systems and Components* important to safety during Normal Operation* used in areas near to fuel assemblies shall be seismically qualified.

2.11.9.1.E

Lifting tackle for routine handling operations shall be provided with electric motions where dictated by the height of lift, weight or travel length, unless agreed to the contrary with the Owner*.

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2.11.9.1.F

For continuously operated components, the permanent maintenance trolleys and blocks shall be equipped with electrically operated hoists, irrespective of weight.

2.11.9.2 MAINTENANCE

A

Where permanent lifting provisions are not considered necessary then space shall be enabled for temporary floor based equipment, or an eyebolt/runway beam shall be provided to achieve maintenance handling in accordance with the following principles:



AB

Lifting tackles shall be provided for component for which, whatever the weight, a manual lift would be dangerous.



AE

For loads of 5 tonnes or more, or where accuracy is required in positioning for dismantling or assembly of components, electric operation and creep control shall be on all motions.

AF

Where lifting points above equipment would be inaccessible, an alternative handling device shall be provided.



AH

Where a load can be luffed and before the item is raised into a vertical position the weight of load involved, distance to be moved, height of the suspension point and method of adjustment are the factors shall be considered.

AI

Lifting equipment provided to cover the above requirements may be shared when usage is infrequent.

AJ

Main corridors and hallways shall allow for the use of a forklift truck scaled for a standard European pallet.

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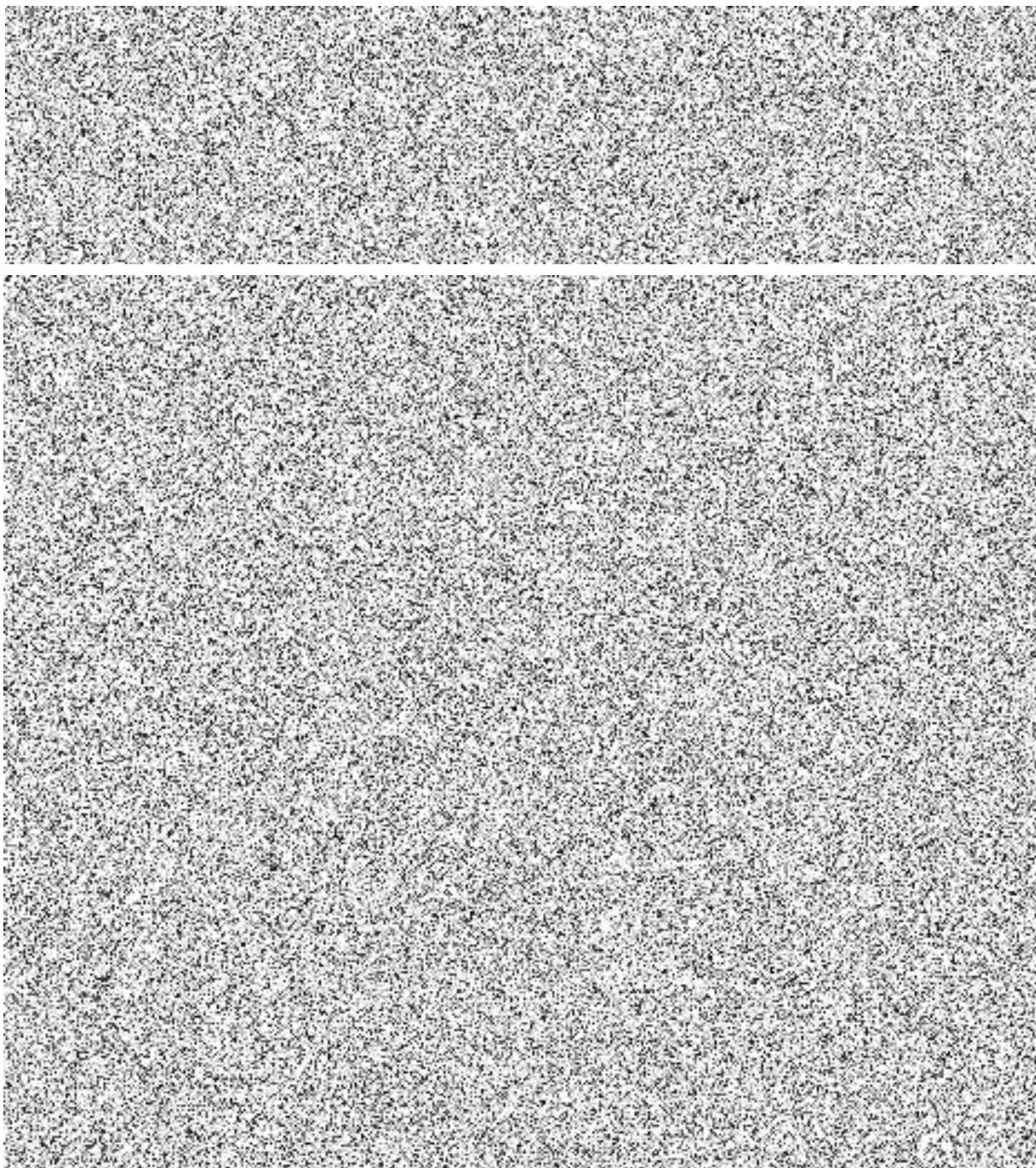
AK

Elevators shall all be designed to provide enough space to accommodate electric and manual trolleys provided by the design for cargo delivering.

2.11.9.3 REFUELLING POOL FACILITIES

2.11.9.3.A

Where special handling facilities are required, or when time limits could be imposed for handling operations, the lifting tackle and handling procedure shall be approved by the Owner*.



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2.11.9.3.D

The minimum retention capacity shall be implemented so as to get a minimum water height of 150 mm above the spent fuel racks and cask, in case of accidental pool drainage.

2.11.9.3.E

The Supplier* shall take into account a reasonable area for fuel tools storage (average of 25 m²) and sufficient free space between the walls and the fuel racks (average of 600 mm) for radiological aspects, cooling and handling facilities.

2.11.9.4 LIST OF EQUIPMENT

A

A list of lifting beams and hoists shall be prepared as the Supplier* develops the design so that the relevant maintenance requirements can be identified, standardised and optimised.

AA

The list of lifting beams and hoist shall be approved by the Owner*.

2.11.10 SHELTERS

2.11.10.A

The Supplier* shall design and construct the shelter/s of the rescue system according to the Mandatory Law*.

AA

Shelter/s shall be designed according to the Rules* (See Chapter 2.5).

2.11.10.B

Shelters shall be designed to accommodate:

- Technical Support Centre (if not located in other dedicated protected rooms),
- Operational Support Centre (if not located in other dedicated protected rooms),
- Emergency Preparedness Centre (if not located in other dedicated protected rooms),
- All personnel needed for the accident management for the at least 72 hours,
- Other personnel according to emergency plan.

2.11.10.C

The shelter/s including revised Emergency Plan shall be ready to operate 3 months before the first fuel loading of the earlier Unit*.

2.11.10.D

Other technical requirements for buildings of shelters are described in the Technical Requirements Document*, Section 4.7.4.

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EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.12 DESIGN PROCESS AND DOCUMENTATION
VERSION DATE:	March 2025

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CHAPTER 2.12 DESIGN PROCESS AND DOCUMENTATION

The objective of the Chapter 2.12 is to outline a set of requirements aimed at design process and documentation.

Other requirements relating to this Chapter are stipulated in other parts of the EPC Contract* especially in the Technical Requirements Document*, Project Management Document*, Scope of Supply Document* and Terms and Conditions*.

The Chapter includes 2 attachments:

- Attachment 1: Content of Design,
- Attachment 2: Basic Modelling Rules.

2.12.1 INTRODUCTORY PROVISIONS

2.12.1.A

The Plant* design shall be based on the Standard Design* as described in the Licensing and Permitting, Safety and Quality Document*.

The Plant* design shall be based on the Standard Design* developed and managed in a controlled way by the Supplier*. The Standard Design* shall incorporate lessons learned from the Reference Plant* and other projects (in particular from APR1400 and OPR1000 projects).

The Plant* design shall comply with applicable Rules* and the requirements stipulated by the EPC Contract* as a whole.

AA

The design and licensing documentation of the Reference Plant* and Standard Design* and any other standardized parts of the Plant* (PGP, BOP), up to and including Basic Design* documentation and PSAR including PSA, upon which the Plant* design will be based on shall be provided to the Owner*. The documentation shall be in English.

2.12.1.B

All the design and design process requirements shall be identified, developed and documented within Supplier's* design process incl. their Design Basis* and information about their origin. Supplier's* design process shall be integral part of Project Configuration Management System* and vice versa. Supplier's* design process shall appropriately include inter alia Project* requirements identification, collection, validation and verification process (i.e. requirement management) (see also Section 2.5.2 of the Project Management Document*).

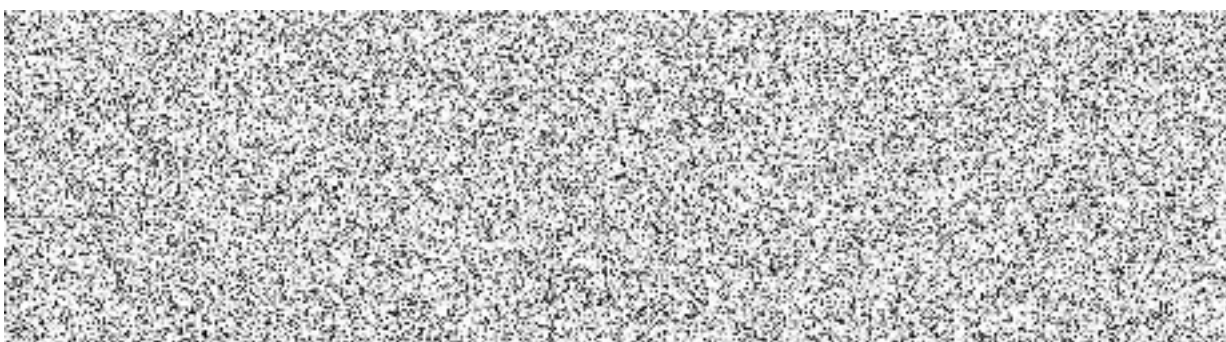
2.12.1.C

The Project* (Plant*) design and engineering process shall be developed and carried out duly in two Phases* in accordance with the Project* implementation schedule.

During the LWA Phase*, the Supplier* shall develop and carry out all design activities, processes and documentation for:

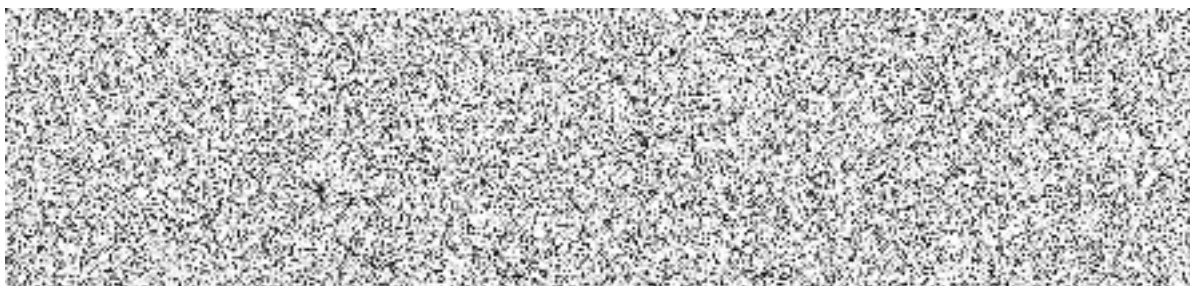


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2.12.1.D

The Plant* design and engineering process, inter alia shall comply with the requirements specified in the Technical Requirements Document* and shall also include following design development sub-processes associated with elaboration of Design Basis Documentation* (see Section 2.12.1.2.1), but not limited to:



DA

The Supplier* shall provide the Owner* with all related Documents*.

2.12.1.1 DESIGN, ENGINEERING AND DESIGN PROCESS

2.12.1.1.A

The Supplier* is fully responsible for its Project* design and engineering process and related activities that shall be well established, carried out, staffed and documented to ensure efficient progress of controlled design activities without any negative impact on the Project*.

2.12.1.1.B

The Supplier* shall develop-implement, provide, operate and maintain advanced software-based environment for collaborative, efficient and integrating design and engineering work. This software-based environment shall be ready to operate before the start of design and engineering process and shall be supported with related procedures and manuals.

BA

Software-based environment for work shall fully support data-oriented designing including information exchange, information modelling and other advanced methods for management of design and engineering processes.

BB

Software-based environment for collaborative and efficient design and engineering work shall be designed to facilitate, unify and automate design and engineering processes of all design participants.

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BC

Software-based environment for collaborative and efficient design and engineering work shall be software application or set of applications integrating design and engineering activities and engineering fields and it shall be integrated with Project Configuration Management System*.



2.12.1.1.D

The Supplier's* design and engineering process shall include all activities to enable the successful engineering, licensing, permitting, manufacture, construction, Commissioning* (start-up) and handing over of the Plant* and/or Unit* to the Owner*. The design and engineering process shall be consistent, coordinated and integrated with Project* Configuration Management* program and its processes. The design itself and design and engineering process shall also ensure the future safe, reliable, effective and long-term operation and effective maintenance, Inspection*, modifications, overhauls, repairs, and replacements of the Plant* and/or Unit* and its SSC.

DA

Supplier* is responsible to adapt its design procedures and manuals and apply them on all design participants. Control mechanisms shall be adequate. An interface between the design procedures and the licensing and permitting process/procedures shall be established in order to allow smooth course of the design works taking into account the results of the licensing and permitting processes in a timely and coordinated manner.

2.12.1.1.E

The Supplier's* design process shall be managed as a single integrated process. The Supplier* shall propose, establish and lead a project organization, which shall include all necessary participating organizations to cover all design aspects ensuring smooth design activities and completion of the design in full scope and in a timely manner. Project* organization shall include the Owner*, including its Subcontractors*, Supplier* and Subcontractors* providing relating design activities (all mentioned are hereinafter referred to as "Project* participants" or design participants" or "design organizations").

EA

POMM shall include all necessary procedures, principles and information to ensure coordination of design activities between the Supplier* and the Owner*, other relating requirements are defined in the Project Management Document*, Chapter 3.

2.12.1.1.F

The Supplier* shall ensure that the design requirements and design process requirements and procedures applicable to the Supplier* shall apply automatically to all the Project* participants respectively design organizations participating in the Supplier's* design and design process for their particular scope including all their Subcontractors*. At the beginning of the design process, those requirements shall be transferred into specific requirements and procedures (project manual, procedures and guides, etc.) which shall be followed by each of the Project* participant during the whole design cycle. This shall be the whole responsibility of the Supplier*, with the exception of the design in the Owner's Scope of Supply*, for which, however, the Supplier* shall also provide the design interfaces and input data where needed.

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2.12.1.1.G

The Supplier* shall keep and maintain design requirements at all levels of detail (plant/ system/ component levels) systematically within Requirement Management System linked to the data and Information Models*. Requirement Management System shall ensure requirements traceability, their easy identification, grouping to different categories including those relevant for operation and maintenance, understanding of requirements origin, evolution and aggregation, evidence of fulfilment of each requirement, etc. (see Section 2.12.9.1 of the Technical Requirements Document*). Requirement Management System shall be inherent part of Project Configuration Management System* and shall be transferred into Operational Configuration Management System* without loss of any substantial information. Requirement Management System shall be used since design phase of the Project* is started or even earlier up to the Plant* and/or Unit* operation phase and shall be handed-over to the Owner*.

2.12.1.1.H

Several subjects addressed in this Chapter are also developed in the Technical Requirements Document*, Chapter 2.10, specifically for I&C (including H-MI). I&C specific design process aspects defined in the Technical Requirements Document*, Chapter 2.10 shall be fully adapted in the Supplier's* overall design process.

2.12.1.2 ENGINEERING AND DESIGN DOCUMENTATION



2.12.1.2.B

The Supplier* or its Subcontractor* shall start preparation of any subcontracting or providing design output only when relating design and engineering documentation or information is sufficiently detailed and mature to allow its Subcontractor* to proceed with its task without any risk of re-designing or re-contracting caused by wrong or incomplete specification that was provided.

2.12.1.2.C

The same principle as above shall be dully applied by the Supplier* within Supplier's* design organization and design organization led by Supplier* for multi-disciplinary design coordination, design inputs/outputs control and baseline control.

2.12.1.2.D

All Documents* (including all related information in accordance with Terms and Conditions*, Article 4.1.6.) shall be listed in List of Project Documents*.

2.12.1.2.E

When the Supplier* presents any design or technical document relating to the Plant* (no matter the design stage), the Supplier* shall properly explain its purpose and content, Supplier* also shall indicate and evaluate the open design points and the main options or alternatives foreseen to resolve them.

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2.12.1.2.1 DESIGN BASIS

2.12.1.2.1.A

Comprehensive Design Basis* program shall be developed, documented, carried up and maintained by the Supplier* up to the Provisional Takeover*.

AA

The Design Basis* program/s shall supplement and support Configuration Management* programs, Project Configuration Management System*, Operational Configuration Management System* and design control by providing a foundation of Design Basis* and supporting design information.

AB

Design Basis* program/s shall provide a documented reference, but not limited to:



AC

Design Basis* shall serve as a basis for technical reviews, safety reviews, and safety evaluations.



AE

Design Basis* as the result of well-established Design Basis* program/s and other Design Basis* related Documents* shall be provided, well developed and maintained through the whole lifecycle up to the Provisional Takeover*, efficiently used and comprehensively utilized during design process within Configuration Management* system by the Supplier*. Design Basis* shall be developed, maintained and provided for plant system/structure and also for component levels by the Supplier*.

2.12.1.2.1.B

Design Basis* forms the set of conditions, needs, and requirements taken into account in designing a facility or product (SSC) and their justification.

2.12.1.2.1.C

Design Basis* shall be a special set of Documents* (also called Design Basis Documentation*) and also shall be well integrated by the Supplier* in data-centric Project Configuration Management System* and in fully developed data-centric Operational Configuration Management System*.

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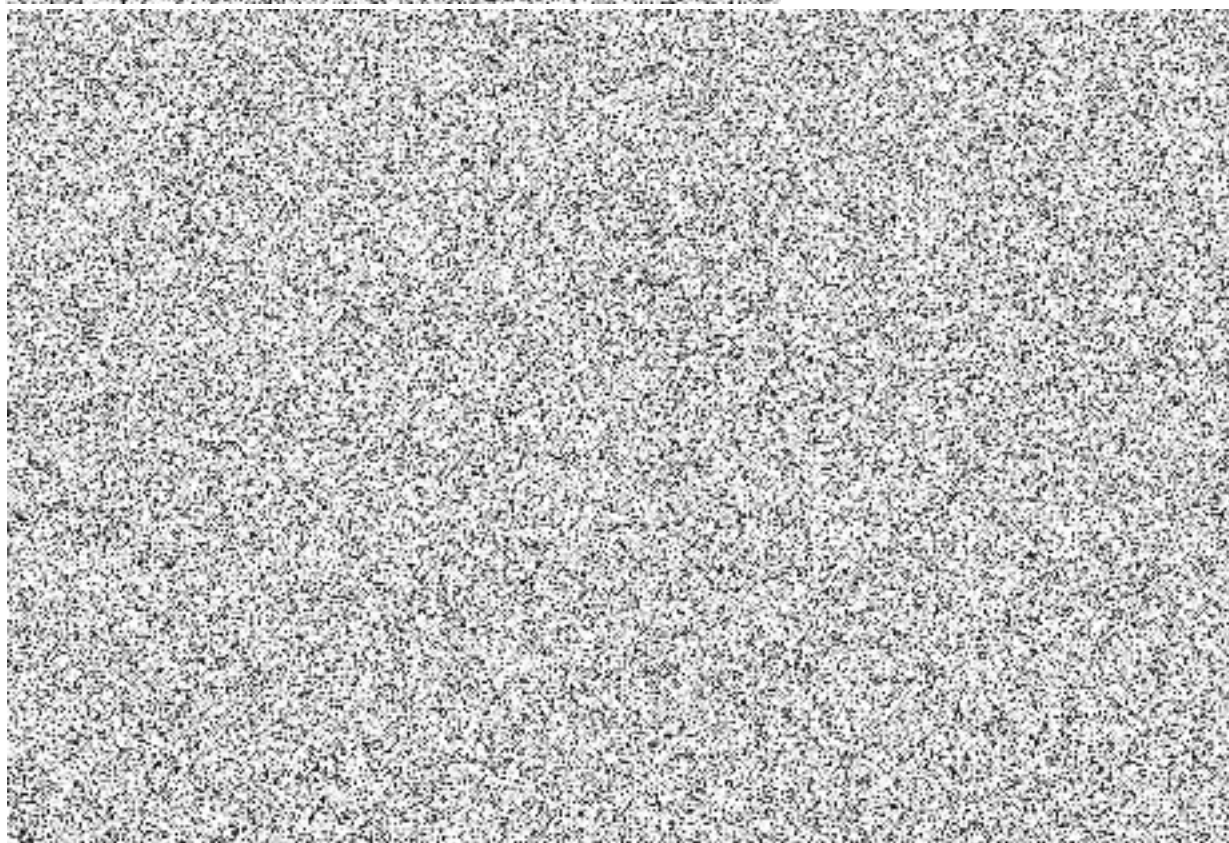
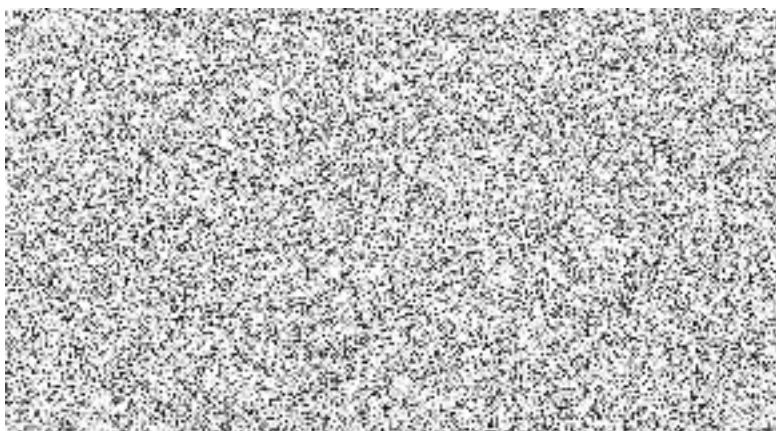
CA

Well integrated (as mentioned in paragraph C) means, that each Design Basis* (of all levels - plant/ system/ component) shall be linked with related data-centric design information both graphical and non-graphical and shall be easily and directly reachable from various environments where are those related data-centric design information displayed.

2.12.1.2.1.D

Design Basis* shall include the following, but not limited to, aspects:

- safety Design Basis*,
- non-safety Design Basis* (power generation),
- other aspects.



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DB

- The non-safety (power generation) Design Basis* includes all Design Basis* related SSC non-safety functions.

DC

The other aspects are e.g.

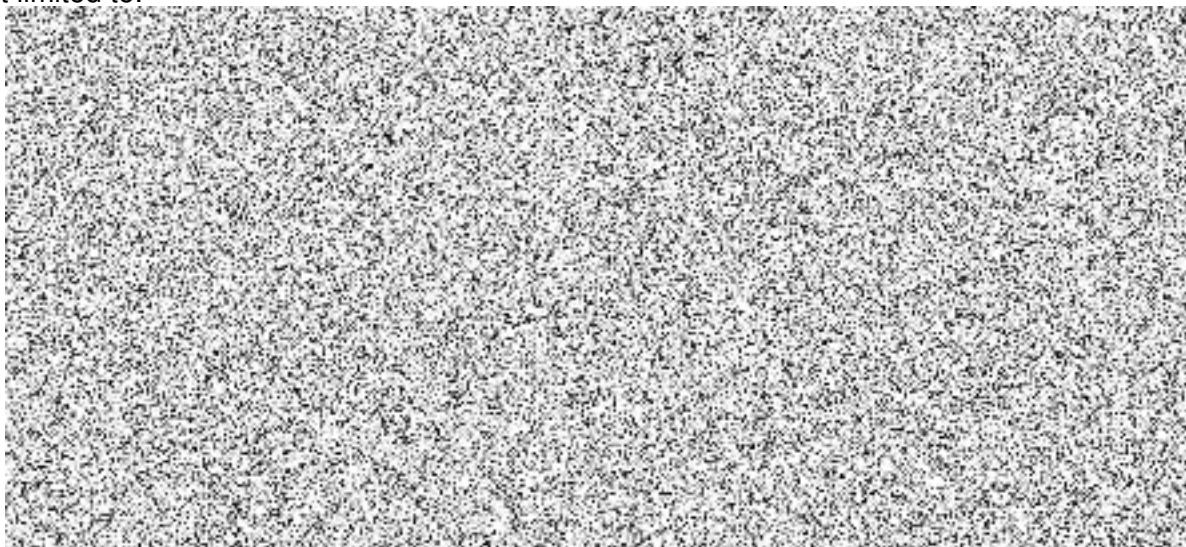
- maintenance, Inspections*, testing and SSC monitoring, diagnostics and prognostics,
- construction,
- Commissioning*,
- Decommissioning*.

DD

The Design Basis* shall be provided also for individual components and parts of SSC (further indivisible) like e.g. bolt, capacitor, wire, blade, gasket, chip, relay, etc., whose failure has significant or immediate impact on safety or availability of the Plant*.

2.12.1.2.1.E

The Design Basis* shall be provided for Plant* and all its SSC at the Plant*, system/structure and component levels and shall be understood as the set of information that identifies and justifies conditions, needs and requirements necessary for the design and shall include, but not limited to:



EA

The Design Basis* shall be completed and supplemented by specification sheets and by detailed design calculations.

2.12.1.2.1.F

Design Basis* shall be specified separately for Design Basis Conditions* and Design Extension Conditions*. Similarly, within Design Basis* the Hazards shall be specified in two separate categories: Design Basis Hazards* and Rare and Severe External Hazards*.

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2.12.1.2.2 PLANS AND PROGRAMS

2.12.1.2.2.A

The Supplier* shall prepare, provide and execute detailed plans and programs

- (1) to justify and verify design and properly carry out important design related activities etc.
- (2) where required, specified or indicated by the EPC Contract* or any required or applied Rules* or if required by the Owner* or Authorities*.

2.12.1.2.2.B

Plans shall be specific Documents* describing how to get key objectives with adequate confidence (including claims, arguments and evidences, criteria, conceptual solutions, detail description of processes, description of planned actions, etc.). All the plans which are required or mentioned in the EPC Contract* or which are necessary to be developed shall be established, carried out, implemented and maintained by the Supplier* up to the aims are reached. All the plan Documents* and all relating inputs, outputs, knowledge and other support, related deliverables and Things* shall also be provided by the Supplier* to the Owner*.

2.12.1.2.2.C

Programs (or programmes) are typically comprised of multiple projects and activities and are aimed at particular outcomes and benefits, and shall include various outputs and deliverables including time and source planning, documentation, systems, SW tools, products, procedures etc. All the programs which are required or mentioned in the EPC Contract* or which are necessary to be developed shall be established, carried out, implemented and maintained up to the aims are reached by the Supplier*. All the program Documents* and all relating inputs, outputs, knowledge and other support, related deliverables and Things* shall also be provided by the Supplier* to the Owner*. Objectives of programs are comprehensive and typically include significant mid or long-term effort and activities across several fields, therefore programs shall be launched in a timely manner and when necessary before the start of design activities and shall typically follow respective plan and program Documents*.

2.12.1.2.2.D

High quality processes of creation, implementation and maintenance of all launched plans and programs shall be defined and provided by the Supplier*, well in advance. Those processes shall be fully integrated with design and engineering processes and CM system, and shall be followed by all affected Project* participants. Supplier* shall ensure that all related activities are continuously documented and duly carried out.

2.12.1.2.3 CONCEPTUAL DESIGN

2.12.1.2.3.A

Conceptual Design* shall specify concept of the Plant* design and its main SSC with relation to the main design requirements and criteria.

Conceptual Design* shall be developed, documented, carried up and maintained by the Supplier* since the initial phases of the Project* and then it shall be transferred into the Basic Design* including its Design Basis*.

AA

Main design requirements and criteria and their Design Basis* shall be clearly identified, documented, clarified and the way they will be applied in the design shall be agreed with the Owner*.

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AB

Besides the design requirements and criteria used in designing the Reference Plant*/Standard Design*, this shall include application of the requirements of the EPC Contract*, of the Rules* and of the Site*/local conditions.

AC

Proposed modifications of the Plant* design with respect to the design of the Reference Plant*/Standard Design* shall be identified and their impact assessed.

AD

The design requirements and criteria shall be managed in a controlled way within the Requirement Management System (see Section 2.12.1.1 of this Technical Requirements Document*).

AE

Discovered inconsistencies among the design requirements and criteria (if any) shall be addressed and resolved to eliminate any inconsistency.

Note:

Conceptual Design* is the first phase of the design (provided before Basic Design*) whose purpose is inter alia to identify, document, clarify requirements of the EPC Contract*, of the Rules* and of the Site*/local conditions and agree on the way of how to implement these requirements into the design of the Reference Plant*/Standard Design* as part of the subsequent design phases of development of the design of the Plant*.

AF

Any issues associated with the use of the Rules* shall be resolved within the Conceptual Design* phase.

AG

Any issues due to use of the Rules* after the Conceptual Design* phase shall be resolved by the Supplier* at no additional cost to the Owner* and any associated delay shall be deemed a delay due to the Supplier*.

2.12.1.2.3.B

Conceptual Design* shall serve as design instrument for decision making on specific design issues already at a general level. Conceptual Design* shall eliminate variability of the solutions to the extent possible and shall be adapted to the Site*/local conditions.

2.12.1.2.3.C

Conceptual Design* shall exist as self-standing design Document* (e.g. general concept, engineering field concept, etc.) and its parts shall be cited and referenced in related design Documents* as necessary (e.g. plans, program Documents*, general specifications, etc.) but consistency and traceability shall be kept.

CA

The internal structure of the Conceptual Design* documentation (division to the individual Documents*) shall be proposed by the Supplier*. The internal structure of the Conceptual Design* shall enable delivery of design documentation in coherent packages and traceability of design requirements via Requirements Management System*. Structure of Conceptual

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Design* shall be subject of the Owner's* approval in accordance with the Terms and Conditions*, Article 4.1.1.

2.12.1.2.3.D

Finally, Conceptual Design* shall exist for the whole Plant* and all its parts shall be easy identifiable within design Documents* and Configuration Management* system.

2.12.1.2.3.E

NA

2.12.1.2.3.F

The Conceptual Design* shall be subject of the Owner's* approval in accordance with the Terms and Conditions*, Article 4.1.1.

2.12.1.2.3.G

Conceptual Design* documentation shall be multi-disciplinary design documentation and shall include information about the Plant* stipulated in Attachment 1 of this Technical Requirements Document*.

Note: For non-exhaustive list of Documents*, forming the Conceptual Design* documentation, see also Attachment 3 of the Project Management Document*.

2.12.1.2.4 CONCEPT OF BASIC DESIGN

2.12.1.2.4.A

Concept of Basic Design* shall be developed on the basis of Conceptual Design* and shall specify overall design of the Plant* and overall design in all technical professions in such a detail as required for coordination of the technical professions and shall define design requirements and criteria to enable development of full scope Basic Design* in all technical professions.

AA

Concept of Basic Design* shall also be used as basis for consultations with Authorities* on application of Rules*. Therefore, Concept of Basic Design* shall show the way how the Rules* (in particular Mandatory Law* and Requirements of the Authorities* and Codes and Standards* required by them) are and/or will be applied and implemented into the Plant* design. The results of the consultations as agreed with the Owner* shall be incorporated into the Plant* design.

Note:

Concept of Basic Design* is the first phase of the Basic Design* whose purpose is to provide basis (through overall design and design requirements and criteria in various technical areas and SSC design) for consultations with the Authorities* and development full scope Basic Design*.

AB

The internal structure of the Concept of Basic Design* documentation (division to the individual Documents*) shall be proposed by the Supplier*. The internal structure of the Concept of Basic Design* shall enable delivery of design documentation in coherent packages and traceability of design requirements via Requirements Management System. Structure of Concept of Basic Design* shall be subject of the Owner's* approval in accordance with the Terms and Conditions*, Article 4.1.1.

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AC

The Concept of Basic Design* shall be subject of the Owner's* approval in accordance with the Terms and Conditions*, Article 4.1.1.

2.12.1.2.4.B

Concept of Basic Design* shall correspond to all technical and other requirements on the Plant* specified in the EPC Contract* and shall respect Site* conditions. The requirements of Mandatory Law*, Requirements of the Authorities* and requirements of the Codes and Standards* shall be reflected in Concept of Basic Design* as well.

2.12.1.2.4.C

Concept of Basic Design* documentation shall be multi-disciplinary design documentation and shall include information about the Plant* stipulated in Attachment 1 of this Technical Requirements Document*.

Note: For non-exhaustive list of Documents*, forming the Basic Design* documentation, see also Attachment 3 of the Project Management Document*.

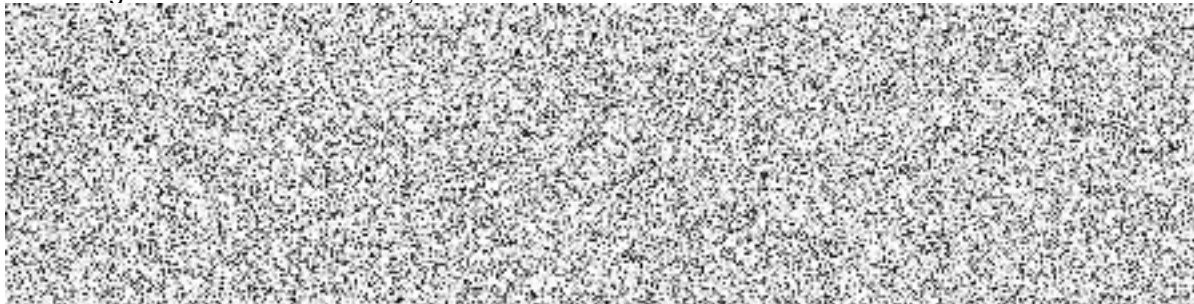
2.12.1.2.5 BASIC DESIGN

2.12.1.2.5.A

Basic Design* shall be developed on the basis of Concept of Basic Design* and shall specify design of the Plant* and design in all technical professions in such a detail as required for licensing and permitting and development of Detail Design* coordinated in all technical professions (incl. specifications of associated design requirements and criteria).

AA

Basic Design* shall form basis for, but not limited to:



AB

Basic Design* shall serve as the basis for coordination of all SSC as well as for the design coordination between Supplier* and all Subcontractors* (incl. the coordination among the Subcontractors*).

AC

Basic Design* shall correspond to all technical and other requirements on the Plant* specified in the EPC Contract* and shall respect Site* conditions. The requirements of the Mandatory Law*, Requirements of the Authorities* and requirements of the Codes and Standards* shall be incorporated to Basic Design* as well.

AD

Basic Design* shall be subject of the Owner's* approval in accordance with the Terms and Conditions*, Article 4.1.1.

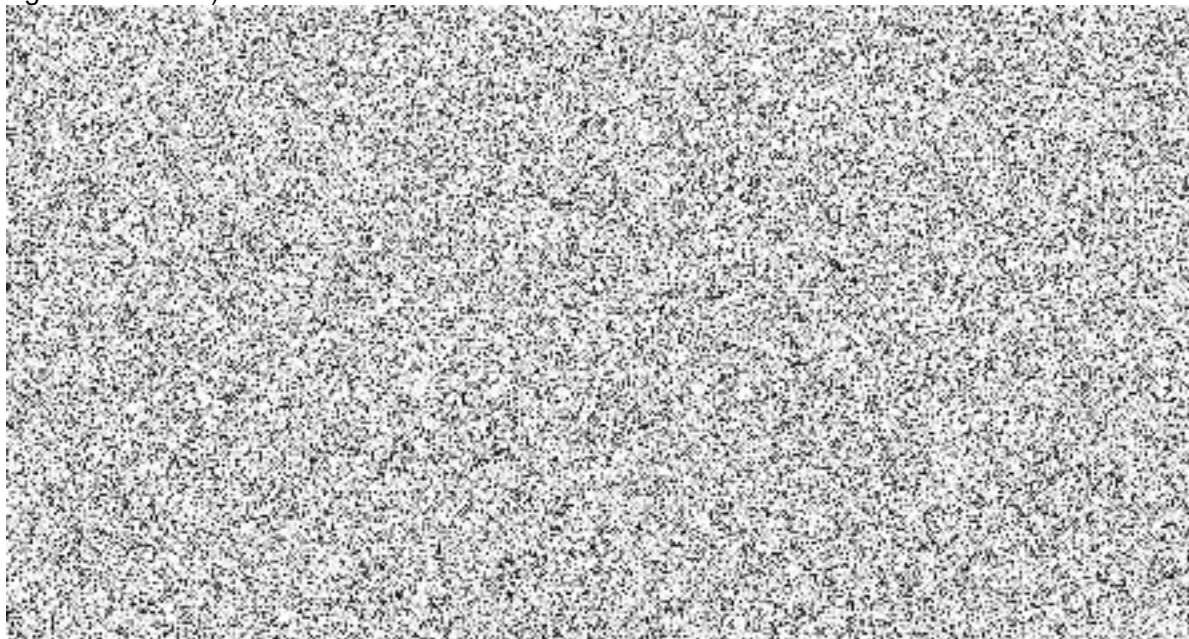
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2.12.1.2.5.B

Basic Design* shall be regularly updated to include all design changes approved within change control process (see Section 2.12.9.3 of this Technical Requirements Document*).

2.12.1.2.5.C

Basic Design* shall be design Documents* which specify the overall design of the Plant* and its SSC in such a way and in such a detail (including both layout driven and function driven design information) that:



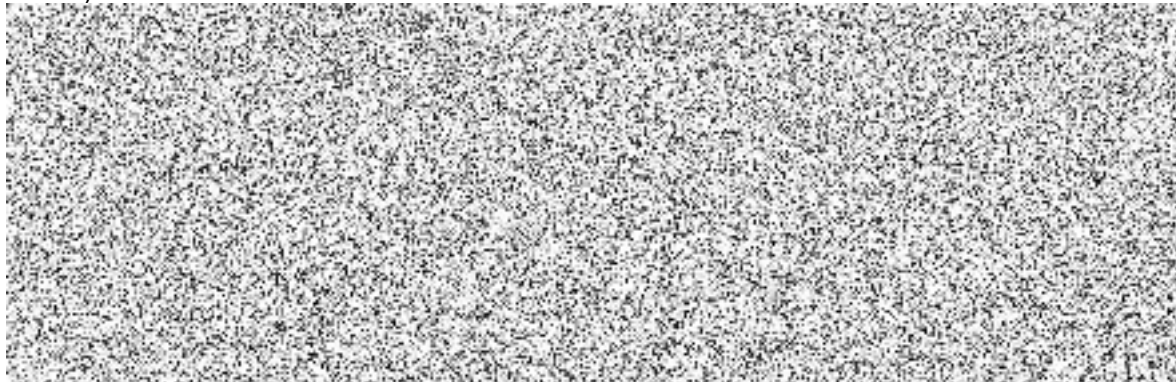
CA

Basic Design* shall include commented links to its Design Basis* for each individual design information.

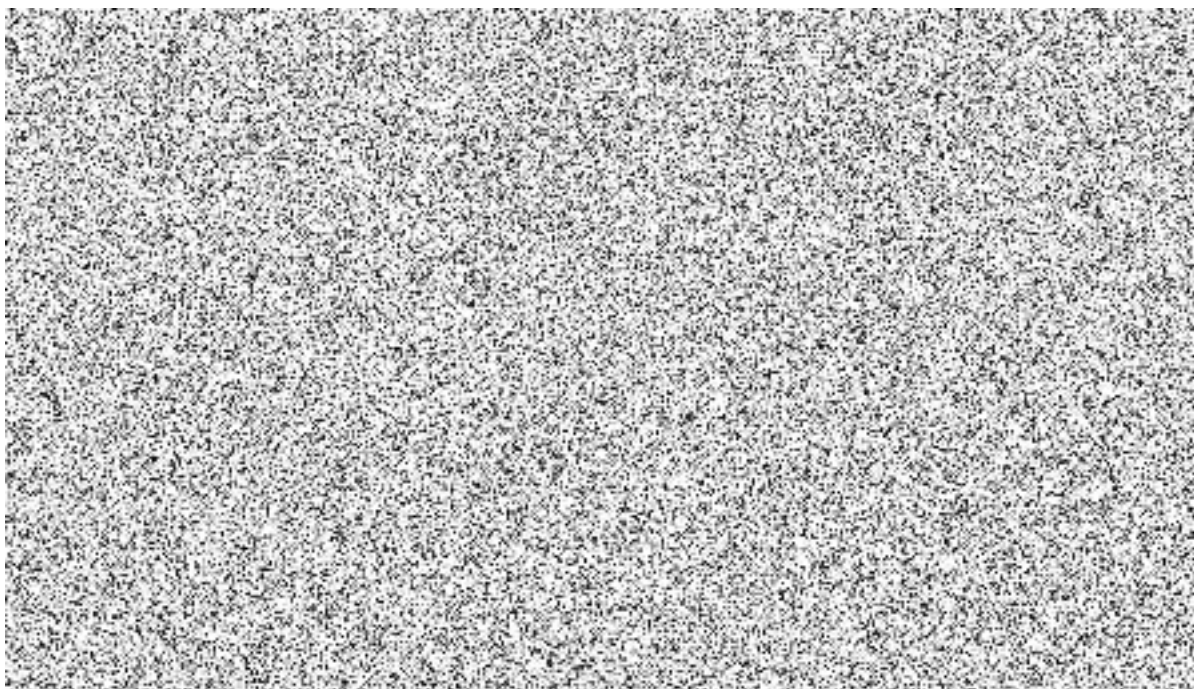
2.12.1.2.5.D

The Basic Design* shall include all Information Models*, data models, necessary analysis, plans, programs and design information within other design Documents* to explain and justify design solution used and/or to support safety case.

In general, the Basic Design* shall include and shall describe following information (but not be limited to):



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[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.1.2.5.D into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

DA

The Basic Design* shall also include associated assessment, analyses and calculation documents, reports and reviews (incl. deterministic safety analysis and PSA).

DB

The Basic Design* shall also include heat and mass balance diagrams, process flow diagrams, Piping & Instrumentation diagrams, Layout and arrangement drawings, electrical diagrams and other diagrams, lists of equipment etc.

DC

The Basic Design* shall also include Information Models* of the Plant* and its SSC including 3D model.

DD

The Basic Design* shall also include other documents related to design, such as programmes and procedures (PAM, RAP, Plant Life Management, Ageing Management, principles of Project Configuration Management System* etc.).

DE

Based on the Basic Design*, preliminary version of outage programmes, operating procedures and maintenance programmes shall be provided (see Operation and Maintenance Document, Section 3.3).

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DF

The internal structure of the Basic Design* (division to the individual Documents* shall be proposed by the Supplier* respecting the following principles:

- Basic Design* shall be divided into two basic parts:
 - common part - valid for the whole project and containing updated Concept of Basic Design* documents, general layout, map and geodetic data and general requirements of individual professions / disciplines
 - technical solution of individual buildings and functional technological systems
- technical solution of individual buildings and functional technological systems will be completed comprehensively (one separable document package - text and drawing part) for each individual building and functional technological system
- the internal division of Basic Design* simultaneously defines smallest groups/packages of Basic Design Documents* (text and drawing) which the Supplier* submits commonly for Owner's* approval in accordance with the Terms and Conditions*, Article 4.1.1.

The internal structure of the Basic Design* shall enable delivery of design documentation in coherent packages and traceability of design requirements via Requirements Management System.

2.12.1.2.5.E

Basic Design* shall be multi-disciplinary design documentation and shall include information about the Plant* stipulated in Attachment 1.

Note: For non-exhaustive list of Documents*, forming the Basic Design* , see also Attachment 3 of the Project Management Document*.

2.12.1.2.6 DETAIL DESIGN

2.12.1.2.6.A

Detail Design* shall fully respect the requirements of Basic Design* and shall also fully respect obligatory Requirements of the Authorities* and the Rules* including all applicable conditions contained in the Licenses* and Permits*.

2.12.1.2.6.B

The Detail Design* shall be properly coordinated to allow smooth execution of the Works* and therefore shall include all required data, databases and Documents* (see definition).

2.12.1.2.6.C

Detail Design* shall provide higher detail of solution defined in the approved Basic Design*. Detail Design* shall be developed in such detail as it is needed for execution of the Works* and proper on-site coordination. It shall form sufficient basis for the manufacturing, transportation, construction, erection, Commissioning* and future operation, maintenance, modifications, refurbishment, etc.

CA

Detail Design* shall describe all SSC in the structure respecting the breakdown of all SSC mutually agreed between Parties*.

2.12.1.2.6.D

Moreover to what is required above, Detail Design* shall also form basis for, but not limited to:

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- Licensing Documents* and Permitting Documents* following Building Permit*, including Commissioning* and subsequent operation;
- as-built status Documents*.

2.12.1.2.6.E

Detail Design* shall be developed and maintained using fully integrated, unambiguous and auditable design and engineering processes duly supported by Project Configuration Management System* and shall be finally provided together with final design Documents* within data-centric Operational Configuration Management System* in its native form including Information Models*, data models and databases.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.1.2.6.E into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*.

However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

2.12.1.3 GENERAL POLICY WITHIN DESIGN AND ENGINEERING PROCESS

2.12.1.3.A

The Supplier's design and engineering process shall be an inherent part of the Project* management system as specified in the Project Management Document*, Chapter 2 and shall be fully supported by Project Configuration Management System*. Supplier's design and engineering process shall also reflect all process relating requirements, statements and policy and shall fully ensure fulfilment of all design relating requirements. Design relating requirements are any requirements having impact (even potentially) on design of the Plant* and/or Unit* including various aspects as e.g. safety, quality, availability, performance, Operability*, Maintainability*, etc.

2.12.1.3.1 HUMAN FACTORS

2.12.1.3.1.A

The design process shall emphasize the Human-Machine Interfaces, system interfaces, and human-to-human interfaces early in the design stage and throughout the whole Plant* design.

2.12.1.3.1.B

Analyses shall be conducted throughout the design process to ensure that balanced relationship between people and the machine is met while possibility of human error shall be minimized to the lowest possible level.

2.12.1.3.1.C

Other relating requirements are defined also in the Technical Requirements Document*, Section 2.14.1.1.

2.12.1.3.2 BALANCE IN DESIGN

2.12.1.3.2.A

The design and engineering process shall apply the following priorities:

1. nuclear safety,
2. public and personnel safety

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3. SSC availability and safety, Plant* performance, investment protection, and the cost of electricity production.

2.12.1.3.2.B

Taking into account the above-mentioned priorities, the design shall be optimized using value engineering approach.

BA

For that purpose, the Supplier* shall establish and maintain and appropriately implement in design process cost-effective value engineering processes and procedures to optimize the Plant* design by analysing requirements for and functions of all SSC and Works* delivered by the Supplier* to the Owner* within the Supplier's Scope of Supply* with the goal of improving safety, quality, performance, reliability and Plant* life-cycle costs and taking into account risk analysis.

BB

When performing these analyses, the Supplier* shall take into account total expenditures (TOTEX) model approach facilitating a wholistic view from the Conceptual Design* to Decommissioning* of the Plant*.

BC

The Supplier* shall take into account the expected design life and potential life extension of the Plant* (60 years+) and optimize operational OPEX and operational CAPEX.

BD

The Supplier* shall define and properly explain the approach and methods for the cost-benefit (TOTEX) and risk analysis, including a description of relevant data, processes and systems employed, and shall indicate responsibilities of the Owner* and the Supplier* and related interfaces with respect to EPC Contract*. However, the Owner* has the right of the final choice of particular method to obtain credible outputs and the Supplier* shall perform this cost-benefit (TOTEX) and risk analysis, based on the Owner's* requirement.

2.12.1.3.2.C

If during the Project* design development, a design change or alternative is proposed by the Supplier* or by the Owner*, then the Supplier* shall produce a cost-benefit (TOTEX) and risk analyses including time schedule impact analysis to justify proposed design change to support the Owner's* final decision. When presenting, for Owner's* decision, design alternatives, proposals or design change solutions during particular Project* design step, the Supplier* shall follow principles and procedures agreed by the Owner* and also those for resolving competing interests. Design changes and proposals and relating processes and activities shall be in accordance with the relating requirements defined in the Project Management Document*.

CA

The Supplier* shall develop a specific change management procedure for the Plant* to form relevant part of its Project* design manuals/procedures and Quality management stage program (see Licensing and Permitting, Safety and Quality Document*, Section 3.2) for the Project*. This change management procedure shall comply with Project Management Document*.

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CB

Design change management shall be integrated part of Project Configuration Management System* and Operational Configuration Management System*.

2.12.1.3.3 EXPERIENCE FEEDBACK

2.12.1.3.3.A

The design process shall identify and solve significant problems which impact Plant* design and Plant* safety, constructability, Operability*, in-service Inspection*, Maintainability*, radiation doses, availability, performance, reliability, etc. The Supplier* shall report and duly describe all changes to the Standard Design* and Reference Plant* design based on specific experience (positive or negative) with the design, manufacture, construction, Commissioning* (start-up), operation and maintenance of the Reference Plant* and applicable reference solutions (at the same or similar type of Plant*). This information shall also be duly documented within Project Configuration Management System* and Operational Configuration Management System*.

2.12.1.3.3.B

The Supplier* shall provide the Owner* with its design experience feedback along the Project* up to the Provisional Takeover*, so that the Owner* is updated with the latest information (as well as historical if it is relevant) from other or similar projects. The Supplier* shall immediately inform the Owner* of any design experience feedback that could negatively affect (even potentially) the design objectives of the Plant*.

2.12.1.3.3.C

The Supplier's* design and engineering process shall duly adopt relevant experience feedback of the Supplier*, its Subcontractors* and experience from most recent and relevant projects and recent projects in EU, UK and US to decrease licensing risk. In any case, the Supplier* shall be responsible for proper collection and documentation of relevant experience feedback (even if it is not its own) covering in sufficient scope all technical fields.

2.12.1.3.3.D

The Supplier's* design and engineering process shall also incorporate the experience feedback from the Owner's* organization and the experience feedback collected by the Owner*. The Owner's* experience feedback shall be duly taken into account by the Supplier* in the design and Design and engineering process.

DA

Supplier* shall systematically collect Owner's* experience feedback and use it as design input throughout the whole design process in all phases of the engineering and design process. This experience feedback shall be appropriately incorporated in design manuals and procedures (see Section 2.12.6.1) and its implementation shall be subject for the Owner's* approval.

2.12.1.3.3.E

The Supplier's* design and engineering process shall be in accordance with the requirements defined in the Project Management Document*.

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2.12.1.3.4 DESIGN FOR CONSTRUCTABILITY, OPERABILITY AND MAINTAINABILITY

2.12.1.3.4.A

The design and engineering process shall be structured in a manner that allow to identify and evaluate relationships among design, constructability, Operability*, Maintainability*, modification capabilities, staffing, training, obsolescence, etc. Those relationships shall be taken into account for cost optimization (TOTEX).

AA

Cost optimization and its outputs shall not negatively influence future operation of the Plant* in terms of safety, Operability*, availability, performance, Maintainability*, modification capabilities as defined in Technical Requirements Document*, Section 2.12.12, staffing, training, obsolescence, etc.

2.12.1.3.4.B

The design and engineering process shall explicitly integrate those factors. The Supplier* shall enable and facilitate access to Supplier's* design and engineering process and to construction, Commissioning* (start-up), operation and maintenance of the Project* and shall provide related Documents* to the Owner*.

BA

Supplier* shall also enable visits to the Reference Plant* and plants from which reference solutions was adopted and shall provide comprehensive information related to design, design and engineering processes, construction, Commissioning*, operation, maintenance, modification capabilities, staffing and training applied at Reference Plant* and plants from which reference solutions was adopted.

2.12.1.3.4.C

Clear and systematic links and relations among relating information and data in different kinds of Documents* and databases belonging to different processes (as design, construction, Commissioning*, operation, maintenance, etc.) shall also be implemented in Project Configuration Management System* and implemented, supplemented and provided within Operational Configuration Management System* to ensure long term operation of the Plant* and allow the Owner* to understand and evaluate design from safety, availability, constructability, Operability* and Maintainability* point of view and as required in the Technical Requirements Document*, Section 2.12.12.

2.12.2 TECHNOLOGY BASE AND DESIGN MARGINS

2.12.2.A

The Plant* shall be designed using proven SSC, i.e. those which have the same characteristics and use materials proven under the same environmental and working conditions (stress levels and water chemistry, for example) as those which have been successfully applied in existing PWRs or similar operating environments and applications in other industries (for adequately long time period).

AA

However, the Supplier* shall consider state-of-the-art techniques, experience, knowledge, products and technologies in terms of safety, performance and/or a cost reduction.

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AB

An "evolutionary" policy based on proven technologies shall be specifically implemented for the design of the Reactor Coolant System* components and for the RCS operating conditions.

2.12.2.B

If the Supplier* uses systems or equipment not proven in the sense defined above, he shall provide justification and describe compensatory measures to support his proposal.

BA

Novel designs may be used only if they provide clear advantages in one or more specific areas (e.g. safety, cost, performance, reliability) without negative consequences affecting the others.

BB

The Supplier* shall inform the Owner* of all improvements known to the Supplier* which are achieved in the status and evolution of technology and which may be in any way relevant to the Plant* (see Article 8.3.2 of the Terms and Conditions*).

BC

The Supplier* shall develop a programme for updating its design (i.e. introducing of modifications to the Plant* design), and the programme to obtain proper Licenses* and/or Permits* for it.

BD

An appropriate testing programme shall be associated with any novel design. The result of this programme shall be available on request for Owner's* information before being implemented in the Plant* design.

BE

The requirements relating use of proven technology can also be found in the Section 2.7.0.3.2 of this Technical Requirements Document*.

2.12.2.C

In those cases of use of non-proven technology, the experience basis justifying the structure, system, equipment and structure such as adequate in-plant use or testing, shall be reviewed by the Supplier* and made available for Owner*'s approval.

CA

The required information on proven design shall be provided within the document "Proven Design" (see Attachment 3 of the Project Management Document*).

2.12.2.D

The Plant* shall be designed with increased margins for reduction of sensitivity of the Plant* to faults and with increased margins in capability of the Essential Components* to guarantee that the safety and performance targets are achievable for the whole design life of the Plant*.

DA

Margins shall be implemented in particular for Core*, Fuel System*, NSSS, Safety Systems* and Safety Features for Design Extension Conditions*.

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DB

For the Core*, the Fuel System* and the NSSS and other Essential Components* design, specific design margins (preferably quantified) shall be implemented that will be kept at the Owner's* disposal.

DC

For specific requirements related to design margins of the Core* and Fuel System* see Sections 2.2.3.4.1 and 2.8.2.2.3.1 of this Technical Requirements Document*.

DD

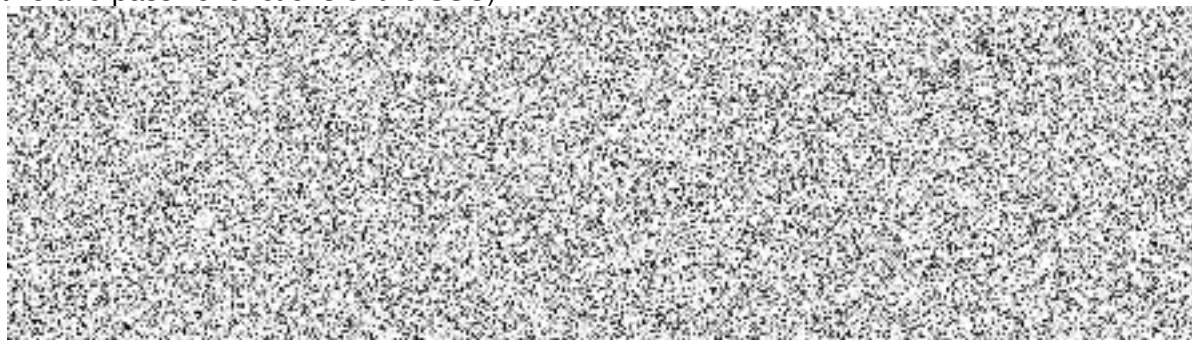
Such margins shall also enable the Owner* to procure fuel from various fuel suppliers used in various types of Core* designs.

DE

The Supplier* shall clearly specify, quantify and document the design margins for the Core*, Fuel System*, the NSSS and other Essential Components*.

DF

The Supplier* shall specify, quantify and document the following types of margins (for both active and passive functions of the SSC):



DG

The margins shall be managed within the Project Configuration Management System* to be available for operation, modifications and replacement of the SSC, for power uprate, and life extension.

DGA

The required information and their management on margins shall be provided within the document "Plant Margin Assessment" (see Attachment 3 of the Project Management Document*).

2.12.2.E

In addition, specific components shall meet the specific requirements listed in the Chapter 2.7 of this Technical Requirements Document*.

2.12.3 DESIGN LIFE OF EQUIPMENT

2.12.3.1 DESIGN LIFE CLASSIFICATION

2.12.3.1.A

The Supplier* shall develop and describe a design life classification system.

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2.12.3.1.B

The Supplier* shall provide a list which categorizes SSC according to design life capability, and develop the strategy within the Plant Life Management Programme (i.e. maintenance, testing and Inspection* activities) to be employed to support the overall Plant* design life requirement.

BA

Graded approach for scope and frequency of maintenance, testing and Inspection* activities shall be used with focus on the Essential Components* as specified in the Sections 2.14.2.6 and 2.14.6 of this Technical Requirements Document*.

BB

Maintenance, testing and Inspection* activities for each SSC shall suit the design life classification of the SSC.

BC

Scope and frequency of maintenance, testing and Inspection* activities for each item shall be incorporated in the maintenance and Inspection* programmes, starting at the construction period.

BD

Requirements related to the Plant Life Management Programme are specified in the Section 2.15.5.5 of this Technical Requirements Document*.

2.12.3.2 REPLACEMENT PROGRAMME

2.12.3.2.A

All Plant* operational components and equipment, except the RPV, shall be replaceable, design life notwithstanding.

AA

Specific requirements on SSC replacement are defined in Section 2.14.5.

2.12.3.2.B

The Supplier* shall develop a list of components which are expected to be replaced and/or modified due to obsolescence, ageing or early failure.

BA

For those components, the Supplier* shall provide a plan for replacement, refurbishment, modification and repair activities, as appropriate, to ensure that the design life of the overall Plant* can be achieved.

The list and the plan shall be provided in frame of the document "Plant Life and Plant Life Management programme" (see Attachment 3 of the Project Management Document*).

BB

Environmental protection measures and ALARA criteria shall be taken into account when planning such activities.

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BC

Such activities shall be scheduled to demonstrate that the Plant* availability and replacement requirements are satisfied simultaneously.

2.12.3.3 ADDITIONAL REQUIREMENTS TO SUPPORT THE PLANT DESIGN LIFE

2.12.3.3.1 DOCUMENTATION

2.12.3.3.1.A

The Supplier* shall define specifications for the documentation and all necessary design data to be supplied by all the participants in the Project*, so that the Documents* can be maintained and updated under the Configuration Management* System (described in Section 2.12.9) in a detailed and readily accessible form covering the whole life of the Plant*.

AA

Ageing of the documentation itself (physical ageing of data carrier and applied software or hardware) shall be addressed here.

2.12.3.3.1.B

The Supplier* shall provide all necessary documentation needed to establish Plant Life Management Programme as specified in Section 2.15.5.5.

BA

This shall include, but not be limited to, the following:



2.12.3.3.2 CONDITION MONITORING

A

Requirements for condition monitoring are specified in the Section 2.14.2.7.

2.12.3.3.3 LIFE CAPABILITY EVALUATION PROGRAMME

2.12.3.3.3.A

The Supplier* shall provide a comprehensive programme for evaluation of actual life capability of SSC (including obtaining the necessary data) based on their operating history and measurement of their life-limiting characteristics.

AA

Data shall be obtained by monitoring systems and/or by Inspection* and testing and from maintenance.

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AB

Acceptance criteria shall be defined for each SSC and each degradation mechanism/ageing effect for approval of design life expectancy.

2.12.3.3.3.B

Sufficient and appropriate instrumentation, recording and evaluation systems shall be provided to enable performance of the life capability evaluation programme.

BA

The monitoring systems shall include Plant* environmental conditions monitoring, process conditions monitoring and SSC condition monitoring as specified in Section 2.14.2.7.

BB

The evaluation systems shall include both advanced diagnostics to evaluate actual life of the SSC and also advanced prognostics to predict the residual life of the SSC.

2.12.4 PLANT SIMPLIFICATION

2.12.4.A

The Supplier* shall assess and implement, as far as possible, simplification in all areas of design, construction, operation and maintenance.

2.12.4.B

The Supplier* shall prepare a policy to promote simplicity in all aspects of Plant* design, construction, operation and maintenance.

2.12.4.C

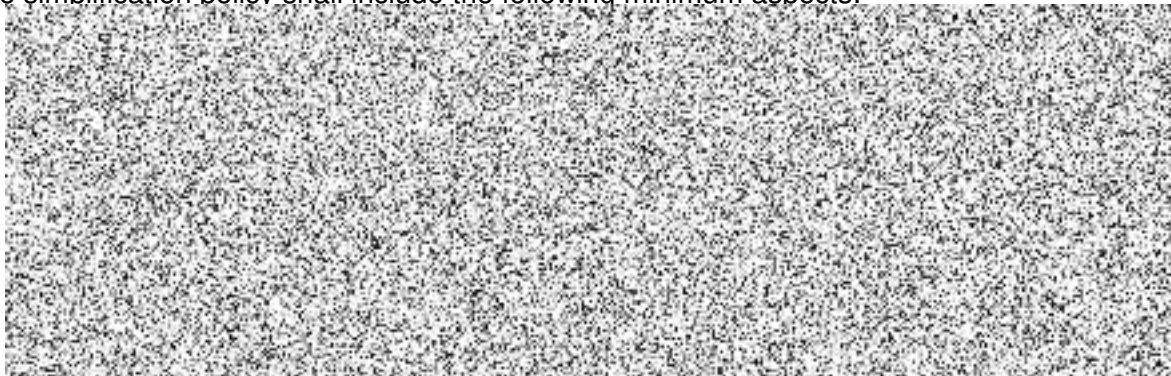
This policy shall form part of the design process and shall be incorporated in the design review process (as per Section 2.12.11.1).

CA

The Supplier* shall organize specific design reviews to demonstrate simplification achieved by the Plant* design.

2.12.4.D

The simplification policy shall include the following minimum aspects:



2.12.4.E

Simplicity is a design objective, but where systems or components are reduced in number, this shall not compromise the overall safety, reliability and availability of the Plant*.

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2.12.5 STANDARDISATION

2.12.5.A

The Plant* design shall be based on the Reference Plant*.



2.12.5.B

The Supplier* shall aim at minimizing changes of the Plant* design with respect to the Standard Design*, unless such changes result from lessons learned in previous projects, or are necessary due to the established system of the Rules*, implementation to the Site* or are specifically requested by the Owner*.

BA

Exceptionally, particular Structures, Systems or Components which are not a part of the Standard Design* may be applied in the Plant*.

BB

In such a case, the Supplier* shall provide clear and comprehensive justification of the modification.

BC

In addition, the Supplier* shall provide reference to a nuclear power plant which uses such SSC and information on its operational experience.

2.12.5.C

The philosophy of standardisation of equipment throughout the Plant* itself shall be promoted by the Supplier*.

2.12.5.D

Standardised equipment shall be used throughout the Plant* for ease of maintenance, decrease number of spare parts and to ensure their availability except if otherwise required to provide Diversity* as a defence against CCF.

2.12.5.E

For that purpose, the Supplier* shall develop a Plant* standardization policy focused mainly on the facilitation of Plant* operation and maintenance.

EA

The policy shall define the process and set out the procedures that shall be followed by the Supplier* and Subcontractors* in order to implement this standardization policy throughout Plant* in the design and construction.

EB

This policy shall cover the different Project* phases from the design up to the operation and maintenance.

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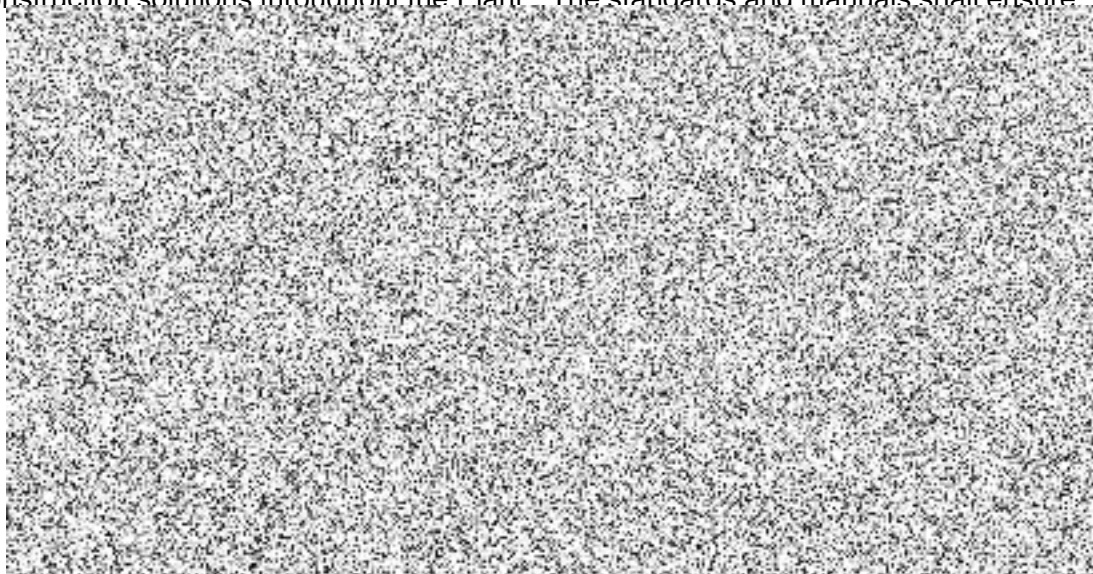
EC

The standardisation policy shall set specific requirements to be followed by the Supplier* and all Subcontractors* to avoid Plant* undue complexity and enhance the standardisation of Systems and Components* for the overall Plant*, including those provided by all Subcontractors*.

2.12.5.F

The Supplier* shall as a minimum:

- define a coherent and reduced set of Codes and Standards* for the Plant*, avoiding the use of different codes and/or standards particularly in the conventional area (PGP, BOP and Support Facilities*),
- develop design and engineering standards and guides as part of the Project* design manuals (see Section 2.12.6.1) to be used by all Project* organizations including Subcontractors* in order to typify and repeat the same basic and detail engineering and construction solutions throughout the Plant*. The standards and manuals shall ensure:



FA

Standardisation of the following main interfaces as defined in Section 2.8.2.3.2 shall be particularly considered:

- interface between NI and PGP,
- interface between NI and BOP,
- interface between PGP and BOP as far as possible,
- interface of the Plant* with the grid,
- Plant* optimisation for the Site* environmental conditions.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.5.F into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

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2.12.5.G

In order to allow standardisation of the Plant* design and thus an efficient control of Plant* operation, testing, inspections and maintenance, the Supplier* shall develop standardised SSC specifications.

GA

The standardised SSC specifications shall be used by the Supplier* when interfacing with its Subcontractors*.

GB

In order to allow standardisation in process of modifications, substitutions for equipment procurement and equipment replacement during Plant* operation and maintenance, the SSC specifications shall be supplied to the Owner*.

2.12.5.H

For that, the SSC specifications:

- shall allow, as far as possible, functional standardisation of SSC in the Plant*,
- shall make use of and specify applicable Codes and Standards* from coherent set of Codes and Standards*,
- shall be developed in standardised form to enable standardisation of SSC procurement (as required in Section 2.15.6.2),
- shall utilise standard materials and components to facilitate Plant* maintenance and reduce stocks (reduce number of different spare parts and number of different component suppliers) during operation (use of component catalogues for valves, electrical components, etc. for the overall Plant*).
- shall allow, as far as possible, the Owner* to use several suppliers for each piece or set of components (e.g. in case the original supplier stops production).

2.12.6 DESIGN AND ENGINEERING PROCESS

2.12.6.1 DESIGN MANUALS AND PROCEDURES

2.12.6.1.A

The Supplier* shall establish, develop, maintain and follow design development and implementation plan describing goals, manuals, procedures and main activities related to design and engineering processes of the Project*. Design development and implementation plan shall be respected and shall be described and referenced in related parts of the POMM.

AA

The Project* design manuals and procedures which are specific regulating Documents* (where also goals, manuals, procedures and main activities relating to design development and implementation processes are developed in more detail) shall be elaborated, followed and provided by the Supplier* in very beginning design stage. Project* design manuals and procedures shall be duly applied on the Project* and kept updated including related statements in PQM and any other relating Documents* through all stages of the Project* respectively Plant*.

The Project* design manuals and procedures shall be fully compliant with Project Organization and Management Manual* and shall provide for a design organization that clearly identifies responsibilities and authorities for all aspects of the design process.

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AB

The Project* design manuals and procedures shall also cover design and engineering process interface between Supplier* and the Owner* during design of interrelated SSC (i.e. SSC which are to be supplied by the Supplier* and which are interrelated to the SSC supplied by the Owner*, including connection points), the Supplier* shall also duly describe this interface in the POMM.

AC

The Supplier* shall incorporate into Project* design manuals and procedures and duly describe, inter alia, following:

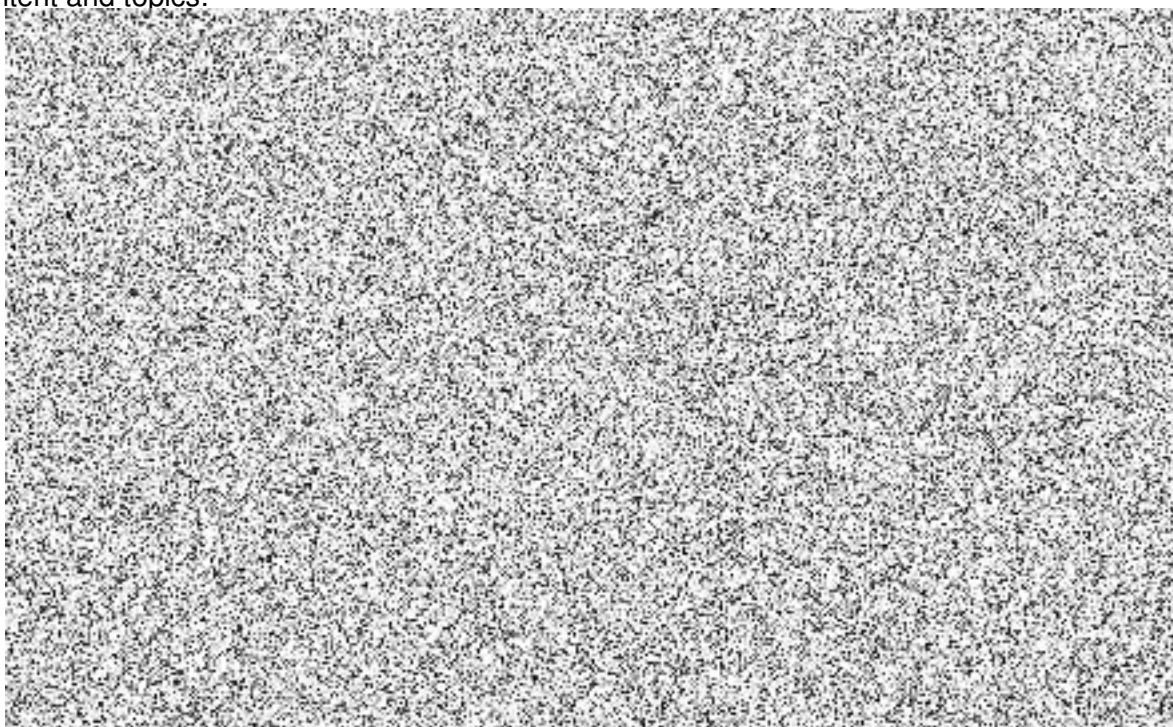
- Procedures for well-timed and appropriate development particular design stages documentation (Conceptual Design*, including relevant Design Basis*, Concept of Basic Design*, Basic Design*, Detail Design*) and preparation of Licensing and Permitting* documentation, in compliance with requirements of the Owner* and Authorities*.
- Procedures for handing over of input design data for design of interrelated SSC to be exchanged between the Parties*,
- Procedures for review of exchanged design data in order to ensure coordinated design of interrelated SSC and their integration with the Plant* SSC,
- Applicable tools and means.

AD

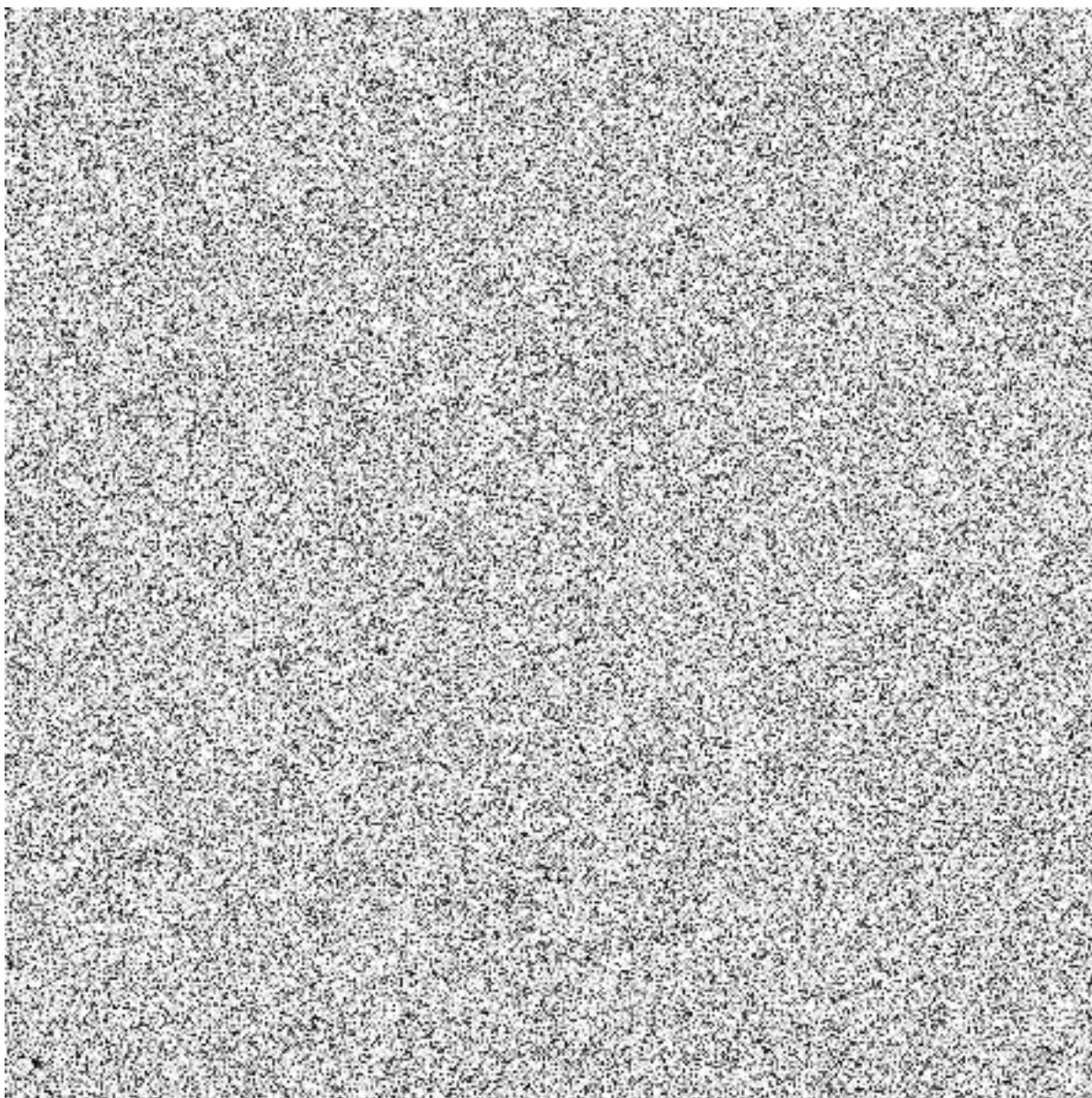
The scope of supply for interrelated SSC is defined in the Scope of Supply Document*, particularly in Section 2.3.11 and Chapters 3 and 4.

2.12.6.1.B

The Project* design manuals and procedures shall include but not be limited to the following content and topics:

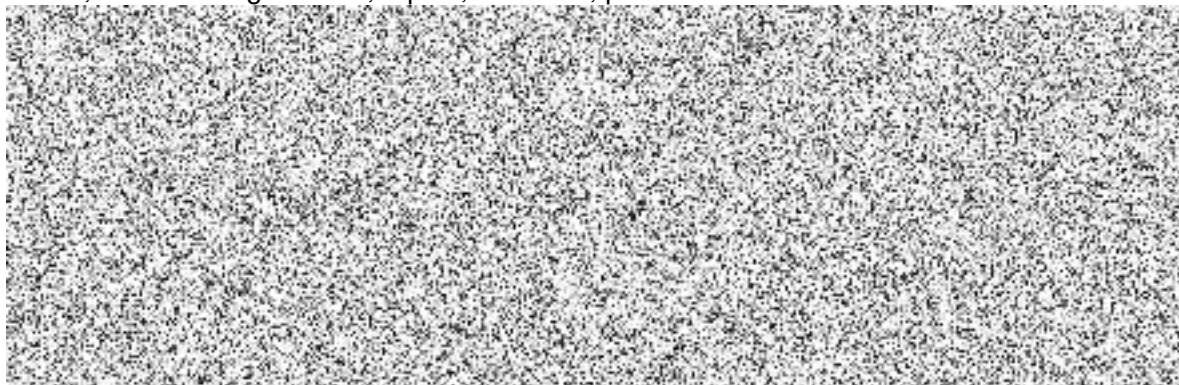


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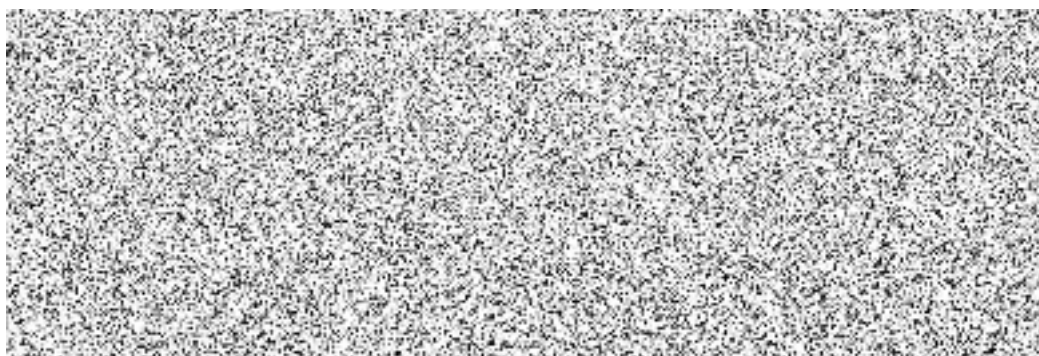


BA

The Project* design manuals and procedures shall also include information primarily stipulated in Quality Management Stage Program (see Licensing and Permitting, Safety and Quality Document*, Section 3.2) for design and engineering process which shall cover, but not be limited to, the following content, topics, activities, processes:



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2.12.6.1.C

The Supplier* shall ensure that Project* design manuals, procedures, master Documents*, Documents* and design and engineering process Documents* are available for all relevant organizations involved in the Project*.

CA

The Project* design manuals, procedures Documents* and design and engineering process Documents* shall be well and systematically elaborated by the Supplier* through the dedicated program or programs starting well in advance to ensure availability each design manual, procedure, Document* and design and engineering process Document* before it is needed to be used. Owner's* design manuals, procedures Documents* and design and engineering process Documents* shall be carefully taken into account to ensure mutual compatibility, Owner* shall be invited to participate.

The Project* design manuals, procedures Documents* and design and engineering process Documents* shall be subject for Owner's* approval.

CB

These Documents* of the Plant* shall also reflect the actual status of the design and elaboration and implementation status of each Plant* structure, system and component.

2.12.6.1.D

The Documents* shall be valid from the first day of the Project* and throughout all Phases* of the Project*, with the required revisions to reflect the actual design and status of the systems.

2.12.6.1.E

Design Documents* for all Structures, Systems and Components* shall have defined and documented level of detail and the level of interdisciplinary review that shall be reached, and authorization steps that shall be passed.

EA

Level of detail of the design Documents* (including level of detail of Information Models*) shall be adequate to fully support design development stages, licensing, permitting, construction, Commissioning*, operation, maintenance and modifications needs and shall ensure fulfilment of the requirements of EPC Contract*. Level of detail is subject of Owner's* approval.

Note: to avoid any doubts, with regard to the Definitions, the term Document* or Documents* shall naturally include, inter alia, data-centric information as e.g. Information Models*, data models, databases, data, attributes, etc., always, regardless of the fact that in some cases it is emphasized the importance of some of those data-centric design information by their additional repetition and in some other cases are not already repeated.

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[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.6.1.E into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

2.12.6.2 HUMAN-MACHINE INTERFACE (H-MI) DESIGN PROCESS

2.12.6.2.A

The Supplier* shall carefully incorporate in the Plant* design process the Human-Machine Interface (H-MI) aspects and shall fulfil following requirements, but not limited to:

- H-MI design team: one single integrated and multi-disciplinary design team shall be set up in the Supplier* organization and shall be charged with the overall responsibility (definition, supervision, review and approval) for the H-MI design
- function-based task analysis: this approach shall be used for segmentation of equipment hardware, and software, as well as for operation procedure and strategy, displays and alarm definitions, etc.
- verification and validation shall be used, including the use of models and simulators
- software Configuration Management* shall be integrated in Project Configuration Management System* and provided including data from design, construction and commissioning and supplemented with data necessary for future operation, maintenance and modifications as integral part of Operational Configuration Management System*, respecting Technical Requirements Document*, Sections 2.12.9, 2.12.12, 2.10 and another relevant requirement of EPC Contract*.
- Owner's* staff shall participate in H-MI design team and his inputs shall be respected and implemented by the Supplier*.

AA

Specific I&C (including H-MI) aspects are also addressed in the Technical Requirements Document*, Chapter 2.10.

2.12.6.2.B

The design development and implementation plan shall specifically identify H-MI related objectives, features and processes that shall be incorporated into relating manuals and procedures, to ensure a systematic consideration of human factors in the design process.

2.12.6.3 INVOLVEMENT AND KEEPING INFORMED OF CONSTRUCTION, TECHNICAL AND OPERATION PERSONNEL

2.12.6.3.A

Provisions shall be made by the Supplier* so that the Owner's* including its Subcontractors* operation and maintenance personnel, technical personnel (including engineering) and Plant* construction and Commissioning* (start-up) representatives have full on-line access into the Project* Configuration Management* System and in to other related design tools and Documents*.

2.12.6.3.B

On-line access to all Supplier's* design Documents* during designing (including information treated within special software and special software tools) and provision of related means,

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approaches, methodologies and training together with Supplier's* proper planning and graduated hand over of the design Documents* to the Owner* shall ensure that the Owner* has enough time for its design review and approval without any negative impact on schedule. Supplier* shall be sufficiently conservative during the planning and shall keep distinction between review and approval processes and shall carefully reflect Owner's* technical capacity.

2.12.6.4 ENGINEERING PLAN AND SCHEDULE

2.12.6.4.A

Engineering plan and schedule shall reflect all relating requirements described in Project Management Document*, Section 2.6.8.1 and Technical Requirements Document*.

2.12.6.5 FUNCTIONAL ARCHITECTURE

2.12.6.5.A

NA

2.12.6.5.B

The Supplier* shall provide a complete functional architecture of the Plant* and/or Unit* to cover all Operational States*, Accident Conditions*, Hazards* and applicable requirements of EPC Contract*. The architecture shall be available to the Owner* in Object Modelling Language - Unified Modelling Language (or similar) supplemented with other forms of Documents* (as e.g. behaviour diagrams, control flow diagrams, functional flow block diagrams etc.) in order to reach unambiguous functional architecture definition and demonstrate the fulfilment of all requirements of the Plant* and/or Unit* and systematic approach to application of the project specific DiD concept to Plant* and/or Unit* design. The functional architecture shall demonstrate the complete decomposition of the plant function(s) to basic subfunctions to lowest level of functional hierarchy in order to demonstrate which functions are assigned to SSC.

The functional architecture shall demonstrate the operation of the Plant* and/or Unit* in various Operational States*, Accident Conditions*, Hazards* and fulfilment of the EPC Contract* requirements and also for continuous verification of compliance with Fundamental Safety Functions* throughout the whole lifecycle of the Project*.

BA

The available version of functional architecture of the Plant* and/or Unit* shall be provided to the Owner* on request. Requests can be made also during Plant* and/or Unit* functional architecture development.

BB

The complete functional architecture shall be developed iteratively in frame of functional analysis once all functions have been allocated.

BC

The complete functional architecture of the Plant* and/or Unit* shall be delivered for first time to the Owner* no later than 48 months after LWA Date*.

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BCA

Development of Functional architecture will respect the SSC Safety classification.

BCAA

Preliminary schedule of Functional Architecture preparation is as follows:



Provision of the preliminary FA shall be agreed under the implementation plan.

BD

The complete functional architecture shall be verified by deterministic safety analysis (see TR 2.1.4.2), which shall prove that all plant systems including their SSC are capable to fulfil assigned functions.

BE

The Functional Architecture shall be kept actual by Supplier in relation to SSCs design development.

The functional architecture is created by iterative process, where the iterative process shall lead to (inter alia):

- to define successively lower-level functions required to satisfy higher level functional requirements and to define alternative sets of functional requirements,
- to define mission and environment-driven performance and to determine that higher-level requirements are satisfied,
- to flow down performance requirements and design constraints to architecture and design.

[Note]

For avoidance of doubt the provision of functional architecture mentioned in Chapter 2.12.6.5.B is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

2.12.6.5.C

The functional architecture of the Plant* and/or Unit* shall be delivered to the Owner* in unlocked (editable) native format.

Note:

The Owner* is going to use the functional architecture throughout all lifecycle stages of the Plant* inclusive of decommissioning stage.

For avoidance of doubt the provision of functional architecture mentioned in Chapter 2.12.6.5.C is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

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2.12.7 FUNCTIONAL AND TECHNICAL IDENTIFICATION

2.12.7.A

The Supplier* shall develop and provide the Owner* with the Project Identification System* for all Structures, Systems and Components* for the whole Plant*, including the Nuclear Island*, Power Generation Plant*, Balance of Plant* and Support Facilities* and functional and technical identification for all Plant* Structures, Systems and Components* including items and spare parts.

The Supplier* shall provide and apply the Project Identification System* optimized and unified for the whole Plant* including SSC within Owner's Scope of Supply* covering all specificities (e.g. technological processes, software, I&C functions, algorithm identification, etc.). Project Identification System* shall be based on internationally recognized or EU standards, preferably "RDS-PP".

2.12.7.B

Identification of SSC (incl. proper use of the different types of identifiers as e.g. "functional", "physical", "loop" etc.) shall be unambiguous, clear, properly linked with all Documents* , data and all relevant databases and shall be systematic and systematically expandable in order to ensure efficient and save operation, maintenance and design modifications.

This also shall allow a correct traceability of the component location over the time, and an efficient management of the historical data needed for maintenance and replacement purposes. Extensive use of Project Identification System* within CM system shall be considered during its drafting and usage.

2.12.7.C

The Supplier* shall define and use standardised identifiers in equipment and component tagging and in associated Documents* including Information Models*, data models and databases, as appropriate.

2.12.7.D

Supplier* shall ensure that all design, construction, Commissioning* (start-up), and operation organizations and participants, have available and properly use those clearly defined and explained identifiers and standards in their Documents*, Information Models*, data models and databases in accordance with the Project Identification System*.

2.12.7.E

The structure of the SSC identification (part of the Project Identification System*) shall consider the PBS of the Plant* (it shall take into account all PBS level)

2.12.8 SPECIFIC DESIGN PROCESS REQUIREMENTS

2.12.8.A

The Supplier* shall utilize design methods for the Project* of the Plant* as required by EPC Contract*, Rules* and regulations, and shall adopt and demonstrate its own extensive experience, Good Engineering Practice*, use of advance and most modern methods and design tools, evaluations and design approaches and shall fully follow requirements of the EPC Contract*.

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2.12.8.B

The Supplier* shall also carefully take into account the site-specific conditions and requirements (including Requirements of the Authorities*), and shall provide well in advance description of the special and/or specific Documents*, software, studies and evaluations (seismic analysis, environmental design data, etc.) that shall be provided to comply with these site-specific or local conditions and requirements, identifying all the methods and design tools at the initial stage of the Project*. The Supplier* shall develop and maintain a list of these special or/and site-specific Documents*, software, studies and evaluations including a brief description of their intended purposes and content (and features and specifications in case of e.g. software tools). The list of mentioned Documents* and Documents* itself, shall be included in and regularly updated and maintained within Project Configuration Management System* and provided to the Owner* within Operational Configuration Management System* together with other design information and data included in Project Configuration Management System*.

2.12.8.C

Requirements defined in Technical Requirements Document*, Section 2.12.8 shall be understood globally and shall be applied on site-specific as well as on non-site specific design and relating processes and activities.

2.12.8.1 SPECIAL STUDIES AND EVALUATION

2.12.8.1.A

Where special studies and evaluations (licensing justification analyses, trade-off studies, optimization analyses, etc.) are necessary, those shall be provided by the Supplier* in the course of completing or justifying the design. These studies and evaluations and related activities and actions shall be clearly identified in the design development and implementation plan, with clearly assigned responsibilities and scheduled activities to be completed in a timely manner, and shall be consistent with the need for related design decisions and the need for information exchange and cooperation with all Project* participants.

AA

Full scope of special studies and evaluations necessary for choice of the technical solution or approval need for design decision to be made by the Owner* shall be provided by the Supplier* to the Owner* well in advance, taking in to account complexity and importance of the study or evolution and need for clarification, negotiation, decision making and where appropriate also need for obtaining of approval of the Authorities*.

2.12.8.1.B

The content and results of special studies and evaluations studies and evaluations shall be documented formally, submitted for the Supplier's* internal review, as well as for the review, information or approval (where applicable) of other Project* participants (incl. the Owner*), and results and full content and scope of these studies and evaluations shall be incorporated in all relevant technical Documents* and properly linked with relating design information.

2.12.8.2 SPECIAL SOFTWARE

2.12.8.2.A

The Supplier* shall provide the Owner* with special software to decrease human involvement as much as possible and also where it is beneficial for use in operation and maintenance of the Plant*.

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Note:

The aim shall be automation and standardization of the design for minimization of human errors.

2.12.8.2.B

The Supplier* shall also use proven special software tools to make engineering and design process, and licensing process smoother, more efficient and less risky. Those software tools including all the data shall be finally handed over to the Owner* and shall be consistent with associated processes, Documents* and shall be incorporated in the Operational Configuration Management System*.

2.12.8.2.C

The Supplier* shall provide all special analytical data models, methods and data and associated special software tools and software to facilitate analyses to be made by the Owner* as part of Plant* operation and maintenance and to allow the Owner* performance of all activities and reaching of all objectives associated with design modifications, as it is defined in the Technical Requirements Document*, Section 2.12.12.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.8.2.C into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

2.12.8.2.D

Special software to be provided by the Supplier* shall also include software for facilitation of system management, surveillance, diagnostics and life-time management for all SSC where it is appropriate (including, but not limited to, software for monitoring and surveillance of Technical Specifications* requirements, for analysing data, for fuel tracking getting data from fuel handling machine, for plant condition monitoring, for plant thermal performance monitoring etc.) for Plant* performance evaluation and maintenance, for facilitation of various analysis (including analysis for emergency purposes, but not limited to) including continuous on-line analysis (as e.g. chemical analysis, but not limited to), etc.

In case that special software is implemented in I&C system, it shall meet the general requirements for software, defined in the Technical Requirements Document*, Chapter 2.10 nevertheless in any case, any failure of special software shall not negatively affect safety and availability of the Plant*.

DA

List of the Special software includes all softwares required by the section 2.12.8.2 shall be submitted to the Owner in the early Project stage and then updated if needed.

DB

As minimum, the following information shall be included:



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2.12.8.2.E

Other related requirements are stipulated in Operation and Maintenance Document*, Section 3.9.

2.12.8.3 RELIABILITY AND PROBABILISTIC SAFETY ASSESSMENTS

2.12.8.3.A

The Supplier* shall develop a design reliability assurance programmes as specified in the Chapter 2.15.

2.12.8.3.B

The design reliability assurance programme shall assure that the Plant* and its SSC will be designed, manufactured, constructed, erected etc. to meet the Plant* safety and performance targets.

2.12.8.3.C

During the detailed design, the Supplier* shall perform successive cross-functional reviews and assessments of the design with respect to reliability assurance and modify the design, as appropriate to meet the targets of this programme.

CA

The Supplier* shall provide the necessary data to the Owner*, so that he will be able to utilise them subsequently for his own verification and validation reliability studies (i.e. PSA, PAM and RAP).

CB

The probabilistic safety data shall be handed over in the form enabling a PSA to remain live as specified in Section 2.17.1.3.

2.12.8.3.D

The Supplier* shall also develop an operational reliability assurance programme as specified in Chapter 2.15.

DA

The operational reliability assurance programme shall assure that the Plant* and/or Unit* and its SSC will be operated, tested, inspected and maintained etc. as required for the Plant* and/or Unit* to continue to perform as designed for the whole lifetime of the Plant* and/or Unit*.

2.12.8.4 DESIGN AND DESIGN PROCESS COORDINATION

2.12.8.4.1 SUPPORT FACILITIES

2.12.8.4.1.A

Requirements of this Section shall apply to following facilities described in the Chapter 4.7 of the Technical Requirements Document*:

- Fire station
- Drinking water storage

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- Waste management facility
- Training facilities
- Office building
- Repair shops Cold machine shop (Clean repair shop)
- Facilities for spare parts supply, storage and control (Spare parts storage inside LAA)
- Outdoor lighting
- Transport infrastructure (heliport, garages and fuel station)
- Main and supplementary Gatehouse
- Police station
- Medical centre
- Service building
- Substation and EDG building
- Fire water pump station
- Operational data centre

2.12.8.4.1.B

The Supplier* shall provide to the Owner* in accordance with mutually agreed schedule *Design Study* for each of the Support Facility* (or group of Support Facilities* if applicable) identified in the item A above. Such studies shall be provided to the Owner* for the approval.

BA

For requirements on the content of the *Design Study* see Section 4.1.90 of the Attachment 3 of the Project Management Document*.

2.12.8.4.1.C

The Owner* shall provide comments to the *Design Study*, and have the right to specify additional design requirements, mainly with respect to the future user properties of the facility (such as arrangement of the facility and architectural design, deployment of the power supply, IT, HVAC and other utility networks, etc.).

2.12.8.4.1.D

The Supplier* shall incorporate all the Owner's* comments and additional design requirements into the *Design Study* of the above mentioned Support Facilities*.

2.12.8.4.1.E

Approved *Design Study* shall be then properly implemented and used as a basis by the Supplier* for the development the Concept of Basic Design*, Basic Design* and Detail Design* of the Plant*.

2.12.8.4.2 INTERRELATED SSC

2.12.8.4.2.A

Requirements of this Section shall apply to the design of the interrelated SSC, i.e. the SSC to be supplied by the Owner* which are interrelated to the SSC supplied by the Supplier* (such as, but not limited to, connection points).

2.12.8.4.2.B

The Supplier* shall provide the Owner* with all design and other information (i.e. input design data) necessary for timely completion of the design of interrelated SSC in the scope of the Owner* (for division of responsibility see the Chapter 4 of the Scope of Supply Document*).

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BA

Such design and other information shall be provided by the Supplier* in coordinated and timely manner and in accordance with mutually agreed schedule, fully respecting the design processes of the Supplier* and of the Owner* (see Chapter 4 of the Terms and Conditions*). The design and other information provided by the Supplier* shall be based on the design of the Plant* and shall be such of quality, maturity, scope and detail allowing the Owner* to design its interrelated and where appropriate related SSC in appropriate and timely manner without necessity for additional design changes.

BB

For the avoidance of doubt, the Supplier* shall adapt schedule of its design activities of particular parts of the Plant* within all design stages in such a way to ensure timely provision of design and other information to the Owner* respecting fully all requirements of this section.

2.12.8.5 DATA MANAGEMENT PROGRAM

2.12.8.5.A

The Supplier* shall provide and implement comprehensive data management program to support overall data lifecycle within the Project*.

2.12.8.5.B

The data management program shall support among others also main aims of data management which are to eliminate redundant, obsolete and trivial data.

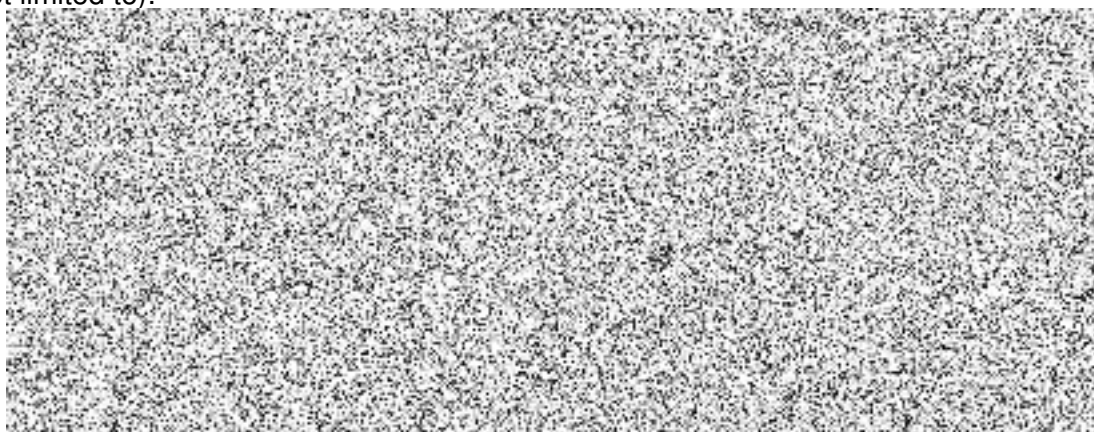
2.12.8.5.C

The data management program shall cover, but not limited to, processes used to:

- plan data
- acquire and use data
- transfer, transform and store data,
- maintain data,
- share data,
- archive / purge data

2.12.8.5.D

The Supplier* shall specify, maintain and apply general requirements on data including (but not limited to):



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2.12.9 CONFIGURATION MANAGEMENT SYSTEM

2.12.9.1 CONTENT OF CONFIGURATION MANAGEMENT SYSTEM

2.12.9.1.A

The Supplier* shall establish, develop-implement, carry out and maintain its comprehensive Project* Configuration Management* program, and develop and use its comprehensive Project Configuration Management System* supported by specific well-adapted software applications and procedures to ensure that all Configuration Management* objectives and all Configuration Management* relating requirements (and recommendations where specifically required) shall be properly met.

AA

Supplier* shall use proven and efficient software tools with implemented systematic Configuration Management* method, also based on relevant experience, to develop and maintain all levels of requirements and specifications. This tool shall be used to deliver a complete, unified and hierarchical well-structured licensing documentation with clear traceability from plant level requirements to equipment level specifications, including links to design/licensing basis and Requirement Management System.

AB

Supplier* shall duly and systematically monitor and document performance and effectiveness of its Configuration Management* program and system using several approaches including, but not limited to, CM performance indicators. All related information including regular reports shall be provided to the Owner*.

AC

Supplier* shall establish, develop, use, carry out and maintain the Plant* Information Model, including the description of the information hierarchy, traceability, description, purpose, guarantor (owner), format (including the registry lists).

Plant* Information Model shall be comprehensive and complete to fully support all features and functions of both Project Configuration Management System* and Operational Configuration Management System*.

All the information within Configuration Management* system software applications shall be stored in accordance with the Plant* Information Model.

2.12.9.1.B

The Project Configuration Management System* shall be established, developed, used and maintained from the start of the LWA Phase* through the handing over of the Plant* to the Owner*.

2.12.9.1.C

Main Configuration Management* objectives are as follows, but not limited to:

- Configuration Management* shall prove and maintain the consistency between Design Basis*, Project* Documents* and physical state of Plant*.

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- Configuration Management* process shall provide disciplined approach to the control of the physical configuration, design requirements and Plant* configuration information so as to ensure that all configured SSC are fully functional and support safe, reliable long-term operation of the Plant*.
- It shall be ensured that the Plant* can be operated, maintained and modified in a manner that maintains the physical Plant*, design requirements, and Plant* configuration information consistent within and with each other.
- Physical configuration of the Plant* shall be maintained in accordance with Design Basis*, licensing basis, design requirements, regulatory requirements and Permits*/Licenses* for operation.
- Readily available and accurate Design Basis* and licensing basis shall be available and linked with design requirements, Concept of Basic Design*, Basic Design* and Detail Design* of SSC.
- Responsibilities shall be assigned throughout standard CM process and activities.
- Information control and data consistency; traceability of the modifications and requirements; and access, security and activation of the configured Plant* data shall be ensured.
- Configuration Management* shall also enable Plant* modifications through life in the scope as defined in 2.12.12 (Means of Plant* Modification through Life).
- accurate information, consistent with physical and operational characteristics of the Plant*, shall be available in a timely manner, for making safe, knowledgeable, and cost effective decisions, with confidence.
- Configuration Management* shall be compliant with IAEA TECDOC 1335, IAEA TECDOC 1651, INPO AP-929 and other standards as required in Technical Requirements Document*, Section 2.12.9.2.D as agreed with the Owner.

2.12.9.1.D

In the Project Configuration Management System* shall also be gradually collected all initial data necessary for Owner's* future operation, maintenance, modifications as defined in the Technical Requirements Document*, Section 2.12.12 and Plant* life management, etc. Those data shall be collected instantly when they are available starting from design stage up to the Final Takeover*. Special attention shall be paid and measures shall be taken during construction and Commissioning* of the Plant* and/or Unit* to collect maximum possible unique data available during those stages and initial operational data.

2.12.9.1.E

With the use of Project Configuration Management System*, the Supplier* shall establish, develop and regularly maintain consistency within and conformity among design requirements, Design Basis*, licensing basis, physical configuration and all other Documents* (including all analysis, drawings, data, information, databases, procedures, etc.) up to the Final Takeover*. The keeping of mentioned consistency and conformity shall be properly ensured, documented, processed and verified and shall be verifiable and auditable by the Owner*, related Things* shall be provided in such a scope to allow the Owner* to perform efficient audits of the content of the Project Configuration Management System* continuously during the whole design and engineering process.

2.12.9.1.F

Supplier's* Configuration Management* program and Project Configuration Management System* shall be applied to full scope of the Plant* and/or Unit* but if Graded Approach* is

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applied the greater emphasis shall be placed on SSC of safety classes 1,2,3 (and other SSC having potential side effect on them), PSA important SSC, high economic value SSC and SSC having impact on availability of the Plant* and/or Unit*. Use of the Graded Approach* shall not be argument for reduction of amount of configured items in Configuration Management* program and Project Configuration Management System*.

2.12.9.1.G

CM System shall be adapted by the Supplier* in such a way so that it can be effectively utilized throughout all phases in the Plant* and/or Unit* life, including operation and maintenance and modifications of the Plant* and/or Unit* during commercial operation.



2.12.9.1.I

CM program and system shall be respected in the PQM of the Supplier* in accordance with Licensing and Permitting, Safety and Quality Document*, Chapter 3. Also the design validation and verification programme shall be incorporated into the PQM of the Supplier*.

Note:

Validation of the design is to be performed by Supplier for I&C systems and major changes (for novel design features).

2.12.9.1.J

CM program and system shall assure that documentation important to defining the Design Basis*, technical baselines and interface requirements of the Plant*, the actual configuration of the Plant* equipment, Structures, Systems and Components*, and the Plant* design, construction, operating and maintenance procedures, and all relevant support activities, regardless of discipline or source, are available in detailed and readily accessible and well organized form over the life of the Plant*.

2.12.9.1.K

In particular, the Supplier* shall ensure that the information needed for incorporation in the Configuration Management* system is identified for the whole Plant*, including information generated by or related to activities performed by its Subcontractors*. The Supplier* shall define the CM guides and Rules* and incorporate them into programmes and procedures for all Project* participants, including all Subcontractors*, to ensure that they will provide all input information and in a consistent format.

2.12.9.1.L

The Supplier* has the sole responsibility of ensuring that documented Plant* configuration is consistent at any time with the current design of Plant* Structures, Systems and Components*, while the Supplier* shall pay special attention to the maintenance of mentioned consistency at the beginning and during the Commissioning* (start-up) activities development and at hand-over time.

2.12.9.1.M

The Supplier* shall arrange and conduct the internal configuration audits of CM planned in the Supplier* Configuration Management* plan and programme and if necessary new internal

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audits shall be added. The Owner* shall be informed about the results of all Supplier's* internal audits.

In addition, the Owner* has the right to conduct by himself or by his representative, periodic or single functional or physical configuration audits/Inspections* to verify the correct implementation of the CM programme as well as current state and scope of filling of CM system. The Supplier* shall provide the Owner* with means and information to allow the Owner* to fully understand, use and audit Project Configuration Management System*.

2.12.9.1.N

The Plant* documentation shall also include the background information of design solutions taken during the Project* design process, a summary of the interdisciplinary design reviews, meetings and discussions and Supplier's* operational experience information. The Supplier* shall hand over to the Owner* the background information of design solutions and where it is possible those shall be duly linked with or included in Design Basis Documentation* to form basis for future operation, maintenance and design change process to be performed by the Owner* during future Plant* operation and maintenance as defined in the Technical Requirements Document*, Chapter 2.12.12.

2.12.9.1.O

In addition to the major basic options defined in the Design Basis*, the documentation shall list and justify the major design choices made, in order to solve specific issues raised during the design process. All the systems implemented in the Plant* in their software and hardware aspects shall also be addressed.

2.12.9.1.P

As a part of Project Configuration Management System*, the Supplier* shall provide the Owner* with a complex and comprehensive object-oriented data model which defines the Plant* configuration as relations and properties of respective Structures, Systems and Components*. This model shall reflect the organization of Project*.

2.12.9.1.Q

The Supplier* shall apply Building Information Modelling methodologies as far as possible to make the Configuration Management* fully data-centric, efficient and comprehensive, but the requirements and objectives related to the Configuration Management* shall be always fulfilled.

2.12.9.2 HAND-OVER TO THE PLANT OPERATOR

2.12.9.2.A

The Project* Configuration Management* shall be the responsibility of the Supplier*.

2.12.9.2.B

Supplier* shall provide the Owner* with comprehensive data-centric Operational Configuration Management System* including all relevant data, SSC's initial data, information, Information Models*, data models (including 3-D object oriented graphical model), Documents*, design documentation, analysis, cross-reference matrices, information, procedures, operation experience information, procedures and methodologies, plans and programme Documents*, customised software and other features and means (but not limited to) to fully support 60+ years of operation, maintenance of the Plant*/Unit* and ability to analyse and

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perform modifications of the Plant*/Unit* in the scope as it is defined in the Technical Requirements Document*, Section 2.12.12.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.9.2.B into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

BA

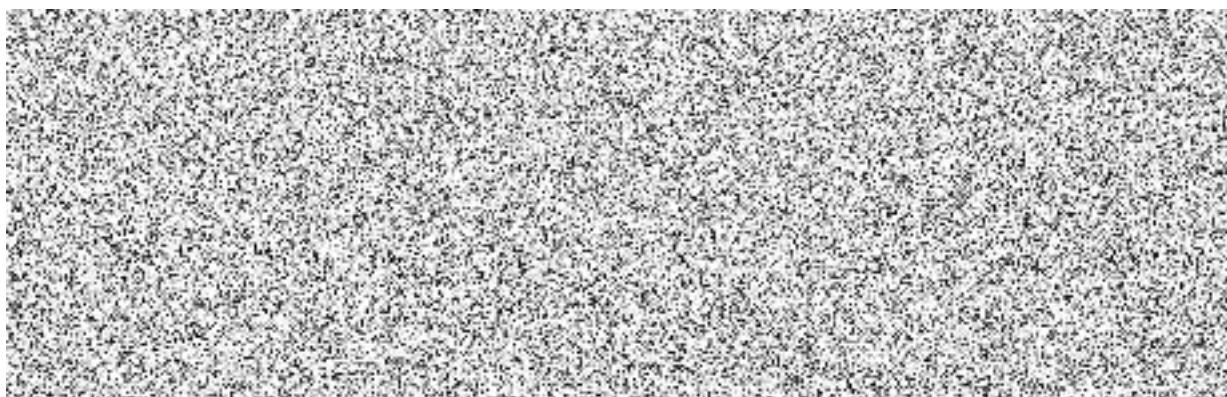
Supplier* shall plan, and structure graduated handover of the data of the SSC* from the Supplier* (design and construction team) to the Owner* (operation and maintenance team) providing emphasis on operational readiness and performance in use.

2.12.9.2.C

Provided Operational Configuration Management System* shall be ready to use and shall fulfil all relating requirements of the EPC Contract* including also those stipulated for Supplier's* Configuration Management* program and Project Configuration Management System*. Operational Configuration Management System* shall be based on Supplier's* Configuration Management* program and Project Configuration Management System* including its data and shall be complemented with features, data, Information Models*, data models with minimum scope of IFC as will be defined in in Attachment 3, Chap. 5.2.9 of Project Management Document* and agreed with Owner to meet all relating EPC Contract* requirements and targets.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.9.2.C into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.



DA

In any case the Terms and Conditions*, Article 2.1.1 shall be followed.

2.12.9.2.E

A formal handing-over process of CM System, which shall ensure that all configuration information is provided to the Owner* in a controlled manner, gradually and with sufficient time to allow the Owner* to verify them, shall be developed by the Supplier* and reviewed by the Owner*.

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2.12.9.2.F

The Configuration Management* process shall be in compliance with PQM and shall include clear delineation of responsibilities for each SSC until hand-over is completed.

2.12.9.2.G

Handing-over of the Operational Configuration Management System* shall be consistent and integrated with the OIMS as defined in Project Management Document*, Section 4.1.2.

GA

The data, Information Models* and data models with minimum scope of IFC model as will be defined in Attachment 3, Chap. 5.2.9 of Project Management Document* and agreed with Owner and information necessary for future operation, maintenance and modifications as it is defined in the Technical Requirements Document*, Section 2.12.12 and other parts of EPC Contract* which are not available before the Operational Configuration Management System* is handed over to the Owner*, shall be collected or/and developed by the Supplier* and provided to the Owner*, directly into its Operational Configuration Management System*, as soon as possible, but not later than Final Takeover*.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.9.2.G into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

2.12.9.3 CHANGE CONTROL PROCESS TO BE IMPLEMENTED IN CMS

2.12.9.3.A

Both the Project Configuration Management System* and Operational Configuration Management System* shall include and shall have implemented comprehensive change control procedure including clear change-approval criteria. This procedure shall be compliant with the PQM and shall be supported by specific software applications. Procedure shall provide for a single accountable change-control organization along with the criteria and administrative process for change initiation, evaluation, review, approval, implementation, disposition, status reporting, distribution, etc. and change of the Documents*, data and life-cycle technical data updating, physical configuration and so on, as needed.

2.12.9.3.B

The principles of the PQM shall be fully integrated in all design supporting applications and data management procedures and where relevant into Project Configuration Management System*, Operational Configuration Management System* and related programs.

2.12.9.3.C

Both the Project* Configuration Management System* and Operational Configuration Management System* shall automatically notify and archive all changes in data and Documents*. All the design Documents* shall be kept updated.

2.12.9.3.D

The design and engineering process and Configuration Management* programs shall be managed in such a way so as to ensure the avoidance of any deviations from the Design Basis* and other design Documents* previously approved by the Owner* and/or Authorities*.

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Any proposal for deviation from Design Basis* and other design Documents* and design changes shall be dully explained and justified by the Supplier*, proposed deviations and design changes that could affect licensing or permitting status of the Plant* shall be brought to the Owner's* attention immediately. Any proposed deviations and design changes shall be subject of Owner's* and/or Authorities* approval (see the Terms and Conditions*, Chapter 4).

2.12.9.3.E

Any need for design change rising from permitting and licensing processes shall be dully analysed by the Supplier* and brought to the Owner's* attention and approval. Approved design changes shall be introduced into design and affected design Documents*.

2.12.9.4 FEATURES OF THE CONFIGURATION MANAGEMENT SYSTEM

2.12.9.4.A

The Operational Configuration Management System* to be developed by the Supplier* for the Plant* shall follow all relating requirements in the EPC Contract*, including the following items, but not limited to:

- Verification methods to ensure compliance of the design at all levels with the Design Basis Documentation*.
- Design life and related parameters that shall be explicitly identified and readily retrieved to ensure residual lifetime of all SSC
- Change-control methods which shall ensure that all changes of the original design (or modified design) are approved at the appropriate level of authority in the involved organizations including the Owner* and documented for the life of the Plant*.
- Auditing and checking of the Configuration Management* data performed regularly as the initial database is assembled to ensure it is correct, actual, accurate and complete.
- A process to ensure verification and auditing of Configuration Management* data gathering, updating, revising, dissemination and security so that the data are (and can be maintained) up-to-date (actual), readily accessible, consistent and complete over the life of the Plant*
- Implementation of the Configuration Management* shall be based on use of the latest proven electronic database technology, consistent with adequate control of the data.
- Configuration Management* shall be based on internationally recognized recommendations, codes, standards, Rules* and best practices from successful applications of the similar scope solutions.
- Information of "know-why" shall be easily achievable among different kinds of data and Documents*.
- performance objectives of safety and security (including cyber security) shall be ensured and maintained

2.12.9.4.B

Operational Configuration Management System* shall enable users easily and efficiently search for and navigate through information contained in Operational Configuration Management System* based on, inter alia, identification, SSC, discipline, classification, metadata, the reference to multi-dimensional Information Models* and their data structures and content, data models, diagrams, algorithm diagrams, drawings and other graphical and non-graphical interpretations of the Plant* design.

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BA

The searching and navigation shall be intuitive, adapted to the Owner's* needs and adaptable for the Owner's* potential future needs. It shall, inter alia, be possible to use full text searching, limit a expand the searching and navigation scope, search across all configured items and related Documents*, use all metadata and references as the search criteria, etc.

2.12.9.4.C

Multi-dimensional Information Models* and their data structures and content, data models with minimum scope of IFC model as will be defined in Attachment 3, Chap. 5.2.9 of Project Management Document* and agreed with Owner, diagrams, algorithm diagrams, drawings and other graphical interpretations of the Plant* design shall serve as one of the graphical user interfaces to the management of the configuration data behind each Plant's* SSC.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.9.4.C into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

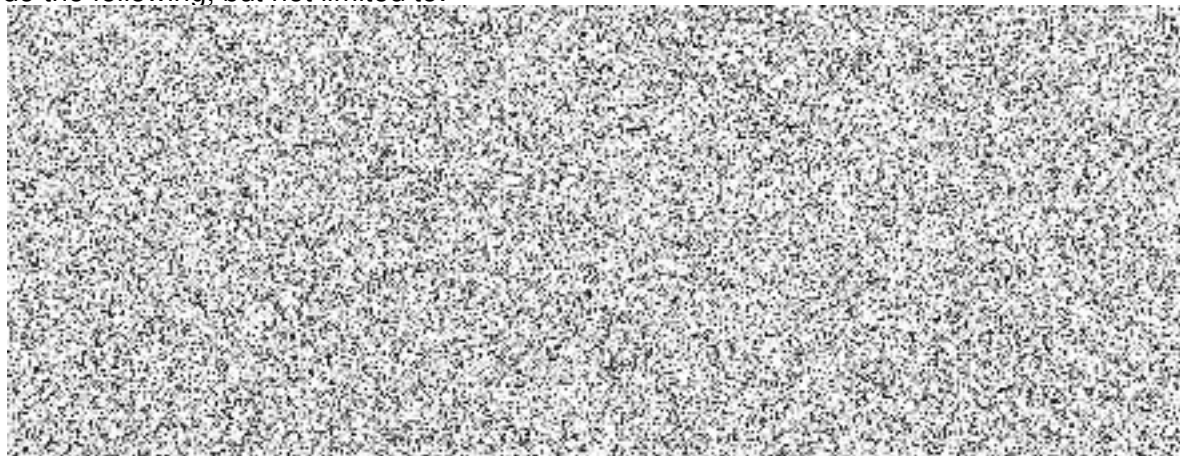
2.12.9.4.D

Requirements above shall be applied to the Project Configuration Management System* as well.

2.12.9.5 ADDITIONAL REQUIREMENTS FOR THE HANDLING OF SAFETY DATA

2.12.9.5.A

The Operational Configuration Management System* shall carefully manage safety data so as to do the following, but not limited to:



2.12.10 DESIGN INTEGRATION

2.12.10.1 DESIGN CRITERIA DOCUMENTS

2.12.10.1.A

The Supplier* shall prepare a top-level design criteria document for each Plant* and/or Unit* system or subsystem and for the Plant* and/or Unit* main structures and components, respecting, among other, all relating requirements of the EPC Contract*.

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2.12.10.1.B

This top-level design criteria document shall be included in the database as part of Project Configuration Management System* (as well as other design Documents*), and shall be available to the Owner* well in advance (at the beginning of engineering and design works).

BA

Design Basis Documentation* shall contain specific design criteria for each Plant* and/or Unit* SSC and detailed description of how the design features satisfy the criteria.

2.12.10.1.C

The top-level design criteria Documents* shall be sufficiently complete so that the Plant* and/or Unit* design can be developed from the top-level requirements, and that the conformance of the as-built plant with any applicable technical requirements (incl. EPC Contract* and Rules* requirements and requirements of Authorities*) can be assessed also by the Owner*. The criteria specified within the top-level design criteria Documents* shall be appropriately incorporated into the Requirement Management System to enable traceability of each of the design criteria.

2.12.10.1.D

Fuel System* and Core* design criteria Documents* are to be provided under Nuclear Fuel Contract*.

2.12.10.2 DESIGN DOCUMENTATION

2.12.10.2.A

The Supplier* shall provide documentation, ensuring that the top-level design criteria are fully met including extensively and clearly documented design, calculations, fabrication, construction, Commissioning* and testing information and requirements. The detailed plan shall be available at the beginning of the design stage.

Requirements related to specific types of design documentation are also described in Section 2.12.1.2.

2.12.10.2.B

All design related Documents* shall be generated by the particular SW applications to ensure among other conformity between the data in applications and the content of Documents*.

Mentioned applications shall be part of data-centric Project Configuration Management System*. Data-centric Operational Configuration Management System* shall include mentioned SW applications in the scope to fully support all features, goals, capabilities, functions etc. of the Operational Configuration Management System* required by the EPC Contract*.

2.12.10.2.C

All schematic diagrams in all disciplines (civil, mechanical, HVAC, Electrical, I&C, etc.) shall be possible to generate from multi-disciplined Information Models*, data models and databases of the complete Plant* during all design phases (e.g. P&ID are to be generated from the data model once being incorporated into that data model).

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2.12.10.2.D

Drawings of all Plant* Structures, Systems and Components* in all disciplines (civil, mechanical, HVAC, Electrical, I&C, etc.) respecting as-built status shall be possible to generate from multi-discipline Information Models* and databases of the complete Plant* during all design phases.

2.12.10.2.E

The Supplier* shall provide source data and native files of all databases, Information Models*, data models and other Documents*.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.10.2.E into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

2.12.10.2.F

The Supplier* shall provide a complete set of Documents* standards defining content and form rules of each type of design Document*. Names of project items shall be created using a general standard, which shall be applied over the whole Plant* and over all disciplines and areas. The name of any project (incl. design) item shall be unique in whole Project*. The representation of an item in all Documents* of its appearance shall have the same name.

2.12.10.2.G

All design Documents* shall be created and managed in digital form with corresponding QA. All SW applications and tools used to create and manage design Documents* shall be object-oriented. Each named item shall be represented by a data object (given the item name) with attributes defined by a general data object class.

2.12.10.2.H

All data of applications used to create and manage design Documents* shall be communicated via a prescribed standard interface protocol. All applications shall be bundled in a general information management system enabling control of compliance with document rules and information consistency in data of all used applications. In the common data model Configuration Management* System shall automatically check and control, that all representations of the same item appear in non-contradictory structure and relations with consistent properties.

2.12.10.2.I

The Documents* in form of graphical or text shall be used for presentation of the data and information stored and maintained actual under the databases (Information Models*).

It shall be ensured throughout the whole project lifecycle that data and information presented under the document in graphical or text form is consistent with data and information contained under any part of multi-disciplinary Information Models*, thus that the Documents* generated in various lifecycle stages shall be consistent with each other.

IA

The Documents* generated from multi-disciplinary Information Models* shall contain an attached data file or other feature that links the data and information presented in the document to multi-disciplinary Information Models*.

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It shall be ensured connectivity (by hyperlinks) of the Documents* generated from Information Models* between model and document itself.

IB

The Documents* generated from multi-disciplinary Information Models* shall contain an attached data file or other feature that contains links to input Documents* (e.g. Basic Design* of a system is linked to Conceptual Design* of the system) as well as to related Documents*.

It shall be ensured connectivity (by hyperlinks) of the Documents* generated from Information Models* between each other.

IC

The Documents* generated from multi-disciplinary Information Models* shall contain an attached data file or other feature for linking of information. The data file shall contain links which represent a relation of a data/information presented in the text document and the same data/information presented in the graphical document (e.g. a link between a data/information presented in the text document in form of system description/system specification and the same data/information presented in the graphical document in form of P&ID of the system).

It shall be ensured connectivity (by hyperlinks) of the information presented in various Documents* generated from different Information Models* between each other to ensure consistency of information.

ID

The Documents* generated from data model which belongs to multi-disciplinary Information Models* shall contain an attached data file or other feature for linking of information. The data file shall contain links to related Documents* (e.g. if the scheme in form of system P&ID does not fit on single A3 sheet, than the P&ID must be split into various cross-referenced A3 sheets or if the system P&ID has interfaces to other systems which are related to the system presented on the P&ID).

It shall be ensured connectivity (by hyperlinks) of the Documents* generated from Information Models* between each other.

2.12.10.3 INFORMATION AND DATA MODELS, AND LAYOUT

2.12.10.3.A

The information and data shall be stored under multi-disciplinary Information Models*. The Documents* shall be generated from multi-disciplinary Information Models*.

To avoid any doubts, in the context of Chapter 2.12, the term Information Model* shall also be understood to include general data models, databases, data structures whose purpose is broader than just for buildings and civil engineering, i.e. they are multi-disciplinary data models covering all relevant engineering professions. All requirements for the Information Model* shall be specifically interpreted in accordance with the purpose of the use of that data model, database, data structure.

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2.12.10.3.1 INFORMATION AND DATA MODELS

2.12.10.3.1.A

Information Models* and data models containing both graphical and non-graphical information and data shall be developed by Supplier* and extensively used for designing, construction and commissioning of the Plant* by the Supplier*, all its Subcontractors and all design participants.

AA

Information Models* and data models shall be used where possible having the priority over the non-database information.

AB

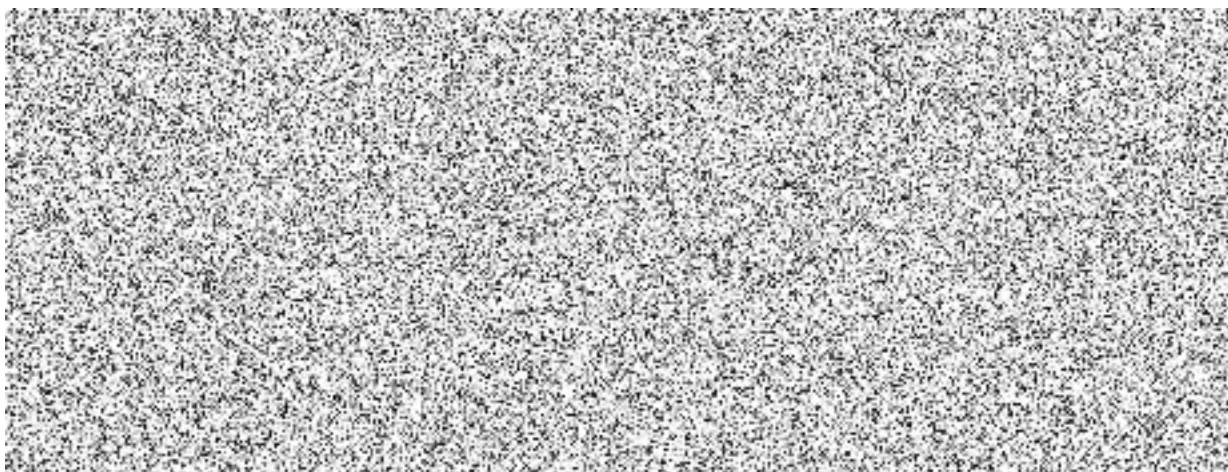
Supplier* shall gradually extend and supplement those Information Models* and data models with the data, properties, features and functions necessary to ensure their efficient use during future operation, maintenance and for modifications.

AC

Data model as part of Information Models* shall be object-based, data-rich, digital model representing both, native model resulting from proprietary software tools and IFC model with minimum scope as will be defined in Attachment 3, Chap. 5.2.9 of Project Management Document* and agreed with the Owner.

AD

The IFC model shall be standardised, digital description of the building environment, including buildings and civil infrastructure and all technological systems/facilities located in buildings, based on international standard (ISO 16739-1:2018) as amended, meant to be vendor neutral, or agnostic, and usable across a wide range of hardware devices, software platforms, and interfaces for many different cases.



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- acquisition of additional software tools / features etc.,
- software tools maintenance and updating,
- non-readability of the data in the long-term future.

AG

The Supplier* shall respect predefined basic modelling rules as defined in the Technical Requirements Document*, Chapter 2.12, Attachment 2 as a one part to determine the Employers Information Requirements (EIR) document and BIM execution plan (BEP) document as required in the Project Management Document*, Chapter 4.5.1.

AH

The finalized and applied modelling rules, provided as a part of Employers Information Requirements (EIR) document and BIM execution plan (BEP) document, shall cover all needs given by all purposes of use of model, and shall be comprehensive, complete and justified, and extensively complementing basic modelling rules. It shall be elaborated by the Supplier* and approved by the Owner*.

AI

The modelling rules shall include, inter alia, a detail description of how the Supplier* verifies data model compliance with the Owner's requirements applied to the Supplier* by the EPC Contract* using project design review tools before the data model submission to the Owner* for approval.

Note: example of verification the requirement:

Requirement: all pipes with nominal size DN600 or less shall be seamless.

- use filter for IfcPipe:

Pset_PipeSegmentTypeCommon.NominalDiameter>600mm

- colouring (blue) of the filtered pipe according to the value of the parameter:

Pset_PipeSegmentOccurrence.InteriorRoughnessCoefficient>0,001

Visual inspection that all displayed pipes are blue = are seamless.

AJ

The modelling rules shall include, inter alia, a detail description of the Supplier's rules applied to the Subcontractor's to verify the Subcontractor's data models compliance with the Owner's requirements applied to the Supplier* by the EPC Contract*.

AK

Further requirements on 3D data models will be described in Attachment 3, Chap. 5.2.9 of Project Management Document*.

2.12.10.3.1.B

The Supplier* shall develop-adapted, maintain and provide comprehensive discipline-specific, integrated (federated) and functional multi-discipline Plant* Information Models* and data models, including 3D graphical models containing all relevant data for each SSC (e.g. functional specifications, Design Basis*, design information, information related to lifetime management, verification and validation, etc.), interprofessional relations and links.

BA

The Supplier* shall ensure, inter alia, for all the discipline-specific and integrated (federated) Information Models* and data models that the models have appropriate exchange file formats

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and are capable of being aggregated and brought together to the common data environment in the PIMS and OIMS in order to allow, inter alia, the Owner* for viewing, clash-detection, issue management, comments recording, analysis etc.

The Supplier* shall ensure that all 2D drawings, 1D information and other information models related Documents* are derived from the models wherever possible and are to be transferable within common data environment into appropriate exchange file formats ensuring exchange of all modelled information.

BB

Supplier* shall ensure that the one dedicated modelling tool or sets of tools is appropriately used for modelling of graphical and nongraphical information by all design participants. Data exchange among design participants shall be standardized but the work on the data models itself shall follow the principle of sharing one model among all participating organizations. The process shall ensure smooth, efficient and non-conflict modelling for all design participants. Measures shall be made to limit access as needed.

BC

Supplier* shall ensure consistency among 3D, 2D and 1D Information Models* and data models using advanced methods and design and engineering SW tools.

BD

The Supplier* shall specify the specific level of detail of information to be delivered at each stage of the Project* and data drop for each SSC and group of SSC and discipline in Plant* data structures and information models Documents*, see the Project Management Document*, Section 4.5.1. Specification of level of detail of information shall be subject of the Owner's approval.

BE

The Supplier* shall develop the definitions of the information model structure (e.g. volumes, zones and areas) and related rules.

BF

The Supplier* shall apply an innovative approach for use of the Information Models*, data models and associated processes, inter alia, to help with issues around health and safety aligned with the Project* stages. This shall include but not be limited to access and maintenance strategy, equipment routes, site orientation/welfare, temporary works, designer risk assessment and risk scheduling. The associated data and records capturing processes shall be documented and controlled within Data management program.

2.12.10.3.1.C

All Information Models*, data models and other Documents* shall be provided to the Owner* within data-centric Operational Configuration Management System* and shall be implemented in both the data-centric Project Configuration Management System* and Operational Configuration Management System*. All the Information Models*, data models and other Documents* available already in Project Configuration Management System* shall be managed and maintained up-to-date by the Supplier*. All the Information Models*, data models and other Documents* relevant just for future Owner's operation, maintenance and design modifications (as defined in Technical Requirements Document*, Chapter 2.12 and other parts of the EPC Contract*) shall be provided to the Owner* complete, ready to use and up-to-date within the Operational Configuration Management System* at the latest. Completeness of all Information Models*, data models and other Documents* shall be ensured and

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demonstrated, all those Information Models*, data models and other Document* shall be provided to the Owner* according to the mutually agreed schedule to enable also validation of selected data by the Owner* before the Operational Configuration Management System* is handed over to the Owner*.

CA

The Supplier* shall define, inter alia, its validation process of Information Models*, data models and other Documents* and shall ensure careful and efficient application and use of the process by the Supplier*, its Subcontractors* and the other Project* participants. The process shall ensure, inter alia, that there is a recorded feedback process to rectify any shortfalls prior to moving forward at final information handover.

CB

The Supplier* shall provide the Owner* with all required data sets and SSC information sequentially at data drop stages agreed by the Owner* and in suitable information exchange format/s to enable both review and validation data and information of the Information Models* and data models by the Owner* without incurring time constraints of the Owner* and without negative impact on the Project* schedule, before that the Operational Configuration Management System* is completed and handed over to the Owner*.

Note: The Owner* may decide to validate just selected set of data and information but Supplier* shall not rely on this possibility for data drops planning.

CC

Owner's* comments and findings at each data drop shall be carefully applied by the Supplier*.

CD

The Supplier* shall provide a procedure outlining which data sets and SSC information shall be provided at individual data drop stages to the Owner* by the Supplier* including all its Subcontractors* and Project* participants. The preliminary procedure shall be part of master information delivery plan and information model production & delivery table defined in Project Management Document*, Section 4.5.1.

2.12.10.3.1.D

Information Models* shall include state-of-the-art 3-D comprehensive computer graphical-database data model of the whole Plant* and its SSC, which shall be developed during design process following all relating engineering and design manuals and procedures and shall be extensively used during construction. Information Models* shall be continuously updated, maintained and periodically provided to the Owner* since Conceptual Design Phase start (in accordance with Attachment 3, Chap. 5.2.9 of Project Management Document*). The Supplier* shall fully demonstrate to the Owner* that the finalized Information Models* including 3-D comprehensive computer graphical-database data model of the whole Plant* is entirely compliant with Plant* and its individual SSC as it is built. For the demonstration, the Supplier* shall use advanced measuring, optimizing and data processing methods.

DA

The Information Models* periodically provided to the Owner* shall be delivered together with a changelog (file), and this changelog shall list all changes that have been made by Supplier* since previous provision of Information Models*.

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DAA

The changelog (file) shall contain an identification to the SSC, as per Project Identification System* described in Chapter 4 of Project Management Document*, which has been changed/modified and a reference ID to associated change/modification protocol. The change/modification protocol shall be available to the Owner*.

DAB

Changelog for IFC data models shall be provided as Building Collaboration Format (BCF) file or BCF online platform. BCF changelog issues shall use all data option for each issue (marking relevant elements, author of each issue, view on changed elements, description, etc.) to provide information about changes in most effective manner. BCF shall be also used as design review communication schema.

2.12.10.3.1.E

Information Models* and data models shall be used since Conceptual Design Phase start (in accordance with Attachment 3, Chap. 5.2.9 of Project Management Document*) for preventing, identifying and resolving design errors, for managing design modifications, for improving and verifying Plant* maintainability and constructability.

2.12.10.3.1.F

The information and data models shall since Conceptual Design Phase start (in accordance with Attachment 3, Chap. 5.2.9 of Project Management Document*) also be capable of demonstrating installation and removal of major components and modules, and for evaluating efficient maintenance access and radiation exposure.

2.12.10.3.1.G

All the Information Models* and data models shall be on-line accessible to the Owner* during design, construction and Commissioning*, and handed over to the Owner* at the date of the Provisional Takeover* and updated up to the Final Takeover*.

2.12.10.3.1.H

To avoid any doubts, the terms as information or data model, database, data structure, etc. if mentioned anywhere in the EPC Contract* shall be understood, that they are filled with relevant respecting all applicable requirements of EPC Contract*

2.12.10.3.1.I

All elements included in any information and data model shall use agreed Project Identification System* as described in Section 2.12.7 and in Terms and Conditions*, Section 4.9.

2.12.10.3.1.J

All data used in any Information Models* and data models shall be based on valid and approved inputs in accordance with Rules* and EPC Contract*.

2.12.10.3.1.K

All applications and tools (software, databases, etc.) related to Information Models* and data models shall be listed and described in PIMS implementation and design documents as defined by Project Management Document*, Section 4.10. and Project Management Document*, Section 4.3.G.

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2.12.10.3.1.L

Information Models* and data models quality shall be checked with appropriate tool that is able to report any inconsistency. The structure and process of quality control shall be described in PIMS implementation and design documents as defined by Project Management Document*, Section 4.10.

2.12.10.3.1.M

Inter alia, PIMS shall include searching tool for any SSC in order to report, navigate through and review data contained in Information Models* and data models. Searching criteria and displayed results shall be expandable and configurable as needed for the purpose, based on (but not limited to) SSC, SSC groups (pipes, equipment, rooms, steel structures, etc.), safety class, etc.

2.12.10.3.1.N

Information Models* and data models shall include, as minimum, the following data (in their 1D, 2D and/or 3D representation):

- Identification of SSC (title, etc.)
- SSC group identification (pipe, equipment, steel structure, civil structure, cable tray, HVAC line, etc.)
- Status (project phase, Configuration Management* reference)
- Identification of location (room, building, system, subsystem, etc.)
- Environmental information (temperature, humidity, radiation, qualification requirements etc.)
- Geodetic location (global coordinates, local coordinates, elevation, etc.)
- Geometry information (width, length, high, diameter, thickness, etc.)
- Geometrical orientation
- Document reference (Isometric for pipes, etc.)
- Data sheets for SSC
- Specification reference (catalogue, etc.)
- P&ID reference (incl. electrical and I&C diagrams)
- Calculation reference (safety analyses, dimensioning and sizing calculation etc.)
- References regarding manuals and procedures
- Reference regarding changes (design changes, field changes, Owner* or Authorities* comments, margins etc.)
- Design data (design and operation temperature, design and operation pressure, humidity, power rating, safety class, reliability, DiD level, CCF, SW CCF, SFC, Redundancy*, seismic class, quality class, material, insulation, coating, cleanliness class, service inspection category, medium, design lifetime, EMC emission and immunity levels, explosion protection, setpoints, IP Codes etc.)
- Design Basis* and requirements reference
- Measured parameters
- EPC Contract* information (WBS, batch identification, black box supply, manufacturer etc.)
- Construction information (erection package, erection area, etc.)
- Insulation details (material, thickness, etc.)
- Coating details (material, thickness, etc.)

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- Details regarding welding (weld type, welding conditions, etc.)
- Terminal diagrams (electrical termination report)
- References to Algorithms (links to the control logic diagram)
- Reference to construction and implementation procedures
- Design verification and validation including testing (links to the documents which are dealing with validation/verification activities)
- Manufacturing and accompanying documentation
- Principles of cabling data and information
- Code and Standards
- Photo documentation (of the installations)
- Certificates of conformity and other QA documentation
- Interfaces (connection points, technical packages, technical interfaces between various entities, interfaces between systems etc.)
- Operation and Maintenance procedures
- Testing, calibrations during construction and for future operation and maintenance and relating procedures
- Tagging information

NA

All Structures*, parts, elements and equipment of the Plant* shall be divided into the following SSC groups:

- Civil structures (building, walls, etc.)
- Steel structures (beams, platforms, supports etc.)
- Embedded parts (liner, anchoring, sleeves, etc.)
- Isolating elements (doors, etc.)
- Equipment - tanks, pumps, heat exchangers, etc. (mechanical parts)
- Equipment - motors, transformers, switchboard etc. (electrical parts)
- Special equipment – (e.g. parts of Nuclear Fuel System* etc.)
- Pipes (mechanical parts)
- HVAC ducts (mechanical parts)
- Valves (mechanical parts)
- Valves (electrical parts)
- Instruments - flow restrictors, etc. (mechanical parts)
- Instruments (electrical parts)
- Electrical trays and cables (power, I&C)

SSC groups and related attributes shall be extended by the Supplier* in case that there are any other structures, parts, elements and equipment of the Plant* which are not covered or when it is needed or practical to provide higher detail of information or/and to fulfil any requirement of EPC Contract* (special attention shall be paid on Technical Requirements Document*, Chapter 2.12).

Specifics and details of the above information and data models shall be further discussed and agreed by both Parties during the Project implementation phase. Among the information above, the scope of the data that are to be included in the 3D model will be specified in Attachment 3, Chap. 5.2.9 of Project Management Document*.

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2.12.10.3.1.O

General requirements for coordinate system shall be in accordance with Rules* (Gov. Order No. 430/2006 Coll., as amended, etc.).

OA

Coordinates of any element included in any Information Models* and data models shall reflect physical location defined by agreed global coordinate system described in Technical Requirements Document*, Section 5.2.13.

OB

If reasonable (in case of simplification, etc.), Supplier* can define a one local coordinate system related to Site*.

OC

If any local coordinate is mentioned in Documents* there shall be stated it's local. In such cases the Document* shall clarify the relation between local and global coordinate system.

2.12.10.3.1.P

All measurable values in Information Models* and data models shall use SI (metric) system in accordance with Terms and Conditions*, Article 4.1.13 and Rules* (Act No. 505/1990 Coll., as amended, Decree No. 264/2000 Coll., as amended, etc.)

2.12.10.3.1.Q

Any information model, data model or related tool used for nuclear safety purposes (inter alia, for safety analysis, etc.) shall be validated by independent committee in accordance with Requirements of the Authorities* and Rules* (Decree No. 408/2016 Coll., as amended).

2.12.10.3.1.R

The Supplier* shall provide documentation proving quality assurance concerning the selection and use of the computer programmes. This documentation should be in accordance with the recommendations of the safety guide Safety Guide BN-JB-2.4, section 4, item (4.4) and will be provided for each computer programme used for safety assessment presented in the source Documents* submitted to the Owner* during the LWA Phase* in accordance with the Project Management Document*, section 1.1.3. The Owner* will submit it for SÚJB evaluation.

2.12.10.3.2 LAYOUT

2.12.10.3.2.A

Information and data models related to layout shall be in line with requirements specified in Technical Requirements Document*, Section 2.11.1.3.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter. 2.12.10.3 (from 2.12.10.3.A to 2.12.10.3.2.A) into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

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2.12.10.4 PLANT SIMULATOR/PERFORMANCE MODEL

2.12.10.4.A

The Supplier* shall use and provide the Owner* with a Plant* engineering simulator(-s)/performance model (-s) as a design tool for

- (1) studying Plant* response, human-engineering aspects of the Plant*, controls and control room design, and
- (2) for development of Plant* operation procedures for normal, abnormal and accident events (DBC1-4, DEC) as well as
- (3) for optimisation of the Plant* performance and analyses of transients
- (4) for optimisation of Commissioning* tests.

AA

However, Plant* engineering simulator(-s) /performance model(-s) shall be provided to the Owner* only on condition that the Training Simulator* cannot assure hereabove requested functions.

2.12.10.5 APPROVAL OF DESIGN INTERFACES

2.12.10.5.A

The Supplier* is responsible for the adequacy of the design interfaces of all Subcontractors* participating in design and, in particular, major civil work contractors and the Commissioning* (start-up) organization before initiating construction. The interface Documents* shall be presented to the Owner* for approval.

2.12.10.5.B

Project time schedule shall be established in such a way that the requirements on components, requirements for interdisciplinary reviews and other key basis, criteria or requirements, can be reviewed and/or approved by the Owner*, in a timely manner, taking into account potential risks of the Project*. In that context, relating design Documents* shall be provided sequentially and well in advance to avoid congestion of Owner's engineering capacity.

2.12.10.6 IDENTIFICATION OF SSCS INTERACTION

2.12.10.6.A

The Supplier* shall review the design of the Plant* based on extensive operating experience and deterministic assessment, also shall apply Probabilistic Safety Assessment, Plant* engineering simulator/performance data models, Training Simulator*, FMEA, fault tree analysis and other methods and tools to identify and avoid any potential detrimental interactions of Structures, Systems and Components*.

2.12.10.7 INTEGRATION OF SYSTEMS, STRUCTURES AND COMPONENTS

2.12.10.7.A

Technical Specifications* and verification and validation of fulfilment of the design criteria and safety objectives (which includes also testing coverage, testing criteria, tolerances, response times, accuracy etc.) shall be developed by the Supplier* at the early design stage, those shall be kept up-to-date through the Project* and shall be fully integrated into the Detail Design* as the Detail Design* is being developed.

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2.12.10.7.B

The Structures, Systems and Components* test programme and qualification programmes shall be coordinated with the Commissioning* (start-up) programme for the Plant* and/or Unit*. See Section 3.2 of the Construction and Commissioning Document* for additional requirements.

2.12.10.7.C

Sufficient overlap among all kinds of tests shall be specified, justified and documented. Special attention shall be paid to specification and documentation of overlap between factory and site tests.

2.12.10.8 SIMULATORS UPDATE

2.12.10.8.A

The Supplier* shall provide the Owner* with all necessary data, Things* and documentation to allow the future operation and modifications of the Training Simulator* and Plant* engineering simulator/performance model.

2.12.10.9 DESIGN PROGRESS AND REVIEW MEETINGS

2.12.10.9.A

The Supplier* shall organize design progress and review meetings between the Supplier* and the Owner*. Such meetings shall be held (1) regularly and (2) when necessary at the Construction Site*, or other location if agreed by the Parties*, and they shall be organized, moderated and documented by the Supplier*.

2.12.10.9.B

Main goal of such design progress and review meetings shall be, but not be limited to, reporting of the progress of the design of the Plant* and addressing associated issues, risks or delays, identified during the designing of the Plant*. This includes any issues, risks and delays resulting from design issues identified within Licensing and Permitting* process and with implementation of Rules*. For the avoidance of doubt, record (e.g. minutes of meeting) from design progress or review meetings shall not substitute any form of approval of any Documents* by the Owner* as described in the Chapter 4 of the Terms and Conditions*.

BA

Status and completeness of design shall be reviewed with the best available tools (including inter alia, design and engineering 3D tool). The valid version of Information Models* and data models shall be used for design review and comment purposes.

2.12.10.9.C

The Supplier* shall implement and carefully describe the role of the design progress and review meetings within engineering and design process Documents* and within POMM.

2.12.10.9.D

In addition, the Supplier* shall also organize regular design coordination meetings associated strictly with design of interrelated SSC (see requirements of Section 2.12.8.4.2 of the Technical Requirements Document*) in order to ensure, among other, following:

- reporting of the progress of the design of interrelated SSC and addressing identified issues or delays;

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- clarification of input design data exchanged between Parties*;
- clarification and compatibility of the technical solution of the respective interrelated SSC, respecting the requirements of the EPC Contract*, Rules* and Site* conditions (including the requirements of the Existing Nuclear Power Plant*) prior to providing interrelated document to the Supplier* according to the Chapter 4.3 of the Terms and Conditions*;
- clarification of the battery limits and related responsibilities;

2.12.11 INTERDISCIPLINARY DESIGN REVIEWS

2.12.11.1 DEFINITION OF THE REVIEWS

2.12.11.1.A

Inter-disciplinary design reviews shall be conducted by the Supplier* throughout the design, construction and Commissioning* stage of the Project* to ensure proper design and coordination among individual SSC of the Plant*.

AA

The design shall be properly coordinated and adjusted among individual SSC of the Plant*, always, without reliance only on inter-disciplinary design reviews.

2.12.11.1.B

The Owner* has the right and shall be invited in time to participate in these reviews.

2.12.11.1.C

The Supplier* shall provide the Owner* with an Inter-disciplinary Design Review Program, means and Documents* (including success criteria), early enough, to allow the Owner* be fully familiarized before the review starts. The inter-disciplinary design review program shall be regularly updated to reflect actual needs.

CA

Best available tools (including inter alia, design and engineering 3D tool) and the valid version of Information Models* and data models shall be used for the inter-disciplinary design reviews.

[Note]

For avoidance of doubt the conversion of data models mentioned in Chapter 2.12.1.2.C into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

2.12.11.1.D

Design reviews shall focus on Site* specific design, construction and Commissioning* works and on modifications requested by Authorities* or due to Czech nuclear regulations. In any case, the proceedings and records of all reviews shall be provided by the Supplier* as part of the Documents* including those performed for Standard Design* or Reference Plant* (for identical parts of design) in the past.

2.12.11.1.E

The Supplier's* Quality management stage program document shall indicate which design reviews are assumed and at which step of the design process. This document shall be

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submitted to the Owner* for approval within standard PQM process (in compliance with PQM). Design reviews shall be summoned in appropriate Project* phases in order that the design review resolutions that could modify the present design could be implemented with minimal impact on the Project*.

EA

The Supplier's* Quality management stage program document shall also include the design reviews methodology for all steps of design process in compliance with Licensing and Permitting, Safety and Quality Document*, Section 3.1.

2.12.11.1.F

The following specific requirements shall apply to the organization of the inter-disciplinary design reviews:

- an independent inter-disciplinary review group shall be established within the Supplier's* organization. This group shall report to the senior management of the participating organizations. Members of inter-disciplinary group must be individuals not involved directly in the Project* design process,
- the scope of review, action, and authorization of the review group shall be defined by the Supplier* and have the concurrence of the participating organizations,
- the review group shall include, but not be limited to, individuals experienced in nuclear safety, technical safety, radiation protection, fire safety, emergency preparedness and response, security, cyber security, occupational health and safety, environmental protection, civil engineering, electrical engineering, I&C engineering, mechanical engineering, chemical engineering, material engineering and nuclear engineering and nuclear Plant* operation, maintenance, construction and Commissioning*. At least one member of the group shall be knowledgeable of the principles of human factors. Participation of individuals in each review shall be appropriate to the subject,
- as appropriate, the technical reviews shall employ rigorous systems analysis techniques such as thermal-hydraulic transient analysis, safety and hazards analysis, reliability analysis, and probabilistic risk assessment. Special attention shall be given to systems interaction considerations,
- a schedule of the reviews shall be established early in the design process and updated periodically,
- the reviews shall be documented and maintained as part of the Plant* design record,
- information or comments and recommendations resulting from the design reviews in the Project* shall be followed up.

2.12.11.1.G

The Supplier* shall periodically survey the implementation status of the actions agreed in the design reviews, providing the Owner* with the details and conclusions of these controls.

2.12.12 MEANS OF PLANT MODIFICATION THROUGH LIFE

2.12.12.A

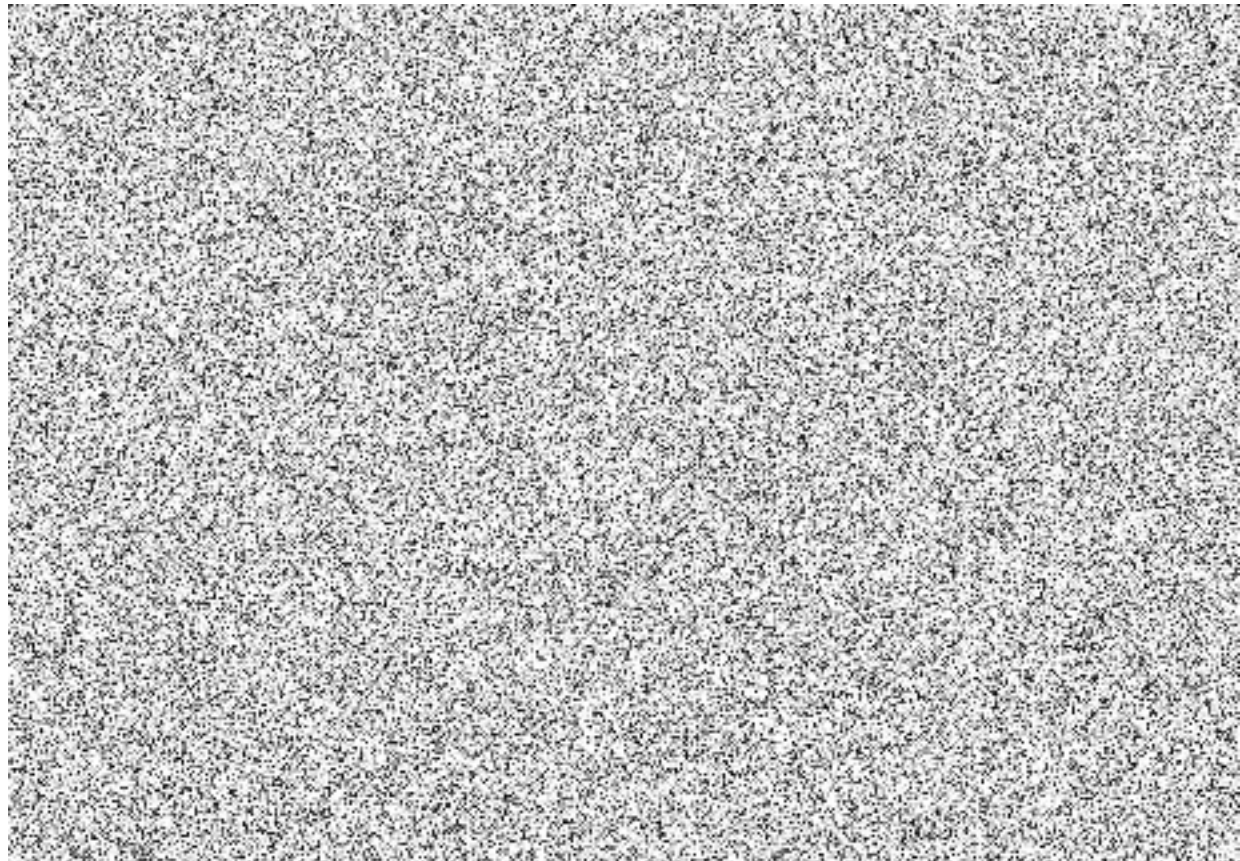
The Supplier* shall provide the Owner* with Means of Plant* Modification through Life.

2.12.12.B

Means of Plant* Modification through Life shall consist of all necessary technology, knowledge, training, tools, data, design information, engineering, Things* (including testing facilities), and



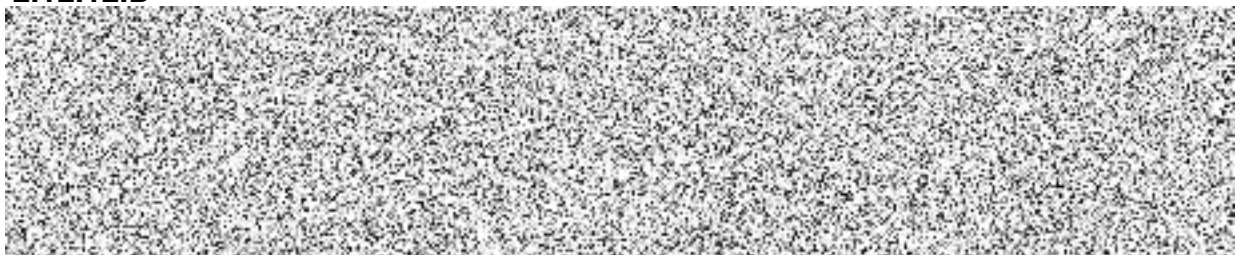
2.12.12.C



Supplier shall submit the Plan for Means of Plant Modification through Life for the Owner's approval and it shall include the list and description of the Means of Plant Modification through Life to fulfil the above requirements.

The list of Means of Plant Modification through Life provided in the Volume XXI, Attachment 9 shall be considered as preliminary one, non-exhaustive and shall not be considered as the list approved by the Owner*.

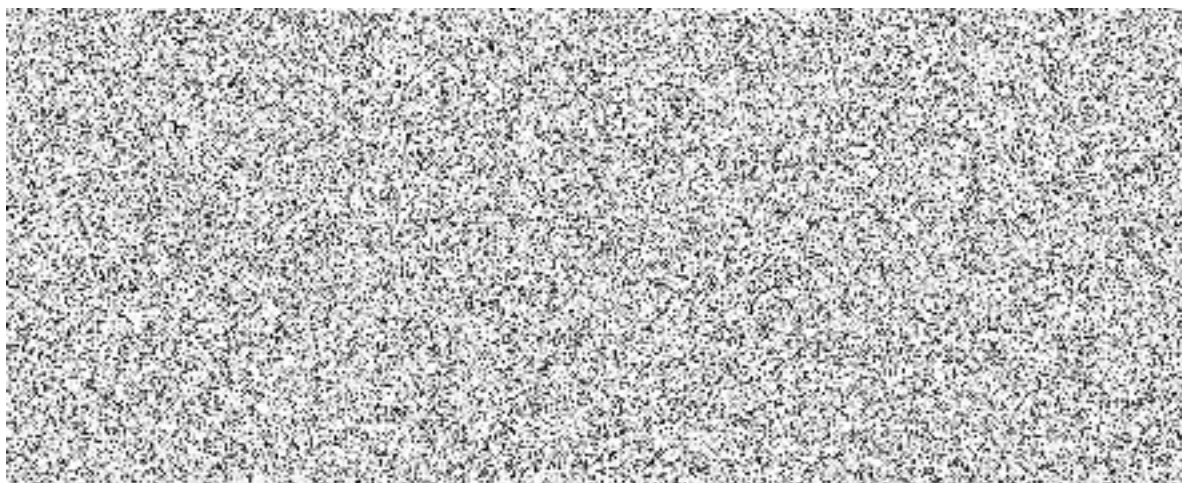
2.12.12.D



2.12.12.E

Means of Plant* Modification through Life provided by the Supplier* shall enable the Owner*:

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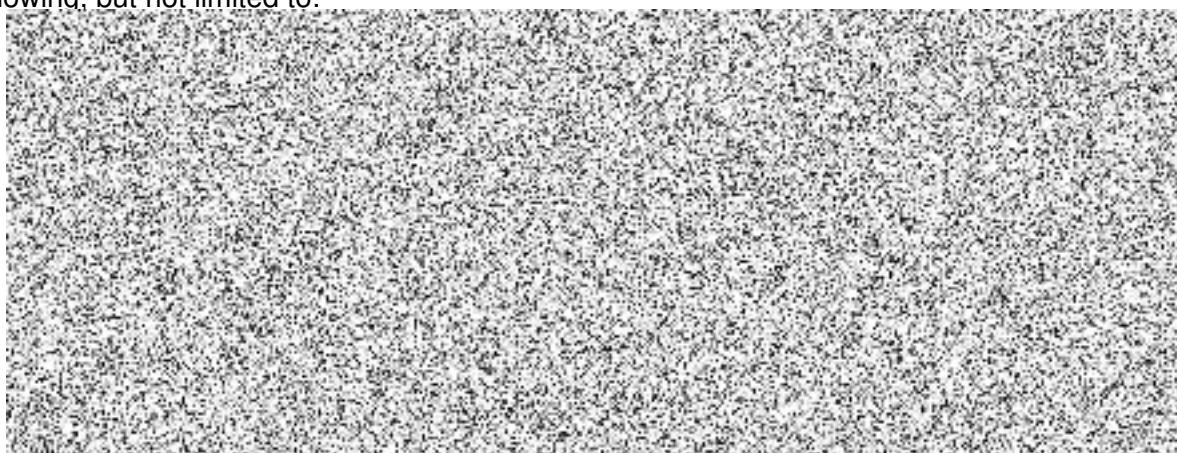


2.12.12.F

Means of Plant* Modification through Life provided by the Supplier* shall follow guides and recommendations in the IAEA Guide NS-G-2.3, other guides, standards and recommendations mentioned in the Technical Requirements Document*, Chapter 2.12 and Rules*.

2.12.12.G

Means of Plant* Modification through Life shall be duly provided and well executed and planned as comprehensive Means of Plant* Modification through Life program. Supplier* shall provide the Owner* with program document of the Means of Plant* Modification through Life for its approval at the beginning of the design stage. The Program document shall reflect Means of Plant* Modification through Life plan and shall contain detailed specification of all activities to be performed as part of Means of Plant* Modification through Life including following, but not limited to:



2.12.12.H



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2.12.13 ENGINEERING FIELD VERIFICATION OF AS-BUILT CONDITIONS AND DESIGN/CONSTRUCTION INTEGRATION

2.12.13.A

Engineering field verification of as-built conditions is defined in the Construction and Commissioning Document*, Section 2.3.10.

2.12.13.B

Design/Construction integration is defined in the Construction and Commissioning Document*.

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ATTACHMENT 1 CONTENT OF DESIGN

1 CONCEPTUAL DESIGN

Conceptual Design* shall include all design information as necessary for specification of concept of the Plant* design and its main SSC (incl. specification of main design requirements and criteria) and also information on On Site Facilities* and process of construction and Commissioning*.

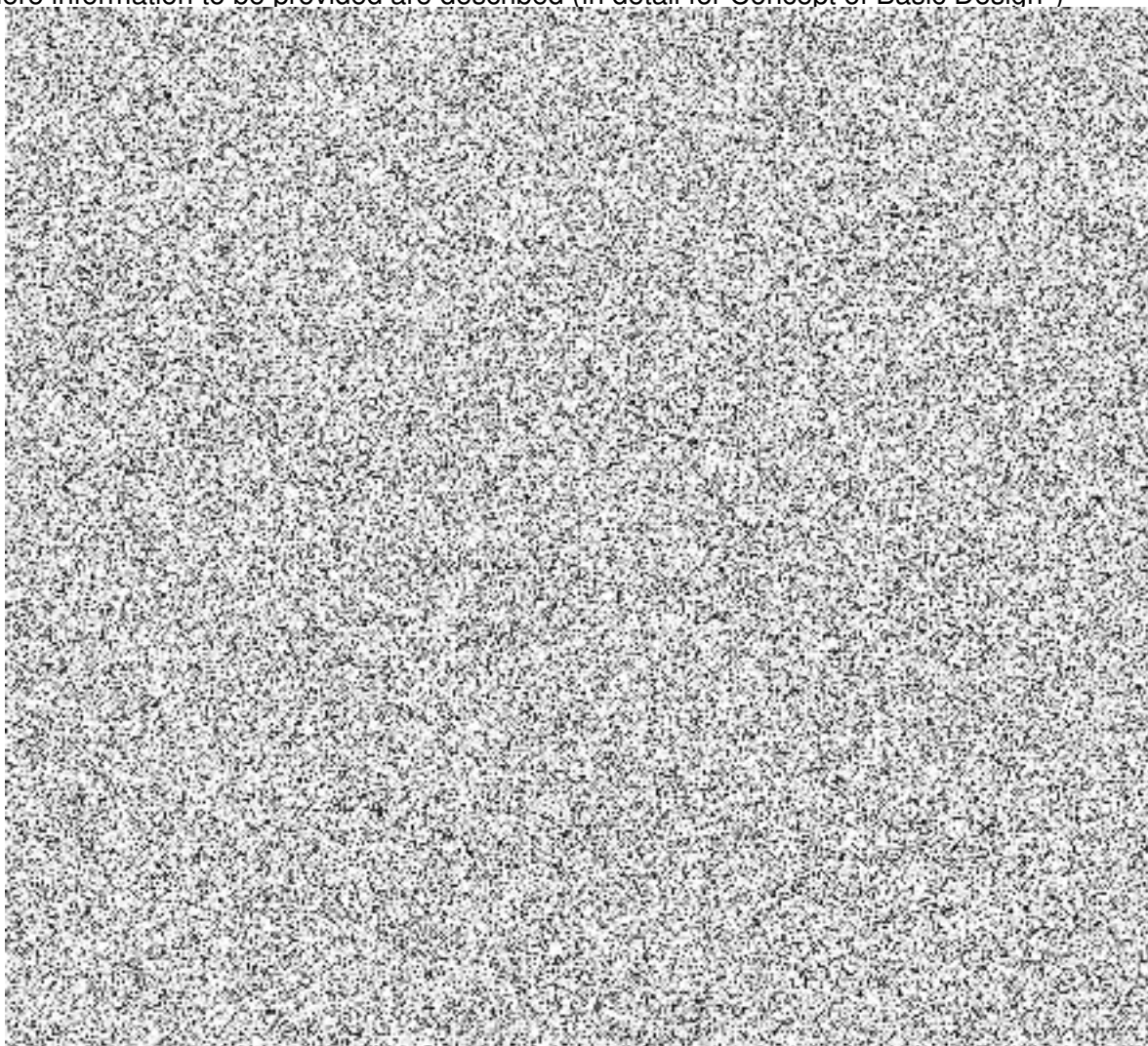
It shall also include information on proposed modifications of the Plant* and SSC design with respect to the design of the Reference Plant*/Standard Design*.

The specific list of Documents* related to Conceptual Design* shall be available in List of Project Documents* (if the specific filter criteria are set and the result list is displayed).

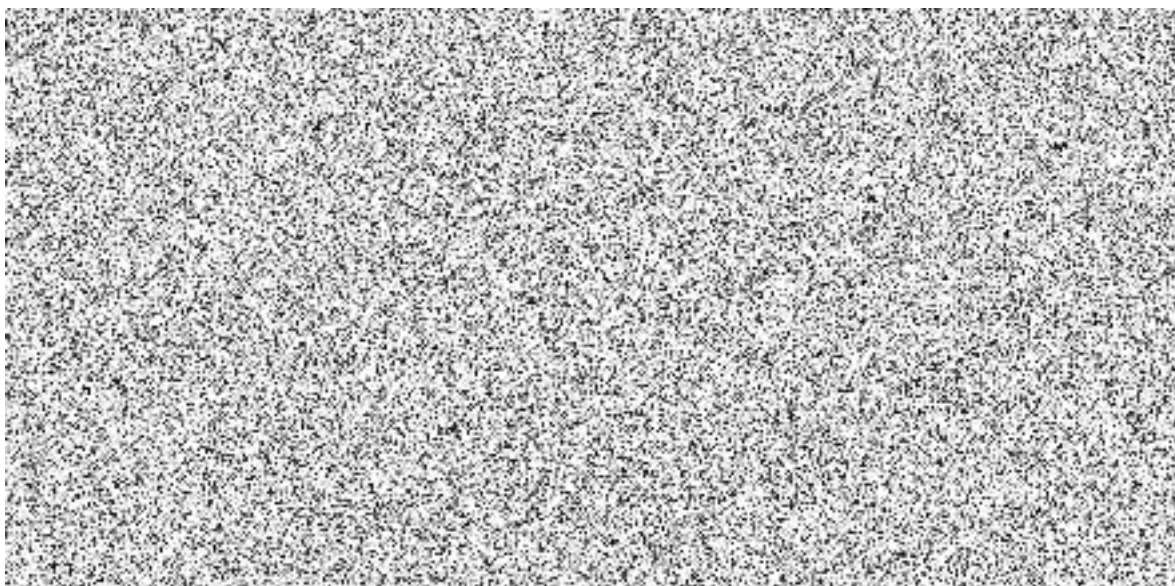
Information included in Conceptual Design* documentation shall be in line with EPC Contract* and the Rules*.

It shall include, but not be limited to, the following design information:

Note: The numbers in the brackets are Sections of this Technical Requirements Document*, where information to be provided are described (in detail for Concept of Basic Design*)



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Plant* and main SSC functions and parameters and Site* layout and main structures drawings shall include:

1.1 PLANT DESIGN

- Main Plant* design criteria and their Design Basis*,
- Documents specifying concepts in general design aspects (e.g. safety concept, physical protection concept, fire protection concept, emergency preparedness and response concept, accident management concept, environmental protection and monitoring concept, Radioactive Waste* management concept, waste management concept, water management concept, concept of maintenance, Inspections*, testing, condition monitoring, concept of labelling and colour coding, concept of margins and spare capacities, concept of Site* support and service systems and concept of Support Facilities*, material selection methodology, H-MI engineering criteria and standardization, etc.),
- Commented links to Design Basis Documentation* at the Plant* level (including safety, Licensing and Permitting* basis and power generation basis),
- Overall Plant* design description and specifications with clear link to design criteria/requirements/Design Basis*,
- Proposed modifications of the Plant* design with respect to the design of the Reference Plant*/Standard Design*.

1.2 NUCLEAR ENGINEERING

- Commented links to Design Basis Documentation*,
- Nuclear Fuel System* design requirements/criteria,
- Core* design requirements/criteria,
- Core* performance control concept,
- Fuel storage and handling system design requirements/criteria,
- Shielding and radiation protection requirements/criteria,
- Nuclear instrumentation (neutron flux measurement) design requirements/criteria.

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1.3 MECHANICAL ENGINEERING AND DESIGN OF MECHANICAL SYSTEMS AND COMPONENTS

1.3.A

Process engineering and fluid systems engineering

- Commented links to Design Basis Documentation*,
- Main systems design criteria/requirements,
- Main systems functional description and operating parameters,
- Main schematic diagrams,
- Main process flow diagrams,
- Main mass and heat balance diagrams,
- Proposed modifications of the Plant* design with respect to the design of the Reference Plant*/Standard Design* in area of process engineering and fluid systems engineering.

1.3.B

Mechanical equipment and piping and HVAC engineering

- Commented links to Design Basis Documentation*,
- Main mechanical equipment design criteria/requirements,
- List, description and basic data of main mechanical components (incl. main handling equipment),
- Main layout and arrangement drawings,
- Proposed modifications of the Plant* design with respect to the design of the Reference Plant*/Standard Design* in area of mechanical equipment and piping and HVAC engineering.

1.4 ELECTRICAL ENGINEERING AND DESIGN OF ELECTRICAL SYSTEMS AND COMPONENTS

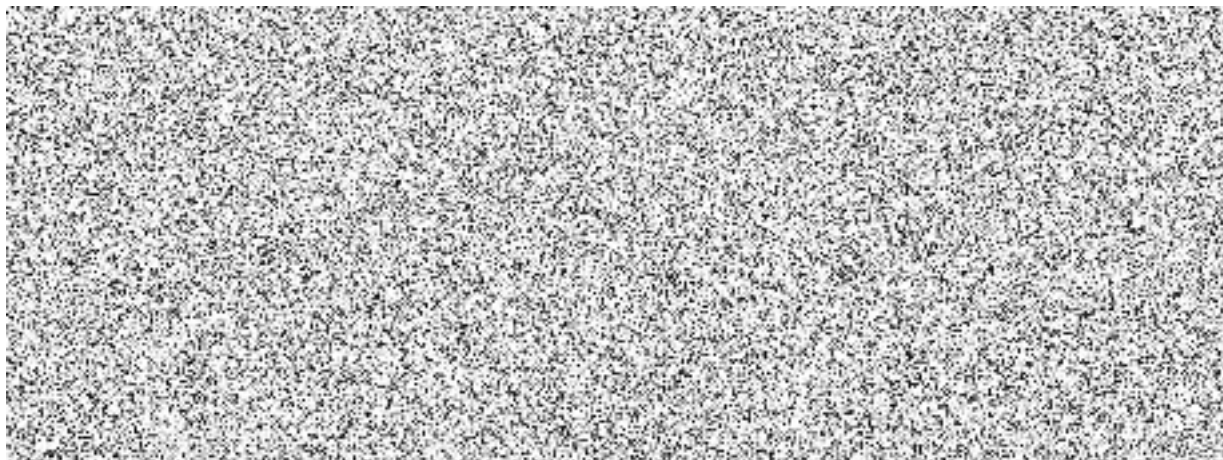
- Commented links to Design Basis Documentation*,
- power outlet, normal and stand-by auxiliary power supply diagram (connection to the grid),
- simplified auxiliary power supply diagram to the and including load centres and Emergency Power Supply*,
- main parameters of power sources and its functions in various Operational Modes* (SA and DEC as well),
- description of auxiliary power supply system (power sources, system, grounding, operation states, transfers among power sources, main equipment),
- description of Defence in Depth* application concept ,
- specification of SSC qualification requirements,
- description of concept of protection against internal and External Hazards* and electromagnetic hazards (incl. short circuits, overvoltages, EMC, lightning protection etc.),
- concept of elimination Single Failure Criterion and common cause failure,
- concept of electrical protection (incl. fault identification and location, protected zones, back up concept, fault recording, etc.),
- concept of cabling,

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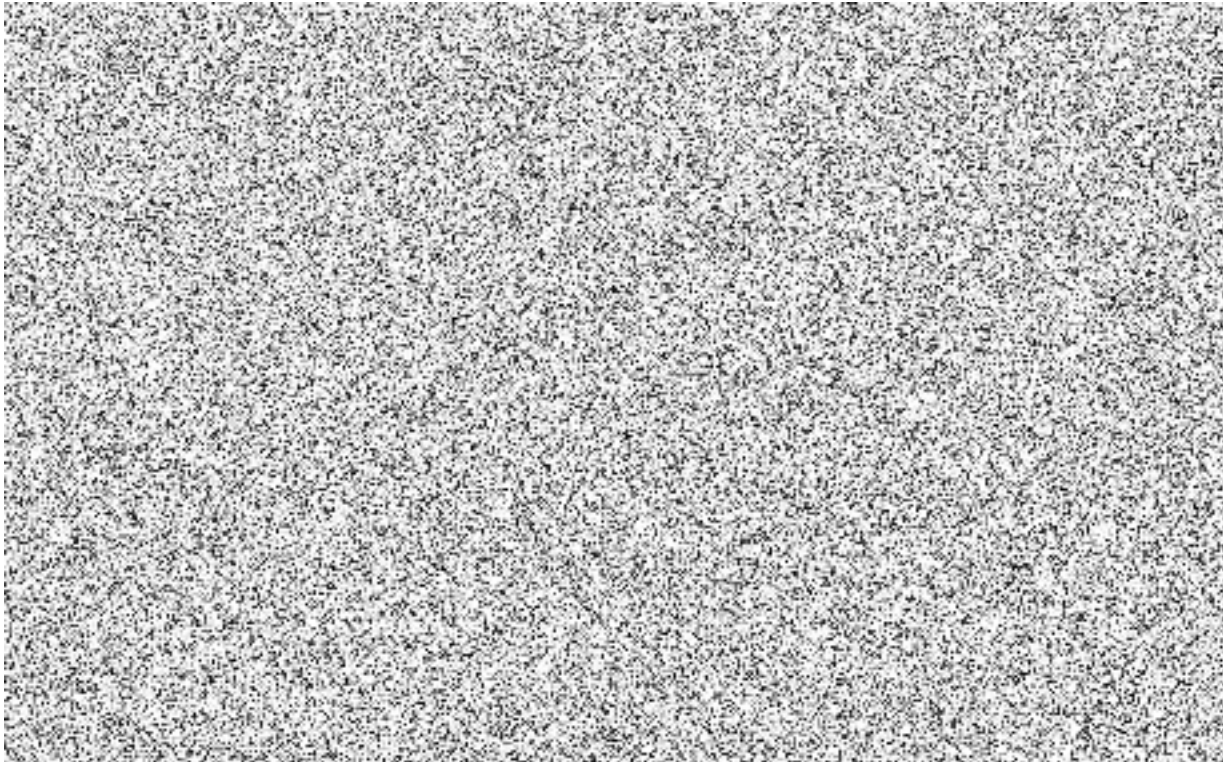
- concept and requirements on main automatics (automatic transfer switches, load shedding and sequencing logic controllers, etc.),
- preliminary load flow (P, Q) of auxiliary power supply system for sizing of main SSC
- layout concept of main electrical SSC,
- concept of internal and external grounding for buildings and whole Plant* area,
- concept of lighting.

1.5 I&C ENGINEERING AND DESIGN OF INSTRUMENTATION AND CONTROL SYSTEMS AND COMPONENTS

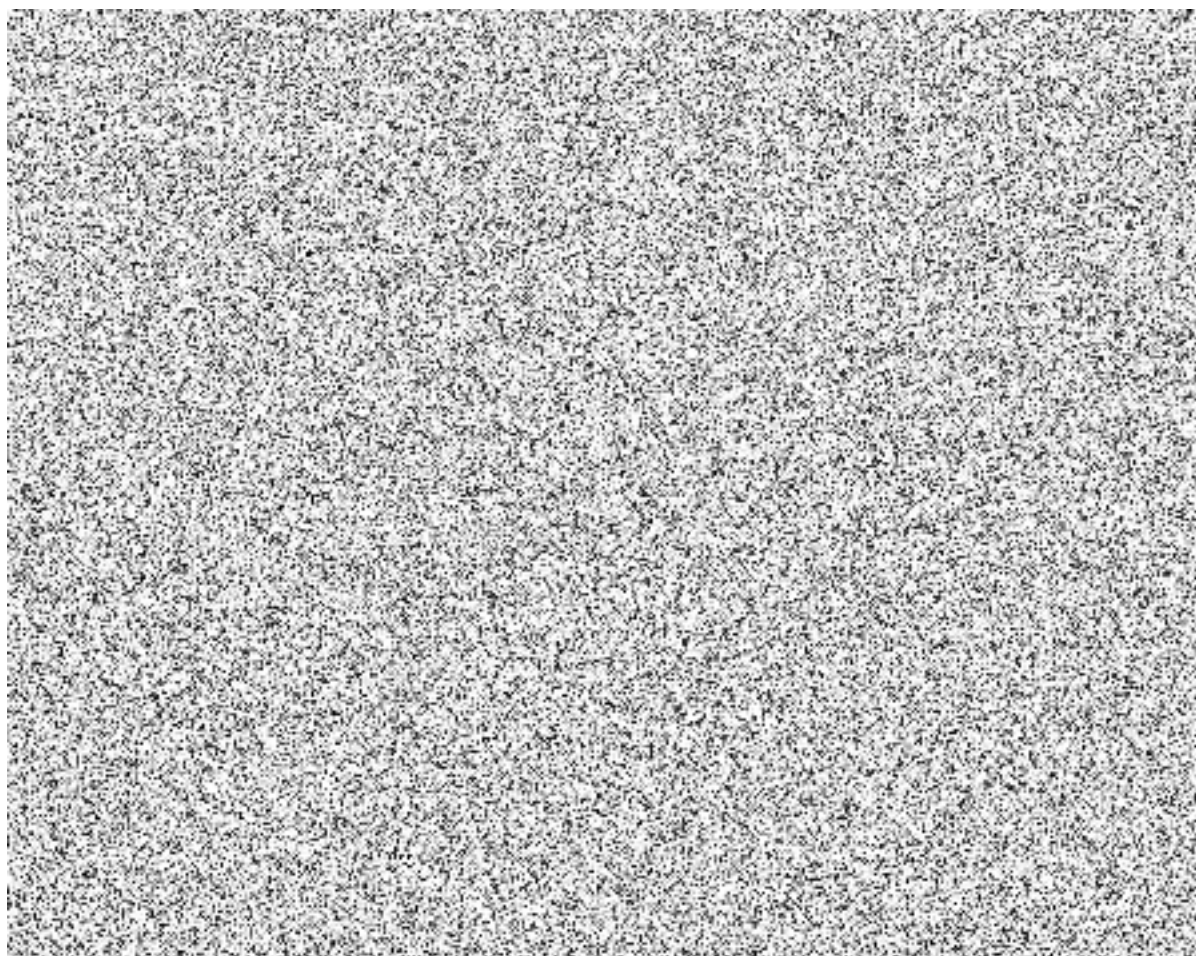
1.5.A



1.5.B



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1.6 CIVIL ENGINEERING, SITE AND STRUCTURES

Information included in Conceptual Design* documentation for civil engineering shall be in line with inter alia, EPC Contract*, Rules* (especially Act No. 183/2006 Coll., as amended, Decree No. 499/2006 Coll., as amended, Act No. 254/2001 Coll., as amended, Decree No. 146/2008 Coll., as amended, Decree 246/2001 as amended), etc.

The Conceptual Design* documentation related to civil engineering shall include following information (but not limited to):

- Conceptual Site* layout drawings of entire designed buildings, other ground and underground structures (e.g. cooling tower, galleries, etc.), and areas (e.g. parking area) located and incorporated at the Site* (e.g. interconnection to the existing buildings, others structures and areas),
- Description of principles for earthwork design (including felling of the trees, landscaping, excavation works, shoring, drainage, etc.)
- Description of principles for surveying and investigation of Construction Site* (e.g. geodetical, geological including borehole position, seismic, environmental survey etc.), as inputs for conceptual verification of civil structures location and design of foundation, waterproof isolation, radon isolation, type of finish coat etc.
- Land parcel plan drawings,
- Conceptual civil structures steel design (load bearing, vertical and horizontal structures)

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- Conceptual civil structures concrete design (foundation, load bearing, vertical and horizontal structures)
- Conceptual of ground and underground civil structures drawings including dimensions (representation of openings bigger than 1,5 m²)
- Conceptual civil structures analysis (static and dynamic calculations reports confirming compliance with the Design Basis Documentation*) for the dimensioning and sizing the civil structures including all anticipated loads of the systems and components,
- Description of principles for insulation and resistance (e.g. heat, water, ultraviolet radiation) design of civil structures of the Plant*,
- Conceptual surface treatment of the civil structure,
- Description of principles for drainage of Construction Site* and all civil structures of the Plant*,
- Description of principles for fire zoning and fire protection design (layout drawings including the dividing into fire compartments and fire hazardous areas) of the Plant*,
- Description of principles for Safety, quality and seismic classification of civil SSC (including classification of civil SSC related to Conceptual Design* stage),
- Description of principles for radiological and contamination zoning and radiological and contamination protection design of the Plant*,
- Conceptual general arrangement drawings (representation of all equipment heavier than 5t),
- Conceptual load drawings (representation of all equipment heavier than 5t and the conversation of the all other technological load on uniform load, the best estimated max. designed loads including external areas of the Plant*),
- Equipment introduction note/report (representation of equipment introduction routes for components/equipment heavier than 5t or with cross section area bigger than 1,5 m²),
- Interface lists related to Conceptual Design*,
- Building specifications related to Conceptual Design* (description of purpose, interfaces, list of systems designed in the building, references, etc. for each civil structure/building),
- Architectural design concept,
- Status reports (description of layout status for all SSC of the Plant* designed at Conceptual Design* stage including the civil engineering structures/buildings),
- Specification of Site* parameters (incl. External Hazards* – normal level – for non-safety SSC, Design Basis* level, rare and severe level),
- List and description of other necessary projects related to EPC Contract*,
- Maximum temporary and permanent acquisition of the agricultural land and forest areas,
- Codes and Standards* for civil engineering,
- List of references and status clarification list of requirements issued by authorities
- Legend, descriptions, references, dimensions (including representation of the origin and axes of local coordinate system, clarification of the relation between local and global coordination system including elevations, clarification of the view orientation by compass rose, designation and description of the main civil structures/buildings, useful area, built-up area, built-up space, etc.)
- Used plot scale of all Documents* shall ensure good readability and acceptance for all Authorities*

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- etc.

1.7 3D DESIGN

Expected content of the 3D federated information model at the Conceptual Design* stage should include:

- Preliminary (Best estimated) shape and general arrangement of all ground and underground civil Structures* (including openings $>1,5 \text{ m}^2$, access and transport routes) related to the Plant*,
- Preliminary (Best estimated) shape and general arrangement of all components for NSSS system including supports and obstructions,
- Preliminary (Best estimated) shape and general arrangement of other components for all other systems (including equipment or components heavier than 5t, components, lines or group of lines (piping, HVAC ducts, electrical trays) where the cross section area (measured including insulation) is $>1,5 \text{ m}^2$),
- Preliminary (Best estimated) shape and general arrangement of main steel structures (in the technology and civil scope of work),
- Shape and height levels of Plant* final terrain surface,
- Identification codes of all included SSC,
- Classification of all included SSC (Safety class, Seismic class of SSC are set),
- Design status of all included SSC is tracked.

The specific implementation of the above 3D/BIM requirements shall comply with Attachment 3, Chap. 5.2.9 of Project Management Document*.

2 CONCEPT OF BASIC DESIGN

Concept of Basic Design* shall include all design information as necessary for specification of overall design of the Plant* and overall design in all technical professions in such a detail as required for coordination of the technical professions and definition of design requirements and criteria to enable development of full scope Basic Design* in all technical professions.

Commented links to Design Basis Documentation* (including safety, Licensing and Permitting* basis and power generation basis) shall be provided.

It shall also include information on proposed modifications of the Plant* and SSC design with respect to the design of the Reference Plant*/Standard Design* and assessment of their impact.

The specific list of Documents* related to Concept of Basic Design* shall be available in List of Project Documents* (if the specific filter criteria are set and the result list is displayed.

Information included in Concept of Basic Design* documentation shall be in line with the approved and valid Documents* issued during previous stages (EPC Contract*, Conceptual Design*) of the Project* and the Rules*.

Design information (groups of information) shall be provided for both the Plant* and also for On Site Facilities* (incl. information on construction and operation).

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Note that the information to be provided for the On Site Facilities* are mainly for permitting activities a shall be provided in detail required by the Mandatory Law* and Requirements of the Authorities* and are expected to be less detailed than information for the Plant*.

The Concept of Basic Design* shall include, but not be limited to, design information in the following subsections.

2.1 LIST OF RULES

- list of Mandatory Law*, Requirements of the Authorities* and Codes and Standards* to be applied in the design,
- description of the way the requirement will be applied in the design,
- specifications of problematic requirements (with respect to application in the design) and proposal for their resolution,
- proposal for solution of design interfaces among parts of Plant* designed in accordance with different set of Codes and Standards*.

2.2 STANDARDISATION AND SIMPLIFICATION POLICY

The documentation includes policy for ensuring standardisation and simplification of the Plant* design and processes (see Sections 2.12.4 and 2.12.5 of the Technical Requirements Document*).

2.3 RELIABILITY ASSURANCE PROGRAMME

The documentation includes design RAP in scope stipulated in Chapter 2.15 of the Technical Requirements Document*.

2.4 PERFORMANCE ASSESSMENT

The documentation includes performance (availability) assessment in scope stipulated in Chapter 2.18 of the Technical Requirements Document*.

2.5 MARGIN ASSESSMENT AND MANAGEMENT

The documentation includes requirements for the Plant*, Core*, Fuel System*, the NSSS and other Essential Components* as stipulated in Section 2.12.2 of the Technical Requirement Document*. The documentation includes description of the margin management during design and operation of the Plant*.

2.6 ACCIDENT MANAGEMENT

Description of accident management incl., but not limited to:

- specification of accidents and associated risks and required accident tasks,
- technical means – description of the technical means including use of Non-Permanent Equipment*, of shelters and accident management centres and their capabilities including habitability,
- organizational aspects – description of management of the accident and all interrelations between various accident management centres.

2.7 EMERGENCY PREPAREDNESS AND RESPONSE

Description of emergency preparedness and response incl., but not limited to:

- specification of accidents and associated risks (selected in accordance with the Decree No. 359/2016 Coll.),

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- technical means – description of the monitoring and communication means, of shelters and Emergency Response Facilities* and their capabilities including habitability,
- organizational aspects – description of management of the emergency and all interrelations between various Emergency Response Facilities* on-site and off-site.

2.8 PHYSICAL PROTECTION

Description of physical protection incl., but not limited to:

- Identification of areas to be protected including source analyses,
- Threat assessment,
- Defence-in-Depth* approach, robustness and Graded Approach*,
- Description of zones and accesses and drawings,
- Description of detection means and systems (e.g. Intrusion and Hold-up Alarm System (I&HAS), Close Circuit TV systems, Access Control systems, Intercom, Control systems),
- Description of delay means (Barriers*),
- Description of response means,
- Description of control centres,
- Description of organizational aspects,
- Analysis of the intentional aircraft crash impact on the physical protection system (in case the analysis is needed)

2.9 CYBER SECURITY

Description of cyber security incl., but not limited to:

- Identification of Systems and Components* to be protected,
- Threat assessment,
- Defence-in-Depth* approach, robustness and Graded Approach*,
- Description of security operations centre,
- Description of design measures,
- Description of administrative measures.

2.10 FIRE PROTECTION

Description of fire protection incl., but not limited to:

- Principle of protection from internal and external fires incl. secondary fires effects,
- Identification and specification of fire hazards and fire hazard areas (internal and external sources),
- Fire hazard minimisation incl. secondary fires effects (separation of areas to Fire Areas* and Fire Zones*, Fire Barriers*, use of non-combustible and/or fire retardant materials and Consumables*; in particular cables, HVAC and openings/penetrations through Fire Barriers* and control rooms;),
- Design of the Fire Barriers* incl. their fire resistance,
- Explosion hazard minimisation and protection against explosions,
- Description of fire detection and alarm systems,
- Description of fire suppression systems (manual and fixed) incl. description of fire water systems,
- Description of fire ventilation systems,

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- Description of organizational aspects (design of the fire station, fire brigade),
- Fire escape routes and access routes for fire-fighting,
- Fire hazardous areas, separation distances, staging area for fire intervention (see also chap. 2.33)
- Measures to prevent/minimise impact of fires on nuclear safety incl. potential for combination of fires and External Hazards* such as earthquake; and minimization of potential radioactive releases,
- Methodology and preliminary results of fire hazard analysis (incl. ATEX analysis) and fire PSA,
- List and specifications of Structures* and Fire Barriers* (with regards to fire hazard analysis).
- Fire reporting system.

2.11 RADIATION PROTECTION AND MONITORING

- specification of radiation sources,
- design criteria/requirements for protection from radiation sources (e.g. equipment arrangement, routing of services, shielding, HVAC),
- limits for operational doses (individual and collective),
- radiation zoning, specifications of the zoning, drawings,
- assessment of the operational doses and their optimisation,
- description of accesses, change rooms, facilities in controlled areas and non-process radiation monitoring (staff, items),
- description of process radiation monitoring (incl. accidents),
- assessment of radiation doses and zoning during accidents.

2.12 ELECTROMAGNETIC COMPATIBILITY

The document determines anticipated EMC conditions and defines EMC requirements for particular SSC of the Plant* according to their functionality in light of nuclear safety, radiation protection, fire safety, technical safety, electromagnetic interference of equipment and place of its installation.

The document includes as a minimum but not limited to the following:

- provides information about set of relevant Codes and Standards* and Rules* with regard to EMC,
- determination of specific requirements and measures with regard to EMC (I&C, electrical and other devices whose part are electrical, electronic and radio-electronic components),
- determination of electromagnetic interference levels and frequencies with respect to device and place of its installation (maximum permissible levels of electromagnetic emission, definition of tests of electromagnetic emission of particular device according to valid EMC Codes and Standards*),
- determination of functional criterions from the perspective of delivered device or designed system depending on its purpose, its affect on safety, availability and EMC conditions (influence of EMC environment) during its operation,
- implementation of EMC qualification procedure on I&C and other systems important with regard to nuclear safety,

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- requirement on cabling (type and Segregation* of cables, coupling impedance of cable and cable routes, shielding, way of shielding grounding, etc.),
- requirements on grounding,
- defines EMC tests after installation for proving, that EMC conditions and EMC requirements defined in „EMC Concept“ are fulfilled or if it is necessary to design additional EMC provisions.

2.13 NUCLEAR FUEL MANAGEMENT

- description of fresh and spent fuel management including all activities performed during and SSC involved in fresh and spent fuel Inspections*, storing, handling and refuelling,
- all the handling, storage, refuelling conditions and Inspections* and tests shall be described and justified,
- Nuclear Fuel* accounting and safeguard provisions,
- transport routes.

2.14 RADIOACTIVE WASTE MANAGEMENT

- description and justification of production, treatment and conditioning of the Radioactive Waste*,
- amount, physical and chemical properties of the Radioactive Waste*,
- description of radwaste processing systems (gaseous, liquid and solid) and their process flow diagrams incl. radioactive discharges optimization (in particular of tritium),
- Radioactive Waste* accounting and safeguard provisions,
- transport routes and storage.

2.15 PLANT LIFE AND AGEING MANAGEMENT

Description of Plant* life and ageing management incl. concept of Ageing Management Programme (see Technical Requirements Document* Sections 2.1.8.1.3 and 2.15.5.5.1).

2.16 DECOMMISSIONING

Description of Plant* Decommissioning* incl. description of related design aspects and criteria/requirements (see Technical Requirements Document* Chapter 2.16).

2.17 CONSTRUCTION AND COMMISSIONING

Description of Plant* construction and Commissioning* incl. description of the working and safety procedures resulting from applicable legislation (see Chapter 2.34).

Description of Plant* construction with regards to the local conditions and requirements of applicable Mandatory Law* and Requirements of the Authorities*.

The information shall include, but not be limited to:

- the quantity of the main construction materials and special materials (e.g. shielding concrete), sources of them,
- principals of the Construction Site* drainage,
- connection of the Construction Site* on the transport (roads, railway etc.) and technical (water, electricity etc.) network,
- impact of the construction on the surrounding civil structures and land,

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- protection of the Construction Site* surrounding and requirements for related demolition, tree felling,
- maximum temporary and permanent land occupation for Construction Site*,
- requirements for the barrier-free go round routes,
- maximum produced quantities and types of the waste and emissions during construction, their disposal,
- balance of the earthworks, requirements for soil transport or storage,
- environmental protection during construction,
- principles of the safety and health protection at work on the Construction Site* (see also Chapter 2.34),
- modifications for barrier-free use of the affected buildings by the construction,
- principles for the traffic measures,
- determination of special conditions for the construction execution - execution of the construction during operation, measures against the effects of the external environment during construction (e.g. winter measures), etc.,
- description of the staff quantity during erection works time,
- the main demanding consumers and manner of supplying them,
- description and schemes of the temporary fencing for all phases of units construction and Commissioning*.

Description of the Commissioning* shall include the below mentioned individual stages with a description of the activities, requirements for equipment and staff, general evaluation criteria and schedule (see Construction and Commissioning Document* Sections 3.4, 3.5 and 3.6):

- pre-commissioning tests,
- Inactive Testing*,
- Active Testing*.

2.18 ENVIRONMENTAL PROTECTION AND MONITORING

- specification of environmental risks (e.g. consumable storages, technological systems, waste, discharges, etc.),
- description of design and organizational means to minimize risks,
- description of environmental impact minimisation (incl. requirements of the Authorities such as EIA statement conditions),
- process and non-process monitoring.

2.19 WASTE MANAGEMENT

- description and justification of production and management of the non-radioactive waste (incl. collection, separation, recycling, storage, transportation and disposal).
- description of waste facilities,
- classification and amount of the waste based on its physical and chemical properties.

2.20 WATER MANAGEMENT

Description of the water management (during Plant* construction and Plant* operation) incl., but not limited to:

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- Overall description of water management (water sources, water treatment, water use, waste water treatment, discharge and monitoring, overall water balances – by type; total amounts and also amounts/MWh),
- Detailed description of water supply (description of system/technology and water balances - by type – e.g. raw, drinking per year, month, max.; water quality),
- Detailed description of water treatment (description of system/technology and water balances – by type – e.g. treated water, demineralized water – and by purpose/consumer),
- Detailed description of water use (description of purpose/consumer/system/technology – incl. potable and fire water – and water balances),
- Detailed description of water cooling systems (in particular open recirculating systems),
 - water type (raw, treated, demineralized etc.) and amount used,
 - chemical and mechanical treatment,
 - evaporation and drift losses,
 - blowdown,
- Detailed description of waste water treatment (description of system/technology and water balances – by type of waste water and resulting waste water quality) incl. reuse,
- Detailed description of waste water and stormwater discharge and monitoring (description of technology, water balances per year, month and max. and waste water and stormwater quality) and impact of waste water and stormwater on the recipients,,
- Proposed limits for Permits* (water amount and quality),
- Basic description of associated SSC (of all water management facilities),
- Description of water pollution prevention and emergency management and features.

In addition, overall and by system process flow diagrams and Plant* layout with the location and dimensions of associated SSC and services shall be provided (incl. connection to off site services).

In addition, chemistry of primary and secondary circuit and cooling systems shall be described (incl. used chemicals).

In addition, use and management of the underground water shall be described.

2.21 CLASSIFICATION OF ENVIRONMENTAL CONDITIONS

Specification of environmental conditions in Plant* areas and rooms in to enable correct design and qualification of equipment in Normal Operation*, AOO, DBA and DEC and during Hazards*:

- area/room identification,
- specification of environmental conditions such as temperature, pressure, humidity, radiation dose (in Normal Operation*, AOO, DBA and DEC and during Hazards*),
- noise level,
- environmental conditions in accordance with CSN 33 2000-5-51).

2.22 MATERIAL SELECTION METHODOLOGY

The documentation includes design specific methodology for material selection (similarly as Chapter 2.6 of the Technical Requirements Document*) which is based on criteria such as SSC operating and environmental conditions, operating experience, ease of manufacture and inspections, price etc.

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2.23 SURFACE FINISHING

Specification of criteria/requirements for surface finishing (incl. wall, ceilings, floors, prefabricated components, locksmith products, equipment, piping, etc.) such as types, properties, materials, resistance and design (incl. decontamination, radiation resistance etc) and for process of surface finishing taking into account location and environmental conditions (incl. accidents).

2.24 LABELLING AND COLOUR CODING

Specification of criteria/requirements for labelling and colour coding of areas, floors, equipment (incl. cables) and piping for purpose of occupation health and safety, radiation protection, fire protection, security, emergency response, environmental protection (incl. waste management) and in general to ease operation and maintenance and to minimize human error (labelling in compliance with Project Identification System*).

2.25 THERMAL INSULATION

Specification of criteria/requirements for equipment and piping thermal insulations such as types, properties, materials, resistance and design (e.g. ease of removal, decontamination, etc.) taking into account location and environmental conditions (incl. accidents).

2.26 OCCUPATIONAL HEALTH AND SAFETY

Description of the design with respect to occupational health and safety incl., but not limited to:

- Methodology for hazard identification and risk assessment,
- Specification of main hazards in main areas (e.g. risk of fire and explosion etc.)
- Design criteria/requirements in area of occupational health and safety (such as illumination, noise, temperature, humidity, fresh air, escape routes, ergonomics, measures to limit chemical and biological hazards etc.),
- Description and specification of safety provisions,
- System of markings (permanent and temporary),
- Operational aspects (provisions) of occupational health and safety,
- Identification of buildings or areas that reflect facilities for the disabled

2.27 ENVIRONMENTAL IMPACT

Regarding the conventional impact, the Supplier* shall describe:

- all inputs necessary for Plant* operation/construction (e.g. consumption of raw water, electricity, Consumables*, etc. with focus on hazardous substances),
- all outputs of Plant* operation/construction (e.g. amount and chemical content of non-radioactive gaseous and liquid discharges, non-Radioactive Waste, etc.), and their management,
- other health and environmental impact (e.g. noise, external appearance, thermal and steam emissions, land use, traffic, etc.) and their management.

Regarding the radiological impact from the Plant* operation/construction, the Supplier* shall provide the following information:

- Radioactive discharges (gaseous and liquid) per year: activity (for all radionuclides) and their treatment (incl. measures to reduce discharges of tritium into the watercourses),

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- Radioactive Waste* as ready for disposal to Radioactive Waste* Repository Dukovany: amount (volume and weight) per year and parameters: activity, activity composition (radionuclides content) and chemical composition, leachability, mechanical properties, form of packaging, surface dose rate etc.,
- Radioactive Waste* to be stored in Plant* (expected to be disposed afterwards to deep repository): amount (volume and weight) and parameters: activity, activity composition (radionuclides content) and chemical composition, mechanical properties etc.,
- approach to Radioactive Waste* minimization, segregation, treatment and conditioning.

Management and protection of soil.

2.28 ENERGY AND CONSUMABLES MANAGEMENT

Description of energy management incl.:

- electrical power – electrical power output, house load during operation and outage incl. specification of sources and consumers, expected electrical power consumption,
- heat – heat load during operation and outage incl. specification of sources and consumers, expected heat consumption, potential for district heating,
- Nuclear Fuel* – specification a number of Fuel Assemblies* on Core*, fuel burnup and refuelling strategy,
- fuel (e.g. diesel) – fuel specification, fuel consumption during operation, outage and emergencies incl. specification of consumers,
- other Consumables* – consumable specification, consumable consumption during operation and outage incl. specification of consumers,
- other (if any).

In addition, environmental protection and monitoring and accident prevention and management aspects of use and storing of Consumables* (in particular hazardous) shall be described.

For accident management purposes, this includes list of all dangerous substances, their location (buildings, equipment incl. layout drawings), type, quantity, physical form, concentration, classification per Act No. 224/2015 Coll. etc

Associated design criteria/requirements shall be included.

2.29 PHYSICO-CHEMICAL PROPERTIES OF THE CONSUMABLES

Specification of physico-chemical properties of Consumables* incl. requirements for their purity (Consumables* used during operation, outage, emergencies and for maintenance incl. decontamination).

2.30 EQUIPMENT ARRANGEMENT RULES AND RULES FOR ROUTING OF SERVICES

The documentation includes rules for equipment arrangement and routing of services as specified in Chapter 2.11 of the Technical Requirements Document*.

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2.31 PRINCIPLES OF CABLING

The document includes as a minimum but not limited to the following:

- specification of technical requirements and requirements of Codes and Standards* on cables according to their function and location,
- specification of requirements on fire protection of cable systems and cable compartment,
- provision of separation of redundant cables, especially with regard to backing up of functionality,
- provision of Segregation* of cables in shared routes, especially with regard to EMC,
- provision of requirements on cables routing and laying,
- provision of requirements on cable penetrations,
- provision of requirements on designing and sizing of cables,
- provision of requirements on cable aging management system and its implementation,
- definition of boundaries of cable deliveries between particular professions and eventually suppliers.

2.32 TECHNICAL REQUIREMENTS FOR ELECTRICAL MOTORS

Technical requirements for electrical motors restrict the scope of delivered drives in such a way as to ensure (not to jeopardize) performance of the safety functions both on the part of electrical part equipment and on the part of a drive (e.g. from the reason of elimination of voltage drop during long heavy start of drive).

The document provides requirements for type and basic parameters of drives from the point of view of operation, performance of safety function and transients in electrical part (range of operating voltages and frequencies). The document provides requirements for the torque of significant drives (which have influence on parameters of electrical systems), starting current, starting on restored voltage (according size and type of drive), etc. The document standardise use of starters, soft starters, frequency converters, etc.

2.33 SITE TRAFFIC MANAGEMENT

- description of expected traffic management and requirements during construction, Commissioning* and operation,
- drawing of the traffic infrastructure (1:1000) (Site* accesses, gates, fences, roads, railways, garages, depots, parking places, sidewalks, stairways, bridges, ramps etc.) (drawing shall also show elevations and position coordinate system/grid, On Site Facilities* and Plant* structures, stormwater gutters etc.),
- basic specifications of the traffic infrastructures (purpose, sizes, traffic and load capacity, materials, etc.),
- staging area for fire intervention.

2.34 OCCUPATIONAL HEALTH AND SAFETY DOCUMENTATION

- Method of ensuring safety and health protection at work,
- Ensuring fencing, fencing of the building, entrances and entrances,
- Providing lighting for construction sites and workplaces,
- Determination of protection and controlled zones and measures against their damage,
- Solution of measures in case of danger of explosion or fire,

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- Ensuring communication on the Construction Site*,
- Temporary electricity distribution on the Construction Site*, water sources, night lighting,
- Assessment of external influences on the construction, in particular traffic shocks, flood risk, landslide, and specification of measures in case of crisis situation,
- Measures relating to the location and design of the site equipment, including a situational picture of the wider site relationships, solutions for the vertical and horizontal transport of persons and material,
- Procedures for earthworks, including treatment of risks involved,
- Procedures for concrete work, including treatment of risks involved,
- Procedures for masonry work, including treatment of the risks involved,
- Procedures for assembly work addressing safety measures during individual assembly operations,
- Procedures for demolition and reconstruction work, including treatment of the risks involved,
- Ceiling mounting solutions, including treatment of the risks involved,
- Procedures for working at heights, including the treatment of risks arising therefrom,
- Securing additional requirements on work safety, especially material transport, storage in the workplace, ensuring the workplace in terms of requirements when working at height, measures relating to the auxiliary building structures used for individual work, the use of machines,
- Procedures dealing with individual works and activities and laying down measures for the interweaving and concurrence of individual works, in particular the use of several cranes on one construction site and work with the simultaneous operation of public transport,
- Ensuring safety measures in connection with work at height and above free depth, when performing finishing work and auxiliary construction work, especially in the installation of antennas and lightning conductors, installation of windows, installation of railings, horizontal insulation of balconies, terraces and roofs, installation of elevators, air conditioning , air conditioning, when painting structures and facades and during finishing work around the building, such as sidewalks, lighting, and when performing maintenance work,
- Procedures for specific measures under the terms of the execution of construction and other works and activities in buildings for their operations, including the timing of these works and activities,
- Procedures for measures resulting from specific construction requirements, such as consultations with labour inspection authorities, building authorities, public health authorities and other bodies, in accordance with specific legislation provided in the consultation and the public authorities concerned requirements,
- Procedures for measures resulting from specific requirements for work and activities related in particular to the use of toxic chemicals, ionizing radiation and explosives and the presence of asbestos,
- Further data specified in part B and C of bullet II Annex No. 6 of Gov. Order No. 591/2006 Coll. about minimal requirements on health safety and protection during construction works not specified in above mentioned bullets,
- Etc.

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2.35 PROJECT IDENTIFICATION SYSTEM

Project Identification System* (see Technical Requirement Document* Section 2.12.7).

2.36 PLANT DESCRIPTION AND PERFORMANCE

- Reactor type,
- Core*,
- Rules*,
- Thermal, gross and net electrical power output, house load consumption, gross and Net Heat Rate*,
- Availability,
- Fuel cycle, Refuelling Interval*, Outage Duration*,
- Manoeuvrability (taking into account design of Nuclear Fuel*),
- Design life (incl. manoeuvrability aspect),
- Plant* and systems functional description and operating parameters incl. list of systems,
- List, description and basic data of main structures and components (incl. Nuclear Fuel*),
- Process flow diagrams,
- Mass and heat balance diagrams (for various power levels and environmental conditions).

2.37 PLANT NUCLEAR SAFETY

- Safety objectives and associated technical, radiological and probabilistic acceptance criteria (incl. specification of controlled states and safe states) incl. doses to operational staff,
- Proven design,
- Margins,
- Rules* (incl. assessment of compliance with Czech nuclear legislation, IAEA and WENRA and justification of Codes and Standard*),
- Barriers*,
- Defence-in-Depth*,
- Classification system and SSC list and associated requirements,
- Environmental resistance levels (incl. seismic categorization) and SSC list and associated requirements,
- Environmental and seismic qualification,
- List and specifications of DBC,
- List and specifications of DEC,
- List and specifications of hazards (Design Basis* level, rare and severe level),
- List and specifications of relevant combinations of events,
- Practical elimination,
- Cliff Edge Effect*,
- Autonomy,
- Use of Non-Permanent Equipment*,
- Deterministic and probabilistic safety analysis methods,

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- SFC,
- CCF,
- Fail safe design,
- Reliability,
- Break Preclusion*/Leak Before Break* methodology,
- Human factors,
- Nuclear accounting system (incl. safeguard),
- Basic description and specifications of the Safety Systems* and safety features for DEC (incl. instrumentation and control systems, electrical power systems, cooling systems etc.), their design criteria/requirements and performance in AOO, DBA, DEC, hazards and their relevant combinations incl. control rooms (and their resistance and habitability),
- Description of Plant* safety in (management of) Normal Operation*, AOO, DBA, DEC, Hazards* and their relevant combinations incl. Operator* actions,
- Results of the deterministic safety analysis and probabilistic safety assessment,
- Technical Specifications*,
- System of procedures (Normal Operation* , EOP, SAMG).

2.38 PLANT OPERATION AND MAINTENANCE

- List and description of various Operational Modes* and associated operations (power operation, start-up, hot and cold shutdown, outages, power manoeuvring),
- Basic description and specifications of the systems for Normal Operation* (incl. Core*, instrumentation and control systems, electrical power systems, cooling systems etc.), their design criteria/requirements and performance in various Operational Modes*,
- Description of maintenance (incl. replaceability), testing, Inspections*, SSC monitoring, diagnostics and prognostics (during both power operation and outages) and H-MI and associated SSC design criteria/requirements,
- Plant* operational capabilities (see Technical Requirements Document* Section 2.2.2) incl. management of AOO without actuation of Safety Systems*/safety features for DEC,
- Organizational chart,
- Spare parts.

2.39 NUCLEAR ENGINEERING

- List of nuclear engineering systems (Nuclear Fuel System*, Core*, nuclear instrumentation, fuel storage and handling system),
- Design Basis* for all nuclear engineering listed systems/components,
- Design requirements/criteria for all systems/components,
- Functional description of all systems/components,
- Nuclear instrumentation operational specification,
- Core* performance control description,
- Fuel storage and handling system control description,
- Operating parameters of all systems/components.

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2.40 MECHANICAL ENGINEERING AND DESIGN OF MECHANICAL SYSTEMS AND COMPONENTS

Process engineering and fluid systems engineering

- Design Basis*,
- List of Rules*,
- List of systems,
- Systems design criteria/requirements,
- Systems functional description and operating parameters,
- Schematic diagrams,
- Process flow diagrams,
- Mass and heat balance diagrams,
- Main T-H design and calculations,
- Optimization of cooling and heating systems incl. water cooling systems and HVAC,
- Requirements and interfaces with other technical professions (electrical, instrumentation and control) incl. process control and monitoring,
- Safety and reliability.

Mechanical equipment and piping and HVAC engineering

- Design Basis*,
- List of Rules*,
- Mechanical equipment and piping and HVAC design criteria/requirements,
- List, description and basic data of main mechanical components (incl. main handling equipment),
- Main equipment and piping stress analysis (in scope and detail corresponding to Concept of Basic Design phase, based on the Reference Plant data),
- Design inputs for HVAC systems,
- Main layout and arrangement drawings,
- Main piping and HVAC layout drawings (isometric),
- Requirements and interfaces with other technical professions (electrical, instrumentation and control, civil),
- Safety and reliability,
- Hazards associated with the equipment incl. requirements with regard to fire protection (incl. penetrations and fire and smoke dampers), radiation protection, occupational health and safety (incl. noise and vibrations), environmental protection, etc.

2.41 ELECTRICAL ENGINEERING AND DESIGN OF ELECTRICAL SYSTEMS AND COMPONENTS

Text documentation

- determination of Design Basis* and requirements on particular electrical systems,
- Codes and Standards* used in electrical systems,
- description of connection to transmission system
 - connection to transmission system,
 - confirmation of conformity with analysis of connection of the Plant* to transmission system

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- management of transients, all necessary inputs for verification of dynamic stability, all necessary inputs for static stability, all necessary inputs for short circuit contribution of the Unit* to the grid, open phase conditions, transition to house load operation, transition on island operation, maneuverability, loading, operation of a Plant* under disturbed grid condition (frequency and voltage distortion)
- communication between transmission system and the Plant*,
- Load list of consumers with requirements on their power supply
- diagram of auxiliary power supply of the Plant* (NI, TI, BOP)
 - description of power supplies (including availability of the power supply – duration of start) and distribution systems of auxiliary power supply
 - description and requirements on the main SSC
 - indicative evaluation of calculations of electrical scheme of auxiliary power supply of the Plant* for particular Operational Modes* and configuration of electrical scheme (in stable states and transients),
 - classification / identification / specification of requirements on power supply importance,
- concept of DiD,
- description of electrical systems function and states in particular DiD levels,
- concept of Single Failure*, common cause failure,
- description to countermeasures to Fukushima, Forsmark and Byron accident,
- operational characteristics of main SSC,
- description of functions (transfers among power sources, sequence of starting etc.),
- requirements on qualification of SSC (electrical part),
- concept of electrical protection of electrical SSC
 - principal diagram of protection of the Plant* (single line diagram including protected devices, protection zones and their overlay, measuring transformers, protective functions),
 - description of generator protection, protections of power outlet, protections of normal and standby power supply,
 - tripping table of the electrical protections (contains action of electrical protections on particular actuating device),
 - principal diagram of unit measurement,
 - principal diagram of invoice metering concept of data connections with transmission system,
 - concept of data connection wit transmission system
 - description of electrical protection in MV system,
 - description of electrical protection in LV system,
- concept of overvoltage protection,
- concept of lightning protection with risks analyses,
- concept of internal and external grounding,
- concept of explosion protection,
- concept of artificial lighting
 - provides description of design of lighting – type of lighting (normal, stand by, emergency, security, etc.),
 - determines basic parameters of lighting (light intensity, colour rendering index, uniformity, dazzlement, power supply demand, description of lighting inside of control rooms, etc.),

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- parameters of consumers and their interpretation,
- concept of layout of electrical SSC,
- documentation of typical wiring diagrams of control of electrical SSC,
- documentation of automatics of electrical SSC,
- concept of central unit fault monitoring system.

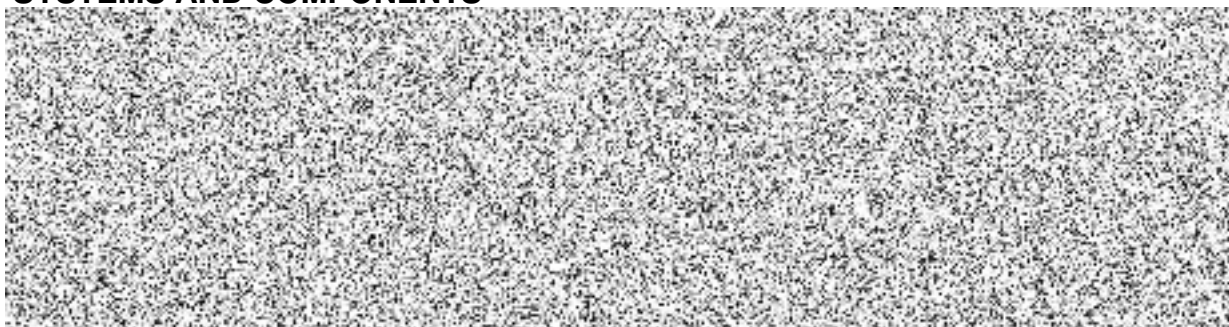
Calculations

- all necessary for network analyses (calculations for connection to transmission system)
 - static stability,
 - dynamic stability,
 - short circuits contribution to the grid,
 - P, Q diagrams (with relation to grid interface and generator),
 - abnormal parameters of voltage and frequency,
- control calculations of electrical SSC diagram for different Operational Modes* (Normal Operation*, AOO, DBA, DEC) and electrical SSC configuration.
 - power balance P, Q (load flow) of auxiliary power supply and particular switchboards – stable states and transients, loads startup,
 - short circuits in internal distribution system,
 - voltage conditions,
 - overvoltage including recovery voltages,
 - check of DG loading,
 - check of battery discharging,
 - automatic starts (including transfer among power supply – fast, in-phase, residual voltage, fixed time),
 - design of power supplies.

Drawing documentation

- overview diagram of power outlet, normal and stand-by power supply,
- overview diagram(s) of auxiliary power supply (up to the and including load centres),
- common documentation of typical wiring diagrams of control, protections and automatics of electrical SSC,
- layout of main electrical SSC,
- typical wiring diagrams of control of electrical SSC,
- typical wiring diagram of automatics of electrical SSC
- overview diagram of power supply of main lighting switchboards.

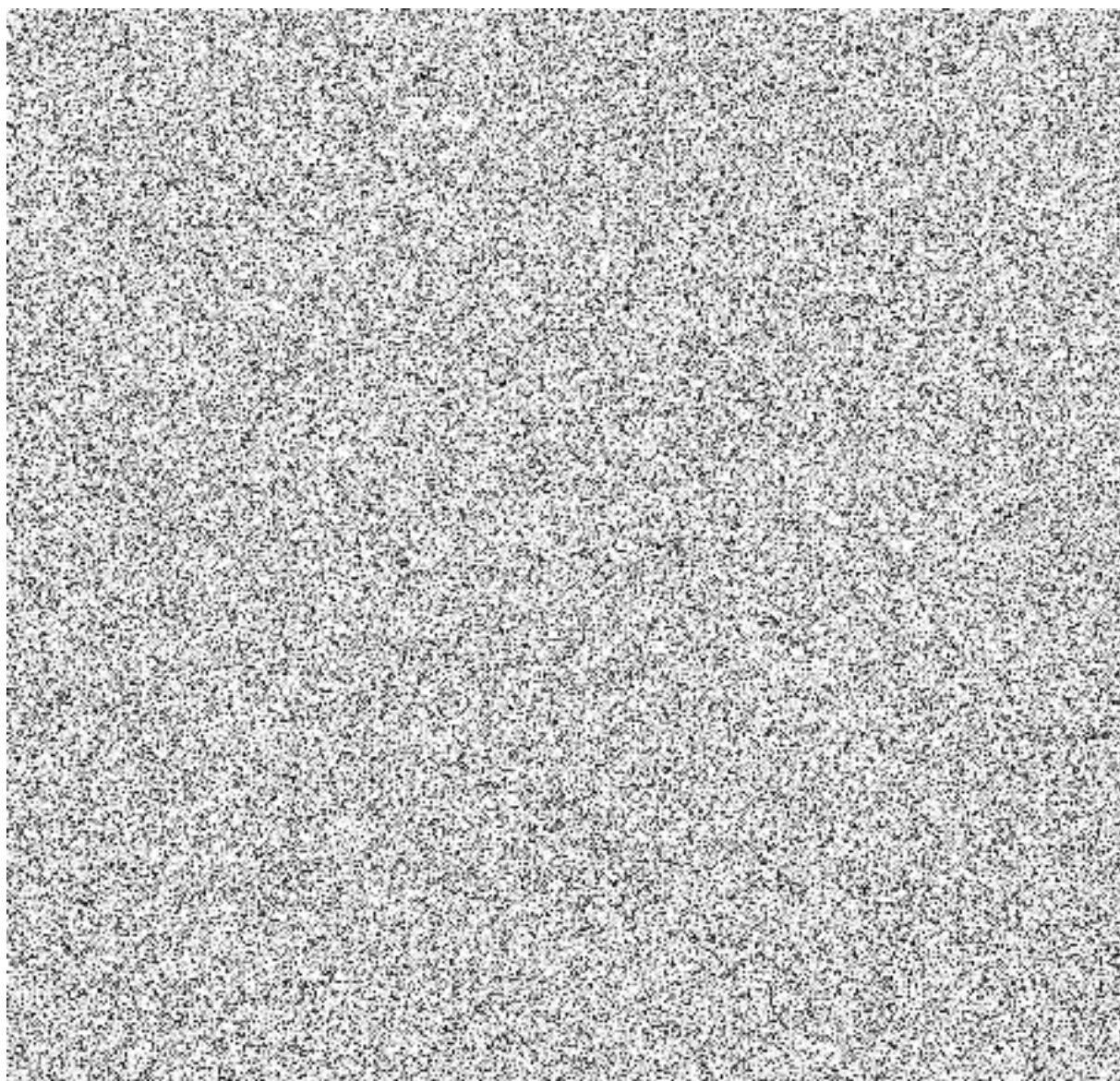
2.42 I&C ENGINEERING AND DESIGN OF INSTRUMENTATION AND CONTROL SYSTEMS AND COMPONENTS



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- structural overview diagram defining I&C architecture, hierarchy and division of individual systems/sub-systems
- related overall Quality Assurance* and safety plans (nuclear and cyber),
- V&V including analyses for e.g. reliability assessment, Protection against Common-cause Failures*, Qualification, Cyber Security,
- Requirement Specification for Individual Systems

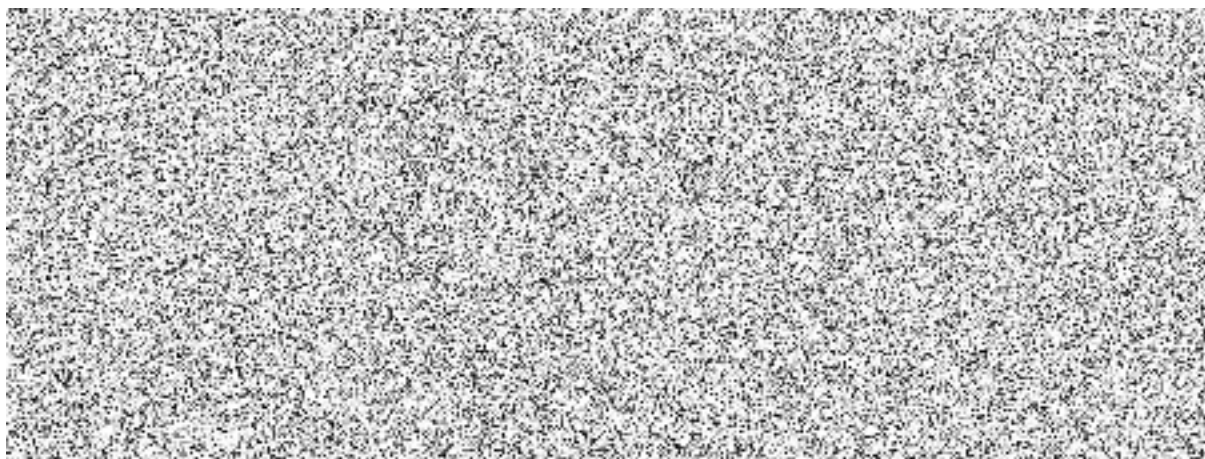
In this way designed architecture and function assignment to the I&C systems represents inputs for design of individual systems in Basic Design* in terms of functional, performance and reliability parameters, design of interfaces between systems and for detailed design of interfaces with technological and electrical part and shall be taken into account in output documentation of I&C part.



Drawing documentation

- overall I&C structure,
 - block diagram of all I&C systems,

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Lists

- functional, constraints and other requirements/attributes assigned to I&C systems, their interfaces and to interfaces with other disciplines SSCs overall I&C structure,

2.43 GENERAL MAP

The document includes description of the Site* and its vicinity incl. drawings and specification of Site* parameters

- General map with representation of the Plant* impact on local environment and local infrastructure (used plot scale of the map shall ensure good readability and acceptance for all Authorities*)
- Representation of emergency planning zones of the Plant* and the emergency planning zones of the Existing Nuclear Power Plant*.
- Representation of main boundaries of the Plant* (external fence layout) and the relation to boundaries of Existing Nuclear Power Plant*.
- Representation of all entrances, service and transport infrastructure located inside the Construction Site* (roads, railways, raw water supply, etc.) and the relation to existing service and transport infrastructure.
- Plan view of the main civil structures/buildings (including main civil structures/buildings of the Plant* and Existing Nuclear Power Plant*)
- Representation of main interconnections to power grid (connection to power supply grid, connection to back-up power supply grid)
- Legend, descriptions, references (including representation of the origin and axes of local coordinate system, clarification of the relation between local and global coordination system including elevations, clarification of the view orientation by compass rose, designation and description of the main civil structures/buildings, etc.)

2.44 SITE LAYOUT AND DESCRIPTION

The document includes description of the Site* and its vicinity incl. drawings and specification of Site* parameters and connection points

- Site layout drawings of entire designed ground and underground civil structures, other civil structures (e.g. cooling tower, galleries, foundations for technology equipment's, protective barriers, etc.), and areas (e.g. parking area, hardened surface, pedestrian routes, etc.) located and incorporated in the Site* (e.g. interconnection to the existing buildings, others structures and areas),

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- Site infrastructure drawings (permanent/ temporary, including piping systems, electrical cable lines, roads and pavements, channels, etc.), including connection points specified in Chapter 4 of the Scope of Supply Document*
- Site landscaping drawings (including the representation of final elevations, slopes, etc.)
- Parcel plan drawing,
- Topographical benchmark drawing (representation of all benchmarks located on Construction Site* and the relation to benchmarks located outside Construction site* in accordance with principles defined in Technical Requirements Document*, Section 5.2.13 and 2.5.3.2.3),
- Detail earthwork design (including felling of the trees, landscaping, excavation works, shoring, drainage, etc.),
- Detail description of surveying and investigation of Construction Site* (e.g. geodetical, geological, seismic, environmental survey etc.), as inputs for verification of civil structures location and design of foundation, waterproof isolation, radon isolation, type of finish coat etc.,
- Specification of Site* parameters (incl. external hazards – normal level – for non-safety SSC, Design Basis* level, rare and severe level),
- List and description of other necessary projects related to EPC Contract*,
- Maximum temporary and permanent acquisition of the agricultural land and forest areas,
- Legend, descriptions, references, dimensions (including representation of the origin and axes of local coordinate system, clarification of the relation between local and global coordination system including elevations, clarification of the view orientation by compass rose, designation and description of the main civil structures/buildings, useful area, built-up area, built-up space, etc.) that ensure good understanding of the Document*,
- Used plot scale of all Documents* shall ensure good readability and acceptance for all Authorities*.

2.45 CIVIL STRUCTURES/BUILDINGS

Information included in Concept of Basic Design* documentation for civil engineering shall be in line with inter alia, approved and valid Documents* issued during previous stages (EPC Contract*, Conceptual Design* stage) of the Project*, Rules* (especially Act No. 183/2006 Coll., as amended, Decree No. 499/2006 (Decree No. 405/2017) Coll., as amended, Decree No. 246/2001 Coll., as amended, Act No. 254/2001 Coll., as amended, Decree No. 146/2008 Coll., as amended), etc.

The Concept of Basic Design* documentation related to civil engineering shall include following information (but not limited to):

- List of civil objects and their functional description
- Further elaborated design data and Information Models* provided in General part of Concept of Basic Design*,
- Civil structures concrete and steel design (foundation, load bearing, vertical and horizontal structures),
- Civil structures drawings (incl. cross sections and longitudinal sections, views, emplacement of embedded part (e.g. anchor plates), representation of openings bigger than 0,25 m²,
- Civil structures analysis (static and dynamic calculations reports confirming compliance with the Design Basis Documentation*) for the dimensioning and sizing the civil structures including all anticipated loads of the systems and components,

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- Concrete reinforcement design and drawings in relation to civil structures analysis,
- Foundation design and drawings (incl. calculation report confirming compliance with the Design Basis Documentation*),
- Building insulation and resistance against the negative effects of the external environment (e.g. heat, water, UV, anti-corrosion, stray current) design (incl. calculation report confirming compliance with the Design Basis Documentation*),
- Storm drains design and drawings (incl. calculation report confirming compliance with the Design Basis Documentation*),
- Seismic design (incl. calculation report confirming compliance with the Design Basis documentation*),
- Fire design (incl. fire zoning reports, fire protection drawings, emergency escape paths and calculation report confirming compliance with the Design Basis Documentation*), in detail according paragraph 41 Fire safety design, article 1, 2 and 3 Decree No. 246/2001 Coll. of fire prevention
- Architectural design and drawings (incl. material and colour solutions),
- Height of the building (height of the attic, height of the structure at the highest point of the building or in other essential parts),
- Maximum foundation depth,
- Footing bottom level,
- Reference level of height dimensions,
- Number and specification of elements - separate parts of the building (complete fitted products and parts),
- Level of prepared terrain,
- Main parameters of utility services (e.g. heating, air conditioning, elevators),
- Codes and Standards* for civil engineering,
- List of references and status clarification list of requirements issued by the Authorities*,
- Safety, quality and seismic classification of civil SSC,
- Classification of dedicated SSC,
- Radiological and contamination zoning drawings and reports,
- Ensuring stability of excavations (construction pit walls, steep slopes etc.),
- Description of technical requirements enabling the barrier free usage of the buildings,
- General coordination arrangement drawings (representation of any equipment heavier than 1t for each level/section of any civil structure/building and the main pipe and electrical routes),
- Load drawings (representation of max. designed loads for each level/section of any civil structure/building including external areas of the Plant*, assembly areas and storage spaces with load capacity marking, the main pipe and electrical routes with description of the force effects on the civil structure and the conversation of the all other technological load on uniform load),
- Equipment introduction note/report (representation of equipment introduction routes for any components/equipment heavier than 1t placed in all civil structure/building of the Plant* or with cross section area bigger than 0,25 m²),
- Description of technical requirements regarding construction and expansion joints
- Topographical benchmark drawings (representation of all topographical benchmarks located inside any civil structure/building including the related coordinates in

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accordance with principles defined in Technical Requirements Document*, Section 5.2.13 and 2.5.3.2.3) in level of detail corresponding to Concept of Basic Design* phase

- Interface lists (designation and description of all interfaces between any Suppliers* and Subcontractors* deliveries including the connection points specified in Chapter 4 of the Scope of Supply Document*),
- Door and hatch lists (designation and description of all isolating elements – doors, hatches, etc. within the Plant*),
- Room books (designation and description of all rooms within the Plant*),
- Building specifications (marking of the building, description of purpose, seismic class, build up area, build up space, principal of the internal environment solution (HVAC, Heating, lighting etc.), water, gas, electricity supply, basic principles of the building interior installation (energy and media balance, layouts of main distribution lines and machinery, basic schemes, list of key machinery and equipment including main parameters) in level of detail corresponding to Concept of Basic Design* phase including specified equipment, specified fire safety equipment, the list of civil disciplines solved in the each building, data of the compliance with spatial planning documentation, principles of the solving of the effect on the surrounding (noise, vibration, dustiness etc), basic assumptions of erections (construction time, indicative costs etc.), principals for the energy saving, manner of the hygienic requirements fulfilment in the internal spaces, principals of the building protections against the negative effects of the external environment, fulfilment of the requirements for the population protection, description of the buildings purpose, interfaces, list of systems designed in the building, references, etc. for each civil structure/building), (in level of detail corresponding to Concept of Basic Design* phase)
- Civil engineering handover report for each civil structure (description of civil engineering design status),
- Design safety rules for safety usage of civil structures/buildings,
- Design maintenance rules for long term operation of civil structures/buildings,
- Design requirements for indoor spaces,
- Estimation of the civil structure settlement (in level of detail corresponding to Concept of Basic Design* phase)
- Legend, descriptions, references, dimensions (including representation of the axes of local coordinate system, clarification of the relation between local and global coordination system including elevations, clarification of the view orientation by compass rose, designation and description of the main civil structures/buildings, rooms, useful area, built-up area, built-up space, etc.),
- Used plot scale of all Documents* shall ensure good readability and acceptance for all Authorities*,
- etc.

2.46 3D DESIGN

Expected content of the 3D federated information model at the Concept of Basic Design* stage should include the following information to the extent within scope of documents produced in the Concept of Basic Design* stage:

- Detail shape and general arrangement of all civil structures (including specification of load-bearing structures, openings >0,25 m², access and transport routes, obstructions) related to the Plant*,

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- Detail shape and general arrangement of all components for NSSS system including supports and obstructions,
- Preliminary (Best estimated) shape and general arrangement of other components for all other systems (including all equipment or components heavier than 1t, main equipment of electrical part (as switchboards, transformers, rectifiers, inverters, UPSs), main I&C switchboards, panels and racks, pipes >DN100, HVAC ducts/components where the dimension (measured including insulation) of any side is >500mm, cable tray and Isolated phase bus duct where the dimension (measured including insulation) of any side is >500mm) including supports and obstructions),
- Preliminary (Best estimated) shape and general arrangement of insulation elements (door, hatches, etc.) including obstructions,
- Preliminary (Best estimated) shape and general arrangement of embedded parts (frames, anchoring, penetrations, etc.) including obstructions,
- Shape and general arrangement of main steel structures in the technology and civil scope of work (steel bearing stiffening and supporting structures, crain tracks, steel bridges, steel access platforms, steel ladders, steel handrails and protections barriers) including obstructions,
- Identification codes of all included SSC,
- Classification of all included SSC (Safety class, Quality class, Seismic class of SSC are set),
- References of all included SSC (Configuration, Catalogue, Material, Building specification, P&ID references of SSC are set),
- Design status of all included SSC is tracked.

Other known attributes are set where applicable (building reference, room reference, level reference, medium temperature, medium pressure, medium, etc.).

The specific implementation of the above 3D/BIM requirements shall comply with Attachment 3, Chap. 5.2.9 of Project Management Document*.

[Note]

For avoidance of doubt the conversion of data models mentioned in this Attachment 1 Chap. 2.46 into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

3 BASIC DESIGN

Basic Design* shall include all design information as necessary for specification of design of the Plant* and design in all technical professions in such a detail as required for the Licensing and Permitting* and development of Detail Design* coordinated in all technical professions (incl. specifications of associated design requirements and criteria).

The specific list of Documents* related to Basic Design* shall be available in List of Project Documents* (if the specific filter criteria are set and the result list is displayed).

Information included in Basic Design* documentation shall be in line with approved and valid Documents* issued during previous stages (EPC Contract*, Conceptual Design*, Concept of Basic Design* of the Project* and the Rules*.

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It shall include, but not be limited to, the following design information:

- all design information (updated and more detailed as required taking into account and justifying compliance with the requirements of the Authorities*) stipulated under above mentioned Concept of Basic Design* (Section 2).
- In addition, more detailed information shall be provided as stipulated below.

3.1 PLANT DESIGN

- Overall Plant* design criteria/requirements (incl. Licensing and Permitting* criteria/requirements incl. Codes and Standards*, power generation criteria/requirements and any other design criteria/requirements as stipulated in the EPC Contract* and/or which were used when preparing the Plant* design such as Project* identification system, standardisation, simplification, maintainability, etc.) with clear link to the Design Basis* and EPC Contract* requirements,
- Documents* specifying approach to general design aspects and reports/analyses of their fulfilment (e.g. nuclear safety, physical protection, fire protection, emergency preparedness and response, accident management, classification of environmental condition, environmental protection and monitoring, Radioactive Waste* management, waste management, water management, maintenance, Inspections*, testing, condition monitoring, labelling and colour coding, etc.),
- Commented links to Design Basis Documentation* at the Plant* level (including safety, Licensing and Permitting* basis and power generation basis),
- Overall Plant* Basic Design* description and specifications with clear link to design criteria/requirements/Design Basis*.

3.2 NUCLEAR ENGINEERING

Nuclear Fuel System* design

- Further elaborated design information provided in Basic Design*,
- Codes and standards*,
- Materials,
- Nuclear safety, seismic and other sorts of classification and qualification,
- Fuel System* components design (nuclear, thermal-hydraulic (T-H), mechanical),
- Fuel System* components handling and storage, surveillance and repair (incl. reception, Inspection*, handling, storage),
- Design interfaces to fuel – related systems (Core*, fuel storage and handling systems),
- Mechanical, material, thermal-hydraulic and other sorts of compatibility with Core*, fuel storage and handling systems and other parts of the Plant*,
- Provisions for fuel tracking and accounting,
- In-core and out-of-core operational limitations (handling, power, start-up rates, etc.).

Core* design and performance control

- Further elaborated design information provided in Basic Design*,
- Codes and standards*,
- Composition and geometry,
- Nuclear flux and Core* reactivity control,
- Core* power distribution control,
- Nuclear instrumentation sensors, calibration, classification and qualification,

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- Nuclear instrumentation data acquisition and processing, computational systems, precision and uncertainties, data presentation,
- Core* thermal power calculation, calibration, precision, uncertainties,
- Core* control strategies and operational limitations,
- Core* related Reactor Control and Limitation System settings,
- Core* and fuel related Protection System settings.

Note: Core* Design (fuel cycle management, nuclear design, T-H design, Fuel Rod* design, reload safety evaluation) related documentation shall be provided as a part of the Nuclear Fuel Contract* documentation.

Fuel storage and handling systems for fresh and spent Nuclear Fuel*

- Further elaborated design information provided in Basic Design*,
- Nuclear, thermal-hydraulic and shielding design of Fuel Storage and Handling Systems,
- Nuclear safety, seismic and other sorts of classification and qualification,
- Compatibility with the Nuclear Fuel System*,
- Operation and control of FSHS, including fuel Inspection* and repair equipment,
- Control rooms design, human-machine interface,
- Provisions for Nuclear Fuel* accounting and safeguard.

3.3 MECHANICAL ENGINEERING AND DESIGN OF MECHANICAL SYSTEMS AND COMPONENTS

Process engineering and fluid systems engineering

- Further elaborated design information provided in General part of Basic Design*,
- Commented links to Design Basis Documentation*,
- Design inputs,
- List of Rules*,
- List of systems (name and identification),
- System design criteria/requirements (incl. safety criteria/requirements such as SFC, CCF, emergency power, testing; margins and functional and other criteria/requirements such as functions, standardisation, simplification, materials, chemistry, arrangement, routing, etc.),
- Functional description and specification of the systems (description of operation and safety and non-safety functions in various Operational Modes* incl. associated safety and non-safety criteria, process control and monitoring incl. setpoints, interface to other mechanical systems, inputs, outputs) incl. role of the system in DiD,
- Systems specifications (operating/design parameters/limits and margins and operational constraints),
- Requirements and design inputs for HVAC (incl. internal and external environmental conditions),
- T-H design and calculations (incl. transient analysis),
- Heat and mass balance calculations,
- Interfaces parameters and specifications,

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- Description of testing, inspections, monitoring, diagnostics and prognostics and maintenance,
- Calculations and design reports and reviews,
- Schematic diagrams,
- Process flow diagrams,
- P&I diagrams (showing also safety class and seismic category etc.),
- Chemical programme (and related design of monitoring and sampling and laboratories),
- Optimization of cooling and heating systems incl. water cooling systems and HVAC,
- etc.

Mechanical equipment and piping and HVAC engineering

- Further elaborated design information provided in General part of Basic Design*,
- Commented links to Design Basis Documentation*,
- Design inputs,
- List of Rules*,
- Component design criteria/requirements (incl. safety criteria/requirements such as safety classification, quality, design loads and loads combinations and acceptance criteria, resistance to hazards, environmental qualification, fail safe design, reliability, testing, inspections, BP/LBB, margins, cyber security; and functional and other criteria/requirements - e.g. functions, noise, vibrations, equipment standardisation, simplification, type and design, equipment arrangement and routing, materials, maintenance, condition monitoring, diagnostics, prognostics, H-MI, etc.),
- Functional description of the components (description of operation and safety and non-safety functions in various Operational Modes* incl. associated safety and non-safety criteria, concept of process control and monitoring incl. setpoints, interface to other mechanical components, inputs, outputs, requirements for services such as cooling, electrical power, instrumentation and control and associated interfaces and interface with civil part, requirements for handling equipment etc.),
- T-H data,
- Heat loss data,
- List of components per types (name and identification) (incl. handling equipment) (e.g. list of pumps, list of heat exchangers, list of valves, list of piping and piping supports, list of ventilation dampers, list of ventilation ducts and supports, list of fans etc.),
- List of associated pump drives, valve actuators, list of fan drives, list of instrumentation and controls,
- Component description, specification and parameters (physical parameters, operating/design parameters/limits incl. working conditions and margins and operational constraints; materials) and data sheets,
- Equipment Supplier Document
 - preliminary issue based on Reference Plant data shall be provided as part of Basic design
 - final issue for Plant* shall be provided in LWA+37M
- List of tapping points,
- Coating and paintings,
- Insulations,
- Colour coding,

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- Labelling,
- Energy, Consumables*, waste requirements and management,
- List of interfaces,
- Interfaces parameters and specifications,
- Description of testing, inspections, monitoring, diagnostics and prognostics and maintenance (incl. handling equipment),
- Design life (incl. basis) and ageing management,
- Calculations and design reports and reviews
- Main component drawings,
- Layout and arrangement drawings (floor plans, cross sections, elevation drawings, typically 1:100 – for complex parts more detailed; typically DN100 and larger piping – smaller piping for important systems when necessary showing, but not limited to:
 - Arrangement of mechanical equipment and routing of piping and HVAC (incl. insulations, penetrations) with their identifications and dimensions,
 - Interfaces with other technical professions (incl. equipment, piping and HVAC supports, fire protection),
 - Areas for equipment inspections, testing, manual operation and maintenance (incl. laydown areas, handling equipment, stairs, ladders, platforms, etc.),
 - Transport routes,
 - Hazardous areas.
- Piping layout (isometric) incl. supports
 - preliminary issue based on Reference Plant Data shall be provided as part of Basic Design*,
 - final issue for Plant* shall be provided in LWA+25M,
- HVAC layout (isometric) incl. supports,
- Piping and component stress analysis (incl. seismic) and Break Preclusion*/Leak Before Break* analysis
 - preliminary issue of Stress Analysis for Large/Small Bore Pipe based on Reference Plant Data shall be provided as part of Basic Design*,
 - final issue for Plant* shall be provided in LWA+35M,
- Large Bore (L/B) Support Drawings
 - preliminary issue based of Reference Plant data shall be provided as part of Basic Design*
 - final issue for Plant* shall be provided in LWA+37M
- Small Bore S/B Support Drawings
 - preliminary issue based on Reference Plant data shall be provided as part of Basic Design*
 - final issue for Plant* shall be provided in LWA+37M
- Hazards* associated with the equipment incl. requirements with regard to fire protection (incl. penetrations and fire and smoke dampers), radiation protection, occupational health and safety (incl. noise and vibrations), environmental protection etc.,
- Requirements for manufacture (incl. welding), transport, storage and erection,
- Construction package
 - preliminary issue based on Reference Plant data shall be provided as part of Basic Design*
 - final issue for Plant* shall be provided in LWA+33M
- Commissioning*,
- etc.

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3.4 ELECTRICAL ENGINEERING AND DESIGN OF ELECTRICAL SYSTEMS AND COMPONENTS

Based on requirements arising from the design of the electrical Concept of Basic Design*.

Text documentation

- input documentation,
- Codes and Standards*,
- Design Basis*, general information, scope, structure, purpose and description of individual electrical SSC,
- main power supply requirements of individual technological SSC,
- description of functions,
- description of interfaces among electrical, I&C and technological SSC (drives control, blocking, signalling, monitoring),
- description of power supply diagram,
- selection of system type, voltage, grounding, power supply continuity,
- principle of protection against short circuit, overloading, overvoltage, protection against electric shock, etc,
- load flow and short circuit levels to the motor control centres and distribution centres,
- layout principle,
- cabling,
- grounding,
- environment conditions and its impact on SSC,
- SSC qualification,
- description of central unit fault monitoring system.

Drawing documentation

- single line electrical diagrams of individual SSC power supply
 - description of system (type of network – voltage, grounding, DC, AC, secured, etc.),
 - up to the and including the motor control centres and distribution centres,
 - including electrical protection setting,
 - including short circuit levels,
- layout (recommended in scale 1:100)
 - depiction of main SSC (switchboards (to the motor control centres and distribution centres), transformers, inverters, chargers and other relevant SSC, assignment to Emergency Power Supply* needs,
 - depiction of main cable trays and sorted according to Emergency Power Supply*,
- single line diagrams of switchgears including:
 - main parameters (type, dimensions, current rating etc.),
 - internal equipment (circuit breakers, disconnectors),
 - cable sizing and type,
- typical diagrams of electrical control and automatics.

Lists

- list of SSC (specification) - list and specification of main electrical SSC to the motor control centres and distribution centres with following information:

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- identification,
- simplified description incl. main parameters and related requirements,
- type,
- applicable Rules*, Codes and Standards*,
- main parameters – nominal and other relevant parameters (nominal current, short circuit current, voltage, impulse voltage, ratio etc.),
- system (type of network – voltage, grounding, DC, AC, secured, etc.),
- other electrical and construction information (i.e. protection of personal, arrangement, cooling, input and output configuration, etc.),
- main classification and qualification requirements (safety class, seismic resistance, environmental qualification incl. EMC, etc.),
- location,
- summary items of assembly materiel (incl. cabling),
- list of supplied SSC:
 - identification (within Project Identification System*) and type,
 - power supply requirements from safety function point of view (qualification and time aspect),
 - assignment to power source and switchgears – compliance with power supply requirement,
 - electrical parameters (power, current, starting current, voltage, ranges etc.),
 - other relevant i.e. IP,
- list of safety and safety related equipment.

Power outlet:

- power outlet diagram,
- diagram of metering (invoice, control and balance metering) and electrical protection,
- interface with the grid/TSO (list of signals),
- list of measuring circuits,
- diagram of information flow,
- tripping table of the electrical protections,
- diagram of electrical protection (single line form with protective zones),
- diagram of synchronization.

Lightning protection

Based on requirements arising from the concept of lightning protection.

3.5 I&C ENGINEERING AND DESIGN OF INSTRUMENTATION AND CONTROL SYSTEMS AND COMPONENTS

Based on requirements arising from the design of the I&C architecture in the Concept of Basic Design* and from other requirements specified here, design of I&C systems and processed in Basic Design* among other in accordance with CSN EN 61513, chapter 5.5 and 6, which include:

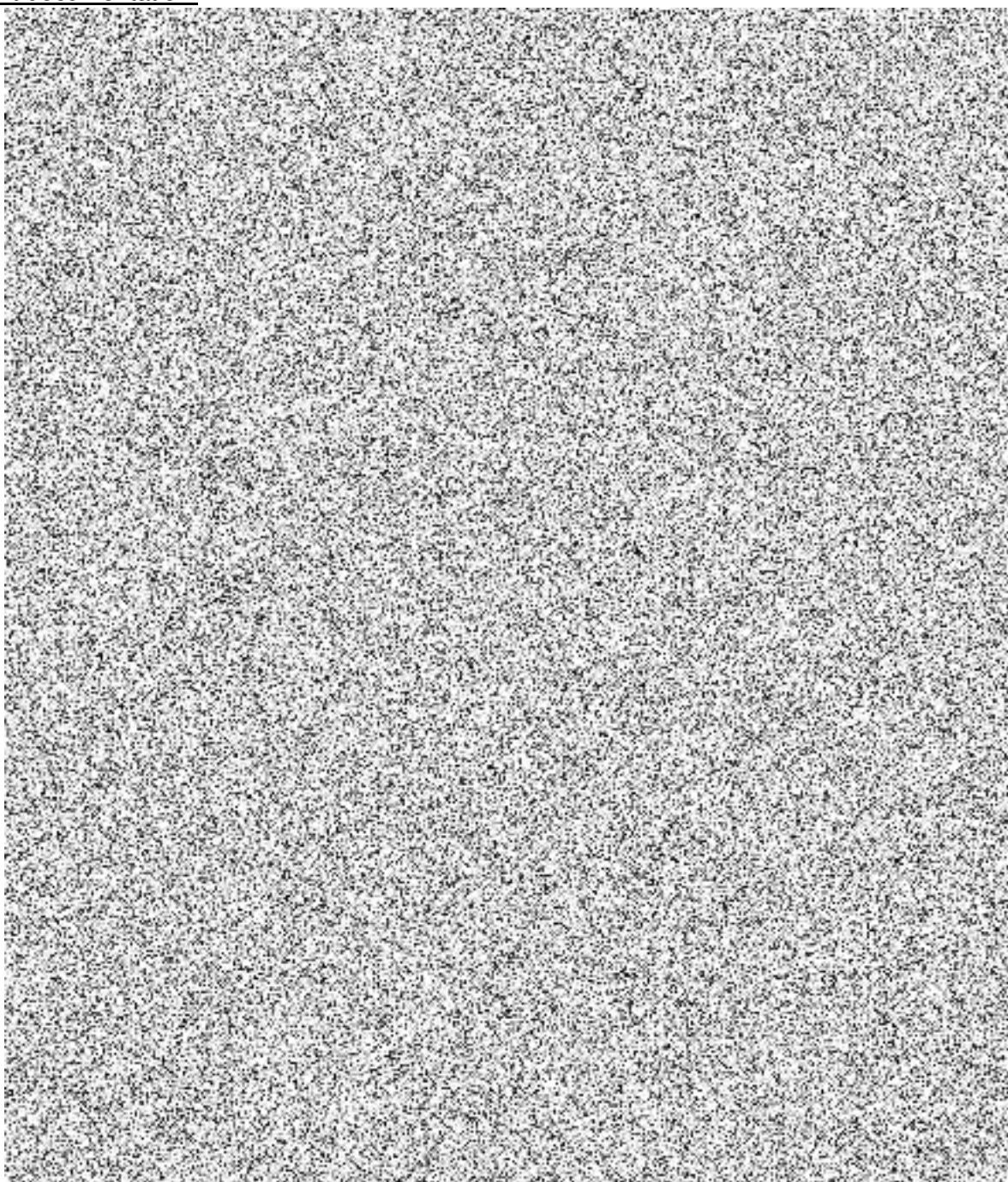
- requirements on particular I&C systems (reliability, performance, system's interfaces, environmental conditions, classification, qualification, Independence*, testability, Maintainability*),
- I&C system specification (platform specification internal system architecture - internal wiring) shall be provided in Detail Design* phase
- implementation of assigned requirements (functions and constraints) to I&C SSCs,

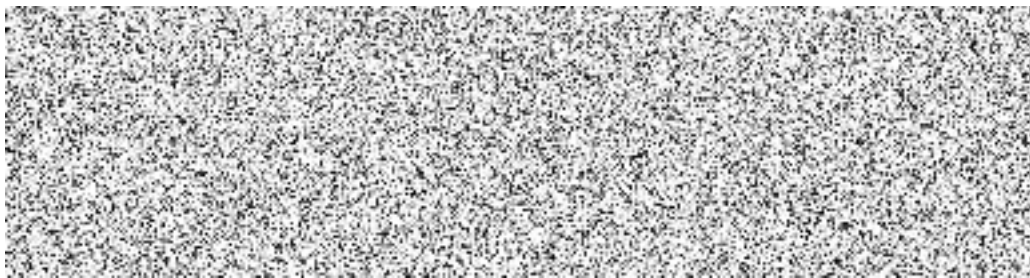
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- overall I&C integration plans during construction and overall Commissioning* plans,
- system requirements verification and implemented functions validation,
- V&V including analyses for e.g. reliability assessment, Protection against Common-cause Failures*, Qualification, Cyber Security.
- Requirement specifications for I&C Systems Detail Design

The Basic Design* documentation creates basis for detail designing within the Detail Design* and includes the following Documents*:

Text documentation:





Drawing documentation:

- system structure diagram
 - block diagram,
 - links and interfaces (within the system, to other systems, measurement, control, H-MI),
 - location of individual parts.
- layout solution (mostly in 1:100 measuring scale)
 - location of system cabinets,
 - location of HMI - control rooms, control panels, consoles and workstations.
- drawings of main cable routes (mostly in 1:100 measuring scale)
- graphical control algorithms assigned to I&C SSCs.

Lists:

- List and specification of the systems including list of SSCs:
 - identification,
 - name,
 - brief description, including basic technical and performance parameters and related requirements,
 - type,
 - technical datasheet – dimensions, power supply, radiated power,
 - location,
 - basic classification and qualification requirements
(such as: safety class, CSN EN 61226, seismic resistance, environmental qualification (external influences) including EMC).
- List of measurements
 - identification,
 - name,
 - device type,
 - identification of the connection to the mechanical (electrical) part,
 - type connection,
 - information about measurement sharing with another system,
 - location,
 - measuring range,
 - signal (4-20mA, contact etc.),
 - basic classification and qualification requirements,
(such as: safety class, CSN EN 61226, seismic resistance, environmental qualification (external influences) including EMC).
- List of controlled devices
 - identification (according to identification in the mechanical/electrical part),
 - name,
 - type connection,

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Communication systems

It is based on superior conceptual part.

- documentation is broken down by individual systems, e.g.
 - telephone exchange,
 - information and office system data network,
 - public address system,
 - dispatching speech equipment,
 - clock equipment,
 - radio network, warning and notification system,
 - CCTV system,
 - communication and data network cabling,
 - eventual other systems as needed or as required.

Text part

- basic information: subject, purpose, scope,
- input documentation,
- Mandatory Law*, Requirements of the Authorities* and Codes and Standards*,
- description and scope of proposed solution,
- description of system structure,
- description of the function, arrangement and technological solution,
- description of the layout,
- specification of required key features, functionalities and system capacity,
- description of power supply, including determination of back up requirements,
- overvoltage protection,
- description of cable wiring and cable routes,
- interfaces and links to other systems and equipment,
- system boundaries determination and interfaces definition,
- operating conditions,
- operating mods,
- protection against electric shock,
- classification,
- qualification, environmental resistance (environment, EMC, seismicity),
- fire-fighting measures,
- requirements for the process of implementation works and requirements of the designer for the construction, commissioning and operation during its lifetime,
- operation and maintenance, requirements on staffing,
- training and exams.

Drawing parts

- system structure diagram
 - block diagram,

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- links and interfaces (within the system, to other systems),
 - location of individual parts.
- layout (mostly in 1:100 measuring scale)
 - location of system cabinets,
 - location of control rooms, control panels, consoles and workstations,
 - location of terminal devices and their identification in accordance with Project Identification System* – only for CCTV.
- drawings of main cable routes (mostly in 1:100 measuring scale)

Lists

- Equipment list
 - type, description, number,
 - description of basic technical and performance parameters and related requirements.

3.6 FIRE DETECTION AND FIRE ALARM SYSTEM

It is based on superior conceptual part.

Text part

- basic information: subject, purpose, scope,
- input documentation,
- Mandatory Law*, Requirements of the Authorities* and Codes and Standards*,
- description and scope of proposed solution,
- description of system structure,
- description of the function, arrangement and technological solution,
- description of the layout,
- specification of required key features, functionalities and system capacity,
- interfaces and links to other systems and equipment, specification for control and monitoring of fire safety equipment,
- system boundaries determination and interfaces definition,
- alarm signalization,
- graphical user interface,
- description of power supply, including determination of back up requirements,
- overvoltage protection,
- description of cable wiring and cable routes and requirements for ensuring of the functionality of cable routes during fire,
- requirements to other professions,
- operating conditions,
- operating mods,
- protection against electric shock,
- classification,
- qualification, environmental resistance (environment, EMC, seismicity),
- fire-fighting measures,
- requirements for the process of implementation works and requirements of the designer for the construction, Commissioning* and operation during its lifetime
- operation and maintenance, requirements on staffing,

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- training and exams.

Drawing parts

- system structure diagram
 - block diagram,
 - links and interfaces (within the system, to other systems),
 - location of individual parts.
- layout solution (mostly in 1:100 measuring scale)
 - location of control and indication systems and system cabinets,
 - location of control rooms and workstations,
 - location of terminal devices and their identification in accordance with Project Identification System*; can be solved in the form of the list – see Tables of detectors and outputs
- drawings of main cable routes (mostly in 1:100 measuring scale)

Lists

- Equipment list
 - type, description, number,
 - description of basic technical and performance parameters and related requirements.
- Tables of detectors and outputs
 - type specification and number of fire detectors for all rooms,
 - room number, name of the Fire Area*, Fire Zone*,
 - definition of output activation algorithms for control of fire fighting devices.

3.7 PHYSICAL PROTECTION SYSTEM

It is based on superior conceptual part.

Includes solution of integrated group of the technical systems:

- detection system,
- CCTV,
- entrance and entry system,
- intercom equipment,
- control system.

Text documentation

- basic information: subject, purpose, scope,
- input documentation,
- Mandatory Law*, Requirements of the Authorities* and Codes and Standards*,
- classification of nuclear material into categories and definition of areas of interest in accordance with requirements of Atomic act. (Vital Area*, Inner Area*, Protected Area*, Limited Access Area*),
- method of determination of areas, mechanical protection barriers,
- description of system structure,
- description of the function, arrangement and technological solution of particular PPS; protection of premises, buildings, rooms, equipment and utilities,
- description of functional scenarios,

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- control centre, back up control centre; layout, equipment, functional requirements, measures for uninterrupted operation,
- description of other supervisory and service centres,
- description of the layout,
- specification of required key features, functionalities and system capacity,
- HW and SW requirements,
- description of internal links and interfaces between subsystems of PPS,
- description of links and interfaces to other systems and equipment,
- system boundaries determination and interfaces definition,
- data recording and archiving,
- security, cyber security,
- description of measures during construction,
- security measures for SSC beyond the requirements of Atomic Act,
- description of cable wiring and cable routes,
- description of power supply, including determination of back up requirements,
- overvoltage protection,
- auxiliary load-bearing structures,
- operating conditions,
- operating mods,
- protection against electric shock,
- classification,
- qualification, environmental resistance (environment, EMC, seismicity),
- fire-fighting measures,
- anti-corrosion protection of including above-ground structures,
- requirements for the process of implementation works and requirements of the designer for the construction, Commissioning* and operation during its lifetime,
- operation and maintenance, requirements on staffing,
- training and examinations.

Drawing documentation

- system structure diagram
 - block diagram,
 - links and interfaces (within the system, to other systems),
 - location of individual parts.
- layout (mostly in 1:100 measuring scale)
 - location of system switchboards,
 - location of control rooms and workstations,
 - location of terminal devices and their identification in accordance with Project Identification System*.

Lists

- Equipment list
 - type, description, number,
 - description of basic technical and performance parameters and related requirements.

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- Terminal devices tables
 - identification,
 - type,
 - location,
 - configuration description,
 - definition of interrelations.

3.8 RADIATION PROTECTION

It is based on superior conceptual part.

Documentation is divided by individual systems.

Text documentation

- System
 - input documentation,
 - Mandatory Law*, Requirements of the Authorities* and Codes and Standards*,
 - basic information: subject, purpose, scope,
 - description of controlled technology,
 - basic system requirements,
 - functional description of system,
 - description of system structure,
 - description of links and interfaces to other radiation protection systems,
 - description of links and interfaces between radiation protection, mechanical (including HVAC), I&C and electrical parts (drive control, blocking, signalling, measuring)
 - link of the radiation protection to the construction part,
 - description of the link to radiation protection control rooms and other control rooms,
 - radiation protection laboratories,
 - power supply description,
 - layout description,
 - security, cyber security,
 - Defence In Depth*,
 - reliability,
 - performance,
 - classification,
 - quality assurance,
 - qualification, environmental resistance (environment, EMC, seismicity),
 - testability,
 - maintainability,
 - maintainability principles,
 - thermal insulation,
 - surface protection and colour solution,
 - OH&S
 - chemical and physical properties of used substances,
 - requirements for hermetic bushings,
 - HW and SW requirements.
- Control rooms radiation protection
 - input documentation,
 - Codes and Standards* used,

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- basic information: subject, purpose, scope,
- description of control principles,
- description of control workplaces,
- description of means of control,
- interfaces to radiation protection,
- human factors,
- description of the layout of control panels and consoles,
- control room layout,
- power supply,
- security, cyber security,
- Defence In Depth*,
- reliability,
- performance,
- classification,
- OH&S,
- Quality Assurance*,
- qualification, environmental resistance (environment, EMC, seismicity),
- testability,
- Maintainability*,
- HW and SW requirements.

Drawing documentation

- system structure diagram
 - block diagram,
 - links and interfaces (within the system, to other systems, measurement, control, information presentation),
 - location of individual parts.
- Layouts drawings
 - the location and arrangement of the main technological equipment in connection with construction objects,
 - links and interfaces to the complete solution of the Plant*, including location of connection points to other suppliers,
 - dimensioning of the connecting pipelines of the main pipeline routes
 - for the main pipelines, marking pipe gradient, fixed points, and laying of pipes
 - layout solution in 1:100 measuring scale,
 - dividing into ground plans, views and cuts,
 - arrangement of lifting equipment and elevators in links onto technological equipment,
 - transport and transportation routes and areas for transport and transportation (doors, gates, mounting holes, etc.),
 - lay down/storage spaces with marking of maximum load, etc.),
 - marking of areas with harmful effects.
- Isometric drawings
 - isometric drawings shall be provided in LWA+25M
- Piping and instrumentation diagrams
 - basic overview diagrams of equipment and main distribution pipelines, including identification of connection points into subsequent P&ID,
 - diagrams with marking of safety classified equipment,
 - diagrams with marking of seismicity.
- Graphic algorithms of control circuits.

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Lists

- List of selected parameters of measured media.
- List of radiation protection cabling.
- List and specification of devices of the system
 - identification,
 - name,
 - brief description, including basic technical and performance parameters and related requirements,
 - type,
 - main technical datasheet – dimensions, power supply, radiated power,
 - location,
 - basic classification and qualification requirements, (such as: safety class, CSN EN 61226, seismic resistance, environmental qualification (external influences) including EMC).
- List of measurements
 - identification,
 - name,
 - device type,
 - identification of the connection to the mechanical, HVAC, electrical and I&C part,
 - type connection,
 - information about measurement sharing with another system,
 - location,
 - measuring range,
 - signal (4-20mA, contact etc.),
 - basic classification and qualification requirements, (such as: safety class, CSN EN 61226, seismic resistance, environmental qualification (external influences) including EMC).
- List of controlled devices
 - identification (according to identification in particular part),
 - name,
 - type connection,
 - information about controlling by another system,
 - basic classification and qualification requirements, (such as: safety class, CSN EN 61226, seismic resistance, environmental qualification (external influences) including EMC),
 - location.

3.9 CIVIL ENGINEERING, SITE AND DESIGN OF STRUCTURES

Information included in Basic Design* documentation for civil engineering shall be in line with inter alia, approved and valid Documents* issued during previous stages (EPC Contract*, Conceptual Design* stage, Concept of Basic Design* stage) of the Project*, Rules* (especially the following Acts and Decree must be strictly and completely respected: Act No. 183/2006 Coll., as amended, Decree No. 499/2006 (Decree No. 405/2017) Coll., as amended, Act No. 254/2001 Coll., as amended, Decree No. 146/2008 Coll., as amended, Decree 246/2001 as amended, Decree 246/2001 as amended), Requirements of the Authorities* etc.

The Basic Design* documentation related to civil engineering shall include following information (but not limited to):

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- The update of Documents* issued during the previous design stages including incorporation of all requirements (especially the incorporation of Requirements of the Authorities*) needed for successful Licensing and Permitting* process as described in Terms and Conditions*, Chapter 5 and the Licensing and Permitting, Safety and Quality Document*, Chapter 1.
- Approved input documentation needed for successful beginning of Detail Design* stage (especially building specification, technical reports, hand over reports and status reports for all civil structures).
- Civil structures drawings (incl. cross sections and longitudinal sections, emplacement of embedded part (e.g. anchor plates), representation of openings bigger than 200x200mm.
- If a product fulfilling the function of a building is part of a set of buildings, a document pursuant to Act No. 22/1997 Coll. proving the conformity of the characteristics of this product with the requirements for buildings pursuant to Section 153 of the Building Act, or technical documentation of the manufacturer or importer, or another document from which compliance with the requirements for buildings can be verified.

3.10 3D DESIGN

Expected content of the 3D federated information model at the Basic Design* stage shall include the updated version of 3D federated information model that is, all information described in Chapter 3 of this document.

The specific implementation of the above 3D/BIM requirements will comply with Attachment 3, Chap. 5.2.9 of Project Management Document*

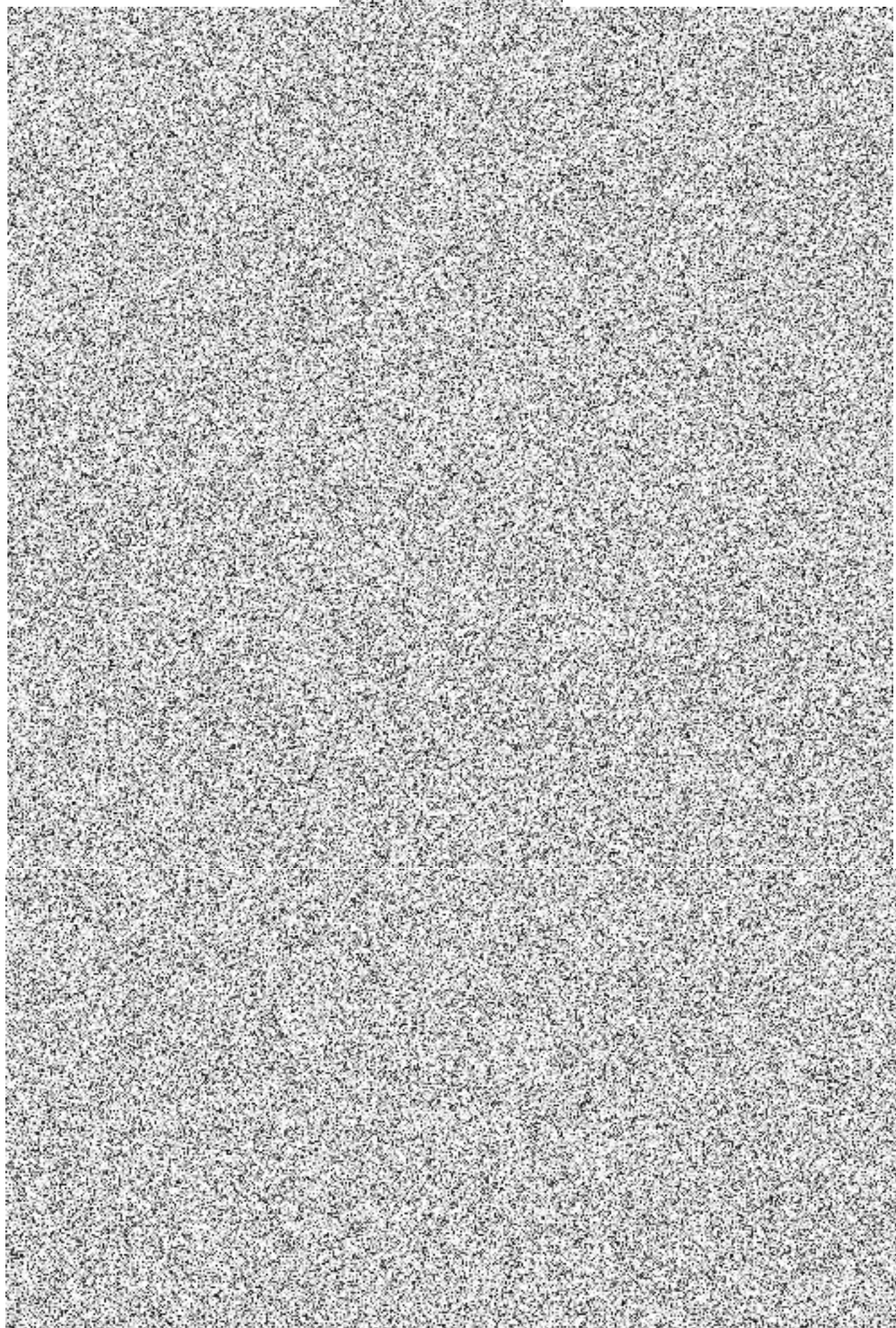
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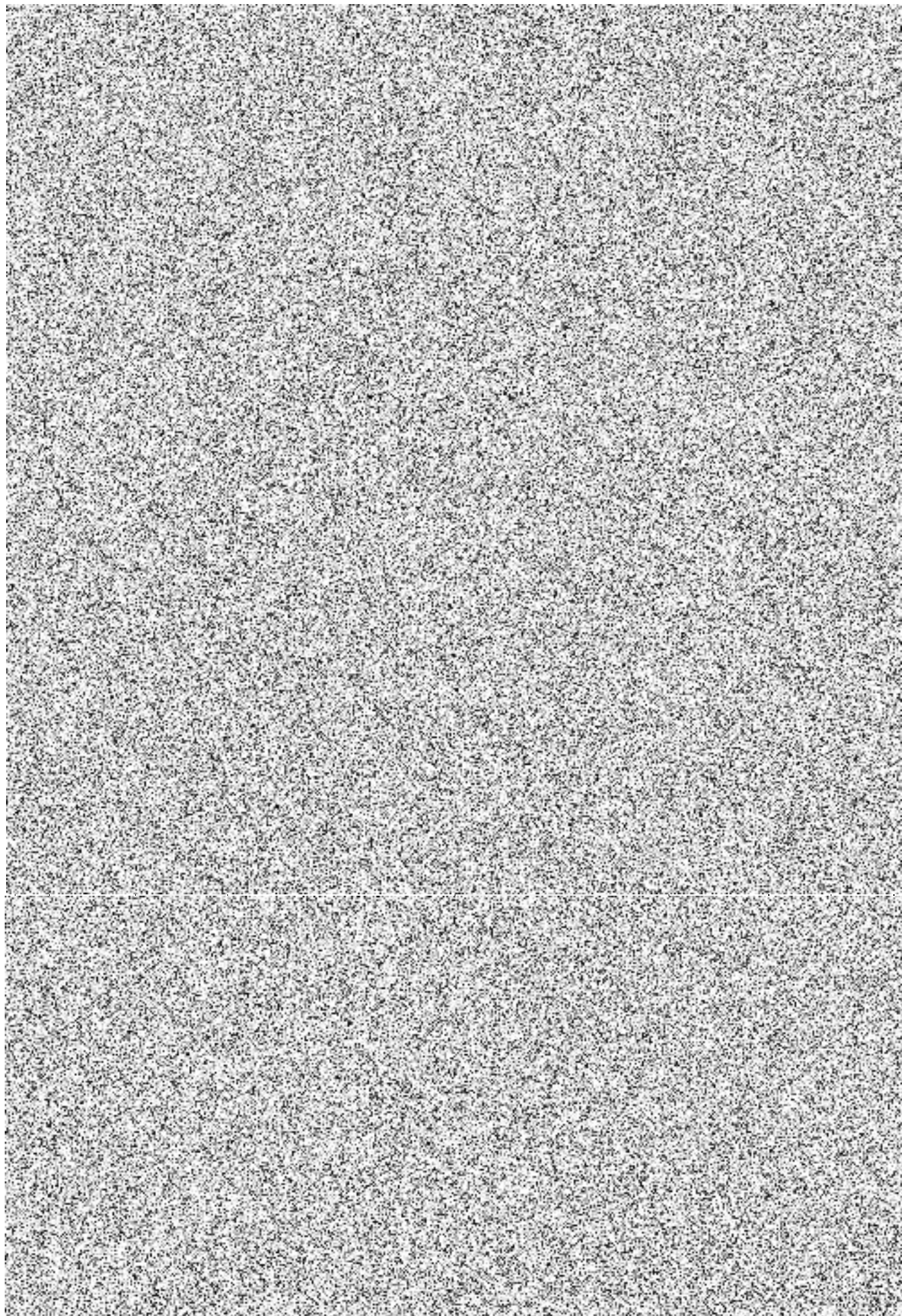
For avoidance of doubt the conversion of data models mentioned in this Attachment 1 Chapter 3.10 into IFC format is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

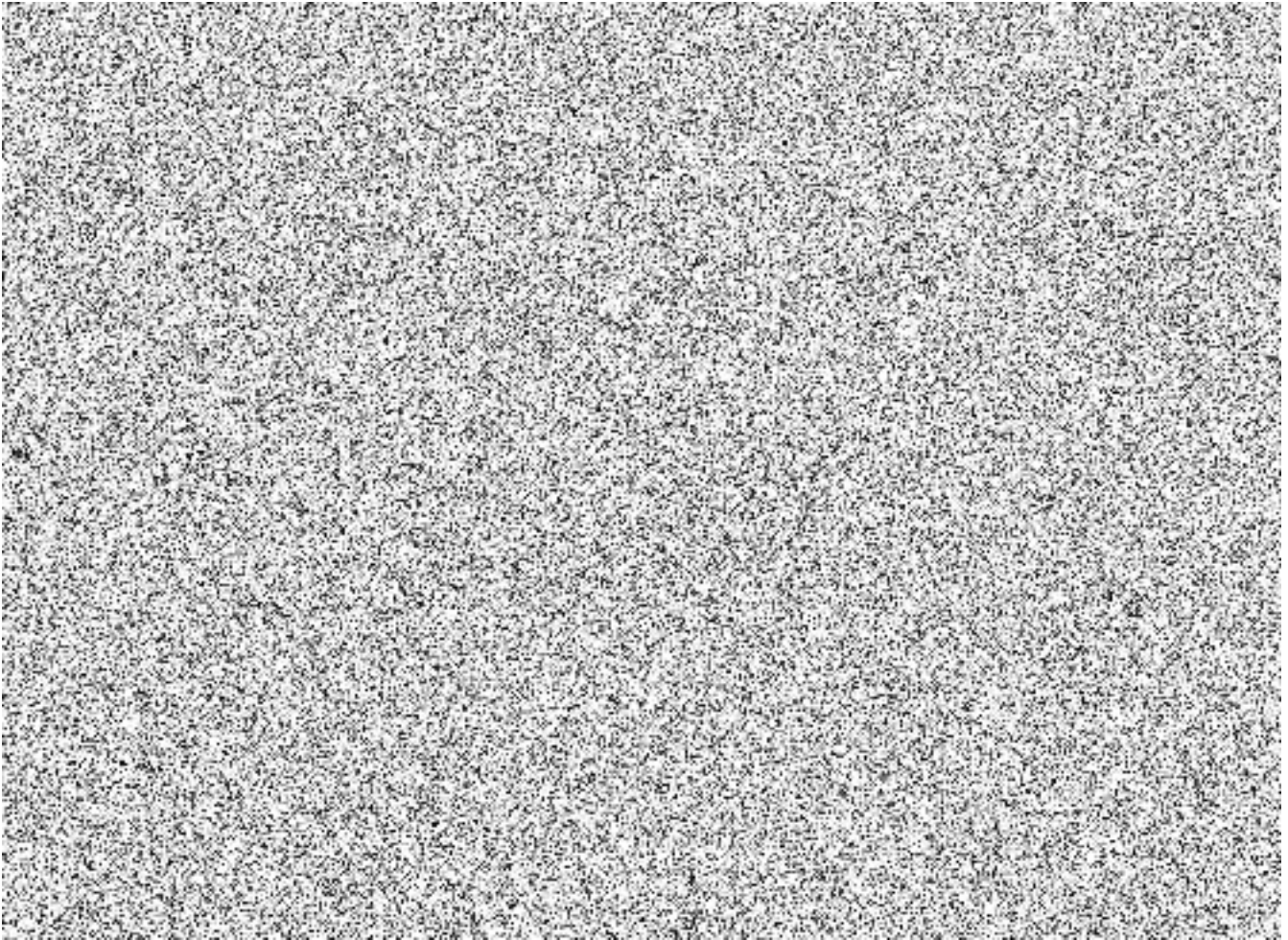
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ATTACHMENT 2 BASIC MODELING RULES

(See included separate file TR02_12_Att2_final.pdf)







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EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.13 CONSTRUCTABILITY AND COMMISSIONING
VERSION DATE:	March 2025

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CHAPTER 2.13 CONSTRUCTABILITY AND COMMISSIONING

2.13.1 INTRODUCTION

A

This Chapter includes design requirements related to constructability and Commissioning* of the Plant*.

AA

Other requirements related to construction and Commissioning* are presented in the Construction and Commissioning Document*.

2.13.1.1 GENERAL PRINCIPLES

2.13.1.1.A

The Plant* design shall take into account the Owner* target to minimise the construction cost and shorten the construction schedule (see Section 2.12.1.3.4).

2.13.1.1.B

Plant* design shall be such that construction and Commissioning* can be done safely and with required quality level in accordance with the Rules*.

BA

Inter-disciplinary design reviews shall be conducted to verify constructability (incl. occupational health and safety aspects) and to take into account requirements for Commissioning* into the Plant* design (see Section 2.12.11.1).

2.13.1.1.C

The Plant* design shall prevent problems (e.g. due to need for special and/or dangerous works) during construction and Commissioning*.

2.13.1.1.D

The Plant* design shall take into account the schedule of construction and Commissioning* of the Units*.

2.13.1.1.E

The Plant* design shall take into account construction and Commissioning* of the shared systems, services and facilities.

2.13.1.2 LOCAL CONDITIONS

2.13.1.2.A

The Supplier* shall make sure that the Plant* design in terms of construction and Commissioning* is adapted and modified to meet the requirements of the Site* conditions, licensing requirements, the local construction markets, the local industry, and the local infrastructure in terms of:

- the Basic Design* and layout,
- the functional requirements and specifications for Systems and Components*,

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- the set of the Rules*.

2.13.1.2.B

The intended pre-fabrication level and the use of modular constructions shall be such that they lead to an optimum cost figure and an optimum time schedule.

BA

The benefits in terms of efficiency of utilization of prefabrication and modularization shall be analysed based on the local market conditions and available area on the Construction Site*.

2.13.1.2.C

The Supplier* shall take into account the transportability to the Site*.

CA

See Volume 5 Chapter 5.4.

2.13.2 CRITERION FOR EFFECTIVE CONSTRUCTABILITY

2.13.2.A

The Plant* design and associated construction techniques shall allow effective construction of the Plant*.

2.13.2.B

The construction techniques used to improve the Plant* constructability shall allow the design to meet the operational and maintenance targets of the Plant* (including the design life).

2.13.2.C

The construction techniques shall consider the implementation of further back fittings which may be needed.

2.13.2.D

They shall also be taken into consideration in what refers to life extension and the future Decommissioning* plan and activities.

2.13.2.E

Constructability shall not be improved by violating requirements of safety (nuclear, radiation, work regulation, environmental, fire protection regulation etc.).

2.13.2.1 USE OF LOCAL CONSTRUCTION MARKETS

2.13.2.1.A

The Plant* design shall permit supply by the local industry.

2.13.2.1.B

The local engineering and construction companies, local material and equipment manufacturers, existing prefabrication workshops, etc. shall all be taken into account in the detailed design, procurement specification and tendering process and in the detailed construction plans.

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2.13.2.2 MINIMISED CONSTRUCTION COMPLEXITY

A

Simple and standard Plant* design shall be used so that proven, simple and standard construction solutions can be used, and complex construction solutions are avoided.

2.13.2.2.1 BUILDING DESIGN AND LOCATIONS

2.13.2.2.1.A

The building volumes and masses shall be minimised.

2.13.2.2.1.B

However, enough space shall be provided for Plant* maintenance and operation, for construction and for erection and storage of equipment, when minimising the building volumes and masses.

2.13.2.2.1.C

The In-service Inspection*, component maintenance and changes shall be easily possible without any additional costs due to lack of space for the duration of the activities.

2.13.2.2.1.D

The design, shape and layout of the buildings shall be kept as simple as possible to allow efficient design and erection of civil structures and installation and assembly of equipment.

2.13.2.2.1.E

The number of connections between buildings shall be minimized as well as penetrations of the walls.

EA

Systems which are not required to be physically separated and serve the same function shall be located in one building so that the connections between the buildings remain as few as possible.

2.13.2.2.1.F

The building's entrances shall be located as close as possible to the ground level to simplify transport.

FA

However, protection of the Plant* SSC from the external flooding shall have priority.

2.13.2.2.1.G

Steel linings shall be avoided, except for containment, embedded tanks, and pools and/or when required by the Rules*.

2.13.2.3 PROPER CONSTRUCTION QUALITY

2.13.2.3.A

The Plant* design and proposed construction techniques shall take into account the achievable construction quality level.

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AA

The Plant* design shall be tolerant of the possibility of minor construction errors.

AB

The Supplier* shall demonstrate how to deal with these construction errors which may occur during the construction work.

2.13.2.3.B

The Supplier* shall pay particular attention to interfaces and configuration control.

2.13.2.4 ACCURACY AND COMPLETENESS OF THE DESIGN

2.13.2.4.A

The Supplier* is responsible to ensure that the areas to be constructed are completely designed or at least to the extent necessary to ensure a logical procurement and construction sequence in accordance with installation work package management and to the satisfaction of the construction manager and work package manager before the construction work starts so that there will be constraint free progress and no negative impact to the Construction Time* schedule or risk that the already completed construction will require rework and modification.

AA

Requirements for construction management are specified in the Construction and Commissioning Document*, Section 2.1.2.

2.13.2.4.B

The interfaces between civil works and mechanical parts, and in case of utilization of pre-fabrication and modularity between the different modules, shall be defined with required accuracy.

2.13.2.5 MODULARITY

2.13.2.5.A

Modularity shall be applied in the Plant* design.

AA

Standardised modules for civil and other parts of the Plant* shall be applied in the design where beneficial to achieve main goals mentioned in the Construction and Commissioning Document*, Chapter 1 considering local conditions (including Rules*).

AB

The design of modules shall maximize the use of standardised elements and components in order to simplify the work.

AC

The dimensioning system shall be based on systematic recurrent dimensions for wall thickness, room dimensions, etc.

AD

Standard pillars and beams sizes shall be applied.

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AE

Pre-fabricated elements shall also follow the modular dimension system.

2.13.2.5.B

The design shall consider access space provisions for installation and construction fit-up and for maintenance, operation, and component removal/replacement.

2.13.2.5.C

The design of any module shall be 100 percent complete without “holds” and/or constraints and in accordance with Detail Design* at the time the module is released for fabrication.

2.13.2.5.D

Dimensions of applied modules shall be in conformity with the local conditions and capabilities of the local construction companies.

DA

If use of large and heavy modules is selected, then detailed construction drawings shall be prepared, as well as plans for their manufacturing, transportation, storage on-site and installation in the buildings’ civil structures.

DB

The large and heavy modules shall be made well in advance in order to allow enough time to finish the prefabrication.

2.13.2.5.E

Whether the module will be fabricated entirely in the off-site shop, its major elements will be fabricated off-site with final assembly at the on-site shop or lay down area, or whether will be fabricated entirely on the Site* in a module assembly area shall be decided based on the local conditions.

2.13.2.5.F

Examples of the types of modules which have been previously developed and which shall be considered are as follows:

- Basemat reinforcing steel assemblies
- Main condenser
- Main control panel assemblies
- The RPV pedestal structural steel
- The RPV nozzle support ring
- Containment vessel or linear plate
- Refuelling pool and spent fuel pool liner plates
- Steel turbine generator pedestal
- Precast concrete walls, beams, slabs (where practical)
- Turbine lube oil system
- Water treatment and radwaste systems
- Sampling panels and labs
- Piping, pump, and valve assemblies

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2.13.2.6 DESIGN TOOLS

A

The Supplier* shall verify the constructability using a state-of-the-art multi-D Computer Aided Design system.

AA

Requirements for the layout model are specified in Section 2.12.10.3.1.

2.13.3 COMMISSIONING

2.13.3.1 GENERAL

2.13.3.1.A

The Plant* design shall allow safe and effective Commissioning*.

AA

The Supplier* shall provide all equipment necessary for verification of the design functions of the Plant*.

AB

The Supplier* shall provide systems for collection, evaluation, and storage of data from the Commissioning*.

AC

For that purpose, conditions monitoring systems specified in the Section 2.14.2.7 and Plant* performance assessment system specified in the Operation and Maintenance Document*, Section 3.8 shall be used.

2.13.3.1.B

The access to and area around components including space required for extra monitoring systems and Inspections* needed for Commissioning* shall be provided.

2.13.3.1.C

The Plant* SSC shall allow and provide input points, when required, for extra monitoring and Inspections* needed for Commissioning*.

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EPC CONTRACT

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CHAPTER 2.14 OPERATION, MAINTENANCE AND PROCEDURES

2.14.0 INTRODUCTION

2.14.0.A

The objective of the Chapter 2.14 is to outline a number of requirements aimed at enhancing the operation and maintenance of the Plant* by incorporating experience gained at operating facilities.

2.14.0.B

Simplifying operation and optimising maintenance and reducing the need for Inspections* and surveillance is a main objective, thereby minimising the necessary personnel workload and also exposure of Plant* personnel to radioactivity during Plant* life.

2.14.1 INTERFACE BETWEEN OPERATORS AND EQUIPMENT

2.14.1.A

The Plant* shall include features to make the design Operator*-friendly and to minimise the operational and maintenance burden while complying within the Technical Specifications*.

AA

To this end, increased margins, simplified systems, optimisation of inherent behaviour, high level of automation and online monitoring and diagnostics and use of advanced and reliable human-machine interfaces are called for.

2.14.1.B

The Plant* shall be designed with simple, effective and ergonomic human-machine interface allowing easy and efficient operation and maintenance and also control of DBC 2, DBA and DEC and in order to minimise potential for human error.

2.14.1.C

The Plant* design shall include:

- simple and easy-to-understand processes, especially for the infrequently used systems,
- orientation of the inherent behaviour of the systems towards simplicity of operation and reduction of the risk of human error that could impair safety or performance (sufficient time before action during a transient, reduction of the number of changes to the system configuration during a transient, etc.),
- use of modern technology and ergonomic principles (in particular in Operator* aids and Operator* displays).

CA

The requirements are further specified in Technical Requirements Document*, Section, 2.10.

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2.14.1.1 GENERAL DESIGN

2.14.1.1.A

The design process shall emphasise the H-MI, system interfaces, and man-man interfaces throughout the Plant* design.

AA

The design process shall address that it is people, not institutions and robots, who maintain and operate the Plant* and that it is their interface with the machine and the technology involved that determines how safe, reliable and efficient the Plant* will be.

AB

See also Technical Requirements Document*, Section 2.10.5.4.2.3.

2.14.1.1.B

For that purpose, the Supplier* shall be conduct analysis throughout the design process to ensure there is a balanced relationship between human and the machine.

BA

During the initial phase of the design, the Supplier* shall include an integration of all technical disciplines along with experienced operating and maintenance personnel to establish the performance objectives and operating and maintenance requirements for the Plant*.

BB

The Supplier* shall set up an iterative process to frequently and systematically review the design as it progresses from the initial phase up to the construction phases and shall take into account lessons learned from the Commissioning*.

BC

As the design proceeds, Plant* operating and maintenance functions shall be allocated to humans, machines, or a combination of them according to the perceived capabilities and limitations of each.

2.14.1.1.C

The Supplier* shall apply the same sound criteria and philosophy for H-MI throughout all the Plant* systems.

CA

The Supplier shall prevent non-uniformity in the design approach applied to different systems (NI, PGP and BOP) in order to minimise various Operator* interfaces, employing different conventions, different alarm and display philosophies, non-standardised hardware, etc.

CB

The H-MI design process shall not depend on the system involved in the NI, PGP or BOP, nor the safety classification, e.g. safety or non-safety classified equipment, nor location, e.g. Main Control Room* or local control panels.

2.14.1.1.D

Human factor design principles shall be consistently applied throughout the design process for each operation or maintenance workspace, in order to reduce operation and maintenance errors during all Plant* operating modes and during maintenance.

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2.14.1.1.E

The design process shall ensure that problems related to H-MI are identified and that features are incorporated in the Plant* design which provide satisfactory solutions to those problems (See Section 2.14.2.8).

EA

The Supplier* shall explicitly address each of the problems so that the merit of the solutions can be independently evaluated and so that the basis for the design features which represent solutions are maintained for the Owner* to evaluate future changes.

2.14.1.1.F

The H-MI design process shall result in the explicit identification of the functions needed for safe, reliable and efficient Plant* operation.

FA

The design process shall result in the explicit identification of the individual tasks, mental and physical, necessary to perform these functions.

2.14.1.1.G

The Supplier* shall systematically identify the tasks required to operate and maintain the equipment, including definition of skills, tools, test equipment, access, environmental conditions, etc.

GA

These tasks shall include any testing required to return the equipment to service after maintenance is completed.

GB

This identification shall carefully balance the need for operation and maintenance tasks and the incurred constraints. Each task identified in the design process shall mention the rationale behind it, to prove its worth.

GC

The result of this identification shall be documented and provided to the Owner*.

2.14.1.1.H

Reviews for Operability* and Maintainability*, involving both Supplier* and Owner*, shall be made during the design phase to achieve suitable balance between man and machine during both operation and maintenance.

HA

The result of these reviews shall be documented and provided to the Owner*.

HB

Additional requirements for evaluation of maintenance and operation are specified in the Operation and Maintenance Document* Section 3.2.

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2.14.1.1.I

Based on the identified operational and maintenance tasks, communication tasks among the Operators* or with other members of the Plant* staff or visitor within the Plant* shall be identified, analysed, documented and provided to the Owner*.

IA

Using the identified overall communication tasks, the Supplier* shall determine the specific communication needs and the specific design requirements for the various communication systems.

IB

Communication systems and equipment shall be provided to support all operation and maintenance activities, including accident management.

IC

This communication systems and equipment shall allow communication throughout all areas of the Plant*.

ID

No dead areas are permitted except for EMI/RFI interference areas as defined in the Technical Requirements Document, Section 2.10.5.4.2.3.8.F.

IE

Since the personnel need to be able to communicate from any part of the Plant*, not just near fixed communication stations, this system shall support portable wireless communication devices in areas where this may be done without risk of electromagnetic interference.

IF

The Plant* shall have communication capability that is dedicated to operating and maintenance personnel and designed to support their needs.

IG

Other requirements for communication are included in Part II, Volume 2, Section 2.10.5.4.2.3.8.

2.14.1.2 MAIN CONTROL ROOM AND I&C

2.14.1.2.A

In the Main Control Room*, the Operator* shall be provided with well arranged information which give the Operator* a clear understanding of the current status of all SSC in all states and conditions in a coordinated manner.

2.14.1.2.B

The adequate (similar or the same) provisions shall be made for the Emergency Control Room* and the Technical Support Centre*.

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2.14.1.2.C

The Operator* shall be provided with adequate information to:

- assess readily the general state of the Plant* in all DBC and DEC, and to confirm that the automatic safety actions are being carried out,
- determine the appropriate Operator*- initiated actions that should be taken,
- operate the Plant* safely using information on parameters associated with individual SSC.

2.14.1.2.D

The MCR shall be located where Operators* can easily gain access under all Plant* conditions.

2.14.1.2.E

The access to the MCR shall be secured.

2.14.1.2.F

The location and the layout of the MCR shall also be based on reducing the need for access to the MCR by other Plant* personnel, while maintaining the necessary possibility for the MCR staff to interact effectively with the field equipment Operators* and maintenance staff.

2.14.1.2.G

Separate space (rooms) shall exist in connection to MCR for the purpose of giving out work orders, work permits, etc.

2.14.1.2.H

In terms of room arrangement attention shall also be given to the access of the MCR with other rooms such as I&C equipment rooms, I&C service centre, maintenance management room and documentation room.

2.14.1.2.I

The MCR shall have sufficient space to allow the control room staff to perform all necessary actions, while minimising Operator* movement. Temporary plant life phases such as commissioning, refuelling shall also be considered as well as potential need of space for field Operators*, Operator* trainees and other temporary personnel.

2.14.1.2.J

In the MCR there shall be sufficient work areas, writing space and storage space for documents.

2.14.1.2.K

The floor material of any control room and I&C rooms shall be such that static electricity does not cause disturbances on the electrical equipment.

KA

Typically, the floor covering material and the flooring system provide resistance values from 50 kΩ to 100 MΩ measured between two points on the floor spaced by 1m.

2.14.1.2.L

Specific requirements on I&C and H-MI are specified in Chapter 2.10.

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2.14.1.3 OPERATING AREA ENVIRONMENT

2.14.1.3.A

The Plant* design shall include human factor considerations (including ergonomics) that assure adequate space, illumination, noise levels, and environment control according to the performed operational and maintenance tasks and in compliance with Rules*.

2.14.1.3.B

Suitable environment (temperature, humidity, noise, illumination and radiation) ensuring the safety and comfort of Plant* personnel and Operability* of Plant* equipment shall be provided for all areas in the Plant* during Normal Operation* and for those areas necessary to maintain or establish control and implement recovery actions in DBC 2 and DBA and DEC.

BA

In particular, environmental conditions in the MCR shall be such that the Operators* can perform their task effectively and comfortably.

2.14.1.3.C

Illumination in all areas of the Plant* shall be provided in such a way that operational as well as maintenance work can be performed without extra lighting.

CA

The illumination shall be non-flammable and shall not contaminate the atmosphere and its intensity shall depend on the type of the operation or maintenance activities it is necessary to carry out the task.

CB

Illumination in areas (in particular in control places) used for accident management shall be ensured in both DBA and DEC.

CC

Emergency lighting shall be provided in compliance with the Rules*.

CD

Lighting in MCR shall be provided in accordance with the layout criteria for the equipment and with the required operation tasks.

CE

Reflection effects, blinding effects and inconveniences for the staff shall be reduced,

CF

The MCR shall be provided with several lighting areas, which can be manually adjusted to provide illumination suitable for the Operators* to perform their tasks.

2.14.1.3.D

All ventilation and environmental control systems required for Normal Operation* shall be available continuously.

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2.14.1.3.E

In radiation areas where operational and/or maintenance activities will be performed, temperature and humidity shall be maintained at a level required for worker efficiency and the potential for difficult working conditions shall be eliminated as much as possible.

2.14.1.3.F

The Supplier* shall ensure to the extent possible that no action is required in areas where the environment parameters may evolve during DBA or DEC to levels unsuitable for safe and efficient human working conditions.

FA

In areas where manual action may be required, the environmental conditions shall be assessed, and provisions needed in order to prepare and perform these actions shall be described.

2.14.1.3.G

Appropriate level of equipment Redundancy*, and appropriate combination of design margin and recommendation for component replacement intervals shall be provided for the above mentioned systems.

2.14.1.3.1 NOISE

2.14.1.3.1.A

The Plant* design shall ensure suitable acoustical environments for Plant* personnel which will not cause personnel injury, interfere with voice or other communications, cause fatigue or degrade overall system effectiveness.

2.14.1.3.1.B

For personnel protection, the acoustic pressure level shall not exceed the overall balanced value according to Rules*.

BA

Special restrictions may be imposed in areas where critical tasks are being performed (such as the MCR).

BB

The overall permanent noise pressure level in the MCR shall be limited to a maximum 50 dB (A).

2.14.1.3.1.C

If necessary, noise attenuation features shall be incorporated by the Supplier* into the Plant* and/or individual equipment to assure the required acoustical environments.

2.14.1.3.1.D

Areas where personal noise protection would be required shall be minimised.

DA

Time demand of tasks performed in these areas shall be as low as practicable.

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2.14.1.4 HUMAN-MACHINE INTERFACE IN MAINTENANCE

2.14.1.4.A

The design shall simplify maintenance and minimise to the extent possible difficult maintenance tasks required over the lifetime of the Plant*.

AA

Modern technologies and tools to assist Plant* staff together with continuous online condition monitoring systems shall be provided to simplify inspection, testing and maintenance.

AB

The Supplier* shall perform cost-benefit analysis of application of above mentioned technologies to optimize number of operating personnel.

2.14.1.4.B

The Supplier* shall provide demonstration that simplification and ease of the maintenance tasks have been considered at the design stage.

2.14.1.4.C

The Plant* design shall optimise Maintainability* by including human factor considerations and providing adequate space and provisions for overhaul maintenance of major components, adequate transport routes, illumination, platforms, lifting equipment, handling gear, shielding, communications, HVAC, and services supply and providing for reduction of operational radiation exposure.

2.14.1.4.D

Features to facilitate Critical Maintenance Activities* shall be provided.

DA

The specific support systems and services, including special handling equipment, required for the Critical Maintenance Activities* shall be determined and provided for in the design, considering all detailed aspects of the maintenance job.

2.14.1.4.E

Consideration shall be given to facilitate maintenance of equipment in-situ or easy exchange of components.

EA

Similarly, where modular construction techniques are used, consideration shall be given to maintenance of all components in-situ or easy exchange of the complete module.

2.14.1.4.F

The accessibility (orientation and surrounding space) of the equipment shall be in a way that facilitates maintenance operations, particularly for Essential Components* or those expected to be replaced on a regular basis.

FA

Pathways shall be designed through the Plant* to selected locations where heavy tools, equipment, or replacement components must travel.

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FB

Drawings and other design Documents* shall delineate these pathways and indicate structural limits.

2.14.1.4.G

In high radiation areas, the need for maintenance shall be minimised and the Supplier* shall consider the use of robotics as specified in the Section 2.14.8.4.

GA

The Supplier* shall provide the Owner* with a detailed list of the components inside high radioactive zones, specifying the spare parts and Consumables* (e.g. o-rings) and the maintenance frequency needed.

GB

The Supplier* shall use parts and Consumables* that last longer in operating conditions, to reduce maintenance work.

2.14.1.4.H

A system shall be developed and provided for verification of valve position where required for safety or security reasons (see Section 2.7.2.6).

2.14.2 PROVISIONS TO ENHANCE OPERABILITY AND MAINTAINABILITY

2.14.2.A

This Section includes the requirements to enhance Operability* and Maintainability*.

2.14.2.B

The SSC design shall include provisions to enable simple and efficient operation and maintenance and special tools shall be provided as specified in Scope of Supply Document*, Section 2.2.5.4.

BA

The Supplier* shall design the Plant* and its SSC to eliminate as much as possible/practicable the need for dismantling or removing the Plant* SSC in order to ensure operation, maintenance, Inspection* and testing required.

BB

Particular attention shall be paid to SSC that are critical for safety and for Plant* performance.

2.14.2.C

Due consideration for ease of operation and maintenance shall be taken in the design, starting from the earliest stages of the design process.

2.14.2.1 PERSONNEL

2.14.2.1.A

The Plant* design shall minimise as far as possible the number of operating and maintenance personnel, both per shift and their total number while maintaining the Plant* required safety level of safety and availability.

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2.14.2.1.B

The Site* and Plant* arrangement shall aim at minimising loss of time due to personnel circulation.

2.14.2.1.C

Additional requirements for Plant* personnel are specified in the Operation and Maintenance Document* Section 1.1.

2.14.2.2 ORGANIZATION

2.14.2.2.A

The Plant* design shall be consistent with the organization of Plant* personnel.

2.14.2.2.B

Additional requirements for organization of Plant* personnel are specified in the Operation and Maintenance Document* Section 1.2.

2.14.2.3 TRAINING

2.14.2.3.A

Training facilities and equipment shall be provided so that all operational and maintenance tasks can be trained as required.

AA

The Supplier* shall define and provide training tools such as mock-ups, and CAD, for critical equipment to facilitate training, minimise the potential for maintenance errors, and reduce personnel exposure to high radiation.

AB

These shall include electronic and physical mock-ups, laboratories, workshops as necessary to train the tasks.

2.14.2.3.B

Requirements related to training process and training documentation are specified in the Operation and Maintenance Document* Chapter 2.

2.14.2.3.C

Requirements related to training centre are specified in Chapter 4.7.

2.14.2.3.D

Requirements related to the Training Simulator* are specified in Technical Requirements Document*, Section , 2.20.

2.14.2.4 COMPONENTS

2.14.2.4.A

Redundancy, in addition to Redundancy* implemented to cope with the Single Failure Criterion* for equipment which provides a Safety Function*, to allow maintenance shall be provided in the Plant* design based on the availability and reliability assessments.

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AA

PSA, RAP and PAM shall take into account maintenance programmes. Requirements for PSA are specified in the Chapter 2.17, requirements for RAP are specified in the Chapter 2.15 and requirements for PAM are specified in the Chapter 2.18.

AB

The redundant equipment/components shall be maintainable during Plant* operation for short periods of time, based on PSA studies and availability analysis.

AC

For specific cases, where maintenance is scheduled to last for long periods during Plant* power operation, increased Redundancy* shall be implemented.

2.14.2.4.B

Components shall be designed allowing for wear, corrosion and erosion, etc., so that Plant* performance is not degraded by such phenomena and avoidable maintenance is not incurred throughout Plant* design life.

BA

Requirements for selection of materials to prevent and/or minimise effects of ageing are specified in the Section 2.6.3.1.

2.14.2.4.C

According to the objectives of simplification and standardisation and consistent with safety, functional reliability and availability requirements, use of different types and sizes of pumps, valves and other components and systems, including the different types of instrumentation, control, and power equipment used, shall be minimised.

CA

Simplifying and reducing the maintenance effort and the number of spare parts shall be a priority to be considered during the design phase.

2.14.2.4.D

Proven components shall be used to the greatest extent possible, and in preference to components of new design.

2.14.2.5 SYSTEMS AND EQUIPMENT IDENTIFICATION

A

Structures, Systems and Components* shall be suitably identified using an identification system which shall be clear, unambiguous and common for the entire Plant* so that the potential for human error during Plant* operation and maintenance is minimised.

AA

Additional requirements for identification system are specified in the Section 2.12.7.

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2.14.2.6 PREVENTIVE AND PREDICTIVE MAINTENANCE

2.14.2.6.A

The Plant* design shall minimise the necessary scope, frequency and the time requested for the maintenance while maintaining the Plant* required level of safety and availability, assuring the design life of the Plant* and individual SSC and meeting requirement of the Rules*.

AA

Requirements related to component design with regard to Maintainability* are specified in the Section 2.14.2.4.

2.14.2.6.B

Graded Approach* shall be used with focus on the Essential Components*.

BA

The Supplier* shall take into account industrial recommendations such as EPRI Preventive Maintenance Basis Database.

2.14.2.6.C

The Supplier* shall demonstrate that all necessary major and minor maintenance work can be accomplished within the refuelling maintenance period in accordance with the availability goals defined in Section 2.2.7.2.

CA

The Supplier* shall take into account of all past problems as specified in the Section 2.14.2.8.

2.14.2.6.D

Impact of maintenance optimisation on PSA, RAP and PAM shall be evaluated and incorporated back into the PSA, RAP and PAM.

2.14.2.6.E

In order to simplify the maintenance, the Supplier* shall incorporate the following features and measures in the Plant*:

- installation of well tested and reliable components,
- extended intervals between Inspections*,
- increased service life,
- reliability-centred maintenance plans,
- means for easy dismantling, exchange and remounting of components,
- means to transport replacement components and special tools to the equipment rooms,
- minimised number of welds to be inspected, especially in the RCS (pressure vessel, loops, Steam Generators*) and located so that they can be easily accessed,
- identification signs on SSC.

2.14.2.6.F

The Supplier* shall conduct reviews during the development of the Plant* design on the design features and measures for maintenance simplification.

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FA

The Owner* shall have the right to attend said meetings and shall have right to study the reviews and consult the Supplier* with regards to same.

2.14.2.6.G

The Plant* shall be provided with condition monitoring, advanced diagnostics and advanced prognostics to optimise scope of SSC maintenance and reliability by means of the Predictive Maintenance*.

GA

The advanced diagnostics shall allow analysis of the data gathered by condition monitoring or by other means (other measurement, tests, Inspections*, etc.) and to determine nature of the problem and shall allow evaluation of the actual state and life of the SSC.

GB

The prognostics shall allow prediction of the failure probability (time to and risk of failure) and residual life of the SSC and shall serve as input for maintenance planning.

GC

Both diagnostics and prognostics shall be automated as much as possible.

GD

Special attention shall be paid to diagnostics of I&C equipment.

2.14.2.6.H

Requirements for establishing the maintenance programmes and maintenance optimisation as specified in the Operation and Maintenance Document* Section 3.5.

2.14.2.7 PLANT CONDITIONS MONITORING

2.14.2.7.A

Plant* conditions monitoring shall be provided by the Supplier* to ensure that Plant* equipment and structures and environments are maintained within design values throughout the life of the Plant*.

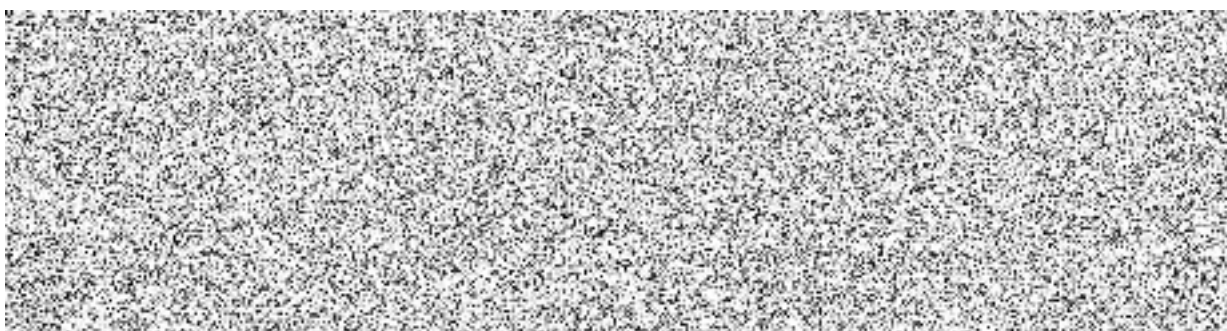
AA

The online Plant* conditions monitoring systems shall be provided and integrated within the I&C system.

AB

The conditions monitoring shall provide support to assure that all Plant* and SSC design life and qualification assumptions are met. In addition, the monitoring shall be used to enable effective troubleshooting, diagnostics and Predictive Maintenance*. In addition, the monitoring shall provide data to improve Plant* efficiency and to optimize radiation protection.

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AD

The condition monitoring (systems) shall be of proven design including system for evaluation of data.

AE

The Supplier* shall identify the parameters to be measured, provide means of measurement, together with a system to process, record and evaluate these measurements.

AF

The time resolution and accuracy of the data collected shall be sufficient for their purpose including detailed studies of plant transients.

AG

The monitoring programmes shall cover all ageing effects which can influence safety and reliability.

AH

The records obtained shall be evaluated within the life capability evaluation programme and also evaluated for purpose of Predictive Maintenance*.

AI

Graded Approach* to scope and frequency of the monitoring (including need for online monitoring) shall be used with focus on the Essential Components*.

AJ

Essential Components* shall be specifically equipped to determine the trend of performance characteristics (e.g. valve closing times, pump head and pump flows) to ensure adequate margins exist for compliance with applicable safety and reliability requirements.

2.14.2.7.B

Environmental and process conditions monitoring shall be provided to monitor and record history of environmental stressors (e.g. temperature, humidity, radiation, pressure, flow and vibration) in and around all Plant* SSC and to monitor operation of the Plant* systems in terms of their performance, efficiency and record their operational history.

BA

The instrumentation shall be provided to record operational history of the Plant* SSC (such as number of operation cycles etc.) in order to evaluate fatigue.

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2.14.2.7.C

In addition, condition monitoring shall be provided for all SSC for which such monitoring is cost effective with respect to safety, reliability and maintenance costs.

2.14.2.7.D

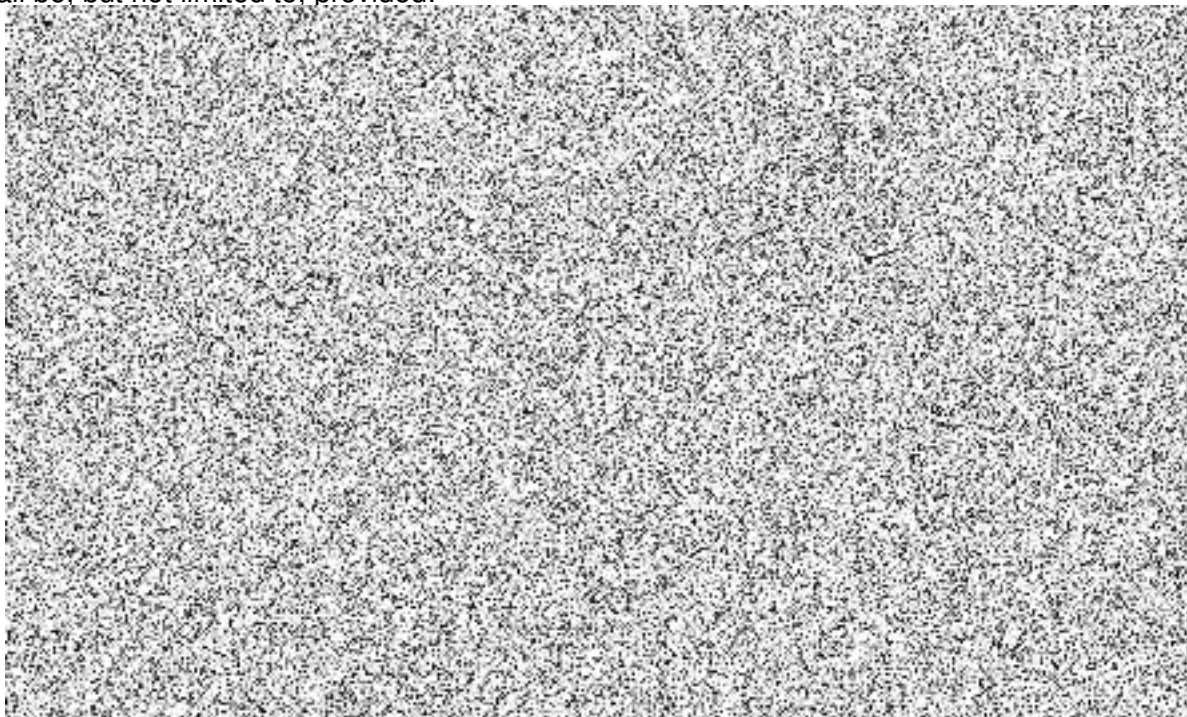
The conditions monitoring shall be coordinated with other environmental monitoring needs such as monitoring of personnel environments (area radiation) and Site* conditions (on-site environmental monitoring system).

2.14.2.7.E

The conditions monitoring shall be used also for the Commissioning*.

2.14.2.7.F

Besides the abovementioned conditions monitoring, the following specific monitoring systems shall be, but not limited to, provided:



2.14.2.7.G

Note that other parts of EPC Contract* may include and/or imply additional specific requirements for conditions monitoring. Such requirements shall be met as well.

2.14.2.8 RESOLUTION OF PAST PROBLEMS

2.14.2.8.A

The Supplier* shall incorporate into the design of the Plant* the lessons learned from operation and maintenance of the present nuclear (including Reference Plant*) and conventional power plants.

AA

The Supplier* shall identify and provide solutions for the problems known in the operation and maintenance of nuclear and conventional power plants.

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AB

The Supplier* shall consult his own sources and any other available data sources.

AC

As a minimum, the Supplier* shall consider the information sources in Technical Requirements Document*, Section , 2.14.11.1.

2.14.2.8.B

The Supplier* shall perform an analysis report covering all issues of Plant* performance related to nuclear and non-nuclear equipment and at a level detailed enough so that root causes can be determined and appropriate solutions incorporated in the Plant* design.

BA

Based on a review of experience, a number of operation and maintenance problems that exist in present nuclear plants can already be identified and are presented in Technical Requirements Document*, Section 2.14.11.2 and 2.14.11.3 and shall be analysed.

BB

During all stages of the Project, the Supplier* shall periodically update the analysis report to complement it with new experience gained at the Plant* and also from other data sources (in particular from the Reference Plant*) and propose design improvement.

BC

The Supplier* shall document known operation and maintenance problems specific to the Plant* design (including Standard Design* and Reference Plant*) and their solutions in a report made available to the Owner*.

BD

In particular experience from the Commissioning* and operation till the final acceptance of the Plant* shall be analysed and incorporated into the Plant* design.

BE

For that purpose, the Supplier* shall participate in operational experience feedback till the final acceptance of the Plant* and openly contribute to investigation of the failures, errors and design deficiencies.

2.14.2.8.C

The analysis report shall be complemented with a Maintainability* evaluation report to demonstrate that maintenance features have been considered in the Plant* design and the required availability is achievable.

CA

The Maintainability* evaluation report shall demonstrate that:

- Outages can be completed within the required time period which are specified in Technical Requirements Document*, Section , 2.2.7.2.2,
- Proposed maintenance during Plant* power operation is feasible and does not negatively impact Plant* safety and/or availability,
- The Plant* design allows execution of reasonably expectable modifications to be made during the Plant* life.

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CB

For that purpose, the evaluation report shall identify the critical maintenance and transportation tasks and the demonstrate that:

- Critical maintenance tasks can be performed safely, easily and quickly,
- Satisfactory Plant* services and repair shops are provided,
- Access for maintenance is provided to all SSC,
- Space for lay down, dismantling and assembling of equipment is provided,
- Suitable environmental conditions are ensured for maintenance personnel,
- Components and tools can be transported using safe, pre-planned lifting and transport methods,
- Decontamination can be performed.

CC

The evaluation report shall identify limiting loads and dimensions, the lifting and pulling points in walls, ceilings and floors, the needed workspaces and clearances, adequacy of platforms and ladders, access routes to be followed, and the transport facilities to be employed for equipment and parts, tools and personnel.

CD

The results shall be utilized to confirm the adequacy of aisle widths, heights, access hatchways, transport facilities (including monorails, cranes, elevators and motorized transport, i.e., fork-lift trucks), temporary rigging and attachment points and laydown space.

CE

The Maintainability*, in terms of space for equipment access, transportation, lay down etc., shall be demonstrated through the use of the 3D electronic mockup.

CF

The specific requirements for Plant* layout including equipment access, transportation, lay down are specified in the Chapter 2.11.

CG

All equipment needed to be periodically accessed for operation, maintenance, testing or Inspection* shall be provided with access stairs and work platforms.

CH

The Supplier* shall include a robotic applications analysis (incl. use of drones) in conjunction with the Maintainability* evaluation and the in-service Inspection* considerations as specified in Technical Requirements Document* , Section 2.14.8.4.

CI

The Supplier* shall identify the maintenance and operating access routes in highly congested areas to minimise the potential damage to components caused by personnel climbing over the components.

2.14.2.8.D

The maintenance evaluation process and its results shall be documented, and required reserved spaces (with floor load capacities) and facilities shall be shown on the Plant* drawings.

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DA

The Maintainability* evaluation report shall be available for Owner*.

DB

Supplier* shall provide lists, procedures and layout drawings of necessary service and maintenance routes during plant operation and maintenance, including the routes used for changing of heavy components.

2.14.3 PROVISIONS FOR EMERGENCY PREPAREDNESS

A

Adequate facilities for Design Basis Conditions* and Design Extension Conditions* support shall be provided and considered in Plant* design such as a complete Technical Support Centre*, and other emergency facilities, meeting points, emergency evacuation routes, and shelters as well as provisions for emergency communications and emergency equipment facilities rooms.

A1

See Chapter 2.1 Section 2.1.8.1.

2.14.4 SUPPORT FACILITIES REQUIREMENTS

2.14.4.A

All necessary support facilities for personnel and equipment including, but not limited to, those specified in Scope of Supply Document* Section 2.2.1.2 shall be provided in the Plant*.

AA

The Section 2.14.4 addresses:

- requirements for access to radioactive work areas,
- requirements for Plant* services,
- requirements for contaminated and clean workshops (i.e. hot and cold)
- and requirements for spare parts control.

2.14.4.B

The Supplier* shall demonstrate that there are sufficient support facilities and Plant* services including provisions for access for operation, outages, testing, inspections and maintenance of the Plant*.

2.14.4.C

The Supplier* shall provide a list of recommended commercially available lifting and handling means to be used during the Plant* operation (i.e. the means which are not part of the Supplier's Scope of Supply* or are not provided by the Supplier* as Specials tools).

CA

The list shall be provided before start of the Active Testing*.

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2.14.4.1 ACCESS TO RADIOACTIVE WORK AREAS

2.14.4.1.A

The Plant* design shall include provisions for personnel contamination and radiation exposure control (see also the Technical Requirements Document*, Section 2.11.2.5), including the following:

AA

- only one controlled area within the Unit*, although this may be segregated into zones as defined in the Technical Requirements Document*, Chapter 2.11, and in Normal Operation* one unique access to this controlled area,

AB

- facilities to control personnel and item contamination and radiation exposure as specified in Technical Requirements Document* , Section 2.11.2.5.4,

AC

- facilities for storage and issue of protective clothing that do not interfere with the flow of personnel,

AD

- facilities for storage, issue, and processing of respiratory equipment,

AE

- protected areas for assignment and processing of dosimetry equipment,

AF

- storage areas/facilities for contaminated equipment that is frequently used for operations and maintenance,

AG

- buffer zones located near work areas subject to contamination, with at least one change room located at the entrance to the controlled area. These change rooms shall accommodate both males and females and shall include sanitary facilities. The number of lockers is subject of the Owner's* approval. Buffer zones shall not be located in close proximity to radiation sources.

2.14.4.1.B

Change rooms shall be located in areas to avoid high dose rates from overhead piping, drain lines, etc. to prevent the accumulation of significant exposure during use of the change areas.

2.14.4.1.C

The Plant* and/or Unit* layout shall provide for post-accident access as required for surveillance and recovery operations.

CA

The Supplier* shall prepare a plan which identifies areas requiring access and assure this capability.

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2.14.4.2 PLANT SERVICES

2.14.4.2.A

The Plant* shall provide sufficient Plant* services* to support performing a large amount of work in a short length of time in the place and at the time they are required, in particular during outages.

2.14.4.2.B

Plant* air, instrument air, separate breathing air system protected from toxic and noxious contaminants, and demineralised water systems designed for on-line operation and maintenance of all major components and with a capacity well in excess of that which is normally required for Plant* operation and/or maintenance shall be provided.

2.14.4.2.C

Drinking and demineralised water systems, including eye washes and emergency showers, designed to assure that there is complete isolation from any system that has a potential for becoming contaminated by radioactivity shall be provided.

CA

Emergency eye washes and showers shall be provided in the radiologically controlled areas, in chemical laboratories, near chemical addition tanks, and caustic storage tanks.

2.14.4.2.D

The Plant* design shall provide electrical power outlets for portable and maintenance equipment clearly marked for voltage and capacity and not connected in any way through distribution power supplies that feed instruments and controls or other Plant* operating equipment, or may be connected using appropriate protection device with feeders of sufficient capacity. These electrical power outlets shall include welding outlets as needed.

2.14.4.2.E

Service outlets for all service systems (compressed air, breathing air, communications, service water, demineralised water, low-voltage three phase power and single phase power, vacuum cleaning system, video and data collection cables, etc.) shall be provided on all Plant* elevations near where any maintenance or operating activities are expected to be performed, or at more frequent intervals where work is expected to be concentrated.

EA

Mobile or fixed services for maintenance shall be provided such as for argon, nitrogen and carbonic gas.

EB

Service connections shall be standardised throughout the Plant*.

2.14.4.2.F

Communication systems and equipment, including telephones, public address systems, sound powered or special circuits for point-to-point communication, shall be provided in all areas of the Plant*, including the containment, to support all operation and maintenance activities, including accident management.

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FA

Means shall be provided for visual and voice communication between radioactive work controlled areas and uncontrolled areas to allow consultation between personnel dressed in full anti-contamination clothing and personnel situated outside in a clean area. These shall not interfere with Plant* control systems.

FB

Connections to a computer network and specific workstations for utilisation in various operation and maintenance activities shall be provided.

2.14.4.2.G

The Plant* design shall facilitate personnel movement within the Plant*, provide adequate access to all buildings and provide space and provisions for maintenance.

GA

The Plant* design shall incorporate ramps or steps instead of ladders provided for personnel movement between decks, floors, and platforms at different elevations in all areas where personnel are required to wear anti-contamination clothing.

GB

Stairs shall be provided between all of the main working elevations of the Plant*,

GC

Laydown space shall be available for all components that will be temporarily removed during maintenance Works*.

GD

Tool rooms and warehouses with spare parts shall be located close to the place where the maintenance work is performed, in order to minimise walking distances.

GE

Warehouse facilities shall allow new or non-contaminated spare parts to be obtained by Plant* personnel without their having to leave the boundary of the Limited Access Area*. Slightly contaminated equipment shall also be stored in warehouses inside the Limited Access Area*.

2.14.4.2.H

Dedicated fire protection, and firefighting facilities and evacuation routes shall be provided.

2.14.4.2.I

Provisions shall be provided to manage hazardous substances, chemicals and radioactive spills.

2.14.4.3 REPAIR SHOPS

A

Well equipped repair shops designed for maintenance of mechanical, electrical, and I&C equipment shall be provided in accordance with the Operation and Maintenance Document* Section 3.5.1.

2.14.4.4 SPARE PARTS SUPPLY, STORAGE, AND CONTROL

A

The Plant* design shall provide features to store, manage and handle the spare parts.

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AA

Additional requirements related to spare parts are specified in the Operation and Maintenance Document* , Section 3.5.2.

2.14.5 PROVISIONS FOR REPLACEMENT OF PLANT COMPONENTS

2.14.5.A

The Plant* design shall facilitate the replacement of all Plant* components including major Plant* components other than the RPV and basic Plant* structures, consistent with the Plant* design life.

AA

This includes among other building layout, equipment arrangement, handling and lifting equipment, equipment dismantling, radiation protection, etc.

AB

Possibility of such replacement shall be checked using 3D model of the Plant*.

2.14.5.B

The Supplier* shall provide the Owner* with data, including drawings and procedures for dismantling, transport and reinstallation, concerning all the components (i.e. tanks, vessels, pumps, motors, heat exchangers, piping, cables, etc.) that may be replaced during the life time of the Plant*:

- defining if they have to be installed or dismantled in one piece or in more,
- layouts/spaces for dismantled equipment/pieces,
- specifying and identifying auxiliary means, cranes, lifting devices, etc. which would have to be used,
- as well as the sequence, procedures, durations, radiological burdens of operation, etc.

2.14.5.C

Permanent outlets shall be designed (hatches, locks, doors) with dimensions allowing replacement of elements during the operation without need to destroy any structures.

2.14.5.D

The Supplier* shall install lifting and handling facilities, transport means and storages which will enable effective replacement of any components other than the RPV and basic Plant* structures during Plant* operation taking into account possible contamination of the replaced equipment.

2.14.5.E

The replacement which need to be done during the Plant* design life (including those components to be replaced due to obsolescence such as I&C, etc.) shall be taken into account in the Plant* design and in outage planning and requirements for Outage Durations* specified in the Section 2.2.7.2.2.

2.14.5.F

The Plant* design shall allow execution of reasonably expectable modifications to be made during the Plant* life.

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2.14.5.G

It shall be possible to anneal the RPV in order to extend its lifetime.

2.14.6 INSPECTION AND TESTING

2.14.6.A

Due consideration for testing and Inspections* shall be taken in the design, starting from the earliest stages of the design process.

AA

Particular attention shall be paid to SSC that are critical for safety and for Plant* performance and to those non-replaceable (including structures).

AB

Current best practices in non-destructive evaluation shall be used, where possible, to evaluate the condition of components both prior to installation, and during service.

2.14.6.B

The Plant* design shall minimise the necessary scope, frequency and the time requested for the testing and Inspections* while maintaining the Plant* required level of safety and availability and meeting requirements of the Rules*.

BA

Graded Approach* shall be used with focus on the Essential Components*.

2.14.6.C

Note that other parts of EPC Contract* may include and/or imply additional specific requirements for Inspections* and testing. Such requirements shall be met as well.

2.14.6.D

Requirements for establishing the maintenance programmes and maintenance optimisation (including testing and Inspections*) as specified in the Operation and Maintenance Document* Section 3.5.

2.14.6.E

Requirements related to Inspections* and testing during the Commissioning* are specified in the Construction and Commissioning Document*.

2.14.6.1 TESTING

2.14.6.1.1 START-UP TESTING

2.14.6.1.1.A

The Plant* design shall allow performance of all start-up tests after an outage in order to check that Plant* and its systems are capable of operation as designed.

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AA

The system design shall include provisions and testing equipment shall be provided to test essential characteristics in accordance with relevant Rules*, including adequate instrumentation and testing connections.

2.14.6.1.1.B

The Supplier* shall review and optimise the start-up test programme to minimise their contribution to Plant* unavailability.

BA

The start-up tests shall be optimized and, as far as possible, automated in order to reduce human errors and to minimize their impact on the critical path of the outage.

BB

As a basis for this review and optimisation, the Supplier* shall consider existing start-up test programmes and any reports on optimisation of these test programmes which have been made.

BC

The Supplier* shall also consult with staff experienced in start-up and operation.

BD

The Supplier* shall incorporate the relevant consequences of this review/optimisation into the design of the Plant*.

2.14.6.1.2 PERIODIC TESTING

2.14.6.1.2.A

The Plant* design shall allow the execution of the necessary periodic operability/performance tests during power operation, without interfering with Plant* operation, except where this would result in counterproductive provisions.

AA

Only the remaining items that cannot reasonably be done at power shall still be done during outages.

AB

These tests shall not impair Safety Functions*.

AC

It shall be possible to test systems/subsystems or instrument loops in as close to normal operation conditions as practical.

2.14.6.1.2.B

The system design shall include provisions and testing equipment shall be provided to test essential characteristics in accordance with relevant Rules*, including adequate instrumentation and testing connections.

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2.14.6.2 INSPECTION

2.14.6.2.A

The Plant* design shall allow performance of Inspections* in order to check that Plant* and its systems are capable of operation as designed.

AA

The system design shall include provisions and Inspection* equipment shall be provided to inspect the Plant* SSC in accordance with relevant Rules*.

AB

Where ISI of a component or a weld can be potentially required, the requirement on the design, materials and fabrication Inspections* for that component and/or weld shall ensure that adequate ISI in the field can be performed.

AC

This applies in particular to essential pressure-retaining equipment including piping.

2.14.6.2.B

The Supplier* shall consider the provisions for the Inspections* of the Plant* in all Plant* areas.

BA

This shall include the access requirements for the equipment and associated personnel, and the space to operate that equipment.

BB

The specific requirements for Plant* layout including equipment access are specified in the Chapter 2.11.

2.14.6.2.C

The Inspection* techniques used during manufacturing shall be harmonised with the Inspection* techniques used for ISI during operation in order to establish a reference base-line for all Inspections* to be performed in-service.

CA

The same applies to Inspection* of materials as specified in the Section 2.6.3.4.

2.14.6.2.D

The detailed Inspection* procedures to be used both in manufacture and at the Site* shall be provided within the equipment procurement specification or they shall be provided by the equipment supplier.

2.14.7 CONSUMABLES FOR OPERATION AND MAINTENANCE

2.14.7.1 HAZARDOUS AND TOXIC CHEMICALS

2.14.7.1.A

The Plant* design shall minimise the need for use of hazardous or inert gases and toxic chemicals unless there is no practicable alternative to their use, in particular in controlled areas due to risk of mixing the radioactive and chemically hazardous wastes.

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2.14.7.1.B

If such substances are used, the Plant* design shall include means for monitoring and control of the substances by the Owner* during shipping, storage, handling and use to minimise the hazard to personnel and to the environment in accordance with the Rules*.

2.14.7.1.C

Storages of hazardous or inert gases and toxic chemicals shall be designed in accordance with the Rules*.

2.14.7.1.D

The Plant* shall be designed not to be classified in category A or B according to the Act No. 224/2015 Coll., as amended.

2.14.7.1.E

The measures necessary for protection of personnel and environment shall be made.

2.14.7.2 LUBRICANTS AND OTHER CONSUMABLES

2.14.7.2.A

The Plant* shall use, as much as possible, standard commercially available Consumables*.

AA

The number of various Consumables* shall be minimised by standardisation of Plant* design.

AB

General requirements for standardisation are specified in the Section 2.12.5.

2.14.7.2.B

The Plant* design shall provide features to safely store, control and handle the Consumables*.

BA

Storages of Consumables* shall be designed in accordance with the Rules*.

BB

The measures necessary for protection of personnel and environment shall be made.

BC

Fire hazard shall be minimised.

2.14.7.2.C

Additional requirements for Consumables* are specified in the Operation and Maintenance Document* Sections 3.5.3.

2.14.8 OCCUPATIONAL RADIATION EXPOSURE

A

This Section includes general requirements and design features to minimise radiation levels, limit the occupational radiation exposure and achieve the ALARA targets for personnel dose over the life of the Plant*.

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AA

The limits for radiation exposure are specified in the Section 2.1.3.2.3.

2.14.8.1 BASIC REQUIREMENTS

2.14.8.1.A

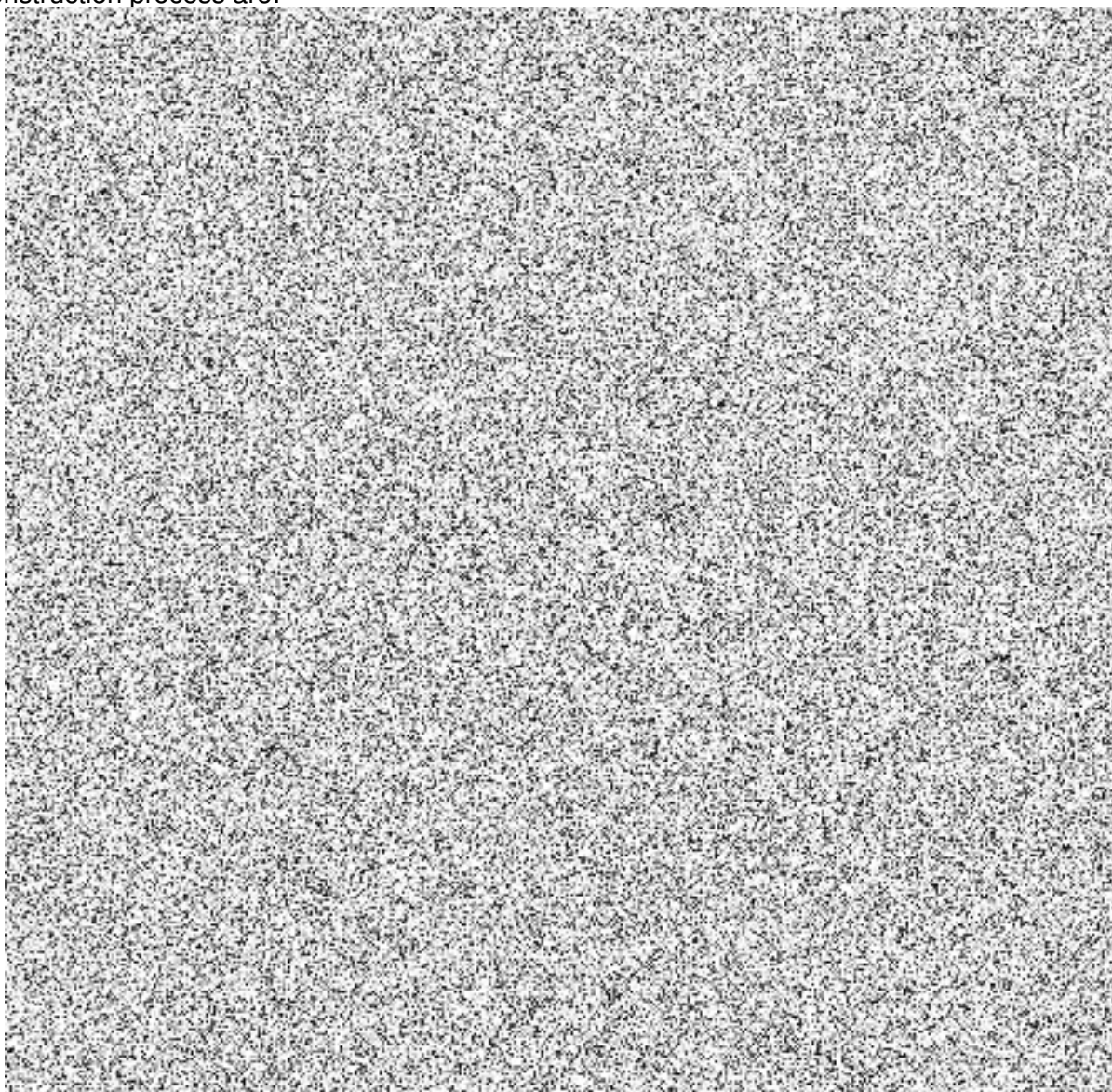
Specific design features shall be provided in the Plant* to minimise personnel doses and to meet the specified collective dose target of Section 2.1.3.2.3.

2.14.8.1.B

The Plant* shall be designed and constructed so that occupational radiation exposure can be As Low As Reasonably Achievable (ALARA) over the life of the Plant*.

2.14.8.1.C

The basic requirements that shall be met to obtain low radiation levels via the design and construction process are:



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2.14.8.2 NEEDS FOR MAINTENANCE

2.14.8.2.A

Maintenance-free equipment in areas where design ambient doses are higher than 100 mSv/h (non-design basis access) shall be met.

2.14.8.2.B

In areas where ambient doses are between 1 mSv/h and 100 mSv/h (restricted access), maintenance-free equipment shall be provided on case by case basis based on the expected maintenance demand (mainly time demand).

BA

Maintenance demands (in hours per year) in separate parts of controlled areas shall be specified with a view at keeping doses ALARA.

2.14.8.2.C

Radiation zoning is specified in Technical Requirements Document , 2.11.2.5.2.2.1.

2.14.8.2.D

Facilities for flushing and decontamination of equipment with potential high dose rates and which need maintenance or the Inspection* shall be provided.

2.14.8.3 ELECTROPOLISHING

A

The use of electropolished surfaces shall be considered in those areas of the Plant* where this treatment will significantly reduce the dose to personnel during maintenance (e.g. Reactor Cavity*, spent fuel pool and transfer canal liners and Steam Generator* (SG) channel heads and divider plates).

2.14.8.4 USE OF ROBOTICS AND REMOTE CONTROLS

2.14.8.4.A

The necessary SSC manual control, handling, In Service Inspection (ISI), testing and maintenance and repair shall be done with as little Plant* personnel exposure as reasonably achievable.

2.14.8.4.B

Remote control devices, handling, ISI, testing, maintenance and repair devices, incl. robotics identified in the robotic applications analysis, shall be provided where necessary.

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2.14.8.4.C

Generally, for components in compartments with a design ambient dose rate of more than 1 mSv/h which require routine maintenance use of remote maintenance shall be considered.

CA

Use of remote maintenance shall be considered also in areas with other environmental stressors (such as humidity, heat, noise) and for maintenance difficult due to limitations of human strength, need for accurately perform repetitive tasks and in areas hard to access for humans.

2.14.8.4.D

A robotic applications analysis (incl. use of drones) shall be performed by the Supplier* and provided to the Owner*.

DA

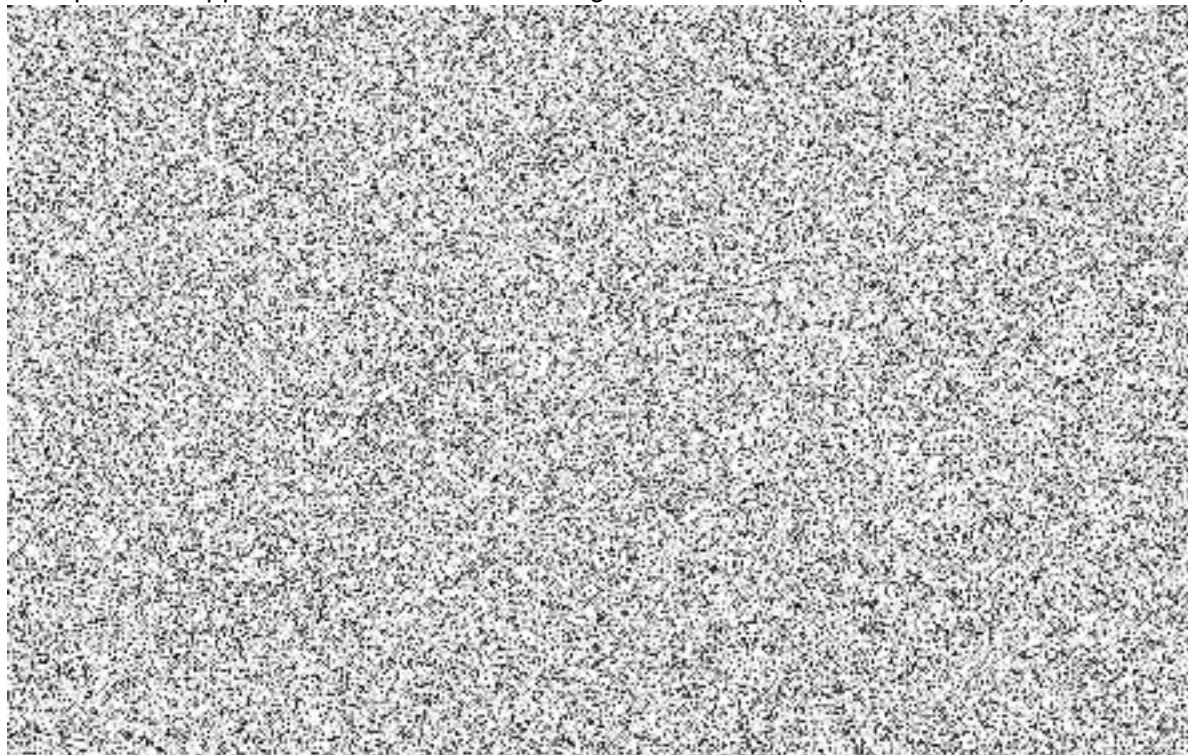
The purpose of this analysis shall be to identify activities for use of robotic equipment to be accommodated in the design.

DB

The analysis shall also consider possible uses of robotics in accident management and Plant* recovery after an emergency conditions (DBC 2-4, DEC and/or hazards) resulting in hostile conditions for humans.

DC

A list of possible applications for remote handling tools shall be (but not limited to):



2.14.8.4.E

Specific design features important to the effective functioning of robotic devices shall be included in the design of the Plant*.

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EA

The building design and arrangement shall facilitate use of robotics.

2.14.8.4.F

The Plant* arrangement shall provide secure areas for the storage of robotic equipment with provision for decontamination.

2.14.9 PLANT ARRANGEMENT AND ACCESS CONTROL

2.14.9.1 PLANT ARRANGEMENT

2.14.9.1.A

Access for construction, maintenance, testing, Inspection* and operation shall be taken into account in the arrangement of buildings and components.

2.14.9.1.B

Consideration shall be given to personnel and equipment access and the need for adequate working space during construction, operation and maintenance.

2.14.9.1.C

Equipment layouts shall provide adequate space for access and replacement.

2.14.9.1.D

The building design and the plant arrangement shall provide facilities for the security and radiological control of personnel and materials.

2.14.9.1.E

These facilities shall be sized on the basis of all maintenance operations and shall allow passage of personnel with the minimum of delay.

2.14.9.2 CONTROL OF ACCESS TO SECURITY ZONES

2.14.9.2.A

Adequate facilities shall be provided for controlling access to the security zones. The personnel access facilities shall be designed with the capability to process the number of personnel needed to perform the required activities. The facility for access to restricted areas with separate paths for the entry and exit of personnel shall have adequate space to prevent crowding and be designed for straight-through flow.

2.14.9.2.B

Post-accident access shall be provided by the Plant* arrangement as required for surveillance and recovery operations. To ensure this capability, a plan which identifies areas requiring access shall be prepared.

2.14.9.2.C

Access ways to be used by personnel under emergency conditions shall be defined e.g., from the Main Control Room* to the Emergency Control Room* (ECR) (Remote Shutdown Panel*), and on-site Emergency Response Facilities*.

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Note CA

Emergency conditions may be Abnormal Operation*, Accident Conditions* or Hazards* (for example fire). Access ways under emergency conditions to deploy Non-Permanent Equipment* when needed are also to be defined.

2.14.9.2.D

The security provisions shall not be capable of failing in a manner which would block necessary access for Owner* personnel during emergency conditions. See Chapter 2.11 Section 2.11.6

2.14.9.2.E

Access control shall be compatible with the need for rapid entrance to and exit from important areas for safety, security and Plant* reliability under emergency conditions.

Note EA

The need for overall Plant* safety and the safety of personnel under emergency conditions outweighs the need to control access to important areas for security.

2.14.9.3 ACCESS WITHIN THE PLANT

2.14.9.3.A

The access to the different areas of the Plant* shall be evaluated for construction, refuelling and other major outages as well as for the Normal Operation* (see the Technical Requirements Document*, Chapter 2.11 for layout requirements).

AA

The Supplier* shall provide the Owner* with the cost-benefit evaluations demonstrating the increased building space contribution to Operability* and Maintainability* of the Plant*.

2.14.9.3.B

Maintenance and operating access routes in highly congested areas shall be identified in order to introduce the adequate design for a more efficient movement of personnel.

2.14.9.3.C

Pathways shall be provided through the Plant* to selected locations where heavy tools, equipment, or replacement components must travel. Drawings and other design documents shall delineate these pathways and indicate structural limits.

CA

Aisleways shall provide unobstructed pathways for easy removal and reinstallation of all components (except in-building large tanks) from the point of installation to a vertical hatchway removal pathway or elevator, and on to a building exit. Aisleways shall be sized to accommodate the turning of a small lift truck or motorized pallet as confirmed by the access and transport portion of the Maintainability* evaluation (see the Technical Requirements Document*, Section 2.14.2.). Aisleways shall also accommodate construction activities, including easy movement of craft personnel and transportation of material.

2.14.9.3.D

For vertical lifts through multiple levels, hatchways shall be aligned to the extent practical. Staging areas shall be provided at intermediate levels.

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Openings provided in walls which are normally provided to facilitate equipment removal and installation shall be filled with materials that are easily removable but also provide the necessary shielding and other functions required during the Normal Operation*.

Elevators shall be provided in major high traffic routes. Elevators shall be designed for freight, personnel or both, based on the Maintainability* evaluation. Stairways shall always be provided.

Means for lifting and handling major equipment and its components parts shall be provided. This includes floor plugs and hatches for the use of building cranes, monorail hoists (manual or powered, as appropriate), auxiliary jib cranes, and rigging attachment points. Additional embodiments shall be provided, as required, in the walls, floors and overhead facilities for special rigging which may be required occasionally. The design load shall be marked on each embodiment. Appropriate hoistways shall be provided in the buildings for use by building cranes or by external cranes where there is no building crane.

The Supplier* shall identify any limitations or restrictions on the use of hoisting and rigging equipment which are inherent in the design.

Where robotic applications are identified (see the Technical Requirements Document*, Section 2.14.8) and the following features for platforms, ladders and manways are appropriate, provisions shall be included in the design to facilitate robotic equipment:

- Unobstructed path to permit unassisted robot movement,
- Door swings to fully open position,
- Passage of electrical cabling through doors without violating security requirements,
- Door opening device suitable for operation by robotic vehicle (straight handle in lieu of a round knob).

Access stairs and work platforms shall be provided to all equipment requiring to be periodically accessed for Normal Operation* or abnormal operation, maintenance, testing, or Inspection*.

DA

Ramps and on-grade access to equipment shall be utilized to the extent practical. Ramps provide a convenient and flexible means of moving material between elevations.

2.14.9.3.E

Access to the different areas shall be computer logged (i.e. time of day, date, area, etc.) for each exit and entry and controlled to allow access of specified individuals only.

EA

Surveillance and review of access patterns of individuals, and the evaluation of appropriateness of access authorization shall be included. In addition, alarms to indicate attempts at unauthorized access will be provided.

2.14.9.3.F

Access to equipment important for security reasons (as determined by the Owner* in their security plan), shall require passage through at least two physical barriers.

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FA

The design of important area boundary doors/barriers shall be based upon penetration delay times which are compatible with the capabilities of the intrusion detection systems and the response capability of the Site* security force.

2.14.9.3.G

In order to allow access by individuals into the areas where the Safety Systems* are located (i.e. the Main Control Room*, electrical safety Divisions*, etc.) means shall be provided for their positive identification.

GA

This can be accomplished by using video systems, card readers, and/or hard key and lock controls as permit/concur devices. The means shall be agreed with the Owner*.

2.14.9.3.H

Fire barriers shall not impede access to the safety classified SSC*.

2.14.9.3.I

Components shall be labelled with a unique number and name, consistent with the Plant* nomenclature procedure and designations on design drawings. The size of labelling shall be large enough to allow personnel operating and maintaining equipment to identify equipment in inaccessible areas.

2.14.9.3.J

Access stairs and work platforms shall be provided to all equipment requiring to be periodically accessed for the Normal Operation* or abnormal operation, maintenance, testing, or the Inspection*.

The Supplier* shall provide drawings showing all fire areas and zones based on the general arrangement drawing of each building and the layout Site* plans. Additionally, the Supplier* shall provide drawings showing the escape routes for each building.

2.14.9.4 ACCESS DURING EMERGENCY CONDITIONS

2.14.9.4.A

Access during emergency conditions (during DBC 2-4, DEC and Hazards*) shall be provided by the Plant* arrangement as required for surveillance and recovery operations (e.g. for use of Non-Permanent Equipment*; see Section 2.1.6.8).

AA

To ensure this capability, a plan which identifies areas requiring access shall be prepared and provided to the Owner*.

AB

Access paths to be used by personnel under emergency conditions, shall be defined e.g., from the Main Control Room* to the Emergency Control Room*, the on-site Emergency Power Supply* and the Alternate Power Source*.

AC

Requirements for access with regard to security needs are specified in the Section 2.11.6.

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AD

Effect of the Hazards* such as debris from collapsed structures shall be taken into account when assessing accessibility.

AE

The Supplier* shall provide the Owner* with details of environmental zones during emergency conditions.

AF

Specific requirements for environmental zoning are specified in the Section 2.11.2.5.

2.14.9.4.B

Access control shall be compatible with the need for rapid entrance to and exit from important areas for safety, security and Plant* reliability under emergency conditions.

BA

The security provisions shall not be capable of failing in a manner which would block necessary access for Owner* personnel during emergencies.

BB

The need for overall Plant* safety and the safety of personnel under emergency conditions outweighs the need to control access to important areas for security.

2.14.9.5 ACCESS FOR IN SERVICE INSPECTION (ISI)

In addition to the requirements outlined in earlier Sections of the Chapter 2.14, the following shall be taken into consideration:

2.14.9.5.A

Where ISI or testing for assessing operational readiness is needed, components shall be designed accordingly, and be provided with access.

2.14.9.5.B

Piping insulation, hangers, pipe supports and stops shall be designed so as not to interfere with Inspection* personnel and equipment. If this is not possible, those components shall be easily and quickly removable.

2.14.9.5.C

Separation of piping welds shall be suitable so that space is available to perform ISI. Tees, valves, elbows, and pumps shall not be joined together. They shall be separated by Sections of piping with sufficient length. Welds in piping that passes through walls shall be located sufficient away from the wall. Branch pipe connections, support lugs, nozzle welds, and other attachments shall also meet these separation criteria.

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2.14.10 PROCEDURES GUIDELINES

2.14.10.1 GENERAL

2.14.10.1.A

For the Main Control Room* Operator* workplaces and, where practical, at other workplaces which utilise electronic, selectable displays, procedures shall be presented on electronic displays.

2.14.10.1.B

For those workplaces where electronically displayed procedures are not practical and to supplement all electronically displayed procedures, extra space and facilities to store hardcopy procedures shall be available.

BA

It is expected that hardcopy procedures will be required at a number of local stations, e.g. MCR, ECR, TSC and other workplaces if required. In addition, hardcopy procedures will be provided to supplement electronically displayed procedures for training, study, and other off-line purposes.

2.14.10.1.C

Requirements for procedures are specified in the Operation and Maintenance Document* Sections 3.3 and 3.6.

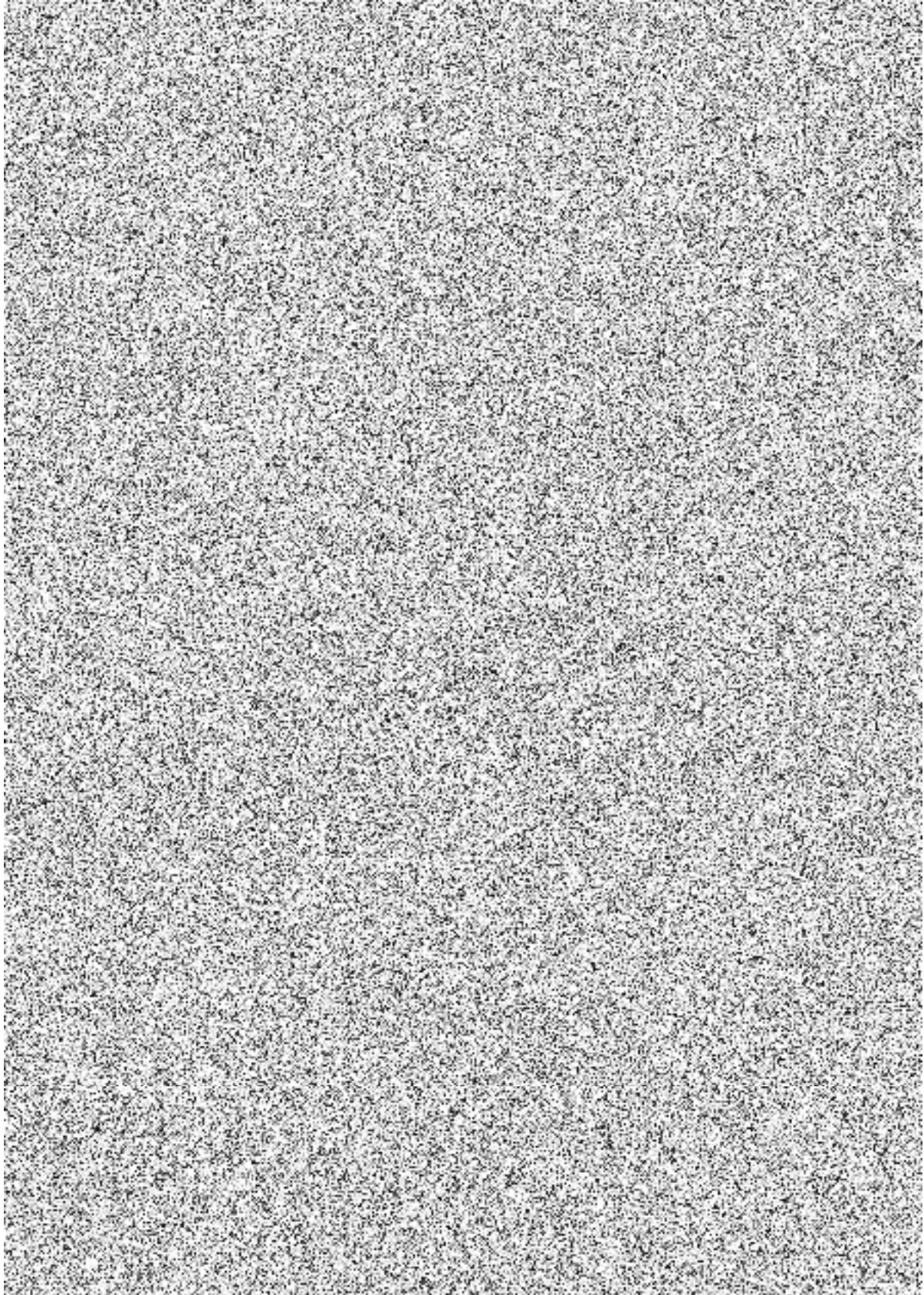
2.14.11 OPERATIONAL AND MAINTENANCE ISSUES

2.14.11.1 TABLE 1: IDENTIFICATION OF MAINTENANCE AND OPERABILITY ISSUES

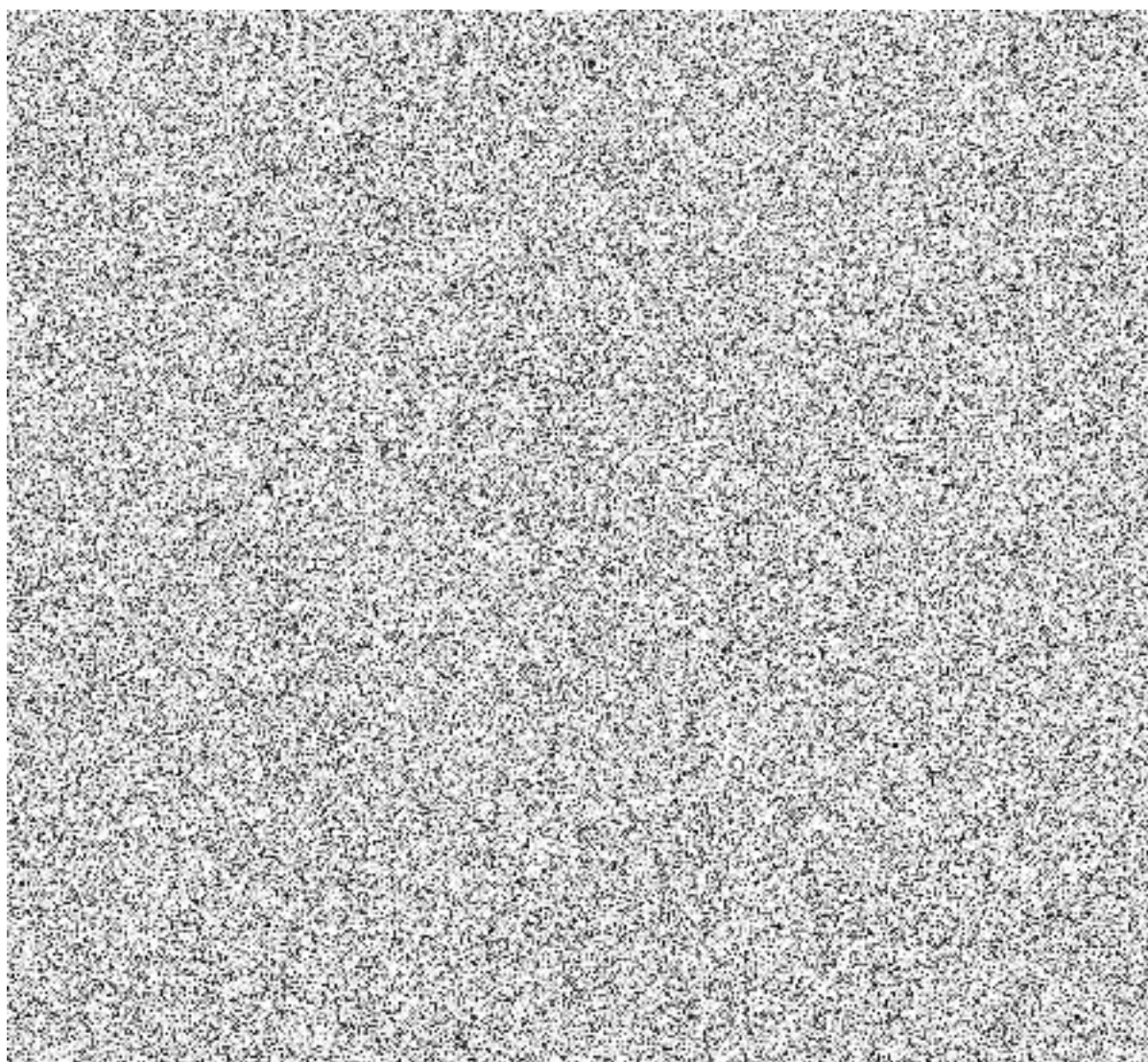
- Operating experience information exchange programme by WANO,
- Incidents Reporting System (IRS) by IAEA and OECD (NEA),
- Results and conclusions obtained from the OSARTs performed by IAEA,
- Reports issued by European and other relevant Regulatory Authorities,
- Reliability Data Collection System (RDSCS) by EDF, and other European national data bases on operating experience,
- Significant event evaluation and information network, operated by INPO,
- Significant Operating Experience Reports (SOERs) by INPO,
- Nuclear Plant* Reliability Data System (NPRDS) Reports,
- A maintenance analysis of safety significant events by NUMARC,
- License Event Reports (LERs) - NUREG/CR-2000,
- Licensed operating reactors - status summary report - NUREG-0020,
- Nuclear power experience data base, by Hagler, Bailly Inc.,
- North American Electric Reliability Council (NERC),
- NRC Reports, Analysis and Evaluation of Operational Data – AEOD/5502/5504,
- Owner* contacts and Site* visits,
- Supplier* data sources (such as in-house databases).

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2.14.11.2 TABLE 2: LWR OPERATION ISSUES TO BE ADDRESSED IN DESIGN



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2.14.11.3 TABLE 3: LWR MAINTENANCE ISSUES TO BE ADDRESSED IN DESIGN

- Steam Generator*,
- Reactor Coolant Pump Seals and Seal Auxiliary Systems,
- Piping Cracks,
- Main Steam PORVs and Safety Valves,
- Reactor Water Level Indication During Shutdown modes,
- Inverters,
- Diesel Generators or Gas-Turbines,
- Instrumentation Set Point Drift,
- Reactor Trip Breakers,
- Service Water Heat Exchangers,
- Balance Of Plant* Pipe Erosion,
- Motor Operated Valves,
- Check Valves,

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- Seismic Snubbers,
- Reactor Vessel Heat Stud and Steam Generator* Manhole Stud Removal,
- Smoke Detectors,
- Main Steams Isolation Valves,
- Main and Auxiliary Feedwater Pumps and Turbine,
- Buried Components and Piping,
- Filters and Demineralisers in Radioactive Systems,
- Fuel Handling Equipment,
- Containment Electrical Penetrations,
- Canned Rotor Pumps,
- Generator Hydrogen Seals,
- Containment Air Monitoring Systems,
- Post accident Sampling System,
- Circulating Water Intake Structures and Pumps,
- Containment Purging,
- Main Control Room* Ventilation/Isolation.
- Bolting Materials,
- Turbine Blade Failure,
- Control Rod Drive Mechanisms,
- Penetrating in-core Nuclear Probes,
- RHR Heat Exchangers,
- In-core instrumentation replacement.

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EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.15 RELIABILITY ASSURANCE PROGRAMME
VERSION DATE:	March 2025

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CHAPTER 2.15 RELIABILITY ASSURANCE PROGRAMME

2.15.0 INTRODUCTION

A

This Chapter specifies the requirements for Reliability Assurance Programme (RAP).

AA

The methodology shall be used to assure and verify sufficient reliability of the SSC to meet Plant* and/or Unit* safety, availability and reliability objectives.

2.15.1 GENERAL

A

The Supplier* shall establish a reliability assurance programme as specified in this Chapter.

2.15.2 RAP GOALS AND OBJECTIVES

2.15.2.A

The Supplier* shall establish and provide design (D-RAP) and operational (O-RAP) reliability assurance programmes.

AA

The reliability assurance programme shall be based mainly on deterministic and probabilistic assessments augmented by engineering judgement.

AB

INPO AP-913 provides a recommended guidance.

2.15.2.B

The design reliability assurance programme shall assure that the Plant* and its SSC will be designed, manufactured, constructed, erected etc. to meet the Plant* and/or Unit* safety and performance targets.

2.15.2.C

The operational reliability assurance programme shall assure that the Plant* and/or Unit* and its SSC will be operated, tested, inspected and maintained etc. as required for the Plant* and/or Unit* to continue to perform as designed for the whole lifetime of the Plant* and/or Unit*.

2.15.2.D

The reliability assurance programmes shall be focused on the Essential Components* with due consideration of the non-replaceable and long-life SSC.

DA

The programmes shall therefore take into account:

- deterministic safety analysis,
- PSA insights (see Technical Requirements Document*, Section 2.17),
- PAM insights (see Technical Requirements Document*, Section 2.18),
- Protection of investment (i.e. cost of the SSC, its replacement and maintenance).

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2.15.2.E

The reliability assurance programme shall be periodically updated to take into account development of the Plant* and/or Unit* design and eventually SSC procurement, manufacturing and Plant* and/or Unit* construction, Commissioning* and operation.

2.15.3 PLANT AND/OR UNIT SAFETY, RELIABILITY AND AVAILABILITY OBJECTIVES

A

It shall be assured by RAP that reliability of SSC is sufficient to meet the Plant* and/or Unit* safety, reliability and availability objectives.

AA

The Plant* and/or Unit* safety objectives are specified in Technical Requirements Document, Section 2.1

AB

The quantitative safety objectives, namely PSA, are specified in Technical Requirements Document , Section 2.1.3.

AC

The Plant* and/or Unit* reliability and availability objectives are specified in Technical Requirements Document* , Section 2.2.7.

2.15.4 RELIABILITY ASSURANCE PROCESS ORGANIZATION

2.15.4.A

An expert panel shall be established by the Supplier* to perform the task within reliability assurance program.

2.15.4.B

The expert panel shall include engineers experienced in:

- PSA,
- reliability engineering including PAM,
- system engineering,
- nuclear power plant operation and maintenance including plant life management,
- deterministic safety analysis.

2.15.4.C

The expert panel meetings and outputs shall be documented within the meeting minutes.

2.15.4.D

The outputs of the reliability assurance programme shall be implemented into the Plant* design and respective procedures.

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2.15.4.E

The Supplier* shall set up a sub-organization in charge of coordinating RAP activities with the Owner* and responsible for the formal communication channels for resolution of RAP (including PSA and PAM) issues.

2.15.4.F

The Supplier* shall provide recommendations for and assist with establishment of the Owner* sub-organization responsible for Operational RAP activities during Plant* and/or Unit* operation.

2.15.5 RELIABILITY ASSURANCE PROCESS

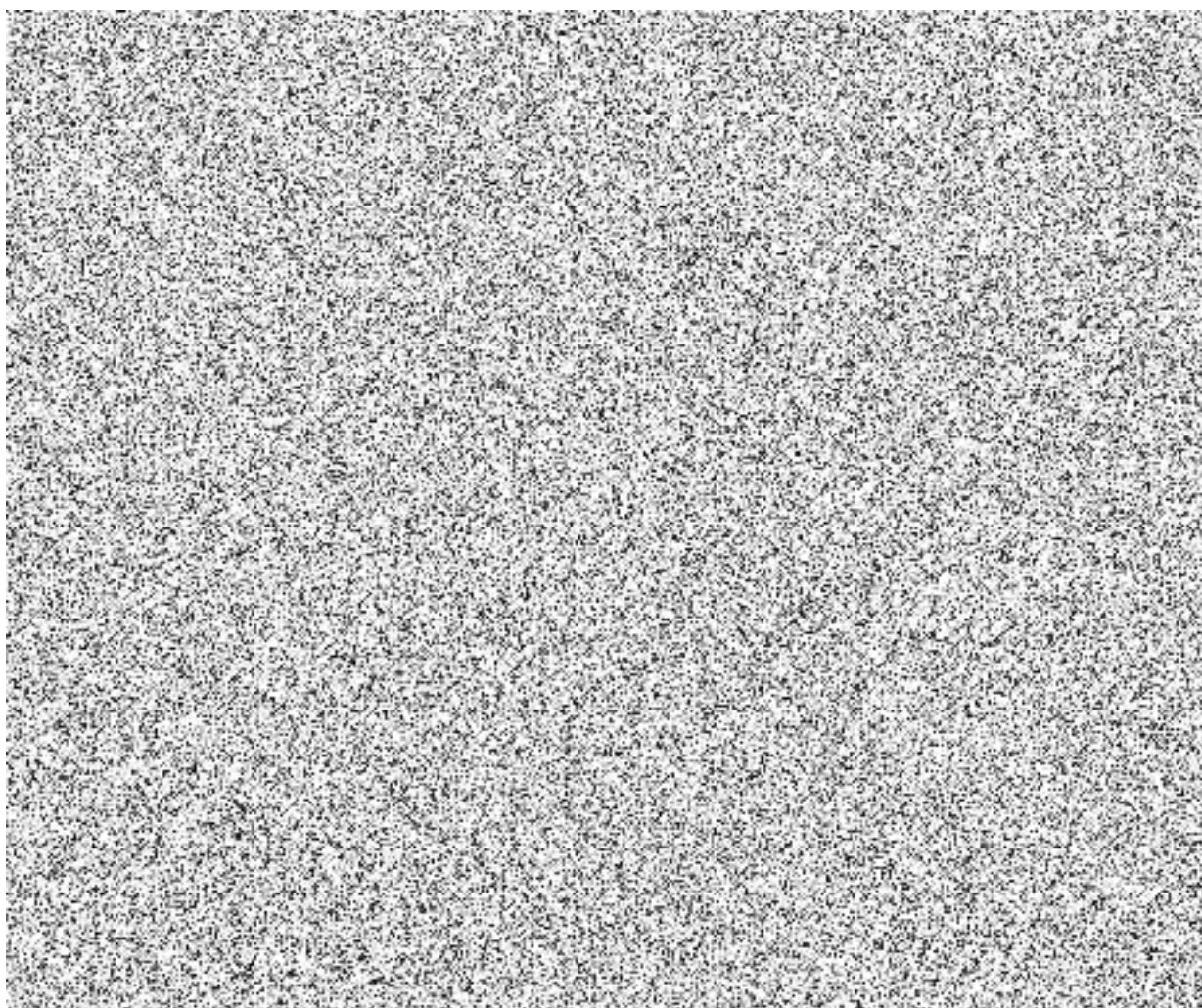
2.15.5.A

The following Sections describe requirements for the reliability assurance process elements.

2.15.5.B

All the data shall be managed within the Configuration Management* System.

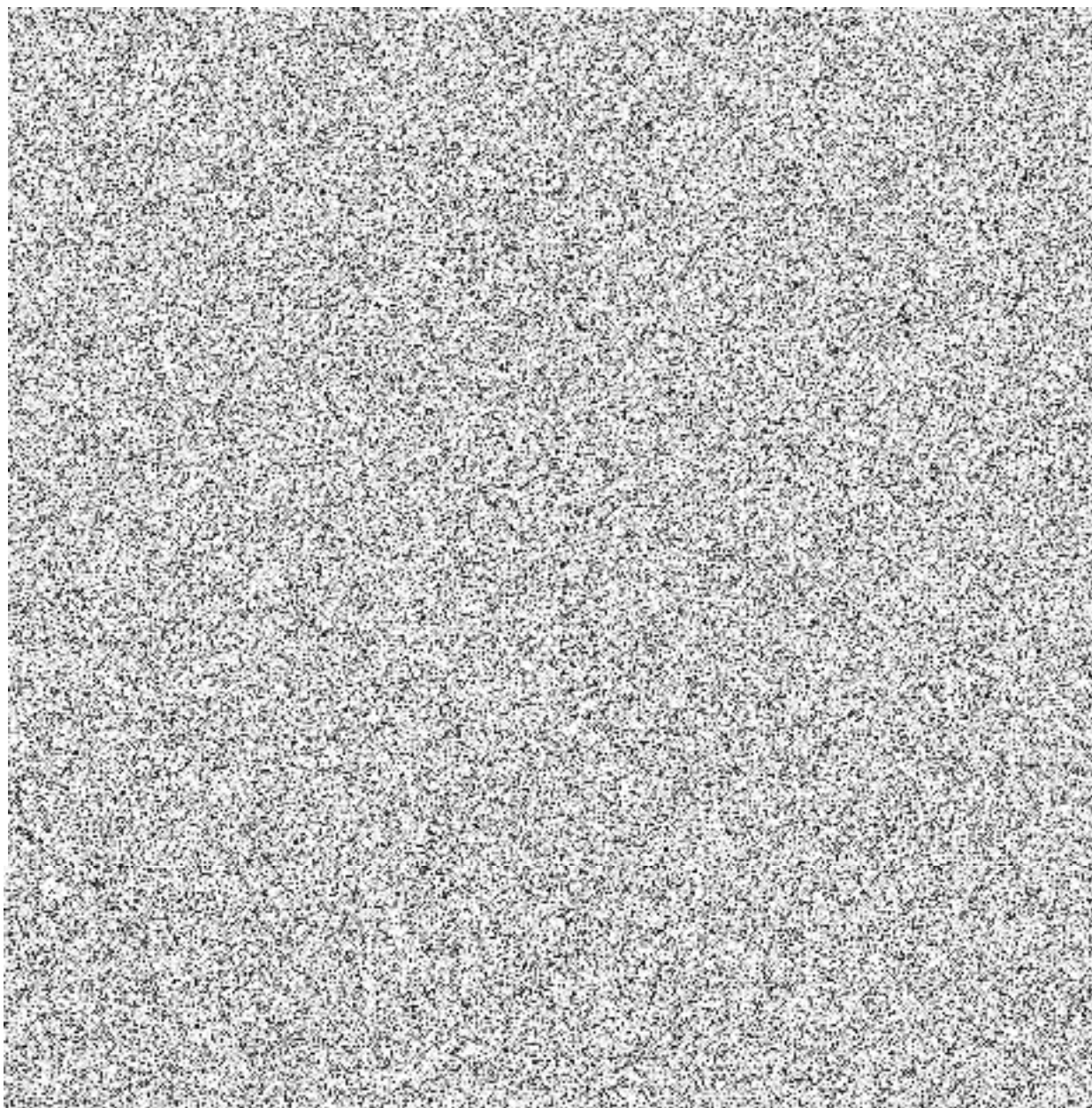
2.15.5.1 SCOPING AND RANKING OF SSC



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2.15.5.2 PERFORMANCE MONITORING

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2.15.5.3 CORRECTIVE ACTIONS

2.15.5.3.A

The programme for corrective actions shall be established to manage the design and operational issues related to PAM goals and objectives.

2.15.5.3.B

Using the PSA and PAM, the Supplier* shall assess and periodically update the assessment, as the design is developed, to make sure the Plant* and/or Unit* design meets the Plant* and/or Unit* safety, reliability and performance objectives.

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BA

The Supplier* shall determine and incorporate into the Plant* and/or Unit* and SSC design appropriate design measures to minimise reliability vulnerabilities, in particular single-point vulnerabilities, identified within the RAP (including PSA and PAM).



BB

The results of experience review specified in the Section 2.18.4.1 shall be taken into account.

BC

The SSC supplier shall provide a detailed description of the SSC and an operational experience report which identifies operational and maintenance problems recognised by the industry (both nuclear and non-nuclear) with similar components of this nature, the supplier's operating and testing experience with their particular model.

BD

For the most important SSC (based on ranking), the SSC supplier shall provide a FMEA report which identifies the possible failures and their effect at the component part level and action to reliability assurance measures (including design measures) to prevent them.

2.15.5.3.C

During Plant* and/or Unit* operation, this means mainly SSC failures, in particular unexpected failures, and excessive ageing.

CA

For that purpose, procedures and standardised templates for managing SSC failures shall be provided.

2.15.5.3.D

The failures shall be evaluated in terms of their impact on the RAP goals and objectives, and to identify their root cause, to identify possible consequential failures and to identify appropriate reliability assurance activities to prevent its recurrence.

DA

Performance criteria used in performance monitoring shall be modified, if necessary.

DB

For run-to-failure SSC, it shall be checked whether they are correctly ranked and if they in fact should be subject to Preventive Maintenance*.

2.15.5.3.E

The evaluation shall include consideration of susceptibility of other SSC to the failure, in particular of the same component type.

2.15.5.3.F

The failures shall be checked with international experience.

2.15.5.3.G

Corrective Maintenance* procedure shall be provided.

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2.15.5.4 CONTINUING EQUIPMENT RELIABILITY IMPROVEMENT

2.15.5.4.A

The programme for continuing equipment reliability improvement shall be established to critically review and optimise the RAP activities.

AA

The Supplier* shall draw up a set of indicators for annual evaluation of Plant* and/or Unit* safety, reliability and performance.

2.15.5.4.B

The Plant* and/or Unit* design shall be optimised in terms of safety, reliability and availability to prevent cost ineffective overdesign of SSC.

2.15.5.4.C

Based on the results obtained by performance monitoring and corrective actions programmes, the RAP shall be optimised to use the Plant* and/or Unit* resources as effectively as possible.

CA

These may include e.g. establishment of new or modification of the existing Preventive Maintenance*, additional requirements on or modification of existing performance monitoring (in particular SSC condition monitoring) but also SSC design modifications (including operational limits, operational environment etc.) and/or replacement.

2.15.5.4.D

Also operational experience from other nuclear power plants and recommendation of internationally recognized organizations such as EPRI and WANO (INPO) shall be periodically checked.

2.15.5.5 PLANT LIFE MANAGEMENT

2.15.5.5.A

In order to ensure long term reliability of the Plant* and/or Unit* SSC, i.e. at least 60-year as required in Section 2.4.2, and to enable possible life extension, the Supplier* shall develop Plant Life Management Programme.

2.15.5.5.B

Graded approach with focus on non-replaceable and long-life SSC and Essential Components* shall be used.

BA

However, when defining the scope of Plant Life Management Programme, no account shall be taken for Redundancy*.

2.15.5.5.C

The Plant* and/or Unit* Life Management Programme shall include:

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2.15.5.5.D

Design life classification shall be provided. For that purpose, the Supplier* shall perform SSC life assessment including obsolescence studies, which takes into account number and nature of all environmental conditions and transients assumed in the design life of the SSC (including all DBC and DEC as appropriate) and associated potential ageing/degradation mechanisms that could affect the functions of the SSC during their design life e.g. thermal and radiation embrittlement, fatigue, corrosion, environment assisted cracking, creep and wear etc.

DA

The life assessment shall prove that the design life of 60 years of non-replaceable SSC is achievable.

DB

Special attention shall be paid to effect of Load Following*.

2.15.5.5.E

For SSC which are expected to be replaced due to obsolescence, ageing or early failure, replacement and obsolescence programmes shall be provided,

2.15.5.5.F

Ageing Management Programmes shall be provided. They shall be also used to optimise maintenance, testing, Inspections*, condition monitoring and surveillance in order to preserve the defined systems functions during the Plant* and/or Unit* lifetime.

FA

The extra requirements for maintenance (including plan for SSC replacement, refurbishment and/or repair), testing, Inspection*, condition monitoring, diagnostics, prognostics and surveillance for each of SSC shall be integrated into the Reliability Assurance Programme, Ageing Management Programmes, maintenance programmes and associated procedures and scope of SSC monitoring and surveillance.

FB

See also Sections 2.12.3, 2.14.2.6 and 2.14.2.7.

2.15.5.5.G

Plant life evaluation programmes to enable the Owner* to demonstrate continued compliance with the safety and performance requirements as the Plant and/or Unit* ages and to demonstrate that the Operational RAP is effective.

GA

During the development of the assessment and its methodology, the Supplier* shall take into account that the assessment will be an essential part of periodic safety reviews (in accordance with IAEA SSG-25 Periodic Safety Review of Nuclear Power Plants).

GB

The Supplier* shall take into account BN-JB-2.1, IAEA SSG-48 Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants, WENRA Reactor Safety Reference Levels Issue I: Ageing Management and IAEA Safety Reports

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Series No. 82 Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL).

2.15.5.5.H

The Plant Life Management Programme shall take into account the recommendation provided by the SSC supplier and also relevant experience and research results.

HA

Recommendations for ageing management including maintenance, Inspections* and testing and condition monitoring from the SSC supplier shall be provided.

HB

This includes identification and justification of using advanced materials with greater ageing resistant properties.

2.15.5.5.I

The Plant Life Management Programme shall be submitted for Owner's* approval as a part of design Documents* (see Project Management Document* Attachment 3).

2.15.5.5.J

The actual history of SSC in terms of design life (i.e. impact of manufacturing, SSC and Plant* and/or Unit* testing, etc. from start-up to handing over the Plant* and/or Unit*) shall be duly documented to allow comparison with the transient setup as a basis for design life of the SSC.

JA

The SSC condition at the date of the Provisional Takeover* shall be thoroughly documented in the Plant Life Management Programme and corrective and/or preventive actions shall be implemented accordingly.

2.15.5.5.1 AGEING MANAGEMENT PROGRAMMES AND PROCEDURES

2.15.5.5.1.A

The Supplier* shall develop and provide Ageing Management Programmes and related procedures (see Project Management Document* Attachment 3 Section 1.1.3-1.1.5).

2.15.5.5.1.B

Each Ageing Management Programme shall include:

2.15.5.5.1.C

Definition of scope of the programme.

2.15.5.5.1.D

Identification of design life and related parameters including materials and number and description of all environmental conditions and transients assumed in the design life of the SSC (including all DBC and DEC as appropriate).

2.15.5.5.1.E

Information on how ageing can affect the SSC active and passive functions (i.e. identification and description of the degradation mechanisms) and measures needed to control the ageing effects.

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EA

Potential degradation mechanisms/ageing effects shall be identified for each active and passive function.

EB

Parameters to be monitored and related acceptance criteria and preventive and corrective actions which need to be followed.

EC

The indicators of effectiveness shall be specified.

2.15.5.5.1.F

For that purpose, the Supplier* shall provide the matrix of all SSC and their materials as specified in Section 2.6.2.1.

2.15.5.5.1.G

Time limited ageing analyses shall be provided.

2.15.5.6 PREVENTIVE MAINTENANCE

2.15.5.6.A

Preventive Maintenance* shall be established for Essential Components* and for non-Essential Components* for which cost-effective Preventive Maintenance* makes sense, i.e. to establish RCM.

AA

Predictive Maintenance* shall be used where cost-effective. For that purpose, monitoring, diagnostics and prognostics shall be provided as specified in Sections 2.14.2.6, 2.14.2.7 and 2.15.5.2.

AB

The Plant Life Management Programme shall be taken into account.

2.15.5.6.B

Standardised Preventive Maintenance* templates shall be provided by the Supplier*.

BA

The templates shall include a maintenance strategy for a particular component type that lists significant failure modes, possible indications of degradation, and recommended condition-based or time-based Preventive Maintenance* activities.

BB

The maintenance strategy shall be based on an SSC reliability analysis which shall include:

- definition of the SSC boundaries,
- definition of the important functions of the SSC,
- identification of the dominant failure modes and the effects of these failures,
- determination of the significance of these failures modes and the associated critical components,

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- identification of the applicable and effective tasks that can prevent the failures or reduce their likelihood, based on actual or credible equipment failure mechanisms.

BC

The templates shall be based on the results of the reliability analysis and on experience and recommendation of internationally recognised organizations such as EPRI and WANO (INPO) and shall take into account maintenance recommendations and manuals of the SSC suppliers and experience of the expert panel.

BD

The expert panel shall verify that the Preventive Maintenance* accounts for all the potential degradation mechanisms of the abovementioned Plant* and/or Unit* SSC

BE

The SSC supplier shall provide a detailed description of the SSC and an operational experience report which identifies operational and maintenance problems recognised by the industry (both nuclear and non-nuclear) with similar components of this nature, the supplier's operating and testing experience with their particular model.

BF

For the most important SSC (based on ranking), the SSC supplier shall provide a FMEA report which identifies the possible failures and their effect at the component part level and action to reliability assurance measures (including Preventive Maintenance* activities) to prevent them.

BG

The experience review performed in accordance with requirements of Section 2.18.4.1 shall be checked.

BH

It shall be checked that the maintenance activities assumed in the PAM and PSA are incorporated.

2.15.5.6.C

SSC specific Preventive Maintenance* procedures shall be developed for each of the Preventive Maintenance* activity.

2.15.6 IMPLEMENTATION OF RAP

2.15.6.A

The Supplier* shall establish, implement and periodically check effectiveness of the reliability assurance.

2.15.6.B

The following Sections specify the main RAP tasks shall be performed by the Supplier* in frame of the D-RAP and included (properly described) in the O-RAP documentation.

2.15.6.1 DESIGN

Key tasks of the design phase are as follows:

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2.15.6.1.A

Design manual and procedures are developed as specified in Section 2.12.6.1.

2.15.6.1.B

Critical functions of SSC and critical SSC are determined and reliability vulnerabilities, in particular single-point vulnerabilities, are minimised.

2.15.6.1.C

The results of experience review are incorporated into the Plant* and/or Unit* and SSC design.

2.15.6.1.D

Standardised criteria and technologies for performance monitoring are identified and assigned to critical SSC.

2.15.6.1.E

Performance monitoring needs are considered in the Plant* and/or Unit* and SSC design.

2.15.6.1.F

Life cycle cost and obsolescence issues are taken into account in the Plant* and/or Unit* and SSC design.

2.15.6.1.G

Preliminary ageing management programmes are developed.

2.15.6.1.H

Constructability and Maintainability* is considered in the Plant* and/or Unit* and SSC design.

2.15.6.1.I

Standard format maintenance instructions are set up.

2.15.6.1.J

Methods to be used to ensure safety and reliability of SSC include FMEA/FMECA, HAZOP, SIL, PSA etc.

2.15.6.1.K

Manufacturing and factory Inspections* and acceptance tests are specified.

2.15.6.1.L

Transport and storage of materials/SSC as well as site inspections and acceptance tests and Commissioning* are considered in the design.

2.15.6.2 EQUIPMENT PROCUREMENT AND MANUFACTURING

Key tasks of procurement and manufacturing phase are as follows:

2.15.6.2.A

Standardised procurement process and SSC specifications are implemented.

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2.15.6.2.B

Additional special requirements for critical components, such as reliability requirements (e.g. MTBF, MTTR, etc.) and additional Owner* and vendor oversight and testing, storage requirements, inspection points, and spares, etc. are specified.

2.15.6.2.C

The SSC suppliers provide operational experience report and FMEA, as applicable, and implement the corrective actions to prevent the failures (including modification of the SSC design, if needed).

2.15.6.2.D

Site Inspection* and acceptance test requirements including verification of all the manufacturing and factory Inspections* and tests are established.

2.15.6.2.E

Preventive Maintenance* and performance monitoring technical bases and instructions as well as technical basis for ageing management are supplied in a standard format by the SSC supplier.

2.15.6.2.F

Manufacturing and factory Inspections* and acceptance tests are performed and recorded.

FA

Information from manufacturing and factory tests of SSC related to design life of the SSC which will be subject to Ageing Management shall be provided (such as description of the manufacturing and factory tests and evaluation of their impact on design life and verification that the degradation is as expected in the SSC design).

2.15.6.2.G

Tools for maintenance and performance monitoring are identified.

2.15.6.2.H

Spare parts and Consumables* are identified based on the lead time.

2.15.6.2.I

Obsolescence is taken into account in the procurement process.

2.15.6.2.J

Requirements for protection and monitoring of the materials/SSC during transport are specified and followed and site Inspections* and SATs of materials/SSC are performed.

2.15.6.3 EQUIPMENT STORAGE

Key tasks of equipment storage phase are as follows:

2.15.6.3.A

Site Inspections* and tests are performed and recorded.

2.15.6.3.B

The requirements for materials/SSC storage and their protection are specified and followed and materials/SSC is stored and preserved as required.

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BA

This includes provisions for monitoring of the storage environment, as necessary.

2.15.6.3.C

Preventive Maintenance* is performed, when necessary.

2.15.6.4 CONSTRUCTION AND ERECTION

Key tasks of construction and erection phase are as follows:

2.15.6.4.A

Construction and erection documentation is developed as specified in the Construction and Commissioning Document* Section 2.3.

2.15.6.4.B

Equipment is installed and preserved as required.

2.15.6.4.C

Preventive Maintenance* is performed, when necessary.

2.15.6.4.D

A layup procedures are followed.

2.15.6.4.E

Provisions for monitoring of the materials/SSC environment shall be provided, as necessary.

2.15.6.4.F

Construction inspections and tests are specified, performed and recorded as specified in the Construction and Commissioning Document* Section 2.8.2.

2.15.6.5 COMMISSIONING

Key tasks of Commissioning* phase are as follows:

2.15.6.5.A

Commissioning* documentation is developed.

2.15.6.5.B

SSC are inspected and tested, failures are evaluated and resolved.

2.15.6.5.C

Performance monitoring is implemented and baseline performance data are obtained.

2.15.6.5.D

Operational Preventive Maintenance* is implemented as SSC become operational.

2.15.6.5.E

The SSC condition at the date of the Provisional Takeover* is thoroughly documented as stipulated in Section 2.15.5.5.

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2.15.6.6 OPERATION

Key tasks of operation phase are as follows:

2.15.6.6.A

Preventive Maintenance* is performed.

2.15.6.6.B

The SSC are monitored for their performance.

2.15.6.6.C

Corrective actions are made in case of failures and/or excessive ageing and to optimize Plant* and/or Unit* and SSC performance.

2.15.6.6.D

The reliability assurance programme and its elements are being periodically evaluated, reviewed and optimised.

2.15.6.6.E

Plant* and/or Unit* life is managed and periodically evaluated.

2.15.7 DOCUMENTATION

2.15.7.A

The Design RAP and Operational RAP methodologies, technical bases and results shall be documented by the Supplier* and provided to the Owner*.

AA

All the programmes and procedures (including templates) shall be provided.

2.15.7.B

Information on all the reliability assurance activities shall be provided.

BA

For each identified reliability assurance activity, the following information shall be provided:

- the basic procedure for performing the task,
- the purpose or expected benefit of performing the task (i.e. technical bases),
- the frequency or conditions recommended for task performance,
- the quality standards and material specifications of materials used for performing the task (when important for assuring reliability),
- the important factors or consequences to consider when evaluating task elimination or frequency changes for the task.

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EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.16 DECOMMISSIONING
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CHAPTER 2.16 DECOMMISSIONING

2.16.0 INTRODUCTION

The Chapter 2.16 establishes general requirements concerning the Decommissioning* and addresses those aspects of the Decommissioning* that can be realistically taken into account during the design stage of the Plant*. Chapter 2.16 is a common chapter for the Nuclear Island* (NI), the Power Generation Plant* (PGP), Balance of Plant* and Support Facilities*.

Note

For new nuclear power plants, an initial Decommissioning* plan is a licensing issue in most countries nowadays. A feasibility study and Initial decommissioning plan (IDP) are required to be performed by the Supplier* in order to prove that the Plant* design enables for the future implementation of the Decommissioning* strategy, as well as to perform an estimation of the Decommissioning* costs for the Plant*. The evaluation of the costs shall allow the Owner* to define the provision of adequate funds for the Decommissioning*. Information from feasibility study and Initial decommissioning plan (IDP) as such will be part of the licensing documentation, see the Licensing and Permitting, Safety and Quality Document*, Section 1.3.5.

2.16.1 GENERAL

2.16.1.A

The Decommissioning* and plans describing it shall be in accordance with requirements presented in this chapter, in accordance with applicable Rules* (see the Technical Requirements Document*, Chapter 2.5, in particular Decree No. 377/2016 Coll., as amended) and also shall take into account valid national conception of radioactive waste and spent fuel management of the Czech Republic.

Note

Decommissioning* includes actions involving decontamination, dismantling and removal of radioactive materials, waste, components and structures as well as planning and licensing thereof. The goal of Decommissioning* is to achieve a progressive and systematic reduction in radiological risks. It is assumed that most of the radioactive waste* during Decommissioning* of the Plant* will be disposed into the Dukovany radioactive waste disposal facility and only limited amount (High Level Waste*) will be disposed into a deep geological repository (see national conception of radioactive waste and spent fuel management of the Czech Republic).

2.16.1.B

The Supplier* shall provide feasibility study and initial decommissioning plan (IDP). Requirements for the IDP are stated in the Technical Requirements Document*, Section 2.16.2.

BA

The provided feasibility study, initial decommissioning plan (IDP) or any other documents related to Decommissioning* shall take into account specific features and interconnections between Units* in multi-unit site as well as activities and organization of works to be done during Decommissioning* of any Unit*.

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2.16.1.C

Decommissioning* aspects of the Plant* shall be taken into account from design phase on, throughout its operational life, until the Plant* is fully dismantled.

2.16.1.D

In addition, available requirements of the final disposal facility for Decommissioning* waste shall be taken into account, when selecting methods for Decommissioning*, dismantling and waste treatment.

2.16.1.E

The Plant* design shall facilitate the two different Decommissioning* strategies:

- immediate dismantling
- deferred dismantling

Note E

The strategy of entombment is not currently applicable in the Czech Republic according to Czech legislation.

2.16.2 DECOMMISSIONING PLANS

2.16.2.A

Two Decommissioning* plans shall be distinguished: the Initial Decommissioning Plan (IDP) for purpose of construction and the Final Decommissioning Plan (FDP) for purpose of finalizing planning for Decommissioning*.

AA

The IDP based on the Decommissioning* strategy shall include the feasibility of Decommissioning*, main steps of the Decommissioning*/dismantling and the end state of the facility and is the basis for the estimation of Decommissioning* costs.

AB

The IDP shall be developed by the Supplier* and handed over to the Owner* during the design stage to facilitate processing of any documentation (in accordance with Licensing and Permitting, Safety and Quality Document*, Section 1.3.5) and shall be adjusted at time of Commissioning* according to actual execution of Plant* (in accordance with Licensing and Permitting, Safety and Quality Document*, Section 1.3.5).

Note A

The Supplier* shall provide the Owner* with information on decommissioning to support permitting and licensing process. Some information on Decommissioning* are also required as a part of other licensing, permitting, safety or quality documentation, which shall be handed over to the Authorities* (e.g. Licensing and Permitting, Safety and Quality Document*, Section 1.3.5).

2.16.2.B

The decommissioning plans shall be performed assuming that the Plant* will be finally shutdown after having been in operation for its design life.

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2.16.2.C

The decommissioning plans shall be performed in accordance with requirements on content of documentation for decommissioning purposes (see the Technical Requirements Document*, Chapter 2.5, in particular Decree No. 377/2016 Coll.).

2.16.2.D

Decommissioning* or possible further use of non-nuclear infrastructures shall also be addressed.

2.16.2.1 INITIAL DECOMMISSIONING PLAN

2.16.2.1.A

The IDP shall facilitate the final Decommissioning* by allowing some measures such as an initial cost estimate to be taken at an early stage.

2.16.2.1.B

The IDP shall identify a preferred Decommissioning* strategy without excluding other strategies and provide comparison between them.

2.16.2.1.C

The Supplier* shall work out a feasibility study as part of the IDP and provide it to the Owner*. For each Decommissioning* strategy, this study shall:

CA

- demonstrate that Decommissioning* based on the layout of the Plant* and on the maintenance and repair provisions is feasible using proven engineering techniques available at the time of the study, taking into account the importance of the health and safety of the workers and protection of the public and the environment, and in accordance with applicable Rules* using the engineering techniques available at the time of the Commissioning* (e.g. robotics, decontamination facilities and other mechanical aids),

CB

- demonstrate that the Decommissioning* can be carried out safely while considering the ALARA principle,

CC

- include an estimation of the inventory and distribution of radionuclides throughout the Plant* based on the source term,

CD

- present estimates of the amount and type of waste which is to be disposed of during the Decommissioning* of the Plant*, including waste which can be released and/or recycled,

CE

- show that the expected doses for personnel and Representative persons* during Decommissioning* meet the dose targets for Operational States* stated in the Technical Requirements Document*, Chapter 2.1.3.2

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CF

- provide sufficient information at the design stage to determine a first estimate of the Decommissioning* cost.

CG

- Cost estimates shall be in accordance with methodology for determination of decommissioning costs used in the Czech Republic. Cost estimates shall be provided for each major activity and major Decommissioning* stage or time period. The decommissioning* cost estimate shall also account for the entire Decommissioning* work scope. The decommissioning* cost issues such as evaluation of volumes and Plant* inventories, cost of main activities and technologies, manpower, containers and transportation to the national repository, as well as the costing model used for the Decommissioning* waste shall be addressed in the study.

CGA

- Escalation and inflation indices shall be in accordance with methodology for determination of decommissioning costs (i.e. nowadays in current prices of the year of estimation) and shall be subject to Owner's* approval before starting works on the Decommissioning* feasibility study to enable an accurate cost calculation. The technical and economical (escalation and inflation) part of the feasibility study or decommissioning plan shall be drawn up to the same release date.

CH

- identify Decommissioning* design provisions already included in the Plant* design and identify and recommend those design provisions not yet included in the Plant* design (see the Technical Requirements Document*, Chapter 2.16.3),

CI

- provide input information necessary for the development of the environmental monitoring programme that has to be defined by the Owner* for the period during and after the Decommissioning*.

CJ

- provide description of applicable important technical and administrative considerations such as safeguards (spent fuel remains in spent fuel interim storage at the Site*), physical security arrangements and details of emergency preparedness.

2.16.2.1.D

For performing the feasibility study as a part of IDP, the Supplier* shall consider:

DA

- the Decommissioning* of the Plant* period will be started right after the final shutdown of the Plant* (i.e. when the spent fuel is transported from the Plant* into spent fuel storage facility as required by the Rules*). The Supplier* shall assume the Plant* having been in operation for the Plant* design lifetime,

DB

- the Decommissioning* strategies shall be applied taking into account the future use of the Construction Site* after the Plant* has been finally dismantled. The final condition for the Construction Site* shall be the greenfield condition in accordance with the Rules*.

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DC

- the interfaces with the environment during the Decommissioning* process,

DD

- appropriate radiological criteria for guiding the Decommissioning*. Authorized discharge, authorized use (reuse and recycling) and clearance of materials from regulatory control shall be applied to the extent possible to keep the generation of the Radioactive Waste* to the minimum practicable. The Supplier* shall define related criteria for these issues.

DE

- Regarding the minimisation of costs, the Supplier* shall focus, among others, on cost minimisation of temporary operation of the Plant* after the final shutdown, when the electricity is no longer produced but the operational costs of the Plant* are still high due to handling of spent fuel in spent fuel pool inside NI.

Note DE

According to the Rules*, the process of Decommissioning* cannot be started before all the spent fuel is transported into another storage facility capable of fully handling it. Until then, only minimum works leading to Decommissioning* can be performed.

2.16.2.1.E

The experience from previous Decommissioning* shall be taken into account for the development of the Feasibility Study as a matter of principle. The study shall benefit from the existing international experience in the Decommissioning* of nuclear power plants, referring to best practices, mistakes and associated lessons learned.

2.16.2.2 TABLE OF CONTENT OF THE DECOMMISSIONING PLANS

2.16.2.2.A

The Decommissioning* plans shall adopt structure defined by the Mandatory Law*. See the Technical Requirements Document, Chapter 2.5, in particular Decree No. 377/2016 Coll.

AA

In order to ensure standardisation and to treat exhaustively all the aspects, the Decommissioning* plans shall cover following areas.

1. Introduction.
2. Description of the facility.
3. Physical and radiological inventory of the facility.
4. Decommissioning* strategy.
5. Maintaining safe conditions.
6. Decontamination and dismantling techniques (focused on the execution method and description of decontamination and dismantling).
7. R&D* programmes (description of programmes to be applied for safe implementation of Decommissioning* (e.g., expected technologies for decontamination, dismantling of RPV and primary circuit components, demolition of Nuclear Island*), identification of needs for training of complicated works, computer visualisation, 3D modelling etc.)
8. Management of material and waste.

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9. Decommissioning* implementation schedule.
10. Project organization.
11. Cost and financing of the Decommissioning* activities.
12. QA programme.

2.16.3 DESIGN FOR DECOMMISSIONING

The Supplier should be aware of design requirements on Decommissioning*, in accordance with the Technical Requirements Document*, Chapter 2.5, defined in Czech legislation, in particular Decree No. 377/2016 Coll., par. 13 and Decree No. 329/2017 Coll. par. 16. These requirements need to be met beyond those mentioned below.

2.16.3.A

Preparing the Decommissioning* shall be a part of the design of the Plant*.

2.16.3.B

The Plant* shall among others be designed to:

- facilitate Decommissioning*,
- minimise Decommissioning* waste,
- minimise the impact of Decommissioning* operations on people and the environment.

2.16.3.C

The Supplier* shall demonstrate those design solutions that facilitate the Plant* dismantling procedure.

2.16.3.D

The Supplier* shall foresee a complete baseline survey, including radiological conditions of the Site* before construction, for comparison with the proposed end-state after Decommissioning*.

Note D

Since the locality houses the Existing Nuclear Power Plant*, a lot of information on radiological conditions of the Site* is already known.

2.16.3.E

If, during the course of the feasibility study, any difficulties are identified which may impede Decommissioning* activities, they shall be evaluated and possible modifications to be made to the design shall be recommended to the Owner*.

2.16.3.F

The principles of safe reliable operation and good availability shall take priority over specific design provisions for Decommissioning* purposes, in case both would be contradictory. Nevertheless, the extra burden during Decommissioning* shall be described and evaluated.

2.16.3.G

The Supplier* shall take into account operational and Decommissioning* experience from other comparable NPPs.

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2.16.3.H

The Supplier* shall maximise the ability to use well proven conventional dismantling techniques.

2.16.3.I

The Supplier* shall illustrate that measures have been taken to prevent contamination of the Plant*, in order to minimise the amount of contaminated equipment and thus the production of Radioactive Waste* or of material to be decontaminated or disposed of.

2.16.3.J

Furthermore, the following features are especially relevant and shall be used in the design:

- easy isolation of systems,
- systems designed with minimum interdependencies,
- easy disassembly allowing heavy component replacement,
- choice of materials, with the aim of reducing risks resulting from high dose rate in the vicinity of radioactive material, and reducing the amount of long half-life radioisotopes. Especially, materials leading to formation of ⁶⁰Co and ¹⁴C under irradiation shall be minimised (as described in the Technical Requirements Document*, Chapter 2.6),
- achievement of good surface condition for potentially contaminated metallic components, thus facilitating subsequent possible decontamination,
- ready accessibility and easy removal of components and internals in order:
 - to minimise the radiation exposure to the personnel,
 - to reduce the number of personnel required for Decommissioning* work,
- provision of systems to monitor and record leakage throughout the life time of the Plant* at strategically chosen points.

2.16.3.K

The Supplier* shall avoid the installation of radioactive pipelines and/or channels inside concrete structures or soil.

2.16.3.L

The Supplier* shall study the possibility for tanks, vessels and large pipes below grade, within the structure or in close proximity to the facility, to be filled with grout during dismantling after decontamination.

2.16.3.M

The Supplier* shall identify tools for handling and removal of large components. Evacuation routes for large components shall be described. During the feasibility study it will be defined whether in one piece removal or in situ fragmentation is recommended.

2.16.3.N

The design shall allow the one-piece removal of the RPV, allowing segmentation of the RPV in a workshop or disposal in one piece.

2.16.3.O

Areas of the Plant* needed during Decommissioning* for equipment lay down or dismantling shall be identified during design and provisions shall be made to convert these for this use during Decommissioning*.

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2.16.3.P

In the frame of an optimisation process the Supplier* shall study the reduction of radioactive releases and waste production. Parameters to be considered shall include:

- material specification for components in contact with reactor coolant or exposed to neutron flux with the aim of reducing activated material and the production of long half-life radioisotopes,
- reactor coolant chemistry,
- provisions to minimise the deposition of corrosion products which can potentially be activated (e.g. minimise areas of low fluid flow, low points, bends, ...),
- treatment process for liquid and gaseous effluents.

PA

The activation of the structural material of the vessel pit shall be limited using one or several of the following means:

- reduction of the fast neutron fluence out of the vessel,
- addition of neutron absorbers or moderators to the concrete,
- selection of the raw material and composition of the concrete and rebars in such a way that it limits formation of long-lived radioisotopes during the operation of the Plant*.

2.16.3.Q

Biological shield shall be designed to facilitate its future dismantling. In any case the Supplier* shall demonstrate that the dismantling can be done with reasonable effort.

2.16.3.R

The Supplier* shall foresee provisions to allow the implementation of future designed in-situ tools for cleaning and decontamination of the primary circuit (post-operational clean-up) and of equipment which is merely contaminated. A recycling or declassification could then be envisaged.

2.16.3.S

The design shall foresee, wherever possible, that contaminated and non-contaminated systems are segregated. Alternatively cross contamination shall be avoided.

2.16.3.T

The Supplier* shall foresee expandable waste storage facilities based on life cycle considerations.

2.16.3.U

The Supplier* shall design the Plant* that production of mixed and hazardous waste will be avoided during construction, operation and maintenance.

2.16.3.V

The Supplier* shall make an assessment of the amount of Radioactive Waste* that will be generated during Decommissioning*. Distinction shall be made between different categories (Temporary Radioactive Waste*, Very Low-Level Waste*, Low-level Waste*, Intermediate Level Waste*, High Level Waste*, see Decree No. 377/2016 Coll.) and activated or non-activated materials.

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2.16.3.W

The volumes of Radioactive Waste* originating from Decommissioning* shall be optimised.

2.16.3.X

The Supplier* shall document for the design efforts done to optimise production of the Radioactive Waste* production during Decommissioning*.

2.16.4 DOCUMENTATION FOR DECOMMISSIONING

2.16.4.A

The Plant* physical inventory and an initial radiological inventory with appropriate information as may be needed for the Decommissioning* cost estimate shall be provided by the Supplier*.

2.16.4.B

The Supplier* shall provide the Owner* with information about the material composition of SSC that can be activated.

2.16.4.C

Especially, material information about the composition of the biological shield concrete, RPV and reactor internals shall include those elements, which could lead to formation of Co-60 and C-14. The contents of N, Eu, Ag, Nb, Mo, Co, Ni and any other significant elements in materials that can be activated shall also be provided.

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EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.17 PROBABILISTIC SAFETY ASSESSMENT METHODOLOGY
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CHAPTER 2.17 PROBABILISTIC SAFETY ASSESSMENT METHODOLOGY

2.17.0 INTRODUCTION

The Supplier* shall develop a Probabilistic Safety Assessment (PSA) to assess in a consistent and integrated model the safety level and balance of safety provisions of the Plant*.

This Chapters define the requirements to be fulfilled by the Supplier* in the development of the Plant* PSA.

The requirements are as follows:

- to define the objectives of the PSA, i.e. the roles expected from the probabilistic assessment tool when designing plants,
- to specify the scope of the PSA and its general format to allow its future intended uses and possible extensions,
- to fix the methodology and assumptions to be used when performing the PSA either by referencing commonly agreed methods or by identifying new or improved methods.

The following requirements on PSA methodology and assumptions have been written on the basis of the IAEA PSA guidelines for conducting Level-1 and Level-2 probabilistic safety assessment, as well as on the basis of the recent EU guidelines for Harmonisation of European Practices in PSA Level 1 methodology and data collection.

The intention of this Chapter is to specify an approach that will result in a comprehensive, high quality and credible PSA.

The generally referred term “PSA of the Plant”, “Plant* PSA” or generally just “PSA” means the PSA study for each Unit*. The documentation (and results) of the PSA is standalone for each Unit*.

2.17.1 OBJECTIVES OF THE PSA

2.17.1.A

The main goal of Probabilistic Safety Assessment (PSA) is complex Plant* Design Safety Evaluation.

2.17.1.B

The PSA shall be used in at least three areas:

- Support to design,
- verification of the design,
- assistance to Plant* operation.

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2.17.1.1 SUPPORT TO DESIGN

2.17.1.1.A

The PSA shall be applied as much as possible in the design stage, in order to ensure that probabilistic safety targets will be met prior to the stage of design verification, and to provide technical elements showing that balanced design has been achieved.

AA

The Supplier* shall use the PSA to optimize the Plant* design and the licensing and operational aspects of the Plant* (e.g. Technical Specifications*, H-MI analysis, operating and maintenance programmes, procedures including equipment monitoring and testing, etc.).

2.17.1.1.B

Each time the probabilistic tool is used by the Supplier* in order to select or to optimise a technical option, the analysis shall be properly documented, i.e. in terms of methods, data and assumptions used.

BB

The Supplier* shall update the PSA during the Project* until Final Takeover* of each Unit*, so that the PSA always reflects the actual design of the Plant*.

2.17.1.1.C

In the design phase, the probabilistic tool shall also be used, as specified in Chapters 2.1, 2.9 and others, to identify sequences and compare design options in situations not involving Core Damage*, such as Complex Sequences*.

Note C

The consistency with Performance Assessment Methodology (PAM) is needed (e.g. availability and reliability of equipment) at the design stage. Among the key points is a consistency of reliability data used in the PSA and PAM.

See Chapter 2.18 Section 2.18.5

2.17.1.2 VERIFICATION OF THE DESIGN

2.17.1.2.A

The PSA shall prove Plant* design compliance with the probabilistic safety Targets defined in Chapter 2.1.3.5.

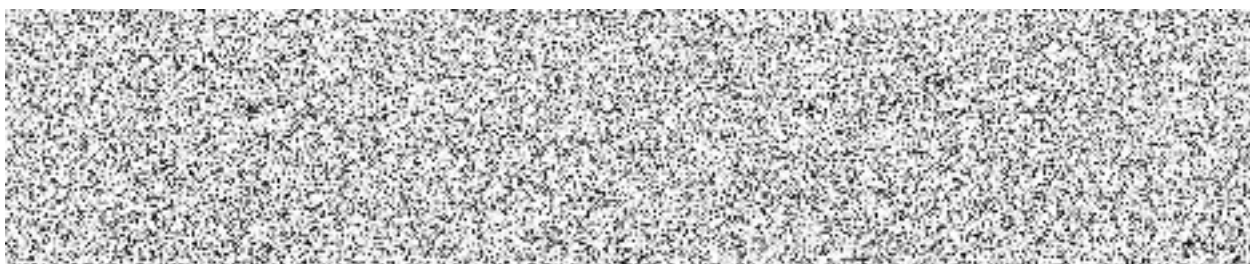
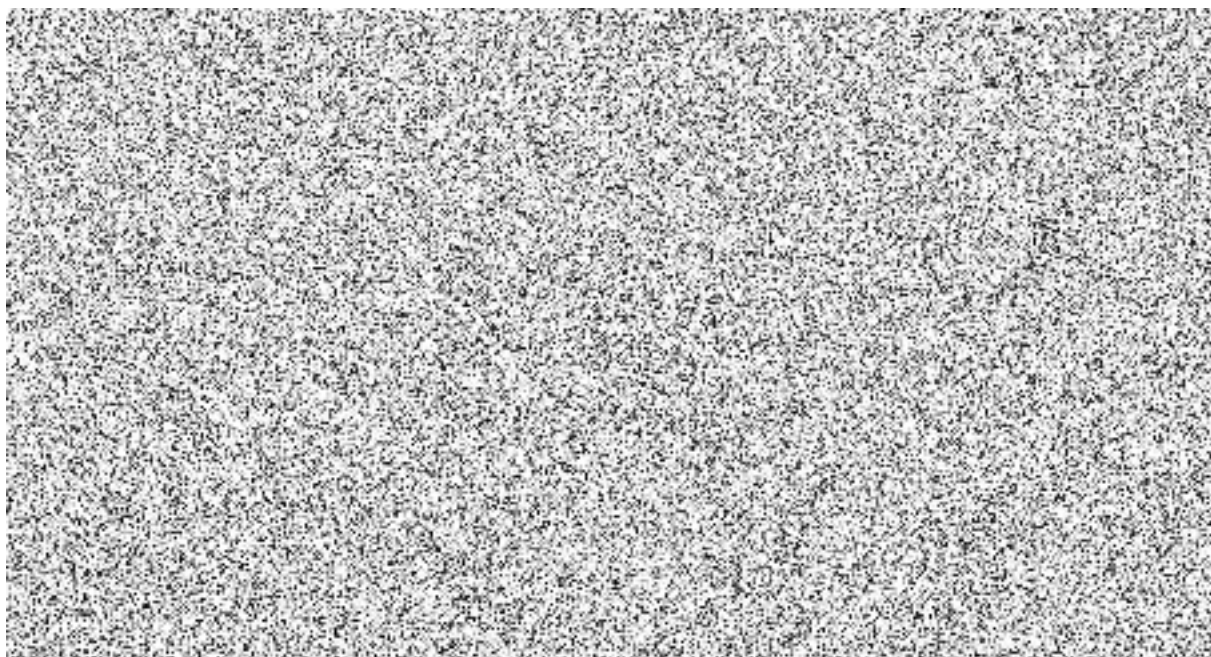
2.17.1.2.B

The risks associated with various accident sequences addressed in the PSA shall be compared with each other to ensure that no dominant risk factors deviating from the common risk level remain.

2.17.1.3 ASSISTANCE TO PLANT OPERATION

2.17.1.3.A

The PSA shall remain live for the duration of Plant* operation after its initial purpose of providing a systematic Plant* safety evaluation against Probabilistic Targets. The PSA shall provide a sufficiently detailed and documented Plant* safety analysis in order to allow the Owner* to do the following for the living PSA:



Note AB

For Probabilistic Targets (or Probabilistic Safety Targets) see Section 2.1.3.5.

2.17.1.3.B

After Provisional Takeover*, the Owner* will keep the PSA live on his own (staff, HW, SW). The Supplier* shall provide to the Owner all necessary tools for self-reliant and independent implementation of living PSA to the Plant* (i.e. models, databases, documentation, SW, HW etc.). All the changes to the Plant* by the Supplier after Provisional Takeover* based on an Owner* claims, shall be implemented to the PSA by the Supplier*.

Note BA

For further information see the Terms and Conditions*, Chapter 15, the Operation and Maintenance Document*, Section 3.9 and Technical Requirements Document*, Section 2.12.9.

2.17.2 SCOPE OF THE PSA



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Note A

The list of Level 1 and 2 PSA Issues are provided in Technical Requirements Document*, Section 2.17.9.

2.17.2.1 OVERALL SCOPE

2.17.2.1.A

As a support to the design and when verifying the design against probabilistic safety targets, the PSA shall cover all initiating events (including those caused by Internal Hazards* and External Hazards*) for both power and shutdown modes.

Note A:

Specific guidance on PSA for low power and shutdown modes can be found in the IAEA guide IAEA-TECDOC-1144.

The requirement to cover all initiating event does not necessarily mean that all initiating events shall be analysed by the PSA in detail, rather it requires them to be included in the identification and screening process, which is a standard PSA task.

2.17.2.1.B

Given the aim of the verification that the Plant* design complies with the probabilistic safety targets given in Section 2.1.3.5, the scope of the PSA shall cover the assessment of the Core Damage* frequency, the evaluation of containment response and the estimation of the frequency for exceeding the Criteria for Limited Impact*.

2.17.2.1.C

Therefore, the PSA shall include a Level 2 type analysis, which may be simplified during the Basic Design Phase* to give a preliminary assessment of the Plant* damage state frequency, but which shall be developed during the detailed design phase to provide a basis for the demonstration of compliance with quantitative safety criteria associated with the CLI (frequency and magnitude).

Note C-1:

Level 2 type analysis can be structured in a simplified way during the Basic Design Phase*. NUREG/CR-6595 provides guidance on such simplified approach. The intent is to use accident sequence information provided in the Level 1 PSA to estimate the frequency of a Large Release* and/or Early Release* being associated with early containment failure or containment bypass. During the detailed design phase, a complete Level 2 analysis shall be performed to assess the cumulative frequency of exceeding the CLI and to demonstrate that this frequency is lower than the Probabilistic Safety Targets. Beyond the Level 1 part of the PSA that verifies that the Core Damage* frequency target is met, a Level 2 type PSA shall assess the Plant* design over the whole spectrum of the potential accidental radioactive releases (e.g. fuel storage and transport, Radioactive Waste* transport, processing and storage, etc.).

Note C-2:

The results of the PSA Level 2 shall be expressed in terms of containment release categories. In-Containment Source Term* release fractions, frequency (per reactor-year) and characteristics of the plume (number, timing, release height, heat, etc.) shall be given for each release category.

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2.17.2.2 DEFINITION OF CORE DAMAGE

2.17.2.2.A

Verification of the probabilistic safety targets related to Core Damage* frequency requires a precise definition of the Core Damage*.

2.17.2.2.B

Acceptance criteria are given in Technical Requirements Document*, Section 2.1.9.2 and 2.1.7.1.1.3 and in the Nuclear Fuel Contract* document, shall be used by the Supplier* in order to differentiate between accident sequences that do not lead to Core Damage* and those sequences that would lead to the Core Damage*.

2.17.2.2.C

Core Damage* occurs when the Fuel* acceptance criteria for DBC4 specified in Section 2.1.9.2 are exceeded.

2.17.2.3 RADIOACTIVE SOURCES

2.17.2.3.A

The PSA shall cover all possible Core Damage* sequences in all Plant* states where at least one Fuel Assembly* is loaded into the reactor, spent fuel pool, in fuel building or fresh fuel storage, and all transition periods shall be covered.

Note AA:

The main potential source of radioactive releases of concern to the PSA is fuel in the reactor Core* and spent fuel storage.

2.17.2.3.B

Although reactor Core Damage* accidents are expected to be predominating for off-site releases, possible sequences where an accident with less severe consequences than Core Damage* may occur with an open containment or with a bypass of the containment or in fuel storage facilities and shall be also identified and examined.

2.17.2.3.C

The PSA shall justify that risk from potential radioactive releases from other sources (such as spent fuel handling facilities and Radioactive Waste* Processing Systems) can be reasonably neglected, due to their comparatively low magnitude and to their low frequency of occurrence.

2.17.2.3.D

All interfaces of spent fuel cooling systems with other systems shall be considered.

2.17.2.4 PLANT OPERATION MODES

2.17.2.4.A

All Plant* Operational Modes* shall be considered in the PSA. When reactor Core Damage* is examined, all Plant* operating states where at least one Fuel Assembly* (FA) is loaded into the Core* and all transition periods shall be covered.

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Note A-1:

It is expected that the frequency of radioactive releases into the environment may be dominated by the events occurring during power operation. However, the Core Damage* frequency might be significantly impacted by the initiators specific for Cold Shutdown Modes*, as clearly indicated by some previous PSAs.

Note A-2:

Examples of Plant* Operational Modes* are:

- power operation;
- start-up;
- hot standby;
- hot shutdown;
- cold shutdown;
- refuelling; and
- fuel completely unloaded to spent fuel storage.

Note A-3:

Plant* Operational Modes* also include operation of spent fuel storage.

2.17.2.4.B

For the probabilistic analysis, the Plant* Operational Modes* shall be divided into a limited number of Plant* operating states.

Note B-1:

For the analysis, the particular Plant* configurations and states can be grouped into a limited number of Plant* operating states on the basis of the similar operational conditions they represent, such as:

- residual heat level;
- reactivity, Reactor Coolant System* (RCS) temperature, pressure and level;
- Reactor Coolant System* integrity;
- front line system availability and Redundancy*,
- actuation of the Safety Systems*,
- containment integrity.

Note B-2:

Also, if any of these states whose description is based on current Plant* operating experience is not relevant for the actual design, it may be omitted in the analysis provided that a proper justification is given.

2.17.2.5 TYPE OF INITIATING EVENTS

2.17.2.5.A

The scope of the PSA shall include internal events, Internal Hazards* and External Hazards*.

Note A-1:

The probabilistic safety targets intend to cover all types of events which can potentially affect Plant* safety. During the Basic Design Phase*, External Hazards* need not to be considered

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when assessing the design against probabilistic safety targets. As a support to design, External Hazards* need not to be considered in the PSA when deterministic analyses of External Hazards* are sufficient to support the design during the Basic Design Phase* to achieve the targets.

Note A-2:

An initiating event is an event that could lead directly to undesired events (Core Damage*), e.g. reactor vessel rupture, or that challenges Normal Operation* and which requires successful mitigation using safety or non-safety systems to prevent Core Damage*. See Chapter 2.12 Section 2.12.1.

2.17.2.5.B

Sabotage shall be explicitly excluded from the PSA as initiating event.

Note B:

The frequency of acts of sabotage cannot be meaningfully quantified. It will be assumed that deterministic requirements for Plant* protection are stringent enough to ensure adequate protection.

2.17.2.6 TYPES OF QUANTIFICATION

2.17.2.6.A

PSA quantification shall include: point estimate quantification, uncertainty, sensitivity and importance evaluations.

2.17.2.6.B

The performance of the computer code and Plant* model shall enable that all aspects of PSA quantification are performed with an acceptable execution time and accuracy.

Note B:

The computing time to process the PSA model needs to be limited adequately, if the model is to be used to assist Plant* operation.

2.17.2.6.C

The mean values of the basic parameters shall be used for assessing the point estimate results, i.e., the frequency of Core Damage*, and the frequency of exceeding the CLI.

2.17.2.6.D

These point estimate results shall be used for comparison with the Probabilistic Safety Targets.

2.17.3 PLANT ANALYSIS

2.17.3.1 PLANT MODEL STRUCTURE

2.17.3.1.A

The Plant* model shall consist of the accident sequences that could occur, starting from an initiating event, and that identify the combinations of successes or failures of systems and Operator* actions.

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Note A-1:

It is not considered sufficient only to calculate sequence frequencies. The basic events combinations specific to each accident sequence are required in order to obtain insights into Plant* vulnerabilities and to assess the possibilities and the likelihood of recovery actions. Assessment of the likelihood of success of recovery actions is required to be done during two different phases: (1) when at the initial stage of design, the procedures are not available, and (2) later on when operating procedures are available. During this later stage, recovery actions include local recovery actions needed to provide substitution for failed equipment by means of restoring redundant or alternative equipment.

Note A-2:

The widely applied approach to PSA model development is to use a combination of event trees and fault trees.

2.17.3.2 SELECTION OF INITIATING EVENTS

2.17.3.2.A

A systematic and as exhaustive as possible search for potential initiating events shall be conducted and shall include the following approaches:

Note A-1:

It is essential to achieve an acceptable level of completeness of the PSA. The Supplier* needs to be aware that a new design could introduce specific initiating events, different from those that have been identified as important for current generation plants.

Note A-2:

The relevant initiating events, identified after applying a systematic search process, as described here, may be grouped into bins for the purpose of probabilistic analysis, if they are expected to lead to similar Plant* response. To facilitate the grouping of initiating events, qualitative event tree analysis may be used to evaluate Plant* response and to identify the similarities.

AA

Engineering evaluation of Plant* operational and Safety Systems* and major components, including and all Plant* FSHS and RWPS.

Note AA:

In the engineering evaluation approach, a systematic review is conducted of the design and operation of front line systems, support systems and standby systems to see whether any failure mode could eventually lead to reactor trip or to other demands on safeguard systems. Such review could involve deductive or inductive analyses such as Hazard* and Operability studies, Failure Mode and Effect Analysis, or Master Logic Diagrams, if feasible.

AB

Review of the operating experience of current similar plants.

AC

Examination of PSAs performed for plants with similar design characteristics.

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AD

Review of Postulated Initiating Events* considered in the deterministic DBC analysis and DBE analysis.

2.17.3.2.B

The selection of initiating events which can impact the analysed Unit* shall address potential initiating events occurring in the other Unit* and/or Existing Nuclear Power Plant*. This requirement also applies to the initiating events caused by the construction of the Plant*.

2.17.3.3 EVENT SEQUENCE DELINEATION

2.17.3.3.1 EVENT TREE CONSTRUCTION

2.17.3.3.1.A

The event tree shall address all the Safety Functions* that need to be performed as specified by the success criteria. It consists of an initiating event and a number of nodes, the headings of which are called generic events. The generic events usually correspond to the operation of front-line systems and human actions needed to achieve a stable state of successful fulfilment of Plant* fundamental Safety Functions*.

2.17.3.3.1.B

The possible impact of the initiating event on the availability of the systems that are credited for such event shall be carefully examined.

Note B:

For example, in case of a large Loss of Coolant Accident (LOCA), the discharge of the safety injection tank connected into the broken primary loop can be lost through the break.

2.17.3.3.1.C

The delineation of Core Damage* sequences shall incorporate the availability of containment systems to the extent that those systems may impact the availability of the systems needed to prevent Core Damage* with the Level 2 part of the PSA in view, therefore the status of the containment systems shall be integrated in these event trees. This way each accident sequence can be correctly assigned to a Plant* damage state.

Note C-1:

Availability of containment systems can be assessed in bridge trees which extend Level 1 PSA sequences to Plant* damage states if Level 1 event tree delineation is not used for integration of the containment.

Note C-2:

If desired, several Core Damage* end states can be specified, thus revealing more information on the Core Damage* scenario (low pressure Core* melt, high pressure Core* melt, fast Core* melt, slow Core* melt) and on the status of the containment systems.

2.17.3.3.1.D

The generic events shall be ordered in priority firstly in a chronological and causal sequence, and secondarily in such a way that the total number of sequences in the event tree is optimised.

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2.17.3.3.1.E

In order to construct the event trees in a systematic way, the following critical Safety Functions* shall be examined:

- Reactivity control,
- Reactor Coolant System* inventory control,
- Reactor Coolant System* integrity control,
- Decay Heat Removal from the fuel,
- Fuel Rod* cladding integrity,
- Containment integrity, if containment systems are included in the event trees.

2.17.3.3.1.F

The event tree end states shall, besides the Core Damage* end state, also include end states of non-degraded Core* sequences with significant release of radioactivity.

FA

Although reactor Core Damage* accidents are expected to be predominating for off-site releases, possible sequences where an accident with less severe consequences than Core Damage* may occur with an open containment or with a bypass of the containment or in fuel storage facilities, and shall be also identified and examined.

2.17.3.3.2 SUCCESS CRITERIA

2.17.3.3.2.A

The definition of the success and failure criteria of a system represented in a sequence shall be based on best-estimate analysis of the Plant* response.

Note A:

The success criterion for each system is defined as the minimum level of performance required to achieve the Safety Function*, taking into account the specific features of each sequence. See Chapter 2.1 Section 2.1.4.2

2.17.3.3.2.B

In order to avoid undue conservatism, verified and validated best-estimate thermal-hydraulic computer codes shall be used for Plant* response analysis to support success criteria definition in Level 1 PSA.

Note B

To keep the scope of the analysis reasonable, the analyst may choose to apply conservative criteria.

2.17.3.3.2.C

To improve the coherence of the study and to avoid undue conservatism, it is recommended, to the extent possible, that the same computer codes should be used for Plant* response analysis to support success criteria definition and for Severe Accident* progression assessment In-containment Source Term* analysis.

2.17.3.3.2.D

The analyst shall identify where conservative assumptions have been introduced and shall review the results to ensure that such conservatism does not obscure insights from the results.

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2.17.3.3.2.E

Uncertainties of knowledge shall be considered when defining criteria for phenomenological states in branches of containment event trees in Level 2 PSA, but the success probability of structures shall be calculated using stress/strength distributions.

2.17.3.3.3 MISSION TIME

2.17.3.3.3.A

The safe stable state shall be defined to justify the mission time and the success state in event tree sequences.

2.17.3.3.3.B

A proper mission time shall be selected for equipment required to remain running for successful Core* reactivity control and cooling after an initiating event.

Note B:

In many cases a mission time of 24 h could be taken. In fact, while the Core* has been successfully cooled during 24h, the decay heat power has significantly decreased. Subsequently the lower heat generation rate leads to much less restrictive success criteria and also considerably relaxes time delay between system failure and appearance of insufficient Core* cooling. See Chapter 2.1 Section 2.1.4.2.1

2.17.3.3.3.C

Actions that have to be taken beyond the selected mission time shall be considered explicitly (e.g. changes in system alignment, replenishment of water sources...).

Note C:

This greater time can be used for recovery actions and repair, if they can be demonstrated as feasible, so that the contribution of events occurring after 24h may be neglected in the basic study. The complete accident sequence modelling beyond the selected mission time may be needed in certain cases.

2.17.3.3.3.D

A sensitivity study shall be performed for specific initiating events using a longer mission time. The initiating events and the longer mission times shall be selected case by case in order to ensure to the extent possible that no significant increase of Core Damage* frequency, or frequency of exceedance of CLI could result with a longer mission time.

Note D:

The consideration of longer mission time includes an evaluation of the repair capabilities of the design. For this sensitivity study, it is possible to take credit for component repair and for more appropriate success criteria, provided that they are feasible (e.g. accessibility is possible).

2.17.3.4 SYSTEM MODELLING

2.17.3.4.A

Fault trees or the equivalent analysis tool shall be used to model system failures.

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Note A:

System reliability modelling could be used to demonstrate that the current design of system architecture has sufficient Redundancy* to reach an adequate reliability level. Markov graphs or other techniques may be used to take into account the possibility of repairing accessible components.

2.17.3.4.B

Component failures, Common Cause Failures*, human errors and unavailability due to testing and maintenance shall be taken into account in the basic events.

Note B-1:

The PSA model shall contain both active and Passive Components*. Active components are identified as components which need to be actuated and which depend on support systems. Passive Components* on the other hand do not need any actuation or support systems and operate independently on the basis of the evolution of the Plant* parameters.

Note B-2:

A component shall be excluded from the fault tree model only if the total failure probability, taking into account testing interval, of the different failure modes resulting in the same effect on system operation is at least two orders of magnitude lower than the highest failure probability of the other components in the same system Train* that result in the same effect on system operation. Single Failure* of components affecting multiple Trains* of a system shall be assessed based on total system reliability.

2.17.3.4.C

A systematic and exhaustive search for basic events shall include:

- a failure mode and effect analysis, including analysis for novel components,
- a list of equipment and typical types of equipment failures (failure models),
- Technical Specification* requirements for limiting conditions for unavailabilities and surveillance requirements, analysis of Emergency Operating Procedures*, Severe Accident Management Guidelines*, and test and maintenance procedures.

Note C:

At the time of design, final Emergency Operating Procedures*, Severe Accident Management Guidelines*, test and maintenance procedures may still be unavailable. Therefore, the PSA report shall clearly document system related criteria and assumptions taken, that represent a system design or operational constraints at the time, the analysis are carried out. Once the above-mentioned inputs are known, the Supplier* shall make PSA complete, up-to-date and credible.

CA

PSA shall include all the Plant* and Site* specific features and aspects (e. g. External Hazards*, water cooling systems, operating and maintenance procedures, Nuclear Fuel* specification (for example MOX fuel), availability requirement, CDF goal, CLI goal, LERF goal etc.).

2.17.3.4.D

Component or system unavailability due to test or maintenance shall be taken into account. The analysis shall clearly indicate how this aspect is treated and shall take care to provide the

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consistency with reliability data used for basic events quantification. Specific features of digital systems need to be reflected in the PSA model.

DA

Rules for voting logic degradation shall be well documented and followed up in the PSA model.

Note DA

Up-to-date I&C systems are characterised by specific features leading to the automatic change of configuration based on unavailability e.g. due to testing results or maintenance. Typically, several levels of on-line diagnostic are applied, both internal and external, by separate diagnostic systems. It very often leads to an active or a passive change of a voting logic between particular channels/divisions.

2.17.3.4.E

At the level of basic events, human errors shall encompass:

- the failure of Operators* to carry out required actions, including miscalibration errors,
- the failure of Operators* and/or Plant* staff to restore the operational status or the proper configuration of a component upon completion of testing or maintenance interventions or any other failure (e.g. miscalibration) which can cause latent unavailability of equipment prior to or at the time of initiating event.

2.17.3.4.F

The basic events shall be coded in such a way so that consistency and readability of final cut sets are ensured. Whichever scheme is used, it shall cover at least the following items:

- component identifier,
- component failure mode,
- independent or common cause nature of the failure,
- specific identifiers for types of components and other basic events (CCF, IE, including HE, unavailability for maintenance, unavailability for testing),
- specific system in which the component is located in.

Note F:

For modelling convenience, the basic event coding may also consider special events (e.g. failure of a system), conditional events and house events.

2.17.3.4.G

The general logic adopted to construct fault trees shall be uniformly applied to all fault trees, in order to ensure consistency and traceability of the study. It concerns especially system boundaries, logic symbols, event coding as well as representation of basic events, human errors, and Common-Cause Failures* (CCF).

2.17.3.4.H

Breaking of logic loops in fault tree models shall be done in the way that no important contributors to the system unavailability are lost.

Note H:

Example of a potential logic loop is a dependency of a Diesel Generator (DG) on service water, which also depends of power supply from DGs during LOOP.

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2.17.3.5 HUMAN RELIABILITY ANALYSIS

2.17.3.5.A

Human Reliability Analysis (HRA) shall be integral part of the PSA.

Note A:

Human interactions have been found in past PSA's to be important elements of the risk profile.

2.17.3.5.B

The analysis shall at least include:

- the systematic identification of human actions that are involved in the Plant* model. This is likely to include both qualitative and quantitative elements of analysis,
- derivation of the error probability of those human actions identified as important to risk,
- a sensitivity analysis by varying HRA parameters;
- interpretation of results and providing recommendation to the human factors area;
- a framework for further extension of HRA along with design development, procedure development, operating practices, etc.

Note B-1:

Systematic identification of human actions could be done by using existing framework such as Systematic Human Action Reliability Procedures (SHARP) or relevant articles of IAEA guide SSG-3.

Note B-2:

At the design stage, a complete set of Plant* procedures and Plant* specific input may still be unavailable. In that case, the initial PSA in the area of human reliability aspects shall be extended using the procedures and inputs developed for the plants with sufficiently similar design (preferably Reference Plant* or Standard Design*). Once the above-mentioned inputs are known, HRA shall be extended by the Supplier* to make PSA complete, up-to-date and credible.

2.17.3.5.C

Probabilistic goals shall be achieved also without credit to Operator* action for 30 minutes after initiating event occurs; exceptions, if any, shall be clearly identified in the PSA.

2.17.3.5.D

Any human action required to be performed before 72 hours shall be identified and justified (see Section 2.1.6.7.2).

2.17.3.5.E

Following types of human actions shall be identified and their reliability evaluated:

- Pre-accidental human errors, i.e. actions that can leave a component or portion of a system unavailable prior to an initiating event. As a minimum, following human errors shall be considered for standby systems or sub-systems taking part in Plant* response to initiating event:
 - the erroneous closure of a normally open manual isolation valve,
 - the erroneous isolation or de-isolation of a valve or a pump,
 - the erroneous opening or closing of any non-manual valve,
 - the erroneous disconnection of a power source to an active component,

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- the wrong calibration of protecting devices,
- the wrong calibration of instrumentation and other devices used in the actuation logic.
- Human actions that lead to an initiating event.
- Human actions following an initiating event, i.e. actions that are dictated by procedures to mitigate the consequences of the initiating event and potentially important errors of commission due to misdiagnosis.
- Human actions necessary to recover equipment or systems to terminate an accident sequence; these actions shall be included in written procedures. Additional requirements are mentioned in Section 2.17.3.8.3.

Note E-1:

The identification of pre-accidental human errors is in principle the result of an analysis of test and maintenance procedures. Since, at the design stage, these procedures may still be unavailable, the preliminary PSA might at least take into account for stand-by systems or subsystems the pre-accident human errors modelled in existing PSAs for the Plant* of similar design.

Note E-2:

Besides the identification of acts of omission and recovery actions the analyst makes a review of systems and procedures to uncover potentially important incorrect actions the Operator* may take that may have a detrimental effect (error of commission).

2.17.3.5.F

The derivation of the error probability of the human actions as outlined above shall be done in accordance with the written methodological guideline or procedure which is part of the PSA documentation. See Chapter 2.17, Section 2.17.3.7.4 and Section 2.17.8

2.17.3.6 TREATMENT OF DEPENDENCIES

2.17.3.6.A

Dependencies between systems or components shall be treated in the event tree and fault tree Plant* models.

Note A:

Dependencies have the potential to defeat Redundancy* in the design and therefore deserve special care in the PSA.

2.17.3.6.B

The following types of dependencies shall be considered:

- sequence-specific dependencies,
- intra- and inter-system dependencies,
- dependencies due to human actions,
- Common-Cause Failures* (CCF).

Note B:

IAEA Specific Safety Guide SSG-3 defines 4 types of dependencies: functional, physical (or spatial), human interaction, and component failure dependencies.

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2.17.3.6.C

Dependencies causing an initiating event and potential failures of Plant* mitigating systems due to the same influence, such as Internal Hazards* and External Hazards* or support system failures, shall be treated separately.

2.17.3.6.1 SEQUENCE-SPECIFIC DEPENDENCIES

2.17.3.6.1.A

Sequence-specific dependencies shall be explicitly incorporated in the event trees.

Note A:

Sequence-specific dependencies are dependencies where a specific initiating event or the failure or the success of a function affects the performance of another function. For example, when delineating accident sequences, the success or failure of low-pressure safety injection needs, in some circumstances (e.g. small LOCA combined with the failure of the high-pressure safety injection), only be considered if a primary system depressurisation phase has already been successful.

2.17.3.6.2 INTRA AND INTER-SYSTEM DEPENDENCIES

2.17.3.6.2.A

The following types of intra and inter-system dependencies shall be treated specifically:

AA

Support system dependencies (with the fact that those shall be explicitly incorporated in the fault trees).

Note AA:

Software and hardware in instrumentation and control systems, electrical power supplies, cooling systems, compressed air supply system, etc. are typical support systems used by various system components or front-line systems, thus creating intra- or inter-system dependencies.

AB

Shared equipment dependencies (with the fact that those shall be explicitly incorporated in the fault trees).

Note AB:

As an example of inter-system dependency due to shared equipment, some current Plant* designs have common pumps for the residual heat removal system and for the low-pressure safety injection system.

AC

Environmental dependencies.

Note AC:

Exceeding some specification limits (e.g. temperature or moisture) could cause component failure. For example, in case of a LOCA, the temperature and pressure increase inside containment can exceed operating limits of certain equipment, e.g. residual heat removal equipment, if no containment heat removal systems are available.

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AD

Spatial dependencies.

Note AD:

Examples of spatial dependencies are a pipe whip or jet impingement or high moisture following steam line break or missile impact after reactor cooling pump failure.

AE

Site* aspects and interaction in between Units, and in between Units* and the Existing Nuclear Power Plant*.

2.17.3.6.2.B

Phenomenological dependencies may be important and special attention shall be paid in the investigation of phenomenological intersystem dependencies, if Passive Systems* are used.

2.17.3.6.3 DEPENDENCIES DUE TO HUMAN ACTIONS

2.17.3.6.3.A

Dependencies due to human actions shall be treated in the Plant* model using Human reliability analysis (HRA) methods.

Note A:

This type of dependencies is related either to human actions that can affect simultaneously the performance of several systems or components or to dependencies between several human actions included in the Plant* model. See Chapter 2.17 Section 2.17.3.5

2.17.3.6.4 COMMON-CAUSE FAILURES

2.17.3.6.4.A

The Common-Cause Failure* (CCF) analysis shall be performed by using a generally accepted methodology for CCF grouping, logic modelling and quantification.

Note A:

Common-Cause Failures* are failures of several identical or similar components, at the same time or within a small time interval, due to a common cause which is not covered by the explicit modelling of sequence specific dependencies, inter-systems dependencies or dependencies due to human actions. CCF may be due to errors in design, manufacturing, installation or operation, or due to environmental effects. CCFs represent all dependencies that are not modelled explicitly in event sequence and system models, i.e. they are the residual dependencies. At present, the frequently used CCF quantification models are the Alpha Factor Model, the Multiple Greek Letter Model, Binomial Model and Shared Cause Model.

2.17.3.6.4.B

The CCF model adopted shall reflect the state-of-the-art. In any case, the CCF model shall be justified.

2.17.3.6.4.C

The groups of components subject to CCF shall be groups of redundant and identical type components which fulfil similar functions under similar conditions, and which are from the same system or from different systems.

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Note C

A typical example of CCF group of components is a group of components of the same type and function in the redundant trains of the same system.

2.17.3.6.4.D

The CCF analysis shall not assume the Diversity* exists between two systems merely because they perform similar functions and have "different system names". These systems could have CCFs if they have similar components, environments, maintenance, operating constraints, etc. (i.e. they are subjects of impact of common cause coupling factors).

2.17.3.6.4.E

If a simplified CCF method is applied, the sensitivity of the frequency obtained for Core Damage*, frequency for exceeding CLI, and Large Release* or Early Release* frequency (LERF) to this applied CCF method shall be examined.

Note E:

It is generally known that CCFs yield an important contribution to the probabilistic results (i.e. risk of Plant* operation). Therefore, it is important to check the insights gained when applying a simplified CCF method (e.g. beta factor). CCF analysis insights can be used for identifying initiating events due to CCF of Safety Systems* or safety-related systems used in Normal Operation*.

2.17.3.6.4.F

The sensitivity of the frequencies obtained for the Core Damage*, for exceeding CLI and LERF on the applied CCF method shall be examined and discussed.

2.17.3.7 RELIABILITY DATA

2.17.3.7.A

A complete set of reliability data shall be carefully drawn up to ensure the representativeness of the study. In case that Plant* type specific data are not currently available appropriate generic data shall be used. This set shall cover at least the following areas:

- initiating event frequencies,
- component failure data (failure rates),
- component failure, test, repair and maintenance data (time of unavailability),
- Common-Cause Failure* (CCF) data,
- Human Error Probabilities (HEP),
- duration of Plant* operating states.

2.17.3.7.B

The Supplier* shall justify that in each case the data are applicable to the actual design or operation of the reactor. If not, more conservative failure rates shall be applied.

2.17.3.7.C

The Supplier* shall justify that the data are applicable to the actual design, i.e., that the components selected for the actual design are at least as reliable as the component population reflected in the reference data set (including list of sources) or that the initiating event frequency is applicable. If not, higher failure rates of frequencies shall be applied.

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2.17.3.7.D

In addition, the Supplier* shall appropriately assess, by some well-established method, the reliability data specific to the newly identified or site-specific initiating events, new types of equipment, new potentials for CCF or human errors, that may be part of the Plant*.

Note D:

Since the PSA is intended to be performed on a new reactor design, it is possible that some new components could appear. Moreover, detailed and specific data related to Plant* operation (operating profile, frequency of some transient events, Inspection* and maintenance...) will not be available from experience field at the time the PSA is conducted. In those cases, a selection of applicable data to be used in the PSA supported by Bayesian approach or judgement can be made.

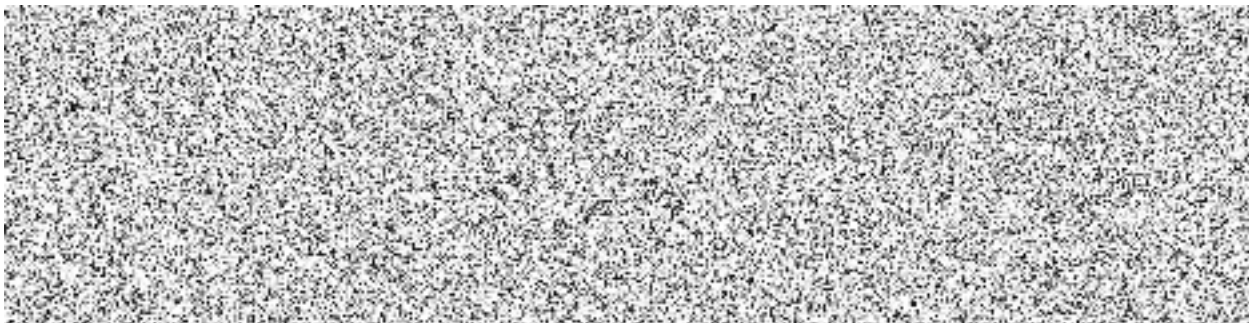
2.17.3.7.E

The Supplier* shall develop and validate the methods for assessment of reliability of Passive Components*.

2.17.3.7.1 INITIATING EVENT FREQUENCIES

2.17.3.7.1.A

The frequencies of internal initiating events shall be established for the new design considering at least: the estimated number of events occurring in similar plants over a period of time and the Plant* Operational States* durations of the activity that causes the initiating event.



Note A-2:

The applicability of these data to the initiating event frequencies for the new reactor design is to be examined.

2.17.3.7.2 COMPONENT FAILURE, TEST, REPAIR AND MAINTENANCE DATA

2.17.3.7.2.A

A list of component failure, test, repair, maintenance, mode reliability and repair data shall be established for the design. Expected time interval between tests shall be taken into account for standby components. Applicability of generic data shall be justified. Some well-established database shall be used. The database choice shall be subject of the Owner's* approval and shall be acceptable for the Authorities*.

Note A:

At present, several national databases exist within the EU which provide information related to component reliability data: the Swedish T-book (Nordic Nuclear Power Plants), the Spanish



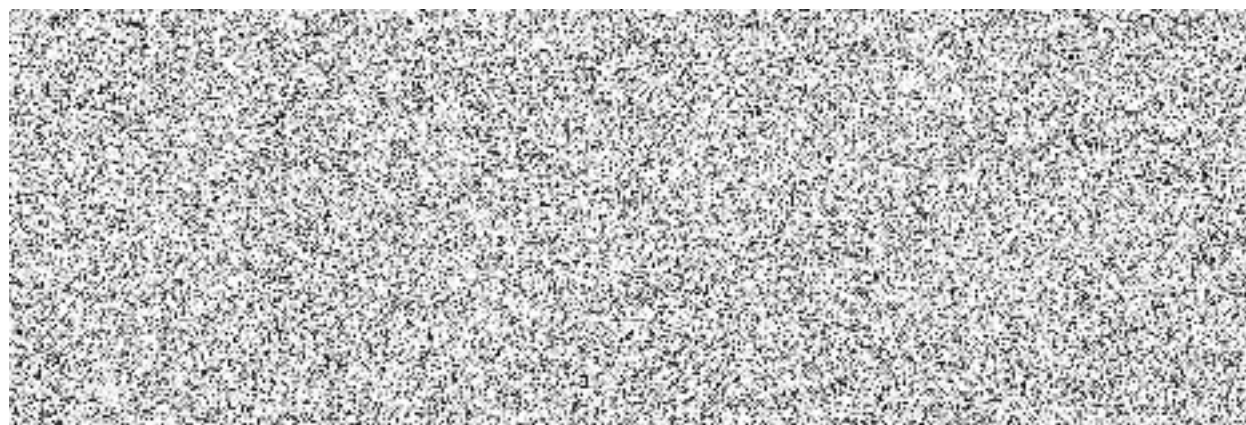
2.17.3.7.2.B

If component failure data significantly differ from the corresponding PAM values, then a detailed justification for this shall be provided.

2.17.3.7.3 COMMON-CAUSE FAILURE DATA

2.17.3.7.3.A

A list of Common-Cause Failure* (CCF) data shall be established, based either on information available from operating feedback and applicable for the new reactor design, or on generic data.



2.17.3.7.4 HUMAN ERROR PROBABILITIES

2.17.3.7.4.A

Human error probabilities (HEP) shall be quantified by using a generally accepted and coherent methodology.

Note A-1:

An example of a generally accepted methodology, which was used in many PSAs for quantification of human error probabilities, is given in Technique for Human Error Rate Prediction (THERP) - NUREG/CR-1278. It is recommended that the chosen methodology provides a model which enables a quantification process based on a sufficiently broad set of performance shaping factors. Examples of performance shaping factors are: time window available for the action quantified, complexity or difficulty of the situation, status of the procedures, efficiency of indicators and of Operator* aids, stress, training.

Note A-2:

Since significant volume of plant-specific information and procedures will not be available during the licensing regime of an advanced NPP, generic data can be used to assess HEP (emergency procedures used at plant of similar design, for example).

2.17.3.7.4.B

For the final Plant*-specific PSA performed by the Supplier*, the HEP derivation shall be adapted to address the differences in operating regimes.

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2.17.3.7.4.C

The methodology shall:

- use screening conservative HEP values in the PSA model in order to permit the identification of sufficiently large number of minimum cut sets,
- apply more detailed realistic analysis for important human actions,
- if necessary, carry out the analyses of the most important actions with alternative methods.

Note C-1:

Too much conservatism in HRA may lead to wrong insights in the performed PSA. Therefore, a special focus on dominant HEP may lead to adjustments by using alternative methods (CBDT/EPRI, CREAM, SPAR-H, NARA, etc.) or engineering judgement if a well-documented rationale is provided. On this subject it is recommended that symptom-based procedures greatly reduce the opportunities for serious misdiagnosis and that the advanced control room designs will further reduce the possibilities for errors of commission.

Note C-2:

For the identification of human error dependencies with potential significant impact on the risk the use of very high screening value is recommended (to reveal cut sets with three and more human errors).

2.17.3.8 ACCIDENT SEQUENCE QUANTIFICATION

2.17.3.8.A

The accident sequence models shall be quantified in an integrated manner. The following additional ground rules apply to the quantification process.

Note A:

Integrated quantification is necessary to ensure that all dependencies are treated properly, and that all conditions important to the recovery analysis are explicitly identified.

2.17.3.8.1 POINT ESTIMATES

2.17.3.8.1.A

The initiating event frequencies and the Plant* response event probabilities shall be estimated by means of point values which are the mean values of the uncertainty distribution of basic parameter values.

Note A:

As required in 2.17.2.6 C, point estimates of the risk (either Core Damage* frequency or frequency of exceeding the CLI) are used to be compared with the Probabilistic Safety Targets. As required in 2.17.2.6 D and 2.17.7.1, the point estimate calculations are complemented by uncertainty and sensitivity analyses.

2.17.3.8.1.B

Best Estimate* values shall be used as far as possible to ensure that the PSA provides a realistic assessment of Plant* safety. Where detailed data are not available, conservative values may be used for the first evaluation. If these conservative values are identified to have a significant impact on the results, they shall be more precisely evaluated in a second round

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quantification once detailed data are available. Importance, sensitivity and uncertainty analyses shall be performed and the results discussed to get a thorough insight and assessment of the impact on integrated quantification results of uncertainties of point values used.

2.17.3.8.2 TRUNCATION PRINCIPLES

2.17.3.8.2.A

Truncation values can be defined to reduce the PSA model quantification time. The Supplier* shall justify that the selection of truncation values for each calculated output does not result in the loss of event combinations whose cumulative frequency could constitute a non-negligible contributor to the Core Damage* cumulative frequency, to the cumulative frequency of exceeding the CLI or LERF.

Note A-1:

The best way to determine the proper frequency cut-off value (i.e. minimum cut sets with a lower frequency than that are not included into the analysis) is to adjust it based on the impact and on the convergence of the PSA results. For example, a truncation value lower than $10^{-9}/\text{ry}$ can be chosen to decide about the truncation for each Core Damage* accident sequence.

Note A-2:

Retaining information regarding low frequency sequences may also be important with respect to identifying those sequences with a relatively high potential for containment failure, as well as preserving the ability to assess the effects on risk of certain sensitive areas of the design.

2.17.3.8.2.B

The Supplier* shall also verify for each accident sequence that the selection of truncation value does not result in the loss of event combinations whose cumulative frequency could constitute a non-negligible contributor to the Core Damage* cumulative frequency or to the cumulative frequency of exceeding the CLI.

2.17.3.8.3 RECOVERY ANALYSIS

2.17.3.8.3.A

All feasible recovery actions within a given timeframe, which excludes high-speed recoveries, shall be accounted for in order to make the risk quantification as realistic as possible.

Note A-1:

Unless the frequency of a particular accident sequence is comparatively low or no recovery is possible in a particular case, recovery analysis may significantly impact the final results. Therefore, the recovery analysis must be performed with great care and the changes made in PSA model have to be comprehensively and correctly justified.

Note A-2:

A recovery action can be:

1. a mitigation action taken by non-safety systems according to EOPs; or
2. a non-standard mitigation action (using safety or non-safety systems), which are not (or poorly) described in EOPs; or
3. a mitigation action taken locally (both described and not described in EOPs) as a backup of the failed equipment; or

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4. a repair of the failed equipment to be used;
5. combinations of any of the possibilities above.

2.17.3.8.3.B

Identification of recovery possibilities shall be carried out at the minimal cut set level rather than at the accident sequence level including effects of External Hazards*.

Note B:

The information available to the Operator* and the recovery actions that might be taken generally depend on the combination of events that have occurred and hence on the particular minimal cut-set.

2.17.3.8.3.C

In principle, no repair action shall be taken into account for the basic variant of risk quantification using the postulated mission time.

Note C-1:

However, if a particular component which can be demonstrated to have a much lower repair time than the selected mission time significantly contributes to the results, its repair may be considered. Furthermore, the possibility of reparability in shutdown modes may also be considered since time to reach unacceptable conditions in the Core* or the spent fuel pool may be very long.

Note C-2:

As non-safety equipment may be used to recover failed functions; the feasibility of recovery actions needs, however, to be well justified and documented.

2.17.3.8.3.D

Recovery actions performed from the Main Control Room* (MCR) and those performed locally shall be clearly distinguished.

2.17.3.8.3.E

Life threatening actions shall not be considered.

Note E:

For example, if a recovery action can only be undertaken inside the containment where harsh conditions exist due to accident progression, then the subject of possible recovery must be considered as non-recoverable.

2.17.3.8.3.F

Recovery actions being considered as diverse ones to I&C functions need to be thoroughly examined from the point of Independence* both on sensing and actuating means and a sufficient time window available, depending on the individual accident scenario.

Note F:

PSA model shall clearly mirror the level of Diversity* of human to automatic actions. Also, feasibility of human recovery actions in the case of loss of part of I&C needs to be scrutinised.

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2.17.4 CONTAINMENT ANALYSIS

2.17.4.A

Level 2 PSA report shall include:

- Accident progression and containment response analysis:
 - Identification of Plant* features important to accident progression.
 - Interface with the Core Damage* frequency analysis (Plant* Damage State Grouping).
 - Evaluation of the analytical tools used in accident progression and containment response analysis.
 - Development of containment event trees (CETs).
 - Analysis of the containment structural performance against static and dynamic pressure loads.
 - Thermal hydraulic analysis of Severe Accident* progression with realistic assumptions.
- In-Containment Source Term* analysis:
 - Identification of Plant* features important to In-Containment Source Term* analysis.
 - Identification of In-Containment Source Term* issues.
 - Definition of In-Containment Source Terms* and their uncertainties.
 - Creation of model for release and transport of radio nuclides.
- Risk integration and importance analysis:
 - Definition of radiological implications of releases.
 - Binning of CET end states (Release Categories).

2.17.4.1 CORE DAMAGE SEQUENCE BINNING

2.17.4.1.A

Core Damage* sequences shall be grouped into Plant* damage states.

Note A:

Grouping of similar sequences provides a means of managing the number of accident sequences. In addition, it provides a means of gaining information needed for the in-plant analysis task.

2.17.4.1.B

The Plant* damage states shall be defined such that all sequences within a particular bin lead to similar effects with respect to In-Containment Source Term* phenomena. The definition of the bins shall provide a means to ensure that the delineation of Core Damage* sequences is discriminated sufficiently to afford the proper level of co-ordination with the containment analysis.

2.17.4.1.C

The Core Damage* bins are likely to be defined by an iterative process using Level 1 and Level 2 analyses. It is important to note that the Plant* damage states must be sufficiently and uniquely defined to ensure that they adequately reflect the characteristics important to the containment response and release magnitudes, in order to avoid introducing uncertainties that could otherwise be avoided.

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Note C:

An example of Plant* damage state attributes is: status of RCS integrity, RCS pressure, status of ECCS, status of containment systems, availability of Alternating Current (AC)/Direct Current (DC) power, time at which Core Damage* occurs.

2.17.4.2 CONTAINMENT SYSTEM ANALYSIS

2.17.4.2.A

A Containment System* analysis shall be developed in a such way that it will explicitly account for any Common-Cause Failures* and other dependencies between the Core Damage* prevention systems and the Containment System*.

Note A:

Conditional probability of failure of Containment System* must be determined by correctly accounting for dependencies between "upstream" events in the Core Damage* sequence (such as support system failures) and the causes of failure of the Containment System*. One way to address this requirement is to extend the Level 1 event tree such way that it contains all the necessary system status information required to unambiguously assign all sequences to specific Plant* damage states.

2.17.4.2.B

If grouping of accidents, including the status of the Containment System*, is used prior to the in-plant analysis, the frequency representative sequence for each Plant* damage state shall be used to define in-plant phenomenological analysis parameters for use in determining containment performance.

Note B:

This simplifying assumption is made in order to reduce the number of deterministic analyses runs necessary to develop the containment event tree branch point probabilities.

2.17.4.2.C

Representative accident sequences shall not be the worst case bounding sequences but shall take into account frequency and consequences.

2.17.4.3 CONTAINMENT ISOLATION

2.17.4.3.A

Containment penetrations shall be accounted for in the evaluation of containment leakage paths. Containment pressure achievable during Severe Accident* sequences, as well as other relevant parameters, shall be taken into account when assessing the integrity of containment leakage paths.

Note A:

The potential for releases to occur due to failure of some penetrations to be isolated or properly sealed has been found to be important in previous studies. In particular, large leakage paths may exist. For example, equipment hatches that are left open may result in a large leakage path.

2.17.4.3.B

Penetrations shall be analysed for both of the following types of release pathways:

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- failure to isolate normally-open lines or normally-closed lines that might be open at the time of an accident (e.g. due to mal-positioning of valves) due to the initiating event or due to additional failures,
- leakage through a penetration where no pathways should be present (leakage past the seat of a closed valve, through an electrical penetration, past the seal of a personnel airlock, etc.).

BA

Detailed assessment shall be performed of leak tightness behaviour of large containment penetrations (e.g. equipment hatches) at high pressure and temperature scenarios.

2.17.4.3.C

Criteria for screening of containment penetrations from the analysis shall be justified.

Note C-1:

Containment penetrations can be screened from the analysis if they can meet one of the following criteria:

- conditional probability of leakage or of failure to be isolated is very small (i.e. less than about 10^{-3} /event), taking into account the dependencies with support systems,
- low consequence (e.g., release that must take place through a line that will remain filled with enough water throughout the accident),
- closed loop inside or outside the containment, small in size (e.g., instrumentation lines).

Note C-2:

Failure of penetrations at a frequency of less than 10^{-3} /event is not expected to significantly contribute to risk and is excluded from the analysis. Examples of penetrations that could be expected to have a failure rate lower than this value would include the following:

- lines containing a blind flange; and
- lines in which there are at least two automatic isolation valves plus an additional, normally closed valve.

Note C-3:

The consequences resulting from a release through enough water are not significant.

Note C-4:

Any system that starts and terminates in the containment without any release path to the environment can be excluded from the containment penetration model, provided that its design against External Hazards* is adequate.

Note C-5:

Small lines typically tend to become plugged quickly and are generally not important potential release pathways.

2.17.4.4 CONTAINMENT BYPASS ACCIDENT

2.17.4.4.A

Containment Bypass Accident* sequences shall be assessed and shall include all connections to the Reactor Coolant System* (RCS). The containment bypass analysis shall be based on functional analysis and quantification of the potential initiating events and shall evaluate the risk of bypass for each of the selected scenarios.

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Note A:

Containment bypass sequences can result in significant releases from containment and have the potential to be important risk contributors. Past PSAs have identified the following bypass sequences as important:

- Steam Generator* Tube Rupture (SGTR),
- Residual Heat Removal (RHR) isolation failure,
- Interfacing LOCA.

2.17.4.5 IN-PLANT SEQUENCE ASSESSMENT

2.17.4.5.A

In-plant analysis of the accident progression shall be performed as a minimum for each Plant* damage state that is an important contributor to the Core Damage* frequency or have the potential to result in exceeding the CLI.

Note A:

In order to adequately model the processes involved, an integrated model of the Core Damage* and containment is required to address generation of heat, effects of steam inerting, containment geometry and containment pressurisation.

2.17.4.5.B

For the purpose of establishing accident progression, a thorough understanding of key physical processes and phenomena shall be demonstrated. Such processes and phenomena are e.g. Core* heat-up and melting, containment loading, release of radionuclides, molten core-concrete interaction, and combustible gas generation and ignition.

2.17.4.5.C

Different approaches can be used for establishing accident progression, e.g. Severe Accident* integrated codes, mechanistic codes or models, Core Damage* frequency models, applicable experiments, etc. The applied tools shall be justified for the respective purposes. Experiments shall be properly scaled.

2.17.4.5.D

The selected codes and models shall be adequately supported by documentation including code validation against experimental data or international benchmarks.

2.17.4.6 CONTAINMENT EVENT TREE ANALYSIS

2.17.4.6.A

A containment event tree shall comprise the important phenomenological issues associated with containment loading and/or In-Containment Source Term* evolution.

Note A:

A containment event tree provides a means to identify and quantify important phenomena.

2.17.4.6.B

Elements which shall be addressed in the development of the containment event tree include as appropriate (but are not limited to):

- hydrogen, fission product behaviour in containment (aerosol behaviour),

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- Core* coolability (in-vessel and ex-vessel), steam explosions, direct containment heating,
- missile impact,
- fast containment melting-through.

2.17.4.6.C

The quantification of the events in the containment event tree and of the resulting event-tree outcomes shall be performed using Best Estimate* values. For those phenomenological events that could be important to the potential releases and are subject to large uncertainty, the Best Estimate* shall reflect an appropriate assessment of expert opinion or other relevant input, in addition to the deterministic result obtained using the simulation computer code.

Appropriate sensitivity analysis shall show that adding some conservatism to Best Estimate* values do not result in consequences that are well beyond the acceptance criteria.

Note C:

The use of Best Estimate* values is consistent with the guidance provided for Core Damage* assessment. However, the outcome of a deterministic code may not properly reflect the Best Estimate* for some branch points representing phenomena. The deterministic outcome, together with other characterisations of the phenomenon, may be used to arrive at a Best Estimate*. For example, one approach would be to develop a probability distribution for an event, reflecting the available inputs, with subjective weighting assigned to each input. The mean value of such a distribution would then be used as the Best Estimate* in the quantification process. Caution must be kept in such an approach to ensure that dependencies among different events in the containment event tree are properly accounted for.

2.17.4.6.D

The basis of the containment event tree and the supporting information used to determine containment event tree probabilities shall be thoroughly documented. This ensures quality and traceability of this process.

2.17.4.7 IN-CONTAINMENT SOURCE TERM DEFINITION

2.17.4.7.A

In-Containment Source Term* shall be characterized by:

- the definition of times and rates of appearance of radioactive fission products in the containment,
- types and quantities of the species released,
- the frequency of the In-Containment Source Term* categories,
- and other important attributes such as their chemical and physical forms.

Note A:

Especially for containment bypass occurring via sequences through main steam lines or other primary circuit penetrations, the In-Containment Source Term* arising from inside the Core* may be more important than that one after vessel melt-through. See Chapter 2.1 Section 2.1.2.4.3.

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2.17.5 INTERNAL HAZARDS

2.17.5.A

The Internal Hazards* shall be considered in the PSA for both power and shutdown modes. For this purpose, a comprehensive initial list of Internal Hazards*, including those listed in Chapter 2.1, shall be established for consideration based on the references such as IAEA NS-G-1.7, NS-G-1.11 and others.

Note A-1:

Internal Hazards* could lead to consequences similar to common cause events that have the potential for causing an internal initiating event and/or degradation or unavailability of Safety Systems*. These events are usually results of environmentally stressing conditions.

Note A-2:

The Internal Hazards* can be screened out on a probabilistic basis if their impact on the increase of frequency of exceeding the CLI can be bounded to $10^{-7}/\text{yr}$ or less.

See Chapter 2.17 Section 2.17.2.5 See Chapter 2.1 Section 2.1.9.3

2.17.5.B

PSA for Internal Hazards* shall include the following main stages:

- Collection of initial information on Internal Hazards*;
- Internal Hazards* identification, including single and combined Internal Hazards*;
- Internal Hazards* screening analysis, both quantitative and qualitative;
- Bounding assessment or detailed analysis or both.

Note B-1:

Other Internal Hazards* may include turbine disintegration and heavy load drop. Some specific considerations for these two Hazard* are provided in comments Note B-2 and Note B-3.

Note B-2:

Structural failure of a turbine rotor could result in the generation of high-energy missiles which can penetrate casing and potentially damage safety related equipment. The distribution of missiles following a turbine disintegration will be determined and hence the probability of such missiles impacting buildings. The resulting failure probabilities of safety related equipment within the buildings will then be determined taking into account the proportion of missiles with sufficient kinetic energy to penetrate the buildings. These probabilities will be used together with the probabilities of random failure of surviving safety related equipment and the frequency of turbine disintegration to calculate the frequencies of accident sequences which lead to appropriate damage states.

Note B-3:

In the consideration of dropped loads, all permanent lifting equipment on the Plant* will be considered. The areas where a dropped load could affect nuclear safety will be identified and examined in detail. In each case, the maximum load is assumed to be dropped and the effects on the building structure and on Plant* will be assessed. Each identified event will be considered to determine the potential radiological consequences and the frequency contribution (if any) to a damage state. The analysis will specifically consider direct fuel damage caused by heavy load drops into the open reactor or spent fuel storage.

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2.17.5.C

Detailed analysis for Internal Hazards* which have not been screened out shall include:

- Internal Hazards* characterization including calculation of Hazard* frequency and analysis of Hazard* impact;
- Integration into accident sequence modelling based on internal initiating events PSA, including determination of induced initiating events, performing necessary revisions to the event trees and fault trees from the internal initiating events PSA, analysis of specific dependencies and specific data, and specific human reliability aspects.

Note C:

Specific requirements for PSA for Internal fire Hazard* and internal flooding Hazard* are provided in Sections 2.17.5.1 and 2.17.5.2. For any other Internal Hazard* category which cannot be screened out, the PSA is generally expected to include the main stages and tasks specified in Sections 2.17.5.1 and 2.17.5.2

2.17.5.D

Quantification of the contribution of Internal Hazards* to the risk measures shall include induced Core Damage* frequency, frequency of exceeding CLI and LERF.

2.17.5.1 FIRES

2.17.5.1.A

The fire PSA shall be performed in the following steps:

A-1

The main concern of fires is their potential to simultaneously damage electrical components of redundant safety equipment, particularly control and power cables. Fire effects can therefore influence significantly the safety of nuclear plants. Guidance on the treatment of internal fires in probabilistic safety assessment is provided in the IAEA Safety Report Series N°10 and other international guiding documents on Fire PSA.

2.17.5.1.AA

Qualitative and quantitative screening to identify Plant* locations which are important to the fire risk.

Note AA-1:

Qualitative screening of Plant* rooms can be established on the following principles.

Plant* rooms can be screened out qualitatively if the following two conditions are fulfilled:

- no equipment is present in the room which can cause an initiating event; this also includes equipment which can induce manual reactor trip (by Operators*) or request for a forced shutdown in short time frame; additionally: it is demonstrated that spreading of fire to other rooms which do contain such equipment can be neglected; and
- systems important for mitigation of initiators or safe shutdown or their support systems are not located in the room; additionally: it is demonstrated that spreading of fire to other rooms which do contain such equipment or equipment causing an initiator can be neglected.

Also, Plant* room can be screened out if fire loading in the room (i.e. presence of combustibles) is so low that even in the case of ignition no relevant fire scenario can be produced.

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Note AA-2:

Screening of Plant* rooms by their contribution to the Probabilistic Targets, on the basis of quantitative criteria, can be done by a bounding assessment (including bounding propagation analysis) for further elimination of single Plant* rooms or fire scenarios involving multiple Plant* rooms remaining after the qualitative screening.

This quantitative screening can be implemented by means of PSA model for internal initiating events and by using conservative assumptions regarding the growth and propagation of fire, the effects of fire on equipment and the associated human actions.

Note AA-3:

The fire occurrence frequency in a room is based on generic fire data, complemented with additional room specific data such as ignition source, ignitability, reliability of fire detection and subsequent automatic or manual extinguishing actions, potential of fire load, etc.

2.17.5.1.AB

Quantitative assessment of fire induced scenarios for selected rooms by means of fire propagation analysis. All the effects of fire, including flame, plume, ceiling jet, radiant heat from hot gases, high energy arcing, spurious actuation and smoke shall be considered and assessed. Potentially relevant pathways of propagation (e.g. ventilation or cable gutters) shall be taken into account.

Note AB:

Fire scenarios describe the time-dependent course of an initiating fire in a selected room and the subsequent component failures. A fire scenario can be represented by fire event trees where all-important features affecting fire development (design of Fire Barriers*, fire detection and suppression) are modelled and probabilities of component failures are used for quantification.

2.17.5.1.AC

Incorporation of fire propagation analysis results and associated accident sequence development in the internal events PSA model to obtain, as a minimum, the fire-induced Probabilistic Targets frequency.

Note AC:

The combination of the fire frequencies, probabilities of fire induced failures of components and probabilities of independent failures, yields the fire induced Core Damage* frequency or frequency of exceeding CLI or LERF.

2.17.5.2 FLOODING

2.17.5.2.A

A

The flooding PSA shall be performed in the following steps:

2.17.5.2.AA

Qualitative and quantitative screening to identify Plant* locations which are important to the flooding risk.

Note AA-1:

Qualitative screening of Plant* rooms can be established on the following principles.

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Plant* rooms can be screened out if the following two conditions are fulfilled:

- no equipment is present in the room which can cause an initiating event; this also includes equipment which can induce manual reactor trip (by Operators*) or request for a forced shutdown in a short time frame; additionally: it is demonstrated that spreading of flood to other rooms which do contain such equipment can be neglected,
- systems important for mitigation of initiators or safe shutdown or their support systems are not located in the room; additionally: it is demonstrated that spreading of flood to other rooms which do contain such equipment can be neglected.

Also, Plant* room can be screened out if Plant* room does not contain any sources of flooding, including in-leakage from other compartments, sufficient to cause failure of equipment.

Note AA-2:

Screening of Plant* rooms by their contribution to the Probabilistic Targets frequency, on the basis of quantitative criteria, can be done by a bounding assessment (including bounding propagation analysis) for further elimination of single Plant* rooms or flood scenarios involving multiple Plant* rooms remaining after the qualitative screening.

Note AA-3:

This quantitative screening can be implemented by means of PSA model for internal initiating events and by using conservative assumptions such as that that all components in the compartment being affected by the flooding will fail.

The flooding occurrence frequency of a room is based on the estimation of the probability of activation of the possible flooding sources (piping failure, mal-positioning of valves, rupture of tanks), combined with the probability of failure of flood related alarms and automatic or manual actuations of isolation of flow source.

2.17.5.2.AB

Quantitative assessment of flood induced scenarios for selected rooms by means of flooding propagation analysis.

Note AB:

Flooding scenarios describe the time-dependent propagation of an initiating flood in a selected room and the subsequent component failures. A flood scenario can be established by flooding event trees where all-important features affecting flooding development (design of flood barriers, flood detection and isolation of flooding sources) and probabilities of component failures are modelled.

2.17.5.2.AC

Incorporation of flooding propagation analysis results and associated accident sequence development in the PSA model of internal events to obtain, as a minimum, the flooding-induced Probabilistic Targets frequency.

Note AC-1:

This includes identification of location of cabinets and terminal boxes for cables supporting the safety related components in order to identify the vulnerability of components with respect to flooding of certain rooms.

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Note AC-2:

The combination of the flood frequencies, probabilities of flood-induced failures of components and probabilities of independent failures, yields the flood-induced Probabilistic Targets frequency.

Note AC-3:

It is noted that flooding and damage to Structures, Systems and Components* due to high energy pipe breaks is expected to be treated in the Level 1 PSA for internal flooding if it has not been included as part of the Level 1 PSA model for internal initiating events.

2.17.6 EXTERNAL HAZARDS

2.17.6.A

The External Hazards* listed in the Section 2.1.9.3.2 and 5.2 of Technical Requirement Document*, except sabotage (see Section 2.17.2.5), shall be considered in the PSA for both power and shutdown modes based on the current state of science and technology.

Note A-1:

External Hazards* shall include natural events (earthquake, external flooding, extremes of temperature, extreme winds, extreme precipitation, drought, lightning etc.) and man-made events (Hazards* arising from the Existing Nuclear Power Plant* and/or other Unit* (including impact of potential Accident Conditions*), aircraft crash and electromagnetic interference, Hazards* from the industrial, transport and military infrastructure in the vicinity of the Plant*, as well as from mobile sources in case of accident on adjacent roads and railways (mostly on the road No. II/152)). External Hazards* shall mean Hazards* arising from outside the Plant*.

Note A-2:

External events are produced by natural phenomena or hazardous activities in the vicinity of a nuclear power plant. Complete analysis of these Hazards* can only be made if sufficient site specific details are available. Demonstration of compliance with probabilistic safety targets cannot be completed without site-specific considerations. Guidance on the treatment of External Hazards* in PSA can be found, for example, in the IAEA SSG-3.

Note A-3:

In site-specific phase, a systematic identification of all potential External Hazards* relevant for the site shall be performed based on all available generic sources and site-specific data. The list of Hazards* shall include those specified in Chapter 2.1.

Note A-4:

An example of a generic source for identification of relevant External Hazards* is IAEA NS-G-1.5 or IAEA SSG-18.

Note A-5:

In order to limit the number of Hazards* to be analysed, screening of external Hazards* can be done based on the following set of screening criteria:

- The Hazard* will not lead to an initiating event. For External Hazards*, this criterion is generally applied when the Hazard* cannot occur close enough to the Plant* to affect it;
- The Hazard* will be slow to develop and it can be demonstrated that there will be sufficient time to eliminate the source of the threat or to provide an adequate response;
- The Hazard* is included within the definition of another Hazard*; and

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- The Hazard* has a significantly lower mean frequency of occurrence than other Hazards* with similar uncertainties and will not result in consequences that are worse than those from other such Hazards*.

Note A-6:

The external events are always Site*-dependent and they are often design-dependent. Generally, earthquakes, floods, extreme temperatures, snowfalls, high winds and man induced Hazards* have emerged as being risk-significant. However, because of the "site dependency", the consideration of only these Hazards* could make the analysis incomplete. This is avoided by a successive screening process, with detailed analyses being performed only for those events, which cannot be eliminated by the screening process. The successive screening methodology allows a comprehensive approach, concentrating the efforts in the areas with the most risk potential. The successive screening analysis used involves the following steps:

- screening based on qualitative criteria;
- quantitative screening based on low Hazard* frequency;
- bounding risk assessment based on Hazard* frequency; and
- conditional probability of Core Damage*, exceeding CLI or LER.

2.17.6.B

PSA for External Hazards* should include the following main stages:

- Collection of initial information on External Hazards*;
- Hazard* identification;
- Hazard* screening analysis, both quantitative and qualitative; and
- Bounding assessment or detailed analysis or both.

2.17.6.C

The realistic combinations of External Hazards* which are likely to combine together shall be also considered with specific attention paid to synergistic impacts.

2.17.6.D

Detailed analysis for External Hazards* which have not been screened out shall include:

- Hazard* characterization including calculation of Hazard* frequency and qualitative and quantitative analysis of Hazard* impact;
- Integration of previous results of the analysis into the accident sequence modelling process based on internal initiating events PSA, including determination of induced initiating events, performing necessary revisions to the event trees and fault trees from the internal initiating events PSA, fragility analysis using fragility curves, analysis of specific dependencies and specific data, and addressing of specific human reliability aspects.

2.17.6.E

Quantification of the contribution of External Hazards* to the risk measures shall include induced Core Damage* frequency, frequency of exceeding CLI and LERF.

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2.17.6.1 EARTHQUAKES

2.17.6.1.A

For the assessment of risk from earthquakes, a seismic PSA shall be performed for site-specific design. It shall include:

- Assessment of frequency of occurrence of earthquakes and the associated magnitude of force;
- Seismic fragility analysis including all Structures, Systems and Components* and their combinations that, if failed, could contribute to Probabilistic Targets frequency;
- Incorporation of seismic Hazard* into the PSA model for internal initiating events, including all important seismically induced initiating events and seismically induced impacts on Plant* Structures, Systems and Components*;
- Assessment of seismically induced Core Damage* frequency, frequency of exceeding CLI and LERF.

Note A:

In order to limit the effort required for Level 1 PSA for seismic Hazards*, it is possible to perform a bounding seismic PSA analysis if the level of earthquake is low.

2.17.6.2 EXTERNAL FLOODING

2.17.6.2.A

If the calculated flood level is above the level at which water ingress could cause failure of equipment important for mitigation of an initiating event caused by external flooding, the occurrence frequencies of such floods shall be estimated and the required associated PSA outputs, including Core Damage* frequency, frequency of exceeding CLI and LERF, shall be assessed.

Note A:

Possible events and scenarios from the external flooding Hazard* category are subject to qualitative and quantitative screening, as defined in 2.17.6B. The experience has shown that in many cases external flooding Hazard* cannot be screened out, see e.g. IAEA Specific Safety Guide SSG-3 paragraph 8.1.

2.17.6.2.B

For external flooding, an estimate shall be made of the extreme flood levels from relevant flood sources (sea, river, dams, dykes), as well as other relevant parameters such as warning time and flood velocity. Duration and contribution of the action of the waves shall be taken into account when assessing the water levels.

2.17.6.3 TEMPERATURES

2.17.6.3.A

An assessment shall be performed of risk arising from Plant* faults caused by failure of equipment that is not qualified to provide protection against extreme temperatures, based on the assessment of frequency of extreme temperature Hazard* and an appropriate equipment fragility assessment. The required associated PSA outputs, including Core Damage* frequency, frequency of exceeding CLI and LERF, shall be assessed.

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Note A-1:

Protection against extreme temperatures will usually be provided by qualifying equipment important to safety to function under specified conditions or by housing such equipment inside buildings designed to withstand those conditions.

Note A-2:

Possible events and scenarios from the extreme temperatures Hazard* category are a subject to qualitative and quantitative screening, as defined in 2.17.6.

2.17.6.4 HIGH WINDS AND TORNADOES

2.17.6.4.A

An assessment shall be performed of risk arising from Plant* faults caused by failure of Structures, Systems and Components* which are not qualified against extreme wind speeds, based on the assessment of frequency of extreme wind Hazard* and an appropriate fragility assessment. Hazard* and fragility assessment shall consider possible impacts of missiles generated by high wind. The required associated PSA outputs, including Core Damage* frequency, frequency of exceeding CLI and LERF, shall be assessed.

Note A-1:

For extreme winds (including tornadoes), protection against extreme wind, including wind generated missiles, will usually be provided by qualifying equipment important to safety, to function under specified conditions or by housing such equipment inside buildings designed to withstand such conditions.

Note A-2:

Possible events and scenarios from the extreme wind Hazard* category are subject to qualitative and quantitative screening, as defined in 2.17.6B. The experience has shown that in many cases the extreme wind Hazard* cannot be screened out, see e.g. IAEA Specific Safety Guide SSG-3 paragraph 8.1.

2.17.6.5 PRECIPITATION

2.17.6.5.A

If the buildings are not qualified for the full range of events, an assessment shall be made of the risk arising from extreme precipitation and induced failures of equipment important for mitigation of an initiator caused by precipitation which is more severe than the qualification level. It shall be based on the estimate of frequency of extreme precipitation Hazard* and conditional probability of failure of an appropriate Plant* response. The required associated PSA outputs, including Core Damage* frequency, frequency of exceeding CLI and LERF, shall be assessed.

Note A-1:

Protection against extreme precipitation will usually be provided by qualifying buildings to withstand such Hazards*.

Note A-2:

Possible events and scenarios from the extreme precipitation Hazard* category are subject to qualitative and quantitative screening, as defined in 2.17.6.

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2.17.6.5.B

For extreme precipitations, estimates shall be made of the rate and duration of extreme precipitation (rain, hail and snow) corresponding to the initiating event screening frequency. The concerns are:

- flooding;
- roof loads;
- blockage of air intakes, exhausts, etc.

2.17.6.6 DROUGHT

2.17.6.6.A

The required PSA outputs, including contribution to the Core Damage* frequency, frequency of exceeding CLI and LERF, shall be derived by considering the potential damage resulting from the impact of drought on the Safety Functions*, which may be demanded, and their conditional probability of failure.

Note A:

Possible events and scenarios from the drought Hazard* category are subject to qualitative and quantitative screening, as defined in 2.17.6.

2.17.6.7 LIGHTNING

2.17.6.7.A

The required PSA outputs, including contribution to the Core Damage* frequency, frequency of exceeding CLI and LERF, shall be derived by considering the potential damage resulting from the impact of lightning on the Safety Functions*, which may be demanded, and their conditional probability of failure.

Note A:

Possible events and scenarios from the lighting Hazard* category are subject to qualitative and quantitative screening, as defined in 2.17.6B.

2.17.6.8 AIRCRAFT IMPACT

2.17.6.8.A

A

The required PSA outputs, including contribution to the Core Damage* frequency, frequency of exceeding CLI and LERF, shall be derived by considering the potential damage resulting from the impact on the Safety Functions* which may be demanded and their conditional probability of failure.

Note A-1:

The probability of aircraft crashes will be derived from the statistics of aircraft crash in the neighbourhood of the Site* being considered. Usually, three categories of aircraft are considered in the analysis:

- light aircraft;
- military aircraft such as fighters;
- commercial aircraft such as large passenger carriers.

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Note A-2:

For aircraft impact, the frequencies of impact of various types and masses of aircraft at various velocities on the buildings on the Site* will be evaluated.

Note A-3:

Where necessary the conditional probabilities of impact on components important for safety and mitigation of induced initiators within the buildings will be estimated as a result of building vibration or of building perforation. The sensitive parts of the Plant* are the buildings housing significant amounts of radioactivity (primary system, spent fuel pool); systems, or parts of them, which, if damaged, could lead to an accident; and the systems which are needed to bring the Plant* to a Safe State* and to maintain it safely in this condition.

Note A-4:

Typically, sensitive parts of an Advanced Light Water Reactor (ALWR) would include:

- the reactor building;
- the fuel building;
- the building housing the steam/feedwater lines from the containment up to and including at least the steam and feedwater isolation valves; and
- the auxiliary buildings, at least the parts which house the control rooms, the reactor control and Protection System*, the safety injection system and the associated support systems (including I&C and Emergency Power Supply*), the auxiliary feedwater system and its support systems, the residual heat removal system and its support systems, and the control room habitability system, Control Room support systems etc.

Note A-5:

Calculation of this probability can be based on probability distributions of the crash speed and of the crash angle. Those distributions can be defined per aircraft family (military, commercial, general aviation). The associated secondary effects (e.g. secondary missiles, fire risk, etc.) may be discarded when this can be justified on a probabilistic basis.

Note A-6:

Possible events and scenarios from the aircraft crash Hazard* category are subject to qualitative and quantitative screening, as defined in 2.17.6B. The aircraft crash Hazard* belongs to the group of human-induced Hazards*, and the experience has shown that in many cases it cannot be screened out, see e.g. IAEA Specific Safety Guide SSG-3 paragraph 8.1.

2.17.6.8.B

The analysis of the consequences of the aircraft impact shall include:

- mechanical damage of the containment and safety related equipment due to penetration of heavy particles,
- damage of containment structures and sensitive equipment due to vibration of the buildings,
- fire of the fuel inside and outside the buildings.

2.17.6.8.C

The contribution of the malevolent aircraft impact, equivalent to a sabotage, shall not be included in the required PSA outputs, including summary Probabilistic Targets frequency, because the initiating event frequency cannot be meaningfully defined.

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2.17.6.9 HAZARDS FROM INDUSTRIAL INSTALLATIONS

2.17.6.9.A

For Hazards* from industrial installations, pipelines and transport routes, contributions to the required associated PSA outputs, including the Probabilistic Safety targets, shall be derived by consideration of the potential damage resulting from the impact of the accident on the Safety Functions* which may be demanded and their conditional probability of failure. In the characterization of the Hazards* from industrial installations, all primary and secondary effects shall be taken into account.

Note AA:

The effect of on-site fires on the Site* may be considered to bound the effects of the off-site fires. Typically, fires of concern are those which could cause large quantities of smoke of the type produced by oil pool fires. Such fires outside safety classified buildings are of concern mainly for the effects of un-burnt hydrocarbons on the performance of the station Operators* and equipment.

Note AB:

Possible Hazard* sources, events and scenarios from this Hazard* category are subject to qualitative and quantitative screening, as defined in 2.17.6.

2.17.6.9.B

The frequency of smoke ingress to safety classified buildings shall be assessed taking account the automatic isolation of part of the Heating, Ventilation and Air Conditioning (HVAC) system and the separation between buildings.

2.17.6.10 ELECTROMAGNETIC INTERFERENCE

2.17.6.10.A

The required associated PSA outputs, including contribution to the Probabilistic Safety targets frequency, shall be derived by considering the potential damage resulting from the impact of electromagnetic interference on the Safety Functions* which may be demanded and their conditional probability of failure.

Note A:

Possible events and scenarios from the electromagnetic interference Hazard* category are subject to qualitative and quantitative screening, as defined in 2.17.6.

2.17.7 UNCERTAINTY, SENSITIVITY AND IMPORTANCE ANALYSIS

2.17.7.1 UNCERTAINTY AND SENSITIVITY ANALYSIS

2.17.7.1.A

A qualitative uncertainty analysis shall be performed for the reliability data in the basic events in the PSA model. A systematic quantitative analysis shall reflect uncertainty in the numerical values of the reliability data, as initiating event frequencies, component failure data and Human Error Probabilities (HEP).

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Note A:

The uncertainty analysis can be performed by systematic assigning appropriate uncertainty distributions to the reliability parameters necessary for quantification of the basic events and by propagating them using a Monte Carlo simulation. Uncertainty propagation is done by sampling at the parameter level, i.e. by taking into account that the same parameter may be assigned to multiple basic events. Failures of components containing software need to be treated with a special attention within the uncertainty analyses.

2.17.7.1.B

For other sources of uncertainty, namely modelling uncertainty due to a lack of complete knowledge (for example success criteria, Severe Accident* phenomena, extreme containment behaviour, or extended use of expert judgment...), a sensitivity analysis shall be performed. The areas which need further sensitivity analysis shall be identified on the basis of the following issues:

1. modelling uncertainty related to the dominant accident sequences, and
2. modelling uncertainty identified on the basis of engineering judgment and having the potential to generate dominant sequences.

Note B-1:

When performing sensitivity analysis, only one modelling assumption is usually modified at the same time. However, for model uncertainties affecting the same parts of the PSA model, sensitivity studies may be performed simultaneously to determine whether there are synergistic effects. This enables to draw the correct conclusions with respect to the modelling uncertainty.

Sensitivity analyses on modelling uncertainties, such as success criteria, may need fundamental changes in the PSA model (for example changing the fault tree logic).

Note B-2:

For PSA of plants with Passive Systems*, the passive features may lead to concerns regarding the validity of PSA results. Phenomenological uncertainties may be taken into account in the reliability data of passive Systems and Components. It is, therefore, necessary for the plants with Passive Systems* where the Supplier* shall ensure that the validity of assumptions for passive features is commensurate with the level of their contribution to the reliance of the Probabilistic Targets.

2.17.7.1.C

Sensitivity analysis shall be performed by varying statistical input data.

Note C:

The sensitivity analysis can be performed by dividing and multiplying the value of the basic event parameter.

2.17.7.2 IMPORTANCE ANALYSIS

2.17.7.2.A

Importance measures shall provide a means of interpretation of the PSA results. Therefore, importance measures shall be calculated for events and for groups of events.

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Note A-1:

The following importance measures should be calculated: Fussel-Vesely, Risk Reduction Worth and Risk Achievement Worth.

Note A-2:

The groups of basic events, for which importance measures are calculated, represent a system, pre-accidental human errors, post-accidental human errors, components containing software, etc.

2.17.8 DOCUMENTATION AND QUALITY MANAGEMENT OF THE STUDY

2.17.8.1 QUALITY MANAGEMENT

2.17.8.1.A

The PSA shall be planned, managed, controlled, documented and maintained in compliance with the PQM (see the Licensing and Permitting, Safety and Quality Document* Chapter 3.1).

Note A:

When developing the management scheme of the PSA project, it could be useful to review the up-to-date proven methods used in similar studies. Selection or development of appropriate working methods at this stage would ensure that there is a minimum of modifications of these procedures during the Project* and the Project* runs effectively without non necessary delays.

2.17.8.2. DOCUMENTATION

2.17.8.2.A

The primary objective of the PSA documentation shall be to fulfil the requirements of its users and be suitable for the applications/uses of a PSA as identified in Section 2.17.1 in conjunction with the definition of the PSA objectives.

2.17.8.2.B

The documentation shall consist of a summary report and of a more detailed technical documentation:

- the summary report shall cover all topics related to the PSA in a format which is understandable for nuclear safety specialists having just the very basic knowledge of PSA principles. The results and insights gained from the PSA shall be described such that it allows to evaluate the risk benefit of the different safety measures and the compliance with the probabilistic safety criteria. Also design changes based on PSA elements shall be taken into account,
- the detailed technical documentation shall provide within the report all necessary information to reconstruct the results of the study. All intermediate sub-analyses, calculations, assumptions, etc.; which will not be published in any external reports, shall be retained and fully documented as reports, notebooks and notes, working papers or computer input data, models and outputs.

Note B:

The first step in organizing the documentation of the study consists in determining the nature and the amount of information that is going to form the external documentation, i.e. what is going to be published, and the information that is going to form the internal documentation. It is very important for reconstructing and updating each detail of the analysis in the future to have

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an easy access of this type of internal documentation. It is recommended to use well-organized computer and word processor files as much as possible for storing this type of information.

2.17.8.2.C

The documentation of PSA shall be well-structured, clear and easy to follow, to review and to update.

Note C:

In addition, means should be provided for possible extensions of the analysis, including integration of new topics, use of improved models, broadening of the scope of the PSA in question, and use for broad set of applications. Explicit presentation of the assumptions, exclusions and limitations of extending and interpreting the PSA is also of critical importance to the users.

2.17.8.2.D

The organization of the detailed PSA documentation shall be governed by two general principles:

DA

Traceability:

For review and updating of the analysis it shall be possible to trace any information with minimum effort; in particular all information forming the documentation shall be clearly identified and referenced.

Note DA:

Specific forms of presentation of the PSA documentation are given in Chapter 13 of NUREG 2300, in Appendix VIII of IAEA Safety Series N° 50-P-4 "Procedures for Conducting Probabilistic Safety Assessments of Nuclear Power Plants (Level 1)", in IAEA Specific Safety Guide SSG-3 "Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants" and in IAEA Specific Safety Guide SSG-4 "Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants" and ASME RA-S Code.

DB

Sequentiality:

The analysis in the final documentation shall follow this list:

- initiating event identification, selection, analysis and grouping,
- success criteria definition,
- accident sequence analysis,
- systems analysis and related topics,
- reliability data determination,
- human reliability analysis,
- PSA model integration and quantification, including uncertainty, importance and sensitivity analysis,
- interface with the Core Damage* frequency analysis,
- development of the containment event tree and related topics,
- Internal Hazards* analyses,

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- External Hazards* analyses,
- low power and shutdown state analyses,
- In-Containment Source Term* analysis,
- grouping of containment event tree end states (Release Categories),
- quantification,
- uncertainty and sensitivity analysis.

2.17.8.2.E

The results of the PSA shall be compiled and presented in such a manner that they clearly convey the quantitative risk measures, the dominant sequences and cut sets, the aspects of Plant* design and operation that are important contributors to those risk measures as well as those responsible for limiting risk, and the effects of important sources of uncertainty. The presentations of results shall be accompanied by a table format and discussion of quantitative importance measures deemed by the analysts to provide meaningful insights with respect to the Plant* features.

Note E:

Clear explanations of the key points are crucial both to properly characterising the comparisons of the assessed risk measures to the overall safety criteria for the Plant* design, and to understanding the significance of the results in a qualitative manner. The discussions and interpretation of the results need to be augmented by clear tabular and graphical representations. Various measures of importance, including Fussel-Vesely, risk achievement worth, and risk reduction worth, can be useful in further illuminating the results. The analyst should choose for presentation those measures that are most helpful in understanding the results for the particular design being analysed.

2.17.8.2.F

The frequency of challenging Passive Systems* shall be well documented in order to understand the significance of the results with respect to Plant* concepts with Passive Systems*.

2.17.9 LEVEL-1 AND LEVEL-2 PSA ISSUES

2.17.9.A

The scope of the PSA shall include:

- power operation as well as shutdown operation of the Plant*;
- analysis of risk from reactor Core*;
- analysis of risk from spent fuel pool;
- internal initiating event;
- Internal Hazards*;
- External Hazards*;

AA

The level 1 PSA shall include the following tasks:

- overall description of the Plant*;
- determination of Plant* operating states to be analysed and determination of their durations;

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- determination and description of initiating events;
- success criteria for the safety and support systems, and descriptions of physical, thermo-hydraulic or reactor physical methods and analyses used for their determination;
- description of the safety and support systems and an account of their interdependencies;
- event trees analysis including determination of accident sequences based on success criteria;
- estimation of the frequency of initiating events;
- analysis of interdependencies and Common-Cause Failures* between various Structures, Systems and Components*;
- human reliability analysis;
- fault tree analysis including descriptions of systems and functions;
- analysis of reliability data based on either generic data or operating experiences of similar plants;
- Internal Hazards* analysis;
- External Hazards* analysis;
- quantitative probabilistic analysis which takes into account the most important factors affecting the results;
- evaluation of the uncertainty and sensitivity of the results, conclusions.

AB

The level 2 PSA shall include the following issues:

- analysis of the Core Damage* associated with various accident sequences and timing (Core Damage* sequence grouping), classification of sequential events (analysis of the progression of Severe Accidents*);
- analysis of the interactions between the Safety Systems* and the processes taking place in the containment in the course of an accident;
- reliability analysis of the systems used for Severe Accident* management taking into account the conditions prevailing in the containment during an accident and the possibility of erroneous measures;
- analysis of containment performance during Severe Accidents*, containment isolation, containment bypass;
- development and quantification of containment event tree;
- estimation of the amounts of radioactive substances released from the damaged reactor Core* into the containment and estimation of the transportation and retention of radionuclides in various accident sequences;
- estimation of the amounts, height and timing of various radioactive substances released to the environment, and estimation of the respective probability of accident sequences with the associated uncertainties;
- expert judgements with related justification;
- results and evaluation, including interpretation;
- conclusions.

Note A

See the Decree No. 162/2017 Coll., as amended, for additional requirements on PSA.

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EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.18 PERFORMANCE ASSESSMENT METHODOLOGY
VERSION DATE:	March 2025

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CHAPTER 2.18 PERFORMANCE ASSESSMENT METHODOLOGY

2.18.0 INTRODUCTION

A

This Chapter specifies the requirements for Performance Assessment Methodology (PAM).

AA

The methodology shall be used to assure and verify sufficient reliability of the SSC to meet each Unit* availability and reliability objectives.

2.18.1 GENERAL

A

The Supplier* shall perform the performance assessment as specified in this Chapter.

2.18.2 PAM GOALS AND OBJECTIVES

2.18.2.A

The goals and objectives of the PAM shall be:

- to review of the nuclear industry experience with the aim of identifying the significant causes of failures, risk and unavailability,
- to develop reliability and availability models of the systems and the overall Plant* and/or Unit*,
- to demonstrate that each Unit* reliability and availability goals are met.

AA

The demonstration of reliability and availability shall include demonstration that the objectives for Planned Outages* durations and frequencies are met.

AB

The PAM shall provide inputs for reliability assurance programme specified in Technical Requirements Document* , Section 2.15.

2.18.2.B

An analysis shall be performed to demonstrate that appropriate provisions have been made in the Plant* and/or Unit* design to facilitate and reduce as far as possible the nominal durations of the tasks on the critical or sub-critical paths of the Planned Outages*.

BA

A set of availability and performance criteria shall be prepared for evaluation of the Normal Operation* and maintenance during outages as specified in Technical Requirements Document* , Section 2.15.5.4.

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2.18.3 UNIT RELIABILITY AND AVAILABILITY OBJECTIVES

2.18.3.A

It shall be demonstrated by PAM that reliability of SSC is sufficient to meet each Unit* reliability and availability objectives.

AA

The reliability and availability objectives are specified in Technical Requirements Document* , Section 2.2.7.

2.18.3.B

The Supplier* shall demonstrate each Unit* availability according to the methodology developed in Chapter 2.18A.

BA

The unavailability contributors shall be distributed as specified in Technical Requirements Document* , Section 2.2.7.2.2.

2.18.3.C

The Supplier* shall demonstrate required level of Unplanned Outages* as specified in Technical Requirements Document* , Section 2.2.7.2.2.

2.18.3.D

The Supplier* shall demonstrate the Planned Outages* durations as specified in Technical Requirements Document* , Section 2.2.7.2.2.

DA

For that purpose, the Supplier* shall develop a reference outage programmes as required in Section 2.18.6.1 and start-up test programme as required in Part II, Volume 2, Section 2.18.6.2.

2.18.4 PRELIMINARY TASKS PRIOR TO THE PAM ANALYSIS PROCESS

A

Prior to starting the performance assessment, the Supplier* shall perform preliminary work in order to have at his disposal as much information as possible, to enable realistic modelling.

2.18.4.1 EXPERIENCE REVIEW

2.18.4.1.A

The Supplier* shall prepare a review of industrial experience as described in Technical Requirements Document* , Section 2.14.2.8.

AA

The purpose of this requirement is to emphasise the need to use the lessons learned by the commercial nuclear and non-nuclear industry over the past decades.

AB

This review shall not be limited to PWR (Pressurized Water Reactor) experience.

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2.18.4.1.B

Based on this review, the Supplier* shall identify significant causes of failures of SSC functions having a significant effect on the Forced Outages*.

BA

The identification shall address both external and internal hazards, like harsh weather conditions.

BB

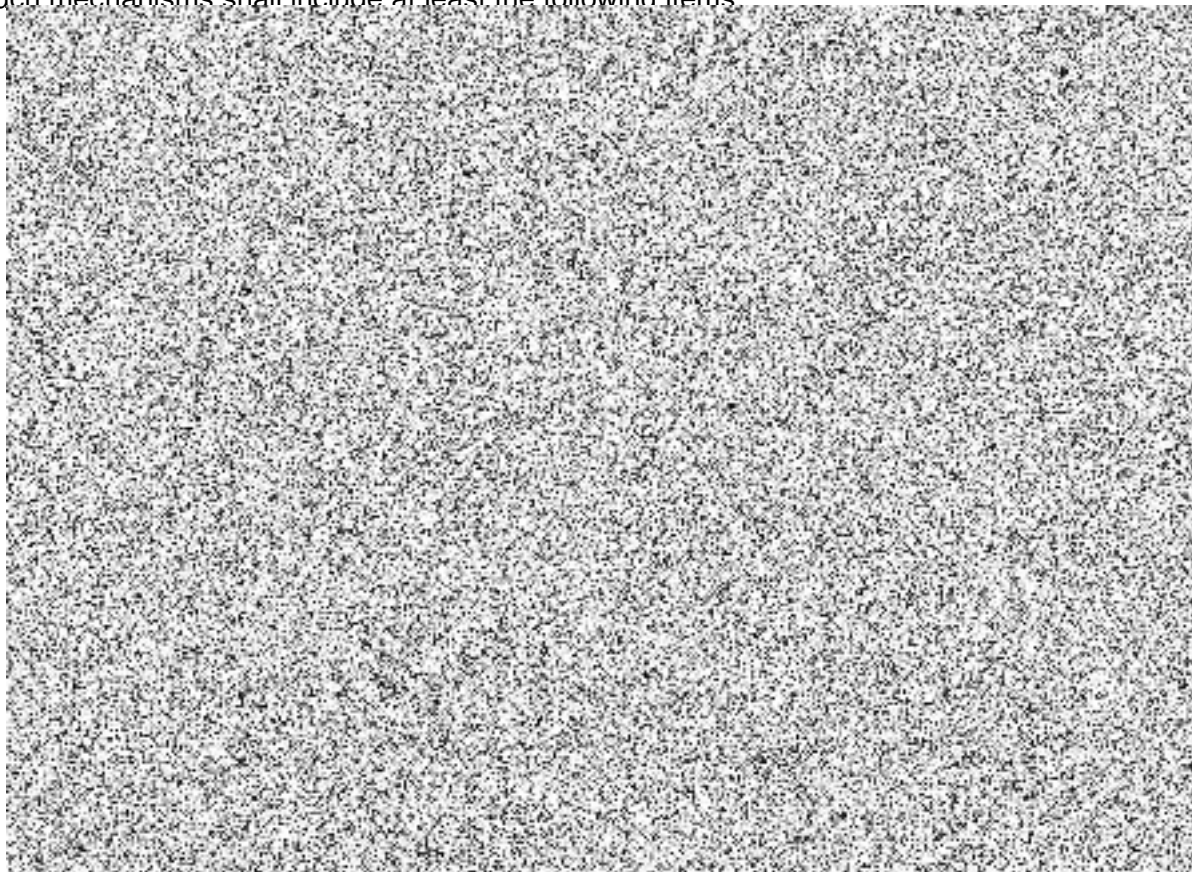
For guidance, see the Tables in Technical Requirements Document* , Section 2.18.9 and 2.18.10.

2.18.4.1.C

In addition, the Supplier* shall identify significant causes of the failure mechanism for SSC.

CA

Such mechanisms shall include at least the following items:



CB

For those SSC that are anticipated to require repairs or replacement after a specified period of time, the repair/replacement shall be planned to take time during Planned Outages* and/or outage extensions for special works as specified in Technical Requirements Document* , Section 2.2.7.2.2.

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2.18.4.1.D

The information shall be used to verify the component reliability data and when developing the Plant*-specific model.

2.18.4.2 LIST OF MAIN FUNCTIONS

A

To facilitate the design performance assessment analyses, the Supplier* shall establish the list of the main functions to be addressed by the PAM.

AA

The Supplier* shall take into account the major contribution to the Unit* unavailability based on historical experience as specified in Technical Requirements Document* , Section 2.18.4.1.

AB

All systems which may have an impact on Unit* availability shall be taken into account.

2.18.4.2.1 IMPACT OF SAFETY CLASSIFIED DEVICES

2.18.4.2.1.A

Spurious actuation or malfunction of safety classified SSC whose spurious actuation or malfunction may affect availability shall be taken into account.

2.18.4.2.1.B

In addition, the limits and conditions set in the Technical Specifications* shall be taken into account.

2.18.4.3 COMPONENTS RELIABILITY DATABASE

2.18.4.3.A

A set of equipment reliability data shall be carefully drawn up so as to ensure that the availability assessment study is truly representative.

AA

The reliability data used for the availability assessment shall be calculated directly from the operation experience of existing equipment (data provided by the equipment suppliers and/or from a widely recognised generic reliability database).

AB

Together with the reliability data, the Supplier* shall provide data on maintenance, testing, Inspections* and conditions monitoring which the data are based on.

2.18.4.3.B

A reliability data set shall be provided for equipment used in the Plant* and/or Unit* design.

BA

The data set shall comprise component failure data (Mean Time Between Failures (MTBF) or failure rates per hour - λ , probability of failure per demand), test data (test interval), repair and maintenance data (Mean Time To Repair (MTTR) or repair rate per hours - μ), Common-Cause Failure* (CCF) data.

BB

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A generic reliability data base shall be used if Plant* and/or Unit* specific data are not available.

2.18.4.3.C

These data shall be, to the greatest extent possible, consistent with the PSA reliability data which are specified in Technical Requirements Document* , Section 2.17.3.7 for common items.

2.18.4.3.D

The Supplier* shall check that the data are really Best Estimate* data so as not to bias the results.

2.18.4.3.E

The Supplier* shall perform the final performance assessment for the specific Plant* and/or Unit* design.

EA

For this study, the Plant* and/or Unit* specific data shall be provided and used provided they have first been approved by the Owner*.

2.18.4.3.F

Specific reliability data (i.e. for new components) provided by the Supplier* will be accepted as far as they are demonstrated to be correctly assessed.

FA

For new equipment with an impact on safety and availability, reliability data shall be verified by a reliability, uncertainty and sensitivity analysis performed by Supplier*.

FB

Reliability data can be estimated based on engineering judgement in cases of non-critical equipment in terms of performance assessment.

2.18.4.3.G

The Supplier* shall supply the complementary information necessary to establish an engineering database sufficient for the optimisation of both the PAM and reliability activities during the Plant* and/or Unit* operation.

2.18.4.3.H

The engineering data shall be provided in a format that allows direct input into the proposed PAM database without editing, translating, or other manual processing of the data by the Owner*.

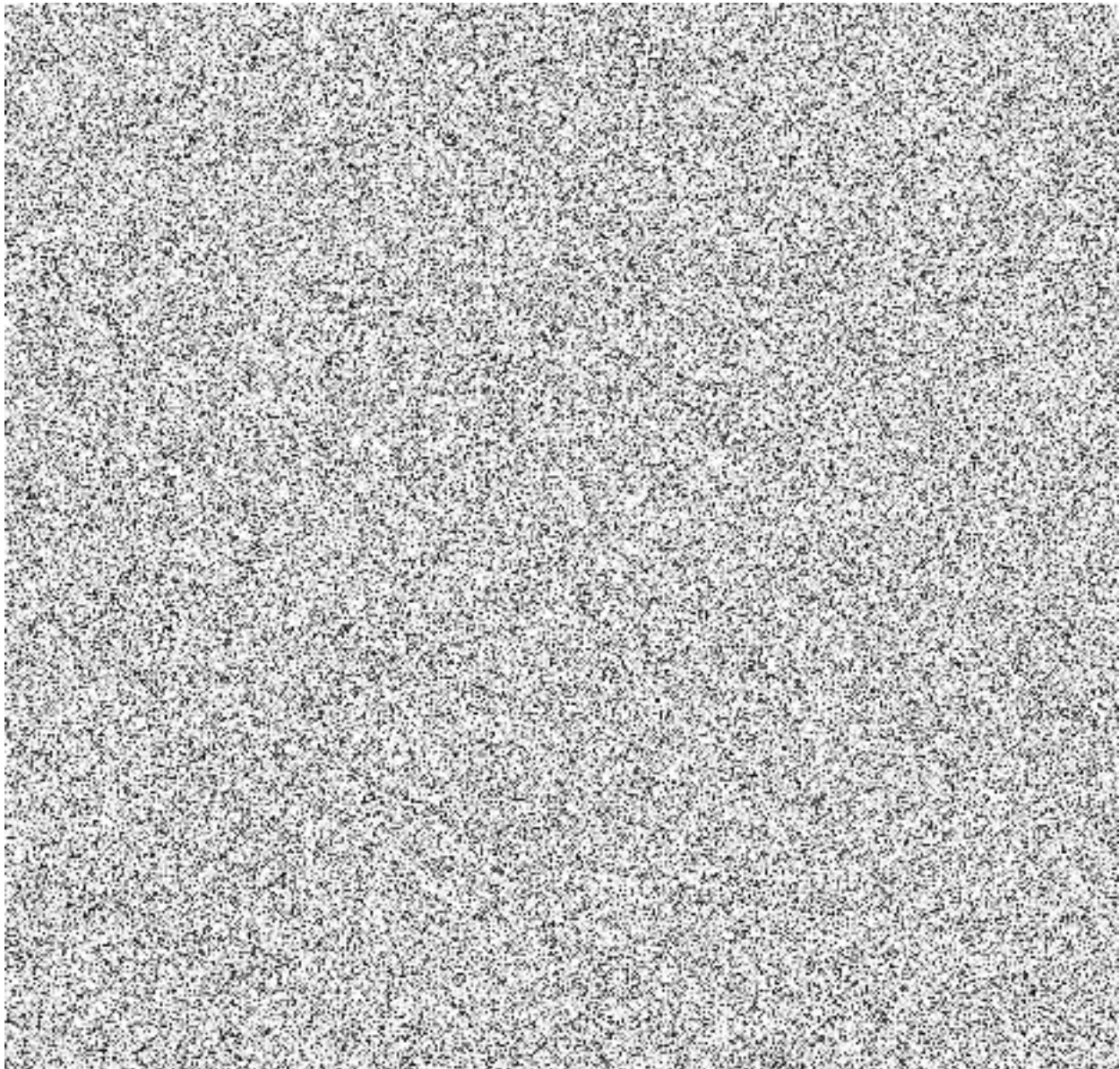
2.18.5 AVAILABILITY ANALYSIS PROCESS

2.18.5.1 ANALYSIS REQUIREMENT

2.18.5.1.A

The Supplier* shall develop and perform an availability analysis for the Plant* and/or Unit* SSC whose reliability has a significant effect on the Unit* reliability and availability objectives.

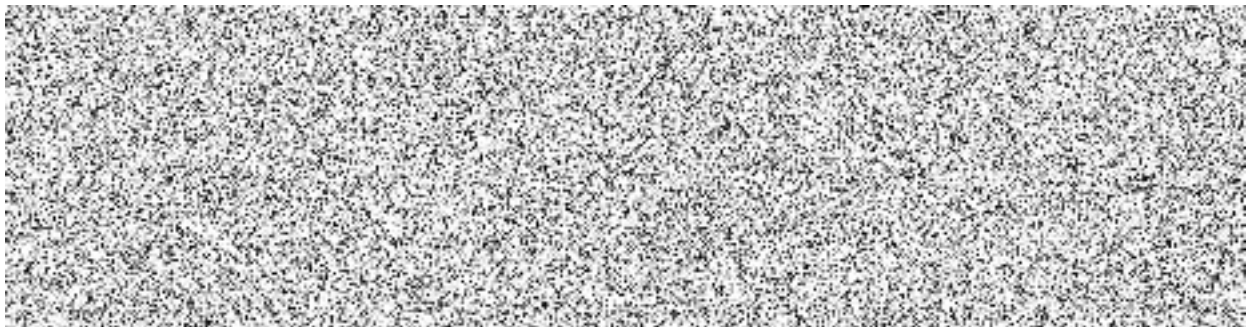
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2.18.5.2 DEVELOPMENT OF MAIN FUNCTIONS LEVEL MODELS

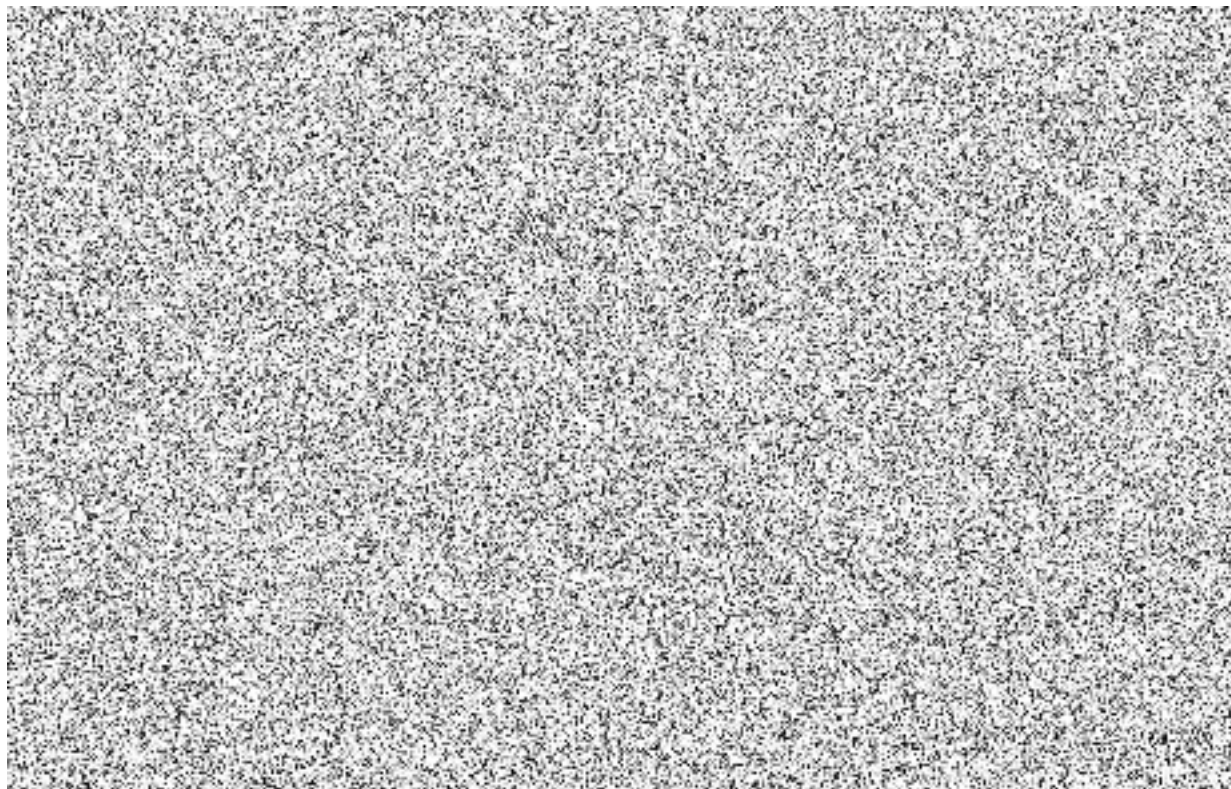
2.18.5.2.A

An availability model shall be developed for Plant* and/or Unit* main functions.

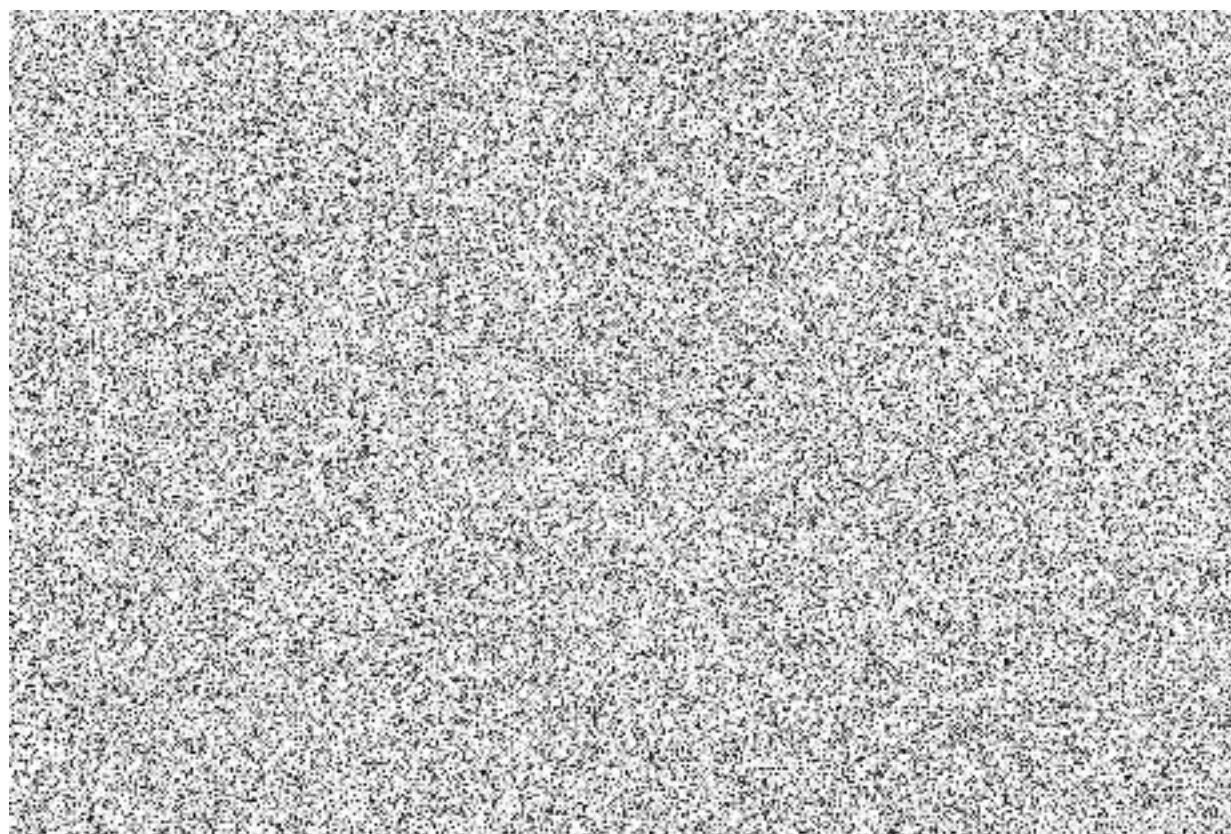


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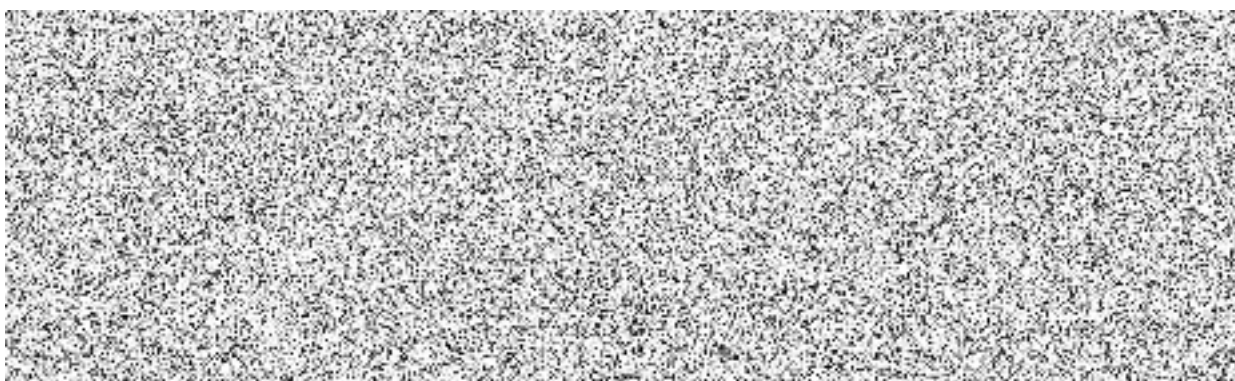
2.18.5.3 MODELLING TECHNIQUES



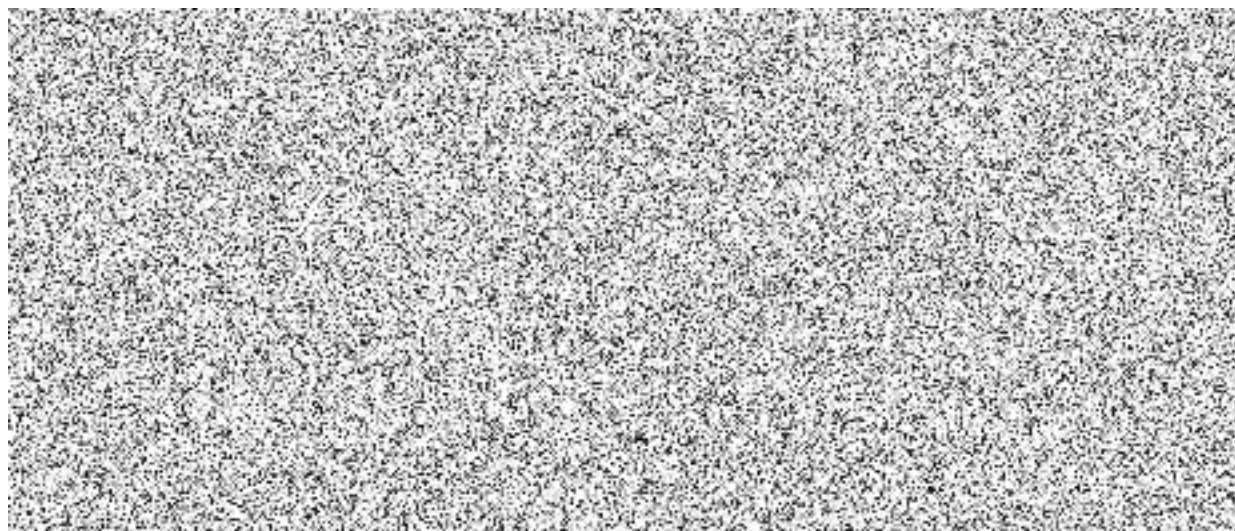
2.18.5.4 UNAVAILABILITY ALLOCATION



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2.18.5.5 CONTENT OF ANALYSIS



2.18.6 OUTAGE OPTIMISATION

A

The Supplier* shall demonstrate the Planned Outages* durations as specified in Technical Requirements Document* , Section 2.2.7.2.2.

AA

The Outage Duration* shall take into account the necessary start-up testing.

2.18.6.1 REFERENCE OUTAGE PROGRAMMES

A

The Supplier* shall develop the reference outage programmes for the different Planned Outages* in order to demonstrate the Planned Outages* durations as specified in Section 2.2.7.2.2.

AA

Whereas main functions availability analysis is based on the probabilistic approach, the outage planning shall be prepared on a deterministic basis using experience from the existing PWR.

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AB

The time frame for each major outage activity shall be justified in terms of actual experience from the existing PWR and the Plant* and/or Unit* design features to reduce the Planned Outages* durations.

AC

The time frames shall take into account fuel related activities, such as fuel transport from fresh fuel storage to the refuelling cavity, loading of the spent fuel cask and its transport out of the Unit*, fuel leak testing, leaking fuel Inspection* and repair, etc.

2.18.6.2 START-UP TEST PROGRAMME

2.18.6.2.A

The Supplier* shall develop an optimised start-up test programme.

AA

The start-up tests shall be optimized and, as far as possible, automated in order to reduce human errors and to minimize their impact on the critical path of the outage.

2.18.6.2.B

As a basis for this review and optimisation, the Supplier* shall consider existing start-up test programmes and any reports on optimisation of these test programmes which have been made.

2.18.6.2.C

The Supplier* shall also consult with staff experienced in start-up and operation.

2.18.6.2.D

The Supplier* shall incorporate the relevant consequences of this review/optimisation into the design of the Plant* and/or Unit*.

2.18.7 RECOMMENDED RELIABILITY ACTIVITIES

2.18.7.A

As specified in Section 2.18.4.3, the Supplier* shall provide information on maintenance, testing, Inspections* and conditions monitoring of all SSC which are part of the availability model.

AA

The maintenance, testing, Inspections* and conditions monitoring are key assumptions of the PAM.

2.18.7.B

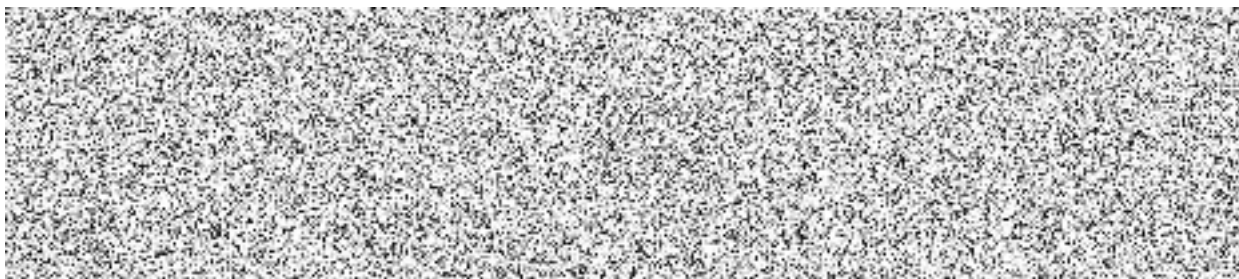
This maintenance, testing and Inspections* activities and conditions monitoring requirements shall be integrated into the Plant* and/or Unit* design and procedures (see Operation and Maintenance Document* Section 3.5).

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2.18.8 DOCUMENTATION

2.18.8.A

The Performance Assessment Methodology shall be documented by the Supplier* and be included as part of the design documentation for the Owner*.



2.18.8.B

The experience review, the performance analysis and the assumed maintenance, testing, Inspections* and conditions monitoring shall provide a useful technical base for future optimisation of reliability assurance activities by the Owner* (i.e. optimization of maintenance, testing, Inspections* and condition monitoring and associated programmes and procedures).

2.18.8.1 MONITORING OF PAM DESIGN ASSUMPTIONS

2.18.8.1.A

For those portions of the design that are important for the Plant* and/or Unit* performance assessment, the assumptions to be maintained in effect by each of the participants in the design and construction process shall be defined by the Supplier*, to facilitate the setting up of a PAM that can be used by the Owner* for supporting Plant* and/or Unit* operation.

AA

For portions of the Plant* and/or Unit* design that are not sufficiently detailed, monitoring requirements shall be established by the Supplier* to maintain the validity of the performance assessment during Plant* and/or Unit* SSC procurement, manufacturing, storage and Plant* and/or Unit* construction and SSC erection.

AB

The assumptions include also the maintenance, testing and Inspection* activities and conditions monitoring.

AC

All of these shall be subject to reliability assurance programme specified in Chapter 2.15.

2.18.8.1.B

These assumptions shall be included as part of the final design documentation.

2.18.8.2 PLANT OPERATION FEEDBACK

A

Monitoring requirements shall be established by the Supplier* to maintain validity of the Plant* and/or Unit* performance assessment as specified in Section 2.15.5.4.

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2.18.8.3 DESIGN ORGANIZATION INTERFACE

A

The documentation and insights gained from the PAM shall be used within the reliability assurance programme as specified in Chapter 2.15.

2.18.9 HISTORICAL LWR UNAVAILABILITY

2.18.9.1 TABLE 1: HISTORICAL PWR UNAVAILABILITY

- Planned Outages*
 1. Refuelling (1)
 2. Planned Maintenance
- Forced Outages* (distribution by plant systems)
 1. Main Steam System
 2. Turbine/Generator
 3. Reactor Coolant System*
 4. Main Feedwater
 5. RPV Internals
 6. Main Steam Isolation
 7. Off-site Power
 8. Auxiliary Feedwater
 9. Core*
 10. Reactivity Control
 11. Reactor Protection
 12. Main Condenser

Notes:

(1) Concurrent with planned maintenance which also includes Inspection* & retrofits.

2.18.10 MAIN SYSTEMS CONTRIBUTING TO CURRENT LWR UNPLANNED TRIPS

2.18.10.1 TABLE 3: CURRENT PWR UNPLANNED TRIPS

1. Main Feedwater System and Instrumentation
2. Turbine-Generator System and Controls
3. Reactor Protection System*
4. Vital AC Power Systems
5. Reactivity Control Systems/Control Element Drive Mechanism
6. Main Steam System and Instrumentation
7. On-Site Electrical Power Systems
8. Off-Site Electrical Power Systems

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CHAPTER 2.18A METHODOLOGY FOR ASSESSING OVERALL AVAILABILITY

2.18A.A

The method consists in assessing the overall average availability of the Unit* over a representative operating period of 20 years that includes all kinds of outages foreseen at the design stage: Forced Outages*, Planned Outages* and outages for special works.

2.18A.B

Availability assessment of Plant and/or Unit* shall consider Site*-specific aspects (layout, etc.).

BA

However, it shall not consider Owner*-specific contributors.

BB

Special attention shall be paid to any common SSC and/or services, if applicable.

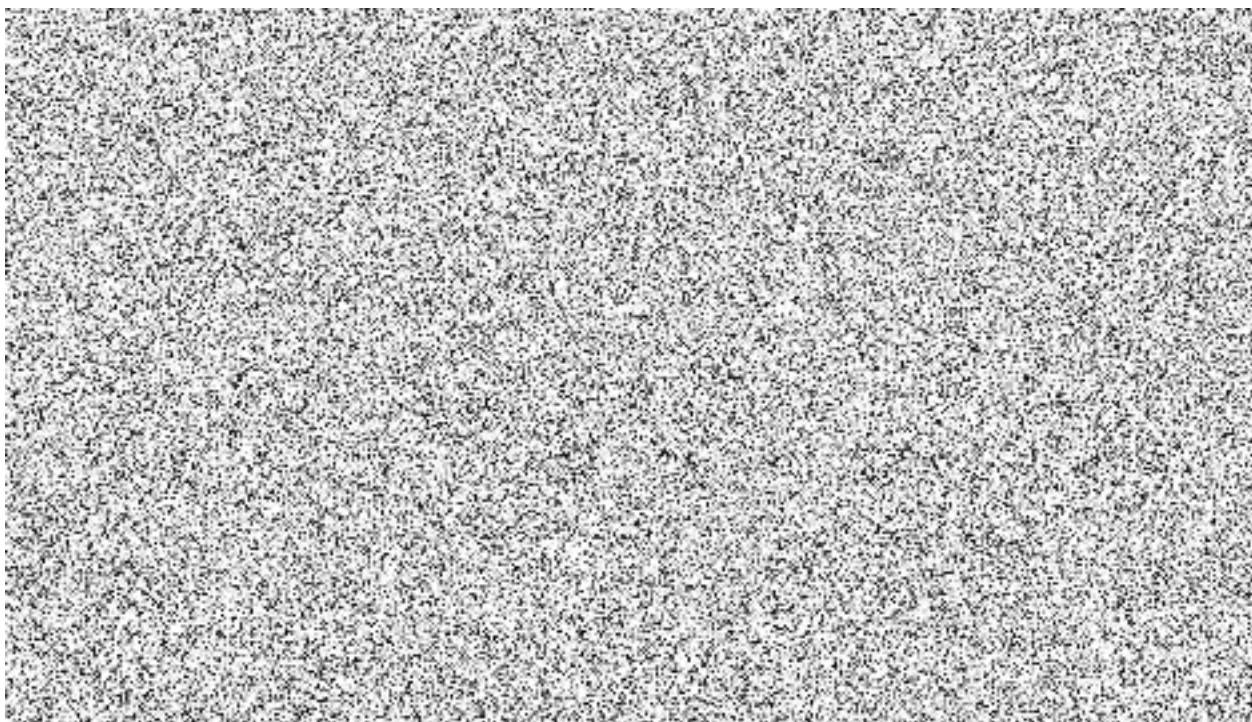
2.18A.C

In the Plant* operating lifetime the least frequent outage that can be foreseen at the design stage is generally the major In-Service-Inspection Outage* required by the Authorities* to inspect a large number of components.



DA

Otherwise, a shorter period shall be assumed.



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CHAPTER 2.19 SAFETY ASSESSMENT

2.19.1. SAFETY ASSESSMENT AND LICENSING DOCUMENTS UPDATE

2.19.1.A

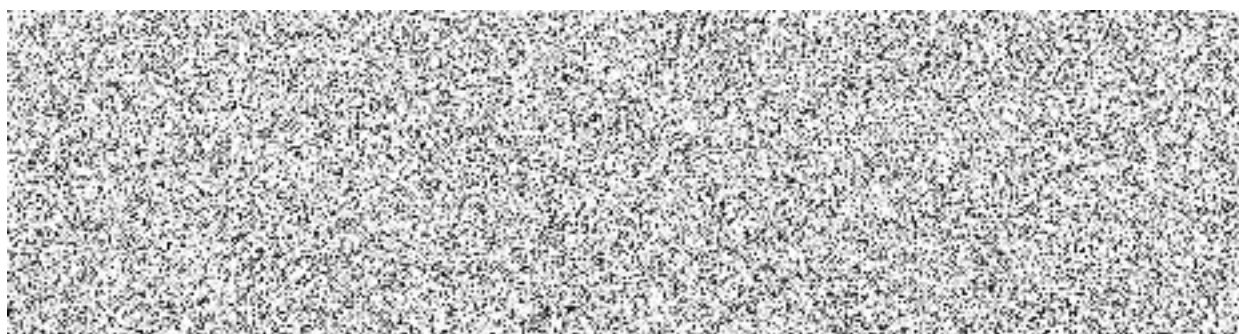
The Supplier* shall provide to the Owner* sufficient data, Documents*, other relevant information and training in order to enable the Owner* or the Owner's* Subcontractors* to execute the legal obligations in performing Safety Assessment and Licensing Documents* Update throughout the Plant* lifetime, independently of the Supplier's* support.

2.19.1.B

All necessary data, Documents*, information and training shall be provided by the Supplier* as soon as is practicable in the design and construction processes, so that verification, validation and approval of the safety assessment by the Owner* can be completed before operation of the Plant* is commenced. Data, Documents*, information and training provided by the Supplier* shall ensure that following the Provisional Takeover* of the Plant* all safety assessments and updates of Licensing Documents* can be done by the Owner's* personnel or by the Owner's* Subcontractors*.

2.19.1.C

Safety assessment shall concern matters relevant to nuclear safety, radiation protection, technical safety, radiation monitoring, emergency preparedness and security through the Plant* lifetime and shall include:



2.19.1.E

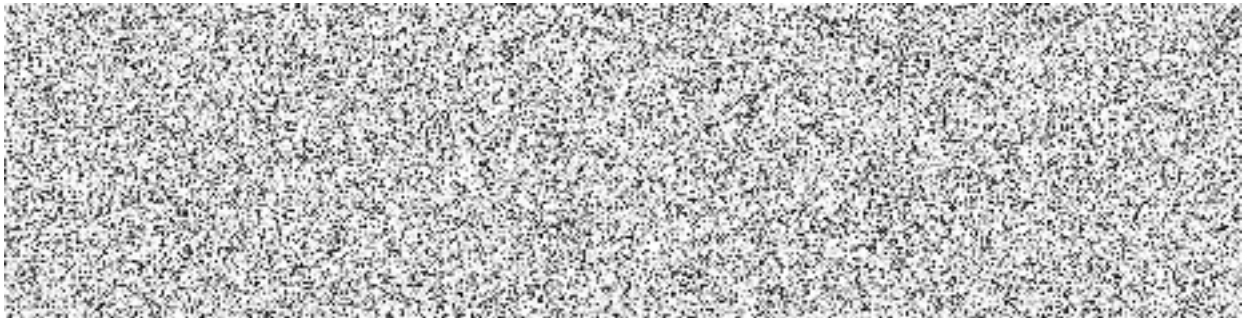
In addition, the Supplier* shall provide cooperation and support as necessary for maintaining the design basis over the Plant* lifetime as part of the LTSA (see the Terms and Conditions* Section 19.6).

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2.19.2. INDEPENDENT VERIFICATION OF SAFETY ANALYSIS

2.19.2.A

The Supplier* shall provide to the Owner* sufficient data, Documents*, information and training in order to enable the Owner* or the Owner's* Subcontractors* in accordance with the Rules* and IAEA Safety Standards to perform the Independent Verification of Safety Analysis.

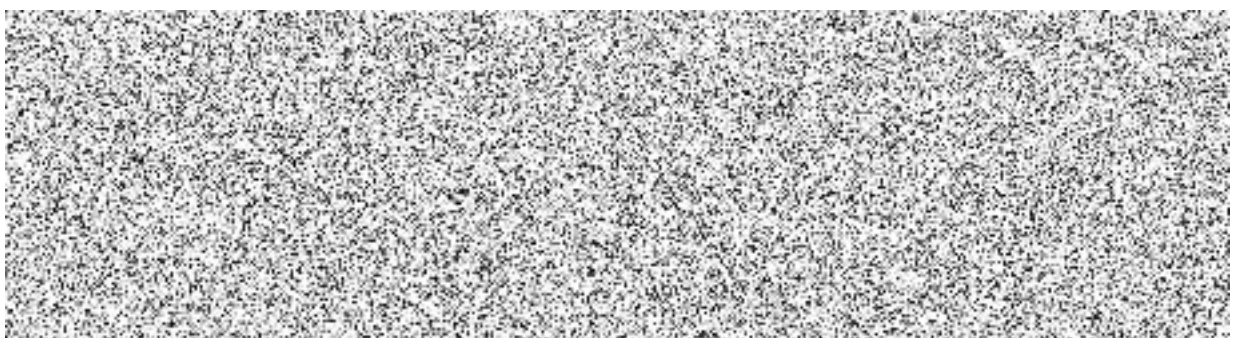
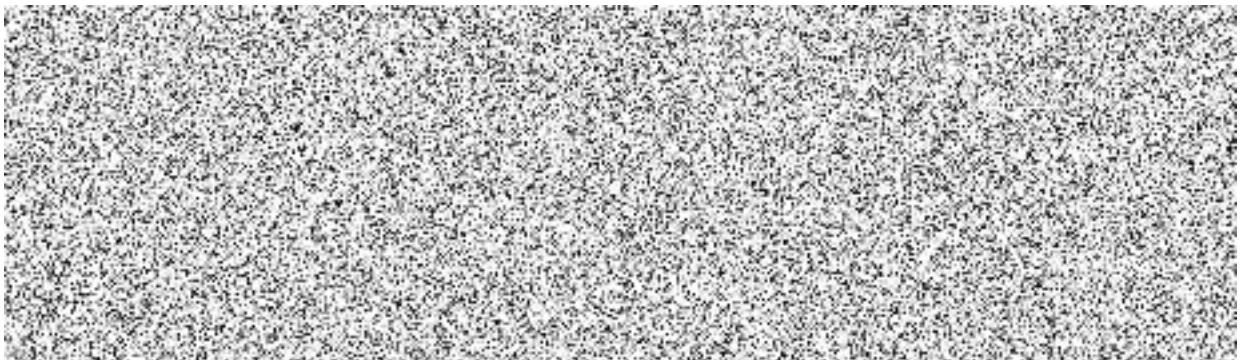


2.19.2.C

Information requested from the Supplier* shall be provided as soon as is practicable, in parallel with finalization of the respective part of the design, in order to allow timely completion of the first independent verification analyses before applying for license for the construction of a nuclear installation. The plant design information that will be provided shall be complete, accurate, and consistent with information included in PSAR and shall be updated to as-built status to be consistent with information in FSAR.

CA

The selected information related to Fuel System* shall be handed over to the Owner* separately within the Nuclear Fuel Contract* (in order to ensure consistency with other relevant information provided to the Owner*).



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2.19.2.F

The detailed scope and the structure of the information needed for the Independent Verification of Safety Analysis will be defined by the Owner* or the Owner's* Subcontractors*. The Supplier* shall provide to the Owner* the data and all necessary support that the Owner* may reasonably require in the process of the Independent Verification of Safety Analysis. In particular, the Supplier* shall provide cooperation aimed at clarification and justification of the differences in the results of analyses provided by the Supplier* and the independent verification.

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CHAPTER 2.20 TRAINING SIMULATOR

2.20.0 INTRODUCTION

2.20.0.A

The purpose of this chapter is to establish functional and design requirements, related to the Training Simulator* of the Plant*.

2.20.1 GENERAL

2.20.1.A

The Supplier* shall provide a full scope Training Simulator*. The earlier of the Units* to be constructed on the Site* will be the reference unit for the Training Simulator* i.e. the simulator control room configuration, system control arrangement and simulator design database shall be derived from the earlier Unit*.

AA

The Supplier* shall provide to the Owner* set of information related to the differences of the latter Unit* to the reference unit (if any), which are applicable to the Training Simulator* characteristics such as simulator control room configuration, system control arrangement and simulator design database; such set of information shall also cover Commissioning* and operation phases of the latter Unit* and shall be comprehensive to allow use of the Training Simulator* for training of the personnel pertaining to the latter Unit*.

AB

The Supplier* shall provide following Specific Simulators:

- 1) Plant* Engineering Simulator for studying Plant* response, human-engineering aspects of the Plant*, controls, control room design and training purposes with full scope model of the Plant*.
- 2) Virtual MMIS Simulator for the engineering purposes, representing the digital twin of Plant I&C.
- 3) Core Simulator for training of Reactor Engineers of reactor core management team.

For all these Specific Simulators, the Supplier* shall provide all information, documentation, training and support in the same scope as for Training Simulator*. For the avoidance of doubt, requirements of the Chapter 2.20 shall apply to these Specific Simulators as appropriate, respecting their different purposes and characteristics.

2.20.1.B

This chapter presents the design bases, general, functional and technical requirements for the Training Simulator* which shall be used for the Plant* personnel training and examination, emergency preparedness training and for development, verification and validation of any further modifications and improvements to the Plant*.

2.20.1.C

A reliable and proven solution of Training Simulator* as well as completeness and fidelity of delivery fulfilling training needs shall be the primary goal of the Training Simulator* design.

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2.20.1.D

The design shall be well balanced as defined in the Section 2.12.1.3.2.

2.20.2 GENERAL REQUIREMENTS

2.20.2.1 CODES AND STANDARDS

2.20.2.1.A

All Training Simulator* systems shall comply with the requirements of the Rules* specified in the Technical Requirements Document*, Chapter 2.5.

2.20.2.1.B

In cases when applicable Codes and Standards* do not exist, reasonable and commonly accepted practice shall be followed in terms of design, preparation, erection, development software methods and testing rules, etc.

2.20.2.2 SUPPLIER'S SCOPE OF SUPPLY

2.20.2.2.A

The Supplier* shall provide the Training Simulator* based on the design of the reference unit.

AA

The scope shall include replicas of MCR and ECR, dedicated H-MI for the presentation of live Training Simulator* data in Technical Support Centre* for emergency preparedness training purposes and simulator classroom equipment for training sessions, explanation and evaluation. For the avoidance of doubt, wherever this Chapter 2.20 refers solely to MCR replica, such requirement shall be also adequately applied to ECR replica.

AB

The Supplier's Scope of Supply* shall include among others all equipment and any activities for the development, design, production, implementation of the Training Simulator* and for a satisfactory and reliable operation under all operation conditions as well as for convenient and proper maintenance and further development of the Training Simulator*.

AC

The Training Simulator* shall be designed by the Supplier* for the use in the Plant* personnel training and examination, emergency preparedness training and for development, verification and validation of any further modifications and improvements to the Plant*. It shall be designed for a complete and accurate simulation of reference unit systems during the Design Basis Conditions* and Design Extension Conditions* scenarios.

AD

For functional requirements refer to Technical Requirements Document*, Section 2.20.3



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BA

Immediately before the Provisional Takeover* of the first Unit*, the Supplier* shall provide final update of the Training Simulator*, if necessary to keep the Training Simulator* fidelity with the reference unit. For avoidance of doubt, this scope is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

BB

After the Provisional Takeover* of the first Unit*, if the Commissioning* and operation of the reference unit reveal any new specific features in the operation of the reference unit, then such modifications shall also be incorporated by the Supplier* in the Training Simulator*. For avoidance of doubt, this scope is not included in the Supplier's Scope of Supply* at the LWA Date*. However, such scope can be added to the Supplier's Scope of Supply* upon request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

2.20.2.2.C

The Supplier* shall provide following information and services:

- Perform on-job training for Owner's* personnel or staff of its designated supplier to familiarize them with design, operation and maintenance.
- Collect and document the reference data of the Training Simulator*, as well as put all collected information together, thereby facilitating suitable and effective use of the information at all stages of design, development, operation and maintenance of the Training Simulator*.
- Training Simulator* Configuration Management* shall be integrated with Plant* Configuration Management* system.
See the Technical Requirements Document*, Section 2.12.9.
- Provide the Owner* with all information needed to be able to collect the data regarding the Site* and needed by the Supplier* to design, construct, test and operate the Training Simulator*.
- Make it possible for the Owner* to follow the implementation of the design, quality verification in compliance with PQM and testing of the Training Simulator* and to become familiar with the Training Simulator* equipment and systems for training of the Owner's* personnel in operation, maintenance and development activities.
- Demonstrate that the Training Simulator* meets the design requirements and specifications.
- Provide technical assistance for the simulator SW until the date of Provisional Takeover*.

CA

The Supplier* shall respect EPRI Guideline on Configuration Management No. 1022991, and 3002015755.

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2.20.2.2.D

The Supplier* shall provide documentation in accordance with Section 2.2.3 of the Scope of Supply Document*, and Section 2.20.2.4 of this Technical Requirements Document*.

2.20.2.3 OWNER'S SCOPE OF SUPPLY

N/A

2.20.2.4 DOCUMENTATION

2.20.2.4.A

The Supplier* shall submit all documentation, information and software according to the schedule in order to avoid any schedule-related delays.

2.20.2.4.B

Documentation shall be supplied to enable the Owner* to:

- Be knowledgeable about the conception of the Training Simulator* as a whole and about its functions, operation, maintenance and software development tools
- Control the progress of the work
- Check the correspondence of the Training Simulator* to the specified operating characteristics, and its compliance with the applicable Codes and Standards* requirements and tests, to ensure that all design requirements and specifications are met

BA

This documentation shall include at least the following:

Software Quality Plan, Verification and Validation Plan and Software Management Plan.

BB

A set of Design and Engineering Documentation (DED) shall contain technical notes and calculations, constructive drawings, hardware specifications, software specifications and description of software applications, documentation concerning the factory tests and others showing how the Supplier* intends to meet the requirements and specifications.

BC

The content of the DED shall be complete and detailed to enable it to be duly analysed. During the design and implementation process of the Training Simulator*, the DED shall include supplementary material, comments or corrections by mutual agreement of both Parties*. Nevertheless, when necessary, the Owner* shall have the right to require the Supplier* to provide additional information.

BD

The Supplier* shall give to the Owner* all definitive documents, in order to obtain a complete notion about the Training Simulator*, its structure, effective operation, maintenance and development.

BE

For additional requirements related to design process see Section 2.12 of the Technical Requirements Document*.

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2.20.2.4.C

The reference data concerning the reference unit shall be presented in the form of a full data base (as specified in Technical Requirements Document*, Section 2.20.3.6.4).

2.20.2.4.D

The Supplier* shall provide the Owner* with operation and maintenance manuals that shall contain detailed information on all simulator systems and equipment. The manuals shall be written in enough depth of detail to enable the Owner's* Training Simulator* operating staff (who will have been previously trained by the Supplier*) to operate, maintain and improve the Training Simulator* in an appropriate and effective way. The Supplier* shall supplement the information and instructions contained in the standard Suppliers* manuals. In particular, the manuals shall contain all necessary instructions for operation, maintenance and development of software.

2.20.2.5 TRAINING OF SIMULATOR OPERATIONAL PERSONNEL

2.20.2.5.A

The Supplier* shall provide training of the operation and maintenance personnel, as well as the personnel involved in the implementation of further modifications and upgrades of the Training Simulator*.

2.20.2.5.B

The training shall be carried out in accordance with the training documentation approved by the Owner*.

BA

The Supplier* shall provide adequate training materials, training aids for training of the Owner's* personnel in accordance with the training programmes in a timely manner.

2.20.2.5.C

The Supplier* shall carry out the training of the Owner's* personnel in accordance with the training programmes in a timely manner.

2.20.2.5.D

Requirements relating to training of the operation personnel are stipulated in the Operation and Maintenance Document*, Chapter 2.

2.20.2.6 ACCEPTANCE AND AVAILABILITY TESTS

2.20.2.6.A

Testing shall prove that the Training Simulator* is complete, all functions are properly tested and don't exist noticeable differences between the simulator control rooms or simulated systems when evaluated against the control rooms or systems of the reference unit.

AA

The Supplier* shall provide the Owner* with quality related records for all test as stipulated in the Licensing and Permitting, Safety and Quality Document*, Section 3.2.

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AB

The Owner* shall be entitled to inspect any of the Supplier's* activities as stipulated in the Terms and Conditions*, Section 6.2.

2.20.2.6.B

The Commissioning* of the Training Simulator* shall be performed in accordance with requirement stipulated in the Construction and Commissioning Document*.

2.20.2.6.C

Until the date of ready-to-train, the Supplier* shall ensure tests at least as below:

1. Factory acceptance tests as stipulated in the Construction and Commissioning Document*, Section 2.8.1
2. Site acceptance tests as stipulated in the Construction and Commissioning Document*, Section 2.8.2
3. Availability tests as stipulated in the Technical Requirements Document*, Section 2.20.2.6.3

CA

During the Training Simulator* testing following types of tests shall be at least performed by the Supplier*:

- Simulator verification and validation
- Simulator performance testing
- Simulator operability testing
- Simulator scenario- based testing
- Simulator reactor core performance testing
- Post-event simulator testing

2.20.2.6.D

The detailed schedule shall be developed based on the integrated project time schedule.

2.20.2.6.1 FACTORY ACCEPTANCE TESTS

2.20.2.6.1.A

The Training Simulator* hardware, software and functions shall be tested prior to the delivery from the Supplier's* facility to the Site* for the final installation as stipulated in Construction and Commissioning Document*, Section 2.8.1.

AA

During the Factory Acceptance Testing the Supplier* shall perform tests that are comprehensive enough to give confidence that the Training Simulator* capabilities and performance is in accordance with the requirements and specifications under Mandatory Law* and EPC Contract*.

2.20.2.6.2 READY-TO-TRAIN ACCEPTANCE TESTS

2.20.2.6.2.A

In accordance with the Operation and Maintenance Document*, training programs, procedures, training facility shall be approved by Authorities* for training, including Training Simulator* equipment and software. At that time simulator is ready-to-train.

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2.20.2.6.2.B

At appropriate time for application for approval to Authorities*, the Training Simulator* shall be fully completed, tested and compliance of training programs and procedures shall be confirmed with the requirements and specifications.

2.20.2.6.3 AVAILABILITY TESTS

2.20.2.6.3.A

The availability tests shall be carried out as a part of the Commissioning*. The availability tests shall be run for at least 500 hours.

2.20.2.6.3.B

The purpose of the availability tests is to show that the Training Simulator* is capable of performing all of the necessary operations without disturbance in the operation of the equipment, the software or the functioning, and thereby verify that the complete Training Simulator* is ready for day-to-day use for training of licensed personnel.

2.20.2.6.3.C

The Supplier* shall carry out the availability tests. The Supplier* shall specify a procedure for carrying out the availability tests on the Training Simulator* that shall be approved by the Owner*. If the availability tests are stopped due to any reason for which the Supplier* is responsible, then after the elimination of the cause of the interruption according to the conditions presented below, either the time for performing the tests shall be increased or performance of the tests shall start again.

CA

Any interruption in the availability tests shall lead to prolongation of the time frames for performing the tests, provided that no single interruption exceeds 12 hours, or that the total duration of all interruptions does not exceed 24 hours. The prolonged testing period shall correspond to the total duration of all delays. In addition, an interruption in the availability tests shall lead to restart the tests, provided that any single interruption exceeds 12 hours, or that the total duration of all interruptions exceeds 24 hours, or the number of the interruptions is greater than 3.

CB

Interruptions due to the operation of equipment and/or components not included in the Supplier's Scope of Supply* shall not be considered as interruptions in the availability tests.

2.20.2.6.4 OPERATOR TRAINING PHASE

2.20.2.6.4.A

After the Training Simulator* is ready-to-train as defined in Section 2.20.2.6.C, the Owner* shall perform maintenance of the Training Simulator* in accordance with the Documents* for maintenance provided by the Supplier*. The Owner* shall be liable for defects and deficiencies caused by the improper maintenance of the Training Simulator*, provided that the Owner* breaches any instruction of the respective Document* for maintenance. The Supplier* shall ensure the replacement parts and special tools needed for the Training Simulator* maintenance.

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2.20.2.7 DELIVERY AND FINAL INSTALLATION

2.20.2.7.A

The Supplier* shall ensure and prove that delivery and final installation complies with the requirements provided under the EPC Contract*.

For other related information refer to Terms and Conditions*, Chapter 18.

2.20.2.8 TRAINING SIMULATOR PROJECT INTRODUCTION

2.20.2.8.A

The extensive applicability of the Training Simulator* at every stage of the Plant* design process shall be demonstrated, therefore the Training Simulator* can be effectively used during the development, verification and validation of any further modifications and improvements to the Plant*.

2.20.2.8.B

At every stage of the design and development, the Training Simulator* and/or Plant* engineering simulator/performance model (refer to Technical Requirements Document*, Section 2.12.10.4) shall be widely utilized to verify and validate the Plant* design to provide evidence of the correct functions, capability and performance of the Plant*. Such work includes, but is not limited to, verification and validation of the Safety Systems*, the electrical systems, the monitoring and control system, the design of the MCR and H-MI, as well as the operating procedures, including emergency operating procedures and Severe Accident Management Guidelines* (For further information refer to Operation and Maintenance Document*, Section 3.3).

BA

Because the Training Simulator* models shall be real models with the best rating and shall cover the entire scope of the reference unit, the data obtained from using the Training Simulator* as well as the support can subsequently be utilized further for detailed development of the Probabilistic Safety Assessment (PSA), an activity which shall also be included in the Training Simulator* implementation project.

2.20.2.8.C

Owner's* personnel shall be incorporated into testing phase to familiarize with Training Simulator*, after ready-to-train the Supplier* shall promote operational personnel training.

2.20.3 FUNCTIONAL REQUIREMENTS

2.20.3.1 GENERAL CONSIDERATIONS

2.20.3.1.A

This section presents the main functional requirements for the full-scope Training Simulator* applicable to the Supplier's Scope of Supply*. The Training Simulator* system design, in accordance with the requirements and specifications shall be based upon the reference data, which describes the performance, operation, physical properties, operational experience and other relevant characteristics of the reference unit.

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2.20.3.2 PLANT MODEL

2.20.3.2.1 SCOPE OF SIMULATION AND FUNCTIONS

2.20.3.2.1.A

The scope, fidelity and range of operating conditions of the evaluations, simulated Structures, Systems and Components* shall be carefully assessed based on the objectives and needs. In general, the systems directly involved with nuclear safety and the power production shall be simulated in great detail. Auxiliary systems such as air conditioning, water treatment, etc. are only simulated as much as is necessary to produce realistic response in the MCR and the ECR of the Training Simulator*.

2.20.3.2.1.B

The Training Simulator* shall include a complete simulation of all the systems characteristics of the reference unit. System models shall simulate all interfaces with other simulated systems and provide a realistic, integrated simulation for normal, abnormal and emergency plant conditions including all the Design Basis Conditions* and the Design Extension Conditions* scenarios.

2.20.3.2.1.C

The Training Simulator* response shall not depart from actual reference unit response in any aspect that would tend to mislead the Operator* or cause an inappropriate Operator* action. Characteristics of equipment and components of the systems such as motors, pumps, valves, regulators etc. shall be included to reproduce the correct static and dynamic performance of the systems.

CA

Within the scope of simulation are also refuelling outages with open reactor vessel and water level low in it (i.e., with the water level only reaching approximately half of the main primary loop nozzles).

CB

All performance and handling characteristics in the MCR and the ECR shall be faithfully simulated as specified herein and in accordance with the approved data. All major characteristics and functions of digital control systems, plant process computers and computerized H-MI systems shall be reproduced with a high fidelity.

CC

Appropriate computer driven displays, instruments, recorders, alarms and position indications shall automatically follow the operations of the various controls. The Training Simulator* shall provide the transient response caused by changes in various pressures and flows, moderator temperature, fuel temperature, fission product inventory and rod positions, etc.

CD

Operating procedures shall also be able to be performed in the MCR with realistic responses on the available instrumentation. The Training Simulator* shall simulate process variables corresponding to the particular operating conditions, display these variables on the relevant instruments and computer displays, and provide the proper alarm or protection actions when predetermined limits are approached or exceeded.

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2.20.3.2.1.D

The scope of simulation of administrative systems closely interacting with the I&C systems and used in the administration of the Plant* operation shall be evaluated by the Supplier* and implemented to an extent relevant to reach the training objectives. Especially systems to supervise the Technical Specifications* compliance and safety status of the Plant* shall be included in the scope of simulation.

2.20.3.2.1.E

It shall be possible to experience all modes of refuelling outage, normal and disturbed operation according to the operating procedures of reference unit. Also periodical testing performed to plant or system level shall be included. The transients analysed in the safety analysis of the Plant* and the tests performed during the Commissioning* as well as the malfunctions listed in Section 2.20.3.3 shall also be executable in a realistic way in the Training Simulator*. As all of Training Simulator* models shall be based on the laws of physics, the response of the Training Simulator* shall be realistic within its full operating range from room temperature to core overheating, from zero power to the highest power anticipated in severe disturbances and accidents.

2.20.3.2.1.F

Provisions shall be taken to alert the Instructor when model parameters exceed values indicative of events beyond the expected Plant* behaviour.

2.20.3.2.1.G

Thermo-hydraulic and neutron physics processes in the Core* shall be simulated with high fidelity utilizing 3 dimensional physical models. All significant reactivity factors and feedbacks shall be included. Reactivity effects due to Xenon build-up and decay shall be considered. The Training Simulator* shall be capable of simulating variations in operating and transient conditions that occur from beginning to end of all types of fuel cycles including first cycle. Simulator shall provide information about reactivity and power distribution in the Core* for all modelled situation.

2.20.3.2.1.H

The required local operator actions or local control of centrally controlled equipment shall be simulated by appropriate instructor's functions. In systems not simulated in great detail such as conditions of the plant cooling water and outside grid conditions, the instructor should control certain parameters and alarm functions to give the correct input to the MCR instruments and other systems.

2.20.3.2.1.I

The preparation for refuelling (e.g. mechanical work as reactor vessel head removal) and for start-up after refuelling shall also be carried out as instructor functions.

2.20.3.2.1.J

The electrical system model shall simulate the powers, frequencies, voltages and currents in the systems for auxiliary power and the main generator connection to the external grid. The inputs to the electrical system models include pump, fan motor states, breaker states and states of protection relays and other automatics, malfunction status and external parameters set by the instructor.

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JA

The model of Plant* electrical power generation shall enable Operator* training in the several operation modes in which the Plant* can operate. Other information are stipulated in the Section 4.2.8.1.2

JB

The auxiliary AC and DC power supplies shall be simulated in great detail. The power supply to a motor control valve, control and measuring circuits including the protection devices shall be simulated.

JC

The external grid shall be simulated to the extent needed to give a realistic voltage and frequency response to disturbances in the grid. Typical minimum and maximum load scenarios for the grid shall be included.

JD

Model of the Plant* electric systems shall enable training in the island mode (the operation to the outer electrical grid is restricted). The island mode shall be capable of operating under variable stress loads. It shall be possible to change from the island mode to normal operating mode.

2.20.3.2.1.K

The simulation of the automation, control and instrumentation of the process and electrical systems shall also be simulated, divided into modules following the general construction principles of the Plant*.

KA

The overall digital I&C system (including plant process computer system) and H-MI implementation shall be, as a minimum requirement, based on utilizing the same high level input specification, which is used to generate the actual running software system, to generate the model software. As an alternative, the same final software shall be used in the simulation models as in the Plant*.

2.20.3.2.1.L

The effect of boron on the reactivity and the water chemistry shall be simulated with high fidelity. In addition the water chemistry shall be simulated to give a realistic response in conductivity measurements and also a correct input for the build-up of activated corrosion products for the radioactivity models. Input parameters, which are set by the instructor, are amounts of corrosion products.

LA

The model for radioactivity content in water and room atmosphere shall generate reasonable radioactivity levels for the modelled radiation monitoring systems. The fission products released from leaking Fuel Rods* or the activation of the reactor coolant and corrosion products may cause radioactivity in the water. The normal paths of radioactivity in the Plant* shall be considered as well as the spreading of radioactivity inside and outside the containment during loss of coolant accidents. The decay of the radioactivity products may be approximated with the half-lives of the most important nuclides.

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2.20.3.2.2 METHODS

2.20.3.2.2.A

Each Plant* system shall be defined and implemented as a separate software model and shall have corresponding designation with the actual Plant* system. Physical objects, simulated by software, shall be maintained in identifiable, separate program modules. The structure of the model software shall reflect the actual organization of the process and instrumentation systems of the Plant* and thus provide a controlled framework for the Training Simulator* development or implementation of the general malfunctions.

2.20.3.2.2.B

All models shall be designed so that alterations to any module shall not require re-engineering of any other unchanged module. The models shall further be designed so that they are easy to tune to the reference data.

2.20.3.2.2.C

The methods used for implementation of the process models shall be based on the laws of physics and the regulator and control logic, which govern the real Plant* processes. The laws of physics and the algorithms of the regulators shall be described in mathematical form as differential and algebraic equations. The control logic is naturally represented as Boolean equations. Plant* process models shall simulate the functioning of the real process systems by solving the state equations describing the process and deriving the values for the physical variables that are measured by the process sensors. Except for the state variables, the input data to the process models includes variables calculated by other models, the states of pumps, valves and fans and of the automatics and control systems as well as malfunction status information and external parameters set by the Instructor.

2.20.3.2.2.D

All processes, which are of the same type, shall utilize the same implementation method to achieve the same model accuracy for the whole the Training Simulator*. Appropriate considerations must be taken in the treatment of unusual conditions, as well as in the alteration of the fundamental physical characteristics (water, steam, etc.).

2.20.3.2.2.E

Suitable methods shall be used to generate process and measurement noise. It shall be possible to add noise of similar nature as in the Plant* to the most important state variables. This noise shall apply through all simulation models to the different variables and to the displays in the MCR.

2.20.3.2.3 MODELED SYSTEMS

2.20.3.2.3.A

The selection of the Plant* systems, which will be subjected to modelling, shall be based on the requirements and the specifications, on the necessity of their utilization on the Training Simulator*, as well as on the application of their operational characteristics in the training process and in the validation activities.

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2.20.3.3 MALFUNCTIONS

2.20.3.3.1 GENERAL CONSIDERATIONS

2.20.3.3.1.A

The Training Simulator* shall be capable of simulating the malfunctions which are requested in the scope of the Simulation. The possibility of malfunctions has to be taken into consideration in all plant process and instrumentation system models so that full Operator* interaction as in the reference unit is possible during the malfunction.

2.20.3.3.1.B

The system shall be such that malfunctions could be added without restriction by the Owner* in case of future modification.

2.20.3.3.1.C

The malfunction shall have an address (component affected), a severity parameter (e.g. leak size) and a ramp time showing how fast the severity is increasing.

2.20.3.3.1.D

The possible instructor actions associated with the malfunctions are:

- All malfunctions shall be validated by the instructor before their initiation
- One or more malfunctions may be initiated at any time
- At any given time, the instructor shall be able to modify the value of a variable malfunction, suppress one or all active malfunctions, activate one or more malfunctions depending on the time elapsed since the malfunction introduction or on the Plant* power
- An adjustable time delay capability shall be included to insert a specific initiation time for any malfunction with a variable delay time
- Permanent visualization of all active or validated malfunctions

2.20.3.3.1.E

A final listing of malfunctions and the cause and effects of each shall be jointly agreed by the Owner* and the Supplier* but the system shall be designed so that among other considerations the instructor, with the help of general malfunctions, shall be able to execute at least the following:

- Manipulate the controls of the MCR in the same way as the Operator*
- Block or trip manoeuvre signals
- Block or trip status changes in indicators
- Introduce leakages through valves
- Block valve movement in a previously defined position
- Introduce mechanical breakdowns between electrical motors and pumps or fans
- Change the flow restrictions in heat exchangers
- Introduce internal leaks in heat exchangers
- Alter constants in regulators and amplifiers
- Block or trip electrical relay protections
- Introduce short circuits in electrical motors, transformers and electrical buses
- Introduce various faults in diesel or gas turbine plants installed

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- Introduce faults in instrumentation, computer displays or alarms in the MCR
- Introduce faults in limit switches and transmitters
- Introduce credible failures in the digital control systems

2.20.3.3.2 COMPONENT MALFUNCTION

2.20.3.3.2.A

The component malfunctions are generic malfunctions that are intended to simulate on-off or variable malfunctions on every identical component. The generic malfunctions shall be consistent with the real plant design. They shall include all the typical failure modes of a certain component. As a minimum the following component malfunctions shall be included:

AB

- Valve malfunctions
 - Stuck control valve in position
 - Blocked valve (open or closed)
 - Valve leakage
 - Spurious opening or closing
 - Safety valve set point drift
- Pump malfunctions
- Fan malfunctions
- Heat exchanger malfunctions
- Instrumentation malfunctions
 - Failure to low/high of a transmitter/meter
 - Meter override
 - Stuck meter
 - Instrument drift at a variable rate
 - Controller/regulator failure
 - Control and logic malfunctions
 - Malfunction of a control signal
 - Alarm malfunction
 - Malfunction of an automatic protection signal
 - Malfunction of an automatic analogue control
 - Instrument air leakage (in anywhere)
- Electrical
 - Spurious switch on/off of an equipment breaker
 - Spurious protection trip of a breaker
 - Stuck breaker
 - Loss of a Bus (HV, MV, LV, AC/DC power supply distribution)

2.20.3.3.3 SPECIFIC MALFUNCTIONS

2.20.3.3.3.A

Example of special characteristic failures:

- Control Rod failures
- Control Rod Withdrawal
- Stuck Rod (single or group rods)

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- Unrequested Rod (single or group) insertion or extraction
- Rod Drop
- Rod Ejection
- Rod Position Indication Failure

Reactor Coolant System*

- Small LOCA (cold leg, hot leg, intermediate leg)
- Large LOCA (cold leg, hot leg, intermediate leg)
- Pressurizer Pressure/Level Controller Failure
- Reactor Coolant Pump Trip
- Reactor Coolant Pump Blocked Rotor

Primary/Secondary Auxiliary Systems

- CVCS System Leakage
- Heat Exchangers Leakage
- SIS System Leakage
- RHR System Leakage
- Heater Leakage
- Turbine Bypass Spurious Opening/Failure
- Loss of Feedwater/Auxiliary Feedwater System
- Failure of Primary/Secondary Containment* Isolation
- Inadvertent or Degraded Containment Isolation
- Internal Flooding of Power Plant* Buildings

Steam Generator* and Main Steam System

- Steam Generator* Tube (s) Rupture
- Main Steam Line Break Inside/Outside Containment Building
- MSIV Closure
- MSIV Blocked
- MSIV Disk/Stem Separation
- MSR Internal Leakage
- Main Steam Safety Valve Failure to Open/Reclose

Turbine and Generator

- Turbine Trip
- High Pressure Fluid Leak
- Failure of Turbine Non-return Check Valve
- Generator Load Rejection
- Generator Trip

Electrical Distribution and Diesel Generator

- Main Grid Frequency / Voltage Drift
- Main Grid Disturbance

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- Loss of Main Grid
- Station Black-out
- Diesel Generator Fails to Start
- Failed Load Sequence of Diesel Generator
- Diesel Generator Trip
- Plant* Protection
- Failure of Protection Signal
- Unrequested Protection Signal
- Setpoint Drift
- Etc.

2.20.3.4 INSTRUCTOR STATION

2.20.3.4.1 GENERAL CONSIDERATIONS

2.20.3.4.1.A

The instructor's facilities shall be conveniently located in close contact with the MCR and ECR replica. The instructor shall have the capacity as directly as possible to observe the trainees' activities and also have a view of the H-MI equipment and especially of the overview panels and large screen displays.

2.20.3.4.1.B

The most important design criterion for the instructor's system shall be to have the instructor free of long operation sequences and other type of work. Instead, he shall be allowed to concentrate on advising, controlling and evaluating the trainees in an environment that is as comfortable as possible.

2.20.3.4.1.C

Special consideration shall be given to the storage and retrieval of initial conditions and backtracks in stimulated systems. The selection and initiation of initial conditions and backtracks shall include all parts and aspects of the Training Simulator*. It shall be reasonably fast to initiate and the start of the simulation shall be bump less and smooth. Historical data shall be available in the different systems to the extent beneficial for the use of the Training Simulator*.

2.20.3.4.2 INSTRUCTOR'S CONTROL FUNCTIONS

2.20.3.4.2.A

The station hardware shall provide the capability for the instructor to conveniently perform any of the following functions:

- Initialize the simulator in one of the specified initialization modes.
- Freeze and Reset the simulator dynamics but retain the I/O to the instrumentation.
- Select, control and initiate any of the specified or combined malfunctions with or without conditions.
- Initiate total of backtrack recordings that shall automatically be recorded with a time interval that can be pre-selected by the instructor. This time interval ranges from 30 sec to 60 min.

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- Initiate a snapshot of the simulator Plant* conditions at the instructor's discretion.
- Emergency power off that will safely shut down all power to the MCR and instructor's station.
- Initiate instructor remote function
- Initiate input/output override
- Initiate any of the specified monitoring functions
- Initiate recorder power off, computer fault acknowledge, master annunciator control and malfunction clear.
- Initiate simulator readiness checks which shall include diagnostics for all simulator equipment.
- Perform simulator switch check against model state. Also switch check override function shall be provided.
- Initialization of departure from real time (slow down or acceleration).
- Display the simulation diagram on the instructor station flat displays monitor. Also, the current value of each parameter shall be able to be displayed for all the dynamic parameters at each node and flow path.

2.20.3.4.2.B

It shall be possible to execute all the functions from the instructor's main console. All functions provided in the instructor's system through pushbuttons, touch screens or display menus shall also be executable from software applications running on the workstation which is defined as having this privilege. In this case, the ordinary instructor's system is disabled and vice versa.

2.20.3.4.3 SIMULATOR OPERATING FEATURES

2.20.3.4.3.A

Initialization and Reset

The instructor will select initial condition sets for simulator from the set of defined initial conditions. An initial condition table shall be provided on the colour flat display monitor at the instructor station.

AA

At the end of the factory test program, the Owner* shall have the right to determine and approve, for each initial condition, the specific Plant* system and equipment configuration.

2.20.3.4.3.B

Freeze/Run

The freeze/run function shall enable the instructor to stop and resume the progression of all dynamic simulation. When in freeze, all conditions remain static except the time axis on strip chart recorders.

2.20.3.4.3.C

Backtrack

A backtrack capability shall be provided to allow the instructor to backtrack simulations during a training exercise as an initialization mode. The computer shall automatically record into memory all simulator status at pre-selected time frames.

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2.20.3.4.3.D

Snapshot

The snapshot capability shall be provided to allow recording simulator status into computer memory at the discretion of the instructor.

2.20.3.4.3.E

Switch Check

The switch check function will identify control room switches and other instrument settings which are improperly set when the system is initialized to a new initial condition set. The switch check function shall have the following features:

EA

Any digital/analogue input which is not correctly positioned for initialization condition will cause an indicator lamp as near as possible to the control to be illuminated until the control is corrected.

EB

An on-demand display of all wrongly positioned switches or instrument settings shall be shown on the instructor's station display monitor. This on-demand function shall be initiated manually from the instructor's station. The display shall identify all wrongly positioned switches and controllers by their panel identification number, instrument number and name, and shall be automatically updated. The instructor may bypass this switch check feature. A list of all switches and instrument not concerned with the switch check function shall be supplied to the Owner* for approval as part of the instructor station preliminary design specification.

2.20.3.4.3.F

Time-Scaling

The instructor may activate a departure from real time by selecting the fast time or slow time feature for the desired mode of operation. The rate of time variation may be changed on the initial entry table. Fast time mode shall provide the capability to accelerate the dynamic simulation of a number of phenomena by 1 to 10 times the real time rate.

Fast time shall facilitate the observation of slow dynamic phases of Plant* operation.

The dynamic simulation of the following parameters shall be accelerated so that their operation will appear to be faster than real time:

- Fission product (xenon, samarium) concentration and decay heat
- Heat up and cool down rate of RPV and turbine metal temperatures
- Condenser vacuum
- Reactor coolant system* borate and dilute rate
- Primary/Secondary Containment* hydrogen
- Primary/Secondary Containment* oxygen concentration

FA

Slow time simulation shall provide an apparent expansion in time rates for all Plant* models by changing the call rate of the simulation routines. This mode shall facilitate the observation of fast changing phases of Plant* operation.

The real-time mode shall be the normal simulation mode of operation and to all systems.

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2.20.3.4.3.G

Remote Functions

The following remote functions will be performed by the instructor:

- Local actions
 - The local actions are those which are performed by Operators* outside the MCR, but that are necessary to the simulator model and to the operator training
 - The local actions include valve opening and closing, valve throttling, breaker racking in or out, etc.
 - All those local actions which are necessary to execute normal, incident and accident operating procedures shall be provided. Procedures or parts of procedures dealing with the system line-up, system draining or venting, or maintenance operations need not be taken into account.
- External parameters
 - The instructor will be able to modify external parameters which have an impact on the simulation, such as cooling water temperature, outside air temperature and humidity, fuel leakage rate, system leakage for radiation monitoring, Steam Generator* continuous leak, etc.
- Special commands
 - Instantaneous setting of the residual power
 - Boron concentration adjustment in various locations, including the Reactor Coolant System*. This could require the adjustment of the control rods position
 - Instantaneous setting of the reactor coolant conductivity
 - Instantaneous setting of the background radiation

The Supplier* shall be responsible for defining and providing the remote functions

2.20.3.4.3.H

Expert Mode

The instructor station shall provide the capability for the instructor to use Expert Mode for any of the commands without requiring him to follow the menu options.

2.20.3.4.3.I

Emergency Stop

An emergency stop switch shall completely de-energize the simulator panels, computer, consoles, and peripheral equipment, and shall be located on the instructor's station.

2.20.3.4.3.J

Alarm Control

There shall be master "silence", "acknowledge" and "reset" switches located on the instructor's station that will control the complete simulator alarm system.

JA

Manual switches shall be provided to allow the simulator operations personnel to silence the MCR alarms or to lower their volume during testing.

2.20.3.4.3.K

Instrument Noise

All analogue and digital instruments shall have noise simulation. There shall be a control function on the instructor's station which shall enable the instructor to completely remove all simulated noise to these instruments.

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2.20.3.5 TRAINING SIMULATOR EQUIPMENT

2.20.3.5.1 TRAINING SIMULATOR COMPUTER SYSTEM

2.20.3.5.1.A

The Training Simulator* computer system shall be a standard distributed multi-processor and multi-server system to provide flexibility and ease of reconfiguration and capacity for future upgrades. All the systems shall be built of components, equipment and communication equipment based on open standards. The hardware shall include equipment for maintenance and development as well as the equipment required for the simulation. A sufficient number of workstations for the Training Simulator* development shall be included. Simulator model and software development shall be possible at the same time as the training is taking place. The hardware system design shall, to the greatest extent possible, provide capabilities for reconfiguration of the system in case of failure of a specific unit. The primary goal for the reconfiguration shall be to provide training using still operational units. Reasonably fast and easy replacement of any hardware component shall be possible.

2.20.3.5.1.B

The system and arrangement for simulator software and model development shall be designed in a way to make remote use from other locations on the Site* possible.

2.20.3.5.1.C

Equipment shall be included for efficient storage and retrieval on the Training Simulator* reference data database, Initial condition database and training session data. In addition incremental and full backup of the software files and systems shall be possible. The backup system shall support an extensive Configuration Management* system to manage the Training Simulator* hardware and software system. Appropriate storage devices shall be provided (e.g. hard disk and tape); the volume shall be determined by the program data required to perform any operating conditions specified including a minimum of 100 % spare volume for future use. The Supplier* shall define the mass memory required to meet these requirements. Mass memory shall be expandable with only minor changes or replacements if additional memory capacity is added.

2.20.3.5.1.D

Hardware and software shall be provided to the Technical Support Centre* and other premises for use in accident management training (emergency operation). Facilities shall be provided to present the model state of the Training Simulator* in the Technical Support Centre* in the same way as real Plant* data are presented.

2.20.3.5.2 INSTRUCTOR STATION

2.20.3.5.2.A

The Supplier* shall provide an advanced instructor station, utilizing large-screen, high-resolution colour graphics with pop-up windows. Instructor capabilities shall be enhanced by the use of touch screens, mouse, track ball or similar means, to insert commands such as malfunctions and remote functions as well as using a keyboard. It shall be physically located in the room for the instructor's systems in such a way that it is possible for the instructor to fully observe what is happening in the MCR replica.

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2.20.3.5.2.B

The human-machine interface for the instructor station shall be ergonomically designed and easy to operate. The use of windows, menus and mouses (or equivalent) shall be systematic. The instructor's station shall at least consist of the following state of the art components:

- Complete workstations
- Capability to support at least two flat display monitors, 19" or larger
- Colour printer with true colour reproduction and high print quality

2.20.3.5.2.C

The instructor station shall be implemented as workstation system.

2.20.3.5.2.D

A high-speed communication link shall be provided for transfer of data between all processors in the simulator computer complex.

2.20.3.5.2.E

As a complement to the equipment in the instructor's room, an instructor's system control unit shall be provided which is movable in the MCR's replica and which contains the most important functions of the instructor's system. This unit shall be used for training course development and testing, but also during normal training, when there is a need for the instructor to be in close contact with the trainees.

2.20.3.5.3 COMPUTER - MCR'S REPLICA INTERFACE

2.20.3.5.3.A

The computer – MCR replica interface shall be standardized and physically located in a way that minimizes cabling. The interface for conventional analogue or binary replicas equipment shall be based on a generally available industrial hardware. The interface with simulated or stimulated equipment and systems shall, to the greatest extent possible, be based on open standard communication protocols.

2.20.3.5.3.B

The diagnosis and maintenance tools for the system shall be given special consideration. It shall be possible to test single inputs and outputs during operation of the Training Simulator*.

2.20.3.5.3.C

20 % spare capacity shall be reserved on the input and output cards, physically evenly distributed over the system. Later expansion with new card racks shall be possible.

2.20.3.5.3.D

A digital clock located in the MCR's replica shall show the simulated time and be dependent on freeze, backtrack, slow time, fast time, etc. and shall always reflect the time elapsed from start of the simulation session or from a time defined by the instructor as an external parameter.

2.20.3.5.4 MCR AND ECR REPLICAS EQUIPMENT

2.20.3.5.4.A

The MCR and the ECR in the Training Simulator* shall be a replica of the actual reference unit MCR and ECR containing all the panels, consoles and desks that are necessary for fulfilment of simulator training requirements.

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2.20.3.5.4.B

The operating face, physical arrangement and colour of the control boards, panels and board mounted instruments and computer driven displays shall exactly duplicate those of the reference unit. All instruments and devices shall be identical in front face appearance, function and operating feel as those found in MCR or ECR.

2.20.3.5.4.C

The H-MI shall also be connected (to receive data) to the LAN as in the reference unit.

2.20.3.5.5 TRAINING SIMULATOR AUXILIARY SYSTEMS

2.20.3.5.5.A

Camera Observation System

The Training Simulator* camera observation system shall consist of video cameras mounted on the ceiling in such positions to allow instructor to watch all MCR staff members. The cameras shall have proper zoom capability to allow dynamic adjustment of the necessary fields of view and shall be remotely rotated. All cameras shall move inside a shelter to prevent disturbance of trained staff and to hide what is being focused on.

Video signals from all cameras shall be presented at the instructor workplace on two dedicated monitors. The camera system switch allows selection of either full-screen real-time image from one camera or split monitor screen and display images from different cameras at once. Camera images shall be digital and it shall be possible to record them. These records shall also be accessible in the Training Simulator* classroom.

2.20.3.5.5.B

Training Simulator* Voice Communication System

The Training Simulator* voice communication system shall simulate real the communication system used by Operators* in the reference unit MCR. It shall simulate all necessary Operator* communications between MCR and local work areas. All dialled calls shall be routed to the instructor who shall be enabled to select either hands free mode or ear-phone mode.

BA

The system shall provide special functions and equipment assisting the instructor during the training sessions, such as:

- Noise microphone system covering MCR's replica area and transmitting it to the instructor station
- Mobile communication system allowing the instructor to communicate with instructor station

BB

Any communication through the Training Simulator* voice communication system shall be able to be recorded.

2.20.3.5.5.C

Simulation of Plant Camera Observation System

The simulator shall also simulate the reference unit closed circuit television system. The TV monitors located in Training Simulator* MCR shall follow the real camera system. In the case of focusing on the Plant* system with a simulated leakage, the steam or water outflow shall also be animated according to the malfunction setting.

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CA

Plant* CCTV shall be available on the Training Simulator* for training purpose.

2.20.3.5.5.D

Panel mimics

Panel mimic diagrams are graphic representations of simulator panel (control board of the simulated control room). They are used to monitor the actual position of the instrument devices.

DA

In case the I/O executive of the simulator is cancelled, instructor can also use these mimics to control the simulation model (push the buttons, switch the switches ...).

DB

Instrument devices like lights, switches, meters, or pushbuttons are represented by graphic symbols.

2.20.3.5.5.E

Training Simulator* classroom

The Training Simulator* shall include simulator classroom equipment for training sessions, explanation and evaluation. The training classroom shall be located close to Training Simulator* MCR and shall be designed for 6 persons as minimum.

EA

The classroom shall be equipped with a computer workstation and 2 large screen displays. The workstation shall contain state of the art storage unit allowing video presentations in very high quality on large screen displays and audio power output with speakers. The video system shall be able to display Plant* parameters during transient conditions and provide trainee interaction with graphics replicating main control board instruments and switches.

EB

The workstation shall be linked to the simulator LAN and to the Plant* LAN. Workstation shall allow access to the operating procedures.

EC

The workstation will be used in three modes:

1. mode - The training classroom workstation is connected to (linked to) MCR replica simulator software environment as regular operator workstation and there is possible to perform all training actions, manipulations.
2. mode - The training classroom workstation is connected to (linked to) MCR replica simulator software environment as regular operator workstation and there is not enabled to perform any training actions or manipulations.
3. mode - The training classroom workstation is not connected to (linked to) MCR replica. There are conditions for presentation static information and displays.

2.20.3.5.5.F

Technical Support Centre* connection

The Training Simulator* shall be connected to the Technical Support Centre* of reference unit. One remote Training Simulator* workstation shall be supplied and mounted in the Technical Support Centre* to support Plant* accident training led from the Training Simulator*. This station shall be interconnected to the simulator LAN.

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2.20.3.6 TRAINING SIMULATOR SOFTWARE

2.20.3.6.A

The Supplier* shall provide a totally integrated software system which supports the development, documentation, real-time execution, and testing of a complete simulator software package. The system shall be suitable for simulation applications which meet the following criteria:

- Large data base
- Simulation models programmed entirely in high level language, including all subroutines, such as steam tables, heat exchangers, breakers, and valves etc.
- Structured (Top Down) software development process
- Multi-processor computer configuration
- Program debugging
- Real-time monitoring of variables
- Real-time break pointing and instruction modification
- All program variables or constants in the global data base shall be dynamically modifiable on-line by variable or constant name via a simplistic command structure available from the simulator developer terminal

2.20.3.6.B

The Training Simulator* software shall present state-of-the-art and proven technology supporting all the requirements and specifications given herein. Well-known commonly used industry standards shall be applied. Preference shall be given to software, which is portable to several computer platforms. User friendliness shall be achieved through the use of modern graphical user interfaces on all levels where practical. The Training Simulator* maintenance and development shall be performed utilizing effective software tools. Human factors shall be duly considered in development of the user interfaces.

BA

The operator's HMIs shall be presented in the identical language as at the reference unit control rooms. See also TR 2.10.5.4.2.3.9.LB.

BB

All information, messages, aids, maintenance tools and help functions in the simulator specific H-MI (such as instructor station, engineering station, etc.) shall be presented in Czech language with respect to Czech H-MI specifics (e.g. usage of standard Czech keyboard, etc.). Justified exceptions can be made in cases when use of Czech language is not possible to implement because of single-purpose device without possibility to add Czech language. In those cases comprehensive instruction for operation and maintenance of particular HMI shall be provided also in the Czech language.

BC

The scope of Czech language application for the simulator and collaboration with the Owner* on the Czech language translation work shall respect Technical Requirements Document*, Sections 2.10.5.4.2.3.9.LB-LD.

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2.20.3.6.C

The different software systems shall be synchronized and give a consistent time marking of different system or actual process event. Lists of events with time stamps provided for the MCR operators shall list the events in a physically correct order and with realistic time stamps.

2.20.3.6.D

The simulator programs shall be well “protected”; at least it shall not be destroyed or modified in case of power interruption, computer failure or false data transmission.

2.20.3.6.E

Cyber security provisions shall be implemented as an integrated part of the security provisions of the Plant* (see the Licensing and Permitting, Safety and Quality Document*, Section 2.4.1.1).

2.20.3.6.1 COMPUTER OPERATING SYSTEM

2.20.3.6.1.A

The operating system, which is included in the system software, shall be a standard operating system. The functions of the system software shall as far as possible be included in this and modifications in the operating system shall be avoided to the greatest possible extent. Such modifications shall under no circumstances prevent or make complicated the introduction of new releases of the standard operating system. The Owner* shall approve any non-standard modifications of the operating system before they are implemented.

2.20.3.6.1.B

The functionality of the operating system shall be based on a state-of-the-art graphical user interface. The operating system shall include a modern, well-integrated multi-tasking real time monitor, which fully supports the proposed hardware and software configuration. The monitor shall support full time sharing, advanced task communication, resource management, batch computation, error handling and multi-processor control as well as communication capabilities for a multi-vendor environment and supporting great number of users.

2.20.3.6.1.C

The operating system shall provide a full range of file management services, language processors, link load processor and utilities for data movement and communication, housekeeping, diagnostics and crash analysis.

2.20.3.6.1.D

The operating system shall be supplied under conditions ensuring that complete customer support and documentation is provided. The system shall be supplied with the latest issued version of the operating system.

2.20.3.6.1.E

Not applicable.

2.20.3.6.1.F

Not applicable.

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2.20.3.6.2 INTEGRATED DEVELOPMENT ENVIRONMENT

2.20.3.6.2.A

Integrated Development Environment shall provide a complete program development environment needed during the different phases of software development. Among others, utilities of the following type shall be included in the Training Simulator*:

- Text and program editors
- Tools for maintenance and development of graphics
- Appropriate compilers, linker/loaders, run-time library, user-generated libraries, symbolic debugger, etc.
- Command language/script processors
- Standard office automation and communication tools

2.20.3.6.3 COMPUTER - CONTROL ROOM INTERFACE

2.20.3.6.3.A

The Training Simulator* system shall include software for sending and receiving signals to and from the Computer MCR replica interface. The software shall handle signals of the types needed for all the equipment in the MCR's replica. The Training Simulator* response to Operator* actions shall not depart from reference unit response in any aspect that would tend to mislead the Operator* or cause an inappropriate Operator* action.

2.20.3.6.3.B

Testing of single control room subsystem or component shall be possible during a normal simulator session. Software for testing and calibration purposes shall be included.

2.20.3.6.3.C

Computer driven displays and stimulated MCR equipment shall be interfaced with the simulation system with communication links and software based on open standards. The communication concept shall be based on a common general standard to make possible easy additions of new MCR equipment.

2.20.3.6.4 DATABASE SYSTEM

2.20.3.6.4.A

A database suitable for storing simulator data and with real time features shall be included. Data in the database shall be accessed by centrally controlled logical references.

AA

The information contained in the data base shall include such data as:

- size, type, location and name of all global variables in the system
- data for equipment like pumps, valves, etc. related to the model building blocks
- data for the interface between the instructor's system and the model programs, for malfunction, local operation actions etc.
- data for defining the links between the in/out buffers and the control room devices
- information for control of the compatibility between program versions and database versions

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2.20.3.6.4.B

Sufficient storage space for store multiple data sets defining different initial conditions for simulation scenarios shall be provided. These data sets shall be able to read down from disc to select a defined initialization point.

BA

The generation of new initial conditions after a model software modification shall be a fast and straightforward process. The software shall fully support this generation.

2.20.3.6.4.C

Software shall be available for modifying and generating the structure and content of the database. The database management system shall be designed to combine simplicity of use with high security. The database management system shall be an integrated program system which automatically gives the user information about other items that have to be changed and processes to be run (including recompiling and reloading of the model program system) if an alteration of the database information is made. The database management system shall be written in a standardised high-level language to achieve portability of the simulator software.

2.20.3.6.5 TRAINING SIMULATOR CONTROL SYSTEM

2.20.3.6.5.A

The running of the simulator and the execution rate of single model program shall be under full control of the system programmer through an executive routine. This routine activates the model programs in a fixed predefined order from a model queue defined in the database on a cyclic basis and synchronized with the real time. The execution rate of different models shall be able to be kept different. Some models may also be activated from interrupts generated by MCR operations or other programs. Supervision of the running of the whole simulator in real time shall be provided in this function as well as provisions for running the simulator in "background" mode.

2.20.3.6.6 SIMULATOR SOFTWARE DEVELOPMENT SYSTEM

2.20.3.6.6.A

Integrated general tools for simulator software development shall be provided. As a rule the tools shall be based on a graphical user interface, which is used for interactive model building. In addition the Owner* shall have the possibility of adding his own software modules and of integrating them into the simulator model libraries and software.

AA

The simulation model development shall be based on graphical interactive modelling. Standard models for commonly used plant components shall be available. Tools shall be provided to modify these models and to add new own-design models if deemed necessary.

2.20.3.6.6.B

The above-mentioned database system and simulator control system can be considered as such general tools. The tools in the development system shall be written in a standardised high-level language to achieve portability of the simulator software.

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2.20.3.6.6.C

The software shall be based on open-source codes, which are available on different computer hardware platforms. The software design and external interfaces shall be open to facilitate the development of the simulator models.

2.20.3.6.6.D

Support for control and communication with digital control systems from different vendors shall be provided. The digital control systems for which this support is available shall be listed by the Supplier*.

2.20.3.6.7 PLANT MODELING SYSTEM

2.20.3.6.7.A

The plant modelling system shall include generalized graphical tools for the simulation of process systems, electrical systems and logics and instrumentation. The general models shall include interfaces for interchange of information with the instructor's system, the malfunction system and the MCR interface. The generalized modelling tools shall be written in a standardised high-level language to achieve portability of the simulator software.

2.20.3.6.8 TRAINING SIMULATOR DIAGNOSTIC AND MAINTENANCE SYSTEM

2.20.3.6.8.A

Maintenance support programs, including diagnostic and test programs shall be provided. These need to be fully maintained in computer storage. A diagnostic program to exercise and test all computer instructions shall be provided.

2.20.3.6.8.B

Equipment troubleshooting diagnostic programs shall be provided which will identify the malfunctioning area and with associated maintenance routines reduce the failing area down to the circuit boards. Where fault detection dictates resetting a computer process, the process progression shall be recorded at point of fault. The results of the diagnosis shall be presented via an input/output device wherever fault information is available to the computer.

2.20.3.6.8.C

The simulation software system shall have on-line diagnostic routines which will monitor key individual internal software programs to detect software program loops, computer program stalls, or other software malfunctions, and which will initiate individual alarms via the instructor station or output terminal.

2.20.3.7 VERIFICATION AND VALIDATION PROGRAM

2.20.3.7.A

Verification testing shall be performed by comparing the simulated component to the original requirement to ensure that each step in the model development process completely incorporates all the design requirements.

2.20.3.7.B

Validation testing shall be performed by comparing the simulated process parameters to the actual system parameters of the reference unit in integrated mode under steady state and transient conditions.

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2.20.3.7.C

The Supplier* shall provide a V&V tools (HW, SW, services, manuals, training) to facilitate the validation of Training Simulator* performance against Best Estimate* transient data derived from reference unit, experience or experimental data including uncertainties where available. Best estimate* transient data shall be also provided. The V&V tools shall automatically generate reports comparing the performance of the simulator with the Best Estimate* transient data.

2.20.4 REQUIREMENTS TO OPERATION

2.20.4.A

The Supplier* shall provide the Owner* with analysis specifying the Training Simulator* functional and technical requirements based on the requirements defined in the Rules* and the objectives and requirements specified in Technical Requirements Document*, Section 2.20.3.