

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 11/122

2.7.1.2 GENERAL

2.7.1.2.A

The Supplier* shall, in accordance with the Section 2.7.0.3.2, justify that RCS and its components are of proven design.

2.7.1.3 DESIGN CONDITIONS

2.7.1.3.A

The RCS components shall be designed to ensure operation under the full range of its design conditions with respect to the stipulated safety margins against all types of mechanical damage which may occur as the result of imposed load combination.

2.7.1.3.B



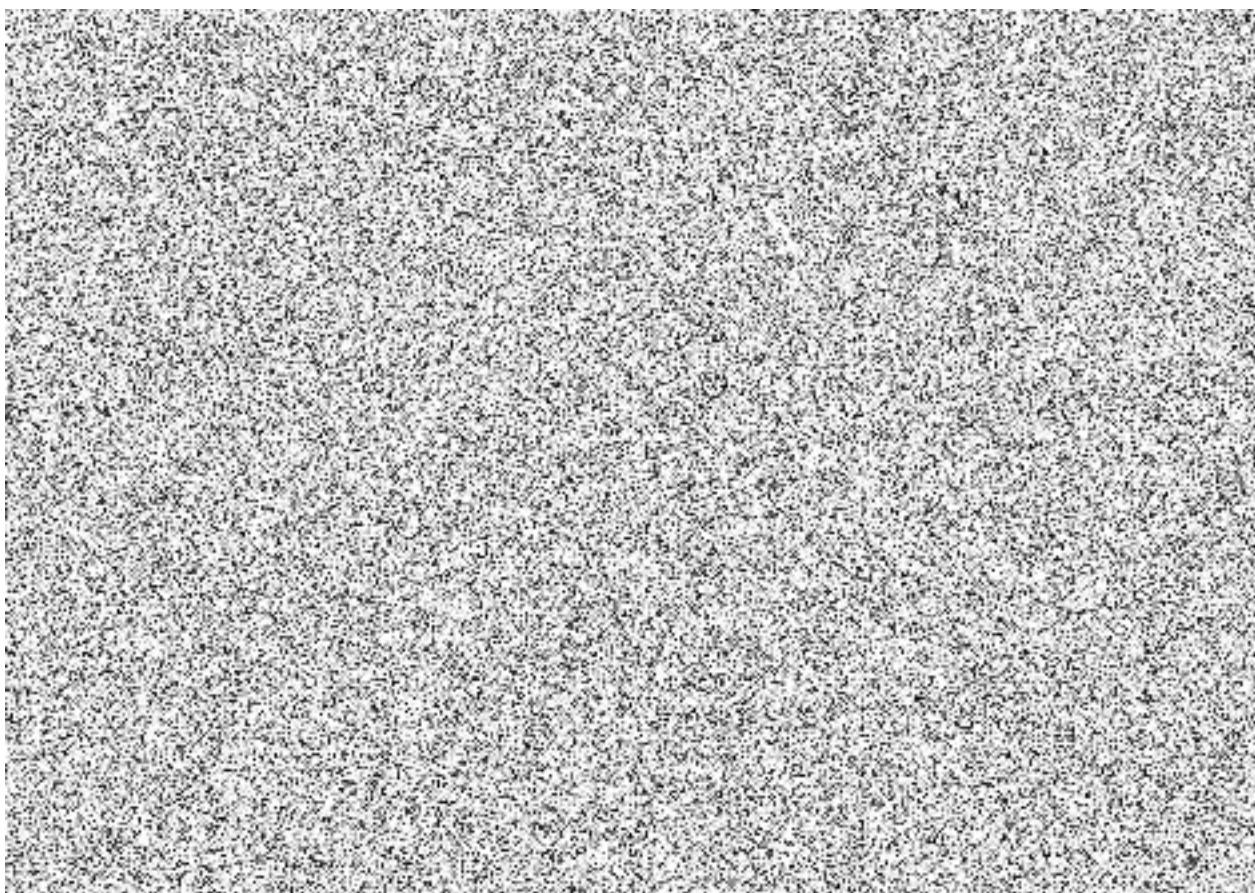
BA



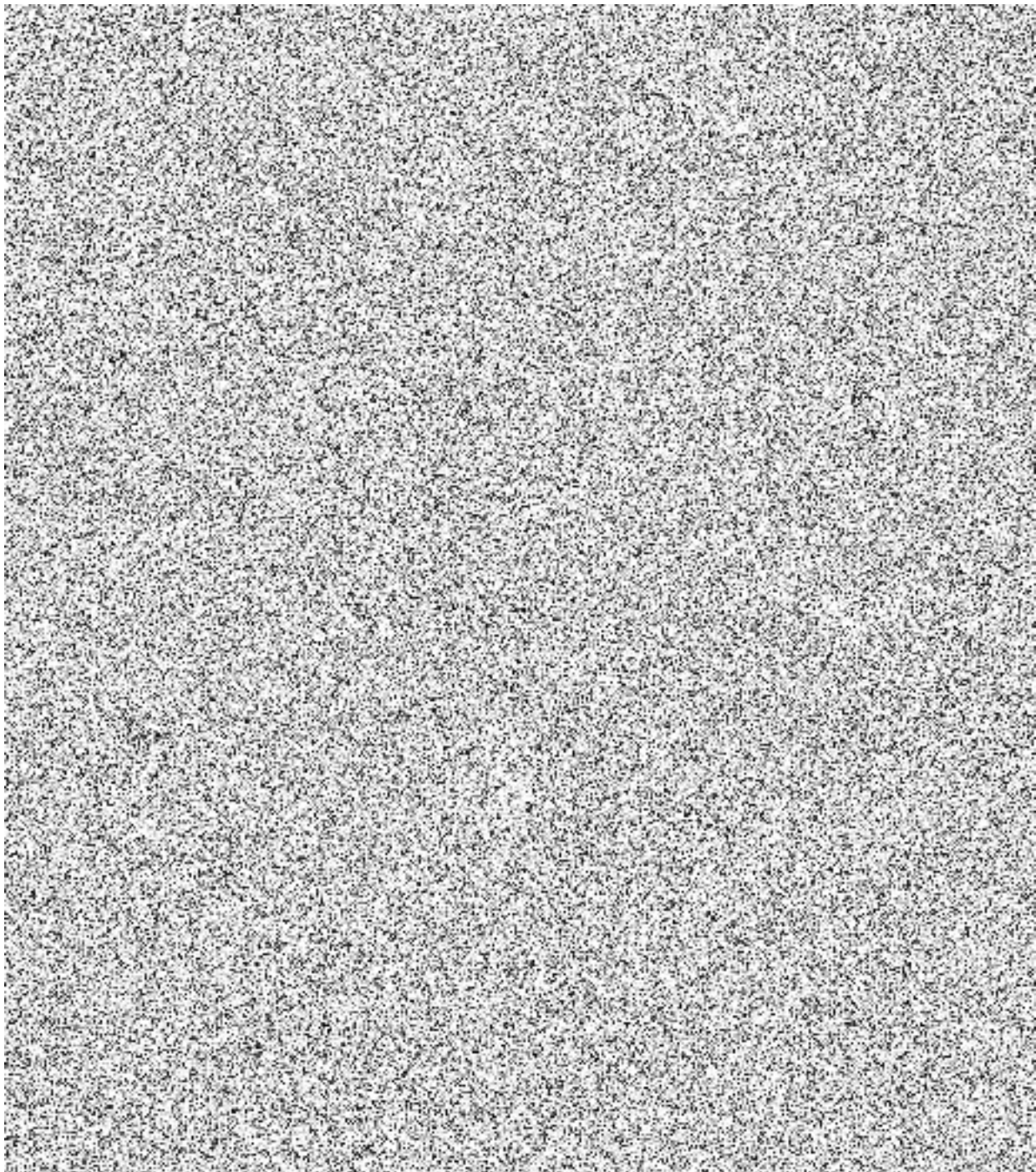
2.7.1.3.1 TYPES OF DAMAGE

2.7.1.3.1.A

The Supplier* shall consider the following types of mechanical damage for the design of the RCS components according to the relevant Codes and Standards*:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 12/122



2.7.1.3.2 OTHER CONDITIONS

2.7.1.3.2.A

Other types of degradation with the potential to threaten the integrity of the RCS components shall be taken into account, e.g. corrosion and erosion damage, irradiation and thermal ageing of material.

2.7.1.3.2.B

The Supplier* shall carry out activities and procedures to treat all RCS surfaces, in order to form a passive layer on RCS surfaces which will reduce formation and deposition of activated

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 13/122

corrosion products in contact with the coolant, before the first start-up of nuclear operations (e.g. during hot functional tests).

BA

The design of the Plant and/or Unit* shall enable to repeat this procedure during the Plant and/or Unit* life (e.g. after decontamination).

2.7.1.3.3 COMPONENT DESIGN CONDITIONS

2.7.1.3.3.A

The list and classification of design conditions for each component shall be defined in the component data description.

AA

It shall include all design conditions which RCS components may be subjected to (i.e. also those which do not necessarily concern only the problems posed by their mechanical strength).

AB

The design conditions are specified in the Section 2.4.5.

2.7.1.3.3.B

Safety margins shall be specified and guaranteed as part of the acceptance criteria.

BA

These criteria shall be graduated in accordance with the operating conditions, to ensure the integrity of the structure and the other functional requirements such as the functional capability and operability.

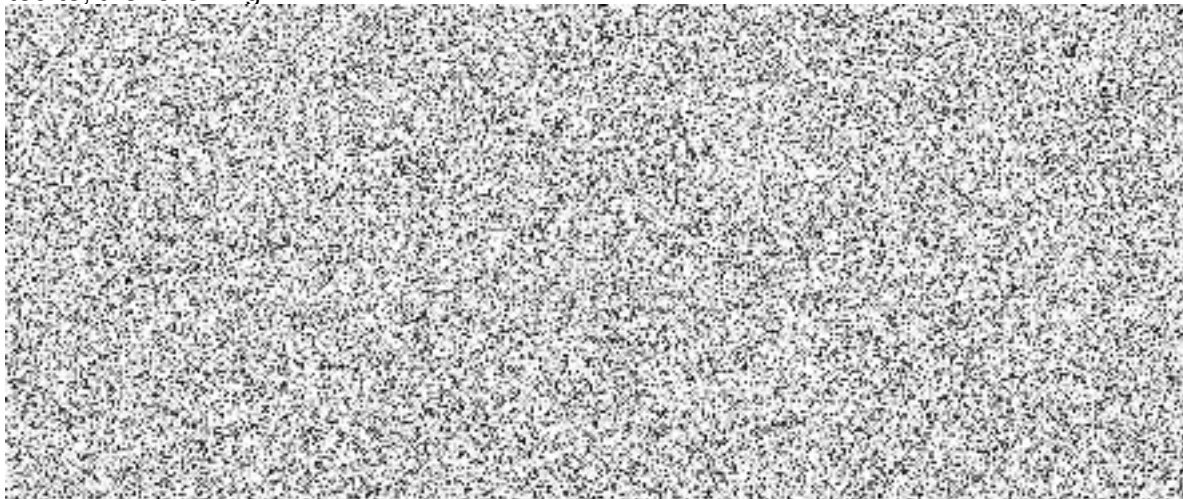
2.7.1.4 LOAD COMBINATION CONSIDERATIONS

2.7.1.4.A

The RCS design shall take into account a set of environmental effects (pressure, forces, heat flux, temperature, etc.) corresponding to each condition.

AA

The loads constituting load combinations to be taken into account shall include, but are not limited to, the following:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 14/122

AB

The load combinations to be taken into account are specified in the see Section 2.4.5.9.

2.7.1.4.B

Fatigue monitoring shall be provided as specified in the Section 2.8.2.14.2.

BA

The monitoring shall include fatigue monitoring of the pressuriser surge line.

2.7.1.5 MAINTAINABILITY AND IN-SERVICE INSPECTION

2.7.1.5.A

2.7.1.6 TESTING

2.7.1.6.A

RCS components shall be tested individually before assembly.

AA

Special considerations affecting testing of components are specified in the Construction and Commissioning Document*.

2.7.1.6.B

Further, an initial hydrostatic test of the RCS shall be performed in order to check the integrity and the leaktightness of the pressure-retaining components before the first fuel loading.

2.7.1.6.C

Following the initial hydrostatic test, the hydrostatic test shall be repeated after any work that has impact on RCS integrity (e.g. cutting and welding of piping, etc.).

2.7.1.6.D

2.7.1.6.E

Special considerations affecting testing of individual components and RCS are specified in the Construction and Commissioning Document* Sections 2.8, 3.4, 3.5 and 3.6.

2.7.1.7 STEAM GENERATORS

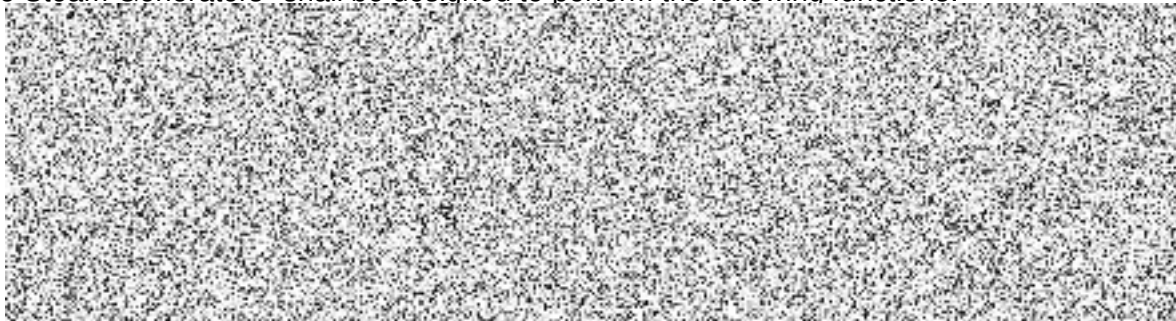
Sections 2.7.1.7.1 through 2.7.1.7.5 define the design and functional requirements that apply specifically to the Steam Generators*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 15/122

2.7.1.7.1 FUNCTIONS

2.7.1.7.1.A

The Steam Generators* shall be designed to perform the following functions:



2.7.1.7.2 GENERAL DESIGN REQUIREMENTS

2.7.1.7.2.1 TUBE BUNDLE

2.7.1.7.2.1.A

The tube bundle shall be designed with the following requirements:

AA

The tubes shall be welded on the primary side of the tube sheet and/or collector and expanded to suppress the crevice between the tube and the secondary side of the tube sheet and/or collector.

AB

The expansion method shall be chosen to reduce stresses.

AC

The tubes shall be supported to prevent their degradation due to vibration.

AD

The supports shall be designed to minimise wear, fretting, denting, drying and hide out of the corrosion products.

AE

The shape (i.e. trifoil, quatrefoil, others) of the tube/support openings or the use of lattice grids shall be justified based on a good operating experience.

AF

The design shall provide sufficient flow around the tubes at the tube support plates to avoid fouling depositions.

2.7.1.7.2.2 OTHER INTERNALS

2.7.1.7.2.2.A

The following requirements shall be considered:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 16/122

AA

Accumulation of corrosion products in the SG (in particular on tube sheet/around collectors) shall be minimised by appropriate hydraulic design to avoid dead areas.

2.7.1.7.2.2.B

The SG shall be arranged in such a way that its primary side can be drained for tube Inspection* without lowering the water level in the RPV below the upper level of the Core* and with the required margins to permit the simultaneous refuelling activities.

2.7.1.7.2.2.C

Crevice corrosion and associated crevice chemistry in the SG secondary side shall be evaluated by the Supplier*.

CA

Protective measures against and monitoring of the SG crevice corrosion shall be evaluated and implemented by the Supplier*.

2.7.1.7.2.2.D

Evidence shall be provided to justify that the economizer and downcomer feedwater lines and nozzles will not suffer thermal stratification.

2.7.1.7.3 MATERIALS

2.7.1.7.3.A

The materials shall comply with the requirements of Chapter 2.6.

2.7.1.7.3.B

In addition, the tube materials shall be intergranular corrosion resistant and wear resistant in contact with the materials of the support and of the anti-vibration system.

2.7.1.7.4 SIZE

2.7.1.7.4.A

2.7.1.7.4.B

The water and steam volumes shall be adjusted to match safety requirements given in Section 2.1.6.7 and Section 2.8.2.3.1.3.3.

BA

The water volume shall be such that:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 17/122

2.7.1.7.5 MAINTAINABILITY

2.7.1.7.5.A

A specific study on the Steam Generator* Inspection* and testing program shall be provided showing that the design of all components and parts of the Steam Generators* allows periodic Inspection* and testing of critical areas and features to assess their structural and leaktight integrity.

AA

The following requirements shall be met:

On the primary side:

- manholes located for easy access,
- all welds which are to be subjected to ISI to be easily accessible,
- anchor for the nozzle dam.

On the secondary side:

- easy external access for tube sheet and/or collectors Inspection*, lancing and loose parts removal,
- all welds which are to be subjected to ISI to be easily accessible.

2.7.1.7.5.B

Robotic applications shall be considered for opening the manholes, fixing the nozzle dams and inspecting the tubes on both sides.

2.7.1.8 PRESSURIZER

Sections 2.7.1.8.1 through 2.7.1.8.3 define the design and functional requirements that apply specifically to the pressurizer.

2.7.1.8.1 FUNCTIONS

A

The pressurizer shall be designed to perform the functions specified in Section 2.8.2.3.1.2.2 and listed below:



2.7.1.8.2 DESIGN REQUIREMENTS

2.7.1.8.2.A

The configuration of the pressurizer vessel and heaters and the layout of the nozzles, thermal sleeves and surge lines shall minimise the low and high cycle fatigue produced by the operational transients, the in-surges and out-surges caused by power changes and the stratified flows during reactor heat up and cooldown.

2.7.1.8.2.B

The configuration of the spray lines, nozzles and sleeves shall avoid the thermal stratification and the accumulation of condensate.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 18/122

2.7.1.8.2.1 SIZING

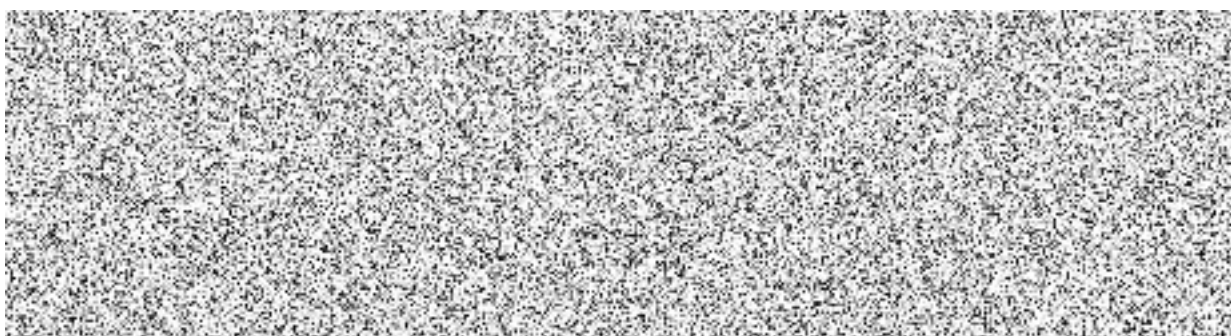
2.7.1.8.2.1.A

A large pressurizer, both in terms of its water and steam phase, shall be favoured when this results in increased design margins which allow more tolerant operation, according to the policy defined in Sections 2.1.2.2 and 2.1.6.7.

2.7.1.8.2.1.B



2.7.1.8.2.2 SPRAY SYSTEM



2.7.1.8.2.2.B

The auxiliary spray system shall be separate from the spray system used in the Normal Operation*.

BA



2.7.1.8.2.2.C



2.7.1.8.2.2.D

The spray nozzles shall be easily inspectable and replaceable.

2.7.1.8.2.3 HEATERS

2.7.1.8.2.3.A

The heaters shall be accessible and easy to replace without cutting the pressurizer vessel.

2.7.1.8.2.3.B

The heaters shall be split into control and backup groups.

BA

A redundant group of heaters shall be provided and each of these heater groups shall be capable of being powered from either off-site power through different non-safety buses (normal backup) or from different emergency power buses (emergency backup).

2.7.1.8.2.3.C

The heaters shall have sufficient power to allow the required RCS heat up rate.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 19/122



2.7.1.8.2.4 SURGE LINE

A

The routing of the surge line and the location of the surge nozzle shall be optimised taking into account the following:



2.7.1.8.3 MATERIALS

2.7.1.8.3.A

The materials shall comply with the requirements specified in Chapter 2.6.

2.7.1.8.3.B

In addition, the following specific requirements shall be applied:

BA



BB

The material of the sprays shall be justified from the point of view of its resistance to erosion.

BC

The materials used for heater sleeves and pressure tubes shall be selected such that intergranular stress corrosion cracking of the welded joints is avoided.

2.7.1.9 REACTOR PRESSURE VESSEL

Sections 2.7.1.9.1 through 2.7.1.9.4 define the design and functional requirements that apply specifically to RPV.

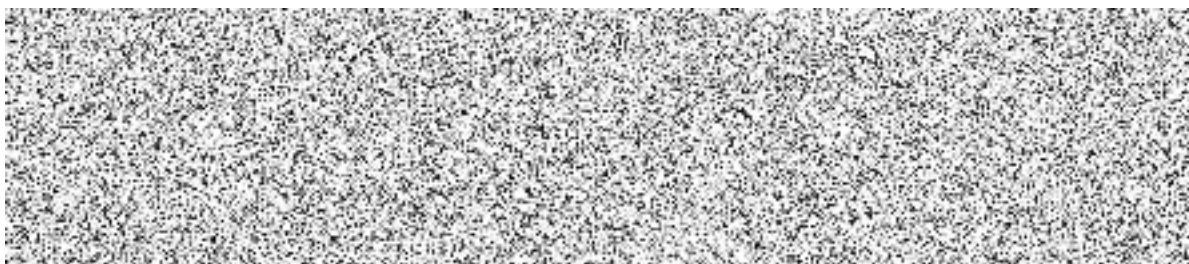
2.7.1.9.1 FUNCTIONS

2.7.1.9.1.A

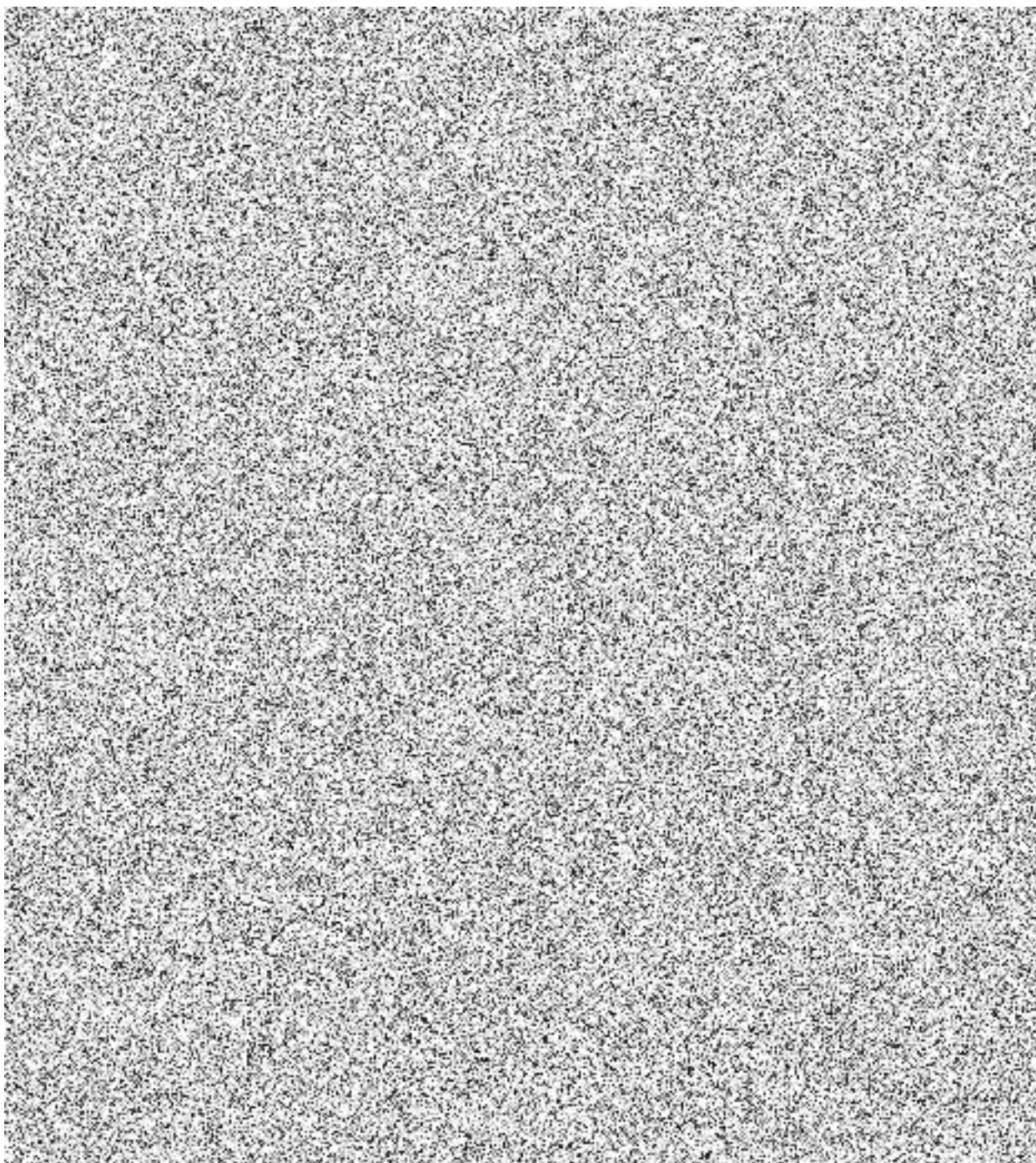
The RPV shall be designed to perform the following functions:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 20/122



2.7.1.9.2 GENERAL DESIGN CRITERIA



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 21/122



2.7.1.9.3 MATERIALS



2.7.1.9.3.B

RPV shall be made of low alloy steel with the inner surface covered by stainless steel cladding.

2.7.1.9.3.C

Stainless steel cladding shall be resistant against corrosion effects of coolant and shall avoid coolant interaction with the RPV material.

2.7.1.9.3.D

Cladding welding technology shall be resistant to under cladding cracking.

2.7.1.9.3.E

The RPV shall include specimen capsules for RPV.

EA

The RPV surveillance program shall be provided to enable verification of the RPV residual life.

2.7.1.9.4 MAINTAINABILITY

2.7.1.9.4.A

Access and equipment shall be provided such that automated ISI are possible for all welds including nozzle welds and upper head counterflange weld.

2.7.1.9.4.B

Means shall be provided to perform RPV stud detensioning and removal and stud hole covering and upper head and related components removal and installation.

BA

Automatic stud tensioner(s) shall be provided.

2.7.1.9.4.C

Features shall be incorporated into the reactor bolting design to allow ISI to detect degradation or failures.

2.7.1.9.4.D

Bolting designs, locking designs and joint designs shall allow precise preload verification and ISI.

2.7.1.9.4.E

RPV ISI shall be possible without removing the thermal insulation.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 22/122

2.7.2 VALVES

2.7.2.1 SCOPE

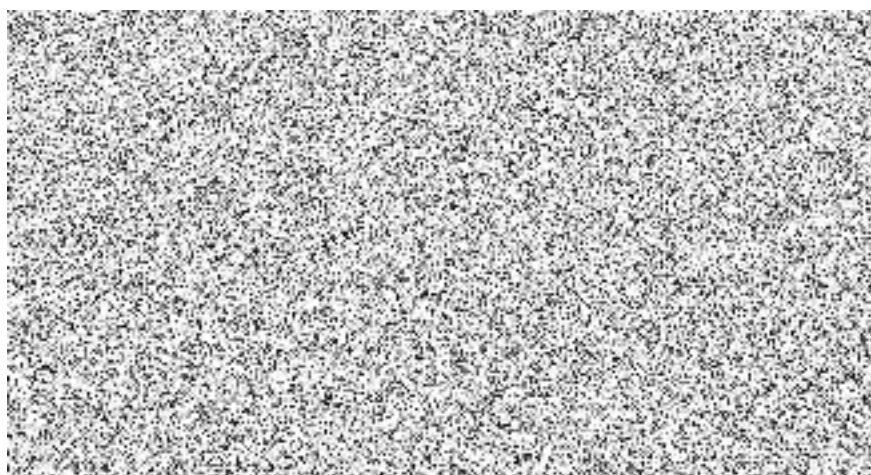
2.7.2.1.A

This Section defines the common functional requirements that apply to all, but in particular to essential, valves used in the Plant*.

2.7.2.2 GENERAL

2.7.2.2.A

Systems shall be designed to minimise the number of valves consistent with safety, functional, reliability and availability requirements.



2.7.2.2.C

In particular, the use of double valving shall be limited, based on the above guidelines.

2.7.2.2.D

The number of power-actuated valves shall be limited by taking account, for each potential application, of the required frequency of operation, the system configuration, and the functional and As Low As Reasonably Achievable (ALARA) requirements.

2.7.2.2.E

The Supplier* shall submit a list of motor operated valves for the Owner's* information.

2.7.2.3 INTERCHANGEABILITY



2.7.2.3.B

Moreover, they shall be interchangeable with the corresponding part of any other valve with the same physical identifier located in the Power Generation Plant* or Balance of Plant*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 23/122

BA

Physical identifiers are defined in Section 2.12.7.

2.7.2.3.C

Each valve or set of identical type of valves shall be supplied with corresponding parts documentation and the list of the recommended and supplied spare parts.

2.7.2.4 DESIGN CONDITIONS

2.7.2.4.A

The Supplier* shall specify the functional requirements of each valve and valve actuator.

2.7.2.4.B

Each valve and valve actuator shall be designed to ensure operation under the full range of its own design conditions.



2.7.2.4.D

The valve actuator shall provide the required torque or force and valve actuation time without damaging the valve.

2.7.2.4.E

Motor-driven valves containing pressurized primary water or steam shall be designed in such a way that a failure to stop the drive mechanism will not result in a loss of the pressure boundary and will not damage the valve body.

2.7.2.4.F

The valve body, bonnet, and yoke structures, and the connections between the valve and the actuator shall be adequate to support the maximum compression, tension, and shear loads (including seismic) imposed by the valve actuator in conjunction with other design loads.

2.7.2.4.G

All valves utilizing stem packing, except piston actuated main steam isolation valves, safety relief valves and small solenoid valves, shall be provided with backseat capability.

2.7.2.4.H

The orientation of normally closed globe valves shall be such that the higher pressure is under the disc. Exceptions shall be justified.

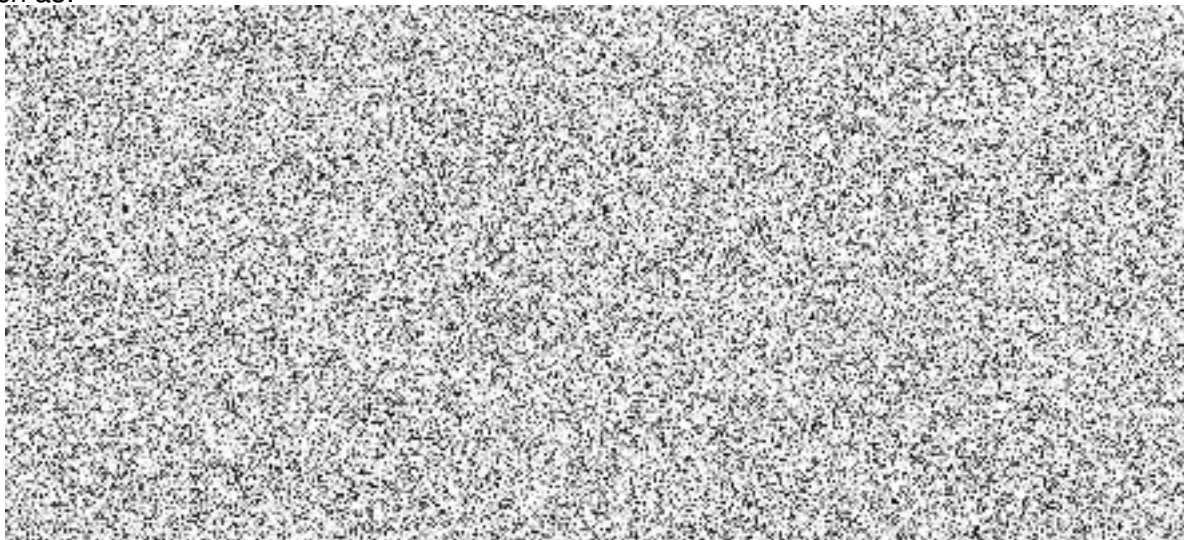
2.7.2.5 VALVE TECHNICAL INFORMATION

2.7.2.5.A

In addition to the operating and maintenance procedures and the drawings and diagrams provided with each valve, the technical information required to support the selection of

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 24/122

operating conditions and support future modifications and/or maintenance shall be provided, such as:



AA

Alternative valve specifications are allowed, if documented and justified by the Supplier*.



2.7.2.6 DESIGN REQUIREMENTS

2.7.2.6.A

Forged valve bodies shall be used in preference to cast bodies on all circuits directly connected to the RCS.

2.7.2.6.B

Welding to pipework shall be used in preference, except for valves installed on systems containing untreated water.

2.7.2.6.C

For valves attached to piping by a flanged connection, through-bolts in the flanges shall be used in preference to tapped holes in the body of the valve.

2.7.2.6.D

All external valve parts that could be wetted with borated water as a result of leaks via valve packing or gasket shall be made from stainless steel or other material which is resistant to boric acid.

2.7.2.6.E

Cobalt-based hard-facing materials for seats of valves in contact with reactor coolant (RCS and connected systems) shall be minimised, as specified in Sections 2.6.4.1.2 and 2.6.3.1

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 25/122

2.7.2.6.F

Valve types in which the closure is not mechanically connected to the stem shall not be used as they are liable to inadvertent closure under reverse flow conditions. This does not apply to solenoid valves and Pressurizer Pilot Operated Safety Relief Valves.

2.7.2.6.G

The valve bonnet and disc design shall be such as to prevent pressurisation due to heat-up of fluid trapped in the bonnet.

GA

Specifically, internal pressurisation of the bonnet greater than in both the upstream and the downstream piping shall be prevented to eliminate the potential for “thermal binding” and “pressure locking” which can jeopardize the valve function.

2.7.2.6.H

Each manual or power-operated valve shall have a local, mechanical indication of its overall position, i.e. open or closed, which can be determined by direct observation at the valve.

HA

In addition, the design of these valves shall provide the capability to determine the position of a partially opened valve by direct observation at the valve.



2.7.2.6.J

Power operated valve assemblies shall be provided with easily accessible standard test connections so that signature tracing can be performed without disassembling the motor.

2.7.2.6.K

Packings shall be chosen to minimize Ag, Sb or As content, as specified in Sections 2.6.4.1.2 and 2.6.3.1.

2.7.2.7 MINIMISATION OF LEAKS

2.7.2.7.A

Valves used for fluids that are radioactive or hazardous shall be designed to preclude or minimise potential leaks to the ambient atmosphere based on the following guidelines:

AA

- where possible, packless valves, with bellow and diaphragm, shall be used for applications where any leakage would be radioactive or hazardous,

AB

- valves with pressure seals shall be avoided on systems containing radioactive fluids,

AC

- double stem packing valves with a leak-off system between the packing shall be considered for systems under pressure which carry reactor coolant, radwaste, or other radioactive fluids,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 26/122

AD

- for valves used on radioactive circuits, valve stem leak-offs shall be routed to, or collected by, the radwaste system via an appropriate drain sump or tank,



AF

- shaft of swing check valves shall not cross the valve body,

AG

- where practicable, valves using stem packing shall be provided with adequate back seat capability to minimise stem leakage until maintenance can be performed. The back seat shall be capable of retaining the valve stem against full system pressure. In addition, the failure of the valve actuator to stop shall not impair the leaktightness of the valve pressure boundary, and shall not result in valve damage.

2.7.2.8 ISOLATION VALVES

2.7.2.8.A

Valves having an isolating or shut-off function shall be designed such that they can be actuated (opened or closed) under the maximum circuit operating pressure, under the maximum operating flow and under the maximum differential pressure, without exceeding the maximum specified force on the actuator (or emergency actuator for a motor-operated valve).

AA

Specific requirements for Containment isolation valves are included in Section 2.9.4.1.5.

2.7.2.8.B

Isolation valves upstream of pumps and compressor inlet shall be low pressure drop.

2.7.2.8.C

Instrument isolation valves shall be needle or globe valves. For low temperature and pressure service the use of metallic diaphragm valves may be considered.

2.7.2.8.D

The function of isolation valves in primary systems shall be verified in type tests under relevant Design Basis Conditions*. The function of isolation valves in primary systems shall be verified in type tests under relevant Design Extension Conditions* to the extent reasonably practicable.

2.7.2.9 GATE VALVES

2.7.2.9.A

Gate valves shall not be used in flow regulation and throttling service.

2.7.2.9.B

The large parallel slide gate valves shall be equipped with a by-pass valve for balancing the differential pressure between the upstream and downstream of the gate valve, especially for the large pressure drop gate valve.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 27/122

2.7.2.9.C

Solid wedge gate valves shall not be used.

CA

Nevertheless, the Supplier* may propose usage of solid wedge valves if it is technically and economically justified.

2.7.2.10 CONTROL VALVES

2.7.2.10.A

A flow control or regulating valve shall not be used for isolation unless valves of the same type have proven successful operation in similar operating conditions under the same environmental conditions.

2.7.2.10.B

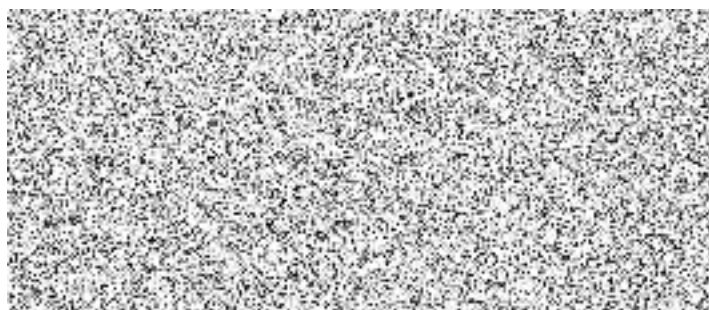
Control valves shall be maintainable in-place.

2.7.2.10.C

Control valves shall be designed and fabricated to have high resistance to cavitation, flashing, vibration and erosion, at each position of the stem.

2.7.2.10.D

The location of control valves shall accommodate any requirements for straight pipe lengths needed for proper operation.



2.7.2.10.F

Damage by erosion shall be avoided in the piping downstream of control valves which are operated close to cavitation conditions.

FA

The pipeline downstream of the control valves shall be fabricated from steel with high resistance to erosion.

FB

Where feasible, internal welds downstream of control valves which are operated close to cavitation conditions shall be ground flush with the pipe wall (i.e. same inner pipe diameter).

2.7.2.10.G

Cage or top and bottom guiding shall be used for globe or angle type control valves.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 28/122

2.7.2.11 CHECK VALVES

2.7.2.11.A

Following the general requirement for minimising the number of valves, check valves shall be used only where necessary as they are usually difficult to maintain and are likely to leak when operating under low differential pressure.



2.7.2.11.C

Consideration shall be given to internal clearances, disc stability and wear, relative to the actual flow conditions.

2.7.2.11.D

The location of check valves shall accommodate any requirements for straight pipe lengths needed for proper operation.



EA

Should slamming of the check valve occur, double plate check valves or non-slamming devices shall be used.

2.7.2.11.F

Standard piston check valves shall not be used on gas systems which operate at low pressure.

2.7.2.12 SAFETY VALVES (OVERPRESSURE PROTECTION)

2.7.2.12.A

Safety valves shall be designed to work (properly) in the full range of design flows without fluttering or chattering which could generate valve component damages or non acceptable pressures waves in the system.

AA

Staggered set points shall be used to reduce the mechanical stresses except for Pilot Operated Safety Relief Valves.

2.7.2.12.B

The loads due to the free jet effect caused by valve opening shall be considered for the design of safety valves.

2.7.2.12.C

Safety valves shall be equipped with springs and capable of being blocked for hydraulic testing.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 29/122

CA

In some specific cases pilot operated safety valves can be used but the pilot valve shall be able to operate without external sources as well.

CB

The design shall be flexible enough to accommodate pilot valves if required by the process and accepted by regulation.

CC

The pilot valves shall be also equipped with springs. For some specific applications, explosive membranes for depressurisation are also acceptable.

2.7.2.12.D

Pressurizer and other RCS safety valves, as applicable, shall be qualified for operation with steam, water and steam-water mixture conditions.

2.7.2.12.E

Safety valves shall be designed to avoid any accumulation of condensed water.

2.7.2.12.F

Pressure drop of the discharging line shall be minimized.

FA

The resulting back pressure shall not preclude safety valve opening or closure set point.

2.7.2.12.G

Safety valves shall be provided when required in the overpressure protection reports.

GA

The overpressure protection reports shall be provided in the design documentation.

2.7.2.12.H

Safety valves shall enable easy dismantling for valve setting.

2.7.2.13 RELIEF VALVES

2.7.2.13.A

Relief valves shall be designed to operate in the full range of design flows without fluttering or chattering which could generate valve component damages or unacceptable pressures waves in the system.

AA

NA

2.7.2.13.B

The loads due to the free jet effect caused by valve opening shall be considered for the design of relief valves and also for the design of connected pipeworks.

2.7.2.13.C

Valves on radioactive circuits shall be designed to preclude outward leaks during valve actuation by discharging to a closed collection system.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 30/122

CA

The resulting counter pressure shall not impair valve actuation.

2.7.2.13.D

The design of relief valves shall have functional provisions for the application of experimental tests.

2.7.2.13.E

Pressurizer and other RCS relief valves, as applicable, shall be qualified for operation with steam, water, and steam-water mixture conditions.

2.7.2.13.F

Relief valves shall be designed to avoid any accumulation of condensed water.

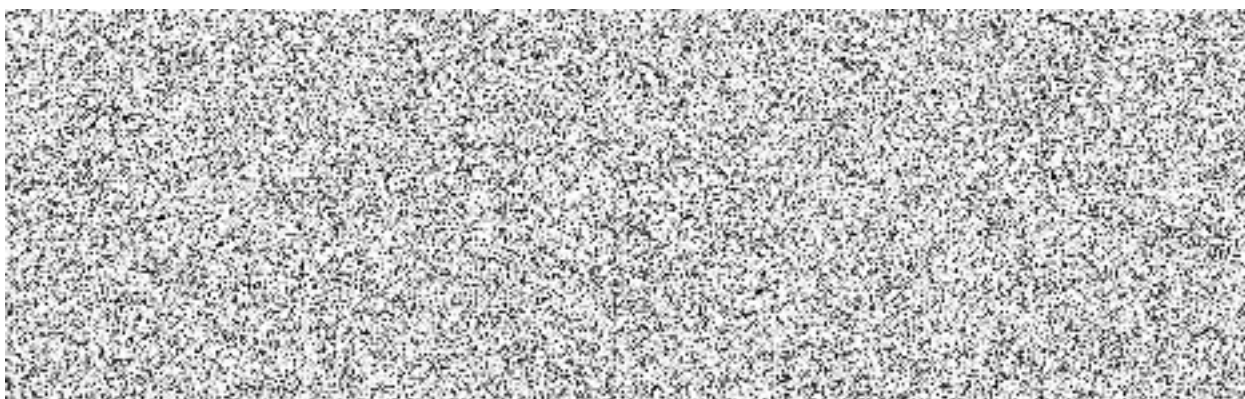
2.7.2.14 TESTING

2.7.2.14.A

Testing of safety classified valves (including relief valves) shall be possible.

2.7.2.14.B

The test conditions shall be met according to relevant codes and standards.



2.7.2.14.D

Where direct full flow or reverse flow checking capability demonstration is not possible, provisions shall also be included for non-intrusive diagnostics on check valves to determine "in-situ" changes of critical parameters by comparison with a set of reference data.

2.7.2.14.E

Pilot-operated safety valves shall be provided with means for local exercising tests and in some cases due to hazardous attributes by remote control tests.

2.7.2.14.F

Provisions shall be done in order to allow testing stipulated in the Rules*.

2.7.2.14.G

Online condition monitoring of essential valves shall be provided (see Section 2.14.2.7).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 31/122

2.7.3 VALVE ACTUATORS

2.7.3.1 GENERAL

2.7.3.1.A

Valve actuators shall be used only where necessary in compliance with safety, functional, reliability and availability requirements.

2.7.3.1.B

The number of different actuator types and designs (size, model, etc.) shall be the minimum to be compatible with safety and Diversity* requirements.

2.7.3.2 INTERCHANGEABILITY

2.7.3.2.A

Each part of a valve actuator shall be interchangeable with the corresponding part of any other valve of the identical type (i.e. same physical identifier taking into account the safety classification) located in the Nuclear Island* without modification.

2.7.3.2.B

Moreover, they shall be interchangeable with the corresponding part of any other valve actuator with the same physical identifier located in the PGP or Balance of Plant*.

BA

Physical identifiers are defined in the Section 2.12.7.

2.7.3.2.C

Each valve actuator or set of identical type of valve actuators shall be supplied with corresponding parts documentation and the list of the recommended and supplied spare parts.

2.7.3.3 DESIGN CONDITIONS

2.7.3.3.A

Each valve and valve actuator shall be designed to ensure operation under the full range of its own design conditions, including recovery from potential mis-positioning of the valve.

AA

The structural strength of the complete power chain from actuator via connecting components to the valve shall be verified by stress calculations.

AB

These calculations shall be based on the loads which might occur by shut-off failure of the actuator drive stop mechanism.

AC

Valve actuators shall be designed and fabricated to have high resistance to vibration at each position of the stem.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 32/122

2.7.3.3.B

Maximum or worst-case operating conditions taking account of safety margins and potential inaccuracy of setting moments of forces shall be considered for the actuator sizing and design, in accordance with equipment classification and applicable standards.

2.7.3.3.C

The actuator motors shall be capable of operation over the full range of voltage variation, as specified in Section 2.7.11.4.4, for the Plant's* electrical power distribution system, with the following requirements:



2.7.3.3.D

Motors of valve actuators which are needed to cope with the Accident Conditions* shall also be designed for voltage degradation that may occur under the Accident Conditions*.

2.7.3.3.E

Pneumatic actuators shall be capable of performing their required function over the full range of compressed air pressure (with sufficient margin), taking into account the actual ambient pressure conditions.

2.7.3.3.F

The calculation of required actuator spring load shall include margin to cover relaxation of the spring and friction load in the actuator.

2.7.3.3.G

Self-medium actuators shall be able to perform the required function under the full range of medium characteristics defined in the specification.

2.7.3.4 SELECTION OF ACTUATORS

2.7.3.4.A

Inside the Primary Containment*, valves, especially control valves, shall be provided with an electric motor-driven actuator. However, where electric motor drives cannot meet the relevant process or safety requirements, self-medium drives or pneumatic actuators are acceptable.

2.7.3.4.B

Diaphragm actuators shall be minimized in the Primary Containment*.

2.7.3.4.C

Outside the Primary Containment*, valves shall be driven by electric motor or pneumatic drives, or by self-medium operated drives.

CA

However, electric motor drives shall be used for valves requiring high actuator forces and for wedge gate valves.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 33/122

2.7.3.4.D

Valves, function of which is isolation, and which are required to have a short actuation time or a Fail-Safe* position, shall be provided with actuators compatible with the size of the valve and the stem force (or torque) needed to achieve actuation.

DA

The actuator performance shall be in accordance with the specified safety requirements (isolation function).

2.7.3.4.E

Direct-acting solenoids shall be restricted for valves larger than 50 mm in diameter unless justified otherwise on a case by case basis.

2.7.3.4.F

Pneumatic actuators shall be used for containment isolation valves. However, depending on the applicable nuclear codes and regulatory requirements some limitations or alternatives could be justified.

2.7.3.4.G

Valves function of which requires a rapid rate of actuation to a fully open or closed position shall be provided with a pneumatic, hydraulic, explosive /propellant, or solenoid actuator dependent on the size of the valve and stem force (or torque) needed to achieve actuation.

GA

Such valves shall provide the feature that the valve will reach a specific position (closed or open) by action of a biasing spring or other means on the loss of external power. Actuators that use the pressure of the flowing media are also included in this category.

GB

Actuators which utilise the pressure of the flowing media may also be used in this category of valves. However, these actuators shall not to be used for Safety Functions*.

2.7.3.4.H

Valves function of which requires the valve to be maintained in a fixed position for relatively long periods of time either open, closed or intermediate (e.g., in throttling applications) shall be provided with an electric motor driven actuator.

HA

The rate of actuation shall be moderate and the actuator shall provide a self locking feature such that the valve will remain in the last position at the time of a loss of external power and shall not drift regardless of internal flow or pressure.

2.7.3.4.I

The actuator type for valves, function of which requires the valve to be modulated in response to an instrument signal to control a system parameter (e.g., flow rate), shall be chosen based on the required rate of modulation, required accuracy and number of cycles.

2.7.3.4.J

Manual valve actuators shall be designed so that one man can operate it manually without any device.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 34/122

2.7.3.4.K

The suitability of the explosive valves for specific applications shall be duly demonstrated.

2.7.3.4.L

Pneumatic piston actuators shall not be used on gate valves in steam systems.

2.7.3.5 MANUAL OPERATION AND LOCKING

2.7.3.5.A

Power-operated valves shall be provided both with the capability for local manual operation, if required, and with devices for administrative controls, such as chains and locks.

2.7.3.5.B

Whenever applicable, valves with built-in hand locking devices shall be used.

2.7.3.5.C

All pneumatic operated valves shall be capable of manual operation.

CA

Valves included in this category shall reach a specific position (closed or open) by action of a spring or other means on loss of external power.

2.7.3.6 CONTROL AND TESTING

2.7.3.6.A

Testing of safety classified active valves and actuator assemblies shall be met according to relevant codes and standards.

2.7.3.6.B

Online condition monitoring of essential valves shall be provided (see Section 2.14.2.7).

2.7.3.7 PNEUMATIC ACTUATORS

2.7.3.7.A

The material for diaphragms and seals of pneumatic-actuated valves shall be qualified.

2.7.3.7.B

Instrument air system which supplies air to pneumatic drivers shall be equipped with air reservoirs to provide reliable function of those drives. Individual air reservoirs may be used for each pneumatic drivers if necessary to meet safety and availability targets.

2.7.3.7.C

The air reservoir shall provide sufficient compressed air capacity for relevant number of the pneumatic drive working cycles if an air receiver is equipped.

2.7.3.7.D

Integral part of each air reservoir shall be a check valve installed for case of voltage loss (accident) on compressed air supply system if an air receiver is equipped.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 35/122

2.7.3.7.E

A hand operated stop valve shall be provided to separate the air reservoir from the main compressed air supply piping system in case of maintenance/service works on relevant pneumatic valve if an air receiver is equipped.

2.7.3.8 PROTECTION OF VALVES

2.7.3.8.A

Torque switch and thermal overload relays shall be provided for mechanical and motor protection of motor-operated valves.

2.7.3.8.B

The torque switch shall limit the output torque by tripping the motor when the actuator output torque exceeds the set-point of the torque switch.

2.7.3.8.C

Thermal overload relays shall be set to de-energize the motor before it will be damaged permanently by overheating.

CA

This protection shall be maintained in-service at all times in order to avoid undetected failure or degradation only for motor operated valves that can affect the Plant* and/or Unit* availability.

2.7.3.8.D

For safety classified motor-operated valves, the use of protection devices shall be non-disabling.

DA

The difficulty and the potential inaccuracies of selecting appropriate thermal and torque setpoints shall not compromise the Safety Functions* of the motor-operated valves.

DB

The thermal overload relays shall be connected to alarms to indicate an over-current or an overloading condition without disabling the valve.

DC

This feature shall make control room Operators* aware of the mechanical and thermal overload on a motor-operated valve without compromising its Safety Functions*.

2.7.3.8.E

Peripheral devices such as switches, switch arms, air lines and fittings, necessary for valve actuator function, shall be protected from inadvertent mechanical damage or actuation.

2.7.3.8.F

Motor actuators shall have water-tight hub or cable connections.



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 36/122

2.7.3.8.H

Non-metallic parts shall be selected to maximize their service life and require a minimum of maintenance.

HA

Recommended replacement intervals for all non-metallic parts necessary for valve operator function shall be identified.

HB

Replacement intervals shall be based upon wear, temperature, pressure, humidity and radiation environments appropriate to each component application.

2.7.4 PUMPS

2.7.4.1 SCOPE

2.7.4.1.A

This Section defines the functional requirements that apply to all, but in particular to the essential, pumps of the Plant*.

2.7.4.2 GENERAL

2.7.4.2.A

Pumping equipment shall be designed to minimise the need for support systems.

2.7.4.2.B

Where support systems are to be implemented, the need for such systems shall be justified by the Supplier*.

2.7.4.2.C

The head versus flow curve shall be continuously rising from design point to zero flow except for the helicoidal and helico-centrifugal pumps that might have a local dip in the central part of the curve.

2.7.4.2.D

Variable speed drives shall be used when applicable.

2.7.4.3 DESIGN CONDITIONS

2.7.4.3.A

The equipment shall be designed to ensure operation under the full range of its own design conditions i.e. max. pressure, differential pressure, max. fluid temperature, max. flow rate, taking account of normal wear over the operating life of the pump.

2.7.4.4 PUMP SIZING

2.7.4.4.A

The flow curve shall be compatible with stable operation of a single pump and permit stable operation of several pumps operating in parallel, for all operating flowrate conditions.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 37/122

2.7.4.4.B

Pumps with constant-speed drivers shall be capable of at least a 5 percent head increase at rated conditions by replacement of the impeller or impellers with ones of larger diameter or different hydraulic design.

2.7.4.4.C

Pumps shall be sized with appropriate flow and head margins to account for normal degradation and previous operating experience.

CA

The requirement for flow and head margin applies in particular to Essential pumps.

2.7.4.4.D

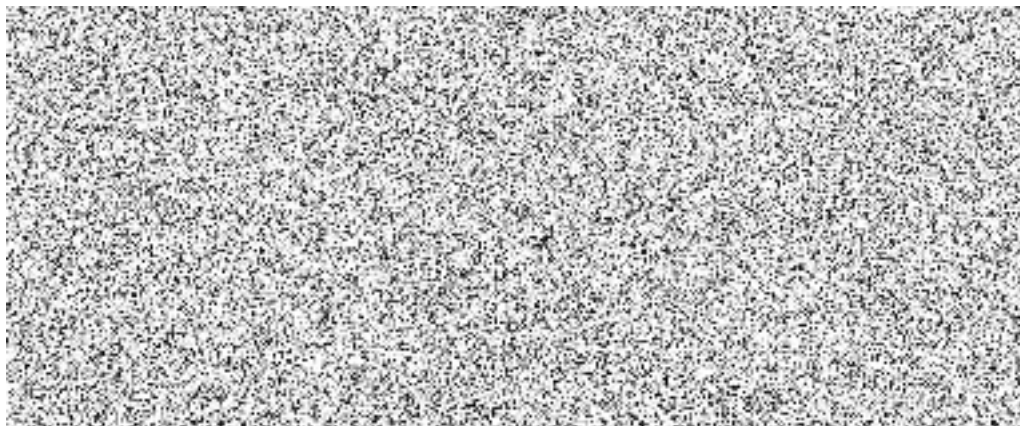
The Supplier* shall select hydraulic balance systems and thrust bearing adequate for the operational flow/pressure range.

2.7.4.4.E

Pumps and their electrical motors shall be sized to meet operational requirements listed in Section 2.7.11.4.4.

2.7.4.5 PUMP APPLICATIONS

This Section gives some non-permitted or non-recommended pump applications. The list is not exhaustive.



2.7.4.5.C

Multi-stage ring-casing pumps with through-bolts shall not be permitted for applications involving radioactive fluids where the pump would be subject to thermal shocks.

2.7.4.5.D

Multi-stage pumps with overhanging impeller are permitted only for some specific applications where adequate justification can be provided.

2.7.4.5.E

Shaft-seal type pumps shall be provided with leakage collection and recovery.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 38/122

2.7.4.6 MINIMUM FLOW OPERATION

2.7.4.6.A

System designs shall be such that, for all design conditions, the pumps do not operate below the minimum flow required for pump protection.

2.7.4.6.B

If minimum recirculation flow lines are required, these lines shall be sized to ensure that damage to the pump will not result from continuous bypass operation.

2.7.4.6.C

The design of the minimum flow lines, if installed, shall permit periodic testing to verify that this flow is in accordance with design.

2.7.4.7 INTERCHANGEABILITY

2.7.4.7.A

AA

Pump assemblies shall be interchangeable with the corresponding part of any other pump of the identical type (i.e. same physical identifier taking into account the safety classification) located in the Nuclear Island* without modification.

AB

Moreover, they shall be interchangeable with the corresponding part of any other pump with the same physical identifier located in the PGP or BOP. Physical identifiers are defined in the Section 2.12.7.

2.7.4.7.B

Each component of one pump assembly shall be interchangeable with its counterpart on any other pump assembly of the identical type.

2.7.4.7.C

NA

2.7.4.7.D

Each pump shall be capable of being equipped with mechanical seal from different manufacturers.

2.7.4.8 ORIFICES

2.7.4.8.A

In general, regulating valves external to the pump shall be used in preference to orifices for adjusting the pump hydraulics.

2.7.4.8.B

Orifices shall only be used for hydraulic balancing of circuits in order to overcome some particular asymmetric operating condition.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 39/122

2.7.4.9 SUCTION CONDITIONS

2.7.4.9.A

In no circumstances shall pump operation give rise to cavitation that would result in excessive impairment of pumping characteristics, for all DBC and DEC, as applicable.

AA

Systems shall be arranged and sized and pump behaviour shall be optimised to get that pumps work with an available suction head having enough margin to avoid cavitation threatening the pump performances for its life cycle.

2.7.4.9.B

The lifetime of impellers, flow nozzles and casing shall be commensurate to their service conditions and the fulfilment of the requirements on the Plant* and component lifetime performance as set out in the Sections 2.2.2.1.3 and 2.4.2.

2.7.4.9.C

Cavitation erosion shall be precluded and shall neither result in loss of operability of the pump assembly nor lead to the necessity to replacement of equipment parts.

CA

This shall be accomplished by ensuring that NPSH available is always above NPSH required with a margin for all operating flowrate conditions.

CB

In the case of large or high-speed pumps cavitation shall be studied more closely by defining incipient cavitation conditions.

2.7.4.9.D

The use of booster pumps, or pumps operating in series, shall be avoided as far as possible.

2.7.4.9.E

Where a booster pump is used, it shall provide the flowrate and pressure head required to preclude cavitation of the main pump, especially during pump start-up and shutdown transients.

2.7.4.10 PUMP/CIRCUIT INTERACTION

2.7.4.10.A

The Plant* design shall be such that, in all design conditions, resonances do not occur which could:



2.7.4.10.B

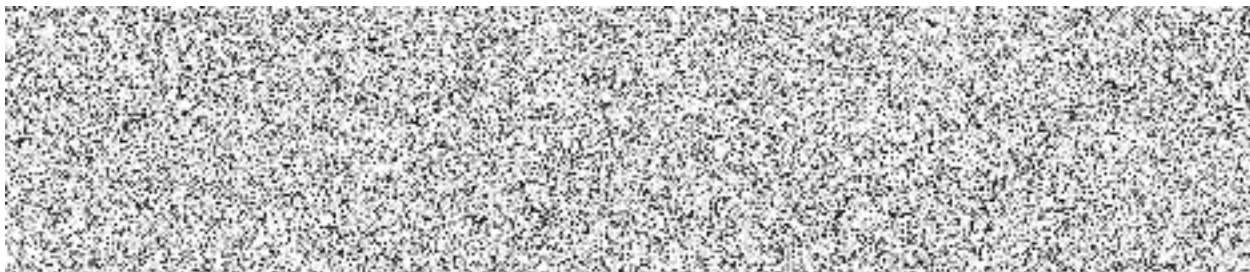
In all design conditions the resonances shall not have any adverse effect on the facilities of control system.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 40/122

2.7.4.10.C

The design of the pumps shall allow appropriate start-up at any media temperature, especially with cold water.

2.7.4.11 ROTATIONAL SPEED



2.7.4.12 SEALS AND BEARINGS

2.7.4.12.A

Pumps shall be designed to facilitate replacement of pump and motor seals and bearings in a minimum time, and give minimum radiation exposure to workers.

2.7.4.12.B

The seal shall be designed to minimise the effects of pressure and temperature changes on its performance.

BA

The Supplier* shall obtain from the pump manufacturer the seal water purity and temperature requirements and include this information in the documentation provided to the Owner*.

2.7.4.12.C

The seal material shall be compatible with the chemical content of the process fluid.

2.7.4.12.D

The seals and bearings materials shall not negatively affect materials of other components (See Section 2.6.4).

2.7.4.12.E

The seal shall be designed to operate with the pump at shut-off head.

2.7.4.12.F

Where practical, pumps in radiation areas shall be provided with long-life bearings and permanent type lubrication.

2.7.4.12.G

Pump internals shall be designed so that they can be readily removed for maintenance.

2.7.4.12.H

However, if this is impractical, the pump shall be designed to facilitate its removal and replacement, e.g. flanged connections and electrical "quick disconnects".

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 41/122

2.7.4.12.I

Pumps in nuclear service shall be provided with drain and flush connections for decontamination.

IA

Decontamination pipework sleeves shall be provided either on the pump or on the associated pipelines, if required.

2.7.4.12.J

Self-lubricated bearings shall not be used for:



2.7.4.13 PUMP IN-SERVICE TESTING

2.7.4.13.A

System design shall provide the capability for pump flow testing (including stand-by pumps) on a periodic basis at a flow rate which adequately verifies operability and will not result in pump degradation.

2.7.4.13.B

The actual test conditions shall be as close as possible to the design flow rate.



2.7.4.13.D

If practical, the capability for flow testing during the Normal Operation* shall be provided.

2.7.4.13.E

The system design shall include provisions to test all essential pumps in accordance with relevant applicable Rules* as defined in the Chapter 2.5, including adequate instrumentation and test connections.

2.7.4.14 VIBRATIONS

2.7.4.14.A

The Supplier* shall provide specifications related to the vibration requirements and maximum vibration level of equipment in accordance with the relevant Rules*.

AA

Vibration monitoring shall be provided for Essential pumps.

2.7.4.14.B

The foundation block for the pumps (pumping assemblies), common to the driven system and the pump, shall be designed with due regard to the avoidance of excessive vibration at running speed and machine misalignment under all operating conditions.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 42/122

2.7.4.15 MINIMUM NPSH

2.7.4.15.A

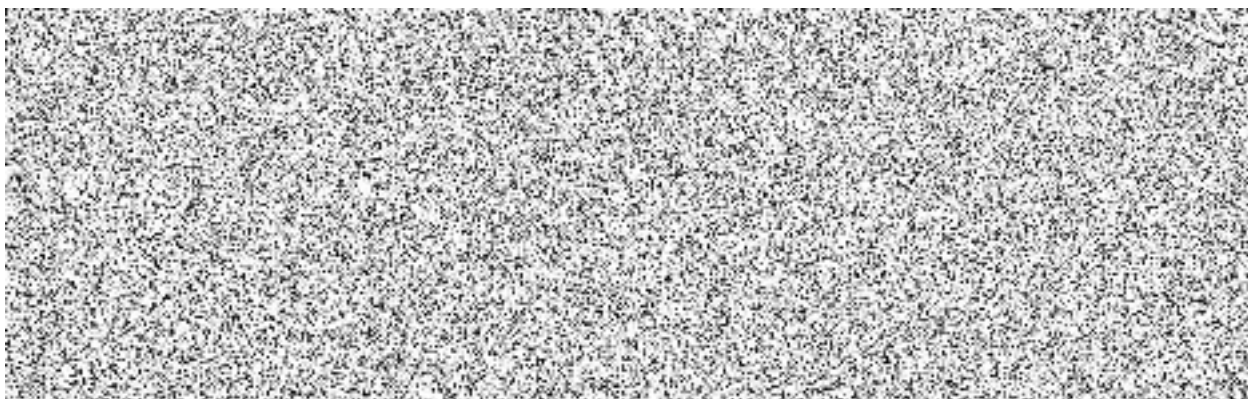
In order to eliminate Net Positive Suction Head (NPSH) problems, a sufficient margin shall be provided between the available NPSH and the specified minimum NPSH. This can be achieved either by the pump design, or by the appropriate location and routing of the suction pipework.

AA

Typical ratio between NPSHA and NPSHR shall be not less than 1,1.

2.7.4.15.B

In general terms, systems shall be arranged and pumps behaviour shall be optimized to get that pumps work with enough margin between the available (NPSHA) and the required (NPSHR) suction head to avoid cavitation that could affect the pump performances for the full life of the Plant*.



2.7.4.16 SPECIFIC REQUIREMENTS FOR RCS PUMPS

2.7.4.16.A



AA

Consideration shall be given for anti-rotation or reverse rotation capability.

2.7.4.16.B

Proven solutions for seals, thermal barriers, couplings, bearings, coolers, hydraulic design and electric motors shall be provided.

BA

If the proposed RCPs are unproven equipment then their adequacy shall be supported by full tests results.

2.7.4.16.C

Fatigue analysis of transients in RCP seal injection (for RCP with seals) and component cooling system shall be available.

2.7.4.16.D

NA

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 43/122



2.7.4.16.F

The RCP and its auxiliary systems shall be capable of restart after an indefinite period at hot standby.

2.7.4.16.G

The RCP shall be provided with a complete monitoring system including vibration and displacement sensors.

GA

The system shall be connected to the alarm and central panel in control rooms and shall be able to connect to acquisition and recording systems for testing and maintenance purposes.

2.7.4.16.H

Specific requirements for canned-motor and wet-winding pumps are stipulated in Section 2.7.4.20.

2.7.4.17 SPECIFIC REQUIREMENTS FOR RHR PUMPS

2.7.4.17.A

The Residual Heat Removal (RHR) pumps shall be of either a centrifugal type with mechanical seals, or a canned-motor type.

2.7.4.17.B

The seal design for mechanically-sealed pumps shall be capable of withstanding the pressure corresponding to the option chosen by the Supplier* according to Section 2.8.2.4.1.3.5, without seal leakage exceeding the normal makeup capacity.

2.7.4.17.C

The RHR pumps shall be designed to tolerate conditions with substantial voids or air entrainment in the fluid.

2.7.4.17.D

The number of stages shall be kept at minimum, one stage if possible.

2.7.4.18 SPECIFIC REQUIREMENTS FOR SIS PUMPS

2.7.4.18.A

High- or Medium-Head Safety Injection pumps shall be of the centrifugal one-shaft direct-coupled type or of the piston type.

2.7.4.18.B

NA

2.7.4.18.C

The number of stages shall be kept at minimum.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 44/122

2.7.4.19 SPECIFIC REQUIREMENTS FOR ALTERNATIVE AXILIARY PUMPS

2.7.4.19.A

The Alternative Auxiliary Pump shall be of the multi-stage centrifugal type

2.7.4.19.B

NA

2.7.4.20 SPECIFIC REQUIREMENTS FOR CANNED-MOTOR AND WET-WINDING PUMPS A

The Section 2.7.4.20 and its subsections include specific requirements on the canned-motor and wet-winding pumps.

2.7.4.20.1 BASES FOR SELECTION

A

Canned-motor and/or wet-winding pumps shall be considered in order to:



2.7.4.20.2 DESIGN LIFE

A

Adequate design bases shall be used to determine corrosion allowance, for calculating cycle fatigue and determining wear of components in order to establish the maintenance and Inspection* (including replacement, if required) needed to achieve the Plant* lifetime.

2.7.4.20.3 NORMAL DESIGN REQUIREMENTS

2.7.4.20.3.A

The pressure-boundary components of the pump shall be capable of withstanding full system pressure.

AA

In case of canned-motor pumps, the stator and rotor of the electric induction motor shall be encased in corrosion-resistant cans constructed and supported to withstand full system pressure.

AB

In case of wet-winding pumps, the rotor shall be encased in corrosion-resistant can and the rotor and the winding shall be constructed and supported to withstand full system pressure.

2.7.4.20.3.B

Leak-off connections at the bolted flanges shall monitor any leakage past the gasket area, if necessary.

BA

The Supplier* shall define the scope of the monitoring and justify any bolted flanges without monitoring.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 45/122

2.7.4.20.3.C

The materials in contact with the reactor coolant, cooling water, and purge flow shall be selected in accordance with the requirements of Section 2.6.4.

2.7.4.20.3.D

All pump parts which are wetted by the reactor coolant shall be also compatible with the solutions used in their decontamination.

DA

It is also acceptable to remove and replace incompatible parts after decontamination.

2.7.4.20.4 INSPECTION AND MAINTAINABILITY REQUIREMENTS

2.7.4.20.4.A

The pumps shall be designed and manufactured to permit ISI.

2.7.4.20.4.B

The design shall enable disassembly and removal of the pump internals and canned motor for Inspection*.

2.7.4.20.4.C

The frequency and the time requested for the routine Inspection* and maintenance activities shall be minimised without affecting Plant* and/or Unit* operation, performance or safety.

2.7.4.20.4.D

The radiation ALARA requirements shall be met during Inspection* and maintenance activities.

2.7.4.20.4.E

The pump shall be equipped with capability to a perform a water purge of the pump casing to minimise deposition of radioactive material in the motor portion of the pump and/or shall be designed to be compatible with an automated and robotic system for Inspection*, maintenance and replacement of components.

2.7.5 HEAT EXCHANGERS

2.7.5.1 SCOPE

2.7.5.1.A

This Section defines the functional requirements that are common to all, but in particular to essential, heat exchangers used in the Plant*.

2.7.5.2 DESIGN CONDITIONS

2.7.5.2.A

The equipment shall be designed to ensure operation under the full range of its own design conditions.

2.7.5.2.B

For all essential heat exchangers (such as heat exchangers with impact to safety and operational reliability), either provisions for measurement of heat transfer rate shall be provided

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 46/122

or the heat exchangers shall be designed with sufficient heat transfer area margin in order to ensure their heat transfer capability during their design life.

2.7.5.2.C

Design provisions shall be supplied for the erosion/corrosion monitoring or Inspection* of the main components during their design lifetime including necessary means.

2.7.5.3 START-UP CONDITIONS

2.7.5.3.A

Each heat exchanger shall be capable of operating at any time without requiring any special preparation or conditioning when the fluid temperature is less than 100 °C, or the temperature difference is low.

2.7.5.3.B

Where practicable, this shall also be the case for high temperature difference.

2.7.5.4 TYPE OF EQUIPMENT

2.7.5.4.A

Plate-type heat exchangers shall not be used for applications where the fluid has a high degree of impurity and a high level of fouling is likely.

2.7.5.4.B

2.7.5.4.C

Where plate-type heat exchangers are used, the design shall provide:

CA

The filtering device shall not be directly on the exchanger. It may be a separate system where part of medium is fed into.

CB

The external loop shall start-up in case of loss of heat exchanger efficiency (e.g. fouling).

2.7.5.4.D

For tubular heat exchangers, the design shall ensure that no boiling can occur on the tube sheet and/or collector (except for special process heat exchanger, e.g. evaporator), especially in the transition area of the rolled expansion of a tube.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 47/122

2.7.5.4.E

For tubular heat exchangers, the fluid which is most contaminated shall be routed inside the tubes.

2.7.5.4.F

Where possible and appropriate, this fluid shall also be at a lower pressure.

2.7.5.5 VIBRATION

2.7.5.5.A

Heat exchangers shall be designed to reduce flow-induced tube vibration under the most adverse flow and temperature conditions.

2.7.5.5.B

Adequacy with respect to flow induced vibrations shall be demonstrated by either of the following:



2.7.5.6 EQUIPMENT SIZING

2.7.5.6.A

Heat exchanger fouling factors shall be established by the Supplier* taking into consideration conservative predictions of material build-up based on actual system and equipment designs, expected Plant* and/or Unit* operating conditions, and maintenance programme.

2.7.5.6.B

Adequate design margins shall permit plugging of tubes without impairment of equipment performance.

2.7.5.6.C

A sufficient corrosion allowance shall be provided depending on the actual corrosion risk.

2.7.5.6.D

However, design margins shall not result in undue over-design which could penalise safety and operation.

2.7.5.6.E

The Supplier* shall submit the design margins for all heat exchangers to the Owner* for information.

2.7.5.6.F

Heat exchangers for raw water (sea water, river, reservoirs, etc.) shall be constructed using materials in the same galvanic range for the different parts (special care for joined parts)

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 48/122

2.7.5.7 DESIGN PRESSURE

2.7.5.7.A

Heat exchangers shall be designed to withstand the maximum system pressure and differential pressures, including pressure tests.

2.7.5.7.B

The allowable stress limits for the different load combinations shall be as defined in the applicable pressure vessel codes.

2.7.5.7.C

The overpressure in an isolated heat exchanger due to fluid thermal expansion or as a result of other beyond design events, shall be prevented.

2.7.5.8 HYDRAULIC DESIGN

2.7.5.8.A

The heat exchanger design shall ensure that the inlet flow neither results in local high velocities which could lead to erosion of the tubes, tube sheets, and other internal parts of the heat exchanger, nor results in asymmetrical temperature distribution which could lead to thermal stresses of the equipment.

2.7.5.8.B

In addition, provisions shall be taken to limit inlet flow disturbances or severe fluid impingement.

2.7.5.9 EQUIPMENT ARRANGEMENT

2.7.5.9.A

The heat exchanger design shall provide easy access for operation and maintenance purposes. For general equipment layout rules see the Chapter 2.11.

AA

Equipment layout shall provide adequate space for heat exchanger or heat exchanger tube bundle removal.

2.7.5.9.B

The equipment configuration shall facilitate cleaning operations by eliminating "dead zones" where fluids, gases, or particles could accumulate.

2.7.5.9.C

Complete drainage of the equipment shall be possible.

2.7.5.9.D

Where plate-type heat exchangers are used, they shall be designed so that dismantling is possible for mechanical cleaning except for small welded heat exchangers where replacement is easier and cheaper than cleaning.

2.7.5.9.E

Plate-type heat exchangers shall also be provided with the facility for chemical cleaning.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 49/122

2.7.5.9.F

Complete draining and venting of the equipment shall be possible.

FA

It shall be arranged to avoid flooding the floor surface.

2.7.5.9.G

The heat exchanger design shall enable Non Destructive Test examinations and pressure test.

2.7.5.9.H

Temperature monitoring equipment shall be fitted to the largest heat exchangers in PGP.

2.7.5.10 MANHOLES AND HANDHOLES

2.7.5.10.A

If used, manholes and handholes shall be designed taking account the need for proven leaktightness during all their own design conditions.

2.7.5.10.B

Where necessary, a leak-off collection system shall be implemented, including individual lines in order to identify leakage size and place.

2.7.6 TANKS

2.7.6.1 SCOPE

2.7.6.1.A

This Section defines the functional requirements that are common to all, but in particular to the essential, tanks used in the Plant* to provide receipt, storage, distribution, or preparation of various fluids.

2.7.6.2 EQUIPMENT TYPE

2.7.6.2.A

Tanks shall permit complete tank drainage.

AA

Tanks shall not have plain bottom heads. Exceptions shall be justified by the Supplier*.

2.7.6.2.B

Where there is the potential for the accumulation of sediments, recirculation mixers or agitator devices shall be installed.

2.7.6.2.C

Free-standing metallic tanks shall meet the following requirements:

CA

- relevant evenness of metal sheets shall be assured by stiffeners as needed,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 50/122

CB

- internal stiffeners shall not lead to fluid or particulate retention during tank drainage, nor to air retention during tank refilling,

CC

- external stiffeners shall not constitute a receptacle for any external contamination.

2.7.6.2.D

Floating roof tanks shall be avoided unless duly justified.

2.7.6.2.E

Concrete tanks shall be provided with a liner which is compatible with the stored fluid.

2.7.6.2.F

Internal liners, coatings, or cladding for any type of tank shall either be designed to withstand all their design conditions for the lifetime of the Plant* and/or Unit*, or shall be easily maintainable.

2.7.6.2.G

Outdoor tanks shall be protected against freezing.

2.7.6.2.H

Where required, overflow and vortex suppression device shall be provided.

2.7.6.2.I

Where samples are taken from tanks and where necessity of mixing exists to homogenize the medium volume, a suitable method of mixing shall be provided. The specific type of the mixing method shall be justified (i.e. mechanical mixing, recirculation mixing).

2.7.6.2.J

Sampling place for taking samples shall ensure representative sample.

2.7.6.2.K

Two sampling places shall be provided for tanks with oil products. One in lowest point for sampling of water and other higher for sampling of representative sample of oil product.

2.7.6.2.L

Where required for operational reasons, underpressure protection device shall be provided.

2.7.6.2.M

Tanks shall be provided with appropriately sized vents and fitted with any special vent equipment (i.e., fire arrestors, CO₂ absorbers) as required by the service.

2.7.6.2.N

Pressurized tanks shall be provided with appropriately sized safety relief valves.

2.7.6.2.O

Tanks that may operate under vacuum (e.g. during draining), shall be protected by vacuum relief means or vacuum breaker devices.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 51/122

2.7.6.3 RADIOACTIVE FLUIDS

2.7.6.3.A

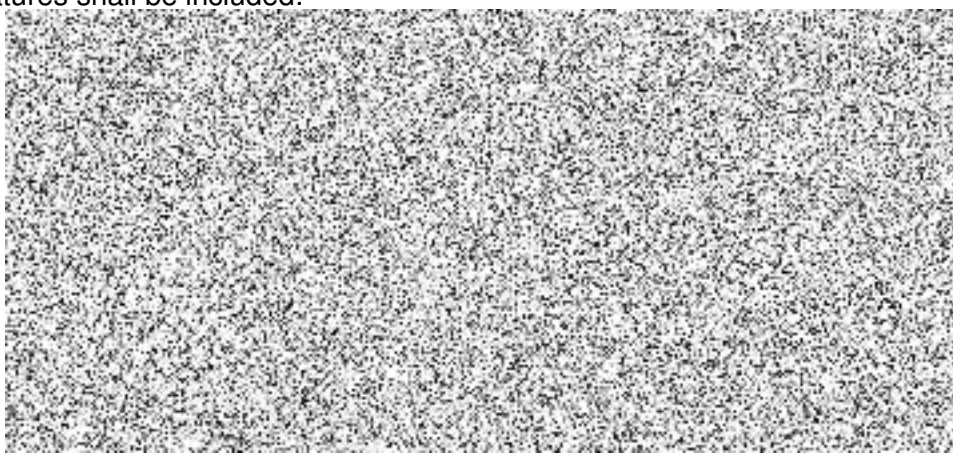
All tanks containing radioactive fluids shall include provisions to prevent unintended retention of particulate material.

AA

Tanks shall be designed so that all crud and sludge can be easily removed.

2.7.6.3.B

Depending on the characteristics of the material to be stored, one or more of the following features shall be included:



BA

A complete leak-retention capability shall be provided where there is a risk of radioactive pollution.

BB

Tanks containing radioactive liquids shall be enclosed in watertight compartments or shall be surrounded by curbs with leak collection as specified in Decree No. 377/2016 Coll., as amended.

BC

Vents on tanks, in particular on tanks which contain thermally hot liquids that could carry potentially contaminated material into vapour, shall be piped to the Plant* ventilation exhaust system and suitably filtered.

BD

The vent design shall prevent liquids and solid from entering the Plant* ventilation system.

BE

Atmospheric tanks in the Liquid Radioactive Waste* Processing System (LRWPS) and Solid Radioactive Waste* Processing System (SRWPS) shall be provided with vents which are separate from and above overflow pipes and which are sized to prevent tank overpressure or vacuum conditions from occurring under maximum filling and draining conditions.

2.7.6.3.C

Tanks that store radioactive fluids shall be equipped with features that allow their easy decontamination without any need for personnel access.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 52/122

2.7.6.3.1 CHARCOAL ADSORPTION TANKS

2.7.6.3.1.A

The charcoal adsorption tanks in the Gaseous Radioactive Waste* Processing System (GRWPS) shall be designed so that if gas flows vertically upward the bed is not fluidized under any expected process condition.

AA

Flow into the first bed shall be downward.

AB

In subsequent beds, in series, the flow shall be that requiring the least pipe.

AC

The vessel shall be sized such that loss of efficiency due to axial diffusion is minimal.

2.7.6.3.1.B

The vessel design shall make provision for the loading and removal of the adsorption media.

2.7.6.3.1.C

Drains shall be provided on each charcoal adsorber vessel to permit complete draining.

2.7.6.3.1.D

Provision shall be made for charcoal drying.

2.7.6.3.1.E

Discharge from pressure relief devices (if required), provided on tanks, shall not be piped outside the GRWPS.

2.7.6.3.2 PRESSURIZED GAS STORAGE TANKS

2.7.6.3.2.A

Tank design shall provide means for purging or inerting of the tank vapour space with nitrogen to remove residual gaseous activity or potentially combustible gases.

AA

Purge and vent connections shall be double-valved to reduce leakage unless connections are made back to the GRWPS.

2.7.6.3.2.B

Discharge from pressure relief devices, provided on tanks in the GRWPS, shall be piped into a building ventilation system or to another system capable of containing the discharge and having provisions for the monitoring and control of the releases..

2.7.6.3.2.C

Tank design shall provide for moisture removal.

CA

A drain line shall be located in the lowest point of the tank to allow for complete drainage.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 53/122

2.7.6.3.3 SPENT RESIN, PHASE SEPARATOR, AND SLUDGE TANKS

2.7.6.3.3.A

Tanks and internals in SRWPS service shall be constructed of austenitic stainless steel.

2.7.6.3.3.B

Phase separator type tanks can be provided to concentrate water slurries (powder ion exchange resins, filter sludges, etc.) by settling. If phase separator type tanks are provided in SRWPS, following requirements are applicable:

BA

Fluid powered mixers shall be provided on or near the tank bottom and arranged to suspend settled solids and keep them suspended for discharge from the tank.

BB

Mixing shall be sufficient to enable obtaining of representative samples of sludges transported to shipping containers.

BC

The fluid powered mixers shall be powered by air or water circulated from the tank bottom via pump of sufficient capacity to suspend the tank solids.

BD

The pumps shall be separate from the sludge transfer pump if necessary to gain the necessary flow.

BE

Debris which can plug the mixing devices shall be kept out of the tanks or away from the mixing devices.

BF

A decant connection and pump shall be provided above the maximum sludge level to remove clarified water from the settled sludge.

2.7.6.3.3.C

Tanks containing spent bead type ion exchange resins shall have the overflow fitted with a non-plugging screen.

CA

The resin screen shall be arranged inside the tank (not in the overflow line) so that resins will fall into the tank and not accumulate or plug the screen.

CB

The screen area shall be large enough so as not to affect the required overflow capacity.

2.7.6.3.3.D

Spent resin tanks shall have provisions for mixing the spent resins by means of fluid powered mixers (e.g. eductors). Mixing shall be sufficient to enable obtaining of representative samples of resins transported to shipping containers.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 54/122

2.7.6.4 ACCESS AND MAINTENANCE

2.7.6.4.A

Each tank shall be equipped with at least one easily accessible manhole (or handhole, depending on the tank size).

2.7.6.4.B

Those areas requiring periodic regulatory controls including ISI (e.g. welded joints) shall be easily accessible.

2.7.6.4.C

All areas of the tank shall be accessible for the Inspection* and maintenance.

2.7.6.4.D

The Inspection* and maintenance requirements shall be minimised in all areas with difficult access (e.g. inside and at the bottom of tanks).

2.7.7 BOLTED JOINTS & THREADED FASTENERS

2.7.7.1 SCOPE

2.7.7.1.A

This Section defines the common functional and main design requirements that apply to the bolted joints and threaded fasteners of all, but in particular in the essential, systems of the Plant*.

2.7.7.2 GENERAL

2.7.7.2.A

Bolted joints and threaded fasteners shall be used only where there is a potential need for frequent disassembly.

2.7.7.2.B

Preferably they shall be of a simple, rugged design, without high strength or unusual materials, precision parts, or specialised assembly and Inspection* methods.

2.7.7.2.C

The design shall nevertheless allow specialised techniques to be used, if necessary, during Normal Operation* (e.g. ultrasonic measurement of the length of threaded fasteners, hydraulic tensioning devices, etc.).

2.7.7.2.D

The configuration of bolted joints shall be selected on the basis of their previous satisfactory performance in similar applications.

2.7.7.2.E

The installation and configuration of bolted joints and threaded fasteners shall accommodate any requirements to facilitate ISI.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 55/122

2.7.7.3 DESIGN REQUIREMENTS

2.7.7.3.A

Bolted joints which provide sealing of a pressure boundary, and where the contained fluid is contaminated, corrosive, or toxic, shall be designed to minimise the potential for leakage and to facilitate detection of any leakage and in-service leakage test.

2.7.7.3.B

In order to minimise the consequences of such leakage, adequate corrosion-resistant joint materials shall be used as needed.

2.7.7.3.C

These materials shall not impair the functional adequacy of the joint.

2.7.7.3.D

Joints for which corrosion-resistant fasteners cannot be used, and which could be subject to corrosion, shall be identified by the Supplier* and a suitable Inspection* and maintenance programme provided.

2.7.7.3.E

The joint configuration design shall facilitate Inspection* (e.g. direct visual Inspection* shall be possible without dismantling).

2.7.7.3.F

The gasket material and arrangement shall be such that adequate geometrical fit is achieved between the gasket and the sealing surfaces (e.g. metal to metal).

2.7.7.3.G

Locking and retention of threaded fasteners shall be provided for the following situations:



2.7.7.3.H

Where a bolted joint uses preloaded fasteners, the Supplier* shall specify in appropriate Documents* the preload required and how it is to be achieved.

2.7.7.3.I

The bolting torque shall be specified for all connections.

IA

Sealing joints for primary part equipment shall be provided with strength and tightness calculation including determination of tightening torque.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 56/122

2.7.8 PIPING AND FITTINGS

2.7.8.1 SCOPE

2.7.8.1.A

This Section defines the functional requirements that are common to all, but in particular to the essential, piping and fittings used in the Plant* to provide circulation and distribution of various fluids.

2.7.8.2 GENERAL REQUIREMENTS

2.7.8.2.A

Piping shall be designed according to the requirements specified in Section 2.11.4.3.

2.7.8.2.B

The number of pipe welds shall be minimised in the High Energy Lines* systems.

2.7.8.2.C

Where possible, pipe spools shaped to incorporate bends shall be specified rather than straight pipe and elbow fittings.

2.7.8.2.D

There shall be no pressure-retaining welds in portions of piping which pass through guard pipes in containment penetrations.

2.7.8.2.E

Flue fittings connecting process piping to guard piping in these areas shall be designed for welding to the process pipe without cutting the pipe pressure boundary.

2.7.8.2.F

The Supplier* shall minimise number of piping with stratification and T-joints with temperature mixing.

2.7.8.2.G

The number of high points and low points on piping shall be reduced to as low as practicable; each high point shall be provided with a venting device, each to low point with a draining device. See also Section 2.11.4.3.6.

GA

Particular consideration shall be given to the safety injection piping layout to avoid incondensable gases accumulation in dead spots.

2.7.8.2.H

The Supplier* shall specify maximum flow velocities, temperatures and pressures for piping for different pipe materials, surface roughness and media.

2.7.8.2.I

The Inspection* of corrosion shall be possible on representative points.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 57/122

2.7.8.3 RADIOACTIVE PIPING

2.7.8.3.A

In pipes subject to ISI, insulation parts shall be of a quick-disconnect design, and of sufficiently small size and weight that they can be handled by a single person.

2.7.8.3.B

Piping containing radioactive fluid shall be all-welded.

2.7.8.3.C

For systems that may carry radioactive fluids, preference shall be given to butt-welding.

CA

NA

CB

Flanges may be used where frequent disassembly is required for maintenance.

2.7.8.3.D

Piping of Reactor Coolant System* shall be seamless type and the number of circumferential joints shall be minimized to reduce ISI.

2.7.8.4 FLOW RESTRICTORS

2.7.8.4.1 SIZING

2.7.8.4.1.A

Flow restrictors, e.g. orifices, shall be sized so that pressure drop across each one is sufficiently low to prevent cavitation under all Design Basis Conditions 1* and Design Basis Conditions 2*. This may require the use of two or more restrictors in series.

2.7.8.4.1.B

This requirement does not apply to devices designed to limit flow by cavitation, e.g. a cavitation venturi. However, the Supplier* shall identify any such applications and show that no damage to piping will result.

2.7.8.4.2 LOCATION

2.7.8.4.2.A

See Section 2.11.4.3.1.L.

2.7.8.4.3 DESIGN

2.7.8.4.3.A

Flow restrictors shall be designed so that their presence in the system can be verified by direct visual observation of the exterior of the pipework.

2.7.8.4.3.B

In addition, the flow restrictor shall have an identification of size and flow direction, if applicable, which can be verified by direct observation without opening the system.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 58/122

BA

Local removal of insulation to make the identification is permissible.

2.7.8.4.3.C

This identification shall be installed by the Supplier*, i.e. it shall be permanent, preferably integral with the restrictor itself, and not subject to change as a result of field assembly operations.

2.7.8.4.3.D

Those restrictors which cannot practically meet this requirement, such as Steam Generator* outlet-nozzle flow restrictors, shall be identified to the Owner* by the Supplier*.

2.7.9 FILTERS AND ION EXCHANGERS

2.7.9.1 SCOPE

2.7.9.1.A

This Section defines the functional requirements and main generic design requirements that are common to all, but in particular to the essential, filtering equipment (e.g. mechanical filters and ion exchangers).

2.7.9.1.B

Furthermore, this Section defines the functional requirements and main generic design requirements for filtering equipment used in radioactive service.

2.7.9.2 GENERAL

2.7.9.2.A

When designing filtering equipment, the Supplier* shall assess the merits of each technology compared with other possible techniques.

2.7.9.2.B

Access to filtering equipment shall be designed for ease of disassembly and assembly, and ready access for removal, maintenance, and replacement of internals.

2.7.9.2.C

In particular, removable parts such as filter cartridges, membranes, resins and seals shall be designed such that they can be easily replaced and evacuated without excessive exposure of personnel to radiation.

CA

It is connected with requirement of thermal insulation implementation, which shall be easily removable.

2.7.9.2.D

Provisions for use of remote or semi-remote tools shall be provided, as required, for vessel and internals maintenance.

2.7.9.2.E

Process vessels shall be designed to allow complete venting and drainage.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 59/122

EA

Vent and drain valves shall be located outside the process equipment compartment to be accessible for operation and maintenance in low radiation areas.

EB

Vents and drains shall be piped to vent and drain service systems or, preferably, to a local subsystem receiver such as a spent resin tank or backwash receiver tank.

2.7.9.2.F

Construction of filtering equipment shall make provisions to avoid deposit generation/crystallization on internal surface.

2.7.9.2.G

Filtering equipment shall be equipped with autonomous device to provide efficiency control in the process of operation.

2.7.9.2.H

Process vessels which operate under pressure shall be designed to facilitate regulatory periodic Inspections*.

2.7.9.2.I

Interchangeability of spare parts shall be ensured for all equipment of the same type (i.e. same physical identifier).

2.7.9.2.J

Filtering equipment used in radioactive service shall be designed to allow processing and conditioning of secondary generated radwaste (removable cartridges, membranes, resins) to be able to disposal.

2.7.9.3 FILTERS

2.7.9.3.A

Only filters used in liquid service are covered in the following Sections. Air filters used in HVAC systems are covered in Section 2.7.13; air filters used in GWRPS are covered in Section 2.8.2.8.3.

2.7.9.3.1 PERFORMANCE

2.7.9.3.1.A

The filters shall be designed to meet the process needs of adequate solids removal.

AA

The filters used in radioactive systems shall be designed to meet the process needs of adequate solids removal in order to comply with dose targets (Section 2.1.2.2.1 and 2.1.2.3) and to prevent entrance of solids to RCS and FSHS.

2.7.9.3.1.B

Filters shall be ready to operate on demand at any time.

2.7.9.3.1.C

Filters shall be easily removable to a specific receiver and from the receiver back to the system.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 60/122

2.7.9.3.1.D

Maintenance of filters shall not require any specific provisions, including preparation or conditioning of the filters.

2.7.9.3.1.E

Maintenance or failure of the filters shall not impair Unit* start-up, operation and/or shutdown.

EA

For this purpose, redundant filters shall be provided where necessary.

2.7.9.3.1.F

Filter internals shall be designed to withstand a differential pressure corresponding to the maximum pressure drop the system can develop.

2.7.9.3.1.G

The flow distribution in filter vessel shall be uniform.

2.7.9.3.2 TYPE OF FILTERS

2.7.9.3.2.A

Only filter types whose efficiency has been proven by operating experience in similar nuclear service or by qualification tests shall be used.

AA

Advanced filtration techniques such as magnetic filters, hollow-fibre filters or high-temperature filters may be used provided this requirement is met.

2.7.9.3.3 CARTRIDGE FILTERS

2.7.9.3.3.A

Cartridge filters shall use consumable elements.

AA

Cartridge filters may use long life (e.g. metallic) elements.

2.7.9.3.3.B

Cartridges shall be sized to enable their replacement at intervals in accordance with the refuelling cycle (i.e. 18 months or longer) with an objective of up to three years.

2.7.9.3.3.C

They shall be replaceable during power operation.

2.7.9.3.3.D

Cartridges shall be sized so that they can be packaged for disposal in a standard container.

2.7.9.3.3.E

The space between the cartridges shall be sufficient to allow solidification agent to be poured during encapsulation of spent filters.

2.7.9.3.3.F

The filter housing and internals shall be designed so that:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 61/122

- if necessary, all multi-element cartridges can be handled simultaneously,
- cartridge replacement and filter housing decontamination are simplified,
- operational exposure during cartridge replacement is ALARA,

2.7.9.3.3.G

Spent cartridges shall be removed either from the top of the filter housing, with the appropriate biological shielding in place, or other acceptable way (not only from the top of the equipment).

2.7.9.3.3.H

Handling procedures and equipment for cartridge replacement shall be standardised throughout the plant.

2.7.9.3.4 BACKWASHABLE TYPE FILTERS

2.7.9.3.4.A

The ability of the filter to operate at high particulate levels by adjustment of flocculant addition and/or body feed levels shall be evaluated by the Supplier* and the filter size adjusted accordingly.

2.7.9.3.4 B

Backwashable type filters shall be arranged with a nearby backwash receiver accessible for gravity flow from the filter.

2.7.9.3.4.C

Backwashable type filters shall not be backwashed more frequently than every eight hours.

2.7.9.4 ION EXCHANGERS

2.7.9.4.A

For some particular applications the use of ion exchangers may be replaced by the use of reverse osmosis. A typical example is the water treatment system where, depending on site-specific raw water quality, the use of reverse osmosis may be more efficient and economical. They may be used also in radwaste systems when proven.

2.7.9.4.1 TYPE

2.7.9.4.1.A

The ion exchangers shall be deep-bed type.

2.7.9.4.1.B

The choice between resin replacement and resin regeneration shall be assessed by the Supplier* taking into consideration operational requirements, Plant* and/or Unit* availability and radwaste volume.

2.7.9.4.1.C

Consideration of radwaste form shall also be included. The form proposed by the Supplier* shall be justified in comparison with alternatives.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 62/122

2.7.9.4.1.D

The type of ion exchange resin shall be selected from those which are currently used in industrial water-conditioning processes and which have proven adequate capacity, regeneration efficiency, resistance to wear, and resistance to polluting media.

2.7.9.4.2 RESIN CHARACTERISTICS

2.7.9.4.2.A

The ion exchange resin shall be wear resistant and shall be subject to only limited loss of exchange capacity.

2.7.9.4.2.B

Flocculation in powdered resins shall be strong enough to ensure long life time of precoat.

2.7.9.4.2.C

Provisions shall be made in the system, either by automatic or manual action, to ensure that the resin operating temperature is not exceeded.

2.7.9.4.2.D

Depth of resin bed shall be according to resin specification. Maximum depth shall be governed by the maximum allowable pressure drop of dirty resins and shall be less than the value which could cause mechanical damage to the resin beds.

2.7.9.4.2.E

The cation and anion ratio in mixed beds shall be selected to be the most economical for a specific service.

2.7.9.4.3 ION EXCHANGER VESSEL

2.7.9.4.3.A

Ion exchanger vessels processing radioactive fluids shall be fabricated from, or lined with, austenitic stainless steel.

2.7.9.4.3.B

The cross-sectional area of the resin beds shall be selected to provide suitable volumetric flow and adequate exchange capacity in order to achieve required quantity and quality of the fluids.

2.7.9.4.3.C

The ion exchanger vessel shall be sized with sufficient space to allow swelling of resins during operation, and expansion of the resin bed for back-washing or resin regeneration operations.

2.7.9.4.3.D

Strainers shall be provided on all ion exchanger vessels to prevent spurious resin transfer either to the external circuit or between two resin beds of a different type.

2.7.9.4.3.E

A resin trap shall be provided downstream of ion exchangers to trap resins and fines.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 63/122

EA

Resin traps shall be located outside the ion exchanger enclosure and, whenever possible, shall be provided with remote backwash capability. For traps that cannot be backwashed, means shall be provided to limit the personnel radiation exposure during their removal.

2.7.9.4.3.F

The design of flushable ion exchanger vessels shall be such that:

- resins are removed hydraulically, remotely, from the ion exchange vessel and added by gravity (possibly with complementary hydraulic capability) from an accessible area,
- provisions are made to assure that cation and anion resins are mixed well before addition and remain mixed after placement in the ion exchange vessel, or provisions are made to enable mixing to the resins in the vessel without stratification.

2.7.9.4.3.G

The design of the ion exchanger vessels shall allow ion exchange resin sampling if regeneration is used.

2.7.9.4.3.H

Ion exchanger vessels shall be provided with sight glass on appropriate level(s) unless inappropriate from the ALARA perspective.

2.7.10 FUEL

2.7.10.A

This Section defines functional requirements on components of the Fuel System*

2.7.10.B

Safety design requirements on Fuel System* components

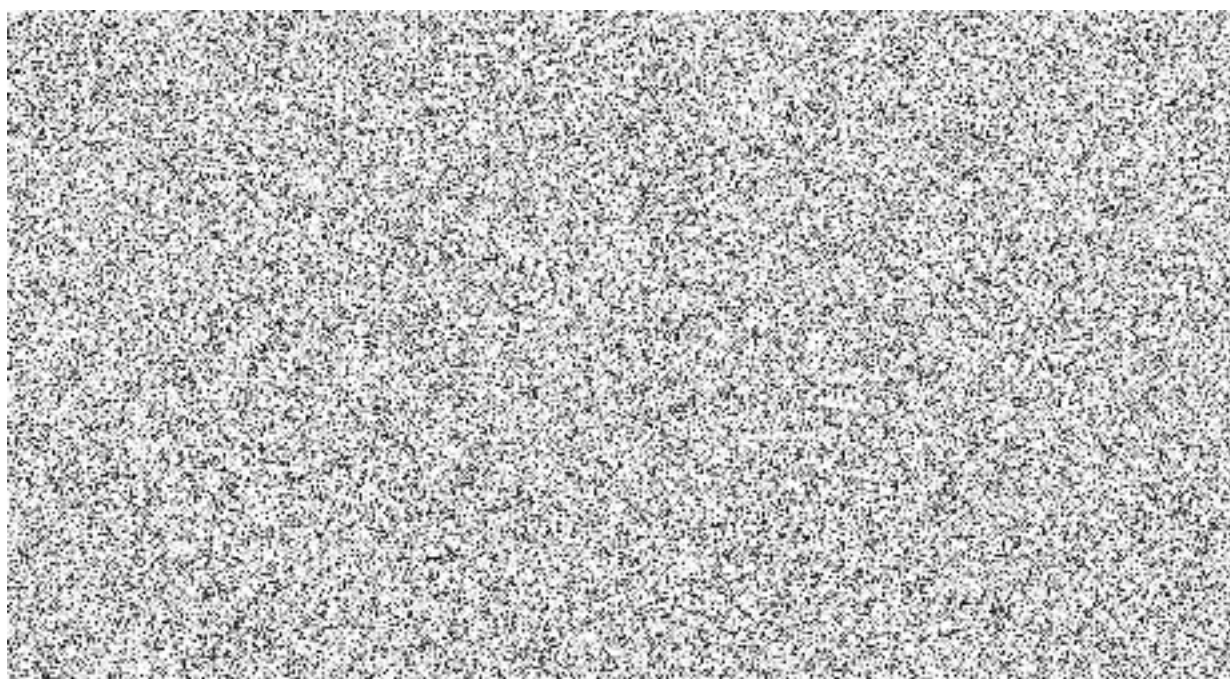
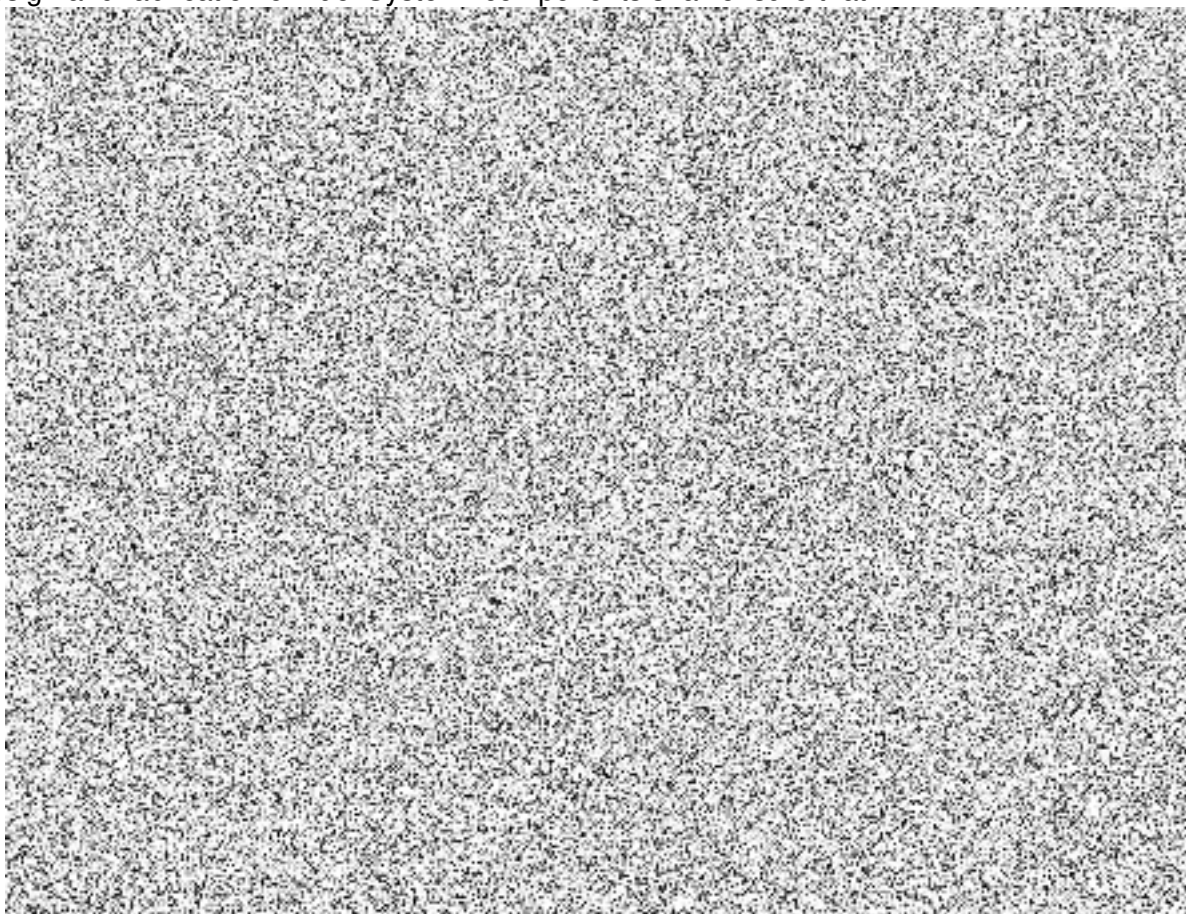
- Design of the Fuel System* components shall take conservatively into account full extent of design conditions in Operational States* and Accident Conditions*.
- Fuel System Damage* including Fuel Rod* failure shall not occur as a result of Operational States*, including transport, storage and handling, in-reactor operation, testing, Inspection* and repairs.
- Severe Fuel System* damage shall not occur in consequence of Accident Conditions* except of Severe Accident*.
- Number of failed Fuel Rods* shall not be underestimated for accident radiological consequences evaluation purposes.
- No other Barrier* shall fail as a result of Fuel Rod* cladding failure during Accident Conditions*.
- RPV failure, caused by Core Damage* during Severe Accident* is expected for Plants*, equipped with Core Catcher*.
- Fuel Rod*, Fuel Assembly*, RCCA and other Core Components* shall be classified according to applicable law and international guidelines (e.g. IAEA SSG-030) and included into appropriate safety class.
- Nuclear Fuel* design shall allow for easy tracking and accounting in order to fulfill all obligations, resulting from non-proliferation treaty.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 64/122

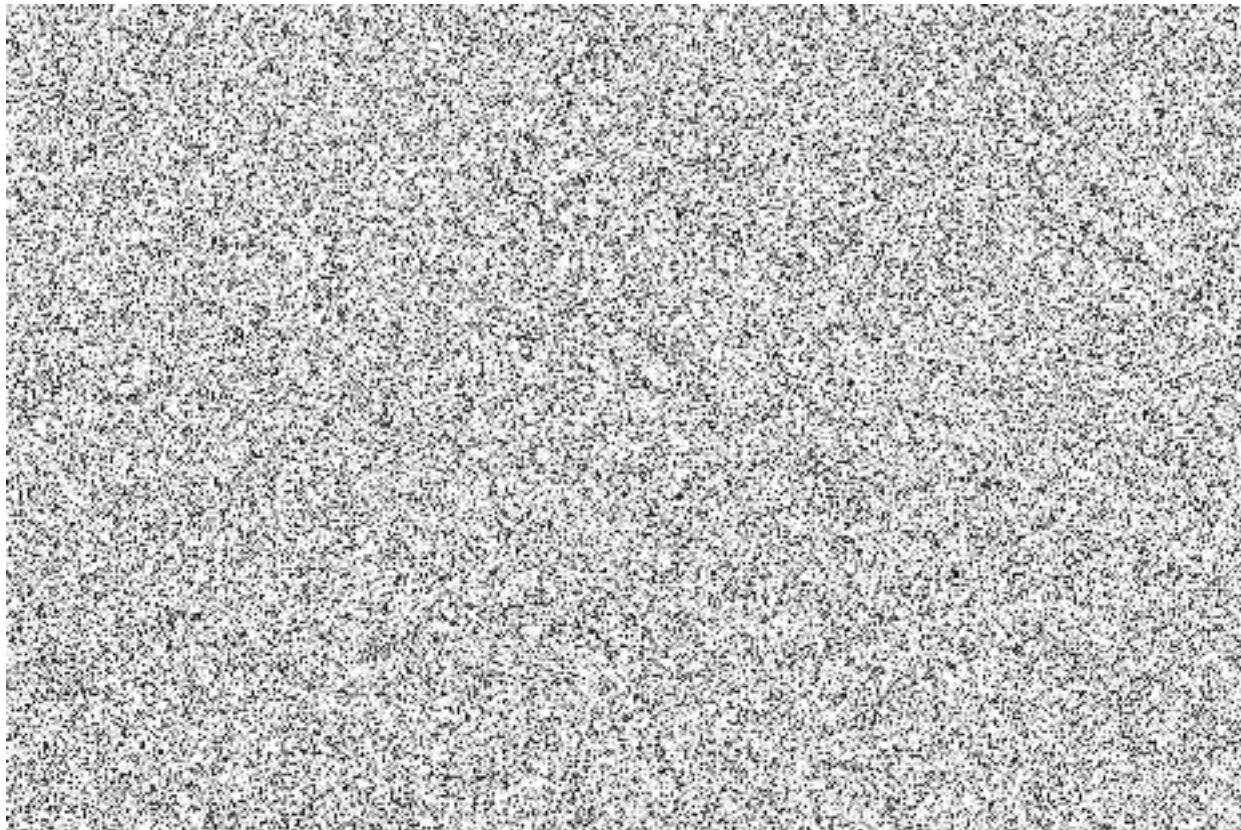
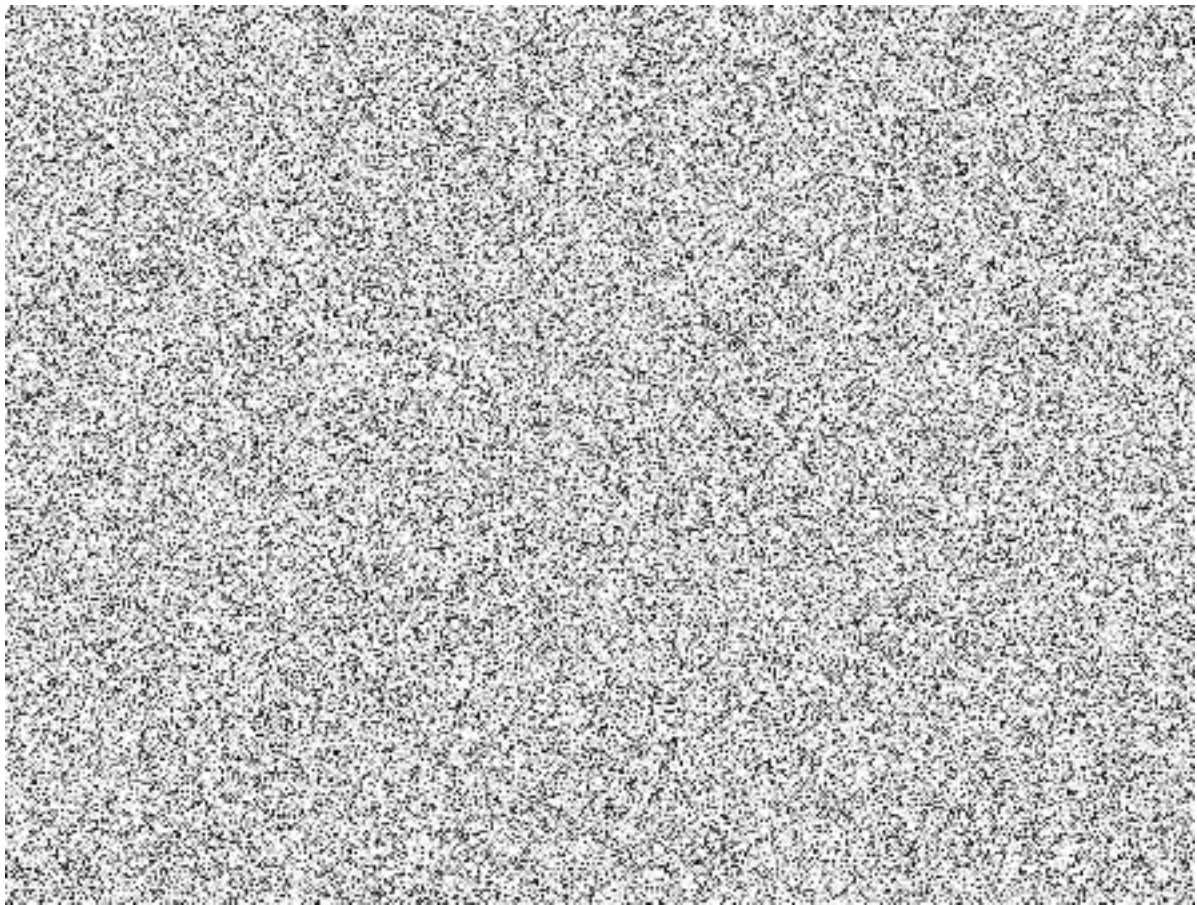
2.7.10.C

General functional requirements on Fuel System* components

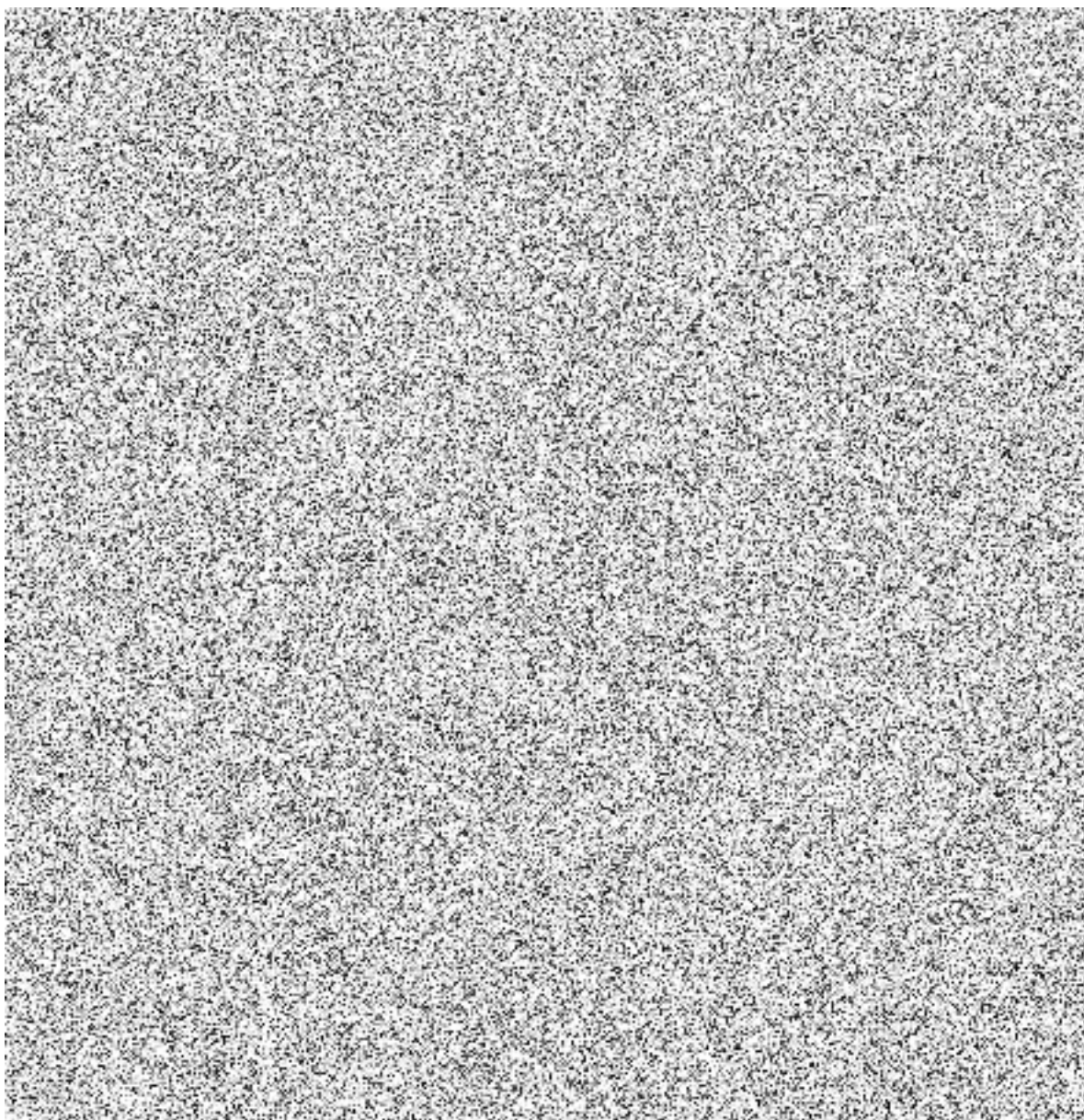
Design and fabrication of Fuel System* components shall ensure that:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 65/122



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 66/122



2.7.10.F

Specific functional requirements on Core Components*

- Core Components* design shall allow for safe and easy handling and insertion into FA using standard Plant* fuel handling equipment.
- Core Components* shall bear easily readable identification marks to allow for their easy tracking.
- Radial deformation of the Core Components* rodlets shall be limited in order to preserve sufficient radial gap inside FA guide tubes to ensure adequate cooling and to prevent jamming.
- Internal temperature, internal pressure, stress, strain, mechanical wear, corrosion and crud deposition, fatigue lifetime usage and gas production inside Core Components* rodlets shall be limited in Operational States* to prevent Fuel System Damage*.
- RCCA top nozzle design shall provide for safe and reliable locking and unlocking with RCCA drive draw bar, using Plant* standard handling equipment.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 67/122

- RCCA design shall provide for easy axial movement and drop into FA, adequate drop braking and impact damping,
- RCCA design shall allow for easy installation and operation of RCCA axial position and drop time measurement instrumentation.
- RCCA design shall be compatible with all relevant reactor internals. RCCA damage due to vibration wear inside protection tubes shall be excluded.
- RCCA rodlets failure and melting shall be excluded in Operational States* and Accident Conditions*, except of Severe Accidents*.
- RCCA, neutron sources and external burnable absorbers shall retain their required nuclear properties (macroscopic cross-sections, neutron production rates) within specified design limits during their specified lifetime.
- Flow restrictors/ hydraulic plug assembly design and performance shall ensure, that Core* by-pass coolant flow will remain within specified design limits.

2.7.10.G

Reference Notes

- Fuel System* safety design limits in Normal Operation* are included in Section 2.1.7.1.1.1
- Fuel System* safety design limits in Anticipated Operational Occurrences* are included in Section 2.1.7.1.1.2
- Fuel System* safety design limits in Accident Conditions* are included in Section 2.1.7.1.1.3
- Specific Fuel System* performance requirements are given in Section 2.2.4.
- General Rules* for design loads application are given in Sections 2.4.5 and 2.4.6.
- Specific Fuel System* material requirements are given in Section 2.6.4.11.
- Specific Fuel System* functional requirements for systems are given in Section 2.8.1 and 2.8.2.

2.7.10.H

Requirements on design of Fuel System* components listed in 2.7.10 are stipulated in Nuclear Fuel Contract*. Fulfilment of the requirements listed in 2.7.10 shall be demonstrated by deliveries under the Nuclear Fuel Contract*.

2.7.11 ELECTRICAL EQUIPMENT

2.7.11.1 SCOPE

This Section defines requirements that apply to electrical equipment used at the Plant*.

The term electrical equipment, if not further specified in particular requirement differently, shall be understood as both electrical and Instrumentation and Control (I&C) SSC of the Plant*. This shall apply to the whole EPC Contract*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 68/122

2.7.11.2 INTERCHANGEABILITY

2.7.11.2.A

Each part of a component located in the Nuclear Island* shall be interchangeable with the corresponding part of any other component of identical type and with identical Safety Category, located in the Nuclear Island*, without modification.

2.7.11.2.B

Each part of a component located in the Power Generation Plant*, the Balance of Plant* shall be interchangeable with the corresponding part of any other component of identical type and with identical Safety Category, located in the Power Generation Plant*, the Balance of Plant* or the Nuclear Island*, without modification.

2.7.11.2.C

Physical identifiers are defined in the Section 2.12.7.

2.7.11.3 DESIGN ENVIRONMENTAL CONDITIONS

2.7.11.3.A

The electrical equipment shall be capable of operating under environmental conditions existing at the time of performance of its function.

2.7.11.3.B

The requirements for component ageing in accordance with the Technical Requirements Document*, Section 2.1.8.1.3, and component qualification in accordance with the Technical Requirements Document*, Section 2.4.8, shall also be applied.

2.7.11.4 DESIGN REQUIREMENTS

2.7.11.4.1 GENERAL RULES FOR ELECTRICAL EQUIPMENT DESIGN

2.7.11.4.1.A

All types of electrical equipment shall be designed in compliance with the Mandatory Law* and Codes and Standards* specified in the Chapter 2.5.

2.7.11.4.1.B

Any electrical fault resulting in a short-circuit on a Plant* circuit shall not cause damage to any equipment other than that affected directly by the fault (selectivity principle).

BA

A short circuit study shall be carried out for all operating cases, and equipment shall subsequently be chosen for the worst case.

BB

In order to comply with this rule, an adequate selection of protective devices of the electrical equipment is needed. These protection devices, together with earthing schemes, shall take into account personnel protection.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 69/122

2.7.11.4.1.C

The maximum voltage value shall be calculated on the basis of the highest voltage of the electrical power system and preset transformer turns ratio, with no load and no voltage drop in the cables.

2.7.11.4.1.D

The minimum voltage value shall be calculated on the basis of the lowest voltage of the electrical power system and preset transformer turns ratio, with full load and voltage drop in the cables.

2.7.11.4.1.E

Electrical equipment function shall be ensured under the whole design conditions of electrical equipment for its intended lifetime.

EA

Over-voltage, under-voltage, frequency variations and phase angle displacement shall be considered in power system design and equipment selection. The functioning of electrical equipment during different voltage and frequency fluctuations shall be proven.

2.7.11.4.1.F

Electrical equipment shall also comply with other requirements given in the Section 2.6.4.4.

2.7.11.4.1.G

The unified technology platform shall be used for control of electrical equipment in the Nuclear Island*.

GA

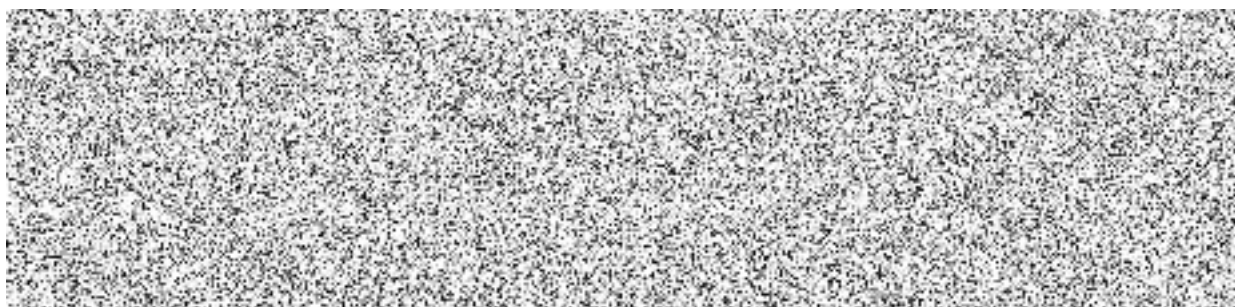
Control of electrical equipment of the Power Generation Plant* and the Balance of Plant* shall be based on the same technology platform as control of other systems in the Nuclear Island*.

GB

Electrical equipment shall include instrumentation to collect and record measured data during operation, testing and transients for more detailed analysis.
See Section 2.7.11.4.10.

2.7.11.4.1.H

All electrical and I&C systems and components shall be designed and certified in accordance with the Mandatory Law* and Requirements of the Authorities* (in particular Government Order No. 117/2016 Coll., as amended) and shall comply with other relevant requirements stated in e.g. CSN EN 61000, CSN EN IEC 62003, CSN EN 55032 (CISPR 32), CSN EN 50561-1 resp. CSN EN 55011 (CISPR 11) – and any other Rules* specified in the Chapter 2.5.



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 70/122

Immunity and emission levels shall be demonstrated in control and electrical equipment rooms specifically for major emission sources and susceptible devices. EMC design and installation principles shall be presented.

HB

The effect of electromagnetic interference due to Plant* equipment shall be assessed.

HC

Where the level of electromagnetic disturbances may exceed the permissible levels, special counter-measures shall be implemented.

HD

Where these counter-measures include the banning of certain types of portable equipment (exclusion zones) when the reactor is operating, information on the means of enforcing such a ban shall be provided.

HE

All electrical drives including frequency converters where converters are used (variable frequency drives) shall be designed in accordance with requirements of the electrical supply, driven equipment and all applicable standards including EMC standards specified in the Chapter 2.5.

HF

Maximum content of harmonics produced by nonlinear loads shall be in accordance with applicable standards specified in the Chapter 2.5.

HG

Electromagnetic Compatibility (EMC) for electrical and I&C SSC shall be proved by test. The test results shall be in accordance with EMC concept and relevant standards. It can be proven by laboratory test for well organized prototype which is fully conservative enough to be representative for all other same kind of electrical and I&C SSCs.

HH

As a possible Variation: Electromagnetic Compatibility (EMC) for electrical and I&C SSC shall be sufficiently tested by Site Acceptance Test (SAT) during Pre-operational testing period to prove the SSC operability under the real operational conditions. It means, that not only operability of device itself, but also the location and the way of its installation shall be verified. Scope of SAT testing shall correspond to laboratory tested prototypes and shall sufficiently demonstrate the capability of safety classified systems to perform their function in the operational environment. The SAT results shall be in accordance with EMC concept and relevant standards. For avoidance of doubt the above 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*.

HI

NA

2.7.11.4.1.1

All electrical and I&C systems and components shall meet EMC requirements to assure immunity to electromagnetic interference caused by potential use of wireless data

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 71/122

communication (except the I&C equipment and computer room which contains I&C systems related to safety and availability, ECR and MCR, where special counter-measures as mentioned in requirements 2.7.11.4.1.HC and 2.7.11.4.1.HD may be applied) in its surroundings during operation of the Plant* (including, but not limited to LTE; IEEE 802.11a/b/g/n/ac/h/i; IEEE 802.15.4).

IA

All electrical and I&C systems and components, where these EMC requirements are not easy achievable due to significant impact to standard design solution, justification and cost impact shall be provided.

IB

Requirement on immunity to EMI from wireless data communication devices shall be implemented within EMC Concept.

IC

To allow implementation of wireless technology, the improved electrical and I&C systems immunity for Radiated, radio-frequency, electromagnetic field immunity test (ČSN EN 61000-4-3) with field strength 20V/m (or higher) and testing of equipment with open cabinet doors shall be considered and where possible proposed.

2.7.11.4.1.J

All distribution and power supply systems shall have at least 10 % reserve (power, free space, number of free outlets) at the Final Takeover* date in order to provide a possibility for future extension of electrical loads, or elaboration of new loads.

2.7.11.4.1.K

For inlets and outlets of electrical and I&C switchgears and panels only a limited number of typical electrical control circuits shall be used.

2.7.11.4.1.L

All auxiliary power supply systems of the Plant* (AC and DC) shall be protected by overvoltage protections in compliance with the EMC concept to provide the necessary protection against overvoltages. These overvoltage protections shall be distributed in different places according to protection zones.

2.7.11.4.1.M

Division to protection zones and classification of protection zones from the point of view of EMC shall be defined according to standard CSN EN 62305-4.

2.7.11.4.1.N

Insulation and overvoltage protections level shall be coordinated in compliance with standard CSN EN 60664-1 for low voltage systems and CSN EN 60071 for MV, HV and EHV systems.

2.7.11.4.1.O

The whisker effect shall be considered in the design of electrical equipment. In electrical or automation areas, all significant metal parts that are hot-dip galvanized or electroplated shall be painted.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 72/122

2.7.11.4.1.P

All electrical equipment shall be designed in accordance with the Czech Codes and Standards* CSN EN resp. IEC/European electrical Codes and Standards* where Czech is not available.

2.7.11.4.1.Q

The software included in the electrical equipment shall comply with the requirements for software design in Chapter 2.10 except embedded software in non-classified relay modules for circuit breakers, which is designed and manufactured as per vendor's design standard, proven design for the reference plant.

QA

For such non-classified relay modules, the Supplier* shall provide the Owner* with software documentation necessary for operation, maintenance and modifications of the Plant*.

2.7.11.4.1.R

If commercial off-the-shelf (COTS) components or equipment is used they shall comply with the requirements in Section 2.10.6.2.3.2.

2.7.11.4.1.S

Design of electrical SSC shall conform to the requirements of cyber security and cyber security support system established by the Supplier*, including connection to the Security Operation Centre*, see Section 4.7.17.

SA

Safety function performance of related electrical SSC shall be coordinated with requirements of cyber security in accordance with CSN EN IEC 62859.

SB

The Supplier* shall develop cyber security program and cyber security plan for electrical SSC, which shall conform to requirements in Sections 2.10.5.5.3, 2.10.6.3.3 and 2.10.7.1.

SC

All cyber security assumptions, its impacts and related design inputs shall be included and justified within Design Basis Documentation*.

2.7.11.4.1.T

Separation of electrical SSC shall meet the principles and requirements stipulated in CSN EN IEC 60709.

2.7.11.4.2 MV SYSTEM (HOUSE LOAD DISTRIBUTION)

2.7.11.4.2.A

The maximum voltage for MV systems shall not be more than 12 kV. The voltage levels shall be according to CSN EN 60038.

2.7.11.4.2.B

The MV system shall be designed to withstand the short-circuit current.

2.7.11.4.2.C

The breaking capacity of the upstream switchgear shall be compatible with the highest short-circuit current which can occur.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 73/122

2.7.11.4.2.D

The MV system shall be resistance grounded.

DA

The MV system shall enable identification of the failure location and selective trip of earth fault.

DB

The MV grounding system shall limits fault currents and overvoltages during earth faults.

DC

The grounding resistor shall be connected to neutral points of Auxiliary Normal Transformers and Auxiliary Standby Transformers.

DD

The MV system, in case of Emergency Power Supply* (diesel generator) shall enable continued operation of affected equipment for a limited period with a phase to earth fault and may be operated with an isolated neutral.

2.7.11.4.2.E

A key interlocking system or similar system shall be provided to protect the personnel during maintenance operations, making sure that all the busbars are earthed, and all the MV sources are isolated.

2.7.11.4.2.F

The interlock shall not prevent temporary earthing disconnection, allowing the insulation of the switchboard and connected equipment to be checked.

2.7.11.4.2.G

Provisions shall be made to permit opening and closing all MV switching devices manually in the absence of a power supply.

2.7.11.4.2.H

The degree of ingress protection provided by enclosures shall be in compliance with the environmental conditions and personal safety (CSN EN 60529).

2.7.11.4.2.I

All equipment shall be designed to withstand transient overvoltage (e.g. because of switching, earth fault).

IA

MV switchgear shall be designed to limit switching impulse.

IB

Ferroresonancy overvoltage shall be minimized.

2.7.11.4.2.J

The control voltage shall be supplied by DC voltage from the DC system (in normal operation from chargers, during unavailability of charges from batteries) for all the switchboards.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 74/122

2.7.11.4.2.K

MV switchgear shall comprise circuit breakers for switchboard incomers, couplings and feeders (e.g. motor feeders, transformers etc.). Exceptions are outlets terminals to voltage transformers for protection relays and measuring purposes which shall be equipped with fuses.

KA

A motor drive shall be provided for MV earthing switches, controlled locally from the switchgear front panels.

2.7.11.4.2.L

All MV switchgear rooms shall be equipped with a fire detection/alarm system in compliance with the Mandatory Law* specified in the Technical Requirements Document* Chapter 2.5.

2.7.11.4.2.M

All MV switchgear shall be LSC 2B (loss of service continuity category) and partition class PM and one-sided box type for indoor installation. All assemblies shall be type-tested according to IEC and shall fulfil the standard CSN EN 62271.

2.7.11.4.2.N

All inlets and outlets shall be equipped with withdrawable vacuum-circuit-breaker and with socket for connection of auxiliary circuits.

2.7.11.4.3 CABLES

2.7.11.4.3.A

Cables and supports shall withstand the short-circuit current and resulting forces during the time necessary for the protections to clear the fault.

2.7.11.4.3.B

The choice of cable cross section shall ensure that for the whole power supply system (power sources, cables) the required voltage is achieved on consumer terminals in steady-state or transient conditions (power changes, starts of a motor or group of motors) and also a proper function of electric protection system during faults in power supply system.

2.7.11.4.3.C

For high power motor ratings, the temperature rise in steady-state operation shall be taken into account.

2.7.11.4.3.D

Cables shall be halogen free according to CSN EN 60754-1 with Cu wires manufactured according to CSN EN 60228 and CSN EN 60445.

2.7.11.4.3.E

Cables shall comply with requirements of:

- Test for ability to limit flame spread according to CSN EN 60332-3
- Test for ability to limit smoke density of burning cables according to CSN EN 61034

EA

Where required for performance of safety functions under fire conditions, cables and cable trays shall be selected in accordance with required functional (circuit) integrity under fire conditions.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 75/122

- Cables shall be tested for circuit integrity under fire conditions according to CSN IEC 60331.
- Cables and cable trays shall be tested for functional integrity under fire conditions according to CSN 73 0895.

2.7.11.4.3.F

Cables and accessories shall be environmentally qualified for operation in their installed location (in all design conditions). Qualification shall be performed according to methodology:



FA



FB

Qualification environmental condition shall be defined by the Supplier* and shall comply with conditions during and after LOCA in the Unit* (i.e. it is not possible to use a general conditions from different design).

2.7.11.4.3.G

Cable splices shall be prohibited unless protected by junction boxes specifically intended for that purpose and the splices shall use only materials specifically approved for the expected operating environment.

2.7.11.4.3.H

The document "Principles of cabling" shall be elaborated by the Supplier*. This document shall summarize the basic requirements on the designing, delivery and laying of cables belonging to the technologic or civil engineering delivery. They shall be respected for ensuring the Power Plant reliability and safety, mainly:

- Cable selection according to fire resistance: classes and technical properties
- Cable selection according to environmental conditions – among others radiation (Environmental Qualification)
- Main rules for cables laying and routing (see also Section 2.11.4.5)
- Main cables separation and cables segregation groups and criteria
- Cable penetrations: types and technical properties
- Cable structures (constructions): types and technical properties
- Description of principles of cable design modification during plant operation (e.g. exchange of faulty cables or cables with expired qualification, addition of new cables).
- Specify the basic requirements on cabling for individual groups of equipment according to technological and safety importance of equipment.

2.7.11.4.3.I

A cable ageing management program shall be provided by the Supplier*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 76/122

IA

Cables for surveillance samples shall be selected by the Supplier*. At least samples of cables used to perform Safety Functions* and economically important cables shall be selected.

IB

Initial data about cables, surveillance samples of selected cables and areas with adequate environmental condition for deposition of surveillance samples of selected cables for cable ageing management shall be provided by the Supplier*.

IC

Cable ageing management shall be in accordance with CSN EN IEC 62465 and in accordance with recommendations in IAEA TECDOC 1188 and IAEA NP-T-3.6.



IE

Cable aging management program shall be based on extensive (environmental) condition monitoring in all cable areas and in critical locations. Coverage of condition monitoring shall be so extensive to identify all area or location relevant aging mechanisms (e.g. radiation, temperature, humidity etc.).

IF

The number of used cable types shall be optimized with respect to ageing management program.

IG

If it is used more significantly different cross-sections of one cable type and if ageing mechanism requires it, it is necessary to make surveillance samples for different cross-sections of one cable type.

IH

Properties and quality of each cable type shall always be proven within one package (cable drum), one delivery and every other delivery. The Supplier* shall allow the Owner* to take samples for his own independent tests.

II

Location of deposits shall be based on the ageing management program and shall cover all environments, including the environment where is the maximum temperature, maximum radiation or combination of temperature and radiation.

IJ

Deposits shall be placed even in a mild environment.

IK

For measuring of transmission parameters, surveillance sample of each type of optical cable shall correspond to the measurement method based on the ageing management program.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 77/122

IL

For measuring of transmission parameters, surveillance sample of each type of metallic data cable shall correspond to the measurement method based on the ageing management program.

IM

The Joule heating effect of power cables on ageing shall be taken into account in the cable ageing management program.

2.7.11.4.3.J

Other requirements are given in the Section 2.6.4.4 and in the Section 2.11.4.5.

2.7.11.4.3.K

Cable lifetime shall be 60 years.

2.7.11.4.3.L

Cables shall be well proven and shall have references from NPP in EU, US or Korea.

2.7.11.4.4 ELECTRICAL DRIVES (MOTORS AND VALVE ACTUATORS)

2.7.11.4.4.A

Electrical drives shall be designed to ensure operation under the full range of their own design conditions within a satisfactory safety and operational power margin (at least 15 % above the driven equipment).

2.7.11.4.4.B

Maximum operating and starting conditions (i.e. maximum load, minimum voltage, maximum ambient temperature, pressure, humidity, radiation, operation vibrations etc.) shall be considered for the sizing and design in accordance with equipment classification, qualification and applicable standards.

2.7.11.4.4.C

MV and LV electrical drives shall be direct on-line started (apart from application of frequency converters in special cases caused by technology requirements) and shall secure reliable and safety start and prove it during Commissioning*. The minimum starting voltage for MV and LV drives shall be equal to 80 % of the nominal voltage.

2.7.11.4.4.D

Electrical drives (include motor/frequency converter assemblies and other actuating electrical equipment) shall be designed to operate as intended to the power requirements of driven equipment for frequency and voltage variations in the A and B range according to CSN EN 60034-1 and in accordance with voltage frequency field defined in the Figure 2.3.1.2.2-1. Time limitations are specified in the Section 2.3.1.2.2, Fig 2.3.1.2.2-1.

DA

In the case of using frequency converters (if any) the design of electrical drives shall reflect theirs specific characteristics.

DB

The frequency converters and their auxiliaries (if any) shall be operationally verified in similar conditions (ambient temperature, operation condition, etc.).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 78/122

DC

The frequency converters (if any) shall have minimum harmonic distortion effect on other Plant* systems.

2.7.11.4.4.E

The stator winding temperature shall not exceed class B temperature and insulation class of the drive shall be class F according to CSN EN 60034, CSN EN 60085.

2.7.11.4.4.F

Minimum electromagnetic torque for electric motors shall permit start-up and transfer of supplies (e.g. from normal to standby power source) under conditions acceptable to the driven equipment and voltage conditions given by the short-circuit impedance of power sources. Reacceleration of electric motors shall be reliable and safety.

2.7.11.4.4.G

Electrical drives shall always be connected to the power supply via terminal box. Whenever design identifies risk of cable damage in close proximity of the drive (due to its exposed location, lack of space for cable testing and inspection, frequent drive manipulation, etc.), separated (intermediary) ancillary terminal box for power connection shall be installed between power source (e.g. switchgear) and terminal box on the motor and located near to the motor, or the appropriate mechanical protection of the cable shall be provided.

2.7.11.4.4.H

All of the electrical drives shall be equipped with service control (e.g. for the Commissioning*, maintenance, settings of the valve actuators).

HA

Electrical motors shall be placed in position so that all supposed maintenance operations are possible, notably assembling and disassembling from the position and transport on maintenance place.

2.7.11.4.4.I

Motors performing the Safety Functions* shall be qualified in accordance with IEEE 334, IEEE/IEC 60980-344 or CSN EN 60780-323.

IA

Electrical drives performing Safety Functions* shall operate within limits/operational conditions defined in safety analysis.

2.7.11.4.4.J

Continuously operated MV electrical drives shall be provided with on-line electric diagnostic system, temperature monitoring system and vibration monitoring system.

2.7.11.4.4.K

MV and LV electrical drives (AC motors and driven equipment) shall withstand without any damage mechanical and electrical stresses caused by switching during power supply transfer in any mutual position of residual voltage generated by motors and recovery voltage of the power source. All types of power supply transfer method shall be considered. (See Section 2.8.2.7.3)

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 79/122

2.7.11.4.5 DISTRIBUTION TRANSFORMERS

2.7.11.4.5.A

The distribution transformers (MV/LV) shall meet standard CSN EN 60076-11.

2.7.11.4.5.B

The minimum short-circuit impedance of distribution transformers (MV/LV) shall be compatible with the breaking capacity of the LV equipment and with the voltage variation range stipulated for the LV systems.

2.7.11.4.5.C

The distribution transformers shall be standardised (total number of all MV/LV transformer types shall not be more than 5).

2.7.11.4.5.D

Distribution transformers shall be provided on the MV side with off-circuit tap changer.

DA

Number of taps and voltage difference for one tap shall be designed in accordance with requirements of low voltage system and connected SSC (at least 5 taps and maximum voltage difference 2.5 %).

2.7.11.4.5.E

Distribution transformers shall be equipped with directly earthed neutral of LV winding (TN).

2.7.11.4.5.F

Distribution transformers located inside buildings shall be dry type with cast resin or air winding insulation, AN cooled type and in the metal-clad cubicle.

2.7.11.4.5.G

Other requirements regarding layout are given in the Section 2.11.3.9.

2.7.11.4.5.H

The hot-spot winding temperature shall be measured for monitoring and diagnostic purposes.

2.7.11.4.6 DC SYSTEMS

2.7.11.4.6.A

DC systems comprise batteries, chargers, distribution switchboards, inverters and DC/DC converters used to supply the Safety Systems* and Safety Features for Design Extension Conditions* for DBC and DEC and investment and personal protection (e.g. Instrumentation and Control (I&C) systems, switchgear and switchboard control systems etc.).

2.7.11.4.6.B

Features of chargers, inverters (and other sources, e.g. DC/DC converters) and functions of their electrical protection and monitoring systems shall be set and coordinated so that upon failures and transients in the upstream AC grid, the transfer of vital loads to the power supply from batteries is always secured.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 80/122

2.7.11.4.6.C

Chargers shall be instantly switched off upon significant voltage and frequency deviation in AC power supply grid with subsequent automatic soft start (ramp-up function) after voltage and frequency are stabilized in the AC system.

CA

If power supply from batteries is available during these events, the inverters and DC/DC converters shall not switch off nor transfer to bypass.

CB

Chargers shall reduce transient overvoltage.

2.7.11.4.6.D

Batteries shall be vented lead-acid type, with reference from applications in nuclear power plant or nuclear industry.

2.7.11.4.6.E

Their lifetime shall be at least 15 years. Reduction factors due to ageing, duty temperature and design margin shall be taken into account in the sizing.

2.7.11.4.6.F

Battery sizes shall be calculated by methodology in accordance with the IEEE 485.

2.7.11.4.6.G

Two chargers per battery shall be supplied from three-phase LV emergency busbars. Inputs of chargers shall be connected to the different AC switchboards.

2.7.11.4.6.H

Each charger shall be capable of simultaneously feeding direct current to the loads in worst-case load combination and charging the storage batteries according to the Section 2.8.2.7.6.

HA

The charger shall be capable of feeding necessary direct current to the loads even if the storage battery has been disconnected.

2.7.11.4.6.I

The transfer from normal to standby charger shall be automatic and without voltage interrupting (chargers in parallel operation).

IA

It shall be possible for operating personnel to perform manual transfer.

2.7.11.4.6.J

The chargers shall be of a modular type or unified design within the Plant*. The chargers shall enable a permanent monitoring of the battery, e.g. voltage symmetry monitoring.

2.7.11.4.6.K

The chargers shall be sized to supply the normal load of the associated DC switchboard and charge the battery to its rated capacity, with a peak-to-peak ripple factor of less than 5 % and an rms ripple factor of less than 2,5 %.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 81/122

KA

Nevertheless, the chargers and batteries shall provide power supply with ripple factor compatible with connected loads.

2.7.11.4.6.L

Capacity test of batteries shall be possible during normal operation and without interruption of power to supplied loads.

LA

Battery discharge devices shall be provided (e.g. for capacity tests).

LB

Chargers and DC distribution system shall enable fast charging mode after capacity test without interruption of power to supplied loads.

2.7.11.4.6.M

The inverters (and DC/DC converters if any) shall be testable without interruption of power to their loads.

2.7.11.4.6.N

The DC power supply system shall be operated ungrounded.

2.7.11.4.6.O

Independent systems for earth fault detection without outage of the whole DC power supply system and isolation monitoring of DC power supply system shall be provided.

OA

NA

2.7.11.4.6.P

The maximum voltage (maximum equalization voltage in normal charging mode) in DC system shall not be more than 250 V DC.

2.7.11.4.6.Q

DC systems shall be in accordance with the requirements of CSN EN IEC 61225.

2.7.11.4.7 DC/DC CONVERTERS (IF ANY)

2.7.11.4.7.A

DC/DC converters shall maintain the I&C voltage within its normal range when the DC battery voltage varies from its minimum to its maximum value.

2.7.11.4.7.B

Each converter shall have a current-limiting feature in order to protect the converter from faults on the distribution system.

2.7.11.4.7.C

The converter shall be equipped with adequate protections and alarm functions (including e. g., over-/under-voltage of output voltage, ripple of output voltage, over-temperature alarm and trip).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 82/122

2.7.11.4.7.D

DC/DC converters shall be in accordance with the requirements of CSN EN IEC 61225.

2.7.11.4.8 INVERTERS AND UNINTERRUPTIBLE POWER SUPPLY

2.7.11.4.8.A

The Uninterruptible Power Supply UPS shall maintain the AC voltage within its specified range of frequency, voltage and harmonic distortion value when its DC battery voltage varies from its minimum to its maximum value.

2.7.11.4.8.B

Single standing UPS (with internal battery) are acceptable only in specific cases, for separated groups of sensitive loads (e.g. in external and administrative buildings).

BA

Single standing UPS shall be capable of power supply to their loads without internal battery (e.g. due to the battery replacement).

BB

The number of local UPS systems shall be optimised with redundancy.

2.7.11.4.8.C

UPS shall be testable without interruption of power to their loads.

2.7.11.4.8.D

The UPS shall be equipped with a manual and an electronic by-pass switch without power supply interruption to transfer loads to a backup source of AC power upon failure of the inverter.

2.7.11.4.8.E

The UPS systems input and output circuits shall be equipped with short-circuit protection that is adequately sized and selective.

EA

The UPS shall provide short circuit current to secure selective trip of damaged circuit.

2.7.11.4.8.F

The UPS shall contain protection that prevents voltage transients of the feed network producing over-voltages on the UPS network that would adversely affect the loads. However, the selectivity principles for safety loads (e.g. inverters for battery supply shall not trip before the rectifier) shall be taken into account in design.

2.7.11.4.8.G

Static and motoric loads shall not be supplied from the same Inverters.

GA

NA

GB

NA

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 83/122

2.7.11.4.8.H

Inverters and UPS shall be in accordance with the requirements of CSN EN IEC 61225.

2.7.11.4.9 ELECTRICAL CONTAINMENT PENETRATIONS

2.7.11.4.9.A

The electrical containment penetrations shall be of 3 different types:

- MV power
- LV power and control
- instrumentation (measurements)

Each penetration shall carry cables of one voltage class only.

Penetrations carrying cables serving safety loads shall not be used for non-safety circuits and shall be used only for safety circuits belonging to the same safety division. The non-safety circuits shall not have negative influence to the safety circuits.

2.7.11.4.9.B

For other requirements of the electrical Primary Containment* cable penetrations see also the Section 2.9.4.1.6.

2.7.11.4.9.C

The electrical containment penetrations shall assure pressure-tightness and electrical function under minimally the same conditions as those of the connected equipment.

2.7.11.4.9.D

Electrical protection of outlets into containment shall resist a Single Failure* without the electrical containment penetrations damage (by securing of integrity and functionality). Protective system of cables in safety important buildings and of the electrical containment penetrations shall be highly reliable and fulfill all requirements according to the Section 2.7.11.4.10.

The electrical containment penetrations shall be rated so that a failure of any circuit of the penetration shall not result in exceeding the maximum currents versus time capability of the penetration in the event of a Single Failure* of a protective device.

2.7.11.4.9.E

The electrical containment penetrations shall meet the IEC 60772 or IEEE 317 standard requirements.

2.7.11.4.9.F

There shall be available at least 15 % of electrical containment penetrations of each type as reserve. These types of spare electrical containment penetrations shall be placed in the same room as the original types.

2.7.11.4.9.G

As part of the containment, the penetrations shall meet all relevant limits and requirements (e.g. fire resistance and accident pressure) of the containment vessel for mechanical design and structure.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 84/122

2.7.11.4.10 ELECTRICAL PROTECTION, METERING AND DIAGNOSTIC SYSTEM

2.7.11.4.10.1 GENERAL REQUIREMENTS

2.7.11.4.10.1.A

The Supplier* shall have the overall responsibility of the design and functionality of the electrical protection system.

AA

The electrical protection system shall also include:

- protective devices,
- the logic system that elaborates the actions and information to be sent,
- the necessary software,
- the cabling,
- a test device for checking protection when it is not operating,
- the central unit fault monitoring system.

2.7.11.4.10.1.B

The electrical protection system shall include the protections of generator, isolated phase busbars, transformers, EHV Plant* substation (if it is applicable), HV Plant* substation, MV and LV switchboards and all the current and voltage transformers used for protection or measuring functions.

BA

In this chapter the electrical protection system means only protection functions working with inputs (U, I) from sensors-convertors (U: 0-100 V, I: 0-1/5 A).

BB

Detailed information on designing and testing electrical protection systems regarding their electromagnetic compatibility (EMC), shall be provided by the Supplier*.

2.7.11.4.10.1.C

Electrical protection systems shall provide protection and some control, monitoring and diagnostic functions.

CA

Electrical protection system shall be based on digital protections or digital terminals.

2.7.11.4.10.1.D

The Supplier* shall provide a central unit fault monitoring system for electrical systems.

DA

Central unit fault monitoring system for electrical systems is a special complex monitoring and analysing digital system, mostly independent of I&C system.

2.7.11.4.10.1.E

There shall be redundant protection modules with backup power supply for these electrical systems: generator, excitation systems, GCB, GT, ANT(s), AST(s), power outlet line, isolated busbars area. The protection modules for Emergency Diesel Generator(s) shall be designed to prevent from CCF (Common Cause Failure).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 85/122

2.7.11.4.10.1.F

The electrical system shall include devices for control metering and balance metering of electrical power.

2.7.11.4.10.2 GENERATOR PROTECTION

2.7.11.4.10.2.A

Generator protection system shall include these protection functions:

- Short-circuit under-impedance (*multi-stage*),
- Over-current short-circuit time independent,
- Stator over-current (overloading),
- Differential,
- Overvoltage (*multi-stage*),
- Undervoltage (*multi-stage*),
- Stator earth-fault (*shall protect 100 % winding*),
- Rotor earth-fault,
- Turn (winding) – based on measurement of slot temperature,
- Reverse power,
- Phase unbalance (asymmetrical load),
- Field failure (field-loss),
- Underexcitation,
- Overexcitation,
- Rotor over-current (overloading),
- Bearings,
- Rotor (pole) slipping resp. stability-failure,
- Out of step (loss of synchronizing),
- Underfrequency,
- Overfrequency,
- Oversaturation,
- Voltage and frequency drop in grid.

2.7.11.4.10.3 TRANSFORMER PROTECTION

2.7.11.4.10.3.A

The Generator Transformer* protection system shall include:

- Over-current short-circuit on the EHV side,
- Gas (Buchholz),
- Differential,
- Tank earth-fault or ground differential protection I_0 ,
- Over-current for zero phase sequence current (I_0) against the short circuit to the earth at the transformer's terminals and in the 400 kV grid,
- Over-current for zero phase sequence current (I_0) against the Open Phase Circuit the 400 kV grid (Byron accident),

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 86/122

- Over-voltage ($3U_0$) for zero phase sequence voltage at generator voltage of the generator transformer (busbar earth fault detection),
- Oversaturation U/f ,
- Overload (high temperature).

2.7.11.4.10.3.B

Auxiliary Normal and Stand-by Transformers protection system shall include:

- Over-current short-circuit on the HV and generator voltage side,
- Over-current
- Overload (high temperature),
- Gas (Buchholz),
- Differential,
- Ground differential protection I_0 and/or neutral ground overcurrent except transformers with d/D type windings connection,
- Impedance on the MV side (using of over-current short-circuit protection or impedance protection according to operation conditions),
- Over-current short-circuit on the MV side.

2.7.11.4.10.3.C

Distribution transformers MV/LV protection system shall include:

- MV side in accordance with Section 2.7.11.4.10.4,
- Over-current short-circuit in neutral point of LV winding.

2.7.11.4.10.4 MV SWITCHBOARD PROTECTION

2.7.11.4.10.4.A

MV switchboard protection system shall include:

- Failure (arc flash) protection
- Automatics of circuit breaker (disconnection) failure (breaker failure protection)

2.7.11.4.10.4.B

Normal and standby supply inlet of MV switchgear protection system shall include:

- Over-current short-circuit protection
- Over-current (overload) protection
- Earth-fault protection
- Overvoltage and undervoltage protection forming a part of the Unit* protection against faults and disturbances in the Grid

2.7.11.4.10.4.C

Outlet to transformer MV/LV protection system shall include:

- Over-current short-circuit protection, high-speed
- Over-current short-circuit protection, delayed
- Earth-fault over-current protection

2.7.11.4.10.4.D

Outlet to MV motor protection system shall include:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 87/122

- Over-current short-circuit protection
- Overload protection (thermal model)
- Starting (run-up) protection
- Phase unbalance (asymmetrical load) protection
- Earth-fault over-current protection
- Differential protection (for selected motors)

2.7.11.4.10.4.E

Outlet to subordinate power distribution MV protection system shall include:

- Short-circuit protection
- Earth-fault protection
- Differential (comparison) protection

2.7.11.4.10.4.F

Medium Voltage measurement cubicle protection system shall include:

- Under-voltage protection
- Synchronizing check relay

2.7.11.4.10.5 PROTECTIONS AGAINST FAULTS AND DISTURBANCES IN THE GRID

2.7.11.4.10.5.A

The Unit* shall be equipped by a "back-up distance protection" against external faults in order to enable house load operation.

2.7.11.4.10.6 CIRCUIT BREAKER PROTECTION

2.7.11.4.10.6.A

Generator Circuit Breaker* protection system shall include:

- Inadvertent energization
- Breaker failure with time
- Breaker failure
- Busbar earth fault detection

2.7.11.4.10.6.B

Outlet Circuit Breaker protection system shall include:

- Inadvertent energization
- Breaker failure with time
- Breaker failure

2.7.11.4.10.7 OVERHEAD OR UNDERGROUND POWER LINE PROTECTION

2.7.11.4.10.7.A

Power line 400 kV and underground line 110 kV protection system shall include.

- Line differential protection
- Open Phase Circuit (1-phase or 2-phase)

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 88/122

AA

The Supplier* shall coordinate the specific type of a line differential protection relays in the Unit* with Transmission System Operator* and Distribution System Operator*.

2.7.11.4.10.7.B

Optical ground wires shall be used as a communication lines.

2.7.11.4.10.8 SYSTEM FUNCTIONS

2.7.11.4.10.8.A

The protective devices shall give alarms or trip signals in order to protect the electrical equipment when faults or abnormal/dangerous processes occur.

2.7.11.4.10.8.B

Central Unit Fault Monitoring system shall provide analysis of electrical faults and abnormal status of the Unit* concerning transient events etc.

BA

The system shall be used for evaluating the operating tests and even for evaluating special test programs during the Commissioning* etc.

BB

The system shall provide monitoring of frequency oscillations in the grid in range 0,1 Hz to 5 Hz.

2.7.11.4.10.8.C

Control metering and balance metering systems shall give data about electricity production and consumption.

CA

The control metering shall be used as a back-up and verification of the commercial metering in adjacent substation.

CB

The balance metering system shall give data about electricity production and consumption in the various places of electrical scheme of Unit* (such as generator output, MV side of the ANT, HV side of the AST, MV system).

2.7.11.4.10.9 SYSTEM PERFORMANCE

2.7.11.4.10.9.A

The electrical protection system shall be designed to operate in the normal and exceptional operating ranges of electrical supply. Its design shall take into account the electromagnetic environment.

2.7.11.4.10.9.B

Spurious operation shall not occur in case of:

- loss of supplies,
- loss of a measuring chain,
- internal failure of components such as relays etc.,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 89/122

- variations of the measured values in the exceptional operating conditions which may be withstood by the protected equipment.

2.7.11.4.10.10 SYSTEM REQUIREMENTS

2.7.11.4.10.10.A

The electrical protection system shall comply with Rules*.

2.7.11.4.10.10.B

The electrical protection system shall support defence in depth principle (DID) and functions stated in Section 2.3.3 and shall respect these basic principles:

1. sensitivity to disturbances (faults) in protected area,
2. nonsensitivity (stability) to the Operational Modes*,
3. selectivity (discrimination) of function (to limit the range of grid tripped upon a fault). Between basic protections there shall be full selectivity. Reduced selectivity is acceptable between basic and backup protection.
4. fast acting with the objective of limiting consequences of failures (limiting of short circuits effects, protection of persons against electrical shock etc.),
5. coordination between protections and detection/measuring devices (current transformers, potential transformers) that secure correct function according to principles 1 through 4 stated above,
6. the basic protection system shall be backed-up by higher protection system in case of basic protection system malfunction,
7. mutual coordination between electrical protections, sizing of equipment and function of control and limiting systems and automations,
8. diagnostic (self-control) function of electrical protection,
9. events and failures fault recording (a link to Central unit fault monitoring system),
10. resistance against ambient environment (seismicity, EMC, surrounding atmosphere, power supply...).

2.7.11.4.10.10.C

The main requirements and design principles for electrical protection systems based on digital protection relays shall include:

1. reliable digital system, in compliance with CSN EN 61850,
2. high degree of integration (united protection, control and monitoring/archival functions at voltage level EHV, HV, MV and as a possible Variation: incoming side for LV (LC, MCC). For avoidance of doubt the digital protection relays in incoming side for LV (LC, MCC) are 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. possibility of integration of majority support electrical functions (local control, interlocking, backup automatics and undervoltage release automatics, local status and failure indication, summarization and classification failures for the purpose of remote indication etc.),
4. high degree of self-diagnostic functions,
5. use of Diversity* principle for safety resp. control functions within selected emergency power supply systems (for Systems Important to Safety),

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 90/122

6. use of backup principle for safety resp. control functions within selected important and expensive electrical systems,
7. possibility of easy and reliable communication with superordinate information system and Central unit fault monitoring system (i.e. using a standardised communication protocol),
8. function of event and failure recording including long term archiving of selected time flows and measured values, binary inputs and outputs,
9. easy reparability and Maintainability* (connector and slot construction resp. removable boards in terminal chassis),
10. testing of disconnecting circuits closing (MV, HV and EHV circuit breakers),
11. possibility of inputting time-independent and also time-dependent characteristics,
12. devices for ensuring secure and quick communication of protections (precondition for using “goose” reports - CSN EN 61850).

2.7.11.4.10.10.D

The main requirements and design principles for central unit fault monitoring system for electrical systems shall be as follows:

1. the system shall record faults in EHV, HV, MV and as a possible Variation: incoming side for LV (LC, MCC). For avoidance of doubt the recording faults in incoming side for LV (LC, MCC) 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*. In the case of other LV feeders, only the circuit breaker status is recorded using the auxiliary contact of the circuit breaker.
2. reliable sophisticated system, optimally in compliance with CSN EN 61850,
3. high degree of integration,
4. amount of binary inputs: as necessary,
5. amount of analogue inputs: as necessary,
6. SW support for evaluating failures resp. planned checks and tests,
7. possibility of automatic data export on suitable archival medium in case of overloading of “operational memories”,
8. self-diagnostic functions,
9. time synchronization (including function of time control in connection with protection systems etc.)
10. minimal requirements on sensors and inputs in general,
11. suitable sampling frequency of input data capture during transients (min. 2 kHz),
12. possibility of easy and reliable communication (i.e. using a standardised communication protocol) with cooperated protection systems, electrical systems of house load (self consumption) scheme, superordinate information resp. control systems,
13. possibility of triggering from an arbitrary binary input resp. under/over-range adjusted value of an arbitrary analogue input,
14. open system, extensibility ca 30 %.
15. the possibility to implement individual autonomous diagnostic systems of important devices (generator, excitation, transformers etc.)
16. remote access

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 91/122

2.7.11.4.10.10.E

The adjustment limits for each protective device shall allow the specified set values to be obtained easily (e.g. directly at the protection relay, via the computer connected to protection relay etc.).

2.7.11.4.10.10.F

Internal failures, loss of supplies and loss of measuring chains shall be indicated by warning signals.

2.7.11.4.10.10.G

Digital devices shall be used to give information allowing failures to be located.

2.7.11.4.10.10.H

The control, trip and alarm signals shall be coordinated with the signals of the grid sub-station control and protection system.

HA

The adjustment of the electrical protections shall be performed by the Supplier* in cooperation with Transmission System Operator* and DSO respectively.

2.7.11.4.10.10.I

Galvanic separation shall be provided between the internal circuits of each means of protection and the external circuits.

IA

This separation shall be provided by transformers for the analog inputs and for auxiliaries or test supplies.

2.7.11.4.10.10.J

The electrical protection system shall include devices for checking the operation of each means of protection without voltage or current injection.

JA

Test devices used to check the protection when it is not operating shall allow reliable measurement and record of the injected signals.

JB

The design shall allow an ammeter or a voltmeter to be inserted in the injection circuit for precise measurement of the test signals.

2.7.11.4.10.10.K

When a grid fault current is discharged to earth, the magnitude/duration relationship of the possible current passing through the human body standing at this point shall remain within allowable current limits stated in CSN IEC 60479, ČSN EN 61936-1.

2.7.11.4.10.10.L

The electrical protections of generator, excitation systems, GCB, GT, ANT(s), power outlet line and isolated busbars areas shall be realized as three redundant relay protection modules, each possessing all of the protection functions. The protection system shall comply with the following requirements:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 92/122

- The systems shall realize redundant tripping logic.
- Shall be supplied by provision of backup power supply and for generator, excitation systems, GCB, GT, power outlet line and isolated busbars areas shall have three independent measurement transformers and sensors, connected to independent breaker trip coils. Both independent power supply sources shall be backed-up on battery power by DC switchboards (UPS).
- As a possible Variation: three redundant protections of AST(s) shall be installed, including backup power supply and three independent measurement transformers and sensors. For avoidance of doubt the scope of this bullet 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*.
- As a possible Variation (as per Chapter 8, Terms and Conditions*) ANT(s) shall have three independent measurement transformers and sensors. For avoidance of doubt the scope of this bullet 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*.
- Shall be possible to take out of service one of the relay protection modules without disturbing Unit* operation.

LA

All medium and low voltage power circuits passing through the containment cable penetrations shall be provided with primary and back-up protective devices which are capable of limiting the maximum heat produced by fault or overload currents at the penetration to a value less than the thermal capability of the penetration.

2.7.11.4.10.10.M

All protection devices, schemes for connection and adjustment levels shall comply with the Rules* and accepted practices.

2.7.11.4.10.10.N

The control metering and the balance metering system shall meet these requirements:

- Current and voltage transformers in each phase with accuracy class 0,2 (above 52 kV)
- Current and voltage transformers in each phase with accuracy class 0,5 (above 1 up to 52 kV)
- Active energy meters in each phase with accuracy class 0,5 (above 52 kV)
- Active energy meters in each phase with accuracy class 1,0 (above 1 up to 52 kV)
- Reactive energy meters in each phase with accuracy class 1,0 (above 52 kV)
- Reactive energy meters in each phase with accuracy class 2,0 (above 1 up to 52 kV)
- Telecounting (the transmission of the measured values)

2.7.11.4.11 LIGHTING AND SMALL POWER SYSTEMS

2.7.11.4.11.1 SCOPE

Small power systems include LV switchboards, LV power distribution, power outlets for 400 V three phase and 230 V single phase equipment.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 93/122

Lighting systems include normal lighting system, standby lighting system, emergency lighting system and security lighting system.

2.7.11.4.11.2 SYSTEM FUNCTIONS

The lighting systems provide artificial lighting necessary for Plant* staff.

The small LV power systems provide the electric power for fixed and portable tools and appliances.

2.7.11.4.11.2.A

The lighting concept and its power supply shall include four mutually independent systems:

- A normal lighting system, which serves for normal illumination under Plant* operating, maintenance and test conditions.
- A standby lighting system, which serves for operation of the essential Plant* items and safe movement for essential Plant* operation (i.e. safe shutdown) of personnel in all areas.
- An emergency lighting, which serves for escape orientation, manual fire fighting activities and emergency operations.
- A security lighting, which serves for monitoring of the Limited Access Area*, Protected Area*.

2.7.11.4.11.3 SYSTEM REQUIREMENTS

2.7.11.4.11.3.A

LV distribution system shall be designed according to CSN 33 2000.

2.7.11.4.11.3.B

These systems shall be designed to ensure protection of personnel.

BA

Personnel safety shall be guaranteed and possibilities for injuries due to stroboscopic effects, discomfort, and wrong colour recognition shall be excluded.

2.7.11.4.11.3.C

The rated values at the final consumer point shall be 690 V or 400/230 V.

2.7.11.4.11.3.D

All power plugs and outputs shall be marked in a proper manner for voltage and current capacity.

2.7.11.4.11.3.E

As a possible Variation: site service non-safety classified equipment essential for maintenance (lighting, lifting equipment, elevator, repair activities etc.) shall be available also during regular maintenance of its power supply. This can be achieved e.g. by two power sources, redundant equipment etc. For avoidance of doubt the above 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*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 94/122

EA

At least a selected part of small power systems in selected rooms shall also remain functional in case of disconnecting (maintaining) the power supply in the relevant room (i.e. supply by two independent power supply circuits).

2.7.11.4.11.3.F

For low-voltage artificial lighting and heavy current distribution and for non-important power distribution, 400/230 V AC and 220 V DC standardised (CSN EN 61439) panel switchboards shall be used.

2.7.11.4.11.3.G

400 V and 230 V AC sockets shall be provided in all areas where portable tools and equipment are likely to be used.

2.7.11.4.11.3.H

The small power systems shall include the supplies provided for anti-condensation heater circuits (motors, panels, etc.), and for panels or cubicles internal lighting.

2.7.11.4.11.3.I

The illumination levels shall be specified by the Supplier* for each type of location throughout the Plant*

IA

Lighting systems shall be designed in accordance with CSN EN 12464, CSN EN 1838 and CSN EN 50172.

2.7.11.4.11.3.J

A normal lighting system shall be supplied by NAPS and SAPS.

2.7.11.4.11.3.K

A standby lighting system shall be supplied by Emergency Power Supply* system in case of LOOP.

2.7.11.4.11.3.L

An emergency lighting system shall be supplied by DC or uninterruptible AC low-voltage power supply system in case of LOOP and SBO.

2.7.11.4.11.3.M

A security lighting system shall be supplied by DC or uninterruptible AC low-voltage power supply system in case of LOOP and SBO.

2.7.11.4.11.3.N

The standby lighting shall provide illumination with minimal delay resulting from the diesel start-up sequence, in the event of failure of the main AC lighting supply.

2.7.11.4.11.3.O

Different lighting systems components shall be marked – for example there shall be special separate colour, text or pictogram code for normal, emergency and evacuation lighting.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 95/122

2.7.11.4.11.3.P

The lighting fittings shall be provided appropriate to the Plant* area in which they are located (e.g. type of light source, color rendering index, luminous efficiency).

2.7.11.4.11.3.Q

Explosion proof equipment shall be used in battery rooms and other areas where hydrogen is generated or used.

2.7.11.4.11.3.R

As a possible Variation: the main technological LV switchboards shall be equipped with a monitoring and diagnostic device using common bus transfer data connection to other systems and analysis. For avoidance of doubt the above 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*.

2.7.11.4.11.3.S

Low-voltage switchgears shall be tested and designed according to CSN EN 61439.

2.7.11.4.11.3.T

Low-voltage switchgears with open doors shall provide degree of protection IP2X.

2.7.11.4.11.3.U

LV distribution system for areas with fire hazard shall be protected by Arc Failure Detection Devices.

UA

Where reliability of Safety Function* prevail, exception may be applied.

2.7.11.4.12 LIGHTNING PROTECTION SYSTEM

2.7.11.4.12.1 SCOPE

2.7.11.4.12.1.A

Lightning protection of civil structures consists of:

- air terminations
- down conductors,
- earth terminations
- perimeter earthing line,
- interconnection with internal earthing network of civil structure.

2.7.11.4.12.2 SYSTEM FUNCTIONS

2.7.11.4.12.2.A

A lightning protection system shall provide protection against lightning strokes throughout the Plant*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 96/122

2.7.11.4.12.3 SYSTEM PERFORMANCE

2.7.11.4.12.3.A

The design-basis lightning levels that shall be used for the protection of building are defined in Section 2.4.1.2.6.

2.7.11.4.12.4 SYSTEM REQUIREMENTS

2.7.11.4.12.4.A

The perimeter earthing of civil structures shall be connected to main earthing network.

2.7.11.4.12.4.B

Each down conductor shall be connected to an earth electrode via a test link to allow disconnecting and testing.

2.7.11.4.12.4.C

Connection of earth conductors of a building to the main earthing network shall be made in at least two different points.

2.7.11.4.12.4.D

Lightning protection materials shall be compatible with the main earthing network.

2.7.11.4.12.4.E

Lightning protection system design lifetime shall be the same as the whole Plant* design life.

2.7.11.4.12.4.F

Structures with metallic roofs shall not be protected with separate air terminations.

2.7.11.4.12.4.G

The lightning protection concept shall be an integral part of the design of electrical and I&C systems.

2.7.11.4.12.4.H

The lightning protection concept shall comply with the power Plant* EMC concept.

2.7.11.4.12.4.I

The lightning protection shall be designed in accordance with CSN EN 62305.

2.7.11.4.12.4.J

Connections to absolute earth shall be routed in such a way that the effects of lightning discharges do not jeopardise the functions of electrical and I&C systems.

2.7.11.4.12.4.K

The installation of equipment shall be designed to be selective with other devices on-site with regard to insulation coordination requirements.

2.7.11.4.12.4.L

The lightning arresters shall be connected in the shortest possible way to the plant earthing system.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 97/122

2.7.11.4.12.4.M

Electrical equipment shall include protection against surges resulting from lightning strikes on electrical transmission lines.

2.7.11.4.12.4.N

Cables running outdoors, which may be influenced by lightning strikes, shall be equipped with surge suppression devices to protect equipment from lightning strikes.

2.7.11.4.12.4.O

The reinforcing bars of concrete structures shall be connected to the down conductors, except when prestressed cables are used (reactor building).

2.7.11.4.12.4.P

The grid feeders shall be protected against lightning.

2.7.11.4.13 PLANT EARTHING SYSTEM

2.7.11.4.13.A

A Plant* earthing system shall be provided.

2.7.11.4.13.B

Earthing shall be divided into three categories:

- lightning protection earthing,
- system earthing,
- equipment earthing.

BA

All three categories shall be provided with a reference connection to absolute earth.

2.7.11.4.13.C

The Supplier* shall perform measurement of ground resistivity.

2.7.11.4.13.D

The designed performance of the grounding system shall be guaranteed during the entire operational life of the Plant* plus Decommissioning*.

2.7.11.4.13.E

Material of underground part of the Plant* earthing system shall be copper.

EA

Galvanic corrosion shall always be eliminated (by use of appropriate technology of joints of copper with different material).

2.7.11.4.13.F

The underground joints shall secure low value transition resistance during the whole Plant* design life.

2.7.11.4.13.G

The Plant* earthing system shall be designed in accordance with CSN EN 61936-1.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 98/122

2.7.12 DIESEL GENERATORS

2.7.12.1 SCOPE

2.7.12.1.A

This Section is applicable to on-site standby diesel generators used as Emergency Power Supply* (refer to the Technical Requirements Document*, Section 2.8.2.7) and Alternate Power Source* (AAC Diesel Generator) except mobile diesel generators.

AA

The term Emergency Diesel Generator is used in this Section for Emergency Power Supply* sources for power supply of SSC which perform Safety Functions* in case of DBC (refer to the Section 2.1.5.1.2). These on-site standby power sources may be used for power supply of selected non-safety (defense-in-depth) functions. However these non-safety (defense-in-depth) loads shall not lower performance of Safety Functions*. Emergency Diesel Generator shall be safety classified.

AB

The term non-safety (defense-in-depth) diesel generator is used in this Section for emergency power supply sources for power supply of non-classified SSC (refer to the Section 2.1.5.1.2). These on-site standby power sources may be used for power supply of selected important consumers (for investment protection, etc.) and for power supply of SSC to secure defense-in-depth related functions. Non-safety diesel generator shall be assigned as non-classified from the safety category point of view.

2.7.12.1.B

This Section defines the common functional requirements that apply to the emergency diesel generators on the Plant*, designed as Emergency Power Supply* and Alternate Power Source*.

2.7.12.1.C

If other equipment (e.g. gas turbines generators) is used instead of diesel generators, the Supplier* shall provide a suitability analysis.

2.7.12.2 GENERAL REQUIREMENTS

2.7.12.2.A

Emergency Diesel Generators and Alternate Power Source* shall achieve the reliability expected for the function performed by the system, the total Core Damage* frequency target and Acceptance criteria specified in the Section 2.1.9.2. For Emergency Diesel Generators the Single Failure Criterion* shall be applied.

AA

Non-safety diesel generator shall be provided with redundant auxiliaries (such as fuel oil transfer pump) to achieve the reliability expected for the function performed by the system.

2.7.12.2.B

Diesel generator shall be equipped with an autonomous I&C system and autonomous auxiliary systems.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 99/122

2.7.12.2.C

Diesel generator related SSCs shall be placed so as demanding maintenance will be possible (space, floor load capacity, lifting devices etc.).

2.7.12.2.D

The Emergency Diesel Generators and AAC Diesel Generator shall be tested in accordance with IEEE 387.

DA

The non-safety diesel generator shall be tested according to manufacturer's standards and by set of pre-operational tests to confirm the non-safety diesel generator performance and claimed starting and loading reliability factor of 0.98.

2.7.12.2.E

The diesel generators shall meet EU requirements for non-road mobile machinery emissions.

2.7.12.2.F

Diesel generators shall be equipped with torsion dampers, which eliminate mechanical stress of crankshaft (unless the crankshaft has been designed for such stresses).

2.7.12.2.G

If commercial off-the-shelf (COTS) components or equipment is used they shall comply with the requirements in Chapter 2.10.6.2.3.2.

2.7.12.3 SIZING

2.7.12.3.1 POWER RATING

2.7.12.3.1.A

The power ratings of the diesel generators shall be determined by calculating peak load demand under the worst limiting conditions with regard to environmental conditions at the place of installation.

2.7.12.3.1.B

For Emergency Diesel Generators at least the following Loss Of Off-site Power (LOOP) situations shall be considered:

- LOOP and transition to Hot Shutdown Modes*
- LOOP and transition to Cold Shutdown Modes*
- LOOP coincident with a LOCA (both small and large break)
- LOOP coincident with a Steam Line Break in the Primary Containment*

LOOP in this section means situation, when the voltage or frequency of off-site power is out of acceptable range.

2.7.12.3.1.C

For diesel generators designed as an Alternate Power Source* (in case of SBO), the combination of LOOP and failure of all diesel generators designed as Emergency Power Supply* shall be considered.

2.7.12.3.1.D

The rated output of diesel generators shall be at the time of commissioning:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 100/122

- +10 % of worst-case load demand calculated for Emergency Diesel Generators and Alternate Power Source*
- +20 % of worst-case load demand calculated for non-safety diesel generators

2.7.12.3.1.E

The diesel generator shall withstand an overload of 10 % above its rated output for 2 hours.

2.7.12.3.2 INSTRUMENTATION AND CONTROL PRINCIPLES

2.7.12.3.2.A

The Single failure* of instrumentation and control SSC of the Emergency power supply* shall not affect execution of its Safety Functions*. In case of the Single failure* of instrumentation and control SSC of the Alternate power source* there shall be other means which secure execution of its Safety Functions*.

AA

Evaluation of the diversity of start conditions of the Emergency Diesel Generators (voltage and other diverse signal, e.g. frequency) shall be ensured and implemented in each channel via diverse technical equipment. Emergency Diesel Generators shall be designed to start-up automatically on accident conditions:

- voltage of the relevant MV power busbar is out of acceptable range and other diverse signal, e.g.:
- frequency of the relevant MV power busbar is out of acceptable range
- the state of circuit breakers of NAPS and SAPS system supplying APS

AB

Non-safety diesel generators shall be designed to start-up automatically on accident conditions:

- voltage of the relevant MV power busbar is out of acceptable range

AC

Diesel generators designed as Alternate Power Source* shall be designed with automatic start-up, if manual start-up is not compatible with time period set for Operator* action.

2.7.12.3.2.B

The diesel generator shall also be designed for manual start-up:

- from the Main Control Room*
- from the Emergency Control Room*, or Remote Shutdown Panel*
- using local controls (following operator authorization from the MCR)

BA

Emergency Diesel Generators and Alternate Power Source* shall be capable of being manually started and brought to rated speed and voltage without any AC or DC electric power (it means for instance use of permanent magnet generator, a manually operated air starting valve, spring starter etc.).

2.7.12.3.2.C

Reconnection to the off-site source and diesel generator shutdown shall be done manually.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 101/122

2.7.12.3.3 OPERATING CONDITIONS AND PERFORMANCE

2.7.12.3.3.A

The diesel generators shall be ready for immediate start-up at any time in their own design conditions, except during maintenance.

2.7.12.3.3.B

Emergency Diesel Generators shall be started up and loaded sequentially, in the event of LOOP, or if voltage or other diverse signal (e.g. frequency) of the relevant MV power busbars is out of acceptable range (See Section 2.7.12.3.2).

BA

Non-safety diesel generators shall be automatically started up and loaded, in the event of LOOP, or if voltage of the relevant LV (690 V) power busbars is out of acceptable range.

BB

The diesel generator shall be capable of being restarted after shutdown.

2.7.12.3.3.C

Only a limited number of reliable protections shall exist (trip) in the Accident Conditions* for Emergency Diesel Generators and AAC Diesel Generator.

CA

Blocked protection functions in the Accident Conditions* shall be annunciated in the Main Control Room* and Emergency Control Room*.

CB

Only a limited number of reliable protections shall exist (trip) for non-safety diesel generators. The rest of unnecessary protection functions shall be alarmed in the Main Control Room* for possibility of manual trip.

2.7.12.3.3.D

All protective devices shall remain effective during diesel-generator unit testing or during operation in non-accident conditions.

2.7.12.3.3.1 START-UP, LOADING, UNLOADING

2.7.12.3.3.1.A

Start-up of diesel generators shall require only DC sources to supply the relays or the actuation devices on the Train* associated with the diesel generator. For reasons of reliability, the air starting system shall be used for the Emergency and AAC Diesel Generators. (see the Section 2.7.12.5.3)

2.7.12.3.3.1.B

The time to reach the nominal frequency and voltage following receipt of a start-up signal shall be compatible with the start-up time of the first auxiliary under worst-case loss-of-voltage conditions. The start-up and loading time of Emergency Diesel Generators shall be in accordance with the requirements of safety analysis.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 102/122

BB

The start-up and loading time of non-safety diesel generators shall be based on requirements of people and investment protection.

2.7.12.3.3.1.C

The diesel generator shall be connected to the relevant LV or MV power busbar as soon as acceptable frequency and voltage have been established.

2.7.12.3.3.1.D

During step-by-step (sequential) loading, frequency and voltage drops as well as recovery times shall be kept within the ranges established by the Supplier*.

2.7.12.3.3.1.E

The connection of the largest single load shall be possible in the following cases:

- with the first load when the diesel generator MV breaker is closing
- during the sequential loading, but without superposing, because control devices shall be designed to allow insertion
- at the end of the sequential loading

2.7.12.3.3.1.F

Satisfactory transfer of the auxiliaries shall be verified analytically during plant design.

2.7.12.3.3.1.G

The Emergency Diesel Generator shall be able to accept load step at least 10 % greater than largest single load step in the step-by-step (sequential) loading under the worst limiting conditions.

GA

The AAC Diesel Generator and the non-safety diesel generator shall be capable of recovering from a load step 10% greater than the most severe load step in the planned load profile.

2.7.12.3.3.1.H

The disconnection of the largest single load, or the transient operating conditions following step load increase, shall not lead to an increase in Emergency Diesel Generator and AAC Diesel Generator speed exceeding 75 % of the difference between the minimum overspeed trip set-point and the nominal speed.

2.7.12.3.3.1.I

Full load rejection shall not trip overspeed protection.

2.7.12.3.3.2 STEADY-STATE OPERATION

2.7.12.3.3.2.A

During steady-state operation, output at the generator terminals shall be between zero and nominal power, for a power factor from 0,8 to 1.

2.7.12.3.3.2.B

The maximum static generator voltage deviation shall be 5 % of the nominal voltage around the nominal voltage.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 103/122

2.7.12.3.3.3 SYNCHRONIZED OPERATION WITH THE ELECTRICAL POWER SYSTEM

2.7.12.3.3.3.A

The diesel generator shall be able to be synchronized with the electrical power system.

2.7.12.3.3.3.B

This mode of operation is only envisaged during full-load periodic tests and, in this case, only one diesel generator at a time shall be connected. The construction of diesel generators, dimensioning electric power distribution systems and control systems shall allow operating in parallel with the off-site grid.

2.7.12.3.3.3.C

The contribution of the diesel generators to the on-site electrical power system short-circuit capability shall be taken into account when sizing switchgear under the conditions provided for this configuration.

2.7.12.3.3.4 TRANSIENT OPERATION

2.7.12.3.3.4.A

The diesel generators shall be designed to satisfy the following conditions:

- speed at overspeed protection trip shall not exceed 125 % of nominal speed;
- each generator shall be able to withstand the faults (such as short-circuits and over-voltages) liable to occur in the on-site electrical power system to which it is connected;
- in addition, it shall withstand the overspeed operation and a limited number of out-of-step connections to the electrical power system.

2.7.12.3.3.5 LIFE-TIME

2.7.12.3.3.5.A

The main components of the on-site standby diesel generator shall be designed for a lifetime of not less than 40 years, and for at least 2 000 starts.

2.7.12.4 BASIC RULES GOVERNING ANCILLARY SYSTEMS

2.7.12.4.A

Each diesel generator shall be provided with completely independent essential systems: fuel oil, engine exhaust, lubricating oil, cooling water, combustion air, air starting if any and electrical systems.

2.7.12.4.B

The fuel oil systems and vital portions of the air starting, lubricating oil, cooling water and combustion air systems of the Emergency Diesel Generators and Alternate Power Source*, together with the structures of the above-mentioned systems, shall be protected from the effects of postulated Internal Hazards* and External Hazards*.

BA

The fuel oil systems and vital portions of the air starting, lubricating oil, cooling water and combustion air systems of the non-safety diesel generator, together with the structures of the above-mentioned systems, shall be protected from the effects of environmental conditions and expected hazards in the place of installation (e.g. flooding, fire etc. if needed).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 104/122

2.7.12.4.C

Fuel oil, cooling water, lubricating oil, combustion air and air starting systems

- for Emergency Diesel Generators shall remain functional during and after the Design Basis Earthquake*
- for Diesel generators designed as Alternate Power Source* shall remain functional during and after a RSEH earthquake.

2.7.12.4.D

Fluid and electrical systems shall be so designed as to permit their periodic Inspection* and their periodic testing and maintenance.

2.7.12.5 SPECIFIC RULES GOVERNING ANCILLARY SYSTEMS

2.7.12.5.1 FUEL OIL SYSTEM

2.7.12.5.1.A

Test programmes or another measures shall ensure fulfilling minimal prescribed values of physical-chemical properties, including quality requirements. The stability of fuel within permitted range of values during storage and using shall be ensured. The way of fuel storing shall guarantee conditions for the stability of fuel.

2.7.12.5.1.B

The minimum quantity of fuel shall be stored on-site to enable the diesel generators to be operational in accordance with the requirements on autonomy given in Section 2.1.6.7.3.

2.7.12.5.1.C

Each diesel generator shall be provided with a fuel oil tank mounted above its fuel feed pumps.

CA

The fuel oil tank of the Alternate Power Source*, which feeds the diesel engine by gravity, shall have sufficient capacity to sustain full-load diesel engine operation for the minimum time specified by safety analyses, but not less than 4100 liters.

CB

The fuel oil tank of Emergency Diesel Generator, which feeds the diesel engine by gravity and is itself fed from the storage tank by transfer pumps, shall have sufficient capacity to sustain full-load diesel engine operation for the minimum time specified by the safety analyses in the event of failure of the fuel transfer pumps, but not less than 4100 liters. The fuel transfer pumps shall be supplied from relevant switchboards (from diesel generator whose fuel oil tank is fed by those fuel transfer pumps). The storage fuel oil tank of Emergency Diesel Generator shall have sufficient capacity to operate Emergency Diesel Generator at continuous rating of at least 72 hours.

CC

The fuel oil tank of non-safety diesel engine, which feeds the diesel engine by gravity and is itself fed from the storage tank by transfer pumps, shall have sufficient capacity to sustain full-load diesel engine operation for the minimum time specified by the safety analyses in the event of failure of the fuel transfer pumps, but not less than 2 hours. The fuel transfer pumps shall be supplied from relevant switchboards (from diesel generator whose fuel oil tank is fed by those fuel transfer pumps).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 105/122

2.7.12.5.1.D

Protective measures shall be taken to minimize the causes of fires and explosions.

2.7.12.5.1.E

Fuel and oil storage systems of diesel generators shall be equipped with devices for representative media sampling.

2.7.12.5.2 LUBRICATING OIL AND COOLING WATER SYSTEMS

2.7.12.5.2.A

The lubrication oil inventory in the diesel generator oil sump or in an associated lubrication oil tank shall be sufficient to ensure an operation of at least the same time as a fuel oil gravity tank without falling below the minimum level. Leakages to components having surface temperatures above 220 °C shall be prevented. Lubrication oil systems shall include a filter system with fouling indication.

2.7.12.5.2.B

An internal and an external circuit shall be provided for cooling the diesel engine. The design of the heat exchanger shall be based on the most unfavourable values of temperature and coolant flow rate in the external circuit.

2.7.12.5.2.C

The lubricating oil and cooling water systems shall be provided with heaters and motor-driven circulating pumps, which keep the engine warm under standby conditions, enabling the engine to be started without causing mechanical damage.

2.7.12.5.3 STARTING SYSTEM

2.7.12.5.3.A

The diesel engine shall be equipped with full backup starting system.

AA

Air compressors and reservoirs of Emergency and AAC Diesel Generator shall be independent of any other plant air systems. Each of the start air reservoirs of each Emergency and AAC Diesel Generator shall be sized with capacity for at least 5 sequential starts without air reservoirs recharging.

AB

Air compressor and reservoirs of non-safety diesel generator shall be independent of any other plant air systems. Each of the start air reservoir of non-safety diesel generator shall be sized with capacity for at least 5 sequential starts without air reservoirs recharging.

2.7.12.5.3.B

For the Alternate Power Source* and the non-safety diesel generator, in reasonable and justified cases, an alternative starting system (different from air starting system) may be used for at least 3 sequential starts.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 106/122

2.7.12.5.4 COMBUSTION AIR SYSTEM

2.7.12.5.4.A

The installation for diesel generators shall be designed to prevent exhaust gases from being drawn in by the combustion air system, even with DBE.

2.7.12.5.5 FIRE PROTECTION

2.7.12.5.5.A

Fire detection systems are obligatory for all rooms. It shall be foreseen fire protection measures in accordance with the relevant Czech and European standards for NPP diesel generators equipment specified in Chapter 2.5.

2.7.12.5.5.B

The diesel generator shall be protected by an effective fire extinguishing protection system. The fire extinguishing protection system shall not endanger the functioning of the diesel generator. The protection of diesel generator provided by enclosure shall be adequate to the environment conditions caused by functioning of this system (e.g. spraying water, wet, moisture).

2.7.13 HVAC EQUIPMENT

2.7.13.1 SCOPE

2.7.13.1.A

This Section defines the functional requirements and some main generic design requirements that apply to the components of HVAC systems such as fans, ducts, filters, coils, heat exchangers, dampers, fan coolers, and others.

2.7.13.1.B

In particular, HVAC shall meet all health and safety, environmental and fire Rules*.

2.7.13.2 GENERAL

2.7.13.2.A

The Supplier* shall standardise, as far as possible, the types and sizes of components such as ducts, fans, filters, coils, fan coolers and dampers used in the HVAC systems.

AA

Each part of a HVAC component shall be interchangeable with the corresponding part of any other identical component located in the Plant* taking into account its safety class.

2.7.13.2.B

Components of HVAC systems shall be designed to operate in the Site* environmental conditions specified in Chapter 2.4 and to meet requirements provided in Section 2.8.2.9 and Sections 2.9.4.1.4 and 2.9.4.2.1 and 4.6.2.

2.7.13.2.C

Adequate instrumentation shall be provided to permit initial and periodic testing of components and systems.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 107/122

2.7.13.2.D

Components of HVAC systems for which leaktightness is required shall be both shop-tested and field-tested.

2.7.13.2.E

The component design shall take account of any requirements for noise limitation for Plant* personnel protection, as well as for external noise limitation as specified in Section 2.14.1.3.1.

2.7.13.3 VENTILATION DUCTS

2.7.13.3.A

The Supplier* shall select the dimensions of HVAC ducts from a set of standardised dimensions, following current industrial practice.

2.7.13.3.B

Ductwork and associated supports shall be constructed to suit the radiological classification of the areas served, and shall be designed for the normal and emergency static, dynamic and seismic loads and load combinations which are applicable to their safety classification, geometry, location, and function.

BA

The following types of ductwork shall be utilized:

- high-integrity (very low leakage) fabricated ductwork systems manufactured from mild steel (galvanised or zinc coated) and stainless steel, duct elements all welded. Plastics or high-density polyethylene can be used for some specific applications (e.g. highly corrosive media),
- normal commercial quality ductwork systems manufactured in a range of materials.

2.7.13.3.C

Supports and hangers of ventilation ducts shall be such that easy removal of one or several duct elements, including associated dampers, coils, heat exchangers, etc., is possible for repair or replacement.

2.7.13.3.D

The design and spacing of all supports shall take account of seismic requirements.

DA

The development of a standard series of seismic supports to cover a range of duct and component sizes shall be considered.

2.7.13.3.E

The ventilation ducts shall have sufficient thickness, and be adequately stiffened, to accommodate any requirement for maximum allowed deformation under the maximum operating internal over-pressure or maximum operating internal negative pressure.

EA

When possible, round duct shall be used instead of rectangular duct due to its higher strength and resistance to collapse under external pressure.

2.7.13.3.F

Consideration shall also be given to future dismantling and disposal of the contaminated duct.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 108/122

2.7.13.3.G

Corrosion protection requirements like coatings and painting shall be consistent with the corrosion expected in the application and with the size of the duct.

2.7.13.4 FANS

2.7.13.4.A

The characteristics of fans used in HVAC systems shall be compatible with stable operation of a single fan and permit stable operation of several fans operating in parallel, for all operating flowrate conditions.

2.7.13.4.B

All rotating or moving parts which are accessible shall be provided with a protection casing.

2.7.13.4.C

For fans of the centrifugal type, the casing shall allow easy removal of the rotating assembly.

2.7.13.4.D

Connections between the fan and the other system components shall be such that transmission of vibrations from the fan is precluded.

2.7.13.4.E

The shaft diameter shall be such that a sufficient margin of at least 25 % is kept between the maximum design rotating speed and the first critical rotating speed.

2.7.13.4.F

The fans shall be driven by direct coupling or belt-drive.

FA

Each belt-driven fan shall be provided with at least two belts, and the fan shall maintain its full capability (including start-up) with one belt out of service.

FB

A protective cage shall be provided around the belts to provide personnel protection.

2.7.13.4.G

The belts shall be non-friable and antistatic.

2.7.13.4.H

Belt-driven fans shall not be used in areas that are not easily accessible, in particular inside the Primary Containment*.

HA

Fans in containment and their drives shall be made so that their operating during Unit* power operation is maintenance-free.

2.7.13.5 FILTERING EQUIPMENT

2.7.13.5.A

Filter cells shall be easily accessible.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 109/122

2.7.13.5.B

Quick mounting and dismantling of filter units shall be possible.

2.7.13.5.C

Particulate filters, when not refillable, shall come in the form of cells with one standard face dimensions.

2.7.13.5.D

Where the use of charcoal filters is proposed, the Supplier* shall perform analyses and evaluations to determine whether such filter types are needed for operational and in-plant ALARA considerations, and for minimising releases to the environment.

2.7.13.5.E

Charcoal filters shall be of the refillable type and facilities shall be provided for both filling and emptying the charcoal.

2.7.13.5.F

In general, a moisture separator, a preheating device, a pre-filter, and a High Efficiency Particulate Air (HEPA) filter shall be provided upstream of charcoal filters.

FA

A post HEPA filter shall be provided downstream the charcoal filters to retain particles carried out from the adsorber.

FB

HEPA filters and adsorbers shall be protected against moisture.

FC

Preheating shall be provided if the relative humidity is not assured to be below 70 % since the efficiency of charcoal filters is highly dependent on the relative humidity.

FD

The temperature upstream the charcoal filter shall be below 107 °C.

2.7.13.5.G

The filtering efficiency of the particulate filters and iodine traps (charcoal filters) shall be sufficient to meet the radiological targets and shall meet at least the requirements of the Codes and Standards*.

2.7.13.5.H

Charcoal filters shall be isolated by dampers during change of charcoal.

2.7.13.5.I

HEPA filters installed in HVAC systems potentially contaminated shall incorporate safe-change arrangements with isolation dampers either side of the filter housing to isolate the filtration unit in case of malfunction or fire.

2.7.13.5.J

The filter housing shall be provided with proven in-situ testing equipment.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 110/122

2.7.13.5.K

The housing of filter units shall address the following:

- the facility for quick and easy filter changing to minimise contamination and irradiation of personnel,
- the use of proprietary bag change systems to maintain containment with consideration for remote filter changing, if required,
- where a system is designed with filters in series, the arrangement of filters unit shall allow testing of each filter.

2.7.13.6 HEATING AND COOLING EQUIPMENT

2.7.13.6.A

Heating coils and/or heaters in ventilation systems shall be either electrically-heated or water-heated.

2.7.13.6.B

Heating coils and/or heaters that have to remain operative under seismic conditions shall be of the electrical-type.

2.7.13.6.C

For HVAC equipment inside the Primary Containment*, aluminium shall not be used as material for cooling fins.

2.7.13.6.D

Coils and/or heat exchangers circulating water (or any other fluid) shall comprise tube bundles with crimped fins.

2.7.13.6.E

The spacing between the fins shall be sufficient to limit fouling.

2.7.13.6.F

When determining the heat exchange area, account shall be taken of the thermal resistance resulting from any fouling inside the tubes and from the oxide layer on the air side.

2.7.13.6.G

When necessary, protection from freezing shall be installed at the ventilation inlets.

2.7.13.7 DAMPERS

2.7.13.7.A

Each manual damper shall have a local and visual indication of its overall position and each powered or controlled electrically damper shall be provided with local and remote status indication.

2.7.13.7.B

The isolation dampers shall be equipped with a lock-up system for security blocking.

BA

Lock-up system for security blocking prevents dampers from accidental opening (closing).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 111/122

2.7.13.7.C

Regulating dampers shall be provided with a device that allows the damper to be locked in a specific position.

2.7.13.7.D

Main Control Room* HVAC dampers shall be provided to ensure habitability during DBA and DEC, in particular in case of SBO.

DA

The dampers shall be of bubble-tight and butterfly valve construction with fail/close or battery-backed type operators.

2.7.13.7.E

Dampers shall not be installed at low points of the circuit.

2.7.13.8 HOUSINGS

2.7.13.8.A

Material used shall have properties composition and protective coatings suitable for the service conditions.

2.7.13.8.B

The design shall incorporate requirements for structural strength, rigidity and sealing surfaces to provide leak tightness of internal mounting frames to the housings.

2.7.13.8.C

Equipment shall be designed to allow decontamination.

CA

Decontamination requirements shall be specified by the Supplier* in the design specification.

2.7.13.9 MOISTURE SEPARATORS

2.7.13.9.A

The separators (e.g. fibrous pads, fins) shall be held in place in the frame by retaining grids or mechanism.

2.7.13.9.B

Frames shall be designed to include drain holes to prevent re-entrainment of trapped liquids.

2.7.13.9.C

Seals shall be provided as necessary to prevent by pass of entrained liquid droplets.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 112/122

2.7.14 HANDLING EQUIPMENT

2.7.14.1 HANDLING EQUIPMENT IN NI

2.7.14.1.1 SCOPE

2.7.14.1.1.A

This Section states the functional requirements and dimensioning regulations of handling equipment installed in the Nuclear Island* (NI).

AA

The equipment concerned is permanent and includes:

- the polar crane of the reactor building and the external handling gantry (reactor building),
- external handling gantry - lifts tools from ground level up to containment hatch level
- other cranes which shall be used for lifting in the NI (in particular of heavy objects).

AB

Requirements concerning the fuel handling systems are outlined in accordance with the Section 2.8.2.6.

2.7.14.1.2 GENERAL

2.7.14.1.2.A

These handling devices shall be designed in order to:

- lift and transport loads with a reliability compatible with the hazards encountered with this operation, particularly concerning damage which could occur if a load were to be dropped,
- guarantee the possible shortest handling times, while remaining compatible with overall safety objectives,
- provide minimum requirements on attendance (remote control, camera system for attendance outside NI areas),
- provide their operation in power output mode of the Unit*,
- cover max. working area to eliminate not attended areas,
- allow a parallel movement mode of the main handling equipment (polar crane) in more axes (directions) to achieve maximum optimization of machine working time. This shall be compatible with the restrictions due to safe load paths if required,
- guarantee horizontal transport and reach of all loads presumed in the design including a reduction of safety equipment, which is necessary to dismantle (e.g. railing, terminal switches, other safety devices).

The main handling equipment shall be equipped with a coordinate control system.

AA

This requires optimised handling operations in order to meet the requirement for Outage Duration* (see the Section 2.2.7.2.2).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 113/122

AB

An adequate level of defence in depth shall be analysed. If the analysis detects an unacceptable probability of load accident, specific measures shall be defined and justified. The resulting measures shall be oriented to improve the reliability of the handling equipment and/or to implement operational restrictions or load path and areas limitations near spent fuel, the Core* or equipment required to achieve safe shutdown or to permit decay heat removal.

Depending on each case, these measures shall be:

- using of Single Failure* proof cranes,
- electrical interlocks and/or mechanical stops for restricting crane travels.

2.7.14.1.3 PRINCIPAL FUNCTIONAL REQUIREMENTS

2.7.14.1.3.1 FUNCTIONS

2.7.14.1.3.1.A

The NI handling equipment shall fulfil the following functions:

- receiving and transport of fresh Fuel Assemblies*,
- hoisting in the spent fuel pit and disposal of irradiated fuel,
- refuelling,
- handling of fresh and spent fuel casks,
- handling casks for irradiated equipment,
- handling of other heavy objects in the NI,
- handling of the RPV cover and its shielding, and of the reactor internals (during Unit* outage),
- handling of the stud tensioner (during Unit* outage),
- handling of other components and equipment in the reactor building (during Unit* outage),
- handling of heavy tools outside the reactor building in order to introduce them through the equipment hatch,
- prevention of load drop in DBE: In case of failure of handling equipment following a DBE, the fall of the equipment itself or the drop of the load may impair a Safety Function*. All the handling equipment whose failure could cause a fuel accident or may impair required Safety Functions* in this event shall be seismically qualified (see the Chapter 2.4).

2.7.14.1.3.2 SPECIAL CRITERIA CONCERNING THE REACTOR BUILDING'S POLAR CRANE

2.7.14.1.3.2.A

The polar crane shall be designed to be equipped with a construction trolley in addition to trolleys used for the Plant* operation.

2.7.14.1.3.2.B

The crane equipped with the trolley for the Plant* operation shall be capable of handling the heaviest components that may be replaced during the lifetime of the plant.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 114/122

BA

The crane with a construction trolley shall be designed to handle the SG, RPV and other RCS components as required during construction of the Plant*.

2.7.14.1.3.2.C

The construction trolley shall be withdrawn before the first FAs are loaded into the reactor.

2.7.14.1.3.2.D

Girder and crane track shall be designed against a possible loss of reactor coolant accident (pressure and temperature increase in the Primary Containment*).

2.7.14.1.3.2.E

Polar crane shall have, as a minimum, redundant hoist components between hook and drum and redundant braking system with the emergency brake acting on the drum.

2.7.14.1.3.3 FUNCTIONAL CHARACTERISTICS

2.7.14.1.3.3.A

For each of the lifting devices used in the NI, the following functional characteristics shall be specified by the Supplier* and agreed with the Owner*:

- lifting capacity, including possible needs during construction of the Plant*,
- areas to be served,
- nominal travel and lifting speeds, with variable speed in the whole range,
- maximum permissible acceleration and deceleration,
- maintenance objectives (in particular, duration of maintenance operations).

2.7.14.1.4 MECHANICAL DESIGN

2.7.14.1.4.1 DEVICES PERFORMING PREVENTION OF IMPACT ON SAFETY FUNCTIONS

2.7.14.1.4.1.A

For handling equipment whose failure could cause a fuel accident or impair a Safety Category 1 and/or 2 Functions*:

- Redundancy* of the load's securing mechanism shall be ensured either by a safety brake acting on the drum, or by a second hoisting mechanism; the safety brake shall be used only if other braking means are inoperable,
- hoists used for transporting irradiated fuel shall include two independent cables; if one cable ruptures, a device shall ensure movement stoppage,
- manual operation shall be capable of successively lowering the load in each of the following situations: loss of power supply, loss of motive torque, mechanical failure,
- the service bridge shall be guided by
 - horizontal rollers along its track in rotational or translational movement,
 - or by wheel flanges.

2.7.14.1.4.1.B

Structural steelwork and mechanisms shall be designed:

- either, in accordance with the Rules* with an extra safety coefficient of 1,25,
- or in accordance with a design code adapted to the handling requirements and explicitly taking account of nuclear risks.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 115/122

2.7.14.1.4.1.C

A seismic study shall be carried out with the DBE spectrum:

- stresses due to earthquake shall remain smaller than the yield strength of the material,
- the calculation of the crane's dynamic response shall be accomplished through the response spectrum method,
- the possibility of crane slippage is taken into account in the form of spectrum adaptation.

CA

Seismic analysis of cranes often leads to consideration of sliding effects using time-history computations. A simplified approach may be used for these effects including sliding displacements and softening of response spectra to sliding. This approach is based upon white noise simulations of earthquake motions.

2.7.14.1.4.1.D

Cranes shall be designed to retain control of and hold the load during earthquake. The bridge and trolleys shall be designed to remain in place with the wheels prevented from leaving the tracks. If needed, seismic clamps shall be provided.

2.7.14.1.4.2 OTHER HANDLING EQUIPMENT

2.7.14.1.4.2.A

Handling equipment which cannot impair Safety Category 1 or Safety Category 2 Function* shall be designed in compliance with the Rules*.

2.7.14.1.4.2.B

The braking action on the lifting motion shall be redundant.

BA

Redundant brakes are necessary for heavy loads.

BB

A braking device is not required on the drum.

2.7.14.1.5 DESIGN OF ELECTRICAL INSTRUMENTATION AND CONTROL EQUIPMENT

2.7.14.1.5.A

In case of loss of power, all electromechanical equipment shall be placed in a Fail-Safe* position; because of this, emergency power supplies are not provided and electrical equipment is not designed within seismic specifications.

2.7.14.1.5.B

Operational logic shall be of maintained-action type.

BA

When power has returned after power interruption the equipment is maintained in locked position until restored manually.

2.7.14.1.5.C

All handling equipment shall be equipped with a load weighing device, permanently visible by the Operator*; this system shall be in conjunction with an overload Protection System*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 116/122

2.7.14.1.5.D

All handling equipment shall be equipped with an upper limit switch in addition to the normal stop motion devices.

2.7.14.1.5.E

Handling equipment having a Safety Functions* shall be equipped with redundant overspeed detection and failed hoisting mechanism detection devices, which shall actuate emergency braking independently of Operator* commands and normal controls.

2.7.14.1.5.F

The equipment used for fuel handling shall be equipped with anti-collision devices and limit switches on horizontal motions.

2.7.14.1.5.G

The overhead lifting equipment shall be designed so that it can be used only in specified plant states, by means of safety interlocks on the crane.

2.7.14.1.5.H

Locking devices shall be placed in order to inhibit movement outside prescribed zones.

2.7.14.1.5.I

Remote control shall be used where practical.

2.7.14.1.6 TESTING

2.7.14.1.6.A

All equipment, including lifting tackles and gantries, shall be tested according to regulatory requirements of the Czech Republic.

2.7.14.1.6.B

For all equipment, nominal load tests shall be carried out on:

- braking with braking distance measurement,
- sag measurement,
- operation of safety devices as stated in accordance with the Section 2.7.14.1.5.

2.7.14.1.6.C

Periodic Inspections* and tests during use shall be carried out to ensure the operation of ultimate safety devices: upper limit switch, overspeed, overload.

2.7.14.2 OTHER HANDLING EQUIPMENT

2.7.14.2.1 SCOPE

2.7.14.2.1.A

This section states the functional requirements and dimensioning rules for handling equipment installed in the Power Generation Plant*, BOP* and Support Facilities*.

The relevant equipment is:

- handling devices in the turbine generator building, particularly the main overhead crane,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 117/122

- the feedwater pumps area crane (if the main overhead crane does not reach the area),
- other cranes which shall be used for lifting in the PGP, BOP and Support Facilities* (in particular of heavy objects).

2.7.14.2.2 GENERAL

2.7.14.2.2.A

Cranes and hoists shall be designed to lift and transport loads above and across various areas of the plant, precluding load drop that would cause:

- any damage which could occur if a load was to be dropped,
- risk of malfunction, which could lead to increased outage duration.

The main handling equipment shall be equipped with a coordinate control system.

2.7.14.2.3 PRINCIPAL FUNCTIONAL REQUIREMENTS

2.7.14.2.3.1 FUNCTIONS

2.7.14.2.3.1.A

PGP handling equipment shall fulfil the following functions:

- during the erection phase, lifting and transporting the parts of turbine, generator and other mechanical equipment of the buildings (pumps, pipes, valves, moisture separators...). If generator stator cannot be handled by the PGP handling equipment during erection or after stator failure, the Supplier* shall propose alternatives for this handling operations,
- during operation phase, lifting of the parts above mentioned, in order to perform their maintenance,
- handling of other components and heavy tools in PGP.

2.7.14.2.3.1.B

BOP and Support Facilities* handling equipment shall fulfill the following functions:

- during the erection phase, lifting and transporting the equipment,
- during operation phase, lifting of the parts above mentioned, in order to perform their maintenance,
- handling of other components and heavy tools in BOP and Support Facilities*.

2.7.14.2.3.2 FUNCTIONAL CHARACTERISTICS

2.7.14.2.3.2.A

For each of the handling devices used in PGP, BOP and /or Support Facilities*, the following functional characteristics are to be precisely specified by the Supplier* and agreed with the Owner*:

- lifting capacity, including possible needs during construction of the Unit*,
- areas to be served,
- nominal travel and lifting speeds,
- maximum permissible acceleration and deceleration,
- maintenance objectives (in particular, duration of maintenance operations),

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 118/122

- areas where the equipment is stored.

2.7.14.2.3.3 SYSTEM REQUIREMENTS

2.7.14.2.3.3.A

A safe load path shall be provided for moving all heavy loads above and across various areas served by lifting equipment.

2.7.14.2.3.3.B

The main crane of the turbine generator building shall be equipped with a main trolley and an auxiliary trolley.

2.7.14.2.4 MECHANICAL DESIGN

2.7.14.2.4.A

Structural steelwork and mechanisms of the handling equipment shall be designed in accordance with the Rules*.

2.7.14.2.4.B

The travelling crane handling heavier than 20 t load shall be guided by horizontal rollers along its track in translational movement.

2.7.14.2.5 DESIGN OF ELECTRICAL INSTRUMENTATION AND CONTROL EQUIPMENT

2.7.14.2.5.A

In case of loss of electrical power supply, all electromechanical equipment shall be placed in the Fail-Safe* position.

2.7.14.2.5.B

All handling equipment shall be equipped with an upper limit switch in addition to the normal stop motion devices, and with limit switches on horizontal motions.

2.7.14.2.5.C

The action of the redundant brake shall be immediate in the cases of overspeed detection, overload detection, emergency stop and action on the upper limit switch.

CA

In any other cases, the action of the redundant brake may be time-delayed.

2.7.14.2.5.D

If two cranes are installed in the steam turbine hall, with possibility of collisions of cranes or handled loads, each of the cranes shall be equipped with anti-collision devices.

2.7.14.2.5.E

The main travelling cranes shall be equipped with:

- an overspeed detection device,
- a load weighing device, permanently visible by the Operator* this system shall be in conjunction with the overload Protection System*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 119/122

2.7.14.2.6 TESTING

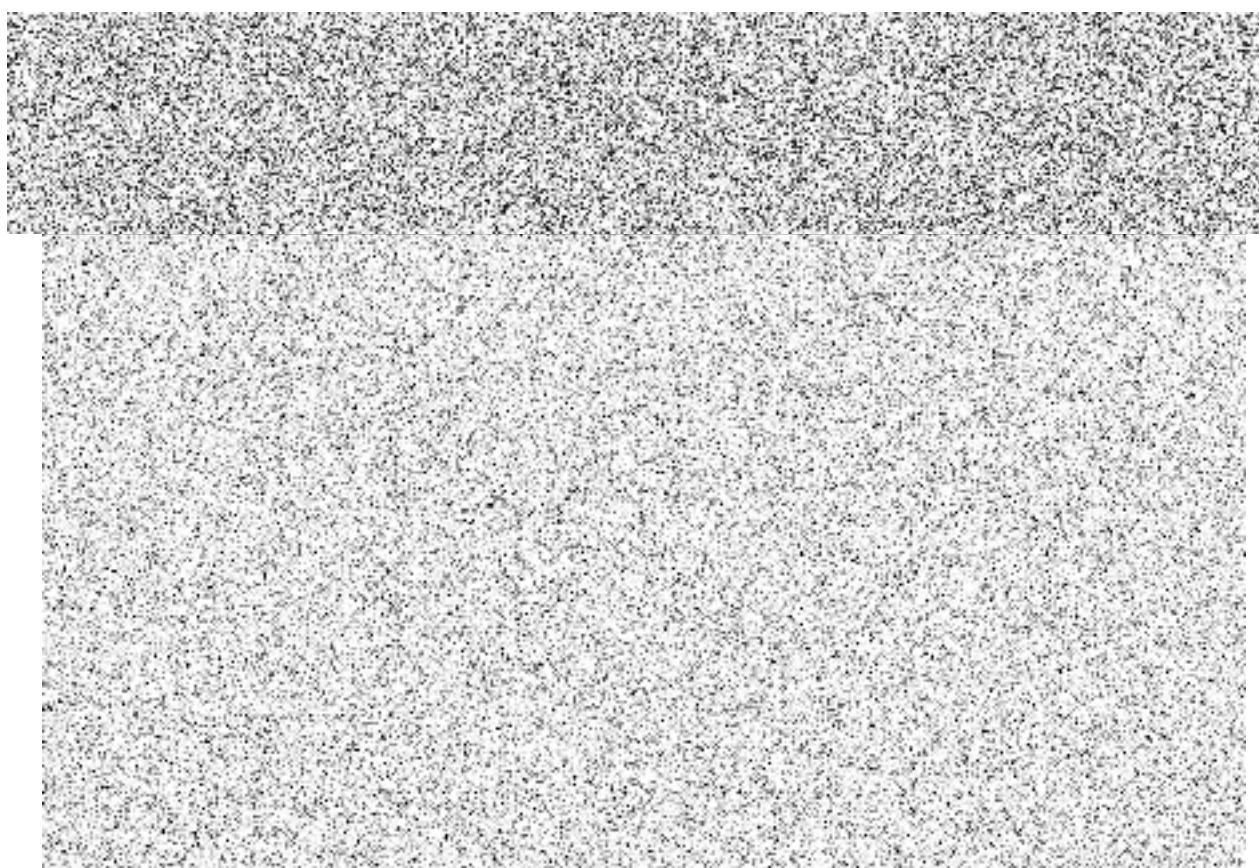
A

All equipment including tackles and gantries shall be tested according to the regulatory requirements of the Czech Republic.

In addition, for all equipment, nominal load tests shall be carried out on:

- braking with braking distance measurement,
- vertical deflection measurement,
- operation of safety devices (overspeed and overload protection devices).

2.7.15 EVAPORATORS



2.7.16 IMMOBILIZATION PLANT

2.7.16.A

The immobilization technology provided by the Supplier*, shall be based on the use of matrix with high level of waste load and its product shall be in compliance with Radioactive Waste Repository Dukovany requirements, as specified by the "Limits and conditions of safe operation at the RWR Dukovany" regulation (see Section 2.5.4).

2.7.16.B

The amount of space required for the immobilization plant shall be estimated. The space reserved for the immobilization facility shall be within the controlled area.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 120/122

2.7.16.C

The solidification agent handling system shall include equipment for filling, storage, sampling, and metering of the solidification agent, additives, and catalysts. Solidifications agents shall be compatible with the waste to be solidified and with the disposal container, in compliance with the "Limits and conditions of safe operation at the RWR Dukovany" regulation (see Section 2.5.4)

CA

Overflow protection shall be provided.

2.7.16.D

If cement or other powdered material is used as the solidification agent, the storage tank shall have a dust collector system, including a filter to remove dust.

2.7.17 COMPACTOR

2.7.17.A

Compactor shall be provided to limit the volume of the Radioactive Waste*.

2.7.17.B

The compactor(s) shall be fit for compacting into drums and shall have sufficient capacity to process in one 8 hour shift the maximum expected generation of DSW (dry solid waste) from a 48-hour period during an outage.

2.7.17.C

The compactor shall provide a compaction pressure of approximately 2 MPa or greater.

2.7.17.D

The compactor shall have an installed air filtration system, including a HEPA filter which discharges to the radwaste building HVAC system.

2.7.17.E

The compactor shall be sealed so that air discharges only through the air filtration system.

2.7.17.F

The compaction process shall permit the use of anti-springback devices in the waste container if they will economically increase the density of the compacted waste.

2.7.17.G

The compactor shall employ a mechanism to automatically centre and securely hold the container in correct alignment for ram travel.

2.7.17.H

The ram shall be interlocked to stop ram motion prior to mechanical component failure.

2.7.17.I

Hydraulic systems shall have over-pressure protection. Interlocks or safety doors or covers shall be provided to prevent personnel injury during ram motion.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 121/122

2.7.17.J

To reduce radiological consequences during maintenance, the compactor design shall incorporate compartmentalization to segregate the ram section from such operating equipment as pumps, fans, controls, and filters.

2.7.17.K

The compactor output product shall be in compliance with Radioactive Waste Repository Dukovany requirements, as specified by the "Limits and conditions of safe operation at the RWR Dukovany" regulation (see Section 2.5.4).

2.7.18 SUPERCOMPACTOR

2.7.18.A

The supercompactor shall be provided to compact radwaste drums (of different sizes up to 200L drums) as a possible Variation.

For avoidance of doubt the supercompactor 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*.

2.7.18.B

The supercompactor shall provide a compaction force of approximately 20 MN.

2.7.18.C

The supercompactor shall have an installed air filtration system, including a HEPA filter which discharges to the radwaste building HVAC system.

2.7.18.D

The supercompactor shall be designed so that air discharges are routed only through the air filtration system.

2.7.18.E

The supercompactor shall be equipped with drainage system and the provision to connect to effluent collection system and drainage system.

2.7.18.F

The supercompactor shall be provided with an automated loading device for the drums and an unloading device for the pellets.

2.7.18.G

The supercompactor shall be designed to automatically centre and securely hold the container in correct alignment for ram travel.

2.7.18.H

The ram shall be interlocked to stop ram motion prior to mechanical component failure.

2.7.18.I

Hydraulic systems shall have over-pressure protection.

Interlocks or safety doors or covers shall be provided to prevent personnel injury during ram motion.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.7 FUNCTIONAL REQUIREMENTS FOR COMPONENTS	Page 122/122

2.7.18.J

The supercompactor output product packed in the final container shall be in compliance with Radioactive Waste Repository Dukovany requirements, as specified by the “Limits and conditions of safe operation at the RWR Dukovany” regulation. (See Section 2.5.4)

2.7.18.K

The supercompactor shall be mobile equipment fit for transportation on road (with limited height of 4 m).

2.7.18.L

Compatibility of supercompactor with the compactor output product shall be verified and approved by the Owner.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 1/148

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES
VERSION DATE:	March 2025

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 2/148

This Page Intentionally Left Blank

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 3/148

CONTENTS

CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES.....	4
2.8.0 INTRODUCTION.....	4
2.8.1 REQUIREMENTS ON FUNCTIONS.....	8
2.8.2 SYSTEMS FUNCTIONAL REQUIREMENTS	35
2.8.3 SYSTEMS ASSOCIATION REQUIREMENTS.....	143

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 4/148

CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES

2.8.0 INTRODUCTION

2.8.0.1 SCOPE

2.8.0.1.A

This Chapter establishes the functional, and for some systems also performance and system requirements to be fulfilled by the Supplier* that apply to systems of the Nuclear Island*.

AA

Additional requirements related to the functions of the Containment System* are given in Chapter 2.9.

AB

Additional requirements related to the I&C are given in Chapter 2.10.

AC

Specific requirements related to PGP, BOP and Support Facilities* are given in Volume 4.

AD

Requirements for systems interfacing the Nuclear Island* and either the Power Generation Plant* or the Balance of Plant* are cross-referred to Volume 4.

2.8.0.2 STRUCTURE OF THE CHAPTER

2.8.0.2.A

The functional requirements are set for the Plant* design, regardless whether with or without passive Safety Systems*.

2.8.0.2.B

In Section 2.8.0, the general role of systems is outlined in terms of safety, as defined in Chapter 2.1, and availability performance as defined in Chapter 2.2. Then the operational performance requirements are addressed.

2.8.0.2.C

Section 2.8.1 outlines the main functions to be performed by the systems in the Design Basis Conditions* (DBC) and the Design Extension Conditions* (DEC).

CA

It also further develops classification of functions specified in Section 2.1.5.

2.8.0.2.D

In Section 2.8.2, the main systems are listed and system specific functional, performance and system requirements are given.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 5/148

DA

Using these requirements, the Supplier* shall propose an association of systems and shall establish complete functional, performance and system requirements for each system to ensure that the Plant* will meet the safety and performance targets.

DB

Both DBC and DEC shall be covered.

DC

This shall include definition of SSC functions for Decommissioning*.

2.8.0.2.E

In Section 2.8.3, requirements are given on the way to combine systems in order to fulfil functions described in all DBC and DEC and to reach the required reliability.

2.8.0.3 GENERAL OBJECTIVES

2.8.0.3.A

The Plant* systems shall be designed to fulfil the required Safety and non-Safety Functions* in order to meet:



2.8.0.3.B

The Supplier* shall perform and provide assessment studies to show that each system fulfils, as appropriate, deterministic safety requirements (e.g. Single-Failure Criterion*) and that, as part of the overall design, has the adequate reliability to meet the Plant* probabilistic safety and availability targets.

BA

The assessment shall be performed, namely:

- Chapter 2.17 specifies the methodology for the assessment that the safety objectives are met,
- Chapter 2.18 specifies the methodology for the assessment that the availability performances are met.

2.8.0.4 OTHER GENERAL OBJECTIVES

2.8.0.4.A

Provisions for the construction, Commissioning* and for testing, Inspection* and maintenance of systems and equipment shall be addressed in the design of all the Plant* systems as specified in Chapters 2.13 and 2.14.

2.8.0.5 OPERATIONAL PERFORMANCES

2.8.0.5.A

The Plant* systems shall be designed to fulfil the operational performance specified in the following Sections in order to meet the Plant* safety and availability objectives.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 6/148

AA

The overall Plant* performance requirements for the Plant* are given in Chapter 2.2.

2.8.0.5.1 PERFORMANCE IN NORMAL OPERATION

2.8.0.5.1.A

Under the Normal Operation*, all the Operational Modes* shall be controlled and safe.

2.8.0.5.1.B

The maintenance Cold Shutdown Mode* shall be a safe shutdown mode allowing personnel intervention.

2.8.0.5.1.C

Hot Shutdown Mode* shall be a controlled state of the Plant* in Normal Operation*.

CA

During this mode, capability to switch to the Cold Shutdown Modes* shall be provided.

2.8.0.5.1.D

In order to meet the overall availability objective, the Hot Shutdown Modes* shall be reached in a minimal time from reactor trip.

2.8.0.5.1.E

Similarly, the systems needed to reach and to remain the Cold Shutdown Modes* shall be designed to minimise the time to reach Cold Shutdown Modes* from the Hot Shutdown Modes*.

2.8.0.5.1.F

For maintenance and refuelling, safety of the operational and maintenance personnel shall be assured.

2.8.0.5.1.G

Systems shall ensure safe transfer from one Operational Mode* to another.

2.8.0.5.2 OPERATIONAL OBJECTIVES

2.8.0.5.2.A

Operational factors which have strong influence on availability shall be addressed and optimised:

- unplanned outage,
- duration of shutdowns for refuelling and maintenance,
- duration of start-up after shutdown for refuelling and outages,
- time required for power increase up to full power,
- operation cycle.

AA

The overall Plant* reliability and availability objectives are specified in Sections 2.2.7.1 and 2.2.7.2.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 7/148

2.8.0.5.2.B

The Plant* systems shall be designed with adequate cooling capability to comply with duration of cool down as specified in Section 2.2.2.1.1.

BA

Controlled cooling with high cooling rate shall be used to reach this objective.

2.8.0.5.2.C

The RCS, specifically the reactor coolant pumps and pressurizer, shall be designed to allow a two-phase cooling process from the Hot Shutdown Modes* to the Cold Shutdown Modes*.

CA

Two phases refer to conditions inside the pressurizer. In this cooling process, the pressurizer continues to be utilised for primary pressure control during main coolant system cooldown performed through the Steam Generators*.

2.8.0.5.2.D

Chemical control and purification of reactor coolant shall not be on the critical path of the refuelling.

2.8.0.5.2.E

Time for RPV opening and closing (including transport and cleaning of bolts and nuts, measurement, acquisition and recording of all relevant data) as well as need for manual operation, and thus radiation dose, shall be minimised.

EA

Automatic stud tensioner(s) shall be provided to meet this objective.

2.8.0.5.2.F

Handling systems shall be optimised to shorten the time for dismantling of control rod and drive assemblies and, where applicable, in-core instrumentation systems.

2.8.0.5.2.G

Fuel handling systems shall be capable of performing a complete Core* unloading for each refuelling outage.

2.8.0.5.2.H

Overall unloading and loading duration shall meet the target for a Refuelling-only Outage* including fuel reshuffling as given in Section 2.2.7.2.2.

HA

The overall loading duration shall take into account the difficulties associated with distorted Fuel Assemblies* (such as bowed Fuel Assemblies*).

2.8.0.5.2.I

The Plant* systems shall be designed with adequate heating and pressurisation capability to comply with duration of start-up as specified in Section 2.2.2.1.2.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 8/148

2.8.0.5.2.J

The time required for synchronisation and power increase up to full power shall be minimised to meet the requirements of Section 2.2.2.1.2.

2.8.0.5.2.K

The Plant* shall provide high degree of operational flexibility, in particular as specified in Sections 2.2.2.2 to 2.2.2.8.

2.8.0.5.2.L

Systems shall perform their functions to be consistent with the Load Following* performance required in Section 2.3.2.

2.8.0.5.3 INTERFACING REQUIREMENTS

2.8.0.5.3.A

The DBC 2 or any disturbance on the main turbine generator systems shall not result in the design limits of the fuel and reactor coolant boundary being exceeded. This is particularly the case for total loss of turbine load and turbine trip.

AA

For example, the following DBC 2 and disturbances to be addressed are:



2.8.0.5.3.B

The Plant* shall be designed so that there is no need to initiate a reactor trip due to a main turbine or generator trip, as required in Section 2.2.2.4.

2.8.0.5.3.C

The Supplier* shall ensure consistency between the design assumption made by the NI designer and the PGP and BOP designers to ensure that the safety, probabilistic and performance objectives will be met and are based on actual PGP and BOP design.

2.8.0.5.3.D

The same applies for the Nuclear Fuel* which is subject to a separate contract (Nuclear Fuel Contract*).

DA

The Supplier* shall be responsible for managing all interfacing requirements of the Plant* with the Nuclear Fuel*, particularly in aspects related with the Core*, ensuring that the Nuclear Fuel* comply with all Plant* requirements.

2.8.1 REQUIREMENTS ON FUNCTIONS

2.8.1.A

Requirements on the Fundamental Safety Functions* are given in accordance with the safety objectives described in Chapter 2.1.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 9/148

2.8.1.B

Then, requirements are specified for other functions with safety or non-safety functional aspects.

BA

Non-Safety Functions* contribute to fulfil the objectives in terms of operational performance, investment protection and achievement of the overall availability target.

BB

Specifically for PGP and BOP they are specified in the Volume 4.

2.8.1.1 MAIN SAFETY FUNCTIONS

2.8.1.1.A

The fundamental Safety Functions* provided by SSC of the Nuclear Island* (NI) shall be in accordance with Section 2.1.1.2.

AA

For confinement of radioactivity, only the first and the second Barriers* are addressed in this Chapter. Requirements related to the third Barrier* are specified in Chapter 2.9.

2.8.1.1.B

These functions shall be ensured in the Design Basis Conditions* (DBC) as well as in the Design Extension Conditions* (DEC) taking into account internal and external hazards.

BA

For Severe Accidents*, the Core* heat removal shall be understood as corium heat removal.

2.8.1.1.1 CORE REACTIVITY CONTROL

2.8.1.1.1 GENERAL REQUIREMENTS

2.8.1.1.1.A

Core* design and Fuel System* design shall assure that the reactor can be operated for the requested time period (Core* life or cycle), therefore each fuel loading shall provide adequate excess of reactivity which shall be adequately distributed, controlled and compensated for. Excess of reactivity shall allow operation of the Core* at requested power level up to the nominal power level and the design of the Plant* systems and Core* design shall assure that all relevant Core* parameters will meet initial boundary conditions used for safety evaluation.

AA

Excess of reactivity shall be achieved by the following measures:

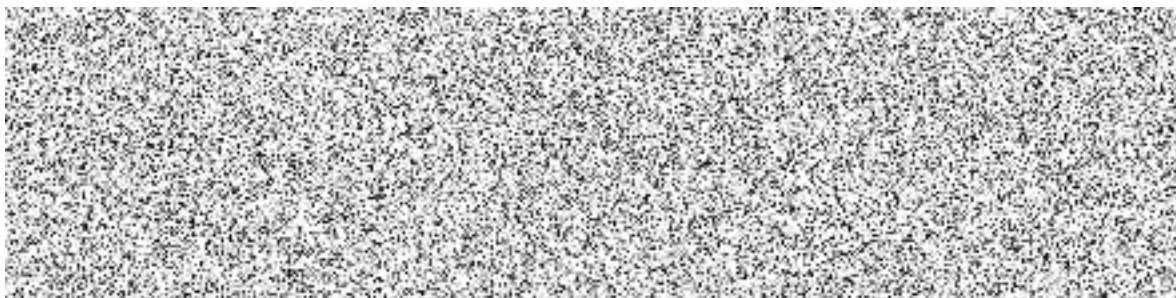


AB

Excess of reactivity shall be controlled and monitored by the following sub-functions:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 10/148



2.8.1.1.1.1.B

The reactivity control of the Core* shall be normally accomplished by the control rods, amount of boron dissolved in the coolant and other poisons. The concentration of boron is normally used to adjust long-term trends in Core* reactivity (e.g., due to fuel depletion, cooldowns).

BA

The Core* shall be designed with sufficient insertable negative reactivity by control rods alone (if necessary, in combination with change of the soluble boron concentration) to control Core* power during Normal Operation* conditions, including intended manoeuvres. See also requirements in the Section 2.2.3, e.g. Sections 2.2.3.7 and 2.2.3.8.

2.8.1.1.1.1.C

All sub-functions assuring the reactivity distribution, reactivity control and compensation specified in following Sections 2.8.1.1.1.2 to 2.8.1.1.1.6 shall satisfy the requirements of the Decree of the Nuclear Regulatory Authority of the Czech Republic (Safety Authority*) No. 329/2017 Coll., as amended.

2.8.1.1.1.1.D

Adherence to Core* reactivity control requirements provided under the Section 2.8.1.1.1 shall be also stipulated by the Nuclear Fuel Contract* and NFC Appendices and demonstrated by the deliveries under the Nuclear Fuel Contract*.

2.8.1.1.1.2 POWER DISTRIBUTION CONTROL

2.8.1.1.1.2.A

Nuclear Fuel* management and used measures and mode(s) of reactor control and Core* protection shall ensure that defined limits on maximum Core* linear power are not violated during all DBC.

AA

This function shall be ensured in accordance with the requirements on Fuel System* design limits given in Sections 2.1.7 and 2.2.4 and thermal margins given in Section 2.2.3.4.1, and relevant specific design criteria stipulated by the Nuclear Fuel Contract* and NFC Appendices.

2.8.1.1.1.2.B

The reactor Core* shall be designed to ensure that Fuel System* design limits will not be exceeded for any power oscillations, without Operator* actions, through inherent Core* characteristics or prevention by the reactor control and/or Protection System*. As an objective, the reactor Core* shall be designed to be free of power oscillations or be self-damping against power oscillations throughout Core* life.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 11/148

BA

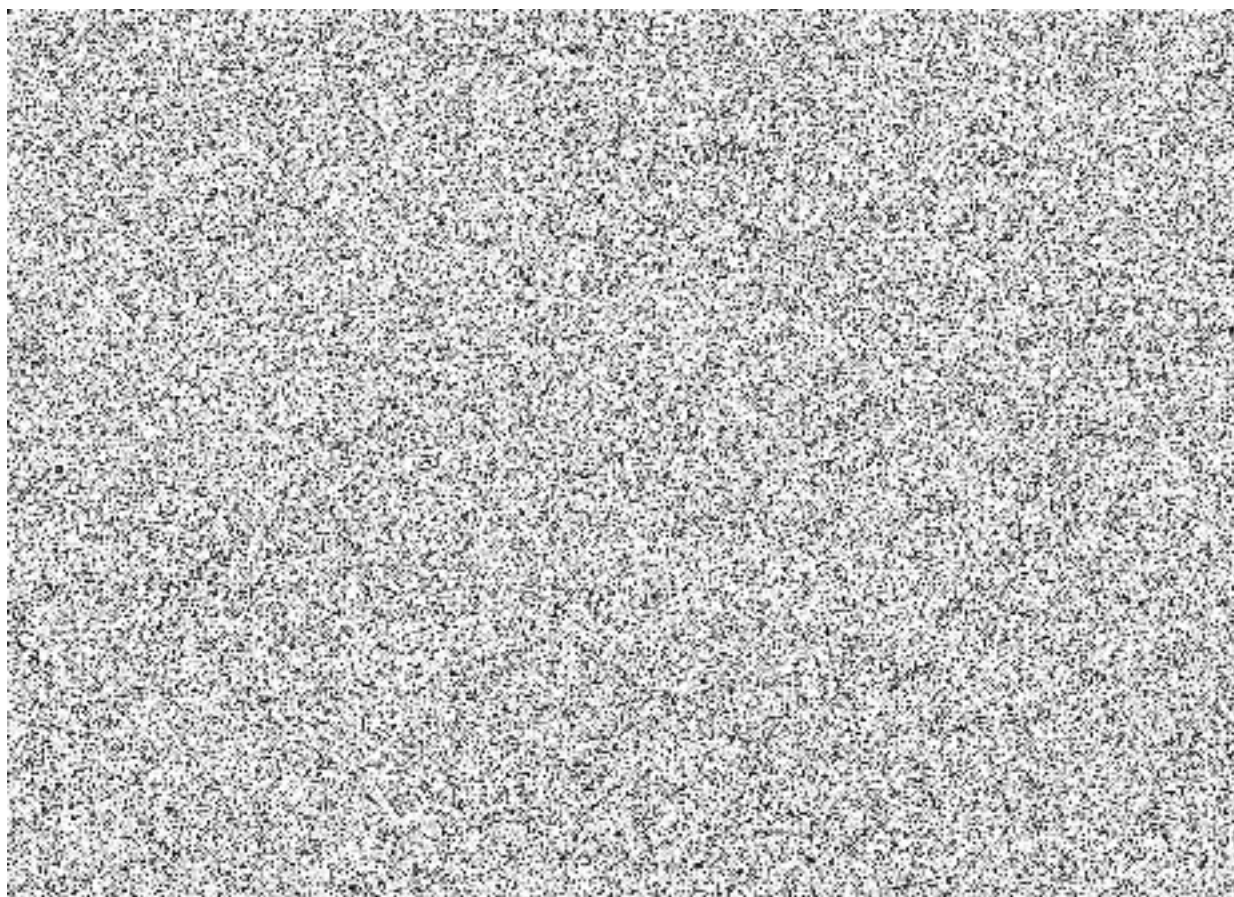
Other requirements regarding the Core* stability are presented in Section 2.8.1.1.1.4 here below.

2.8.1.1.1.2.C

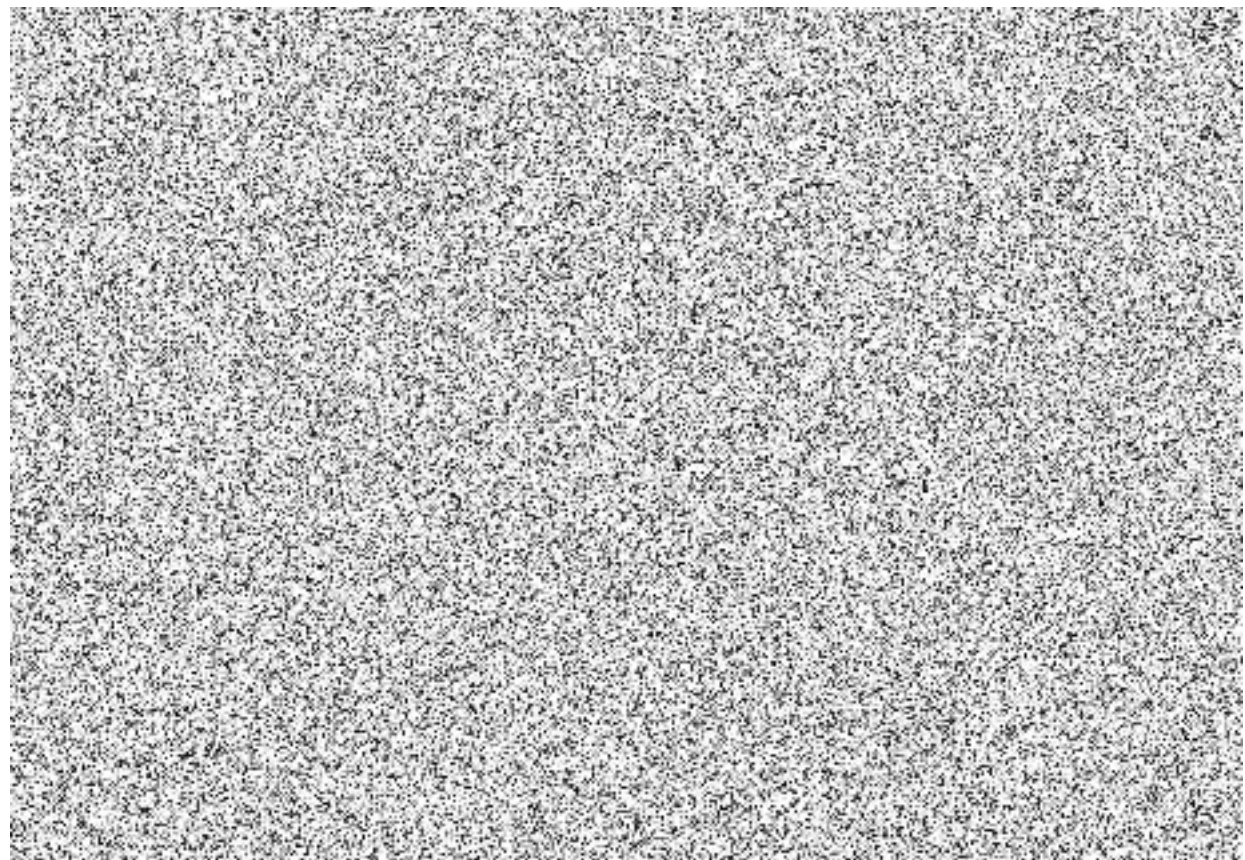
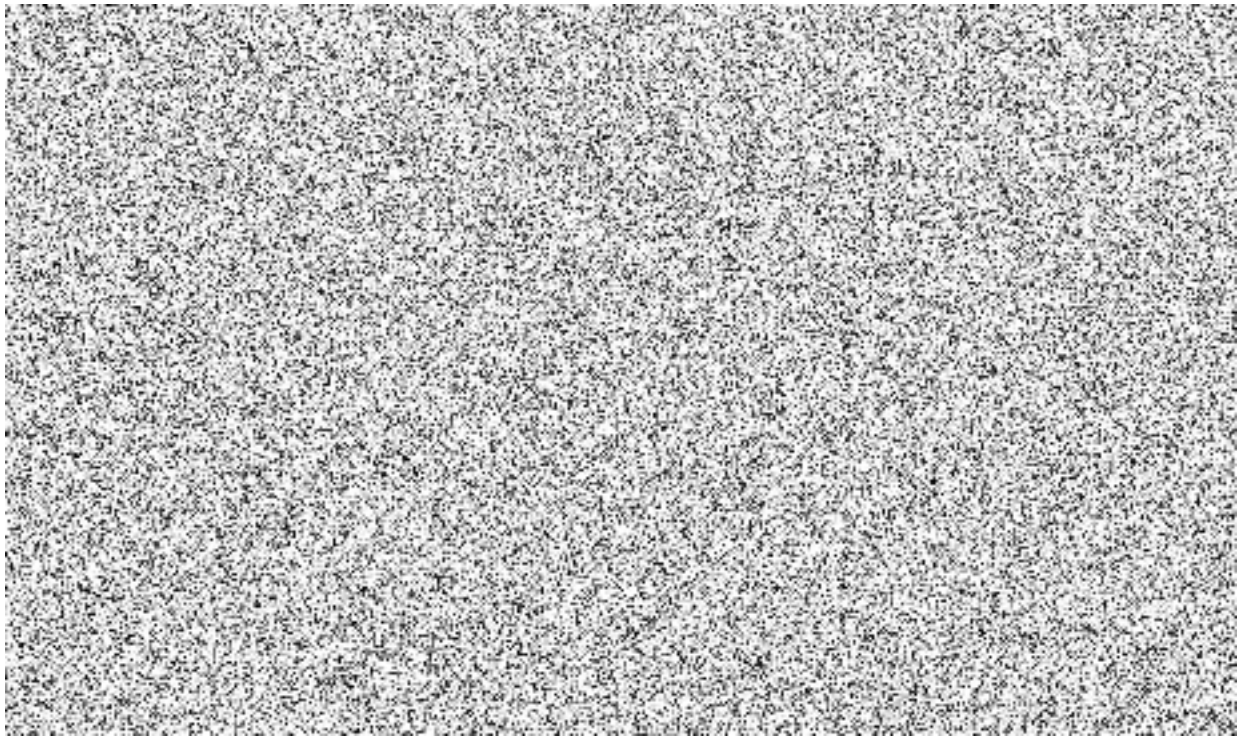
The reactor systems shall be designed to assure that Fuel Rods* operate well below specified Nuclear Fuel* design limits. Specifically, the design shall establish value of a minimum margin to the limit (e.g. 15 percent) which shall be provided on the limiting power parameters (as will be defined in the Plant* Technical Specifications*) used in evaluating the compliance with applicable regulatory fuel design requirements. This margin shall be demonstrated as existing over and above allowances included as part of the Plant* licensing basis (e.g., instrument error, correlation uncertainty, penalties, etc.).

CA

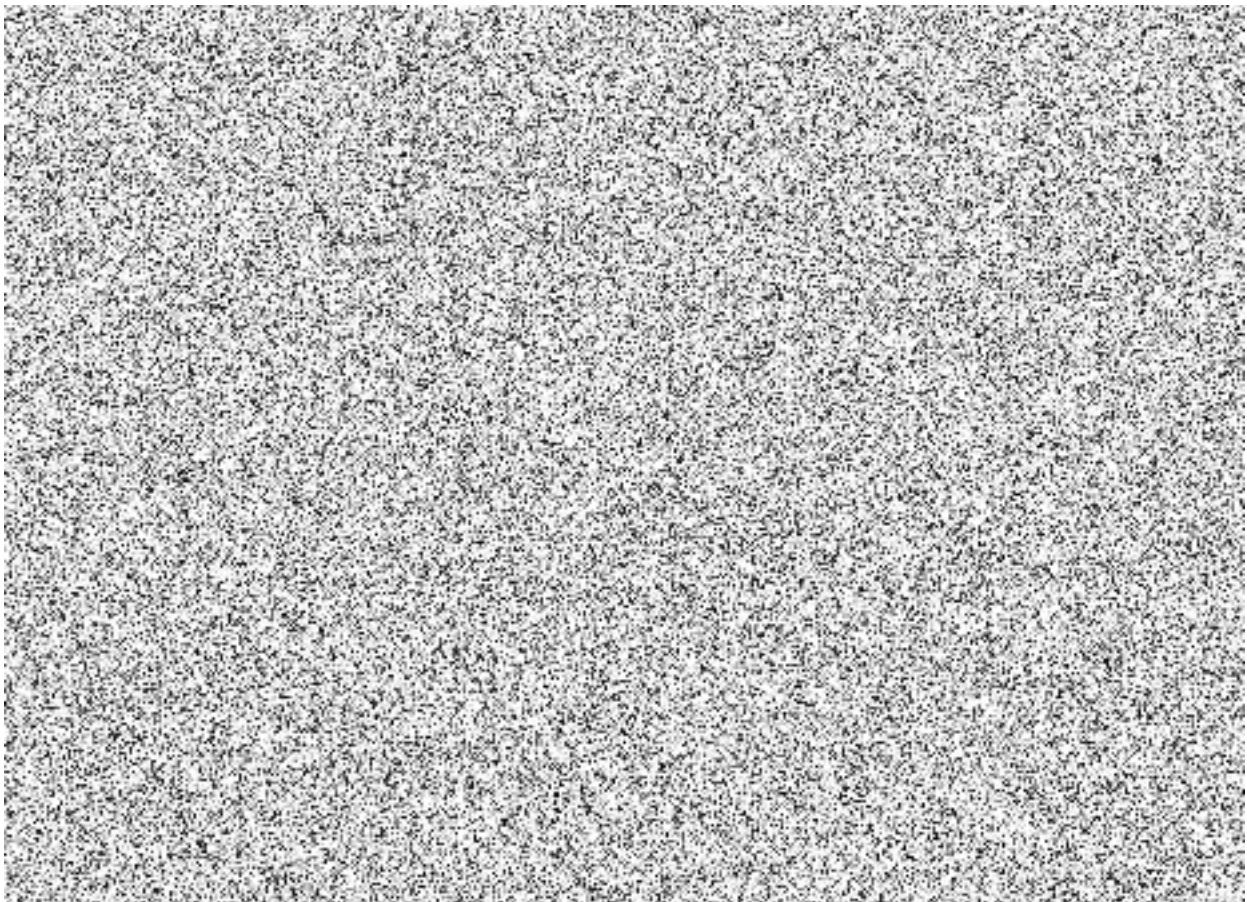
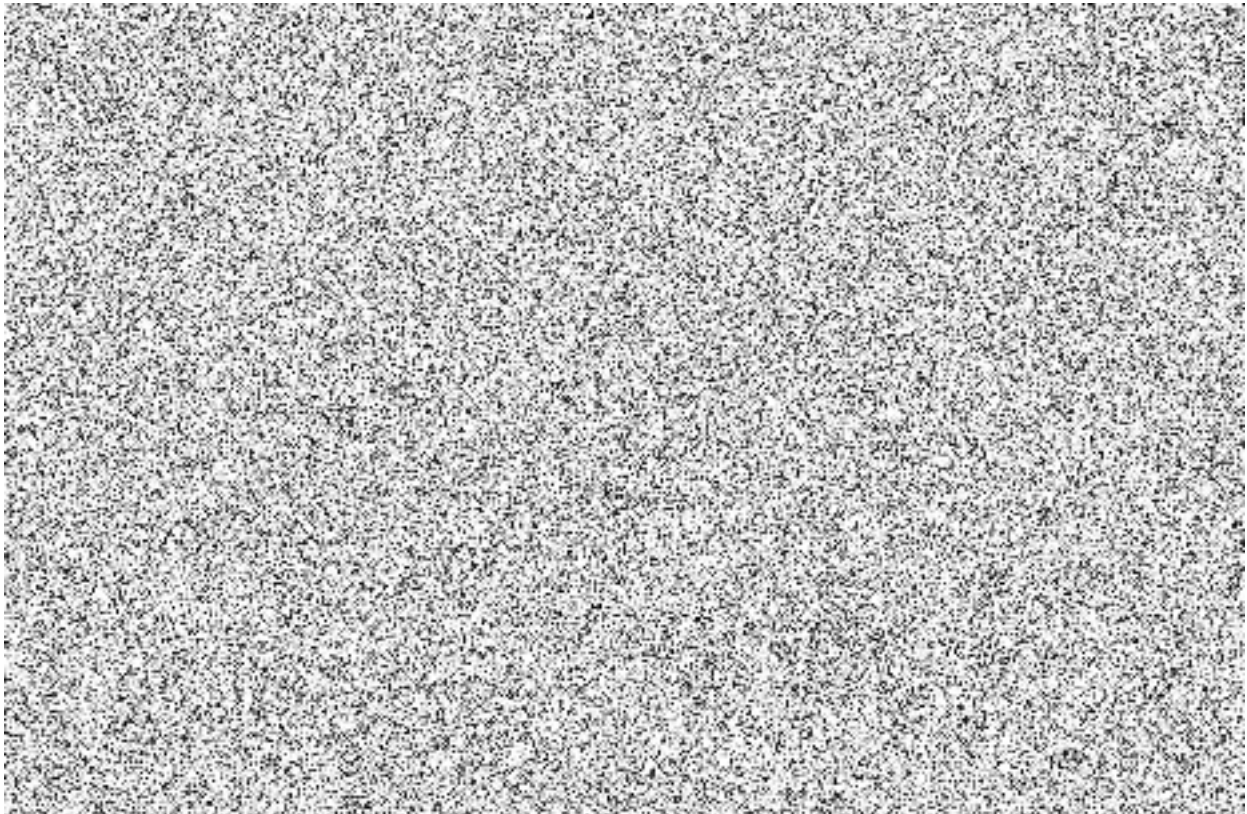
Such margin shall ensure that a sufficient, demonstrated margin relative to Nuclear Fuel* design limits exists in the Plant* and Fuel System* designs to accommodate unanticipated conditions encountered over the Plant* life and to avoid operating restrictions imposed by limiting conditions of operation. This margin is not intended to change the licensing basis of the Plant* or shall not represent a derating of the Plant* design.



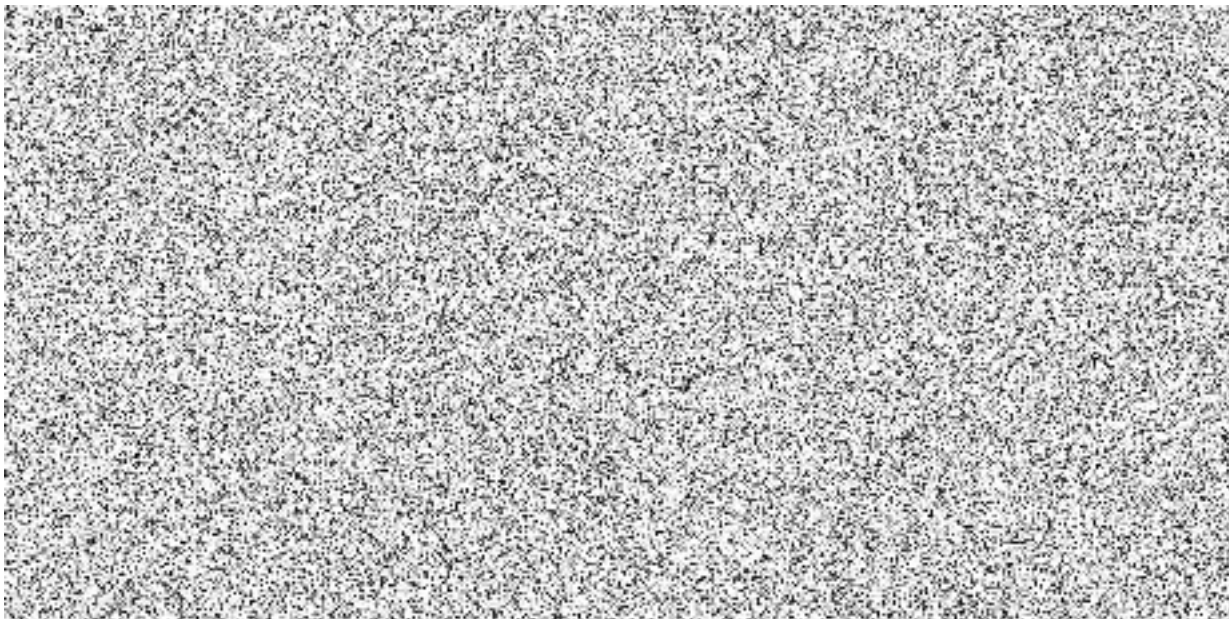
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 12/148



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 13/148



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 14/148



2.8.1.1.2 CORE HEAT REMOVAL

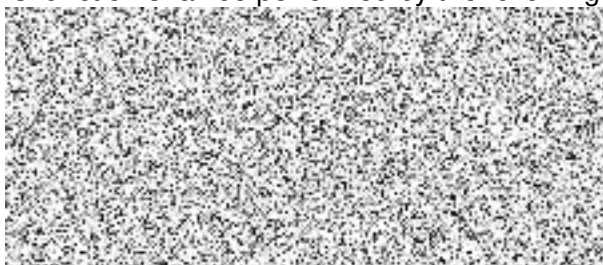
2.8.1.1.2.1 GENERAL REQUIREMENTS

2.8.1.1.2.1.A

The Core* heat removal function shall be ensured in all DBC and DEC.

AA

This function shall be performed by the following subfunctions:



2.8.1.1.2.1.B

Fuel parameters, and reactor coolant pressure and temperature shall be maintained within adequate design limits under all the Design Basis Conditions*.

BA

For the Complex Sequences*, in general the same criteria shall be met, however using DEC assessment rules as specified in Section 2.1.4.2.

2.8.1.1.2.1.C

The Core* heat removal function shall ensure that, in the Power Operation Modes* at full power, there will be adequate margin to Fuel System* design criteria as requested in Section 2.2.4.2.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 15/148

2.8.1.1.2.2 TEMPERATURE CONTROL OF CORE COOLANT

2.8.1.1.2.2.A

Temperature control of the Core* coolant shall be provided in all DBC and DEC.

2.8.1.1.2.2.B

In the Normal Operation* conditions, the average coolant temperature shall be controlled, and the hot legs temperature monitored, not to exceed operating conditions.

2.8.1.1.2.2.C

Core* coolant shall be maintained at a temperature compatible with personnel intervention during Core* loading and unloading operations, maintenance operations and any other technical operations performed when the reactor is shutdown.

2.8.1.1.2.2.D

Maximum Core* exit temperature shall be monitored in all DBC and DEC.

2.8.1.1.2.3 PRESSURE CONTROL OF CORE COOLANT

2.8.1.1.2.3.A

The pressure of Core* coolant shall be controlled in both DBC and DEC.

2.8.1.1.2.3.B

The pressure of Core* coolant shall be controlled so that it is maintained within the specified limits without actuation of the pressure relief devices for all Design Basis Conditions 1* and Design Basis Conditions 2*.

2.8.1.1.2.3.C

The RCS safety valves shall provide the ultimate means for overpressure protection to control the maximum overpressure as specified in Section 2.7.1.8.2.1.

2.8.1.1.2.3.D

The safety valves shall be spring-loaded or pilot-operated safety valves may be used, in case the pilot valves are spring loaded.

2.8.1.1.2.3.E

Core* coolant systems shall also be protected against overpressure in the Cold Shutdown Modes* with the system full of water.

EA

Overpressure protection may be provided either by RCS equipment or by the equipment of Residual Heat Removal System (RHRS) as specified in Section 2.8.2.4.1.

2.8.1.1.2.3.F

Under conditions where Core* coolant system is water-solid (i.e. without a gas space in the RCS, and without a vent path), let-down shall be provided to control the pressure of Core* coolant.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 16/148

2.8.1.1.2.3.G

The capability to lower the pressure of Core* coolant shall be provided as specified in Section 2.8.1.1.2.6.

2.8.1.1.2.4 FLOW CONTROL OF THE CORE COOLANT

2.8.1.1.2.4.A

Flow control of Core* coolant shall ensure Core* heat removal in all DBC and the Complex Sequences*.

AA

Forced circulation shall be used during the Normal Operation* conditions.

AB

The Core* bypass flowrate shall be as low as possible while meeting the temperature limits of equipment.

2.8.1.1.2.4.1 FLOW CONTROL AT THE SHORT TERM, IN CASE OF LOSS OF OFF-SITE POWER

2.8.1.1.2.4.1.A

During the Power Operation Modes*, in the event of Loss Of Off-site Power (LOOP), Core* cooling and Fuel Rod* integrity shall be maintained by RCP inertia and actuation of protective functions, as required.

2.8.1.1.2.4.2 FLOW CONTROL DURING SHUTDOWN SEQUENCE

2.8.1.1.2.4.2.A

When the reactor is shutdown, the Unit* shall have the capability to evacuate reactor heat by natural circulation of Core* coolant.

2.8.1.1.2.4.2.B

This capability shall be maintained until Cold Shutdown Mode* is reached.

2.8.1.1.2.5 INVENTORY CONTROL OF CORE COOLANT

2.8.1.1.2.5.A

Inventory control of Core* coolant shall be maintained in all DBC and DEC.

2.8.1.1.2.5.B

Control of Core* coolant inventory (normal make-up and let-down) shall be provided during the Normal Operation* conditions specifically during power changes, start-up and shutdowns.

2.8.1.1.2.5.C

Following a break in the reactor coolant pressure boundary (Loss of Coolant Accident [LOCA] or Steam Generator Tube Rupture [SGTR]), Core* coolant inventory shall be ensured by coolant injection at adequate pressure.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 17/148

CA

In addition for SGTR, leakage from RCS to secondary part of the Steam Generator* shall be quickly eliminated.

CB

Loss of coolant from the Safety Systems* and Safety Features for Design Extension Conditions* shall be prevented.

2.8.1.1.2.5.D



DA

The demonstration shall be made assuming all systems available and using the Best Estimate* analysis.

DB

Absence of Core* uncover is considered as a suitable (but conservative) decoupling criterion to assure no Fuel System Damage*.

2.8.1.1.2.5.E

A cooling water source for mitigation of the Severe Accidents* shall be provided.

2.8.1.1.2.6 DEPRESSURISATION CAPABILITY

2.8.1.1.2.6.A

Core* coolant systems shall be provided with a highly reliable depressurisation function.

2.8.1.1.2.6.B

The depressurisation function for Severe Accidents* shall be provided to reduce pressure to less than 2 MPa.

2.8.1.1.2.6.C

The depressurisation function shall be preferably fulfilled by a specific dedicated system.

CA

Requirements for such a depressurisation system are specified in Section 2.8.2.4.6.

2.8.1.1.2.6.D

The capability for removal of non-condensable gases from any part of the RCS where they could prevent natural circulation, or at least from the RPV head, shall be provided for DBC and DEC, if it is not demonstrated that volume of non-condensable gases is not sufficient to impair Safety Functions*.

2.8.1.1.2.7 PRESSURE BOUNDARY INTEGRITY

2.8.1.1.2.7.A

A high-integrity boundary shall be provided for the RCS in order to avoid LOCA.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 18/148

AA

The RCS design criteria are specified in Section 2.4.5.

AB

Requirements for the materials of the reactor coolant pressure boundary are specified in Section 2.6.4.1.3.

2.8.1.1.2.7.B

The design and material of the RCS shall be such that implementation of Break Preclusion*/Leak Before Break* concept is possible.

BA

Break Preclusion*/Leak Before Break* concept is specified in Section 2.4.5.10.

2.8.1.1.2.7.C

Overpressure protection of the RCS pressure boundary shall be provided for all DBC and DEC as specified in Section 2.8.1.1.2.3.

CA

For every RCS main component, specific requirements related to the function of pressure boundary integrity are specified in Section 2.7.1.

2.8.1.1.2.7.D

A fatigue monitoring system shall be provided as specified in Section 2.8.2.14.2.

2.8.1.1.2.7.E

A primary loop leakage monitoring system shall be provided as specified in Section 2.14.2.7.

2.8.1.1.2.7.F

Loose parts monitoring and vibration monitoring as specified in Section 2.14.2.7.

2.8.1.1.2.7.G

A monitoring system for leakages from primary to secondary loops shall be provided.

2.8.1.1.2.7.H

All components forming reactor coolant pressure boundary shall be clearly identified and described.

2.8.1.1.3 CONFINEMENT OF RADIOACTIVITY

2.8.1.1.3.A

Requirements for this function shall be consistent with the defence in depth concept specified in the Section 2.1.1.4.

AA

The Safety Functions* of systems acting as the first or second Barriers* are described in the subsequent Sections.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 19/148

AB

Functional requirements of the Containment System* as third or ultimate Barrier* are specified in the Chapter 2.9.

2.8.1.1.3.B

All systems which circulate contaminated fluids (mainly waste and releases) shall also provide confinement of radioactivity.

2.8.1.1.3.1 FIRST BARRIER



2.8.1.1.3.1.B

Maintenance of the integrity of the first Barrier* shall be provided by appropriate control of Core* coolant parameters to ensure operation within the Fuel System* design criteria as requested in Section 2.2.4.2.

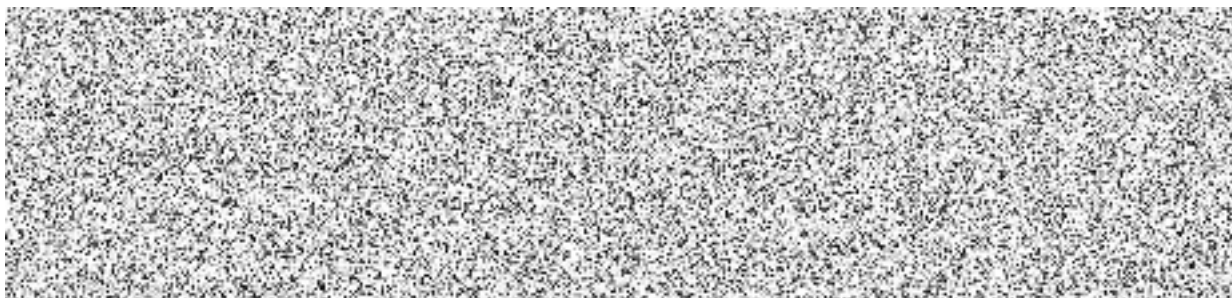
2.8.1.1.3.1.C

The integrity of the first Barrier* shall be continuously monitored by measurement of activity of Core* coolant and also specific radionuclides which indicate fuel leakage.

2.8.1.1.3.1.D

The integrity of the first Barrier* shall be periodically checked during the refuelling outages.

2.8.1.1.3.2 SECOND BARRIER



2.8.1.1.3.2.B

The maintenance of the integrity of the second Barrier* shall be provided by adequate control of Core* coolant parameters and by overpressure protection devices.

2.8.1.1.3.2.C

The isolation function of systems acting as the second Barrier* shall be provided by at least two devices in series which can be closed in the event of a pipe rupture downstream or upstream of these devices.

2.8.1.1.3.2.D

These isolation devices shall be located as close as possible to the RCS pipes.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 20/148

DA

The closure criteria and the method of device actuation shall depend on the specific design of each system.

DB

These isolation valves may be the same as the containment isolation valves for specific systems. In that case these valves shall be placed one inside and the other outside the containment, as close to the containment penetration as possible.

DC

If passive isolation devices are used it shall be demonstrated that such technology ensures that flow is possible only in RPV injection direction.

2.8.1.1.3.2.E

In order to avoid contaminated fluids circulating outside the third Barrier*, systems acting as the second Barrier* shall be located inside the Primary Containment*.

EA

Nevertheless, systems or part of systems may be located outside the Primary Containment*, if it is acceptable with regard to safety (negligible probability of the Secondary Containment Bypass* following leakage).

2.8.1.1.3.2.F

If the system is used, outside the Primary Containment* and at high pressure or temperature, automatic high-reliability means for isolation shall be provided.

2.8.1.1.3.2.G

Integrity of the second Barrier* shall be continuously monitored by measurement of the activity of the containment atmosphere and connected systems and by leakage monitoring.

2.8.1.1.3.2.H

Sufficient data shall be available to the Operator* to manually isolate systems making up the second Barrier*.

2.8.1.1.3.2.I

Sampling lines connected to the reactor heat removal and cooling systems shall be considered as part of the second Barrier* up to and including the isolation devices.

2.8.1.1.3.2.J

Where required by the reactor pump design, a reactor grade water injection to, and a controlled bleed-off from, the reactor coolant pump seals shall be provided to ensure high-pressure leaktightness.

2.8.1.1.3.3 RADIATION MONITORING

2.8.1.1.3.3.A

Compliance of the Plant* and/or Unit* radiological conditions during operation with the Technical Specifications* and with the regulations concerning radiation protection and radioactive discharges and discharges shall be verified.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 21/148

2.8.1.1.3.3.B

Radiation monitoring function shall include:

- monitoring of confinement Barriers*,
- monitoring of radioactive discharges and releases,
- forewarning of any risk of irradiation or contamination of personnel (non-safety function).

2.8.1.1.3.3.C

Radiation monitoring of gaseous discharges shall be possible at a single point (for each Unit*).

CA

In any case, every discharge point which could be potentially contaminated with radioactivity shall be monitored.

2.8.1.1.3.3.D

Radiation monitoring of liquid discharges shall be performed at a single point (for each Unit*).

DA

In any case, every discharge point which could be potentially contaminated with radioactivity shall be monitored.

2.8.1.1.3.3.E

Dose rate and contamination monitoring shall be provided for personnel protection.

2.8.1.1.3.3.F

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

2.8.1.2 OTHER FUNCTIONS

2.8.1.2.1 FUEL RELATED FUNCTIONS

2.8.1.2.1.A

Design of systems performing fuel related functions and related operational procedures (FSHS) shall be fully compatible with relevant deliverables provided in Nuclear Fuel Contract* and shall assure full compliance with limitations and conditions for fuel transport, handling, manipulation, Inspection*, storage, operation and other functions and requirements, as stipulated by Nuclear Fuel Contract*.

AA

The design of the Systems and Components* shall take into account the design conditions and loads as defined in Chapter 2.4.

AB

The materials of the SSC shall meet the requirements of the Chapter 2.6.

AC

The SSC shall be designed in accordance with the Chapter 2.7.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 22/148

AD

See also Section 2.1.7.7, 2.8.2.6 and 2.8.1.2.2.1.

2.8.1.2.1.B

The provisions for Nuclear Material* accounting incl. safeguard shall be provided as required by the Decree No. 374/2016 Coll., as amended.

BA

Equipment and space of IAEA and Euratom equipment to ensure safeguard of Nuclear Fuel* shall be provided.

BB

See Operation and Maintenance Document* Section 3.9.

2.8.1.2.1.1 FUEL RECEPTION, HANDLING AND STORAGE

2.8.1.2.1.1.A

Fuel storage and handling functions shall be ensured in accordance with the proposed fuel types as specified in Section 2.2.3.1 and fuel burn-up and the requirements for storage capacity specified in Section 2.2.5.1.

AA

When performing fuel storage and handling functions, reactivity control, heat removal and confinement of radioactivity of stored fuel shall be ensured.

AB

The design shall allow maintenance, Inspections* and testing of the components important to safety.

2.8.1.2.1.1.B

The Inspection* including appropriate means, if required, and storage of both new and spent fuel shall be provided.

BA

Fresh fuel receipt Inspection* is treated under Nuclear Fuel Contract*.

2.8.1.2.1.1.C

Permanent facilities for reception of new fuel shall be provided.

2.8.1.2.1.1.D

Facilities for loading of the spent fuel to spent fuel casks and loading of the spent fuel casks on the transport shall be provided.

2.8.1.2.1.1.E

Storage for other irradiated Core Components* shall be provided before shipment off site.

2.8.1.2.1.1.F

When performing fuel reception, Inspection*, handling and storage functions, radiological protection for personnel shall be ensured in all DBC.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 23/148

2.8.1.2.1.1.G

The design shall take into account required space for decontamination and for storage of decontamination equipment.

GA

Easy decontamination of the surface of all materials, structures and equipment shall be among other design objectives.

2.8.1.2.1.1.H

Provisions for loading and unloading the RPV and reactor internals shall be provided in accordance with the operational objectives given in Section 2.2.7.2.2.

2.8.1.2.1.2 REACTIVITY CONTROL IN FUEL STORAGE FACILITIES

2.8.1.2.1.2.A

Plant* storage facilities (FSHS) shall be designed in such way that is physically impossible to achieve criticality, for all anticipated fuel management programs.

2.8.1.2.1.2.B

Plant* safety analyses shall demonstrate that a critical arrangement cannot be formed in FSHS under any DBC and DEC.



2.8.1.2.1.2.E

Fuel storage racks and containers, containing neutron-absorbing additives in the composition of structural elements, shall be designed, manufactured and controlled in such a way as to avoid the impermissible reduction of the absorbing capacity in the event of mechanical, chemical or radiation impact of the DBC or DEC.

EA

The use of extractable heterogeneous neutron-absorbing materials in the structural components of fuel storage racks and containers shall not be allowed.

2.8.1.2.1.2.F

The absorbing capacity of the neutron absorbers shall not be reduced during the lifetime of the Plant*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 24/148

2.8.1.2.1.2.G

For fuel storage racks, in which the sub criticality is ensured through the use of neutron absorbers (e.g. borated steel), adequate surveillance and conditions monitoring shall be possible.

2.8.1.2.1.3 HOISTING AND HANDLING

2.8.1.2.1.3.A

The hoisting and handling equipment, including transfer and lifting devices, shall be designed to prevent damage to fuel or other Core Components* as a result of drop, impact, or Single Failure* specifically in case of loss of electrical power or the occurrence of an earthquake.

AA

The Diversity* and the Physical Separation* in the design of the dedicated protection and electrical power supplies shall be provided.

AB

Fall of the Fuel Assembly* shall be specifically prevented.

2.8.1.2.1.3.B

Transfer of fuel within the spent fuel pool, the RPV and the spent fuel casks and among them shall take place under water to permit direct visual observation while ensuring fuel cooling and radiological shielding of personnel.

2.8.1.2.1.3.C

All hoisting and handling equipment shall be designed in accordance with the Rules*.

2.8.1.2.1.3.D

In general, no heavy load, i.e. the objects with the mass greater than the mass of the Fuel Assembly*, in particular fuel casks, shall be handled above the spent fuel storage areas.

DA

In any case, fall of heavy objects on the Fuel Assembly* shall be prevented.

2.8.1.2.1.3.E

Where fuel transfer to the transport cask takes place via the bottom or the side of the fuel storage pool, provisions shall be made to preclude drainage of the pool and to preclude damage to stored fuel.

2.8.1.2.1.3.F

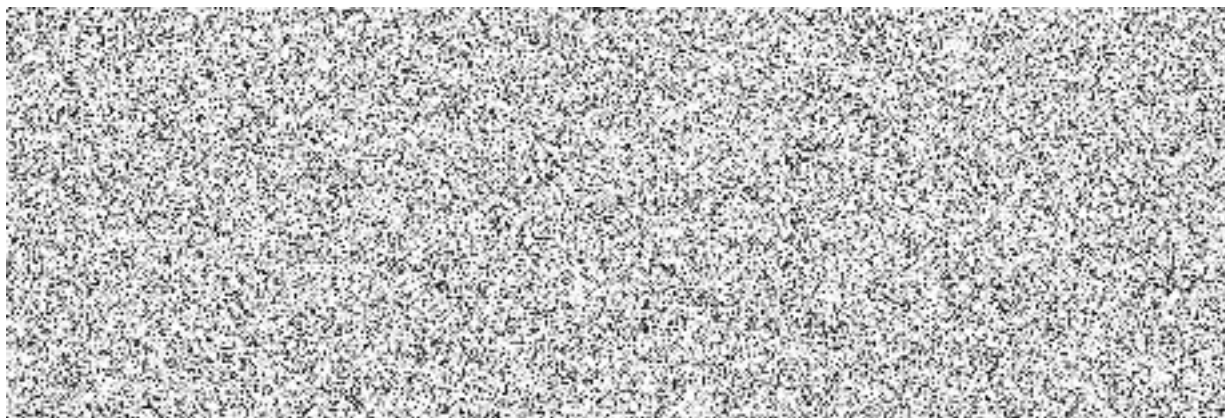
Fuel storage and handling areas shall be protected against Internal and External Hazards*.

2.8.1.2.1.4 CRITICALITY MARGIN IN THE CORE DURING FUEL HANDLING

2.8.1.2.1.4.A

The reactor, Core* and associated components/systems shall be designed such that sufficient subcriticality is maintained during reshuffling or refuelling. The Keff shall be ensured less than 0,95 before and after reshuffling or refuelling.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 25/148



AC

The Plant* systems, Core* design and Fuel System* design shall ensure that the following parameters can be measured and evaluated during the refuelling process assuring that the refuelling conditions are maintained within applicable limitations:

- Core* configuration,
- thermal neutron flux density,
- coolant temperature and level in all relevant volumes,
- boron concentration

with appropriate frequency of data evaluation.

2.8.1.2.1.5 NEW FUEL STORAGE FUNCTION

2.8.1.2.1.5.A

The new Fuel Assemblies* shall be stored in a dry on-site storage facility which is an integral part of the Nuclear Island* of the Unit* with the capacity for the number of new Fuel Assemblies* replaced during each refuelling outage for refuelling intervals of up to 24-months.

AA

The total dry storage capacity for fresh fuel within the Plant* shall be for at least one full Core* for each Unit* (i.e. total of at least 2 full Cores*).

AB

The design of the dry storage shall take into account the fuel types as specified in Section 2.2.3.1.

2.8.1.2.1.6 SPENT FUEL STORAGE FUNCTION

2.8.1.2.1.6.A

The spent fuel storage system (spent fuel pools) design and capacity at the Unit* shall allow for:

- storage of spent fuel for as long as it cannot be safely and economically transported out of the Unit* to interim storage or reprocessing facility,
- storage of adequate quantity of Core Components*,
- emergency/maintenance full Core* offload,
- emergency/maintenance offload of the spent fuel storage cask, if not provided otherwise,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 26/148

- storage of reload fresh fuel batch,
- storage of various irradiated equipment which is to be stored under water.

AA

The Supplier* shall provide reasonable number of storage casks for failed Fuel Rods* baskets/Fuel Assemblies* based on its operational experience.

2.8.1.2.1.6.B

The spent fuel pool(s) capacity shall be designed in accordance with the requirements specified in Section 2.2.5.1.

2.8.1.2.1.6.C

Heat removal shall be ensured as specified in Section 2.8.1.2.2.1 and 2.8.2.10.4.

2.8.1.2.1.6.D

The design of the spent fuel storage system shall take into account all the potential fuel parameters (in particular burn-up) as specified in Section 2.2.3.

2.8.1.2.2 EQUIPMENT COOLING (EXCEPT CORE)

2.8.1.2.2.1 STORED FUEL HEAT REMOVAL

2.8.1.2.2.1.A

The residual heat released by spent fuel stored in pools shall be removed in all DBC and DEC.

AA

For case of SBO, the heat removal shall be ensured by either boil-off or using the SBO AC power supplies in line with the autonomy requirements in Section 2.1.6.7.2.

2.8.1.2.2.1.B

Back-up to stored fuel heat removal systems shall be provided during refuelling shutdown mode.

2.8.1.2.2.1.C

Water inventory control in spent fuel pools shall be provided in all DBC and DEC.

2.8.1.2.2.1.D

For Normal Operation* including refuelling, a minimum water height shall be consistent with the maximum dose rate required in Section 2.11.2.5.2.3.

DA

Consideration shall also be given to the minimum water height needed to provide a scrubbing function for the iodine potentially leaking from defective Fuel Rods*.

2.8.1.2.2.2 COMPONENT COOLING FUNCTION

2.8.1.2.2.2.A

Component cooling function shall be provided for all Structures, Systems and Components* during DBC and DEC.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 27/148

AA

The component cooling function shall be sufficient to:

- in DBA and Complex Sequences* to reach and maintain Safe Shutdown State*,
- in Severe Accidents* to reach and maintain Severe Accident Safe State*.

2.8.1.2.2.2.B

The component cooling function shall be ensured assuming external air/water temperatures defined in Section 2.4.1.2.2 and the maximum heat load.

2.8.1.2.3 CHEMICAL CONTROL OF FLUIDS (EXCEPT BORON MANAGEMENT)

2.8.1.2.3.A

The Supplier* shall develop detailed chemistry of NI systems (See Operation and Maintenance Document*, Section 3.10).

2.8.1.2.3.B

Chemical monitoring of fluids (liquids and gases) shall be achieved by both continuous and batch sampling processes (See Section 2.8.2.5.2).

2.8.1.2.3.C

The chemistry of Core* coolant (concentration of dissolved gases, pH, etc.) shall be controlled in the Normal Operation* conditions (by means of chemical addition, noble gases removal, purification systems).

2.8.1.2.3.D

The Supplier* shall incorporate the capability to achieve the optimal high-temperature pH in the design as soon as possible after the Reactor Coolant System* heat-up.

2.8.1.2.3.E

The addition of hydrogen or another source of hydrogen to RCS shall be provided.

2.8.1.2.3.F

Avoidance of corrosion within RCS shall be achieved by chemistry control together with material selection.

2.8.1.2.3.G

During the Normal Operation* and especially for refuelling shutdown, the concentration of fission and corrosion products in RCS shall be controlled by providing means for demineralisation and filtration of reactor coolant.

2.8.1.2.3.H

During cooling to the Cold Shutdown Modes*, the required reactor coolant radiochemistry shall be achieved before venting and opening RCS.

2.8.1.2.3.I

The Supplier* shall make sure that purification during the Cold Shutdown Modes*, especially during fuel handling operations, will not impact the critical path.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 28/148

IA

It can be done by a higher level of purification flow rate during the Cold Shutdown Modes* than during Power Operation Modes*.

2.8.1.2.3.J

In addition, the following functions shall be performed:



2.8.1.2.3.K

Effective and quick removal of hydrogen during the Units* shut down shall be ensured.

2.8.1.2.4 RADWASTE PROCESSING FUNCTION

2.8.1.2.4.1 PURPOSE

2.8.1.2.4.1.A

The provision of the Radioactive Waste* processing function shall comprise the collection, sorting, processing, recycling and volume reduction or release of Radioactive Waste* produced by let-down, drainage, purge, venting, or leakage in the systems during Design Basis Conditions 1*.and Design Basis Conditions 2*.

AA

The radiation monitoring function for waste (liquids, gases and solids) is specified in Sections 2.8.2.11.5 and 2.8.1.2.4.8.

2.8.1.2.4.1.B

The waste processing function shall include the following subfunctions:

- liquid waste collection, treatment, and control release,
- gaseous waste collection, treatment and control release,
- reactor coolant waste treatment and boron recycling,
- solid waste collection, treatment, conditioning (incl. packaging), storage and transport.

2.8.1.2.4.2 GENERAL REQUIREMENTS

2.8.1.2.4.2.A

The main goals of the radwaste processing function shall be the safe collection, treatment and conditioning of waste, and their storage or release, while meeting the performance and safety requirements specified in Section 2.2.5 and Chapter 2.1.

AA

Recycle and reuse shall be used to the maximum practicable extent.

2.8.1.2.4.2.B

As a general policy, the operational discharges shall be reduced as low as reasonably achievable.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 29/148

BA

For that purpose the liquid and gaseous Radioactive Waste* shall be treated to meet the dose and discharge criteria set in Section 2.1.3.2.

2.8.1.2.4.2.C

The wet solid and dry solid waste shall be treated and conditioned such that its final form will comply with Limits and Conditions of Safe Operation at the Radioactive Waste Repository Dukovany (See Section 2.5.4).

2.8.1.2.4.2.D

The radwaste processing function shall include packaging of waste in accordance with Limits and Conditions of Safe Operation at the Radioactive Waste Repository Dukovany (See Section 2.5.4)..

2.8.1.2.4.2.E

Sufficient storages shall be provided to meet the requirements of Section 2.2.5.3.

2.8.1.2.4.2.F

The Supplier* shall create system for Radioactive Waste* production monitoring. This system shall allow the Owner*:

- to compare real production of Radioactive Waste* during operation with production expected in IDP and
- to identify any inconsistency of such production in order to update IDP.

2.8.1.2.4.2.G

NA

2.8.1.2.4.3 WASTE COLLECTION

2.8.1.2.4.3.A

The following functions shall be provided:

- selective collection and Segregation* of liquid and gaseous effluents produced by the RCS nuclear auxiliary systems, Reactor Cavity* and spent fuel pool, as well as of all potentially-contaminated liquids produced in the Plant* (such as floor drains, laundry and decontamination waste).
- routing of the collected waste to the storage and processing facilities.

AA

Generally, the Radioactive Waste* shall be segregated as soon as practical after generation to avoid mixing waste streams.

AB

Solid waste shall be collected and sorted at location of their generation.

2.8.1.2.4.3.B

The liquid waste processing system shall have sufficient margin for treatment of highly contaminated liquids from the auxiliary buildings, or Secondary Containment* in DBA and DEC or capability for re-injection of such highly contaminated liquids into the Primary Containment* shall be provided.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 30/148

2.8.1.2.4.4 REACTOR COOLANT WASTE TREATMENT AND BORON RECYCLING

2.8.1.2.4.4.A

The following functions shall be provided:



AA

Boron recycling shall be provided.

2.8.1.2.4.5 LIQUID WASTE TREATMENT

2.8.1.2.4.5.A

The following functions shall be provided:

- selective front-end storage of potentially contaminated liquid effluents according to the chemical composition and radioactivity of the various waste streams,
- provide alternate or redundant processing paths to assure Unit* availability and continuous waste receiving capability.
- analysis of the contents of each storage tank and subsequent adequate treatment so that the treated waste produced are:
- of acceptable quality for reuse within the Plant*, or
- can be discharged to the environment.
- corresponding transfers to the storage capacity of the discharge system for monitoring,
- transfer of wet solid waste produced (e.g. concentrates, spent ion-exchange resins, spent filters, etc.) to the solid waste treatment system.

AA

Separation of effluents from the equipment drains (low conductivity, high activity) from that of the adjacent floor drains (high conductivity, low activity) shall be provided.

2.8.1.2.4.6 LIQUID EFFLUENTS RELEASE

2.8.1.2.4.6.A

The following functions shall be provided:

- sufficient volume of control tanks enabling adjustment of release and allowing coordination of discharge with the Existing Nuclear Power Plant*,
- measurement of the volumes of liquid effluents to be released,
- determination or adjustment of release rates,
- automatic isolation of the discharge line if authorized limits is exceeded,
- sampling and analysis of liquid effluent.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 31/148

2.8.1.2.4.6.B

Liquids discharges shall comply with the dose and discharge criteria established in Section 2.1.3.2 and meets all requirements of the Rules*.

BA

The control and monitoring of LRWPS releases to the environment shall include the handling and disposal of “mixed-wastes” (contains both radioactive and (chemically) hazardous waste).

2.8.1.2.4.6.C

The discharges from control tanks shall be routed to the waste water collection tank specified in Section 4.6.13.

CA

The release rate from control tanks shall be controlled such that there is always sufficient mixing in the waste water collection tank.

2.8.1.2.4.7 GASEOUS WASTE TREATMENT AND RELEASE

2.8.1.2.4.7.A

The following functions shall be provided:

- receive and/or collection, treatment and monitoring of gaseous Radioactive Waste* such that a minimum required decay time is achieved before routing to a discharge point,
- avoidance of combustible gas mixtures due to hydrogen (e.g. by recombining),
- condition the gases to provide the moisture and temperature necessary for the desired performance of the charcoal adsorbers,
- measurement of volume and activity of effluent to be released,
- an automatic isolation mechanism of the gaseous discharge route if the authorised limits are exceeded.

2.8.1.2.4.7.B

Gaseous discharges shall comply with the Rules*.

BA

The cleanup equipment for the gaseous radioactive substances shall provide the necessary retention factor.

2.8.1.2.4.7.C

Filter systems shall be designed so that their efficiency can be tested, their performance and function can be regularly monitored over their service life, and filter cartridges can be replaced while maintaining the throughput of air.

2.8.1.2.4.8 SOLID WASTE TREATMENT AND CONDITIONING

2.8.1.2.4.8.A

The following functions shall be provided:

- collection, storage, and processing of solid waste including:
 - sorting (by activity, by type and used treatment technology),
 - volume reduction by use of compactor or super compactor,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 32/148

- immobilisation of compacted waste or ashes in packages,
- packaging of the waste,
- hold-up storage,
- volume reduction, solidification and drumming of wet solids waste,
- temporary or long-term storage for drums and otherwise packed waste on site before shipment to Radioactive Waste* repository as required in Section 2.2.5.3,
- monitoring of package volume activity,
- monitoring and removal of package surface contamination,
- assay of package inventories,
- package weight measurement, marking and data recording.

2.8.1.2.4.8.B

Provisions for Radioactive Waste* accounting with clear identification and marking of each package and/or container shall be provided as required by Decree No. 377/2016 Coll., as amended.

BA

The information to be specified and recorded of untreated waste subject to extended storage shall include (indicative list):

- waste type,
- amount, expressed e.g. in cubic metres, kilograms, linear metres or as number of items,
- special characteristics,
- location in the storage.

BB

The records of waste packages transferred into on-site storage shall include (indicative list):

- waste type,
- amount of waste,
- treatment and packing method,
- identification of waste package,
- date of packing,
- location in the storage,
- date of activity determination,
- activities of dominant nuclides,
- surface contamination, if any,
- other information required for wastes to be disposed of.

2.8.1.2.5 ELECTRICAL SUPPLY

2.8.1.2.5.A

Electrical equipment and I&C which perform the Safety Functions* shall be supplied with electrical power from both on-site and off-site power sources under DBC and DEC.

AA

Some equipment which performs non-safety classified functions shall be also supplied by on-site power for investment and personal protection.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 33/148

2.8.1.2.5.B

The safety loads (or safety auxiliaries) shall be supplied from on-site sources by safety electrical distribution systems.

BB

Requirements related to the autonomy in respect of power supply systems are given in Section 2.1.6.7.4.

2.8.1.2.5.C

Non-safety power distribution systems shall supply the following loads:

- plant auxiliaries required in the Normal Operation* conditions,
- permanent auxiliaries which have to remain permanently operational including when the reactor is shutdown.

2.8.1.2.6 HEATING, VENTILATION AND AIR CONDITIONING FUNCTIONS

2.8.1.2.6.A

Ambient conditions for the correct operation of systems which perform Safety Functions* and non-Safety Functions* and for personnel accessibility and work environment (e.g. temperature, pressure, relative humidity, cleanliness and radioactivity level) shall be maintained by:

- removal of heat generated by equipment and maintaining air temperatures and relative humidity within satisfactory limits (notably to prevent freezing) for equipment and personnel,
- renewing air,
- ventilating rooms containing inert gases, noxious and other hazardous gases without impairing the capability to control radioactive effluents,
- maintaining an appropriate direction of air flow between different areas, such that flow is not directed from a volume with a higher potential for airborne radioactivity, to one of lower potential,
- providing uniform air temperatures and humidity within each room,
- reducing the concentration of radioactive gases and aerosols, removing and inhibiting the spread of contamination by providing appropriate HVAC filtration systems,
- maintaining appropriate relative pressure within a building or volume to assure controlled leakage of potentially radioactive effluents,
- preventing migration of fire, smoke, hot gases, and fire suppressants into other Fire Areas*, to the extent that safe shutdown capabilities, including Operator* actions, could be adversely affected,
- venting escape routes,
- assuring that the HVAC design meets physical protection requirements such as bullet-resistance and being effective barrier against intrusion.

2.8.1.2.6.B

The habitability of the Main Control Room*, Emergency Control Room*, Technical Support Centre*, Operational Support Centre*, Emergency Preparedness Centre* and shelters shall be ensured as specified in Sections 2.1.7.4.6, 2.1.7.4.7 and 2.1.8.4.1.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 34/148

2.8.1.2.6.C

In order to limit radioactive releases, HVAC systems shall provide the following functions:

- ventilation of and maintaining air below atmospheric pressure in the Secondary Containment*,
- ventilation of containment atmosphere to improve efficiency of hydrogen management system (if mixing via natural circulation is not efficient enough),
- maintaining negative pressure versus environment and filtration of contaminated air before releasing it to external environment if necessary to meet the radiological targets.

CA

Additional requirements concerning Primary Containment* and Secondary Containment* HVAC are specified in Sections 2.9.4.1.4 and 2.9.4.2.1.

2.8.1.2.6.D

Radioactivity of releases shall be measured to monitor activity concentrations and provide a record of gaseous releases from the Plant* during both DBC and DEC.

2.8.1.3 CATEGORISATION OF FUNCTIONS

2.8.1.3.A

The functions of the NI shall be categorised according to the safety classification methodology described in Section 2.1.5.

2.8.1.3.B

The following Sections further develop categorisation of functions specified in Section 2.1.5.

BA

Additional requirements regarding the categorisation of the Safety Functions* of the Containment System* is presented in Section 2.9.4.3.

2.8.1.3.C

The Supplier* shall demonstrate that the safety category of the following functions is aligned with the safety classification methodology defined in Section 2.1.5.

- Functions credited during DBC conditions until achievement of the Controlled State*:
 - Core* reactivity control, until achievement of Controlled State*,
 - pressure control of the Core* coolant, until achievement of Controlled State*,
 - inventory control of the Core* coolant, until achievement of Controlled State*,
 - temperature monitoring of the core coolant,
 - maintenance in acceptable limits of integrity of the first Barrier*, until achievement of Controlled State*,
 - reactor coolant pressure boundary isolation, until achievement of Controlled State*,
 - maintenance of integrity of the second Barrier*, until achievement of Controlled State*,
 - MCR habitability, until achievement of Controlled State*;
 - and functions like electrical supply, cooling, heating, ventilating and air conditioning that are necessary for equipment to provide the functions specified above.
- Functions credited during DBC conditions to reach and maintain a Safe State*:
 - achievement of Core* subcriticality,
 - maintenance of the Core* subcriticality,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 35/148

- pressure control of the Core* coolant,
- inventory control of the Core* coolant,
- temperature control of the Core* coolant,
- maintaining integrity of the first Barrier* within acceptable limits,
- reactor coolant pressure boundary isolation,
- maintaining integrity of the second Barrier*,
- containment leaktightness and integrity (addressed in Chapter 2.9),
- MCR habitability;
- and functions like electrical supply, cooling, heating, ventilating and air conditioning that support equipment which provide the functions specified above.
- Functions credited during Complex Sequences* or Severe Accidents*:
 - achievement of Core* subcriticality in Complex Sequences*,
 - maintenance of Core* subcriticality in Complex Sequences*,
 - temperature control of the Core* coolant in Complex Sequences*,
 - pressure control of the Core* coolant in Complex Sequences*,
 - inventory control of the Core* coolant in Complex Sequences*,
 - maintaining integrity of the second Barrier* in Complex Sequences*,
 - maintenance of Core* or debris configuration subcriticality in Severe Accident*,
 - heat removal of the Core* debris in Severe Accident*,
 - containment leaktightness and integrity (addressed in Chapter 2.9),
 - MCR habitability;
 - and functions like electrical supply, cooling, heating, ventilating and air conditioning that support equipment which provide the functions specified above.

2.8.2 SYSTEMS FUNCTIONAL REQUIREMENTS

2.8.2.1 INTRODUCTION

2.8.2.1.A

The following Sections define the system functional requirements to be fulfilled by the Supplier* that apply to systems of the Plant*.

AA

For each system the general architecture is described. Then the functions of each system are outlined, based on the main functions specified in previous Section 2.8.1 together with requirements for system arrangements.

2.8.2.1.B

Complete functional, performance and system requirements shall be established by the Supplier* for all Plant* systems to ensure that the Plant* will meet the safety and performance targets.

BA

Each safety and non-safety function of the SSC and its Design Basis* shall be adequately documented with clear links between protection systems, actuation systems and system support features (that is also between mechanical, electrical, instrumentation and control equipment and civil structures). See Section 2.12.1.2.1.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 36/148

2.8.2.1.C

All the functions listed in Sections 2.8.1.1 and Sections 2.9.1.1 shall be fulfilled with sufficient reliability (see Section 2.8.3).

CA

The fulfilment of the Safety Functions* shall be assured with the proper degree of the Redundancy*.

CB

Furthermore, appropriate degree of Redundancy* shall be implemented also for fulfilment of certain non-safety functions in order to meet the Availability Factor* objective.

2.8.2.1.D

The functions and the characteristics of each SSC under all Plant States* shall be clearly specified.

2.8.2.1.E

The design of each system shall take into account their relationship with all the of systems needed to fulfil each function during all DBC and DEC with adequate reliability and consistent with the safety and availability objectives described in Chapters 2.1 and 2.2.

2.8.2.1.F

The systems proposed by the Supplier* shall meet the requirements and conditions set out in Volume 1, Volume 2, Volume 4 and Volume 5.

2.8.2.2 CORE AND FUEL SYSTEMS

Section 2.8.2.2 covers system requirements for Fuel System* (Fuel Rods*, Fuel Assemblies* and Core Components*), and Core* system.

2.8.2.2.1 SCOPE

This Section specifies functions, system requirements, mechanical design and performance requirements for Fuel System* and the Core* system.

All system requirement for Fuel System* and Core* system provided in Section 2.8.2.2 are stipulated in Nuclear Fuel Contract*. Fulfilment of requirements listed in Section 2.8.2.2 shall be demonstrated by deliveries under Nuclear Fuel Contract*.

2.8.2.2.2 FUNCTIONS

The Fuel System* and the Core* system shall:

- generate required Core* thermal power for given time period, according to Plant* operational Targets*,
- provide for efficient utilization of Nuclear Material* and minimization of spent fuel production,
- provide for Fundamental Safety Functions* together with other related Plant* systems under whole extent of DBC and DEC,
- constitute the first Barrier* against release of radioactive substances by retention of fuel and fission products within the Fuel Rod* and Core Components* cladding boundary,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 37/148

- provide for Core* reactivity control through a suitable combination of fuel enrichments, neutron sources, soluble neutron absorber and burnable neutron absorbers in order to meet the Core* power and cycle energy objectives,
- provide for adequate heat transfer from the Fuel System* components,
- provide for reliable operation, monitoring, surveillance, control, Inspection* and repairs.

2.8.2.2.3 SYSTEM REQUIREMENTS

2.8.2.2.3.A

Fuel System* shall:

- be of proven design with well-documented operational experience,
- be designed by qualified personnel with proven, verified and validated design tools and methods,
- compatible with all related Plant* systems, including but not limited to FSHS, RPV internals and Core* instrumentation,
- compatible with environmental conditions of all related Plant* systems, including but not limited to primary coolant,
- provide for Plant* Fundamental Safety Functions* together with related Plant* systems, including but not limited to Core*, FSHS, instrumentation and control systems, Reactor Protection System* and Safety Systems*,
- allow for flexible and effective Core* design and operation according to Plant* operational targets,
- allow for adequate Inspection* and repair of damaged / failed fuel,
- allow for easy fuel tracking and accounting,
- allow for safe spent fuel storage and handling.

2.8.2.2.3.B

Core* system shall:

- be designed by qualified personnel with proven, verified and validated design tools and methods,
- generate thermal power according to Plant* operational targets,
- provide for Plant* Fundamental Safety Functions* together with related Plant* systems, including but not limited to Fuel System*, instrumentation and control systems, Reactor Protection System* and Safety Systems*,
- provide for adequate power and power distribution monitoring and control,
- prevent from positive power reactivity effects at power,
- provide for adequate stability of the power distribution,
- provide for effective utilization of Nuclear Material*,
- provide for minimization of spent fuel production,
- allow for low RPV fast neutron fluence.

2.8.2.2.3.C

- Core* and Fuel System* safety requirements are in Section 2.1.7.1.
- Specific Core* and Fuel System* performance requirements are given in Sections 2.2.3 and 2.2.4.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 38/148

- General Rules* for design loads application are given in Sections 2.4.5 and 2.4.6.
- Fuel System* material requirements are given in Section 2.6.4.11
- Specific functional requirements for Fuel System* components are given in Section 2.7.10.

2.8.2.2.3.1 CORE AND FUEL PERFORMANCE

2.8.2.2.3.1.A

Purpose of this requirement is to summarize performance requirements of the Fuel System* and the Core*.

The Fuel System* design shall allow for reliable Core* and fuel operation according to Plant* operational targets.

AA

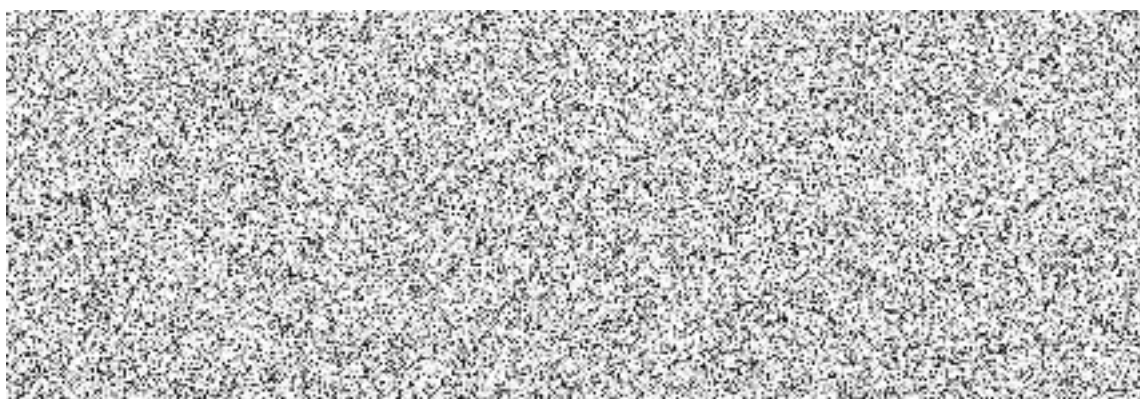
The Fuel System* design shall allow for reliable storage of the spent fuel in the Plant* spent fuel storage system before its transport to either reprocessing Plant* or spent fuel interim storage.

Note A1

- Core* and Fuel System* safety requirements are in Section 2.1.7.1
- Specific Fuel System* performance requirements are given in Section 2.2.4.
- General Rules* for design loads application are given in Sections 2.4.5 and 2.4.6.
- Specific Fuel System* material requirements are given in Section 2.6.4.
- Specific Fuel System* functional requirements for components are given in Section 2.7.10.
- Specific Fuel System* functional requirements for systems are given in Sections 2.8.1 and 2.8.2.

2.8.2.2.3.1.B

The Core* design shall allow for optimization the fuel cycle costs, Plant* operational and maintenance costs, optimum utilization of the nuclear materials, over the whole Plant* lifetime.



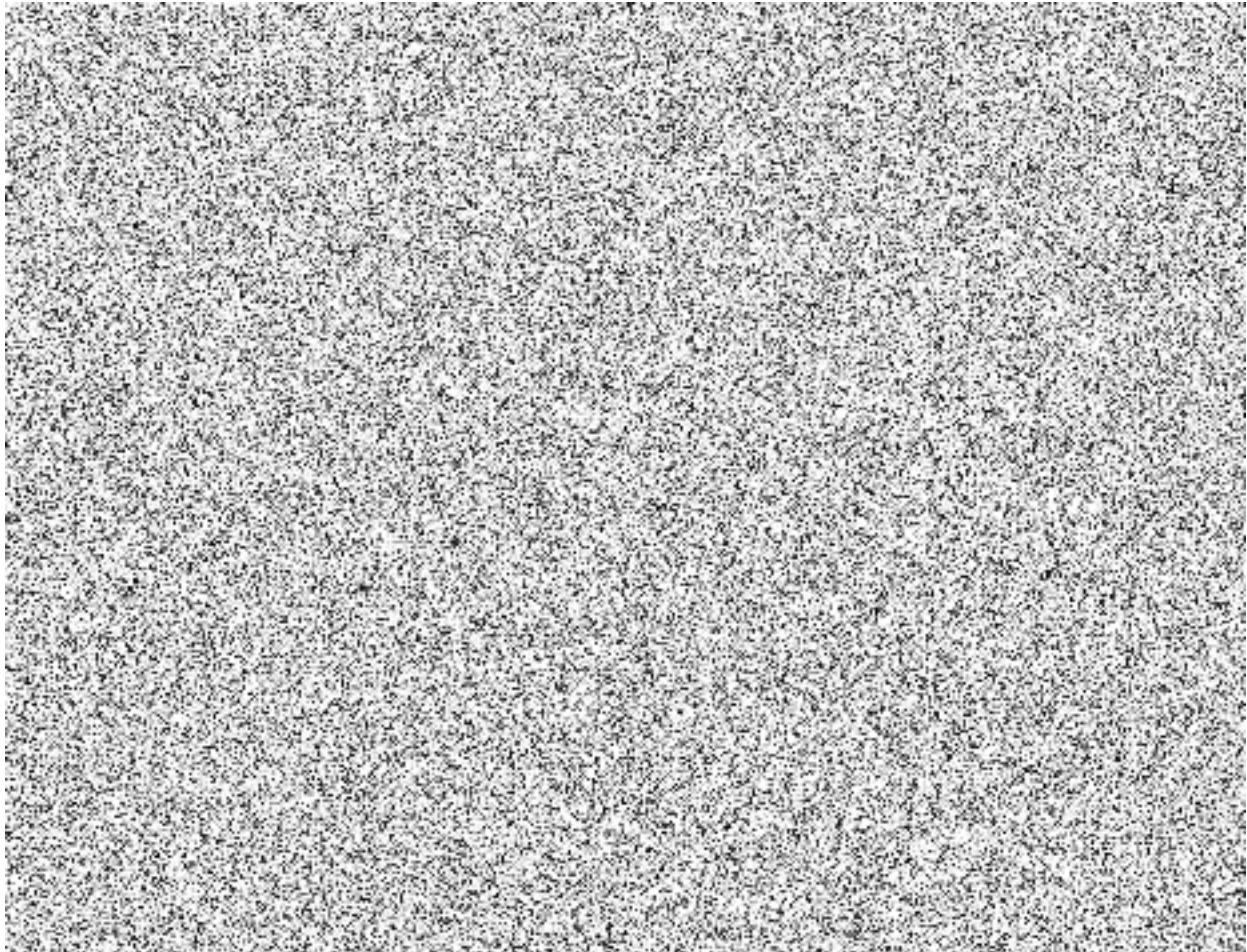
BB

- Specific Core* performance requirements are given in Section 2.2.3.
- Specific Core* functional requirements for systems are given in Sections 2.8.1 and 2.8.2.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 39/148



2.8.2.2.3.2 MECHANICAL DESIGN



2.8.2.2.3.2.C

Core* and Fuel System* mechanical design shall:

- meet their mechanical design requirements and criteria with adequate margins,
- take into consideration all mechanical damage mechanisms, design loads, loading modes and combined loads, as required in Sections 2.4.5 and 2.4.6,
- be performed by qualified personnel using proven, verified and validated design tools, methods and material properties, as required in Section 2.6.4.11,
- follow applicable industrial design codes.

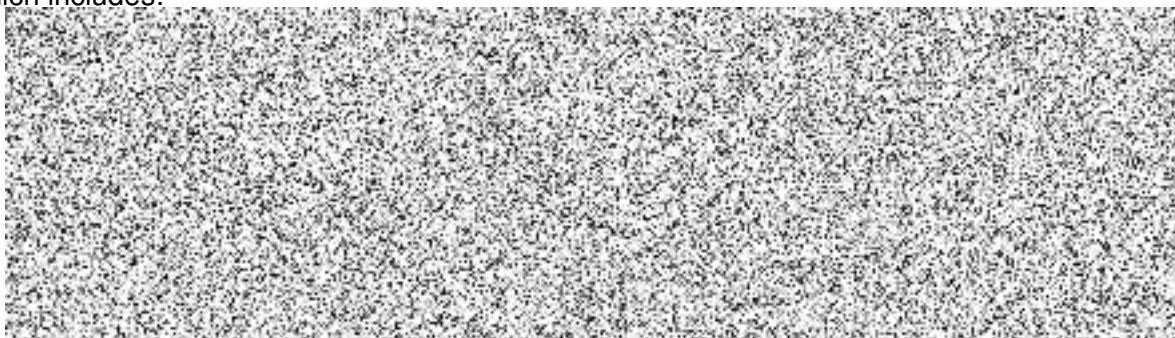
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 40/148

2.8.2.3 REACTOR COOLANT SYSTEMS

2.8.2.3.1 REACTOR COOLANT SYSTEM

2.8.2.3.1.1 SCOPE

This Section defines the functional requirements for the Reactor Coolant System* (RCS), which includes:



2.8.2.3.1.2 FUNCTIONS

2.8.2.3.1.2.A

The RCS shall be designed to perform the functions listed below:



2.8.2.3.1.2.1 CORE COOLING AND HEAT REMOVAL

2.8.2.3.1.2.1.A

The RCS shall, by forced circulation, transfer the heat generated by the Core* to the secondary circuit via the Steam Generators* in order to ensure that the Fuel Rods* are kept within the specified temperature range.

2.8.2.3.1.2.1.B

The RCS shall, by means of the Reactor Coolant Pumps (RCPs), provide forced circulation of reactor coolant for all Normal Operation* conditions ranging from cold shutdown to full power.

2.8.2.3.1.2.1.C

The RCS shall provide natural circulation of reactor coolant sufficient to achieve transfer of decay heat from the Core* to the Steam Generators* when the reactor is shutdown (RCS full, RCPs off).

2.8.2.3.1.2.1.D

The potential effect that crud may have on the Core* flow distribution and the potential effect of increased rod surface roughness on this shall be assessed.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 41/148

2.8.2.3.1.2.1.E

The Reactor Coolant System* shall be designed for heat-up using the RCPs.

2.8.2.3.1.2.2 PRESSURE CONTROL OF CORE COOLANT

2.8.2.3.1.2.2.A

The pressurizer spray and heaters shall be designed to absorb changes in reactor coolant inventory and to limit pressure transients due to variations in coolant loop temperature under all DBC 1-2.

2.8.2.3.1.2.2.B

The design of surge line shall be designed to minimise potential for stratification.

BA

The routing of the surge line shall be provided with a continuous slope and without low points to avoid water plugs.

BB

Nevertheless, the design of the surge line shall take into account potential occurrence of thermal stratification.

2.8.2.3.1.2.2.C

Stratification problems shall be prevented also in others RCS lines like the following:

CA

The accumulation of hydrogen in the upper part of the pressuriser system lines shall be prevented.

CB

The spray lines shall be designed to prevent or minimise thermal stratification with very little spray water flow on DBC 1.

2.8.2.3.1.2.2.D

Temperature monitoring system shall be provided to check the magnitude of thermal stratification in the pressurizer system lines.

2.8.2.3.1.2.2.E

For all DBC 1-2, control of the reactor coolant pressure shall be achieved by means of a water-steam interface which is maintained inside the pressurizer.

EA

The pressure of the pressurizer shall be maintained above the saturation pressure of the coolant in the hot legs.

EB

Coolant level in pressurizer shall be maintained in design limits.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 42/148

2.8.2.3.1.2.2.F

For the Design Basis Conditions 3* and some Design Basis Conditions 4* without significant loss of coolant, control of the reactor coolant pressure shall also be achieved by means of a water-steam interface which is maintained inside the pressurizer.

2.8.2.3.1.2.3 PRESSURE RELIEF DEVICES

2.8.2.3.1.2.3.A

The pressurizer shall be equipped with power operated relief valves which can be isolated with high reliability.

AA

Alternatively, the pressurizer (volume and spray capacity) may be sized in such a way to avoid need for automatically actuated power operated relief valves. In such a case, a dedicated safety depressurisation capability shall be provided.

AB

Depressurisation and feed-and-bleed capability shall be considered either in the design of these pressurizer power operated relief valves, or in the design of any other depressurisation system.

2.8.2.3.1.2.3.B

The safety relief valves shall be provided for RCS overpressure protection.

BA

The safety relief valves shall provide high reliability of reclosing in order to prevent depressurisation of RCS.

2.8.2.3.1.2.3.C

Pressurizer safety relief and power operated relief valves shall be provided with a leak detection system with clear indication to the Operators* when leakage across each valve has been exceeded.

2.8.2.3.1.2.3.D

A special care shall be paid to the inadvertent RCS depressurisation which shall be demonstrated by reliability analysis to have an expected frequency of less than $2 \cdot 10^{-3}$ events per reactor year.

2.8.2.3.1.2.4 CORE REACTIVITY CONTROL

2.8.2.3.1.2.4.A

The reactor coolant shall perform adequate neutron moderation and reflection, and shall function as a solvent for the concentrated boric acid solution which is used for reactivity control.

AA

The neutron flux on the RPV shall be limited to ensure its design life.

AB

Neutron reflector shall be implemented when necessary.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 43/148

2.8.2.3.1.2.5 PRESSURE BOUNDARY INTEGRITY

2.8.2.3.1.2.5.A

The isolation function of the RCS shall be provided by at least 2 valves in series which close manually or automatically in the event of a pipe rupture downstream of these valves (except for the RHRS suction line when the RHRS is located inside the Primary Containment*).

2.8.2.3.1.2.5.B

Provisions shall be made to prevent problems with dead legs, undetected leaks during the Normal Operation* conditions, and the circulation of cold water.

2.8.2.3.1.2.5.C

The RCS design shall accommodate the detection of leakage from the reactor coolant systems so that pressure boundary leakage can be detected with adequate confidence to support the Leak Before Break*.

2.8.2.3.1.3 SYSTEM REQUIREMENTS

2.8.2.3.1.3.1 STEADY STATE PART LOAD DIAGRAM

2.8.2.3.1.3.1.A

The Supplier* shall prove suitability of Power Operation Modes* in the upper power range (from about 50 % to 100 % load) to minimize make-up and blowdown of RCS, to minimise decrease of RCS lifetime and to ensure optimal behaviour of the Unit* during Load Following*.

AA

This shall be achieved by monitoring and control of main Unit* parameters.

2.8.2.3.1.3.2 SYSTEM ARRANGEMENT AND MID-LOOP OPERATION

RCS and connected systems shall be designed and laid-out to satisfy the following requirements.

2.8.2.3.1.3.2.A

No piping shall be connected to RPV below the Top Of Active Fuel level.

2.8.2.3.1.3.2.B

The RCS shall be arranged in such a way that only one free surface, in pressurizer, normally exists in the system.

2.8.2.3.1.3.2.C

NA

2.8.2.3.1.3.2.D

In the case of 2 or 3 Steam Generators*, the RCS arrangement shall enable the maximum expected reactor decay heat to be transferred adequately from the reactor by only one Steam Generator* and by natural circulation, without exceeding maximum design temperatures for Normal Operation* in the primary loop.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 44/148

2.8.2.3.1.3.2.E

The RCS circuits shall be designed and laid-out so that it is physically impossible to drain water out of the RCS below the mid-loop low level.

EA

RCS valves, except CVCS letdown valves and RHRS suction valves, shall be arranged above the primary coolant hot and cold legs to eliminate potential drawbacks like dead legs (stratification) and water hammer.

EB

Moreover, the need of mid-loop operation during Unit* operation and for Unit* maintenance (e.g. for drainage of the Steam Generators* or maintenance of the RCP seals) shall be minimised.

EC

The Supplier* shall justify the design features and administrative procedures to prevent loss of cooling during mid-loop operation.

ED

It shall be demonstrated that functionality of residual heat removal systems is not impaired.

EE

The RPV main flanges shall have a double sealing feature allowing leakage detection.

2.8.2.3.1.3.3 SIZING OF MAIN COMPONENTS

2.8.2.3.1.3.3.A

Large main RCS components shall be designed with increased design margins allowing more tolerant operation, according to the policy defined in Section 2.1.6.7

2.8.2.3.1.3.3.B

Nevertheless, the Supplier* shall demonstrate that the RCS components still ensure all required functions in Accident Conditions*.

2.8.2.3.2 MAIN INTERFACES BETWEEN NI (NSSS) AND PGP (EXCEPT FOR I&C)

2.8.2.3.2.1 SCOPE

2.8.2.3.2.1.A

This Section describes the following main interfaces between NI and PGP:



AA

These systems are described further in this Section and also requirements for their equipment are included.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 45/148

2.8.2.3.2.1.1 MAIN STEAM PIPEWORK

2.8.2.3.2.1.1.A

The main steam pipework included in the scope of the Nuclear Steam Supply System (NSSS) and therefore in the NI shall be as follows:



2.8.2.3.2.1.1.B

The Steam Generator* outlet parameters such as pressure, temperature, moisture, flowrate for full load to part load operation modes including flow limitations shall be provided to PGP as functional interfaces.

2.8.2.3.2.1.2 FEEDWATER PIPEWORK

2.8.2.3.2.1.2.A

The feedwater pipework included in the scope of the NSSS and therefore in the NI shall be as follows:



2.8.2.3.2.1.2.B

NSSS requirements such as pressure, temperature, flowrate for full load to part load operation modes shall be provided to PGP as functional interfaces.

2.8.2.3.2.1.2.C

PGP shall provide to NSSS a description of abnormal conditions of the feedwater systems.

2.8.2.3.2.1.3 STEAM GENERATOR BLOWDOWN SYSTEM

2.8.2.3.2.1.3.A

The Steam Generator* Blowdown System included in the scope of the Steam Generator* System, and therefore in the NI, shall be as follows:

- From Steam Generator* blowdown nozzles through the downstream of the blowdown isolation valves and up to interface between the relevant NI and PGP building, including safety supports and restraints against pipe break (if applicable) and interface with the liquid RWPS.

2.8.2.3.2.2 SYSTEM AND EQUIPMENT REQUIREMENTS

2.8.2.3.2.2.A

The Supplier* shall be responsible for managing the designs of the NI, PGP and BOP systems to ensure they are compatible.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 46/148

AA

The NI designer shall provide the PGP and BOP designers the required specifications and requirements, in particular regarding safety.

2.8.2.3.2.2.B

The variation of pressure between any two Steam Generator* outlet nozzles shall be limited as follows:



2.8.2.3.2.2.C

Each main steam line shall be provided with safety and relief valves and MSIV.

2.8.2.3.2.2.1 MAIN STEAM ISOLATION VALVES (MSIV)

2.8.2.3.2.2.1.A

MSIVs and associated supporting devices shall be designed and qualified to accommodate a large steam-line break.

AA

Independent and redundant means of closing the MSIV upon initiation of a main steam isolation signal shall be provided.

AB

MSIV closure requirements and leak rate for steam line break (forward and reverse flow conditions) shall be determined by the Supplier*.

AC

The actuators of MSIVs shall have a closing circuit separately.

AD

The actuator of MSIV shall have pneumatic/hydraulic source of energy.

AE

Closure capability to meet the required stroke time under simulated steam pipe break (forward and reverse flow conditions) must be demonstrated by prototype testing.

AF

The valve shall not be damaged by the closure; close damping shall be provided to reduce dynamic loads in the pipe and the Steam Generator* internals in case of a pipe rupture, if required.

AG

Testing capability shall be provided for stroke testing either at power or shutdown modes.

AH

The Supplier* shall justify the reliability of closure when not tested at power operation.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 47/148

2.8.2.3.2.2.1.B

Each MSIV shall have a bypass line designed for warming up the main steam lines by condensing steam and for pressure equalisation.

BA

The line shall have an isolation and control valve with flow control and pressure reduction capabilities.

BC

The isolation valve shall meet all isolation criteria imposed on the MSIV.

2.8.2.3.2.2.1.C

The valve shall be of proven design which was proven by experience during valve operability test to perform reliably.

CA

Inadvertent closure shall be prevented.

CB

Valve design shall assure ease of maintenance and repair (e.g., replacement of valve packing, grinding of valve seat, replacement of actuator).

2.8.2.3.2.2.1.D

Valve design features shall include back-seating of the stem, if feasible, when the valve is in the full-open position.

DA

The pressure loss shall be less than 25 kPa.

2.8.2.3.2.2.1.E

The valve shall be designed as fail-closed.

2.8.2.3.2.2.1.F

The valve shall be designed to perform at minimum of 1,000 full open/full fast close cycles and 1,000 partial close/full open cycles.

2.8.2.3.2.2.1.G

The valve shall have remote control of position.

2.8.2.3.2.2.1.H

Pipe restrainers shall be provided on the main steam lines downstream of the MSIVs to eliminate dynamic effects of the steam line breaks on the MSIVs unless the effects can be eliminated by design of break exclusion based on Standard Review Plan (SRP) 3.6.2 BTP 3-4.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 48/148

2.8.2.3.2.2.2 SAFETY AND RELIEF VALVES

2.8.2.3.2.2.2.A



AA

The safety valves shall be designed to function at the Accident Conditions*.

AB

They shall be of a design proven to consistently open fully, at a pressure within acceptable limits around the set pressure, during operability tests.

AC

The Supplier* shall specify acceptable limits, based on transient analyses and control system designs.

AD

Main steam safety valves shall be qualified for operation with steam conditions.

2.8.2.3.2.2.2.B

The safety valves and Main Steam Atmospheric Dump Valves (MSADVs) shall be located on the main steam lines outside containment upstream of the main steam isolation valve.

BA

These valves shall be vented to the atmosphere.

2.8.2.3.2.2.2.C

The safety valves shall be spring-loaded or pilot-operated safety valves could be used, in case the pilot valve are spring loaded.

2.8.2.3.2.2.2.D

Loop seals shall not be utilized in safety valve inlet piping unless the valve has demonstrated, under actual test conditions and with loop seals initially filled with water, the capability to meet functional requirements (e.g., transient flow rate) without damaging itself or the downstream discharge piping.

2.8.2.3.2.2.2.E

The opening action of the valve shall be of a design proven to minimize slight leakage of the valve near the set pressure (“simmering”).

2.8.2.3.2.2.2.F

The MSADVs shall be designed to maintain the steam pressure below the lowest opening pressure of the main steam safety valves during emergency shutdowns or Unit* hot standby conditions.

FA

They shall fail closed on a loss of electrical power or control signal.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 49/148

FB

Spurious opening of any one valve shall not compromise reactor safety requirements.

FC

NA

2.8.2.3.2.2.2.G

The MSADVs shall be mounted on separate headers connected to the seismically designed portions of the main steam piping.

GA

One header shall be associated with each main steam line.

GB

The headers shall be horizontal with the valve mounted vertically upward.

GC

The valves shall vent directly to atmosphere, with a separate vertical vent stack provided for each valve.

GD

Piping shall be designed to avoid any accumulation of condensed water.

2.8.2.3.2.2.2.H

The valves shall be of a design providing for quick change trim.

2.8.2.3.2.2.2.I

The valve internals shall be designed for removal for maintenance without removing the valve from the line.

2.8.2.3.2.2.2.J

An isolation valve with remote controls shall be provided upstream of each MSADV.

2.8.2.3.2.2.2.K

The piping and valve arrangement shall minimize the loads on the attachment.

2.8.2.3.2.2.2.L

Silencers shall be provided at the discharge of MSADV.

2.8.2.3.2.2.3 FEEDWATER ISOLATION VALVES

2.8.2.3.2.2.3.A

Double valve feedwater isolation shall be provided in the SG supply lines.

AA

The feedwater control valve may serve as one of these valves.

2.8.2.3.2.2.3.B

A separate feedwater isolation valve shall be provided in the main feedwater line to each Steam Generator*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 50/148

BA

This valve shall also serve as a containment isolation valve.

BB

This valve shall be located outside containment and as close to the containment as practical, and shall fail closed on loss of actuating fluid if it is actuated by fluid.

BC

The design closure time shall be justified by safety analysis.

BD

The valve shall not be required to close automatically on a containment isolation signal.

2.8.2.3.2.3.C

Feedwater isolation valves shall be closed on main steam or feedwater line break signals.

2.8.2.3.3 CONTROL ROD DRIVE SYSTEM

2.8.2.3.3.A

Sections 2.8.2.3.3.1 through 2.8.2.3.3.3 define the requirements that apply specifically to the Control Rod Drive System.

2.8.2.3.3.1 SCOPE

A

Control Rod Drive System is defined as the Control Rod Drive Mechanisms, position indicators, drive shafts (draw bar), and electrical connectors.

Note A:

The control rods (RCCA) are covered in Section 2.7.10.

2.8.2.3.3.2 FUNCTIONS

2.8.2.3.3.2.A

The Control Rod Drive System shall perform the following functions:



2.8.2.3.3.3 SYSTEM REQUIREMENTS

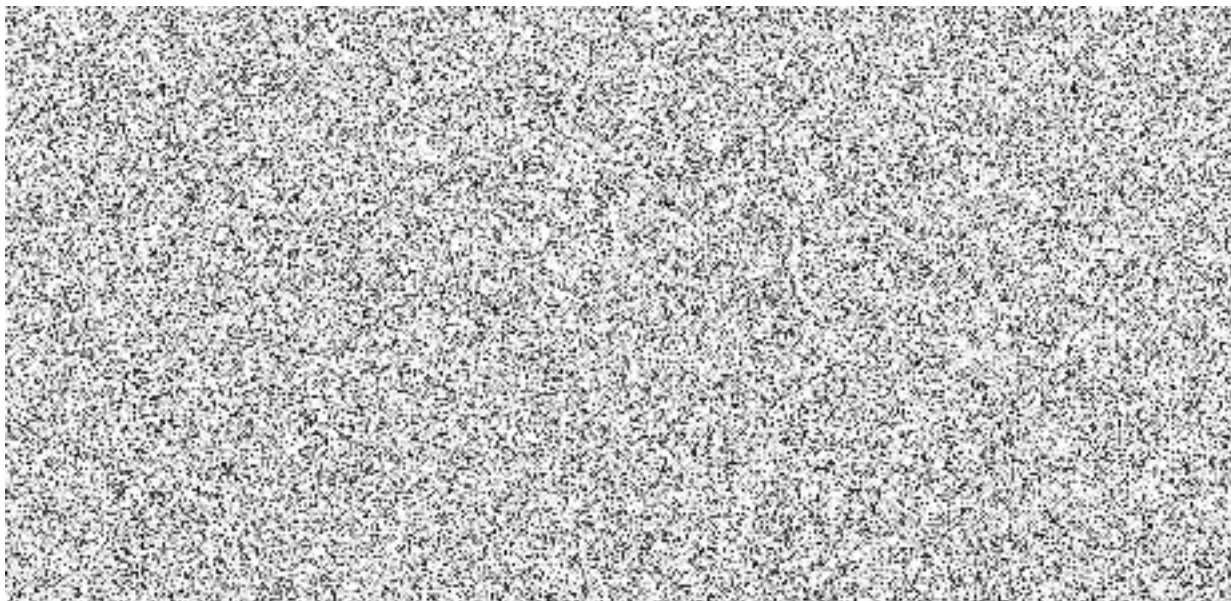
2.8.2.3.3.3.A

Requirements for Control Rod Drive System structural and mechanical design are as follows:

AA



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 51/148



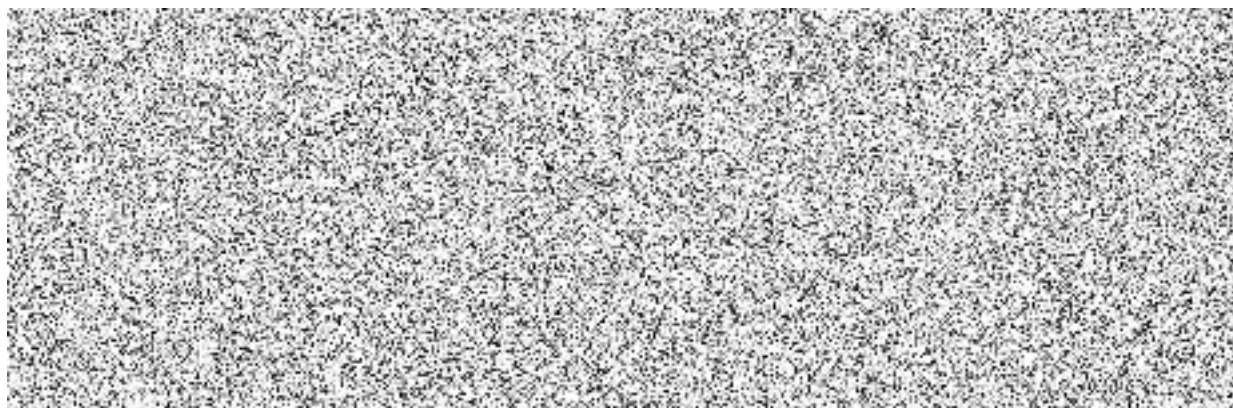
2.8.2.3.3.3.B

Number of load cycles for design purposes shall be as follows:



2.8.2.3.3.3.C

Cooling requirements are as follows:



2.8.2.3.3.3.D

The Control Rod Drive System shall be designed such that, upon power interruption to the Control Rod Drive System coils or motors, control rods insert by gravity from the fully withdrawn position to the fully inserted position within predetermined scram time such that total time from primary sensor response to a change in a monitored parameter to full rod insertion satisfies requirements of the most restrictive accident analysis.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 52/148

DA

This total scram time shall include all delays inherent in the associated I&C system, as well as delays caused by assumable Fuel Assembly* bow.

2.8.2.3.3.3.E

The Control Rod Drive System response time and rate of control rod movement shall be such that the Core* reactivity insertion rate can provide acceptable operational control characteristics (desired Core* power level and power distribution) while avoiding unacceptable rates of reactivity insertion due to unintentional control rod withdrawal (i.e., faulted conditions).

2.8.2.3.3.3.F

Each Control Rod Drive Mechanism shall prevent insertion or withdrawal of its control rod beyond a point where it would affect the ability of the Control Rod Drive System to perform its intended Safety Function* or damage other components (lower and upper end switch).

FA

The mechanical design shall be capable of receiving the full operating force of the Control Rod Drive Mechanism without damage.

2.8.2.3.3.3.G

The Control Rod Drive System shall have redundant position indication methods to incrementally indicate the position of each individual control rod from fully inserted position to fully withdrawn position. There shall be at least one direct position sensing method.

GA

Where rod position is used as an input to the reactor Protection System* to protect against rod position deviation events, both position sensing methods shall be direct.

2.8.2.3.3.3.H

The Control Rod Drive System shall be designed such that no Single Failure* shall prevent the Control Rod Drive System from performing its Safety Function* of rod drop and rod ejection prevention.

2.8.2.3.3.3.I

The Control Rod Drive Mechanism drive and drive train shall be designed such that unintentional withdrawal of control rods from the Core* cannot occur during disassembly of the RPV. RPV design shall provide unambiguous visual means of verification that Control Rod Drive Mechanism drive rod (draw bar) are uncoupled, disengaged and pulled clear of control rod assembly, so that unintentional lifting of the control rod is not possible.

2.8.2.3.3.3.J

Power to the Control Rod Drive Mechanism power supplies shall originate from two independent sources. The power supplies shall be arranged so that, upon loss of power to both Control Rod Drive Mechanism supplies, the RCCA will scram automatically.

2.8.2.3.3.3.K

The disconnection of plug-in connectors, modules and subassemblies from the circuits required for controlled movement of RCCAs shall be annunciated to Operators* by means of human-machine interface.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 53/148

2.8.2.3.3.3.L

Materials shall be selected according to principles set in Chapter 2.6, considering the requirements of applicable Codes and Standards* and a history of satisfactory service in PWR Control Rod Drive System applications.

2.8.2.3.3.3.M

The materials of welded seals, the welding methods used, and venting methods provided for the Control Rod Drive Mechanisms shall be selected such that probability of intergranular stress corrosion cracking of the welded seals, driven by trapped oxygen, is minimized.

2.8.2.3.3.3.N

The Control Rod Drive Mechanism stator coils and all electrical parts shall be replaceable without removing any adjacent Control Rod Drive Mechanisms.

2.8.2.3.3.3.O

All external cooling and electrical connections to the Control Rod Drive Mechanisms shall have couplings of a highly reliable and proven design.

OA

The couplings shall be accessible without the necessity of removing other equipment and shall be designed for rapid disassembly.

2.8.2.3.3.3.P

NA

2.8.2.3.3.3.Q

All major Control Rod Drive Mechanism components shall be individually replaceable.

QA

Magnetic coils shall be interchangeable.

2.8.2.4 SAFETY SYSTEMS

2.8.2.4.1 RESIDUAL HEAT REMOVAL SYSTEM (RHRS)

2.8.2.4.1.1 SCOPE

2.8.2.4.1.1.A

The Residual Heat Removal System (RHRS) system shall ensure adequate cooling of the RCS for conditions in which heat transfer via the Steam Generators* is no longer efficient.

2.8.2.4.1.1.B

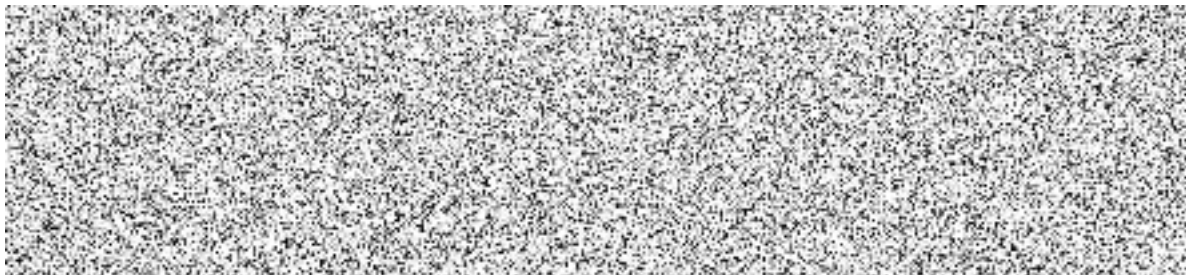
It shall provide continuous heat removal from the RCS to the Component Cooling Water System (CCWS) during shutdown modes including refuelling conditions.

2.8.2.4.1.1.C

The RHRS shall include:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 54/148



2.8.2.4.1.1.D

Redundant Trains* shall be provided in accordance with the safety classification.

DA

NA

2.8.2.4.1.1.E

Each Train* shall have suction connection from the Reactor Coolant System* and its own discharge connection to the Reactor Coolant System*.

EA

NA

2.8.2.4.1.2 FUNCTIONS

2.8.2.4.1.2.A

The RHRS shall be designed to perform the following functions:

AA

- remove decay heat from the Core*, heat produced by pumps and sensible heat of RCS and RHRS during normal and safe Unit* cool-downs after partial cool-down by the Steam Generators* is achieved,

AB

- remove decay heat from the Core* and sensible heat of the RCS and RHRS during normal and safe Cold Shutdown Modes*,

AC

- maintain the RCS at the required temperature during Core* unloading and reloading operations, maintenance operations and any other technical operations performed when the reactor is shutdown,

AD

- provide flow control of reactor coolant in the RCS by means of the RHRS pumps in all situations where the RHRS is in operation and the RCS pumps are shutdown,

AE

- provide a high-integrity pressure boundary as part of the second Barrier* in all situations where RHRS is connected to the RCS,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 55/148

AF

- remove decay heat from the Core* and sensible heat of RCS and RHRS in Safe State* after partial cool-down by other means is achieved, in particular, provide long-term Core* cooling e.g. after a Steam Line Break or a small break LOCA,

AG

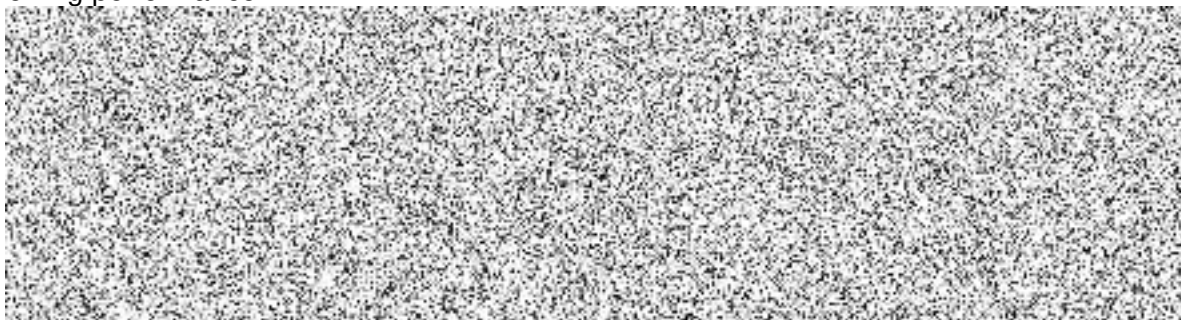
- provide RCS protection against overpressure at low temperature, if not protected by RCS itself.

2.8.2.4.1.3 SYSTEM REQUIREMENTS

2.8.2.4.1.3.1 HEAT REMOVAL FUNCTION

2.8.2.4.1.3.1.A

The RHR function shall be capable of removing decay heat and RCS sensible heat (plus heat generated by at least one RCP) to permit cooling of the reactor when shutdown with the following performance:



2.8.2.4.1.3.1.B



2.8.2.4.1.3.2 CONTROL OF COOLING RATE

2.8.2.4.1.3.2.A

The RHRS shall permit the Operator* to control the cooling rate of the RCS within its acceptance criteria.

2.8.2.4.1.3.3 DESIGN PRESSURE AND TEMPERATURE

2.8.2.4.1.3.3.A

The RHRS shall be designed for an operating pressure and an operating temperature which provide increased overlap between operating ranges of the RHRS and normal heat sink (i.e. SG) and thus provide higher operational flexibility.

2.8.2.4.1.3.3.B

If the RHRS is partly located outside the Primary Containment*, the design of the system shall prevent containment bypass, e.g. by higher design temperature and pressure or pressure relief devices inside the Primary Containment*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 56/148

2.8.2.4.1.3.4 LOCATION

2.8.2.4.1.3.4.A

If the RHRS is partly located outside the Containment System* (including Primary and Secondary Containment*), the RHRS shall be located in areas which are vented to filtered HVAC and shall be protected against External Hazards*.

2.8.2.4.1.3.4.B

The Supplier* shall demonstrate that the risk and potential consequences of containment bypass following leakage in the RHRS is negligible.

2.8.2.4.1.3.5 CONTAINMENT BYPASS PREVENTION

2.8.2.4.1.3.5.A

If the RHRS is partly located outside the Primary Containment*, the portions of the system which connect directly to the RCS and circulate Core* coolant outside the Primary Containment* shall be designed:



2.8.2.4.1.3.6 OVERPRESSURE PROTECTION

2.8.2.4.1.3.6.A

Relief valves shall be provided to ensure that the design pressure of the RHRS will not be exceeded due to the most limiting event.

AA

The RCS shall be protected from overpressure at low temperature either with relief valves in the RHRS or in the RCS.

2.8.2.4.1.3.6.B

The relief valves shall be located inside the Primary Containment*.

2.8.2.4.1.3.6.C

The RHRS shall be designed to limit leakage, both normally and following the most limiting mass or thermal input overpressurization transient.

2.8.2.4.1.3.7 VENT AND DRAIN PROVISIONS

2.8.2.4.1.3.7.A

Vents, drains and suitable isolation valves shall be provided for draining, filling, and venting.

AA

Components and piping shall be arranged such that there are no undrained piping low points in the systems.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 57/148

2.8.2.4.1.4 SYSTEM REQUIREMENTS

2.8.2.4.1.4.1 BACK-UP SYSTEM

2.8.2.4.1.4.1.A

The ability to back-up the RHRS with diverse means in situations where the Steam Generators* are unavailable shall be provided.

2.8.2.4.1.4.1.B

In addition, means shall be provided to ensure that decay heat removal capability is not lost during RHR pump maintenance, assuming failure of an operating pump.

2.8.2.4.1.4.2 CONFIGURATIONS WITH LOWERED RCS COOLANT LEVEL

2.8.2.4.1.4.2.A

The RHRS shall be designed to eliminate the risk of losing suction to the RHR pumps in situations where the RCS coolant level is lowered (e.g. mid-loop operation for RCP and SG maintenance).

AA

System piping shall be sloped continuously upward from the pumps to the connections with the RCS, with as few high points as practical.

AB

The RHRS design shall ensure that the required pump NPSH is available in all operation modes.

2.8.2.4.1.4.2.B

The Supplier* shall provide detailed analyses of possible causes that can impair functioning of RHRS and of design solutions to prevent these causes.

2.8.2.4.2 PASSIVE RESIDUAL HEAT REMOVAL SYSTEM (PRHRS)

2.8.2.4.2.1 SCOPE

2.8.2.4.2.1.A

NA

2.8.2.4.2.1.B

NA

BA

NA

2.8.2.4.2.1.C

NA

2.8.2.4.2.2 FUNCTIONS

A

NA

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 58/148

2.8.2.4.2.3 SYSTEM REQUIREMENTS

2.8.2.4.2.3.A

NA

2.8.2.4.2.3.B

NA

2.8.2.4.2.3.C

NA

2.8.2.4.2.3.D

NA

2.8.2.4.2.3.E

NA

2.8.2.4.2.3.F

NA

FA

NA

2.8.2.4.2.3.G

NA

2.8.2.4.3 SAFETY INJECTION SYSTEM (SIS)

2.8.2.4.3.1 SCOPE

2.8.2.4.3.1.A

The Safety Injection System (SIS) shall provide emergency Core* cooling in the event of an accident (e.g. with loss of reactor coolant, main steam line break or RCS loop level decrease during shutdown).

2.8.2.4.3.1.B

It shall be designed to supply a sufficient water inventory to limit damage to the fuel and subsequent release of radioactive products.

2.8.2.4.3.1.C

The SIS shall include the following parts:

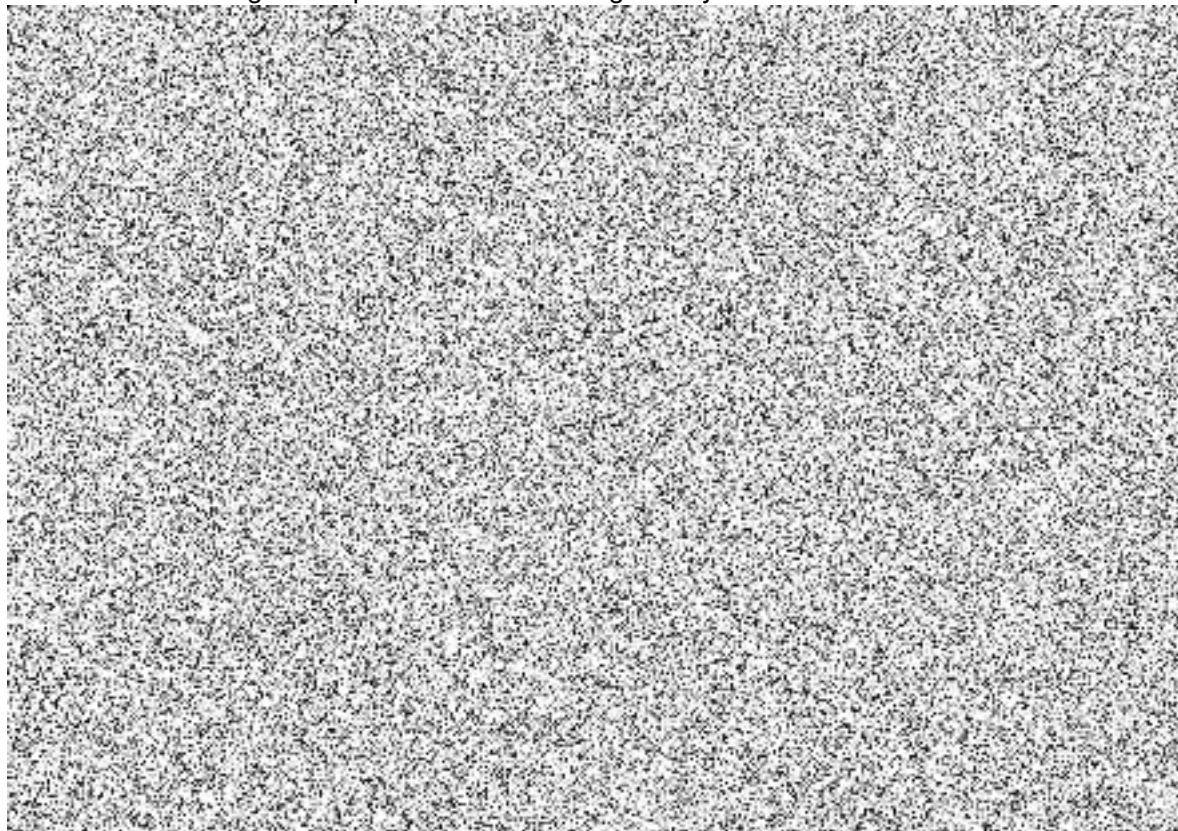


Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 59/148

2.8.2.4.3.2 FUNCTIONS

2.8.2.4.3.2.A

The SIS shall be designed to perform the following Safety Functions*:



AA

The actuation criteria shall not be the leakage rate.

AB

For DEC, diverse reactivity control may be carried out with a dedicated independent system.

AC

Following a Main Steam Line Break injection of borated water into the RCS via the SIS, is one possible way of achieving a return to subcriticality.

AD

Automatic return to subcriticality is not a requirement after large Steam Line Break.

2.8.2.4.3.2.B

NA

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 60/148

2.8.2.4.3.3 SYSTEM REQUIREMENTS

2.8.2.4.3.3.A

To simplify the design, the number of accumulators shall be the minimum compatible with the accomplishment of the required functions.

2.8.2.4.3.3.B

Sizing of accumulators (and their injection rate) shall allow the refilling of the lower plenum and downcomer in the event of any large LOCA.

2.8.2.4.3.3.C

Furthermore, in the case of any small break LOCA, the accumulators shall be sized to ensure the inventory control of Core* coolant, (i.e. the Core* will remain covered) until injection flow from the IRWST is available (see Section 2.8.1.1.2.4).

2.8.2.4.3.3.D

Accumulator discharge shall be isolated when empty to prevent injection of non condensable gas in RCS, if not justified.

2.8.2.4.3.3.E

Accumulators shall be designed to prevent discharge in the event of SGTR.

2.8.2.4.3.3.1 MAKE-UP TO RCS

2.8.2.4.3.3.1.A

The SIS shall provide adequate water inventory for Core* cooling to meet fuel cladding temperature limits in DBA as specified in Section 2.1.9.2.

2.8.2.4.3.3.1.B

The SIS shall have sufficient capacity in order to satisfy the requirement that no fuel be damaged for RCS pipe breaks up to an equivalent area of 250 mm in diameter, as specified in Section 2.8.1.1.2.5.

2.8.2.4.3.3.1.C

NA

CA

The Supplier* shall demonstrate how containment bypass is prevented following an SGTR.

2.8.2.4.3.3.1.D

The SIS pressure injection shall be high enough to ensure achievement of the functions listed but also low enough to avoid the injection in case of spurious actuation in Normal Operation* conditions.

2.8.2.4.3.3.1.E

The design shall ensure that the required SIS pump NPSH is available in all operation modes.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 61/148

2.8.2.4.3.3.2 DECAY HEAT REMOVAL

2.8.2.4.3.3.2.A

Adequate cooling of the injected water in order to maintain the containment pressure below its design value and to ensure that the steam released to the containment atmosphere condenses rapidly.

AA

The injected water shall be cooled by an intermediate cooling system like the CCWS.

2.8.2.4.3.3.2.B

NA

2.8.2.4.3.3.3 CONFIGURATION

2.8.2.4.3.3.3.A

An evaluation of the SIS pump suction lines shall be performed to demonstrate that sufficient NPSH is available during postulated RCS pipe breaks.

AA

This evaluation shall include the effects of in-containment water temperature, sump screen resistance with debris, pump performance and uncertainties in hydraulic losses in the pump suction line.

2.8.2.4.3.4 PWR SYSTEM REQUIREMENTS

2.8.2.4.3.4.A

There shall be no automatic actuation of the SIS in Design Basis Conditions 2*.

2.8.2.4.3.4.1 BORATION

2.8.2.4.3.4.1.A

The SIS shall be the Safety System* for the provision of boration in DBA.

AA

For DEC, other system may be used.

AB

The selection of the SIS as the Engineered Safety System* for the provision of boration may be achieved in conjunction with the implementation of a system for RCS depressurisation.

2.8.2.4.3.4.1.B

The SIS shall provide sufficient boron following a Main Steam Line Break, to meet the safety criteria.

2.8.2.4.3.4.1.C

The SIS shall provide sufficient boration to maintain the reactor in Safe State* with a coolant temperature down to ambient temperature, assuming the most reactive control rod remains out of the Core*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 62/148

2.8.2.4.3.4.1.D

Continuous combined hot leg and direct vessel Safety Injection shall ensure in the long term no boron precipitation in the Core*.

2.8.2.4.3.4.1.E

The source of borated water shall be the IRWST.

EA

NA

EB

The boron concentration of such a source for high concentration boron injection shall be such to prevent any boron precipitation in the Core*.

2.8.2.4.3.4.2 REFUELLING WATER STORAGE TANK

2.8.2.4.3.4.2.A

The RWST shall be located inside the Primary Containment*, thus permitting:

- improved protection against External Hazards*,
- the facility to deal with the discharge of coolant when depressurisation of RCS is performed (if required),
- internal water reserve for Severe Accident* mitigation.

2.8.2.4.3.4.2.B

The In-Containment Refuelling Water Storage Tank (IRWST) shall store the borated water for the spent fuel pool (if located in the Primary Containment*) and the refuelling cavity and, also for the SIS, the Containment Spray System (CSS), if any.

BA

The IRWST may provide a heat sink to condensate steam discharge from the pressurizer.

2.8.2.4.3.4.2.C

In any case, permanent alignment of suction lines for all DBC and DEC shall be ensured.

CA

The sumps shall be designed to prevent the formation of vortices in the intake connections.

CB

The suctions shall be protected against clogging by means of sufficient Redundancy*, Physical Separation* and anti-clogging devices.

CC

The Supplier* shall provide design criteria used and the tests performed to guarantee correct operation of the pumps.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 63/148

2.8.2.4.3.4.3 FEED-AND-BLEED

2.8.2.4.3.4.3.A

The SIS shall provide sufficient make-up and heat removal capability to satisfy the performance requirement for feed-and-bleed operation in connection with the pressurizer relief devices or the safety depressurisation system at all levels of RCS pressure.

2.8.2.4.4 PASSIVE SAFETY INJECTION SYSTEM (PSIS)

2.8.2.4.4.1 SCOPE

2.8.2.4.4.1.A

NA

2.8.2.4.4.1.B

NA

2.8.2.4.4.1.C

NA

2.8.2.4.4.2 FUNCTIONS

2.8.2.4.4.2.A

NA

AA

NA

AB

NA

2.8.2.4.4.3 SYSTEM REQUIREMENTS

2.8.2.4.4.3.1 MAKE-UP TO RCS

2.8.2.4.4.3.1.A

NA

2.8.2.4.4.3.1.B

NA

2.8.2.4.4.3.2 BORATION

2.8.2.4.4.3.2.A

NA

2.8.2.4.4.3.2.B

NA

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 64/148

BA
NA

2.8.2.4.4.3.2.C
NA

2.8.2.4.4.3.2.D
NA

2.8.2.4.4.3.2.E
NA

EA
NA

EB
NA

2.8.2.4.4.3.3 SYSTEM ARRANGEMENT

2.8.2.4.4.3.3.A
NA

2.8.2.4.4.3.3.B
NA

2.8.2.4.4.3.4 INTERCONNECTIONS

2.8.2.4.4.3.4.A
NA

2.8.2.4.4.3.5 LOCATION OF PSIS COMPONENTS

2.8.2.4.4.3.5.A
NA

2.8.2.4.4.3.6 ACCUMULATORS

2.8.2.4.4.3.6.A
NA

2.8.2.4.4.3.6.B
NA

2.8.2.4.4.3.6.C
NA

2.8.2.4.4.3.6.D
NA

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 65/148

2./8.2.4.4.3.6.E

NA

2.8.2.4.4.3.7 PSIS WATER STORAGE (RWST, IRWST)

2.8.2.4.4.3.7.A

NA

2.8.2.4.4.3.7.B

NA

BA

NA

2.8.2.4.4.3.8 CORE MAKE-UP TANKS (CMTS)

2.8.2.4.4.3.8.A

NA

2.8.2.4.5 PASSIVE AUXILIARY FEEDWATER SYSTEM (PAFS)

2.8.2.4.5.1 SCOPE

2.8.2.4.5.1.A

The Passive Auxiliary Feedwater System (PAFS) shall provide feedwater to the Steam Generators* when the main feedwater and start-up feedwater supply is not available.

2.8.2.4.5.1.B

The PAFS shall include the following parts:

- several storage tanks of demineralised water (which is also deaerated if used for Unit* start-up and shutdown),
- Trains* pumping water from the auxiliary feedwater supply tanks to the Steam Generators*,
- valves, piping,
- components supports, vent and drain piping,
- instrumentation and control,
- power supply.

2.8.2.4.5.2 FUNCTIONS

2.8.2.4.5.2.A

The PAFS shall be a dedicated system.

2.8.2.4.5.2.B

It shall be designed to perform the following functions:

- supply feedwater to the Steam Generators* to ensure heat removal from the RCS until the Residual Heat Removal System(s) entry conditions of the RHRS are reached, in all situations where the normal feedwater and start-up systems are unavailable,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 66/148

- in the event of a LOCA, remove decay heat in situations where primary coolant circulation is maintained (small breaks), to minimise leakage through pre-existing tube cracks or contribute to decay heat removal by condensation of steam in the Steam Generators* in situations where coolant circulation is lost (intermediate breaks).

2.8.2.4.5.3 SYSTEM REQUIREMENTS

2.8.2.4.5.3.A

System functional parameters (minimum flowrate, minimum number of SGs to be supplied, storage tank capacity, etc.) shall be determined such that, under all DBCs, the reactor can be brought to operating conditions of the RHRS without make-up water being supplied to the storage tank of PAFS.

2.8.2.4.5.3.1 FEEDWATER SUPPLY

2.8.2.4.5.3.1.A

A sufficient supply of water shall be maintained to bring the RCS to conditions for switchover to RHRS.

2.8.2.4.5.3.1.B

There shall be no bulk boiling or Core* uncover in the RCS, under Design Basis Conditions 4* such as a feedwater line break, assuming automatic isolation of main steam lines and, after 30 minutes, isolation of the affected Steam Generator*.

2.8.2.4.5.3.1.C

The PAFS shall be designed as a back-up for start-up feedwater supply under Design Basis Conditions 2*, such as Loss Of Off-site Power (LOOP) or loss of main feedwater.

CA

In such a case provision shall be made:

- to prevent the pressurizer from filling completely with water and preclude water discharge through pressurizer relief valves,

2.8.2.4.5.3.1.D

Sufficient auxiliary feedwater capacity shall be provided to avoid feed-and-bleed actuation under all Design Basis Conditions* and Design Extension Conditions*.

2.8.2.4.5.3.2 AUTONOMY

2.8.2.4.5.3.2.A

The Auxiliary Feedwater (AFW) storage capacity shall satisfy the following requirements:

- capability to operate in Hot Shutdown Mode* for at least 24 hours, bringing the Unit* to the operating conditions of the RHRS, with the RCS in natural circulation mode,
- capability to operate in Hot Shutdown Mode* in Station Black Out* conditions, followed by subsequent cooling to the operating conditions of the RHRS with backup supply from the SBO power sources.

2.8.2.4.5.3.2.B

The safety-classified source of feedwater shall be sufficient to permit cooling with the RCS in natural circulation mode.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 67/148

2.8.2.4.5.3.2.C

NA

2.8.2.4.5.3.2.D

In addition, it shall be possible to use non-classified systems and equipment and water sources to restore AFW water reserves (such as demineralised water supply, auxiliary feedwater supply etc.).

2.8.2.4.5.4 TANK CONFIGURATION

2.8.2.4.5.4.A

The PAFS shall be provided with at least two separate and dedicated tanks, each tank supplying 50 percent of the total water supply required

2.8.2.4.5.4.B

The two tanks, together, shall have the capability for operation in Hot Shutdown Modes* during 24 hours with the RCS in natural circulation mode as specified in Section 2.8.2.4.5.3.2.

2.8.2.4.5.4.C

There shall be the facility to feed each tank from other systems/water sources as specified in Section 2.8.2.4.5.3.2.

2.8.2.4.5.4.D

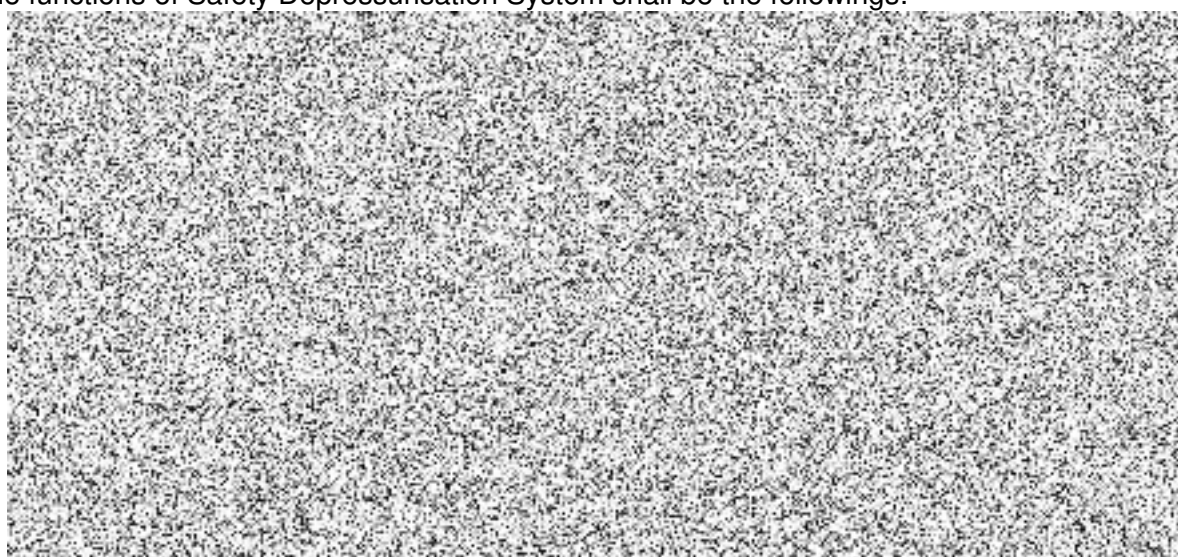
NA

2.8.2.4.6 SAFETY DEPRESSURISATION SYSTEM

2.8.2.4.6.1 FUNCTIONS

2.8.2.4.6.1.A

The functions of Safety Depressurisation System shall be the followings:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 68/148

2.8.2.4.6.2 SYSTEM REQUIREMENTS

2.8.2.4.6.2.A

The reliability of the depressurisation function shall be such that the Plant* and/or Unit* safety targets are fulfilled.

AA

Dedicated depressurisation to practically eliminate high-pressure Core* melt ejection shall be implemented when needed.

2.8.2.4.6.2.B

The safety depressurisation system actuation channels shall be designed such that it minimises spurious or inadequate actuation of the system.

2.8.2.4.6.2.C

However, in the event of this occurring, it shall not result in flooding the Reactor Cavity* up to the level of the RPV lower-head.

CA

NA

2.8.2.5 REACTOR AUXILIARY SYSTEMS

2.8.2.5.1 PWR CHEMICAL AND VOLUME CONTROL SYSTEM (CVCS)

2.8.2.5.1.1 SCOPE

2.8.2.5.1.1.A

The chemical and volume control system (CVCS) comprises, at least:



AA

CVCS system may also comprise some auxiliary equipment such as:



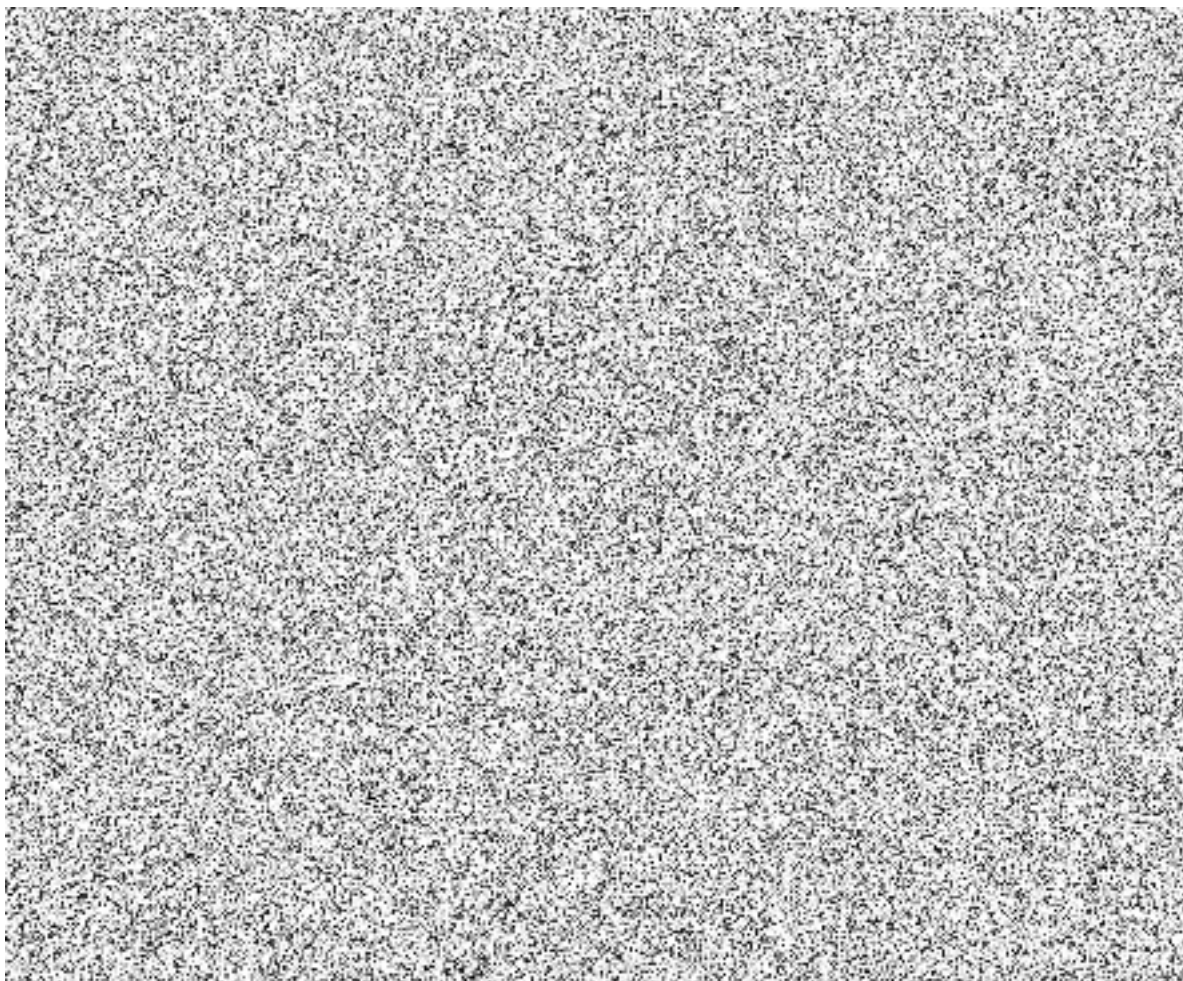
2.8.2.5.1.2 FUNCTIONS

2.8.2.5.1.2.A

The CVCS shall be designed to perform the following functions in the Normal Operation* conditions:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 69/148



2.8.2.5.1.2.B

The CVCS shall be designed to perform the following functions in Design Basis Conditions 2*:



2.8.2.5.1.2.C

The CVCS shall have no specific function in Design Basis Conditions 3* and Design Basis Conditions 4*.

2.8.2.5.1.3 SYSTEM REQUIREMENTS

2.8.2.5.1.3.1 REACTIVITY CONTROL

2.8.2.5.1.3.1.A

The CVCS shall:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 70/148

2.8.2.5.1.3.1.B

An evaluation of the potential risk for inadvertent boron dilution shall be made by the Supplier*. Component safety classification shall be taken into account.

BA

The Supplier* shall define the appropriate corrective action.

BB

In the event of inadvertent boron dilution, the Operator* shall be given enough time to take the appropriate correctives actions.

2.8.2.5.1.3.2 INVENTORY CONTROL

2.8.2.5.1.3.2.A

The CVCS shall:

2.8.2.5.1.3.3 CHEMICAL CONTROL

2.8.2.5.1.3.3.A

The CVCS shall control the coolant chemistry such that all types of corrosion and activation of corrosion products within the RCS and related risks, in particular risk of intergranular stress corrosion cracking, and radiation exposure are prevented as much as possible.

2.8.2.5.1.3.3.B

The Supplier* shall ensure such conditions to minimize Crud Induced Powershift and Crud Induced Local Corrosion.

2.8.2.5.1.3.4 SYSTEM ARRANGEMENT

2.8.2.5.1.3.4.A

The CVCS High energy lines* and components upstream of the pressure reducing device shall be located inside the Primary Containment*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 71/148

2.8.2.5.1.3.4.B

If some equipment has to be located outside Primary Containment*, for any purpose, that design choice shall be justified and balanced with regard to safety. Therefore, provisions shall be taken to demonstrate that the risk of containment bypass following leakage in the CVCS system is negligible.

BA

Specific requirements concerning High Energy Lines* (stress and strain analysis) are addressed in Section 2.4.7.6.

2.8.2.5.1.3.4.C

The design shall prevent harsh environment in the auxiliary building in case of CVCS pipe breaks.

2.8.2.5.1.3.4.D

The design and arrangement of the CVCS shall minimise the risk of accumulation of non-condensable gases and their potential effects on the charging pumps.

2.8.2.5.1.3.4.E

Lines with control valves shall be located in radiologically protected areas in order to be maintained during Unit* power operation.

2.8.2.5.1.3.4.F

The CVCS shall provide sufficient Redundancy* in Normal Operation* to ensure appropriate availability.

2.8.2.5.1.3.4.G

Demineralizers and filters shall be separately isolable and shielded so that access to one will not require draining of the other.

2.8.2.5.1.3.4.1 CHARGING PUMPS

2.8.2.5.1.3.4.1.A

Centrifugal pumps shall be used to fulfil all Reactor Coolant System* charging functions.

2.8.2.5.1.3.4.1.B

A minimum of two centrifugal charging pumps, each with flow capacity equal to system design flow, shall be provided.

2.8.2.5.1.3.4.1.C

Radioactive leakage of centrifugal charging pumps, in the event of a seal failure, shall be minimised.

2.8.2.5.1.3.5 PREVENTION OF BORON PRECIPITATION

2.8.2.5.1.3.5.A

The temperature of systems containing boric acid shall not fall below the precipitation temperature.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 72/148

2.8.2.5.1.3.5.B

The precipitation shall be prevented by appropriate concentration (maximum boron concentration 7 000 ppm, roughly equal to 40 g/kg of boric acid) and/or by using the HVAC systems to maintain the ambient temperature at a suitable level in rooms and areas containing the pipework and tanks.

2.8.2.5.1.3.5.C

Electric heat tracing shall be provided only where necessary.

2.8.2.5.2 NUCLEAR SAMPLING SYSTEM

2.8.2.5.2.1 SCOPE

2.8.2.5.2.1.A

The nuclear sampling system shall be a facility for analysing the chemical and radiochemical characteristics of samples from several systems.

AA

Examples of these systems are:

- the Reactor Coolant System* and auxiliary systems
- the Radioactive Waste* processing system
- the Steam Generator* blowdown system

2.8.2.5.2.1.B

The system shall perform monitoring of boron concentration in the RCS*, during the Normal Operation* conditions.

2.8.2.5.2.1.C

In order to meet regulatory requirements and operational needs, data from the nuclear sampling system shall be available throughout the Plant* and/or Unit* so that all workplaces which need such data have access to them in a simple online way. See Section 2.10.5.4.2.4 and Section 2.8.2.14.6..

2.8.2.5.2.2 FUNCTIONS

2.8.2.5.2.2.A

The nuclear sampling system shall be designed to perform the following functions:

- act as the Barrier* against fission products as needed,
- collect, condition, and deliver representative samples of fluids (liquids and gases) to one or more sampling stations,
- monitor the chemical and radiochemical characteristics of liquids and gases in representative process streams,
- provide additional information on the activity of the reactor coolant (including prediction of suspicious leaking Fuel Assemblies*) and its boron concentration,
- safe sampling of primary coolant and manipulation with samples even in case of fuel leakage.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 73/148

2.8.2.5.2.3 SYSTEM REQUIREMENTS

2.8.2.5.2.3.A

Samplings in the Design Basis Conditions 1* and the Design Basis Conditions 2* (except LOOP).

AA

The nuclear sampling system shall provide the samplings needed to ensure fulfilment of regulatory requirements and operational needs. It shall be compatible with the monitoring required to support compliance with the requirements on water chemistry of the reactor coolant, auxiliary and secondary systems.

AB

Main physico-chemical and radiochemical parameters of the Reactor Coolant System* and auxiliary systems shall be monitored by sampling periodically or as needed (or continuously as a possible Variation).

For avoidance of doubt the continuous monitoring 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*.

AC

The parameters for automatic and continuous determination of the high temperature pH (boric acid and alkali concentrations), dissolved hydrogen and oxygen and specific conductivity of the Reactor Coolant System* shall be measured whenever needed (or continuously as a possible Variation).

For avoidance of doubt the continuous measurement 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*.

AD

The nuclear sampling system shall also provide measurements of boron and oxygen concentration in CVCS and boron concentration in the pressurizer whenever needed (or continuously).

For avoidance of doubt the continuous measurement 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*.

AE

If enriched boric acid is used in the Reactor Coolant System*, determination of boron-10 isotope shall be provided whenever needed.

AF

The nuclear sampling system shall provide continuous measurement of the Steam Generator* blowdown system, especially: specific conductivity, cation conductivity and sodium.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 74/148

AG

The Supplier* may exclude some of the above mentioned measurements if they are unsuitable and/or unnecessary for its design. But in such a case, the Supplier* shall justify any exception to the above mentioned measurements.

AH

The Supplier* shall provide other continuous and grab measurements of important parameters of the main and auxiliary Nuclear Island* systems based on its design.

AI

The Supplier* shall incorporate means for monitoring of selected components condition in order to evaluate water chemistry.

AJ

The system shall provide a constant, continuous and adequate sample from turbulent flow in order to ensure that it is representative. Where necessary, fluids shall be cooled and reduced in pressure before sampling.

The sampling system shall provide isokinetic samples where it is necessary (e.g. for heterogenous samples, corrosion products).

AK

The design and arrangement of the system shall be such that the time between sampling and analysing is minimised. The reduction of distances or implementation of fast transportation systems shall be considered.

2.8.2.5.2.3.B

Segregation* of samples

BA

Samples that are radioactive or potentially radioactive shall be segregated from non-radioactive samples. The Segregation* level shall be consistent with the requirements of the radwaste processing system design.

BB

Whenever possible, sample discharges shall be returned to the system being sampled to reduce waste treatment.

BC

The following consecutive actions after sampling such as samples analyses and utilisation of each specific result shall be assured.

BD

Primary side sampling system shall be equipped with means to take correct samples of dissolved gasses from primary coolant.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 75/148

2.8.2.5.2.3.C

Post-accident sampling

CA

The system shall be used as non-safety means in the Design Basis Conditions 3*, the Design Basis Conditions 4* and the Design Extension Conditions* and shall allow operability check during Design Basis Conditions 1*.

CB

The Supplier* shall provide a complete system including relevant procedures and means for transport, storage and analyses of highly radioactive samples.

CC

If analysed outside of the Primary Containment*, re-injection of highly radioactive samples to the Primary Containment* shall be provided if there is a risk to exceed the treatment capability of such a waste.

CD

To maximise the familiarity of the Plant* Operators* with the operation of this system, either the same equipment shall be used both in the Design Basis Conditions* and in the Design Extension Conditions*, or provisions shall be made for periodic testing of the equipment dedicated to accident management.

CE

As the non-safety means for DBC 3 and 4 and DEC, the system design shall allow reactor coolant and containment atmosphere sampling within 24 hours of a reactor scram.

2.8.2.5.2.3.D

Containment isolation

DA

Sampling lines connected to systems located inside the Primary Containment* shall be provided with automatic isolation features.

2.8.2.6 FUEL STORAGE AND HANDLING SYSTEMS

2.8.2.6.A

Fuel Storage and Handling Systems (FSHS) shall ensure the safety requirements defined in Section 2.1.7.7.

AA

Design of FSHS and related operational procedures shall be fully compatible with relevant deliverables provided in Nuclear Fuel Contract* and shall assure full compliance with limitations and conditions for fuel transport, handling, manipulation, Inspection*, storage, operation and other functions and requirements, as stipulated by Nuclear Fuel Contract*.

2.8.2.6.B

The systems shall also ensure that every Fuel Assembly* and other irradiated equipment can be easily identified to ensure administrative control over nuclear materials and Radioactive Waste*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 76/148

2.8.2.6.1 SCOPE

A

The scope of the Fuel Storage and Handling Systems (FSHS) shall include:



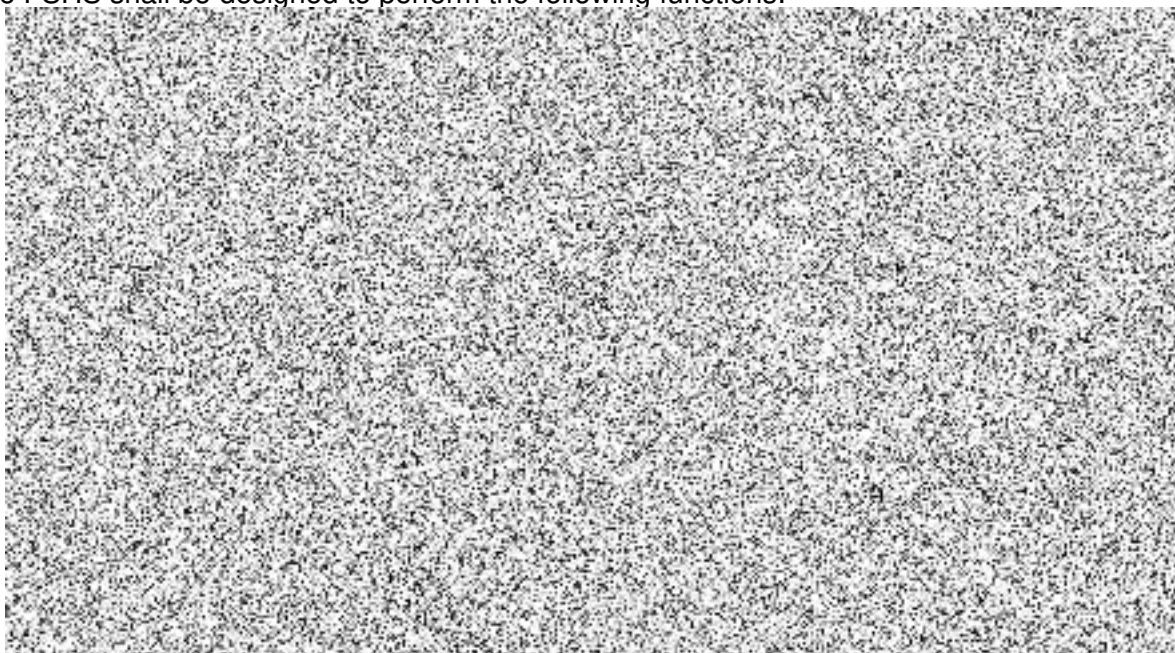
AA

Requirements for cooling systems applicable to the Fuel Pool Cooling and Clean-up System are specified in Section 2.8.2.10.4.

2.8.2.6.2 FUNCTIONS

2.8.2.6.2.A

The FSHS shall be designed to perform the following functions:



AA

The systems for identification and repair of leaking Fuel Assemblies* shall be technically and timely effective and shall be acknowledged by Supplier* for Nuclear Fuel* warranties purpose.

2.8.2.6.2.B

Heat removal function from spent fuel and maintenance of the required water quality shall be provided by the Fuel Pool Cooling and Clean-up System as specified in Section 2.8.2.10.4.

2.8.2.6.2.C

HVAC function shall be provided as specified in Sections 2.8.1.2.6 and 2.8.2.9.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 77/148

2.8.2.6.3 SYSTEM REQUIREMENTS

2.8.2.6.3.1 REFUELLING OUTAGE LENGTH

A

The fuel storage and handling systems shall be designed so that the requirement for Outage Duration* for refuelling is fulfilled, as specified in Section 2.2.7.2.2.

AA

In addition, the fresh fuel storage shall be sufficient for the whole First Core* and such storage space shall be usable for potential storage of fresh fuel for several refuellings.

2.8.2.6.3.2 SPENT FUEL POOL(S)

2.8.2.6.3.2.A

Spent fuel pool(s) shall be designed in accordance with the functions required in Section 2.8.1.2.1.

AA

Spent fuel pool(s) shall maintain its structural integrity in order to ensure the minimum stored fuel coverage that is needed for radiation shielding and fuel cooling following the effects of Internal Hazards*, Design Basis External Hazards* and applicable Rare and Severe External Hazards* (including intentional aircraft crash).

2.8.2.6.3.2.B

The spent fuel pool(s) shall have a leak-tight stainless steel liner of welded construction.

BA

The lining shall provide appropriate impact endurance.

BB

The lining of the bottom of pools shall endure the fall of a Fuel Assembly* from a maximum height during transportation and technological operations.

BC

The cask shall not be transported above the spent fuel pool.

2.8.2.6.3.2.C

The liner shall be surface finished (for example electropolishing, polishing) to reduce the adherence of contamination and to increase the efficiency of refuelling pool decontamination after draining.

2.8.2.6.3.2.D

A leak detection and collection system shall be provided to identify leakages from the liner plates of the spent fuel pool.

As a possible Variation, a leak detection and collection system shall be provided to allow remote detection of leakages from underwater seam weld joining the liner plates of the spent fuel pool and to allow identification of specific leakage location.

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

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 78/148

request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

DA

The system for control and collection of leaked water shall be equipped with technical means for detection and identification of leakages and their collection in vessels or storage reservoirs, equipped with level control devices.

2.8.2.6.3.2.E

A failure in any of the connected fluid circuits shall not result in draining of the pool to a level below that required for spent fuel cooling and biological shielding.

EA

Drains or permanently connected mechanical or fluid systems whose failure could cause sufficient loss of coolant to reduce water coverage over the stored Fuel Assemblies* to less than 3 m shall not be installed or included in the pool design.

EB

The bottom surface of all gates shall be above the top of the top spent fuel stored in the spent fuel racks.

EC

Draining of the pools through siphoning shall be precluded.

ED

Overfilling of the pools shall be precluded

2.8.2.6.3.2.F

A dedicated stationary or removable cask decontamination system shall be provided for the cask decontamination pit (if the contamination of the cask is not prevented by the design).

2.8.2.6.3.2.G

The pools shall be drainable with submersible pumps, if needed. The submersible pumps shall not be located on the pool or power supply shall not be provided for these pumps in Normal Operation* mode.

2.8.2.6.3.2.H

Where there are locks between the pools, they shall be designed in such a way as to sustain the pressure of water at each side in case there is no water from the opposite side.

2.8.2.6.3.2.I

The facilities shall be equipped with underwater reliable lighting and the materials used in the lighting shall be corrosion compatible with the medium of the pools and preclude contamination of water.

2.8.2.6.3.2.J

The equipment for performing technological operations under water shall be constructed in such a way so that when submerged it shall allow for the empty spaces underneath it to be filled with water in order to ensure water protection and to be drained when it is removed from the pool.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 79/148

2.8.2.6.3.2.K

Spent fuel pools shall be provided with protection measures against foreign material ingress.

2.8.2.6.3.2.L

Design of the SFPs located outside the containment shall not allow accumulation of hydrogen formation which would challenge the integrity or means to manage hydrogen shall be provided.

2.8.2.6.3.2.M

Instrumentation shall be provided to alarm the Operators* in case the spent fuel pool level drops below a predetermined level.

MA

Instrumentation to monitor the spent fuel pool water level shall be provided by two independent instrument channels: primary instrumentation channel and back-up instrumentation channel.

MB

The instrumentation channels shall provide a reliable monitoring in Internal Hazards*, Design Basis External Hazards* and applicable Rare and Severe External Hazards* (including intentional aircraft crash) and for an extended period after loss of all plant power.

MC

The instrumentation channels shall be qualified for the spent fuel pool saturation conditions for an extended period.

2.8.2.6.3.2.N

In addition to level monitoring, also temperature and fuel handling area air activity shall be monitored and alarms shall be provided for Operators*.

NA

Sampling shall also be provided for boron concentration, pH, electric conductivity, chemical composition and hydrogen content.

2.8.2.6.3.2.O

The spent fuel racks shall withstand the temperature and pressure arising from the decay heat of the assemblies and also they shall be resistant to chemical reactions between the fuel cladding and the fuel pool coolant.

2.8.2.6.3.2.P

The leaking Fuel Rods* shall be stored in hermetic containers.

PA

When the leaking Fuel Rods* cannot be removed from the Fuel Assembly*, then the complete Fuel Assembly* shall be stored in hermetic containers.

PB

In accordance with its experience and best practice, the Supplier* shall justify and deliver a reasonable number of hermetic containers for leaking Fuel Rods* and for damaged Fuel Assemblies*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 80/148

PC

It shall be possible to extend such storage capacity if needed during operation.

PD

The hermetic containers shall be compatible with the spent fuel pool and associated equipment.

2.8.2.6.3.2.Q

The Supplier* shall propose and describe a method for repairing the spent fuel pool in case of significant leakage (including description of impact on storage capacity during repairing).

2.8.2.6.3.3 STORAGE RACK DESIGN

2.8.2.6.3.3.A

The storage racks shall make it impossible to place more than one Fuel Assembly* in any cell, or to place or jam one assembly between two cells or between one cell and the pool wall.

AA

Storage racks shall be of the compact design, with built-in neutron-absorbing material.

2.8.2.6.3.3.B

The design of the fuel storage racks shall be such that any Fuel Assembly* of any life can be placed in any storage location.

BA

If, in order to provide higher capacity of the spent fuel pool, the spent fuel pool is composed of different regions for fresh spent fuel and older spent fuel, there shall be strict administrative procedures for checking the correct position.

2.8.2.6.3.3.C

The racks shall be designed to be free standing (without lateral support from walls or anchorage to the floor) and to be stable for all conditions of rack fill and seismic loading.

2.8.2.6.3.3.D

The arrangement and design of the spent fuel storage racks shall be such as to not hinder natural circulation cooling of the spent fuel stored in the racks.

2.8.2.6.3.3.E

Storage racks shall not lose its absorbing ability by means of mechanical damage (friction, etc.).

2.8.2.6.3.3.F

Removable absorbers shall not be used.

2.8.2.6.4 FUEL REPAIR AND INSPECTION EQUIPMENT

The Supplier* shall provide the fuel repair and Inspection* equipment system to in order to:

- proof fulfilment of Fuel System* design criteria, which could only be proven by post irradiation Inspection* of the Fuel System* components,
- allow for repair of damaged Fuel Assemblies* to minimize fuel cycle costs, losses of Nuclear Material*, doses to Plant* personnel and generation of Radioactive Waste*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 81/148

2.8.2.6.4.1 SCOPE

2.8.2.6.4.1.A

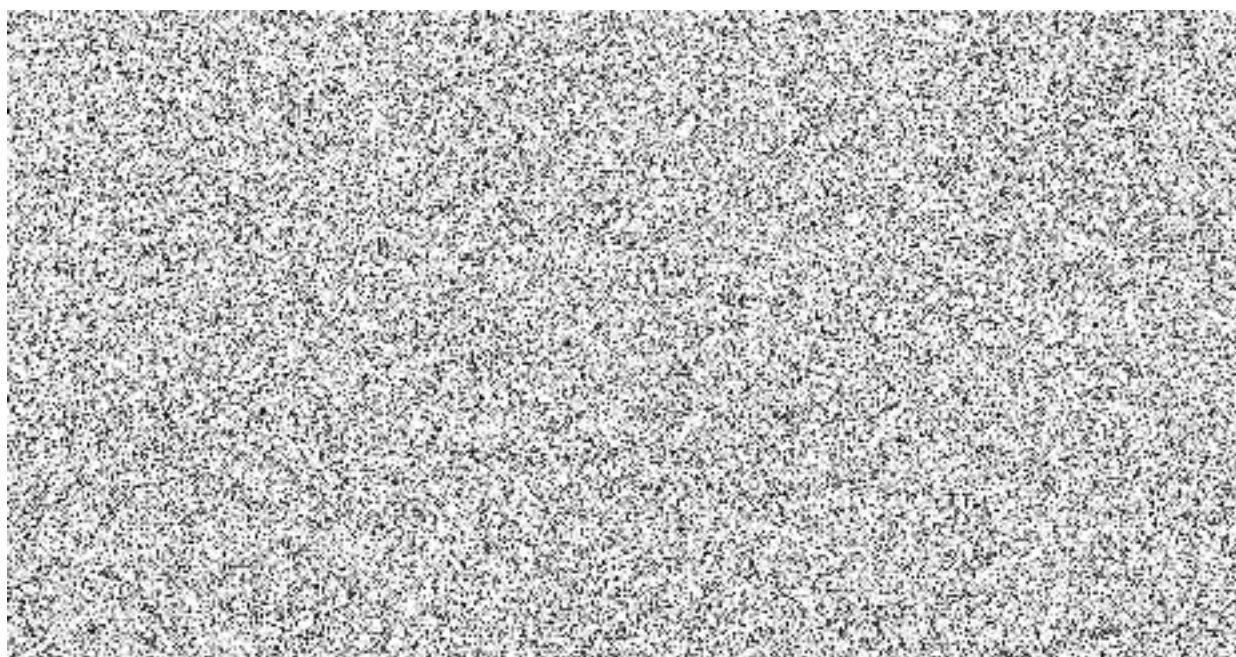
The Supplier* shall provide fuel repair and Inspection* equipment and all related deliverables, in order to:

- perform functions required in Section 2.8.2.6.4.2
- meet functional requirements defined in Section 2.8.2.6.4.3
- to allow for repairs of damaged Fuel Assemblies* and Fuel System* Inspections* in the extent defined in Nuclear Fuel Contract*, Appendix O (Post Irradiation Inspection Program and Repair Services*) as a minimum

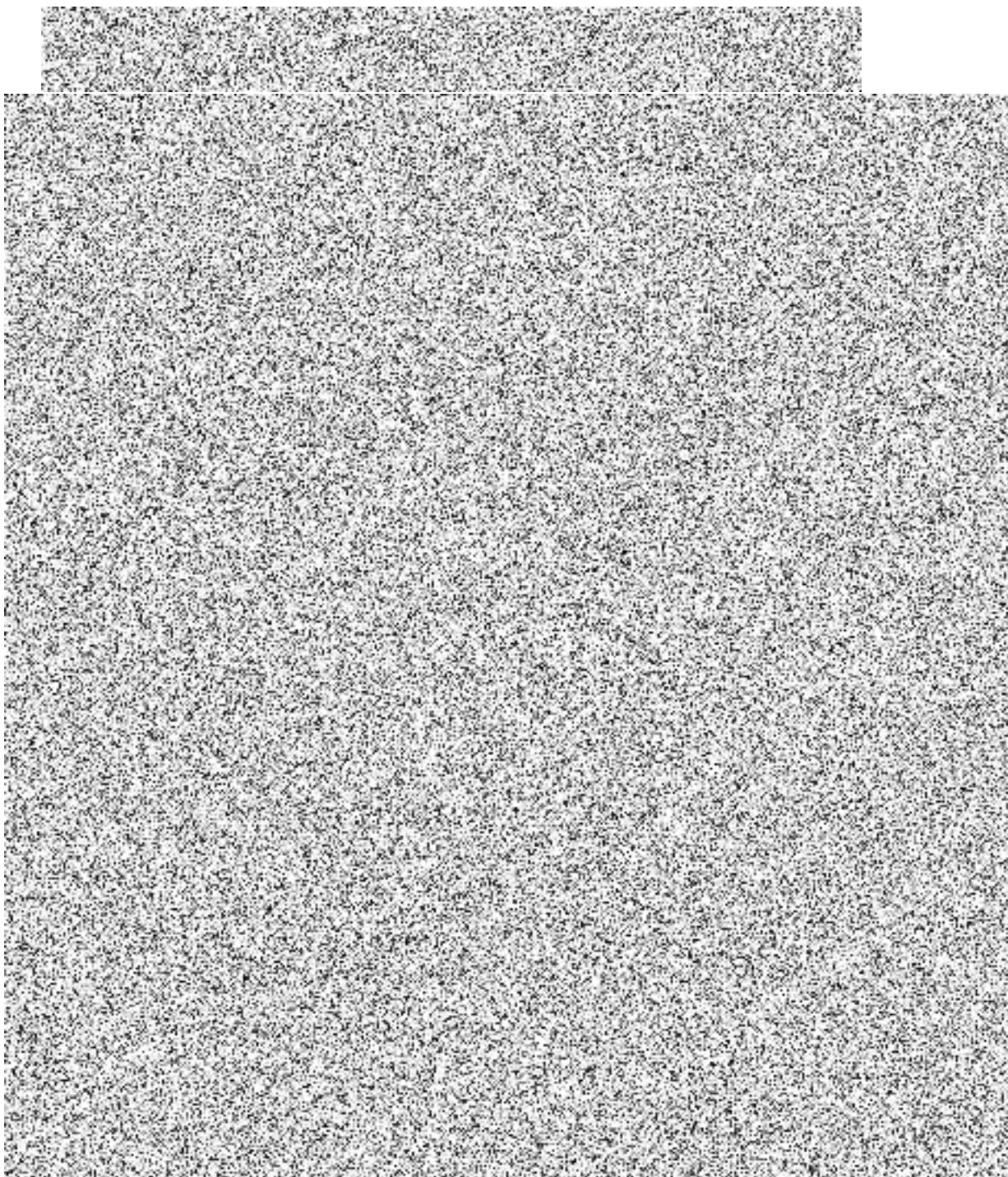
2.8.2.6.4.1.B

The Supplier* shall provide following deliverables related to fuel repair and Inspection* equipment:

- one set of structural parts of the fuel repair and Inspection* equipment per Plant*
- at least one set of small/movable components, measuring and evaluation devices, manipulators etc. for the whole Plant*
- design and as-built equipment documentation, operation procedures and training documentation
- all necessary user licenses related to software, documentation and methods, related to fuel repair and Inspection*
- training of the Owner's* personnel in handling and usage of fuel repair and Inspection* equipment, (training in measurements and data evaluation shall be provided under Nuclear Fuel Contract*)
- installation and testing prior Plant* start-up (testing of the measuring equipment shall be provided under Nuclear Fuel Contract*)
- technical support, maintenance and possibility to order spare parts shall be provided for the whole period of Nuclear Fuel Contract* execution.



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 82/148



2.8.2.6.5 CAN OR VACUUM CAN SIPPING

2.8.2.6.5.A

Can or vacuum can sipping (off-line sipping) shall be provided to analyse potentially leaky irradiated fuel assembly in the spent fuel pool as required in Section 2.8.2.6.1.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 83/148

AA

Off-line sipping system shall be able to confirm or exclude presence of failed fuel rod(s) within the analysed fuel assembly.

AB

Off-line sipping system shall be able to analyse, as far as practicable, gas and fluid samples to estimate if the damaged fuel rods exist in the Fuel Assembly*.

AC

Off-line sipping system shall provide for fundamental safety functions under respective plant states.

AD

Off-line sipping system shall be classified and given appropriate safety category.

2.8.2.6.6 REFUELLING AND SPENT FUEL HANDLING MACHINES

2.8.2.6.6.1.A

The scope of Supply shall include the Refuelling machine and the Spent fuel handling machine for handling the Fuel Assemblies and neutron source assemblies within containment building and fuel handling area of auxiliary building.

AA

The Refuelling machine handles Fuel Assemblies within the containment building.

AB

The Spent fuel handling machine handles Fuel Assemblies and neutron source assemblies in the fuel handling area of auxiliary building.

2.8.2.6.6.1.B

The Refuelling machine shall include underwater lights, cameras, control system, data storage system and other systems to allow adequate control and recording of the fuel handling operations and the correct loading verification.

BA

Spent fuel handling machine shall include control system, cameras, data storage system and shall provide sufficient information on fuel handling state/situation to the operator.

2.8.2.6.6.2 SAFETY REQUIREMENTS

2.8.2.6.6.2.A

The Refuelling machine and the Spent fuel handling machine shall fulfil fundamental safety functions under all respective plant states. Respective safety analyses shall be included in the SAR.

2.8.2.6.6.2.B

The Refuelling machine and the Spent fuel handling machine shall be classified and given an appropriate safety category, seismic class, lifting machinery class, electrical equipment class, cyber security class and other relevant nuclear and industrial safety classification.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 84/148

2.8.2.6.6.2.C

Design of the Refuelling machine and the Spent fuel handling machine and their control systems shall prevent:

- Fuel Assembly withdrawal above maximum allowable height to keep safe water cover depth,
- accidental drop of the Fuel Assembly into the pool or reactor,
- accidental opening of the mechanical latches,
- collision of the machine or the transported Fuel Assembly with adjacent fuel assemblies or structures,
- exceeding loading and speed limits during the Fuel Assembly movements.

2.8.2.6.6.2.D

Automatic breaks shall be included to stop any movement in the case of energy/working medium loss, seismic event leading to equipment failure, or any other accident. The breaks shall prevent spontaneous movement of bridge, trolley, and hoist.

2.8.2.6.6.2.E

Design of the Refuelling machine and the Spent fuel handling machine shall allow contingency manual operation in the case of power or other working medium/energy loss in order to bring Fuel Assembly into safe position. Manual operation shall not require operating personnel to be exposed to any potentially dangerous or harmful conditions.

2.8.2.6.6.3 FUNCTIONAL REQUIREMENTS

2.8.2.6.6.3.A

The Refuelling machine and the Spent fuel handling machine shall be compatible with the Fuel Assemblies and any other interfacing systems/SSCs. All vertical and horizontal speed, acceleration and deceleration values shall be limited by the control systems to comply with the Fuel Assembly design loading limits to prevent their damage.

2.8.2.6.6.3.B

The Refuelling machine and the Spent fuel handling machine and their control systems shall include precise and reliable measurement and indication of horizontal and vertical position of the movable working part. Diverse/backup position measurement and indication system shall be provided for contingency conditions.

2.8.2.6.6.3.C

The control system shall include both horizontal and vertical pre-defined co-ordinates of all positions (fuel cells) inside the reactor and pools. Horizontal fuel movements shall be programmable and performed in automatic mode according to the fuel shuffling plan.

2.8.2.6.6.3.D

The actual verified position of all Fuel Assemblies shall be stored in the machine control system database and data storage system at any time.

2.8.2.6.6.3.E

Mechanical design and the control system of the Refuelling machine and the Spent fuel handling machine shall allow for small corrections of horizontal/vertical or angular position of working parts to allow insertion of slightly distorted Fuel Assemblies into reactor, storage and handling cells/positions.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 85/148

2.8.2.6.6.3.F

Control systems of the Refuelling machine and the Spent fuel handling machine shall provide adequate interface for (a) loading and verification of the fuel shuffling plan(s) from Core Design branch, and (b) communication with tracking and accounting systems.

2.8.2.6.6.3.G

The Plant* design shall implement movable Refuelling Supervisory Console located at or close to MCR which shall provide information on the operation of refuelling machine and spent fuel handling machine (such as current positions, active movements, failure/interlock information and alarms, direct voice communications between the refuelling supervisory console and both the refuelling machine and the spent fuel handling machine) to the plant personnel without radiation exposure during the refuelling operation.

2.8.2.6.6.3.GA

As an alternative solution, dedicated Fuel Handling Surveillance Room (FHSR) with monitoring devices and communication means shall be provided to allow fuel handling surveillance by the Owner's licensed personnel as required by the applicable law of the Czech Republic. This FHSR shall include functions of Refuelling Supervisory Console and additional surveillance information such as neutron flux density in reactor, water levels and temperatures in reactor and SFP, boron concentration (grab sampling), fuel cooling condition, video signals from underwater cameras and fuel tracking. Licensed personnel in the dedicated FHSR shall be able to communicate directly with Main Control Room and operators of Refuelling Machine and Spent Fuel Handling Machine. For avoidance of doubt, this alternative solution 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*.

2.8.2.6.6.3.H

Any horizontal movement of the Refuelling machine and the Spent fuel handling machine bridge shall be indicated by acoustic signal, audible to personnel in the vicinity of the machine.

2.8.2.6.6.3.I

Design of the Refuelling machine and its control system shall be fully compatible and shall include interface with the on-line sipping system, inspection cameras and other measurement systems to allow adequate Fuel Assemblies* inspection.

2.8.2.6.6.4 SYSTEMS REQUIREMENTS

2.8.2.6.6.4.A

The Refuelling machine and the Spent fuel handling machine design process, manufacturing, installation, testing, operation, inspection plans, maintenance and other part of the system life cycle shall follow relevant engineering rules and quality control plans according to their nuclear safety and industrial safety classification.

2.8.2.6.6.4.B

Position-dependent speed limits and interlocks shall be provided to prevent Fuel Assembly overloading, other damage or collisions with adjacent structures/SSCs.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 86/148

2.8.2.6.6.4.C

The Refuelling machine and the Spent fuel handling machine bridge, trolley and hoist motion shall be driven by variable speed electric motors. Simultaneous traversing and hoisting shall be prevented.

2.8.2.6.6.4.D

Each Control Console of the Refuelling machine and the Spent fuel handling machine shall be equipped with adequate HMI and shall be designed according to the relevant rules of engineering ergonomics.

2.8.2.6.6.4.E

Design of the Refuelling machine and the Spent fuel handling machine and their Control Consoles shall have a man-machine interface to minimize the probability of human error to the greatest extent possible.

2.8.2.7 ELECTRICAL POWER SUPPLIES

2.8.2.7.1 SCOPE

The following Sections give the functional requirements for the following systems:

- power transmission and auxiliaries supply system (sometimes called the off-site power system, including also the auxiliaries normal supply system);
- on-site standby AC power supply system (e.g. diesel generator supply system);
- medium-voltage AC power distribution system; and
- low-voltage Direct Current (DC) and AC power supply and distribution system.

2.8.2.7.2 GENERAL REQUIREMENTS

2.8.2.7.2.A

Electrical power supply systems shall provide for supply and distribution of electrical power from on-site and off-site power sources to all electrical equipment and I&C, under DBC and DEC.

The scope shall correspond to the following systems:

- Normal Auxiliary Power Supply system (NAPS)
- The Stand-By Auxiliary Power Supply system (SAPS)
- Emergency Power Supply*
- medium-voltage and low-voltage Auxiliary Power Supply system (APS)
- low-voltage DC and uninterruptible AC power supply

This electrical power supply system is separate from the grid. The boundary between off-site power system and the grid is defined in the Section 4.1.3.2.

2.8.2.7.2.B

Design of electrical power supply system shall be well documented and shall be based on safety requirements, electrical requirements, functional, performance requirements and maintenance requirements as prescribed in IEC 63046.

BA

Unless otherwise specified in the EPC Contract*, scope and content of analyses, studies and other design Documents* shall be in accordance with IEC 63046 and IEC 62855.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 87/148

BB

Design of electrical power supply system shall include all provisions emerged from such analyses, studies, design Documents* and design requirements applicable to the electrical power supply systems and also all other provisions required by EPC Contract*.

BC

The design of the electrical power distribution systems shall be such that disturbances in the non safety classified parts of the system will not impair the function of the safety classified part.

2.8.2.7.2.C

The NAPS system and the SAPS system shall support Defence in Depth* principle and related functions mentioned in the Section 2.3.3.

2.8.2.7.2.D

The design of the electrical power distribution systems shall be such that following disturbances will not impair the function of the Safety Systems*:

- frequency variations of the power supply system,
- phase angle displacement of the supply voltages,
- voltage surges and over-voltages of the power supply systems,
- under-voltages of the power supply system.

2.8.2.7.2.E

Different failures causing the above-mentioned voltage disturbances shall be identified and functionality studies for their effects shall be analysed considering all possible power supply sources potentially powering the Safety Class 1 and Safety Class 2 SSC.

2.8.2.7.2.F

Each electrical SSC shall be classified according to safety classification approach defined in Technical Requirements Document*, Chapter 2.1. and classification approach defined in IEC 63046 which shall be based on categorisation of functions pursuant to standard IEC 61226. See Technical Requirements Document*, Section 2.1.5

2.8.2.7.3 POWER OUTLET AND AUXILIARIES NORMAL AND STAND-BY SUPPLY SYSTEM

2.8.2.7.3.1 FUNCTIONS

2.8.2.7.3.1.A

In Power Operation Modes*, the NAPS systems shall transmit the generated power to the grid and to the APS.

2.8.2.7.3.1.B

During Plant* start-up, shutdown or outage, the NAPS or SAPS systems shall supply power from the grid to the APS.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 88/148

2.8.2.7.3.2 SYSTEM REQUIREMENTS

2.8.2.7.3.2.A

The NAPS system shall be designed so that, in case of failure or unavailability of the NAPS system, SAPS system shall remain available.

2.8.2.7.3.2.B

The NAPS system shall be supplied by one 400 kV line per Unit*.

BA

The SAPS system shall be supplied by two 110 kV lines per Unit*.

BB

The 110 kV lines shall be terminated in the on-site 110 kV substation.

2.8.2.7.3.2.C

The NAPS system shall be equipped with at least two Auxiliary Normal Transformer* and one Generator Transformer*.

2.8.2.7.3.2.D

The SAPS system shall be equipped with at least two Auxiliary Standby Transformer* (The number of ASTs shall comply with number of ANT(s)).

2.8.2.7.3.2.E

A single failure affecting power outlet equipment and/or the NAPS shall not affect the SAPS and vice versa.

2.8.2.7.3.2.F

When the NAPS system is unavailable (the main EHV supply is unavailable and at the same time the main generator is also unavailable or after an ANT(s) failures, etc.), the auxiliaries shall be supplied by the SAPS system, if the stand-by grid is ready.

2.8.2.7.3.2.G

The bus transfer system shall secure change-over from NAPS to SAPS and reversely to supply APS.

GA

The bus transfer system shall measure and evaluate 1 line to line voltage.

GB

The bus transfer system shall include fast transfer method. In this method, the bus transfer system shall secure fast controlled change-over from NAPS to SAPS. This mode shall be used when 3 phase voltage systems have nearly the same frequency, voltage and phase. When it is impossible to perform a load transfer via fast transfer method the residual transfer method shall be used.

GC

NA

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 89/148

GD

When it is impossible to perform the fast controlled transfer (fast transfer method of the bus transfer system) the load transfer from the ANT(s) to the AST(s) shall be arranged with interruption of the supply (residual voltage) to avoid an out-of-phase bus transfer.

GE

The bus transfer system shall include residual voltage transfer method. In this method, the system shall secure change-over from NAPS to SAPS. This method shall be used when residual voltage in APS system is decreased to acceptable low level (from the out-of-phase bus transfer point of view).

GF

The bus transfer system shall include synchronous manual transfer method. In this method, the system shall enable change-over from NAPS to SAPS or reversely.

GG

Fast transfer method shall not cause a reactor trip.

GH

The initiation of bus transfer system shall be manual or automatic.

GI

NA

GJ

All automatic function of the bus transfer system shall be possible to disable or enable.

GK

The bus transfer system shall include human machine interface.

2.8.2.7.3.2.H

NA

HA

NA

2.8.2.7.4 ON-SITE STANDBY AC POWER SUPPLY SYSTEMS

2.8.2.7.4.1 FUNCTIONS

2.8.2.7.4.1.A

The on-site standby AC power supply system shall be designed to supply standby power to the Unit* in case of DBC and DEC for accident mitigation.

These types of on-site standby AC power supply systems shall be installed:

1. Emergency Diesel Generators as an Emergency Power Supply* for loads performing Safety Category 1 and Safety Category 2 Functions*,
2. Alternate Power Source* (AAC Diesel Generator) for mitigation of SBO consequences,
3. mobile AC sources as an On site Non-Permanent Equipment* for mitigation of Severe Accidents* consequences,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 90/148

4. non-safety diesel generators for loads performing no safety functions and for investment and personal protection.

2.8.2.7.4.1.B

The Alternate Power Source* (AAC Diesel Generator) and mobile AC sources as an On site Non-Permanent Equipment* shall be provided, even for the Plant* with passive Safety Systems*.

2.8.2.7.4.1.C

Alternate Power Source* (AAC Diesel Generator) shall be possible to put into operation quickly enough and its capability and reliability shall be sufficient to achieve the total Core Damage* frequency target and Acceptance criteria specified in the Section 2.1.9.2 and monitoring of main safety parameters.

2.8.2.7.4.1.D

It shall be possible to supply the safety loads from Alternate Power Source* in case of DEC.

2.8.2.7.4.2 SYSTEM REQUIREMENTS

2.8.2.7.4.2.A

The Emergency Power Supply* sources for safety loads shall consist of a Safety Class 1 emergency power generator unit, except for plant with only passive Safety Systems*.

2.8.2.7.4.2.B

On-site standby AC power sources shall be divided according a level of the Safety Functions* mentioned in the Section 2.1.5.1.2.

2.8.2.7.4.2.C

Each Alternate Power Source* shall consist of at least a Safety Class 3 emergency power generator unit.

2.8.2.7.4.2.D

NA

2.8.2.7.4.2.E

The power for automatic starting of the Emergency Power Supply* unit shall be ensured by battery backed power supply. This battery shall be supplied from the train associated with the same Emergency Power Supply* unit.

2.8.2.7.4.2.F

The start-up time of Emergency Power Supply* unit shall be in accordance with the requirements of the supplied systems and in accordance with the Section 2.7.12.3.3.1.

2.8.2.7.4.2.G

The design principles of power supply which support Safety Functions* and equipment in DEC as well as for Internal Hazards*, Design Basis External Hazards*, and Rare and Severe External Hazards* shall be confirmed as met using the Probabilistic Safety Assessment (PSA).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 91/148

2.8.2.7.4.2.H

The Non-Permanent Equipment* (i.e. portable generator) and Alternate Power Source* (i.e. AAC Diesel Generator) shall be possible to test on the rated electrical power. Equipment for the testing shall be provided.

2.8.2.7.4.2.I

The design of the Non-Permanent Equipment* (i.e. portable generator) and Alternate Power Source* (i.e. AAC Diesel Generator) shall be as simple as is possible. The use of electronic control devices shall be minimized.

2.8.2.7.5 MEDIUM-VOLTAGE AND LOW-VOLTAGE AC DISTRIBUTION SYSTEM

2.8.2.7.5.A

The medium-voltage and low voltage distribution system shall be designed to supply power to the plant loads as follows.

Power shall be supplied to safety and non-safety loads as necessary by:

- NAPS
- SAPS
- Emergency Power Supply* systems (EDG and non-safety diesel generators)
- Alternate Power Source* in case of station black-out. (e.g. AAC Diesel Generator)
- Non-Permanent Equipment* (e.g. mobile AC sources)

2.8.2.7.5.B

The low-voltage distribution system shall be supplied from the medium-voltage distribution system through medium-voltage to low-voltage distribution transformers.

2.8.2.7.6 DC AND UNINTERRUPTIBLE AC LOW-VOLTAGE POWER SUPPLY AND DISTRIBUTION SYSTEM

2.8.2.7.6.A

The DC and uninterruptible AC low-voltage power supply system shall provide continuous and reliable electrical power for Safety Systems and Safety Features for Design Extension Conditions* and other loads which require uninterrupted power supply during DBC and DEC (i.e. I&C loads, protection relays, investment and personal protection SSC etc.)

2.8.2.7.6.B

The DC batteries shall constitute the on-site power sources for operation of the loads of the DC and low-voltage AC systems.

2.8.2.7.6.C

The DC chargers shall have sufficient capacity to restore the batteries from a discharged condition to its rated capacity state within an acceptable time but not longer than 12 hours, while at the same time supplying the largest combined demands of the various steady state loads following the loss of normal power.

2.8.2.7.6.D

The DC chargers shall have selectively designed fast protections to ensure, that in case of over-voltages or voltage surge transients, the battery chargers are tripped before damaging

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 92/148

the batteries or equipment supplied by the batteries. The design of electrical systems shall take into account the recovery procedure for supplies after activation of protections.

2.8.2.7.6.E

If SSC require continuous AC or DC power supply, a non-interruptible power supply system shall be provided to supply such loads.

2.8.2.7.6.F

Batteries backing up the operation of electrical systems important to safety shall maintain their capability to operate according to requirements in the Section 2.1.6.7.3.

2.8.2.7.6.G

Batteries backing up the operation of Non-Safety SSC (i.e. investment and personal protection etc.) shall maintain their capability to operate according to technical needs of protected equipment and at least 2 hours.

2.8.2.7.6.H

Independent additional DC battery capacity shall be provided for emergency lighting of Main* and Emergency Control Rooms* (MCR and ECR). Minimum lighting for escape routes shall be provided by luminaires with replaceable internal batteries.

2.8.2.7.6.I

The batteries for Safety Systems and Safety Features for Design Extension Conditions* shall be protected in order to withstand DBEH and applicable RSEH effects.

2.8.2.8 RADIOACTIVE WASTE PROCESSING SYSTEMS

2.8.2.8.1 SCOPE

2.8.2.8.1.A

The following Sections establish the functional system and process requirements for the Radioactive Waste* Processing Systems (RWPS). These systems are listed below:

- liquid waste collection, treatment and discharge system,
- gaseous waste collection, treatment and discharge system,
- solid waste collection, treatment and conditioning system (incl. packaging) and interim storage.

2.8.2.8.1.B

These systems shall provide the functions listed in Section 2.8.1.2.4 and shall be designed in compliance with the equipment design requirements in Chapter 2.7.

2.8.2.8.1.C

Laundry for clothes from radiation areas shall be provided.

CA

Where cleaning processes are used, selected detergents shall be specified rather than soaps unless use of water only is sufficient.

CB

Dry cleaning of radioactive clothing shall not be used.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 93/148

2.8.2.8.2 SYSTEM REQUIREMENTS

2.8.2.8.2.A

The RWPS shall be a simple system, and the number of items of equipment kept to a minimum and standardised, to an extent consistent with the performance, operability, and availability goals.

AA

The proposed design shall comply with the objective of minimization of Radioactive Waste* production, in accordance with the requirements in Section 2.2.5.2 and for reducing radioactive discharges to ALARA, that is, to meet the performance and safety requirements specified in Section 2.2.5 and Section 2.1.3.2.

2.8.2.8.2.B

The RWPS shall have an adequate storage and processing capacity to handle waste resulting from all Normal Operation* conditions, including systems maintenance and testing as well as Design Basis Conditions 2*.

BA

There shall be the ability to handle larger, anticipated but infrequent, volumes of waste.

BB

Expected input volumes, rates and activity of gaseous and liquid Radioactive Waste* from various sources shall be specified.

BC

The expected amounts and activity from various sources of the different wet and dry solid waste shall be specified.

2.8.2.8.2.C

The systems shall be designed such that the treated and conditioned waste and effluents comply with the Rules*.

CA

The waste and the containers shall be compatible with the Radioactive Waste repository Dukovany.

CB

Shielding and shield covers shall be installed on containers as needed.

2.8.2.8.2.D

The system features shall preclude inadvertent transport of highly contaminated fluids to the RWPS under DBC and DEC, if not designed for their treatment.

2.8.2.8.2.E

The Radioactive Waste* processing systems shall be arranged for remote, coordinated control from central radwaste control rooms.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 94/148

EA

To the maximum practical extent, Radioactive Waste* processing systems shall be automatically monitored and controlled.

EB

Process equipment shall have instrument and/or sampling provisions to enable periodic evaluation of the operability and functional performance of components of the system.

2.8.2.8.2.F

The building for liquid/solid systems shall permit removal and replacement of process equipment.

2.8.2.8.2.G

Control and monitoring of the discharge of radioactive materials to the environment shall be consistent with the requirements for management of environmental impact of the radioactive releases as specified in Section 2.8.2.14.1.

GA

Instrumentation and control provisions shall be compliant with the requirements in Chapter 2.10.

2.8.2.8.3 GASEOUS RADIOACTIVE WASTE PROCESSING SYSTEM

2.8.2.8.3.A

This Section, together with the applicable portions of Section 2.8.2.8.2 of this chapter, specifies the requirements for the Gaseous Radioactive Waste* Processing System (GRWPS).

AA

The equipment design requirements are specified in Chapter 2.7.

2.8.2.8.3.B

The GRWPS shall be designed to treat the gaseous Radioactive Waste* arising from the operation with sufficient capacity to accommodate the load-following transients and Anticipated Operational Occurrences*.

BA

The GRWPS shall be capable of operating continuously, as well as periodically, at flow rates established by the requirements of the CVCS and the boron containing waste processing subsystem.

BB

The GRWPS shall be designed for hydrogen explosion confinement, in order to maintain the system integrity if the potential for an explosive mixture of hydrogen and oxygen exists.

2.8.2.8.3.C

The GRWPS shall treat the radioactive gases originating within the RPV and released via the Chemical Volume and Control System (CVCS) and boron containing waste processing subsystem of LRWPS with the associated degasification device.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 95/148

CA

The reactor coolant drain tank and the auxiliary building drain tank may also provide infrequent inputs.

CB

The GRWPS shall be designed to have the capacity to process the combination of all waste gas streams.

2.8.2.8.3.D

The GRWPS shall be designed such as to limit effluents in accordance with the requirements specified in Section 2.1.3.2.

DA

The holdup for decay process of the radioactive gases before releasing may be performed by:

- collection of gases in a buffer tank or
- on-line release via a delay line (charcoal delay beds);
- a combined solution: decay retention tanks and activated carbon adsorbers.

DB

The GRWPS design shall assure that after the holdup for decay, the gases shall be discharged to a monitored discharge point, i.e. Plant* and/or Unit* stack.

DE

The Plant* and/or Unit* stack shall be of sufficient height to ensure effective dispersion of both discharges and potential accident releases, preferably 100 m or higher (see Section 2.1B.5).

2.8.2.8.3.E

The GRWPS shall be designed to prevent, detect and isolate any leakages.

2.8.2.8.3.F

The off-gas process stream shall be continuously maintained non-flammable by maintaining an oxygen free (< 4 percent by volume) atmosphere.

FA

Nitrogen shall be available for inerting during periods of transition from hydrogen rich reactor coolant (e.g., during shutdown for refuelling) and in the event of > 4 percent oxygen content of the gas stream.

2.8.2.8.3.1 RECOMBINER/VOLUME REDUCTION SYSTEM

2.8.2.8.3.1.A

Recombiner/Volume reduction feature can be used in order to reduce the quantity of waste gas, thereby permitting either a reduction in the size of the tank storage or delay system, or an increase in the hold-up or delay time.

2.8.2.8.3.1.B

Recombiner/Volume reduction systems shall have the following design features, in addition to the requirements for a typical tank storage system in Section 2.8.2.8.3.3:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 96/148

- for dilution type recombiners, provisions to ensure that condensable water vapour does not enter the catalyst vessel,
- for wet-proof catalyst recombiners, provisions to ensure that the catalyst is completely wetted by water,
- a means to direct gaseous Radioactive Waste* discharges through HEPA filters prior to release to the environment, if necessary.

2.8.2.8.3.2 CHARCOAL ADSORBER TYPE OFF-GAS SYSTEMS

2.8.2.8.3.2.A

The delay time in the charcoal adsorbers shall be sufficient to reduce radioactive gas discharges to the atmosphere such as to meet the radioactive discharge criteria as specified in Section 2.1.3.2, for the expected input rates, while taking into account other potential discharge sources, e.g., from HVAC.

2.8.2.8.3.2.B

The charcoal mass required shall be determined using the equation:

$$M = FT/K_d$$

where:

M = charcoal mass, gm

F = flow rate of carrier gas, cc/sec

T = average delay time, sec

K_d = dynamic adsorption coefficient, cc/gm

BA

All values are those at operating conditions.

2.8.2.8.3.2.C

A minimum of two charcoal adsorber beds, in addition to a guard bed, shall be provided with interconnections to bypass any of the beds.

2.8.2.8.3.2.D

Adsorption type waste gas processing systems shall include the following process design features:

- a means to remove moisture from the gas so that the required performance of the adsorbent may be achieved,
- a means to detect the formation of potentially flammable mixtures,
- a means to purge the system with an inert gas.

2.8.2.8.3.3 PRESSURIZED GAS STORAGE (BUFFER) TANK SYSTEM

2.8.2.8.3.3.A

If pressurized gas storage gas system is provided in GRWPS, pressurized gas storage gas systems shall have the following design features, in compliance with the requirements in Sections 2.8.2.8.2 and 2.8.2.8.3:

- multiple storage tanks to hold up the gas for decay,
- a means to transfer gas from one decay tank to another,
- a means to detect the formation of potentially flammable mixtures,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 97/148

- provisions to sample the tank contents,
- provisions to release gases from the system via a monitored release point,
- a means of diluting or purging individual tanks with an inert gas,
- a means to analyse the gas prior to release and monitor it during release,
- provisions that preclude the introduction of oxygen into the system due to air in-leakage pathways or from aerated liquid sources.

2.8.2.8.4 LIQUID RADIOACTIVE WASTE PROCESSING SYSTEM

2.8.2.8.4.A

This Section, together with the applicable portions of Section 2.8.2.8.2, specifies the requirements for the LRWPS.

AA

The specific equipment design requirements are specified in Chapter 2.7.

2.8.2.8.4.B

The LRWPS shall be available to receive input at all times and during all Normal Operation* conditions with sufficient capacity to accommodate the load-following transients and Anticipated Operational Occurrences*.

BA

The LRWPS shall achieve this requirement through a combination of storage capacity, processing capacity, equipment Redundancy* and/or cross connection, an appropriate combination of design margins, and recommended intervals of equipment replacement.

BB

The LRWPS shall have the ability, through tank storage and processing rate, to accommodate all waste volumes including the maximum anticipated. For system sizing purposes, it shall be assumed that the average flow rates and maximum flow per event all occur simultaneously.

2.8.2.8.4.C

The LRWPS shall provide for the collection, segregation, processing, and discharge or recycle of liquid radioactive wastes, storage and transfer of LRWPS generated wet solid waste (concentrates, resins and filter backwash sludges) to the SRWPS.

CA

Recycling shall be a preferred way.

2.8.2.8.4.D

The LRWPS shall be designed such as to limit effluents in accordance with the objectives of Section 2.1.3.2 (including reducing tritium discharges into the watercourses) and Section 5.3 CP06A.

DA

All the processed waste water from LRPWS shall be collected in the control tanks and sampled before discharge.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 98/148

DB

The discharge from the control tanks shall be controlled to ensure sufficient mixing in the waste water collection tank.

2.8.2.8.4.E

Liquid radioactive wastes shall be segregated by routing to the initial collection sump or tank.

EA

Segregation* shall be by provision of a subsystem to process each of the following waste categories:

- low conductivity wastes (CVCS let down and equipment drains),
- high conductivity waste (floor drains),
- chemical wastes,
- detergent wastes (including laundry wastes, wastes from personnel decontamination stations, and detergent type decontamination solutions),
- mixed wastes (including contaminated oil and potentially radioactive toxic or hazardous liquids).

2.8.2.8.4.F

Two parallel collection tanks shall be provided for large volume subsystem.

FA

For small volume subsystems, such as the chemical and detergent systems, single collection tanks are acceptable.

FB

Same solution shall be considered for the control tanks.

FC

Provisions for repumping between the tanks shall be provided.

2.8.2.8.4.G

There shall be control tanks wherein wastes are sampled and analysed as batches prior to routing for discharge or recycling, as appropriate.

GA

The processing flow rate and tank capacities for subsystems in LRWPS shall be determined by taking into account the following factors:

- the average daily flow rates and maximum flow per event of each category of waste,
- the cycle time required to perform each of the individual component operations. This includes the time necessary for operations such as ion-exchanger resins replacement; chemical adjustment of evaporator feed; tank and equipment feed; start-up and emptying time; mixing, sampling, and analysis; and Operator* availability to perform the necessary functions at the proper time.

2.8.2.8.4.H

If the evaporator system is used for LRWPS, the evaporator system processing design capacity shall be consistent with its subsystem flow rate and shall be sized based on a maximum availability factor of 75 %.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 99/148

2.8.2.8.4.I

Additive subsystems shall be provided for chemical additions, as required.

2.8.2.8.4.J

The Supplier* shall provide bypasses around process equipment as necessary to provide start-up requirements and operating flexibility.

2.8.2.8.4.K

Treated liquid waste activity concentration shall be measured downstream of the LRWPS to allow detection of waste treatment faults and automatic isolation.

2.8.2.8.4.1 LOW CONDUCTIVITY WASTES

2.8.2.8.4.1.A

Reactor coolant grade wastes shall be retained, to the extent practicable, by collection in the reactor coolant and auxiliary building drain tanks, and by reprocessing through the boron containing waste processing subsystem in order to minimize the amount of liquid waste to be processed by other subsystems of LRWPS.

2.8.2.8.4.1.B

The equipment drains shall be collected in equipment drain collector tanks and processed by filtration and ion-exchange and/or evaporator.

2.8.2.8.4.1.C

Degasification shall be accomplished prior to storage and sampling or evaporative processing.

CA

The boron containing waste processing subsystem shall provide degasification facilities to assure non-flammability, if not provided before.

2.8.2.8.4.1.D

Boron recycling shall be provided.

DA

Where the option of a boron evaporator is chosen, the evaporator bottoms shall be batch sampled and recycled to CVCS boric acid storage tanks.

DB

Evaporator distillate shall be recycled or routed to sample tanks for monitoring and discharge, if necessary.

2.8.2.8.4.2 HIGH CONDUCTIVITY WASTES

2.8.2.8.4.2.A

Floor drains shall be routed into the collector tanks and processed by mechanical filtration and ion-exchange and/or evaporator.

AA

It shall be possible to check and remove any possible contamination by oil.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 100/148

2.8.2.8.4.2.B

Floor drain collector tanks shall be provided with capability to adjust pH as required on a batch basis.

2.8.2.8.4.3 CHEMICAL WASTES

2.8.2.8.4.3.A

Chemical wastes shall be segregated and collected in the chemical waste tanks for processing prior discharge, if necessary.

AA

Non detergent decontamination solutions, chemical sample drains, and radiochemistry laboratory drains shall be considered to be chemical wastes.

2.8.2.8.4.3.B

pH shall be measured in the chemical waste tank and neutralization chemicals added as necessary to adjust the pH to meet discharge requirements.

2.8.2.8.4.4 DETERGENT WASTES

2.8.2.8.4.4.A

All detergent bearing wastes shall be segregated and collected for sampling and processing in the detergent waste subsystem, if necessary prior to discharge.

2.8.2.8.4.5 MIXED WASTES

2.8.2.8.4.5.A

Mixed wastes shall be kept separate and stored for disposal without on-site treatment.

AA

Mixed wastes include contaminated liquids such as oil, paint and other substances which require controlled disposal even if not radioactive.

2.8.2.8.4.5.B

Storage space shall be provided.

2.8.2.8.4.5.C

Storage space shall be designed to prevent risk to environment.

2.8.2.8.4.5.D

The storage shall be provided with fire detection and suppression systems.

2.8.2.8.5 SOLID RADIOACTIVE WASTE PROCESSING SYSTEM

2.8.2.8.5.A

This Section, together with the applicable portions of Section 2.8.2.8.2, specifies the requirements for the SRWPS.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 101/148

2.8.2.8.5.B

The design, construction, and operation of the SRWPS shall prevent the release of radioactivity to the environment and in-plant areas that could result in an undue risk to the health and safety of the public or Plant* personnel and/or environment.

2.8.2.8.5.C

The solid waste as prepared for disposal and transport shall comply with Limits and Conditions of Safe Operation at the Radioactive Waste Repository Dukovany (See Section 2.5.4).

CA

The waste shall be sorted, treated, conditioned and packaged as required and shall meet the applicable limits for activity and surface contamination and physical and chemical properties.

2.8.2.8.5.1 WET SOLID WASTE (WSW) PROCESSING SYSTEM

2.8.2.8.5.1.A

WSW processing system shall process following major streams: spent resins, filter backwash sludges, evaporator concentrates and tank sludges. Provisions for immobilization of wet solid waste shall be made.

AA

The immobilization system shall be based on the use of matrices with high level of waste load.

AB

In case of use of cementation, the system shall allow use of other inorganic matrices (e.g. aluminosilicates, mixed cement-aluminosilicate matrices, etc.).

AC

The Plant* shall include connection point for application of mobile processing technology of wet solid waste.

2.8.2.8.5.1.B

Spent ion-exchange resins shall be collected by type (bead or powdered) and/or by expected radiation level (low/high) in either a phase separation type tank or a resin storage tank.

BA

Sufficient storage capacity for decay shall be provided.

2.8.2.8.5.1.C

Processing shall include further concentration in phase separators (e.g. in evaporators) (with routing of the decant to LRWPS), followed by the immobilization technology in compliance with Radioactive Waste Repository Dukovany requirements, as specified by the "Limits and conditions of safe operation at the RWR Dukovany" regulation (see Section 2.5.4).

CA

The Supplier* shall define the physical characteristics of all wet solid wastes to be conditioned by the immobilization system, as well as the „as-shipped“ waste volume.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 102/148

2.8.2.8.5.1.D

Sufficient storage capacity shall be provided in the spent resins tanks and phase separators to allow for the processing time at the conditioning station and to accumulate delays due to maintenance, potential equipment failures or lack of containers.

DA

The Supplier* shall establish a process schedule and conditioning system capacity such that, periodically, an adequately decayed tank of wet solid wastes can be processed and shipped within one-half the time interval between successive discharges into spent resin tank or phase separator.

2.8.2.8.5.1.E

The wet solid waste transfer and conditioning system shall consist of a single Train* and provide for redundant components where within the Train*, e.g. instrument sensors, based on failure rate experience and ease of accessibility for repair or replacement.

2.8.2.8.5.2 DRY SOLID WASTE (DSW) PROCESSING SYSTEM

2.8.2.8.5.2.A

DSW processing system shall be capable of processing compactable wastes, such as paper, rags, and clothing, and non-compactable wastes, such as contaminated tools, discarded radioactive equipment parts, maintenance wastes, and filter cartridges.

AA

Incinerable waste shall be sorted for possible off-site incineration.

AB

Sufficient storages shall be provided for untreated waste.

2.8.2.8.5.2.B

The system shall provide for the following capabilities:

- transportation devices which provides shielding;
- compaction and packaging of the compactable dry active waste;
- packaging and immobilization of non-compactable dry active wastes including filter cartridges and ashes,
- fragmentation and packaging of large waste.

2.8.2.8.5.2.C

The system shall provide decontamination capabilities.

2.8.2.8.5.3 ON-SITE STORAGE FACILITY

2.8.2.8.5.3.A

Storage capacity for Radioactive Waste* shall be provided as specified in Section 2.2.5.3.

2.8.2.8.5.3.B

Storage facilities shall be designed and constructed for efficient handling, identification and accountability, Inspection*, loading and transport of waste.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 103/148

BA

The design shall respect the sorting requirements.

BB

Storage areas shall be provided for different types of wastes and in particular high radiation containers and low radiation containers.

BC

The configuration of drum storage area shall permit retrieval from storage of any drum on a row-by-row basis.

2.8.2.8.5.3.C

The storage shall be located in the controlled area as specified in the Section 2.11.2.5.2.2.1.

CA

The system shall contain provisions for controlling an inadvertent breach of a container, including monitoring and control for a potential airborne contamination, e.g., by the building HVAC system.

2.8.2.8.5.3.D

Sufficient shielding shall be used depending on the radiation level present in different areas.

2.8.2.8.5.3.E

Remote viewing for the high radiation storage area shall be provided.

2.8.2.8.5.3.F

Fire detection and suppression systems shall be provided.

2.8.2.8.5.3.G

The loading on trucks shall take place inside of the storage within the controlled area.

GA

For that purpose, the storage shall be equipped with sufficiently sized gate for radwaste trucks.

2.8.2.9 HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS (HVAC)

2.8.2.9.1 SCOPE

2.8.2.9.1.A

The following Sections give the functional requirements for the Heating, Ventilation and Air Conditioning (HVAC) systems of the Plant*.

AA

Specific requirements related to the containment HVAC systems are defined in Sections 2.9.4.1.4 and 2.9.4.2.1.

AB

Specific requirements related to the PGP and BOP systems are defined in Sections 4.6.2.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 104/148

2.8.2.9.2 FUNCTIONS

2.8.2.9.2.A

HVAC systems shall provide three different categories of functions:

- functions necessary to limit the possible release of radioactive substances into the external environment,
- functions necessary to maintain room air and noise conditions suitable to personnel and correct operation of equipment in all Plant States*,
- functions necessary for assuring safety of the emergency routes (in particular prevention of spread of fire and smoke).

2.8.2.9.3 SYSTEM REQUIREMENTS

2.8.2.9.3.A

The design of the HVAC systems shall meet the requirements for accommodating the Site* temperature and humidity ranges as specified in Section 2.4.1.2.

AA

HVAC systems shall provide a working environment in accordance with health and safety requirements for the workplaces as specified in the Rules*, in particular Government Order No. 361/2007 Coll., as amended, and as necessary for equipment operation.

AB

The Supplier* shall justify the temperature and humidity ranges in the rooms and buildings with regards to habitability and elimination of negative effects on equipment.

2.8.2.9.3.B

Adequate Redundancy* shall be provided for HVAC systems in accordance with the classification system and also with reliability and availability objectives, including need for maintenance.

2.8.2.9.3.C

To accommodate higher than calculated HVAC loads, the process related heat removal capacity shall include the 10 % margin in:

- the total heat/cool load,
- fan differential pressures,
- fan airflow.

2.8.2.9.3.1 PROTECTION AGAINST CONTAMINATION SPREAD

2.8.2.9.3.1.A

HVAC systems shall be divided into two main groups:

- systems for rooms subject to contamination,
- systems for other rooms.

2.8.2.9.3.1.B

HVAC system shall be designed to avoid the continuous use of respiratory protection.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 105/148

2.8.2.9.3.1.C

HVAC systems shall provide a minimum rate of air renewal to meet the health and safety requirements for the workplaces as specified in the Rules*, in particular in Gov. Order No. 361/2007 Coll., as amended, or higher if necessary for equipment operation.

CA

The rate of air renewal is defined by the ratio of airflow to the volume of the room in a once-through system, and the ratio of the airflow to the volume of the room by the average percentage of outside air to total air in recirculating systems.

CB

Air shall be renewed with external fresh air.

2.8.2.9.3.1.D

In addition, the HVAC systems for rooms subject to contamination, other than Primary Containment*, shall provide maximum control over the spread of radioactive gases within Plant* rooms and their release to the external environment as follows:

DA

- in order to minimise the risk of internal exposure, adequate rate of air renewal shall be provided based on ALARA evaluation for areas where this risk is high, in case of need for working in such areas,

DB

- in areas where the risk of internal exposure is non negligible but no iodine in gaseous form or radioactive liquids exist, the adequate rate of air renewal shall be provided based on ALARA evaluation,

DC

- in areas where the risk of internal exposure is negligible, the minimum rate shall be one volume per hour,

DD

- in order to limit spread of radioactive gases, the systems shall be of once through type.

2.8.2.9.3.1.E

The ventilation shall be designed to define the direction of air transfer from areas of least potential contamination to those of the highest potential contamination. For this purpose, a differential pressure in the range of about 50 Pa shall be maintained continuously between areas liable to radioactive contamination and the adjacent ones.

2.8.2.9.3.1.F

Iodine adsorber systems shall be testable for its efficiency without usage of radioactive iodine.

2.8.2.9.3.2 SYSTEM LAYOUT

2.8.2.9.3.2.A

Taking into account the risk of contamination, two ways of ventilation systems layout shall be designed:

- subsystems in parallel,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 106/148

- subsystems with air circulation between rooms.

2.8.2.9.3.2.B

Choice shall be done with respect of dimensions of systems, and economical and operational reasons.

2.8.2.9.3.2.C

The system layout choice shall not impair fire protection capabilities.

2.8.2.9.3.2.D

A single common exhaust stack for radioactive releases shall be used wherever possible.

2.8.2.9.3.2.E

HVAC subsystems in parallel:

EA

Systems shall be divided into subsystems according to the building concept in order to avoid contamination of "clean" areas by "dirty" ones.

EAA

In this case connections shall be avoided between different ventilated areas.

EB

This system layout shall provide stable pressure equilibrium between different rooms.

2.8.2.9.3.2.F

HVAC subsystems with air circulation between rooms:

FA

Facilities shall be laid out so that air circulates from areas least subject to contamination towards the most exposed ones.

FB

Air supply shall be situated in corridors or other "clean" rooms and air exhausts in areas with higher potential of contamination.

2.8.2.9.3.3 CONTAINMENT ISOLATION

2.8.2.9.3.3.A

The containment sweeping ventilation systems shall be designed to meet containment isolation requirements specified in Chapter 2.9.

2.8.2.9.3.4 PROTECTION AGAINST HAZARDS

2.8.2.9.3.4.A

Internal Hazards*:

HVAC system shall be designed to operate during Internal Hazards* like fire.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 107/148

AA

Such operability may include both continuous operation and/or switching off and isolation of smoke as required for protection of personnel in accordance with results of the fire hazard analysis.

2.8.2.9.3.4.B

Precautions shall be taken to protect iodine absorbers from fire.

2.8.2.9.3.4.C

HVAC systems shall also be designed to reduce the risk of fire spread and to extract smoke (see Sections 2.1.2.6 and 2.11.2.4.2).

2.8.2.9.3.4.D

D

The HVAC systems, which serve Fire Zones* protected with gas suppression systems, shall be interlocked with the functioning of the fire system.

2.8.2.9.3.4.E

External Hazards*:

Protection against External Hazards* relevant for Site* in extent necessary to ensure that Safety Functions* shall be performed in accordance with Site* conditions.

EA

The Hazards* include, but are not limited to, the following:

- explosion or chemical contamination,
- external fire and smoke,
- radiological effects of other nuclear facilities,
- extreme meteorological conditions, sandstorms, etc.; and
- consequences of an aircraft crash (including intentional) such as radiological effects, fire ball and pool fire combination, other consequential fires etc.

EB

HVAC design shall meet security system requirements for bullet resistance and personnel barriers.

2.8.2.9.3.5 INSTRUMENTATION AND CONTROL PRINCIPLES

2.8.2.9.3.5.A

Instrumentation and controls shall be designed to start-up iodine absorber systems and/or shutdown (isolate) ventilation systems not fitted with iodine absorbers once the radioactivity or radiation level exceeds a given threshold determined by fixed radiation detectors installed in rooms liable to be contaminated or in discharged ducts.

AA

Instrumentation and controls shall allow identification of location of the radioactive leak.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 108/148

2.8.2.9.3.5.B

Depending on the ventilation system and its functions, these operations may be automatic or controlled remotely by an Operator*.

BA

Iodine absorber systems, however, shall be started up remotely.

2.8.2.9.3.6 HABITABILITY



2.8.2.9.3.6.B

In Normal Operation* conditions, the following requirements shall be provided:

- continuous supply of filtered fresh air to replace the used air,
- acceptable relative humidity for equipment and personnel,
- the removal of heat dissipated by operating equipment and personnel and also external loads or loads from adjacent rooms in order to ensure that the maximum permissible ambient temperatures are not exceeded,
- heating to ensure the minimum permissible ambient temperatures.

BA

Applicable values are specified in Government Order No. 361/2007 Coll. Annex 1, as amended.

2.8.2.9.3.6.C

In Accident Conditions*, the following requirements shall be provided:

- continuous supply of filtered fresh air to replace the used air,
- the removal of heat dissipated by operating equipment and personnel and also external loads or loads from adjacent rooms in order to ensure that the maximum permissible ambient temperatures are not exceeded.

CA

Maximum and minimum permissible ambient temperatures, humidity and dose rates in Accident Conditions* shall be justified by the Supplier*.

2.8.2.9.3.6.D

In both DBC and DEC, the atmosphere shall be kept at a slight overpressure to prevent ingress of contaminated air from outside in case of radioactive contamination of the Site*.

Emergency Control Room may be kept at a slight overpressure during DBC only if justified in accordance with Section 2.1.7.4.7.

DA

In-leakage tests shall be performed to verify habitability assumptions.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 109/148

2.8.2.9.3.6.E

Appropriate filters and monitoring shall be provided on intake of fresh air.

2.8.2.9.3.6.F

HVAC shall be provided with airtight dampers allowing isolation, even in case of loss of AC power.

2.8.2.10 COOLING WATER SYSTEMS

2.8.2.10.1 SCOPE

2.8.2.10.1.A

This Section establishes the functional requirements for the cooling water systems.

AA

The Sections 2.8.2.10.2-6 set specific requirements for the following systems:

- Component Cooling Water System (CCWS),
- Essential Service Water System (ESWS),
- Fuel Pool Cooling and Cleanup System (FPCS),
- Chilled Water System (CDWS),
- Ultimate Heat Sink* (UHS).

2.8.2.10.1.B

The main goals for the design of the cooling water systems shall be:

- simplification of systems and standardisation of equipment to the extent not to jeopardize safety and the availability of the Plant* and/or Unit*,
- prevent deterioration and/or damage to components due to hydraulic and thermohydraulic phenomena such as water hammer, cavitation etc.,
- prevent deterioration of components due to various types of corrosion,
- preclude unmonitored release of radioactive liquids to the environment by means of adequately designed leak-detection methods, radioactivity measurements, and isolation devices,
- automation of system operation consistent with that provided for systems to which cooling water support is provided,
- components in parallel heat exchanger lines shall have isolation valves enabling their isolation, thereby allowing Maintainability* and protecting the Operability* of the remainder of the system or sufficient Redundancy* (i.e. number and capacity of trains),
- possibility blow-down of each components,
- ability to monitor and control of critical corrosion processes and fouling development,
- prevention of systems and their parts - pipes, exchangers, pumps from freezing when outside temperature is below 0 °C.

2.8.2.10.1.C

The Supplier* shall provide thermal and hydraulic performance analysis of cooling systems to demonstrate the design cost optimisation, taking into account the various operating conditions and the maximum/minimum cooling water and external air temperatures. See Section 2.4.1.2.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 110/148

2.8.2.10.1.D

The cooling water systems:

- shall maintain the circulation of coolant to remove heat from SSC during normal power operation, and reactor shutdown conditions, including the removal of decay heat, and to transfer those heat loads to the environment,
- act as a pressure boundary and Barrier*, when applicable, to prevent the release of radioactivity to the environment,
- Safety Functions* cooldown shall be based on the worst case weather expected.

2.8.2.10.1.E

The temperature differentials across the component cooling water heat exchangers and the essential service water and component cooling water flows shall be optimized based on operating considerations, safety requirements, and cost of both the cooling water systems and the heat sinks.

2.8.2.10.2 COMPONENT COOLING WATER SYSTEM (CCWS)

2.8.2.10.2.1 SCOPE

2.8.2.10.2.1.A

The Component Cooling Water System (CCWS) shall be closed-loop system which shall provide circulation of cooling water to remove heat from the Unit* systems and transfer it to the ESWS. It shall consist of independent piping sub-systems, each with pumps, heat exchangers, and associated equipment as required for regulating the cooling water flows.

AA

When CCWS provides also heat removal for safety loads, the degree of Segregation* between safety and non-safety loads shall be assessed with due consideration given to the functional, safety and reliability goals..

2.8.2.10.2.2 FUNCTIONS

2.8.2.10.2.2.A

The CCWS shall be designed to perform the following functions:

- remove heat from equipment including those which are in contact with radioactive substances and transfer it to the ESWS,
- protect against leakage of service water into the Nuclear Island* fluid systems,
- protect against release of radiological contamination into the Ultimate Heat Sink*.

AA

NA

2.8.2.10.2.3 SYSTEM REQUIREMENTS

In addition to the general requirements applicable to all water cooling systems specified in Section 2.8.2.10.1, the CCWS shall satisfy the following requirements::

2.8.2.10.2.3.A

The CCWS shall comprise a closed-loop system to transfer component heat loads via heat exchangers to the ESWS and the Heat Sink*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 111/148

2.8.2.10.2.3.B

Segregation* shall be provided between the CCWS and the corresponding system for the Power Generation Plant* (PGP).

2.8.2.10.2.3.C

If the system supports both safety and non safety loads, the following requirements shall be fulfilled:

CA

- Non-safety heat loads shall be automatically separated from the safety loads on an engineered safety actuation signal or in case of detection of leakage,

CB

- The system shall be designed, and the heat loads distributed, such that the loops are approximately equally sized,

CC

- The system shall meet the same requirements related to Redundancy* and separation as those applicable to the supported equipment,

CD

- There shall be no cross connections between the safety divisions of the system unless an improvement in safety, operability or availability is demonstrated.

2.8.2.10.2.3.D

Redundancy* of the system for the support of non-safety loads only shall be sufficient to meet the reliability and availability objectives and to provide defence in depth.

2.8.2.10.2.3.E

A source of make-up water shall be provided to each Division* and shall be able to compensate for leaks and to provide for timely alarms and to prevent for the Operator* action.

2.8.2.10.2.3.F

An adequate facility shall be provided to drain the system water partially or completely into the storage tank (within the CCWS or other system).

2.8.2.10.2.3.G

An adequate facility shall be provided to monitor and control the system water chemistry.

2.8.2.10.2.3.H

The water temperature shall be manually controlled in order to avoid reaching and exceeding of minimum and maximum boundary temperatures, at which it is possibly to operate the equipment which have to be cooled. The temperature indicator and alarm shall be provided to confirm the temperature in MCR.

HA

Ambient condensation shall be avoided on the pipes and the equipment, which have to be cooled.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 112/148

2.8.2.10.2.3.I

A leak detection system shall be provided to detect any contamination of the CCWS water.

IA

The leak detection system shall alarm the Operators* of high activity in the system and shall allow identification and isolation of the leakages.

IB

The sampling shall be performed to analyse samples from the system, regularly, or whenever there is an indication of potential (such as high water level in the surge tanks) during Normal Operation*.

2.8.2.10.2.3.J

An elevated surge tank, connected to the pump suctions, shall supply make-up water to the cooling loop.

2.8.2.10.2.3.K

The surge tank shall keep the system full, minimize system pressure variations, help maintain NPSH available, and absorb thermal expansion and contraction.

2.8.2.10.2.3.L

The surge tank shall be supplied with make-up water and tank vents.

2.8.2.10.2.3.M

The manual make-up for initial fill of the system shall be capable of filling the system in a reasonable time. This may be a remote manual operation.

2.8.2.10.2.3.N

The make-up for the Normal Operation* shall be automatic and shall be able to compensate for the largest relief valve sticking open sufficiently to provide for timely alarms and the Operator* action to prevent equipment damage.

2.8.2.10.3 ESSENTIAL SERVICE WATER SYSTEM (ESWS)

2.8.2.10.3.1 SCOPE

2.8.2.10.3.1.A

The ESWS takes water from the Ultimate Heat Sink*, provides cooling of the component cooling water system, and transfers heat to the Ultimate Heat Sink*.

AA

It consists of pumps, heat exchangers, and associated equipment as required for regulating the system flow.

2.8.2.10.3.1.B

The ESWS shall provide a reliable path to Ultimate Heat Sink* from the closed cooling water circuit heat exchangers.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 113/148

2.8.2.10.3.2 FUNCTIONS

2.8.2.10.3.2.A

The ESWS shall be designed to remove the heat from heat exchangers of the component cooling water system CCWS (which cools safety and non-safety loads), and to transfer it to the Ultimate Heat Sink*.

2.8.2.10.3.2.B

Segregation* between the ESWS and the corresponding system for the Power Generation Plant* (PGP) shall be consistent with the Segregation* applied to the component cooling water system (CCWS).

BA

Each Division* shall be provided with a minimum of one motor pump and two heat exchangers and the pump and heat exchangers shall be sized such that full power operation can be supported with one pump and one heat exchanger out of service, or sufficient Redundancy* of trains shall be provided.

2.8.2.10.3.3 SYSTEM REQUIREMENTS

In addition to the general requirements applicable to all water cooling systems as defined in Section 2.8.2.10.1, the ESWS shall satisfy the following specific requirements:

2.8.2.10.3.3.A

Direct service water shall not be used for cooling equipment.

2.8.2.10.3.3.B

Where the ESWS supports safety loads, it shall meet the same requirements related to Redundancy* and separation as those applicable to the component cooling water system (CCWS) and supported equipment.

BA

Moreover, if some non safety loads are connected, the CCWS requirements, defined in Section 2.8.2.10.2.3, shall also apply to ESWS.

2.8.2.10.3.3.C

There shall be no cross-connections between the independent divisions of the system unless an improvement in safety, Operability* or availability is demonstrated.

2.8.2.10.3.3.D

Redundant divisions are not required for the support of non-safety equipment except where they provide Defence in Depth*, specifically in Plant* designs with passive features.

2.8.2.10.3.3.E

The ESWS shall be designed to minimise the risk of damage to other systems by service water.

2.8.2.10.3.3.F

The ESWS shall be provided with the facility for:

- piping Inspection* and replacement,
- flushing of stagnant treated water at full flow,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 114/148

- easy maintenance and cleaning of heat exchangers,
- minimum flow operation of components that are not operational, and draining and filling them with treated water,

2.8.2.10.3.3.G

Blowdown of ESWS from each Division* shall be provided.

GA

The whole blowdown shall be possible to discharge only from the cool down branch of ESWS.

GB

Blowdown shall be drained to the waste water collection system.

GC

Blowdown calculations and estimated blowdown concentrations shall be provided.

2.8.2.10.3.3.H

The Supplier* shall design the ESWS chemistry, water treatment and blowdown facilities taking into account makeup water quality at the Site*, environmental restrictions, and Site*-specific evaporation rate.

2.8.2.10.3.3.I

The Supplier* shall provide adequate means to control and monitor the ESWS chemistry as specified in Section 4.5.3.2.

2.8.2.10.3.3.J

Every ESWS Division* shall have floor drainage loop from components to dedicated drain system.

2.8.2.10.3.3.K

ESWS pumps discharge piping shall be equipped with a strainer and/or a silt removal capability, consistent with the fouling design limits established for the heat exchanger tubing piping designs.

KA

Provisions for periodic cleaning and backflushing, as necessary for the system surfaces, shall be included. System unavailability to perform these required functions shall be minimized.

2.8.2.10.3.3.L

If cooling water supplies for the pump seals or packing and the motor bearings (if required) is provided from the pumped fluid, it shall be through suitable strainers.

2.8.2.10.3.3.M

The Supplier* shall include provisions to ensure surveillance of biofouling and silting can be accomplished.

MA

The provisions shall facilitate visual Inspections* of intake structures and monitoring populations of biofouling agents.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 115/148

2.8.2.10.4 FUEL POOL COOLING AND CLEANUP SYSTEM (FPCS)

2.8.2.10.4.1 SCOPE

2.8.2.10.4.1.A

The Fuel Pool Cooling System shall be designed to perform the removal of decay heat generated by spent Fuel Assemblies* which are stored in the spent fuel pool so that Fuel Assemblies* are cooled properly all the time.

AA

Requirements specific to the spent fuel pool are specified in Section 2.8.2.6.

2.8.2.10.4.1.B

This pool cooling system shall be also designed, to maintain the quality and visual clarity as well as the level of the water, for spent fuel handling and for filling the refuelling cavity.

2.8.2.10.4.1.C

The system shall consist of pumps, piping, heat exchangers, filter and demineraliser capacity and associated equipment, and control for regulating the system flow.

2.8.2.10.4.2 FUNCTIONS

2.8.2.10.4.2.A

The system shall be designed to perform the following functions:

- maintain the spent fuel pool at a temperature below that specified for the storage and handling of the Fuel Assemblies*,
- provide make up and maintain the water quality within the specified limits for the fuel pool and refuelling cavity,
- maintain the quality of the refuelling water storage within the specified limits and ensure its transfer between the spent fuel pool or the refuelling cavity (for cask loading).

2.8.2.10.4.3 SYSTEM REQUIREMENTS

In addition to the general requirements applicable to all water cooling systems specified in Section 2.8.2.10.1, the system shall satisfy the following requirements:

2.8.2.10.4.3.A

It shall consist of at least two subsystems.

AA

Cross-connections between the sub-systems or interconnections with other Safety Systems* shall be avoided unless an improvement in safety, operability or availability can be demonstrated.

2.8.2.10.4.3.B

The possibility of connecting the system or the spent fuel pool to the refuelling water storage (RWST, IRWST) shall be provided.

2.8.2.10.4.3.C

The system shall provide makeup and allow draining of the pools.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 116/148

2.8.2.10.4.3.D

The system together with the spent fuel pool design shall assure sufficient flow and mixing in the spent fuel pool with as little turbulence as possible to avoid thermal and mechanical damage to the fuel and the pool.

DA

In case flow diffusers are used, they shall be controlled at the operating floor to enable the local Operator* to achieve optimum recirculation patterns.

2.8.2.10.4.3.E

The system shall not allow the level of water in the fuel pool to fall below that required for spent fuel cooling and radiological shielding.

2.8.2.10.4.3.F

In Normal Operation* conditions including refuelling, the water temperature in pools shall remain below 50 °C with the fuel storage capacity specified in Section 2.2.5.1.

2.8.2.10.4.3.G

Even when performing maintenance of one subsystem, that fuel pool temperature limit of 50 °C shall be maintained.

GA

Regular maintenance shall be scheduled to be performed at power operation, when the spent fuel pool decay heat is minimal.

2.8.2.10.4.3.H

When active spent fuel pool heat removal systems are used, the temperature during DBA shall not exceed temperature which could jeopardize function of the cooling system (maximum of 80 °C).

2.8.2.10.4.3.I

If passive safety heat removal system is used, in DEC, and in DBA, boil-off is an acceptable way to remove the spent fuel heat as long as emergency makeup is ensured.

IA

For that purpose, the Supplier* shall demonstrate that:

- integrity and leaktightness of the fuel storage racks and fuel pool structures and liner are guaranteed during boil-off operation,
- fuel criteria are not exceeded,
- subcriticality is maintained,
- the safety objectives and radiological release targets are met.

IB

Sufficient water inventory shall be maintained during boil-off operation to ensure that boiling conditions will not preclude potential necessary access by personnel to perform accident action, if necessary.

IC

Adequate radiological shielding shall be provided for necessary personnel actions, if needed, even in case of total loss of cooling.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 117/148

ID

The system components such as pumps, valves, heat exchangers and piping shall be capable of operating at saturated conditions at 100 °C to allow their restart and operation during/after boil-off conditions.

2.8.2.10.4.3.J

Connection points shall be provided in order to supply cooling water to the spent fuel pool using Non-Permanent Equipment*.

2.8.2.10.5 CHILLED WATER SYSTEMS (CDWS)

2.8.2.10.5.1 SCOPE

2.8.2.10.5.1.A

The Chilled Water Systems (CDWS) shall provide chilled water for cooling HVAC loads and, when required, some process loads.

2.8.2.10.5.1.B

These systems consist of sub-systems, each with a chilled water pump, heat exchanger, refrigeration loop (chiller) and associated controls.

2.8.2.10.5.2 FUNCTIONS

A

The CDWS shall provide the following functions in DBC 1-2 and also in DBA and DEC if required:

- supply a sufficient quantity of chilled water to different loads in specific areas,
- ensure sufficient chiller water flow for HVAC and process loads,
- ensure air cooling when ventilation is performed by the containment cooling system.

AA

The chilled water shall be provided for post accident cooling, if required after an accident.

2.8.2.10.5.3 SYSTEM REQUIREMENTS

In addition to the general requirements applicable to all water cooling systems as defined in Section 2.8.2.10.1, the CDWS shall satisfy the following specific requirements:

2.8.2.10.5.3.A

The CDWS shall be a centralised system that will supply HVAC loads in different buildings.

2.8.2.10.5.3.B

Its chillers shall be cooled by the component cooling water system or by air.

2.8.2.10.5.3.C

The performance of the chillers, when cooled by the component cooling water system (CCWS), shall be based on its water temperature, on the heat loads and Site* conditions (See Section 2.4.1).

2.8.2.10.5.3.D

The CDWS containment penetrations shall meet the requirements given in Section 2.9.4.1.6.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 118/148

2.8.2.10.5.3.E

Normal make-up shall be provided to the CDWS.

2.8.2.10.6 ULTIMATE HEAT SINK (UHS)

2.8.2.10.6.1 SCOPE

2.8.2.10.6.1.A

The Ultimate Heat Sink* (UHS) in evolutionary plants is the final repository for heat rejected from the Essential Service Water System (ESWS) following an accident and during Normal Operation*. It consists of cooling tower with water storage structures or cooling ponds, makeup lines, blowdown lines and associate valves, controls and instrumentation.

AA

The capability to transfer heat to an Ultimate Heat Sink* shall be ensured for all Plant States* and heat transfer function shall be fulfilled for Rare and Severe External Hazards* taking into account the Site* hazard evaluation.

AB

Systems for transferring heat shall have adequate reliability for the Plant States* in which they have to fulfil the heat transfer function. This may require the use of a different Ultimate Heat Sink* or different access to the Ultimate Heat Sink*.

2.8.2.10.6.1.B

NA

2.8.2.10.6.2 PERFORMANCE REQUIREMENTS

In addition to the general requirements applicable to all water cooling systems as defined in Section 2.8.2.10.1, the UHS shall satisfy the following specific requirements:

2.8.2.10.6.2.A

The UHS shall be capable of providing heat removal in all Plant States* (including DBA, DEC and Hazards*).

AA

A worst case weather profile for the Site* shall be used as described in Section 2.4.1.2.2.

2.8.2.10.6.2.B

The UHS shall be capable of performing its intended function during freezing weather.

BA

System features shall be provided to control the potential impact of freezing of the UHS.

BB

The Supplier* shall provide supporting analyses showing that the function of the UHS is not impaired during winter months. Weather conditions from the Site* survey shall be used for this analysis and the effects of icing of the in-take structure shall be considered.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 119/148



2.8.2.10.6.2.D

A report of the analysis used for sizing the UHS shall be provided and shall include the following information as a minimum:

- A description of the Ultimate Heat Sink* model, including weather parameters, UHS facility parameters, heat transfer equations, and engineering assumptions,
- Conservative weather profiles and “realistic” conditions,
- 30-day heat load profile for DBA and DEC,
- Heat load profiles for the Normal Operation* and normal shutdown using the ESWS,
- Results of the analysis, including cooling water temperatures and expected uncertainty.

2.8.2.11 PROCESS RADIATION MONITORING SYSTEM

2.8.2.11.1 SCOPE

2.8.2.11.1.A

The Process Radiation Monitoring System (PRMS) shall consist of several radiation protection channels including a detection assembly and a processing and indicating centralised assembly.

2.8.2.11.1.B

The PRMS shall perform its functions in DBC, DEC and the post-accident conditions.

2.8.2.11.1.C

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

2.8.2.11.2 FUNCTIONS

2.8.2.11.2.A

The PRMS shall provide the verification of the conformance of the Plant* operating radiological conditions with the Technical Specifications* concerning radiation protection and radioactive releases.

2.8.2.11.2.B

Radiation protection channels shall ensure:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 120/148

BA

Systems and Components* shall be monitored to detect radioactive contamination and effectivity of the filtering equipment.

2.8.2.11.2.C

Sampling points for relevant systems shall be installed for intermittent monitoring by laboratory analyses (especially for systems which do not operate in the Normal Operation* conditions).

2.8.2.11.2.D

Radiation protection channels shall provide alarms or initiate actions to limit release when a predetermined value is reached.

2.8.2.11.3 SYSTEM REQUIREMENTS

2.8.2.11.3.A

The PRMS channels shall perform its functions:



2.8.2.11.3.B

The relevant PRMS data shall be available for display in the MCR, ECR, TSC and other accident management centres (e.g. OSC, ECC) as required, in radiation monitoring control room, if any, and recorded for long-term storage.

BA

Software to display relevant PRMS data, in particular in radiation monitoring control room, shall allow basic mathematical analysis (trend analysis, data fitting, prediction of data development, etc.).

2.8.2.11.4 MONITORING OF CONFINEMENT BARRIERS

2.8.2.11.4.A

Integrity of the first confinement Barrier* and integrity of the second confinement Barrier* shall be monitored continuously by measurement of the activity of media (e.g. reactor coolant, containment atmosphere, steam, SG blowdown, condensate water, cooling media in CCWS etc.) in contact with the Barriers* in all DBC and DEC, as applicable.

AA

Batch sampling shall be used to analyse the specific radionuclides presence.

2.8.2.11.4.B

For the second Barrier*, radioactive monitoring shall be performed continuously on the atmosphere of rooms crossed by reactor coolant pipes, and, on the fluids (liquids and gases) which are not normally active but could be contaminated by leakages from radioactive systems for the case of loss of integrity of the second Barrier*.

2.8.2.11.4.C

Also the atmosphere of different buildings such as the reactor, fuel, nuclear auxiliary, safeguard auxiliary and waste treatment buildings shall be monitored continuously.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 121/148

2.8.2.11.4.D

Liquid from the component cooling system shall be monitored as well as the secondary side of the Steam Generators*.

2.8.2.11.4.E

Under the post-accident conditions including DBA and DEC, the PRMS shall provide identification and counting of the radiologically significant releases into the containment atmosphere.

2.8.2.11.4.1 MONITORING OF THE FIRST BARRIER

A

The activity of fission products and eventually transuranium elements shall be measured with no additional samplings than the one required in Section 2.8.2.5.2 (also used for corrosion and activation products) so as to avoid supplementary confinement systems.

AA

Measurements shall be based on detection of gamma rays, with automatic start-up and permanent availability.

2.8.2.11.4.2 MONITORING OF THE CONTAMINABLE AREAS

2.8.2.11.4.2.A

Detection of leakages:

AA

All the radioactive products which may be released into the Primary Containment* atmosphere in case of leak from the RCS shall be detected.

AB

Continuous monitoring of the atmosphere in the Primary Containment* shall ensure monitoring of all radiologically significant radionuclides (e.g. iodines – I₁₃₁, noble gases – Kr₈₅, aerosols - Rb₈₉, Cs₁₃₈ and Co₆₀).

2.8.2.11.4.2.B

Secondary cooling fluid:

BA

Activity measures on main steam pipes (e.g. nitrogen-16 and noble gases), blow-downs (e.g. iodine and other radionuclides such as potassium-42 and sodium-24) and condenser (e.g. noble gases) shall be provided to monitor continuously secondary side activity and to provide automatic protection and Operator* alarm.

BB

Attention shall be paid to capability to detect activity of the secondary cooling fluid during outages and during Plant* start-up after an outage.

2.8.2.11.4.2.C

Other fluids:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 122/148

CA

Activity measures of the fluids (liquids and gases) which are not normally active but could be contaminated by leakages from RCS and various radioactive systems.

2.8.2.11.4.2.D

Monitoring of ventilation from rooms subject to contamination:

DA

Air contamination measures shall be provided on main ventilation ducts from rooms subject to contamination.

DB

Taking account of the number of ducts to be monitored, scanning measures shall be provided with a scanning time per duct to give adequate channel response time.

DC

Shutdown of normal ventilation and start-up of the iodine and particulate filtering system shall be actuated automatically when the limit is exceeded.

2.8.2.11.4.2.E

Monitoring of miscellaneous tanks:

EA

Any tank which may contain radioactivity as a result of leaks shall be monitored.

2.8.2.11.5 MONITORING OF RADIOACTIVE RELEASES

2.8.2.11.5.A

Monitoring of releases to the environment shall be ensured at all normal release points (e.g. vent stack, control tanks and discharge lines etc.) and, as reasonably practicable, at all potential release points where releases may occur during DBA and DEC.

Note A:

According to Section 2.1.3.2.4, it is expected that one of the normal release point will be also MCWS cooling towers.

2.8.2.11.5.B

The monitoring of liquid and gaseous releases shall ensure:

- balance measurement of all radioisotopes to determine released activity for all released radionuclides,
- continuous monitoring of representative radionuclides for rapid detection of potential deviation from Normal Operation*,
- monitoring of potential release points during DBA and DEC.

BA

Detection of potential deviation from Normal Operation* shall be annunciated to MCR, ECR and other control centres as required (e.g. radiation monitoring control room).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 123/148

BB

The Supplier* shall identify all potential release points during DBA and DEC.

Note BB:

They may include main steam relief valves, ESWS, non-radioactive liquid waste system, sewage drainage system, stormwater drainage and discharge system etc.

2.8.2.11.5.C

Monitoring shall meet requirements of the Decree No. 360/2016 Coll., as amended.

2.8.2.11.5.D

Liquid releases:

DA

Continuous measurements of activity concentration of liquid releases shall be provided on the liquid radwaste discharge system when discharge is taking place.

DB

When any limit is exceeded, automatic isolation of the discharge line shall occur accompanied by an alarm.

DC

However, the limits of activity shall be checked before the actual discharge from the control tank.

DD

Sampling for nuclide specific laboratory analysis shall be enabled at each control tank.

DE

The balance measurement shall be provided for all radioisotopes of liquid releases.

2.8.2.11.5.E

Gaseous releases:

EA

All gaseous releases shall be discharged through the stack of the nuclear auxiliary building (releases may be stored to allow radioactive decay).

EB

The activity concentration of noble gases, particulates, halogens, and airflow shall be continuously monitored and recorded over a wide range of activity and shall include an alarm.

EC

Sampling for nuclide specific laboratory analysis shall be enabled at each ventilation stack.

ED

The balance measurement shall be provided for all radioisotopes of gaseous releases.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 124/148

2.8.2.11.5.F

As a possible Variation (as per Chapter 8, Terms and Conditions*), dose rate shall be monitored at boundary of the Limited Access Area*.

For avoidance of doubt the above dose rate monitoring at boundary of the Limited Access Area* 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*.

2.8.2.11.6 PERSONNEL PROTECTION

2.8.2.11.6.A

Dose rate shall be monitored by permanent equipment at Plant* locations which are routinely accessible by operating personnel (such as the reactor building, outer surface of the Reactor Cavity*, refuelling machine area, in the areas of spent fuel pools, waste building, decontamination rooms, etc. (see also Section 2.11.2.5.4.3).

2.8.2.11.6.B

Monitors shall also be provided in areas subject to possible contamination as a result of equipment failure or other unusual circumstances.

2.8.2.11.6.C

Stationary dose rate meters shall be installed to indicate the general radiation levels at suitable Plant* locations in Accident Conditions*. The stationary dose rate meters shall provide sufficient information in the control room or in the appropriate control position that operating personnel can initiate corrective action if necessary.

CA

A radiological protection channel shall be provided at the air intake of the MCR, ECR, TSC and other accident management centres (e.g. OSC, ECC) as required, to measure beta activity and, if needed, to enable an automatic or manual closure of the air intake or start-up the iodine and particulate filtering system.

2.8.2.11.6.D

The volumetric activity of atmosphere in the Primary Containment* and other Plant* locations (see requirement A and B) shall be permanently monitored.

2.8.2.11.6.E

Associated alarms shall be provided for personnel evacuation and for confinement of radioactive gases with automatic actions.

2.8.2.11.6.F

The monitors shall be designed and calibrated according to their potential use in different Plant* modes.

2.8.2.11.6.G

Equipment used to lift potentially highly radioactive fuel or reactor components (e.g. refuelling machine and reactor service bridge) shall be equipped with redundant high radiation interlocking and alarm functions.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 125/148

2.8.2.11.6.H

For the filters of systems subject to contamination (e.g. the CVCS), dose rate shall be measured to permit replacement of filters before the excessive dose rates are reached.

HA

The replacement of filter cartridge shall be performed by means of shielding cask.

2.8.2.11.6.I

Surface contamination shall be monitored in all areas containing large quantities of radioactive liquids and solid active waste.

2.8.2.11.7 RADIATION MONITORING DURING DBA AND DEC

2.8.2.11.7.A

Accessibility to the sampling points for systems involved or used during DBA and DEC shall be taken into account in design.

2.8.2.11.7.B

Containment atmosphere:

BA

In order to have indications of containment atmosphere contamination, at least one measurement of the dose rate shall be continuously provided.

BB

If the measurement is not permanent the sampling frequency shall be high enough to allow the complete evolution of the monitored parameters to be reconstructed.

BC

Furthermore, the activity of air and quantity of radioisotopes in the containment atmosphere shall be measured and displayed by spectral analysis on demand.

2.8.2.11.7.C

Gaseous releases:

CA

The activity concentration of gaseous releases discharged from the Plant* and/or Unit* shall be measured continuously in a range corresponding to the DBA and DEC.

2.8.2.11.7.D

Primary coolant:

DA

Radiation monitoring channels shall measure continuously the activity of the reactor coolant even when the activity is high.

2.8.2.11.7.E

Waste in sumps:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 126/148

EA

Measurement of dose rate shall be continuously provided for each sump which is susceptible to collecting highly contaminated waste.

EB

Automatic isolation of the discharge of sumps to the radwaste processing system shall occur when the limit is exceeded.

2.8.2.12 PROCESS INSTRUMENTATION & CONTROL FUNCTIONS

2.8.2.12.A

The I&C systems shall perform Safety and non-Safety Functions* as well as monitoring functions required for the overall safety, performance and availability of the Plant*.

2.8.2.12.B

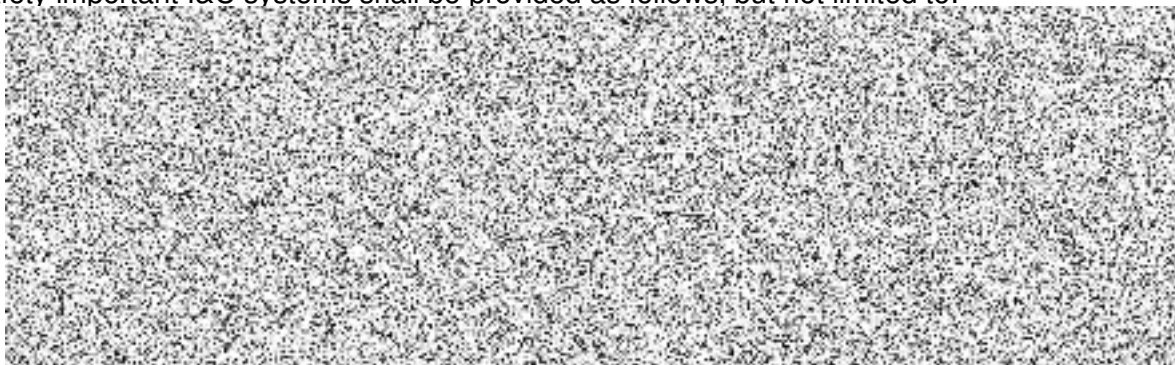
The list of defined parts of I&C shall be provided and justified for transparency of I&C design principles and to identify Site* or country specific requirements applied into the I&C architecture.

2.8.2.12.C

In the following sections, the requirements are only related to main functions of I&C systems. Other design requirements for I&C are detailed in Chapter 2.10.

2.8.2.12.D

Safety important I&C systems shall be provided as follows, but not limited to:



2.8.2.12.E

The definition of the I&C architecture and the allocation of the functions in the different systems according to the DiD principle, including the definition of necessary automatic and Human-Machine Interface (H-MI) functions of I&C systems according to the accident management approach, shall be provided by Supplier*.

2.8.2.12.F

I&C systems shall take over automatically monotonous and repetitive actions such as control of essential process variables and transition of equipment to all power level changes (e.g. start-up/shutdown of pumps) in Normal Operation* conditions.

2.8.2.12.G

I&C systems shall also take over automatically functions where manual actuation adds no value such as:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 127/148



2.8.2.12.H

I&C systems shall also take over automatically some complex functions or functions where quickness of action is required.

Nevertheless the appropriate level of automation shall be supported by extensive analysis.

2.8.2.12.I

The functions shall be provided following the levels structure defined in the Section 2.10.5.4.2.1.

2.8.2.12.J

Challenges to the Protection System* due to equipment failures and process disturbance shall be minimized. The control systems shall keep the process parameters, which are essential for the safety and availability of the Plant*, within given limits and shall prevent the escalation of an upset to a condition which activates the Protection System* following Defence-in-Depth* principles defined in the Section 2.1.1.

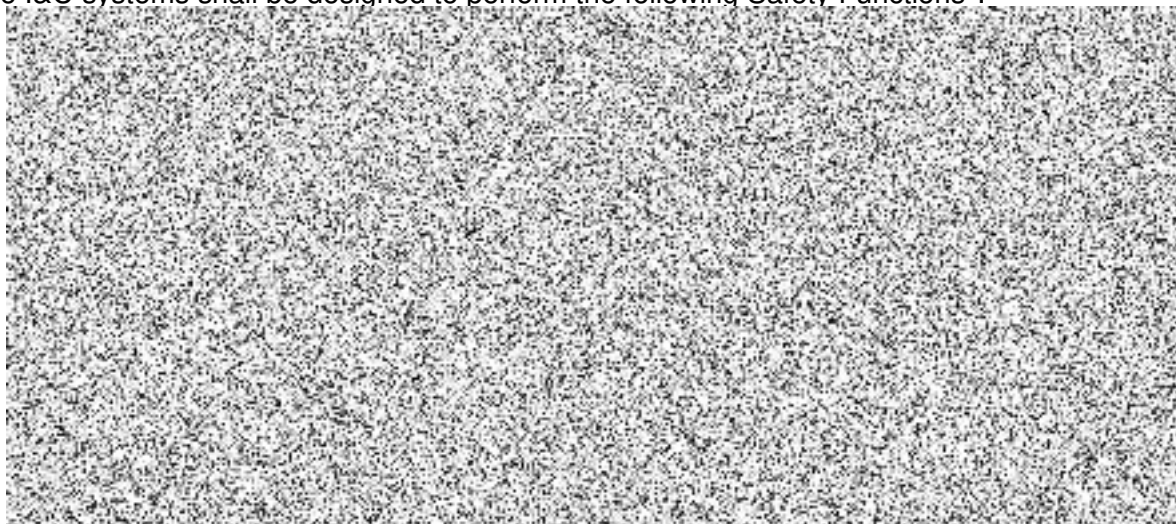
2.8.2.12.K

Design of I&C systems shall follow Defence-in-Depth* principles defined in the Section 2.1.1 in any case.

2.8.2.12.1 SAFETY FUNCTIONS

2.8.2.12.1.A

The I&C systems shall be designed to perform the following Safety Functions*:

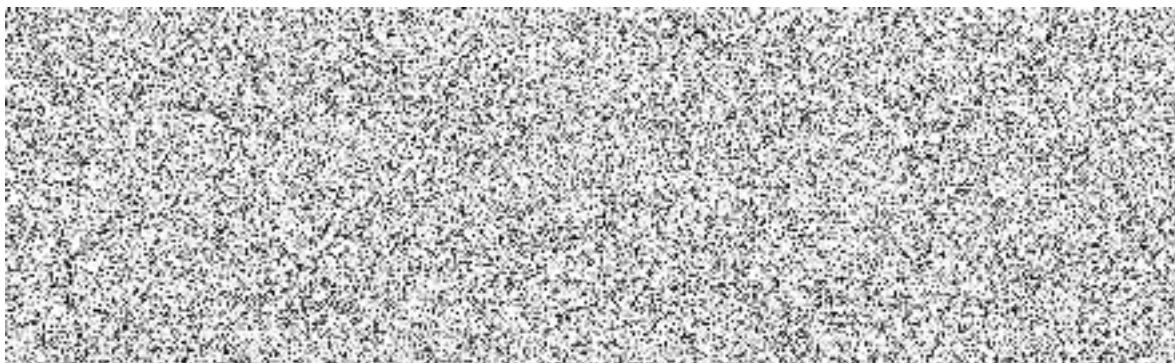


2.8.2.12.2 NON-SAFETY FUNCTIONS

2.8.2.12.2.A

The I&C systems shall be designed to perform the following non-Safety Functions*, but not limited to:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 128/148



2.8.2.13 REACTOR PROTECTION SYSTEM

2.8.2.13.1 SCOPE

2.8.2.13.1.A

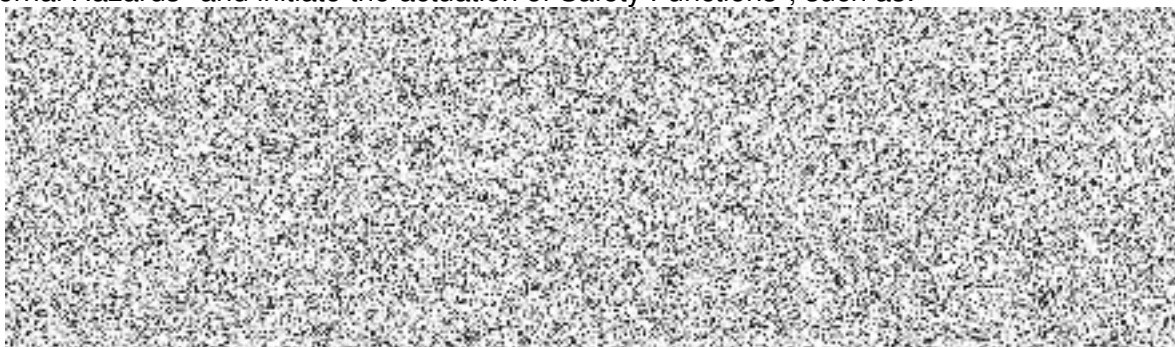
The Protection System* encompasses all the equipment required to:



2.8.2.13.2 FUNCTIONS

2.8.2.13.2.A

The Protection System* shall detect DBC and DEC conditions and External Hazards* and Internal Hazards* and initiate the actuation of Safety Functions*, such as:



AA

This Safety Systems* include, but are not limited to, the systems defined in Section 2.8.2.4 and Section 2.9.4. In addition, number of support systems are needed such as Emergency Power Supply*, HVAC, heat removal, etc.

2.8.2.13.2.B

The list of specific Safety Functions* and the systems and equipment necessary for their actuation shall be specified by the Supplier*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 129/148

2.8.2.13.2.C

The Protection System* shall also provide the following functions:



CA

These signals are used, for instance, when increasing the power from zero power conditions

2.8.2.13.2.D

For protection from CCF, Diverse Protection System* shall be provided as specified in Section 2.10.7.7.

2.8.2.13.2.E

In addition, systems for management of Severe Accidents* shall be provided.

2.8.2.13.3 SYSTEM FUNCTIONAL REQUIREMENTS

2.8.2.13.3.A

The Protection System* shall fulfil the following functional requirements:



AA

Consistent with Chapter 2.10, only functional (not system specific) requirements are defined in this chapter. This seeks to avoid providing design solutions for implementation of the Protection System*.

AB

The requirements for I&C functions not included in the Protection System* are presented in Chapter 2.10.6.2.2

2.8.2.13.3.B

A capability shall be provided to verify that the monitored variables and the set-points for the corresponding protective action initiation are adequate.

2.8.2.13.3.C

Set-points shall be determined which take into account the need for a margin with respect to the safety limits of the Plant* and/or Unit*. The margin itself shall take account of, but not limited to:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 130/148

The bases for nominal set points and margins taken (allowable limits) shall be documented and justified.

2.8.2.13.3.D

The Plant* and/or Unit* shall use a minimum number of parameters to provide reactor trip signals and initiate the Safety Functions*, consistent with Plant* and/or Unit* safety and which shall provide an adequate margin between the normal operating range and the initiating set-point for each safety function

2.8.2.14 NON PROCESS INSTRUMENTATION & CONTROL FUNCTIONS

2.8.2.14.1 MANAGEMENT OF ENVIRONMENTAL IMPACT OF THE RADIOACTIVE RELEASES

2.8.2.14.1.A

Radioactive release management function shall be implemented for both DBC and DEC including the post-accident conditions.

AA

The computing tools shall be selected in cooperation with the Owner* and the final choice shall be subject to the Owner's* approval.

AB

The computing tools shall be certified by the State Office for Nuclear Safety*.

AC

For DBC1-2, computing tools used by the Existing Nuclear Power Plant* may be utilized if approved by the State Office for Nuclear Safety*.

2.8.2.14.1.B

In case of an accident, specific information shall be provided to the relevant support and control centres on-site and off-site and organizations responsible for accident management and emergency preparedness.

2.8.2.14.1.C

This function shall make it possible to forecast the environmental impact of radioactive discharges and release from the Plant*.

CA

The function of the radioactive release management shall include:

- periodic and continuous acquisition of measurements,
- alphanumeric or graphic presentation of measurements,
- calculation of the spread of the releases within the Plant* structures and on-site and off-site, predicting the potential consequences in either a simplified or a precise manner,
- presentation, in either message or cartographic form, of the actual spread of the releases (size and locations),

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 131/148

- communication between the site and the off-site applications,
- archiving of the measurements and calculation results.

2.8.2.14.1.D

It shall be designed to be used both in case of an accident and for the purposes of predictive simulation or exercise.

2.8.2.14.1.E

The basic data used by the function shall be:

- the meteorological conditions which influence distribution,
- the source term, evaluating the release in terms of quantity and quality,
- computing tools for the Normal Operation*, DBC 2, DBA and DEC including dose evaluation.

2.8.2.14.1.F

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

2.8.2.14.2 NSSS FATIGUE MONITORING FUNCTION

2.8.2.14.2.A

A NSSS fatigue monitoring function shall be implemented.

2.8.2.14.2.B

For that purpose, the system shall monitor and archive the data relating to the conditions to which the RCS circuit is subjected and perform stress and fatigue analysis.

2.8.2.14.2.C

This system shall allow:

CA

- Auditing of the statutory conditions according to mechanical and functional criteria. The objective is to show that the mechanical safety margins demanded by the design are respected at all times.

CB

- Fatigue studies of certain sensitive zones of the RCS circuit which are not fitted with direct measurement equipment. The objective is to improve monitoring. This is done by evaluation of the stresses and of the contribution of variations in temperature and pressure.

2.8.2.14.2.D

The system shall allow evaluation of the RCS residual life.

2.8.2.14.3 STAFF RADIATION DOSE MANAGEMENT

2.8.2.14.3.A

The following functions shall be implemented:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 132/148

AA

Checking that no significant radioactive contamination remains on clothes or items or on body when people and/or items leave a controlled area in accordance with the Rules*.

AB

Measuring and managing the radiation doses received by Plant* staff in the controlled area including tentative measurement of internal contamination.

AC

This function shall give an instantaneous indication of the radiation dose (individual security function).

2.8.2.14.3.B

Facilities shall be provided for monitoring of exposure and contamination of operating personnel and activity and contamination of the items.

BA

Processes shall be put in place for assessing and for recording the cumulative doses to workers over time.

BB

Equipment necessary for measuring (dosimeters), loading data from electronic dosimeters to software and managing doses (archiving, etc.) shall be provided.

BC

Stationary monitors (e.g. portal radiation monitors, hand, foot and item monitors) shall be provided at the main exit points from controlled areas and supervised areas to facilitate the monitoring of operating personnel and equipment.

BD

Equipment necessary for tentative measuring and processing of the personnel internal contamination (e.g. walk-in whole-body counter) shall be provided. Whole-body counter for detailed internal contamination measurement shall not be provided (see the Licensing and Permitting, Safety and Quality Document*, Section 2.6).

2.8.2.14.3.C

Facilities and equipment for metrology and calibration of equipment used for contamination and dose measurement (e.g. dosimeters, item monitors etc.) shall be provided, if necessary.

2.8.2.14.3.D

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

2.8.2.14.4 ITEM RADIOACTIVITY MONITORING BEFORE SITE DEPARTURE

2.8.2.14.4.A

Monitoring of the Limited Access Area* accesses and exits shall ensure that no radioactive or contaminated products including vehicles enter and/or leave the Limited Access Area* in an uncontrolled way.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 133/148

AA

Also personnel monitoring shall be provided at Limited Access Area* accesses and exits.

2.8.2.14.4.B

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

2.8.2.14.5 PLANT PERFORMANCE ASSESSMENT FUNCTION

2.8.2.14.5.A

The requirements are specified in Operation and Maintenance Document* Section 3.8.

2.8.2.14.6 CHEMICAL MONITORING FUNCTIONS

2.8.2.14.6.A

The chemical monitoring shall be implemented in a software package provided by the Supplier* and shall perform at least the following functions:

- chemical and radiochemical monitoring (based on data from continuous and grab measurements),
- corrosion, erosion, flow accelerated corrosion, fouling, demineralization efficiency monitoring,
- chemical data assessment, prediction, calculation and statistics,
- display suitable technological schemes and data,
- laboratory and continuous measurements quality control,
- chemical data verifying and exporting,
- provide chemical and physical tabulated data,
- administration (e.g. grab samples scheduling).

AA

The chemical management software shall be used to optimize chemical control and to predict water chemistry and associated degradation phenomena.

2.8.2.14.7 ON-SITE ENVIRONMENTAL MONITORING SYSTEM

2.8.2.14.7.A

On-site meteorological environmental monitoring data will be provided to the Plant* via CP43D (see Chapter 5.3).

AA

The data shall be used for management of environmental impact of the radioactive releases as specified in Section 2.8.2.14.1 and archive the meteorological conditions which influence distribution of radiological discharges and releases.

AB

In addition, the data shall be used for monitoring the environmental conditions of SSC exposed to outside environment to allow evaluation of effects of environment on their residual life.

2.8.2.14.7.B

The data shall be available as required within Plant* and shall be archived.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 134/148

2.8.2.15 PHYSICAL PROTECTION SYSTEM

2.8.2.15.A

Design of the Physical Protection System* (PPS) shall meet requirements of the Mandatory Law* and the Requirements of the Authorities* (See Chapter 2.5), in particular with the requirements of Czech Atomic Act*, Decree No. 361/2016 Coll., and IAEA INFCIRC 225 Revision 5 (NSS-13).

Note AA

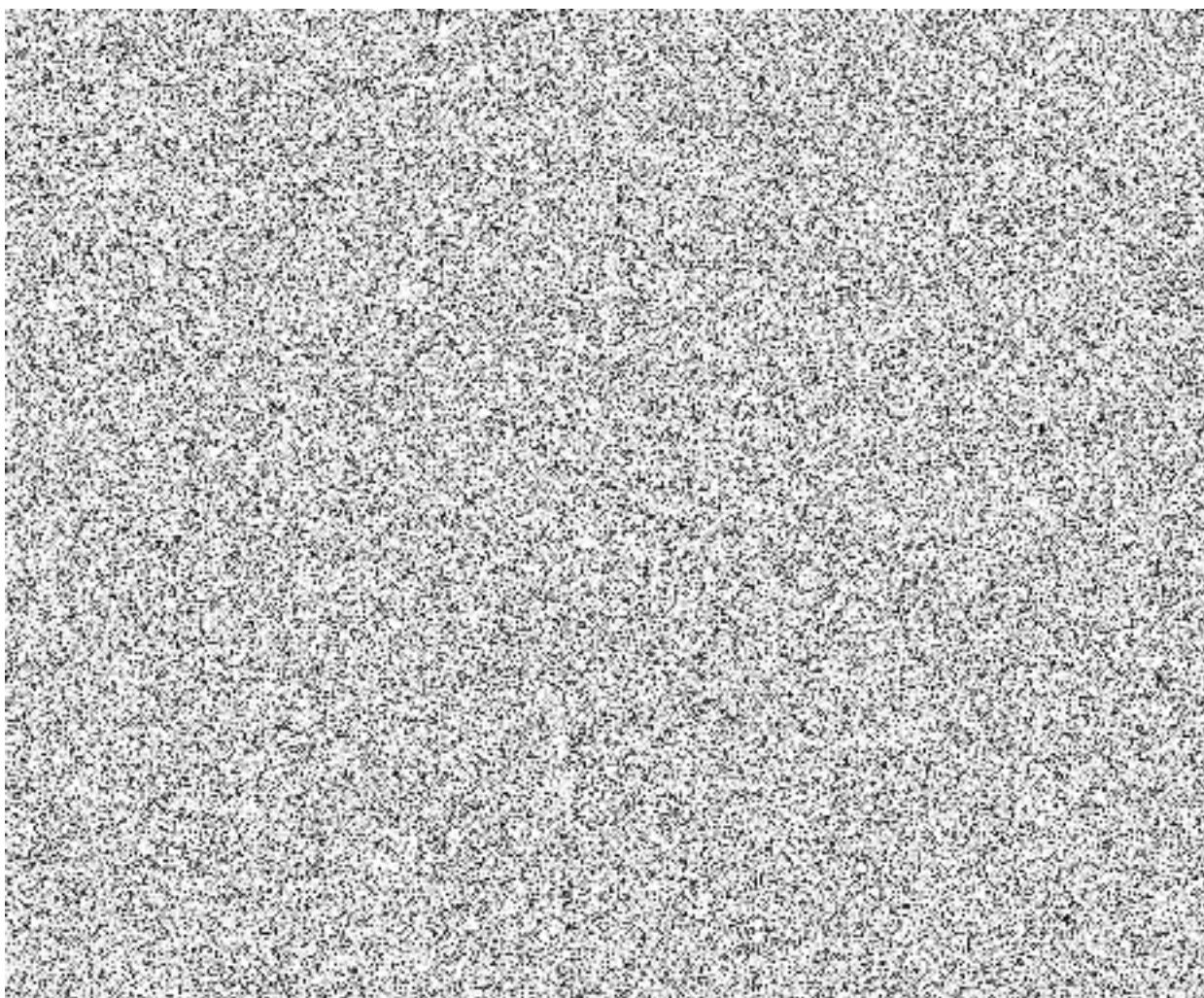
Revision 6 of IAEA INFCIRC 225 (NSS-13) is being prepared.

2.8.2.15.B

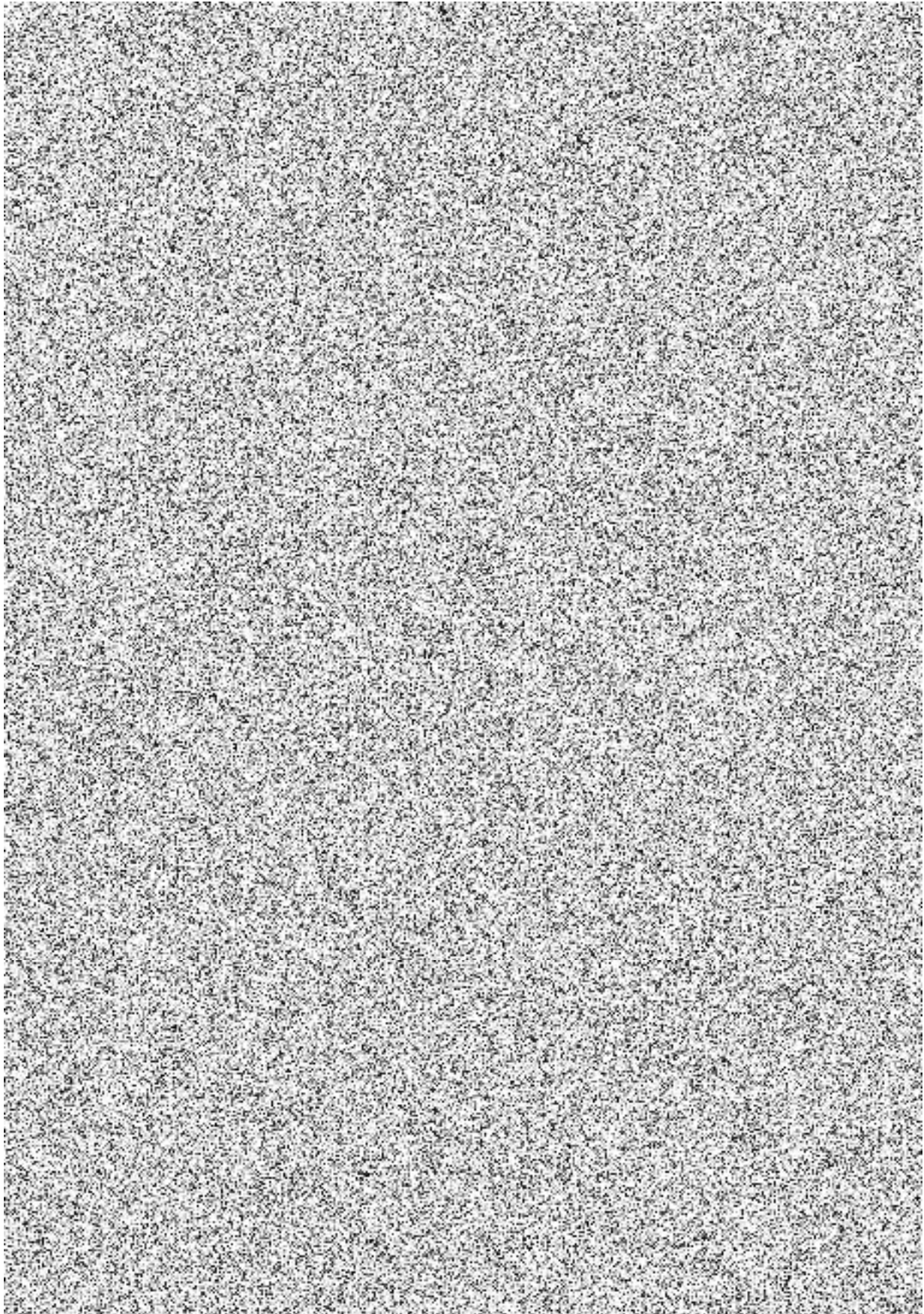
Parameters, properties, and all used components, including HW and SW products within PPS shall meet conditions of Mandatory Law* and the Requirements of the Authorities* for granting all relevant Licenses* from Safety Authority*.

Note B

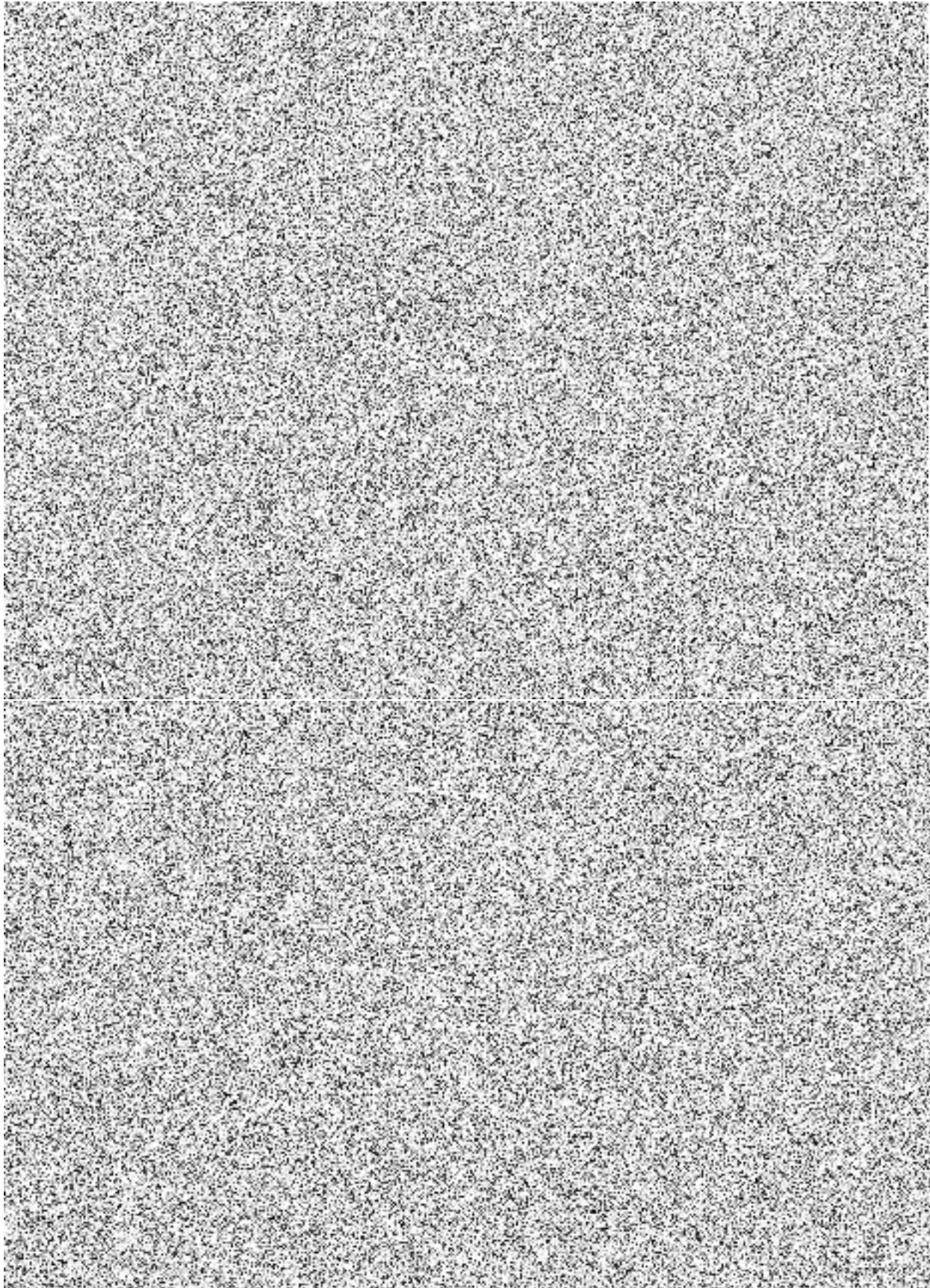
For additional information on Physical Protection System* see Licensing and Permitting, Safety and Quality Document*, Section 2.4 and Technical Requirements Document* Section 4.7.12.



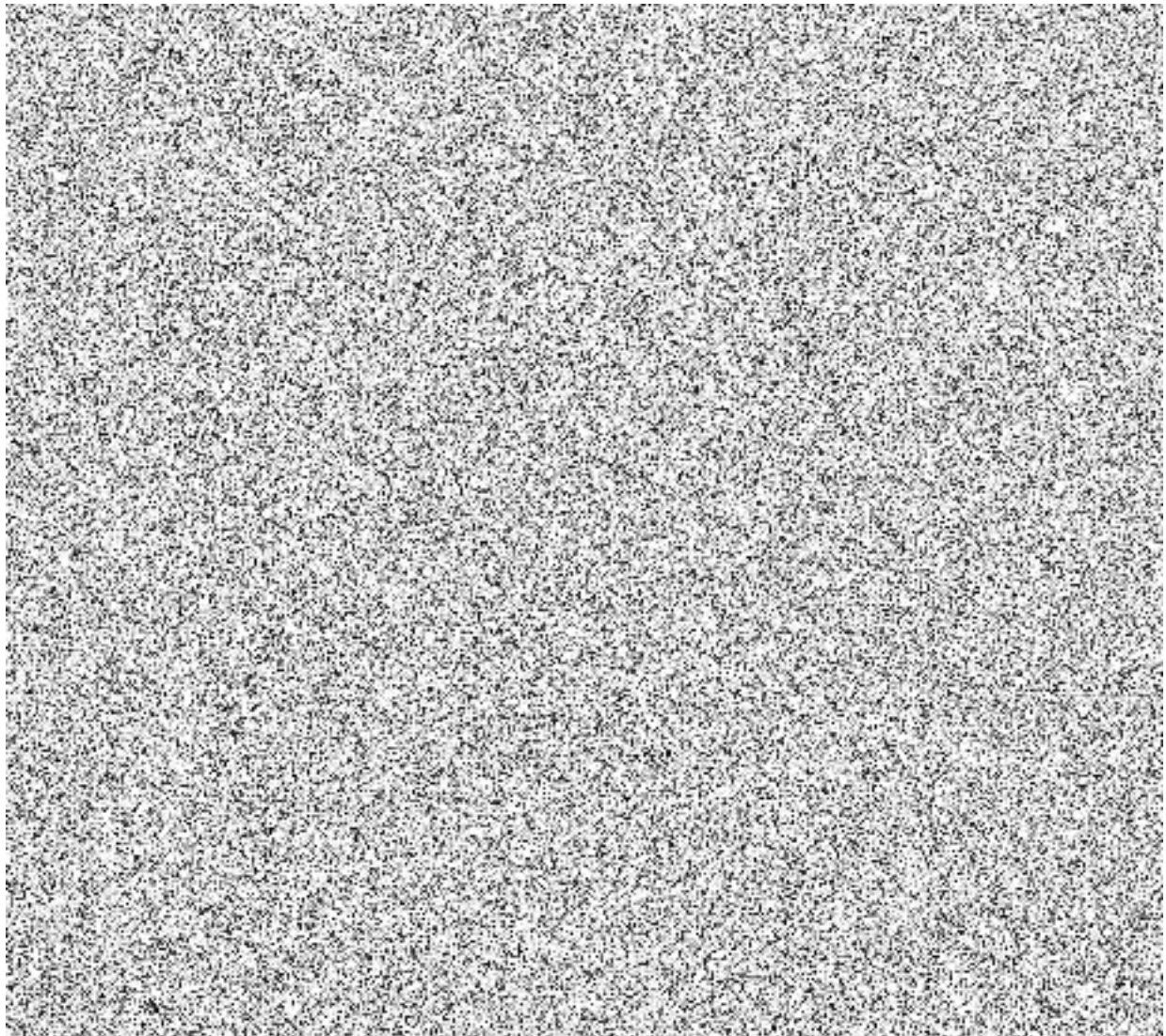
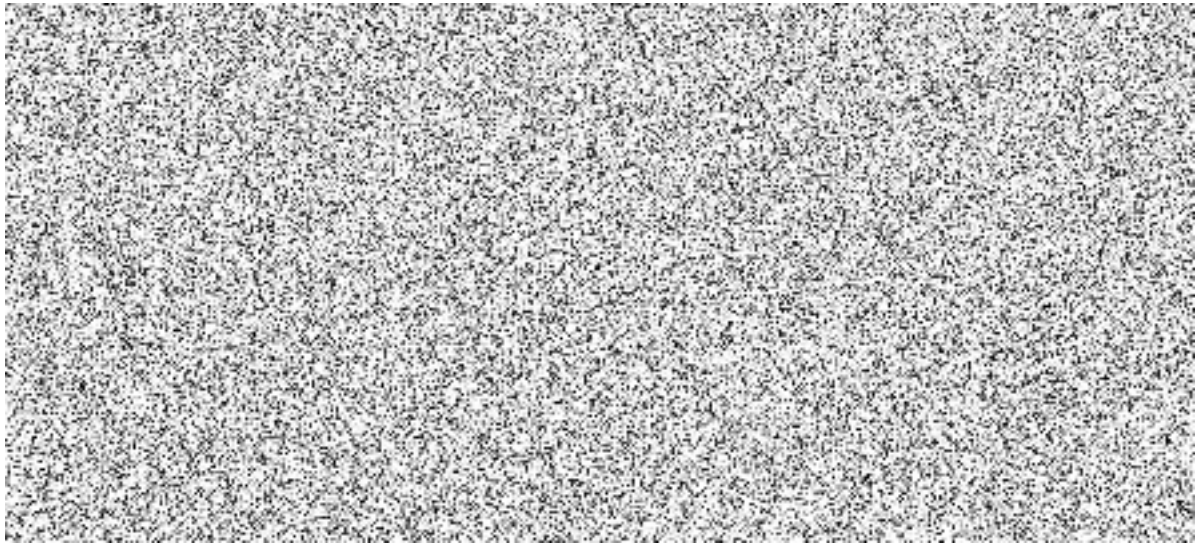
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 135/148



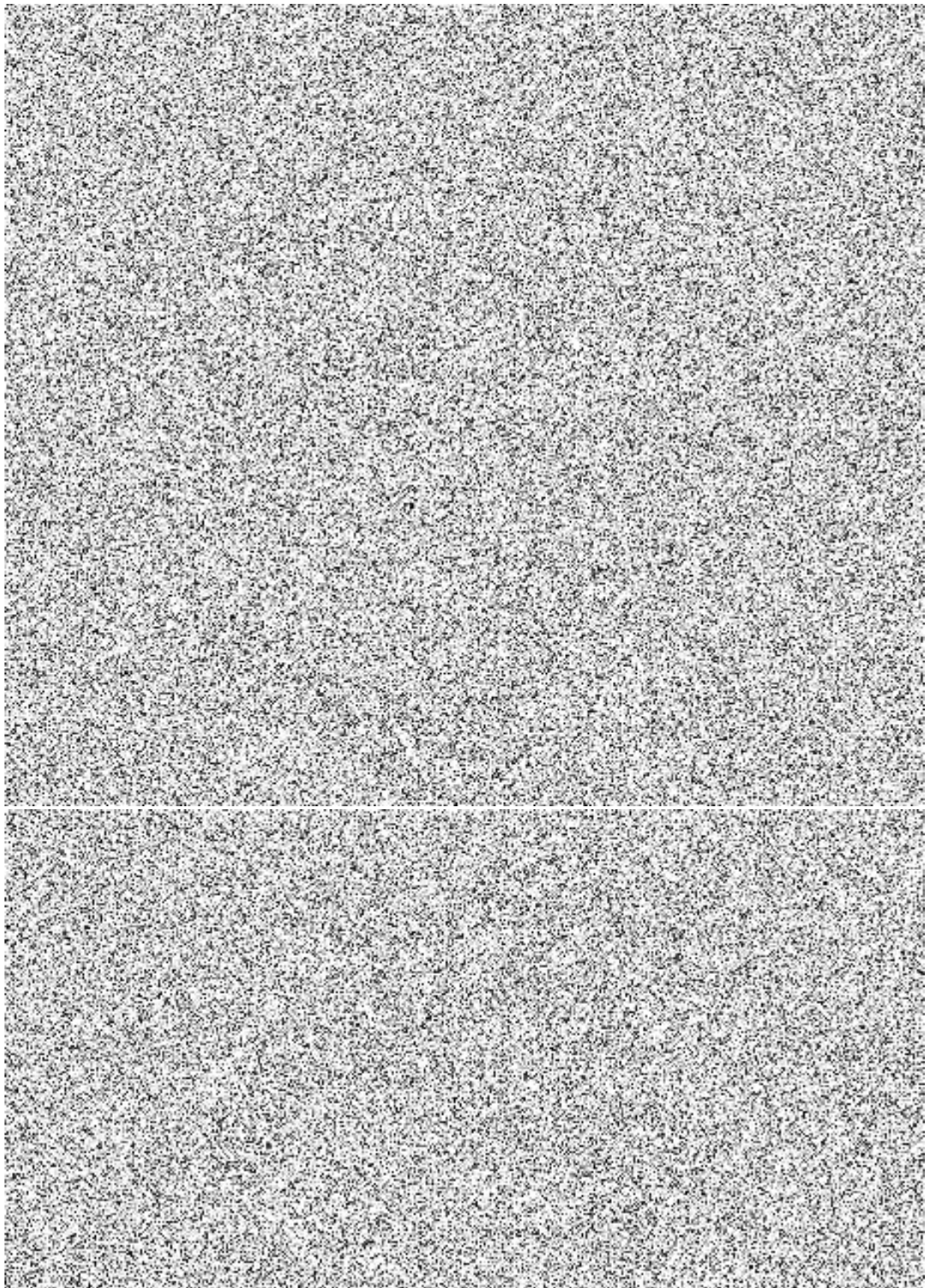
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 136/148



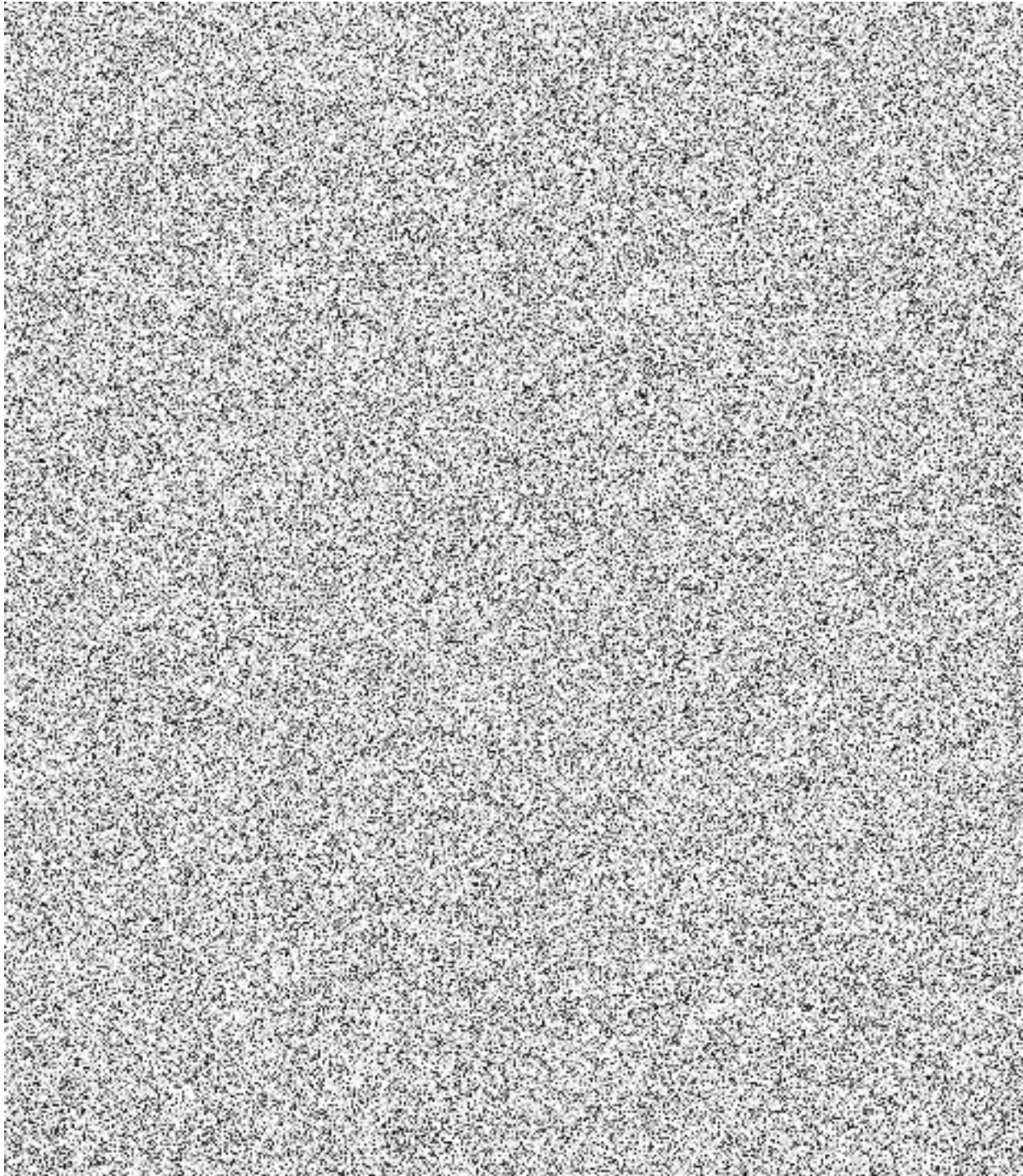
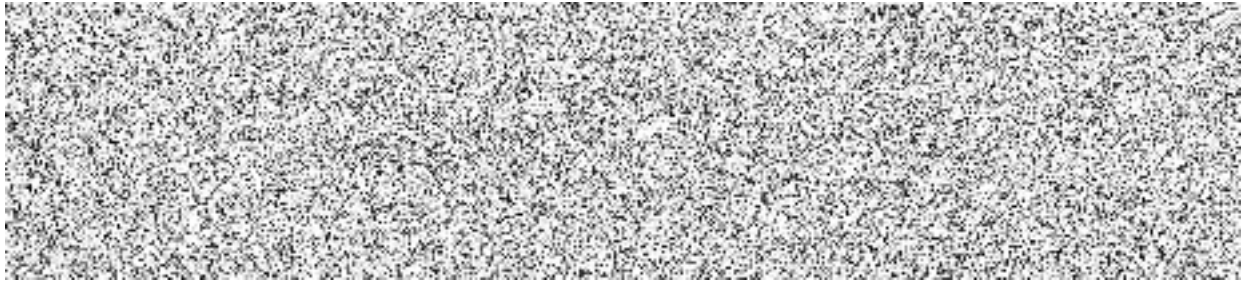
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 137/148



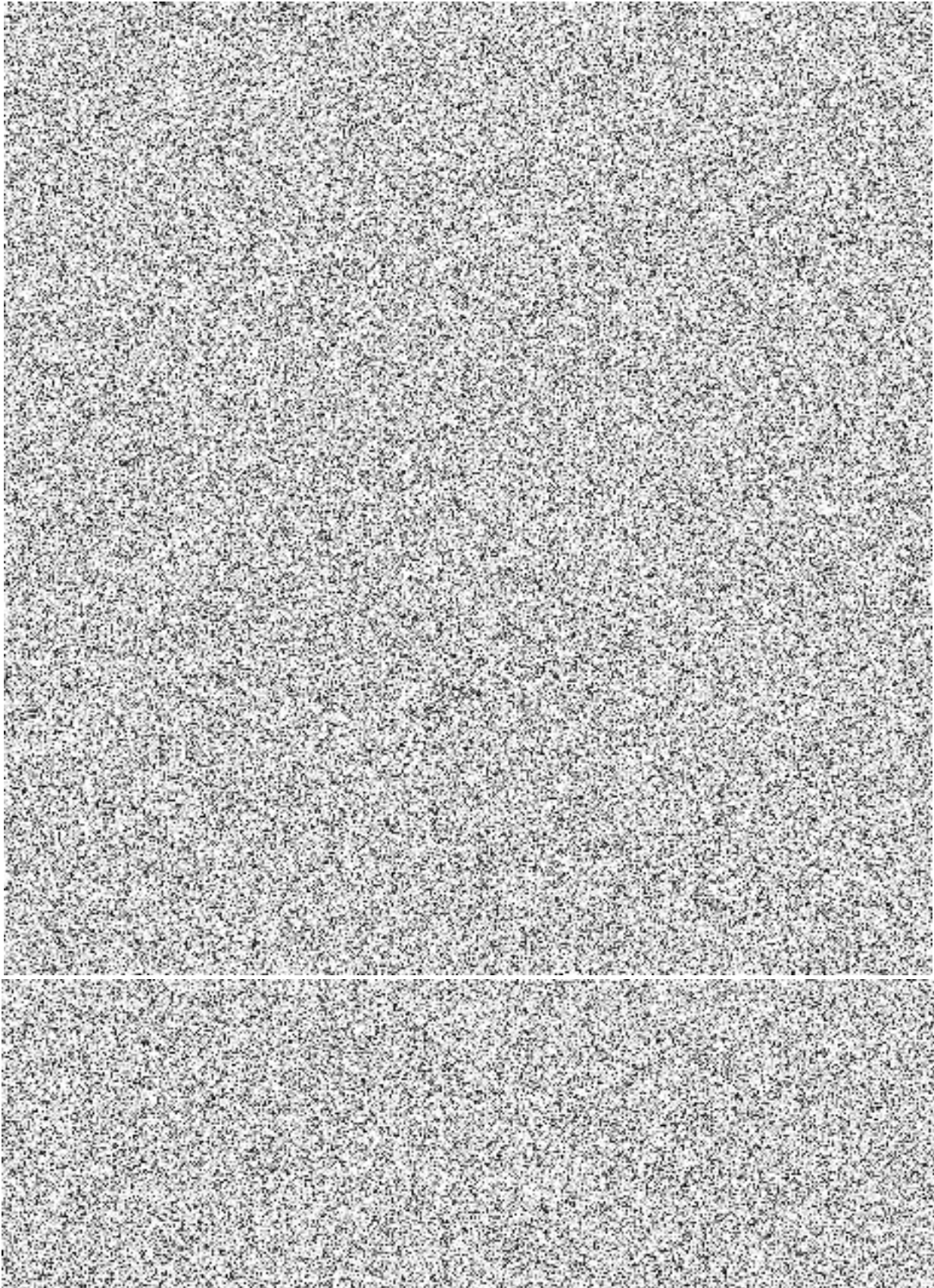
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 138/148



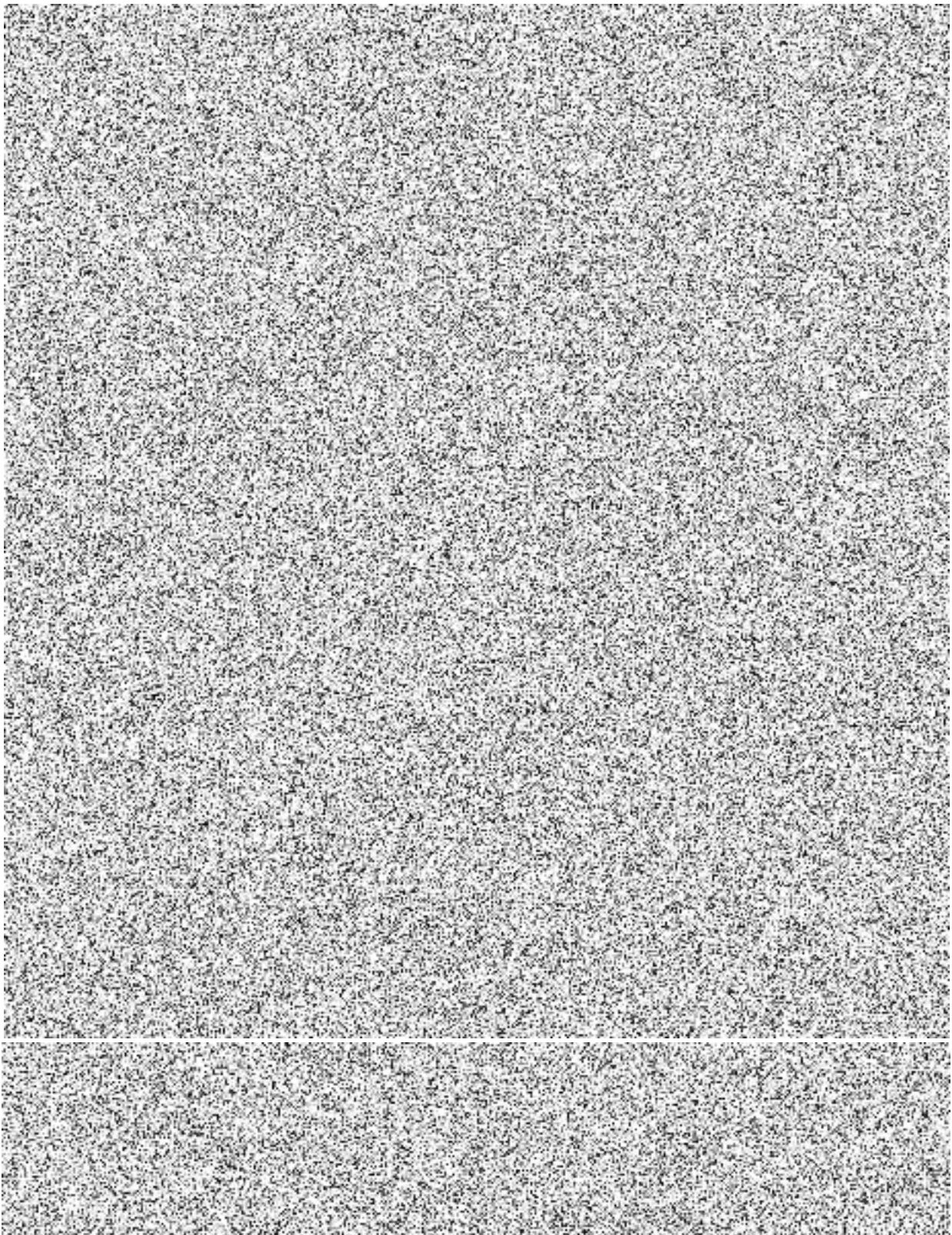
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 139/148



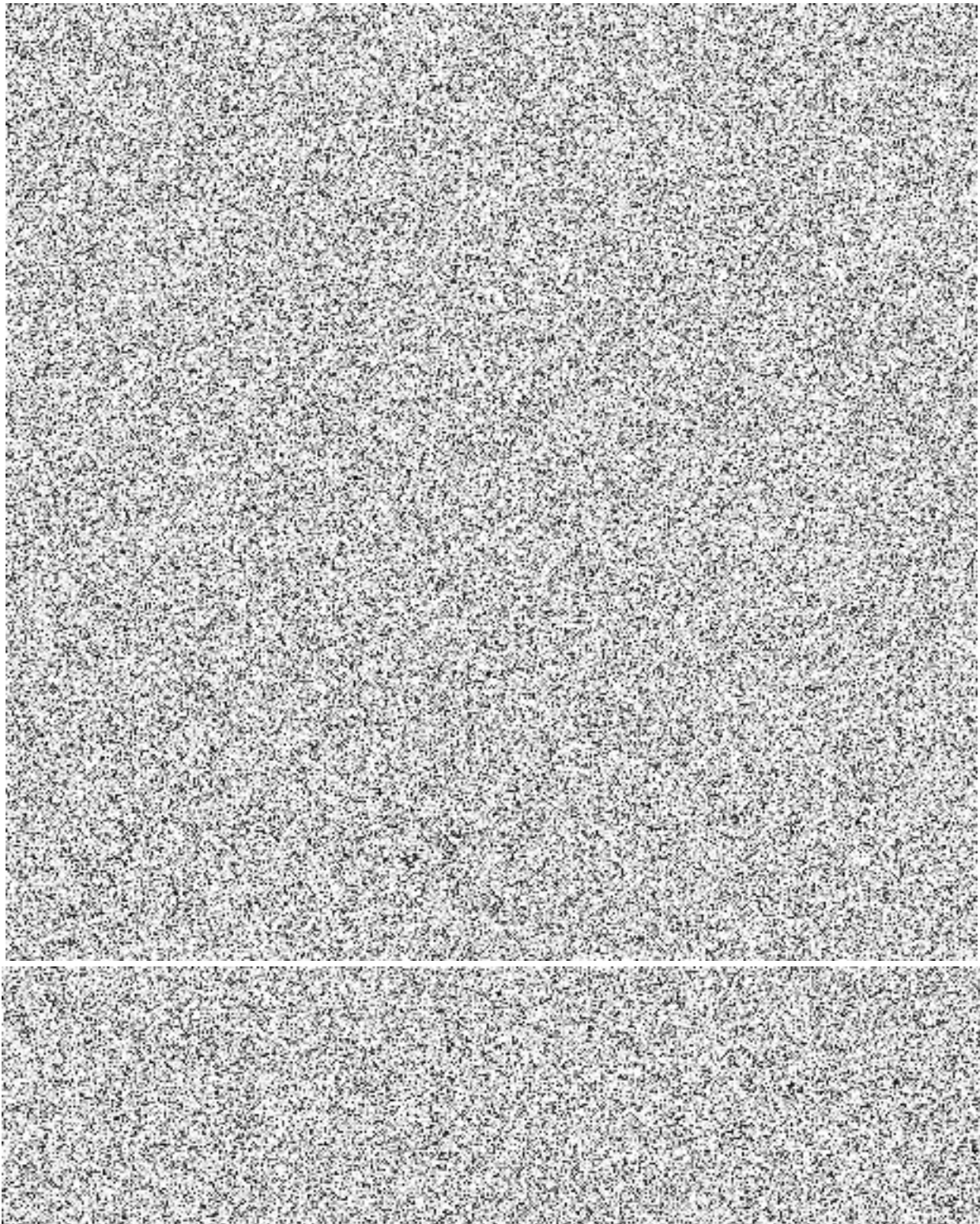
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 140/148



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 141/148



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 142/148



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 143/148

2.8.3 SYSTEMS ASSOCIATION REQUIREMENTS

2.8.3.A

To meet the safety, reliability and availability objectives of the Plant*, each system and set of systems shall be designed by using appropriate level of Redundancy*, Diversity*, Independence* and cross connections.

AA

Methods to be used to ensure safety and reliability of SSC include FMEA/FMECA, HAZOP, SIL, PSA etc.

2.8.3.B

In addition, the SSC shall be protected and/or able to withstand the effects of internal events (AOO, DBA and DEC) and internal and External Hazards* as specified in Section 2.1.5.1.7.

2.8.3.C

To perform a specific function, the Plant* systems shall ensure continuity, back-up and support of the function.

2.8.3.1 GENERAL REQUIREMENT

2.8.3.1.1 REDUNDANCY

2.8.3.1.1.A

Where Single Failure Criterion (SFC) is applicable on equipment which provides Safety Functions*, redundant equipment shall be provided in accordance with the N+1 concept as minimum.

AA

The Safety Function* shall be ensured assuming the most limiting Single Failure* were to occur in addition to the failure constituting the accident.

AB

A system may be required to have specific levels of redundancies associated with each function performed.

AC

Special requirements for Redundancy* of I&C equipment is specified in Chapter 2.10.

2.8.3.1.1.B

The Redundancy* shall also be implemented in the design to meet the probabilistic objectives of the Plant*.

2.8.3.1.1.C

Redundant equipment shall be arranged in several Functional Trains*.

CA

The Functional Trains* shall be arranged in at least 2 Divisions* in order to accommodate Internal Hazards*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 144/148

2.8.3.1.1.D

For each Train*, its capacity to perform a specific function shall be designed on a case by case basis to accommodate all relevant initiating events.

2.8.3.1.1.E

As the Preventive Maintenance* for some specific equipment performing the Safety Functions* is foreseen during the Normal Operation*, the N+2 concept (unavailability due to maintenance plus SFC) shall be applied on a case by case basis depending on the level of function performed and on the design conditions for which the function may be required.

2.8.3.1.1.F

Sufficient level of Redundancy* shall be provided to meet the Plant* reliability and availability objectives.

2.8.3.1.2 DIVERSITY

2.8.3.1.2.A

The design of systems providing the Safety Functions* shall implement the Diversity* to achieve the necessary reliability.

AA

The Diversity* shall be considered in combination with other design measures such as the Redundancy*, the Independence*, and separation.

AB

Special requirements for Diversity* of I&C equipment is specified in Chapter 2.10.

2.8.3.1.2.B

The Diversity* criteria shall also be implemented in the design to meet the probabilistic targets.

BA

The degree of the Diversity* shall be such that the probabilistic targets are achieved, in particular in case of total loss of external power sources and in case of SBO.

2.8.3.1.2.C

Diversification and standardisation of equipment shall be balanced since standardisation is important in reducing the maintenance effort and the number of stored spare parts.

2.8.3.1.3 AUTONOMY

2.8.3.1.3.A

Autonomy of systems performing Safety Functions* shall comply with the overall autonomy objectives specified in Section 2.1.6.7.

2.8.3.1.3.B

Each functional objective shall be met with either a single or several associated systems. Combination of systems-specific autonomies in regard to one function shall be equal at least to the autonomy objective.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 145/148

2.8.3.1.3.C

Autonomy of each system performing Safety Functions* shall be designed taking into account safety classification methodology given in Section 2.1.5.1.2.

CA

If several systems are needed in chronological sequence to reach one autonomy objective, classification of second rank systems (or part of these systems) shall depend on the time at which this system is needed, hence on the autonomy of the first system.

2.8.3.1.3.D

Autonomy of each system providing Safety Functions* shall include transition phase from the one system to another so as to ensure functional continuity.

2.8.3.1.4 INDEPENDENCE OF SYSTEMS

2.8.3.1.4.A

The essential means involved at different levels of Defence-in-Depth* shall be independent as far as reasonably practicable to avoid a failure of one level reducing the effectiveness of other levels.

2.8.3.1.4.B

In addition, interconnection between systems shall be reduced to necessary minimum.

BA

The use of common components belonging to different systems shall not be favoured.

BB

Nevertheless, when it can be demonstrated that there is a substantial improvement in safety needed to satisfy the safety goals of Chapter 2.1, interconnections between systems may be proposed in order to provide simple back-up possibilities between systems, where possible.

2.8.3.1.4.C

The systems shall be designed to perform their required Safety Functions* assuming independence from the off-site power sources.

2.8.3.1.4.D

Independence principles shall be used as specified in Section 2.1.6.3.2.1.

2.8.3.1.5 INDEPENDENCE AND SEPARATION OF DIVISIONS

2.8.3.1.5.A

Each Division* shall be independent and separated from other Divisions* both mechanically and electrically, and shall be protected from External and Internal Hazards*.

2.8.3.1.5.B

Cross-connections between Divisions* of the system which performs the Safety Functions* shall be avoided unless an improvement in safety, Operability* or availability is demonstrated.

BA

Some exceptions may be accepted based on a probabilistic safety analysis.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 146/148

BB

Requirements for divisional separation for I&C equipment are specified in Chapter 2.10.

2.8.3.1.5.C

Interconnections between Divisions* of different systems shall be avoided.

2.8.3.1.6 USE OF PASSIVE FEATURES

2.8.3.1.6.A

Use of passive features shall be sought, when appropriate, for the following purposes:



2.8.3.1.6.B

When designing systems with the Passive Equipment*, simplicity and reliability of the function performed by the whole system shall be sought.

BA

Appropriate measures shall be provided to enable periodical testing.

2.8.3.1.6.C

Use of passive features shall not impair manual intervention on systems specifically when providing mitigation.

2.8.3.1.7 PREVENTION AND MITIGATION

2.8.3.1.7.A

Design, construction and operation of systems providing the Safety Functions* shall strive to achieve high degree of prevention of DBC 2 and Accident Conditions*, particularly any which could be initiators of Core Damage* or significant releases.

AA

The Plant* SSC shall be designed, constructed and operated for assurance of high degree of reliability.

AB

This shall be taken into account in the design, construction and operation of both safety and non-safety classified equipment as they all contribute to prevention.

AC

Non-safety classified equipment shall not impair the prevention capabilities of safety classified equipment.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 147/148

AD

A high degree of prevention shall be also provided in the design of systems by the Redundancy*, the Diversity* and Independence* and fault tolerance.

AE

Reducing sensitivity to failures shall improve both prevention and mitigation capabilities.

2.8.3.1.7.B

Consistent with the Defence-in-Depth* concept, systems shall provide both prevention and mitigation of accidents, both for DBC and DEC.

2.8.3.1.7.C

The SSC used for prevention and mitigation functions shall be classified and resistant to Internal and External Hazards* in accordance with the Section 2.1.5.

2.8.3.1.7.D

Preventive and mitigation measures shall fulfil the probabilistic safety targets stated in Section 2.1.3.5.

2.8.3.1.7.E

Prevention and mitigation functions shall be performed by separated equipment, as far as appropriate.

2.8.3.1.7.F

For DEC, measures shall be addressed to decrease the likelihood and mitigate the consequences of the Complex Sequences* or the Severe Accidents*.

2.8.3.1.8 SIMPLIFICATION

The Plant* design and in particular Safety Systems* and Safety Features for Design Extension Conditions*, shall be as simple as possible to:

2.8.3.1.8.A

Minimise the complexity of the Operator* procedures.

2.8.3.1.8.B

Minimise the number of realignments required to perform a particular function.

2.8.3.1.8.C

Reduce the need for protective interlocks.

2.8.3.1.8.D

Minimise the equipment, consistent with the functional, safety and reliability goals.

2.8.3.1.8.E

Minimise the maintenance and testing burden.

2.8.3.1.8.F

Minimise the need for support systems (electrical power, cooling water, lubrication, etc.).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.8 FUNCTIONAL REQUIREMENTS FOR SYSTEMS AND PROCESSES	Page 148/148

2.8.3.1.9 PROTECTION AGAINST HAZARDS

2.8.3.1.9.A

The Plant* SSC shall be protected from and/or shall be designed to withstand effects of Hazards* (see Section 2.1.2.6).

AA

For that purpose, protective barriers, sufficient level of Redundancy* and protection from CCF shall be provided.

AB

Necessary SSC shall be seismically and environmentally qualified.

2.8.3.1.10 SYSTEM INITIATION

2.8.3.1.10.A

Automatic actuation of the systems performing the Safety Functions* shall be provided, with possible exceptions for some slowly developing accidents taking into account the Grace Period* for the Operators*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 1/60

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM
VERSION DATE:	March 2025

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 2/60

This Page Intentionally Left Blank

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 3/60

CONTENTS

CHAPTER 2.9 CONTAINMENT SYSTEM.....	4
2.9.0 INTRODUCTION.....	4
2.9.1 CONTAINMENT SYSTEM FUNCTIONS.....	4
2.9.2 CONTAINMENT SYSTEM PERFORMANCE	6
2.9.3 STRUCTURAL DESIGN AND VERIFICATIONS	19
2.9.4 EQUIPMENT AND SYSTEM DESIGN REQUIREMENTS	44

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 4/60

CHAPTER 2.9 CONTAINMENT SYSTEM

2.9.0 INTRODUCTION

2.9.0.A

The purpose of this Chapter is to establish the requirements which apply specifically to the Containment System*.

2.9.1 CONTAINMENT SYSTEM FUNCTIONS

2.9.1.1 INTRODUCTION

2.9.1.1.A

The Containment System* shall be designed to perform the following Safety Functions*:

- fission product confinement and control,
- protection against external events,
- biological shielding.

AA

The maximum allowable leaks including possible bypasses through the Primary Containment* and the Containment System* in DBC and DEC (including Severe Accidents*) shall be such small that the radiological targets for off-site releases are met.

AB

The structures of the Containment System* shall also be designed to ensure protection of the NSSS against external hazards (see Section 2.9.1.4).

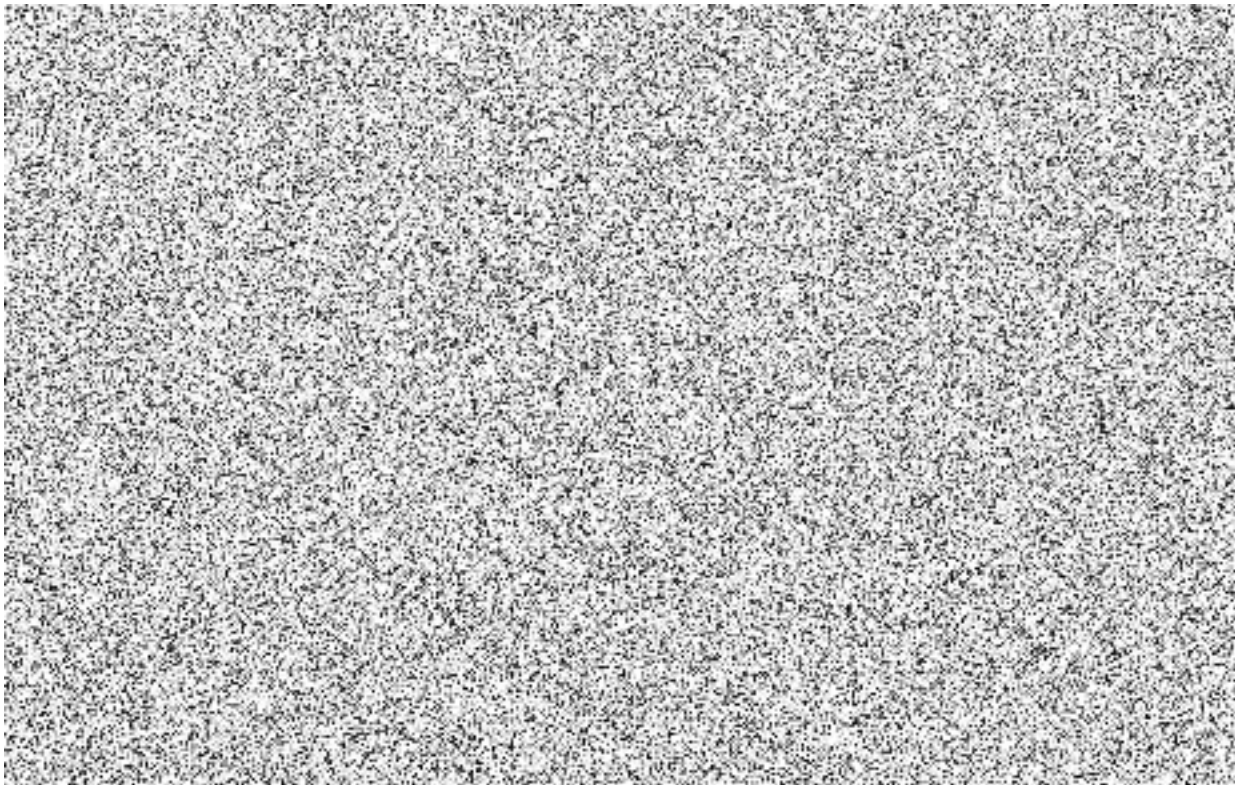
2.9.1.1.B

Related to these main functions, a number of other second-level functions can be recognised as illustrated in the Figure 1 in Section 2.9.1.2.

BA

The Supplier* shall specify all the Safety Functions* of the Containment System*.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 5/60



2.9.1.3 FISSION PRODUCT CONFINEMENT AND CONTROL

2.9.1.3.A

In the Defence-in-Depth* philosophy the Containment System* is the last Barrier* for preventing releases of radioactive materials into the environment and is the cornerstone of the mitigation processes.

AA

Therefore, the Containment System* shall minimise and assure that the releases of radioactive materials into the environment are below the safety objectives and release targets as specified in Chapter 2.1 and Chapter 2.1B, and shall assure that these releases occur under controlled circumstances in any DBC and DEC.

AB

In the case of radioactive release from the fuel into the Containment System* when Containment System* is open (e.g. during refuelling), it shall be possible to restore the leaktightness of the Containment System*, if temporarily lost, through Operator* action in a time compatible with compliance with the applicable safety objectives and release and probabilistic targets.

AC

The Plant* shall include provisions to prevent and mitigate consequences of severe damage to the fuel during refuelling.

AD

Less severe events, like fuel handling accidents are considered DBA and shall be dealt with according to the DBC rules as specified in Section 2.1.4.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 6/60

2.9.1.3.B

In order to provide the fission product confinement and control function, a number of other lower level functions shall be complied with, e.g. decay heat removal, pressure control, hydrogen management etc. as specified in Section 2.9.4.1.

BA

These functions shall be carried out while allowing the necessary penetrations for process and emergency fluid systems, as well as electrical cables and equipment and personnel.

2.9.1.4 PROTECTION AGAINST EXTERNAL EVENTS

2.9.1.4.A

Containment System* structures shall assure (in some cases together with other structural components) that the reactor coolant pressure boundary, Safety Systems* and Safety Features for Design Extension Conditions* are protected from external hazards to meet the objectives stipulated in Sections 2.1.2.6.2 and 2.1.8.3.3.

AA

The Containment System* shall be designed to cope with the natural external hazards, including Rare and Severe External Hazards*, without loss of capability to perform its Safety Functions*.

AB

For the case of severe man-made external events (such as intentional aircraft crash) leaktightness of the Primary Containment* and the Secondary Containment* is not required, while their structural integrity shall be maintained in order to prevent Core Damage* and to meet the radiological target for Complex Sequences*, i.e. capability to scram the reactor, and to remove the decay heat from the Core* shall be retained, as specified in Section 2.9.2.3 and in Chapter 2.1.8.3.3.

AC

The capability to remove decay heat shall be maintained to the extent necessary to prevent loss of containment integrity, of reactor coolant pressure boundary integrity and failure of systems necessary to prevent Core Damage*.

2.9.1.5 BIOLOGICAL SHIELDING

2.9.1.5.A

The Containment System* structures and associated structures within Primary Containment* shall reduce direct radiation from all sources enveloped in order to minimise doses to the public and to workers inside and outside the Primary Containment*.

2.9.2 CONTAINMENT SYSTEM PERFORMANCE

2.9.2.1 CONTAINMENT SYSTEM GENERAL ARRANGEMENT

2.9.2.1.A

The Containment System* shall include a Primary Containment* and a Secondary Containment* that encompasses, as minimum, all Primary Containment* penetrations.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 7/60

2.9.2.1.B

The Primary Containment* shall be of the large dry type.

BA

A Primary Containment* shall be designed to house the Reactor Coolant System*, to withstand the mechanical and thermal loads arising from DBC and DEC and associated loads and internal hazards and to confine the activity released during DBC and DEC as a leaktight structure.

BB

A Secondary Containment* shall be designed to collect all releases from the Primary Containment* and to protect the Primary Containment* from the external hazards.

2.9.2.1.C

Primary Containment* shall be made of pre-stressed concrete with steel liner.

2.9.2.1.D

Secondary containment* shall be made of reinforced concrete without liner.

2.9.2.2 FISSION PRODUCT CONFINEMENT AND CONTROL

2.9.2.2.1 LIMITATION OF RELEASES TO THE ENVIRONMENT

2.9.2.2.1.1 IN-CONTAINMENT FISSION-PRODUCT REDUCTION MECHANISMS

2.9.2.2.1.1.A

The Plant* design shall include design features to maximise the retention of fission products inside Primary Containment*, in particular for Severe Accidents*.

AA

The Plant* design shall maximise the efficiency of the processes for removing aerosols from the Primary Containment* atmosphere.

AB

Assessment of the efficiency of all aerosol removal processes shall be made using adequately validated data and methodologies.

AC

The Source Term* quantification methodology is specified in Chapter 2.1A.

2.9.2.2.1.1.B

With regard to reduction of fission products in the long term, the Supplier* shall demonstrate that, at any time after an accident, water pools inside the containment remain a slightly basic pH taking into account the contribution of all acidic and basic substances which could affect the pH.

BA

Consideration shall be given to permanent storage of soluble buffering substances at appropriate locations inside the Primary Containment*.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 8/60

BB

Their mixing rate shall also be addressed.

BC

NA

BD

Sources of substances lowering pH (such as chlorine in cables) shall be minimised in the Primary Containment*.

2.9.2.2.1.2 PRIMARY CONTAINMENT PERFORMANCE

2.9.2.2.1.2.A

The Supplier* is responsible for defining the Primary Containment* leak rate at the design pressure (see Section 2.9.3.1.4.6.1) within the ranges indicated below.

2.9.2.2.1.2.B

The design integrated leakage rate for all types of Primary Containments* shall be chosen in the range 0,1 % to 0,5 % of the contained mass of free gas and steam per 24 hours at the design pressure and temperature conditions as selected in Section 2.9.3.1.4.6.

BA

The integrated leak rate shall also include the leak rate through the isolation valves in the pipe penetrations, electrical penetrations and other Primary Containment* wall penetrations (including hatches).

2.9.2.2.1.2.C

A suitable pressure/leak rate correlation shall be provided by the Supplier* for Design Basis Accident* (DBA) safety analysis in order to realistically assess the reduction in leak rate with the corresponding pressure reduction during the course of a DBA.

CA

All the required evaluations shall be based on realistic assumptions and best-estimate evaluations; therefore it is important to reduce the leak rate which accompanies the reduction in Primary Containment* pressure.

CB

The assumptions to be used in accident analysis and Probabilistic Safety Analysis (PSA) are also listed in Chapter 2.1A.

2.9.2.2.1.2.D

The Supplier* shall also identify the leak rate and pressure/leak rate to be assumed in the Design Extension Conditions* (DECs), including those sequences in which the containment pressure and temperature may exceed the design pressure and design temperature.

2.9.2.2.1.2.E

The assumed leak rate shall be adequately supported by analytical considerations, by experimental data, and by design and testing provisions and shall include consideration of combined effects of pressure, temperature, radiation, aerosol deposition and local effects of hydrogen deflagration extended for the entire period in which the Primary Containment* is expected to remain at a pressure above atmospheric.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 9/60

EA

Analytical considerations and discussion of representative tests are also needed to investigate the behaviour of containment leaktightness during the depressurisation phase, after the sealing materials have been subject to high temperatures, pressures and radiation.

2.9.2.2.1.2.F

Primary Containment* bypass accidents shall be prevented as much as possible.

FA

Requirements for prevention of the Primary Containment* bypass are stipulated in Section 2.1.7.3.2.1.

2.9.2.2.1.2.G

Bypass leakages shall be estimated by the Supplier* with suitable realistic assumptions and by reference to relevant operating experience.

GA

NA

GB

NA

2.9.2.2.1.3 SECONDARY CONTAINMENT PERFORMANCE

2.9.2.2.1.3.A

The Secondary Containment* shall encase the Primary Containment* so that amount of radioactive substances which leak from the Primary Containment* to the environment can be further minimised, in particular for case of the Primary Containment* bypass.

AA

The Secondary Containment* shall be reasonably leaktight in order to support the operation of the ventilation systems and retention of radioactive substances.

AB

NA

2.9.2.2.1.3.B

When the Secondary Containment* is credited in the dose and release calculations, then:

BA

NA

BB

The Secondary Containment Bypass* leakage (taking into account emergency ventilation system) shall not exceed 5 % of the integrated design Primary Containment* leakage for any DBC or DEC.

BC

NA

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 10/60

BD

If credit is given to a decontamination factor > 10 for aerosols, then a safety classified ventilation system shall be included in the design, and a pressure of about 6 mm of water (60 Pa) below that of adjacent areas shall be maintained in basic wind conditions.

BE

NA

BF

NA

2.9.2.2.1.3.C

NA

2.9.2.2.1.4 SECONDARY CONTAINMENT BYPASS

2.9.2.2.1.4.A

The Secondary Containment Bypass* leakage shall be minimised.

2.9.2.2.1.4.B

When the Secondary Containment* is credited in the dose and release calculations, then:

BA

- NA

BB

- When an active safety classified ventilation system is used in order to meet the safety objectives and/or release targets, an upper limit shall be 5 %.

BC

Bypass leakages shall be estimated by the Supplier* with suitable realistic assumptions and by reference to relevant operating experience.

BD

NA

BE

If necessary piping pressurisation systems or other features may be considered for prevention of any bypass leakages on specific pipes which penetrate the Primary Containment*.

BF

NA

BH

NA

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 11/60

2.9.2.2.1.5 RELEASE FROM THE CONTAINMENT IN SEVERE ACCIDENTS CONDITIONS

2.9.2.2.1.5.A

The probabilistic target about early Primary Containment* failure shall be met without implementing any Primary Containment* overpressure protection and/or venting system.

2.9.2.2.1.5.B

In the long term, neither Primary Containment* overpressure protection system nor venting shall be needed to prevent Primary Containment* overpressurization and Primary Containment* leaktightness and integrity shall be maintained using containment heat removal systems (see Section 2.9.4.1.1) and/or containment spray system (see Section 2.9.4.1.2.1).

BA

The safety objective and release targets for DEC shall be met without crediting any Primary Containment* overpressure protection and/or venting system.

2.9.2.2.1.5.C

A filtered purge system may be necessary to terminate the accident in the very long term.

2.9.2.2.2 TESTING AND PERFORMANCE MONITORING

2.9.2.2.2.1 PRIMARY CONTAINMENT TESTING

2.9.2.2.2.1.1 STRUCTURAL INTEGRITY TESTS

2.9.2.2.2.1.1.A

The pre-operational and periodic Structural Integrity Tests (SITs) of the Primary Containment* shall be possible.

AA

The design shall be capable of withstanding at least 10 SITs of the Primary Containment*.

AB

These SITs shall be carried out in the conditions described in Section 2.9.3.1.4.6.3.

2.9.2.2.2.1.1.B

The Supplier* shall propose and justify the number of tests and the period between them.

BA

The Supplier* shall aim at and provide justification of minimising the number of the SITs needed after the Commissioning*.

2.9.2.2.2.1.1.C

The Supplier* shall provide all necessary instrumentation, equipment and procedures necessary to perform and evaluate the test.

CA

The acceptance criteria and inspection conditions during and after the test shall be defined.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 12/60

CB

Within the procedure, all equipment to be removed from the Primary Containment* or otherwise protected and requirements for the test gas or gas mixture shall be specified.

2.9.2.2.2.1.2 INTEGRATED LEAK RATE TESTS

2.9.2.2.2.1.2.A

Pre-operational and periodic Integrated Leak Rate Tests (ILRTs) of the Primary Containment* shall be possible.

AA

The design shall allow carrying out the preoperational ILRT and consequent periodic ILRTs at the design pressure P_{design} as defined in Section 2.9.3.1.4.6.1.

AB

The tests shall be carried out on a timescale compatible with the outage durations and frequencies defined in Section 2.2.7.2.2.

AC

After pressure and temperature stabilisation, it is expected that a test lasting 8 hours for a Primary Containment* not directly exposed to external environment can provide the necessary accuracy, suitable instrumentation shall be provided.

2.9.2.2.2.1.2.B

The Supplier* shall provide an evaluation of the expected uncertainties associated with the measurements to assure that the measurements are significant and that the error band is acceptable.

2.9.2.2.2.1.2.C

The Supplier* shall provide all necessary instrumentation, equipment and procedures necessary to perform and evaluate the test.

CA

The acceptance criteria and testing conditions during and after the test shall be defined and shall be part of the Technical Specifications*.

CB

Within the procedure, all equipment to be removed from the Primary Containment* or otherwise protected and requirements for the test gas or gas mixture shall be specified.

CC

Test procedures and design provisions shall include both the condition in which the Core* is inside the reactor pressure vessel and the condition in which the Core* is removed and placed in the spent fuel pool.

2.9.2.2.2.1.2.D

The design shall be capable of withstanding at least 10 ILRTs of the Primary Containment* at P_{design} .

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 13/60

DA

The Supplier* shall identify the number of times and the reduced pressure at which the containment could be leak-rate tested during the Plant* life (60 and 80 years) without introducing new constraints in the design arising from fatigue considerations.

DB

The design shall aim at performance of the periodic ILRTs at lower pressure by use of duly justified correlation of pressure and leak rate.

DC

The results of these tests shall be fully representative of the Primary Containment* behaviour at P_{design} .

2.9.2.2.2.1.2.E

A suitable factor shall be determined which allows the measured leakage rate during the tests (Primary Containment* atmosphere in dry air condition) to be related to the allowable leakage rate during an accident (Primary Containment* atmosphere in steam condition).

2.9.2.2.2.1.3 LOCAL TESTING

2.9.2.2.2.1.3.A

Provisions shall be included in the design to allow pre-operational, periodic and emergency local individual testing at either each refuelling or during operation of:

- Each pipe penetration through the Primary Containment*, between the containment isolation valves,
- Mechanical and electrical penetrations,
- Large passages such as the equipment hatch and personnel airlock.

AA

All Primary Containment* penetration welds shall be accessible for Inspection*.

AB

Metallic parts of the Primary Containment* pressure boundary embedded in concrete (not accessible for Inspection*) shall be minimized and qualified by a rigorous manufacturing, installation and Non-Destructive Evaluation programme.

AC

Provisions shall be provided to allow thorough visual inspections of the Primary Containment*.

2.9.2.2.2.1.3.B

The capability of testing the leak rate of each isolation valve separately shall be included to the extent possible, particularly for those valve types and systems shown by operating experience to be major contributors to the containment's integrated leak rate.

BA

If such capability cannot be provided, then alternative methods of leak rate tests (such as testing of valves in pairs), which allow evaluation of the leak rate of each individual valve, shall be provided.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 14/60

2.9.2.2.2.1.3.C

If on some lines the Supplier* has adopted the solution of pressurising the pipe section between the isolation valves or of collecting leakages into the Secondary Containment*, testing of these systems shall be possible at either each refuelling or during power operation.

2.9.2.2.2.1.3.D

Lines assumed to provide a water seal at the containment penetration level shall be periodically testable to prove that adequate amounts of water are present so that they do not dry out in the course of an accident.

2.9.2.2.2.1.3.E

The Supplier* shall provide an evaluation of the uncertainties associated to the measurements.

2.9.2.2.2.1.3.F

The Supplier* shall provide all necessary instrumentation, equipment and procedures necessary to perform and evaluate the test.

FA

The acceptance criteria and testing conditions during and after the test shall be defined.

2.9.2.2.2.1.4 ON-LINE MONITORING

2.9.2.2.2.1.4.A

Means shall be provided to enable the Operators* to perform checks for gross leakages from the Primary Containment* and to check containment integrity during Normal Operation*.

2.9.2.2.2.1.4.B

The system shall make use, to the extent possible, of permanently installed instrumentation for the Primary Containment's* SIT and/or ILRT.

2.9.2.2.2.1.4.C

The system shall be only an Operator* aid and shall not actuate any component.

2.9.2.2.2.2 SECONDARY CONTAINMENT TESTING

2.9.2.2.2.2.A

The Supplier* shall determine the extent of periodic testing of the Secondary Containment* required to assure that performance requirements can be met and shall provide in the design means to conduct such testing.

AA

An acceptable alternative is to use the Heating, Ventilating and Air Conditioning system to assure that satisfactory leaktightness is maintained.

2.9.2.2.2.2.B

The Supplier* shall provide a test procedure covering all the aspects related with test conditions, scope of the tests, periodicity, instrumentation, examination, and acceptance criteria.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 15/60

2.9.2.2.2.3 BYPASS FRACTION VERIFICATION

2.9.2.2.2.3.A

Provisions shall be made to permit pre-operational and periodic leakage-rate tests for each potential bypass leak path identified by the Supplier*.

2.9.2.2.2.3.B

The Supplier* shall provide an evaluation of the capability to identify all bypass leak paths and of the uncertainties associated with the verification of the containment bypass fraction.

2.9.2.2.2.3.C

In particular for Severe Accident*, the Supplier* shall assess whether bypass leakages can be expected from the containment basemat, and any other parts not surrounded by the Secondary Containment* and how to quantify them.

2.9.2.2.3 HEIGHT OF RELEASES

2.9.2.2.3.1 RELEASES FROM THE SECONDARY CONTAINMENT

2.9.2.2.3.1.A

If a safety classified ventilation system is included in the design of Secondary Containment*, radioactive products collected by the system in DBA and DEC shall be released through an elevated point in order to further reduce their environmental effects at short distances from the Plant*.

AA

A filtering system shall be included in the design, if necessary to meet the safety objectives and/or release targets.

2.9.2.2.3.1.B

A suitable release point is the ventilation stack, which shall have adequate height to avoid a wake due to adjacent buildings.

BA

The stack height of relevant location in the Plant* layout shall be specific for the Site* and the dimensions shall be supported with the calculation of releases and their impact on the environment.

2.9.2.2.3.2 SECONDARY CONTAINMENT BYPASS RELEASES

2.9.2.2.3.2.A

It shall be assumed that releases bypassing the Secondary Containment* are released at ground level.

AA

The contribution of the non-surrounded part of the Primary Containment* leaks shall be considered in the total bypass evaluation.

AB

Situations, when a plume rise can be credited, can be assessed on a case-by-case basis.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 16/60

2.9.2.3 PROTECTION AGAINST EXTERNAL HAZARDS

2.9.2.3.1 NATURAL EXTERNAL HAZARDS

2.9.2.3.1.A

The Containment System* shall be designed to cope with the natural external hazards, including Rare and Severe External Hazards*, without loss of capability to perform its Safety Functions*.

AA

Seismic Margin Assessment (SMA) shall also be performed to evaluate margins embodied in the design as specified in Chapter 2.4.

2.9.2.3.1.B

The proposed acceptance criteria are specified in Section 2.9.3.1.4.5.3 (Table 2).

2.9.2.3.2 MAN-MADE EXTERNAL HAZARDS

2.9.2.3.2.A

The Containment System* shall be designed to cope with the man-made external hazards, with exception of severe man-made external events, without loss of capability to perform its Safety Functions*.

2.9.2.3.2.B

For the case of severe man-made external events (such as intentional aircraft crash) leaktightness of the Primary Containment* and the Secondary Containment* is not required, while their structural integrity shall be maintained in order to prevent Core Damage* and to meet the radiological target for Complex Sequences*, i.e. capability to scram the reactor, and to remove the decay heat from the Core* shall be retained, as specified in Section 2.9.2.3 and in Chapter 2.1.8.3.3.

BA

The capability to remove decay heat shall be maintained to the extent necessary to prevent loss of containment integrity, of reactor coolant pressure boundary integrity and failure of systems necessary to prevent Core Damage*.

2.9.2.4 BIOLOGICAL SHIELDING

2.9.2.4.A

The Containment System* shall be designed to limit, in all Plant States*, the exposure of on-site personnel and population to radiation generated by the RCS and associated systems including Fuel Assemblies* and Core Components*.

2.9.2.4.B

The design shall take into account the accessibility criteria presented in Section 2.9.2.5, and the zoning criteria presented in Chapter 2.11.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 17/60

2.9.2.4.C

The containment structure shall assure also that, in all Plant States*, including DEC, sky shine radiation is maintained below values compatible with personnel activities (including accident management activities).

2.9.2.5 CONTAINMENT SYSTEM ACCESSIBILITY

2.9.2.5.1 ACCESS INTO PRIMARY CONTAINMENT

2.9.2.5.1.A

Access by operating personnel to the Primary Containment* shall be through airlocks.

2.9.2.5.1.B

Airlocks shall be equipped with doors that are interlocked to ensure that at least one of the doors is closed during reactor Power Operation Modes*.

2.9.2.5.1.C

Access for large equipment shall be through equipment hatches.

2.9.2.5.1.D

Additional requirements for Primary Containment* penetrations are specified in Section 2.9.4.1.6.

2.9.2.5.1.1 NORMAL OPERATION AND AOO

2.9.2.5.1.1.A

The design of the Primary Containment* shall not require regular personnel access during power operation but shall allow occasional personnel access for maintenance and Inspection* activities in any Normal Operation* conditions and also in Anticipated Operational Occurrences*.

AA

Features shall be provided to perform the maintenance and verification of the required Primary Containment* integrity during power operation.

AB

In particular, all openings such as personnel airlocks and equipment hatches shall be provided with position indicators and alarms having readout and alarm capabilities in the Main Control Room*.

2.9.2.5.1.1.B

NA

BA

NA

2.9.2.5.1.1.C

The Supplier* shall provide all necessary equipment and operating procedures for gaining access into the Primary Containment* in any Normal Operation* conditions and also in Anticipated Operational Occurrences*.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 18/60

2.9.2.5.1.2 ACCIDENT CONDITIONS AND DEC

2.9.2.5.1.2.A

No access by personnel shall be required during Accident Conditions*.

2.9.2.5.1.2.B

The Supplier* shall outline the design features which will permit personnel and equipment (including remotely operated robots) access in the long term after Accident Conditions* involving extensive contamination of the Primary Containment*.

2.9.2.5.2 ACCESS INTO SECONDARY CONTAINMENT

2.9.2.5.2.1 NORMAL OPERATION

2.9.2.5.2.1.A

The Secondary Containment* shall be permanently accessible by Plant* personnel during Normal Operation* and Anticipated Operational Occurrences*.

2.9.2.5.2.1.B

Features shall be provided to assure the maintenance and verification of the required Secondary Containment* integrity and leaktightness during power operation.

BA

In particular all openings such as personnel doors and equipment hatches shall be provided with position indicators and alarms, having readout and alarm capabilities in the Main Control Room*.

2.9.2.5.2.1.C

Access and equipment shall be provided during construction and In-Service inspection* to facilitate the Inspection* of the Primary Containment* tendons or the steel shell containment welds.

2.9.2.5.2.2 ACCIDENT CONDITIONS AND DEC

2.9.2.5.2.2.A

The Plant* design shall avoid the need to access the Secondary Containment* during Accident Conditions* while the Primary Containment* is at pressure.

2.9.2.5.2.2.B

However, provisions shall be made to allow accident management actions by Plant* personnel while maintaining to the maximum possible extent the Secondary Containment* leaktightness.

BA

The Supplier* shall evaluate the personnel doses taking into account the access to the area and the time required to carry out the specific function required by the accident management procedures.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 19/60

BB

Appropriate shielding in the room and its access routes shall be provided to allow such actions.

BC

In addition, the Supplier* shall provide an outline of the access routes to the Secondary Containment* and of the procedures for entry.

2.9.3 STRUCTURAL DESIGN AND VERIFICATIONS

2.9.3.1 PRIMARY CONTAINMENT

2.9.3.1.1 INTRODUCTION

2.9.3.1.1.A

The Primary Containment* structure shall be designed to assure adequate performance in all Plant* conditions considered in the design process and specifically in Design Basis Conditions* (DBC), testing, and DEC. Internal and External Hazards* shall also be considered in the design process.

2.9.3.1.1.B

The Primary Containment* structure shall be designed to assure that releases to the environment beyond relevant Targets* set in Section 2.1.3 are prevented in all considered Plant* conditions.

2.9.3.1.1.C

The Supplier* shall provide evaluation of the structural behaviour (with respect to e.g. temperature and pressure) shall be performed to identify possible “cliff edge” effects, to evaluate margins with respect to the ultimate capability, and to study the failure mode of the structure.

CA

In terms of structural behaviour, avoidance of cliff edge effects means the assurance that a sudden catastrophic failure cannot occur at conditions just exceeding conditions considered in the design process (i.e. both DBA and DEC).

2.9.3.1.1.D

Local effects and details of component design shall also be considered to identify possible leakage mechanisms.

2.9.3.1.2 PRIMARY CONTAINMENT ARRANGEMENT AND LAYOUT

2.9.3.1.2.A

In principle different arrangements and different layouts are acceptable and, for each, specific requirements related to the structural design shall be considered.

2.9.3.1.2.B

The Primary Containment* internal volume shall be in accordance with Section 2.9.4.1.3.2.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 20/60

2.9.3.1.3 PRIMARY CONTAINMENT DESIGN PROCESS

2.9.3.1.3.1 GENERAL DESIGN APPROACH

2.9.3.1.3.1.A

The structural design of the Primary Containment* shall consider within design process all Design Basis Conditions* and Design Extension Conditions*, as well as Internal and External Hazards* to be taken into account in the design.

AA

The Primary Containment* shall be designed to meet its design functions taking into account the ageing (such as concrete peeling, concrete cracking, steel creeping) associated with the environmental conditions (such as temperature, pressure, radiation) and tests (ILRTs, structural integrity tests and local tests) in Normal Operation*.

2.9.3.1.3.2 PRIMARY CONTAINMENT STRUCTURAL BEHAVIOUR EVALUATION

2.9.3.1.3.2.A

The Supplier* shall fully specify behaviour of the Primary Containment* structure in all plant conditions (i.e. testing, DBC and DEC), the following steps shall be considered in the design process:

- definition of the different loads and load combination to be considered,
- definition of the required structural behaviour,
- definition of the acceptance criteria to assure the required structural behaviour, as well as the required leaktightness behaviour.

2.9.3.1.3.2.B

The Supplier* shall specify acceptance criteria for structural integrity, leaktightness and ageing of construction materials.

2.9.3.1.3.3 STRUCTURAL DESIGN AND CONTAINMENT LEAKTIGHTNESS CONTROL

2.9.3.1.3.3.A

The Supplier* shall specify requirements including acceptance criterions for assuring and demonstrating design leak rate within DBC and DEC for its type of containment (steel containment, pre-stressed and reinforced concrete containment with liner).

AA

The Supplier* shall dedicate the leaktightness evaluation to assess the behaviour of different components (including porosity, fragility and cracking mechanics of welding joints).

AB

The Supplier* shall develop appropriate criteria, to evaluate liner integrity and integrity of anchors.

AC

The reinforced concrete containment design shall include a total metal liner.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 21/60

2.9.3.1.3.4 LEAKTIGHTNESS CONTROL - CONTAINMENT COMPONENT DESIGN



2.9.3.1.3.4.B

Conditions to be addressed in the design for each component shall cover all the accident scenarios considered in the design, including DEC.

2.9.3.1.3.4.C

Containment components shall provide the necessary performance in DEC.

2.9.3.1.3.4.D

Local effects (pipe movement, jet forces, pipe whip etc.) shall be considered, as appropriate, defining loads and load combinations to be considered for component design.

2.9.3.1.3.4.E

Components performing a dual function shall meet the requirements related to the intended service or containment functions which are more stringent.

2.9.3.1.3.4.F

Component design conditions shall take into account the effects of local mechanical and thermal loads, if applicable, and other challenges such as direct contact with core debris, if not avoided, and local accumulation in the leak paths of radioactive aerosols.

2.9.3.1.3.5 VERIFICATION PROCESS

2.9.3.1.3.5.A

The final design of the containment structures shall include a re-analysis of all load conditions considered in the design.

2.9.3.1.3.5.B

Specifically loads associated with DBA and DEC shall be confirmed and compared with loads adopted in the preliminary design process to demonstrate that all the loads have been properly addressed in the design process.

2.9.3.1.3.6 ULTIMATE CAPABILITY EVALUATION AND SEARCH FOR CLIFF-EDGE EFFECTS

2.9.3.1.3.6.A

The Supplier* shall perform an analysis to determine the ultimate structural capability of the containment.

AA

Criteria to evaluate this capability shall be proposed by the Supplier* and shall be subject to the Owner's* approval.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 22/60

AB

The analysis shall consider penetrations and their interaction with the containment, interaction, if any, with the Secondary Containment* structures or with other structures inside or outside the Primary Containment*.

AC

The analysis shall demonstrate that the containment structure will not exceed its ultimate capability or be heavily damaged under loading conditions slightly higher than design conditions.

2.9.3.1.3.6.B

Proper methodologies shall address specific issues (i.e. liner tearing, containment opening failure mode).

2.9.3.1.3.6.C

The failure mode associated with the ultimate capability shall be identified.

2.9.3.1.3.6.D

The structural cliff-edge criterion, associated with the probabilistic cliff-edge criterion shall demonstrate the existence of adequate design margins.

2.9.3.1.4 STRUCTURAL DESIGN PROCESS

A

The design process shall be based on the following main steps:

- load identification and classification,
- load combination (with account of probability of occurrence of temporary loads),
- identification of acceptable limit states and corresponding acceptance criteria on stresses (with account of the ageing processes during the design lifetime),
- definition of the design parameters,
- serviceability analysis,
- sizing and verification of structural elements.

2.9.3.1.4.1 LOAD IDENTIFICATION AND CLASSIFICATION

2.9.3.1.4.1.A

The Supplier* shall identify all the loads expected during the life of the Plant* or to be considered in the containment design process.

AA

Loads shall be classified in accordance with the Chapter 2.4.

2.9.3.1.4.1.B

The loads shall be combined, and corresponding acceptance criteria shall be defined, on the basis of:

- probability of occurrence
- operating experience
- engineering judgment

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 23/60

BA

For general guidance a list of load conditions to be considered is presented in Section 2.9.3.1.4.1.1. Any deviation shall be justified and subject of the Owner's* approval.

2.9.3.1.4.1.C

Loads for each structural element shall be identified and evaluated with account of the conditions to which that particular structural element may be subjected.

2.9.3.1.4.1.D

Load combinations for each structural element shall be identified and evaluated with account of physical ability of simultaneous action of loads.

2.9.3.1.4.1.E

Therefore, loads shall be identified and evaluated for each structural element, as applicable.

2.9.3.1.4.1.F

The liner shall be designed to withstand the effects of imposed loads and actions to accommodate deformation of the concrete without jeopardizing its leak-tightness.

2.9.3.1.4.1.G

For serviceability analysis the liner shall be used as a structural element.

2.9.3.1.4.1.H

The liner shall not be used as a structural element for DBC.

2.9.3.1.4.1.I

Consequences on the liner from DEC shall be taken into account.

2.9.3.1.4.1.J

The Supplier* shall identify the specific characteristics of each load (e.g. static and dynamic including seismic, impulse and impact loads, design load cycles). For seismic loads time-history analysis shall be provided.

2.9.3.1.4.1.K

The Supplier* shall identify each load that cannot be classified as quasi-static.

2.9.3.1.4.1.L

Global dynamic loads (e.g. global hydrogen detonation) shall be avoided by design.

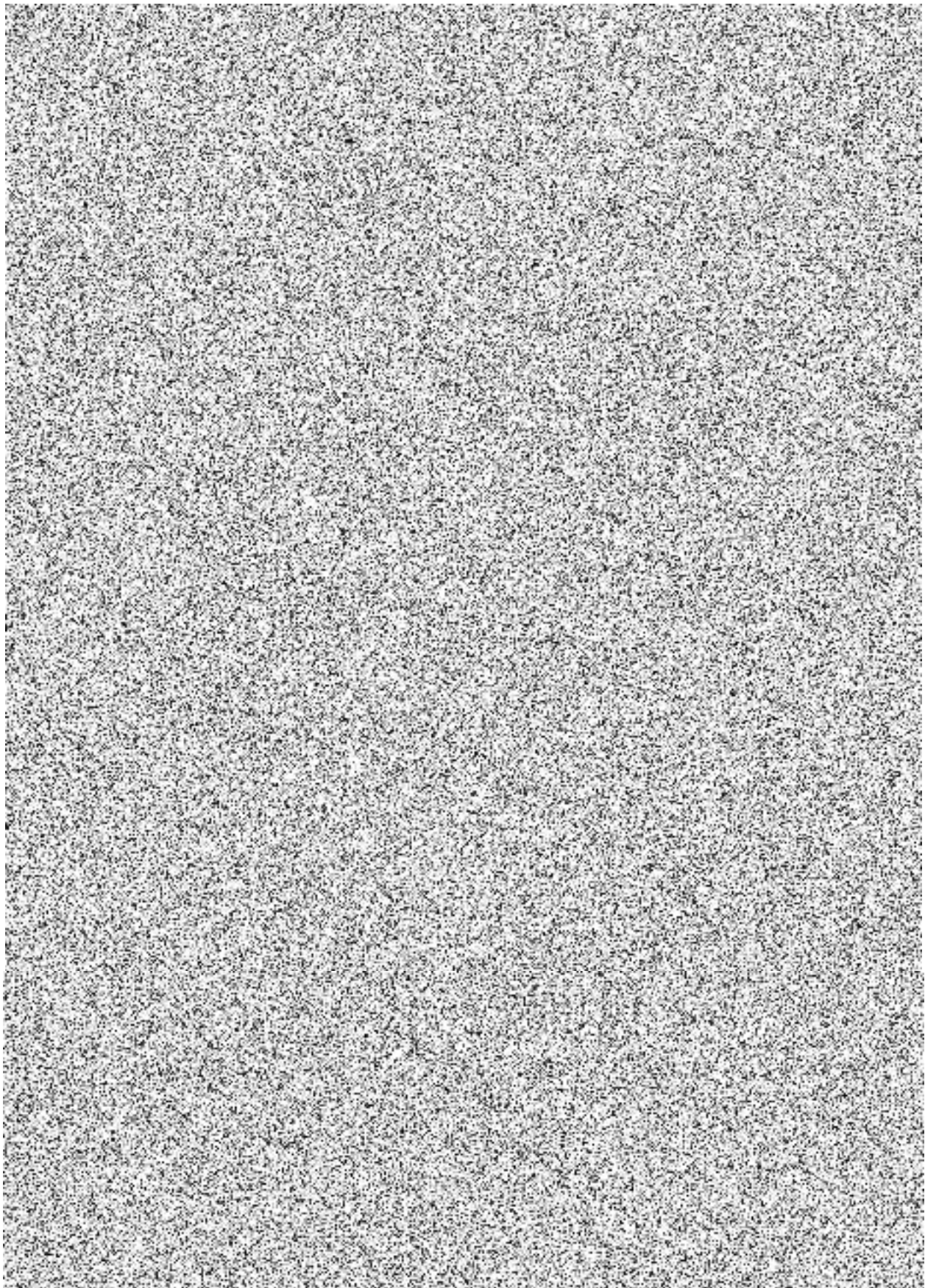
LA

Overall dynamic loads have to be ruled out by design, for means for preventing overall hydrogen detonation.

2.9.3.1.4.1.M

If local dynamic loads cannot be excluded, the Supplier* shall identify all the relevant parameters needed for appropriate consideration in the design process.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 24/60



Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 25/60

2.9.3.1.4.2 DEFINITION OF LIMIT STATES

2.9.3.1.4.2.A

The Supplier* shall perform an analysis (inter alia represented in information models) to consider both global and local behaviour of the structure. Different limit states can be defined for containment structures with reference to their expected performance and in accordance with the Design Code selected.

2.9.3.1.4.3 LIMIT STATES FROM THE STRUCTURAL INTEGRITY POINT OF VIEW

2.9.3.1.4.3.A

From the structural integrity point of view, i.e. the capability of the structural elements to withstand applied loads three Levels of limit states shall be considered.

AA

Furthermore, limit states related to local effects (e.g. stress intensification; discontinuities; local loads; etc.) need to be specifically defined.

2.9.3.1.4.3.1 LEVEL I: ELASTIC RANGE

2.9.3.1.4.3.1.A

The Supplier* shall guarantee structural integrity with large margins (i.e. normal safety factors). As a global effect, no permanent deformation, or damage, of the containment structure.

2.9.3.1.4.3.2 LEVEL II: LOCAL PERMANENT DEFORMATION

2.9.3.1.4.3.2.A

The Supplier* shall guarantee structural integrity with enough margins even if with less than in Level I (i.e. reduced safety factors). Permanent deformations, mainly locally, may be possible.

AA

NA

2.9.3.1.4.3.3 LEVEL III: LARGE PERMANENT DEFORMATION

2.9.3.1.4.3.3.A

In this condition the structure may suffer significant permanent deformation. Local damage is also possible. This condition should not be permitted as a global condition.

2.9.3.1.4.3.4 ULTIMATE CAPABILITY

2.9.3.1.4.3.4.A

Evaluation of the ultimate capability of the structure and consideration of the corresponding failure mode shall be performed to provide a clear understanding of the margins to failure embodied in the design.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 26/60

AA

For the sake of simplicity, it is possible to assume a conventional criterion of failure for each technology. E.g.

- for a pre-stressed concrete containment, "failure" may be defined as the attainment of x % (e.g. 1 %) strain in steel tendons anywhere in the shell,
- for a reinforced concrete structure, "failure" may be defined as a condition of general yielding of the hoop reinforcements,
- for a steel containment, industrial standards usually provide a conventional definition of collapse.

2.9.3.1.4.4 LIMIT STATES FROM THE LEAKTIGHTNESS POINT OF VIEW

2.9.3.1.4.4.1 LEVEL I: LEAK-TIGHT STRUCTURE

2.9.3.1.4.4.1.A

The leakages from the containment structure shall be below the design leakage target and shall be reliably correlated with pressure and other loads.

AA

The limit state definition for leaktightness is, in principle, applicable to the containment shell.

2.9.3.1.4.4.1.B

Leakages through containment components shall be evaluated (and tested) separately in order to limit their contributions to the uncertainties on the evaluation of the overall leakage.

2.9.3.1.4.4.2 LEVEL II: POSSIBLE LIMITED INCREASE OF LEAK RATE

2.9.3.1.4.4.2.A

The Supplier* shall be able to assess (by calculation and/or by testing) the leak rate to be assumed in the safety analysis.

2.9.3.1.4.4.2.B

The Supplier* shall give a great attention to defining transition mechanisms and their acceptability under different load conditions.

2.9.3.1.4.4.3 LEVEL III: LARGE OR VERY LARGE INCREASE OF LEAK RATE

2.9.3.1.4.4.3.A

The Supplier* shall assess (by calculation and/or by testing) the leak rate to be assumed in the radiological and safety analysis.

2.9.3.1.4.5 LOAD COMBINATIONS AND ACCEPTANCE CRITERIA

2.9.3.1.4.5.1 LOAD COMBINATIONS

2.9.3.1.4.5.1.A

Loads identified and classified are described in the Section 2.9.3.1.4.1 shall be combined for different load cases. For each of these load cases, different stress limits shall be assumed.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 27/60

2.9.3.1.4.5.1.B

The Supplier* shall select a design code consistent with the requirements of this Section.

BA

Loads are combined considering mainly:

- load type,
- whether different loads are consequential,
- time-history analysis of each specified load,
- probability of occurrence of different load combinations.

BB

Applicable loads shall be used for DEC.

2.9.3.1.4.5.1.C

As a consequence of this choice, some specific load combinations shall be ruled out.

2.9.3.1.4.5.1.D

The Supplier* shall use the list of load combinations described in the Section 2.9.3.1.4.5.3.

DA

The detailed list of the load cases to be considered shall be defined by the Supplier* in accordance with the applicable design codes.

2.9.3.1.4.5.1.E

Combining loads derived from accident sequences, the maximum expected values in terms of pressure, temperature, pipe reaction and consequential local effects shall be combined unless a time-history analysis justifies lower combined values.

2.9.3.1.4.5.1.F

In assuming the maximum temperature care shall be given for situations in which the ambient temperature is significantly different from structural element temperatures.

2.9.3.1.4.5.1.G

For DBA, appropriate margins shall be initially considered in the design process (see Section 2.9.3.1.4.6).

2.9.3.1.4.5.1.H

Specific care shall be taken with the definition of the DEC load combinations. The DEC are treated in a realistic way and time-history analysis is particularly important in order to avoid unrealistic superposition of different loads, e.g. Automatic Depressurisation System (ADS) actuation coincident with an external pressurisation event.

2.9.3.1.4.5.1.I

In all cases in which consideration of a specific load reduces the stress caused by a second load, the first load shall be set equal to zero if cannot be demonstrated that the loads always coexist.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 28/60

2.9.3.1.4.5.1.J

The Supplier* shall identify enveloping load combinations, analysing accident sequences of the same family.

JA

The Supplier* shall justify every combination of loads which leads which leads to different values of the calculated maximum load combinations values.

2.9.3.1.4.5.2 ACCEPTANCE CRITERIA

2.9.3.1.4.5.2.A

Applicable acceptance criteria shall be defined in terms of working stress corresponding to limit states Level I to Level III, i.e. providing adequate margins of safety by adequate structural integrity and leak-tightness.

2.9.3.1.4.5.2.B

Alternatively, the acceptance criteria shall be defined in terms of load factor (LF), i.e. providing design safety margins by increasing applied loads by some factor (>1) greater than the maximum expected value.

BA

Suggested acceptance criteria are summarised in Section 2.9.3.1.4.5.3, Table 2, both for steel and concrete structures. Acceptance criteria are stated both in terms of structural integrity and of leaktightness.

BB

Any deviation from the suggested acceptance criteria presented in Section 2.9.3.1.4.5.3, Table 2 shall be justified.

BC

The detailed application of this methodology, definition and applicability of acceptance criteria shall be defined by the Supplier* and shall be subject to approval by the Owner*.

2.9.3.1.4.5.2.C

Stress intensity limits (for steel structures) and load factors (for concrete structures) shall be derived from the standard adopted for each specific design.

2.9.3.1.4.5.2.D

A consistent set of applicable standards shall be applied by the Supplier*.

2.9.3.1.4.5.2.E

Stress intensity limits (or load factor) for DEC shall be defined by applying the same methodology as adopted for DBA.

EA

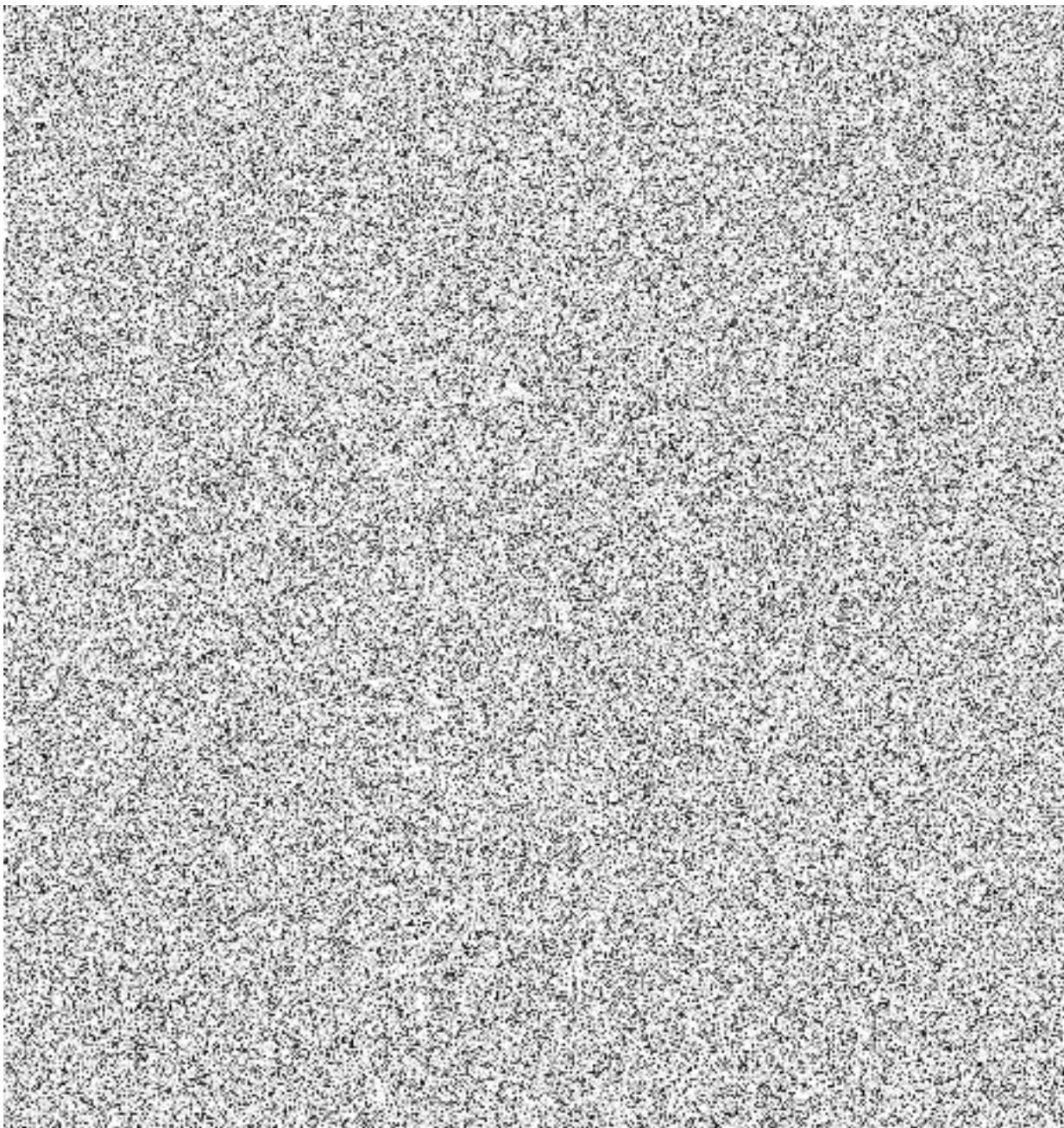
Acceptance criteria presented in Section 2.9.3.1.4.5.3, Tables 2, together with the proposed criteria for selecting critical parameters allow the DEC scenarios to be treated in a non over-conservative way and, at the same time, to meet the target discussed in the same section, i.e. to achieve the possibility of testing the containment structure in conditions as close as possible to DEC.

2.9.3.1.4.5.2.F

Acceptance criteria specified in Section 2.9.3.1.4.5.3, Table 2, translate different behavior of the containment structure into allowable stresses. These acceptance criteria shall cover both the structural integrity and serviceability aspects (i.e., for the containment structure, mainly the leaktightness aspect).

2.9.3.1.4.5.3 TABLE 2: LOAD COMBINATIONS AND ACCEPTANCE CRITERIA FOR PRIMARY CONTAINMENT STRUCTURE

Primary Containment structure is designed in accordance with ASME B&PV Code Sec. III, Div.2. Therefore, the load combination described in Table 4.1.5.1 of DCM based on ASME Code and USNRC RG 1.136 is used for Primary Containment structure.



Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 30/60

2.9.3.1.4.6 SELECTION OF THE CRITICAL DESIGN PARAMETERS

2.9.3.1.4.6.A

The Supplier* shall define, on the basis of the following criteria, the critical parameters for the design.

AA

For each case the final design parameters (inter alia represented in information models) shall be explicitly subject to the Owner's* approval.

2.9.3.1.4.6.1 DESIGN PRESSURE (PDESIGN)

2.9.3.1.4.6.1.A

Design Pressure (P_{design}) shall be determined in such a way that all the load combinations specified in Section 2.9.3.1.4.5.3 (Table 2), are considered, and the related acceptance criteria are fulfilled.

2.9.3.1.4.6.1.B

P_{design} shall be initially assumed equal or greater than the pressure associated with the worst DBA with a margin of at least 10 %.

2.9.3.1.4.6.1.C

Acceptance criteria to be considered, and corresponding limit states, shall refer not only to structural integrity but also to leaktightness.

2.9.3.1.4.6.1.D

Specifically for load combinations for which a Level II acceptance criterion is required, specific attention shall be put on leaktightness considerations.

2.9.3.1.4.6.1.E

Specific analyses shall demonstrate the extent of possible leak rate increase (local effects; concrete cracking; etc.).

2.9.3.1.4.6.1.F

Acceptability of these mechanisms shall be explicitly stated, when applicable. The possibility of demonstrating actual leakages (by calculation or by extrapolation from tested conditions) shall be verified.

2.9.3.1.4.6.2 DESIGN TEMPERATURE (TDESIGN)

2.9.3.1.4.6.2.A

Design Temperature (T_{design}) shall be derived from the corresponding accident scenarios as a constant value to be applied uniformly to the structure.

AA

The Design Temperature shall not be less than the maximum containment temperature.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 31/60

AB

For consideration of thermal gradients, long-term thermal effects and need to consider the whole time history of specific accident sequences, see the Section 2.9.3.1.4.7 (thermal effects).

2.9.3.1.4.6.3 TEST PRESSURE (PTEST)

2.9.3.1.4.6.3.A

Test Pressure (P_{test}) shall be defined on the basis of the design parameters, as selected above and specifically on the basis of P_{design} in compliance with the design standard.

AA

NA

AB

For a concrete containment with a metal liner, the minimum value to be used in test is 1,15 P_{design}

2.9.3.1.4.6.3.B

Requirements from the standard applied shall be complied with.

2.9.3.1.4.7 SIZING OF STRUCTURAL ELEMENTS

2.9.3.1.4.7.A

Sizing of the structural elements of the containment structure that contribute to Containment System* performance shall be decided on the basis of the leading parameters as defined above.

2.9.3.1.4.7.B

Loads shall be classified and combined as required in Section 2.9.3.1.4.1.

2.9.3.1.4.7.C

The Supplier* shall define all the loads that the containment structure can be subject to during the different Plant States*.

2.9.3.1.4.7.D

Local loads, including the dynamic ones (e.g. missiles, pipe whip, jet impingement, etc.) or flooding conditions shall be identified.

2.9.3.1.4.7.E

Among others, pressure difference between adjacent rooms as well as thermal gradient through main walls shall be specified.

2.9.3.1.4.7.1 EXTERNAL PRESSURE LOADING - BUCKLING VERIFICATION

2.9.3.1.4.7.1.A

Stability of the containment under external loads shall be verified both for steel and concrete containments.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 32/60

2.9.3.1.4.7.1.B

NA

2.9.3.1.4.7.1.C

NA

2.9.3.1.4.7.1.D

NA

2.9.3.1.4.7.1.E

For concrete containments, stability verification shall be provided also; consideration shall be given to possible reduction in buckling capacity due to construction tolerances, large deflections and creep.

2.9.3.1.4.7.1.F

Instability phenomena shall be considered for liner design, where applicable.

2.9.3.1.4.7.2 LOCAL FATIGUE ANALYSIS

2.9.3.1.4.7.2.A

NA

2.9.3.1.4.7.2.B

A check of the need for fatigue analysis shall be performed also for the metal liner of a concrete containment, when applicable.

2.9.3.1.4.7.2.C

Thermal stresses shall be considered both in Normal Operation* and in Accident Conditions*.

2.9.3.1.4.7.3 THERMAL EFFECTS

2.9.3.1.4.7.3.A

For concrete containments, the thermal field inside the main structural elements shall be determined both in Normal Operation* and in an event in Accident Conditions* (DBA and DEC).

AA

Maximum allowable temperatures for concrete are as follows:

- for Normal Operation* concrete temperature shall be limited below 65 °C;
- in case of limited local effects (e.g. around penetrations) higher temperatures (up to 100 °C) is allowed;
- for Accident Conditions* concrete temperatures on the surface directly exposed to harsh environmental conditions shall not exceed 175 °C;
- local areas are allowed to reach 350°C for the case of jet impingement.

2.9.3.1.4.7.3.B

If very high concrete temperatures are expected, the Supplier* shall demonstrate by test that the reduction in concrete strength is compatible with the values assumed in the design process.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 33/60

2.9.3.1.4.7.3.C

As far as the structural overall behaviour is concerned, a realistic time history of the thermal profile shall be considered to evaluate its acceptability.

2.9.3.1.4.7.3.D

NA

2.9.3.1.4.7.3.E

For steel liner, temperature effects shall be evaluated.

2.9.3.1.4.7.3.F

The concrete dewatering effect during high temperatures shall be evaluated.

2.9.3.1.4.7.4 LONG-TERM EFFECTS

2.9.3.1.4.7.4.A

NA

2.9.3.1.4.7.4.B

For pre-stressed/reinforced concrete containments, the Supplier* shall address, where applicable, phenomena such as frictional losses due to curvature in tendons; slip at anchorages; steel relaxation; elastic shortening of concrete; creep of concrete; shrinkage of concrete.

2.9.3.1.4.7.4.C

Corrosion phenomena shall be considered also for pre-stressing steel.

2.9.3.1.5 LOCAL EFFECTS

2.9.3.1.5.A

The Supplier* shall evaluate loads deriving from local effects and shall justify the need for further consideration or the possibility of ruling out the associated loads.

AA

Global dynamic loads have to be ruled out by design (see the Section 2.9.3.1.7.1 and Section 2.1.2.5.).

2.9.3.1.5.B

Characteristics of these loads (i.e. quasi-static or dynamic loads) shall be determined together with expected numerical values.

2.9.3.1.5.1 LOCAL EFFECTS ASSOCIATED WITH HYDROGEN BURNING AND DETONATION

2.9.3.1.5.1.A

Local effects such as local hydrogen burning (open flames) or local detonation shall be evaluated by the Supplier* using realistic methodologies.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 34/60

AA

Provisions for global hydrogen management are described in the Section 2.9.4.1.3.

2.9.3.1.5.1.B

The possibility of associated missiles shall be evaluated.

2.9.3.1.5.1.C

If these effects cannot be ruled out, the Supplier* shall evaluate the associated loads on the containment structure, on specific structural elements, and on containment components.

2.9.3.1.5.1.D

The containment components shall be designed to withstand these loads.

2.9.3.1.5.1.E

When appropriate, dedicated shields shall be adopted to protect specific containment components from open flames and/or missiles.

2.9.3.1.5.2 STRUCTURAL CAPABILITY OF THE REACTOR CAVITY

2.9.3.1.5.2.A

If ex-vessel energetic corium-water interaction in the Reactor Cavity* cannot be excluded, the Supplier* shall evaluate the expected associated loads using realistic methodologies (see the Section 2.9.3.1.7.3).

2.9.3.1.5.2.B

The Reactor Cavity* shall be designed to withstand these loads.

2.9.3.1.5.3 DYNAMIC AND HYDRODYNAMIC LOADS

2.9.3.1.5.3.A

Hydrodynamic loads caused by the vent line water clearing, pool swell, pool fallback, condensation oscillation shall be taken into account in the design.

2.9.3.1.5.4 EXTERNAL PRESSURE

2.9.3.1.5.4.A

The Primary Containment* shall be designed to withstand:

- inadvertent internal pressure drops during Normal Operation* and Accident Conditions*,
- pressurisation of the space between the Primary Containment* and the Secondary Containment* for the case of high-energy line break inside that space, unless such break is prevented by design or steam is channelled outside.

2.9.3.1.5.5 METAL LINER

2.9.3.1.5.5.A

Liner design, when applicable, shall be developed using standards consistent with the standards adopted for the overall structural design.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 35/60

2.9.3.1.5.5.B

The liner plate and its anchors shall be designed by considering the loads and load combinations adopted for the containment structure.

2.9.3.1.5.5.C

The liner shall be anchored to the concrete in such a way that consequential liner strains do not exceed allowable strains specified by the applicable standards. Liner stability check shall be performed.

2.9.3.1.5.5.D

The liner plate and its anchors shall be designed to resist unbalanced loads.

2.9.3.1.5.5.E

The Supplier* shall consider suitability of the liner design for the specific operating conditions involving cyclic application of loads and thermal conditions.

2.9.3.1.5.5.F

The metal line shall withstand the thermal loads deriving from actual temperature profiles in the containment structure under Accident Conditions*.

2.9.3.1.5.5.G

A detailed methodology to evaluate liner tearing in Accident Conditions* and consequential leakage shall be developed by the Supplier* and shall be subject to the Owner's* approval (see Section 2.9.3.1.4.1).

2.9.3.1.5.5.H

Liner collapse due to internal pressure drop shall be considered in the design.

2.9.3.1.5.5.I

In the Containment system* water pools with radioactive liquids, leak detection instrumentation behind the pool liner shall be provided.

2.9.3.1.5.6 COMPOSITE LINER

2.9.3.1.5.6.A

NA

2.9.3.1.5.6.B

NA

2.9.3.1.5.6.C

NA

2.9.3.1.5.6.D

NA

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 36/60

2.9.3.1.6 PRE-SERVICE AND IN-SERVICE INSPECTION OF THE CONTAINMENT STRUCTURE

2.9.3.1.6.A

A detailed containment surveillance programme (incl. liner), both during construction and for the pre-operational containment integrity testing, at the completion of construction and during the Plant* life, shall be prepared by the Supplier* in conformity with the applied standards and shall be subject to approval by the Owner*.

AA

The structure of the containment surveillance programme shall be in line with principles described in Licensing and Permitting, Safety and Quality Document*, Chapter 3 (Section 3.2 G, etc.).

AB

Inter alia, the detailed containment surveillance programme shall include the information defined in Project Management Document*, Attachment 3, Section 4.5.28.

2.9.3.1.6.B

Appropriate acceptance criteria shall be defined together with procedures describing additional tests, procedures and monitoring in case these acceptance criteria are not met.

2.9.3.1.6.C

Suitable instrumentation shall be provided to make possible construction, pre-service and in-service surveillance and shall include as a minimum ASME Section XI and requirements of Authority.

- Temperature
- Stress – strain state
- Deformation
- Level of prestressing

CA

Means shall be provided to enable the Operators* to perform checks for significant prestressing losses of the pre-stressed concrete Primary Containment* during Normal Operation*.

2.9.3.1.6.D

The Supplier* shall define limiting conditions for safe operation (e.g. level of prestressing, deformation of liner, etc.).

2.9.3.1.7 SEVERE ACCIDENT PHENOMENOLOGIES TO BE ADDRESSED IN THE DESIGN

2.9.3.1.7.1 GENERAL DESIGN APPROACH

2.9.3.1.7.1.A

The Containment System*, and the Primary Containment* in particular, shall be designed to mitigate the consequences of the Severe Accidents* sequences addressed in the design.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 37/60

AA

Representative Severe Accident* sequences shall be addressed in the design as required in Section 2.1.4.2.1.

2.9.3.1.7.1.B

Early failure of the Primary Containment* (caused, for example, by large scale hydrogen detonations, direct containment heating, steam explosion, reactivity accidents or containment isolation failure) shall be Practically Eliminated*.

2.9.3.1.7.1.C

Long term Primary Containment* failures resulting in the Large Releases* shall be Practically Eliminated*.

2.9.3.1.7.1.D

As specified in general in Section 2.1.2.4. on Design Extension Conditions*, the Severe Accident* evaluations in the design process shall be realistic and best-estimate, while still retaining adequate margins where substantial uncertainties may exist.

2.9.3.1.7.1.E

However, in the process of defining the design parameters, some deterministic assumptions are required such as those defined in Section 2.9.3.1.8.1 for Operator* action and active heat removal systems.

2.9.3.1.7.1.F

Loads from Severe Accident* phenomenologies shall not be summed up without credit to a realistic accident evolution; best-estimate load combinations shall be considered.

2.9.3.1.7.1.G

Loads resulting from hydrogen burning shall be combined with a realistic containment pressure, taking credit for pressure reduction by Primary Containment* cooling and Heat Sinks* before substantial Core* degradation has occurred.

2.9.3.1.7.1.H

In the event of a Severe Accident* and RPV melt-through, the integrity of the basemat shall be demonstrated.

2.9.3.1.7.2 IN-VESSEL CORE DEBRIS/WATER INTERACTIONS

2.9.3.1.7.2.A

The Supplier* shall evaluate loads associated with in-vessel energetic Core* debris/water interactions.

2.9.3.1.7.2.B

The probability of RPV failure and consequential early Primary Containment* failure shall be demonstrated to be Practically Eliminated*.

2.9.3.1.7.2.C

In addition, it shall be demonstrated that a sudden catastrophic failure of the RPV's bottom head, with a consequential reduction of corium cooling capabilities of the Reactor

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 38/60

Cavity*/Core Catcher*, cannot occur as a result of energetic debris/water interaction, or that its probability is extremely low.

2.9.3.1.7.3 EX-VESSEL DEBRIS/WATER INTERACTIONS

2.9.3.1.7.3.A

If corium cannot be retained in the RPV (see Section 2.9.3.1.8.2) and if, at the time of RPV failure, it is not possible to ensure that water is not present in the Reactor Cavity*/Core Catcher*, the Supplier* shall verify (see Section 2.9.3.1.5.2) that the debris/water interaction capable of jeopardising Primary Containment* and Reactor Cavity*/Core Catcher* integrity can be Practically Eliminated*.

2.9.3.1.7.3.B

The Supplier* shall also quantify the loads associated with the steam spike associated with the debris/water interaction to assure that the integrity of the Reactor Cavity* walls and/or Core Catcher* and the RPV supports is maintained.

2.9.3.1.7.3.C

The Reactor Cavity*/Core Catcher* design shall be designed to limit and withstand loads from the consequent corium flooding.

2.9.3.1.7.4 DIRECT CONTAINMENT HEATING

2.9.3.1.7.4.A

Direct Containment Heating (DCH) shall be Practically Eliminated*.

AA

For that purpose, the RCS shall be provided by a reliable depressurisation system, capable of reducing the pressure in the RPV below 2 MPa before it could be penetrated by a melted Core*.

2.9.3.1.7.4.B

In addition, the Reactor Cavity* arrangement (see Section 2.9.3.1.8.3) shall contribute to the prevention of dispersal of debris particulate into the Primary Containment* atmosphere.

2.9.3.1.7.4.C

Analysis shall be performed to confirm that the Reactor Cavity* and/or Core Catcher* design is adequate to confine debris and to avoid early Primary Containment* failure, in case of RPV failure at pressures below 2 MPa.

2.9.3.1.7.5 HYDROGEN BURNING

2.9.3.1.7.5.A

The probability of a global hydrogen detonation capable of endangering the Primary Containment* performance shall be Practically Eliminated*.

2.9.3.1.7.5.B

If the Primary Containment* atmosphere has not been inertised, prevention of global hydrogen detonation shall be achieved primarily by hydrogen dilution in the Primary Containment* free volume (see Section 2.9.4.1.3.2).

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 39/60

2.9.3.1.7.5.C

If the Primary Containment* atmosphere has not been inertised, the design shall assure that, assuming a hydrogen production equivalent to 100% of active fuel cladding/water interaction and a realistic production rate, then the average hydrogen concentration in the Primary Containment* will not exceed 10% by volume in dry conditions, giving credit to hydrogen control measures such as recombiners and/or igniters.

CA

Higher concentration may be considered, in the short-term period when steam inerting can be credited, provided that the necessary margin is available to prevent hydrogen detonation.

2.9.3.1.7.5.D

Primary Containment* design shall combine the effects of progressive hydrogen recombination/ignition and from a global deflagration (Adiabatic Isochoric Complete Combustion: AICC) of the 10 % average concentration of hydrogen with all other loads in a realistic way.

DA

Timing shall be considered in a mechanistic and realistic way. In particular, credit for steam inerting may be assumed as appropriate.

2.9.3.1.7.5.E

The Supplier* shall demonstrate that the Primary Containment* leaktightness is assured after the above overall deflagration.

EA

The demonstration of leaktightness shall be given in accordance with limit state level II, as defined in Section 2.9.3.1.4.3.2.

EB

The Supplier* shall calculate leak increase during the pressure peak and evaluate the impact on the environment.

2.9.3.1.7.5.F

Primary Containment* geometry shall be optimised in order to minimise flame acceleration.

FA

Large, open volumes shall be provided in the Primary Containment*.

2.9.3.1.7.5.G

It shall be demonstrated that adequate precautions have been implemented in the design so that local detonations of hydrogen are unlikely to occur.

2.9.3.1.7.5.H

If local detonations cannot be demonstrated to be unlikely, their effect on equipment and on the Primary Containment* shall be considered.

2.9.3.1.7.5.I

In the evaluation of long-term hydrogen concentrations, the contributions of radiolysis and corrosion reactions shall be considered in addition to the above quantities.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 40/60

IA

Evaluations shall be extended for at least 30 days after accident initiation.

2.9.3.1.7.6 OTHER FLAMMABLE GASES

2.9.3.1.7.6.A

The Supplier* shall evaluate the production of other flammable gases, such as carbon monoxide, and include both their partial pressure in the pressure calculations for the Primary Containment* and the effects of their burning.

2.9.3.1.7.7 INCONDENSIBLE GASES

2.9.3.1.7.7.A

If not eliminated by design, production of incondensible gases such as CO₂ generated mainly by molten core-concrete interaction shall be evaluated and their effect added to the pressure calculations for the Primary Containment*.

2.9.3.1.7.7.B

The contribution of hydrogen partial pressure shall be taken into account in the evaluation of the Primary Containment* structural behaviour.

2.9.3.1.7.7.C

In estimating the amount of incondensable gases a hydrogen production equivalent to 100 % of active fuel cladding/water interaction shall be assumed, giving credit to hydrogen control measures such as recombiners and/or igniters.

2.9.3.1.8 HEAT REMOVAL

2.9.3.1.8.1 IN-CONTAINMENT HEAT SINK AND HEAT REMOVAL FROM THE CONTAINMENT

2.9.3.1.8.1.A

The Primary Containment* pressure and temperature shall be kept controlled to maintain the long-term Primary Containment* integrity and to assure the minimisation of the radioactive releases to the environment.

AA

The long term overpressurisation of the Primary Containment* shall be Practically Eliminated*.

AB

The pressure and temperature inside the Primary Containment* shall also be controlled in order not to exceed the environmental qualification of SSC.

2.9.3.1.8.1.B

The pressure inside the Primary Containment* resulting from the worst postulated DBA shall be reduced below 50% of the design pressure within 24 hours after the initiating event.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 41/60

BA

The containment temperature shall also be kept controlled.

2.9.3.1.8.1.C

Primary Containment* design shall be such that the Primary Containment* can withstand any of the Severe Accidents* addressed in DEC, without Operator* action during the first 12 hours from the beginning of the Severe Accident* conditions.

CA

Some simple Operator* actions from MCR and Emergency Control Room* may be considered for very unlikely accidents (frequency below 10^{-7} /year), when justified.

CB

The Supplier* shall aim at extending this period at least to 24 hours.

CC

The early failure of the Primary Containment* shall be Practically Eliminated*.

2.9.3.1.8.1.D

The Supplier* shall demonstrate that the pressure rise inside the Primary Containment* can be limited, relying only on:

- intrinsic features such as volume and structural strength of the Primary Containment*,
- permanent heat sinks inside the Primary Containment*,
- passive heat removal systems,
- passive hydrogen management system.

2.9.3.1.8.2 IN-VESSEL DEBRIS COOLING

2.9.3.1.8.2.A

The Supplier* shall evaluate the possibility that the design can support a technical demonstration that, while collected in the RPV bottom, the molten Core* can be cooled and the RPV structure is not breached by the corium at any stage of the accident.

AA

Failure of the RPV due to steam explosion shall be Practically Eliminated*.

2.9.3.1.8.2.B

NA

2.9.3.1.8.2.C

In this case the Supplier* may propose to use in-vessel debris cooling.

CA

NA

2.9.3.1.8.2.D

The Supplier* shall prove that re-criticality conditions will not be reached in the sequence, even assuming unfavourable mixing conditions (e.g. stratification) in the corium pool.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 42/60

2.9.3.1.8.3 EX-VESSEL DEBRIS COOLING

2.9.3.1.8.3.A

Specific provisions shall be provided to assure corium confinement and coolability outside the RPV.

AA

This system shall not have any active component inside the Primary Containment*.

AB

The necessary area and volume under the RPV shall be provided to allow ex-vessel corium coolability.

2.9.3.1.8.3.B

The Supplier* shall prove that the corium will not jeopardise the civil structures (including equipment supports) and equipment needed for mitigation of Severe Accidents* consequences.

2.9.3.1.8.3.C

The Core Catcher* and/or the Reactor Cavity* design shall be such that Primary Containment* melt-through due to the Core* melt formed in a Severe Accident* is Practically Eliminated*.

CA

Molten core-concrete interaction shall be limited to minimise generation of hydrogen and other flammable and incondensable gases.

2.9.3.1.8.3.D

The design shall prevent the transport of significant quantities of corium particulate into the large open portion of the Primary Containment* or into direct contact with the Primary Containment* boundary after a vessel melt-through at low pressure.

2.9.3.1.8.3.E

Provision shall be made for the cooling of the Core* melt in such a way that radioactive substances released into the Primary Containment* air space can be effectively restricted and that the radiation heat emitted by the reactor debris does not break the Reactor Cavity* integrity.

2.9.3.1.8.3.F

In all cases the Supplier* shall also demonstrate that, in the most unfavourable cases, re-criticality cannot occur.

2.9.3.1.8.3.G

Vent area to the upper part of the Primary Containment* shall also be provided to release the steam and non-condensable gases produced during the corium cooling process.

2.9.3.1.8.3.H

The hot gases produced in Severe Accidents* shall be managed so that the gases do not break the Primary Containment* integrity via the Steam Generators* or otherwise.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 43/60

2.9.3.1.9 LAYOUT REQUIREMENTS

2.9.3.1.9.1 GENERAL LAYOUT REQUIREMENTS

2.9.3.1.9.1.A

Primary Containment* general configuration (inter alia represented in information models) shall provide openings in walls and slabs:

- to promote atmosphere mixing by natural circulation,
- to minimise the pressure differentials across the walls in Accident Conditions*.

2.9.3.1.9.1.B

General configuration within the Primary Containment* shall avoid long narrow areas promoting transition from deflagration to detonation of hydrogen.

2.9.3.1.9.1.C

Primary Containment* general configuration shall channel condensed water to collect and recirculate it.

2.9.3.1.9.1.D

The containment arrangement shall permit removal and replacement of all Steam Generators* within a 150 day plant shutdown.

2.9.3.1.9.1.E

Adequate space shall be reserved for laydown and storage space for the RPV head and internals, maintenance equipment (e.g. stud tensioner and multi-stud tensioner, if applicable).

2.9.3.1.9.1.F

The arrangement of the Primary Containment* and Secondary Containment* shall facilitate the collection and identification of liquid leakages inside the containment.

2.9.3.1.9.1.G

The Primary Containment* design shall maximise the fraction of free volume which can be directly sprayed by the containment spray system, if included in the design.

2.9.3.2 SECONDARY CONTAINMENT

2.9.3.2.1 FUNCTIONAL REQUIREMENTS

2.9.3.2.1.A

The Secondary Containment* shall collect the leaks from the Primary Containment*.

2.9.3.2.1.B

The Secondary Containment* shall be designed to maintain the required leaktightness during and following loads associated with:

- pressurisation caused in any DBA or DEC by:
 - postulated High Energy Lines* ruptures inside its volume,
 - leakages from components,
 - heat loads generated within the Secondary Containment*,

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 44/60

- heat transfer from the Primary Containment*,
- the compressive effect of Primary Containment* expansion,
- depressurisation caused by any postulated event, such as HVAC malfunction.

2.9.3.2.1.C

In case the Primary Containment* shall be made non-leaktight due to reloading or maintenance, the Secondary Containment* shall be designed to function as an additional technical Barrier* to the spreading of radioactive substances in accidents assessed possible under these conditions including DEC accidents involving severe damages to the fuel.

CA

Operational procedures shall be developed to restore the Primary Containment* leaktight barrier in a short time.

2.9.3.2.2 LAYOUT REQUIREMENTS

2.9.3.2.2.A

The Secondary Containment* layout shall maximise the atmosphere mixing. It shall reduce preferential paths for leakages from the Primary Containment* to the Secondary Containment* boundary.

2.9.3.2.2.B

Volumes shall be connected to the extent possible.

2.9.3.2.2.C

If separated volumes are proposed for the Secondary Containment* layout, the assumption shall be made that the entire Primary Containment* leakage occurs in the smallest volume if less stringent assumptions cannot be demonstrated.

2.9.4 EQUIPMENT AND SYSTEM DESIGN REQUIREMENTS

2.9.4.1 PRIMARY CONTAINMENT EQUIPMENT AND SYSTEMS

2.9.4.1.1 HEAT REMOVAL SYSTEMS

2.9.4.1.1.1 HEAT REMOVAL FROM THE CONTAINMENT

2.9.4.1.1.1.1 HEAT REMOVAL IN DBA

2.9.4.1.1.1.1.A

A Containment Heat Removal System (CHRS) shall be designed to remove heat accumulated in the Primary Containment* during DBA to ensure that the Primary Containment* design pressure and temperature are not exceeded.

2.9.4.1.1.1.1.B

The CHRS shall be designed to perform the following functions in DBA conditions:

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 45/60

BA

- control the pressure inside the Primary Containment* by removing decay heat from its atmosphere and/or water pools to the environment,

BB

- the Containment System* being the last of the defence-in-depth barriers, the CHRS reliability shall be compatible with the probabilistic safety targets.

BC

- the system shall be designed without any active component inside the Primary Containment*.

BD

In addition, the system shall be capable of reducing the Primary Containment* pressure and of terminating all releases in a reasonably short time as specified in Section 2.9.3.1.8.1.

2.9.4.1.1.1.1.C

As part of the ultimate Barrier*, the CHRS shall constitute a leaktight boundary.

CA

No contaminated fluid shall be circulated outside the Containment System* with exception of possible post-accident sampling system.

2.9.4.1.1.1.1.D

Intake of solids, thermal isolation debris, etc., to the pumps suctions shall be avoided (e.g. by use of suction strainers).

DA

The formation of vortices shall be prevented.

DB

NA

2.9.4.1.1.1.1.E

NA

2.9.4.1.1.1.1.F

NA

2.9.4.1.1.1.2 HEAT REMOVAL IN DEC

2.9.4.1.1.1.2.A

Dedicated CHRS shall be provided for heat removal from the Primary Containment* during DEC (in particular during Severe Accidents*).

AA

NA

AB

NA

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 46/60

2.9.4.1.1.1.2.B

The CHRS shall be designed to perform the following functions in DEC conditions:

BA

- control the pressure inside the Primary Containment* by removing decay heat from its atmosphere and/or water pools to the environment,

BB

- the Containment System* being the last of the defence-in-depth barriers, the CHRS reliability shall be compatible with the probabilistic safety targets.

BC

- in particular the system shall be designed without any active component inside the Primary Containment*.

2.9.4.1.1.1.2.C

In addition, the system shall be capable of reducing the Primary Containment* pressure and of terminating all releases in a reasonably short time to reach and maintain the Severe Accident Safe State*.

CA

Investigations shall be carried out to determine whether this goal could be achieved in a time period of about one week after accident initiation.

2.9.4.1.1.1.2.D

The CHRS shall be as independent as possible of all other systems whose failure may have contributed to Core Damage*.

2.9.4.1.1.1.2.E

As part of the ultimate Barrier*, the CHRS shall constitute a leaktight boundary.

EA

No contaminated fluid shall be circulated outside the Containment System* with exception of possible post-accident sampling system.

2.9.4.1.1.1.2.F

Intake of solids, thermal isolation debris, etc., to the pumps suctions shall be avoided.

FA

The formation of vortices shall be prevented.

FB

The suction strainers shall be equipped with provisions for backflushing and with measurements and alarms for the indication of the need for backflushing before the system flow falls below specified minimum value.

2.9.4.1.1.1.2.G

NA

2.9.4.1.1.1.2.H

NA

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 47/60

2.9.4.1.1.1.2.I

The design shall include features to enable safe use of Non-Permanent Equipment* to restore heat removal from the Primary Containment*.

2.9.4.1.1.2 REACTOR CAVITY/CORE CATCHER FLOODING SYSTEMS

2.9.4.1.1.2.A

Specific provisions shall be included in the design to assure the timely injection to RPV/flooding of the Core Catcher* when this is needed to support the in-vessel and ex-vessel corium cooling.

AA

"Timely" implies that:

AB

- in case of in-vessel cooling, the RPV will not fail,

AC

- in case of ex-vessel cooling, the core/concrete interaction will be avoided (i.e. Core Catcher* will not fail).

2.9.4.1.1.2.B

NA

2.9.4.1.1.2.C

Flooding provision shall be independent of the causes of Core* melting.

2.9.4.1.1.2.D

The flooding system shall provide the necessary reliability for its initiation and operation.

2.9.4.1.1.3 OTHER FEATURES TO REMOVE HEAT FROM CORE DEBRIS

2.9.4.1.1.3.A

In the long term, heat shall be removed from Core* debris by cooling the water in direct or close contact with it.

2.9.4.1.1.3.B

If any, active elements of water cooling systems shall be placed outside of the Primary Containment*.

2.9.4.1.2 PRESSURE CONTROL SYSTEMS

2.9.4.1.2.1 CONTAINMENT SPRAY SYSTEM

2.9.4.1.2.1.A

If required in order to meet the safety objectives and release targets, the Containment System* shall be provided with the Containment Spray System (CSS).

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 48/60

2.9.4.1.2.1.B

The CSS shall be designed to reduce pressure and temperature in the Primary Containment* in DBA and/or DEC and/or the concentration of radioactive aerosols in the Primary Containment* atmosphere following DBA and/or DEC.

BA

The Supplier* shall simplify the CSS to the extent possible.

BB

The CSS shall avoid recirculation of contaminated water outside the Containment System*.

2.9.4.1.2.1.C

Intermittent operation of this system may be allowed if the overall performance goals can be satisfied.

2.9.4.1.2.1.D

Local spray headers shall be provided for large volumes which cannot be adequately sprayed via the dome spray headers and which are not adequately vented.

2.9.4.1.2.1.E

Initial water for the CSS shall not contain special additives able to cause severe corrosion.

EA

Additives shall be introduced with a pre-defined time delay into spray water if contamination in Primary Containment* atmosphere is detected.

2.9.4.1.2.2 PRIMARY CONTAINMENT PURGE AND VENTING SYSTEMS

2.9.4.1.2.2.1 PURGE SYSTEMS

2.9.4.1.2.2.1.A

NA

AA

NA

2.9.4.1.2.2.1.B

The Supplier* shall provide analysis and procedure how to purge the Primary Containment* after an accident, if necessary.

2.9.4.1.2.2.2 FILTERED VENTING SYSTEMS

2.9.4.1.2.2.2.A

Filtered containment venting shall not be necessary in order to meet the probabilistic target about early Primary Containment* failure, nor to prevent long-term overpressurization of the Primary Containment* and to maintain its leaktightness and integrity and to meet release targets for DEC.

AA

NA

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 49/60

2.9.4.1.2.2.2.B

If a containment filtered venting system is provided, it shall have the following performance capabilities:

BA

The flow capability shall be determined such that it can reduce containment pressure to an acceptable level as required in Section 2.9 3.1.8.1.

BB

The flow capability shall be such that the filtered venting system can relieve the full residual pressure after a time consistent with the passive capabilities of the containment (at least 12 h as specified in Section 2.9 3.1.8.1).

BC

The retention capability of the filter shall be such that the release targets for DEC can be met.

2.9.4.1.2.2.3 OVERPRESSURE PROTECTION

2.9.4.1.2.2.3.A

The probabilistic target about early Primary Containment* failure shall be met without implementing any Primary Containment* overpressure protection.

AA

The Supplier* shall provide analysis and procedure how to protect the Primary Containment* against overpressure as a robustness feature.

2.9.4.1.2.2.3.B

If provided, it shall have the following performance capabilities:

BA

It shall be set high enough not to be actuated during DBC or DEC.

BB

The overpressure protection device shall be automatically closed after actuation.

BC

The release shall be routed either to the stack through a filter or to the Secondary Containment* or any other reasonable leaktight building with sufficient filtering capability.

2.9.4.1.3 HYDROGEN MANAGEMENT SYSTEM

2.9.4.1.3.1 GENERAL REQUIREMENTS

2.9.4.1.3.1.A

Means for post-accident hydrogen control shall be located inside the Primary Containment*.

AA

An analysis of hydrogen generation shall be performed including identification of all possible hydrogen sources including sources outside of the Primary Containment*, their location, convection routes and development of the hydrogen concentration throughout the accident.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 50/60

AB

If needed, based on the results of the analysis, other Plant* areas shall be equipped with the hydrogen control system as well (such as spent fuel pool building, radioactive waste building, etc.).

2.9.4.1.3.1.B

The general arrangement of structures and components inside the Primary Containment* shall favour efficient mixing of the containment atmosphere by natural circulation.

2.9.4.1.3.1.C

Type and location of hydrogen control devices shall promote natural convection and hence mixing.

2.9.4.1.3.1.D

All cubicles where hydrogen may accumulate shall be vented at the top.

2.9.4.1.3.1.E

Post-accident hydrogen control system shall be designed with sufficient margin, and in case of an active system with sufficient Redundancy*, to ensure continuous function during system necessity.

2.9.4.1.3.2 PRIMARY CONTAINMENT FREE VOLUME

2.9.4.1.3.2.A

The Primary Containment* shall have sufficient internal free volume so that, following a 75% active fuel cladding/water interaction, the average hydrogen concentration remains below 13% by volume without giving credit to hydrogen control devices.

2.9.4.1.3.3 HYDROGEN CONTROL DEVICES

2.9.4.1.3.3.A

The Primary Containment* shall be equipped with hydrogen concentration limitation devices, including catalytic recombiners and/or igniters to cope with DBA and DEC and to comply with the deterministic requirements specified in Section 2.9.3.1.7.5.C.

2.9.4.1.3.3.B

The system shall comply with the general requirements set in Section 2.9.3.1.7.5.

2.9.4.1.3.3.C

System activation shall be passive or automatic if needed within 24 hours of accident initiation (i.e. no manual action can be credited in this timeframe).

CA

Some simple Operator* actions may be considered from MCR and ECR for very unlikely accidents (frequency below 10^{-7} /year), when justified.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 51/60

2.9.4.1.3.4 LONG-TERM HYDROGEN PRODUCTION

2.9.4.1.3.4.A

Assuming the radiolysis contribution to long-term hydrogen concentration, hydrogen burning conditions shall be avoided without taking credit for purging as a means of controlling hydrogen concentration.

2.9.4.1.4 PRIMARY CONTAINMENT HVAC SYSTEM

2.9.4.1.4.A

During Normal Operation*, Primary Containment* pressure shall be controlled in the adequate range by an HVAC system.

AA

More detailed requirements on HVAC systems are provided in Section 2.8.2.9.

2.9.4.1.4.B

The HVAC system shall also maintain the required air temperature, pressure differentials and airborne radioactivity levels inside the Primary Containment* to allow access as defined in Section 2.9.2.5.

BA

The Supplier* shall perform an analysis of anticipated containment airborne activity levels, estimated extent of personnel entries during Normal Operation* and radiation protection (ALARA) measures.

BB

This analysis shall result in the establishment of the functional requirements of the containment cleanup capability.

2.9.4.1.4.C

A Normal Operation* purge system shall also be provided for maintaining Primary Containment* negative pressure.

2.9.4.1.4.D

The required functions shall be fulfilled also in case of LOOP.

2.9.4.1.4.E

Equipment non-sensitive to heat shall be used into Primary Containment* internal chambers.

EA

However, if sensitive to heat equipment are used, adequately environmental conditions shall be assured for such equipment, in particular to take account heat rise when switching to emergency power supply.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 52/60

2.9.4.1.5 CONTAINMENT ISOLATION SYSTEM

2.9.4.1.5.A

Containment isolation provisions shall be designed to assure that lines not required for accident mitigation which penetrate the Primary Containment* boundary are isolated in the event of DBA or DEC, so as to minimise the release of radioactivity to the environment.

AA

Penetration pipes through the Primary Containment* walls shall be seamless.

2.9.4.1.5.B

Configuration of isolation devices shall be defined in accordance with the Decree No. 329/2017 Coll., as amended.

2.9.4.1.5.C

Isolation devices shall be demonstrated able to carry out their specific function in the harsh environment that may be induced by DEC.

CA

This shall be based on realistic and best-estimate evaluations and demonstrations.

2.9.4.1.5.D

Isolation valve closure times, if not dictated by other design specifications, shall not be unduly short in order to increase component reliability, taking into account the timing of fission-product releases into the Primary Containment* in the Reference Source Term*.

2.9.4.1.5.E

Isolation valves designed to close automatically following a containment isolation signal shall be designed to fail in the closed position in the event of loss of their support systems.



EB

Information on their state shall be available at all times.

2.9.4.1.5.F

Remote manual power-operated valves, the closure of which is not initiated by a containment isolation signal, shall be supplied with safety-classified power.

2.9.4.1.5.G

Overpressure protection from excessive pressure due to volumetric expansion shall be provided for portions of piping systems between containment isolation valves which contain fluids at temperatures inside the containment lower than DBA and DEC temperatures if the pipelines between two isolation valves are not designed for possible pressure increase caused by heating under DBA and DEC conditions.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 53/60

2.9.4.1.5.H

The isolation valves and pipe sections between the isolation valves shall be protected against dynamic forces from hazards including possible falling objects.

2.9.4.1.5.I

In addition, conservative values shall be used for the admissible stresses.

2.9.4.1.6 PRIMARY CONTAINMENT PENETRATIONS

2.9.4.1.6.A

The number of penetrations through the Primary Containment* shall be minimised.

2.9.4.1.6.B

Pipes which penetrate the Primary Containment* and end outside the Secondary Containment* shall be avoided to the extent possible.

2.9.4.1.6.C

Penetrations (including penetration bellows) shall be equipped with devices for periodic leak rate tests.

2.9.4.1.6.D

Two independent Barriers* against potential leakages via the electrical penetrations shall be assured.



DB

When permanently pressurized, the pressure shall be monitored individually.

DC

The electrical penetrations shall be designed to reduce the overall containment leakages and testing needs.

DD

The electrical penetrations shall be protected against dynamic forces from hazards including possible falling objects.

2.9.4.1.6.E

At least two personnel airlocks with interlocks for Primary Containment* access shall be provided.

EA

The airlocks shall be located sufficiently apart from and be sized to accommodate the need for Primary Containment* evacuation so that during any event at least one of them can be used as an emergency exit from the Primary Containment*.

EB

In addition, personnel airlocks shall be large enough to allow two men wearing anti-contamination clothing to move through while carrying a man on a stretcher.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 54/60

EC

Personnel airlocks shall have both an inner and an outer door.

ED

Each door shall be designed to withstand the same environmental conditions (temperatures and pressure, radiation levels) as the Primary Containment*.

EE

Local transient effects, however, such as exposure to short-time open flames, could not be considered for the outer door.

EF

Devices shall be furnished to prevent the two doors of the personnel air locks from being opened simultaneously.

EG

A possibility of manual control shall be provided in case of loss of power supply.

EH

It shall be possible to temporarily disable the airlock interlocks.

EI

The inner door shall be of the pressure sealing type.

EJ

Each airlock shall be equipped with a pressure equalization device.

EK

Compression seals (double seal joints with intermediate test chamber between them to facilitate local verification of leaktightness each time they are used) shall be utilised which shall be replaceable in less than 8 hours.

2.9.4.1.6.F

The equipment hatches (i.e. their number and dimensions) shall be provided in accordance with the proposed logistics and equipment handling during operation and maintenance of the Plant*.

FA

The equipment hatches shall be of the pressure sealing type.

FB

NA

FC

Compression seals (double seal joints with intermediate test chamber between them to facilitate local verification of leaktightness each time they are used) shall be utilised which shall be replaceable in less than 8 hours.

FD

NA

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 55/60

2.9.4.1.6.G

Design of large penetrations (i.e. equipment hatches and personnel airlocks) shall assure that the required leaktightness is maintained during DEC in the harsh environment associated with these conditions.

GA

This shall apply at least until it is reasonable to expect that the Primary Containment* is fully depressurised.

2.9.4.1.6.H

The seal gaskets shall be protected against missiles and jet pipes (high temperature). The material used in the manufacture of these gaskets shall be qualified for DBC and DEC conditions.

2.9.4.1.7 DRAINAGE SYSTEM

2.9.4.1.7.A

Leak collection systems and sumps shall allow the detection of a leak.

AA

The requirements coming from BP/LBB shall be applied in the design of containment drainage systems.

2.9.4.1.7.B

The design shall be such to minimise the possibility of sump clogging.

BA

This shall take into account any possible materials and/or equipment parts arising from DBA and DEC (such as paintings, thermal insulation).

2.9.4.1.7.C

The design shall be such that in the event of a Severe Accident*, no local accumulation of melted corium within the drainage system is possible.

2.9.4.1.7.D

Drainage system of Normal Operation* shall not prevent entering of the water into the emergency sump under Accident Conditions*.

2.9.4.1.8 INSTRUMENTATION AND CONTROL

2.9.4.1.8.A

Adequate instrumentation shall be provided in the refuelling cavity to monitor the water level during operations with the RPV open.

2.9.4.1.8.B

Permanently installed instrumentation shall be provided for on-line monitoring of the overall integrity and leaktightness of the Primary Containment* as specified in Section 2.9.2.2.1.4.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 56/60

2.9.4.1.8.C

Permanently installed instrumentation which can be used for accident monitoring and management shall be provided for on-line monitoring of physical parameters like pressure, temperature, humidity, gases concentration sensors, water level in different chambers or areas inside Primary Containment* in an enough number and positions to enable to Operators* to obtain sufficient data for assessment of the status of the Primary Containment* and assessment of the accident and to plan and implement countermeasures.

2.9.4.1.8.D

Hydrogen concentrations shall be monitored in the Primary Containment* following a DBA or DEC.

DA

The number and location of the sensors shall assure that the measures are representative of the entire Primary Containment* volume and provide indication of local accumulations.

2.9.4.1.8.E

Indication shall be provided to Operators* of the water level present in the Reactor Cavity* below the RPV prior to RPV melt-through.

2.9.4.1.8.F

Primary Containment* with ex-vessel cooling shall include the necessary instrumentation to locate the corium.

2.9.4.1.8.G

Instrumentation shall be provided as required for the Break Preclusion* purposes.

2.9.4.1.9 ACCIDENT MANAGEMENT PROVISIONS

2.9.4.1.9.A

As part of the long-term accident management, means independent of the normal or emergency AC power supplies shall be provided for introducing water into the Primary Containment* at a pressure up to and including the Primary Containment's* ultimate capability at a rate sufficient to remove the decay heat by boil-off.

AA

The Operators* shall have the capability of delivering water inside the Primary Containment* at rate sufficient to remove decay heat from fuel in the reactor or in the Core Catcher* and spent fuel (if located in the Primary Containment*).

2.9.4.1.9.B

All actions requiring human activities outside the Main Control Room* shall be proved to be feasible, assuming all radiological hazards generated by a Severe Accident*.

2.9.4.1.9.C

Specific instrumentation and equipment shall be provided to prevent inadvertent containment bypass after an accident while the containment is still pressurised.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 57/60

CA

It is necessary to avoid any potential containment bypass path, including small instrumentation lines, sampling lines or other small connection to the Primary Containment* atmosphere.

2.9.4.2 SECONDARY CONTAINMENT EQUIPMENT AND SYSTEMS

2.9.4.2.1 HVAC SYSTEM

2.9.4.2.1.1 DEPRESSURISATION AND MIXING

2.9.4.2.1.1.A

The Heating, Ventilation and Air Conditioning (HVAC) system for Normal Operation* shall be designed to maintain the Secondary Containment* at sub-atmospheric pressure in order to collect, monitor radioactivity and filter to the necessary extent any leakage from the Primary Containment* and piping space between containments during Normal Operation* prior to release to the environment.

AA

The system shall be designed so that it can be used in case the Primary Containment* must be made non-leaktight due to reactor refuelling or maintenance.

AB

Description of general functions of HVAC systems is provided in Section 2.8.2.9.

2.9.4.2.1.1.B

The emergency ventilation system, if necessary to meet the safety objectives and/or release targets:

BA

- shall be generally independent from the Normal Operation* HVAC system,

BB

- shall be designed to maintain the Secondary Containment* at sub-atmospheric pressure,

BC

- shall be designed to collect and, if necessary, filter and monitor any leakage from the Primary Containment* and piping space between containments during a DBA or DEC prior to release to the environment,

BD

- radioactivity of all elements (noble gases, iodine, aerosols) shall be measured before release to environment.

2.9.4.2.1.1.C

Sub-atmospheric pressure shall be assured throughout the accident period.

CA

NA

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 58/60

CB
NA

2.9.4.2.1.2 FILTRATION

2.9.4.2.1.2.A

The Supplier* shall perform analysis of need for emergency ventilation system in terms of both meeting the release targets and its benefit in terms of ALARA principle.

AA

In particular, the Supplier* shall evaluate need for charcoal filters (see Section 2.1A.18).

AB

Filter design shall consider the heat load caused by radioactive decay of substances which will remain trapped in the filters as calculated from the Reference Source Term*.

2.9.4.2.1.2.B

The Supplier* shall perform an analysis of anticipated containment airborne activity levels, estimated extent of personnel entries during Normal Operation* (in particular power operation), and radiation protection (ALARA) measures.

BA

This analysis shall result in the establishment of the functional requirements of the containment cleanup systems.

BB

The Supplier* shall evaluate the need for charcoal filters for the Normal Operation* HVAC.

2.9.4.2.1.2.C

In order to simplify Plant* design, the Supplier* shall aim at elimination of charcoal filters from the emergency ventilation system (see Section 2.1A.18).

2.9.4.2.1.2.D

NA

DA

NA

DB

NA

2.9.4.2.2 PENETRATIONS AND ACCESSES

2.9.4.2.2.A

Pipe and cable penetrations and passages through the Secondary Containment* Barriers* shall be adequately designed to achieve the required leaktightness.

2.9.4.2.2.B

Sections of high-energy lines included in the Secondary Containment*, the rupture of which may jeopardize integrity of the Secondary Containment*, shall be provided with a double pipe to channel any energy releases from such a pipe break inside the Primary

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 59/60

Containment*, or its rupture shall be excluded by appropriate design, manufacturing and testing.

BA

In any case, risk of containment bypass shall be minimised.

BB

Use of the so-called double pipe sections can be considered an acceptable alternative but always in the frame of the Break Preclusion* concept for pipelines.

2.9.4.2.2.C

In case of lines with redundant isolation valves, the previous requirement can be limited to pipe sections up to the most external isolation valve.

CA

In this case, consequences on Secondary Containment* and on external releases of the transient steam release shall show compliance with other safety objectives.

2.9.4.2.2.D

Penetrations and accesses shall enable leaktightness checking.

2.9.4.2.3 ISOLATION SYSTEM

2.9.4.2.3.A

A Secondary Containment* isolation system shall be provided in order to maintain the leaktightness required during DBA and DEC.

AA

In case the Primary Containment* must be made non-leaktight due to reloading or maintenance, the Secondary Containment* shall be designed to function as an efficient technical Barrier* to the spreading of radioactive substances in accidents assessed possible under these conditions including DEC involving severe damage to the fuel.

2.9.4.2.3.B

If containment isolation valves are not connected directly to containment penetrations, then the intermediate ductwork and supports shall be designed to seismic resistant.

2.9.4.2.4 DRAINAGE SYSTEM

2.9.4.2.4.A

Leak collection systems and sumps shall allow the detection of a leak.

2.9.4.2.4.B

The design shall be such to minimise the possibility of sump clogging.

2.9.4.2.5 SECONDARY CONTAINMENT INSTRUMENTATION

2.9.4.2.5.A

Permanently installed instrumentation shall be provided for on-line monitoring of the overall integrity and leaktightness of the Secondary Containment*.

Dukovany 5&6	BID INVITATION SPECIFICATION TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.9 CONTAINMENT SYSTEM	Page 60/60

2.9.4.2.5.B

The number and location of the sensors shall assure that the measures are representative of the entire Secondary Containment* behaviour.

2.9.4.2.5.C

Instruments like pressure, temperature, humidity, gases concentration sensors, water level shall be included in the Secondary Containment* in an enough number and positions to transmit to Operators the status of the Secondary Containment*.

2.9.4.3 CLASSIFICATION OF SAFETY FUNCTIONS

2.9.4.3.A

The main Safety Functions* related to Containment System* are listed below:



2.9.4.3.B

From these, a number of second-level functions shall be identified and categorized in accordance with the classification methodology specified in Section 2.1.5.

BA

In particular, for the radioactivity confinement and control, the following second-level Safety Functions* can be listed:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 1/122

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL
VERSION DATE:	March 2025

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 2/122

This Page Intentionally Left Blank

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 3/122

CONTENTS

CHAPTER 2.10 INSTRUMENTATION AND CONTROL.....	4
2.10.1 INTRODUCTION.....	5
2.10.2 SCOPE OF THE CHAPTER.....	7
2.10.3 NORMATIVE REFERENCES.....	8
2.10.4 TERMS, DEFINITIONS, SYMBOLS AND ABBREVIATIONS	9
2.10.5 OVERALL I&C LIFE CYCLE.....	10
2.10.6 SYSTEM LIFE CYCLE	61
2.10.7 OTHER I&C SPECIFIC REQUIREMENTS	110

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 4/122

CHAPTER 2.10 INSTRUMENTATION AND CONTROL

2.10.A

This Chapter presents Owner* specific requirements that shall be applied to all Instrumentation and Control (I&C) of the Plant*. I&C term naturally includes Human-Machine Interface* (H-MI).

2.10.B



2.10.C

List of functions to be performed by I&C systems is not presented in this Chapter, therefore the Chapter 2.10 shall be understood in context of other Chapters of the Technical Requirements Document* and EPC Contract*.

2.10.D

Specific relating requirements relevant for I&C exist also in other Chapters of the Technical Requirements Document* especially in Chapters 2.1, 2.4, 2.7, 2.8, 2.9, 2.11, 2.12 and 2.15 and also in other parts of the EPC Contract*.

2.10.E

All the requirements listed in this Chapter and also I&C relevant requirements in other Chapters of the EPC Contract* complemented with Site* specific requirements, licensing requirements, system specific requirements, etc. shall be completed with the design basis for I&C design.

2.10.F

The Supplier* shall evaluate the I&C design used in the Reference Plant*/Standard Design* against requirements of the EPC Contract* and, if necessary, shall provide proposal for design modification.



2.10.G

Decision on the final solution including decision on I&C platforms shall be made at the latest possible date to ensure state-of-the-art solution.

Nevertheless, this postponement of the date of the decision shall not have negative impact on licensing, designing and implementation in terms of time.

Final decision shall be subject to the Owner's* approval. Preliminary regulatory body approval is inevitable condition.

Decision process shall include iterations with Czech regulatory body (respectively Authority*) and the Owner*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 5/122

2.10.1 INTRODUCTION

2.10.1.1 PURPOSE OF INSTRUMENTATION AND CONTROL

2.10.1.1.A

Instrumentation and control is involved inter alia in monitoring, control and protection of the Unit* /Plant*. For this, it consists of but not limited to:

- interfaces with the process - sensors and actuators, either "discrete" or "continuous";
- programmable controllers responsible for acquiring measurements of the process and commands of the Operators*, processing them, controlling the actuators and producing the information necessary for operation;
- interfaces with the Operators* and with the maintenance teams.

2.10.1.1.B

Instrumentation and control shall be organized into systems performing homogeneous set of functions, of which the following should be distinguished for a nuclear power Plant*, but not limited to:

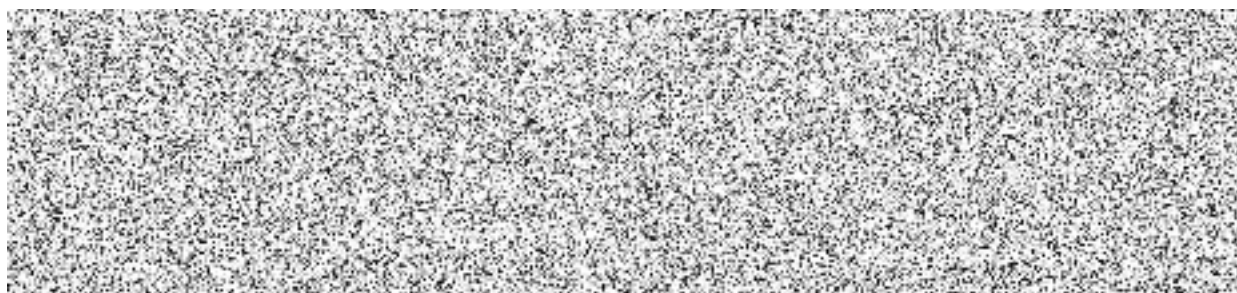
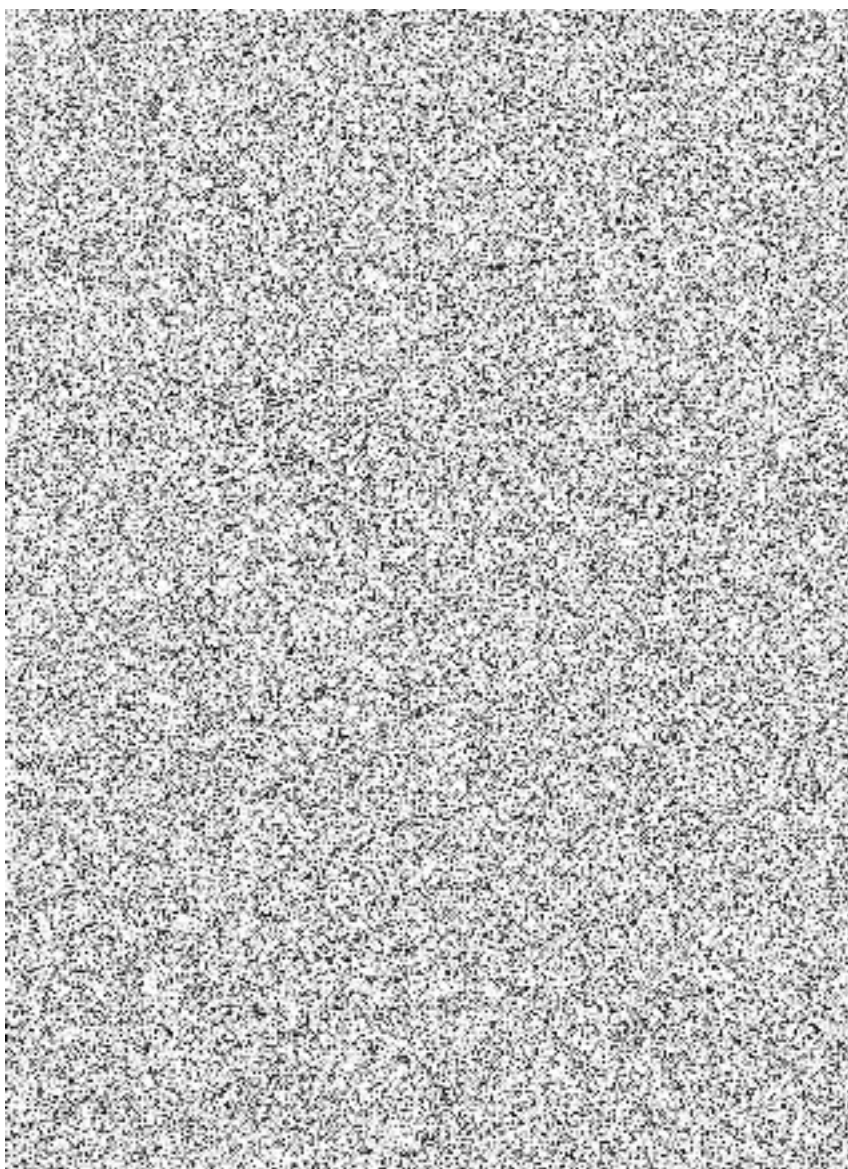
- a system involved in the functions necessary to achieve the Controlled State* in Accident Conditions*;
- a system involved in the functions necessary to achieve the Safe State* in Accident Conditions*;
- a system involved in the functions necessary to decrease the frequency of activation of Protection System* and ESFAS in Abnormal Operation;
- systems involved in the automatic and manual functions of NI, PGP and BOP used in normal conditions;
- a computerized process information and control system which perform functions of main HMI, usable (in all situations) as long as it is available;
- adequate means for monitoring and control when the process information and control system is not available (including, but not limited to, system(s) for post-accident monitoring and safety equipment for manual control functions);
- information and control systems dedicated to complex sequences (preferably non-computer based) and severe accidents.

2.10.1.2 LIFE CYCLE CONCEPT

2.10.1.2.A

Recommendations of IAEA Specific Safety Guide No. SSG-39, Design of Instrumentation and Control Systems for Nuclear Power Plants shall be carefully applied in the design of I&C systems together with other I&C relevant Codes and Standards*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 6/122



2.10.1.2.C

Three fundamental levels shall be established for I&C design in frame of the Project*:

- a) An overall I&C architecture level;
- b) I&C systems level;
- c) I&C systems detailed HW/SW level.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 7/122

CA

The I&C Platform/Components life cycles are typically managed in the framework of platform/equipment development and are independent of the overall architecture level and the individual system level life cycles.

2.10.1.2.D

Other activities also outside of the development of I&C systems will have an important influence on the requirements for, and the design of, I&C systems, therefore such activities shall be well defined and well-coordinated with design process of I&C.

DA

Human factors engineering and cyber security are examples (but not exhaustive) of such activities. Such activities have a broader purpose than the support of I&C system design, but they will have a strong influence on I&C development.

2.10.2 SCOPE OF THE CHAPTER

2.10.2.1 GENERAL

2.10.2.1.A

All the requirements presented in this Chapter shall be applied on the design (or design process where applicable) of the Plant* and/or Unit*.

2.10.2.1.B

Safety and process functions to be performed by I&C systems shall be also derived from I&C related requirements in other chapters of the EPC Contract*.

2.10.2.1.C

The I&C shall contribute to general Plant* and/or Unit* objectives such as safety, reliability and availability of the Plant* and/or Unit*.

2.10.2.2 FRAMEWORK



2.10.2.2.B

This Chapter contains sections as follows:

- Section 2.10.3 references applicable standards and related activities
- Section 2.10.4 deals with definitions specific to I&C and acronyms.
- Section 2.10.5 addresses the overall I&C architecture. It deals with:
 - Review of needed inputs and associated documentation;
 - Design of the overall architecture and associated documentation;
 - Assignment of the I&C functions and associated documentation; and
 - Overall planning
- Section 2.10.6 addresses the requirements for the individual I&C systems. It deals with:
 - System life cycle and associated requirements and documentation;
 - System planning; and
 - Qualification

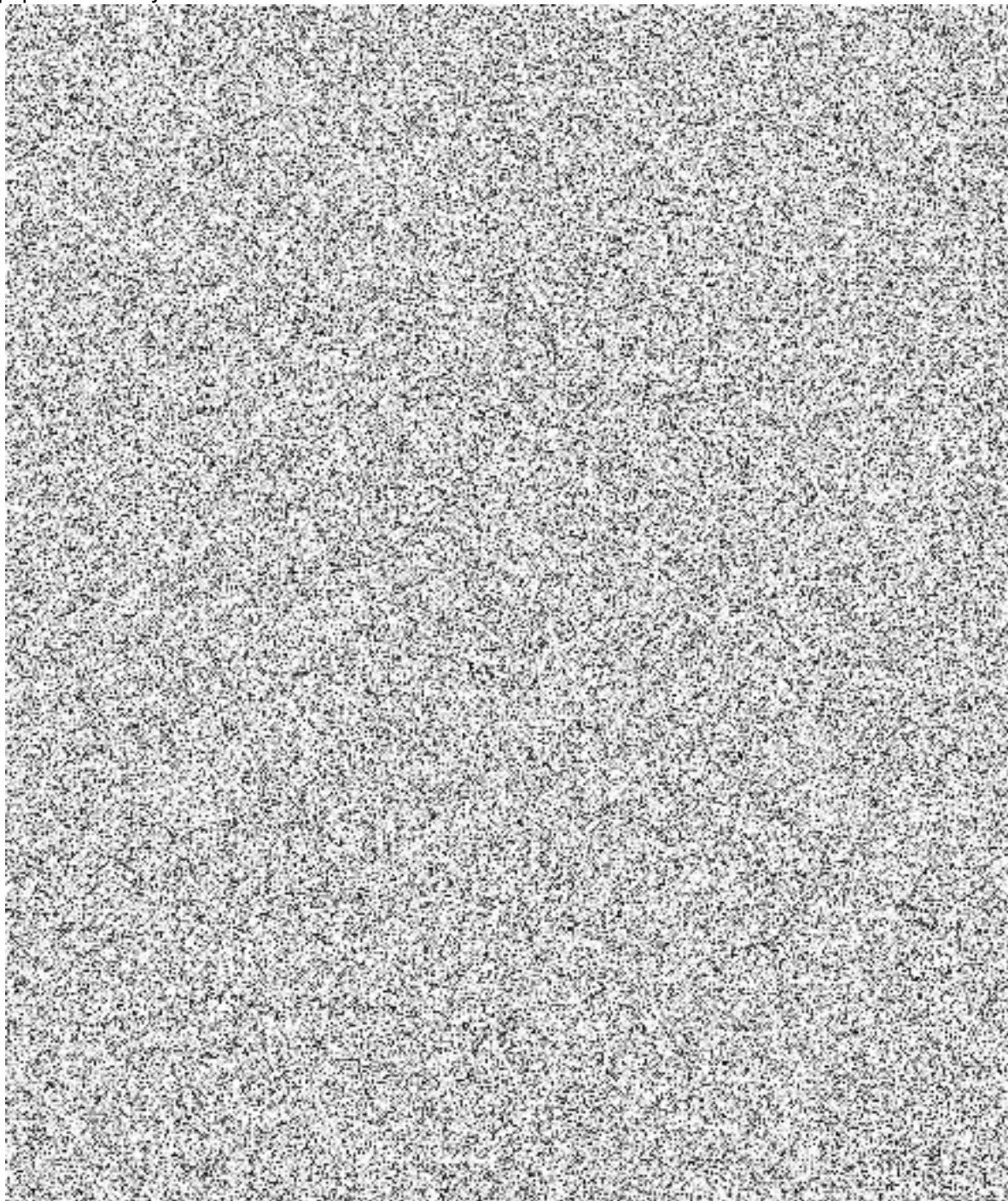
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 8/122

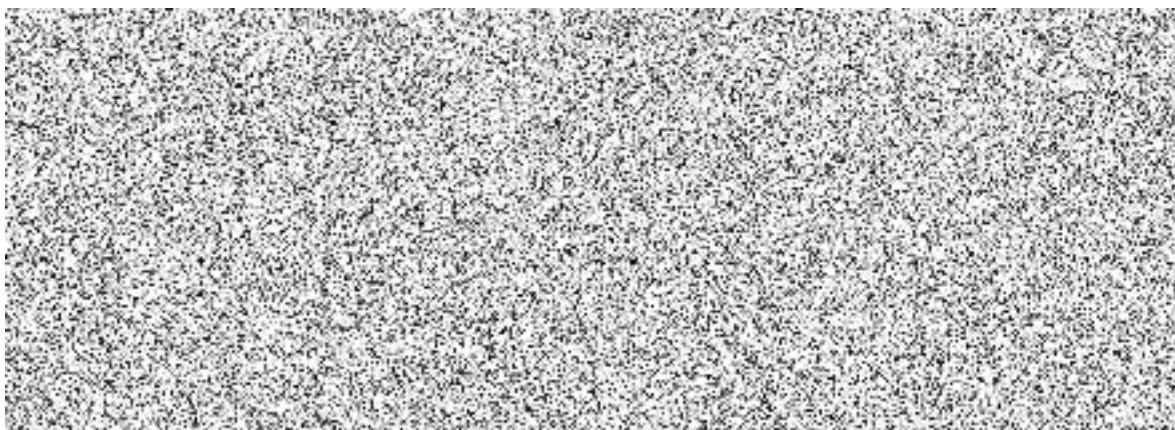
- Section 2.10.7 deals with specific requirements and comments relating to I&C

2.10.3 NORMATIVE REFERENCES

2.10.3.A

Following standards (release which is valid at the time of designing and is agreed by the Owner* or Authority*) shall be fully applied (requirement after requirement) to I&C systems and equipment always:





See the Technical Requirements Document*, Chapter 2.5

2.10.3.B

The Supplier* shall provide the Owner* with a detailed compliance matrix referencing compliance or noncompliance with all requirements of mandatory Codes and Standards* specified in Section 2.10.3 A and other parts of the EPC Contract* to prove, that all requirements defined in those mandatory Codes and Standards* are fully met.

BA

Compliance matrix shall contain adequate justification.



2.10.3.D

In case of any contradictions or different or relaxing requirements, recommendations and principles between mentioned standards and EPC Contract* or among mentioned standards or within mentioned standards, or in case of variants the Supplier* shall analyse them and propose the best possible solution of how to address them in timely manner, in any case the Owner* and where necessary the Authority* is entitled to make a decision on the final solution. In any case the Terms and Conditions*, Article 2.1.1 shall be followed.

2.10.4 TERMS, DEFINITIONS, SYMBOLS AND ABBREVIATIONS

2.10.4.A

Terms and definitions are described in the Terms and Conditions*, Appendix XI, section Definitions.



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 10/122

2.10.4.C

Symbols, acronyms and abbreviations are described in the Terms and Conditions*, Appendix XI, section Acronyms.

2.10.5 OVERALL I&C LIFE CYCLE

2.10.5.1 GENERAL

2.10.5.1.A

Systematic approach shall be adopted to I&C in order to ensure that all the I&C related requirements (process, safety, system, ergonomics, operational, maintenance, etc.), are met by I&C functions implemented. Therefore the activities associated, but not limited to, with development (including modifications), implementation and operation (including maintenance) of I&C shall be included into the framework of an overall lifecycle.

2.10.5.1.B

The Supplier* shall use Good Engineering Practice* and best engineering methods and procedures in its I&C design process.



2.10.5.1.D

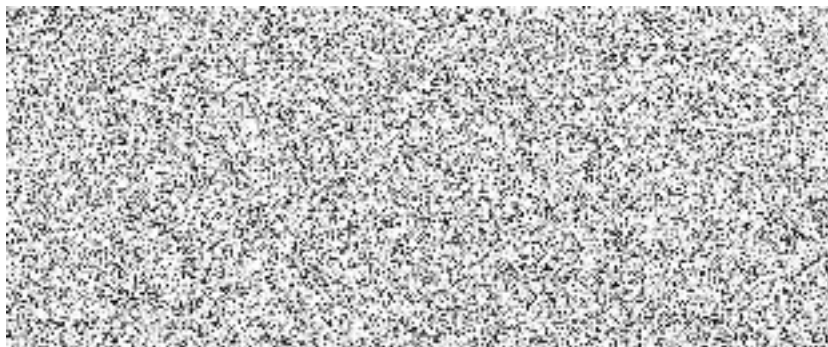
All I&C systems determined as having no safety significance shall follow as far as possible the same life cycle as the safety classified I&C systems.

2.10.5.1.E

The Supplier* shall carefully determine, analyse and adequately manage and mitigate challenges associated with I&C.

EA

The Supplier* shall prepare the I&C Strategy document, describing in sufficient detail the way how the Supplier* shall manage and mitigate challenges associated with I&C to avoid risks associated with licensing, designing, staffing, qualification, testing, construction etc. including but not limited to:



EB

Strategy document shall be comprehensive and shall be provided at the Initial Phase*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 11/122

EC

The Supplier* shall proactively analyse existence of new I&C challenges that were not identified during initial phase and shall well in advance take actions to mitigate them.

ED

The Supplier* shall analyse and mitigate also I&C challenges and issues identified by the Owner*.

2.10.5.2 DERIVING THE I&C REQUIREMENTS FROM THE PLANT DESIGN BASE

2.10.5.2.1 GENERAL

2.10.5.2.1.A

Input requirements and input constraints shall be derived from the Plant* design base and the Plant* design framework.

2.10.5.2.1.B

The main inputs for I&C shall be the result of detailing the performance and safety objectives of the Plant* and identifying the necessary functions to be performed and the associated requirements while taking into account all the requirements stated in this Chapter.

2.10.5.2.1.C

Functional Analysis shall be undertaken with the aim of designing I&C system which allows a high level of performance in the control of the power plant process.

2.10.5.2.1.D

The main steps which shall be considered when performing the analysis are:



2.10.5.2.2 REVIEW OF THE FUNCTIONAL, PERFORMANCE AND INDEPENDENCE REQUIREMENTS

2.10.5.2.2.A

At minimum following inputs provided from Plant* design base shall be assessed in this review:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 12/122

2.10.5.2.2.1 DEFENCE-IN-DEPTH* AND ASSOCIATED FUNCTIONS

2.10.5.2.2.1.A

Inputs provided from the Plant* design base shall include concept of overall Defence-in-Depth* approach and description of functions associated with levels of Defence-in-Depth*.

See Technical Requirements Document*, Section 2.1.1.4

2.10.5.2.2.1.B

The Supplier* shall provide concept of I&C Defence-in-Depth* and Diversity* in early design stage.

2.10.5.2.2.1.C

The concept of Defence-in-Depth* and Diversity* shall be applied in the design of the I&C architecture, functions, systems, equipment and their overall implementation. The I&C functions (with related systems, structures and components) shall form multiple defensive lines that shall be mutually independent and diverse according to its purpose and concept of I&C Defence-in-Depth*.

CA

The Diversity* shall also be achieved using different I&C technology, e.g. different platforms, emphasizing application of non-programmable/hard-wired technology, etc.

CB

See Sections 2.8.3.1.2, 2.8.3.1.4, 2.10.5.4.2.2.1 and 2.10.6.2.2.3.2.3 for Independence* requirements and use of Diversity*.

2.10.5.2.2.2 FUNCTIONAL AND PERFORMANCE REQUIREMENTS

2.10.5.2.2.2.A

Inputs provided from Plant* design base shall include detailed functional and performance requirements including those related to, but not limited to, monitoring, surveillance, diagnostic and if exist also prognostic.

AA

Specific functional requirements related to the different process systems are defined in Chapters 2.8, 2.9, 4.2, 4.3 and 4.5 etc.

2.10.5.2.2.2.B

The Supplier* shall provide all information relating to interfaces among the I&C of the NI, PGP and BOP in order to meet the overall Plant* and/or Unit* performance and functional requirements. All those information shall be carefully analysed to verify that all requirements are met.

2.10.5.2.2.3 LEVEL OF AUTOMATION

2.10.5.2.2.3.A

Inputs provided from Plant* design base shall include detailed information on the level of automation for each function.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 13/122

AA

Detailed information on the level of automation for each function shall also include supporting information as follow, but not limited to:



2.10.5.2.2.3.B

The level of automation for each function shall be highest possible and together with the ergonomics both shall be such that the probability of human errors is minimised and that the consequences of such error, when occurring, are limited.

2.10.5.2.2.3.C

When selecting the level of automation, the Supplier* shall address the need to maintain the Operator's* awareness of the Plant* and/or Unit* status so that they remain, at all times, well informed and able to intervene in Plant* and/or Unit* operations when necessary.

2.10.5.2.2.3.D

The effect of failure of automatic control functions shall also be included in the allocation of functions analysis.

2.10.5.2.2.4 TASK ANALYSIS

2.10.5.2.2.4.A

The Supplier* shall develop as part of the plant design base a task analysis, which shall be used as input to the design of I&C system.

AA

A task analysis shall be done in compliance with:



2.10.5.2.2.4.B

Task analysis shall cover all critical field tasks which are provided by Treatment of Important Human Actions (TIHA) identified from probabilistic safety assessment (PSA) / human reliability analysis (HRA) and deterministic analyses, and tasks which are to be performed in the Main Control Room* and Emergency Control Room*.

BA

By the use of task analysis, the designers and operating staff shall be able to identify all tasks which need to be performed in answer to foreseeable scenarios during all operating conditions (including DBC and DEC).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 14/122

2.10.5.2.2.4.C

Task analysis shall be performed in order to ensure that the operating personnel are capable of performing assigned tasks in Design Basis Conditions* and Design Extension Conditions*.

CA

The distribution between localized and central control will depend on task analysis results.

2.10.5.2.2.4.D

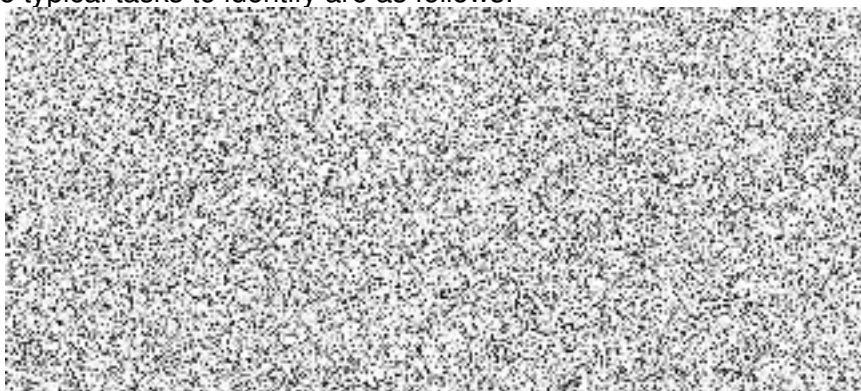
For each task the following information shall be determined but not limited to:

- control actions needed;
- information and data needed for each control action;
- criteria for evaluating the result of each control action;
- criteria for decision making; and
- success criteria.

2.10.5.2.2.4.E

Carrying out task analysis shall identify a list of elementary tasks to be performed. This analysis shall cover both localized tasks and centralized tasks (as e.g. in MCR, ECR, TSC, other operating and maintenance rooms, etc.).

The typical tasks to identify are as follows:



2.10.5.2.2.4.F

The Plant* and/or Unit* I&C systems shall support and facilitate:

- the performance of each elementary task,
- the correlation between individual tasks,
- the co-ordination between individuals,
- clear and rapid understanding (including Operator* changeover or shift turn-over),
- training.

FA

Other non-I&C systems (e.g. ICT, telecommunication systems and etc.) shall be provided to contribute on these objectives as necessary.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 15/122

2.10.5.2.2.5 VARIABLES TO BE DISPLAYED

2.10.5.2.2.5.A

Inputs provided from Plant* design base shall include all necessary Plant* and/or Unit* status parameters to be displayed for the Operator* to be used in taking manual control actions or in supervising the automatic actions and shall be considered as inputs in the I&C design process.

2.10.5.2.2.6 PRIORITY PRINCIPLE BETWEEN AUTOMATIC AND MANUAL ACTIONS

2.10.5.2.2.6.A

Inputs provided from Plant* design base shall include but not limited to description of the priority principles.

2.10.5.2.2.6.B

The priority principles between automatic and manual action shall be defined for each function based on category, location and function itself.

2.10.5.2.3 REVIEW OF THE SAFETY CATEGORISATION REQUIREMENTS



See Technical Requirements Document*, Section 2.1.5

2.10.5.2.3.B

The Supplier* shall review the categorization of I&C functions and verify it for completeness and feasibility. In the case of non-feasibility, the definition and categorization of I&C functions shall be reviewed against to the plant I&C functional requirements. Functional requirements and their associated categorization shall be iterated until a feasible solution is achieved.

2.10.5.2.4 REVIEW OF PLANT CONSTRAINS

2.10.5.2.4.A

Inputs provided from Plant* design base shall include description of constraints placed on I&C from Plant* and/or Unit* framework, operation, maintenance etc.

2.10.5.2.4.B

The design shall take into account natural and human induced External Hazards* and Internal Hazards* defined in Technical Requirements Document*.

See Technical Requirements Document*, Section 2.1.2.6

See Technical Requirements Document*, Section 2.4.1.2

See Technical Requirements Document*, Section 2.4.1.3

See Technical Requirements Document*, Section 2.4.5.8

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 16/122

2.10.5.2.4.C

The design shall take into account the Plant* power supply systems defined in Technical Requirements Document*, Chapter 2.8 and vice versa.

See Technical Requirements Document*, Section 2.8.2.7

2.10.5.3 OUTPUT DOCUMENTATION OF I&C REQUIREMENTS SPECIFICATION PHASE

2.10.5.3.A

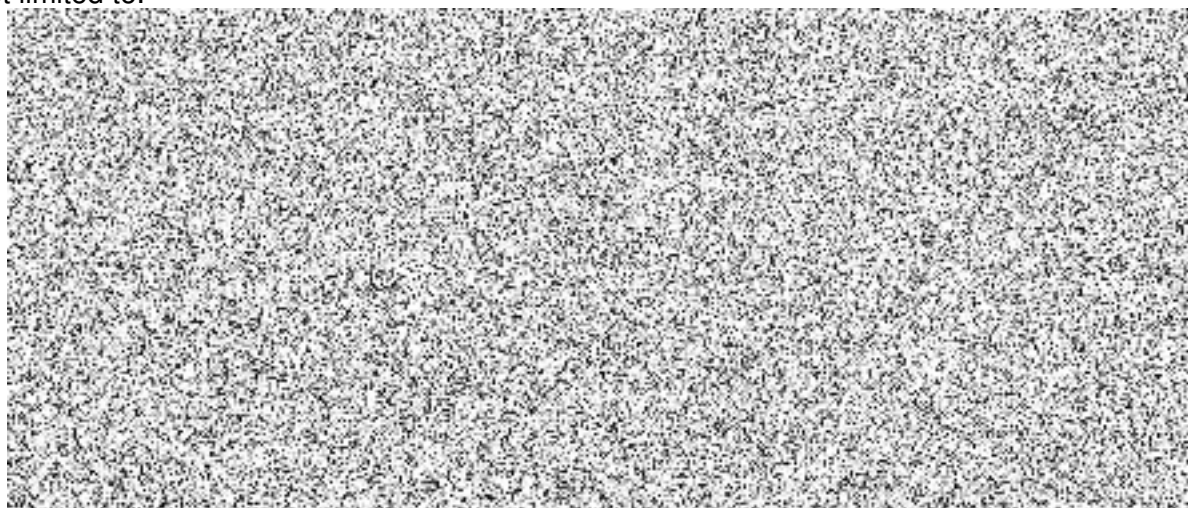
The output Documents* of the activity described in the Section 2.10.5.2 shall be the requirements specifications for the individual functions and associated SSCs.

2.10.5.3.B

This requirement concerns NI, PGP and BOP I&C functions.

2.10.5.3.C

This requirements specification shall include, for each function, the following information, but not limited to:



CA

A clear descriptive method explaining Independence* (relaxation or strict requirement on actuators, sensors, power supply, separation) and Diversity* between each function (functional or/and equipment) shall be used to describe these functions and their relations.



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 17/122

2.10.5.4 DESIGN OF THE OVERALL I&C ARCHITECTURE AND ASSIGNMENT OF THE I&C FUNCTIONS

2.10.5.4.1 GENERAL

2.10.5.4.1.A

This Section describes how:

- requirements from 2.10.5.3 apply to the design of the I&C architecture; and
- I&C functions are assigned to the individual I&C systems.

AA

The I&C architecture is the overall architecture of the I&C systems.

2.10.5.4.2 DESIGN OF THE I&C ARCHITECTURE

2.10.5.4.2.1 GENERAL

2.10.5.4.2.1.A

In order to facilitate understanding, the following four I&C levels can be used for structuring the I&C architecture:



AA

Used structuring of I&C architecture shall be clear and understandable from the design documentation.

AB

If the Supplier* uses different architecture structuring, it shall provide a clear and understandable detailed description and justification of the differences.

2.10.5.4.2.1.B

The NI I&C, PGP and the BOP I&C shall be developed in accordance with common terminology and structure.

2.10.5.4.2.1.C

In particular, this process shall allow to maintain a consistent approach to the whole Plant* and/or Unit*.

2.10.5.4.2.2 GENERAL REQUIREMENTS

2.10.5.4.2.2.A

The overall I&C architecture shall encompass all individual I&C systems according to their importance to safety, while meeting the general requirements for standardisation of equipment.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 18/122

2.10.5.4.2.2.B

Variety of I&C instrument types, platforms shall be minimised except of where it is necessary due to safety reasons

2.10.5.4.2.2.C

All systems in the Plant* (NI, PGP, BOP etc.) shall have uniform set of instruments, to reduce the efforts of:

- a. qualification
- b. engineering
- c. procurement
- d. installation
- e. Commissioning*
- f. maintenance (e.g. calibration)
- g. spare part handling

2.10.5.4.2.2.D

Components shall be standardised/unified except of where it is necessary due to safety reasons.

2.10.5.4.2.2.E

Common types and versions of software and hardware shall be used for the same type of components. Common and standardised design and implementation techniques shall be used.

2.10.5.4.2.2.F

The selection of the I&C components in the design phase shall be done systematically via a Plant* component catalogue containing, but not limited to:

- the acceptable scope and grade of properly validated components and type design,
- implementation and arrangement diagrams/drawings including system /SW/HW design, installation instructions and documentation

2.10.5.4.2.2.G

To meet the high availability and reliability requirements the I&C systems to be implemented shall be based on proven, high-quality I&C system platforms developed for nuclear plants. The use of Commercial off-the-shelf (COTS) components is acceptable under the conditions specified in 2.10.6.2.3.2

2.10.5.4.2.2.H

It shall be demonstrated successful licensing experience of chosen I&C platforms and components in EU, UK, US or Korea and its adequate operational experience to ensure smooth licensing process and sustainable and reliable long-term operation of I&C SSCs. Predecessors of I&C platforms if exist also shall be included in the demonstration including detail description of differences in terms of technical solution.

Any negative impact due to licensing of platform/system not having adequate successful licensing experience in EU, UK or US shall be burden of the Supplier* in terms of costs and schedule.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 19/122

2.10.5.4.2.2.1

To maintain security of Unit*/ Plant* SSC throughout the life cycle acceptable, the Supplier* shall provide well designed dedicated cyber security support system to enable periodic, on demand and continuous monitoring, evaluation and maintenance of status of relevant SSC from cyber security point of view.

Cyber security support system shall fully respect Cyber Security Program and shall be properly integrated in I&C design and its performance shall not negatively influence performance of any I&C system.

All cyber security assumptions, its impacts and related design inputs shall be included and justified within Design Basis Documentation*.

IA

The secure one-way data transfer shall be established from I&C system to the Security Operations Centre* (SOC) of the Plant* to support central collection and evaluation of security logs and other digital inputs.

The secure one-way data transfer shall prevent negative impact of SOC on I&C.

For relating requirements see also Technical Requirements Document*, Section 4.7.17

2.10.5.4.2.2.1 INDEPENDENCE

2.10.5.4.2.2.1.A

The I&C architecture shall achieve adequate Independence* where necessary including different lines of DiD.

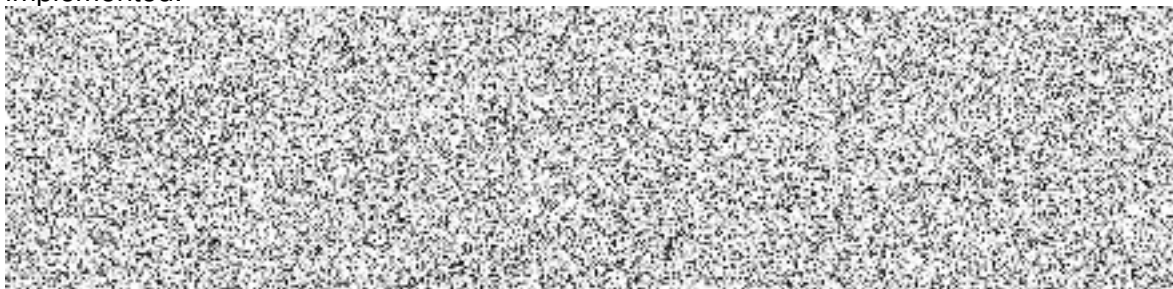
See Technical Requirements Document*, Section 2.1.1.4

2.10.5.4.2.2.1.B

The Independence* shall be justified through an appropriate combination of deterministic and probabilistic safety analyses and engineering judgement in order to fulfil the overall deterministic safety criteria and the probabilistic safety target.

2.10.5.4.2.2.1.C

The need for Independence* shall be considered and adequate level of Independence* shall be implemented:



2.10.5.4.2.2.1.D

When Independence* is implemented in I&C, associated support systems (e.g. power supply, HVAC, etc.) shall also be sufficiently independent.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 20/122

2.10.5.4.2.2.1.E

The Independence* and Diversity* of I&C functions shall be applied as far as necessary. However, in order to optimize I&C Systems and Components* from an economic point of view, multiple use of same equipment could be favoured while meeting the Independence* and Diversity* requirements.

The use of the same equipment shall not jeopardize safety.

2.10.5.4.2.2.2 SINGLE FAILURE CRITERION

2.10.5.4.2.2.2.A

No Single Failure* of an I&C system or a subsystem shall result in the loss of a category 1 and category 2 function for Design Basis Conditions*.

For I&C systems coping with DEC-A conditions, backup functions shall ensure sufficient controls (e.g. manual means) in case of Single Failure* of those I&C systems.

2.10.5.4.2.2.2.B

Resistance to the single failure shall be also considered in I&C system performing functions affecting Plant* availability by application of redundancy including cases where a need to improve reliability of any part of system or component is identified by HAZOP analyses, SPV program or by other way.

See Technical Requirements Document*, Sections 2.1.5, 2.1.6

2.10.5.4.2.2.3 CLASSIFICATION



See Technical Requirements Document*, Section 2.1.5

AA

An I&C system includes equipment from sensor to actuator including the processing and H-MI means.

2.10.5.4.2.2.4 INTERFACES AND PRIORITY MANAGEMENT

2.10.5.4.2.2.4.A

The interfaces of I&C systems with all systems and personnel shall be defined and taken into account in design of I&C.

AA

Interfaces mean H-MI, maintenance facilities, communication interfaces, etc.

2.10.5.4.2.2.4.B

All I&C systems shall provide interface to enable necessary communication as is needed for the centralised operation and maintenance.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 21/122

2.10.5.4.2.2.4.C

The design of the I&C architecture shall handle the priority between:



CA

A priority of actuation orders is necessary in order to achieve the required Independence* for a component which is used for different categories of I&C functions.

2.10.5.4.2.2.4.D

Priority shall be given to actuation demands generated by the function belonging to the highest safety category.

DA

Exceptions may arise and shall be justified; in such case provision shall be made to avoid any spurious actuation.

2.10.5.4.2.2.4.E

The component protection shall be included in the priority management.

EA

The controls relating to Safety Functions* have to take priority over the protection of components, except cases (for which analysis shall be provided), when the aim is to prevent the severe consequences for safety or plant control which would arise from component degradation (fire, flooding, missiles, etc.).

If protection of components has to take priority over the controls related to Safety Functions*, then the Supplier shall demonstrate design solution is acceptable for Authority*.

EB

The protection of components not involved in Safety Functions* has to take priority over any other order (manual or automatic mode).

EC

Following issues shall be also considered in the analysis:

- the necessary completion of the safety action,
- the avoidance of worsened conditions and
- the protection of health, environment and of assets.

2.10.5.4.2.2.5 SINGLE-POINT VULNERABILITY

2.10.5.4.2.2.5.A

The Supplier* shall develop, implement and apply comprehensive program on single-point vulnerability to assure high reliability of I&C design in all phases of its life cycle in order to avoid scram of the Plant* and/or Unit* or power generation loss due single fault.

For relating requirements see also Technical Requirements Document*, Section 2.2.7.1, Section 2.15.5.3 and Section 2.15.6.1

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 22/122

2.10.5.4.2.3 HUMAN-MACHINE INTERFACES

2.10.5.4.2.3.1 GENERAL

2.10.5.4.2.3.1.A

The H-MI design process represents the translation of function and task requirements into a detailed H-MI product, that is, the alarms, displays, controls and task support aids that comprise the H-MI. The design of H-MI shall be the result of a process that considers function and task requirements, operational considerations and ergonomics.

This Section aims at establishing the corresponding functional design requirements.

AA

The design of the H-MI shall include but not limited to:

- the overall work environment;
- workspace layout (e.g. MCR, ECR, Emergency Preparedness Centre*, TSC);
- control panel and console design;
- control and display device layout; and
- information and control interface design details, such as graphic display formats, symbols, dialogue design and input methods.

AB

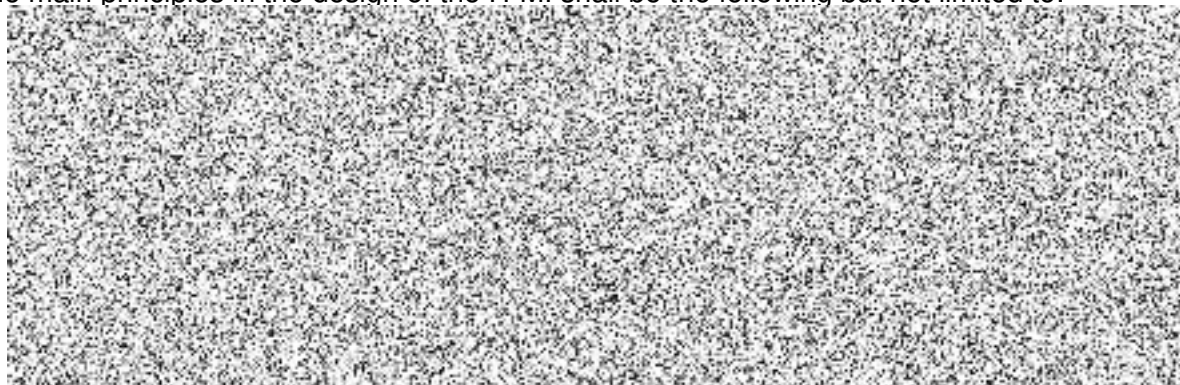
The H-MI designer shall specify, early in the design process, any levels of training, qualification, and experience of the operating staff members which are used as the basis for the H-MI design. Differences from typical Owner* training and operating practices shall be analysed. These differences and their bases shall be included in the H-MI design documentation.

AC

See Section 2.10.5.2.2.4 – Task analysis

2.10.5.4.2.3.1.B

The main principles in the design of the H-MI shall be the following but not limited to:



2.10.5.4.2.3.1.C

The design process shall also be applied to all the interfaces between the Plant*/Unit* and the Operators* and support staff. Consistent principles shall be followed regardless of the part involved (e.g. NI, PGP, BOP, Support Facilities*).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 23/122

CA

Standardisation shall be also applied in the interfaces as e.g. alarm and display principles, homogeneous hardware, design tools, analytical tools, etc.

2.10.5.4.2.3.1.D

The design of the Operator* working areas, their layout, the way to access necessary information or control means and the presentation of information shall strictly follow results of human factors engineering and task analyses.

DA

Human factors engineering shall ensure that the I&C systems or equipment design, human tasks and work environment are compatible with the sensory, perceptual, cognitive and physical attributes of Operators*, and of the staff which maintains and supports the Plant* (the anthropometric characteristics valid in the Czech Republic shall be taken into account in designing process). The Owner* shall be involved in the process of human factor engineering.

2.10.5.4.2.3.1.E

In context of H-MI, the Operator* shall be provided with an overview of the inter-relationships and operating sequences within the whole Plant* and/or Unit* for process monitoring purposes and with detailed information for process control.

EA

This shall enable the Operator* to achieve close mental coupling with the actual processes.

2.10.5.4.2.3.1.F

The information and control facilities shall be designed so that the Operators* can perform their tasks correctly and in time.

2.10.5.4.2.3.1.G

All actuators shall be controllable manually by means of local manual controls where it is necessary for operation, Commissioning* or maintenance purposes. The activation of the local manual control functions shall be determined by the Operator* and reported to the Operator* by I&C system.

GA

This feature, subject to locking or administrative rules if needed, shall be implemented for the purpose of Commissioning* and maintenance. If needed it shall be also available for specific operation conditions, even if their operation is locked by a Safety Function* actuation.

2.10.5.4.2.3.1.H

Supplementary I&C/IT systems, applications, tools or means shall also be provided as necessary for processing appropriate data to support other staff (analytical, technical, etc.).

Note 1

The term “processing data” involve full data life cycle, including data acquisition, collection, translation, structuring, use, archiving, etc.

Note 2

The term "other staff" includes staff who are neither directly involved in the operation of the Plant* nor directly involved in activities related to I&C life cycle processes.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 24/122

Note 3

I&C/IT systems, applications, tools or means for I&C staff involved directly in activities related to operation and I&C life cycle processes will be provided in standard I&C scope.

HA

Supplementary I&C systems, applications, tools or means and their usage shall have no direct functional impact on Plant* operation or SSC status.

HB

All the users (including those not involved in Plant* operation and I&C life cycle processes) who needs processing data shall be provided with appropriate interfaces within I&C and/or ICT.

HC

Due to the diversity of these users an analysis shall be performed to identify the special or similar features in terms of:

- task characteristics,
- required data,
- number of users,
- process dependence,
- inter-staff relationships.

HD

Universal H-MI shall be preferably provided for all categories of Plant* staff.

HE

Usage of specialized interfaces shall be justified taking into account the costs-benefits analyses and the nature of the task.

2.10.5.4.2.3.1.I

For specific Plant* and/or Unit* conditions and modes, a case by case analysis shall identify whether the best solution is the implementation of the specialised interfaces:

- permanently (always available);
- or on a transitory basis (modifiable on request and adaptable).

IA

The requirements of the H-MI dedicated to special operating conditions are based on analysis taking into account the characteristics of the special tasks, such as:

- frequency;
- repetition;
- duration and impact on availability; and
- severity and impact on safety
etc.

2.10.5.4.2.3.1.J

The simulators shall be used as early as possible in the design of H-MI.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 25/122

2.10.5.4.2.3.2 MAIN CONTROL ROOM

2.10.5.4.2.3.2.A

The Main Control Room* (MCR) shall be designed to ensure essential information for monitoring of the Plant* and/or Unit* status for safe and effective centralized operation in all Operational States* and Accident Conditions* and applicable Hazards*, and RSEH.

The MCR provides all the control and information means which are necessary to operate the Plant* and/or Unit* during all Operational States* (including Commissioning*, maintenance, refuelling), Accident Conditions* and applicable Hazards* and RSEH.

AA

Requirement on MCR autonomy, habitability, independence, ergonomic and other objectives are given in Technical Requirements Document*, Section 2.1.6.7.5; 2.1.7.4.6.; 2.8.2.9.3.6; 2.14.1.

2.10.5.4.2.3.2.B

The Power Generation Plant* (PGP) and Balance of Plant (BOP) shall also be operated from the Main Control Room* (MCR), beyond dedicated operational control rooms and/or local panels.

BA

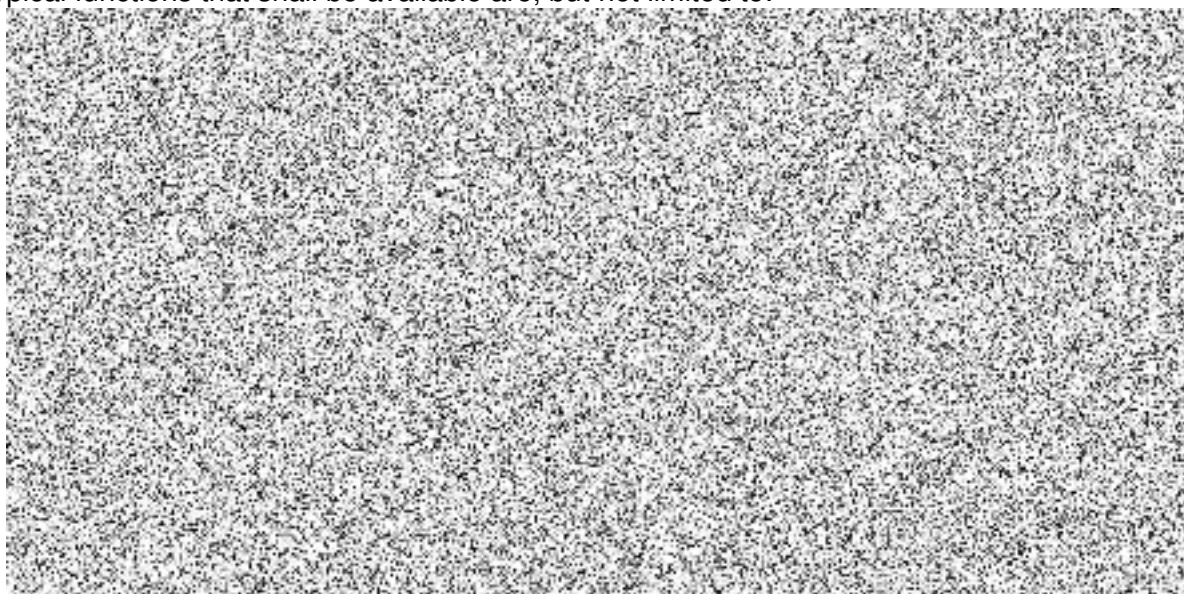
Use of dedicated operational control rooms or local panels shall be duly analysed, considering all operational and maintenance needs and constrains.

2.10.5.4.2.3.2.C

All necessary functions to support operation shall be available from the MCR or from rooms located in its close vicinity.

CA

Typical functions that shall be available are, but not limited to:



2.10.5.4.2.3.2.D

To support the teamwork, large overall displays showing a simplified representation of the Plant* and/or /Unit* parameters and status shall be implemented in the MCR. Displayed

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 26/122

information shall provide clear overview of Plant* and/or /Unit* parameters and main Unit* processes reflecting current Unit* operation states and modes.

DA

This display is used for co-ordination among Operators* and by any people present or entering the MCR to assess Plant* and/or /Unit* status quickly.

2.10.5.4.2.3.2.E

When the MCR is in service, provisions against spurious signals and propagation of faults from the ECR shall be made

2.10.5.4.2.3.2.F

Reflection effects, blinding effects and inconveniences for the staff shall be reduced considering indicator and screen design and taking into account the average lighting level in the room.

2.10.5.4.2.3.2.G

Noise level

Acoustical alarm signal shall not exceed 20 dB above the average noise level.

2.10.5.4.2.3.2.H

All computer equipment of MCR (or ECR) H-MI, as far as feasible, shall be installed in a designated area outside MCR (or ECR) in order to reduce the heat load in the MCR (or ECR). This designated area shall have the same resistance to external conditions as MCR (or ECR). I&C service centre shall be considered as suitable location.

2.10.5.4.2.3.2.I

The MCR shall have sufficient space for:

- accommodating the operating staff;
- all necessary information and control equipment in a well structured arrangement;
- writing; and
- documentation and procedures
etc.

2.10.5.4.2.3.3 EMERGENCY CONTROL ROOM

2.10.5.4.2.3.3.A

The Technical Requirements Document*, Chapter 2.1 requires an Emergency Control Room* to be provided and defines its role, its conditions of use and the corresponding functional requirements.

See Technical Requirements Document*, Section 2.1.7.4.7.

AA

ECR shall utilise the same principles to minimise Operator* distraction and to attract attention as MCR.

2.10.5.4.2.3.3.B

ECR shall be available in case of the loss of MCR.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 27/122

2.10.5.4.2.3.3.C

ECR information and control facilities shall have identical safety classification and seismic qualification requirements as I&C facilities in MCR.

2.10.5.4.2.3.3.D

Control of system and equipment from both the MCR and the ECR shall not be possible at the same time.

2.10.5.4.2.3.3.E

When the ECR is in service, provisions against spurious signals and propagation of faults from the MCR shall be made.

EA

e.g. by means of transfer switches, coded signals, isolated links or similar.

2.10.5.4.2.3.3.F

When the supervision and control of the plant are performed from the MCR, provision against false signals from the ECR shall be made.

2.10.5.4.2.3.3.G

Provisions shall be made to return the control back from ECR to MCR when conditions allow it.

2.10.5.4.2.3.3.H

The design of ECR shall include provisions to prevent unauthorised use.

2.10.5.4.2.3.3.I

Entry and use of the ECR shall be reported within the MCR.

2.10.5.4.2.3.3.J

The design shall pay attention to the human factors engineering principles and human characteristics of personnel under emergency conditions.

2.10.5.4.2.3.3.K

The Human-Machine Interface of ECR shall be consistent to that used for the MCR due to human factors and to limit the number of H-MI types.

2.10.5.4.2.3.3.L

The ECR shall have sufficient space for:

- accommodating the operating staff;
- all necessary information and control equipment in a well structured arrangement;
- writing; and
- documentation and procedures
etc.

2.10.5.4.2.3.3.M

Adequate oral communication facilities shall be provided in the ECR.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 28/122

2.10.5.4.2.3.3.N

Operation of the Unit* from the ECR shall not be dependent on the conditions in MCR and vice versa.

2.10.5.4.2.3.3.O

For requirements relating habitability see Technical Requirements Document*, Section 2.8.2.9.3.6.

2.10.5.4.2.3.4 EMERGENCY CENTRES AND OPERATIONAL SUPPORT CENTRES*

2.10.5.4.2.3.4.A

The Emergency Preparedness Centres* shall be equipped with I&C systems necessary for use in emergency situations by the emergency preparedness organization.

I&C systems of The Emergency Preparedness Centres* shall support fulfilment of requirements stipulated in the Technical Requirements Document*, Section 2.1.8.4.1

2.10.5.4.2.3.4.B

The Operational Support Centres* shall be equipped with I&C systems necessary for use in emergency situations by the emergency preparedness organization.

I&C systems of The Operational Support Centres* shall support fulfilment of requirements stipulated in the Technical Requirements Document*, Section 2.1.8.4.1

2.10.5.4.2.3.5 TECHNICAL SUPPORT CENTRES*

2.10.5.4.2.3.5.A

The Technical Support Centres* (TSC) shall be provided and equipped with I&C systems necessary for Plant* and/or /Unit* management and technical support to reactor operating personnel in MCR (or ECR) in the emergency situations (including Severe Accidents*).

I&C systems of the TSC shall support fulfilment of requirements stipulated in the Technical Requirements Document*, Section 2.1.8.4.1

2.10.5.4.2.3.6 I&C SERVICE CENTRE

2.10.5.4.2.3.6.A

I&C service centre shall be provided, which shall provide all functions necessary for service and maintenance of I&C systems, access to I&C documentation and I&C periodic tests for which the process is not affected.

AA

The I&C service centre shall be dedicated to:

- system administration;
- testing; and
- analysis and diagnosis.

2.10.5.4.2.3.6.B

Provision shall be made in order to facilitate good communications between the I&C service centre maintenance Plant* and/or /Unit* staff and the MCR and where necessary.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 29/122

BA

Provisions shall allow direct contact (related to the location) or provide suitable technical communication means.

BB

The decision on the physical location shall be made in agreement with the Owner*.

2.10.5.4.2.3.7 MAINTENANCE MANAGEMENT ROOM

2.10.5.4.2.3.7.A

Centralised I&C maintenance facilities shall be designed to give access to the whole I&C system.

AA

This room can be united with I&C service room.

2.10.5.4.2.3.7.B

Centralised I&C maintenance facilities should be located close to the MCR.

BA

Since the centralised I&C maintenance facilities address all of the Plant* and/or /Unit* operation systems, it is important to make the link with the Operators* controlling the Plant* as easy and direct as possible.

2.10.5.4.2.3.7.C

The design of the centralised I&C maintenance facilities shall avoid any spurious action on operation when a maintenance task is being performed. In all conditions, the Plant* must be controlled exclusively by the Operators*.

2.10.5.4.2.3.7.D

All maintenance activities shall be permitted by the Operator* before being performed.

2.10.5.4.2.3.7.E

The Supplier* shall also provide storage arrangements for identification and separation of spare parts to different safety classes of I&C equipment.

2.10.5.4.2.3.7.F

A tagging centre shall be provided. It is the place where the tagging functions are carried out and where the work permits are delivered to the maintenance personnel.

FA

The decision on the physical location shall be made in agreement with the Owner*.

2.10.5.4.2.3.8 ELECTRONIC COMMUNICATION

2.10.5.4.2.3.8.A

Electronic communication facilities shall be provided in the MCR and other rooms where it is necessary, to facilitate safe and efficient Plant* and/or /Unit* operation. Special consideration shall be given to the design of communication facilities to be used in AOO and Accident

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 30/122

Conditions* to communicate with relevant control centres to fulfil the functions based on Accident Management Procedures*.

AA

Requirements on communication between MCR, ECR and other Emergency Response Facilities* in emergencies are given in Technical Requirements Document*, Section 2.1.8.4.1

2.10.5.4.2.3.8.B

The MCR shall be designed as the communication centre of the plant for Normal Operation* and during the early stage of an accident.

2.10.5.4.2.3.8.C

The facilities shall be designed according to the relevant local environment needs during their use.

2.10.5.4.2.3.8.D

The electronic communication facilities shall be based on state-of-the art technologies and its design shall follow up best practices.

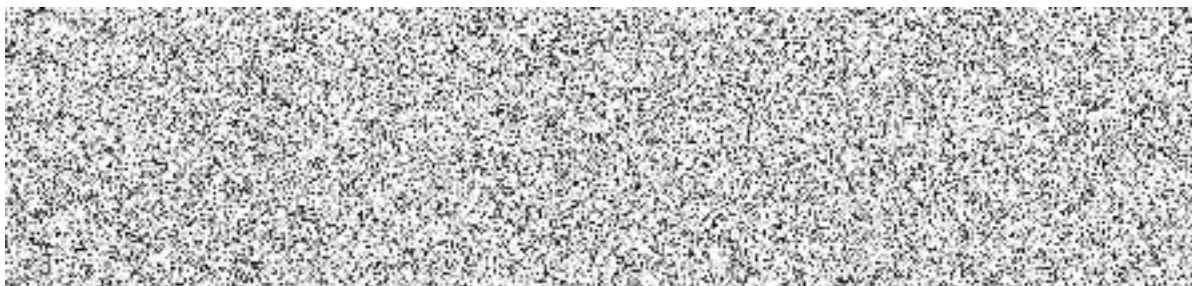
2.10.5.4.2.3.8.E

Electronic communication systems and equipment for electronic communication within the Plant* to support operation and maintenance; and with external organizations and facilities shall be provided to support all phases of operation and maintenance, including emergency operations and Accident Conditions*.

2.10.5.4.2.3.8.F

The electronic communication systems for data transmission, oral and video (video where necessary) communication shall include, but not limited to:

- communication between Operators*, field Operators* and maintenance staff;
- communication system to enable plant-wide wireless communication of personnel. This system shall reach all areas of the Plant*, i.e. no dead areas are permitted, with well justified exceptions for rooms containing EMI/RFI sensitive I&C equipment where the use of wireless communication is not achievable due to negative impact on safety (typically applicable for safety I&C rooms, MCR, ECR), where alternative communication means shall be provided. Other visual and audible means shall be provided for alerting personnel in noisy areas; and



- dedicated communication links with external organizations and facilities, including safety Authorities*, local fire and law enforcement agencies, off-site Emergency Response Facilities* and transmission grid dispatching. See Technical Requirements Document*, Sections 5.3 CP43B and 5.3 CP43C.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 31/122

2.10.5.4.2.3.8.G

The design of the communication equipment and all the H-MI systems, computers, instrumentation and control equipment shall be such that there is no interference among them.

2.10.5.4.2.3.8.H

Other communication facilities shall be provided in or near the MCR and other rooms including a CCTV (where valuable) to enable monitoring of process equipment rooms, of maintenance actions outside of the MCR and of major components (at least the reactor operating floor status, the reactor coolant pumps, strategic locations inside the containment, the turbogenerator status).

2.10.5.4.2.3.8.I

The CCTV provided for AOO and Accident Conditions* shall be designed to withstand relevant environmental conditions.

2.10.5.4.2.3.9 MAIN TARGETS OF H-MI DESIGN

2.10.5.4.2.3.9.A

The I&C functions provided shall include information and control functions enabling the Operators*, but not limited to:

- to be continuously informed of the Plant* and/or /Unit* status, its development and variables important to safety and availability;
- to be able to analyse the information provided and to make decisions; and
- to operate the Plant* and/or /Unit* and to get immediate feedback.

AA

Such functions shall include, but are not limited to:

- control of process functions with Operator* involvement;
- process monitoring functions (process information, high-level functional information, alarms, etc.);
- monitoring of process controlling functions (with and without Operator* involvement);
- other information functions (e.g. expert systems, meteorological data, operation schedule data) ;
- information displaying functions; and
- maintenance-related information.

2.10.5.4.2.3.9.B

The provided information shall be reliable and be processed and displayed within a time limit which is compatible with and in a way that is appropriate to, the Operators* tasks.

2.10.5.4.2.3.9.C

The information shall be easily accessible to those who need it (for operation or maintenance).

CA

The workstation shall have the capability to obtain a hard copy of any display format

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 32/122

2.10.5.4.2.3.9.D

Information shall be presented so as to reflect its importance in terms of the Unit* state or phenomena dynamics and to facilitate its analysis.

2.10.5.4.2.3.9.E

The Operator* shall be given adequate feedback about the progress and completion of commands.

2.10.5.4.2.3.9.F

For commands, which endanger the operation of the Unit*, special arrangements shall be made for avoiding unintended actuation.



GA

I.e. stability in the working place, in the way the Plant* is operated, in the means used to operate, in the tasks to be fulfilled.

GB

The information and control facilities shall implement sufficient Redundancy* (e.g. number of screens, computers) and Independence* so that any failure with significant probability is not leading to the loss of H-MI functions.

2.10.5.4.2.3.9.H

In particular, if backup operating means are provided in the control rooms to compensate unavailability of the normal operating means, the simultaneous use of both means to operate the Plant* and/or /Unit* shall be avoided.

2.10.5.4.2.3.9.I

The information and control functions shall enable the Operator* to be aware of the administrative status (faulty, tagged, on-test, modified) of the components and to generate maintenance request in case of component failure.

IA

This enables the Operator* to know the precise status of the components.

2.10.5.4.2.3.9.J

In addition, information of administrative status shall also be attached to each actuator or sensor and taken into account in the different information and control functions (monitoring, controlling, processing, displaying, etc.).

2.10.5.4.2.3.9.K

The number of different types of H-MI dedicated to operation shall be minimised.

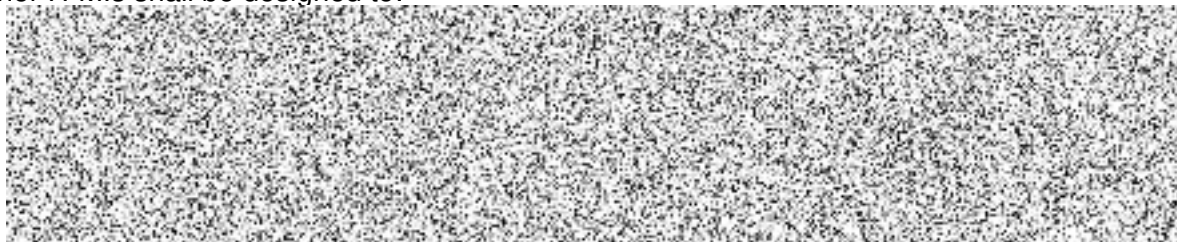
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 33/122

2.10.5.4.2.3.9.L

MCR shall be equipped with H-MI to fulfil its control and monitoring functions in all Unit* conditions:



Other H-MIs shall be designed to:



LA

The interface features shall primarily depend on:

- functional analysis;
- ergonomics; and
- task analysis.

LB

HMI including displays needed for all modes and states of Plant* operation in MCR and ECR shall be presented in Czech language with respect to Czech H-MI specifics (e.g. usage of standard Czech keyboard, ...).

The specific HMI including displays not directly related to Plant* operations shall be in English if appropriate analyses confirm that demand on qualification of Operators* do not exceed acceptable level (incl. need for good knowledge of English), its solution is acceptable for Authorities* and it does not lead to negative impact on safety.

Detail scope of translated HMI including displays will be determined in the appropriate design phase through the mutual agreement.

LC

The Owner* is to participate on HMI's Czech language localization.

The Owner* shall be responsible for translation of mutually agreed HMI including displays and shall participate in following procedures:

- Suitability Verification (SV)
- Integrated System Validation (ISV)

The Supplier* shall be responsible for English HMIs versions, project leading, documents determined to translation, Czech language implementation and final V&V.

LD

Works related to translation of HMI shall begin immediately after EPC Contract signature to avoid negative impact on construction schedule.

The Supplier* shall immediately provide engineering documents and knowledge related with HMI including displays to translate Czech language after issuance of English version to avoid negative impact on construction schedule.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 34/122

LE

For cases when the Czech language cannot be used (for HMI not to be used in MCR or ECR), the English language shall be implemented.

In those cases comprehensive instruction for operation and maintenance of particular HMI shall be provided also in the Czech language.

2.10.5.4.2.3.9.M

The H-MI dedicated to other purpose than operation shall be separated from the operating facilities.

2.10.5.4.2.3.9.N

The H-MI shall be designed to enable it to be operated by different groups of staff.

NA

The H-MI is not only task-oriented, but it also has a collective dimension encompassing all groups of staff, which has to be considered in the design process. The categories of users and their mutual links shall be important inputs for determining the flow of information thus shall be established as practicable for the Owner*.

2.10.5.4.2.3.9.O

When designing H-MI, Owner's* operation and maintenance strategy and following aspects shall be considered, but not limited to:

- description of the operating staff;
- role and responsibility of each staff member;
- shift organization; and
- activities according to Plant* states: nominal, start-up, scheduled outage, AOO and Accident Conditions*.

OA

The description of the operating staff is important input data for the required task analysis. Detailed requirements on operating staff are stipulated in Operation and Maintenance Document*, Chapter 1 PERSONNEL.

OB

The shift organization, the possible changes during a shift and any other changes in the composition of the operating staff shall be supported by data processing aids (e.g. a computerized log book, a computerized note book, etc.).

OC

The shift organization may depend on the Unit* condition. This dependency shall be duly assessed and the impact on the design of interface shall be dealt.

2.10.5.4.2.3.9.P

The I&C systems shall provide through PGP Human-Machine Interface (H-MI) all necessary functions to provide the assurance to Operator* that all parts of the main energy transport process operate in an efficient and effective manner and deliver the required energy to the external electric grid.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 35/122

2.10.5.4.2.3.9.Q

Signals and alarms showing the status of the drives, their related electrical switchgear and related technological components shall be provided for indication by the H-MI interface.

QA

Monitoring of the state of the drive and its related electrical switchgear refers to, but not limited to:

- position, torque limit, power, current;
- release signals or interlocks;
- monitoring of limit position, running time in both directions and tendency;
- alarm annunciation in case of faults;
- test conditions; and
- information for maintenance,
- information from central unit fault monitoring system for electrical systems referred to Technical Requirements Document*, Section 2.7.11.4.10

2.10.5.4.2.3.10 DESIGN OF ALARMS

2.10.5.4.2.3.10.A

Alarms shall be designed for attracting the Operator's* attention to unexpected events, especially to disturbances regarding process control and Plant* and/or /Unit* behaviour.

AA

The knowledge of the Operator's* tasks is a basic element that shall be taken into account in the design of alarms, so that alarms and other information are correctly directed to the appropriate staff. The Operator* must not be distracted from his main tasks. In particular attention shall be drawn to the I&C failures which necessitate a specific analysis to detect those to be considered as real alarms and those to be considered as information directed to the maintenance staff and only to be displayed to the Operator* at his request.

2.10.5.4.2.3.10.B

The alarm function shall be designed as an integral part of the information and control functions in order to ensure the consistency of the alarms with the other information provided and to enhance their functional meaning.

2.10.5.4.2.3.10.C

The alarm function shall include the following features:



2.10.5.4.2.3.10.D

The alarm processing shall suppress non-significant alarms and group alarms with similar meaning or alarms originating from the same event.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 36/122

DA

The purpose is to alert the Operator* only if it is necessary for him to perform corrective action or to be aware of a change in the state of the Plant* and/or /Unit*. The Operator* shall not be disturbed by non-significant alarms. If numerous alarms appear in a short time, particularly if an accident or an upset situation occurs, the Operator* may be confused and spend time on unnecessary actions. Therefore only those alarms which the Operator* needs to be aware of to understand what is going on and to determine what has to be done, shall be displayed.

2.10.5.4.2.3.10.E

The alarm processing shall provide the following features, but not limited to:

- generation of a signal for an alarm only if it reflects the real situation for which this alarm has been provided;
- for safety-classified automatic actions, information on the first cause of the initiation of a protection action;
- elimination of redundant alarms;
- inhibition of the alarms, which are induced by a common event which is itself signalled by an alarm;
- validation or inhibition of the alarms depending on the Plant* and/or /Unit* situation. This is to eliminate alarms which are not significant in a given Plant* and/or /Unit* situation;
- alarms grouping other individual alarms. This kind of alarm is re-activated each time an individual alarm occurs;
- registration of all alarms in a sequence of event records (to be used for event and disturbance analysis).

2.10.5.4.2.3.10.F

Maintenance activities, partial or total loss of power supply and transients shall be properly considered in the design of the alarm function

2.10.5.4.2.3.10.G

The manner of alarm execution shall enable the Operator* to select the right priority of reaction.

GA

The Operator* shall not be unduly perturbed when performing operating tasks when no rapid action is required.

2.10.5.4.2.3.10.H

When designing the alarms, the Supplier* shall consider:

- the available reaction time (in relations with the automatic functions and automation rules);
- the seriousness of the event with regard to safety and availability of the Plant* and/or /Unit*. For example, the event may lead to the loss of a function, to a deterioration of a function or may only have a minor impact.

2.10.5.4.2.3.10.I

Alarm priority tagging shall be implemented in order to enable the Operator* to identify the different alarms and their corresponding severity easily.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 37/122

2.10.5.4.2.3.10.J

Changes of signals for alarms or of the status of functions/systems shall be reported by visual and audible means.

2.10.5.4.2.3.10.K

A limited number of different acoustic means shall be used to identify the most important and critical alarm groups.

2.10.5.4.2.3.10.L

Means shall be provided to enable the Operator* to acknowledge the alarms, either individually or in groups in order to minimise operators' work burden.

LA

Groups means functional groups, manual selected alarms, possibility to create criteria for selection of alarms etc.

The advanced alarm management system shall be provided to enable the Operator* to handle the presentation of alarms (e.g. listing, ranking, suppressing, sorting, etc.).

Appearance and disappearance of alarms shall be logged with date and time.

In addition to alarm list, active alarms shall be visualised also on the process diagram displays in connection with related measurement.

It shall be possible to have individual measurement shown in several different display formats.

When a piece of equipment (e.g. measurement, pump, valve) has an active alarm, it shall be visualized in a uniform manner within each format in which it is presented.

2.10.5.4.2.3.11 OPERATING INSTRUCTIONS

2.10.5.4.2.3.11.A

As defined in Operation and Maintenance Document*, section 3.6, during Normal Operation*, AOO and Accident Conditions*, Operators* operate the Plant* according to the Unit* specific Normal Operation* Procedures, Abnormal Occurrence Procedures* (AOP), Emergency Operating Procedures* (EOP) and Severe Accident Management Procedures* (SAMG), which shall be provided by the Supplier*.

2.10.5.4.2.3.11.B

The combination of Normal Operation* Procedures, AOP, EOP and SAMG and adequate technology interfaces to be used shall be defined by the Supplier*.

2.10.5.4.2.3.11.C

Operating instructions shall be provided and adapted to the characteristics of the operating means and to the operating conditions.

2.10.5.4.2.3.11.D

For the MCR workstations and where practical for other workstations, which utilise electronic selectable displays, procedures shall be presented in electronic displays.

2.10.5.4.2.3.11.E

When complex actions depending on the state of the process are required, the Operator* shall have comprehensive knowledge of current status of the Plant* and/or /Unit* processes and clear guidance (operating procedures) shall be available to support its correct decision-making to avoid erroneous decisions from him.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 38/122

2.10.5.4.2.3.11.F

The Operating procedures design shall allow the Operator*:

- to maintain, without undue stress, his ability to follow what is going on in the process,
- to have sufficient time between different phases of operation.

2.10.5.4.2.3.11.G

Display-based Operating Procedures shall be provided including linking between operating display formats and procedure display formats. Most important measurement values and parameters shall be shown (on-line) also directly on procedure display formats in the same way as in other relevant H-MI.

2.10.5.4.2.3.12 RECORDING, ARCHIVING AND REPORTS

2.10.5.4.2.3.12.A

All the logic events dealing with Plant* and/or /Unit* operation shall be recorded so that they can be presented, at Operator* request, in alphanumeric form always. Powerful and advance searching, querying, filtering and sorting functions shall exist.

AA

Events shall include alarms.

2.10.5.4.2.3.12.B

The events shall be dated and stored in chronological order.

2.10.5.4.2.3.12.C

All the measurements gathered and calculated for Plant* and/or /Unit* operation shall be recorded so that they can be presented, at the Operator's* request, in numerical or graphical form.

2.10.5.4.2.3.12.D

"Status reports" processing which aims at an overall presentation of the Plant*operation, shall be provided to give the operating managers an overview of the Plant* situation.

DA

A complete status report shall consists of 3 types of data, but not limited to:



2.10.5.4.2.3.12.E

"Shift changeover instructions" processing, which aims to provide an overall presentation of the Plant* and/or /Unit* operation, shall be provided to ensure the transmission of data and information between successive operating teams.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 39/122

EA

Shift changeover instructions enable the Operator*(s) and the supervisory staff to transmit a rapid summary of the activity to their respective successors, based on:

- a partial status report (excluding statistics); and
- a list of the important operations performed during the shift by workstations. This list usually includes:
 - for the Operator*(s), the list of control operations, and
 - for the supervisory staff, the list of tagging and test conditions.

In both cases, a comment zone is available to supplement the list of selected operations.

EB

Shift changeover information shall be generated using automatic tools.

2.10.5.4.2.3.12.F

For implementation of requirements mentioned above the data storage system shall be provided.

2.10.5.4.2.3.12.G

Data storage system shall ensure real-time, medium-term data store in the range of 10 years of Plant* operation.

2.10.5.4.2.3.12.H

Data storage system shall enable data security, system monitoring and data management.

2.10.5.4.2.3.12.I

Data storage system shall enable data sharing with plant personnel and periodical and on demand data processing.

IA

The I&C systems shall enable transfer of demanded data to other systems and applications of the Plant* including Operational Information Management System* (OIMS) which shall communicate with Operational Configuration Management System* (OCMS).

2.10.5.4.2.3.12.J

Medium-term data store shall fulfil the requirement on high availability, it ensures that information is continuously available to clients.

2.10.5.4.2.3.12.K

For medium-term data store and long-term data archive shall be established back-up and recovery program to mitigate data lost.

2.10.5.4.2.3.12.L

Data storage system shall ensure real-time data access into medium-term data store and enable providing of following functions, but not limited to:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 40/122

2.10.5.4.2.3.12.M

Long-term data archive shall enable at least:

2.10.5.4.2.3.12.N

Appropriate cyber security policy and measures shall be implemented in conformity with cyber security plan and cyber security program.

2.10.5.4.2.3.13 OPERATING AID

2.10.5.4.2.3.13.A

In order to support the Operators* (and other necessary staff) in the decision-making process, additional operating aids shall be provided.

AA

The aim is to provide the Operators* (and other necessary staff), with function support in all Plant States*.

2.10.5.4.2.3.13.B

Operating aid function shall also take benefit from other techniques than those developed for the Operators, e.g. from expert systems or sophisticated calculation applications.

2.10.5.4.2.3.13.C

The operating aid shall include but not be limited to alarm prioritising and filtration system for Operators* (and other necessary staff) during AOO and accidents.

2.10.5.4.2.3.13.D

The operating aid shall be coordinated and validated with Operating Procedures.

2.10.5.4.2.3.13.E

The supervision process shall allow call upon prediction iterative models or simplified models (charts or tables of values) taken from more complicated models implemented on dedicated systems.

2.10.5.4.2.3.13.F

Functions for the core supervision and the supervision of the efficiency of the Unit* thermal process (including the power generation process) shall be provided.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 41/122

2.10.5.4.2.3.13.G

The I&C functions shall include features which allow easy application of the technical specifications for all Plant* and/or /Unit* conditions.

Note

Technical specification contrary to Technical Specification* (defined term) shall be understood as the set of requirements for items such as safety limits, limiting safety system settings, limiting control settings, limiting conditions for operation, surveillance requirements, design features, and administrative controls.

GA

In relation to the main roles given to the technical specifications for plant operation, I&C system shall provide the operating team with relevant information which will enable the compliance with the technical specification prescriptions to be easily checked for all Plant* and/or /Unit* standard conditions.

2.10.5.4.2.3.13.H

The I&C shall include computerised assistance in applying the technical specifications.

2.10.5.4.2.3.13.I

The compliance of operation with requirements of the Technical Specifications* shall be continuously monitored in all cases where measurements in I&C are available, to warn the Operator* when requirements of Technical Specifications* are being approached or being violated. The system shall automatically log all such violations of Technical Specifications* requirements. To the extent practical, the system shall also indicate the action needed to recover from violations of requirements of Technical Specifications*.

2.10.5.4.2.3.14 DIAGNOSTICS AND PROGNOSTICS

2.10.5.4.2.3.14.A

Monitoring, surveillance and diagnostic functions and techniques shall be implemented to:



The prognostic functions shall be considered those provided under the Technical Requirements Document* section 2.14.2.7 Plant condition monitoring and requirements 2.14.2.6.G, GA, GB, GC, GD.

AA

The monitoring, surveillance and diagnostic functions shall provide coherence in the grouping of analogue and digital processing operations, thus shall support analyses to allow the detection of faults and anomalies in the state (mechanical, electrical, functional, degradation, etc.) of monitored/surveyed SSCs.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 42/122

2.10.5.4.2.3.14.B

These functions shall be, but not limited to:

- acquisition and real-time processing of monitoring data from the parameters measured on each SSC under surveillance;
- analytic and diagnostic processing associated with a graphic data display interface; and
- data processing with the help of systems which provide aid to diagnosis of fault mode;
- further processing and analysis with the help of experts shall be possible on demand and associated tools shall be provided.

2.10.5.4.2.3.14.C

Monitoring and diagnostic functions and techniques shall ensure the acquisition, processing (for example, but not limited to, general calculation, statistical calculations, calculations based on mathematical models, etc.), presentation to end users (for example, but not limited to graphics, sheets, graphs, reports, etc.) and storage of related data received from the SSC as required in other parts of the EPC Contract*.

See Technical Requirements Document*, Section 2.14.2.7

The prognostic functions shall be considered those provided under the Technical Requirements Document* section 2.14.2.7 Plant condition monitoring and requirements 2.14.2.6.G, GA, GB, GC, GD.

CA

All issues mentioned above shall be maintained in the frame of CM. This shall include methods description, databases, list of constants, diagrams, rules, guides, templates, etc.

2.10.5.4.2.3.14.D

The data received from the monitoring and diagnostics functions shall be made available:

- locally, on site;
- off-site, made available to required teams and individuals of a supporting entity
- remotely (taking in to account Cyber security program).

The prognostic functions shall be considered those provided under the Technical Requirements Document* section 2.14.2.7 Plant condition monitoring and requirements 2.14.2.6.G, GA, GB, GC, GD.

2.10.5.4.2.3.14.E

Data from monitoring and diagnostic functions, these functions themselves and dedicated H-MI shall be provided via comprehensive and user friendly dedicated monitoring system with diagnostic functions which also shall include on-line and off-line analyses based on predefined templates, rules, provides tools for ad hoc analyses, and also provides, but not limited to, policies, procedures and smart functions and features for efficient data management.

Necessary monitoring and diagnostic data (see also 2.14.2.7) shall be concentrated and transferred to appropriate staff to allow efficient assessment of SSC health conditions.

EA

Operational staff shall have available monitoring and diagnostic data relevant for their tasks.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 43/122

EB

For other requirements relating to monitoring, diagnostic system see section 2.10.7.9

2.10.5.4.2.3.15 TECHNOLOGY OF H-MI

2.10.5.4.2.3.15.A

The state-of-the-art technology for H-MI, coupled with the advance in screen-based visualisation systems, shall constitute a design basis for the implementation of the human-machine interface.

AA

Technology of H-MI shall be based on the implementation of screen-based controls integrated with a high degree of Operator* aid and the implementation of powerful processing means between the Operator* interface and the process automation level. The amount of information to be collected and then processed is considerable. The consequences are the following:

- high-capacity data communication networks shall be implemented where necessary;
- degree of standardisation shall be high. This concerns the functions processed by the process automation as well as those processed by the equipment for providing information to the Operator*. Data exchange between equipment also shall be standardised;
- powerful engineering tools shall be used and provided to elaborate all Documents*, programs, as well as parameter files needed to define and configure the I&C equipment and related software.

These tools shall be able to check the consistency of data and they also shall be used during Commissioning* and maintenance for on-line modifications.

AB

Following features shall be provided, but not limited to:

- task-related display of the fluid systems in an appropriate form for Operator* actions;
- presentation of situation-specific, pre-processed condensed information in an appropriate context with display formats for system status, trend curves and process diagrams;
- providing situation-specific Operator* aids (e.g. procedures for manual operation, decision aids, detailed information about equipment, periodic test instructions etc.).

The technical advantages of these features shall permit additional margins to be used.

2.10.5.4.2.3.15.B

Particular consideration shall be paid to overall manual actuation of the main protection channels (reactor or turbine trip, safety injection, etc.).

2.10.5.4.2.3.15.C

The Supplier* shall consider human factors in the design also before the selection of technology.

CA

Engineering competence of the available personnel shall be taken into account.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 44/122

2.10.5.4.2.3.16 HUMAN FACTOR TECHNIQUES AND H-MI ERGONOMICS

2.10.5.4.2.3.16.A

H-MI shall be designed according to best ergonomic knowledge.

2.10.5.4.2.3.16.B

Human factors shall be carefully considered and analysed throughout the specific procedures and I&C design.

2.10.5.4.2.3.16.C

The ergonomics of the H-MI shall be addressed in the early phases of the design.

2.10.5.4.2.3.16.D

The Supplier* shall provide the Operator* capabilities analysis that will identify all conceptual information and resources needed for the Operators* to perform each assigned task.

DA

The Supplier* shall use consult experts in ergonomics and psychologists with experience in analysis methods and adequate analysis methods shall be provided by consult experts and applied in system design. Basic human information handling capabilities, cognitive capability, perception capabilities for detecting signals, memory capacity and speed of response as well as physical response capabilities also shall be analysed.

2.10.5.4.2.3.16.E

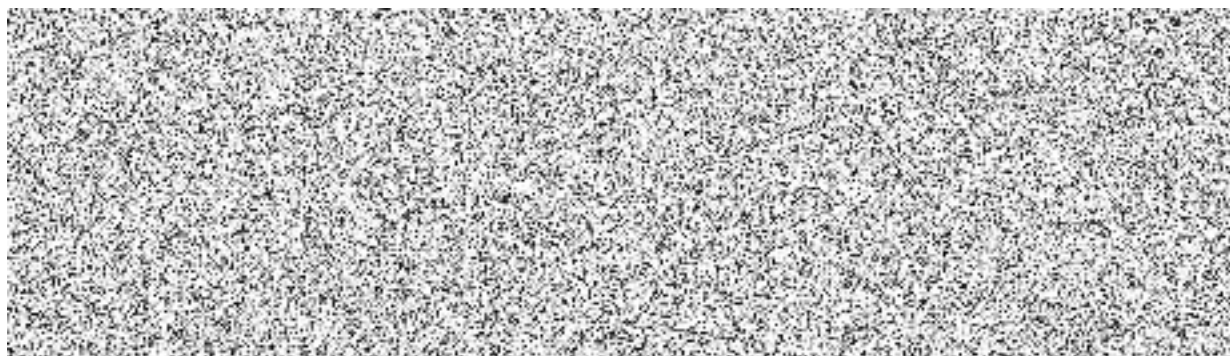
Information and controls shall be logically and functionally grouped, in the same way as controls and action feedback on equipment status and/or process (same format or same element of panel).

2.10.5.4.2.3.16.F

Particular care shall be taken to avoid conflicts of information and controls grouping, especially when different grouping techniques are used simultaneously.

2.10.5.4.2.3.16.G

In order to facilitate good ergonomic design of workstations, relevant standards shall be used.



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 45/122

HA

These formats shall be able to use real time as well as stored process data. They provide the Operators* with clear information on status and trend during and after control actions and alarms. They shall be organized and provided with user functions like display navigation and zoom.

2.10.5.4.2.3.16.I

The display formats shall be established according to the following principles, but not limited to:

- adaptation to the Operator's* task; and
- access to all of the formats by all of the team members however, the procedures can be assigned to individual team members only.

2.10.5.4.2.3.16.J

The workstation design shall provide the Operator* with the capability to call upon specific display formats including, but not limited to:

- lists;
- menus;
- function or a part of a function; and
- cross-reference on display formats.

2.10.5.4.2.3.16.K

The display formats presented to the Operator* shall not change except as a result of an Operator* action.

KA

Where multiple screens are provided, Operators* shall have the flexibility to assign a particular display format to any one of the screens.

2.10.5.4.2.3.16.L

Displays shall be provided on the screen to enable the control sequences, switch-overs, interlocks, etc. to be followed.

The feedback of the success of each control action shall be clearly provided to the Operators*.

2.10.5.4.2.4 DATA COMMUNICATION

2.10.5.4.2.4.A

Properly designed, consistent communications shall provide all the necessary information exchange between I&C systems (including H-MI) and ensure the required Independence*.

2.10.5.4.2.4.B

Data transfer capacity which is sufficient for the most adverse situations such as peak load and bursts of events shall be implemented.

2.10.5.4.2.4.C

Data shall only flow between I&C systems of the same safety class or from higher class I&C systems to lower class I&C systems.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 46/122

2.10.5.4.2.4.D

If data has to be exchanged in the other direction, it shall be verified that the data does not have any undesired impact on the higher class I&C system.

2.10.5.4.2.4.E

If Local Area Network* is used between Safety Class 3 or Non-Classified (NC) I&C systems, it shall be safe and secure, data collision shall be avoided and necessary Redundancy* shall be implemented.

2.10.5.4.2.4.F

The data transmission process shall provide sufficient inherent integrity and error checking to assure that random errors in the process do not degrade the availability and reliability.

2.10.5.4.2.4.G

The Supplier shall provide the interface provision (e.g., ports in Data Link Server, etc.) to the I&C system so that the interface between the I&C of the Units*, and between the I&C of Units* / Plant* and the power transmission grid, Existing Nuclear Power Plant*, transmission grid dispatching and other technologies relating to the Plant* (e.g. water storage facilities, meteostation, hydropower plant etc.) shall be implemented to enable exchange of information with the Plant* and/or Unit* and between the Units* of the Plant* on the conditions that the design ensures sufficient robustness against adverse effects due to postulated cyber attacks.

Final solution shall be compliant with Cyber security program for the Plant* and related regulation.

GA

The links with the transmission grid dispatching shall be established by the Supplier*. The Plant*/Unit* (and namely I&C) shall be able to provide the remote control of power and voltage as required in Technical Requirements Document*, Section 2.2, Section 2.3.2, and Section 2.7.11.4.10. It also shall be provided alarm functions.

GB

A distinction shall be made between:

- signals coming from the grid and initiating a protection action; and
- signals coming from the dispatching.

GC

Only hardwired interface (interface without communication protocol) is allowed between Units*/Plant* I&C systems and external system.

2.10.5.4.2.4.H

All the Plant* Data necessary for each particular Owner's* design, operational and maintenance need (including emergency situations) shall be on-line available at each particular place or location where needed or required (as e.g. MCR, RSS, TSC, Radiation workplace, Chemistry workplace, Reactor physics workplace, Radiation monitoring workplace, local workplaces, other emergency workplaces, etc.). This requirement shall be generally applied to the design, inclusive electronic communication from any systems of the Plant*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 47/122

HA

Data communication systems shall ensure transmission of information relating to controlled and monitored technology and status of relating I&C systems and components as is needed for the centralised operation and maintenance.

2.10.5.4.2.4.I

A data availability needs analysis shall be made and shall take into account Owner's* specific needs.

2.10.5.4.2.4.J

In case the workplace or location where the data shall be available is identified outside the Plant*, data will be available throughout the appropriate interface.

2.10.5.4.2.4.K

This data acquisition, communication and transfer system shall be simplified to allow user easy and seamless operational use and modifications during Plant* operation.

2.10.5.4.2.4.L

Application of the requirements described above shall not have adverse impact to the Plant* (availability, reliability, cyber security, etc.).

2.10.5.4.2.5 TOOLS

2.10.5.4.2.5.1 GENERAL REQUIREMENTS

2.10.5.4.2.5.1.A

To enable uniform processing as well as consistent data management throughout the various steps of the I&C design the Supplier* shall use, provide and integrate appropriate tools within Configuration Management* System (e.g. support tools for Product Lifecycle Management (PLM), information modelling, database management, requirement management, etc.).

AA

Those shall support all aspects related to the design of interfaces between I&C systems and, including but not limited to, to support overall integration and Commissioning* of the I&C functions.



2.10.5.4.2.5.1.C

All necessary tools shall be provided and the way they are used for analysis, design, support, development, HW and SW maintenance and modification (work) shall be identified and documented.

CA

This applies to all kinds of tools required to be provided in the Technical Requirements Document*, Chapter 2.10 and 2.12 as well as those required in the Operation and Maintenance

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 48/122

Document*. The final list of tools shall be confirmed by mutual agreement, however all related requirements of the EPC Contract* shall be fulfilled and their fulfilment is not subject of mutual agreement.

2.10.5.4.2.5.1.D

The functionality and limits of applicability of all tools shall be identified early in the design process.

2.10.5.4.2.5.1.E

Tools shall not be used outside their declared functionality or limits of application.

2.10.5.4.2.5.1.F

The tools shall enable to fulfil the requirement for traceability between all the steps of the I&C design.

2.10.5.4.2.5.1.G

The tool parameters used during the development, verification, or validation of target hardware or software shall be recorded.

2.10.5.4.2.5.1.H

The tools shall enable efficient information exchange among other design/engineering/software/maintenance/etc. tools (e.g. BIM, analytical tools, software tools, building layout, fluid and mechanical systems and electrical engineering) with the aim to have integrated design system with minimised contribution of human repetitive work.

2.10.5.4.2.5.2 SPECIFIC REQUIREMENTS

2.10.5.4.2.5.2.A

The tools shall enable the functional processing to be described on functional diagrams and animation of those diagrams.

2.10.5.4.2.5.2.B

The tools shall provide data and necessary information in a format directly usable for the code generating software tool without the need for manual intervention.

2.10.5.4.2.5.2.C

The tools shall correspond to the state-of-the-art and enable, but not limited to:

- programming the application with graphical or high-level language;
- tests and analyses (incl. code);
- simulating signals;
- validation of the application;
- marking and tracking changes and revisions;
- code generation (executable by the machine);
- documentation (incl. code);
- management of communication routes and inventory
- maintenance (incl. code);

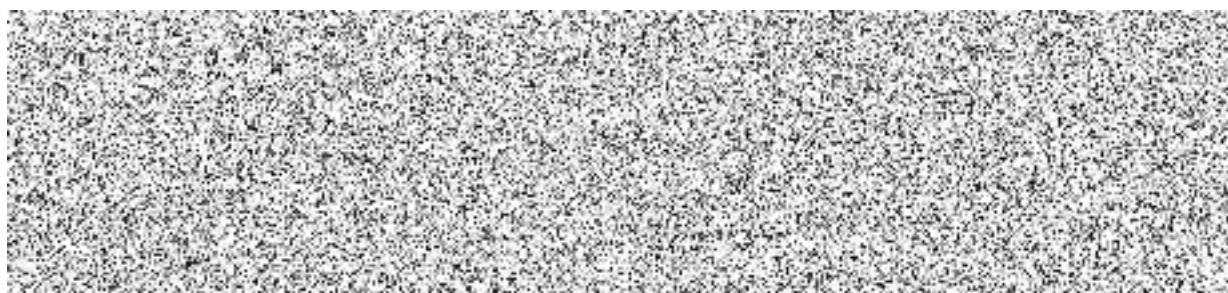
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 49/122

- configure the I&C system and size the equipment (i.e. specify the I&C system topography, buses, gateways, switches, H-MI servers and clients, grouping the parts to cabinets, power requirements); and
- allocate functions to specific parts of the I&C system, i.e. at which card, in which cabinet, cycle times, etc.



2.10.5.4.2.5.2.E

Pre-defined qualified function blocks shall be used to facilitate verification and validation of application logic.



2.10.5.4.2.6 DEFENCE AGAINST CCF

2.10.5.4.2.6.A

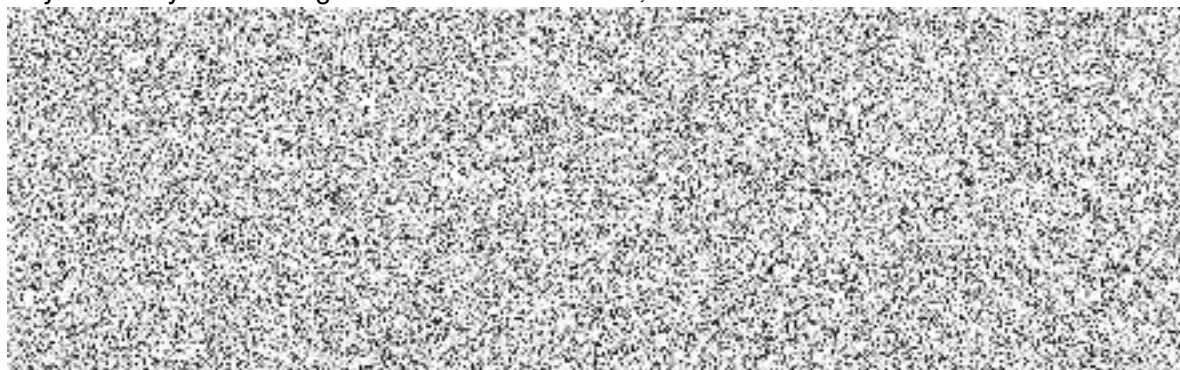
Appropriate measures shall be employed, if necessary in combination, to cope with Common-Cause Failure* (CCF) in order to achieve and maintain the required reliability commensurate with the importance of the Safety Functions* to be performed.

AA

CCF and their consequences can result from different sources (e. g. faulty manufacturing, erroneous design and unpredictable equipment environmental conditions during the course of accidents). Probability of occurrence of CCF shall be minimised at least to achieve the required reliability of the Safety Functions*.

2.10.5.4.2.6.B

Measures against erroneous design, production and handling of software and hardware shall be based on detail analysis elaborated well in advance to allow detail review by the Owner* and by Authority*. Resulting measures shall include, but not be limited to:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 50/122

2.10.5.4.2.6.C

Measures against unsuitable environmental conditions for the equipment, shall include, but not be limited to:

- equipment protection by building construction (e. g. walls) against the internal and External Hazards*;
- simple and reliable support systems (e. g. power supply, ventilation system);
- separation into Divisions*, each Division* with separated I&C functions and their independent support systems; and
- monitoring and generation of alarms of unsuitable environmental conditions.

2.10.5.4.2.6.D

Measures against unsuitable maintenance shall include, but not be limited to:

- detailed maintenance procedures;
- automated logic to prevent or mitigate maintenance errors
- assistance for monitoring and diagnosis; and
- surveillance for unauthorised interventions.

2.10.5.4.2.6.E

The design process for the I&C architecture shall include detail analysis of the effectiveness of the measures implemented to fight the potential CCF. This analysis shall be provided well in advance to take sufficient time for iterative review of the Owner* and the Authorities* approval to avoid any negative impact on schedule due to fixing of design issues.

2.10.5.4.2.6.F

Adequate Diversity* shall be provided where it is necessary. Especially, Diversity* shall be provided where software-based systems are employed, including the H-MI.

FA

Particularly for software-based systems, the reliability shall be enhanced by applying the principle of Diversity* to reduce the potential for software Common-Cause Failure*.

2.10.5.4.2.6.G

The Supplier* shall avoid areas of potential commonality when applying Diversity*, in particular (but not limited to) in choice of materials, technologies, components, manufacturing processes, software modules, logic blocks, firmware, tools and programmable microcontrollers in sensors and actuators and similarities in operating principles or common support features.



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 51/122

See Technical Requirements Document*, Section 2.17

2.10.5.4.2.6.I

The decision to use Diversity*, the choice of type of Diversity* or the decision not to use Diversity* shall be duly justified. This justification including design implications is subject for Authority* review and approval.



2.10.5.4.3 ASSIGNMENT OF FUNCTIONS TO I&C SYSTEMS

2.10.5.4.3.A

The functional assignment process consists in distributing I&C functions into I&C systems of the I&C architecture. This assignment shall be compliant with the overall requirements defined in Section 2.10.5.2.

2.10.5.4.4 REQUIRED ANALYSIS

2.10.5.4.4.1 GENERAL

2.10.5.4.4.1.A

The design process for the I&C architecture shall include an analysis of the effectiveness of the measures implemented to achieve the required Independence*. Such analysis shall be an iterative process that shall to be performed together with the design process. All the methods shall be selected at the beginning of the design process and are subject for Authorities* and Owner* approval.

AA

Independence* is mainly accomplished in the design of I&C systems by using Diversity*, Functional Isolation* and/or Physical Separation*.

2.10.5.4.4.1.B

Each individual safety category 1 and 2 I&C function shall be analysed to detect negative influences on other safety category 1 and 2 I&C functions. Counter-measures shall be applied to cope with negative influences.

2.10.5.4.4.2 ASSESSMENT OF DEPENDABILITY AND DEFENCES AGAINST CCF

2.10.5.4.4.2.A

Appropriate dependability is of prime importance so that the I&C does not jeopardise goals assigned to the power Plant*/Unit*. Dependability encompasses availability (reliability and Maintainability*) and credibility (integrity and safety). Dependability assessment is carried out through the assessment of each sub-items. It is based on analyses of test or study results and also on evidence that specific requirements applicable to I&C design (i.e. quality and design requirements) during the various phases of its lifecycle are met.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 52/122

2.10.5.4.4.2.B

The Supplier* shall identify all the requirements which can either directly or indirectly affect I&C dependability and develop them into detailed clear requirements applicable to the I&C architecture, I&C system design and relating support systems.

BA

Mentioned requirements identification and development shall be captured and provided to the Owner* within requirement management and its traceability.

2.10.5.4.4.2.C

The reliability of the I&C functions shall be based on result from the implementation of the deterministic design requirements and the intrinsic reliability that has to be claimed and proved (documented and tested) for the I&C systems and equipment which perform these functions.

CA

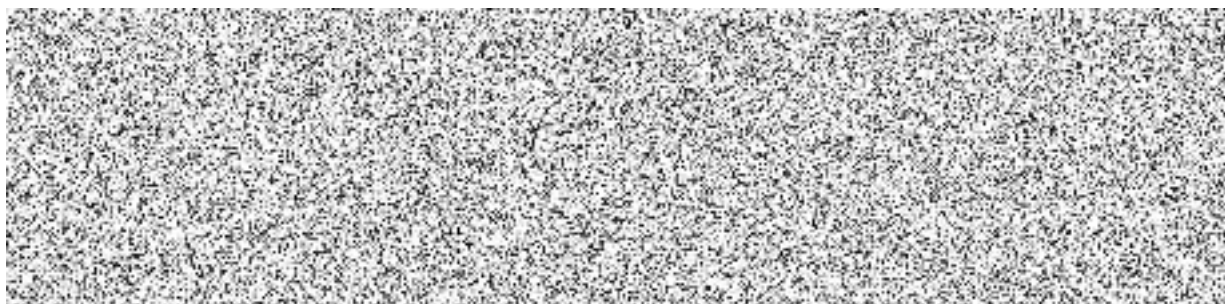
The reliability that is claimed for the I&C systems and equipment shall be supported by adequate analysis to follow the best practice in EU, UK, Korea and Authority* requirements. Both quantitative and qualitative analysis (estimations) shall be used to complement each other. Special attention shall be paid to the software contribution and common cause failures (CCF). A conservative approach shall be applied; sensitivity and uncertainty analyses are methods to justify a degree of conservatism.

CB

The Supplier* shall provide availability analysis which shall demonstrate reliability of I&C Systems for SC1, SC2, SC3 and for NC systems implementing functions important to availability.

2.10.5.4.4.2.D

Reliability and availability data from relevant and credible sources, presented in such a way that they are verifiable, shall be applied in dependability analyses of I&C functions and in the PSA.



EB

Trip-breakers or actuating contacts of ultimate relay are examples of final elements.

EC

It is not expected use of actuated devices local logic.



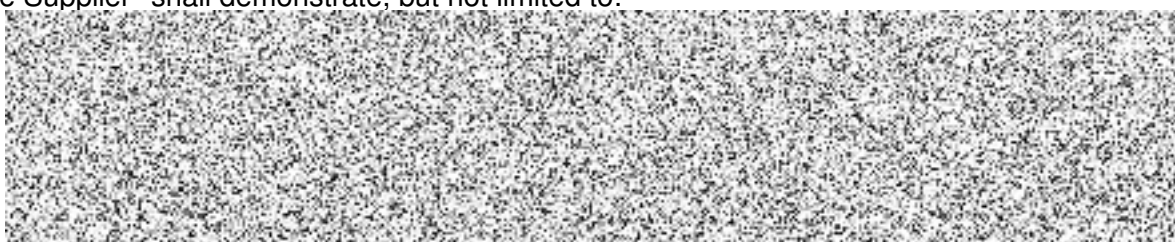


2.10.5.4.4.2.I

The Supplier* shall assess reliability of representative functions and demonstrate that the probability to fail on demand do not violate the overall safety and production goals.

IA

The Supplier* shall demonstrate, but not limited to:



2.10.5.4.4.2.J

The spurious functioning shall be assessed with regard to its safety consequences.
See Technical Requirements Document*, Section 2.1.6.3.



KA

Trip-breakers are examples of final elements. Power supply system is an example of relevant I&C support system which could cause a reactor trip.



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 54/122



MA

Actuating contacts of ultimate I&C relay are examples of final elements.

2.10.5.4.4.2.N

The turbine control system and other control systems limiting availability of the Unit* shall be able to carry out its main functions (e.g. to keep the turbo-generator connected to the grid) minimising the number of spurious shutdowns of the turbo generator in accordance with the availability target of the whole Plant* set out in Technical Requirements Document*, Section 2.2.7.2.

2.10.5.4.4.2.O

All CCF risks related to category 1 (A) functions shall be assessed and the acceptability of the technical solution and architecture has to be justified.



2.10.5.4.4.2.P

For systems safety class 1, 2 and 3 and NC systems important to availability the Supplier* shall provide a FMEA analyses to evaluate systems for possible ways in which failures can occur. For each of the failures identified, an proper estimation of its occurrence, severity, and detection shall be made.

FMEA analyses shall identify all possible failures and their effect up to the basic electronic and/or mechanic component level (resistor, capacitor, processor, terminals, etc.) of I&C components and modules (input, output modules, rack, transmitters, etc.).

FMEA program shall start at the beginning of the design process to prevent possible failures and to mitigate their effects already in the design stage. FMEA shall be developed in several well documented levels (e.g. basic components, electronic board modules, electronic boards, racks, cabinets) with appropriate degree of detail. A clear relationship between FMEA outcomes and dependability analysis shall be demonstrated.

FMEA shall be developed in order to provide the following benefits:

- Provides rigor in identifying single failures and their consequences;
- Facilitates design to avoid or mitigate failure modes which have unacceptable or significant effects;
- Helps avoid costly modifications by early identification of design deficiencies or critical failures;
- Provides criteria to compare design alternatives;
- Provides means to assess/verify robustness of design and ability to meet reliability criteria, and thereby provides an input to assignment of appropriate quality level;
- Provides a logical model for evaluation of the probability of anomalous operating conditions of the system;
- Provides input to other types of system failure analysis and the Preventive Maintenance* strategy and schedule for the system;
- Facilitate or support the determination of test criteria, test plan and diagnostic procedures.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 55/122

2.10.5.5 OVERALL PLANNING

2.10.5.5.1 GENERAL

2.10.5.5.1.A

The plans as defined in this Section 2.10.5.5 shall establish basis for the specific plans established in Section 2.10.6.3 for the individual I&C systems.

2.10.5.5.1.B

The I&C design shall be established by a defined process which ensures that all the requirements which need to be met by the I&C are listed, implemented and maintained throughout the Project*.

2.10.5.5.1.C

Defined I&C design process shall be achieved by considering the activities associated with development, implementation and operation of the I&C systems within the framework of an I&C life cycle

2.10.5.5.1.D

The overall design process shall fully integrate the I&C design process with the other design processes of the Plant*

2.10.5.5.1.E

Well established co-ordination shall be treated throughout all design phases to ensure a balanced and complete design.

2.10.5.5.1.F

Traceability shall be provided within I&C lifecycle including Documents* and data under control of Configuration Management* and in compliance with Technical Requirements Document*, Chapter 2.12.

2.10.5.5.2 OVERALL I&C QUALITY ASSURANCE PROGRAMS

2.10.5.5.2.A

Overall I&C quality assurance programme shall be developed and implemented relating to each activity of the overall I&C safety life cycle.

2.10.5.5.2.B

The phases of the I&C design process shall be transparent and its interfaces with other design disciplines and quality review processes has to be clearly defined.

BA

The design shall be carried out by a multi-discipline design team and include direct Owner's* staff involvement.

BB

Owner's* staff involvement includes the involvement of engineering and maintenance personnel and operations staff familiar with normal, abnormal and Emergency Operating Procedures*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 56/122

2.10.5.5.2.C

Quality management and Configuration Management* methods and tools used in analysing and verification of design input data, design changes and fulfilment of objectives of the phases of the I&C design process shall be well documented and provided (including training of Owner's* staff) by the Supplier* to the Owner*.

Methods and tools shall be in compliance with Technical Requirements Document*, Section 2.15.1 and Section 2.12.9

2.10.5.5.2.D

Configuration Management* plan which shall comprehensively describe the implementation of Configuration Management* program specific to I&C, shall be provided for the approval of the Owner* at the very beginning design stage, and it shall comply with Overall I&C quality assurance program. Proper procedures guiding activities related to Configuration Management* of I&C shall be developed and their usage shall be defined in the related plans.



2.10.5.5.2.F

For each I&C system, the Supplier* shall define separate specific design procedures for software design.

FA

The software design procedures describe requirements and Rules* for design, use of computerised design tools, verification and validation of pre-existing software and of new application software included in electrical and I&C systems and equipment.

2.10.5.5.2.G

As stipulated in Technical Requirements Document*, Chapter 2.12 the H-MI design process shall be directed by a single organization responsible for the design.

See Technical Requirements Document*, Section 2.12.6.2

2.10.5.5.3 I&C OVERALL CYBER SECURITY PLAN

2.10.5.5.3.A

The Supplier* shall establish, implement, and maintain an I&C overall cyber security plan that satisfies the cyber security program and overall security plan requirements.

For details see Technical requirements document*, section 2.10.7.1 and Licensing and Permitting, Safety and Quality Document*, section 2.4

AA

The term Cyber security is equivalent to the term Computer security.

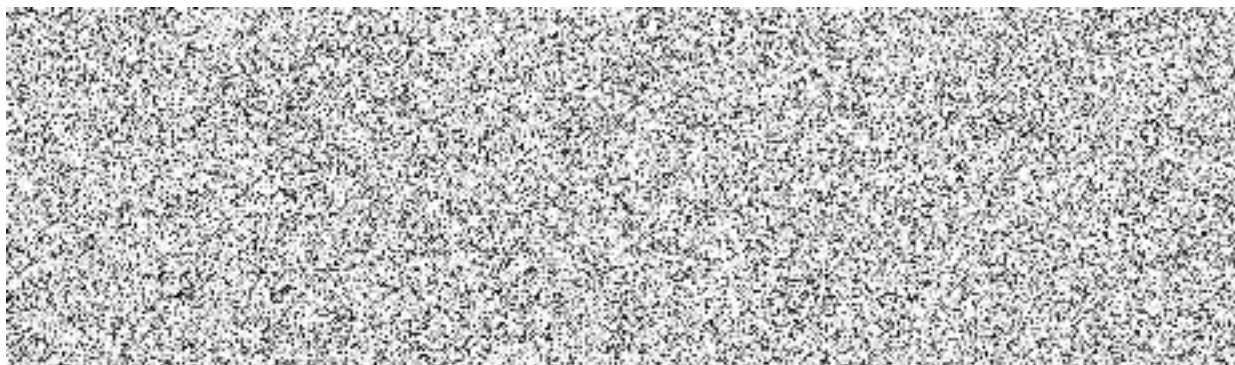
2.10.5.5.3.B

The Supplier* shall establish cyber security policy that includes security goals and implementation of overall cyber security plan shall ensure that these goals are achieved.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 57/122

2.10.5.5.3.C

The I&C overall cyber security plan shall also specify the organization, procedural and technical measures to be taken to protect the architecture of I&C systems from deliberate and intelligent attacks occurring either from an external or internal source, that may jeopardise functions important to safety or that may challenge the overall plant availability or performance or confidentiality.



2.10.5.5.3.E

The Supplier* shall develop, implement and maintain I&C cyber security program that protects any digital system, network, or communication system, associated with the safety, security and emergency preparedness functions of a nuclear facility or which supports such a system and other systems important for the overall plant availability or performance or confidentiality.

2.10.5.5.3.F

I&C Overall cyber security plan shall provide high assurance that digital system and communication systems and networks will be adequately protected against computer (cyber) attacks and threats, up to and including the design basis threat.

2.10.5.5.3.G

The Supplier* shall respect and apply the Owner's* requirements and cyber security policy in the measures for mitigation or protection of cyber threats and attacks.

GA

The Supplier* shall prepare and submit to the Owner* a comprehensive proposal of cyber threats and attack scenarios for assessment of compliance with Design Basis Threat early enough and those shall be completed and fully considered in Basic Design* and Construction License documentation.

2.10.5.5.3.H

Relevant Czech national regulation associated with cyber security shall also be followed.

2.10.5.5.3.I

Strict distinction shall be made between digital assets (DA) relevant from nuclear safety, radiation protection, Nuclear Material* accountancy, emergency preparedness and security point of view and rest of DA.

2.10.5.5.3.J

The Supplier* shall identify all digital assets that must be protected from cyber attacks. List of identified digital asset is subject to Owner's* approval.

All digital asset shall be analysed to identify Critical Digital Asset.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 58/122

JA

Systems and networks associated with following functions (but not limited to) shall be identified as Critical Digital Asset always:

- Safety Functions*
- Security functions
- Emergency preparedness functions including off-site communications
- Support systems and equipment which, if compromised, would adversely impact safety, security or emergency preparedness functions
- Systems belonging to critical information infrastructure according to Czech national regulation

Any proposal for deviation from above mentioned shall be duly evaluated by the Supplier* and provided to the Owner* for its' approval.

JB

Systems and networks having no adverse impact on safety and security functions shall also be carefully considered and analysed in cyber security program.

JC

Process of Critical Digital Asset identification shall be based on state-of-the-art methods and procedures.

2.10.5.5.3.K

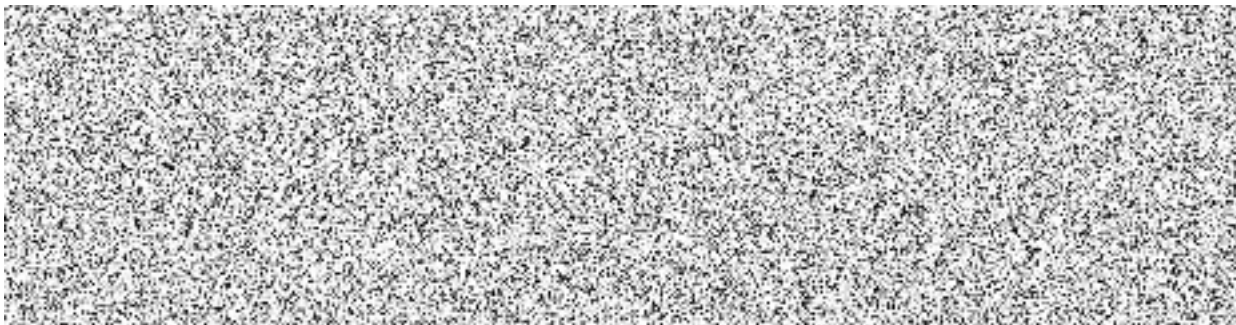
Systems and networks identified based on requirement H and J shall be protected (but not limited to) from cyber attacks that would:

- Adversely impact the integrity or confidentiality of data and/or software;
- Deny access to systems, services, and/or data; and
- Adversely impact the operation of systems, networks, and associated equipment.

2.10.5.5.3.L

The Supplier* shall establish, implement, and maintain an I&C overall cyber security plan that implements the I&C cyber security program requirements of section 2.10.7.1.

- The I&C overall cyber security plan shall describe how the requirements of this section will be implemented and must account for the Site*-specific conditions that affect implementation.



2.10.5.5.3.M

The Supplier* shall develop and maintain written policies and implementing procedures to implement the overall cyber security plan.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 59/122

2.10.5.5.4 OVERALL I&C INTEGRATION AND COMMISSIONING

2.10.5.5.4.A

Overall I&C integration and Commissioning* shall complete overall installation and validation of individual systems.

Overall I&C Commissioning* shall be essential part of overall Commissioning* of the Plant*.

AA

Overall I&C integration is the combination of all on-site technical and administrative actions enabling the I&C systems to be installed on Site*, interconnected, tested, calibrated and set ready for full operational use.

AB

Overall Commissioning* is the combination of all on-site technical and administrative actions necessary to give assurance that the installed systems and Plant* are satisfactory for service before ready for full operational use.

AC

General requirements relevant to Commissioning* are defined in the Construction and Commissioning Document*, Section 3.

2.10.5.5.5 OVERALL OPERATION PLAN

2.10.5.5.5.A

Overall operation plan shall describe measures and instructions for operation of interconnected I&C systems, administrative and technical conditions for modification and potential impact on operation of the plant and describe all modes of operation.

The overall operation plan shall be developed within the overall I&C quality assurance program.

AA

Overall operation planning shall address the operation of the interconnected I&C systems. The overall operation plan complements the operation plans for the individual I&C systems.

AB

General requirements relevant to Operation* are defined in the Operation and Maintenance Document*, Section 3.6.

2.10.5.5.6 OVERALL MAINTENANCE PLAN

2.10.5.5.6.A

The overall I&C maintenance plan shall be developed by the Supplier and shall comply with the Overall I&C quality assurance program.

Additional requirements shall apply to the overall maintenance plan and maintenance activities of individual I&C systems to maintain safety acceptable. The systematic approach to test and replacement to minimise likelihood of CCF and well documented procedures for configuration changes under control of CM shall be assured.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 60/122

AA

The overall maintenance plan addresses maintenance at the level of the interconnected I&C systems. It complements and co-ordinates the maintenance plans of the individual I&C systems.

AB

General requirements relevant to maintenance are defined in the Operation and Maintenance Document*, Section 3.5.

2.10.5.5.7 PLANNING OF TRAINING



AA

The planning of training deals with requirements related to the training of plant personnel working with the I&C systems.

AB

The training of I&C staff shall follow requirements for training stipulated in the Operation and Maintenance Document* including Owner's* representatives designated for construction stage (design participants, construction, Commissioning*, technical management, etc.).

Moreover, for construction stage (EPC realization stage) the Supplier* shall ensure the training of all the Owner's* representatives who are responsible for checking the Supplier's* documents and deliveries.

The training shall include an introduction to the Design and engineering process of the I&C and related disciplines, sufficiently detailed familiarization with the structure of documents and relevant tools for managing and processing documents.
The training shall also cover the introduction of the I&C systems in the depth to be necessary for the control of documents and deliveries.

2.10.5.6 OUTPUT DOCUMENTATION

2.10.5.6.1 GENERAL



2.10.5.6.2 ARCHITECTURAL DESIGN DOCUMENTATION

2.10.5.6.2.A

The Supplier* shall describe in the output documentation, but not limited to:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 61/122

- I&C design constraints derived from Plant* design framework
- the I&C architecture;
- the name of each I&C system;
- the class of each system;
- the physical and functional boundaries between systems; and
- the data flow between I&C systems.

2.10.5.6.3 FUNCTIONAL ASSIGNMENT DOCUMENTATION

2.10.5.6.3.A

The functional assignment documentation shall describe, but not limited to:

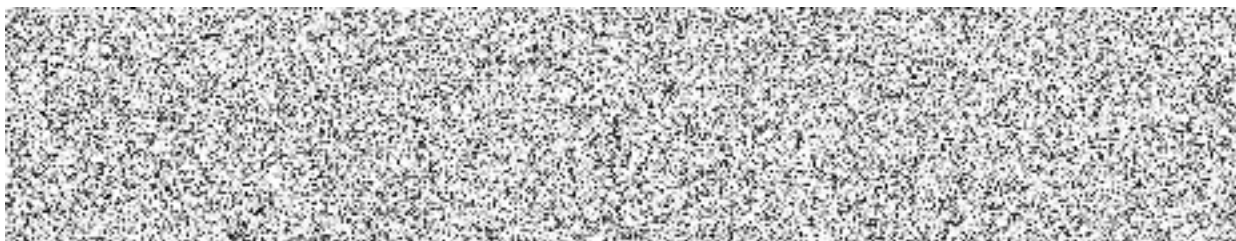
- the assignment of functions;
- the performance requirements (such as accuracy and response time) of the application functions assigned;
- the reliability requirements of the application functions assigned;
- the function verbally in human language and formally in a formal language; and
- for each input and output a safe status is specified.

AA

This documentation can be combined with the architectural documentation.

2.10.6 SYSTEM LIFE CYCLE

2.10.6.1 GENERAL



2.10.6.2 REQUIREMENTS

2.10.6.2.1 GENERAL

2.10.6.2.1.A

This Section contains the requirements which concerns the life cycles of the individual I&C systems. It gives the requirements associated to the different phases of the safety classified system life cycle.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 62/122

2.10.6.2.2 SYSTEM REQUIREMENTS SPECIFICATION

2.10.6.2.2.1 GENERAL

2.10.6.2.2.1.A

This section describes requirements for all I&C systems and specific requirements applicable only to safety classified I&C systems.

2.10.6.2.2.1.B

I&C systems shall meet the general Plant* performance objectives and the Operability* objectives and also dependability objectives.

If the assessment of dependability of I&C system shows that these objectives are not met the Supplier* shall implement additional specific design provisions as required.

2.10.6.2.2.1.C

The Supplier* shall begin, but not limited to, with the identification of:

- functions of the system;
- performance requirements, for example response time requirements and accuracy requirements etc.; and
- restraints such as the space available for I&C and H-MI equipment.

2.10.6.2.2.2 FUNCTIONS

2.10.6.2.2.2.1 GENERAL

2.10.6.2.2.2.1.A

This part contains requirements about application functions and service functions implemented in a system.

2.10.6.2.2.2.2 APPLICATION FUNCTIONS

2.10.6.2.2.2.2.A

The design shall be such that, when initiated, an automatic action in Safety Category 1 function continues to completion.

AA

This is to ensure a defined endpoint.

2.10.6.2.2.2.2.B

Deliberate and particular Operator* action shall be necessary to return to Normal Operation* after the protective action demand is reset.

BA

A safety classified system actuation is always an indication of some abnormal condition and investigation into the cause must be carried out before the system can be returned back to Normal Operation*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 63/122

2.10.6.2.2.2.C

When operating conditions require automatic or manual bypass of an automatic safety category 1 (respectively safety category 2) function, the design shall be such that the bypass will be automatically removed whenever that bypass is no longer permitted. The means used to automatically remove the bypass of an automatic safety category 1 (respectively safety category 2) function has to be safety class 1 (respectively safety class 2).

CA

An operational bypass may be used, for example, to permit start-up or orderly shutdown by inhibiting a particular protection action that would otherwise occur.

2.10.6.2.2.2.D

Closed-loop controls shall be optimised to reduce activation frequencies of the final control elements.

DA

Activation frequencies have a major impact on the loading and service life of final control elements. The loading may be mechanical, thermal or electrical.

2.10.6.2.2.2.E

A manual mode shall be provided in addition to the automatic control mode.

EA

The automatic mode is de-activated by Operator* commands according to operational requirements or in order to overcome malfunctions in control components or in associated components.

2.10.6.2.2.2.F

The following characteristics shall be available as far as possible for each control function (control functions – all manual and automatic functions related to control the Plant* and/or /Unit* via I&C):



2.10.6.2.2.2.G

The changeover of the control mode of controlled technology shall be performed smoothly.

2.10.6.2.2.2.H

It shall be possible to tune the control system in such a way that it operates in a stable manner in conjunction with the corresponding fluid systems. Adequate analysis of control systems shall be performed for a range of defined operating situations (e.g. by simulation).

2.10.6.2.2.2.I

Where fluid systems are designed with back-up systems or components with respect to plant availability, the means to automatic switch-over shall be provided to perform switch-over to the back-up component or system in the event of failure of the operating component or system.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 64/122

IA

This makes use of the designed availability of the fluid systems by adequate measures via the I&C system

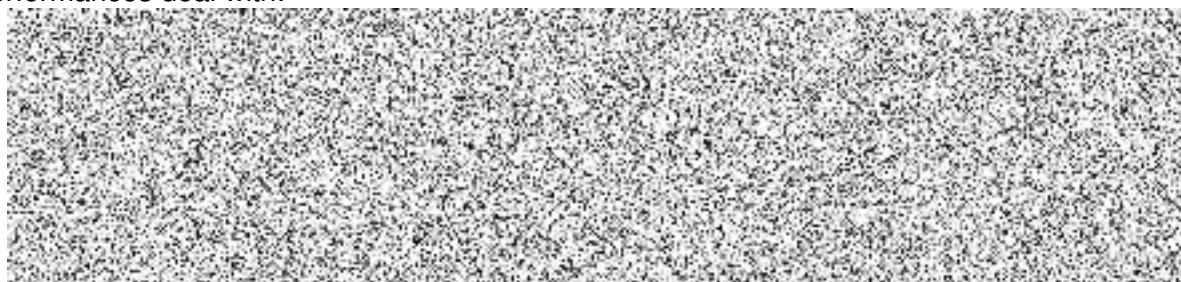
2.10.6.2.2.2.J

Performance

The performances of the I&C systems, mainly those relative to accuracy, response time and capacity shall meet the performance requirements for all functions arising from Normal Operation* and AOO and Accident Conditions* analyses.

JA

Performances deal with:



2.10.6.2.2.2.K

The Supplier* shall optimise and justify the response times according to safety and process requirements on one hand and according to what is available as state-of-the-art technology on the other hand.

2.10.6.2.2.2.L

For analogue inputs, the measuring range, measuring location, measurement accuracy, associated dynamics, sample rate and response rate shall be defined on the basis of the associated I&C task for each signal to be acquired.

The specified accuracy of signal conditioning shall be ensured.

LA

The specified accuracy of measurement signals with respect to required operating conditions and environmental conditions shall be ensured so as to prevent malfunctioning.

2.10.6.2.2.2.3 SERVICE FUNCTIONS

2.10.6.2.2.3.A

The service functions, unlike the application functions, are not directly related to the performance of process-related functions, but relate to specific activities on the system, including the functions necessary for the configuration, validation, qualification, installation, Commissioning*, operation, periodic testing, maintenance, incorporation of design modifications and security.

AA

Service function shall be developed separately for every class of system and the potential of system service functions to jeopardise the application functions shall be analysed appropriately to the safety role of the application functions.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 65/122

2.10.6.2.2.3 DESIGN CONSTRAINTS

2.10.6.2.2.3.1 GENERAL

2.10.6.2.2.3.1.A

The implementation of I&C systems and equipment shall be done according to the specific technological requirements based on the designed architecture of the Plant* and/or /Unit* e.g. requirements for architectural partition, separation, isolation and Redundancy* of equipment and cabling as well as requirements for data transfer communication, grounding, electromagnetic compatibility, process interface and H-MI.

2.10.6.2.2.3.1.B

The I&C cables shall fulfil the requirements specified for materials of electrical and I&C cables.

2.10.6.2.2.3.1.C

The following specific requirements shall be followed in the cabling design, but not limited to:



CA

Other requirements relevant to cabling are defined in the Technical Requirements Document*, Section 2.11.4.5 CABLE ROUTING and Section 2.7.11.4 DESIGN REQUIREMENTS

2.10.6.2.2.3.1.D

Cabling and shielding best practices shall be followed to minimise the effects of high voltage switching surges, inductive coupling and radio signals intrusion in the instrumentation and control circuits.

2.10.6.2.2.3.1.E

Design and implementation shall support modifications, extensions and at the end of intended lifetime the renewal of I&C systems in phases during several, consequent outages of normal timing and length in the Plant* and/or /Unit*.

2.10.6.2.2.3.2 SYSTEM ARCHITECTURE

2.10.6.2.2.3.2.1 IMPLEMENTATION

2.10.6.2.2.3.2.1.A

If the system has implemented functions of different categories, the requirements to apply on the system shall be those linked to the function of the highest safety category.

2.10.6.2.2.3.2.1.B

The design of the global system shall ensure that a subsystem of a lower safety class interferes with a subsystem of a higher safety class as minimal as possible and prevent it from complying with its requirements. These cases shall be duly analysed.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 66/122

2.10.6.2.2.3.2.2 REDUNDANCY

2.10.6.2.2.3.2.2.A

Redundancy shall be employed to improve the reliability of the I&C functions and to meet the Single Failure Criterion* in systems performing safety category 1 and safety category 2 functions for Design Basis Conditions*.

For Safety category 3 and NC functions affecting Plant* availability the Redundancy* shall be employed to achieve reliability targets.

HAZOP analyses, SPV program or other ways shall be utilized to identify any vulnerable part of I&C system where the Redundancy* is to be applied.

See Technical Requirements Document*, Section 2.1.6.3.1

AA

For reliable fulfilment of the Safety Functions the redundancies shall be physically separated from each other in a way that single events, including consequences of these, do not lead to the failure of more than one redundancy.

2.10.6.2.2.3.2.2.B

An equipment failure within I&C systems with consequential effects (with active or passive failure/ failure mode) on availability, loss of functions, spurious actuation or disturbances to Plant's* and/or /Unit's* power operation shall be excluded by means of a redundant design.

BA

Examples of consequences of equipment failures:

- loss of availability (probabilistic target);
- loss of functions or spurious actuation (deterministic target); and
- disturbances to the Plant's* power operation, etc.

2.10.6.2.2.3.2.2.C

The Redundancy* required for safety category 1, category 2 and category 3 functions and associated equipment at the level of the mechanical and fluid systems shall be preserved in the associated redundant I&C functions with the aim to avoid unacceptable impairing of the reliability of the associated mechanical and fluid system.

2.10.6.2.2.3.2.2.D

For I&C systems performing non-safety functions with specified reliability and availability targets, Redundancy* of equipment shall be considered if specified.

2.10.6.2.2.3.2.2.E

The redundant I&C systems performing redundant safety classified application functions shall also have redundant support systems.

EA

Redundancy requirements are applied to support systems so that they do not have an adverse effect on the reliability of the supported system.

2.10.6.2.2.3.2.2.F

Redundant subsystems shall fulfil requirements on Physical Separation*, Functional Isolation* (including also electrical isolation) and have dedicated auxiliary systems.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 67/122

2.10.6.2.2.3.2.2.G

Adequate Redundancy* and Diversity* shall be implemented into the Turbine Protection System* to meet the safety, reliability and availability objectives of the Unit*.

2.10.6.2.2.3.2.2.H

The Redundancy* of tripping actions from the turbine Protection System* to the following actuators shall be determined, but not limited to, considering Single Failure Criteria* (from availability, reliability, investment cost point of view and maintenance requirements):



2.10.6.2.2.3.2.3 INDEPENDENCE



Relevant requirements stipulated in the Technical Requirements Document*, Section 2.1.6.3.2.1 and Section 2.10.5.4.2.2.1 shall be followed.

2.10.6.2.2.3.2.3.B

For I&C systems implementing safety category 1 and safety category 2 functions, Independence* shall be assured by application of Physical Separation* principles and Functional Isolation*.

See Technical Requirements Document*, Section 2.1.5

2.10.6.2.2.3.2.3.C

For I&C systems implementing safety category 1 functions, Physical Separation* shall be achieved to prevent propagation of internal hazards.

2.10.6.2.2.3.2.3.D

For I&C systems implementing safety category 2 functions, the need for Physical Separation* to prevent Internal Hazards* from propagating shall be assessed case by case.

2.10.6.2.2.3.2.3.E

The layout of the I&C systems shall comply with the general Rules* specified for the I&C architecture according to the general Rules* for separation, and Diversity* of Safety Systems* and equipment.

2.10.6.2.2.3.2.4 SINGLE FAILURE CRITERION

2.10.6.2.2.3.2.4.A

No loss of safety category 1 functions due to a Single Failure* shall be enabled even during repair, maintenance or periodic testing. The (N+2) failure criterion shall be used.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 68/122

2.10.6.2.2.3.2.4.B

No loss of safety category 2 functions due to a Single Failure* shall be enabled. The (N+1) failure criterion shall apply unless otherwise specified.

2.10.6.2.2.3.2.4.C

For I&C systems implementing safety category 2 functions, the coincidence of a Single Failure* with maintenance or periodic testing shall be assessed case by case.

2.10.6.2.2.3.2.4.D

For I&C systems implementing safety category 1 functions, no spurious action due to a Single Failure* shall be enabled even during maintenance or periodic testing. Justified exceptions can exist for limited time of operation, but adequate design measures to minimize spurious actuation by human error or testing activities shall be implemented.

2.10.6.2.2.3.2.4.E

No single I&C failure shall result in a turbine trip.

2.10.6.2.2.3.2.4.F

A Single Failure* of a component or power source in the overspeed protection shall not result in an unsafe overspeed or trip actuation of the turbine.

2.10.6.2.2.3.2.4.G

A Single Failure* in the turbine Protection System* shall neither block nor deactivate/reset the protection functions but trigger a relevant alarm.

2.10.6.2.2.3.2.5 POWER SUPPLY AND GROUNDING

2.10.6.2.2.3.2.5.A

The I&C systems associated with safety category 1 and safety category 2 functions shall be supplied with backed up on-site power generating sources.

See Technical Requirements Document*, Section 2.1.7.5



2.10.6.2.2.3.2.5.C

Power systems which are used to provide the power to the I&C systems shall be designed and selected in accordance with the safety and availability requirements of the systems they support.

2.10.6.2.2.3.2.5.D

Where Redundancy* is used to improve the reliability of power supply for I&C equipment employed in control rooms, then separate power supplies in separate enclosures outside the control rooms shall be used to the maximum degree practical.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 69/122

2.10.6.2.2.3.2.5.E

Grounding of I&C systems shall fulfil the following requirements:

- protection and power ground is connected so that disconnection of any equipment from the ground cannot disconnect any other equipment;
- the grounding of wiring shields is independent of modules so that removal of a module from the circuit won't disturb the shield connection;
- when analogue signals are grounded, they are grounded only in one place to prevent circulating ground currents in the signal lead;
- signal transmission between devices where there is a possibility for ground potential differences is galvanically decoupled; and
- I&C cables shall be run in sufficiently separate trays from power cables to avoid negative influences.

2.10.6.2.2.3.3 INTERNAL BEHAVIOUR OF THE SYSTEM

2.10.6.2.2.3.3.A

The response time shall be guaranteed in any situation for safety category 1 and safety category 2 functions.

2.10.6.2.2.3.3.B

Real response time related to H-MI shall be sufficiently similar in all circumstances in order to avoid distraction and unnecessary confusion of the Operators*.

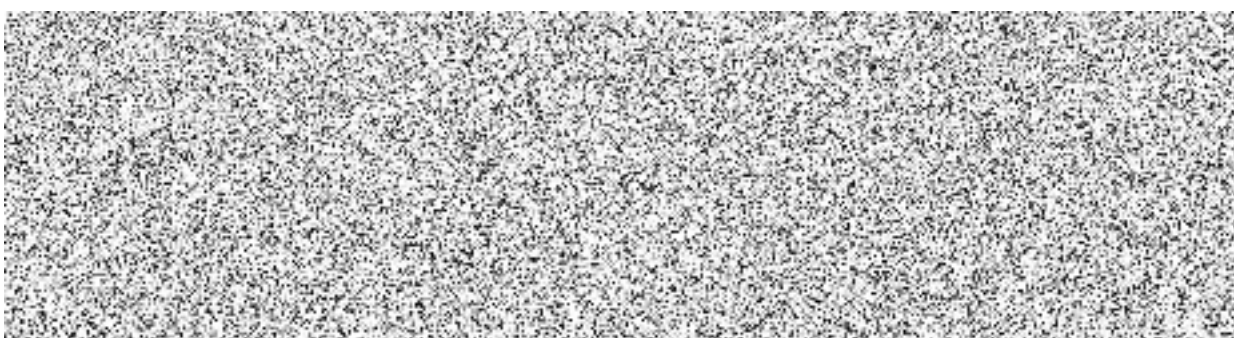
Response time deviations shall not exceed in all circumstances more than half the mean response time.

BA

These requirements condition the ability to perform reliable Plant* and/or /Unit* operation from the computerised control means.

BB

For response time related to H-MI, relevant ergonomic requirements are applied.



2.10.6.2.2.3.3.C

The I&C system shall be sized and structured so as to be able to handle the required amount of data in any situation taking into account also other relating aspects like performance margins, Operability*, Maintainability*, modifiability, etc.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 70/122

2.10.6.2.2.3.3.D

Drift within I&C systems shall be limited in order to minimise the need for periodic testing and calibration. The Supplier* shall optimise and justify the accuracy characteristics according to safety and process requirements on one hand and according to the state-of-the-art technology on the market on the other hand.

2.10.6.2.2.3.3.E

In all Plant* and/or /Unit* States* information gathered from the process or issued from processing, Operator* controls and internal faults and events of the system shall be time-stamped with sufficient accuracy to allow the identification of:

- the initiating event; and
- the correct sequence of events for further analysis.

2.10.6.2.2.3.3.F

The clocks of the I&C system used to time-stamping shall be synchronised with accuracy as needed to the real time provided that it has no negative impact on the fulfilment of requirements (e.g. performance, accuracy, response time, etc.)

FA

The correspondent tools for analysis of Plant* and/or /Unit* transients using time-stamped information shall allow analysis regardless of the origin of the information.

2.10.6.2.2.3.3.G

The accuracy of this time-stamping shall be sufficient to analyse complicated Plant* and/or /Unit* transients.

2.10.6.2.2.3.3.H

All data on the data buses shall have associated signal identification.

2.10.6.2.2.3.3.I

When a signal is to be used for post-event analysis or other applications for which precise timing is required, then time tagging shall be attached to the signal as close to the source as possible.

2.10.6.2.2.3.3.J

All data shall have signal quality tags associated to it to facilitate diagnosis.

2.10.6.2.2.3.3.K

For instrumentation, field bus technology may be used. In such a case the same requirements as for digital I&C systems shall apply and particular attention has to be paid on time stamping to ensure correct sequence of events.

KA

In non-safety applications field bus technology may be used. The use in safety applications requires careful consideration and justification and is subject for Authority* approval.

2.10.6.2.2.3.3.L

Any noise or residual noise on sensor outputs shall be reduced by filtering to a level that will not compromise or decrease credibility of measuring chain output and will not cause

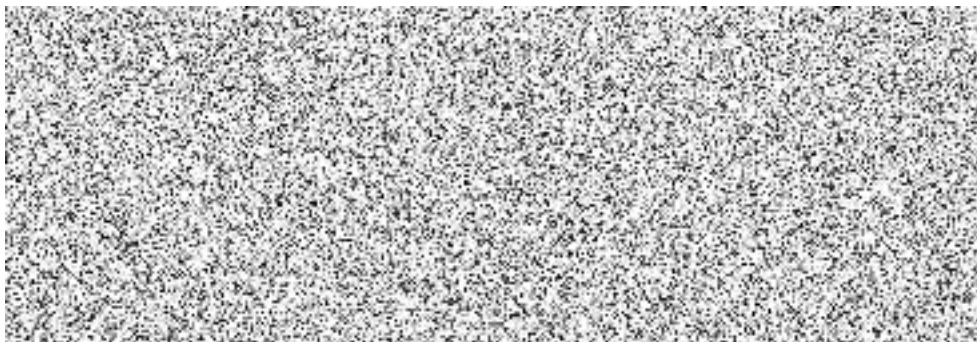
Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 71/122

operational or maintenance problems. Filtering shall not remove or jeopardize signal characteristics that could be used for sensor health monitoring.

2.10.6.2.2.3.4 SELF-SUPERVISION AND TOLERANCE TO FAILURES

2.10.6.2.2.3.4.A

The Supplier* shall include features to maintain integrity consistent with the class or the availability needed for the system.



2.10.6.2.2.3.4.B

The I&C systems shall be designed and configured to readily support in-service testing and providing built-in test features, including self-diagnostics for continuous on-line testing and automated functional testing for periodic on-line surveillance testing.

BA

Human involvement and intervention in testing shall be minimised.

2.10.6.2.2.3.4.C

The availability of the I&C systems implementing Safety Function* shall be under automatic surveillance in all Operational Modes*.

2.10.6.2.2.3.4.D

Failures of the I&C systems implementing Safety Functions* shall be self-announcing as far as possible

DA

Immediate and reliable detection and monitoring of failures shall be provided to prevent accumulation of detected faults resulting in unacceptable deterioration of the overall reliability of the Safety Functions*. Detected failures shall be removed as soon as possible, therefore means for that purpose shall exist.

2.10.6.2.2.3.4.E

Means of detecting failures of input signals used for Safety Functions* shall be provided in order to shorten the time for maintenance and repair. Input signals shall therefore be monitored based on admissible limits and other comparable signals (if any) and suitable actions shall be taken when these are violated.

EA

Validity checks of the overall control functions shall be implemented.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 72/122

2.10.6.2.2.3.4.F

For discrete inputs, the data gathering shall provide immunity against noise causing a false signal indication and also sufficient response and sample rates to capture all transitions of the input and voltage supply for dry contact signals. All failure modes shall be identifiable as early as possible.

2.10.6.2.2.3.4.G

Available measurement signals shall be matched to the associated process engineering task continuously and the validity check of the data shall ensure that the data meets the reliability requirement. As a result, provisions shall be taken, but not limited to:

- to select, as far as possible, suitable signals from a set of redundant signals;
- to automatically substitute measured values with default values in case of measurement failures; and
- to identify faulted signals with suitable actions.

2.10.6.2.2.3.4.H

Tolerance to failures of the power supply

The response of components and equipment in I&C system to short disturbances of power supply shall be analysed and tested. Requirements shall be stated based on the safety or operational importance.

HA

The outputs can be frozen during this time. A typical value for short disturbances is a loss of power supply during 20 ms.

2.10.6.2.2.3.4.I

The system shall be designed to avoid spurious orders in the event of loss of power supply.

2.10.6.2.2.3.4.J

When the power supply returns, the components or equipment of the I&C system shall respond in a determined manner.

JA

The start-up shall be automatic without initialisation. No time consuming run-up procedures will be necessary.

2.10.6.2.2.3.4.K

Component protection

Component protection shall prevent inadmissible operating conditions to occur for expensive mechanical and electrical components as well as for those components with a major impact on plant availability.

KA

The aim of component protection is to prevent damage of mechanical and electrical components and to avoid economic losses.

2.10.6.2.2.3.4.L

Neither malfunctions in automatic systems nor Operator* errors can lead to components damage. Thus, in the event of inadmissible conditions, the component protection logic shall

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 73/122

take the component concerned out of operation. Such commands shall take priority over automatic and manual commands while taking priority rules into account.

LA

Component protection functions shall have reliability and availability relevant to the safety importance and/or cost impacts of the respective component damage due to the loss of the protective function.

LB

Component protection functions are only effective if adequate availability is ensured. This implies a necessity for redundant design for component protection functions

2.10.6.2.2.3.4.M

The component protection functions shall be initiated automatically for all initiations, which require a quick response.

MA

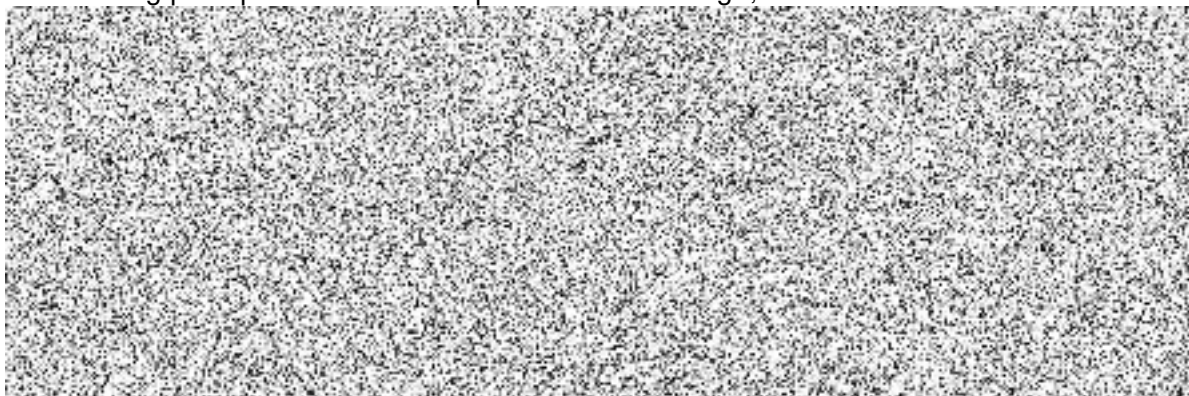
Otherwise, prevention of damage of the associated components could not be ensured.

2.10.6.2.2.3.4.N

The Operator* shall be informed of the action of the component protection. In the case of action of component protection during operation of a component, an alarm shall be provided.

NA

Operation shall be prevented if the conditions for correct operation of a component are not met. Following principles shall be incorporated in the design, but not limited to:



for components which receive an order from the Protection System*, the automatic trip is inhibited (except for electrical, torque protection inhibition, or other conditions that do not allow inhibition due to safety concerns; however fully in compliance with safety concept) as long as the Protection System* signal has not been reset.

2.10.6.2.2.3.4.O

Sensors

The Supplier* shall provide means to minimise improper arrangement of sensor isolation valves and the possibility to leave the valves in an incorrect position following calibration.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 74/122

2.10.6.2.2.3.4.P

As much as possible, sensors and appropriate converters shall have no undetectable failure modes.

2.10.6.2.2.3.4.Q

Requirements for Fail-safe* behaviour shall be evaluated taking into account the characteristics of I&C functions to which the sensor contributes.

QA

Fail-safe* behaviour can be different depending on configuration of the control function process conditions, safety application, etc.

The safe states identified in the design shall be used if self-tests detect failures.

See Technical Requirements Document*, Section 2.10.5.3

2.10.6.2.2.3.5 TESTABILITY

2.10.6.2.2.3.5.A

For safety classified systems, requirements related to in-service Inspection* and periodic testing shall be developed in accordance with Technical Requirements Document*, Chapter 2.1.

See Technical Requirements Document*, Section 2.1.8.1.1

2.10.6.2.2.3.5.B

The safety classified I&C systems shall enable a periodical and sufficiently complete test to detect and monitor failures which are not self-announced. The frequency of periodic testing is determined as a function of the reliability requirements.

2.10.6.2.2.3.5.C

The I&C system architecture shall allow testing of the safety classified I&C without spurious actuation and with a low probability of failure on demand during the testing. It shall be possible to test the whole system including sensors. Properly justified exceptions for sensors may exist. It shall be possible to monitor (without need of intervention on HW) or test (all) voting circuits to confirm correct connection of the circuit to external circuits and to detect pre-existing open-circuits or short circuits that would cause spurious action or a failure on demand.

2.10.6.2.2.3.5.D

The Supplier* shall prepare a comprehensive test program covering both the system functions and internal diagnostics. The requirements for test intervals shall be based upon the reliability targets. A test interval that includes requirements for outages occurring more frequently than the planned refuelling outages shall not be acceptable.

2.10.6.2.2.3.5.E

If simulation facility of individual signals and software blocks of control loops is needed in initialisation and Commissioning* as well as in revisions and maintenance of the I&C system, those facilities shall be carefully designed and documented and their usage thoroughly instructed. The Supplier* shall demonstrate how the simulation is carried out in practice, how the user/the Operator* are automatically informed on a simulation activity and how the inactivation of the simulation mode can be ensured in a sufficient certainty and reliability after termination of the simulation.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 75/122

2.10.6.2.2.3.5.F

Tests and maintenance including preventive maintenance and remedial measures shall not prevent the Safety Functions* category 1 and 2 from being carried out for Design Basis Conditions*.

Safety Functions* category 2 for Design Extension Conditions* shall be maintainable and testable during Normal Operation* without negative impact on power production based on technical solutions accepted by Authorities*.

2.10.6.2.2.3.5.G

Tests and maintenance including preventive maintenance and remedial measures shall not prevent the Safety Functions* category 3 from being carried out where practicable or necessary

2.10.6.2.2.3.5.H

When performed, tests shall not disturb the Normal Operation*.

2.10.6.2.2.3.5.I

I&C systems shall be designed to permit the required periodic testing to be done within the safety limits and conditions.

2.10.6.2.2.3.5.J

Testing and maintenance needs shall be considered at the design stage of the I&C systems and equipment in order to ensure a final design enabling easy tests and preventing testing or maintenance errors.

2.10.6.2.2.3.5.K

Where testing has to be performed manually, it shall be designed to minimise the amount of time the system is required to be in the test mode.

2.10.6.2.2.3.5.L

When a safety classified system has to be taken out of service partly or entirely for testing, clear indication of any bypass, that are necessary for the duration of the testing or maintenance activities, shall be provided.

2.10.6.2.2.3.5.M

Provisions for tests of the major PGP I&C systems (having impact on Unit* safety, availability and CAPEX) during operation shall be provided. In particular for, but not limited to:

- trip signals;
- turbine control system; and
- turbine Protection System*.

2.10.6.2.2.3.5.N

Arrangements shall be made for enabling the required performances of I&C systems and components to be on-line checked and/or monitored.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 76/122

2.10.6.2.2.3.6 MAINTAINABILITY

2.10.6.2.2.3.6.A

The design process of I&C shall encompass means to support Plant* and/or /Unit* maintenance organization.

AA

Maintenance covers all activities which make it possible to maintain or restore equipment to a specified nominal state taking account, in particular, of the constraints of operation, safety and security.

The scope of I&C maintenance shall encompass both:



2.10.6.2.2.3.6.B

The list of the functions related to maintenance shall be as follows, but not limited to:

1. Request for repair;
2. Withdrawal from service; and
3. Tagging (lockout)

BA

A request for repair can be issued because of:



The nature of the repair and the conditions under which it can be carried out are identified.

2.10.6.2.2.3.6.C

The corresponding function shall allow the following steps in the tagging process for a given item of equipment to be implemented:



- verification of the validity of the tagging extent, which consists of validating the tagging zone;
- publication of the warning boards to be affixed to the locked out equipment, the sheets stating the operations to be carried out, the status of the locked out equipment, etc.;
- checking, to ascertain that the status of the locked out systems is such that the security of personnel is guaranteed;

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 77/122

- transmission of information to the operation and control functions indicating equipment status such as: "unavailable", "locked out", or "on test";
- printing and handing over of the work permit;
- maintenance operations;
- unlocking (de-tagging);
- re-qualification test ; and
- return to service

The maintenance and corresponding functions shall allow the management of re-qualification of the equipment previously tagged. It shall make it possible to check by test that the previously tagged equipment is effective, i.e. that it is ready to resume its duty.

Maintenance and corresponding functions shall be inherent part of CM (including SSC maintenance/operation status indication in OCMS) and shall be linked to other parts of CM to ensure long term operation of the Plant* and/or /Unit*.

CA

Tagging makes it possible to guarantee the safety and the security of the personnel during work undertaken for maintenance purposes. A specific item of equipment or a specific system may involve several tagging operations.

CB

The users are personnel responsible for:

- Plant* and/or /Unit* operation; and
- the maintenance of the equipment.

CC

To tag an item of equipment the users usually require:

- worksheet management. Worksheets are pre-determined Documents* describing typical operations. They are consulted as a guide in the preparation of tagging;
- tagging management; and
- non-availability processing, the purpose of which is to give the Operator* an exhaustive knowledge of the unavailable components and systems and to suggest the control criteria to be applied, in compliance with the Technical Specifications* of plant operation.



2.10.6.2.2.3.6.D

The selection of equipment shall be standardised so that the variety of equipment is limited as far as reasonable to facilitate maintenance and training, to simplify spare parts requirements and to support easy replacement and upgrading of the I&C equipment.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 78/122

2.10.6.2.2.3.6.E

The I&C equipment design and implementation shall facilitate maintenance with the aim of reducing the risk of human errors and undue perturbations in all Plant* and/or /Unit* operating modes.

2.10.6.2.2.3.6.F

The design and implementation of I&C systems and equipment shall be done in such a way as to facilitate backfitting, replacements and modifications and make them economically feasible.

FA

At present, lifetime of I&C systems and equipment is considerably shorter than the lifetime of a nuclear Plant* and/or /Unit*. This means that it is necessary to replace I&C systems and equipment at least once during the Plant* and/or /Unit* lifetime.

FB

Obsolescence management program shall be provided and established by the Supplier*. Also, the state-of-the-art of I&C technology is changing continuously and obsolescence of equipment is a continuous concern.

FC

The I&C technology shall be state-of-the-art at the moment when the Unit* is put in the operation, while the requirement for proven solution shall not be jeopardized.

FD

The lifetime of the active, electrically powered I&C systems shall be at least 30 years at the moment when the Plant* and/or /Unit* is put in the operation. For Protection Systems* class 1 and 2 the lifetime shall be at least 40 years.

For other I&C equipment (excluding cables), structures and installations their lifetime shall be equal to intended Plant* and/or /Unit* lifetime, i.e. 60 years.

FE

For cable installations their lifetime shall be equal to intended Plant* and/or /Unit* lifetime, 60 years.

See also Technical Requirements Document*, Section 2.7.11.4.3

FF

For cables their lifetime shall be targeted to be equal to intended Plant* and/or /Unit* lifetime, i.e. 60 years. This is achieved by using commercially available cable types having properly documented technical characteristics for 60 years lifetime in prevailing environmental and operation conditions for their intended use and relevant reference.

FG

In well justified cases limited amount of special cabling inside the containment the cable types having properly documented technical characteristics for at least 30 years lifetime in prevailing environmental and operation conditions for their intended use can be used. As prerequisite for this (30 years) approach proper cable replacement method shall be established for each such cable, added value in terms of costs (including impact on availability of the Plant* and/or /Unit*) shall be demonstrated.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 79/122

FH

The I&C systems, equipment, component and installations shall be maintainable, updatable, modifiable and replaceable to support the intended lifetime of the systems and components and Plant* and/or /Unit*.

FI

The Supplier* shall develop a strategy to achieve compliance with the requirements relating Maintainability* (which shall include, but not limited to backfitting, replacements and modifications).

FJ

The Supplier* shall develop an ageing management plan which shall include necessary measures and detailed descriptions of how to achieve this goal.

2.10.6.2.2.3.6.G

The structure of I&C system shall be modular.

2.10.6.2.2.3.6.H

I&C systems shall be designed in such a way that open architecture principles and standardised interfaces based on internationally accepted standards are used.

2.10.6.2.2.3.6.I

For modifications and backfitting, there shall be sufficient spare capacity, equally spread up to the cabinet level.

The spare capacity shall be based on the analyses of the anticipated modification and backfitting needs. The spare capacity shall be specified for the following aspects at least:

- space in electronic rooms and cabinets;
- terminals for the possible connection for future I&C equipment;
- memory and processing capacity in computerised systems ; and
- capacity in data transfer (compared to the conditions with heaviest load expectancy).

Defined spare capacities shall be valid at the Inspection* during taking-over of the Unit*.

IA

Minimum design requirements for the spare capacity shall be as follows:

- 20 % spare capacity for measurement and drive control cards and inputs/outputs;
- 30 % spare capacity for I&C system software memory and processing;
- 30 % spare capacity for data transfer with possibility to add new data transfer interfaces; and
- 100 % spare capacity for the data storage and processing of information or equivalent possibility for expansion

IB

For the avoidance of doubt, the spare capacity mentioned in paragraphs I and IA shall be available at the date of Provisional Takeover* for future modifications and extensions up to declared extent without any limitation in use and all requirements of Equipment Qualification* program shall be fulfilled accordingly.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 80/122

2.10.6.2.2.3.6.J

The length of the period of service support provided by the Supplier* for installed I&C systems and components shall commensurate with EPC contract - Terms and Conditions 19.6.

2.10.6.2.2.3.6.K

The Supplier* shall define the strategy to be followed to support the Plant* and/or /Unit* operation, demonstrating the ability to support hardware and software maintenance and possibility for replacements and systems upgrade as required without that means major modifications or basic configuration changes to the control, display and monitoring architecture.

2.10.6.2.2.3.6.L

The Mean Time To Repair (MTTR) plus the time to obtain necessary replacements or spares shall be such that availability objectives and autonomy objectives are not jeopardized. General autonomy objectives are given in Technical Requirements Document*, Section 2.1.6.7.

LA

This time (MTTR) shall include the time to detect the failure, gain access to the faulty equipment, determine the necessary repair, make the repair or replacement, and verify that the repair has been successfully accomplished.

LB

When maintenance is needed following a partial or total loss of I&C systems, repair time must be such that operating means are recovered or backup operating means shall be still available in order to avoid any sequence of events which is potentially able to lead to Severe Accidents*.

2.10.6.2.2.3.6.M

The I&C systems shall be designed to minimise the manpower and time required for maintenance. It shall be possible to replace a faulty module while its redundant part remains on line. A modular design is required in such a way that repairs can be carried out by replacing the faulty module during operation without a need to switch off the electric power. Replacing a faulty module shall not jeopardize the rest of the I&C system.

MA

Equipment repair shall be accomplished by simple modular replacement in the field.

MB

The capability of fast system recovery without specific time consuming procedures, tools or resets shall be provided. System recovery shall be independent of other redundant subsystems, trains or Divisions*.

2.10.6.2.2.3.6.N

Sufficient facilities shall be provided to aid testing without initiating spurious action and to enable fault finding down to the lowest replaceable unit level. It shall not be possible to connect test equipment, portable or other, in a way that could negatively affect other parts of I&C systems including avoidance of introduction of common cause failure.

2.10.6.2.2.3.6.O

The equipment shall be built and located where possible, so that forced component cooling is not needed.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 81/122

2.10.6.2.2.3.6.P

The I&C systems shall be designed to allow remote or in-place calibration. Remote calibration and testing of the measuring equipment shall be applied as far as possible and the corresponding facilities shall be provided by Supplier*.

PA

Required periodic testing and maintenance shall be done without putting the Plant* and/or /Unit* in an unacceptable one out of two or one out of three trip logic or other easy to trip conditions. This shall also apply to turbine generator control logic.

PB

This shall minimise personnel radiation exposure and shall ensure efficient maintenance minimising number of personal.

2.10.6.2.2.3.6.Q

The I&C maintenance interface shall be designed to take into account the specificities of the purely maintenance-related activity (either corrective or preventive) which is connected primarily to:

- operation;
- availability;
- safety;
- physical accessibility
- risk of human error;
- difficulty or quality of the activity, particularly during corrective intervention;
- complexity and impact on each system;
- documentation; and
- general functioning knowledge.

2.10.6.2.2.3.6.R

The maintenance of the I&C hardware and field I&C equipment shall be closely tied to and coordinated with the software maintenance activities.

2.10.6.2.2.3.6.S

The I&C design and architecture (layout, cable arrangements, design of internal connections and interfaces between systems) shall take into account the need for large modernizations of I&C during Unit* lifetime. Supplier* shall provide detailed analysis of all possible strategies for large I&C modernization of its I&C solution. Large I&C modernization shall have minimised negative impact on OPEX and CAPEX.

2.10.6.2.2.3.6.T

The design of a maintenance workstation shall be task-oriented.

TA

Different types of workstations can be used at different locations depending on the task.

2.10.6.2.2.3.6.U

Local maintenance station

A local maintenance stations shall be dedicated to specific localised tasks and be located close to I&C equipment maintenance tasks in order to:

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 82/122

- benefit from the proximity; and
- benefit from the simplicity inherent in a specialised interface.

UA

Typical Example is testing facility.

UB

Maintenance solutions shall be justified appropriately against all related requirements of the EPC Contract* and shall be subjected to a cost/benefit analysis.

2.10.6.2.2.3.6.V

This kind of local station shall be located to facilitate the access to the I&C cabinets.

VA

The main objective is an easy link between the computerised interface and the controlled component.

2.10.6.2.2.3.6.W

Alternatively, local maintenance stations shall be dedicated to the tasks which necessitate the use of process equipment in order to:

- benefit from the proximity;
- benefit from the simplicity inherent in a specialised interface;
- enable better co-ordination, if requested, with another type of local maintenance.

WA

Typical example is calibration equipment.

WB

Maintenance solutions shall be justified appropriately against all related requirements of the EPC Contract* and shall be subjected to a cost/benefit analysis.

2.10.6.2.2.3.6.X

This kind of local station shall be designed in order to accommodate:

- the principle of proximity;
- the ability to perform various types of task.

XA

The main objective is the easy link between the computerised interface and the controlled equipment. A cost/benefit analysis and a task analysis shall be used for selecting the equipment concerned.

XB

Flexibility of use is a major feature for this kind of station. Typical uses are:

- testing;
- dedicated I&C (re) qualification;
- equipment (re) qualification; and
- temporary need for localised operation.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 83/122

2.10.6.2.2.3.6.Y

The design of the local I&C maintenance station shall avoid any spurious action on operation when maintenance tasks are being performed.

YA

The same principle as for centralised I&C maintenance facilities shall be applied. Possible interferences of I&C maintenance activities to operation are assessed and validated by the Operators*.

2.10.6.2.2.3.6.Z

Mobile I&C maintenance

Mobile I&C maintenance station shall have a general purpose depending on the location and application, or to be a substitute for local facilities near I&C equipment or for local facilities near process equipment.

ZA

The major feature of this kind of device is its flexibility

2.10.6.2.2.3.6.ZA

When mobile I&C maintenance station is used as substitute for local maintenance station, then a station shall meet the requirements of the facilities it is intended to substitute.

2.10.6.2.2.3.6.ZB

The mobile I&C maintenance station shall not impair the security or Functional Isolation* of any connectable device.

ZBA

Requirements regarding security shall be considered.

ZBB

Requirements regarding Functional Isolation* shall be considered.

ZBC

Requirement regarding Software tools shall be considered.

2.10.6.2.2.3.6.ZC

Maintenance of software

Reliable and disturbance free loading of software and parameters shall be ensured. Other conditions that may influence the function in the different processing units of the equipment shall be avoided.

ZCA

Taking into account the considerable amount of data and parameters acquired by the I&C systems, it is necessary that the adequacy and the consistency of these data shall be assured.

2.10.6.2.2.3.6.ZD

The introduction of modifications to the application software shall not disturb the operation or impair the safety and the availability of the Plant* and/or /Unit*. Safe loading and consistency of software and parameters including its independent check in the different processing units of the equipment shall be ensured for functions critical for safety and availability.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 84/122

2.10.6.2.2.3.6.ZE

Any application software shall be restorable from back-up media with CM system support in a reasonable time. The replacement of cards and component containing firmware shall be easy and fast to perform. Corresponding facilities (as in the field stands/testing facilities/etc.) shall be provided.

ZEA

This corresponds to the average time required for data loading of a system.

2.10.6.2.2.3.6.ZF

Instrumentation

Drift in acquisition equipment shall be small enough to ensure that a calibration interval of 24 months can be justified. Sensor calibration interval shall be longer than 48 months except those where it is not possible due to safety and operational reasons.

2.10.6.2.2.3.6.ZG

The power supply of the instrumentation and signal output of remote measurements shall be standardised as much as possible.

ZGA

Standardised signal characteristics of power supply and sensor outputs enable standardised signal conditioning.

2.10.6.2.2.3.6.ZH

The power supply and signal levels of the instrumentation shall be stipulated by the Plant Supplier*.

ZHA

Analogue measurements shall be given preference especially in cases when high reliability and availability is required. If usage of binary sensors is required, advanced error detection principles shall be implemented.

2.10.6.2.2.3.6.ZI

The variety of instruments shall be as low as possible consistent with achieving the required level of safety and Diversity*.

ZIA

A limited variety of devices facilitates qualification, engineering, procurement, installation, Commissioning*, maintenance (e.g. calibration) and spare part handling.

2.10.6.2.2.3.6.ZJ

All sensors shall have provisions for test equipment to provide a direct input and then to receive a direct output in order to facilitate calibration where mobile I&C maintenance can be used.

2.10.6.2.2.3.6.ZK

If the sensor or actuator requires local logic or electronics, the appropriate module shall be replaceable where possible without having to replace the complete sensor or actuator.

ZKA

Local logic or electronics shall be considered as part of I&C.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 85/122

2.10.6.2.2.4 BOUNDARIES AND INTERFACES WITH OTHER SYSTEMS AND TOOLS

2.10.6.2.2.4.A

All links between I&C systems, other systems and the interfaces (human and non-human) that are necessary to support the wide variety of maintenance tasks performed by a variety of different of users, shall be designed.

2.10.6.2.2.4.B

Depending on the architecture and organization of the electrical grid the Supplier* of the I&C system shall consider in the design all the external sources of control and data flow which can affect the generating process. Final solution shall be compliant with Cyber security program for the Plant* and related regulation.

See Technical Requirements Document*, Chapter 2.3 and Section 2.7.11.4.10.

BA

Requirements regarding security and Functional Isolation* shall be considered.

BB

External systems which need to be interfaced to an I&C system in order to represent their data within the H-MI and/or to use the data in I&C system (and vice versa) shall be considered by the Supplier* of the Plant* I&C system in the design.

BC

Only hardwired interface (interface without communication protocol) is allowed between Units*/Plant* I&C systems and external system.

2.10.6.2.2.4.C

The Supplier* shall take into account in the design that some information or data can be sent from each generating Unit* for information or control of external systems.

CA

Example is but not limited to the data sent to secondary control as a contribution to the grid operation or off-site support centre. A dedicated subgroup is the Plant* and/or /Unit* information transmitted to the competent authority in form of reports or real-time data.

2.10.6.2.2.4.D

Measurement signals shall be pre-processed appropriately for their I&C tasks.

DA

I&C functions impose specific requirements on controlled variables and measurement signals.

2.10.6.2.2.4.E

The data acquisition process shall also provide functions for treatment of situations when signals are physically and electrically out of range and for threshold and cold junction correction. Each data acquisition channel shall contain appropriate filtering of the sensor output to reduce any noise on the signal to acceptable levels.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 86/122

2.10.6.2.2.4.F

The Supplier* shall specify pertinent rules for the cases where one measurement signal is used for multiple purposes or where separate, redundant or diverse measurements has to be used. Those rules shall be in compliance with EPC Contract* (special attention shall be paid to licensing basis) and are subject for Owner's* and Authorities* approval.

FA

The number of measurements, physical process parameters shall be minimised where it does not negatively influence availability and safety.

2.10.6.2.2.4.G

Standardised commands from drive controls to the electrical switchgear and to the drive shall be provided. As a result, the interface to drive controls shall be designed so that:

- commands are activated according to their hierarchy and presence of release signal; and
- memory of commands is foreseen in order to re-establish the former status in case of loss of power supply.

2.10.6.2.2.4.H

The drive control function shall be capable of implementing adequate modes of operation for the different types of drives and actuators.

HA

Types are for example motor valves, solenoid valves, breakers.

2.10.6.2.2.4.I

Manual intervention from the drive control shall be possible.

IA

There could be the need to override a torque limit.

2.10.6.2.2.5 INTERFACES WITH USERS

2.10.6.2.2.5.A

Human factors shall be fully integrated, considered and documented in the I&C design process.

AA

It has generally been recognised that human factors and potential for human errors are significant contributors in achieving the necessary levels of plant safety and availability.

2.10.6.2.2.5.B

Single Operator* errors (excluding diagnostic errors) shall be taken into account in the design of I&C systems and H-MI.

BA

Design of I&C systems (e.g. interlocks and time dependent interlocks) takes into account the potential for Operator* errors.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 87/122

BB

Single Operator* errors (excluding diagnostic errors) are taken into account in the development and validation of EOPs.

See Operation and Maintenance Document*, Section 3.6.

2.10.6.2.2.6 ENVIRONMENTAL CONDITIONS

2.10.6.2.2.6.A

All safety classified I&C systems shall be designed, constructed and, where appropriate, qualified to withstand the effects of Hazards and environmental conditions which they can be reasonably exposed to.

See Technical Requirements Document*, Section 2.1.5

2.10.6.2.2.6.B

Safety Class 1 and 2 I&C systems shall be assigned to Seismic Condition Resistance Level 1 in accordance with the environmental condition resistance levelisation given in Technical Requirements Document*, Chapter 2.1

See Technical Requirements Document*, Section 2.1.5

2.10.6.2.2.6.C

Class 3 I&C systems shall be assigned to Seismic Condition Resistance Level in accordance with the environmental condition resistance levelisation given in Technical Requirements Document*, Chapter 2.1

See Technical Requirements Document*, Section 2.1.5

2.10.6.2.2.7 QUALIFICATION

2.10.6.2.2.7.A

Safety classified I&C systems shall be qualified in order to confirm that they are capable of meeting, throughout their operational life, the requirements for performing Safety Functions* while being subjected to the environmental conditions prior to and at the time of need.

2.10.6.2.2.7.B

A qualification plan shall be provided by the Supplier* (including sub plans) describing the methodology, basic principles, the applied standards and specifications, overall approach and specificities for the equipment qualification.

2.10.6.2.2.7.C

For computer-based system this qualification shall include the hardware, the system software, firmware and the application software both integrated in the hardware.

2.10.6.2.2.7.D

Instruments and equipment (incl. cables) required for accident identification and monitoring shall prove their suitability to withstand Accident Conditions* even in the end of their designed lifetime.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 88/122

2.10.6.2.3 SYSTEM SPECIFICATION

2.10.6.2.3.1 GENERAL

2.10.6.2.3.1.A

The aim of this phase is to select and justify the pre-existing components, define the system architecture and the software specification, and make the assignment of the application functions in the system.

2.10.6.2.3.1.B

The inputs of this phase are the plans from the phase System Planning and the outputs of the previous phase Requirements Specification. The outputs of the System Specification are the specifications Documents*, which will be used as inputs for the next phase System detailed design and implementation.

See Technical Requirements Document*, Section 2.10.6.3

2.10.6.2.3.2 SELECTION OF PRE-EXISTING COMPONENTS

2.10.6.2.3.2.A

Due to the advantages offered by available advanced technology, the state-of-the-art / modern technology shall be used.

For relating requirements on use of state-of-the-art technology refer to Technical Requirements Document*, Section 2.10.7.4.1

2.10.6.2.3.2.B

The technology to be used shall be assessed on the following points: documentation, feed-back of experience from similar power plants or processes in relevant industrial applications, verification and validation that fully demonstrate that the technology meets the specific functional, performance and qualification requirements. Non-proven technology shall not be used.

2.10.6.2.3.2.C

Pre-existing components shall be designed according to relevant standards.

2.10.6.2.3.2.D

Commercial off-the-shelf (COTS) components shall be used as far as reasonable for implementing the systems and equipment included in Non-Classified (NC) category.

2.10.6.2.3.2.E

Term commercial off-the-shelf (COTS) component or equipment also may involve automation equipment, which is not specifically developed for nuclear applications. These components and equipment are developed for different industrial applications and is generally available from automation manufacturers. Their use shall be carefully considered.

2.10.6.2.3.2.F

If commercial off-the-shelf (COTS) component or equipment is used for safety classified systems they shall meet all safety requirements including proper justification (e.g. quality and qualification requirements for hardware and software).

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 89/122

See also Technical Requirements Document*, Section 2.10.6.5

2.10.6.2.3.2.G

Among other, for safety classified systems, the following requirements shall be fulfilled:

- equipment and their functions are described precisely in requirement specifications of automation systems;
- Unit* specific qualification of component and equipment are done;
- unused functions included in software-based equipment are identified and is ensured that they don't affect Safety Functions*;
- purpose, function and validation limits of pre-existing software are the same as originally verified and documented; and
- pre-existing software included in the components and equipment is sufficiently validated by testing.

2.10.6.2.3.2.H

In the turbine island I&C, off-the-shelf component or equipment (hardware, software) complying requirements shall be used.

2.10.6.2.3.3 SYSTEM ARCHITECTURE

2.10.6.2.3.3.1 GENERAL

2.10.6.2.3.3.1.A

The system architecture consists in partitioning the system in subsystems, taking into account the requirements for the Redundancy*, the functionalities, and the performances (reliability, maintenance, etc.). This partition shall be as simple as possible.

2.10.6.2.3.3.2 GEOGRAPHICAL DISTRIBUTION OF SUBSYSTEMS (CENTRALISED /DECENTRALISED)

2.10.6.2.3.3.2.A

To realise the geographical distribution of subsystems, the following issues shall be considered, but not limited to:

- The Single Failure Criterion*, where necessary, and the separation of redundant channels to reduce the effect of localised hazards such as fire; and
- The centralisation of functions or components to facilitate operation, or periodic testing, or maintenance, etc.

2.10.6.2.3.3.3 INDEPENDENCE



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 90/122

2.10.6.2.3.3.4 DEFENCE AGAINST PROPAGATION AND SIDE-EFFECTS OF FAILURES

2.10.6.2.3.3.4.A

The following techniques shall be used:

- internal isolation, where failures cannot propagate due to the lack of propagation paths and shared resources;
- self-supervision or external monitoring to detect corrupted data;
- defensive interfaces between systems to identify corrupted inputs and/or erroneous interactions; and
- on-line validation of redundant input signals, etc.

2.10.6.2.3.4 SOFTWARE SPECIFICATION

2.10.6.2.3.5 ASSIGNMENT OF THE APPLICATION FUNCTIONS IN THE SYSTEM

AA

This includes assignment of:

- input signals to functions and of functions to specific processor units;
- voting process, priority handling, equipment protection functions; and
- links of output control actions to actuators.

2.10.6.2.4 SYSTEM DETAILED DESIGN AND IMPLEMENTATION

2.10.6.2.4.1 GENERAL

2.10.6.2.4.1.A

The objective of this phase is :

- to develop/procure the detailed design of the system hardware;
- to develop (design and coding) the computer programs which constitute the operational and support system software; and
- to develop (design and coding) and generate the application software of the system

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 91/122

2.10.6.2.4.2 REQUIRED ANALYSIS

2.10.6.2.4.2.1 FUNCTIONAL VALIDATION OF THE APPLICATION FUNCTIONS REQUIREMENTS SPECIFICATION

2.10.6.2.4.2.1.A

Simulations and experiments shall be used early in the design to evaluate specific design features and choices and to support an iterative development.

2.10.6.2.4.2.2 RELIABILITY ASSESSMENT



See Technical Requirements Document*, Chapter 2.17

2.10.6.2.5 SYSTEM INTEGRATION

2.10.6.2.5.A

The system integration shall be carried as planned to demonstrate that hardware system is assembled as designed, software is able to operate on HW and verify that software complies with design specification.

See Technical Requirements Document*, Section 2.10.6.3.4

AA

The aim of this phase is to assemble the individual hardware and software components that make up the system. The inputs of this phase are the plans from the phase System Planning and the outputs of the previous phase System detailed design and implementation. The outputs of the System integration are the Integration report and the integrated system. They will be used as inputs for the next phase System validation.

See Technical Requirements Document*, Section 2.10.6.2.4 and Section 2.10.6.3

2.10.6.2.6 SYSTEM VALIDATION

2.10.6.2.6.A

The system validation shall be carried as planned to demonstrate that complete final assembly configuration integrated with a final version of software meets all functional, performance and interface requirements.

AA

The aim of this phase is to validate the system. The inputs of this phase are the plans from the phase System Planning and the outputs of the previous phase System integration. The output of the System validation is the system validation report, which will be used as inputs for the next phase System installation.

See Technical Requirements Document*, Section 2.10.6.3.5 and Section 2.10.6.2.5.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 92/122

2.10.6.2.7 SYSTEM INSTALLATION

2.10.6.2.7.A

The system installation shall be carried in accordance with System installation plan to install, interconnect and test complete system on Site*.

AA

The aim of this phase is to install and test the system. The inputs of this phase are the plans from the phase System Planning and the outputs of the previous phase System validation. The outputs of the System installation are the system installed and tested on Site*, and the installation report.

See Technical Requirements Document*, Section 2.10.6.2.6 and Section 2.10.6.3.6

2.10.6.2.8 SYSTEM DESIGN MODIFICATION

2.10.6.2.8.A

System design modification shall be performed according defined procedures.

AA

The aim of this phase is to modify the system, in order to make corrections, enhancements or adaptations to the system. The inputs of this phase are the plans from the phase System Planning and modification request, if any. The outputs of the System design modification are the system modified, and the modifications reports.

See Technical Requirements Document*, Section 2.10.6.3.

2.10.6.3 SYSTEM PLANNING

2.10.6.3.1 GENERAL

2.10.6.3.1.A

Analyses shall be performed in order to ensure that quality and qualification processes for verification and validation of functions, systems and equipment are precise and covering all input requirements.

2.10.6.3.1.B

The implementation of I&C systems shall be performed in such a way that all design objectives will be achieved to a high quality and within given time and cost.

2.10.6.3.1.C

Plans for V&V, Equipment Qualification* and QA management of I&C systems shall be provided by the Supplier*.

2.10.6.3.1.D

Development and modification are specific tasks that shall be performed by specially designated I&C staff.

2.10.6.3.1.E

I&C development and modification activities shall be kept separate from operation.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 93/122

2.10.6.3.2 I&C SYSTEM QUALITY ASSURANCE PLAN

2.10.6.3.2.1 GENERAL

2.10.6.3.2.1.A

For safety classified systems, transparent processes for verification of requirements, assessment of modifications and approval of software shall be provided by the Supplier*.

2.10.6.3.2.1.B

The design process shall be divided in clearly defined phases. All activities in the previous phase shall be completed and verified before the next phase is started.

2.10.6.3.2.1.C

Adequate co-ordination shall be established between the I&C design team and the Plant* and/or /Unit* systems designers. In order to ensure such co-ordination, strict procedures describing carefully clarified interfaces and mutual responsibilities shall be elaborated by the Supplier*.

CA

It is beneficial if the I&C design team and the Plant* and/or /Unit* systems Supplier's* work together and take into account operation/maintenance inputs



2.10.6.3.2.1.E

The V&V activities shall be part of the general PQM which shall ensure the correct incorporation of functional assignments and other technical, ergonomic and human factors requirements into the I&C and control room concept.

2.10.6.3.2.2 SYSTEM VERIFICATION PLAN

2.10.6.3.2.2.A

Verification activities shall be performed after each phase in the design process. The purpose is to ensure that all requirements are fulfilled before the next phase is started. The verification plan shall address, but not limited to:

- the selection of verification strategies and activities;
- the use of test equipment;
- procedures for the performance of the verification activities; and
- requirements for the evaluation and documentation of results.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 94/122

AA

For example, after the coding phase but before the next phase begins, a verification activity will verify that the code fulfils what is written in the software performance specification (the input to the coding phase).

2.10.6.3.2.3 SYSTEM CONFIGURATION MANAGEMENT PLAN

2.10.6.3.2.3.A

Key Documents*, Data, computer program codes and software tools and other information necessary to be available within whole design life of the Unit* shall be kept under the control of an I&C Configuration Management* system. The Configuration Management* system shall include the control of:

- product Documents*, e.g. specifications of pre-existing products;
- computer programme codes in all relevant formats (source code, object code, machine code, libraries, etc.);
- data bases;
- tools and procedures (including compilers, code generators, test environment, test tools etc.);
- test files and results;
- basic software documentation (operating systems etc.);
- application software (specifications etc.);
- hardware (drawings, specifications etc.);
- documentation (e.g. system descriptions and requirement specifications);
- modifications and their assessment process;
- reviews, audits and personnel training;
- detected nonconformities; and
- associated equipment

See Technical Requirements Document*, Section 2.12.9

2.10.6.3.2.3.B

The Configuration Management* system shall ensure that, but not limited to:

- key Documents*, Data and software codes and tools are not modified without appropriate authorisation;
- key Documents*, Data and software codes and tools corresponding to a given version of the I&C system or of a component can be identified and retrieved if necessary;
- the quality and the consistency of the new I&C software versions is validated in accordance with the adequate qualification and conformity assessment processes before they take effect;
- differences between various versions of the same document can be identified;
- only one version of a software tool is used to generate a given version of the I&C system; and
- it is possible to identify the version of the tools used for the development, testing, documentation and verification of each single application

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 95/122

BA

The ability to trace failures shall enhance the assessment of potential Common Cause Failures*.

2.10.6.3.2.3.C

The Configuration Management* shall take into account the applicable quality requirements depending on their safety class and relevance.

The safety class and relevance shall be used in grading the arrangements in order to guarantee the targeting and efficiency of the methods.

CA

These arrangements are based on safety class and relevance and they can be:

- common to several programmable systems; or
- specific to one system.

2.10.6.3.2.3.D

Additional arrangements shall be made for the management of safety data so as:

- to enable verification (of the conformity of a modification, of its impact on those activities using the data, of its thoroughness) after all modifications;
- to guarantee a minimum level of reliability;
- to identify, prepare, and conduct the activities of creation, modification and control intrinsic to each type of safety data; and
- to preserve and archive such data in a way which makes it easy to find its history

DA

Data is classified according to the system on which it is implemented e.g. for the safety-classified data as follows.

DB

The purpose of arrangements regarding the acquisition and updating of computerised data is:

- to limit the number of anomalies which have an impact on safety;
- to reduce the severity of such an impact; and
- to demonstrate that adequate arrangements have been made.

2.10.6.3.2.3.E

On Site*, arrangements shall be made, but not limited to:

- to emphasize the isolation of any data which has not been validated or which includes an anomaly; and
- to forbid the use of any data which has not been validated or which includes an anomaly in activities.
- isolation of safety and non-safety data

2.10.6.3.2.3.F

The use of safety data shall comply with the following rules, but not limited to:

- implementation of the procedures governing the use and control of data; and
- regulation of the use of data in activities which may affect safety

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 96/122

2.10.6.3.2.4 FAULT RESOLUTION PROCEDURES

2.10.6.3.2.4.A

Procedures for the reporting and resolution of faults found during system integration verification, during system validation and in later phases shall be established before the corresponding phases begin. Such procedures shall comply with the requirements from the system management configuration plan and from the modifications procedures. All faults found during the system integration phase and system validation phase shall be analysed in accordance with the fault resolution procedures.

2.10.6.3.3 SYSTEM CYBER SECURITY PLAN

2.10.6.3.3.A

System cyber security plan shall elaborate overall cyber security plan up to the system and component level.



BA

US NRC REGULATORY GUIDE 5.71 CYBER SECURITY PROGRAMS FOR NUCLEAR FACILITIES shall be also applied especially for areas not sufficiently covered by required standards.

2.10.6.3.3.C

System cyber security plan shall provide high assurance that digital computer and communication systems and networks will be adequately protected against cyber-attacks and threats, up to and including the design basis threat.

2.10.6.3.3.D

The system cyber security plan shall be consistent with the overall cyber security plan. Proper cyber security provision shall be made to avoid unauthorised access to the I&C systems and equipment.

The protection level shall be commensurate with the consequences of an unauthorised access.

2.10.6.3.3.E

System cyber security plan shall also include following, but not limited to:

- information management;
- accountabilities and responsibilities;
- contractual identification of the limits of responsibility for safety;
- security administration;
- scope of authority of those people working on the I&C system;
- control of physical access to the equipment;
- control of access to the logic of software applications;
- recognition of the people gaining access to the I&C system;

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 97/122

- record of the operations;
- transfer of information/data via networks;
- management of the documentation;
- back-up management; and
- monitoring operations carried out on the I&C system
- Disaster recovery plans.

2.10.6.3.3.F

Proper cyber security provision shall be integrated to detect and prevent incorrect inputs to the I&C systems and equipment.

2.10.6.3.3.G

Effective methods including appropriate combinations of physical security (locked enclosures, locked rooms, alarms on panel doors, etc.) and administrative measures according to the degree of supervision in the area where the equipment is located shall also be implemented.

GA

Two areas of concern in relation to access control are set point adjustments and calibration adjustments, because of their importance in preventing degraded system performance due to potential errors in operation or maintenance.

GB

For access control to digital systems, means shall be employed for restricting electronic access to software and data. These restrictions shall be applied to access via network connections and maintenance equipment.

2.10.6.3.3.H

Security provision shall be made so that efficiency of authorised users is not excessively impacted when working on the I&C systems and equipment. Ergonomic provisions shall be considered regarding use and habits related to the different jobs.

2.10.6.3.4 SYSTEM INTEGRATION PLAN

2.10.6.3.4.A

Along with the completion of the hardware and software design and manufacturing, each part of the I&C system shall be integrated into functional subsystem which shall be then in turn integrated into a complete I&C system.

2.10.6.3.4.B

The system integration plan shall plan activities (but not limited to) for the stepwise integration subsystems to system, hardware and software, measures for simulation of external systems, verification procedures and acceptance criteria of the correct integration.

BB

Pre-installation testing is to confirm that the performance of hardware and software satisfies the design requirements

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 98/122

2.10.6.3.4.C

After testing each sub-system, an integration test of I&C systems shall be performed. Another set of integration tests shall be performed when the different parts of the I&C system are integrated with other systems in the Plant*.

2.10.6.3.5 SYSTEM VALIDATION PLAN

2.10.6.3.5.A

The Testing facility shall be used as a part of testing and V&V process of I&C systems, and it shall be provided to the Owner*.

AA

Testing facility is a tool for realistic V&V and testing of the NPP processes and I&C system design.

2.10.6.3.5.B

The Supplier* shall specify, plan and perform tests for each part of the I&C system as well as for the whole system during its integration with interconnected process and fluid systems during system acceptance tests in Commissioning*.

2.10.6.3.5.C

Adequate combination of mock-ups, prototypes and simulations shall be used and the result of the tests and other data collected shall be used in order to support design decisions as well as to verify specified performance and functionality.

Operability* tests shall be done with Full-Scope Training Simulator* in order to test and validate MCR, ECR, I&C and Operator* instructions (e.g. EOP) together as well as for validation of control possibilities of MCR displays.

CA

The Full-Scope Training Simulator* includes the H-MI, the control system and simulation of the Plant* processes:

- control and automation concept;
- I&C system; and
- capability and performance in Normal Operation*, in AOO Conditions* and in Accident Conditions*.

2.10.6.3.5.D

These mock-ups, prototypes and simulations shall serve as the basis for system acceptance, integration, validation and Operability* tests and for the long-term surveillance and maintenance, which confirm the Operability* of the installed system.

2.10.6.3.5.E

The iterative testing and evaluation of the design shall specifically include the human "in the loop". Operators* shall be included in walk-through at mock-ups, in partial or prototype simulations of workstations and full-scale simulations. Maintenance personnel shall participate in relevant test activities, for example, in mock-ups and prototypes of maintenance interfaces.

2.10.6.3.5.F

Rigorous enough methods shall be used in V&V of safety requirements, design processes and software design of safety I&C and I&C functions of safety classified systems.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 99/122

FA

Rigorous methods are methods of description rigorous enough also in order to permit independent verification.

FB

Such methods shall apply to the different phases of the software development process (requirement specification, program design, verification and validation activities etc.).

2.10.6.3.5.G

The Supplier* shall describe the interfaces between I&C and other design disciplines and the benefits of the rigorous methods used in I&C design.

2.10.6.3.5.H

The Supplier* shall declare the following information regarding the selected methods:

- the type of method;
- the phase of the development process where it has been used;
- the reasoning;
- the expected benefit; and
- the sample records of V&V results.

2.10.6.3.6 SYSTEM INSTALLATION PLAN

2.10.6.3.6.A

The system installation plan shall address organization, procedures of installation of individual systems, activities in the installation, measures for installation, verifications procedures of the correct installation of systems, sensors and actuators as well as the internal and external cabling to the I&C system.

2.10.6.3.6.B

The staff shall have at their disposal an interface specially designated for them in order to guarantee that:

- the use of this interface (for e.g. software and configuration files loading, on-line configuration, settings (including instrumentation, actuators, etc.), etc.) has no spurious or voluntary action on operation of particular I&C systems; and
- the Operator* has the exclusive ability to make the installation take effect. This shall be achieved by administrative and technical means.

BA

The specially designated interface shall support easy installation and integration process

2.10.6.3.6.C

During Commissioning*, specialist staff shall be dedicated to I&C tests and to general equipment tests involving I&C.

The Supplier* shall allow the Owner* participation with dedicated I&C specialists during the Commissioning*.

See Construction and Commissioning Document*, Section 3.3.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 100/122

2.10.6.3.6.D

The I&C design shall provide temporary interfaces for Commissioning* purposes.

2.10.6.3.7 SYSTEM OPERATION PLAN

2.10.6.3.7.A

The Supplier* shall develop, implement and maintain system operation plans which shall describe the way the system shall be operated and the requirements applicable during all modes of system operation.

The system operation plan shall describe the measures and procedures to ensure that the plan, associated records, and implementing policies and procedures is met.

AA

The system operation plan shall describe all modes of operation including periodic testing and recovery procedures after a temporary limitation of system operation.

AB

The system operation plan shall describe conditions of system operation for each mode, steps to be performed and impact on operation of the Unit*.

AC

The system operation plan shall provide specification of necessary documentation, tools to be used during operation, personnel involved, verification method and requirements on recording procedures.

2.10.6.3.7.B

The Supplier* and his Subcontractors* shall provide all necessary documentation and supporting aids according operational plan for the system operation phase.

The system operation plan shall include among others requirements on “specific/mandatory” documentation for putting in operation, periodic testing, user documentation, recording procedures relating operation.

2.10.6.3.8 SYSTEM MAINTENANCE PLAN

2.10.6.3.8.A

Documentation shall be readily accessible for all the maintenance and plant operating teams. It shall be possible to update it and to make it conform to the installation.

2.10.6.3.8.B

It shall be presented in graphic form and give:

- the description of the installation in the form of full process and instrumentation diagrams. The graphic library used for the creation of these drawings shall comply with the appropriate standards;
- the programming logic of the I&C system (e.g. Functional Diagram)

2.10.6.3.8.C

The I&C maintenance activity shall be performed from working equipment specially designated for this purpose.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 101/122



2.10.6.3.8.D

The use of specific equipment for the I&C maintenance due the specificity of I&C shall be justified. Task analysis shall be used to prioritise the appropriate requirements, taking into account, notably:

- the frequency of the task;
- the complexity of the task;
- the location of the task and the possible distance from the equipment controlled;
- the variety of tasks to perform;
- the close connection with the operation process and the risk of failure; and
- the specific difficulties in ensuring a high level of quality

2.10.6.4 OUTPUT DOCUMENTATION OF SYSTEM PLANNING

2.10.6.4.1 GENERAL

2.10.6.4.1.A

The Supplier* shall supply all the planning needed for the realization of the I&C system. This includes, but not limited to:

- Project* organization and planning as well as general schedules and plans;
- I&C specific design Documents* and procedures (many of them are included in the Design Manual);
- I&C quality plans, Inspection* and test plans of I&C;
- software and hardware verification plans;
- system Configuration Management* plan;
- system integration plan;
- system installation plans;
- system validation plans;
- training plans;
- factory acceptance test and Commissioning* test plans;
- safety plan;
- maintenance plan; and
- operation plan

AA

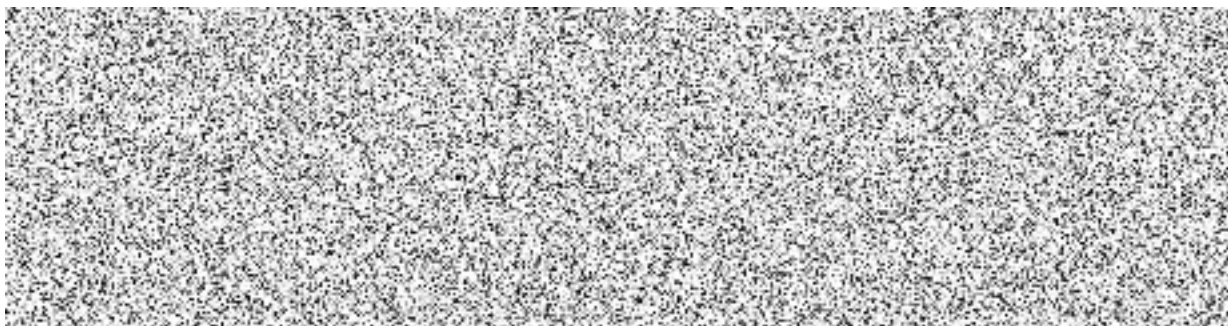
A safety plan shall identify how the safety demonstration is to be achieved; more precisely, a plan which identifies the types of evidence that will be used, and how and when this evidence will be produced. A safety plan is not necessarily a specific document.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 102/122

2.10.6.4.1.B

The Supplier* shall supply all the detailed specifications elaborated for the realization of the I&C system. This includes, but not limited to:

- Project* organization including responsibilities, interfaces and system support and Services*;
- Safety Classified and NC systems I&C requirements;
- system architecture specification;
- software requirements specification (functional and reliability requirements);
- hardware requirements specification (functional and reliability requirements);
- equipment specifications and a list of all items, modules, cabinets etc.;
- detailed specification on program development;
- software and hardware performance specification;
- specification of output documentation from each life cycle phase;
- specification of periodic test procedures;
- factory acceptance and Commissioning* tests specifications;
- training program;
- user manual and user procedures;
- requirements for layout, ventilation and cooling;
- installation specification;
- cabling specification; and
- grounding specification



2.10.6.4.1.C

The Supplier* shall provide operating and maintenance procedures guidelines for the Operator* to develop final procedures for operation and maintenance of the I&C system.

2.10.6.4.1.D

The procedure guidelines shall include all of the Technical Specifications*, Rules* and principles for operation, testing and maintenance etc.

2.10.6.5 SYSTEM QUALIFICATION

2.10.6.5.1 GENERAL

2.10.6.5.1.A

The Supplier* shall establish and maintain its system qualification process that provides assurance that an I&C systems and their components are capable of meeting, on a continuing

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 103/122

basis, the design basis functional and performance requirements needed for the functions important to safety while subject to the specific environmental conditions and specific constraints. All related information incl. traceability shall be treated under control of CM and shall be available within CM system provided to the Owner* for future use.

AA

In the qualification process it is possible to take credit from evidence of qualification of hardware and software components established outside the framework of a Plant* design or specific application context (e.g. pre-qualification or generic qualification of components off the shelf - COTS - products or of an equipment family).

2.10.6.5.1.B

The environmental conditions (e.g. vibration, temperature, pressure, jet impingement, electromagnetic interference, irradiation, humidity etc. or any likely combination thereof) to be considered shall include the variations expected in Normal Operation*, AOO and Accident Conditions*.

2.10.6.5.1.C

The ageing effects caused by various environmental factors (such as vibration, irradiation and extreme temperature) over the design lifetime of the equipment shall be also considered.

2.10.6.5.1.D

Equipment (such as certain instrumentation) that must operate in a Severe Accident* shall be capable of achieving the design intent. This capability shall be demonstrated with high level of confidence.

2.10.6.5.1.E

Equipment Qualification* is a highly specialized field related to Plant*/Unit* safety which requires specific knowledge and skills of participating personnel. The Supplier* shall ensure necessary level of competence of participating personnel (including Owner's* personnel) through a combination of technical education, specialized training, and on the job training.

2.10.6.5.1.F

Traceability shall be established between each installed system and component important to safety and the applicable evidence of qualification. This includes traceability not only to the component itself, but traceability between the qualified configuration and the installed configuration.

2.10.6.5.1.G

Any piece of equipment installed in the MCR but not required to function during or after an earthquake shall be designed to neither cause nor support any situation unsuitable for the Operators* to perform their tasks under seismic loading (Seismic Condition Resistance Level S).

2.10.6.5.1.H

Aircraft crash loading shall be taken into account for the MCR I&C response.

2.10.6.5.1.I

Safety classified I&C systems (hardware and software components) shall be identified and appropriate evidence of the suitability of this equipment for the intended use shall be provided.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 104/122

2.10.6.5.1.J

Additional specific requirements related to I&C cables are defined in Technical Requirements Document, Section 2.7.11.4.3. This section also includes requirements related to their qualification.

2.10.6.5.1.K

The Supplier* shall develop and provide Ageing management programme and all relating procedures as described in Technical Requirements Document*, Section 2.15.5.5.1

2.10.6.5.2 GENERIC AND APPLICATION-SPECIFIC QUALIFICATION

2.10.6.5.2.A

Where pre-existing components or components off the shelf (COTS) are already pre-qualified or have a generic qualification (for different applications or different nuclear projects), the documentation shall be completed to provide demonstration of the qualification for the specific application at hand. If the demonstration is found insufficient by the Owner* or Authority* for any component, the Supplier* shall carry out additional analysis by independent certification organization well recognized in the Czech Republic or Korea, however acceptable for Authorities* to fill any gap in demonstration and complete qualification without impact on contractual price.

2.10.6.5.3 QUALIFICATION PLAN

2.10.6.5.3.1 GENERAL

2.10.6.5.3.1.A

The qualification of safety classified systems shall be achieved through a process that includes generating, documenting and maintaining evidence that equipment can perform its Safety Functions* throughout its design lifetime.

AA

Compared to the general qualification approach as mentioned in Technical Requirements Document*, Chapter 2.4, for I&C specific qualification, the environmental qualification encompasses qualification for the effects of internal and external Hazards* (e.g. seismic) and EMC qualification.

2.10.6.5.3.1.B

Non-classified (NC) I&C systems shall be qualified case by case depending on their importance to availability for the Plant*.

2.10.6.5.3.1.C

The qualification is an ongoing process, from design to the end of service life, therefore Plant* and/or /Unit* ageing, modifications, repairs, refurbishment, equipment failures, replacements and abnormal operating conditions shall be taken into account.

2.10.6.5.3.1.D

The qualification plan shall be provided by the Supplier* (including sub plans) describing the methodology, basic principles, the applied standards and specifications, and overall approach for the equipment qualification.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 105/122

2.10.6.5.3.1.E

The qualification plan (including sub plans) shall provide assurance that a classified system will perform its Safety Functions* when required throughout the life of the Plant* and/or /Unit*.

EA

In order to maintain qualification, ensure long term reliability of the I&C systems and to enable possible life extension, the Supplier* shall involve I&C system into Plant* life management programme.

2.10.6.5.3.2 FUNCTIONAL AND ENVIRONMENTAL QUALIFICATION

2.10.6.5.3.2.1 GENERAL

2.10.6.5.3.2.1.A

The qualification plan shall address all topics affecting the suitability of each system or component for its intended functions, including:

- environmental qualification;
- qualification for the effects of internal and external hazards;
- electromagnetic qualification; and
- suitability and correctness of functions and performance.

2.10.6.5.3.2.1.1 SUITABILITY AND CORRECTNESS

2.10.6.5.3.2.1.1.A

The Equipment Qualification* program shall demonstrate that the design of I&C systems and components meet the following requirements:

- functional (e.g. functionality required by the application, functionality required to support system or equipment Operability*, Operator* interface requirements, and input /output range requirements);
- performance (e.g. accuracy, resolution, range, sample rate, and response time).

2.10.6.5.3.2.1.2 ENVIRONMENTAL QUALIFICATION

2.10.6.5.3.2.1.2.A

Components shall be shown to meet all requirements when subjected to the range of specified environmental conditions:

Environmental qualification is qualification for temperature, pressure, humidity, chemical exposure, radiation, submergence, electromagnetic phenomena, and ageing mechanisms that affect the proper functioning of components under those conditions.

2.10.6.5.3.2.1.2.B

Components exposed only to mild environments.

Qualification shall be based upon a clear specification of functional requirements for the specific environmental conditions associated with Unit* Operational States* together with SSC certification or a separate evaluation demonstrating that SSC is able to perform their required functions under the stated environmental conditions.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 106/122

BA

Mild environments: environmental service conditions during accidents are at no time significantly more severe than conditions during Normal Operation*, except for a seismic event.

2.10.6.5.3.2.1.2.C

Components exposed to harsh environments

Qualification shall ensure that the component, at the end of its qualified life, is capable of performing its required functionality under the full range of specified service conditions taking into account the significant ageing effects (e.g. radiation and thermal ageing).

CA

Harsh environments: environmental service conditions that are at any time significantly more severe than the conditions during Normal Operation*.

2.10.6.5.3.2.1.2.D

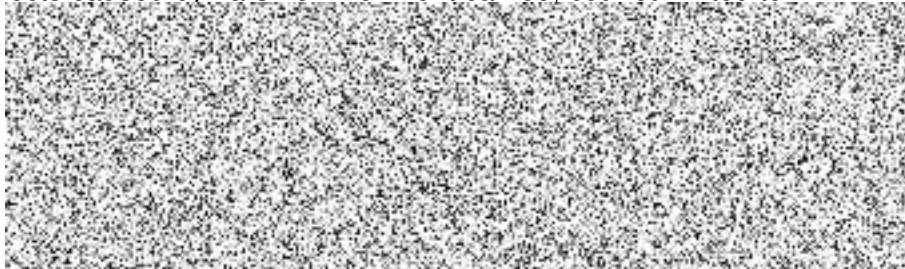
In defining the Equipment Qualification* program, the worst credible combinations of environmental service conditions, including synergistic effects between service conditions, shall be addressed.

2.10.6.5.3.2.1.2.E

Environmental qualification of safety classified components that are required to operate in harsh environments shall include type tests.

EA

Effects caused by harsh environment can be, but not limited to:



2.10.6.5.3.2.1.3 QUALIFICATION FOR THE EFFECTS OF INTERNAL AND EXTERNAL HAZARDS

2.10.6.5.3.2.1.3.A

The Plant* design basis and the Plant* safety analysis shall identify / include identification of all Internal Hazards* and External Hazards*, such as fire, flooding and seismic events, which the Plant* is required to tolerate for operation or which the Plant* is required to withstand safely, and for which protection or system qualification is needed.

2.10.6.5.3.2.1.3.B

Seismic qualification includes both structural integrity and operability/functional capability.

2.10.6.5.3.2.1.3.C

Seismic qualification methods shall include:

- qualification by analysis; and/or (and/or means “according Authorities expectations”)
- qualification by testing.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 107/122

2.10.6.5.3.2.1.4 ELECTROMAGNETIC QUALIFICATION

2.10.6.5.3.2.1.4.A

Detailed EMC requirements shall be determined for all systems and components and their compliance with the requirements shall be demonstrated.

See also Technical Requirements Document*, Section 2.7.11.4.1

2.10.6.5.3.2.1.4.B

When several I&C systems are connected to the same power supply, the electromagnetic qualification shall evaluate interferences and transmission paths for EMI (Electrical Magnetic Interferences).



See Technical Requirements Document*, Chapter 2.5

2.10.6.5.3.2.2 EQUIPMENT QUALIFICATION METHODS

2.10.6.5.3.2.2.A

Equipment Qualification* methods shall be based on a selection of adequately combined following methods:

- use of engineering and manufacturing processes in compliance with recognized standards;
- past experience in similar applications;
- type testing;
- analysis to extrapolate test results or operating experience under relevant conditions;
- evaluation of manufacturer production processes; and
- Inspection* of components during manufacture.

AA

Samples of equipment defined for testing shall be sufficiently representative to ensure credible Equipment Qualification*. Any representative sample of equipment shall be subject to specific testing performed for different aims:

- to qualify a specific equipment; or
- to qualify a family of equipment for specific service condition (Plant* specific or envelope requirements), etc.

2.10.6.5.3.2.2.1 ADDITIONAL QUALIFICATION OF INTERCONNECTED SYSTEMS

2.10.6.5.3.2.2.1.A

A plan shall be developed if additional testing is necessary at the level of the interconnected I&C systems to complete their individual qualification.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 108/122

2.10.6.5.3.2.2.2 ANALYSIS

2.10.6.5.3.2.2.2.A

A quantitative analysis of a mathematical model of the equipment shall be performed for seismic qualification (in simple equipment).

2.10.6.5.3.2.2.3 RELIABILITY DEMONSTRATION

2.10.6.5.3.2.2.3.A

Analysis shall be performed as necessary to justify system characteristics which cannot be adequately substantiated by other means. These may include:

- reliability analysis providing or justifying reliability data;
- failure mode and effect analyses confirming the specified failure modes and providing coverage data for self-surveillance functions; and
- analyses of circuitry confirming the specified functionality; accuracy or margins

2.10.6.5.3.2.2.4 OPERATING EXPERIENCE

2.10.6.5.3.2.2.4.A

Qualification can be accomplished by the use of consistent information on successful operation of similar equipment in equal or more severe service conditions.

2.10.6.5.3.2.2.4.B

Use of operating experience is normally not acceptable as the only means to establish Equipment Qualification* but, in practice, it is useful as a complement to another qualification method (e.g. used in seismic qualification).

2.10.6.5.3.3 SOFTWARE EVALUATION AND ASSESSMENT

2.10.6.5.3.3.A

This part of qualification is only needed if there is software implemented.

2.10.6.5.3.3.B

The software of the computer based system to be qualified includes:

- the system software not specific of the Plant* (which may be pre-developed); and
- the application software integrated into the system, which is Plant* specific

2.10.6.5.3.3.C

The qualification shall evaluate and assess both the system software and the application software to provide assurance that the software quality is appropriate for achieving the required reliability of the functions performed by the system.

2.10.6.5.3.3.D

The software shall be compliant to:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 109/122

2.10.6.5.3.3.E

NA



2.10.6.5.4 ADDITIONAL QUALIFICATION OF INTERCONNECTED SYSTEM

2.10.6.5.4.A

For interconnected systems, a plan shall be established for any additional testing that may be required (for example EMC).

2.10.6.5.5 MAINTAINING QUALIFICATION

2.10.6.5.5.A

The Supplier* shall provide documentation (incl. procedures) and provisions (condition monitoring, related tools, dedicated part in CM system, etc.) including description of the way, they are used necessary for maintaining qualification during operational phase. All relationship between maintaining qualification and Aging management also shall be addressed.

2.10.6.5.6 DOCUMENTATION

2.10.6.5.6.A

Document evidence of qualification shall be provided to ensure that each requirement of the qualification plan is covered. This documentation shall in a form that it is possible to maintain it during NPP life time in a well organized, understandable and auditable form.

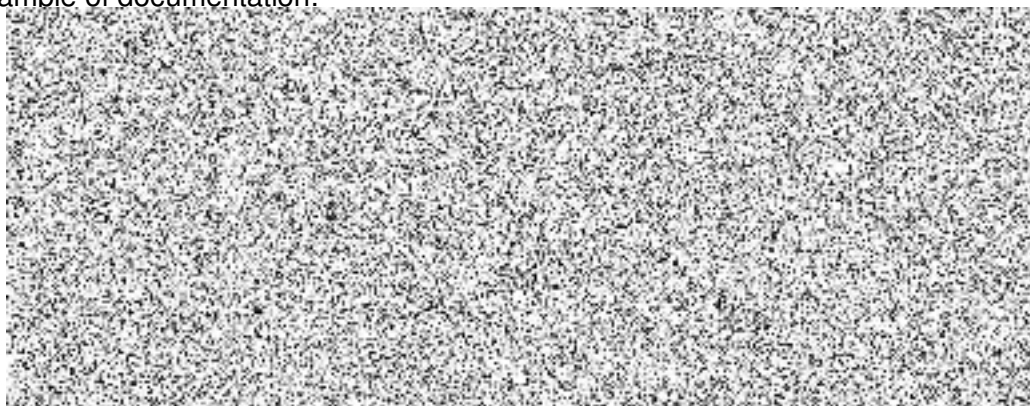
2.10.6.5.6.B

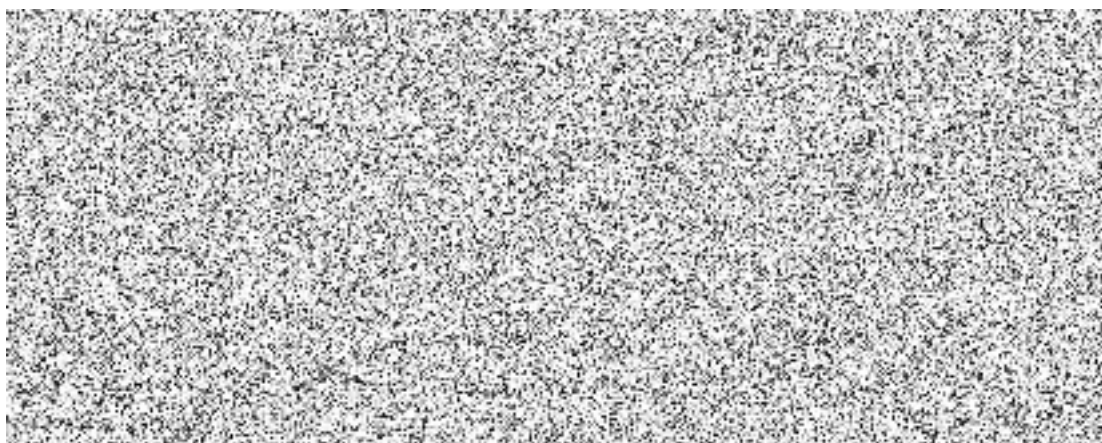
Equipment Qualification* files shall contain summary information identifying:

- Equipment being qualified;
- Required functions and service conditions; and
- Qualification conclusions and limitations.

BA

Example of documentation:





2.10.7 OTHER I&C SPECIFIC REQUIREMENTS

2.10.7.1 I&C CYBER SECURITY PROGRAM

2.10.7.1.A

I&C cyber security programs shall be understood a part of security program and shall be developed, implemented and maintained during all phases of I&C lifecycle.

2.10.7.1.B

The Supplier* shall (but not limited to):

- Analyse digital computer and communication systems and networks and identify all digital assets
- Establish, implement, and maintain a cyber security program for the protection of the digital assets
- Incorporate the I&C cyber security program as a component of the physical protection program.

2.10.7.1.C

The Supplier* shall implement the I&C cyber security program to:

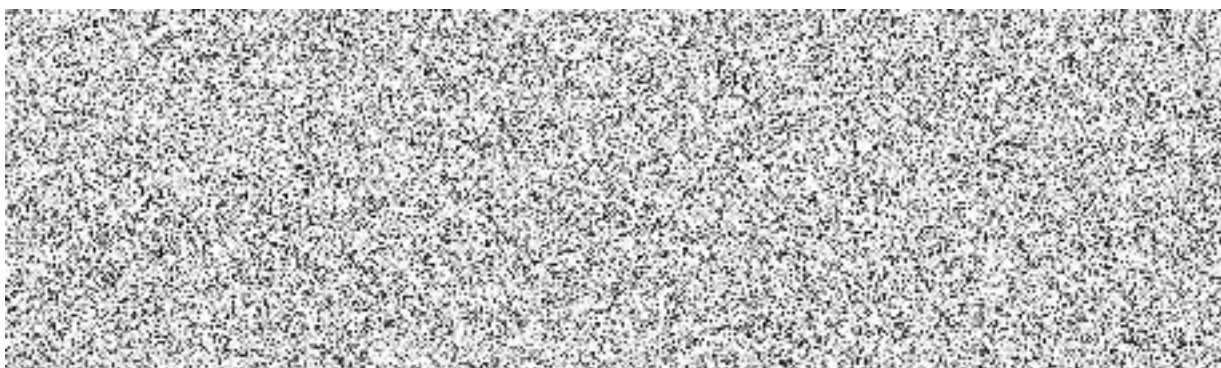


2.10.7.1.D

As part of the I&C cyber security program, the Supplier* shall:



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 111/122



2.10.7.2 TESTING

2.10.7.2.A

The Supplier* shall develop and follow comprehensive and overlapping testing plans and programs (appropriate to importance to safety and availability) for testing in the factory and on Site* including also fulfilment of requirements on the verification and validation of I&C SSC. See also Construction and Commissioning Document*, Section 2.8

2.10.7.2.B

The scope, quality and methods of testing (including independent V&V for safety classified systems) shall be sufficient to demonstrate that all I&C SSC fulfil all corresponding requirements of EPC Contract*, Rules*, and Authorities* expectation and requirements, and shall be subject to Authorities'* and Owner's* approval.

2.10.7.2.C

In terms of verification and validation testing plans and programs shall include for systems safety class 1 checking of each individual function using (but not limited to):

- prior to installation of I&C systems on site, the verification of all phases of the system production process and the validation of the integrated system against its specification by persons not involved in the specification and design activities;
- following installation of I&C systems on site, a demonstration that the safety system, in conjunction with the plant, performs in accordance with its specification. This demonstration shall be devised by persons not involved in the system's specification, design or manufacture;
- programme of dynamic testing, applied to the complete system to demonstrate that the system is functioning as intended in required scope as defined in paragraphs E,F,G

Note: the terms “plan” and “program” and associated duties and requirements are explained in the Technical Requirement Document*, Chapter 2.12

CA

For systems safety class 2 and class 3 shall be used graded approach.

2.10.7.2.D

The Supplier* shall provide testing programs to the Owner* for approval.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 112/122

2.10.7.2.E

The Supplier* shall optimize testing by dividing it into the factory testing and on Site* testing to shorten time of Commissioning* of I&C and simultaneously fulfil requirements on credibility, quality and scope of testing.

2.10.7.2.F

The testing in the factory shall be as far as possible comprehensive, overlapping and in sufficient scope to minimize on-site testing and eliminate potential on-site reworks.

2.10.7.2.G

The Supplier* shall provide the Owner* with all required verification and validation related to safety classified SSC, including independent V&V in sufficient scope and such a way that all corresponding requirements are fully satisfied, including Authorities* expectations and requirements. Main and irremovable criterion for establishment of the scope and the way of testing for safety I&C systems shall be such, that the Authority* do not require any additional excessive independent verification and validation (as e.g. dynamic testing, statistic testing, etc.) performed by the Owner* or by its Subcontractor*. Failure to meet the criterion shall lead to provision of different I&C safety system (also in terms of I&C platform).

GA

For the avoidance of doubt, scope and adequate methods (e.g. dynamic testing, statistic testing, etc.) shall be included in testing, as required and approved by the Owner* and Authorities*, at the stages of V&V plans and programs, and performance of the testing shall be completely under the responsibility and scope of the Supplier*.

2.10.7.2.H

The Supplier* shall already from the beginning of the design phase proceed with respect to necessity to get acceptance in timely manner of verification and validation during the licensing process. Special attention shall be paid to, but not limited to, the choice of a suitable system platform, the design of a suitable architecture and choice of pre-qualified components, and therefore scope of verification and validation including justification its scope and scrutiny, and corresponding design and design process aspects shall be duly incorporated in the overall planning and also in the planning of the individual systems.

2.10.7.3 OBSOLESCENCE PROGRAM

2.10.7.3.A

The Supplier* shall provide standard I&C obsolescence program, in addition, the Supplier* shall define the strategy to be followed to support the overall design life of the Unit* (qualification plan and the condition monitoring programs, the environmental conditions monitoring and the replacement program, etc.) as required in the Technical Requirements Document*, Section 2.4.2.

The main aim of I&C obsolescence program is to ensure as long as possible life cycle of installed I&C systems.

AA

The subject of the I&C obsolescence program shall be, but not limited to:

- to analyse the major I&C equipment that would affect the system availability
- to identify obsolescence issues (it is possible problems with particular component in the future base on MTBF, spare quantities and another aspects)

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 113/122

- to propose optimal spare parts quantity (optimal stock control)
- to resolve unavailable components issues (it is aftermarket supplies, refurbished components, limited production runs, functional replacements)
- to define migration path for oncoming upgrade

2.10.7.3.B

The Supplier* shall develop detailed obsolescence program procedures for subsequent routine operation under Owner* responsibility.

BA

The obsolescence program routine operation shall be supported by application software tools provided by Supplier*.

2.10.7.3.C

The Supplier* shall provide all necessary documentation (including lists of I&C system components in SW/database form) and supporting aids for obsolescence program activities.

CA

Initial obsolescence related data for all I&C system components shall also be provided by Supplier*.

CB

All data related to the obsolescence program shall be managed within the CM system

2.10.7.3.1 LONG TERM SUPPORT/SPARE PARTS

2.10.7.3.1.A

There shall be long term support from the system manufacturers (guaranteed by Supplier* up to the LTSA signature) to guarantee the supply of spare parts and technical know-how for the I&C systems during their lifetime. The Supplier* shall describe the basis of estimated value and the assumption for the estimation of the lifetime costs of the system.

2.10.7.3.1.B

The Supplier* shall define the necessary spare parts for whole scope of I&C systems and equipment as described in Operation and Maintenance Document*, Section 3.5.2 and in the Terms and Conditions*, Chapter 19.

When defining the scope of spare parts to be delivered, MTBF and MTTR values of equipment/components shall be considered together with Technical Specifications* and with Unit* and I&C availability targets. The main approach is that delivery of spare parts shall include the type-specific spare parts of the critical components of the I&C systems. The delivery also includes the Consumables* needed for the guarantee period.

See also Scope of Supply Document*, Section 2.2.5.1

2.10.7.3.1.C

The Supplier's* quality system shall be capable of ensuring the traceability of spare parts and also supporting for licensing purposes.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 114/122

2.10.7.3.1.D

Proper preservation of spare parts and requalification methods when using spare parts shall be developed and instructed for each type of spare part to guarantee their proper functioning after long time storage.

Maximum allowed storage time with defined environmental conditions shall be indicated for each type of spare part.

2.10.7.4 GENERIC

2.10.7.4.1 STATE-OF-THE-ART

2.10.7.4.1.A

The term State-of-the-art references the highest level of technical or general development linked to a device, system, method, technique, or scientific field achieved at a particular time.

2.10.7.4.1.B

State-of-the-art I&C systems, components and in particular I&C platforms which are in productive/active phase of their life cycle (productive/active phase means full sales support incl. full maintenance and repair support, active R&D) shall be implemented. Due date for this requirement is the date when the Unit* is scheduled to be put in commercial operation. The way and strategy of fulfilment of the requirement for supporting critical parts of I&C shall be sufficiently explained and justified with highest possible degree of confidence including (but not limited to) relevant references as e.g. historical experience of the manufacturers and their lifecycle management, realistic assumptions and data of current, previous and assumed products. It shall be done with close support of manufacturer.

2.10.7.4.1.C

All HW and SW components and products designed for I&C systems shall be continuously reviewed by the Supplier* during the life cycle up to the scheduled operation of the Unit* to validate the previous requirement B is fulfilled. Results shall be reported to the Owner*. If find out that there is potential for any component or product to be out-of-the-date or it occurred before the date of planned commercial operation, Supplier shall propose adequate replacement candidate. "Adequate candidate" means that component or product is manufacturer's successor of the original one, approved by Authority*, proven, fitting for purpose, in productive/active phase of its life cycle.

2.10.7.4.1.D

Where necessary, Supplier* shall propose improvement of the technical solution, with the aim to ensure state-of-the-art and smoothly licensable design, at the latest possible date to ensure feasible implementation of proposed design changes without any negative impact on construction schedule. Final decision to implement proposed design changes shall be subject of the Owner's* approval. Supplier* shall support the Owner's* decision making process with adequate and sufficiently detailed Documents* including consistent justification and where necessary formal approval of Authorities*.

2.10.7.4.1.E

Supplier* shall adequately take into account in its design process iterations with Authorities and with the Owner*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 115/122

2.10.7.4.2 UNIFICATION

2.10.7.4.2.A

The amount of different types of platforms, systems, software, equipment and components shall be minimized, unless otherwise approved by Owner* based on proper justification (e.g. safety reasons) made by Supplier* in writing. For example, only one I&C platform for safety class 3 and non-safety I&C throughout the Plant* shall be a goal.

2.10.7.4.2.B

Using systems, software, equipment, components without proper documentation (including, but not limited to, documentation of internal structure and their working), so called "black boxes", is not allowed.

2.10.7.4.3 PROVEN

2.10.7.4.3.A

All system, structures and equipment shall be of a well-proven and reliable design. The highest extent of commonality, uniformity and interchangeability applicable shall be provided. The design shall facilitate safe and easy maintenance and repair without jeopardizing Plant* and/or /Unit* availability and be suitable for prevailing or assumed environmental conditions in which the equipment is located.

2.10.7.4.3.B

Well-proven and reliable design shall be demonstrated by provision of adequate evidence of operational experience and of successful licensing as required in Technical Requirement Document*, Section 2.10.5.4.2.2.

2.10.7.5 SOFTWARE

2.10.7.5.A

Due to the unique nature of the programmable and computer based systems and their software, special attention shall be paid to the quality management and lifecycle design aspects of these areas.

2.10.7.5.B

Adequate measures shall be made to avoid any CCF and mitigate the consequences of CCF, special attention shall be paid to software CCF.

Software faults are typically caused by design errors. This means that the same failure mode may occur simultaneously in redundant parts of the system. The risk of a common cause failure related to design errors shall be brought to a low enough level by using the Diversity* principle and other possible means to ensure a sufficiently high reliability of the I&C functions. The measures and means (appropriate to importance to safety and availability) to avoid a common cause failure shall be duly analysed, documented and justified.

2.10.7.5.C

The probability of failure of digital I&C which include software shall be carefully justified and justification shall be well in advance available for approval by Authorities* and for approval by the Owner*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 116/122

2.10.7.5.D

All requirements and recommendations stipulated in the latest valid edition of report "Licensing of safety critical software for nuclear reactors; Common position of international nuclear regulators and authorised technical support organizations" shall be fully applied except for Software Statistical Testing (SST).

DA

Before the application, of all mentioned requirements and recommendations on design and design process, those shall be analysed by the Supplier* and their proposal for implementation shall be provided to the Owner* and Authorities* for approval.

2.10.7.5.E

The Supplier* shall provide the Owner* with software source codes, software documentation, configuration data necessary for operation, maintenance and modifications of the Plant*, for Licensing documents* elaboration, obtaining and retaining all Licenses* and licenses necessary for future operation of the Plant*, and for Owner's* independent verification and validation, etc.

2.10.7.6 SPECIFIC REQUIREMENTS ON LIMITATION SYSTEM

2.10.7.6.A

The Supplier* shall provide limitation system as Defence-in-Depth level 2 system for process control functions to prevent an AOO from escalating to DBA to minimize Protection system* activation.

AA

The concept of the Limitation system and its incorporation in overall architecture shall be provided in early stage of the Project* for approval of the Authorities*.

AB

If the limitation system is not part of design solution and Supplier* fails to justify non-existence of the system toward Authority*, then Supplier* shall add adequate Limitation system including appropriate limitation functions in to design solution without any negative impact on price and schedule.

AC

Other requirements relating to limitation system are defined in the section 2.1.7.4.2

2.10.7.6.B

Systems performing limitation functions shall be sufficiently resistant to Single Failure* so probability of loss of the functions to be performed shall be minimized as much as possible by application of Redundancy* in following system parts:

1. Field sensors
2. Inputs / outputs modules
3. Processor modules
4. Power supplies
5. Communication networks

2.10.7.6.C

The Supplier* shall apply in the design sufficient independence between systems Defence-in-Depth level 2 and Defence-in-Depth level 1 as far as achievable.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 117/122

2.10.7.7 SPECIFIC REQUIREMENTS ON DAS

2.10.7.7.A

Non-computer based Diverse Actuation System (DAS) which includes Diverse Reactor Protection System* and Diverse ESFAS (incl. diverse H-MI, sensors, final elements) shall be provided as diverse backup of computer based Reactor Protection System* and ESFAS.

The design of non-computer based Diverse Actuation System* shall be deterministic, in order to mitigate CCF consequences and in connection with the probabilistic safety assessment.

AA

The concept of non-computer based Diverse Reactor Protection System* and Diverse ESFAS and its incorporation in overall architecture shall be provided in early stage of the Project* for approval of the Authorities*.

AB

Diverse Reactor Protection System* and Diverse ESFAS shall include back-up Safety Functions* in sufficient scope, which belong to 3b level of defence in depth.

2.10.7.7.B

NA

2.10.7.8 SPECIFIC REQUIREMENTS ON PAMS

2.10.7.8.A

Instruments required for identification and monitoring of DBC and DEC shall withstand the specified environmental conditions.



2.10.7.9 SPECIFIC REQUIREMENTS ON MONITORING, SURVEILLANCE, DIAGNOSTIC AND PROGNOSTIC SYSTEM

2.10.7.9.A

The Supplier* shall provide monitoring, diagnostic and prognostic information system to ensure advanced monitoring, surveillance, diagnostic and prognostic functions as stipulated in section 2.10.5.4.2.3.14 and the solution shall adapt and integrate all requirements on monitoring, surveillance, diagnostic and prognostic functions and systems defined in the EPC Contract*.

Prognostic functions/system shall follow solution stipulated in section 2.10.5.4.2.3.14.

2.10.7.9.B

The Supplier* shall provide state-of-the-art, comprehensive and proven solution of the monitoring, diagnostic systems, which shall be open to custom adjustment and development,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 118/122

shall be open to other technologies and shall be interconnected to share/transmit data from/to other I&C systems and to other IT systems as necessary, including Operational Configuration Management System*.

Prognostic functions/system shall follow solution stipulated in section 2.10.5.4.2.3.14.

BA

To support the effective utilization of monitoring, diagnostic system and integration with other systems the Supplier* shall provide a robust and proven solution based on single unified database, platform and framework.

2.10.7.9.C

For the monitoring, diagnostics the Supplier* shall use available information maintained in other I&C systems, but shall also develop SSC dedicated to monitoring and diagnostic information system (if information for the monitoring and diagnostics are not available in other I&C systems) including, but not limited, sensors, electronic communication, and data acquisition systems.

Prognostic functions/system shall follow solution stipulated in section 2.10.5.4.2.3.14.

CA

The Supplier* shall carefully consider and duly analyse use of state-of-the-art technologies for data acquisition with regard to the benefits for safety, availability of the Plant*.

CB

The Supplier* shall provide provisions of IT areas for using wireless technology for monitoring and diagnostic for future data acquisition.

2.10.7.9.D

The capabilities of monitoring and diagnostic system (including all relevant subsystems) shall be compatible and shall be commensurate in all aspects with the dynamics of the physical phenomena which are monitored.

Prognostic functions/system shall follow solution stipulated in section 2.10.5.4.2.3.14.

2.10.7.9.E

The Supplier* shall implement adequate measures, according to cyber security program, to limit the effects of cyber security threats.

2.10.7.9.F

The Supplier* shall apply on diagnostic data all relevant procedures according to data management program to support the entire data lifecycle.

See also the Technical Requirements Document*, Chapter 2.12.

2.10.7.9.G

The Supplier* shall encompass into monitoring and diagnostic program also all sensors and actuators important for safety or availability of the Plant*, and shall develop state-of-the-art methods of their evaluation and implement them in the monitoring and diagnostic information system.

Prognostic functions/system shall follow solution stipulated in section 2.10.5.4.2.3.14.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 119/122

2.10.7.9.H

The monitoring and diagnostic system shall provide tools to acquire, maintain and present information on all functions relating to self-monitoring, self-diagnostic, continuous testing, on-demand and periodic testing and their results applied in the project.

Prognostic functions/system shall follow solution stipulated in section 2.10.5.4.2.3.14.

2.10.7.9.I

The monitoring and diagnostic system shall also collect the necessary information and reports from appropriate off-line diagnostic systems (for example laboratory) and shall incorporate them into execution of diagnostic functions as needed.

Prognostic functions/system shall follow solution stipulated in section 2.10.5.4.2.3.14.

2.10.7.10 IMPLEMENTATION

2.10.7.10.A

The Supplier* shall be responsible for overall coordination of I&C system development including development of all plans, programs, reviews, analyses or specification of requirements on systems, procurement, quality requirements fulfilment, overall integration, Commissioning* and operation.

2.10.7.10.B

The Supplier* shall identify key positions in development processes of I&C systems and shall preferably cover key positions by its own experts or shall demonstrate full availability of designated project experts. Key positions shall always include personnel responsible to control and coordinate activities associated with overall I&C lifecycle, system lifecycle, overall integration, Commissioning*, operation and maintenance.

2.10.7.10.C

The key positions shall be covered by sufficient number of well skilled experts with relevant experience on comparable I&C nuclear projects. Relevant experience means relevance in terms of type of task, complexity, scope of I&C project and implemented I&C system platforms, overall architecture, individual systems, etc.

2.10.7.11 DOCUMENTATION

2.10.7.11.A

The Supplier* shall duly provide all I&C specific Documents* following requirements stipulated in the Technical Requirements Document*, Chapter 1.3.

2.10.7.11.B

The Supplier* shall process, verify, maintain, and keep under the control all the I&C relating Documents* and provide them to the Owner*, final versions respecting as-built status shall be provided through the Operational Configuration Management System*.

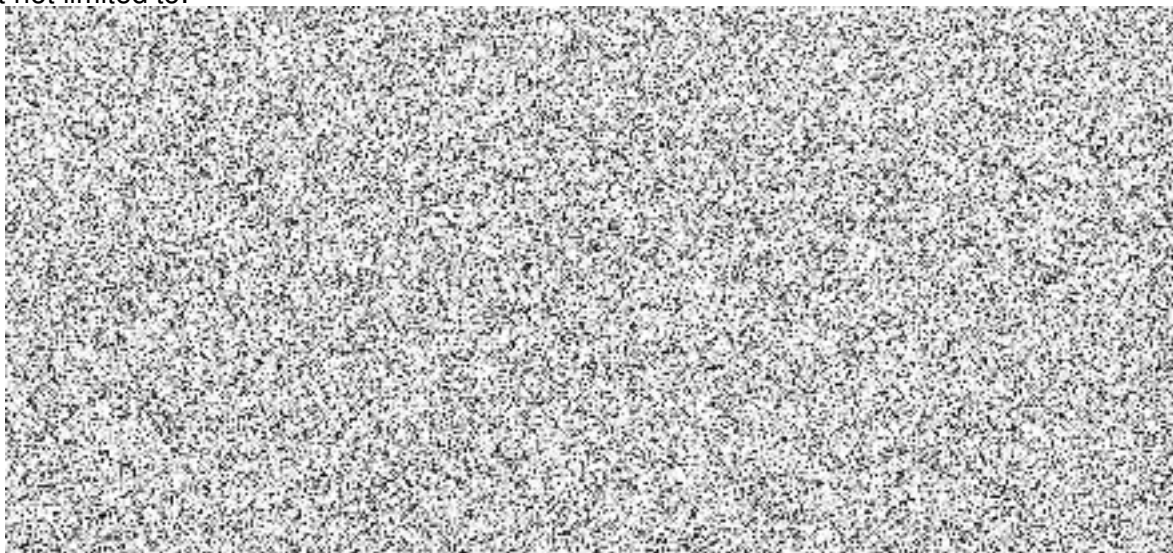
2.10.7.11.C

Other related requirements are defined in the Terms and Conditions* in the Project Management Document* and in the Technical Requirements Document*, Chapter 2.12.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 120/122

2.10.7.11.D

The Supplier* shall provide the Owner* with comprehensive information within a well-structured data-model (also called design database) covering all internal and external elements of I&C systems and equipment and their relations, application functions, including but not limited to:



DA

Mentioned comprehensive design database shall be used as design/engineering tool and shall be generated, created and maintained as much as possible by software tool.

DB

Mentioned comprehensive design database shall be properly documented and shall be fully integrated into Operational Configuration Management System*.

2.10.7.12 AGEING



2.10.7.12.B

The Supplier* shall identify, analyse and provide its knowledge of all ageing-related degradation mechanisms for all I&C SSC, including benchmarking of the consequences of degradation mechanisms under applicable conditions (e.g. description of degradation mechanism, predictive models, patterns of analytical procedures, initial data, etc.)

BA

The Supplier* shall provide the Owner* with all I&C SSC related predictive models and initial data to extrapolate behaviour of systems, supporting structures and components based on user defined scenarios, in order to assess the maintenance of the relevant margins throughout the design lifetime of the I&C SSC.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 121/122

BB

Initial data shall contain among others reliability data, real capacity of systems and existing design margins for operation verified and recorded in the Commissioning Phase* of the Unit* / Plant* and data on the degree of impact of the degradation mechanism on design life.

BC

I&C SSC initial data shall be provided in the form of well-structured database / tables, well documented, identifiable, sortable, and, including appropriate tools, integrated into the CM information system.

2.10.7.12.C

The Supplier* shall provide a list which assigns category to I&C SSC according to their design life and required replacement period and shall develop the strategy and identify and apply appropriate measures to ensure its design lifetime.

CA

The additional margins shall be included into design of I&C SSC to compensate ageing effects with the goal to maintain qualification throughout SSC's design lifetime.

CB

The Supplier* shall prevent already in the design the use of systems, support structures, components, equipment, and parts with short lifetime and those having potential to be obsoleted very fast.



CD

The comprehensiveness of the condition monitoring of SSC, as well as the methods employed, monitoring intervals, resourcing, acceptance limits, and other factors affecting the effectiveness of condition monitoring, shall be commensurate with the safety and availability significance of the SSC being monitored

2.10.7.12.D

Plant Life Management and Ageing Management Programs and related procedures shall be provided by the Supplier* in order to maintain the appropriate margins during the Plant* and/or /Unit* life.

DA

The tools (SW and HW) implementing all relating procedures, models, analytical tools shall be provided and integrated into the CM.

DB

Sufficient and appropriate instrumentation, recording and evaluation means and systems shall be provided in order to assess real impact of ageing mechanisms on I&C SSC and residual margins for qualified equipment during the Plant* and/or /Unit* life.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.10 INSTRUMENTATION AND CONTROL	Page 122/122

DC

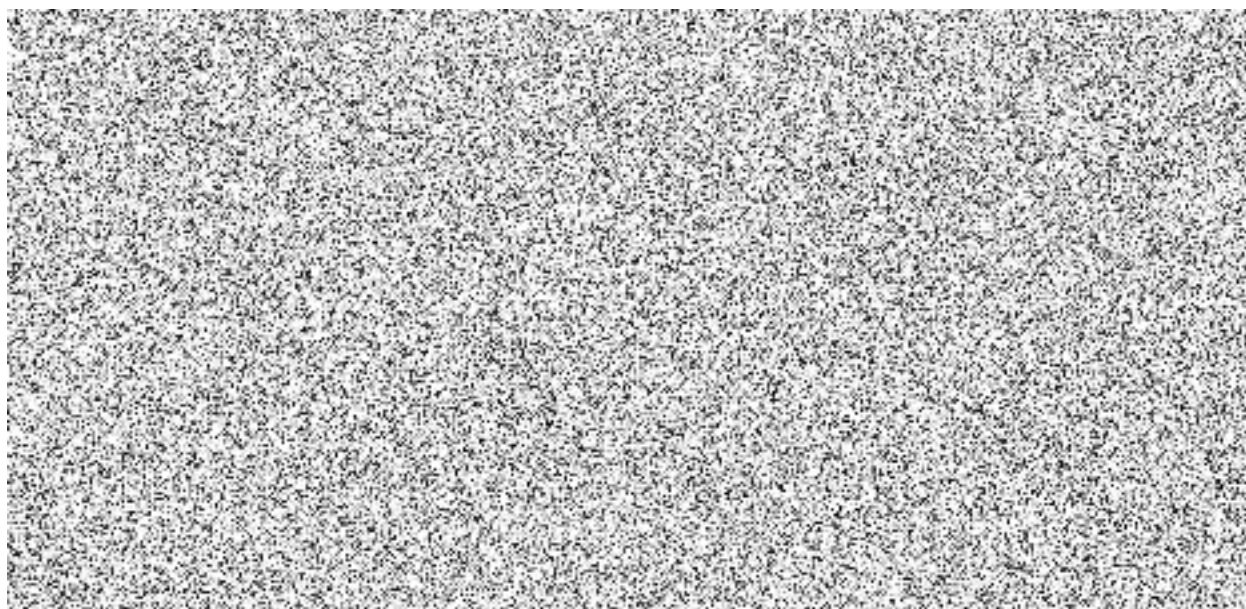
Additionally to Section 2.14.2.7, the monitoring systems providing data for Plant Life Management, Equipment Qualification Program and Ageing Management Programs shall include environmental conditions monitoring, process conditions monitoring and SSC condition monitoring and for Equipment Qualification Program in such scope to be able to verify residual lifetime and to identify the cause of deviation from original assumptions.

2.10.7.12.E

The well-recognized methodology shall be provided for identification, detection and surveillance of ageing mechanisms.

EA

The methodology shall be based on, but not limited to, statistical methods, testing, reliability modelling, measurement and other relevant methods.



Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.11 LAYOUT RULES	Page 1/85

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.11 LAYOUT RULES
VERSION DATE:	March 2025

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.11 LAYOUT RULES	Page 2/85

This Page Intentionally Left Blank

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.11 LAYOUT RULES	Page 3/85

CONTENTS

CHAPTER 2.11 LAYOUT RULES	4
2.11.0 INTRODUCTION.....	4
2.11.1 GENERAL ARRANGEMENTS AND SITE ASPECTS.....	4
2.11.2 SAFETY AND HAZARD ASPECTS.....	22
2.11.3 EQUIPMENT ARRANGEMENT RULES.....	51
2.11.4 ROUTING OF SERVICES.....	61
2.11.5 SITE SUPPORT SYSTEMS	76
2.11.6 SECURITY	77
2.11.7 DECONTAMINATION FACILITIES.....	80
2.11.8 LABORATORIES	80
2.11.9 LIFTING EQUIPMENT	82
2.11.10 SHELTERS	85

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.11 LAYOUT RULES	Page 4/85

CHAPTER 2.11 LAYOUT RULES

2.11.0 INTRODUCTION

This Chapter outlines the requirements that shall be taken into consideration by the Supplier* when establishing the principles for layout.

In general layout means arrangement of any elements (including any SSC element or group of any SSC elements). If any additional word is used with the term „layout“ (Construction Site* layout, Plant* layout, Piping layout, ..., etc.), it specifies the arrangement of specific elements or group of specific elements.

The following Sections address all stages of Plant* lifecycle from designing, construction through to operation, maintenance, repair and replacement. The topics covered include:

- guidelines which enhance safety and take account of potential hazards, including Redundancy*, Physical Separation* and Fire Barriers*,
- definition of environmental zones for radiation and contamination control, and personnel access and escape routes,
- access around the Plant* for installation, operation and maintenance,
- separation and segregation for the routing of services.

There are also Sections devoted to laboratory requirements and lifting equipment.

This Chapter does not set out to specify a particular Plant* layout but specifies criteria to be applied when developing that layout.

2.11.1 GENERAL ARRANGEMENTS AND SITE ASPECTS

2.11.1.1 OVERALL SITE AND BUILDING LAYOUT CONSIDERATIONS

2.11.1.1.1 PLANT LAYOUT

2.11.1.1.1.A

The Plant* layout shall be based on the Reference Plant* design arrangement and standard building design reflecting the Site* conditions.

2.11.1.1.1.B

Plant* layout shall be prepared by the Supplier* showing the size and location of the buildings, other structures and areas associated with the Nuclear Island*, Power Generation Plant*, Balance of Plant*, Support Facilities* and facilities under Owner's* scope and as defined below in Sections 2.11.1.1.2 and 2.11.1.1.3.

BA

The Supplier* shall locate permanent facilities at the Construction Areas*, On Site Facilities* are possible to locate at the Construction Areas* also.

BB

The Supplier* shall locate temporary facilities at the On Site Facility Areas* and/or to the Construction Areas*.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.11 LAYOUT RULES	Page 5/85

BC

The Supplier* shall not locate any permanent facilities associated with the Nuclear Island* and Power Generation Plant* and the Balance of Plant* and preferably also the Support Facilities* at the Reserved Construction Area*. Temporary On Site Facilities* that can be easily dismantled or removed and permanent Support Facilities* could be located at the Reserved Construction Area* only if location and design of these facilities do not deteriorate geological, hydrogeological, geotechnical, seismic conditions and do not impair or even exclude possibility of future construction of later Unit* at the time of construction of the Plant* within the construction area A1, A4 together with all necessary support facilities and all necessary and practical interconnections with the Plant* without need for future design changes. This possibility of use Reserved Construction Area* for the Plant* shall be carefully analysed and justified within Conceptual Design* as requested in the Chapter 2.12.1.2.3 of the Technical Requirements Document* and approved by the Owner*. For the avoidance of doubt, requirements of the EPC Contract* relating to the On Site Facility Area* or Construction Area* shall be also applicable to the Reserved Construction Area*, depending on its use.

Construction Area* shall be also applicable to the Reserved Construction Area*, depending on its use.

2.11.1.1.1.C

Plant* layout shall be based on Site* characteristics and information included in Volume 5.

CA

The Supplier shall not deteriorate geological, hydrogeological, geotechnical, seismic conditions and possibility of future construction of another nuclear power plant within adjacent areas in general.

2.11.1.1.1.D

The Supplier* shall provide to the Owner* with all analyses used in order to confirm that the layout of the buildings, other structures and areas are in accordance with the Rules*.

DA

The Supplier* shall provide to the Owner* with all analyses used in order to confirm that the layout of the interior of the buildings and other structures (e.g. human factors analyses of the control room to increase operational effectiveness) are in accordance with the Rules*.

DB

The Supplier* shall provide to the Owner* with all analyses used in order to confirm that the layout of the interior of the buildings and other structures (e.g. analyses of the steam generator replacement) are in accordance with operation, maintenance, testing requirements.

2.11.1.1.1.E

Any Document* related to layout shall define boundaries (interfaces) between the Plant* SSC and On Site Facilities* (including temporary structures and equipment located within the Construction Areas* used for construction and Commissioning*). The information about time frame usage of On Site Facilities* shall be stated in the Document*.

EA

Any Document* related to layout shall define boundaries (interfaces) between the Plant* permanent SSC and Non-Permanent Equipment* (e.g. fresh fuel packages, spent fuel casks,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.11 LAYOUT RULES	Page 6/85

nuclear waste containers, mobile safety equipment, structures and equipment used temporarily for testing, inspections, maintenance or replacement of Plant* SSCs, etc.).

2.11.1.1.1.F

Buildings, other structures and areas within the Plant* shall be located and designed with the following considerations, but not limited to:

- functional relationship of main power block, auxiliary and ancillary buildings, and circulating water flow routes,
- flexibility for improvements of the general arrangement to take account of different external and internal hazards or specific local requirements,
- separation and alignment of the Plant* for reasons of nuclear safety,
- presence in the vicinity of existing operating plants (see also Technical Requirements Document* Section 2.11.1.1.5),
- provision of adequate protection against internal and external hazards and of influence reduction of non-seismic resistant buildings to the seismic resistant buildings,
- provisions of floor and equipment drain sumps separated to clean and shielded potentially contaminated (critical to building layout and elevation of compartments),
- maintenance and operation need for easy and adequate access, pull space (for coils, heat exchangers, chillers, boiler tubes, filters etc.), laydown space, and heavy lifts,
- personnel flow needed for operation, testing and maintenance,
- provision of adequate number, design and layout of supports for piping, cable tray, conduit, HVAC etc. especially in radioactive contaminated areas to facilitate operation and maintenance,
- provision of adequate construction access for construction personnel and machinery,
- provision of adequate access and emergency routes in case of internal and external hazards,
- provision of facilities for the connection of mobile equipment where necessity for instance due to safety reasons,
- the ability to accommodate additional systems and equipment in the future.

2.11.1.1.1.G

The Supplier* shall provide specific clarifications and information (e.g. in a configuration report) upon which basis the points listed below have been elaborated:

- 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,
- As Low As Reasonably Achievable (ALARA) considerations,
- ability of the design to accept several different component and equipment suppliers,
- waste management of the low and medium activity (amount of activity released, capacity of storage or other strategies),
- connection of the overhead transmission lines serving the Site*,
- the layout of 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).
- arranging cable and pipe runs to the minimum practicable length,

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.11 LAYOUT RULES	Page 7/85

- architecture, landscaping and maintenance of the environment in the vicinity of the Site*,
- aesthetic appearance.

GA

Requirements related to fire protection are also specified in Section 2.4.5.8.2.2.

2.11.1.1.1.H

The arrangement of buildings and components shall be such that access for construction, maintenance, testing, Inspection* and operation is not adversely impacted. Consideration shall be given to personnel and equipment access, and the need for adequate working space during construction, operation, and maintenance.

2.11.1.1.1.I

Equipment layouts shall provide adequate space for access and replacement.

2.11.1.1.1.J

The building design and the Plant* arrangement shall, in general, provide facilities for the security and radiological control of personnel and materials. These facilities shall be sized on the basis of all maintenance operations and shall allow passage of personnel with the minimum of delay.

2.11.1.1.1.K

The Plant* layout shall be arranged so that construction can continue despite possible delays in equipment deliveries.

KA

The Plant* layout shall be arranged so that different progress of construction works in one unit will not have negative impact on another Unit.

2.11.1.1.1.L

The Supplier* shall prepare a crane access study which demonstrates adequate crane coverage of the Plant* structures during the various phases of construction. The swing, reach and capacities of cranes shall be included.

2.11.1.1.1.M

The arrangement of each building it-self, the arrangement of duplicated buildings or group of buildings at Plant* layout shall avoid the mirror image arrangements.

2.11.1.1.1.N

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

2.11.1.1.1.O

The Plant* design shall be based on hazard consideration requirements specified in Sections 2.1.2.6 and 2.4.1.

Dukovany 5&6	EPC CONTRACT – CONTRACT SPECIFICATIONS TECHNICAL REQUIREMENTS DOCUMENT VOLUME 2 GENERIC AND NUCLEAR ISLAND REQUIREMENTS CHAPTER 2.11 LAYOUT RULES	Page 8/85

2.11.1.1.1.P

Collisions of the new civil structures with the Existing Nuclear Power Plant* shall be minimized. The collision shall be specified, and shall be prepared corrective provisions, negotiated and approved by the Owner*.

2.11.1.1.1.Q

The Plant* design shall provide the drainage concept and media supply for the whole site. The media supply shall be designed as circuit network.

2.11.1.1.1.R

In case the information on the technical state of the technical infrastructure, civil structures, land preparation or the other activities of the Owner* is modified, the Owner* will provide the new set of information or documentation of the modified structures to the Supplier*. The Supplier* shall integrate the provided information to the Plant* design and Plant* layout.

2.11.1.1.1.S

The complete list of civil structures, technology systems and subsystems shall be provided. The list of civil structures, technology systems and subsystems shall contain the qualified and unified labelling system. The labelling system of the civil structures, technology systems and subsystems shall be implemented in the Site* layout plan.

2.11.1.1.1.T

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

2.11.1.1.1.U

The Plant* layout shall include the design stage and geodetic survey stage of the Plant*. The Supplier* shall provide the Owner* the Plant* layout.

2.11.1.1.1.V

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

2.11.1.1.1.W

Layout of the Plant* shall take into account future implementation of district heating (e.g. placement of pipework, heat exchange station, etc.), see Section 2.2.2.

2.11.1.1.1.X

The Supplier* shall reserve an extra area for spent fuel interim storage and also for additional storage of fresh fuel.

XA

The area for spent fuel interim storage shall be sized to accommodate entire spent fuel and used Core Components* production during the Plant* life time period (at least 60 years) and equipment for spent fuel management (e.g. casks re-sealing, reloading etc.). The size of area for fresh fuel storage shall be agreed with the Owner*.

XB

The areas shall be located at Construction Areas*, considering requirements for nuclear safety, radiation and physical protection and emergency preparedness and accessibility and infrastructure connectivity (utilities and transportation) during its construction and operation Phase*.