EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT** **VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS**
VERSION DATE:	**March 2025**

CONTENT:

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SIGNATURE PAGE

IN WITNESS WHEREOF the Owner* and the Supplier* have hereby signed the above listed parts of the EPC Contract*.

For and on behalf of the **OWNER**, **Elektrárna Dukovany II, a. s.**

Signature
Name
Title

Signature
Name
Title

For and on behalf of the **SUPPLIER, Korea Hydro & Nuclear Power Co., Ltd.**

Signature
Name
Title

Signature
Name
Title

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS CHAPTER 4.0 INTRODUCTION TO VOLUME 4**
VERSION DATE:	**March 2025**

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CHAPTER 4.0 INTRODUCTION TO VOLUME 4

A

Volume 4 provides component requirements and functional requirements and preferences of the Owner* for the systems that are specific for Power Generation Plant*, Balance of Plant* and Support Facilities*.

AA

In addition to the requirements specific to PGP, BOP and Support Facilities* stipulated hereunder in Volume 4, a major part of Volume 2 shall also apply to the design of PGP, BOP and Support Facilities*.

AB

Those most remarkable are emphasized in Sections 4.0.1 to 4.0.3.

AC

Some requirements which are design dependent are left undefined because they go beyond the scope of this document. A possible solution shall be proposed by the Supplier* of the Plant* to the Owner*.

AD

Design of PGP, BOP and Support Facilities* shall be compatible with NI.

AE

PGP, BOP and Support Facilities* shall comply with the requirements of the Rules* which are listed in Chapter 2.5.

AF

Requirements related to reliability and availability are in detail described in Section 2.2.7. Requirements related to operational capabilities are in detail described in Section 2.2.2. Requirements related to design life are in detail described in Section 2.4.2.

AG

Requirements related to performance of the interfacing systems of the NI are in detail described in Section 4.1 as main functional interfaces (e.g. steam characteristics); for the other interfacing systems the required performance is in detail described in the related sections of Chapters 4.2 to 4.6.

AH

The Power Generation Plant* consists of all facilities to transform steam from NSSS to EHV electric power including, structures, buildings and systems for operation, control, maintenance and safety management.

AI

The content of Volume 4 is as follows:

- Chapter 4.0 - Introduction to Volume 4.
- Chapter 4.1 - Interfaces between the Power Generation Plant* or Balance of Plant* and the Nuclear Island* or grid.
- Chapter 4.2 - Main turbine generator systems.
- Chapter 4.3 - Steam, condensate and feedwater systems.

- Chapter 4.4 - Electric power systems.
- Chapter 4.5 - Circulating water systems.
- Chapter 4.6 - Auxiliary systems.
- Chapter 4.7 - Other buildings and civil engineering works.
- Chapter 4.8 - External Infrastructure.

AJ
The content of Volume 4 covers most of the Owner's* requirements for the assessment, licensing issues (where applicable), design, construction, test and operation of PGP, BOP and Support Facilities* of the future Plant*.

4.0.1 OVERALL REQUIREMENTS

A
The Supplier* shall design the Power Generation Plant*, Balance of Plant* and Support Facilities* to comply with the requirements and respect information, conditions and parameters referred below.

AA
Requirements for Plant* size are defined in Section 2.2.1.

AB
Requirements for availability targets are defined in Sections 2.2.7.2.1 and 2.2.7.2.2.

AC
Requirements for availability analysis are defined in Section 2.18.5.

AD
Requirements for specific design features for reducing unavailability are defined in Section 2.2.7.3.

AE
Requirements for proven design are defined in Section 1.2, Section 2.7.0.3.2 and Section 2.12.2.

AF
Requirements for Plant* design life are defined in Section 2.4.2.

AG
Requirements for conditions of operation are defined in Sections 2.2.2 (including 2.2.2.1, 2.2.2.1.1 – 2.2.2.1.3), 2.2.2.4, 2.2.2.5 and 2.2.2.7, Sections 2.3.1 (including 2.3.1.2.2), 2.3.2 (including 2.3.2.1 and 2.3.2.1.2), 2.3.3 - 2.3.6.

4.0.2 LAYOUT

The Supplier* shall design the Power Generation Plant*, Balance of Plant* and Support Facilities* to comply with the requirements and respect information, conditions and parameters referred below.

A
Requirements for PGP general arrangement and site access are defined in Section 2.11.1 and its subsections.

B
Requirements for Fire areas* and Fire zones* are defined in Section 2.11.2.4.2.

C
Requirements for environmental zones are defined in Section 2.11.2.5 and its subsections.

D
Requirements for equipment arrangement rules are defined in Section 2.11.3 and its subsections.

E
General requirements for routing of services are defined in Section 2.11.4.1 and 2.11.4.2.

EA
Requirements for piping layout are defined in Section 2.11.4.3.1.

EB
Requirements for valve layout are defined in Section 2.11.4.4.

EC
Requirements for cable layout are defined in Section 2.11.4.5.

F
Requirements for Site* support systems are defined in Section 2.11.5.

G
Requirements for security are defined in Section 2.11.6.

H
Requirements for decontamination facilities are defined in Section 2.11.7.

I
Requirements for laboratories are defined in Section 2.11.8.

J
Requirements for lifting equipment are defined in Sections 2.11.9.1, 2.11.9.2, 2.11.9.3.

K
Requirements for interdisciplinary design reviews are defined in Sections 2.12.11.

4.0.3 DESIGN REQUIREMENTS

A
The Supplier* shall design the Power Generation Plant*, Balance of Plant* and Support Facilities* to comply with the requirements and respect information, conditions and parameters referred below.

AA
Site* requirements, information, conditions and parameters are specified in Section 2.4.1 and Chapters 5.1 – 5.3.

AB
Seismic design requirements are defined in Section 2.4.4.2 and Section 2.4.6.

AC
Requirements for design loads and conditions are defined in Section 2.4.5.

AD
Requirements for assessing availability of the Plant* are defined in Chapter 2.18.

AE
Pipeworks systems requirements are defined in Section 2.4.7.

AF
Component design life requirements are defined in Section 2.4.2.

AG
Noise related requirements are defined in Section 2.14.1.3.1.

AH
Vibrations related requirements are defined in Section 2.7.0.3.8.

AI
Functional requirements for valves are defined in Sections 2.7.2.2 – 2.7.2.14.

AJ
Functional requirements for valve actuators are defined in Sections 2.7.3.1 – 2.7.3.5, 2.7.3.7, 2.7.3.8.

AK
Functional requirements for pumps are defined in Section 2.7.4.1 – 2.7.4.15.

AL
Functional requirements for heat exchangers are defined in Sections 2.7.5.2 – 2.7.5.10.

AM
Functional requirements for tanks are defined in Sections 2.7.6.1, 2.7.6.2 and 2.7.6.4.

AN
Functional requirements for bolted joints and threaded fasteners are defined in Sections 2.7.7.1 – 2.7.7.3.

AO
Functional requirements for piping and fittings are defined in Sections 2.7.8.1, 2.7.8.2, 2.7.8.4 (including 2.7.8.4.1 – 2.7.8.4.3).

AP
Functional requirements for filters and ion exchangers are defined in Sections 2.7.9.1 – 2.7.9.3 (including 2.7.9.3.1 – 2.7.9.3.4) and 2.7.9.4 (including 2.7.9.4.1 – 2.7.9.4.3).

AR
Functional requirements for electrical equipment are defined in Sections 2.7.11.2 – 2.7.11.4 (including 2.7.11.4.1 – 2.7.11.4.8) and 2.11.4.5.

AS
Functional requirements for HVAC equipment are defined in Sections 2.7.13.1 – 2.7.13.7.

AT
Functional requirements for handling equipment are defined in Section 2.7.14.2.

AU
Materials related requirements are defined in Sections 2.6.1 – 2.6.3, 2.6.4.1.5 (including 2.6.4.1.5.1 and 2.6.4.1.5.2) and 2.6.4.1.6 – 2.6.4.1.8.

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CONTRACT SPECIFICATIONS

DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS CHAPTER 4.1 INTERFACES BETWEEN THE POWER GENERATION PLANT OR BALANCE OF PLANT AND THE NUCLEAR ISLAND OR GRID**
VERSION DATE:	**March 2025**

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CONTENTS

CHAPTER 4.1 INTERFACES BETWEEN THE POWER GENERATION PLANT OR BALANCE OF PLANT AND THE NUCLEAR ISLAND OR GRID

4.1.0 INTRODUCTION

4.1.0.A
Many systems of the Power Generation Plant* or Balance of Plant* interface with the Nuclear Island* or the grid. A general description of boundaries and interfaces of PGP and BOP is given in the related sections of Chapters 4.2 to 4.6. In this chapter only a brief description of the main interfaces and boundaries is given.

4.1.0.B
In order to ensure consistency among the various interfacing systems of the Plant*, boundaries and interfaces shall be specified:

- for NI
- for PGP
- for BOP
- for the other Unit*

4.1.0.C
The Supplier* shall confirm that the design and the functional requirements of both sides of every interface have been clearly identified and that the interfacing conditions match.

4.1.0.D
Being responsible for the whole Plant*, the Supplier* shall provide the complete set of interfaces with their detailed description and shall ensure consistency among NI, PGP, BOP and the other Unit* interfaces.

4.1.0.E
The types of interfaces are the following:

- functional interfaces,
- physical interfaces or boundaries.

4.1.1 FUNCTIONAL INTERFACES BETWEEN THE PGP OR BOP AND THE NI OR GRID

4.1.1.A
A functional interface is defined as a set of conditions, specifications or requirements relevant to two (or more) functionally connected systems that shall be satisfied in order to assure their correct operation.

4.1.1.B
Functional interfaces shall be detailed to avoid inconsistencies among systems of PGP or BOP and the NI or grid.

4.1.2 PHYSICAL INTERFACES BETWEEN THE PGP OR BOP AND THE NI OR GRID

4.1.2.A
A physical interface is defined as the boundary between two (or more) systems. Depending upon the definition of a system, the interface may be inside the system itself.

4.1.2.B
Physical interfaces shall be specified because there may be limits of supply, or because there may be a change in the classification of materials, components and equipment at the interface level.

4.1.3 MAIN INTERFACES BETWEEN THE PGP OR BOP AND THE NI OR GRID

4.1.3.A
The main interfaces between the Supplier's Scope of Supply* and the Owner's Scope of Supply* are listed in the Scope of Supply Document*. A complete description of the Site* interfaces is in detail listed in Volume 5.

4.1.3.B
The Supplier* shall compile and provide the Owner* with a complete list of all interfaces between PGP or BOP and NI or grid and the other Unit* for all systems that govern the function and design of the interface and shall periodically update the list until the Provisional Takeover* of the latter Unit* if changes are made.

4.1.3.1 MAIN INTERFACES BETWEEN THE PGP OR BOP AND THE NI

4.1.3.1.A
The main interfaces between PGP and NI are in the following systems:

- main steam pipework system,
- main feedwater system,
- turbine generator I&C system,
- electrical power system.

AB
The interfaces between PGP or BOP and NI are specified system by system in Chapters 4.2, 4.3, 4.5 and 4.6.

4.1.3.1.1 MAIN STEAM PIPEWORK SYSTEM

4.1.3.1.1.A
The system includes piping and valves provided to connect the Nuclear Steam Supply System* to the inlet of the high pressure turbine and to the steam bypasses.

AB
See Sections 4.3.1.2 and 2.8.2.3.2 for detailed requirements.

4.1.3.1.2 MAIN FEEDWATER SYSTEM

4.1.3.1.2.A
See Sections 4.3.2.6 and 2.8.2.3.2 for detailed requirements.

4.1.3.1.3 TURBINE GENERATOR I&C SYSTEM

4.1.3.1.3.A
The I&C of many systems of PGP (including turbine-generator) interfaces with the overall general I&C of the Plant* and/or Unit*. For these systems, the physical interface is at the terminals of the control devices and instruments.

AB
The system includes the equipment necessary to generate the signals for the overall Plant* and/or Unit* as applicable I&C and to receive the signals from the overall Plant* and/or Unit* I&C. See Chapter 2.10 for detailed requirements for I&C equipment.

4.1.3.2 INTERFACES BETWEEN THE UNIT AND THE GRID

4.1.3.2.A
Physical interfaces between the Unit* and the grid are specified by DSO and TSO in the 110kV and 400kV switchyards.
See the Scope of Supply Document*, Section 4.4 for detail requirements of Supplier's Scope of Supply* and Connection Points requirements.

4.1.3.3 INTERFACES BETWEEN THE I&C SYSTEM OF THE PGP AND THE GRID

4.1.3.3.A
The I&C of the PGP is included in the general Plant* and/or Unit* I&C, which controls the signal exchange with the grid.
See Sections 2.10.5.4.2.4 and 2.10.6 of this Technical Requirements Document*.

4.1.3.4 STANDARDISATION / INTERFACE POLICY
Requirements for standardisation are defined in Section 2.12.5.

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DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS CHAPTER 4.2 MAIN TURBINE GENERATOR SYSTEMS**
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CHAPTER 4.2 MAIN TURBINE GENERATOR SYSTEMS

4.2.0 INTRODUCTION

A
This Chapter establishes the functional requirements that apply to the main turbine generator systems.

AB
A short description of each system, or subsystem, is given in terms of scope, interfaces, and overall functions, in order to clarify the scope and application of the requirements.

4.2.1 SYSTEM DEFINITION

4.2.1.1 SCOPE

4.2.1.1.A
The main turbine generator system comprises:

- a steam turbine,
- a generator,
- a main condenser,

together with associated auxiliary and support systems.

4.2.1.1.B
PGP shall feature a single steam turbine generator.

4.2.1.1.C
The steam turbine shall be generally in accordance with the requirements of the Rules* (in particular CSN EN IEC 60045-1) unless otherwise specified.

4.2.1.2 INTERFACES

4.2.1.2.A
The main turbine generator system interfaces with:

- the main steam supply system at the connections to the steam turbine stop and control valves,
- the cold reheat and hot reheat connections to the Moisture Separator and Reheater*,
- the steam extraction system at the connections to the HP, IP (if any) and LP turbine casings,
- the feedwater and condensate system,
- the various cooling systems,
- the turbine bypass system at the main condenser connection,
- the generator main electrical busbar connections.

4.2.1.3 PROVEN TECHNOLOGY

4.2.1.3.A
The main turbine generator system shall be designed using systems, components, and equipment proven in operation in LWR, and particularly PWR, plants unless otherwise specifically approved by the Owner*.

4.2.1.3.B
When a design improvement is proposed in order to meet availability, performance, or cost goals and it does not satisfy the requirement for proven experience, analysis and testing techniques shall be used to demonstrate the reliability of the design change.

4.2.1.3.C
The Supplier* shall include a turbine generator reference list which will include a turbine generator of the same technology proposed for the Plant*.

CA
At least the following information shall be included: the Unit* power, turbine generator rotating speed, individual low pressure turbine cylinder power, length of the last stage blade and annular output area of the low pressure turbine.

4.2.2 SYSTEM FUNCTIONS

4.2.2.1 PURPOSE
4.2.2.1.A
The main turbine generator and its auxiliary systems shall transform thermal power to electrical power.

4.2.2.2 PERFORMANCES

4.2.2.2.A
Turbine design shall be made so as to ensure that PGP will achieve general availability objectives specified in Section 2.2.7.

4.2.2.2.B
The turbine-generator life time shall meet requirements listed in Section 2.4.2.

[redacted]

4.2.2.2.D
The Supplier* shall specify recommended intervals and durations for the Inspection* of major components and shall identify provisions for maximizing overall turbine-generator availability with regard to the Planned Outages*.

[redacted]

DB
A list of intervals and duration of the Inspection* of major components shall be provided.

4.2.2.2.E
The turbine-generator shall be able to withstand the torque loading associated with a sudden three-phase short circuit at the output terminals of the generator under a worst case condition of generator operating at the Maximum Continuous Rating* and at the Rated Power Factor* over excited. Refer to Chapter 2.3 for grid requirements.

4.2.2.2.F
Safe shutdown of the main turbine generator system shall be ensured if both the normal and stand-by power supply are lost.

4.2.2.2.1 OUTPUT AND SPEED

4.2.2.2.1.A
The main turbine generator system shall be matched to the output of NSSS to guarantee the normal electrical output as specified in Section 2.2.1.

4.2.2.2.1.B
The definition of the Maximum Continuous Rating* shall be completed by a set of the associated Heat Sink* conditions (condenser cooling water inlet temperature) compatible with data provided in Chapter 5.2.

BA
The nominal steam flow rate and pressure (upstream of the stop valves), corresponding to the Maximum Continuous Rating* shall be specified by the Supplier*.

4.2.2.2.1.C
The speed of rotation shall be determined on the basis of a technical and economic optimisation and rated frequency specified in Section 2.3.1.2.1.

4.2.2.2.1.D
The main turbine generator shall comply with the grid requirements specified in Chapter 2.3.

4.2.2.2.2 OVERSPEED

[redacted]

4.2.2.2.2.B
The turbine rotors shall be tested during manufacture according to the Supplier's* overspeed test guidelines taking into account the Rules* (in particular CSN EN IEC 60045-1).

[redacted]

[redacted]

4.2.2.2.2.E
The overspeed trip system and its components shall be capable of periodic on-load and off-load testing.

4.2.3 COMMON SYSTEM AND COMPONENT REQUIREMENTS

4.2.3.1 BEARINGS

4.2.3.1.A
The bearings of the turbine and generator shall be readily accessible, adjustable and replaceable without damage to adjacent glands.

4.2.3.1.B
Provision shall be made for rotor and cylinder realignment, with minimum dismantling, to rectify the effect of possible foundation settlement and for permanent axial repositioning of the rotor.

4.2.3.1.C
Lubrication oil for the main generator bearings shall be provided by the main turbine lubrication oil system.

4.2.3.1.D
The design shall be such that no bearing instability occurs during run-up, part load or full load conditions.

4.2.3.1.E
All bearings shall be fitted for vibration monitoring probes in at least two planes (i.e., x and y).

EA
Measurements of vibration amplitudes for the whole turbine generator including generator and exciter (if applicable) shall be provided for:

- horizontal and vertical shaft vibrations measured relative to bearings and axial shaft vibration at the thrust bearing,
- horizontal, vertical and axial vibrations for all bearing pedestals,
- torsional vibrations.

4.2.3.1.F
The bearing pedestals and pipe connections shall be of the highest integrity with regard to leak tightness in order to provide the maximum security to fire risk.

4.2.3.1.G
All bearings shall be fitted with metal and oil temperature measurement equipment.

4.2.3.1.H
For the radial bearings:

4.2.3.1.HA
Each rotor of the turbine (HP rotor, LP rotor) and generator rotor shall have two own radial bearings.

4.2.3.1.HB
The radial bearings of the turbine and the generator shall be of the self-aligning type and shall be provided with jacking oil connections.

4.2.3.1.HC
Radial bearings shall be provided with means for adjustment to alter both vertical and lateral alignment.

4.2.3.1.HD
The design of the radial bearing pedestals shall be such that oil leak is prevented.

4.2.3.1.HE
The linings of the radial bearings shall have the best possible bearing properties.

4.2.3.1.HF
The radial bearings of the LP rotors shall be interchangeable. However, radial bearings of the HP rotor (front and rear bearing) are not interchangeable. All the bearings shall be designed so that the shells can be removed without removing the rotors or disconnecting the main oil piping.

4.2.3.1.I
For the thrust bearing:

4.2.3.1.IA
An adjustable tilting-pad-type thrust bearing shall be installed to maintain the correct axial position of the rotor.

4.2.3.1.IB
The thrust bearing shall be of sufficient capacity to carry the maximum possible unbalanced axial thrust in the steam turbine.

4.2.3.1.IC
Tilting type thrust bearings shall be designed so that the thrust pads are easily replaceable.

4.2.3.1.ID
The thrust bearing shall be equipped with an axial shaft position measurement which shall give alarm and cause turbine trip in case of excessive axial displacement.

4.2.3.2 COUPLINGS

4.2.3.2.A
The design shall be such as to facilitate the replacement of rotors and their exchange with spares.

4.2.3.2.B
The arrangement shall be such that hydraulic tightening procedures can be applied.

4.2.3.2.C
Each coupling and its bolts shall be able to withstand the maximum forces and torques defined in Section 4.2.5.3 without:

- sustaining permanent damage to any components,
- exceeding the minimum yield stress of the coupling or bolting,
- relative movement between the coupling halves.

4.2.3.2.D
Each coupling shall be readily accessible for the Inspection* of alignment.

4.2.3.3 PEDESTALS AND FOUNDATIONS - TURBINE AND CONDENSER INTERFACE

4.2.3.3.1 GENERAL REQUIREMENTS

4.2.3.3.1.A
The design of the pedestals of the turbine, the generator and of the condenser especially when considering supports and connection, shall be such as to:

- minimise the effect of the static and dynamic loads on stability and alignment of the turbine generator at all anticipated conditions, including those related to the condenser (vacuum induced forces or stored water mass variation) and those related to the generator (such as short circuit at the generator connection), and alignment of the turbine generator
- mitigate the evolution of the settling of the foundation raft by absorbing the vibrations transmitted across the pedestals
- minimise the effect of the settling of the foundation raft on stability and alignment of the turbine generator

AA
Pedestal design with elastic devices between pedestals and piles is possible.

4.2.3.3.1.B
The Supplier* shall provide project "Monitoring of the turbine-generator unit foundation settlement and strain". (see the Project Management Document*, Attachment 3, Section 4.5.10).

BA
The project of monitoring shall include clearly defined terms of measurements relating to particular stages of the construction process.

BB
The placement, type, and quantity of measuring points shall be determined in the project of monitoring.

BC
The time schedule and procedures of the measurements carried out during the construction and subsequently during the operation shall be determined by the Supplier*.
In addition to generally applicable standards and regulations, the project of monitoring shall comply with the provisions of the Owner's* standard "Deformations Development Monitoring in Foundation/Turbine Generator Unit Systems" (see the Technical Requirements Document*, Section 2.5.4.3).

BD
The project "Monitoring of the turbine-generator unit foundation settlement and strain" shall be subject to the Owner's* approval. The input site soil data are now approximate and serve for information purposes only.

BE
The project "Monitoring of the turbine-generator unit rotation axis and related technology deformations development" shall be provided by The Supplier*. (see the Project Management Document*, Attachment 3, Section 4.5.13).

BF
The Supplier*, in collaboration with the turbine manufacturer, shall use any suitable technical solution to provide the measurement of the turbine-generator unit rotation axis and the top foundation plate deformations development that are needed to perform the adjustment of the turbine.

4.2.3.3.1.C
In any case, the Supplier* shall provide the Owner* with the possibility to perform its own regular control measurements of settlement. For this purpose the bottom and top foundation plates, pillars and the turbine-generator unit shall be equipped with measuring points.

CA
Such measuring points shall be placed around the perimeter of the bottom and top foundation plates above the pillars' profiles, at the pillars' bases, the longitudinal beams and the cross beams. Measuring points shall also be placed at the turbine-generator unit and on bearing support stands.

CB
Measuring points shall be made of stainless steel, shall be mechanically resistant, durable and sufficiently protected against damage. There shall be enough space above all measuring points to place a levelling rod.

CC
Placing and type of measuring points shall be determined in collaboration with the turbine manufacturer and shall be subject to the Owner's* approval.
This project shall be complied with the Owner's* company standard "Deformations Development Monitoring in Foundation/Turbine Generator Unit Systems" (see Section 2.5.4.3).

4.2.3.3.1.D
The effects of concrete volume change, shrinkage and creep shall be evaluated in the design.

4.2.3.3.1.E
The reference temperature of the concrete elements shall be evaluated, especially for large volume ones, taking into account heat of hydration, concreting dimensions and temperature, so that this temperature can be considered in the calculations and thus avoid internal stress concentrations and cracking.

4.2.3.3.1.F
The temperature variations due to potential variation in environmental conditions, including impact of seasons of the year and temperature load from technology located in close proximity, shall be considered.

4.2.3.3.1.G
Before the start of concreting, tests of the concrete shall be made and evaluated. The tests shall be focused on development of hydration heat and strength properties.

[redacted]

4.2.3.3.1.I
The concrete shall be appropriately protected against oil contamination. In the case of using a protective coating for the concrete, it shall be transparent to allow for crack detection.

4.2.3.3.1.J
After the concreting is finished and before the technology assembly, a dynamic load test shall be done. The aim of the dynamic load test is to verify that the construction is without cracks and meets the required rigidity.

4.2.3.3.1.K
After the technology is assembled, second dynamic load test shall be done. The aim is to determine the real damping coefficient for the different frequencies, verify the results of the dynamic analysis and assess the real sensitivity of the foundation to dynamic excitation.

4.2.3.3.2 PEDESTALS

4.2.3.3.2.A
The vibrations of the bearing pedestal shall satisfy the requirements according to the CSN ISO 20816 standard (see Chapter 2.5).

4.2.3.3.2.B
The design of the pedestals and their entire support structure down to the foundations, shall be such that under all anticipated loads and moments, and with adequate reserve, stability and alignment of the turbine remain unimpaired.

BA
Additionally, the pedestals, bearings and keeps, including all bolting, shall be shock-resistant and provide sensible restraint to their respective rotors under extreme dynamic, or jamming conditions, such as loss of blading, etc.

4.2.3.3.2.C
The loss of a single blade of the last LP stage shall be addressed.

4.2.3.3.2.D
Sliding surfaces of each moving pedestal shall be arranged to be, at one level only, as close to and directly underneath the cylinder support feet through which the push/pull forces are transmitted.

DA
The design of these surfaces shall be consistent with the adequate pedestal rigidity.

4.2.3.3.2.E
Grey cast iron shall not be used for pedestals.

4.2.3.3.2.F
The pedestals and frames shall be designed to avoid electric currents being induced in the steelwork due to proximity of the generator terminals and connections.

4.2.3.3.3 FOUNDATIONS

4.2.3.3.3.A
The turbine generator foundations shall be designed with due regard to the avoidance of excessive vibration at running speed and the maintenance of satisfactory machine alignment, with adequate rigidity, under all conditions of operation, including full short circuit, sudden loss of electrical load and emergency shutdown.

4.2.3.3.3.B
The foundations shall be designed to avoid electric currents being induced in the steelwork due to proximity of the generator terminals and connections.

4.2.3.3.3.C
NA

4.2.3.3.3.D
The design of the foundation for the turbine generator shall be such that adequate access is provided for all necessary work, such as lagging, insertion of probes measuring bottom half direct radial clearance and Inspection* of the turbine and the adjacent ancillary equipment.

4.2.3.3.3.E
The spacing of the supports at the slip ring end shall be adequate to accommodate the main generator connections. Entrapment of hydrogen beneath the generator casing shall be avoided.

4.2.3.3.3.F
Provision shall be made to compensate for any non-uniform settlement of the foundations without significant structural alterations.

4.2.3.3.3.G
A level monitoring system shall be provided at the footings of the foundation block.

GA
Additionally, a simple and strictly limited system of measuring the temperatures of the relevant foundation block elements shall be provided.

GB
This system shall be designed so as to indicate clear definition of the conditions under which level readings of any bearing pedestals/foundation block floor are obtained.

4.2.3.3.3.H
The possibility of the settlement of the turbine generator foundations Subsoil* shall be evaluated during the LWA Phase*.

HA
The possibility of an additional setting shall be provided with regard to the Subsoil* settlement of the turbine generator foundations.

4.2.3.4 LUBRICATING OIL SYSTEM

4.2.3.4.1 SYSTEM DEFINITION

4.2.3.4.1.A
The lubricating oil system comprises tanks, pumps, coolers and a conditioning/purification system.

AB
The system interfaces with the turbine and generator bearing housings, hydrogen seal oil system (in case of generator rotor cooling by hydrogen), turning gear oil system, and the turbine building component cooling water system.

4.2.3.4.2 SYSTEM FUNCTION

4.2.3.4.2.A
The lubricating oil system shall supply oil to the turbine and generator for bearing lubrication, for generator hydrogen sealing (in case of generator rotor cooling by hydrogen), for rotor jacking and to the turning gear system under DBC 1 (i.e. Normal Operation*) and DBC 2 (i.e. Abnormal Operation*).

4.2.3.4.2.B
The system shall provide redundancies so that any single failure in the system or failure in the power supply does not jeopardize the safe shutdown of the turbine and generator.

4.2.3.4.2.C
The system shall lift the rotating parts at start-up in order to reduce the necessary starting torque and to avoid turbine damage after turbine trip.

4.2.3.4.3 GENERAL REQUIREMENTS

4.2.3.4.3.A
The main turbine generator system shall be equipped with a lubricating oil system which meets the requirements of the Rules* (in particular CSN EN IEC 60045-1).

4.2.3.4.3.B
The system characteristics shall be such that the oil with required pressure, temperature, purity and quantity is supplied continuously under DBC 1 (i.e. Normal Operation*) and DBC 2 (i.e. Abnormal Operation*).

4.2.3.4.3.C
Adequate provisions shall be implemented to protect the turbine and generator in case of large oil loss.

4.2.3.4.3.D
The Supplier* shall provide the Owner* with the oil specifications and with the operating limits.

4.2.3.4.3.E
The system shall be designed to guarantee safe and reliable function without causing unacceptably high or low oil temperatures.

4.2.3.4.3.EA
The oil temperature shall be controlled automatically by the oil cooling system with temperature checking on the oil side.

4.2.3.4.3.EB
It shall be possible to change over the oil coolers and filters (if any) without interruption of the oil flow.

4.2.3.4.3.F
Automatic oil leakage detection and signalization by redundant channels shall be provided.

4.2.3.4.3.G
The bearing pedestals shall be suitably vented and provided with oil baffles in such a manner that, in combination with rotor profiling, oil egress and steam ingress is prevented.

4.2.3.4.3.GA
The vents shall be provided with an oil mist eliminator at the vent discharge.

4.2.3.4.3.H
Redundant fire detection and fire extinguishing system shall be provided for the area of the oil system.

4.2.3.4.3.HA
The oil tanks, pumps, coolers, valves, pipework and oil treatment facilities shall, as far as possible, be located as a compact unit in a separate fireproof area (compartment) so as to minimise the fire risk.

4.2.3.4.3.HB
All oil piping or devices containing flammable oil must be enclosed in piping/housings to prevent oil spray in case of pipe or device failure.

4.2.3.4.3.HC
In case of pipelines with double walls, glass covered windows shall be provided for the visual Inspection* of oil leakage.

4.2.3.4.3.HD
Oil pipelines shall not be placed adjacent to hot steam lines, or other high temperature surfaces unless special protection preventing their heating is provided.

4.2.3.4.3.HE
Oil tanks and oil filled vessels shall not be located adjacent to pipelines and tanks containing hydrogen or other flammable gases.

4.2.3.4.3.I
An emergency discharge system shall be designed to be capable of emptying the total amount of lubricating oil into an emergency oil tank (Clean & dirty oil tank), preferably gravitationally.

4.2.3.4.3.IA
Special protection (if any) of oil pipes shall convey the discharged oil leakage into an emergency oil tank.

4.2.3.4.3.J
The oil system shall have facilities for taking oil samples because of tribodiagnostics survey of the frictional surfaces of the most important components.

4.2.3.4.3.K
At least two 100% rated main pumps shall be provided.

4.2.3.4.3.KA
[redacted]

4.2.3.4.3.KB
The emergency standby pumps shall be adequately sized to fully safeguard the turbine-generator system in the event of a failure of AC supplies or AC driven pump either at the time when the main pump is not fully primed (start-up, shut down) or in the event of simultaneous failure of the main pump.

4.2.3.4.3.KC
Means shall be provided to ensure that there is no interruption of lubricating oil flow to the bearings during automatic changeover of pumps.

4.2.3.4.3.KD
The auxiliary, emergency and jacking oil pumps shall start and stop automatically.

4.2.3.4.3.L
All oil pipelines shall be prevented from inadmissibly high level of vibration.

4.2.3.4.3.LA
To minimize fire hazard, due to oil leakage, the pressurized oil pipelines shall be fitted with appropriate protection from mechanical damage.

4.2.3.4.3.LB
Waste oil pipes from bearings shall be made of suitable material for this application.

4.2.3.4.3.LC
The lube oil piping downstream the full flow filter shall be made of corrosion resistant material such as stainless steel.

4.2.3.4.3.M
A full-flow filtration system downstream of the main lube oil pump shall have sufficient filtration capacity.

4.2.3.4.3.MA
Filtration/conditioner with water removal capability shall be provided so that oil quality is maintained within acceptable operating limits.

4.2.3.4.3.MB
The system shall be provided with the capability to clean the filters in operation without interrupting oil flow.

4.2.3.4.3.MC
The filter shall be automatically bypassed upon high pressure drop across the filter. An alternative solution shall be justified by the Supplier*.

4.2.3.4.3.MD
The oil purifier shall be permanently connected to the bypass of the main oil system so that it can be used regardless the turbo-generator is running or not and shall have sufficient hourly capacity of the total oil charge.

4.2.3.4.3.ME
The oil purifier shall have water removal capability.

4.2.3.4.3.MF
The parts of the purifier liable to corrosion shall be manufactured from suitable material for this application.

4.2.3.4.3.MG
Means shall be provided for self-cleaning of the purifier without dismantling being necessary.

4.2.3.4.3.N
During rundown, barring and start-up, jacking oil pumps shall provide oil of a sufficiently high pressure to lift the rotating parts from contact with the bearing surfaces.

4.2.3.4.3.NA
It shall be possible to run the jacking oil pumps during overhaul of the turbine even if the main oil system is out of operation.

4.2.3.4.3.NB
The minimum oil parameters necessary for proper operation of the jacking system shall be maintained in case of lubricating system shutdown.

4.2.3.4.3.NC
Jacking oil shall be also connected to the exciter bearings, if applicable.

4.2.3.4.3.ND
It shall be possible to feed motors of jacking oil pumps from a diverse power supply.

4.2.3.4.3.O
The main oil tank and/or the oil purifier shall be designed to facilitate the settling out of water and sludge and the non-entrainment of foam, and shall be equipped with vapour extractors.

4.2.3.4.3.OA
It shall be possible to refill the main oil tank during the operation until the normal oil level is achieved.

4.2.3.5 SHAFT CURRENT PREVENTION AND EARTHING

4.2.3.5.A
The outboard bearing and oil pipes of the generator and any slip ring bearing and oil pipe shall be double insulated from earth using an island layer to prevent the circulation of shaft current.

4.2.3.5.B
Suitable means shall be provided to prevent the circulation of shaft stray currents and to facilitate the measurements of the effectiveness of the bearing insulation with alarm and trip levels.

4.2.3.5.C
The access to the brushgear shall be adequate to allow on-load brushgear maintenance to be safely carried out.

4.2.3.5.D
Any instrumentation cabling at these locations shall include island insulation features for the cable armour, metal sheath or metallic supports as necessary.

4.2.3.5.E
All necessary filtering shall be provided to protect the shaft insulation and earthing system from the effects of any voltage spikes on the turbine-generator shaft line which may arise from the application of a thyristor excitation system.

4.2.3.5.F
To minimise the effects of electrical currents generated by generator and by electrostatic friction, the shaft of the turbine and generator shall be earthed in one point.

4.2.3.6 TURNING GEAR

4.2.3.6.A
Turning gear shall be provided to enable the turbine generator rotors to be rotated continuously during periods of start-up and shutdown in order to prevent rotor bending.

4.2.3.6.B
The drive shall be designed so that it automatically disengages when the speed of the turbine generator exceeds the turning speed and automatically engages when the speed of the turbine generator falls to turning speed.

4.2.3.6.BA
Interlocks shall be provided to ensure that turning cannot commence until the drive is fully engaged and an adequate supply of jacking oil is available.

4.2.3.6.C
The Supplier* shall justify the turbine generator turning speed to ensure the long term operation of the rotors.

4.2.3.6.D
Provision shall be made for an entirely separate rotor turning method, which can be quickly applied in case of non-availability of the normal turning gear.

4.2.3.6.E
The turning gear shall also allow the rotor to be stopped in any position.

4.2.3.6.F
It shall be possible to feed turning gear motor from a diverse power supply.

4.2.4 MAIN TURBINE

4.2.4.1 SYSTEM DEFINITION

4.2.4.1.A
The main turbine shall be composed of the set of expansion cylinders, stop valves, emergency and control valves, gland steam system and other associated systems.

4.2.4.1.B
It interfaces with the main steam supply system, the Moisture Separator and Reheater*, the extraction steam system, the generator and the condenser.

4.2.4.2 SYSTEM FUNCTION

4.2.4.2.A
The main turbine shall convert thermal power into rotational power.

4.2.4.3 MAIN TURBINE GENERAL REQUIREMENTS

4.2.4.3.A
The main turbine shall be designed throughout to assure continuous safe, reliable, and economical operation without undue heating, vibration, or noise.

4.2.4.3.B
The complete turbine line shall consist of axial flow expansions of working steam, on a horizontal centre line, with intermediate water separation and reheat.

4.2.4.3.C
Provision shall be made for extracting steam from suitable points on the main turbine.

4.2.4.3.D
The turbine shall make maximum use of proven components.

4.2.4.3.E
The Supplier* shall ensure that the vibration limits of the machine are compatible with the specified performance and conditions of operation, and do not cause damage to associated equipment and structures.

4.2.4.3.F
Measurements of vibration amplitudes shall be provided for both shaft ends and shafts between all casings as well as for all bearings (including the generator and exciter, if applicable), for more details see Section 4.2.3.1.

4.2.4.3.G
The Supplier* shall avoid the crevices or pockets as much as possible.

4.2.4.3.GA
All unavoidable crevices or pockets shall be adequately drained to reduce the possibility of corrosion, and to reduce the adverse effect on temporary overspeed rise from the flashing-off of water.

4.2.4.3.H
The Supplier* shall make recommendations for the turbine maintenance program which will include the Inspection* and test intervals.

4.2.4.3.HA
These recommendations shall be based on both turbine missile generation probability analysis and the Unit* availability impact.

4.2.4.3.I
[redacted]

4.2.4.3.IA
Intersection with other buildings of the Plant* containing equipment important to safety shall also be avoided (see Section 2.11.1).

4.2.4.3.IB
No missile emission shall occur in the event of blade rupture at a speed below the trip level.

4.2.4.3.J
[redacted]

4.2.4.3.JA
[redacted]

4.2.4.3.K
The turbine shall be designed to operate continuously at the valves wide open condition at rated pressure and all extractions in operation with no reduction in availability or service life.

4.2.4.3.L
[redacted]

4.2.4.3.M
The turbine shall operate normally when the condenser pressure is below the upper limit defined by the Supplier*.

4.2.4.3.N
In addition to the normal operational speed range, the turbine generator system shall be capable of safely traversing, without suffering any mechanical, thermal or electrical damage, and without exceeding the permissible bearing and shaft vibrations, the speed range up to the speed reached due to full-load rejection.

4.2.4.3.NA
Turbine overspeed limits shall not be exceeded, assuming the failure of any single component.

4.2.4.3.O
Machining, cleaning, NDT and other chemical compounds used during manufacture, storage, erection, and the Inspection* shall be controlled such that contamination with chlorine or sulphur containing compounds is avoided.

4.2.4.3.P
To the extent possible component materials shall be referenced to nationally recognized standards or their nearest equivalents and a list of major components and applicable material standards shall be provided.

4.2.4.3.PA
Effects of material strength, heat treatment, temper embrittlement of low alloy steels, and sensitization of stainless steels shall be considered.

4.2.4.3.PB
Material selected for diaphragm blades/vane/partitions shall be field repairable.

4.2.4.3.PBA
Materials which require high preheat temperature and post-weld heat treatment shall be avoided.

4.2.4.3.PC
NA

4.2.4.3.PD
For further material requirements see Section 2.6.4.1.5.

4.2.4.3.R
No deflections of rotating or stationary components that could result in interferences, rubs, or component failures shall occur during the Normal Operation*, including transients.

4.2.4.3.S
Sharp radii shall be avoided in the design as far as possible. If they cannot be avoided, access for the Inspection* of these areas shall be provided.

4.2.4.3.T
LP turbine exhaust hoods shall be provided with bursting discs (diaphragms) for condenser overpressure protection. However, in normal cases (turbo generator at nominal speed) partial condenser vacuum break shall not produce any damage to PGP.

4.2.4.3.TA
The maximum condenser pressure for Normal Operation* shall have a good margin to the design limits for the turbine and the condenser.

4.2.4.3.U
Each of the turbine cylinders (HP/LP A/LP B/LP C) shall be individually assembled at the factory to check that no interferences exist. The Owner* shall be provided with the opportunity to witness the factory acceptance tests.

4.2.4.3.V
The Supplier* shall provide heat and mass balance diagrams that indicate the pressures, temperatures, enthalpies and flow quantities of all important media (e.g. throttle, exhaust, sealing and leak-off steam, condensate and feedwater).

4.2.4.3.VA

Heat and mass balance diagrams shall be provided for steady states of all normal Operational Modes* that may occur in the Unit*. This shall include expected part loads, bypass operation, expected variation in cooling water temperatures and operation after foreseeable equipment failures in the Unit*.

VAA

Heat and mass balance diagrams shall be provided also for Guarantee Test* conditions.

4.2.4.3.VB

The following data and curves shall also be submitted:

[redacted]

4.2.4.4 TURBINE CYLINDERS

4.2.4.4.A

Means of improving the efficiency of the Unit* by extraction of steam from the HP and LP turbine shall be used as appropriate for condensate and feedwater heating and for providing heat to the Moisture Separator and Reheater*.

4.2.4.4.AA

Besides steam extractions used for improving the efficiency of the Unit*, turbine cylinders shall enable also additional steam extraction to provide district heating capability, if required in the future, without major modifications of the steam turbine, see Section 2.2.2.

[redacted]

4.2.4.4.AD

Extraction nozzles shall be located in the lower half of the cylinders.

4.2.4.4.AE
No excessive forces from extraction steam lines shall be imposed on the turbine casings.

4.2.4.4.B
To prevent transient overspeed due to the steam stored in MSR, superheated steam from the outlets of MSR shall be fed to the IP (if any) or LP cylinders through hot reheat pipes, each containing a governor valve and, if necessary, an emergency stop valve.

4.2.4.4.C
Interchangeability shall be sought. Designs shall incorporate LP cylinders with independent hoods and interchangeable rotors.

4.2.4.4.D
Each LP cylinder shall be provided with bursting discs or other suitable protection against overpressure.

4.2.4.4.E
An automatic arrangement for cooling the LP cylinder exhaust shall be provided to maintain acceptable temperatures under low steam flow conditions.

4.2.4.5 TURBINE CASINGS

4.2.4.5.A
Turbine casings shall be of the horizontally split type and shall be supported in such a way that maximum efficiency and maximum operational flexibility can be achieved.

4.2.4.5.B
The steam turbine casings shall be designed to minimize thermal stresses and deformation under all steady and transient operating conditions.

4.2.4.5.BA
The casings and their supports shall be designed to withstand deflections caused by forces and moments encountered within limits which ensure safe operation.

4.2.4.5.BB
Residual thermal stresses shall not result in permanent deformation of turbine casings or bearing pedestal parting flanges.

4.2.4.5.C
Pipe connections to the casings shall be designed and located to facilitate maintenance.

4.2.4.5.D
The casing shall be supplied with a sufficient number of effective drainage points. Hollow spaces where water could collect shall be avoided.

4.2.4.5.DA
If not possible to avoid areas where water can collect during operation, continuous bleed type drains shall be used.

4.2.4.5.E
The casings shall be designed to allow an easy Inspection* of the critical internals including blading without complete dismantling of the casing. Any limitations shall be noted by the Supplier*.

4.2.4.5.F
Full details of the materials proposed for the casings shall be provided by the Supplier*, including composition, specified mechanical properties, heat treatment procedures, fabrication and repair welding procedures, the Inspection* procedures and the Defect* acceptance standards.

[redacted]

4.2.4.5.H
The bolts of the turbine casings and the bearing pedestal parting flanges shall be prestressed by the proper torque.

4.2.4.5.HA
The bolts and flanges for turbine casing shall be designed to accommodate hydraulic tensioners.
The main bolts of the HP turbine casing shall be of electrical heating/induction type.

4.2.4.5.I
The casings shall be protected against the erosive/corrosive effects of wet steam at all joints and surfaces liable to these effects.

4.2.4.5.J
The flanges of the casings shall be designed in such a way that a permanent leaktightness is obtained under all operating conditions.

4.2.4.5.K
Wherever the casings are alloy steel castings, wrought stub type extensions shall be welded in the manufacturer's works to all pipe connections to the casings.

4.2.4.5.KA
Each extension shall terminate in a cylindrical portion of equal diameter and thickness to the pipework that is to be attached by welding in situ.

4.2.4.5.L
The casings shall not be subjected to high temperature without the protection of adequate lagging either at the manufacturer's works or on the Site*.

4.2.4.6 ROTORS

4.2.4.6.A
Turbine rotor material and fabrication techniques shall have a proven high resistance to stress corrosion cracking.

4.2.4.6.B
All the turbine rotors shall be of a one-piece forging or a welded design. If shrunk on discs are offered, the Supplier* shall substantiate that the design eliminates the potential for stress corrosion cracking.

4.2.4.6.C
The compliance of each forging shall be confirmed against the purchase specification. This shall involve the use of test pieces, whose type, number and position provide a valid assessment of fracture toughness values, together with non-destructive test methods.

4.2.4.6.D
The Supplier* shall set the Defect* acceptance standards to be employed in the examination of the rotors.

[redacted]

4.2.4.6.EA
The natural frequencies (critical speeds) for the complete turbine generator unit shall be precalculated in the design phase and verified by modelling before transportation to the Site* or by real experiment at the Site*.

4.2.4.6.EB
Adequate damping shall be provided in the design to minimise vibration level at critical speeds.

4.2.4.6.F
The rotors shall be dynamically balanced at nominal speed in vacuum chamber.

4.2.4.6.G
Adequate provision shall be made, and access provided, for balancing of rotors without major turbine dismantling.

4.2.4.6.H
The design of the rotors shall take due account of the risk of corrosion pitting in the aqueous environment which can lead to stress-corrosion and/or fatigue cracking.

4.2.4.6.HA
Features which give rise to high stress concentrations shall be avoided and the self-weight bending stresses shall be as low as possible.

4.2.4.6.I
Special attention shall be given to the selection of materials to ensure low ductile/brittle transition temperatures, minimum stress concentrations and ability to withstand cyclic thermal stresses.

4.2.4.6.J
The rotor elements shall be manufactured of high quality alloy steel forgings suitably heat treated and dimensioned for the stress conditions encountered, including short circuits described in Section 4.2.5.3.

4.2.4.6.K
Stress concentration at the rotor surfaces due to transient operations and the subsequent generation of residual stress corrosion and/or fatigue shall be reduced as far as possible.

4.2.4.6.L
Lateral and torsional natural frequencies shall not coincide with operating speed harmonics in accordance with the line frequency and test speeds.

4.2.4.6.M
The Supplier* shall provide for the entire turbine generator assembly:

- the existing margin for the critical speeds from operating and test speeds,
- separation between torsional natural frequencies and anticipated exciting line frequencies under normal operating conditions or under upsets (e.g., loss of load or loss of generation on the PGP system).

4.2.4.6.N
It shall be possible to remove the rotor of any cylinder without having to remove the cover or rotor of the adjacent cylinder.

4.2.4.6.O
The vibration measurement of the rotors shall be performed in accordance with Rules* (in particular CSN ISO 20816-2 and ISO 22266-1 standards).

4.2.4.7 BLADING

4.2.4.7.A
The blading shall be of design proven by operating experience and made of materials capable of safely withstanding the mechanical and thermal stresses and the erosion and corrosion effects under all operating conditions, considering the physical and chemical steam properties.

4.2.4.7.B
The blading shall be designed to avoid the possibility of damage from vibration under all operating conditions.

4.2.4.7.BA
The turbine shall be equipped with tip timing vibration monitoring of at least last stage blades.

4.2.4.7.C
The Supplier* shall prove that there is no risk of excitation by the first eight harmonics of rotating speed (low blade frequencies) and by the aerodynamic fluctuations due to the preceding rotating or stationary blades in the path (high blade frequencies).

4.2.4.7.D
Stages of new and prototype moving blade design shall be the subject of a programme of static and/or dynamic vibration testing which is integrated with the manufacturing programme.

4.2.4.7.E
Confirmatory static tests on blading vibrations shall be performed as per OEM's standards.

4.2.4.7.F
Stator and rotor blading shall be designed for minimum leakage loss through the load range, without danger of internal rubbing and without the necessity of making adjustments or otherwise altering the clearances of the rotor relative to the stator.

4.2.4.7.G
The calculation of blade frequencies shall include the effect of centrifugal forces, metal temperatures, root fixing factors, and blade grouping devices (i.e. covers, tie wires, etc.).

4.2.4.7.H
The Supplier* shall provide Campbell diagrams for last stages, and a specific calculation to verify stresses in the last LP root under accidental conditions.

4.2.4.7.I
Blade materials and fabrication techniques shall have proven high resistance to stress corrosion cracking.

4.2.4.7.J
The turbine blades shall be designed to withstand the micro-fissure evolution.

4.2.4.7.K
The HP and LP blades and nozzles in contact with wet steam shall be protected from water erosion by using erosion resistant materials, moisture removal provisions and/or protective shields.

4.2.4.7.KA
These protective measures shall preclude blade row replacements resulting from moisture erosion for at least thirty years under design operating conditions.

4.2.4.7.L
Blade coatings in the wet stages of LP turbines, such as ion deposited aluminium and diffused nickel cadmium for protection against inter-granular stress corrosion cracking, shall meet the requirements for proven experience in Section 4.2.1.3

4.2.4.7.M
The design shall avoid water cutting at the joints of cylinders and diaphragms and carrier rings.

4.2.4.7.N
At low load a function to protect the LP blading from high temperature due to ventilation losses shall be provided.

4.2.4.8 SHAFT AND INTERSTAGE DIAPHRAGM GLANDS

4.2.4.8.A
All shaft and interstage diaphragm glands shall be of a high efficiency design proven by operational experience and shall be arranged for easy maintenance.

4.2.4.8.B
Shaft gland housing shall be supported in such a manner to facilitate adjustment and to minimise the effect on gland clearances of all anticipated cylinder distortions.

4.2.4.8.C
The space of the shaft and diaphragm glands shall be surveyed without necessity of dismantling the case.

4.2.4.9 STOP, EMERGENCY AND GOVERNING VALVES, AND STEAM CHESTS

4.2.4.9.A
Steam for the HP turbine shall be fed from a suitable number of steam chests through a strainer (if necessary), a stop valve and a governor valve.

4.2.4.9.B
All steam valves shall be standardised as far as possible.

4.2.4.9.C
HP valves shall be located close to the inlet manifold in order to limit any overspeed.

4.2.4.9.D
All steam valves shall be designed to prevent any significant valve spindle leakage.

DA
The valves shall remain tight during the Normal Operation* (DBC 1).

4.2.4.9.E
The design and the material of the valves shall comply with their particular operational conditions.

EA
The materials selected for the valve spindles and guide bushes shall have suitable wear resistance properties (e.g. erosion) together with sufficient oxidation resistance to ensure that they can operate without the need for descaling or other interim maintenance work to prevent the risk of seizure such that the Owner's* availability goals are met.

4.2.4.9.F
Where the steam chests are alloy steel castings, wrought stub-type extensions shall be welded to all pipe connections to the steam chests in the manufacturer's works.

4.2.4.9.FA
These extensions shall terminate in a cylindrical portion of equal diameter and thickness to the pipework which is to be attached by welding in situ.

4.2.4.9.FB
The same treatment shall be applied to all forged steam chests if for reasons of access to position direct welding of pipework to the steam chests is difficult or if transitions from pipe thicknesses to steam chest wall thickness would otherwise be too abrupt.

4.2.4.9.FC
Where steam chests are joined by wrought manifolds, the manifolds shall have stubs of sufficient length and proportion to avoid abrupt transition from one thickness to another.

4.2.4.9.G
All steam valves shall be capable of being tested while the turbine is carrying full load.

GA
The valves shall be located such that the travel of spindles during testing can be observed.

4.2.4.9.H
All bolted or otherwise retained valve covers on the steam chests and all flanges in the interconnecting pipework shall be designed to minimise distortion and to remain steam tight. Life time of the parts shall be compliant with Section 2.4.2.

4.2.4.9.I
The valves shall be designed to enable maintenance and changing the valve internals without removing the valve housing from the pipe.

4.2.4.9.J
The main stop, control, reheat stop, and intercept valves shall close upon action of the emergency trip system in time to preclude unsafe turbine overspeed.

4.2.4.9.K
Control valves shall be equipped with individual hydraulic servomotors and shall close in case of a hydraulic pressure drop.

4.2.4.9.KA
A curve showing the governor valves opening lifts on various turbine generator loads shall be supplied.

4.2.4.9.KB
The emergency stop valves shall be equipped with hydraulic servomotors.

4.2.4.9.KC
Valve operating mechanisms shall be of a fail safe (i.e. closed) design that minimizes the use of complicated linkages and uses components which satisfy the proven experience required in Section 4.2.1.3.

4.2.4.9.L
All valve cover studs and flange bolts shall be adequately waisted and shall be of such a diameter as to permit controlled tightening in situ to a controlled strain.

4.2.4.9.M
Provision shall be made to use hydraulic tightening equipment.

4.2.4.9.N
Stop, emergency and governing valves and their supports shall be designed such that excessive vibration cannot result from excitation caused by turbine operating harmonics and hydraulic instabilities in the valves or steam flows.

4.2.4.9.O
Limit switches and valve position logic indication used on these valves shall satisfy the proven experience required in Section 4.2.1.3.

4.2.4.9.OA
Redundant switches shall be used when a limit switch with satisfactory experience is not available.

4.2.4.9.OB
Leaktight enclosures shall be provided for all local turbine control and test logic limit switches and field termination junction boxes.

4.2.4.9.OC
Also, spare cabling shall be provided from the switch location to the first field junction box.

4.2.4.9.P
Valves which incorporate a pilot valve shall satisfy the proven experience required in Section 4.2.1.3.

4.2.4.9.R
The control/governor valves shall be designed to withstand extended periods of operation at part load, including the Load Following*.

4.2.4.9.S
The automatic drain system shall ensure that the steam admission system is kept free of water at all times during operation:

- At a specified turbine load, appropriate drain valves shall be opened automatically.
- Start-up shall include a procedure for preheating and draining the steam lines.

4.2.4.9.T
Emergency and start-up drain valves shall be monitored to indicate any leakage.

4.2.4.10 STEAM STRAINERS

4.2.4.10.A
Steam strainers shall be provided in the initial HP steam circuit to prevent entry of any foreign material, which could damage blading or valve seats, into the machine, both during the initial Commissioning* period and during operation.

4.2.4.10.B
The strainers shall be arranged so as to permit easy Inspection* and cleaning and easy disassembly after the Commissioning*.

4.2.4.11 GLAND SEALING SYSTEM

4.2.4.11.1 SYSTEM DEFINITION

4.2.4.11.1.A
The gland sealing system comprises gland steam condenser, exhaust fans, condenser drain hold tank, desuperheater (if required), regulator, and all associated valves.

AB
It interfaces with the main and auxiliary steam systems, the main turbine and associated valve leak-offs, the main condenser and the feedwater and condensate system.

4.2.4.11.2 SYSTEM FUNCTIONS

4.2.4.11.2.A
The gland sealing system shall prevent air leakage into the turbine under vacuum and prevent steam leakage out of the turbine under pressure for all load conditions.

4.2.4.11.3 GENERAL REQUIREMENTS

4.2.4.11.3.A
The gland sealing system shall be fully automatic in operation and arranged for sequence control operation and shall include arrangement for adjustment and also for manual control.

4.2.4.11.3.B
The system shall be designed to ensure the following requirements under all conditions of operation:

- efficient sealing at shaft glands with the minimum leakage along the shafts and behind the gland housings and consequent loss of efficiency,
- recovery of leakage system,
- adequate control of sealing steam temperature and pressure,
- prevention of steam leakage into the turbine building,
- uniform pressure at all sealing belts regardless of variation in clearance,
- ease of maintenance of all components.

4.2.4.11.3.C
The system shall be capable of operation with main steam or the steam from an auxiliary steam supply so that the glands can be sealed during reactor start-up, shutdown and trip sequences when a main steam supply is not available.

4.2.4.11.3.D
The Supplier* shall provide for the use of redundant steam supplies and controlling devices so that a Single Failure* does not fail the system.

4.2.4.11.3.E
The system shall be capable of providing adequate flow to and from all pressure turbine glands.

4.2.4.11.3.F
Sufficient gland steam spillover capacity at increased gland clearances shall also be provided.

4.2.4.11.4 GLAND STEAM CONDENSER

4.2.4.11.4.A
The gland steam shall be routed to the gland steam condenser where it is condensed and where the non condensable gases are extracted.

4.2.4.11.4.B
Single 100% gland steam condenser shall be incorporated in the condensate system to permit heat recovery, in which case a condensate recirculation connection and valve shall be provided for start-up, low load and shutdown modes of operation.

BA
NA

4.2.4.11.4.C
Drains shall be recovered.

4.2.4.11.4.D
Gland steam condenser shall be of the double-pass type (U tube type) to get better plant performance.

4.2.4.11.4.E
Redundant and independent 100 % motor driven gland steam exhaust fans shall be provided and shall be designed for the maximum steam temperature that can prevail under upset conditions.

4.2.4.11.4.F
Gland steam drains shall be sloped toward the gland steam condenser (located below the turbine elevation) to ensure proper drainage of the glands and piping.

4.2.4.12 TURBINE SUPERVISORY SYSTEM

4.2.4.12.A
Turbine supervisory equipment shall monitor thermal, hydraulic and mechanical parameters of the turbine, provide visual and recorded data and archive the collected data.

4.2.4.12.B
As necessary, the system shall interact with the turbine governor and the turbine Protection System* to initiate alarms when limits are exceeded.

4.2.4.12.C

Operation of the turbine supervisory system or even its malfunctions shall not interfere or disturb the other control and protection systems of the turbine.

4.2.4.12.D

The system shall be designed to ensure safe operation during start-up, shutdown and under normal operating conditions.

4.2.4.12.E

Routine operations of the PGP shall be carried out automatically during start-up, shutdown and under normal operating condition.

4.2.4.12.F

[redacted]

4.2.4.12.G

The Supplier* shall provide the related setpoints trips to the above parameters, when applicable.

4.2.4.12.H
The Supplier* shall provide at least six speed pickups, which can measure also zero-speed sufficiently, and two spare speed pickups.

4.2.5 MAIN GENERATOR SYSTEM

4.2.5.1 SYSTEM DEFINITION
The main generator system comprises the generator, together with its excitation and control system, and generator cooling and seal oil systems, and electrical and I&C system.

It interfaces with the main turbine, generator busbars, cooling water system, and lubricating oil system.

4.2.5.1.A
Except for express indication to the contrary, the design, manufacture and testing of the generators and its auxiliaries shall comply with the latest versions of the following standards and regulations: CSN EN 60034, CSN EN 60044, CSN IEC 72, CSN EN 60529, CSN ISO 20816, Government Order No. 176/2008 Coll., as amended and other relevant Rules*.

4.2.5.1.B
Requirements to active and reactive power production and ranges of operational voltage and frequency are stated in Chapter 2.3.

4.2.5.2 SYSTEM FUNCTION
The main generator system converts rotational power produced by the main turbine into electrical power.

4.2.5.3 GENERAL DESIGN REQUIREMENTS

4.2.5.3.A
The generator shall be of the hydrogen cooled cylindrical rotor type with water cooled stator windings, or water cooled of proven design.

4.2.5.3.B
The generator and all its auxiliary systems shall be field proven.

4.2.5.3.C
Pipework and connections and ancillary equipment located in the area of the generator shall be of a non-ferrous material or stainless steel, or provisions shall be made to eliminate induced currents and production of corrosion impurities.

4.2.5.3.D
For personnel protection the design shall limit electromagnetic fields to preclude all possible biological effects to medically acceptable limits (according to Mandatory Law* regarding the protection against noise, pollution, vibrations and temperature).

4.2.5.3.E
Generator shall be connected to the grid via GT, isolated busbars and circuit breaker.

4.2.5.3.F

The generator shall be designed to withstand forces and torques imposed during the conditions listed below without sustaining damaging movement of the stator windings, frame or core, or damage to the rotor or other major components:

- three-phase zero-impedance short circuit suddenly applied at the terminals from rated voltage open-circuit,
- line-to-line zero-impedance short circuit suddenly applied at the terminals from rated voltage open-circuit,
- operation out of synchronisation (operation and synchronisation out of phase, or phase opposition, may result in imbalance and a need to re-balance the complete turbine shaft)
- connection to grid with a worst case out of phase angle to be specified by the Supplier*.

The specification of duration and frequency of the conditions shall be provided by the Supplier*.

4.2.5.3.G

The insulation shall withstand the load variations during the Plant* life. The generator shall be provided with the insulation system of Class F (CSN EN 60034-1, CSN EN 60085), but the temperature rise under any operating conditions shall not exceed permissible levels for insulation Class B (CSN EN 60034-1, CSN EN 60085) temperatures.

4.2.5.3.H

The Supplier* shall provide means for continuous fast fault detection, associated with location detection.

4.2.5.3.I

The following technical data on the generator shall be provided by the Supplier*: (See the Project Management Document*, Attachment 3):

- Generator electrical parameters;
- Generator characteristic curves;
- The limiting chart for generator operation;
- Full list and description of the generator auxiliaries;
- Full set of auxiliaries/supplementary equipment for the generator, including all measurements lists, range of values, alarm and trip signals;
- Limiting conditions in case of partial or full loss of some auxiliary system(s);
- The project vibration levels for all of the generator areas/components;
- Description of on-line detection, monitoring and diagnostics systems including evaluation programs of measuring data.

4.2.5.3.J

The Supplier* shall provide all generator imposed loads and loading combinations necessary for the dimensioning of the pedestal (See the Project Management Document*, Attachment 3).

4.2.5.3.K
The Supplier* shall provide monitoring and diagnostic program of insulation system, method of insulation monitoring and evaluation criteria for online monitoring and monitoring during outages/overhauling as well (see the Project Management Document*, Attachment 3).

KA
The generator shall be equipped with an online monitoring and diagnostics system in accordance with the monitoring and diagnostics program of insulation system, minimally for analysis of partial discharge.

4.2.5.3.L
The Unit* synchronization shall normally be through the Generator Circuit Breaker* and shall be controlled via the Turbine generator control system.

LA
An auto-synchronizing function, synch-check (voltage/frequency matching), and precision synchronizing relays, shall be incorporated into the design.

LB
There shall also be a backup synchronization check using a separate measuring channel from that used for the primary auto-synchronization function.

4.2.5.4 STATOR

4.2.5.4.A
The casing and frame cross section shall be designed to withstand the specified overpressure tests, and to support the forces set up in the event of an internal explosion of hydrogen (if any) due to external events (e.g. fire during generator maintenance, etc.) without endangering personnel.

AB
The stator, its housing, and the housing bolting shall be designed to contain an internal detonation of the most explosive mixture of hydrogen and air possible.

4.2.5.4.B
The joint and seal design of the casing, seals, valves and pipework shall be such that the average in-service leakage rate shall not exceed a limit of about 18 m^3/24 hours (CSN EN IEC 60034-3) (leakage caused by an intightness in the generator only - the limit for technological separation of hydrogen may be higher).

4.2.5.4.C
The casing and pipework shall be designed so that there are no pockets in which hydrogen or inert gas (if any) can become trapped during scavenging.

4.2.5.4.D
NA

4.2.5.4.E
Facilities shall be provided at two positions on the generator casing for connecting to the station earthing system.

4.2.5.4.F
The stator core shall be made of high permeability low loss laminates, insulated on both sides.

FA
The material specification for the stampings, the insulation between stampings, and the procedure adopted in deburring the plates and checking the finished stampings, shall be such as to eliminate the possibility of interstamping shorts and resulting core faults.

FB
The choice of materials, the proportioning, clamping, and arrangement of the core in the outer casing, shall ensure the minimum noise and 100Hz vibration within the core, and the minimum transmission of vibration to the generator foundations, pipes and associated equipment.

4.2.5.4.G
All fixing and locking components in the ends of the fully assembled generator shall be non-magnetic except for the push plate of the core (protected by non-magnetic screens) and ribs of the stator core with draw bolt and ribs of the body (located on the outer diameter of the core zone of low magnetic flux).

GA
Special attention shall be paid to designing of these structural elements to avoid overheating during normal operation and in reactive power consumption mode.

4.2.5.4.H
The stator winding shall be star (double star) connected. The risk of short-circuit between phase ends shall be prevented.

4.2.5.4.I
The winding insulation system shall be designed and manufactured in such a way that it will meet the specified machine life for the given duty cycle. Insulation thickness and coil support structure shall be amply proportioned to withstand continuous operation at the maximum over-voltage, the generator switching surge voltages and the upset conditions.

4.2.5.4.J
Phase end creepage barriers or alternative solutions shall implemented.

4.2.5.4.K
End windings and connections shall be adequately spaced and braced with non-magnetic supports to prevent any appreciable coil movement or any damage to the windings or other parts during terminal short circuits.

4.2.5.4.L
The end windings (coils end) shall be provided with vibration monitoring and diagnostic system.

4.2.5.4.M

The design shall prevent movement of the coils in the slots and the winding overhang under normal operating conditions, particularly with regard to the avoidance of fatigue failure of the copper sub-conductors. Radial pressure shall be maintained on the coils in the slots over a long period of operation.

4.2.5.4.N

The end winding structure shall incorporate provision for retightening the end winding clamping after a period of service or the end winding structure shall be manufactured with rigid glass roving and shall be designed that no retightening of the end winding structure is required during the lifetime of winding.

4.2.5.4.O

The stator slot wedges shall be capable of withstanding the bursting force imposed during the most severe electrical short circuit between adjacent coil connections of different phases, such that there is an infeed of fault current from the system.

[redacted]

4.2.5.4.R

All pipework connections and ancillary equipment in the cooling water circuit of the directly cooled stator windings shall be of non-ferrous material or stainless steel and adequately supported to prevent vibration.

4.2.5.4.S

Configuration of the neutral connection shall be designed with respect to temperatures of encapsulation and 100 Hz vibrations.

4.2.5.4.T

Means of access to the inside of the frame shall be provided, with the end doors or manholes remaining in position, both on the exciter side and on turbine side.

4.2.5.4.U

Moisture and/or liquid detectors shall be provided at the low point(s) in the stator and the terminal enclosure.

UA

The moisture measurement inside stator shall be integrated into a machine monitoring and diagnostic system.

4.2.5.4.V

The generator monitoring and diagnostics system shall ensure an air/hydrogen moisture monitoring during power operation and outage (nonrunning assembled generator).

4.2.5.5 ROTOR

4.2.5.5.A
The rotor shall be manufactured from a single forging.

4.2.5.5.B
No castings shall be used in the rotor assembly.

4.2.5.5.C
The number of small parts shall be minimised.

4.2.5.5.D
The Supplier* shall specify the quantitative interdependence of material fracture toughness and size of acceptable defects of specific form to guarantee that there is no risk of fast fracture of the major generator rotating components.

DA
The Supplier* shall also stipulate the fracture toughness requirements imposed upon the forge master with the type, number and position of test pieces to be used in deriving a valid assessment of fracture toughness values.

DB
In addition to the fracture analyses indicated for the rotor, the carrying out of stress, fatigue and brittle fracture analyses for the most limiting steady state and transient operating conditions, transient conditions shall include anticipated shutdown and start-up cycles.
The Supplier* shall provide monitoring and diagnostic program and system inclusive period and method of fracture analyses monitoring (see the Project Management Document*, Attachment 3).

4.2.5.5.E
In the design of the shaft system particular attention shall be given to the quality of surface finish and the avoidance of sharp internal corners which may give rise to high stress concentration.

4.2.5.5.G
Permanent deformation of the winding or electrical faults under all conditions of operation, shall be eliminated through the selection of materials and the design, manufacture and fitting.

4.2.5.5.H
The rotor insulation system shall be of sufficient electrical strength to withstand all operational conditions, and high voltage tests.

4.2.5.5.I
The rotor insulation system shall have adequate mechanical strength and flexibility to cope with the stress in services without cracking or otherwise becoming damaged.

4.2.5.5.J
The design shall prevent reaching an unacceptable vibration level of the generator and exciter during all load conditions and transients, especially considering changes in the field current.

4.2.5.5.K

The method of insulation and securing of the coil connections shall eliminate vibration and possible failure of either the connections or their insulation. The rotor slot wedges and the end turns winding arrangement shall be designed to eliminate the copper dusting phenomenon, which may occur during turning gear operation.

KA

A suitable search coil shall be provided in the air-gap of the generator to detect short-circuited turns in the rotor winding.

4.2.5.5.L

A simple means of testing the gas tightness of the rotor lead seals (e.g. without disassembling the enclosure, without special tools, during operation etc.) shall be provided.

4.2.5.5.M

The design of the windings and pole-face slot wedging, the damper winding and bonding arrangements, and the method of attachment of the end rings to the rotor, including any special electrical connections or treatment of surfaces, shall eliminate fretting fatigue or stress corrosion cracking.

4.2.5.5.N

An effective damper winding shall be provided in the rotor. It shall be designed to divert negative sequence and 50 Hz current from the rotor teeth and pole surface and to prevent any overheating or pitting of the slot wedges and end rings.

4.2.5.5.O

Under steady state and transient conditions of operation, temperatures in the rotor shall not reach a level which implies permanent changes in the physical properties of the material, nor reduce interference fits to an operationally hazardous level.

4.2.5.5.P

A suitable discontinuity of whole turbine/generator rotor shall be provided on an accessible part of the turbine/generator rotating shaft system for use as a reference, for monitoring rotation such as keyphasor installed in steam turbine.

4.2.5.5.S

The construction of the generator shall enable all supposed maintenance operations, notably assembling and disassembling of rotor and transport on maintenance place.

4.2.6 GENERATOR AUXILIARY SYSTEMS

4.2.6.1 EXCITATION SYSTEM

4.2.6.1.1 SYSTEM DEFINITION

4.2.6.1.1.A
The excitation system shall be either with rotating exciter (preferably brushless) or static.

4.2.6.1.1.B
The excitation system shall be operationally verified for the specific generator type.

4.2.6.1.1.C
It comprises a main shaft driven exciter (rotating) or an excitation power transformer (static), power rectifier (static or rotating), voltage regulation equipment, field de-excitation equipment, and protection and monitoring systems.

4.2.6.1.1.D
It interfaces with the main generator field windings, the generator rotor and lubricating oil systems for a rotating exciter (except where the rotating exciter is an overhang/extension of the main generator rotor) and a power source for a static exciter.

4.2.6.1.2 SYSTEM FUNCTIONS

4.2.6.1.2.A
The excitation system shall:

- supply and control the DC current for the generator field winding,
- control the generator voltage and reactive power via its excitation,
- be suitable for testing during outage

4.2.6.1.3 COMMON REQUIREMENTS

4.2.6.1.3.A
The excitation equipment shall be designed for continuous operation at the specified generator rated conditions.

4.2.6.1.3.B
A static or rotating exciter shall be provided based upon the Supplier* current practice and performance record.

4.2.6.1.3.C
The excitation system shall be provided with a self-diagnostic system for easy indication of system failures (e.g. signalization in the MCR).

4.2.6.1.3.D
The excitation system shall ensure fulfilling of requirements for static and dynamic stability in case of grid faults - see Chapter 2.3.

DA
In response to a large disturbance, the excitation equipment shall be capable of reaching ceiling voltage in a time compatible with grid requirements. At generator terminal voltages below the nominal value, the ceiling capability shall not be reduced more than linearly with terminal voltage decrease.

4.2.6.1.3.E
The equipment shall be able to withstand nominally 20 voltage rises per year at the excitation transformer terminals equal to the maximum voltage appearing at the generator terminals following full load rejection.

4.2.6.1.3.F
The excitation equipment shall supply the power required by the thyristor convertor and excitation control system under all specified conditions of the generator loading.

FA
The converter shall consist of a three-phase, full wave, fully controlled thyristor or diode bridges containing several parallel sections in each arm of the bridge. Malfunction of one thyristor section (one of several parallelly operating thyristor or diode bridges) in exciter shall be possible without any power reduction during the Nominal Power* operation.

FB
The number of semiconductors and arms of bridges shall be compatible with availability target of the whole Plant* (set out in Section 2.2.7) taking into account the allowed rate of failure of the components.

4.2.6.1.3.G
The excitation control equipment shall consist of an Automatic Voltage Regulator (AVR) of the dual channel type, and also a manual control device with appropriate auto/manual changeover circuits with automatic coupling device.

GA
Switching from assembly A to B and return shall be set without current surges.

GB
A power system stabiliser shall be provided, see the Sections 2.3.2.3. and 2.3.3.2.3.

GC
The AVR shall be capable of remote voltage control for grid stability purposes.

GD
The design of voltage regulator (e.g. number of loops) depends on the stability required for the grid given in Chapter 2.3.

4.2.6.1.3.H
The excitation system shall enable a connection to the secondary and tertiary regulation of voltage and reactive power (U/Q) from the Main Control Room* and the grid. The system shall be manoeuvrable according to the Czech Grid Code*.

4.2.6.1.3.I
Each auto channel shall sense generator terminal voltage and current via its own current transformer and a three-phase voltage transformer or three separate single phase transformers suitably connected.

4.2.6.1.3.J
Each assembly of the exciting system shall be equipped with stator and rotor current limiters and also with an underexcitation limit warning system.

JA
The underexcitation limit warning system shall be adjustable through an external command from a superordinate I&C system (according to changing of an external reactance – configuration of transmission lines).

4.2.6.1.3.K
All necessary isolating voltage and current transformers shall be provided, interposed between the generator main voltage and current transformers and the AVR.

4.2.6.1.3.L
Monitoring and protection devices shall be so connected that their operation shall not be affected in case of a changeover of AVR or output channels.

4.2.6.1.3.M
Each protective device shall monitor as directly as practicable, the circuit which it is intended to protect.

MA
Operation of the protective device in one circuit shall not affect any other circuit.

MB
All monitoring equipment shall operate satisfactorily over the whole operating range of the AVR, i.e. from no-load to full field forcing conditions of the generator.

4.2.6.1.4 EXCITATION SYSTEM REQUIREMENTS

4.2.6.1.4.A
Static excitation system shall be designed with power supply, which enable performance of required functions and testing the excitation system even in case of generator outage.

AA
The main operating power supply shall prove sufficient reliability for all components of the excitation system (i.e. from the Availability Factor*, coping with transients and faults point of view).

4.2.6.1.4.B
In the static excitation system, the transformer shall:

- derive its power from the generator terminals,
- be capable of supplying the harmonic currents taken by the rectifier without exceeding rated working temperatures,

- be naturally cooled,
- have an appropriate protective cover (due to the personal safety).

4.2.6.1.4.C
In case of static (brush) system the requirements for moisture and balanced current distribution for sliding contact shall be fulfilled.

CA
Factors for ghosting creation shall be minimized.

CB
The voltage and current peaks of the excitation voltage shall be suppressed.

CC
The construction of collector devices (brush collector assembly) shall be an operationally verified technical solution that surely ensures supply of excitation current in all operation modes of the generator.

4.2.6.1.4.D
The sliprings and brushgear shall be designed so that:

- the temperatures measured at rated load do not exceed those for the insulation,
- the brushgear will operate continuously at full load for at least three years without the need to shutdown for brushgear or slipring maintenance (e.g. by appropriate construction, moistening – generator of steam etc.),
- the brushes can be replaced with the Unit* in power operation,
- the brushes operate for 6 months under rated load conditions without replacement,

DA
A current diagnostic system for single brushes shall be used on the brush gear.

4.2.6.1.4.E
The slipring brushgear assembly shall be totally enclosed with gasketed covers to prevent the ingress of oil.

EA
Cooling air shall be circulated so that the whole of the circuit is pressurised to prevent ingress of oil and dust.

4.2.6.1.4.F
Constant brush pressure devices or individually brush tension devices, capable of radial adjustment, shall be provided.

FA
The design of sliprings and connections shall be such that carbon dust from the brushes does not accumulate on insulation surfaces.

4.2.6.1.4.G
In case of using of the brushless exciter, adequate number of semiconductor modules (rectifier diodes) in redundant parallel mode shall be foreseen, in order to avoid common

turbine generator set unavailability in result of single component failure and forced the Unit* outage.

4.2.6.2 GENERATOR COOLING WATER SYSTEM

4.2.6.2.1 SYSTEM DEFINITION

The generator cooling water system comprises pumps, tank, coolers, filters, valves, pipes, instruments and bypass stream deionisers, filters and strainers.

It interfaces with the main generator cooling connections, the cooling water system TBCCWS and the demineralised make-up water system.

4.2.6.2.2 SYSTEM FUNCTION

The generator cooling water system removes the heat generated in the stator windings in all operating modes. In case of use water system of rotor cooling, the generator cooling system removes the heat generated in rotor and damper winding, surface of the rotor, shroud rings and air in the gap.

4.2.6.2.3 GENERAL REQUIREMENTS

4.2.6.2.3.A

The generator liquid coolers shall maintain cooling fluid temperature within the allowable range for all design conditions.

AA

Controls shall be provided for automatic regulation of water temperature to the generator windings.

4.2.6.2.3.B

Means of measuring a leakage of hydrogen into water shall be provided with an alarm for indicating when the hydrogen leakage exceeds the recommended limit.

4.2.6.2.3.C

Any water treatment necessary to make the demineralised water suitable for make-up to the generator windings water cooling system, or for continuous treatment of the water circulating in the windings circuit, shall be provided.

4.2.6.2.3.D

Generator cooling water system shall prevent moisture condensation in generator during shutdown and run-up and run-down periods.

[redacted]

EB

Supply and control cables for the pumps shall be arranged to run along different routes to avoid simultaneous damage.

EC
The standby pump shall start automatically upon loss of the primary pump.

4.2.6.2.3.F
Inlet and outlet connections to the generator shall be arranged to keep the internal part of the circuit full of water under all conditions.

4.2.6.2.3.G
Lined pipes and vessels, and corrosive metal mesh type filters shall not be used.

4.2.6.2.3.H
It shall not be possible for hydrogen locks to develop in the pumps.

4.2.6.2.3.I
The pipework, pumps strainers, valves, coolers, etc. in the generator cooling water system and in contact with the generator windings water or water vapour shall be made of non ferrous material or stainless steel.

IA
The material of windings shall be compatible with oxygen contents of cooling water.

4.2.6.2.3.J
A complete control panel shall be provided with pressure gauges, temperature and flow indicators and conductivity recorder, together with alarm indications for the control and supervision of the water cooling system.

JA
The temperatures between bars shall be processed due to clogging indication.

JB
The temperatures between bars in each slot shall be monitored in relation to a high threshold to be defined by the Supplier* [redacted] In addition, temperature at the water outlet of the each group bars in each slot shall be monitored.

[redacted]

4.2.6.2.3.K
The required quality of water shall by fulfilled.

KA
The water circuits shall include two coolers and filters.

KB
The cooling liquid filters shall maintain cooling liquid cleanliness within the allowable criteria specified by the generator manufacturer.

KC
Dual flow strainers, filters, and a deioniser and their associated resin traps shall be provided with the capability for maintenance during power operation.

[redacted]

KE
The system shall be designed to prevent copper contamination of the cooling water.

4.2.6.2.3.L
The types of materials and design of joints between different types of material shall assure that fabrication defects are prevented and that joints are not subject to failure under cyclic duty.

LA
The use of brazed and threaded joints shall be minimised.

LB
Joints of dissimilar metals shall be designed to prevent galvanic corrosion.

LC
The stator windings are parts of the water circuit, and so the brazed joints may be used. These joints shall be manufactured in accordance with a technological procedure of the manufacturer.

[redacted]

MA
A pressure alarm shall be included.

MB
A "liquid-in-casing" detector shall be provided together with the necessary alarm system.

4.2.6.2.3.N
The vent from the hydrogen detraining chamber shall be taken to atmosphere in a location where ignition shall not be possible and shall be capable of passing the flow of hydrogen following a winding water hose fracture.

NA
The hydrogen exhaust pipeline (vent) shall be manufactured from a metal material and grounded to prevent creation of an electrostatic charge.

4.2.6.2.3.O
The provisions for grab samples shall be provided.

4.2.6.2.3.P

[redacted]

PA

The Supplier* shall provide the related setpoints trips to the above parameters, when applicable (Project Management Document*, Attachment 3).

4.2.6.2.3.R

The risk of hydrogen explosion shall be analysed and minimized (see Section 4.2.6.5.3).

4.2.6.3 HYDROGEN COOLING SYSTEM (IF ANY)

4.2.6.3.1 SYSTEM DEFINITION

The hydrogen cooling system comprises hydrogen coolers and water temperature control valves. See Section 2.4.5.8.2.2 for fire hazard analysis.

It interfaces with the main generator hydrogen connections and the cooling water system.

4.2.6.3.2 SYSTEM FUNCTION

The hydrogen cooling system removes the heat generated within the generator and reduces windage loss.

4.2.6.3.2.A

The continuous operation at reduced power output shall be possible for the turbine generator set, with one hydrogen cooler out of service.

AA

The reduced power with one hydrogen cooler out of service shall be at least two-thirds of the Gross Rated Output* (CSN EN IEC 60034-3).

4.2.6.3.3 GENERAL REQUIREMENTS

4.2.6.3.3.A

Water-cooled hydrogen coolers shall be provided to remove heat losses collected by the hydrogen gas in the generator and maintain hydrogen temperature within the allowable limits of the generator for continuous operation at 100 % rated load.

AA
The coolers shall be supplied by demineralised water.

AB
The system shall contain a water flow control valve in order to maintain hydrogen temperature above a specified minimum value ensuring adequate rotor temperature.

AC
Two separate approved temperature detectors fitted with adjustable alarm setting levels shall be provided for each hydrogen cooler for initiating high casing hydrogen temperature alarms.

4.2.6.3.3.B
The hydrogen coolers and ducting shall be arranged to minimise the possibility of damage to the machine due to water leakage from the coolers into the gas space.

BA
The hydrogen cooler water boxes shall be located external to the casing so that the headers can be removed, in the event of leakage.

BB
Provisions shall be included to facilitate waterside cleaning of hydrogen coolers while on line, including isolability, accessibility and means to vent hydrogen.

4.2.6.3.3.C
Any necessary apparatus required to withdraw the hydrogen coolers shall be supplied.

[redacted]

4.2.6.3.3.E
Continuous monitoring devices shall be installed to measure the contents of air, inert gas and H_2 in the generator.

EA
Signalization and information shall be provided on local control panel, with outputs for remote monitoring by the Unit* control systems.

4.2.6.3.3.F
The Supplier* shall provide measures to minimize any fire or explosion risk due to leakage of hydrogen. The hydrogen gas detector is applied in the possibility area that hydrogen can be collected when the hydrogen is leaked at least as follows:

[redacted]

4.2.6.3.3.G
Devices shall be provided for monitoring which initiate alarms (as applicable) in the control room for conditions that could result in abnormal system operation. The parameters shall be as a minimum but not limited to the following:

[redacted]

GA
The Supplier* shall provide the related setpoints trips to the above parameters, when applicable (See the Project Management Document*, Attachment 3).

4.2.6.3.3.H
The risk of hydrogen explosion shall be analysed and minimized (see Section 4.2.6.5.3).

4.2.6.4 HYDROGEN SEAL OIL SYSTEM (IF ANY)

4.2.6.4.1 SYSTEM DEFINITION
The hydrogen seal oil system comprises the main seal oil system with reservoir, main and emergency pumps, coolers installed in lube oil system, regulators and filters; and the vacuum system with pumps and separator tank as required.

It interfaces with the main generator seal oil connections, the turbine lubricating oil system and the cooling water system TBCCWS.

4.2.6.4.2 SYSTEM FUNCTION
The hydrogen seal oil system shall supply pressurised oil to the generator shaft seals to prevent hydrogen leakage and provide necessary cooling.

4.2.6.4.3 GENERAL REQUIREMENTS

4.2.6.4.3.A
The generator shall be fitted with shaft gas seals of either ring or thrust type.

4.2.6.4.3.B
The seal oil system shall be treated such that oil direct from the main lubricating oil tank shall not contain hydrogen.

4.2.6.4.3.C
It shall be capable of delivering oil to the shaft seals with a suitably low moisture level.

4.2.6.4.3.D
The tanks, pumps, valves and pipework shall, as far as possible, be assembled as a compact unit supported from the basement floor, so as to minimise fire risk.

4.2.6.4.3.E
Three full duty seal oil pumps shall be provided, supplied from redundant and diverse systems.

EA
The arrangement shall be one pump supplied from the main electrical supply system, one from a non-safety Emergency Power Supply* system, and the emergency pump driven from a DC power supply.

4.2.6.4.3.F
The seal oil system shall be designed to eliminate the possibility of impurities and corrosion products occurrence in the seals.

4.2.6.4.3.G
Measures shall be taken to avoid oil leakage/splitting of oil.

GA
Drainage shall be foreseen for respective zones.

4.2.6.4.3.H
The pump characteristics shall be such that if two pumps are in operation and one pump fails, the other shall automatically supply the total required oil pressure and quantity.

HA
When only one pump is in service, another pump shall automatically start when the seal oil discharge pressure falls to a preset value.

HB
In the event of the failure of the plant auxiliary supplies, the pump connected to the other supply shall start automatically when the seal oil discharge pressure falls to a lower preset value.

HC
Means shall be provided in the system to ensure that there is no H_2 leakage at the seal during the automatic changeover of the pumps.

HD
In the event of failure of all three motor driven pumps, the seal oil supply shall be taken from the shaft turbine lubricating oil system or the seal oil tank shall supply sufficient seal oil pressure during all required time for full displacement of hydrogen.

HE
A means for reducing generator hydrogen pressure to a value lower than the turbine lube oil pressure in the event of seal oil system failure shall be provided.

4.2.6.4.3.I
The separate seal oil tanks shall contain sufficient oil for the satisfactory operation of the seal oil system under all conditions.

IA
Motors shall be located so that main seal oil pump motors are separated from emergency/standby motors.

IB
Pressure switches shall be intrinsically safe in a hydrogen atmosphere.

4.2.6.4.3.J
Oil supply system for make-up purposes shall include any necessary treatment to ensure that the maximum seal oil moisture level is not expected.

4.2.6.4.3.K
Loops shall be included in pipework, where necessary, to prevent hydrogen entering tanks.

4.2.6.4.3.L
NA

LA
All necessary earth bonding shall be provided to eliminate the possibility of a spark occurring in a pipe or tank which may contain hydrogen.

LB
In case of venting the extracted hydrogen to atmosphere, the exhaust shall be located where ignition shall not be possible.

4.2.6.4.3.M
Controls shall be provided to maintain a constant differential pressure between the seal oil pressure and the hydrogen pressure.

MA
Appropriate control and signalization schemes shall be provided to avoid common cause failures and to eliminate the possibility of entire system failure in case of single component unavailability.

4.2.6.4.3.N
The parts of the oil system shall be placed in position so as all supposed maintenance operations will be possible, notably assembling and disassembling from position and transport on maintenance place.

4.2.6.4.3.O
Devices shall be provided for monitoring which initiate alarms (as applicable) in the control room for conditions that could result in abnormal system operation. The parameters shall be

[redacted]

OA
The Supplier* shall provide the related setpoints trips to the above parameters, when applicable (See the Project Management Document*, Attachment 3).

4.2.6.4.3.P
The risk of hydrogen explosion shall be analysed and minimized (see Section 4.2.6.5.3).

4.2.6.5 GENERATOR H2 AND FILLING / PURGING SYSTEMS (IF ANY)

4.2.6.5.1 SYSTEM DEFINITION

The generator H_2 and filling / purging systems comprise hydrogen storage and pressure control valves, inert gas storage with refrigeration unit, vaporiser and pressure control valves, and gas dryer and analyser.

They interface with the main generator gas supply and discharge connections.

4.2.6.5.2 SYSTEM FUNCTIONS

The generator H_2 and filling / purging systems supply inert gas for purging the main generator either prior to filling with H_2, or prior to admitting air when shutdown for maintenance, and also supplies the H_2 for make-up during operation.

4.2.6.5.3 GENERAL REQUIREMENTS

4.2.6.5.3.A

The hydrogen (H_2) storage facilities shall have a capacity of at least three times the quantity required to purge inert gas to obtain the required hydrogen purity and to subsequently pressurise the generator to its working pressure.

AA

The inert gas storage tanks shall have a capacity of at least three times the quantity required to purge the generator of hydrogen and air while at a standstill.

4.2.6.5.3.B

The hydrogen charging system shall maintain the specified pressure under all generator operating conditions.

4.2.6.5.3.C

Valves in the hydrogen system shall be compatible for use with hydrogen to prevent hydrogen leakage.

4.2.6.5.3.D

If CO_2 is used as an inert gas for filling and purging the generator, pressurized bottles shall be used or a refrigeration unit shall maintain CO_2 in the storage tank in a liquid condition at -18 °C.

4.2.6.5.3.E

Filling with H_2 or purging with an inert gas shall be a safe and efficient operation.

EA

The time needed for hydrogen expulsion from the generator shall not exceed 5 hours.

4.2.6.5.3.F

If necessary, heaters shall be supplied to ensure that the temperature of the inert gas entering the generator during purging is not causing damage to the welded structure or other components.

4.2.6.5.3.G
The Supplier* shall provide a system to determine hydrogen and inert gas (in case of CO_2) leakage.

4.2.6.5.3.H
Compressed air from the instrument air system shall be used for purging the inert gas.

4.2.6.5.3.I
The hydrogen filling system shall prevent inadvertent hydrogen supply during outages..

4.2.6.5.3.J
A mechanical interlocking arrangement for the hydrogen and air admission/venting valves shall be provided to ensure the correct order of gas admission.

JA
The mechanical interlocking arrangement shall be located in an accessible area remote from where burning oil and other hazardous material can collect, and above the maximum flood level.

KB
A gas dryer shall be provided to remove moisture at an efficiency as close to 100% as reasonably achievable from the hydrogen circulating within generator.
KC
For this dryer, the desiccant shall be automatically re-activated and the water extracted shall be drained.

4.2.6.5.3.L
Two independent hydrogen supply regulators shall be provided to control gas pressure.

4.2.6.5.3.M
Pipework and equipment containing hydrogen shall be in one section of the cubicle, sealed from the electrical sections, and ventilated to atmosphere to eliminate the possible formation of an explosive mixture of hydrogen and air.

4.2.6.5.3.N
The dewpoint of the hydrogen in the stator casing shall be recorded by two monitoring devices of an approved type, fitted with the alarm setting levels. One shall monitor the outlet from the hydrogen dryer, the other the inlet to the hydrogen dryer or in the stator casing (due to measuring of dryer efficiency).

4.2.6.5.3.O

A blower suitable for operation with pressurised hydrogen shall be provided in the pipework between the generator casing and the dryer so that when the generator is shutdown, a continuous flow of hydrogen shall be maintained from the generator, through the dryer and back to the generator, with a flow rate sufficient to circulate hydrogen for conservation purpose.

OA

If the blower is used a suitable control shall be provided locally for this condition of operation.

4.2.6.5.3.P

Additional valves and pipework, in series/parallel with the main valves for admitting inert gas to the casing shall be located in an area remote from the main valves and in a non-hazardous area, remote from the main fire protected zones around the turbine generator unit.

4.2.6.5.3.R

All pipework and equipment which may be subject to the leakage of hydrogen shall be positioned so that the surrounding area has natural and adequate ventilation in order to avoid the formation of dangerous gas pockets. This applies particularly to the generator connection area under the stator casing and to slipring housings.

RA

In these areas, flanged joints shall not be used unless essential for maintenance.

RB

Hydrogen pipes shall be double contained, up to the first expansion valve and run well clear of cable runs.

RC

All hydrogen pipework shall be colour coded along its whole length irrespective of its height above ground.

4.2.6.5.3.S

Explosion proof motors and equipment shall be used.

SA

The Supplier* shall provide systems to prevent hydrogen combustion or explosion in the event of a fire.

4.2.6.5.3.T

The hydrogen system shall be equipped with a gas flowmeter or with a diagnostic on-line test of escaping hydrogen for the purpose of measuring the total hydrogen leakage value. In case of excessive hydrogen consumption the supply line shall be automatically shut off.

TA

The Supplier* shall provide measures to minimize any fire or explosion risk due to leakage of hydrogen. The hydrogen gas detector is applied in the possibility area that hydrogen can be collected when the hydrogen is leaked at least as follows:

[redacted]

TB
Devices shall be provided for monitoring which initiate alarms (as applicable) in the control room for conditions that could result in abnormal system operation. The parameters shall be as a minimum but not limited to the following:

- Hydrogen gas purity
- Generator hydrogen pressure
- Gas analyser malfunction

TC
The Supplier* shall provide the related setpoints trips to the above parameters, when applicable (See the Project Management Document*, Attachment 3).

4.2.6.5.3.U
The Supplier* shall provide the Owner* with the explosion protection document required by Government Order No. 406/2004 Coll., as amended (See the Project Management Document*, Attachment 3).

4.2.6.5.3.V
The Supplier* shall determine the hydrogen leak sources, exhaust degree, leak rate and other characteristics of the leakage source, air movement velocity, etc. With these parameters and taking standard CSN EN-60079-10 as a basis, the Supplier* shall define the hazardous zones in a three dimension bases.

VA
The hazardous zones shall be as small as possible taking into account the design of ventilation systems that serve areas where leakage can occur.

VB
The location of the hydrogen detectors shall be in accordance with the hazardous zones and clearly identified in the explosion protection document.

VC
Equipment and components located in hazardous areas shall be qualified in accordance with Government Order No. 116/2016 Coll., as amended.

4.2.6.6 EARTHING

4.2.6.6.A
High impedance earthing of the generator neutral shall be provided.

AA
The impedance shall have a value such as to limit the fault current to a value eliminating damage of magnetic current (stator-core stampings).

4.2.6.6.B
A small transformer shall be used with resistance loaded secondary.

BA

Such a transformer shall be of solid insulation type, and mounted within a metal clad enclosure.

4.2.6.6.C

Provision shall be made on the low voltage side of the equipment for mounting a voltage and current transformer for operation of protective relays.

4.2.6.6.D

The rotor shaft shall be earthed as specified in Section 4.2.3.5.

4.2.6.7 SUPERVISORY AND ESSENTIAL INSTRUMENTATION

4.2.6.7.A

Instrumentation shall provide the Operator* with data specifically warnings against continuous operation under adverse operating conditions of the generator, especially over-temperature, excess current and voltage, incorrect excitation, gas purity, leakage rate and humidity, bearing and winding vibration and water coolant flow, temperature and purity.

For more details for the electrical protections of the generators see Section 2.7.11.4.10 See also I&C requirements described in Sections 4.2.8 and 4.2.9.

4.2.6.7.B

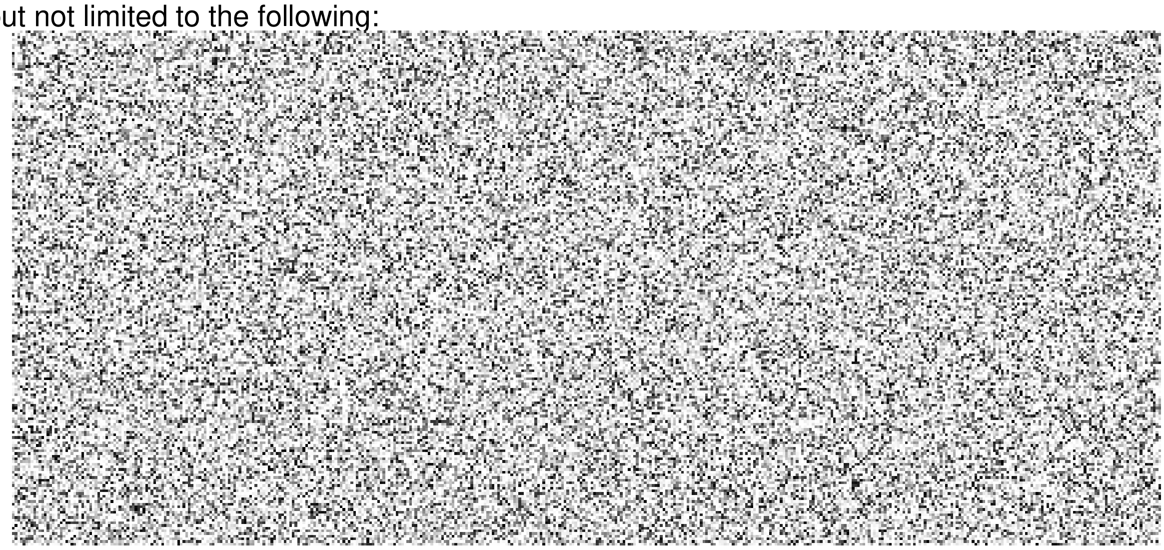
Instrumentation shall also be designed to provide information for maintenance decisions.

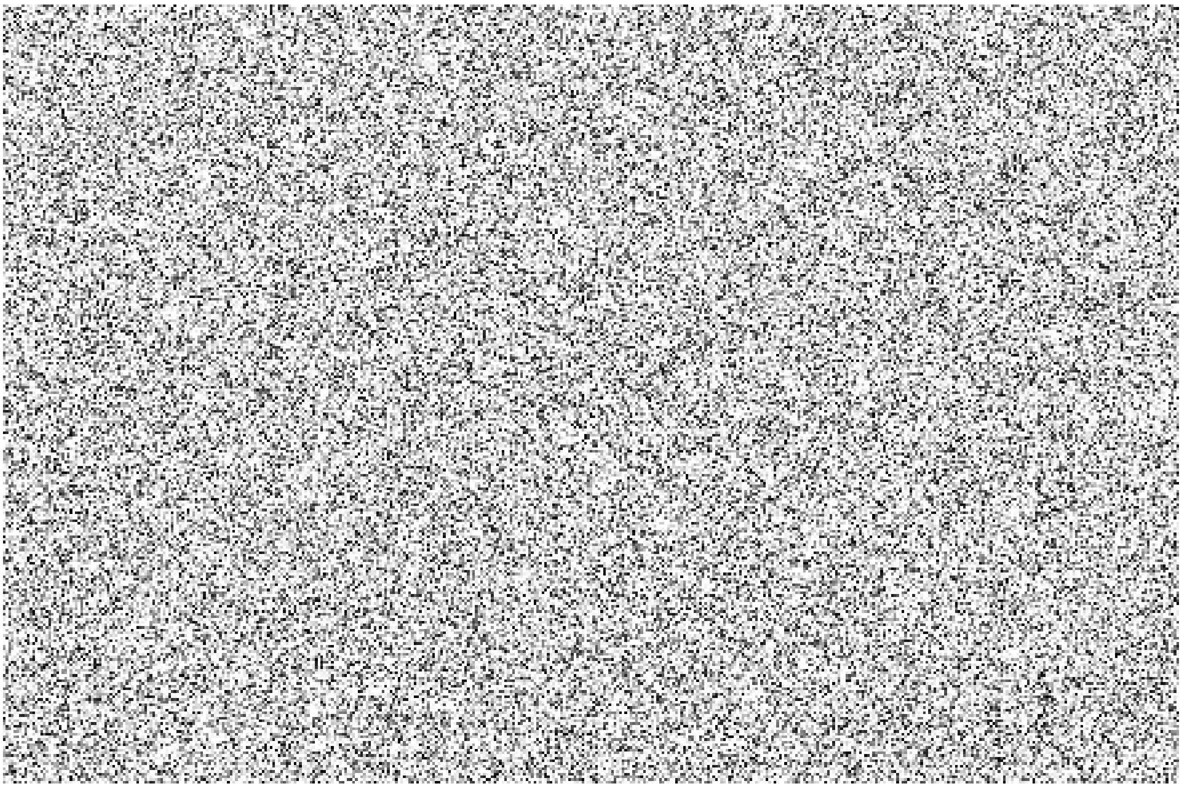
4.2.6.7.C

The instrumentation shall be such that the equipment behaviour with regard to the long term, short term and instantaneous values can be observed for those parameters which control safety of operation and the availability (i.e. the I&C is ready to fulfill all of their design functions).

4.2.6.7.D

Generator supervisory instrumentation shall be provided to monitor electrical, thermal, and mechanical parameters. As required parameters shall initiate alarms in the control room for conditions that could result in abnormal system operation. Selected parameters shall include but not limited to the following:





DA
The Supplier* shall provide the related setpoints trips to the above parameters, when applicable.

4.2.6.7.1 ON-LINE DIAGNOSTIC MONITORING

4.2.6.7.1.A
The Supplier* shall provide an online continuous monitoring program for detection of progressive faults and diagnostic system for maintenance and lifetime monitoring.

AA
It shall include methods of monitoring and evaluating criterions.

AB
The minimum scope of the online monitoring and diagnostic is defined in the relevant Sections 4.2.5.3, 4.2.5.4, 4.2.6.1.3, 4.2.6.1.4, 4.2.6.2.3, 4.2.6.3.3, 4.2.6.4.3 and 4.2.6.5.3.

4.2.6.7.1.B
A means shall be provided for verification of oil drain flow from the bearings.

4.2.7 MAIN CONDENSER

4.2.7.1 SYSTEM DEFINITION

4.2.7.1.A

The condenser shall comprise the condenser shell, tubes and tube sheets, support plates, hotwell, waterboxes, steam and water dump diffusers, air extraction system and other associated systems.

AB

It interfaces with the main turbine, the condensate system, the main circulating water system, the turbine bypass system, and the condenser air removal system.

4.2.7.2 SYSTEM FUNCTIONS

4.2.7.2.A

The functions of the main condenser shall be as follows:

[redacted]

4.2.7.3 SYSTEM PERFORMANCES

4.2.7.3.A

The Supplier* shall provide a set of curves which illustrates the variation in condenser pressure for changes in:

[redacted]

4.2.7.3.B

The design of the condenser shall avoid tube permanent inundation and consequent condensate sub-cooling problems.

4.2.7.3.C

The condenser shall be designed with a sufficient margin to guarantee the condenser performance and mitigate the problem of tube plugging and tube sheets fouling.

4.2.7.3.CA
Additional tubes to the total amount obtained shall be included by the Supplier* [redacted] The guaranteed performances shall not take into account this additional margin.

[redacted]

4.2.7.3.CC
The Supplier* shall provide the condenser cleanliness program which will ensure that the cleanliness factor is maintained as high as possible.

[redacted]

DA
In addition, the hotwell shall have an available standby surge storage capacity (i.e. maximum water level) equivalent to 2 minutes of normal full load condensate flow.

[redacted]

4.2.7.3.F
The Supplier* shall evaluate thermodynamic and mechanical performances when operating the condenser with one or more tube bundles out of service. Provisions shall be made to ensure that the forces and moments imposed on the turbine in these special modes of operation are below the permissible values.

4.2.7.3.G
The main condenser shall be of high integrity, specially designed for the type of cooling water used (river water), so that full-flow condensate polishing is not necessary.

4.2.7.3.H
Condenser vacuum breaker devices shall be provided for cases of emergency.

4.2.7.3.I
Cooling water side of the main condenser shall be protected against overpressure and water hammer.

4.2.7.3.1 CONDENSER HOTWELL LEVEL CONTROL

4.2.7.3.1.A
The condenser hotwell level shall be maintained by the combination of normal condensate makeup and overflow valves.

4.2.7.3.1.B
The makeup line shall use a parallel combination of operated valves.

4.2.7.3.1.C
NA

4.2.7.3.1.D
NA

4.2.7.3.1.E
The local level controller operating range shall be sized as wide as possible within the constraints of the condenser hotwell design (see Section 4.2.7.6).

4.2.7.3.1.F
The operating range of the emergency level controller shall overlap the operating range of the normal level controller.

4.2.7.3.1.G
The level controller float mechanism shall be specified for the expected specific gravity conditions of the hotwell liquid during maximum normal operating conditions, if applicable.

4.2.7.4 GENERAL ARRANGEMENT

4.2.7.4.A
The condenser shall be of the surface type.

4.2.7.4.B
Adequate access space shall be provided in the PGP layout so that it is possible to replace the condenser tubes modules.

BA
It shall be possible to replace the condenser tubes without dismantling the frame.
4.2.7.4.C
The design shall not preclude shop prefabrication.

CA
The condenser shall be assembled in workshops as far as possible and shipped to the Site* fully tubed like modular designs where each section is tubed and prefabricated in workshops, including tube sheets, tubes and tube supports.

4.2.7.4.D
The condensing surface area and vacuum containment shall be optimised on the basis of the required performance and operating regime of the turbine together with details of the Site* environmental conditions provided by the Owner* (see Chapter 5.2).

4.2.7.4.E
Adequate provisions shall be made for high temperature and high pressure drain flows prior to being admitted to the main condenser.

4.2.7.4.F
Facilities shall be provided to ensure that the condensate formed on the heat transfer surfaces and the drains and make-up discharged into the condenser shells are adequately deaerated.

FA
If the condensate system has a deaerator combined with a feedwater tank, the oxygen level measured at the extraction pump discharge shall be less than 12 ppb (condenser outlet) and 5 ppb (at the Steam Generator*) in Normal Operation*.

4.2.7.4.G
The condenser shall be capable of being filled with water for a hydrotest. Provisions shall be made to allow draining and cleaning of the hotwell.

4.2.7.4.H
Means shall be provided to protect the tubes from pitting during periods of condenser shutdown in case the tubes are manufactured from any other material than titanium (a circulating water recirculation loop or provisions to completely drain the condenser waterbox and tubes are examples of achieving this requirement).

4.2.7.4.I
The condenser and circulating water system shall be designed to permit isolation of a portion of the tubes to permit repair of leaks and cleaning of water boxes while operating at reduced power.

4.2.7.4.J
Heater shells and piping installed in the condenser neck shall be located outside of the turbine exhaust steam high velocity regions and within the limits specified by the Supplier*.

4.2.7.4.K
Internal piping shall be as short and straight as possible and all steam extraction piping shall slope downward toward the heater shells.

4.2.7.4.L
Work plans and facilities for cleanup, Inspections* and maintenance of condenser internals shall be pre-engineered.

4.2.7.4.M
Special equipment for normal outage work shall be minimized.

4.2.7.4.N
For material requirements see Section 2.6.4.1.5.

4.2.7.5 DETECTION OF TUBE LEAKS

4.2.7.5.A
To ensure a good water chemistry for the Steam Generator* and turbine, inleakage of raw water shall be avoided.

AA
Therefore, the proven design shall be applied.

4.2.7.5.B
The condensers shall be provided with facilities to detect and locate leaking tubes on load.

4.2.7.5.C
Each section shall be provided with sufficient number of continuous monitoring conductivity probes in order to identify the leaking tube section without access to the waterboxes. See Section 4.3.2.9.

4.2.7.5.D
Each section of the condenser shall be equipped with an isolable cooling water system which prevents polluted water from entering the condenser hotwell in case of tube leakage and ensures the personnel safety during leak detection operation.

4.2.7.5.E
It shall be possible for the turbine to run with one condenser, or with one section of the condenser being isolated from cooling water.

EA
The Supplier* shall provide information on the maximum load that the turbine can sustain under conditions described above.

4.2.7.6 CONDENSER SHELLS

4.2.7.6.A
The exhaust connection between turbine and condenser shall ensure a satisfactory distribution of steam flow and velocity over the condenser tubes to guarantee the highest possible efficiency of the condenser.

4.2.7.6.B
This connection, the condenser shell and other critical parts shall be designed for the most severe thermal and mechanical stresses (both stationary as well as dynamical), which can arise during normal and bypass operation.

4.2.7.6.C
The design of condenser supports, connection to the turbine exhaust, cooling water connection and other piping connections shall provide adequate space for thermal expansion without inducing excessive stresses.

4.2.7.6.D
Connection between the condenser and the turbine shall be solid with the condenser welded to the turbine and spring supported so that the resulting load acting on the pedestals is minimized.

4.2.7.6.E
Access into the steam space of the condenser shells shall be provided.

4.2.7.6.F
Sections of heater shells and piping that are located inside the condenser and normally operated with a full load inside temperature of about 90 °C or more shall be lagged, or the Supplier* shall prove that the lagging is not necessary.

FA
The lagging shall be made of stainless steel and shall be designed in line with experience proven practices.

4.2.7.6.G
The condenser shall include piping between turbine extraction steam connections in the condenser shell to a terminal point outside the condenser shell.

4.2.7.6.GA
Any expansion joints required to reduce piping stresses and reactions on the turbine connections shall be provided including impingement shields for the expansion joints.

4.2.7.6.GB
Connections to the shell shall be minimised and welded where reasonably achievable.

4.2.7.6.H
Adequate baffles and/or spray headers shall be provided for drains entering the condenser to prevent tube erosion or impingement damage.

4.2.7.6.I
Welds attaching steam impingement plates to the condenser shell or internals shall be designed to withstand expected steam impingement loads.

4.2.7.6.J
The vacuum tightness and structural soundness of all welds and joints forming the vacuum containment shall be demonstrated during fabrication or construction or when it is completed.

4.2.7.6.K
The leak tightness of all parts of the condensing system shall be sufficient to prevent an unacceptable rate of pressure increase if the vacuum system is out of order/inoperable.

4.2.7.6.L
The condenser shell tightness verification shall be possible (for example by means of filling water test).

4.2.7.6.M
Depending on design, facilities shall be provided to receive steam and water discharges from the Steam Generator* blowdown system.

4.2.7.6.N
Hotwell drains shall be designed so as to facilitate dumping of condensate water.

4.2.7.6.O
The volume of the hotwell and the automatic level control system shall ensure that the condensate pumps are provided with sufficient net positive suction head to ensure their proper operation during all normal operating conditions, including severe transients.

4.2.7.6.P
The hotwell shall include measures to protect the condensate pumps (e.g. protection from vortex, mechanical damage etc.).

4.2.7.6.R
The Supplier* shall indicate the condenser start-up water level if there is any operation restriction to reduce the water level below the normal water level.

4.2.7.7 TUBES AND TUBE SHEETS

4.2.7.7.A
The material and dimensions of the condenser tubes shall be selected in accordance with the water quality requirements to provide optimum resistance to erosion and corrosion attack both on the steam and on the cooling water sides.

AA
For material selection see Section 2.6.4.1.5.2.

4.2.7.7.B
The design of the condenser shall be tube vibration resistant.

4.2.7.7.C
Tubes shall be rolled and leak welded to the tube sheet.

CA
Tube and tube sheet joints shall withstand any forces and ensure tightness under all operating conditions.

4.2.7.7.D
The soundness of the tube to tube sheet joints shall be demonstrated before construction (through process qualification) and after fixing.

4.2.7.7.E
The material of tube sheets in contact with the cooling water shall be selected on the basis of corrosion resistance for the whole lifetime.

4.2.7.7.F
Special consideration shall be given to the electro-chemical compatibility with the tube and waterbox materials.

4.2.7.7.G
The soundness of any tube sheet joint which cannot be remade shall be demonstrated after fixing and prior to tubing.

4.2.7.7.H
The tube bundle shall be designed to prevent a locally high steam speed and to promote air or gases draining in the direction of the air extraction system.

4.2.7.7.I
The tubes located in the impingement sections of the tube bundle shall have an adequate thickness to avoid tube failure induced by vibrations.

4.2.7.7.J
The top two rows of tubes and the tubes in the areas of high steam velocity shall be designed so as to provide protection for all lower rows of tubes.

4.2.7.7.K
If necessary, tubes shall be protected by baffles and protection plates from impingement of flashing steam and incoming condensate.

4.2.7.7.L
The tube bundle design (inner tube diameter and wall thickness) shall ensure reliable operation of the on-load cleaning system.

4.2.7.7.M
The tube bundle periphery is more susceptible to mechanical damage in the following locations, which shall be taken into account in the design:

- under the low pressure turbine exhaust,
- in the vicinity of the turbine bypass line,
- in the vicinity of the high energy baffled drains.

4.2.7.8 TUBE SUPPORT PLATES

4.2.7.8.A
The number and location of the support plates shall be selected so that the tube life is not shortened by vibrational load caused by other equipment and the steam velocity.

4.2.7.8.B
The vertical location of tube sheets and the support plates shall be such that tubes are self-draining on shutdown conditions.

4.2.7.8.C
Condenser manufacturer shall provide vibration analyses for all condenser-operating modes.

CA
This shall include the following:

- full load steam turbine operation,
- maximum flow full load bypass
- the condition of one waterbox out of service and the other under maximum thermal load

all including the lowest anticipated condenser cooling water temperature.

[redacted]

4.2.7.9 WATERBOXES

4.2.7.9.A
The waterboxes shall be designed with minimum hydraulic loss.

4.2.7.9.B
The waterboxes shall be designed to ensure an optimal distribution of the cooling water speed.

4.2.7.9.C
The waterboxes shape shall ensure that the uppermost tubes remain flooded under all start-up and normal operating conditions so that dead zones and air bubble formation in the upper part of the waterboxes is prevented.

4.2.7.9.D
Water side hydraulic loss including loss through tubes and waterboxes shall be one of the performance parameters.

4.2.7.9.E
The waterboxes shall be constructed and coated to prevent corrosion.

4.2.7.9.F
Special considerations shall be given to fittings in contact with the cooling water (such as thermometer pockets, cap nuts, etc.) to prevent oxidation.

4.2.7.9.G
Fittings shall be manufactured from materials chosen to resist corrosion, particularly galvanic corrosion.

4.2.7.9.H
The waterboxes shall be equipped with vacuum breaker valves, if an analysis of the hydraulic transients following a circulation pump trip demonstrates their need.

4.2.7.9.I
On the circulating water side, drains shall be provided to dump all the water.

4.2.7.9.J
Waterbox venting design shall accommodate the removal of air trapped during circulating water system filling and entrained air during circulating water system operation.

4.2.7.9.K
The design of the water boxes shall give special consideration to good accessibility for maintenance.

4.2.7.9.L
A low level hinged access door shall be provided on each waterbox.

4.2.7.9.M
The location of the doors shall permit safe access to the tube sheets for testing and maintenance.

4.2.7.9.N
The cooling water connections shall be fitted with a safety grid.

4.2.7.10 TURBINE BYPASS STEAM AND WATER DUMP DIFFUSERS

4.2.7.10.A
During operation of the Unit*, it shall be possible to dump steam to the condenser when the flow of steam generated by NSSS is higher than the steam flow to the turbine during the following instances:

[redacted]

4.2.7.10.B
Steam and water dump diffusers, the design of which is consistent with the requirements of Section 4.3.1, shall be fitted in the condenser.

4.2.7.10.C
Desuperheating equipment shall also be fitted in the condenser, according to either a temperature or enthalpy criteria.

4.2.7.10.D
The pressure-reducing and desuperheating stage shall condition the steam to be acceptable to the condenser, without producing any excessive mechanical and thermal stresses and without negative influence on turbine last stage blades.

4.2.7.10.E
Pressure parts of the steam dump system, generally included in the condenser, shall be designed, assembled and operated according to pressure vessel construction code and relevant regulations.

4.2.7.10.F
The diffusers shall be installed so as to minimise their effect on the exhaust steam flow from the turbine.

4.2.7.10.G
The condenser internals shall be protected against high velocity steam and water as well as high temperature from the diffuser.

4.2.7.11 AIR EXTRACTION SYSTEM

4.2.7.11.A
The air extraction system shall extract air coming from the turbine, condenser, feedwater and condensate systems, reheaters and reheater pipework, etc.

4.2.7.11.B
This extraction shall be designed to raise vacuum for turbine start-up and maintain the vacuum produced by the condenser over the complete range of operating conditions by removing non-condensable gases released in the condenser and vented to the condenser from other sources.

4.2.7.11.C
This extraction in the condenser shall be located in an area where condensate subcooling occurs.

4.2.7.11.D
The air extraction system shall be connected to the condenser so that, in the case of multi-shell condensers, each shell can be separately or commonly vented.

4.2.7.11.E
The vacuum pumps shall be used.

4.2.7.11.F
The vacuum pumps shall be capable of attaining a vacuum suitable for operation of the turbine bypass system within a time which is compatible with start-up requirements.

4.2.7.11.G
The condenser air removal equipment shall have sufficient discharge pressure to discharge to atmosphere with the losses in the exhaust pipe and a radiation monitor located in the exhaust pipe.

4.2.7.11.H
The extraction devices shall be designed to meet the air extraction requirements even under unfavourable operating conditions such as low water inlet temperature.

4.2.7.11.I
The condenser air removal equipment shall be designed to be capable of meeting, collectively, if necessary, the air extraction requirements at the lowest possible cooling water inlet temperature and under other unfavourable operating conditions.

4.2.7.11.J
The air extraction system shall be designed to minimize losses of pH conditioning agent from the secondary circuit during all modes of the Unit* operation.

4.2.7.11.K
A failure of one vacuum raising device shall not require the Unit* shutdown or power reduction.

4.2.7.11.L
The number of quick start pumps and vacuum maintaining pumps (or other vacuum raising devices) shall be consistent with the above requirements and shall include adequate standby to fulfill the above stated requirements.

4.2.7.11.M
The materials of the vacuum pumps or other vacuum rising devices shall be chosen for safe and reliable operation so that cavitation erosion and pitting corrosion does not produce mechanical failure or significant loss of performance.

4.2.7.11.N
Specifically for vacuum pumps:

[redacted]

- All bearings shall be automatically lubricated.
- The piping and valve arrangement shall be designed to minimise the possibility of cooling water being drawn into the condenser steam space in the event of a pump shutdown.

4.2.7.11.O
Valves shall be provided in the pipework of each condenser section so that the air extraction route can be isolated from the system when searching for tube leaks.

4.2.7.11.P
The capability to verify the tightness of the main condenser during operation shall be provided (for example by measuring the rate of vacuum reduction of the condenser after shut down of the air extraction system).

4.2.7.11.R
The air extraction system shall have radioactivity measurement system for SG leakages and suitable warning system.

4.2.7.12 ON-LOAD CLEANING SYSTEM

4.2.7.12.A
On-load cleaning of the condenser tubes, comprising equipment for projecting rubber or plastic spheres through the tubes by hydraulic means, shall be provided.

4.2.7.12.B
The tube cleaning system shall be designed to remove and recirculate the cleaning spheres during condenser and circulating water system operation.

4.2.7.12.C
The design shall avoid leakage of circulating cooling water into the secondary circuit.

4.2.8 TURBINE GENERATOR CONTROL SYSTEM

4.2.8.1 THE TURBINE SPEED AND POWER CONTROL SYSTEM

4.2.8.1.1 GENERAL

4.2.8.1.1.A
The turbine control system shall be designed:

- to enable the Plant* to fulfil the grid requirements (see Chapter 2.3),
- to enable manual control of the PGP by H-MI (see Chapter 2.10),
- to provide monitoring and controlling of all parameters (thermal, hydraulic and electrical) necessary for safe operation,
- to provide alarms and means to initiate automatic turbine shutdown in the event of detected unsafe conditions,
- to interface with the NI,
- to interface with the power transmission grid dispatching system,
- to maintain the parameters (power, pressure etc.) within the various limitations.

4.2.8.1.1.B
The turbine control system shall be of electro-hydraulic type.

4.2.8.1.1.C
The control system hydraulic fluid shall be fire resistant.

CA
The Supplier* shall specify the required minimum flash point and fire point temperatures for the hydraulic fluid.

CB
As a minimum, the fire point of the hydraulic fluid shall be greater than the main steam temperature.

4.2.8.1.1.D
In line full flow filters for the control of particulate contaminants shall be provided in the supply line for control system hydraulic fluid.

DA
Parallel filters and valving shall be provided to allow cleaning of a filter without interrupting the flow of hydraulic fluid during the Unit* operation.

4.2.8.1.1.E
A means for the control of chemistry and for the removal of moisture from the hydraulic fluid shall be provided.

EA
Provisions for sampling of the hydraulic fluid shall be provided to enable the verification of chemistry and moisture content.

4.2.8.1.1.F
The need for hydraulic fluid coolers shall be evaluated.

4.2.8.1.1.G
A solid-state electronic speed governor shall be provided.

GA
The speed governor shall have three redundant speed signals with a two-out-of-three voting logic.

4.2.8.1.1.H
The control system shall include provisions for testing and indication of valve position for the main steam stop, control, reheat stop, and intercept valves.

4.2.8.1.1.I
The control system shall be provided with sufficient redundancies such that failure or malfunction of a single component does not result in a turbine trip or unsafe condition.

4.2.8.1.1.J
The Supplier* shall provide redundant information acquisition, processing and controlling devices, such that a single failure does not fail the system.

4.2.8.1.2 SYSTEM OPERATING CONDITIONS

4.2.8.1.2.A
The various operating conditions of the turbine generator system, which shall be taken into account in design, depending on Unit* operation modes described in Chapter 2.3, are as follows:

AA
Operation under normal grid conditions (see Section 2.3.2):

- active power generation and reactive power generation,
- start-up and shutdown of the Unit*,
- frequency response,
- secondary control of grid supply,
- scheduled and unscheduled Load Following* operation.

AB
Operation under disturbed grid and other specific Plant* conditions (see Sections 2.3.3 to 2.3.6):

- emergency load variations,
- house load operation,
- operation in an isolated grid,
- contribution to grid restoration.

AC
The turning gear operation (to start upon zero turbine rotor speed, ensure sufficient lube oil pressure and prevent bowing of the turbine rotors after shutdown and before start-up).

4.2.8.1.2.B
A device enabling the Operator* to modify the speed set-point shall be made available by a dedicated control.

4.2.8.1.2.C
For cases, when the turbine generator is not coupled to the grid, the design shall enable the speed of the turbine generator to be adjusted, between shutdown and coupling up, with accurate speed control when approaching synchronisation, see Section 2.3.1.4.

4.2.8.1.2.D
[redacted]

4.2.8.1.3 TURBINE CONTROL SYSTEM

4.2.8.1.3.A
The turbine control system shall facilitate manual and automatic controls of turbine systems for all modes of turbine operation including safe start-up and shutdown.

4.2.8.1.3.B
Automatic controls for equipment and components shall be designed to minimise Operator* actions.

4.2.8.1.3.C
The turbine controls shall be capable of automatically matching the Unit* power output when given an input signal from the power control system or a manual signal from the Main Control Room*.

4.2.8.1.3.D
Automatic controls shall provide control of turbine speed and acceleration through the entire speed range with several discreet speed and acceleration rate settings.

4.2.8.1.3.E
Turbine and generator rotor critical speeds shall be calculated and the automatic control function shall be programmed to prevent holding at these speeds.

4.2.8.1.3.F
[redacted]

4.2.8.1.3.G
Automatic controls shall be provided for fast valving as required in Section 2.3.3.2.1.

4.2.8.1.3.H
An interlock shall be provided to restrict the turbine valve controls from admitting steam to the turbine until sufficient oil pressure has been developed for lubrication of the bearings.

HA
In addition, the turning gear shall be tripped upon loss of lube oil pressure.

4.2.8.1.4 GENERATOR CONTROL SYSTEM

4.2.8.1.4.A
The generator control systems shall have the following functions:

- provide safe synchronization, operation, reactive power production and shutdown of the generator,
- provide automatic control of generator systems to the extent practical to minimise Operator* actions and optimize system performance,
- initiate various load reduction and/or trip signals to shut down the Unit* in an orderly sequence or instantaneously in the event that an unsafe condition in the generator is detected.

4.2.8.1.4.B
Automatic adjustment of generator output by a signal sent from the power control system or by a manual signal from the Main Control Room* shall be provided.

4.2.8.1.5 SYSTEM PERFORMANCES DURING SPEED INCREASE AND CONNECTION TO THE GRID

4.2.8.1.5.A
The system shall allow progressive speed increase of the turbine generator from shutdown state (i.e. being rotated by the turning gear) to connection to the grid. Set value for the speed shall be fixed either manually (+,-) or automatically.

4.2.8.1.5.B
The Supplier* shall define the performances of the system (speed measurements and stability of the speed control loop) during speed increase and operation at no load and other speed control regimes.

4.2.8.1.5.C
In order to be able to connect the turbine generator set to the grid, the control range of the automatic synchronisation unit shall comply with the requirements stated in Section 2.3.1.4.

4.2.8.1.5.D
Synchronization shall be possible also from the house-load operation.

4.2.8.1.6 INTERFACE REQUIREMENTS

4.2.8.1.6.A
The speed control system shall be designed in order to provide:

- standard connection with other I&C systems, to facilitate the integration,
- standard analogue and logic input and output,
- supervision and control from MCR.

4.2.8.1.7 HUMAN-MACHINE INTERFACE

4.2.8.1.7.A

The H-MI shall provide the monitoring and control of the conversion of the steam energy provided by the main steam system into mechanical energy of the turbine and into electrical energy on the output of main generator.

4.2.8.1.7.B

The H-MI for the turbine generator shall be integrated and coordinated with the H-MI of other systems of the Plant*, see Section 2.10.5.4.2.3.

4.2.8.1.7.C

H-MI of turbine control system shall include control of:

- steam flow to the main turbine and in the main and extraction steam systems,
- conditions in the main condenser, in the feedwater, condensate and circulating water systems,
- main generator.

4.2.8.1.7.D

The standby manual controls of speed and load shall assume control of the Unit* when the Unit* is removed from the primary automatic controls.

4.2.8.2 THE GENERATOR EXCITATION CONTROL SYSTEM

4.2.8.2.A

Voltage/reactive power control

The system shall be able to receive an external signal (control set point) drawn up either "manually" (from the MCR) or "automatically" (signal which is external to the PGP - from the power transmission grid dispatching system).
See Section 2.3.2.2.

4.2.8.2.B

Operating format

The system shall allow the internal angle of the generator to be monitored and a P/Q diagram of the generator to be made up. P/Q diagram shall be accessible to the Operator* in the conditions defined in Chapter 2.10.

4.2.8.2.C

The parameters involved shall be as follows:

- internal angle, active and reactive power to be displayed,
- water temperatures of the stator cooling system, generator voltage and frequency, variables which have an impact on the limits of the P/Q diagram.

4.2.8.3 THE TURBINE PROTECTION SYSTEM

4.2.8.3.1 GENERAL

4.2.8.3.1.A

The Protection System* shall ensure the following functions:

- protection function: this function trips the turbine generator (quickly closes the main stop, control, reheat stop, and intercept valves), following an out-of-limits operation or external command, in a safe and secure manner for the personnel and equipment,
- monitoring function: this function monitors the protective system, i.e. its functional status (closing, tripping), together with the "first fault" (identification of the initiating event, i.e. physical cause initiating tripping of the turbine) when this fault is processed by the system; it also tests the system in the conditions defined in Section 2.10.6.2.2.3.4.

4.2.8.3.1.B

Turbine Protection System* shall comply with the following generic requirements:

- Adequate Redundancy* and Diversity* shall be provided to ensure adequate turbine protection.
- Fail safe principle shall be applied on the Protection System* design.
- The protection response times shall be respected in order to assure that the turbine overspeed is not exceeded and that there is no damage to the turbine-generator and the equipment of the Plant*.

4.2.8.3.1.C

Two independent and diverse triple-redundant electronic overspeed Protection Systems* shall be provided.

4.2.8.3.1.D

The actuation of the turbine Protection System* shall not rely on components of the electro-hydraulic control system.

DA

Conversely, turbine trip initiation devices shall not be used for normal control of the Unit*, i.e. the Protection System* shall not be disabled by turbine control system malfunctions.

4.2.8.3.1.E

A single failure of a component or power source in the Protection System* shall lead neither to a loss of the protective function, nor to a spurious trip.

4.2.8.3.1.F

Any single failure in the Protection System* shall neither block nor trip the protection functions but trigger a relevant alarm.

4.2.8.3.1.G

Provisions for in operation testing of the emergency trip system, including individual trip devices, shall be included.

4.2.8.3.1.H
The system shall be designed to minimize false and spurious trips during the Normal Operation* and testing of the trip system.

4.2.8.3.2 FUNCTIONAL CHARACTERISTIC

4.2.8.3.2.1 MECHANICAL PROTECTIONS

4.2.8.3.2.1.A

[redacted]

AA
The response times shall be compatible with the dynamics of the physical phenomena which are controlled in order to assure that the turbine overspeed is not exceeded and that there is no damage to the turbine generator and other equipment of the Plant*.

AB
This means that the hydraulic controllers for the main stop, control, reheat stop, and intercept valves shall close off these valves sufficiently quickly after receipt of a trip signal to preclude an unsafe turbine overspeed.

4.2.8.3.2.1.B
The response of the controllers shall consider the residual steam in the piping between the valves and the turbine.

4.2.8.3.2.1.C
The turbine Protection System* shall be designed to activate the vacuum breaker valves if potential damage of the bearings or the turbine generator could be reduced by using them.

4.2.8.3.2.2 ELECTRICAL PROTECTION

4.2.8.3.2.2.A
The generator electrical protection system shall be designed in accordance with requirements stated in Section 2.7.11.4.10.

4.2.9 MONITORING AND DIAGNOSTIC FUNCTIONS

4.2.9.1 DATA RECORDING AND LOGGING FUNCTIONS

4.2.9.1.1 SCOPE

4.2.9.1.1.A
The monitoring function shall make it possible to explain and diagnose an incident which has occurred, involving:

- changes in main parameters of the secondary part of the Unit* (overall trouble monitoring of the PGP systems),

- monitoring mechanical parameters of the turbine generator (monitoring of the turbine generator).

4.2.9.1.1.B
The monitoring function shall involve recording signals during disturbances. The function shall be initiated either automatically or by an external order to the system. It shall display the changes in variables recorded before and after the start of the disturbance.

4.2.9.1.1.C
The system function shall be closely coordinated by the Supplier* with the corresponding functions in the Nuclear Island* especially when the NI designer is different from the PGP designer.

4.2.9.1.2 DESCRIPTION

4.2.9.1.2.A
The function shall make it possible to archive the variables to be monitored and then to retrieve them upon order (displayed on screen and print-out) so as to analyse the disturbances affecting the process off line. A display console shall be used for man-machine dialogue and for displaying results.

4.2.9.1.2.B
The system shall be:

- designed to operate during any disturbances,
- able to be externally synchronised,
- able to test and to control circuits.

4.2.9.1.2.C
The system shall have the necessary capability to record the information and be compatible with the dynamics of the physical phenomena which are monitored.

4.2.9.1.2.D
A "pre-time" memory shall give a status of the process before starting acquisitions. The channels shall be able to record parameters such as:

- thresholds,
- values acquired or computed,
- on/off positions.

4.2.9.1.2.E
"pre-time or post-time" storage shall be triggered either automatically or by an external order.

4.2.9.1.2.F
All the channels shall be identified. Their data shall be expressed in physical units and dated.

4.2.9.1.3 OVERALL MONITORING OF THE PGP SYSTEMS

4.2.9.1.3.A
The aim shall be to identify the initial cause of the fault, the way it develops and its consequences and to check operation of the protective circuits and of the tripping devices.

4.2.9.1.3.B
The inputs shall be grouped together in families including the turbine, the generator, the Generator Transformer* and the distribution switchboards.

4.2.9.1.4 MONITORING OF THE TURBINE GENERATOR

4.2.9.1.4.A
The monitoring of the turbine generator set shall detect and assess, by means of vibration analysis, a fault on the shaft line (instability, misalignment etc.) and on the inlet valves (seizure, flow instability). The inputs shall be signals coming from displacement sensors and accelerometers.

4.2.9.1.4.B
The monitoring system shall be common for turbine and generator.

4.2.9.1.4.C
Electrical characteristics of generator stator and rotor shall be part of the central unit fault monitoring system for electrical systems, which is described in Section 2.7.11.4.10, in order to capture the actual condition of stator/rotor windings and insulation capability.

4.2.9.2 MAIN EQUIPMENT MONITORING AND DIAGNOSTIC FUNCTION

4.2.9.2.A
The aim of this function is to monitor critical equipment to enable analysis of its behaviour. Each item of equipment has its own monitoring system, but a common structure shall be used for data analysis. See Section 2.10.5.4.2.3.14.

4.2.9.2.B
The main equipment monitoring shall ensure the following functions:

- gathering and managing data,
- analysing data.

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS CHAPTER 4.3 STEAM, CONDENSATE AND FEEDWATER SYSTEMS**
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CONTENTS

CHAPTER 4.3 STEAM, CONDENSATE AND FEEDWATER SYSTEMS

A

The Chapter 4.3 includes the following systems:

- main steam pipework,
- steam extraction,
- the Moisture Separator and Reheater*,
- main steam bypass,
- condensate,
- condensate cleanup,
- high pressure & low pressure feedwater heaters,
- deaerator and feedwater tank,
- main feedwater system,
- condensate storage and make-up,
- chemical addition,
- chemical sampling.

B

The requirements specific to each system or process covered in the Chapter 4.3 are specified in each individual corresponding Section. A short description of each system or process is given to clarify the scope and application of the requirements.

4.3.0 INTRODUCTION

4.3.0.A

This chapter presents the requirements related to the steam, condensate and feedwater systems of the Power Generation Plant*. It gives a description of each system and defines the functions of the systems. The interfaces with the Nuclear Island* are described in Chapter 4.1.

4.3.0.B

The whole system shall be designed in order to minimize make-up water consumption and also preventing infiltration of impurities into steam, condensate water system and feedwater system. The system shall be provided with the lay up provision equipment for the case of long outages (e.g. MSR) to protect the equipment from corrosion.

4.3.0.C

The whole system shall be designed in order to minimize an effect of flow accelerated corrosion on the system and to monitor selected components. The Supplier* shall provide a flow accelerated corrosion monitoring programme. See Section 2.6.4.1.5.

4.3.0.D

The Supplier* shall provide heat and mass balance diagrams that indicate pressures, temperatures, enthalpies and flow quantities of throttle, exhaust, sealing and leak-off steam and feedwater.

4.3.0.E
Heat balances shall be provided for steady state of all normal Operational Modes* that may occur in each Unit*. This shall include expected part loads, bypass operation, expected variation in cooling water temperatures and operation after foreseeable equipment failures in the Plant*.

4.3.0.F
Requirements related to design life are in detail described in Section 2.4.2.

4.3.1 MAIN STEAM SUPPLY AND EXTRACTION SYSTEM

4.3.1.1 GENERAL INTRODUCTION

4.3.1.1.1 SYSTEM DEFINITION

4.3.1.1.1.1 SCOPE

4.3.1.1.1.1.A
The main steam supply and extraction steam system includes all piping, valves and accessories provided to transport main steam from the interfaces between NSSS and PGP to the steam turbine and bypass system.

4.3.1.1.1.1.B
The steam extraction system includes the piping and valves necessary to transport steam from the turbine extraction points to the LP and HP feedwater heaters and to the deaerator.

4.3.1.1.1.2 INTERFACES

4.3.1.1.1.2.A
The main steam supply and extraction steam system interfaces mainly with:

- NSSS,
- turbine,
- feedwater and condensate system,
- MSR,
- condenser,
- atmosphere,
- building structure.

4.3.1.1.1.2.B
The main steam safety and relief function along with the main steam isolation function are part of NI. Design requirements for safety and relief valves and main steam isolation valves are provided in Section 2.8.2.3.2.2.

4.3.1.1.1.2.C
The interface data that shall be provided for the design of the main/extraction steam system are the steam inlet pressure, moisture, flowrate and temperature for full load to part load operation modes.

4.3.1.1.1.2.D
Interface data related to the following items shall also be provided as follows:

- heat and mass balance diagram,
- protection against overpressure,
- maximum flow limitation in case of an inadvertent opening of valves, steam dump to condenser or to atmosphere,
- maximum pressure reached inside each steam bleed line with turbine at full load and all steam extractions isolated except the one that is considered,
- protection against turbine overspeed.

4.3.1.1.2 SYSTEM FUNCTIONS

4.3.1.1.2.1 PURPOSE

4.3.1.1.2.1.A
The purpose of the main steam supply and extraction steam system is to:

- transport main steam from NSSS to the HP turbine,
- transport extraction steam from the HP, IP (if any) and LP turbines to the feedwater heaters,
- provide moisture separation and reheat (in MSRs), with connections between HP turbine, MSR and IP (if any)/LP turbines,
- provide steam turbine bypass,
- provide steam to the turbine gland seals,
- provide steam to the auxiliary steam header for the Unit* auxiliaries and another additional purpose such as heating during the Unit* outages,
- provide steam for the MSR reheat bundles,
- provide steam to turbine driven feedwater pumps, if any.

4.3.1.1.2.1.B
Sections 4.3.1.2 to 4.3.1.5 present detailed requirements relative to each purpose.

4.3.1.1.2.2 SYSTEM REQUIREMENTS

4.3.1.1.2.2.A
The following general requirements shall apply to all steam systems:

AA
Main lines shall have adequate slope.

AB
Drains shall be provided upstream of steam isolation valves.

AC
Steam traps shall not be used for drains mentioned in this chapter unless they are used in conjunction with an automatic drain system.

AD
The effectiveness of drains essential to operation shall be monitored.

AE
Drains shall be provided at all low points in steam lines.

4.3.1.1.2.2.B
The Supplier* shall specify maximum flow velocities for piping for all pipe materials and media proposed by the Supplier*.

4.3.1.1.2.2.C
No steam safety or relief valve shall have a capacity higher than the limit specified in the Nuclear Island* design.

4.3.1.2 MAIN STEAM PIPEWORK

4.3.1.2.1 SYSTEM DEFINITION

4.3.1.2.1.1 SCOPE

4.3.1.2.1.1.A
The main steam pipework includes piping and valves provided to connect NSSS to the admission of the HP turbine and to the steam turbine bypasses.

4.3.1.2.1.1.B
The main steam pipework does not include the turbine stop valves.

4.3.1.2.1.2 INTERFACES

4.3.1.2.1.2.A
The main steam pipework interfaces mainly with:

- NSSS,
- turbine generator system,
- auxiliary steam system,
- feedwater tank and deaerator (if any),
- steam driven main feedwater pumps (if any),
- reheat bundles of MSRs,
- emergency feedwater system turbine driven pumps (upstream of main steam isolation valve), if any,
- steam turbine bypass,
- chemical sampling and monitoring system,
- building structure,
- steam ejectors (if any),
- condenser.

4.3.1.2.2 SYSTEM FUNCTIONS

4.3.1.2.2.1 PURPOSE

4.3.1.2.2.1.A
The main steam lines transport steam from NSSS to the turbine stop valves and shall be arranged so that the steam flow evacuates the heat released by the core as follows:

- during power operation, the steam is supplied to the HP turbine,
- during quick load variations and start-up, the steam is supplied to the HP turbine and turbine bypass lines,
- during hot standby or when cooling the reactor, the steam is supplied to the turbine bypass lines.

4.3.1.2.2.1.B
The operating conditions to switch to the NI cooling systems shall be defined by the Supplier*.

4.3.1.2.2.1.C
In addition, the main steam lines shall deliver in continuous operation or during start-up minor amounts of steam to various systems such as:

- MSR,
- gland steam,
- deaerator/feedwater tank,
- any auxiliary turbine, (if any),
- auxiliary steam,
- steam ejectors, (if any).

4.3.1.2.2.1.D
The system shall perform isolation by closure of a valve:

- during start-up and shutdown (below residual heat removal system conditions),
- to mitigate the effects of a pipe break.

4.3.1.2.2.1.E
The system shall equilibrate the pressures in the Steam Generators*.

4.3.1.2.2.2 SYSTEM PERFORMANCE

4.3.1.2.2.2.A
The steam pressure and the pressure drop between the NSSS outlet and the turbine stop valves shall be determined in order to achieve the best economic benefit.

4.3.1.2.2.2.B
Pipe anchors shall be provided on the main steam lines downstream the MSIVs.

BA
They shall be designed to eliminate the pipe break loads.

4.3.1.2.2.2.C
The main steam system shall be designed to allow for fuel cycle extension resulting in reduced temperature operation, as described in Chapter 2.2.

4.3.1.2.2.2.D
[redacted]

4.3.1.2.2.2.E
Piping shall be designed for the transient loadings resulting from closure of MSIVs and/or turbine valves.

4.3.1.2.2.2.F
The possibility of discharging a mix of water and steam in case of pipe break shall be taken into account.

4.3.1.2.2.2.G
All main steam lines shall be cross-connected (without valving) downstream of the main steam isolation valves but upstream of the turbine stop valves.

GA
[redacted]

4.3.1.2.2.2.H
The Supplier* shall define a value of the steam velocity limit (a typical value of the steam velocity limit is 40 m/s).

HA
The Supplier* shall optimise the steam velocity to be within this limit.

4.3.1.2.3 SYSTEM REQUIREMENTS

4.3.1.2.3.A
The main steam piping shall be laid out to avoid multiple low points.

4.3.1.2.3.B
Flanged connections shall not be used in the main steam system, except for when no other component removal solution exists for maintenance purposes.

BA
Threaded connections shall not be used in the main steam system.

4.3.1.2.3.C
The design shall consider both the differences in steam piping layout and potential differences in operating conditions (e.g. number of tubes plugged) among the loops.

4.3.1.2.3.1 DRAINS

4.3.1.2.3.1.A
The automatic drain system shall ensure that the steam admission system is kept free of water at all times during the Unit* operation.

4.3.1.2.3.1.B
The drain system for the main steam pipes shall be continuously and automatically operated.

4.3.1.2.3.1.C
All drain valves shall automatically open when required.

4.3.1.2.3.1.D
Main steam lines shall be routed continuously downward from the upper part to the connection to the drain system.

4.3.1.2.3.1.E
Not more than one drain connection per steam line shall be necessary between MSIV and the turbine or turbine bypass valves.

4.3.1.2.3.1.F
A drain shall be located at each low point in the main steam piping system.

FA
When reviewing the location of low points the position of the piping in both hot and cold conditions shall be considered.

4.3.1.2.3.1.G
The main steam drains shall be routed to a tank or condenser flash box.

4.3.1.2.3.1.H
Provisions shall be made to ensure evacuation of water to the condenser under various modes of operation:

- warming the main steam system,
- hot standby,
- power operation.

4.3.1.2.3.1.I
Provisions shall exist to ensure proper removal of water from upstream of MSIV when they are closed, making the normal drain line unavailable.

4.3.1.2.3.1.J
Main steam system drains shall not be connected to manifolds or drain headers serving drains from sources downstream of the turbine throttle valve.

4.3.1.2.3.1.K
The drain system for main steam piping shall be designed to remove water prior to and during initial rolling of the turbine and during shutdown.

4.3.1.2.3.1.L
The main drain valves shall be automatically operated and arranged to fail open.

LA
These valves shall be located as close as reasonably achievable to the main steam header or main steam pipe to reduce the amount of water trapped upstream of the closed drain valve.

LB
The automatically operated valve shall be provided with by-pass manual valve for maintenance or warming and starting up conditions. Alternative solution shall be justified by the Supplier*.

LC
If both steam trap and drain valve are installed in parallel, no other bypass valve is required.

4.3.1.2.3.1.M
NA

4.3.1.2.3.1.N
All main steam system drain lines and valve ports shall have a minimum inside diameter of 25 mm to minimize the risk of plugging by foreign material and two drains shall be provided for each Steam Generator* loop.

4.3.1.2.3.1.O
The main steam drains from MSIV to turbine generator shall be automatically operated.

4.3.1.2.3.1.P
Main steam drain standpipe water level shall be monitored to indicate any leakage. Alternative solution shall be justified by the Supplier*.

4.3.1.2.3.1.Q
Start-up shall include a procedure for preheating and draining the steam lines.

4.3.1.3 STEAM EXTRACTION SYSTEM

4.3.1.3.1 SYSTEM DEFINITION

4.3.1.3.1.1 SCOPE

4.3.1.3.1.1.A
The steam extraction system includes the piping and valves necessary to transport steam from the turbine extraction points to the LP and HP feedwater heaters, auxiliary steam system, deaerator/feedwater tank and other systems, if included in the design.

4.3.1.3.1.2 INTERFACES

The steam extraction system interfaces with:

- the HP, IP (if any), LP turbines, cold and hot reheat piping, and the turbine control and Protection System*,

- the LP and HP feedwater heaters and the deaerator (if any),
- the Moisture Separators and Reheaters*,
- the auxiliary steam system.

4.3.1.3.2 SYSTEM FUNCTIONS

4.3.1.3.2.1 PURPOSE

4.3.1.3.2.1.A
The steam extraction system shall transport steam from the turbine to the feedwater heaters, reheaters, to the deaerator/feedwater tank and to other systems, if included in the design.

4.3.1.3.2.1.B
It shall prevent steam or water from flowing back into the turbine during fast load rejection.

4.3.1.3.2.2 SYSTEM PERFORMANCE

4.3.1.3.2.2.A
The number and positions of the extraction points at the turbine shall be optimised by the Supplier*.

4.3.1.3.3 SYSTEM REQUIREMENTS

4.3.1.3.3.A
The HP steam extraction lines shall have both power-assisted non return valves (check valves) and isolation valve, wherever energy or water accumulated in the heater might potentially damage the connected components (mainly the turbine).

4.3.1.3.3.B
For LP steam extraction, the system shall be protected against water accumulation.

4.3.1.3.3.C
Automatic closure of the isolation valves shall be provided in case of a high water level in the heater shell.

4.3.1.3.3.D
Non-return valves in extraction steam lines shall be located as near to the turbine as practical to restrain uncontrolled high energy release back to the turbine and to minimise the risk of water induction into the turbine.

DA
Motor or compressed air actuated valves shall be used for this purpose.

4.3.1.3.3.E
The isolation valves shall be designed to permit a partial closure operability test during the Unit* operation without inadvertent complete closure of the valve.

4.3.1.3.3.F
The flow area of the extraction steam shall be designed to provide an acceptable steam velocity based on successful operating experience, considering expected fluid conditions (pressure, temperature, and moisture levels) and considering the material requirements.

4.3.1.3.3.G
Piping layouts that result in 90º elbows shall be minimized.

GA
Miter connections shall not be used.

4.3.1.3.3.H
The extraction steam piping material selection shall comply with the requirements of Section 2.6.4.1.5.

4.3.1.3.3.I
Other requirements from the Section 4.3.1.2.3 shall be applied to steam extraction system, if applicable.

4.3.1.4 MOISTURE SEPARATOR AND REHEATER (MSR)

4.3.1.4.1 SYSTEM DEFINITION

4.3.1.4.1.1 SCOPE
4.3.1.4.1.1.A
The Moisture Separator and Reheater* system shall include moisture separators and steam reheaters.

4.3.1.4.1.2 INTERFACES
MSRs interfaces with:

- HP turbine exhaust,
- IP (if any) or LP turbine inlet,
- main and extraction steam systems,
- the feedwater heating system, where reheater condensates and moisture separator drains return,
- the turbine control and Protection System*,
- the condenser for the alternate Moisture Separator and Reheater* drains.

4.3.1.4.2 SYSTEM FUNCTIONS

4.3.1.4.2.1 PURPOSE
MSRs are placed at the exhaust of the HP turbine to remove moisture from steam and reheat it before admission to the IP (if any) or LP turbines.

4.3.1.4.2.2 SYSTEM PERFORMANCE

[redacted]

4.3.1.4.2.2.B
The reheaters shall be of single-stage or double-stage design, based on the best economic benefit and the Supplier's* experience.

4.3.1.4.2.2.C
The performance of the system shall be optimised recognising particularly the trade-off between pressure drop and reheater terminal temperature difference.

4.3.1.4.2.2.D
The steam shall be supplied to the tube bundles through a controllable valve.

4.3.1.4.2.2.E
Provisions shall be made to automatically reduce the reheat temperature under partial load conditions (such as supply to house load) on the turbine-generator to avoid overheating the low pressure turbine.

4.3.1.4.2.2.F
The moisture separators shall be protected to ensure that they are not overpressurised under the most adverse operating conditions of the turbine-generator (i.e. one HP valve fully open, all intercept valves closed).

4.3.1.4.2.2.G
Overpressure protection shall be ensured by safety valves or other systems with appropriate justification.

GA
The technical solution shall comply with the requirements of the Rules*.

4.3.1.4.3 SYSTEM REQUIREMENTS

4.3.1.4.3.A
MSRs shall be installed on each side of the turbine respecting the symmetry of the turbine and of the closely associated steam systems.

4.3.1.4.3.B
MSR shall consist of separators and reheater tube bundles placed in a single shell.

BA
At least two MSRs shall be provided.

4.3.1.4.3.C
The design shall take into account the effect of maldistribution of steam caused by on-load testing of intercept valves.

CA
The effect of this maldistribution on the MSRs and their associated systems shall be evaluated by the Supplier* and allowed for in the design.

4.3.1.4.3.D
No dynamic vibration shall be induced by steam flow.

4.3.1.4.3.E
MSR design shall enable the replacement of the separator components.

4.3.1.4.3.F
Conservation provisions which are appropriate for MSR materials shall be provided.

FA
For the tube side conservation treated water, nitrogen, or dry clean air shall be used.

FB
For the shell side conservation treated water or dry clean air shall be used.

4.3.1.4.3.G
Each moisture separator and each reheater tube bundle shall have its own separate drain system.

4.3.1.4.3.H
A reheater drain line shall be sized for self-venting gravity downflow into the drain tank.

HA
The upper side of the drain tank and the tube bundle steam box shall be connected by a vent to avoid any possibility of lock-up during load transients.

HB
A similar requirement applies to a separator drain line.

4.3.1.4.3.I
The drain tank shall be fitted with independent sets of level controls to initiate operation of the drain valve, dump valve and high level alarm.

IA
The level readouts from these controls shall be located in the control room.

4.3.1.4.3.J
Transient and steady-state hydraulic analyses of moisture separator drain system shall be performed to ensure stability under all operating conditions.

JA
These analyses shall cover all the piping both upstream and downstream of the drain tank from the point of collection in the Moisture Separator and Reheater* to the points of discharge at a feedwater heater and at the condenser.

4.3.1.4.3.K
Where necessary a check valve shall be provided upstream of the drain control valve to minimize flash-back into the drain tank during downward load transients.

KA
The check valve shall be placed as near to the drain tank as possible to minimize the uncontrolled inventory of saturated water.

4.3.1.4.3.L
Drain pumps (if used) shall be designed to operate correctly if sudden MSR depressurisation occurs due to downward load transients.

4.3.1.4.3.M
Other requirements from the Section 4.3.1.2.3 shall be applied to MSR system, if applicable.

4.3.1.4.3.1 REHEATERS

4.3.1.4.3.1.A
Reheater tube material requirements are specified in Section 2.6.4.1.5.

4.3.1.4.3.1.B
The reheater shall be designed to permit steady condensate flow in the tube bundle.

4.3.1.4.3.1.C
If two tube bundles of one stage are located in different shells they shall have separate drain systems.

4.3.1.4.3.1.D
Adequate access shall be provided for tube bundle replacement.

DA
The piping arrangement shall be such that removal of a reheater tube bundle does not require the removal of piping or piping supports other than piping for the bundle heating steam and condensate drains and instrument lines.

4.3.1.4.3.1.E
Reheater tube supports shall be designed and spaced to prevent wear or damage due to aerodynamic, fluid elastic or any other type of vibration of the reheater tubing.

4.3.1.4.3.1.F
Reheater tube bundle design and accuracy of manufacture shall be such as to ensure free thermal expansion of the reheater tubes under all conditions of operation without overstressing or otherwise damaging the tube bundle frame.

4.3.1.4.3.1.G
Venting and/or other arrangements shall be provided to ensure the continuous removal of non-condensable gases from the reheater tube bundle and also to ensure the steady removal of condensate from the reheater tubes with minimum subcooling.

4.3.1.4.3.1.H
Vent piping shall have no low points and shall be sloped to ensure adequate drainage.

4.3.1.4.3.1.I
Thermal/hydraulic instabilities in the reheater tube bundle shall be minimized so that no short or long term operational or reliability problems occur.

IA
Test-supported analyses shall be performed to verify this feature.

4.3.1.4.3.1.J
Provisions shall be made to evacuate and purge all reheater tube bundles prior to pressurization to minimize distortion when heating steam is admitted to the tube bundle.

4.3.1.4.3.2 SEPARATORS

4.3.1.4.3.2.A
Separators shall be designed to avoid unequal moisture removal effectiveness.

4.3.1.4.3.2.B
Reliable and low pressure drop moisture separators with high effectiveness shall be used.

4.3.1.5 TURBINE BYPASS SYSTEM

4.3.1.5.1 SYSTEM DEFINITION

4.3.1.5.1.1 SCOPE

4.3.1.5.1.1.A
The turbine bypass system includes the piping and valves necessary to dump steam to the condenser.

4.3.1.5.1.1.B
The steam dump to the atmosphere function belongs to NI (main steam and relief function).

4.3.1.5.1.2 INTERFACES

4.3.1.5.1.2.A
The main turbine bypass system interfaces mainly with:

- the main steam lines,
- the condenser.

4.3.1.5.1.2.B
For more information about steam discharge equipment placed in the condenser see Section 4.2.7.10.

4.3.1.5.1.2.C
The functional interface includes the reactor control and Protection Systems* described in Section 2.8.2.13.

4.3.1.5.2 SYSTEM FUNCTIONS

4.3.1.5.2.1 PURPOSE

4.3.1.5.2.1.A
The turbine bypass system shall discharge steam and thereby the heat produced by the Core* when the turbine generator load is lower than the reactor load (start-up, shutdown or load rejection).

4.3.1.5.2.1.B
The turbine bypass system is provided to enable:

- turbine generator start-up and shut down,
- reactor cool down to the point where the residual heat removal system can be placed in service,
- load reduction,
- stable operation at low reactor power (connected or not connected to the grid).

4.3.1.5.2.2 SYSTEM PERFORMANCE

4.3.1.5.2.2.A
The turbine bypass system shall enable:

- turbine generator to start-up and shut down,
- load reduction (such as HP turbine valves closure, load rejection with transfer to house load, turbine trip) without resulting in reactor trip but maintaining steam pressure at acceptable levels.

4.3.1.5.2.2.B
The turbine bypass system total flow capacity shall be given as a percentage of the full load steam flow at full load steam pressure.

4.3.1.5.2.2.C
[redacted]

4.3.1.5.2.2.D
The opening time shall be adequate to avoid unnecessary opening of the main steam safety or relief valves and without steam discharging into the atmosphere.

4.3.1.5.2.2.E
The closure time shall be adequate to prevent excessive Reactor Coolant System* cooldown.

4.3.1.5.2.2.F
The turbine bypass system shall be co-designed with the reactor power reduction capabilities (see Chapter 2.2) and the short and long term condenser capacity (see Section 4.2.7).

4.3.1.5.2.2.G

[redacted]

4.3.1.5.2.2.H

The turbine bypass valve actuation parameters, time to full closed from open or to full open from closed, or modulating curve and response shall be established by the Supplier* in accordance with the reactor requirements.

4.3.1.5.3 SYSTEM REQUIREMENTS

4.3.1.5.3.A

The turbine bypass system shall be designed to permit the dumping of steam from the main steam piping upstream of the turbine valves directly to the main condenser (i.e. bypass the steam turbine).

4.3.1.5.3.B

All of the turbine bypass system flow shall be directed to the condenser.

4.3.1.5.3.C

The turbine bypass valves shall be designed to fail closed on loss of motive power.

4.3.1.5.3.D

Turbine bypass system valve interlocks (to prevent valve opening) and trips (to close valves if open) shall be provided to prevent condenser overpressure and RCS excessive cooldown.

4.3.1.5.3.E

The turbine main steam bypass valve control system shall include the following capabilities:

- The capability to select two modes of valve control: reactor temperature average and main steam header pressure control.
- The capability to bypass low Reactor Coolant System* average temperature control in order that the bypass valves can be operated to cool down the Unit*.

4.3.1.5.3.F

Various protection interlocks shall be implemented independent of the control system as follows:

- The turbine bypass valves shall be tripped open upon load rejection or turbine trip. The number of valves opened depends on the magnitude of load shedding required.
- The turbine bypass valves shall be blocked from opening at times of high condenser pressure and/or insufficient circulating water flow and when the reactor coolant average temperature is low. The Operator* shall be able to override this blocking during shutdown.

4.3.1.5.3.G

Vacuum sensors shall be provided to close or maintain closure of the steam bypass valves should the condenser pressure rise to the specified setpoint pressure. Loss of vacuum in the main condenser shall result in closure of the bypass valves.

4.3.1.5.3.H

The design shall ensure that the bypass steam flow and temperature will neither damage nor be detrimental to the main condenser (e. g. with the help of condensate sprayed into the bypass flow).

4.3.1.5.3.I

Other requirements from the Section 4.3.1.2.3 shall be applied to turbine bypass system, if applicable.

4.3.2 FEEDWATER AND CONDENSATE SYSTEMS

4.3.2.1 GENERAL INTRODUCTION

4.3.2.1.1 SYSTEM DEFINITION

4.3.2.1.1.1 SCOPE

4.3.2.1.1.1.A

This section includes the systems designed to provide the required flow of feedwater of appropriate temperature and chemical purity to the NSSS.

4.3.2.1.1.2 INTERFACES

4.3.2.1.1.2.A

The feedwater and condensate systems interface mainly with:

- the condenser which provides condensate to the system,
- extraction steam system which provides steam to the feedwater heaters,
- the condensate make-up purification system provides make-up water to the main condenser hotwell,
- the auxiliary steam system may also provide steam for the deaerator,
- the chemical addition system which provides controlled amounts of chemical additives for water quality control,
- the MSR, the condensate of which returns to the feedwater system,
- the NSSS which receives feedwater,
- the process sampling system which obtains samples of the feedwater and condensate and provides chemical analyses,
- low temperature condensate system which returns water to the condenser,
- waste system which collects dumped water,
- venting system for non-condensable gases,
- condensate cleanup system.

4.3.2.1.2 SYSTEM FUNCTIONS

4.3.2.1.2.1 PURPOSE

4.3.2.1.2.1.A

The feedwater and condensate system is designed to return high quality feedwater from the condenser hotwell to the NSSS. The system includes a number of stages of regenerative feedwater heating and provisions for initiating and maintaining feedwater quality and increasing the cycle efficiency.

4.3.2.1.2.2 SYSTEM PERFORMANCE

4.3.2.1.2.2.A

The condensate and feedwater system shall be designed with the capability of automatically providing the required flow to the NSSS.

4.3.2.1.2.2.B

The trip of one feedwater pump shall not propagate into a turbine generator or reactor trip, however, one feedwater pump trip plus no start of the stand-by pump may result in a partial load rejection.

4.3.2.1.2.2.C

Drain pump trips (if provided) shall result in the drain being dumped to the condenser without a significant load variation.

4.3.2.1.2.2.D

The system shall be designed to allow condensate/feedwater heating to commence at the minimum feasible turbine power, preferably at initial load after the synchronization.

4.3.2.1.2.2.E

[redacted]

EA

The report shall include required Operator’s* actions, timeline, turbine driven feedwater pump (if used) run-out speed change and overspeed potential, as well as the transients NPSH conditions for each operating pump.

4.3.2.1.2.2.F

The system shall maintain water quality so that it is suitable for long-term operation. This requirement applies to all conditions of the Unit*, including power operation, start-up, shutdowns, and extended outages. Chemical addition requirements are specified in Section 4.3.2.8.

4.3.2.1.2.2.G

The feedwater and condensate pumps and pump control systems shall be designed so that loss of a single booster/main feedwater pump assembly or condensate pump in a multiple pump system does not result in trip of the turbine-generator or reactor trip.

4.3.2.1.2.2.H
The pumps and other system components shall be designed to avoid the need for an immediate trip of the condensate, feedwater booster or feedwater main pumps on low NPSH.

4.3.2.1.2.2.I
The design shall take in consideration immediate temperature and pressure of the media in relation to NPSH.

4.3.2.1.2.2.J
The condensate/feedwater system shall be designed to accommodate the increased flow from feedwater heater drains being dumped to the condenser.

4.3.2.1.2.2.K
Sufficient instrumentation shall be provided to maintain an accurate heat energy balance of the Unit*.

KA
The instrumentation for measuring feedwater flow shall be installed so that cleaning of flow sensing elements is possible.

KB
Initial full flow calibration and periodical recalibration shall be enabled.

4.3.2.1.3 SYSTEM REQUIREMENTS

4.3.2.1.3.A
The feedwater temperature at the Steam Generator* inlet shall comply with the specific requirements of NSSS.

4.3.2.1.3.B
Recirculation systems shall be provided for protection of the main feedwater pumps, start-up and shutdown pumps, condensate pumps and the drain pumps (if herein listed pumps are provided), during periods of low flow.

4.3.2.1.3.C
The steam supply system shall provide steam for the deaerator/feedwater tank so that the feedwater temperature at the inlet of the Steam Generators* is higher than minimum required temperature in all operation modes.

4.3.2.1.3.D
The feedwater and condensate system shall be designed to avoid erosion damage.

4.3.2.1.3.E
The design and layout of piping systems shall consider effect of fluid velocity on the piping material, bend location and the location of flash points.

4.3.2.1.3.F
The selection of piping layout, velocity and material shall be based on successful operating experience.

4.3.2.1.3.G
Appropriate stainless steel material or chrome-molybdenum material shall be specified for all valve bodies and internals for regulating applications in the feedwater and condensate system including heater drain valves. Alternative material shall be justified by the Supplier*.

4.3.2.1.3.H
Design features to facilitate Inspection*, maintenance and replacement, as required, of regulating valve internals or valve seats shall be provided.

4.3.2.1.3.I
Feedwater and condensate pump isolation valves shall not be used for throttling or regulating service.

4.3.2.1.3.J
All drain pumps (if provided) shall be designed to stand for incipient cavitation for a certain period of time without need for pump trip.

4.3.2.1.3.K
Local regulations for how to calculate the design pressure of feedwater heater (steam side and water side) and deaerator/feedwater tank shall be defined in accordance with Rules*.

4.3.2.2 CONDENSATE SYSTEM

4.3.2.2.1 SYSTEM DEFINITION

4.3.2.2.1.1 SCOPE

4.3.2.2.1.1.A
This section includes the system that shall provide condensed water to the LP feedwater heaters under adequate pressure.

4.3.2.2.1.2 INTERFACES

4.3.2.2.1.2.A
The condensate system interfaces mainly with:

- condenser hotwell,
- LP feedwater heaters,
- clean-up system (if any).

4.3.2.2.2 SYSTEM FUNCTION

4.3.2.2.2.1 PURPOSE

4.3.2.2.2.1.A
The condensate system shall raise the pressure of condensate issuing from the condenser hotwell to an adequate value before feeding the LP heaters and beyond the deaerator.

4.3.2.2.2.1.B
The condensate system shall not be used for cooling auxiliary heat exchangers.

BA
These systems shall be cooled by the turbine building component cooling water system which is discussed in Section 4.6.1.

BB
As an exception, condensate system may be used for the cooling of the gland steam condenser to get benefit of the energy.

4.3.2.2.2.2 SYSTEM PERFORMANCE

4.3.2.2.2.2.A
The condensate system shall be designed to accommodate the increased flow resulting from:

- one separator drain pump out of service (if drain pump provided),
- or one LP drain pump out of service (if drain pump provided),
- or one LP heater drain being dumped to the condenser,
- discontinuous supply of water to other equipment.

4.3.2.2.2.2.B
It shall be designed to ensure the water inventory control with the use of throttling valves or by pump speed variation.

4.3.2.2.2.2.C
The Supplier* shall provide the flow and total dynamic head margins of the condensate pump in the worst operational mode.

4.3.2.2.3 SYSTEM REQUIREMENTS

4.3.2.2.3.A
The condensate system shall be designed with a certain number of condensate pumps connected in parallel, one of them in standby.

4.3.2.2.3.B
The remaining pump shall start automatically on the loss of one of the operating condensate pumps.

4.3.2.2.3.C
The loss of one pump and auto start of the spare pump may result in a transient power reduction but in any case shall not cause a feedwater pump trip.

CA
The design shall ensure that this requirement is met without the normally running pumps operating far from their design point.

4.3.2.2.3.D
The condensate pumps shall have a sufficient safety margin between available NPSH and required NPSH.

4.3.2.2.3.E
Condensate pump suction strainers shall be provided at least for initial start-up.

4.3.2.2.3.F
Condensate flow shall be controlled either by throttling valves or by pump speed variation.

4.3.2.2.3.G
If control is performed by throttling valves, at least two such valves shall be provided in the condensate line for covering all flow rate range.

GA
The deaerating tank level control system shall control the position of these valves.

GB
A small bypass line with an isolation valve in series with an orifice shall be provided in parallel with the condensate regulating valve.

4.3.2.2.3.H
Condensate pumps shall be equipped with a common minimum flow line.

4.3.2.2.3.I
The minimum flow shall be sized to protect the condensate pumps.

4.3.2.2.3.J
The condensate pump minimum flow protection recirculation system shall consist of a single line routed from the condensate header downstream of the gland steam condenser (if cooled by the condensate system) back to the condenser.

4.3.2.2.3.K
The minimum flow line shall include a modulating type control valve followed by a pressure breakdown device sized to prevent flashing at the valve.

4.3.2.2.3.L
The system shall be sized to provide adequate minimum flow with one or all pumps (except for standby pump), and the gland steam condenser (if cooled by the condensate system) in operation.

4.3.2.2.3.M
The modulating valve shall be controlled from the condensate flow meter and shall have interlocks with the condensate pump motor controls to adjust the valve setpoint for the number of pumps in operation.

MA
If, however, the gland steam condenser is cooled by the condensate system and its minimum flow exceeds the minimum flow of one condensate pump the interlocks may not be required and the valve setpoint shall be adjusted to provide the design recirculation flow for the system.

4.3.2.2.3.N
Condensate returned to the condenser shall be admitted through a spray line located inside and at the end of the condenser away from the condensate outlets.

4.3.2.2.3.O
Condensate pump motor starters shall be interlocked with any valves located between the pumps and recirculation line to prevent starting a pump if a valve is closed.

4.3.2.2.3.P
A make-up line (see Section 4.3.2.7) and a discharge line (usually placed at the discharge of the condensate pumps) shall be provided.

4.3.2.3 CONDENSATE CLEANUP SYSTEM

4.3.2.3.1 SYSTEM DEFINITION

4.3.2.3.1.1 SCOPE

4.3.2.3.1.1A
This system shall include provisions designed to ensure the purity of condensate water, such as filters and demineralizers.

4.3.2.3.1.2 INTERFACES

4.3.2.3.1.2.A
The condensate cleanup system interfaces mainly with:

- condenser,
- condensate system.

4.3.2.3.2 SYSTEM FUNCTIONS

4.3.2.3.2.1 PURPOSE

4.3.2.3.2.1.A
Provisions made in different parts of the condensate systems shall contribute to fulfil the objective of delivering pure water to NSSS during and after start-up and at any load.

4.3.2.3.2.2 SYSTEM PERFORMANCE

4.3.2.3.2.2.A
The system shall fulfil SG feed water quality requirements for SG feedwater.

4.3.2.3.3 SYSTEM REQUIREMENTS

Several points are summarised in this section, while relating to other systems:

4.3.2.3.3.A
Providing water make-up:
The Steam Generator* blowdown, after cooling and circulating through filters and demineralizers, shall return clean water to the condensate cycle. See Section 4.6.9.

4.3.2.3.3.B
Cleaning function during/prior to start-up:
The Supplier* shall make provisions to clean properly the water during/prior to start-up, by minimizing the amount of waste water and shortening the start-up duration.

4.3.2.3.3.C
During the Commissioning*:
The Supplier* shall provide a device to trap the iron oxides in condensate when carbon steel is used.

4.3.2.3.3.D
The condensate cleanup system shall be designed to provide adequate capacity flow.

DA
Flow rate through the condensate cleanup system shall be regulable.

4.3.2.3.3.E
It shall be considered that HP condensate returns from MSR and HP feed heaters to the feedwater tank.

4.3.2.3.3.F
The condensate cleanup system shall be sized to meet the chemistry requirements for continuous operation while operating continuously with a given condenser leak, until repairs can be made, and to maintain water quality during the orderly Unit* shutdown assuming a given condenser leak and duration.

4.3.2.3.3.G
The condensate cleanup system shall utilise a side stream arrangement and be capable of being bypassed during power operation.

GA
High quality of condenser (materials and design) shall be provided to ensure high leaktightness so that during power operation the condensate polishing is not necessary.

GB
This bypass design shall allow for the continuous operation at full condensate/ feedwater flows with condensate cleanup system out of service.

4.3.2.3.3.H
The condensate cleanup system and its individual components (demineralizers and filters) shall be designed with alarms signalling high differential pressure conditions.

4.3.2.3.3.I
The condensate filters and demineralizers shall be located downstream of the condensate pumps to reduce the amount of equipment exposed to condenser vacuum and thus reduce air inleakage.

4.3.2.3.3.J
Either resin replacement or resin regeneration of spent ion exchanger resins shall be used in the condensate cleanup system based on investment and operational cost and environmental protection.

4.3.2.4 HIGH PRESSURE & LOW PRESSURE FEEDWATER HEATERS

4.3.2.4.1 SYSTEM DEFINITION

4.3.2.4.1.1 SCOPE

4.3.2.4.1.1.A
The system contains heat exchangers that shall be divided into:

- a high pressure system, placed at the discharge of the feedwater pumps,
- a low pressure system, between the discharge of the condensate pumps and the deaerator/feedwater tank.

4.3.2.4.1.2 INTERFACES

4.3.2.4.1.2.A
The HP & LP feedwater heaters system interfaces mainly with:

- steam extraction system,
- condensate,
- feedwater tank and deaerator (if any),
- main feedwater system,
- MSR,
- chemical addition system (see Section 4.3.2.8),
- chemical sampling and monitoring system (see Section 4.3.2.9).

4.3.2.4.2 SYSTEM FUNCTIONS

4.3.2.4.2.1 PURPOSE

4.3.2.4.2.1.A
The arrangement of the feedwater heating plant shall ensure that the specified cycle efficiency is obtained.

4.3.2.4.2.1.B
Both LP and HP feedwater heaters shall ensure that water is normally heated before flowing into the next component.

4.3.2.4.2.2 SYSTEM PERFORMANCE

4.3.2.4.2.2.A
[redacted]

AA
If there is no bypass, the Supplier* shall prove sufficient reliability of LP and HP heaters operation.

4.3.2.4.2.2.B
Isolation shall be provided only for each LP or HP train as a whole.

4.3.2.4.2.2.C
Feedwater of uniform temperature shall be delivered to the NSSS at any given power level.

CA
To meet this requirement, a common header shall be provided downstream the HP heaters and bypass (if any).

4.3.2.4.2.2.D
Provisions shall be made to achieve safe operation with one or more heaters being bypassed.

4.3.2.4.2.2.E
Adequate access shall be provided for feedwater heaters replacement.

4.3.2.4.2.2.F
A recirculation line downstream from the header of the HP heaters shall be provided to the condenser in order to clean the feedwater and condensate systems (using the condensate cleanup system) during start-up.

4.3.2.4.3 SYSTEM REQUIREMENTS

4.3.2.4.3.1 GENERAL

4.3.2.4.3.1.A
The arrangement shall be such that none of the LP or HP heaters is above (or partly above) the main turbine floor or means to prevent condensate from flowing back to steam turbine shall be taken, see the requirements of the Rules* (in particular CSN EN IEC 60045-1).

4.3.2.4.3.1.B
The emergency drain lines shall be routed to the condenser or a drain tank.

4.3.2.4.3.1.C
The heaters shall have vents (from HP heaters to deaerators, from LP heaters to condenser).

CA
Feedwater heater vents shall not be cascaded.

CB
The HP feedwater heaters shall be individually vented to the deaerating tank and the LP feedwater heaters to the condenser so that low oxygen content is maintained (corrosion issue).

CC
Orifice plates in feedwater heater vent lines shall be accessible for Inspection* and replacement as experience indicates that these orifices may erode and require regular replacement.

4.3.2.4.3.1.D
Bypassing the LP and HP feedwater heater shall be possible without significant operational difficulties.

4.3.2.4.3.1.E
The condensate draining system (pumps, valves, tanks, piping) shall be designed to work properly in all operating conditions, including the bypass of LP or HP heater trains.

4.3.2.4.3.1.F
The isolation of the condensate or the feedwater flow of a LP or HP heater shall be fast enough so that a tube leakage does not cause the turbine trip due to high level in the defective heater.

4.3.2.4.3.1.G
Sufficient margin shall be applied in the design of the feedwater heaters to account for tube fouling; the fouling factor used in the design shall be reported [redacted]

GA
The Supplier* shall recommend additional design margin for tube plugging of the feedwater heaters.

4.3.2.4.3.1.H
The LP/HP feedwater heater water level shall be maintained by the combination of normal and emergency drain valves.

4.3.2.4.3.1.I
The normal drain valve shall maintain normal feedwater heater levels (by modulation) while the emergency drain valve shall provide for rapid draining to the condenser hotwell during abnormal situations.

4.3.2.4.3.1.J
Feedwater heaters tube material shall be stainless steel with carbon steel tubesheets. Alternative material shall be justified by the Supplier*.

JA
Tube-to-tubesheet joints shall be welded.
4.3.2.4.3.1.K
The design, material and layout of the piping shall include design features proven through successful operating experience and shall consider the effects of fluid velocity, bend location and the location of flash points.

4.3.2.4.3.1.L
The heater drain system shall be designed to avoid erosion damage.

4.3.2.4.3.1.M
Heater drain pumps (if any) shall be located below the heaters, at grade or in a pit.

4.3.2.4.3.1.N
The material for the piping shall be carbon steel.

NA
The piping downstream of the drain control valve, however, shall be of corrosion/erosion resistant material.

4.3.2.4.3.1.O
All feedwater heaters shall be provided with temperature instrumentation at the inlet and outlet.

4.3.2.4.3.2 LP HEATERS

4.3.2.4.3.2.A
If LP heater stages are located in the neck of the condenser, it shall be possible to isolate them.

4.3.2.4.3.2.B
One string of low pressure feedwater heaters shall be provided for each condenser shell (in the case of a six-flow turbine, this results in three parallel isolable strings of LP feedwater heaters).

BA
Exception to this requirement shall be acceptable for the LP heaters which are not located within the condenser shells.

4.3.2.4.3.2.C
The drains of the LP heaters shall be routed downwards to the next heater shell of the lower pressure level or to a drain tank or to the condenser.

CA
The drains of the heater at the lowest pressure shall be routed to the condenser shell through a regulating valve.

4.3.2.4.3.2.D
If the drains return to the main condensate lines, the flow shall be controlled by throttling valves and the number of drain pumps shall be optimised.

DA
If the LP system has drain pumps, one common drain pump shall also be acceptable instead of one drain pump for each drain.

4.3.2.4.3.3 HP HEATERS

4.3.2.4.3.3.A
Two parallel isolable trains (as a whole) of high pressure feedwater heaters shall be provided.

4.3.2.4.3.3.B
The HP drain coolers, if part of the heater, shall be located in the heater shells.

4.3.2.4.3.3.C
The HP heaters shall be designed to accommodate the increased steam and drain flow resulting from one drain of HP feedwater heater drain being dumped to the condenser.

4.3.2.5 DEAERATOR AND FEEDWATER TANK

4.3.2.5.1 SYSTEM DEFINITION

4.3.2.5.1.1 SCOPE

4.3.2.5.1.1.A
The feedwater system shall have a feedwater tank with a deaeration equipment.

4.3.2.5.1.1.B
Both components shall be arranged together so that they meet the general requirements; heating and degassing shall occur simultaneously before water is collected into the tank at the intake of the feedwater pumps.

4.3.2.5.1.1.C
Provision shall be made in the design to prevent the risk of overpressure of the deaerator/feedwater tank.

4.3.2.5.1.1.D
Deaerator/feedwater tank shall be equipped with a pressure control device and transient calculations shall be performed.

4.3.2.5.1.2 INTERFACES

4.3.2.5.1.2.A
The deaerator/feed tank interfaces mainly with:

- condensate water supplied from the condenser,
- main feedwater system,
- steam supply, and live steam or auxiliary steam at low load or during start-up,
- condenser.

4.3.2.5.2 SYSTEM FUNCTIONS

4.3.2.5.2.1 PURPOSE

4.3.2.5.2.1.A
The deaerator and feedwater tank shall be designed for degassing and storing feedwater.

4.3.2.5.2.2 SYSTEM PERFORMANCE

4.3.2.5.2.2.A
Oxygen removal performance shall be specified by the Supplier* (input parameters include the oxygen level and the LP heater outlet temperature):

- at full load in steady-state operation,
- at low load, taking into account a higher air in-leakage and a lower condensate flow,
- during start-up, when warming and degassing the water.

4.3.2.5.2.2.B
The output oxygen level shall be defined according to the NSSS specification.

4.3.2.5.2.2.C
The volume of the feedwater tank shall depend on the feedwater pumps' NPSH requirements including design transient conditions and on loss of a condensate pump conditions.

4.3.2.5.2.2.D
The feedwater tank volume shall allow for water expansion, minimising the make-up and discharge of water during start-up and load transients.

4.3.2.5.2.2.E
Auxiliary steam shall be provided to the deaerating tanks when the main steam is not available.

4.3.2.5.2.2.F
The deaerator and connected steam/water piping shall be designed to minimize water hammer.

4.3.2.5.2.2.G
Deaerator storage tank elevation shall be established to provide adequate NPSH to the feedwater pumps during normal and transient conditions.

4.3.2.5.2.2.H
The Supplier* shall perform a transient analysis necessary to ensure that the feedwater tank/deaerator system operates satisfactory without causing the system or the Unit* trips.

4.3.2.5.2.2.I
Provision shall be made in the design to prevent the risk of failure of the feedwater tank.

4.3.2.5.3 SYSTEM REQUIREMENTS

4.3.2.5.3.A
In order to meet the water temperature requirements during low load or standby operation the system shall receive steam:

- from the main steam system,
- from the auxiliary steam system.

4.3.2.5.3.B
Adequate safety relief shall be provided.

4.3.2.5.3.C
Feedwater tank and feedwater pump suction part shall be arranged so as to eliminate water boiling in the suction piping taking into consideration conditions during transients.

4.3.2.5.3.D
The feedwater tank/deaerator shall have a pressure controling device and transient calculations shall be done in accordance with the requirements of the Rules*.

4.3.2.5.3.E
The deaerator receiving steam from the turbine and parts in contact with wet steam shall be made of corrosion resistant materials.

4.3.2.5.3.F
Provisions shall be made at the inlet of condensate water into the deaerator to avoid steam leakage into LP piping. See also Section 4.3.1.3.3.

4.3.2.5.3.G
The steam extraction line to the deaerator shall have:

- drain line with level control,
- isolation valve,
- power assisted non-return valve (check valve).

GA
Under all circumstances the creation of a mass of water in this line shall be avoided as it might cause damage to the turbine.

4.3.2.5.3.H
Steam lines connections to deaerator shall be designed such as to provide effective water heating.

4.3.2.5.3.I
The feedwater tank/deaerator shall have vents.

IA
The vents shall go to condenser and/or atmosphere and/or LP heaters.

4.3.2.5.3.J
The water inventory shall be adequate to allow regular operation of the feedwater pumps for steady and transients conditions and shall comply with the requirements of NI.

4.3.2.5.3.K
NA

4.3.2.5.3.L
The system shall enable cool and warm flushing of feedwater tank before start-up (after outage).

4.3.2.5.3.M
Connection of condensate clean up system shall be possible. The purpose is to check and adjust chemical mode before water inlet into the Steam Generator*.

4.3.2.6 MAIN FEEDWATER SYSTEM

4.3.2.6.1 SYSTEM DEFINITION

4.3.2.6.1.1 SCOPE

4.3.2.6.1.1.A
The main feedwater system consists of:

- the feedwater pumps and their drives,
- a start-up and shut down feedwater facility or auxiliary feedwater system (as applicable),
- the pipeworks necessary to connect the pumps to the HP feedwater heaters, and beyond to the NSSS, including control and isolation valves.

The requirements for the feedwater isolation valves are stated in Section 2.8.2.3.2.2.3.

4.3.2.6.1.2 INTERFACES

4.3.2.6.1.2.A
The main feedwater system interfaces mainly with:

- deaerator/feedwater tank,
- NSSS,
- HP feedwater heaters,
- steam supplies (extraction steam, live steam),
- chemical addition system,
- chemical sampling and monitoring system,
- condensers (if turbine driven pump).

4.3.2.6.1.2.B
The design shall consider all DBC1 (Normal Operation*) and DBC2 (Abnormal Operation*).

4.3.2.6.2 SYSTEM FUNCTIONS

4.3.2.6.2.1 PURPOSE

4.3.2.6.2.1.A
The main feedwater system shall deliver the water flow required for level control in NSSS during all operation modes and design transients.

4.3.2.6.2.1.B
It shall receive and mix the flows from the HP heaters (HP heater drains, MSR reheater drains, etc.) and then feed it to the NSSS.

4.3.2.6.2.1.C
The flow shall be split according to the number of the Steam Generators*.

4.3.2.6.2.2 SYSTEM PERFORMANCE

4.3.2.6.2.2.A
The main feedwater system shall be designed with the capability of automatically providing the water flow required for level control of the NSSS during all operation modes and Unit* design transients. More specifically:

AA
The pump shall be able to follow the water pressure resulting from the reactor setpoints at any load and during cycle extension, if any.

[redacted]

AC
The system shall be able to accommodate load variations without significant effect on the Steam Generator*. See Chapter 2.3 for load variations.

4.3.2.6.2.2.B
The main feedwater system shall have provisions such as a start-up pump and pressure reducing valves to bring the reactor to RHRS operating conditions. See Section 2.8.2.4.5.2 for possible use of the emergency feedwater system during start-up and shutdown or the auxiliary feedwater system (if any).

4.3.2.6.2.2.C
NA

4.3.2.6.2.2.D
Start-up and shut down feedwater pumps shall take suction from the deaerator/feedwater tank to avoid thermal shock of the Steam Generator*.

4.3.2.6.2.2.E
The Unit* shall remain in operation after a pump trip.

[redacted]

4.3.2.6.3 SYSTEM REQUIREMENTS

4.3.2.6.3.1 GENERAL ARRANGEMENT

4.3.2.6.3.1.A
At least two identical pumps in parallel shall provide the flow at full load.

AA
Feedwater pumps shall be provided to meet the performance requirements (see Section 4.3.2.6.2.2 above).

4.3.2.6.3.1.B
Main feedwater pumps shall be either of:

- centrifugal type with a double suction impeller and a diffuser or
- volute type.

4.3.2.6.3.1.C
Each pump shall be equipped with an independent minimum flow line.

4.3.2.6.3.1.D
If necessary, each feedwater pump shall consist of a booster pump and a main pump, connected by a direct line.

DA
Each booster pump (if any) shall supply one main feedwater pump.

DB
There shall be no headers, isolation valves, or check valves between the booster pumps and the main feedwater pump.

4.3.2.6.3.1.E
The booster pump/main feedwater pump/drive assembly shall be designed so that proper shaft alignment can be maintained without requiring frequent re-alignment.

4.3.2.6.3.1.F
The booster pumps (if any) shall be connected to the drive either directly or through gear reduction.

4.3.2.6.3.1.G
Individual lines to the NSSS shall have isolation valves to mitigate the effects of pipe breaks.

4.3.2.6.3.1.H
[redacted]

4.3.2.6.3.1.I
The Supplier* shall prove that, in order to check hydraulical behaviour, tests on a scaled down model of the main pumps (suction inlet, impeller and diffuser) was undertaken or the full size pump was shop tested.

4.3.2.6.3.1.J
Feedwater pumps (both booster, if any, and main pumps) shall be equipped with mechanical seals of the cartridge-type or throttle injection seals.

4.3.2.6.3.1.K
Material of the seals shall not be sensitive to thermal shocks.

4.3.2.6.3.1.L
The feedwater system layout, valve characteristics, etc. shall be designed so that waterhammer loads are below the Steam Generator* design limits.

4.3.2.6.3.1.M
Damped check valves shall be provided at the feedwater pumps discharge to reduce the water hammer effects in case of pump trip.

4.3.2.6.3.1.N
Feedwater units shall be installed either on foundations blocks or on structural steel baseplates grouted to the foundation.

NA
Elastic devices shall be provided under the foundation block if the necessity of the shock-proof foundation is determined by the calculation.

4.3.2.6.3.1.O
Separate support unit for each feedwater pump and its drive shall be provided.

4.3.2.6.3.1.P
If turbine driven booster pumps are used they shall be on the same support unit as the main feedwater pump and turbine.

4.3.2.6.3.1.R
The feedwater main/booster pump assembly, gear, bearings and drive shall be served by the independent lubricating oil system.

4.3.2.6.3.1.S
The lubricating oil system tanks, pumps, coolers, valves and pipeworks shall, as far as possible, be assembled as a compact unit to minimise the fire risk.

4.3.2.6.3.1.T
Means shall be provided to ensure that there is no interruption of lubricating oil flow to the bearings during transient changeover of feedwater pumps or lubricating oil pump failure.

4.3.2.6.3.1.U
A spare oil cooler shall be included if a common lubrication oil system is used.
4.3.2.6.3.1.V
It shall be possible to easily isolate any cooler and change over the oil flow between coolers, while the set is in operation.

4.3.2.6.3.2 TYPE OF DRIVE

4.3.2.6.3.2.A
The feedwater pumps shall be motor-driven although steam turbine drive is also acceptable. See Section 4.3.2.6.3.8.

4.3.2.6.3.2.B
The choice of the type of drive shall be based on a technical-economical analysis taking into account reliability, investment, maintenance and operational costs.

4.3.2.6.3.2.C
The pumps shall have variable speed control. If variable speed control is not used, the Supplier* shall provide due technical and economical justification.

4.3.2.6.3.3 START-UP FEEDWATER FACILITY

4.3.2.6.3.3.A
For reactor start-up and cooling down a start-up pump function shall be provided.

AA
The start-up pumping unit shall be composed of two identical pumps placed in parallel with the main feedwater pumps.

4.3.2.6.3.3.C
NA

4.3.2.6.3.3.D
Design provisions shall be made for keeping the start-up feedwater pumps in standby conditions.

4.3.2.6.3.3.E
Start-up feedwater pumps shall be able to start from cold state (without any preheating).

4.3.2.6.3.3.F
The start-up pump's recirculation flow shall be regulated by means of control valves actuated automatically by pump flow.

4.3.2.6.3.4 SIZING OF THE PUMP

4.3.2.6.3.4.A
Each pump shall be designed to deliver the required rated flow according to performance requirements (see Section 4.3.2.1.2.2) during normal full power operation and shall depend on the reactor requirements on transients.

4.3.2.6.3.4.B
The main feedwater pumps shall have a specified margin over the maximum required flow in the worst operational mode.

4.3.2.6.3.4.C
Feedwater pumps shall be sized depending on the reactor requirements on transients to maintain full load operation. See Section 4.3.2.1.2.2.

4.3.2.6.3.4.D
Cavitation and vibrations under operation of the pumps, including partial load operation, shall be avoided by design.

4.3.2.6.3.4.E
Sufficient margin shall be provided between available NPSH and required NPSH in all operation modes to avoid cavitation. For next requirements on pump NPSH see Section 2.7.4.15.

4.3.2.6.3.4.F
Feedwater pumps shall not be automatically tripped on low NPSH.

4.3.2.6.3.5 INSTRUMENTATION

4.3.2.6.3.5.A
The thermal load of the reactor shall be determined from instrumentation located on the main steam and feedwater systems, and subsequent calculations. This includes:

- main feedwater flow rate, temperature and pressure through each line,
- pressure and steam quality at the outlet of the NSSS.

4.3.2.6.3.5.B
Flow rates, temperatures and pressures shall be continuously measured.

4.3.2.6.3.5.C
Steam quality shall be taken from the most recent test results.

4.3.2.6.3.5.D
[redacted]

4.3.2.6.3.5.E
Flow measurement elements conforming to ISO requirements shall be provided to allow for the flow measurement.

EA
This flow measurement shall also be considered when performing the turbine acceptance test according to the requirements of the Rules* (in particular CSN EN 60953-2).

4.3.2.6.3.5.F
A cleanout capability shall be provided for the feedwater flow measurement device which is utilized for NSSS power calculations.

4.3.2.6.3.5.G
A flowmeter shall be provided on each line.

4.3.2.6.3.6 FEEDWATER FLOW CONTROL VALVES

4.3.2.6.3.6.A
A main feedwater flow regulating valve and a start-up feedwater flow regulating valve (or downcomer feedwater control valve, if used) shall be provided for each Steam Generator*.

4.3.2.6.3.6.B
The main and start-up feedwater flow regulating valves (or downcomer feedwater control valve, if used) shall control a stable Steam Generator* water level throughout the Unit* start-up and operation up to and including full power.

4.3.2.6.3.6.C
The transition between start-up (or downcomer feedwater control valve, if used) and main feedwater regulating valves shall provide a smooth and stable flow.

4.3.2.6.3.6.D
Seats and trim of feedwater regulating and isolation valves shall be made of a proven erosion resistant material.

DA
The design shall be such that the seats and other wearing parts can be easily removed and replaced.

4.3.2.6.3.6.E
The design of feedwater flow control valves shall be proven satisfactory in actual service for several operating years under throttling conditions at similar conditions of temperature, pressure and flow.

4.3.2.6.3.6.F
Actuators of the feedwater regulating valves and main and start-up (or downcomer feedwater control valve, if used) and emergency isolation valves shall be designed to function with full system pressure difference across the valve and with only the minimum motive force available.

4.3.2.6.3.6.G
The feedwater regulating and isolation valves and their actuators shall be safety graded to satisfy the feedwater isolation requirements, see Section 2.8.2.3.2.2.3.

4.3.2.6.3.6.H
Actuators of the feedwater regulating valves shall maintain current status on loss of motive force to the actuator or the loss of control signal.

4.3.2.6.3.7 BYPASS OF THE CONTROL VALVE

4.3.2.6.3.7.A
Each main feedwater valve shall have a bypass capability for start-up and transient conditions (refusal of the main valve).

4.3.2.6.3.7.B
The bypass shall be closed at full load.

4.3.2.6.3.8 TURBINE FOR MAIN FEEDWATER PUMPS

If the Supplier* proposes turbine driven feedwater pumps a turbine reliability and availability report shall be provided.

4.3.2.6.3.8.1 SCOPE

4.3.2.6.3.8.1.A
This section defines the functional requirements for the turbine of turbine-driven main feedwater pumps.

4.3.2.6.3.8.2 DESIGN CONDITION

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

4.3.2.6.3.8.2.B
The feedwater pump steam turbine shall be generally in accordance with the requirements of the Rules* (in particular CSN EN IEC 60045-1) unless otherwise specified. Any deviation shall be justified by the Supplier*.

4.3.2.6.3.8.3 TURBINE SIZING

4.3.2.6.3.8.3.A
The load cycling transient to be considered for the design of PGP shall be delivered from the one given in Section 2.3.2.

4.3.2.6.3.8.3.B
NA

4.3.2.6.3.8.3.C
The turbine shall be able to operate at any load as required by the feedwater system:

- either fed with live steam,
- or fed with low pressure reheated steam, with margins on pressure and enthalpy levels. If the low pressure reheated steam is chosen as mean to feed the turbine, it shall be used for operating conditions from nominal operating conditions to the lowest possible power, with margins on pressure and enthalpy levels.

4.3.2.6.3.8.3.D
Moving from a feeding with reheated steam to live steam, and vice versa, the turbine shall remain controlled by the feedwater control system of the Unit*.

4.3.2.6.3.8.4 PERFORMANCE REQUIREMENTS

4.3.2.6.3.8.4.1 RESPONSE TO THE LOSS OF A FEEDWATER PUMP

4.3.2.6.3.8.4.1.A
The feedwater pumps and pump control systems shall be designed so that the loss of a single feedwater pump assembly while at 100 % of rated NSSS power shall not result in a reactor or turbine trip.

4.3.2.6.3.8.4.1.B
NA

4.3.2.6.3.8.4.2 ROTATIONAL SPEED

4.3.2.6.3.8.4.2.A
[redacted]

4.3.2.6.3.8.4.2.B
[redacted]

4.3.2.6.3.8.4.3 BARRING SPEED

4.3.2.6.3.8.4.3.A
Barring speed shall be provided to enable the turbine and pump rotors to be rotated continuously before start-up (if necessary) and during periods of shutdown.

AA
In this case, the barring speed shall be such that water temperatures can be homogenised inside the pump.

4.3.2.6.3.8.4.3.B
The barring time before start-up shall be as short as possible.

4.3.2.6.3.8.5 TECHNOLOGY

4.3.2.6.3.8.5.1 SEALS, BEARING AND THRUST BEARING

4.3.2.6.3.8.5.1.A
The bearings shall be readily accessible, adjustable and replaceable without damage to adjacent gland seals.

4.3.2.6.3.8.5.1.B
Provision shall be made for rotor and cylinder realignment, with minimum dismantling, to rectify the effect of possible foundation settlement and for permanent axial repositioning of the rotor.

4.3.2.6.3.8.5.2 ROTORS AND BLADING

4.3.2.6.3.8.5.2.A
The blading shall be designed and constructed to avoid the possibility of damage from vibration when the set is running continuously at any speed in the normal speed range.

4.3.2.6.3.8.5.2.B
The blading in the wet region shall be protected from water erosion.

4.3.2.6.3.8.5.2.C
Adequate provision shall be made and access provided for site balancing of the rotor without major dismantling.

4.3.2.6.3.8.5.2.D
[redacted]

4.3.2.6.3.8.6 AUXILIARY EQUIPMENT

4.3.2.6.3.8.6.1 COMMON AUXILIARY EQUIPMENT

4.3.2.6.3.8.6.1.A
If some auxiliary equipment of the main feedwater turbine is shared with some of the main generator turbine, provision shall be made, to isolate the turbine from the auxiliary equipment in order to make maintenance or repair possible while the turbine generator is running.

4.3.2.6.3.8.6.2 LUBRICATING OIL SYSTEM

4.3.2.6.3.8.6.2.A
The tanks, pumps, coolers, valves and pipeworks shall, as far as possible, be assembled as a compact unit to minimise the fire risk.

4.3.2.6.3.8.6.2.B
Means shall be provided to ensure that there is no interruption of lubricating oil flow to the bearing during transient changeover of turbine driven main feedwater turbine pumps.

4.3.2.6.3.8.6.2.C
A spare cooler shall be included in the system.

CA
It shall be possible to easily isolate any cooler and change over the oil flow between coolers while the set is in service.

4.3.2.6.3.8.6.2.D
If the feedwater turbine is installed on lower level of turbine building a separate lubrication oil system shall be provided.

4.3.2.6.3.8.6.2.E
If a separate lubrication oil system is used filtration/conditioner with water removal capabilities shall be provided such that oil quality is maintained within acceptable operating limits.

4.3.2.6.3.8.6.2.F
The Supplier* shall provide the Owner* with the oil specifications and with the acceptable operating limits.

4.3.2.6.3.8.6.2.G
The oil system shall have facilities for taking oil samples.

4.3.2.6.3.8.6.3 CONTROL FLUID

4.3.2.6.3.8.6.3.A
A non-inflammable fluid shall be used.

4.3.2.6.3.8.6.3.B
The control fluid shall be different from the lubricating oil.

4.3.2.6.3.8.6.3.C
Attention shall be paid to the filtration and moisture elimination of the control fluid.

4.3.2.6.3.8.6.3.D
Neither the control fluid nor the control fluid system of the main feedwater turbine-pump and the main turbine generator shall be common.

4.3.2.6.3.8.6.4 GLAND SEALING SYSTEM

4.3.2.6.3.8.6.4.A
The system shall be capable of operation with auxiliary steam so that the glands can be sealed during reactor start-up, shutdown and trip sequences when live steam is not available.

4.3.2.6.3.8.6.5 CONDENSER AND CONDENSER VACUUM SYSTEM

4.3.2.6.3.8.6.5.A
The vacuum system shall be designed to avoid any substantial losses of alkaline substances from water of the secondary circuit.

4.3.2.6.3.8.6.6 TURBINE/CIRCUIT INTERACTION

4.3.2.6.3.8.6.6.A
The design shall be such that, in all design conditions, resonances do not occur which could:

- result in damage from mechanical vibrations, pressure pulsations, excessive loads on the anchoring, torsional vibration, etc.,
- perturb the signals used for in service surveillance equipment, thus rendering the Unit* monitoring inoperative.

4.3.2.6.3.8.6.6.B
The Supplier* shall provide the allowed vibration limits for all suitable components.

4.3.2.7 CONDENSATE STORAGE AND MAKE-UP SYSTEM

4.3.2.7.1 SYSTEM DEFINITION

4.3.2.7.1.1 SCOPE

4.3.2.7.1.1.A
The condensate storage and make-up system consists of tanks, pumps, piping and accessories designed for storage and preparation of make-up water.

4.3.2.7.1.2 INTERFACES

4.3.2.7.1.2.A
The condensate storage and make-up system interfaces mainly with:

- water treatment,
- condensate system,
- NI,
- main condenser.

4.3.2.7.2 SYSTEM FUNCTIONS

4.3.2.7.2.1 PURPOSE

4.3.2.7.2.1.A
The condensate storage and make-up system provides treatment and storage of water suitable for filling, flushing and make-up for the condensate system.

4.3.2.7.2.1.B
NA

4.3.2.7.3 SYSTEM REQUIREMENTS

4.3.2.7.3.A
NA

4.3.2.7.3.B
The system shall provide a chemical addition if required by the supplied system or subsystem.

4.3.2.7.3.C
The minimum capacity of the condensate storage tanks shall be based on the maximum condensate usage during start-up (e.g., maximum the Steam Generator* blowdown level multiplied by start-up duration), and condensate used for unit cooling through steam dump to atmosphere if required in safety analyses, with appropriate margin.

CA
This required volume shall be in accordance with the design regarding to the provisions for the demineralised water storage and transfer system, see Section 4.6.8.

4.3.2.7.3.D
When designing the capacity, the Supplier* shall take into account the need to refill the Safety Systems* in the long term (as a backup non-safety function), if necessary.

4.3.2.7.3.E
The condensate storage and make-up system shall be designed in such a way to prevent degradation of make-up water (e.g. by CO_2 ingress).

4.3.2.8 CHEMICAL ADDITION SYSTEM

4.3.2.8.1 SYSTEM DEFINITION

4.3.2.8.1.1 SCOPE

4.3.2.8.1.1.A
The chemical addition system includes the chemical addition tanks, pumps, piping, instrumentation and addition points.

4.3.2.8.1.2 INTERFACES

4.3.2.8.1.2.A
The chemical addition system interfaces with condensate and main feedwater systems.

The chemical sampling and monitoring system (see Section 4.3.2.9) provides input data for system control.

4.3.2.8.2 SYSTEM FUNCTIONS

4.3.2.8.2.1 PURPOSE

4.3.2.8.2.1.A
The chemical addition system adds liquid chemicals as necessary to maintain condensate, feedwater, steam and other circuits chemistry within required limits.

4.3.2.8.2.1.B
The Supplier* shall develop detailed chemistry of PGP systems (see Operation and Maintenance Document*, Section 3.10).

4.3.2.8.2.1.C
The steam transformers (if any) shall have provisions for pH control, such as an injection line for alkaline substances and oxygen scavenger into the storage tank.

4.3.2.8.2.2 SYSTEM PERFORMANCE

4.3.2.8.2.2.A
The chemical addition system shall maintain the water quality suitable for the long-term operation. This requirement applies to all Operational modes*, including power operation, start-up, shutdown, and extended outages.

4.3.2.8.2.2.B
This system shall allow all volatile treatment of the condensate and feedwater.

4.3.2.8.2.2.C
The pH range and the oxygen concentration shall be optimised according to the material requirements.

4.3.2.8.3 SYSTEM REQUIREMENTS

4.3.2.8.3.A
Correction chemicals shall be injected:

- during power operation: downstream of the condensate pumps and/or into the suction line of feedwater pumps,
- during cold start-up: into the suction line of the start-up feed pump,
- during the Commissioning* and outages in the points to be specified by the Supplier* to guarantee correct material protection.

AA
NA

4.3.2.8.3.B
Correction chemicals shall be dosed separately.

4.3.2.8.3.C
Control of dosed chemicals shall be done automatically and shall also allow manual control.

4.3.2.8.3.D
Chemicals shall be injected downstream of the condensate cleanup system.

4.3.2.8.3.E
Bulk chemical handling, transfer and dilution with demineralised water shall be controlled manually.

4.3.2.8.3.F
System capacity shall be determined for adequate ease of operation and sufficient space for storage of chemicals shall be provided.

4.3.2.9 CHEMICAL SAMPLING AND MONITORING SYSTEM

4.3.2.9.1 SYSTEM DEFINITION

4.3.2.9.1.1 SCOPE

4.3.2.9.1.1.A
The chemical sampling and monitoring system includes local sampling connections and sampling lines routed from the Unit* systems to the sampling room and sample analyzers.

4.3.2.9.1.1.B
A continual automatic chemical monitoring system shall provide continual monitoring of critical parameters and generate alarms.

BA
In addition, continual monitoring shall be provided for other parameters which may change rapidly during normal operation (including startup and shutdown) or during transients, to get data for assessment of the Unit* operation and life/ageing management and to minimise Plant* personnel work.

BB
Scope of continual and periodic monitoring and grab sampling shall be justified by the Supplier*.

4.3.2.9.1.1.C
In order to meet regulatory requirements and operational needs, actual and historical data from sampling and monitoring system shall be available throughout the Plant* and/or Unit* so that all workplaces which need such data have access to them online. See Section 2.10.5.4.2.4 and Section 2.8.2.14.6.

4.3.2.9.1.2 INTERFACES

A

The chemical sampling and monitoring system interfaces with the monitored systems; particularly:

- condensates, HP heaters and main feedwater systems,
- main steam systems,
- condenser,
- TBCCWS,
- non-radioactive liquid waste system,
- condensate cleanup system.

4.3.2.9.2 SYSTEM FUNCTIONS

4.3.2.9.2.1 PURPOSE

A

The purpose of the chemical sampling and monitoring system is:

- To obtain representative samples from different points of the secondary cycle and other systems and to condition them to be able to carry out continuous analyses and manual sampling so that the water and steam quality is controlled in all operating modes.
- To measure physical/chemical parameters in the secondary cycle to generate the demand signals for the chemical addition system (see Section 4.3.2.8).
- To measure other significant parameters in different parts of the secondary cycle and other systems to detect pollution.

4.3.2.9.2.2 SYSTEM PERFORMANCE

4.3.2.9.2.2.A

Where it is suitable in terms of workers safety, accessibility, etc. and necessary in order to have short response times and to obtain representative sample, the analyzers and grab sample taps shall be located as close as possible to the monitored system.

4.3.2.9.3 SYSTEM REQUIREMENTS

4.3.2.9.3.A

The chemical sampling and monitoring system shall provide following continuous measurements (but not to be limited to) to check physical/chemical characteristics of steam and water and to detect water pollution:

- in condensate: specific conductivity, cation conductivity, degassed cation conductivity, oxygen,
- in feedwater: specific conductivity, cation conductivity, degassed cation conductivity, oxygen scavenger, oxygen, corrosion products,
- in steam at each main steam line to the turbine: specific conductivity, cation conductivity, degassed cation conductivity.
- continuous monitoring of main ion impurities of the secondary circuit (sodium),

- continuous monitoring of condenser tightness in each part of condenser hotwell, allowing leaks to be located in the tube bundle (e.g. cation conductivity, sodium),
- continuous pH monitoring in the secondary circuit (if it is not easy to determine pH value from other continuous measurement).

AA
Further to these provisions, a few more sampling lines shall be installed to complete cycle information.

AB
The measurements shall be provided at the secondary circuit main components.

4.3.2.9.3.B
The Supplier* shall provide continuous and grab measurements of important parameters of other systems.

4.3.2.9.3.C
Sampling points shall be provided with the capability of taking grab samples for laboratory analyses.

4.3.2.9.3.D
The sampling system shall provide isokinetic samples when it is necessary.

4.3.2.9.3.E
Continuous sample lines shall have:

- an isolation valve close to the main line,
- a heat exchanger cooled by TBCCWS (except for condensate water samples), placed close to the connection,
- a pressure control device,
- a sample conditioner,
- a thermal shutoff valve to close the sample flow in case of cooling failure,
- any other components required for the correct operation of the on-line analyzers (second cooler, purge valves, filters, pressure gauges, rotameters, termometers, manual sample valves, drain collectors, buffer solutions, etc.).

4.3.2.9.3.F
On-line analyzers shall be selected and specially designed for use in low conductivity ultrapure water and with an appropriate range that covers the values of parameter at each sampling point and any drift. They shall be of a compact design for panel mounting, with solid state electronics and supplied completely with sensor, cell holder, calibration unit, amplifiers, temperature compensation, indicator, etc.

4.3.2.9.3.G
The system shall be able to take filtered samples with possibility to analyze both matter cumulated on filter (mechanical filter or filter saturated by ion exchanging resin) and filtered water after filtration. This means that filtered water volume shall be measured as well.

4.3.2.9.3.H

All sample lines shall be as short as possible, erosion-corrosion free, flushable, equipped with a sample conditioning station and a manual valve for sampling close to the sampling point.

4.3.2.9.3.I

Samples shall be routed to the draining or to the waste system.

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT** **VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS** **CHAPTER 4.4 ELECTRIC POWER SYSTEMS**
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CONTENTS

CHAPTER 4.4 ELECTRIC POWER SYSTEMS

4.4.0 INTRODUCTION

The Chapter 4.4 presents the generic requirements related to the electric power systems of the Power Generation Plant* (PGP) and Balance of Plant* (BOP).

The requirements specific to each system or process covered in this chapter are specified in each individual corresponding section.

A short description of each system or process is given to clarify the scope and application of the requirements.

The specific functions of the systems are listed, based on current LWR design and practice and desirable evolution from the Owner's* point of view.

This chapter comprises the following systems:

- electrical power transmission,
- Normal Auxiliary Power Supply system (NAPS),
- Stand-By Auxiliary Power Supply system (SAPS),

Principal electrical diagram of Plant* and power outlet diagram is documented in Section 4.4.3, Figure 4.4.3-1.

4.4.1 ELECTRICAL POWER TRANSMISSION AND AUXILIARIES POWER SUPPLY

4.4.1.1 SYSTEM DEFINITION

4.4.1.1.1 SCOPE

Electric power outlet, Normal Auxiliary Power Supply systems (NAPS) and Stand-by Auxiliary Power Supply system (SAPS) include all equipment necessary to transfer power from the generator to the grid and to supply Auxiliary Power Supply system (APS), either from the off-site grids or from the unit generator:

- a Generator Transformer* (GT) and the Auxiliary Normal Transformers* (ANT(s)) with their auxiliaries,
- Auxiliary Standby Transformers* (AST(s)) with their auxiliaries,
- Extra High Voltage (EHV) and HV lightning arrestors,
- isolating switches to isolate each piece of equipment (circuit breakers, GT transformer, ANT(s) transformers, Generator Circuit Breaker* , etc.) from the grid for maintenance purpose,
- earthing switches to connect each piece of equipment to earth during maintenance,
- a Generator Circuit Breaker* (GCB),
- reactance, lightning arrestors and earthing breakers, for neutral equipment of the GT which is directly earthed, or connected to earth via a reactance,
- an EHV outlet circuit breaker and unit circuit breaker.

Location of GCB, outlet circuit breaker (OCB) and unit circuit breakers (UCB) in electrical diagram are obvious from the picture in Section 4.4.3, Figure 4.4.3-1.

4.4.1.1.1.A
Figure 4.4.3-1 in Section 4.4.3, presents solution of the connection to the extra high voltage (EHV) 400 kV grid. This solution corresponds to the current general practice in the Czech Republic.

4.4.1.1.1.B
Generator Circuit Breaker* and branches (with detachable joints) to connect the ANT(s) shall be on generator voltage level.

4.4.1.1.1.C
Generator shall be connected to the GT through air isolated phase busbars, and via the Generator Circuit Breaker*.

4.4.1.1.1.D
The outlet circuit breaker shall be the 400 kV breaker in the NPP area between GT and unit circuit breaker. Unit circuit breaker is located in the grid substation.

4.4.1.1.1.E
The outlet circuit breaker shall be designed to be capable of withstanding and interrupting the maximum short circuit current from the grid.

4.4.1.1.1.F
The following equipment shall be included as well:

- current and voltage transformers used for protection, measurement, and voltage reference for coupling
- electrical protections
- Central Unit Fault Monitoring system - see Sections 2.7.11.4.10.

4.4.1.1.2 INTERFACES
The Unit* is connected to the electrical grid through a grid substation which includes all equipment necessary to protect all the connected feeders with a good reliability compatible with the nuclear power station design data. The diagram of Unit* connection to the grid is documented in Section 4.4.3, Figure 4.4.3-1.

4.4.1.1.2.A
Disconnecting in the Unit* 110 kV and 400 kV substations shall be performed with ability of visual observation of disconnection.

4.4.1.1.2.B
An automatic protective command shall be sent from the NPP to disconnect the unit circuit breaker in the EHV grid substation and indicate the GCB and the outlet circuit breaker status. An automatic protective command shall also be sent from EHV grid substation to disconnect the outlet circuit breaker and indicate the unit circuit breaker status.

4.4.1.1.2.C
The GCB and the outlet circuit breaker shall be operated exclusively from the NPP (manually remote on/off), the unit circuit breaker shall be operated exclusively from the EHV grid substation.

4.4.1.2 SYSTEM FUNCTIONS

4.4.1.2.1 PURPOSE

The purpose of the system is to allow the transfer of power from the generator to the grid via the GT and to supply correctly the plant auxiliaries in all operating conditions specified by the Supplier*.

4.4.1.2.1.A

During all operating conditions, when the main EHV grid power system is ready (during normal operation, shut-down and start-up of the unit, etc.), the auxiliaries shall be supplied from the NAPS source (via ANT(s)).

4.4.1.2.2 SYSTEM PERFORMANCE

4.4.1.2.2.A

The Unit* shall be connected to the grid through transmission line sized for the maximum continuous output power at GT terminal.

4.4.1.2.2.B

The GT rating shall be based on the generator output for the whole environmental temperature range.

4.4.1.2.2.C

The ANT(s) shall be sized to maintain the voltage at equipment terminals in the range specified by the Supplier* in all design modes including transient states.

4.4.1.3 SYSTEM REQUIREMENTS

4.4.1.3.1 GRID FEEDERS

4.4.1.3.1.A

The grid feeders of the Plant* (400 kV main grid connections and 110 kV standby grid connections) shall be physically separated and relatively independent so as to minimize the probability that a single failure affecting a grid feeder affects more than the failed grid feeder.

4.4.1.3.2 COMMON REQUIREMENTS FOR TRANSFORMERS

4.4.1.3.2.A

The Supplier* shall specify the transformer installation conditions (GT, ANT(s) and AST(s)):

- EHV overhead line connection from grid to GT
- HV air isolated phase busbars for ANT(s)
- EHV switchgear with outlet circuit breaker
- EHV overhead line or eventually cable connection for AST(s)
- tank insulated from ground or grounded (depend on using tank earth fault protection or ground differential protection relays)

4.4.1.3.2.B
The oil transformers shall be equipped with grounding pads to directly connect them to the grounding system in combination with ground differential protection (I0) and/or neutral ground overcurrent.

4.4.1.3.2.C
Oil transformers shall be equipped with an independent technological protection initiating disconnection of the transformer at an abnormal temperature.

4.4.1.3.2.D
The transformers shall be designed to withstand all operating conditions including accidental and incidental transients for a period longer than protective devices response time. In particular, they shall be designed to withstand the forces resulting from the specified short circuit duty.

4.4.1.3.2.E
Each transformer tank shall be designed for full vacuum capability, and fitted with safety pressure relief devices, oil conservator with oil gauge, Buchholz device with isolating, draining and gas sampling valves, thermometer pockets and temperature measurements with local indicators and contacts for alarms and control of cooling systems, all valves for filling, draining, oil treatment and sampling.

4.4.1.3.2.F
It shall be used “2 out of 3” selection logic for selected technological signals (e.g. abnormal temperature) for the purpose of incorrect action elimination in case of single failure.

4.4.1.3.2.G
The winding temperature shall be directly measured in the oil transformer winding and permanently displayed in the relevant plant control room.

4.4.1.3.2.H
Each cooling system shall be supplied with valves for filling and draining, allowing for replacement without draining the whole transformer tank.

4.4.1.3.2.I
The oil filled transformers cooler bank shall be located so that an adequate area for airflow exists, which is free from obstruction.

4.4.1.3.2.J
The cooling system of each transformer shall be optimized to avoid pollution sensitivity (i.e. provide stable cooling performance without frequent cleaning).

4.4.1.3.2.K
All stands of spare oil transformers, if they are considered, shall be equipped with an electric power supply enabling connection of filter devices for oil conditioning and supplying of pumps and fans, i.e. keeping the spare unit in instant operating ability.

4.4.1.3.2.L
Large transformers shall be equipped with a solid isolated ladder enabling climbing up to the upper part of the transformer tank. The top of the transformer tank shall be equipped with an isolated guardrail.

4.4.1.3.2.M
The transformers shall be designed according to CSN EN 60076 “Power Transformers”.

4.4.1.3.2.N
The transformers (GT, ANT(s) and AST(s)) and the transformers stands shall meet the Gov. Order No. 272/2011 as amended on minimum health and safety requirements regarding the risk arising from noise and vibration, see Chapter 2.5.

NA
According to Gov. Order No. 272/2011 Coll., as amended, it shall be taken into account all existing noise sources, especially Slavětice substation as a source of tonal noise in municipality Slavětice.

4.4.1.3.2.O
The Supplier* shall provide monitoring program of insulation system, method of insulation monitoring and evaluation criteria for online monitoring and monitoring during outages/oil regeneration as well.

OA
Oil transformers shall be equipped with a online monitoring system in accordance with the monitoring program of insulation system, minimally for analysis of in oil dissolved gases (H_2, CH_4, C_2H_6, C_2H_4, C_2H_2, CO, CO_2, O_2, N_2), humidity and other measured quantities:

- Oil sample temperature
- Top-oil temperature
- Bottom-oil temperature
- Hot-spot winding temperature
- Magnetic circuit temperature
- Tap changer temperature (if tap changer is installed)
- Coolers temperatures
- Ambient temperature
- Coolers state diagnostics (On, OFF, step)

4.4.1.3.2.P
The transformers shall be equipped with the bushings with a solid dielectric.

PA
The transformer bushings with rated voltage 110 kV or higher shall be equipped with measuring tap for the purpose of capacitance, tg d and partial discharge measure. The tap position shall enable to connect measuring device during the transformer operation.

4.4.1.3.3 GENERATOR TRANSFORMER

4.4.1.3.3.A
The Generator Transformer* shall be designed via three single phase transformers.

4.4.1.3.3.B
The vector group shall be: YNd1.

4.4.1.3.3.C
The grounding of the GT neutral on EHV side shall be agreed with the Owner*.

CA
Arrangement rules concerning grounding of the GT neutral are described in the Section 2.11.3.10.

CB
For a neutral connected to earth via a disconnecting switch, a lightning arrester shall be installed in parallel with the disconnecting switch.

4.4.1.3.3.D
The delta connection on MV side shall be made with isolated phase busbars.

4.4.1.3.3.E
Each separate unit shall be equipped with its own oil conservator.

4.4.1.3.3.F
Generator Transformer* ratio (EHV/MV) shall be agreed with the Owner*.

FA
The GT shall be equipped with On-load tap changer on EHV side – 17 taps with step ±1.25%.

FB
Generator Transformer* impedance voltage on the principal tapping shall be agreed with the Owner*.

4.4.1.3.3.G
The transformers shall be equipped with a system for isolation of oil from the surrounding atmosphere (prevention of oil ageing).

4.4.1.3.3.H
The transformers shall be type tested according to CSN EN 60076 and other Mandatory Laws* specified in the Chapter 2.5.

4.4.1.3.3.I
The Generator Transformer* shall be equipped with a partial discharge detection system including an evaluation criteria for early detection of progressive faults.

4.4.1.3.3.J
The cooling system of GT shall be optimized to reach the lowest power consumption and to reduce noise levels.

[redacted]

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

4.4.1.3.4 AUXILIARY NORMAL TRANSFORMER

4.4.1.3.4.A
The ANT(s) shall be connected to the generator busbars according to the Section 4.4.3, Figure 4.4.3-1.

4.4.1.3.4.B
The generator voltage side of the ANT(s) shall be a triangle connection.

4.4.1.3.4.C
For more information about grounding in MV power distribution see the Section 2.7.11.4.2.

4.4.1.3.4.D
The short-circuit impedance shall be defined on the basis of the short-circuit capability of the MV switchgear and of the capability of:

- starting the biggest MV motor, all the other auxiliaries being still connected and in operation,
- reaccelerating auxiliaries after a fault in the EHV grid
- transferring the loads from the AST(s) to the ANT(s),
- tripping to house load.

4.4.1.3.4.E
The voltage ratio shall be defined for the main tapping on the basis of nominal voltage at full load on the MV busbars and nominal voltage on the primary winding. Moreover, the maximum voltage off load and the minimum voltage at full load on the MV busbars shall be within the specified range of voltage for the MV busbars.

4.4.1.3.4.F
The ANT(s) shall be equipped with automatic voltage control and on-load tap changer. This voltage control system (its voltage control range, size of steps and speed) shall be capable to keep the voltage level in auxiliary power supply system in allowed design limits particularly upon these conditions:

- Full range of generator voltage given by active and reactive power production and voltage situation in the 400 kV grid (see the Sections 2.3.1.2.2 and 2.3.2.2).
- Various loading of ANT(s) (in the range from no-load to full load)

FA
The on-load tap changer shall be in the separate tank. The oil from the on-load tap changer shall be fully isolated from the oil in the transformer tank. The tank shall be equipped with safety pressure relief device, oil conservator with oil gauge, Buchholz device with isolating, draining and gas sampling valves. All valves for filling, draining, oil treatment and sampling shall not be shared with the transformer tank. The construction of the tap changer shall minimize oil degradation (i.e. vacuum switching) and oil cleaning shall be prepared (equipped with connection points). Maintenance shall be enabled without disassembling the transformer tank (i.e. outside separate tank).

4.4.1.3.4.G
The vector group shall be selected to allow a fast transfer method of change-over of loads from ANT(s) to AST(s). (See the Section 2.8.2.7.3.2)

4.4.1.3.4.H
Design of the inlet of the ANT(s) shall enable simple disconnecting for the purpose of exchange and repair works.

4.4.1.3.4.I
A circuit breaker with a disconnecting link shall be installed in the MV switchgear on the secondary and tertiary side of the ANT(s).

4.4.1.3.4.J
The cooling system of ANT(s) shall be optimized to reach the lowest power consumption and to reduce noise levels.

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

4.4.1.3.5 AUXILIARY STANDBY TRANSFORMER
See the Section 4.4.2.

4.4.1.3.6 ISOLATED PHASE BUSBARS

4.4.1.3.6.A
The power output of the generator shall be taken to the GT by connections comprising a set of three isolated phase busbars.

4.4.1.3.6.B
Tee-off points in the run of the main busbars may afford tappings to ANT(s), excitation transformer and voltage transformer cubicles. The enclosure will be designed to minimize circulating currents in adjacent structural members and will have not more than 5 percent of the total conductor magnetic flux outside the enclosure.

BA
These connections shall be of the self supporting rigid, isolated phase type, with each conductor enclosed by an earthed aluminium screen. The enclosures shall be of the fully

continuous type and shall be electrically bonded at the extremities, grounded at only one point.

4.4.1.3.6.C
The grounding connection shall be able to transfer the maximal ground fault or short circuit current which may occur in the system while protection system circuit breakers are opening.

4.4.1.3.6.D
Each phase connection shall be housed in a sealed tubular enclosure (not strictly hermetic), of fully welded construction where practicable, incorporating oil resistant flexible bellows where necessary to allow for expansion and vibration. Easy access for inspections and test purposes shall be possible (e.g. without dismantling other SSC).

4.4.1.3.6.E
The enclosures shall be electrically insulated from their supporting steelwork. Support points shall be designed to allow thermal expansion, except certain points which are fixed in order to direct the expansion. The supporting steelwork shall be designed to resist short-circuit forces.

4.4.1.3.6.F
The isolated phase busbars shall withstand all mechanical and thermal effects of the highest possible short-circuit current. The short-circuit rating of the equipment shall be calculated.

FA
The supporting insulating system shall be designed to avoid resonant vibration of the conductors and ensure adequate strength under short-circuit conditions.

4.4.1.3.6.G
Electrical connections bolted to adjacent equipment shall be designed to resist differential vibration during the Unit* life, under the continuous maximum rated conditions.
Adjacent equipment include the generator, the Generator Circuit Breaker*, the GT, the excitation transformer (if it exists), and the ANT(s).

4.4.1.3.6.H
The busbar cooling system shall be capable of dealing with full load for sustained periods and shall be provided with redundant air supplies.

HA
The forced air cooling equipment used to evacuate the heat from the busbars shall be designed for a fan failure by automatic change-over.

HB
The isolated phase busbars shall be filled with clean dry air. The isolated phase busbars shall be installed with humidity removing device.

HC
The generator terminal enclosures shall be air cooled allowing for a fan failure by automatic change-over. These enclosures shall be designed to guarantee a screening effect for electromagnetic fields, and to ensure personal protection.

4.4.1.3.6.I
The replacement of enclosed isolated busbar components, such as support isolators, instrumentation transformers, and sensors shall be possible with minimum disassembly work.

4.4.1.3.6.J
The voltage and current transformers shall be installed in the isolated phase busbars systems.

JA
The voltage transformers shall be separated from the isolated phase busbars (in case of voltage transformers blast).

4.4.1.3.6.K
The complete busbar system shall be protected by the electrical protection systems of the Unit* (differential protection and others), and an isolation monitoring system shall be installed to cover all of the branches of the generator voltage isolated phase busbars (busducts). A partial discharge detection system shall be provided for the generator voltage level components, including generator windings, GT, ANT(s).

4.4.1.3.6.L
Some routes of isolated phase busbars (at least in proximity of GCB) shall be equipped with an inspection bridge or ladder and guard rail for operating and maintenance purposes.

4.4.1.3.6.M
NA

4.4.1.3.7 GENERATOR CIRCUIT BREAKER

4.4.1.3.7.A
Power outlet of the generator shall be equipped with Generator Circuit Breaker* (GCB). See Section 4.4.3, Fig. 4.4.3-1.

4.4.1.3.7.B
A three phase Generator Circuit Breaker* (GCB) shall be installed in the run of the isolated phase busbars, between the generator terminals and the GT, to enable coupling of the generator to the EHV grid. In that case, the unit shall be started with the ANT(s) powered from the off-site power transmission grid through the GT, with the GCB open, and then synchronised with the off-site power transmission grid and coupled by means of the GCB.

4.4.1.3.7.C
The Generator Circuit Breaker* shall be capable of making and interrupting the maximum short-circuit current either from the generator, or from the grid, and of withstanding permanently the maximum continuous output current of the generator.

4.4.1.3.7.D
The GCB shall be equipped with disconnecting switch on the side of the MV terminal of the GT transformer, short circuit connector and earth switches at both sides, for measurement and maintenance purposes (e.g. adjustment/check of protection system setting).

4.4.1.3.7.E
The Generator Circuit Breaker* may be air cooled or air and water cooled; in this latter case, the generator stator cooling water may be used, otherwise, a special deionising plant shall be supplied.

EA
The compressed air supply facility (if any) shall include redundant compressors, and the high pressure air storage shall be sized to allow at least two closing-opening operations.

EB
NA

[redacted]

4.4.1.3.7.G
The GCB shall be equipped with two galvanically separated and physically independent tripping coils, which shall be activated from separate signal circuits.

4.4.1.3.7.H
The GCB shall be equipped with automatics for circuit breaker (disconnection) failure based on the double principle (selection logic "1 out of 2"):

1. current criterion
2. criterion evaluating of circuit breaker status

4.4.1.3.7.I
The voltage transformers shall not be mounted in the GCB hosing, but voltage transformers shall be integrated in the isolated busbars systems.

4.4.1.3.7.J
The Generator Circuit Breaker* shall be designed to be mechanically locked in the open position and its locking key or equivalent interlock shall be included in the general interlocking system of the HV supplies.

4.4.2 STAND-BY AUXILIARY POWER SUPPLY

4.4.2.1 SYSTEM DEFINITION

4.4.2.1.1 SCOPE

4.4.2.1.1.A
SAPS system shall include all devices between connection points CP17A, CP17B, CP17C, CP17D and switchboards of APS such as the following but not limited to the following:

- 110 kV lines
- 110 kV substation on-site
- AST

and their auxiliary device.

4.4.2.1.2 INTERFACES

The interfaces are connection points CP17A, CP17B, CP17C, CP17D and switchboards of APS.

4.4.2.2 SYSTEM FUNCTIONS

4.4.2.2.1 PURPOSE

See the Section 2.8.2.7.3.2.

4.4.2.2.2 SYSTEM PERFORMANCE

See the Section 2.8.2.7.3.2.

4.4.2.3 SYSTEM REQUIREMENTS

4.4.2.3.A
The AST(s) shall be connected to the 110 kV substation on-site according to the Section 4.4.3, Figure 4.4.3-1. SAPS source shall be electrically and physically separated from NAPS sources.

AA
An isolating (disconnecting) switch with earthing blades shall be installed on the primary side of the AST(s).

AB
A circuit breaker with a disconnecting links shall be installed on the secondary and tertiary side of the AST(s).

4.4.2.3.B
The short-circuit impedance of the AST(s) shall be defined on the basis of:

- the short-circuit capability of the MV switchgear
- the capability of starting the biggest MV motor, all the other auxiliaries being still connected and in operation,
- the capability of reaccelerating auxiliaries after a fault in the HV or EHV grid
- the capability of transferring the loads from the ANT(s) to the AST(s).

4.4.2.3.C
The vector group of the AST(s) shall be selected to allow a fast transfer method of change-over of loads from the AST(s) to the ANT(s). (See the Section 2.8.2.7.3)

4.4.2.3.D
The AST(s) shall be designed on the basis of their particular operating conditions (off-load and high voltage level on their HV terminals).

DA
Design of the inlet of the AST(s) shall enable simple disconnecting for the purpose of exchange and repair works.

4.4.2.3.E
The AST(s) shall be equipped with automatic voltage control and on-load tap changer. This voltage control system (its voltage control range, size of steps and speed) shall be capable to keep the voltage level in auxiliary power supply system in allowed design limits particularly upon these conditions:

- Voltage situation in the 110 kV grid (see Section 2.3.1.2.2).
- Various loading of AST(s) (in the range from no-load to full load).

4.4.2.3.F
The on load tap changer of the AST(s) shall be in the separate tank. The oil from the on load tap changer shall be fully isolated from the oil in the transformer tank. The tank shall be equipped with safety pressure relief device, oil conservator with oil gauge, Buchholz device with isolating, draining and gas sampling valves. All valves for filling, draining, oil treatment and sampling shall not be shared with the transformer tank. The construction of the tap changer shall minimize oil degradation (i.e. vacuum switching) and oil cleaning shall be prepared (equipped with connection points). Maintenance shall be enabled without disassembling the transformer tank (i.e. outside separate tank).

4.4.2.3.G
The star point of the AST(s) winding on the 110 kV side shall be solidly grounded.

GA
For more information about grounding in MV power distribution see Section 2.7.11.4.2.

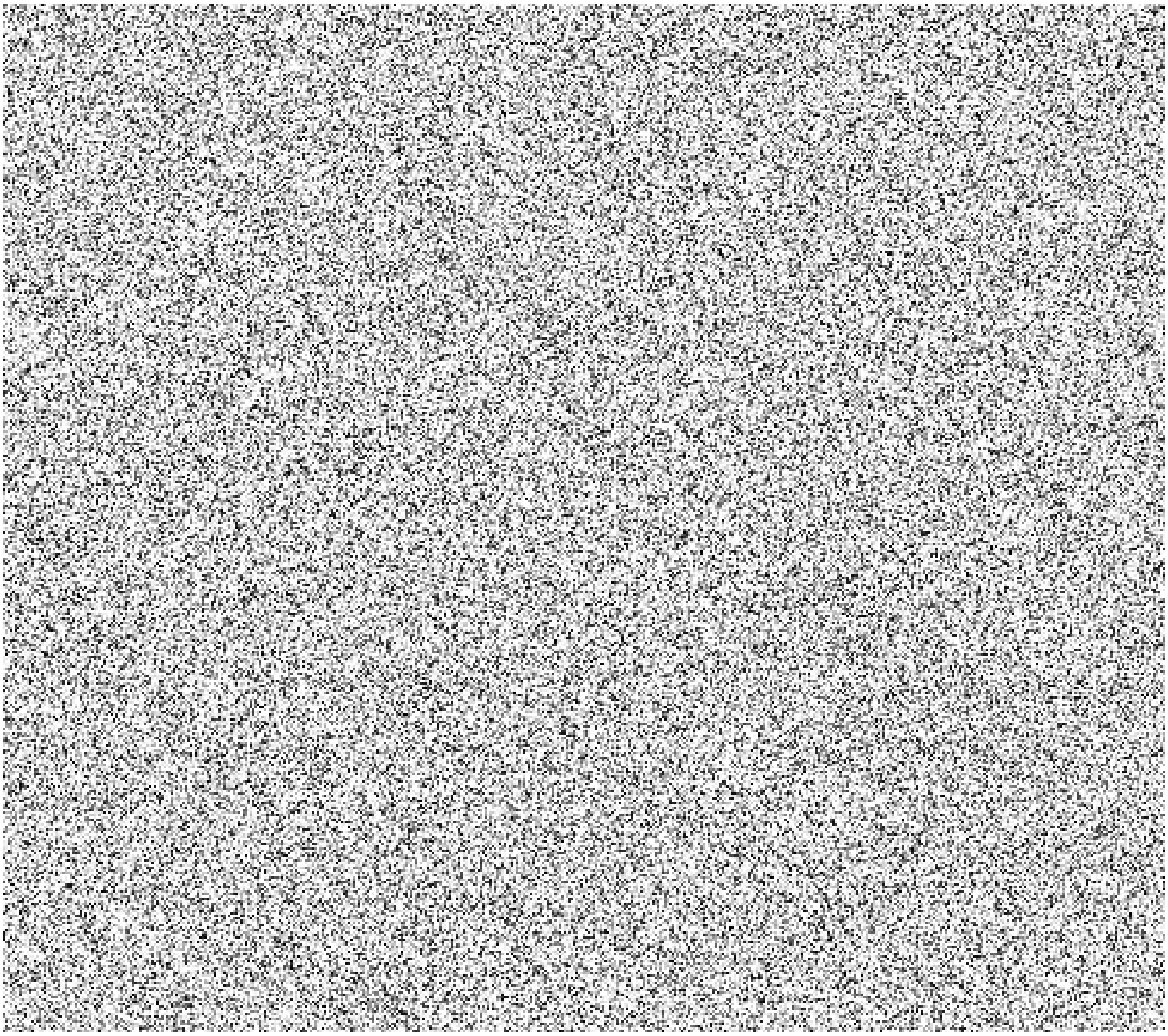
4.4.2.3.H
The cooling system of AST(s) shall be controlled by coolers groups which are controlled automatically from winding temperature and shall be optimized to reach the lowest power consumption and to reduce noise levels.

4.4.2.3.I
Equipment located in the 110 kV substation on-site shall include the following but not limited to the following:

- circuit breakers
- isolating switches to isolate each piece of equipment from the grid for maintenance purpose,
- earthing switches to connect the equipment to earth during maintenance,
- HV lightning arrestors,

4.4.2.3.J
The circuit breakers in the 110 kV substation on-site shall be arranged in "H configuration".

4.4.2.3.K
The AST(s) hot-spot winding temperature shall be measured for monitoring and diagnostic purposes.



EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS CHAPTER 4.5 CIRCULATING WATER SYSTEMS**
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CONTENTS

CHAPTER 4.5 CIRCULATING WATER SYSTEMS

4.5.0 INTRODUCTION

The Chapter 4.5 presents the generic requirements related to the circulating water systems of the Power Generation Plant* (PGP) and Balance of Plant* (BOP).

The requirements specific to each system or process covered in this chapter are specified in each individual corresponding section.

A short description of each system or process is given to clarify the scope and application of the requirements.

This chapter comprises the following systems:

- Main Circulating Water System (MCWS)
- Auxiliary Circulating Water System (ACWS)
- Chemical Injection System (CIS)
- Acid Feeding System (ACFS)
- Make-up Water Treatment Plant (MWTP)

Requirements related to design life are in detail described in Section 2.4.2.

4.5.1 MAIN CIRCULATING WATER SYSTEM (MCWS)

4.5.1.1 SYSTEM DEFINITION

4.5.1.1.1 TYPES OF SYSTEM

4.5.1.1.1.A

In accordance with the local conditions combination of dry and wet cooling shall be used.

4.5.1.1.1.B

In this system the water passing through the condenser is cooled in a cooling tower. The make-up water is supplied from the river (raw or treated, if required). The blowdown is normally directed to the Waste Water Collection System. The thermal load is transmitted to the ambient air.

4.5.1.1.1.C

The Main Circulating Water System (MCWS) shall be designed to minimise negative impact on environment (e.g. blowdown water quality including temperature increment, use of hazardous materials and consumables, etc.).

4.5.1.1.1.D

The Supplier* shall develop Site*-specific chemistry and provide chemical control and measurement as specified in Section 4.5.3.

4.5.1.1.2 SCOPE

4.5.1.1.2.A

The MCWS in the system shall include the following works:

- pumping station with the filtration and the pumps,
- the piping from the pumps,
- the main condenser,
- the auxiliary condensers if any,
- the cooling tower(s),
- the screening plant,
- the valves,
- any associated pipework/interconnecting pipes

AA

Source of the cooling water to the MCWS is water from Jihlava river (raw or treated, if required).

AB

The make-up water shall be treated, if needed.

4.5.1.1.3 INTERFACES

4.5.1.1.3.A

The MCWS interfaces with the following systems:

- the main condenser,
- turbine driven feedwater pump condensers (if any),
- the on-load cleaning system,
- chemical injection system,
- make-up water treatment plant (if required),
- water treatment system (if required),
- fire protection water system (if this solution is included in design),
- the waste water collection system,
- auxiliary cooling water system (if cooling of ACWS by MCWS cooling tower is used),
- turbine building closed cooling water system heat exchangers (if this solution is included in design),
- condenser air removal system pump seal coolers (if any),
- acid feed system,
- raw water system.

4.5.1.2 SYSTEM FUNCTION

4.5.1.2.A

The MCWS shall be designed to provide non-safety cooling water to the main steam turbine condensers and other devices (feedwater pump condenser, if any, main condenser vacuum system priming and air removal, if required) and to reject waste heat to atmosphere by the cooling tower(s).

4.5.1.2.B
The design of the MCWS shall take account of the quality of the raw water available (in accordance with Section 5.2.5.2.1).

4.5.1.3 SYSTEM REQUIREMENTS

4.5.1.3.1 GENERAL ARCHITECTURE

4.5.1.3.1.A
The MCWS shall be designed as combination of dry and wet cooling system. The condenser shall be located on the discharge side of the circulating water pumps.

AA
For raw water quality and Site* information, see Volume 5 and for Site* design conditions see Section 2.4.1.

4.5.1.3.1.B
The Supplier* shall take into account the thermal and hydraulic analyses of the system and the Site* conditions including Plant* arrangement, soil bearing conditions, seismological conditions of the Site*, etc.

BA
The parameters to take into account in sizing the MCWS are the following:

- air dry bulb temperature,
- air wet bulb temperature.

These parameters are determined from the hydrometeorological files of the Site* (see Chapter 5.2).

4.5.1.3.1.C
The choice of the main equipment data and performance as well as system configuration shall be fixed by an optimization programme to maximize the cooling capability and minimise MCWS power consumption and water usage taking account of capital and operating costs.

Note:
The requirement for minimising the water usage is part of the EIA binding conditions.

4.5.1.3.1.D
NA

4.5.1.3.1.E
The design of the Plant* shall be such that no damage occurs to the ESWS due to an accident in the MCWS (see Section 2.8.2.10.3).

4.5.1.3.1.F
The design shall prevent flooding of the buildings and malfunctioning resulting from events such as flooding, water hammer, vibrations.

FA
Flooding protection shall be provided to ensure that large leaks from MCWS piping do not affect any NI building of facility and do not result in the loss of all circulating water pumps.

4.5.1.3.1.G
Blowdown of MCWS shall be provided.

GA
The whole blowdown shall be possible to discharge only from the cool down branch of MCWS.

GB
Blowdown shall be drained to the Waste Water Collection System.

GC
The blowdown flow shall be controlled by regulating valves keeping the flow at the set value.

GD
Blowdown calculations and estimated blowdown concentrations shall be provided.

GE
It shall be possible to divert blowdown from the MCWS directly into the Make-up Water Treatment Plant (MWTP). The blowdown water treatment can be used to ensure the required quality of discharged waste water.

4.5.1.3.1.H
The system shall be designed taking into account the requirements set forth in Chapter 2.6 and Chapter 2.7.

HA
For material requirements see Section 2.6.4.1.6. and 2.6.4.1.7.

4.5.1.3.2 MAIN CIRCULATING WATER PUMPS

4.5.1.3.2.A
Pumps shall include a margin in performance to account for wear during operation. Pumps shall provide the sufficient margin in head at the pump design point. See Section 2.7.4.

AA
These pumps shall be located in one of the following locations: turbine building, pump house, or at the cooling tower basin sumps.

4.5.1.3.2.B
The hydraulic grade from the cooling tower basins to the main circulating water pumps shall be sufficient to ensure that available NPSH and submergence for the main circulating water pumps exceeds the required NPSH and submergence with margins as specified in Section 4.5.1.3.2.1.

4.5.1.3.2.C
At least two pumps shall be provided.

CA
General characteristics of the MCWS pumps shall be provided as follows:

- type and model centrifugal pumps,
- performance characteristic (working point),
- flow rate and total head,
- pumps MPSH (see 4.5.1.3.2.1),
- impeller diameter,
- pumps rotation speed (rpm),
- efficiency (%),
- total losses (Head vs Flow rate).

4.5.1.3.2.D
The system shall be designed to operate with the variation of flow due to the normal operating configuration. This flow range shall be 85 % to 110 %.

DA
There shall be no internal recirculation or cavitation.

DB
The pumps might be designed with a concrete volute and shall be directly driven by a low speed motor. The MCWS pumps shall be fixed-speed, direct-drive, low-rpm units.

DC
Flow control for winter operation and operation with the Unit* shut down shall be provided by changing the number of pumps in operation, by control of water flow within the cooling tower itself, and bypassing MCWS flow around the cooling tower.

DD
It shall be possible to control amount of flow (from minimum to maximum), so that it shall be possible to set minimum flow with respect to winter operation of cooling tower, in case of the Unit* shut down in winter.

DE
A pressure indicator at the pump discharge and a level indicator in the pump bay shall be installed in the circulating water system to verify the pumps performance. Use of other means of verification shall be justified by the Supplier*.

4.5.1.3.2.E
Cooling water flow for pump bearings (directly cooled or oil cooled bearings are permissible) shall be provided in sufficient quantity to maintain bearing temperatures within the pump manufacturer's limits under full pump output on the hottest days of the year.

4.5.1.3.2.F
Separate flow paths, each with their own pressure control, shall be provided for pump support systems requiring cooling water such as thrust bearing cooling, seal water cooling, and wear ring flushing.

FA
Lubricated thrust bearings to secure the load of the motor and the pump as well as the hydraulic thrust shall be provided.

FB
The main circulating water pumps bearings temperature measurement shall be ensured by remote transmission to the control room.

FC
The flow and pressure measurements on the main pumps discharge shall be ensured by remote transmission to the control room.

FD
The actual level in the suction sumps of the main circulating water pumps shall be transferred to the control room.

4.5.1.3.2.G
The lubrication shall be independent and self-governing during start-up, operation and switch off.

[illegible]

4.5.1.3.2.I
The axial thrust shall be equilibrated internally.

4.5.1.3.2.J
The shaft jacket shall be resistant to corrosion and abrasion. Metal ceramic may be used for such application.

4.5.1.3.2.K
During Unit* operation, the failure of one of the operating pumps shall not lead to a turbine trip due to high pressure in the condenser or failure of the remaining pumps in operation due to run-out.

KA
It shall be possible to operate each Unit* with one MCWS pump out of operation under design conditions for cooling water inlet temperature.

KB
The pump shall withstand runback and cavitation during the anticipated time by transient calculation without damage.

4.5.1.3.2.1 MCW PUMPS NPSH

4.5.1.3.2.1.A
The MCWS pumps minimum available NPSH shall be selected with a conservative margin over the required NPSH. It shall be specified by the pump designer.

4.5.1.3.2.1.B
The available NPSH shall be calculated at the highest expected operating temperature and flow and at the normal water elevation with all margins.

[redacted]

4.5.1.3.2.1.C
Level of submergence shall be demonstrated in accordance with the Rules* (see Chapter 2.5) or shall be demonstrated using a hydraulic model.

4.5.1.3.3 COOLING TOWER

4.5.1.3.3.A
The MCWS shall be provided with cooling tower(s).

4.5.1.3.3.B
The type and parameters of the tower(s) shall be fixed by the design optimisation programme. This optimisation programme of MCWS shall be based on the minimization of the water consumption and on the possible future evolution of environmental conditions at the Site*. See the Project Management Document*, Attachment 3.

BA
The results of this optimisation programme shall be subject to the Owner's* approval.

[redacted]

BC
The height and width of the cooling tower shall be fit to the required cooling capacity.

4.5.1.3.3.C
For the cooling towers cooling and correction curves shall be provided, which determine correction of cooling water temperature according to deviation of other parameters (e.g. hydraulic load).

4.5.1.3.3.D
The cooling tower performances guaranteed by the manufacturer at reference conditions shall include at least:

- the main cooling water temperature,
- the drift losses,
- the evaporation losses,
- the sound power level (Lw).

4.5.1.3.3.E
The design of the fills shall achieve good thermal performance with a low fouling risk.

EA
The shape and the material used shall not initiate abnormal scaling.

EB
The plastic fills into cooling tower shall be manufactured from fire-resistant materials.

4.5.1.3.3.F
The distributions, the step of the distributors and the charge shall secure a good distribution of the water with a low dispersion in density.

4.5.1.3.3.G
The cooling towers shall have two independent delivery lines.

GA
It shall be possible to divert flow directly into the basin, bypassing the cooling tower internals. The bypass around cooling tower is normally used only during Unit* start-up in cold weather or to maintain circulating water system temperature while operating at partial load during periods of cold weather. A control valve with remote control shall be installed on the bypass pipe.

4.5.1.3.3.H
It shall be possible to shutdown specific zones of the cooling tower with respect to winter operation mainly during freezing weather condition.

4.5.1.3.3.I
The valves, pipes and installed components inside the cooling tower shall be designed with respect to ambient conditions (e.g. prevent corrosion, prevent contamination of cooling water).

4.5.1.3.3.J
In order to limit the surrounding nuisance, droplet eliminator panels shall be installed above the distribution pipes accordingly with the vicinity risk (e.g. distribution transformers in neighbourhood or other reasons according to NPP design).

JA
The impact of plume from the cooling towers to the Plant* buildings, shall be also analysed.

4.5.1.3.3.K
Basins of the cooling towers shall collect all the water pouring down the fills. Its capacity shall be sufficient to store the necessary volume of water to cope with the following transients: switching on pumps, filling of the condenser and ducts, switching off pumps, clogging the mesh. In this volume a margin shall be included for settled materials.

KA
The maximum level in the basins under of the cooling towers shall be ensured by remote transmission to the control room.

4.5.1.3.3.L
Means shall permit an access to the basin bottom. An inclined plane shall permit the access to the basin bottom for cleaning purposes.

4.5.1.3.3.M
Provisions shall be taken to secure the cooling tower against freezing.

MA
These provisions shall include:

- all distribution pipes and ducts are permanently drained by holes to avoid water stagnation during shutdown,
- an internal bypass (one per pipe), by-passing the fills permits circuit start-up during frost,
- valves to stop the feeding of the central part of the fills, switching the flows to the peripheral fills,
- a freezable grid or a water curtain at the air entrance.

MB
The efficiency of the relevant means shall be demonstrated in the worst conditions by analysis (see Section 2.4.1.2.2).

4.5.1.3.3.N
The isolation valves (if any) performing the anti-icing shut off shall be motor operated. In that case, all bypass and anti-icing valves shall be operable during cooling tower operation.

4.5.1.3.3.O
The make-up water flow shall be controlled to follow the need of MCWS.

OA
The design of the make-up water valves shall respect the requirements for remote control.

4.5.1.3.3.P
Cooling tower control device (in wintertime) shall be located outside the cooling tower, if possible, to prevent corrosion from within the cooling tower.

4.5.1.3.3.Q
The means of access and Inspection* shall secure easy and secure access of operation and maintenance personnel in accordance with the requirements of the Rules* (see Chapter 2.5).

QA
The main access and Inspection* means are:

- to the hot water pipes: a manhole per pipe at the entrance of the pipe,
- to the bypass: an access for each by-pass valve,
- to the hot water ducts: a straight staircase with rectangular landing to give access to the duct level, a door in a humidity resistant material closes the entrance of the tower. In the tower, stairways with parapets permit an easy circulation around valves and stop gates, each duct includes two Inspection* traps: one at each end and also railings and structural made from humidity-resistant and ultraviolet light-resistant materials.
- to the top: one cage ladder gives access to the top; this ladder starts at the top landing of the staircase and includes a sufficient number of rest landings,
- on the top: a walkway with concrete parapet Permits* the beacon maintenance.

QB
The design of drift eliminators shall not inhibit personal maintenance access to the distribution system with spray nozzles during operation.

4.5.1.3.3.R
Adequate lightning protection shall be installed including earth connections, lightning conductors and reinforcement connection (see Section 2.7.11.4.12).

4.5.1.3.3.S
A system of beacons in accordance with the requirements of the Rules* (see Chapter 2.5) (number, level, colour and intensity, …) shall be installed.

4.5.1.3.3.T
Design of the cooling towers shall provide adequate level of safety (see Chapter 2.5) and durability (see Section 2.4.2) at the lowest possible life-cycle cost.

TA
The shell wall shall be designed to resist loads by wind, temperature, and moisture acting on concrete.

TB
Design life and expected maintenance programme shall be provided.

TC
Means for monitoring the deformation of the shell and of the internal structures during construction shall be provided.

4.5.1.3.3.U
The structural elements of the cooling tower shall be constructed with a suitable grade of concrete following the provisions of applicable requirements of the Rules* (see Chapter 2.5).

UA
The design of the mixture shall reflect the conditions for placement of the concrete and the external and internal environment of the tower.

UB
The concrete shall have the following properties:

- high resistance against chemical attacks,
- high structural density,
- high resistance against frost.

UC
The surface finish shall be of high quality and the surface shall be smooth and essentially free of shrink holes. Air bubbles and unintended surface irregularities at joints shall be avoided.

4.5.1.3.3.V
In case of using surface coat protection, high blocking effect and long durability shall be provided.

VA
The value for diffusion resistance shall be provided.

VB
Field proven design shall be used for coating systems.

4.5.1.3.3.X
Mock-up tests for cooling tower shall be performed to clarify concrete mixture, quality of surface, construction joints treatment and coating application.

4.5.1.3.3.Y
The Supplier* shall demonstrate that cooling tower design complies with the Mandatory Law* and the Requirements of the Authorities* in the area of environmental impact especially noise exposure to surrounding municipalities (see the Section 1.2) during Plant* permitting.

YA
External surface of the cooling tower shall preferably be in color of raw concrete to lower light reflection.

4.5.1.3.4 SCREENING SYSTEM

4.5.1.3.4.A
The screening system shall filter the cooling water used in the system.

4.5.1.3.4.B

The screening system function shall be ensured in two steps:

- removal of large elements such as: branches, packages, large pieces of algae, crustacean, etc.,
- removal of any remaining elements up to the anticipated screening level.

4.5.1.3.4.C

The screening system of cooling water shall be located in the circulating pump house before intake to the MCWS pumps, upstream of all ducts and equipment.

CA
A simplified screening system for removal of the large elements shall be located near the water outlet of the cooling tower.

CB
The MCWS screening system shall allow filtration of make–up water added to the MCWS.

4.5.1.3.4.D

The arrangement of the equipment in this system is dependent on the characteristics of the water to be filtered.

DA
The layout shall be determined by the choice of equipment.

4.5.1.3.4.E
The layout of the screening system shall provide clearance for handling all equipment parts and provision to store dismantled parts during maintenance.

EA
Stop gates storage shall also be provided.

EB
The layout of the system shall pay attention to limit the number of stop gates for maintenance purposes and to install identical and interchangeable equipment.

4.5.1.3.4.F
The screening function shall provide sufficient amount of clean water which shall not hinder the proper operation of the systems, with respect to the Site* conditions.

4.5.1.3.4.G
The design of the screening system shall take into account the specific Site* conditions such as ice and frazil ice. See Volume 5, Section 5.2.

GA
The screening system shall be designed to be able to maintain power operation with one screening line taken out of operation for maintenance with the lowest water level for operation of the Unit*.

4.5.1.3.4.H
All the trash rakes shall be hydraulically handled, including screening system for large elements (see CA), with respect to the handling during cold weather.

4.5.1.3.4.I
The cleaning operation of all screening equipment shall be initiated automatically by a head-loss monitor and a timer and shall be monitored in a control room with permanent service.

IA
The screens shall be protected against accidental high loss of head by pump shut off, tie rods snapping, by-pass opening, etc.

4.5.1.3.4.J
All submerged structure shall be corrosion resistant.

JA
The same requirement shall apply to structures in contact with corrosive atmosphere.

JB
This shall be achieved by the use of a protective coating or by stainless steel material for the components such as: bar racks, crossbeams, rake channel guides, rake cables, trolley structure, trash collector, rake tines, shaft, spokes, bearing housing, rims, mesh frame, mesh securing, seal securing, bolts.

4.5.1.3.5 PIPES

4.5.1.3.5.A

The piping system shall be designed to accommodate transient effects that may be generated by the normal starting and stopping of pumps, opening and closing of valves, or other normal operating events.

AA

The system arrangement is such that high points in the system piping do not lead to the formation of vapor pressure voids upon loss of system pumping.

4.5.1.3.5.B

Piping portions above ground such as pump discharge and connections (inlet and outlet) to the main condenser shall be steel pipes provided with a protective internal coating and/or additional material thickness taking into consideration the cooling water quality (see Section 5.2.5.2.1). Pipes materials shall be designed according to Section 2.4.2. Plant* design life.

BA

The embedded pipes shall be protected against corrosion.

4.5.1.3.5.C

Means for entering into circulating water piping and condenser water boxes shall be provided.

CA

Cooling water supply and return piping shall be accessible for Inspection* and/or wall thickness determination.

4.5.1.3.5.D

The circulating water system piping shall permit isolation and draining of one condenser tube bundle to plug condenser tubes during the full power operation.

4.5.1.3.5.E

Provisions to drain the circulating water system piping, pumps, and condenser water boxes quickly shall be specified.

4.5.1.3.5.F

The isolation valves, pipework and flexibility arrangements shall ensure that any thermal dilation and hydrodynamic forces generated during the full power operation (including transients) can be satisfactorily contained by the condenser/turbine generator support provisions (see Section 4.2.3).

4.5.1.3.5.G

Non replaceable part of the pipes placed underground shall be resistant against corrosion and degradation within whole life time of the Plant*.

4.5.1.3.5.H

Provisions shall be taken to secure the pipes against freezing.

4.5.1.3.5.I
In case of use of evaporation of tritium in the MCWS cooling towers, monitoring of potential leaks shall be provided (see Section 2.1.3.2.4).

4.5.1.3.6 VALVES

4.5.1.3.6.A
MCWS valves shall be designed and installed to allow easy access for maintenance or dismantling.

4.5.1.3.6.B
The circulating water system valve design shall be consistent with the planned outage schedule.

BA
The circulating water system valves design shall be resistant against corrosion.

BB
The design of cooling water valves shall respect fully automatic operation with remote control.

4.5.1.3.6.C
The Supplier* shall consider the need for monitoring of the valves and checks of the motor operated actuators and their manual overrides.

4.5.1.3.6.D
Valves of the butterfly type, including associated actuators, shall be provided on the inlet and outlet connections to the water box, and shall be capable of effective isolation to facilitate access into the water box on-load unless there is alternative solution which enables to meet requirements of on-load access, see Section 4.2.7.4.

4.5.1.3.6.E
Provisions shall be taken to secure the valves against freezing.

4.5.1.3.6.F
Operating filling and material substances of the valves shall not pollute the cooling water.

4.5.1.3.7 TURBINE BUILDING FLOODING

4.5.1.3.7.A
Flooding detectors or other protection features shall be provided in the turbine building to prevent a large flood from affecting the more relevant equipment (start-up and shutdown feedwater drivers or auxiliary feedwater drivers, if any, and condensate pump drivers) in case of a circulating water piping expansion joint leak or break.

4.5.2 AUXILIARY CIRCULATING WATER SYSTEM (ACWS)

4.5.2.A
If ACWS is not used, the design of the alternative solution shall meet functional requirements listed in this Section 4.5.2 and the Supplier* shall provide technical and economical justification.

4.5.2.1 SYSTEM DEFINITION

4.5.2.1.1 SCOPE

4.5.2.1.1.A
The Auxiliary Circulating Water System (ACWS) consists of pumps, piping, valves, filters, heat exchangers, the Heat Sink* and associated controls and instrumentation.

4.5.2.1.2 INTERFACES

4.5.2.1.2.A
Generally, the ACWS interfaces with:

- the Turbine Building Component Cooling Water System (TBCCWS),
- the auxiliaries of the turbogenerator (if required),
- condenser vacuum pumps,
- the Waste Water Collection System,
- the Main Circulating Water System (MCWS) (if cooling of ACWS by MCWS cooling tower is used).

4.5.2.1.3 TYPE OF SYSTEM

4.5.2.1.3.A
The ACWS shall be designed as an open recirculating system. The system may be combined with the water make-up of the MCWS.

AA
The Auxiliary Circulating Water System (ACWS) shall be designed to minimise negative impact on environment (e.g. blowdown water quality including temperature increment, use of hazardous materials and consumables, etc.).

AB
The design of the ACWS shall take account of the quality of the raw water available (in accordance with Section 5.2.5.2.1).

4.5.2.2 SYSTEM FUNCTION

4.5.2.2.A
The ACWS shall remove the heat from the turbine building component cooling water system (TBCCWS) via the system heat exchangers. The cooling water from the circulating water pump in circulating water system is used as cooling water and as a heat sink.

AA
The ACWS piping length shall be minimised to minimise the amount of piping exposed to the corrosive effects of ACWS water. This in particular applies to piping inside of the turbine building (see Section 4.6.1.3).

4.5.2.2.B
The system operating reliability shall be ensured so that no single failure of an active component, if any, can affect the Plant* operational performance.

[redacted]

4.5.2.2.C
NA

4.5.2.2.D
Isolation valves shall be provided to allow maintenance during full power operation.

4.5.2.3. SYSTEM REQUIREMENTS

4.5.2.3.A
The choice of the main equipment data and performance as well as system configuration shall be fixed by an optimization programme to maximize the cooling capability and minimise ACWS power consumption and water usage taking account of capital and operating costs.

AA
The Supplier* shall develop Site*-specific chemistry and provide chemical control and measurement as specified in Section 4.5.3.

4.5.2.3.B
The discharge piping from MCWS 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.

BA
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.

[redacted]

4.5.2.3.D
The Supplier* shall include provisions to ensure surveillance of biofouling and silting can be accomplished.

DA
The provisions shall facilitate visual inspections of intake structures and monitoring populations of biofouling agents.

4.5.2.3.E
Piping portions above ground such as pump discharge and connections (inlet and outlet) to the heat exchangers shall be steel pipes provided with a protective internal coating and/or additional material thickness taking into consideration the cooling water quality (see Section 5.2.5.2.1). Pipes materials shall be designed according to Section 2.4.2. Plant* design life.

EA
The embedded pipes shall be protected against corrosion.

4.5.3 CHEMICAL INJECTION SYSTEM (CIS)

4.5.3.1 SYSTEM DEFINITION

4.5.3.1.1 SCOPE

4.5.3.1.1.A
The chemical injection system (CIS) shall include the following equipment:

- chemicals storage, pumps, piping and valves,
- water chemical monitoring, sampling pumps, piping, filters and valves.

AA
Extra space shall be provided for the additional chemicals dosing equipment for possible future need.

4.5.3.1.1.B
Data from monitoring system shall be available throughout the Plant*/Unit* so that all workplaces which need such data have access to them online (see Section 2.10.5.4.2.4 and Section 2.8.2.14.6).

4.5.3.1.1.C
The Supplier* shall develop Site*-specific detailed chemistry of the open cooling systems (see Operation and Maintenance Document*, Section 3.10).

4.5.3.1.1.D
The chemicals (type, concentration and frequency of injection) to be injected shall be chosen by considering make-up water quality, the operating costs, experience from the Existing Nuclear Power Plant* provided by the Owner* and environmental impact, in particular all Rules* for discharges (see Chapter 2.5).

DA
The Supplier* shall justify use of chemicals in the cooling systems, especially in the MCWS.

DB
Gaseous chlorine shall not be used.

4.5.3.1.2 INTERFACES

4.5.3.1.2.A
CIS interfaces with the following systems:

- main circulating water system,
- auxiliary circulating water system,
- essential service water system,
- acid feeding system.

4.5.3.2 SYSTEM FUNCTIONS

4.5.3.2.A
CIS shall control corrosion.

4.5.3.2.B
CIS shall control the biological growth.

4.5.3.2.C
The water systems shall have provisions for the control of water scaling.

4.5.3.2.D
The Supplier* shall provide measurement of physical and chemical parameters needed for control of water quality in the cooling systems and parameters needed to meet the limits for discharges.

DA
Especially the following parameters shall be measured: specific conductivity, alkalinity, turbidity, suspended solids, pH, biological fouling and oil matters fouling.

DB
Important parameters shall be measured continuously.

4.5.3.2.E
Batch injection and continuous injection shall be provided.

4.5.3.3 SYSTEM REQUIREMENTS

4.5.3.3.A
The design and the layout of the system shall ensure the safety of the operation and maintenance team.

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

4.5.3.3.C
The system shall include safety devices for personnel in accordance with the Rules*.

4.5.4 ACID FEEDING SYSTEM (ACFS)

4.5.4.1 SYSTEM DEFINITION

4.5.4.1.1 SCOPE

4.5.4.1.1.A
The acid feeding system (ACFS) shall include all the equipment required to handle and inject the acid in safe conditions.

4.5.4.1.2 INTERFACES

4.5.4.1.2.A
The ACFS interfaces with the following systems:
- MCWS and other open cooling systems,
- chemical injection system (CIS).

4.5.4.2 SYSTEM FUNCTION

4.5.4.2.A
The ACFS shall inject sulphuric acid or hydrochloric acid in order to maintain the water of the open cooling systems above scaling conditions which shall be established during the site pilot plant testing.

4.5.4.2.B
The design of the ACFS shall account for the risk of corrosion.

4.5.4.3 SYSTEM REQUIREMENTS

4.5.4.3.A
The design and the layout of the system shall ensure the safety of the operation and maintenance team.

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

4.5.4.3.C
The system shall include safety devices for personnel in accordance with the Rules*.

4.5.5 MAKE-UP WATER TREATMENT PLANT

4.5.5.1 SYSTEM DEFINITION

4.5.5.1.1 SCOPE

4.5.5.1.1.A
The make-up water treatment plant (MWTP) includes the equipment necessary to supply:

- the quality and quantity of water required for the make-up of the MCWS and other open cooling systems,
- the quantity and quality of water required for the water treatment system and other systems.

4.5.5.1.1.B
The make-up water treatment plant (MWTP) includes the equipment necessary to treat blowdown from the MCWS.

4.5.5.1.1.C
Separate systems for 1) preliminary treatments for the make-up of the MCWS and other open cooling systems and MCWS blowdown treatment and 2) preliminary treatments for water treatment system and other systems shall be provided.

However, preliminary treatment for the make-up of the MCWS and other open cooling systems and MCWS blowdown treatment can be removed from the Supplier's* Scope of Supply* upon the request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

4.5.5.1.2 INTERFACES

4.5.5.1.2.A
MWTP interfaces with the following systems:

- raw water system,
- MCWS,
- other open cooling systems,
- water treatment system,
- waste water collection system,
- sludge treatment plant.

4.5.5.2 SYSTEM FUNCTION

4.5.5.2.A
The MWTP shall supply the quality and quantity of water required for the make-up of the MCWS, other open cooling systems and the water treatment system (if MWTP is used as its a preliminary treatment, see Section 4.6.7).

4.5.5.2.B
The design of the MWTP shall take account of the quality of the raw water available (see Section 5.2.5.2.1).

4.5.5.2.C
The process to achieve the required quality and quantity of water shall be chosen by the Supplier* considering the operating costs and environmental impact.

4.5.5.2.D
The MWTP shall allow to treat blowdown from the MCWS in order to meet the requirements for the Plant* discharges.

DA
Treated blowdown should be discharged via the waste water collection system or reused.

4.5.5.2.E
The Supplier* shall provide a system to process and treat the waste from MWTP in order to meet the requirements for the Plant* discharges.

4.5.5.2.F
The generated sludges shall be processed by the sludge treatment plant (see Section 4.6.10)

4.5.5.3 SYSTEM REQUIREMENTS

4.5.5.3.A
The design and layout of the system shall allow easy supervision of the critical steps of the process and shall ensure the safety of the operation and maintenance team.

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

4.5.5.3.C
The system shall include the safety devices for personnel in accordance with the Rules*.

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS CHAPTER 4.6 AUXILIARY SYSTEMS**
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CHAPTER 4.6 AUXILIARY SYSTEMS

4.6.0 INTRODUCTION

4.6.0.A
This Chapter establishes the Owner* functional requirements, related to the safety and operational objectives, that apply to the auxiliary systems and processes of the Power Generation Plant* (PGP) and Balance of Plant*.

AA
The requirements specific to each system or process covered in this Chapter are specified in each individual corresponding Section.

AB
A short description of each system or process is given to clarify the scope and application to the requirements.

4.6.0.B
This Chapter comprises the following systems:

- turbine building component cooling water system (TBCCWS),
- heating, ventilation and air conditioning system (HVAC),
- auxiliary steam system (ASS),
- fire protection system,
- non radioactive liquid waste system,
- raw water system,
- water treatment system,
- demineralised water storage and transfer system (DWSTS),
- the Steam Generator* blowdown system,
- compressed air and gas system,
- sludge treatment plant,
- sewage treatment plant,
- waste water collection system.

4.6.0.C
Requirements related to design life are in detail described in Section 2.4.2.

4.6.1 TURBINE BUILDING COMPONENT COOLING WATER SYSTEM (TBCCWS)

4.6.1.1 SYSTEM DEFINITION

4.6.1.1.1 SCOPE

4.6.1.1.1.A
The turbine building component cooling water system (TBCCWS) shall performs only the non-Safety Functions*.

4.6.1.1.1.B
The TBCCWS shall provide cooling water to the turbine auxiliary equipment and components.

BA
It includes tanks, pumps, piping, valves, heat exchangers and associated controls and instrumentation.

4.6.1.1.2 INTERFACES

4.6.1.1.2.A
The system has interfaces with:

- the auxiliary circulating water system, if any,
- the main generator cooling,
- turbine lubricant oil coolers,
- condensate pump motors,
- main feedwater pump motors,
- booster pump motors,
- the pump packing cooling,
- cooling of pump motors and seals,
- the main circulating water system (if ACWS is not used),
- other equipment.

AA
The interfaces with the systems of the Power Generation Plant* (PGP) may depend upon their final configuration.

4.6.1.2 SYSTEM FUNCTION

4.6.1.2.1 PURPOSE

4.6.1.2.1.A
The TBCCWS shall provide heat transfer functions operating in conjunction with, Auxiliary Circulating Water System (ACWS) or Main Circulating Water System (MCWS).

These functions are follows:

- cooling of turbine and auxiliary components,
- cooling of the non-safety chillers (if required).

4.6.1.2.2 SYSTEM PERFORMANCE

4.6.1.2.2.A
The system shall transfer all the heat produced in PGP and auxiliary equipment under all the Site* design conditions to ACWS or MCWS (if ACWS is not used) without impairing the generator performance as specified in Sections 2.4.1.2.2 and 2.4.1.2.4 .

4.6.1.2.2.B
The system shall be designed taking into account the requirements set forth in Chapter 2.6 and Chapter 2.7.

4.6.1.3 SYSTEM REQUIREMENTS

4.6.1.3.A
The TBCCWS shall provide a cooling flow rate sufficient to remove all the heat produced by the equipment to be cooled.

4.6.1.3.B
The system pumps and heat exchangers shall be located in the turbine building to minimise the ACWS piping length inside the turbine building.

4.6.1.3.C
The TBCCWS shall be designed to accommodate and withstand the thermal expansion and contraction effect of the closed loop circulating cooling water due to temperature changes in the system.

CA
The design of the TBCCWS shall avoid any potential contamination coming from the interfacing systems and it shall avoid ACWS/MCWS in-leakage into the TBCCWS.

CB
To meet this requirement, the operating pressure of the system shall be such that in-leakage from interface system shall not be possible. A usual way to meet this requirement is to choose a TBCCWS cooling water design pressure higher than that of the ACWS/MCWS.

4.6.1.3.D
In case of in-leakage into the system, means shall be provided for early detection, without any harmful consequences for the operation.

4.6.1.3.E
The corrosive material in the system shall be protected by means of a corrosion inhibitor.

4.6.1.3.F
The Supplier* shall describe the chemistry of TBCCWS.

4.6.1.3.G
For ensuring the reliable operation and Maintainability*, key components of the TBCCWS shall be redundant.

GA
The pumps and heat exchangers shall be sized such that for normal full power operation and reactor shutdown, operation can be supported with any one pump and one heat exchanger out of service.

GB
The standby pump shall be designed to be started automatically on low system pressure.

4.6.1.3.H
Provisions shall be taken for isolation of those failed components, such as bypass and isolation valves. It shall be possible to isolate the auxiliary equipment in order to make maintenance or repair possible while the NI can remain at partial load or hot standby condition.

4.6.1.3.I
Draining and venting of components and pipes shall be arranged to avoid flooding of the floor surface.

4.6.1.3.J
The temperature of the TBCCWS cooled fluids shall be monitored at the input and output of cooling equipment.

JA
TBCCWS water (fluids) temperature downstream of certain critical heat exchangers shall be constant and controlled automatically.

4.6.1.3.K
Provisions shall be made to supervise the system continuously and to enable the optimisation of the operational parameters.

KA
The measurement of temperature shall be used for automatic control of the water temperatures in the ACWS (if any) to avoid reaching or exceeding the boundary temperatures, which could inhibit the proper operation of the equipment.

4.6.1.3.L
Condensation shall be avoided in the pipes and the equipment, which have to be cooled.

4.6.1.3.M
Anti-condensation insulation shall be installed, as needed, on the cold leg pipes to avoid condensation on their surfaces.

4.6.1.3.N
The temperature of the TBCCWS shall be uniform.

4.6.1.3.O
An elevated surge tank, connected to the pump suctions, shall supply make-up water to the cooling loop.

4.6.1.3.P
The surge tank shall keep the system full, minimize system pressure variations, help maintain NPSH available, and absorb thermal expansion and contraction.

4.6.1.3.Q
The surge tank shall be supplied with make-up water and tank vents.

4.6.1.3.R
The 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.

4.6.1.3.S
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.

4.6.2 HEATING, VENTILATION AND AIR CONDITIONING SYSTEM (HVAC)

4.6.2.1 SYSTEM DEFINITION

4.6.2.1.1 SCOPE

4.6.2.1.1.A
The HVAC systems shall provide appropriate ventilation, heating, and cooling for each building of the Power Generation Plant* (PGP), BOP and Support Facilities*.

4.6.2.1.2 INTERFACES

4.6.2.1.2.A
The system has interfaces mainly with:

- the central chilled water system (CDWS),
- fire detection and protection systems,
- the instrument and service air system,
- the environmental monitoring system,
- the non-radioactive liquid waste system.

4.6.2.2 SYSTEM FUNCTION

4.6.2.2.1 PURPOSE

4.6.2.2.1.A
The HVAC system shall provide the functions of the heating, ventilating and air conditioning as follows:

AA
to maintain work environment within comfort levels required for operating and maintenance personnel, and to assure that the proper environment is maintained for equipment and structures,

AB
to provide HVAC designs that segregate Plant* areas in response to fire Protection System* signals,

AC
to assure that the HVAC design meets security system requirements for bullet resistance and personnel barriers,

AD
to assure that the design objectives of standard limits can be met for the Normal Operation* and expected operational occurrences,

AE
to prevent migration of smoke, hot gases, and fire suppressants into other fire areas, to the extent that safe shutdown capabilities, including the Operator* actions, could be adversely affected,

AF
removal of chemical fumes from the chemical addition room and laboratory room.

4.6.2.2.2 PERFORMANCE

4.6.2.2.2.A
The HVAC systems of the PGP, BOP and Support Facilities* shall have no Safety Functions*.

4.6.2.2.2.B
The ventilation system capacity shall be based on environmental temperature as given in Section 2.4.1.2.2.

BA
The HVAC systems shall mainly consist of air units, a humidifier, a ducted supply and return air system, variable air volume terminal units, exhaust fans, automatic controls, and accessories.

BB
HVAC system components shall be selected to meet the required room conditions.

4.6.2.3 SYSTEM REQUIREMENTS

4.6.2.3.1 GENERAL

4.6.2.3.1.A
The HVAC system shall provide a suitable environment ensuring the safety and comfort of the Plant* personnel and operability of the Plant* equipment.

AA
The design temperature of each room shall be determined according to the function of the building/area served.

4.6.2.3.1.B
Each air handling unit shall perform the following functions:

- mixing air (outdoor and return air),
- filtration of air,

- heating,
- cooling,
- provide airflow.

4.6.2.3.1.C
Penetration openings for ventilation systems in fire rated barriers shall be protected by fire dampers having a rating equivalent to that required for the barrier.

CA
Flexible air duct couplings in ventilation and filter systems shall be non combustible.

4.6.2.3.1.D
For Fire Zones* protected with gas suppression systems, the HVAC system serving that zone shall be interlocked with the gas suppression system.

4.6.2.3.1.E
Equipment design shall be provided with features for noise abatement and eliminating of vibrations into building construction.

4.6.2.3.1.F
All HVAC equipment shall be conductible connected to each other and grounded.

FA
Parts of the equipment placed above the roof shall be protected against lightning strike.

4.6.2.3.1.G
All devices shall comply with the requirements of the Rules* (see Chapter 2.5).

4.6.2.3.1.H
HVAC air intakes shall be properly located to avoid suction of Plant* discharges such as the Steam Generator* atmospheric dump valves, relief valves, auxiliary boiler flue gases, engine exhaust fumes, etc.

4.6.2.3.1.I
In all buildings and rooms where toxic gases, combustible vapours or explosive medium can accumulate, the HVAC shall prevent the accumulation of unsafe concentration of these gases.

4.6.2.3.1.J
Provisions shall be made to remove smoke after a fire.

4.6.2.3.1.K
The system shall be designed taking into account the requirements set forth in Section 2.7.13.

4.6.2.3.2 TURBINE BUILDING HVAC SYSTEM

4.6.2.3.2.A
The Turbine Building HVAC system shall provide for removal flammable vapours from the lube oil reservoir room and low quality air.

AA
The Turbine Building HVAC system shall provide for removal of chemical fumes from the rooms for preparation and chemicals dosing, chambers for storage of chemicals and laboratory room.

4.6.2.3.2.B
The Turbine Building HVAC system shall operate during start-up, shutdown, and power operations.

4.6.2.3.2.C
The Turbine Building HVAC system shall be designed so that:

- the exhaust air shall be routed to the outside,
- turbine condenser air extraction systems shall be redirected to radioactive air extraction systems, in the event of Steam Generator* tube leak.

4.6.2.3.2.D
The Turbine Building HVAC system shall provide ventilation in the various equipment area maintaining acceptable temperatures for equipment operation, rooms containing electrical equipment and personnel work areas.

4.6.2.3.3 MAIN CIRCULATING WATER SYSTEM (MCWS) PUMPHOUSE HVAC SYSTEM (IF THIS SOLUTION IS INCLUDED IN DESIGN)

4.6.2.3.3.A
The Main Circulating Water System (MCWS) pumphouse HVAC system shall operate during start-up, shutdown, and normal operation.

4.6.2.3.3.B
The Main Circulating Water System (MCWS) pumphouse HVAC system serves no Safety Functions* and therefore has no nuclear safety design basis.

4.6.2.3.3.C
The system shall be designed to provide:

- acceptable temperatures for equipment operation,
- adequate ventilation and temperature control for personnel working conditions,
- removal of chemical fumes from preparing and chemical dosing.

4.6.2.3.4 OTHER HVAC SYSTEMS

4.6.2.3.4.A
HVAC systems shall provide a suitable environment in other buildings such as diesel driven fire pump room, non safety diesel generator building (if any), and in the rooms for storage of chemical and operational substances.

4.6.2.3.4.B
In these buildings, the HVAC systems shall also:

- provide ventilation in the electrical equipment rooms,
- prevent the build-up of hydrogen in the battery rooms,

- remove low quality air from locker, toilet and shower facilities,
- removal of chemical fumes from the storage of chemical and preparation.

4.6.2.3.4.C
In the non-safety diesel generator building(s), the HVAC shall also prevent the accumulation of unsafe levels of combustible vapours and shall dissipate their concentration in the fuel oil day tank vault.

4.6.2.3.4.D
The on-site standby ac power supply building shall be provided with a normal and supplementary ventilation subsystem for each generator compartment as follows:

- the normal ventilation subsystem shall be designed to maintain the compartment temperature established in the applicable Rules* when the generator is not operating.

4.6.2.3.4.E
In the rooms for the storage and handling of hazardous substances and chemicals, shall be ensured permanent ventilation.

4.6.2.3.5 PLANT HEATING SYSTEM

4.6.2.3.5.A
Water heating system, as a possible Variation, shall supply hot water to selected air handling units, coil units and radiators throughout the Plant*.
For avoidance of doubt the water heating system 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*.

AA
Other types of heating such as steam or electric radiators may be adopted.

4.6.2.3.5.B
It shall serve no Safety Function*.

4.6.2.3.5.C
During normal operation and the Plant* and/or Unit* outages in cold weather, the Plant* heating system shall maintain acceptable ambient air temperatures.

4.6.2.3.6 CENTRAL CHILLED WATER SYSTEM

4.6.2.3.6.A
A central chilled water system shall supply chilled water to the HVAC system in non-safety areas of the Plant* and to other non-safety Plant* equipment requiring chilled water cooling (e.g. electrical switchgear rooms and turbine building ventilation system).

4.6.2.3.6.B
It shall serve no Safety Functions*.

4.6.3 AUXILIARY STEAM SYSTEM

4.6.3.1 SYSTEM DEFINITION

4.6.3.1.1 SCOPE

4.6.3.1.1.A
The auxiliary steam system shall provide steam for the Unit* use during start-up, shutdown and power operation.

AA
The steam shall normally be supplied from steam turbine extractions and/or MSSS.

AB
When not available, the steam shall be supplied from auxiliary boiler and/or from another Unit*.

AC
The Unit* shall be capable of supplying auxiliary steam to another Unit* and also to Plant* shared systems.

4.6.3.1.2 INTERFACES

4.6.3.1.2.A
The auxiliary steam system interfaces are the following:

- demineralised water system (DWS),
- condensate system,
- chemical injection system (CIS),
- hot water heating system,
- main steam system,
- gland seal steam system (GSS),
- feedwater tank,
- NI systems incl. radwaste systems (where required),
- condenser vacuum system (if steam ejectors are used),
- steam extraction system,
- main deaerator.

4.6.3.2 SYSTEM FUNCTION

4.6.3.2.1 PURPOSE

4.6.3.2.1.A
The auxiliary steam system shall provide the functions as follow:

AA
To receive steam from steam turbine extractions and or MSSS, via pressure reducing, if required.

AB
To supply steam to connected systems (including e.g. radwaste systems) as required.

AC
To supply the steam required for turbine-generator start-up (if required).

AD
To supply the steam for the Plant* hot water heating system.

AE
To supply the steam to the auxiliary steam header during the Unit* shutdown.

AF
To supply the sealing steam for the glands of the main turbine prior to the availability of main steam.

AG
To supply steam for heating of the condensate.

AH
To supply the steam for deaeration of the main condensate and heating up the feedwater tank when main steam is unavailable (if required).

AI
NA

AJ
To supply steam to auxiliary steam system of another Unit*.

AK
To supply steam to Plant* shared systems.

4.6.3.2.1.B
The whole system shall be designed to minimize make-up water consumption and also to prevent infiltration of impurities into steam, condensate water system and feedwater system.

4.6.3.2.1.C
The design of system shall take into account the requirements for protection against corrosion in case of long-term shutdown.

4.6.3.3 SYSTEM REQUIREMENTS

4.6.3.3.A
The auxiliary steam system shall provide required capacity of steam for connected systems on rated parameters (pressure, temperature and quality) when maximum steam demands that could occur together, in particular for deaeration and heating of the condensate (see Chapter 4.3).

4.6.3.3.B
To supply steam when main steam is not available, auxiliary boiler shall be provided.

4.6.3.3.C
The auxiliary boiler shall be designed for optimised operation at its normal output level in term of steam production rate and pressure.

CA
It shall be possible to use either condensate from the condensate storage tank or demineralised water.

CB
The preheated condensate shall be pumped either to the boiler deaerator/feedwater tank or directly to the boiler feedwater system.

4.6.3.3.D
The required steam production rate shall be automatically controlled.

4.6.3.3.E
The auxiliary steam system shall be designed to provide steam of condensate quality at a pressure and quantity sufficient to meet the following criteria:

EA
The auxiliary steam for deaerator shall have proper parameters for condensate and feedwater system recirculation and the Unit* start-up and for maintaining deaerator pressure on turbine trip.

EB
The turbine gland sealing steam shall have proper parameters to provide sealing to the main turbine when needed.

EC
The auxiliary steam system shall be designed to maintain steam quality consistent with the requirements of the feedwater and condensate systems.

ED
The auxiliary steam system shall be capable of supplying steam to the consumers without any disturbance or deterioration, even if one connected system is operated only at low steam consumption.

EE
The steam supply for radwaste evaporators and the boron acid batch shall be sufficient to allow intermittent or continuous operation of these components as required.

4.6.3.3.F
A collection tank shall be provided to collect the condensate which returns from the components that utilize the steam.

FA
Condensate drains from auxiliary steam users shall be directed back to the main condenser.

4.6.3.3.G
Each source of steam shall be fed through a separate isolating motor-operated gate valve to the in Unit* auxiliary steam header.

GA
The auxiliary steam shall be reduced in pressure for use as component heating steam.

GB
The steam for the process steam users shall be adjusted to meet their requirements.

GC
Each steam reducing station shall be adequately drained, shall be equipped with strainer with blow-off valve and with by-pass valve.

4.6.3.3.H
The auxiliary steam header shall be provided with adequate relief features (by safety valves) to provide overpressure protection.

HA
Likewise, the other major components of the system shall also be provided with overpressure protection (boiler, deaerator, steam headers, reducing station, etc.).

4.6.3.3.I
The Supplier* shall minimize the number of steam usage pressures, in order to minimize the number of desuperheaters required.

4.6.4 FIRE PROTECTION SYSTEMS

4.6.4.1 SYSTEM DEFINITION

4.6.4.1.1 SCOPE

4.6.4.1.1.A
The fire protection systems shall provide means for fire prevention, detection, extinction and minimisation of the fire consequences.

4.6.4.1.1.B
Where detection systems or fire extinguishing systems are relied upon as protection against a potential fire following a postulated initiating event (e.g. an earthquake), they shall be designed to resist the effects of this postulated initiating event.

4.6.4.1.1.C
Fire protection systems protecting safety classified SSC shall be safety classified in accordance with Section 2.1.5.

4.6.4.1.1.D
Fire protection shall comply with the requirements of the Rules* (see the Technical Requirements Document*, Chapter 2.5) and the Requirements of the Authorities*.

4.6.4.1.1.E
Fire Areas* and Fire Zones* to limit the potential spread of fire shall be implemented. (see Technical Requirements Document*, Section 2.11.2.4.2 and Section 2.4.5.8.2.2).

EA
Fire Areas* shall be established on the basis of the fire hazards analysis.

4.6.4.1.1.F
Fire Barriers* that define the boundaries of a Fire Area* shall have fire resistance in accordance with the Rules* and fire hazard analysis.

4.6.4.1.1.G
Accessibility for fire fighting according to the Technical Requirements Document*, Section 2.11.1.2.3, and Section 2.4.5.8.2.2 shall be assured.

4.6.4.1.1.H
For additional requirements see the Licensing and Permitting, Safety and Quality Document Section 2.5.

4.6.4.1.2 INTERFACES

A
The system has interfaces with:

- the plant data transmission and processing systems,
- power distribution systems,
- lighting and communications systems,
- HVAC system,
- raw water system,
- heat tracing system,
- Lubricant and oil systems,
- tanks containing flammable fluids,
- main circulating water system,
- system of the heating fire water at cool time of the year.

4.6.4.2 SYSTEM FUNCTION

4.6.4.2.1 PURPOSE

4.6.4.2.1.A
The fire protection systems shall provide the functions as follows:

- to detect and locate fires and provide Operator* indication of the location,
- to provide the capability to extinguish fires in any Plant* area, to protect Site* personnel and to limit fire damage,
- to supply fire suppression water at a flow rate and pressure sufficient to satisfy the demand of any fire suppression system,
- to maintain 100 % of fire pump design capacity to the pumps,

- to comply with the requirements of the standards for electrical cables (including optical fibre cables), and raceways,
- the use of the fire protection water system for other uses shall be defined in its design,
- to ensure the necessary functioning of the safety equipment, predominantly by passive measures but not only.

4.6.4.2.1.B
Prevention of fire propagation towards the NI shall be performed by Plant* layout or physical passive Barriers and not by this system.

4.6.4.2.2 PERFORMANCE

4.6.4.2.2.A
The fire protection system shall detect fires and provides the capability to extinguish them, using fixed automatic and manual suppression systems, manual hose streams and/or portable fire fighting equipment.

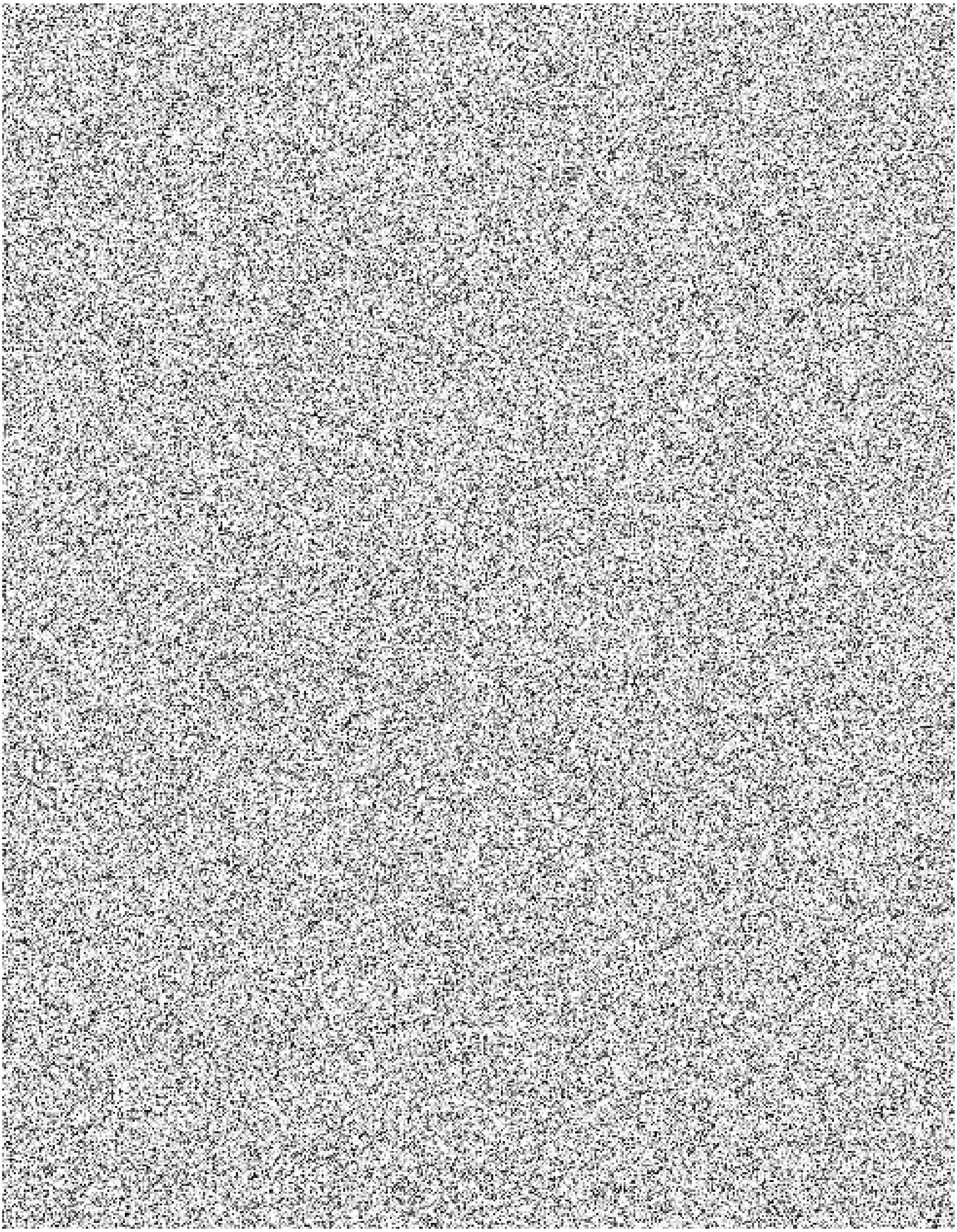
AA
The fire protection system shall consist of a number of fire detection and suppression subsystems, referred to as systems, including:

- detection systems for early detection and notification of a fire,
- a water supply system including the fire pumps, ring main, and interior distribution piping,
- fixed automatic fire suppression systems,
- manual fire suppression systems and equipment, including fixed suppression systems and portable fire extinguishers,
- manual (or partially automatic) fire ventilation systems (smoke removal system).

4.6.4.2.2.B
In case of fire, the fire protection systems shall be able to change the configuration of the ventilation systems from normal to emergency.

4.6.4.3 SYSTEM REQUIREMENTS

4.6.4.3.A



4.6.5 NON RADIOACTIVE LIQUID WASTE SYSTEM

4.6.5.1 SYSTEM DEFINITION

4.6.5.1.1 SCOPE

4.6.5.1.1.A
The non-radioactive liquid waste system shall provide collection and processing of liquid waste streams arising from non-radioactive building areas.

4.6.5.1.1.B
The system shall include all appropriate equipment, such as: storage tanks, pumps, valves, filters, oil separator, chemical treatment equipment, instrumentation and control.

4.6.5.1.2 INTERFACES

4.6.5.1.2.A
The non-radioactive liquid waste system main interfaces may be listed as following:

- the condensate cleanup system,
- the Steam Generator* blowdown system,
- PGP floor and equipment drainage system,
- the water treatment system,
- the make-up water treatment plant,
- the waste water collection system (collection tank).

4.6.5.1.2.B
The interfaces to the Nuclear Island* shall be specified by the Supplier*.

4.6.5.2 SYSTEM FUNCTION

4.6.5.2.A
The non-radioactive liquid waste system shall collect, treat and monitor the non-radioactive liquid waste to obtain effluents with appropriate discharge characteristics.

AA
Discharge shall be routed to the waste water collection system (including treated oil water). See Section 4.6.13.

4.6.5.2.B
The non-radioactive liquid waste system shall include:

- appropriate means to remove oil and suspended solid from the waste water streams
- drains from the building sumps and to the waste disposal.

4.6.5.2.C
The system shall be designed to handle those drains which may contain chemicals.

CA
The chemical and water drain networks shall be independent or water drain network shall have the ability to neutralize the hazardous chemicals.

4.6.5.2.D
In case of radioactivity, it shall be possible to divert the streams to the liquid Radioactive Waste* Processing System (RWPS).

4.6.5.3 SYSTEM REQUIREMENTS

4.6.5.3.A
The non-radioactive liquid waste system shall collect the liquid streams coming from the non radioactive floor and equipment drains, typically from:

- Turbine Building floor and equipment drains,
- the Steam Generator* blowdown floor and equipment drains,
- diesel generator building sumps,
- auxiliary boiler building sumps,
- water treatment system,
- make-up water treatment plant,
- condensate cleanup system regeneration wastes,
- an additional network shall be provided for oily drains such as transformers and fuel oil tanks areas. This drainage subsystem includes oils and organic fuels drains which cannot be collected by the non-radioactive liquid waste system. An independent drain sump for these drains shall be provided for appropriate disposal.

4.6.5.3.B
The non-radioactive liquid waste system shall be designed to handle the expected flow of liquid waste during the power operation and outages.

4.6.5.3.C
The non-radioactive liquid waste system shall provide processing subsystems for the separate collection and treatment of the following types of waste liquids:

CA
<u>Oily wastes</u>
The sumps contents shall be discharged into a waste water surge tank and routed to an oil separator. The oil shall be stored in a waste oil storage tank and the waste water from the oil separator shall flow to the chemical wastewater treatment subsystem for suspended solids settlement and subsequent water treatment with respect to water quality limits. Treated waste

water shall be routed to the wastewater collection system. In case of radioactivity presence in the surge tank, a means shall be provided to divert the waste water from the surge tank to the liquid radwaste system. In this case backflow prevention shall be assured.

CB
Acid or alkaline wastes
In this subsystem shall be collected into the appropriate tank or basin liquid wastes containing acid or alkaline solutions (e.g., resin regeneration wastes). They shall be routed to a chemical treatment plant (neutralisation, flocculation, clarification etc.). In case of an abnormal situation (too high or too low pH), it shall be possible to recirculate the effluents to the collector tank. In case of radioactivity in the streams it shall be possible to route them to liquid RWPS.

4.6.6 RAW WATER SYSTEM

4.6.6.1 SYSTEM DEFINITION

4.6.6.1.1 SCOPE

4.6.6.1.1.A
The system shall provide raw water in a quantity sufficient to meet all the Plant* requirements.

4.6.6.1.1.B
The system shall include equipment necessary:

- to supply and distribute sufficient quantity of raw water required for the Plant* and its systems,

BA
Raw water system mentioned in Section 4.6.6 describes only the distribution of raw water required within the Plant* and its systems (located in the Construction Area* A1).

BB
The supply of raw water from the Jihlava river to the Plant* is described in Chapter 4.8.

4.6.6.1.2 INTERFACES

4.6.6.1.2.A
The system has main interfaces with:

- the Raw Water Supply System
- the Main Circulating Water System (MCWS),
- the Auxiliary Cooling Water System (ACWS),
- the Essential Service Water System (ESWS),
- the Water Treatment System,
- the Make-Up Water Treatment Plant (MWTP),
- the Fire Protection System.

4.6.6.1.2.B
Raw water shall be supplied and distributed to the water cooling systems, water treatment systems and to other systems and services as required.

BA
The interfaces with the systems of the Plant* may depend upon their final configuration.

4.6.6.2 SYSTEM FUNCTION

4.6.6.2.A
The raw water system shall intake raw water from the gravity pipes located in the Construction Area* A1.

AA
The raw water shall be intake to the Construction Area* A1 by two a gravity pipes from the raw water reservoir (see Chapter 4.8).

4.6.6.2.B
The raw water system shall supply and distribute raw water to the related systems of the Plant* as required.

4.6.6.2.C
The raw water supply system shall provide raw water storage capacity as specified in the Section 4.8.1.

4.6.6.3 SYSTEM REQUIREMENTS

4.6.6.3.A
The raw water system shall be equipped with valve chamber, pipes, valves and related equipment for the operation and control of the equipment.

AA
For information on the raw water reservoir, see Section 4.8.1. The location of the raw water reservoir is depicted in Chapter 5.7 Drawings No. 103.

4.6.6.3.B
Provision shall be made to continuously supervise the raw water system and to enable the optimization of the operational parameters.

4.6.6.3.C
The flow rate of raw water shall be designed for the maximum simultaneous demand of the Plant*.

4.6.7 WATER TREATMENT SYSTEM

4.6.7.1 SYSTEM DEFINITION

4.6.7.1.1 SCOPE

A

The system includes equipment necessary to supply:

- the quality and quantity of water required for the water services,
- the water to the condensate storage tank,
- the water to the demineralised water storage and transfer system.

4.6.7.1.2 INTERFACES

A

The system has interfaces with:

- raw water system,
- make-up water treatment plant,
- demineralised water storage and transfer system,
- the non-radioactive liquid waste system,
- sludge treatment plant.

4.6.7.2 SYSTEM FUNCTION

4.6.7.2.1 PURPOSE

4.6.7.2.1.A

The design of the water treatment system shall take account of the quality of the raw water available (See Section 5.2.5.2.1) and shall comprise some of the following features and equipment in order to provide the required quality of demineralised water:

- flocculation,
- filtration,
- atmospheric degassing,
- cation and anion demineraliser,
- mixed bed and vacuum degassing units,
- standby and full regeneration facilities,
- reverse osmosis
- electrodeionisation.

4.6.7.2.1.B

The make-up water treatment plant (MWTP) may be used as a preliminary treatment upstream of the water treatment system (See Section 4.5.5).

4.6.7.2.2 PERFORMANCE

4.6.7.2.2.A
The water treatment system shall provide optimal water treatment conditions during its design life to assure reduction in corrosion of materials, and formation of scales on heat exchanger surfaces.

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

4.6.7.2.2.C
The water treatment system shall receive water from the raw water system (See Section 4.6.6), process it to remove suspended solids, dissolved impurities and gases, and shall provide demineralised water to the demineralised water transfer and storage system.

CA
Treated water from make-up water treatment plant may be received if this plant is used as a preliminary treatment upstream of the demineralisation.

4.6.7.2.2.D
Dissolved oxygen shall be removed in the water treatment system or in the demineralised water storage and transfer system or in appropriate systems located in NI and PGP, as far as necessary for primary and secondary water chemistry.

4.6.7.2.2.E
The physical and chemical characteristics of the demineralised water produced shall be consistent with the requirements of the plant systems to which it is distributed.

EA
These characteristics shall be monitored in order to prevent degradation of the quality of the demineralised water produced.

4.6.7.2.2.F
The Supplier* shall specify the demineralised water characteristics.

4.6.7.2.2.G
Demineralised water pipeline and tanks shall be designed from materials, which do not degrade the quality of water (e.g. stainless steel).

4.6.7.2.2.H
The demineralised water tanks shall be provided with appropriate design features to avoid CO2 dilution e.g. stainless steel floating covers.

4.6.7.2.2.I
The water treatment system shall serve no Safety Function*.

4.6.7.3 SYSTEM REQUIREMENTS

4.6.7.3.A
The water treatment system shall provide make-up and fill water to the demineralised water storage tank and the condensate storage tank.

AA
The capacity of the system shall be sufficient to supply the expected normal plant make-up.

4.6.7.3.B
There shall be no potential sources of radioactive contamination within the water treatment system.

4.6.7.3.C
Backflow prevention shall be addressed in the demineralised water transfer and storage system.

4.6.7.3.D
The Supplier* shall provide a system to process and treat the waste from water treatment system in order to meet the requirements for the Plant* discharges.

4.6.7.3.E
The generated sludges shall be processed by the sludge treatment plant. (See Section 4.6.10).

4.6.8 DEMINERALISED WATER STORAGE AND TRANSFER SYSTEM

4.6.8.1 SYSTEM DEFINITION

4.6.8.1.1 SCOPE

4.6.8.1.1.A
The demineralised water storage and transfer system receives water from the water treatment system, provides a reservoir of demineralised water and its distribution throughout the Plant*.

4.6.8.1.2 INTERFACES

4.6.8.1.2.A
The demineralised water storage and transfer system has main interfaces with the following systems:

- water treatment system,
- condensate storage and make-up system,
- emergency and/or start-up feedwater system depending on the specific Plant* configuration,
- Chemical and Volume Control System (CVCS).

4.6.8.2 SYSTEM FUNCTION

4.6.8.2.1 PURPOSE

4.6.8.2.1.A

The demineralised water storage and transfer system has the following functions:

- the system provides the other Plant* systems with demineralised water through the demineralised water storage tank and the condensate storage tank,
- sufficient storage capacity is available from condensate and demineralised water storage tanks for demand,
- supplies water to those parts of the PGP where leakage causes losses of demineralised water,
- compensates for shortage of demineralised water during transient operating conditions,
- fills up systems of the PGP with demineralized water prior to start-up,
- preserve demineralized water in the appropriate quality.

4.6.8.2.1.B

NA

4.6.8.2.2 PERFORMANCE

4.6.8.2.2.A

The system comprises demineralised water storage tanks and adequate capacity transfer pumps, a condensate storage tanks, degasser, vacuum pumps.

4.6.8.2.2.B

The system serves no Safety Functions*.

BA

Nevertheless, it is used to compensate the water losses of the systems performing Safety Functions*.

BB

Making up water is not a Safety Function* due to the required autonomy of the systems performing Safety Functions*.

4.6.8.3 SYSTEM REQUIREMENTS

4.6.8.3.A

The system shall prevent the return of carbon dioxide into the water.

4.6.8.3.B

The condensate storage tank shall serve as a reservoir to supply condensate as required by the condenser hot well level control system.

4.6.8.3.C

Protection from water tank and outdoor piping freezing shall be supplied (e.g. by immersion-type electric heaters and electrical trace heat tracing).

4.6.8.3.D
The system shall be able to make up the losses of demineralised water in the Plant* during the Normal Operation* condition.

DA
Depending on the design, some functions of the system can be performed by the condensate storage and makeup system.

4.6.8.3.E
The storage system shall provide proper quantities of fresh demineralised water during the Normal Operation* plus the volume required for safety services, without requiring any fresh makeup.

4.6.8.3.F
NA

4.6.8.3.G
The storage shall provide an extra volume of water needed for transients.

4.6.9 STEAM GENERATOR BLOWDOWN SYSTEM

4.6.9.1 SYSTEM DEFINITION

4.6.9.1.1 SCOPE

4.6.9.1.1.A
The Steam Generator* blowdown system shall be designed to maintain acceptable secondary side water chemistry during the Normal Operation* and during expected operational occurrence.

4.6.9.1.1.B
The Steam Generator* blowdown system shall be designed to collect and to process water from any Steam Generator* when required.

4.6.9.1.1.C
The system removes the impurities concentrated in the Steam Generator*. In particular there are three occurrences in which its operation is essential:

- in case of Steam Generator* tube leakage: the primary coolant flows into the secondary side and contaminates it.
- in case of condenser tube leakage: the circulation water, through feedwater system, flows into the secondary loop carrying impurities.
- removal of impurities from dosed chemicals and from make-up water.

4.6.9.1.2 INTERFACES

4.6.9.1.2.A
The major interfaces may be listed as follows:

- main condenser system,
- feedwater system,
- non radioactive liquid waste system,
- water treatment system,
- liquid radioactive waste processing system,
- the Steam Generator*,
- the Steam Generator* hydraulic test systems.

4.6.9.1.2.B
The Steam Generator* blowdown purification shall not be technologically interfaced with condensate treatment.

4.6.9.2 SYSTEM FUNCTION

4.6.9.2.A
The functions of the Steam Generator* blowdown system are to draw the secondary water from each Steam Generator* and process this water in order to:

- control the secondary side water chemistry during Normal Operation*,
- cool down the Steam Generator* for Inspection* and maintenance,
- maintain Steam Generator* wet lay-up conditions during Unit* shutdown,
- drain the secondary side of Steam Generators* for maintenance,
- flush the sludge from the Steam Generator* tube sheet or Steam Generator* bottoms,
- provide hydraulic test of SG if not provided by another system.

4.6.9.2.B
The system shall include measurement of hide-out return effect and slotted medium SG chemistry.

4.6.9.3 SYSTEM REQUIREMENTS

4.6.9.3.A
The blowdown system shall extract the water in a location just above the tube sheet of the vertical Steam Generator* and bottom of the horizontal Steam Generator* or any other location where the impurities are expected to build up.

4.6.9.3.B
To recover the thermal energy, the effluent shall be cooled by regenerative heat exchanger.

4.6.9.3.C
The Steam Generator* blowdown system shall be able to hold the water chemical mode on the secondary side of SG in desired limits.

4.6.9.3.D
The blowdown flow from each Steam Generator* shall be routed to a filter and to a mixed bed demineraliser or other demineralisation equipment for processing and recovery.

4.6.9.3.E
The flow on secondary side of SG shall be set to blowdown location.

4.6.9.3.F
The separate management shall be provided for SG blowdown system ion-exchange resins due to their potential radioactivity.

4.6.9.3.G
The system shall be equipped with a radiation monitoring system.

GA
In case of radioactivity in the secondary side, it shall be possible to divert the blowdown effluent to the liquid Radioactive Waste* processing system (RWPS) and purification systems.

4.6.9.3.H
The flashing shall be avoided in the blowdown system in all power levels of the Unit*.

4.6.9.3.I
In the case of high impurity concentration (condenser leakage) it shall be possible to divert the blowdown flow to the non-radioactive liquid waste system.

4.6.9.3.J
The Steam Generator* blowdown, after cooling and circulating through filters and demineralisers or other demineralisation equipment, shall return clean water to the condenser or elsewhere to secondary circuit according to energy advantage.

4.6.9.3.K
The Steam Generator* blowdown system shall be sized to provide a continuous blowdown at an appropriate value justified by the Supplier*, with primary to secondary leakage at allowable limits for operation.

4.6.9.3.L
The blowdown system shall be equipped with purification capability for the said blowdown rate.

4.6.9.3.M
The blowdown of the Steam Generator* with a tube leakage shall be purified by the SG blowdown purification equipment which shall be designed to ensure sufficient reduction of radioactivity levels in the blowdown stream during design basis fuel failure concurrent with design basis steam generator primary to secondary tube leakage. In the event of high radiation at the downstream of the purification equipment, the blowdown isolation valve shall be automatically closed by high radiation signal. It shall be possible to realign the blowdown flow path to the liquid radioactive waste processing system.

4.6.9.3.N
The blowdown system shall be designed for a very high capacity flow from just above the tube sheet for a short period of time. This flow shall have sufficient velocity to remove sludge before it is hardened into place.

NA
Typical design value is a minimum of 3 % of maximum steaming rate.

4.6.9.3.O
The SG blowdown purification equipment and flash tank shall be designed to manage high capacity blowdown.

4.6.9.3.P
Provisions shall be included for the introduction of nitrogen through the bottom blowdown connection to facilitate sparging and mixing of the Steam Generator* secondary side inventory.

4.6.9.3.Q
Valves regulating the Steam Generator* blowdown flow rate shall not be relied on for isolation. Separate valves shall be provided for system isolation and flow regulation.

4.6.9.3.R
The trim and body materials of valves regulating the Steam Generator* blowdown shall be suitable for the throttling/flashing service, with a high resistance to cavitation and erosion.

4.6.10 SLUDGE TREATMENT PLANT

4.6.10.1 SYSTEM DEFINITION

4.6.10.1.1 SCOPE

4.6.10.1.1.A
The sludge treatment plant shall provide collection and processing of the sludges arising from make-up water treatment plant and water treatment system and other systems (if applicable).

AA
The Supplier* shall propose management of sludges from ESWS, MCWS and ACWS for the Owner's* approval.

AB
Separate sludge treatments for 1) preliminary treatment for the make-up of the MCWS, other open cooling systems and treatment of the MCWS blowdown and 2) preliminary treatment for water treatment system and other systems shall be provided.

However, sludge treatment for the preliminary treatment for make-up of the MCWS, other open cooling systems and treatment of the MCWS blowdown can be removed from the Supplier's* Scope of Supply* upon the request of the Owner* and subject to application of Chapter 8 (Variation) of the Terms and Conditions*.

4.6.10.1.1.B
The sludge treatment plant shall include all appropriate equipment, such as: storage tanks, valves, pumps, sludge thickeners, filter presses, chemical treatment equipment and instrumentation and control.

4.6.10.1.2 INTERFACES

4.6.10.1.2.A
The sludge treatment plant main interfaces are:

- make-up water treatment plant,
- water treatment system.

4.6.10.2 SYSTEM FUNCTION

4.6.10.2.1 PURPOSE

4.6.10.2.1.A
The sludge treatment plant shall collect, process and enable sampling of the sludges and processed water.

4.6.10.2.1.B
It shall include:

- appropriate means to concentrate the sludges (e.g. using sludge thickeners and chemical treatment),
- appropriate means for further concentration of the concentrated sludges (e.g. using filter presses),
- means for sampling of the sludge and processed water.

4.6.10.2.2 PERFORMANCE

A
The final form and composition of the generated sludges shall allow off-site disposal.

4.6.10.3 SYSTEM REQUIREMENTS

4.6.10.3.A
The sludge treatment plant shall be designed to handle the expected flow of sludges during Plant* operation and outages.

4.6.10.3.B
Provisions for sludge storage and sludge removal for off-site disposal shall be included.

4.6.10.3.C
The filtrate shall be recycled to the extent that is reasonable.

CA
This may include the use of the filtrate within the Plant* systems, if their quality requirements in respect of water use allow for it, and such use may include cleaning (e.g. of filter presses).

4.6.11 COMPRESSED AIR AND GAS SYSTEM

4.6.11.1 SYSTEM DEFINITION

4.6.11.1.1 SCOPE

4.6.11.1.1.A
The compressed air and gas system shall provide:

AA
Compressed air for service outlets located throughout the Plant*.

AB
Continuous supply of air for pneumatic instruments and actuators.

AC
Personnel breathing air for protection against airborne contamination.

AD
Adequate supply of the various gases needed for the Plant*.

4.6.11.1.2 INTERFACES

4.6.11.1.2.A
The principal interfaces are:

- the Turbine Building,
- service systems,
- fire protection system,
- water systems,
- HVAC systems,
- laboratories,
- electric power systems,
- the radwaste system,
- the water treatment system.

AA
The interfaces with the systems of the PGP may depend upon their final configuration.

4.6.11.2 SYSTEM FUNCTION

4.6.11.2.A
The compressed air and gas system shall serve no Safety Functions*.

4.6.11.2.B
The compressed air and gas system shall provide the functions developed in the following sections.

4.6.11.2.1 SERVICE AIR SUBSYSTEM

4.6.11.2.1.A
The Service air subsystem shall provide a continuous supply of dry compressed air for tools, miscellaneous equipment, and various maintenance purposes.

4.6.11.2.2 INSTRUMENT AIR SUBSYSTEM

4.6.11.2.2.A
The instrument air subsystem shall provide a continuous supply of dry, oil free, filtered compressed air for control and use in all air operated instrumentation and equipment.

4.6.11.2.2.B
NA

4.6.11.2.3 BREATHING AIR SUBSYSTEM

4.6.11.2.3.A
The breathing air subsystem shall provide a separate purified breathing air.

4.6.11.2.4 COMPRESSED GASES SUBSYSTEM

4.6.11.2.4.A
The Compressed gases subsystem shall provide compressed gases for the needs of the Plant*.

4.6.11.2.4.B
The main gases usually needed in nuclear power plants are N_2, H_2 and CO_2.

4.6.11.3 SYSTEM REQUIREMENTS

4.6.11.3.A
The breathing air subsystem shall provide a means for charging individual breathing air packages.

4.6.11.3.B
The dew point of the instrument air subsystem shall be adequately addressed to ensure that no water is present in the instrument air system with some margin.

BA
[redacted]

BB
[redacted]

BC
If some interfacing systems request for dryer air, it shall be specified.

4.6.11.3.C
The instrument air subsystem shall be provided with stand-by equipment (compressor, valves etc.) as a back-up.

CA
The storage capacity of the system shall be adequate to supply compressed air during the time required for the stand-by equipment to come up to pressure.

CB
The stand-by equipment enhances the overall availability of each Unit* and contributes to investment protection.

4.6.11.3.D
The compressed gases subsystem shall be composed of separate subsections, one for each type of gas.

DA
Every subsection shall be identified by a different colour, typical for a given gas.

4.6.11.3.E
The Supplier* shall determine the required total system capacity and number of independent subsystems and/or standby components needed to meet of the Plant* availability requirements in an effective and economical manner.

4.6.11.3.F
The design pressure and temperature for the compressed air and gas system air supply systems shall be conservatively established to assure selection of commercially available equipment wherever possible.

4.6.11.3.G
The combined design capacity of the air compressors and receiver tanks shall include an adequate reserve capacity to:

- Provide sufficient redundancy for reliable operation.
- To allow time for standby or spare compressor to start and recharge the air receivers to operating pressure following a compressor trip.

4.6.11.3.H
For each system, the Supplier* shall provide technical, safety and economic justification if unproven compressed gases are used.

4.6.12 SEWAGE TREATMENT PLANT

4.6.12.1 SYSTEM DEFINITION

4.6.12.1.1 SCOPE

4.6.12.1.1.A
The sewage treatment plant shall provide processing of the sewage water arising from the Plant* operation and maintenance (including outages).

4.6.12.1.1.B
The sewage treatment plant shall include mechanical and biological treatment followed by final treatment (e.g. nitrification, denitrification, disinfection, processes to remove phosphorus; and carbon adsorption) in order to meet the limits stipulated in the Rules* for the best available techniques.

4.6.12.1.1.C
The same sewage treatment plant may be used already during Plant* construction if ready in time.

4.6.12.1.2 INTERFACES

4.6.12.1.2.A
The sewage treatment plant main interfaces are:

- Plant* sewerage system,
- waste water collection system.

4.6.12.2 SYSTEM FUNCTION

4.6.12.2.1 PURPOSE

4.6.12.2.1.A
The sewage treatment plant shall collect, process and enable sampling and flow measurement of the sewage water, sludges and processed water.

4.6.12.2.1.B
It shall include:

- appropriate means to process the sewage water (mechanical, biological and final treatment),
- appropriate means for storage, treatment (if necessary) and concentration of the resulting sludges,
- means for sampling and flow measurement of the sewage water, sludges and processed water.

4.6.12.2.2 PERFORMANCE

4.6.12.2.2.A
The processed water and sampling and monitoring shall meet the requirements of the Rules* for the best available techniques.

AA
As a possible Variation, online monitoring shall be set to allow verification of emission standards set in Annex 7 of the Government Order No. 401/2015 Coll. (such as turbidity, P, N, CHSKCr (COD), BSK5 (BOD) etc.).
For avoidance of doubt the online 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*.

4.6.12.2.2.B
The final form and composition of the generated sludges shall allow sludge disposal in accordance with the Rules*.

4.6.12.2.2.C
The efficiency shall be ensured during all anticipated weather conditions.

CA
In particular, freezing shall be prevented.

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

4.6.12.3 SYSTEM REQUIREMENTS

4.6.12.3.A
The sewage treatment plant shall be designed to handle the expected flow of sewage water during Plant* operation and outages.

AA
The capacity shall allow maintenance during operation.

AB
It shall be possible to shut down part of the plant in case of lower sewage water generation.

4.6.12.3.B
The sewage treatment plant shall be separated into two isolated parts - one for potentially active sewage water and one for non-active sewage water if there is need to treat sewage water from the controlled area in the sewage treatment plant.

4.6.12.3.C
The monitoring of the process efficiency in terms of sampling shall be provided between each treatment step including monitoring of the sludges.

4.6.12.3.D
The sewage treatment plant shall allow maintenance and Inspection* in a safe manner.

4.6.12.3.E
Provisions for sludge storage, concentration and sludge removal for off-site disposal shall be included.

4.6.12.3.F
The processed water shall be routed to the waste water collection system.

4.6.13 WASTE WATER COLLECTION SYSTEM

4.6.13.1 SYSTEM DEFINITION

4.6.13.1.1 SCOPE

4.6.13.1.1.A
The waste water collection system shall provide collection, monitoring and controlled discharge of the waste water arising from the Plant*.

AA
The waste water includes waste water from the liquid radioactive waste processing system and non-radioactive liquid waste system, blowdown (treated or untreated) from cooling water systems and processed sewage water and any other waste water from the Plant*.

4.6.13.1.2 INTERFACES

4.6.13.1.2.A
The waste water collection system main interfaces are:

- main circulating water system,
- auxiliary circulating water system,
- essential service water system,
- liquid radioactive waste processing system,
- non-radioactive liquid waste system,
- sewage treatment plant,
- make-up water treatment plant,
- waste water discharge system (see Section 4.8.2).

4.6.13.2 SYSTEM FUNCTION

4.6.13.2.1 PURPOSE

4.6.13.2.1.A
The waste water collection system shall collect, sample and discharge the waste water to the waste water discharge system (see Section 4.8.2).

AA
The system provides the final monitoring of the waste water quality and quantity and thus the sampling shall meet the requirements of the Rules*.

AB
The monitoring shall be certified in accordance with the Rules*, in particular Act No. 505/1990 Coll., as amended.

4.6.13.2.1.B
It shall include:

- appropriate means to collect the waste water,
- appropriate means for monitoring and sampling of the waste water,
- means for controlled discharge of the waste water.

4.6.13.2.2 PERFORMANCE

4.6.13.2.2.A
The sampling shall meet the requirements of the Rules*.

AA
It shall include both online monitoring and batch sampling.

AB
The online monitoring shall be provided for pH, turbidity, temperature, flow rate, radioactivity, conductivity as minimum.

AC
The system shall collect 24 hour representative sample.

4.6.13.2.2.B
In addition monitoring of each of the input streams shall be provided.

4.6.13.3 SYSTEM REQUIREMENTS

4.6.13.3.A
[redacted]

4.6.13.3.B
The tank shall be divided into two separate parts to enable maintenance during operation.

BA
Valve chamber shall be provided to allow shut-off and interconnection of the waste water discharge pipes.

4.6.13.3.C
Two discharge pipes DN 800 shall be connected to the two pipes of the waste water discharge system.

4.6.13.3.D
All input streams shall be mixed in the collection tank in such manner to ensure that the waste water discharged from the collection tank will meet the quality requirements set in the Rules* (See Chapter 5.3).

4.6.13.3.E
The system shall allow isolation of any of the input streams.

4.6.13.3.F
The system shall allow to stop the discharge from the collection tank.

FA
It shall be possible to pump out the water for further treatment in case it would not meet the quality requirements.

4.6.13.3.G
The system shall be provided with automatic control allowing manual control.

4.6.13.3.H
The system shall allow maintenance and Inspection* in a safe manner.

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS CHAPTER 4.7 OTHER BUILDINGS AND CIVIL ENGINEERING WORKS**
VERSION DATE:	**March 2025**

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CHAPTER 4.7 OTHER BUILDINGS AND CIVIL ENGINEERING WORKS

4.7.0 INTRODUCTION

4.7.0.A

The Supplier* shall provide other buildings and civil engineering works that are part of the Plant* but are not part of the Units*. In general, these structures and systems are not required to convert the heat energy of Nuclear Fuel* into electrical energy.

AA

The Supplier* shall identify the whole list of the other buildings and civil engineering works.

4.7.0.B

All buildings, structures, systems and associated equipment shall be designed with regard to Plant* operational and maintenance needs.

4.7.0.C

The design and location of other buildings and civil engineering works shall not have negative impact on the Plant* operation and maintenance.

CA

The other buildings and civil engineering works shall be designed not to require excessive maintenance.

CB

The other buildings and civil engineering works shall be located close to the place where they are needed, in order to minimize walking distances and thus negative impact on the time required for operational and maintenance tasks.

4.7.0.D

The civil structures shall follow the architectural design consistent as the NI, PGP and BOP buildings and structures of the Supplier*.

4.7.0.E

The Supplier* shall design and construct other buildings and civil engineering works according to Rules*, see Chapter 2.5.

4.7.1 FIRE STATION

[redacted]

AA
The fire station shall have sufficiently spaced heated garage for fire vehicles equipped with exhaust gas ventilation. It shall also include area for resting and office and formal and physical training of the fire squad personnel.

[redacted]

EA
Fire station shall be provided with furniture and technical infrastructure such as HVAC, electrical installations, water and sewage distribution, security alarm systems, IT infrastructure, fire protection system etc. as applicable.

4.7.1.F
The fire station of the Plant* shall be placed accordingly to provide rapid intervention across the Plant*.

[redacted]

4.7.2 DRINKING WATER STORAGE

4.7.2.A
The Supplier* shall design and construct the drinking water storage as one option in case of insufficient capacities of the CP02, in accordance with the drinking water utility (provider) conditions for connection.

AA
In addition, its volume shall be agreed on with the drinking water utility (provider).

4.7.2.B
Such drinking water storage shall be located inside the Limited Access Area*.

4.7.2.C
The drinking water storage shall be designed in accordance with the Rules* (see Chapter 2.5).

4.7.3 WASTE MANAGEMENT FACILITY

4.7.3.A
The Supplier* shall provide waste management facility.

4.7.3.B
The waste management facility shall be located inside the Limited Access Area* and appropriately designed and equipped for collecting, sorting, temporary deposition and transport of non-radioactive solid waste, excluding domestic and hazardous waste. These include types of waste for example metal, paper, glass, plastics, bio waste, building suit, wood, etc.
The waste management facility shall be completed and fully operable before the Provisional Takeover* of the Plant* in accordance with the Licensing and Permitting, Safety and Quality Document*, Chapter 2.6.

4.7.3.C
The waste management facility shall be designed to collect and sorted municipal waste components. It is a material and waste that can be reused (recycled) or which shall be disposed of in accordance with the Rules*, see the Technical Requirements Document*, Chapter 2.5.

4.7.4 SHELTER/S OF THE RESCUE SYSTEM

4.7.4.A
The Supplier* shall design and construct the shelter/s according to Rules* (see Chapter 2.5).

4.7.4.B
The shelter/s shall be designed to be seismic resistant, and the building arrangements shall fulfill the Rules* (in particular IAEA SSG-64) and fire hazard analysis.

4.7.4.C
The shelter/s shall be designed as resistant structure against to all External Hazards*.

4.7.4.D
The shelter/s shall be designed with connection to all necessary medium and shall be provided with furniture and technical infrastructure such as HVAC, electrical installations, water and sewage distribution, security alarm systems, IT infrastructure, fire protection system etc. as applicable.

4.7.4.E
Requirements for location, capacity/size of shelters according layout rules are described in the Section 2.11.10.

4.7.4.F
The shelter/s shall be fully completed and fully operable in accordance with the Licensing and Permitting, Safety and Quality Document*, Sections 2.3 and 2.5.

4.7.5 TRAINING FACILITIES

4.7.5.A
The Supplier* shall design and construct the training facilities according to Rules*, see the Technical Requirements Document*, Chapter 2.5.

4.7.5.B
[redacted]

4.7.5.C
The training facilities shall be completed and fully operable in accordance with the Contractual Time Schedule*, in accordance with the Licensing and Permitting, Safety and Quality Document*, Chapter 2.7.

4.7.5.D
Functional requirements for Training Simulator* building are described in the Technical Requirements Document*, Chapter 2.20.

4.7.5.E
Training facilities shall be provided with furniture and technical infrastructure such as HVAC, electrical installations, water and sewage distribution, security alarm systems, IT infrastructure, fire protection system etc. as applicable. For additional requirements on training facilities see Operation and Maintenance Document*, Chapter 2.3.

4.7.6 OFFICE BUILDING

4.7.6.A
The Supplier* shall provide Owner* with the office building.

[redacted]

4.7.6.B
The primary function of the office building is to provide a full functional and comfortable workplace for the Plant* management and administrative staff ensuring e.g. personnel administration, procurement of materials or services, specialist technical support during operation of the Plant*.

4.7.6.C
The office building shall be located on the Construction Area* outside the Limited Access Area*.

4.7.6.D
The office building shall be connected to the technical infrastructure including consumption measuring facilities and transport infrastructure with sufficient parking capacity (for cars, motorcycles and bicycles) necessary for its operation and maintenance.

DA
The parking shall be provided with power supply 2 × 1 MVA for future implementation of electric car chargers.

4.7.6.E
All rooms inside the office building shall be suitably sized for the intended equipment and purpose of use.

[redacted]

[redacted]

EB
The primary function of the information centre is to provide a full functional and comfortable place for the Plant* presentation to public during operation of the Plant*.

The information centre for intended purpose of use shall be:

- provided by functional and comfortable workplace for the information centre staff,
- provided by functional and comfortable exhibition space (approx. capacity 60 visitors),
- suitably sized and equipped,
- easily accessible taking the office building operation into account,

The information centre for intended purpose of use shall be equipped with:

- multimedia information technology,
- individual models of the Plant* (e.g. reactor, steam generator),
- storage for presentation materials,
- toilets for public,
- locker rooms for public,

EC
The kitchen shall be designed and equipped with all necessary cooking, ventilation and cleaning facilities for preparation of hot meals, drinks and snacks (necessary plumbing and fixtures, white goods such as gas cookers, freezers, refrigerators and industrial dish washer). The space for serving of hot meals, dining room and buffet shall by designed and equipped with necessary ventilation and cleaning facilities. All tables, chairs, cooking utensils, crockery and cutlery will be provided by the Owner*

ED
The dining room shall also have separate male and female toilets.

[redacted]

4.7.6.F
The indoor environment comfort shall be designed in accordance with primary function of office building and in compliance with the Rules* avoiding the sick building syndrome (headache; eye, nose, or throat irritation; dry cough; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odours).

FA

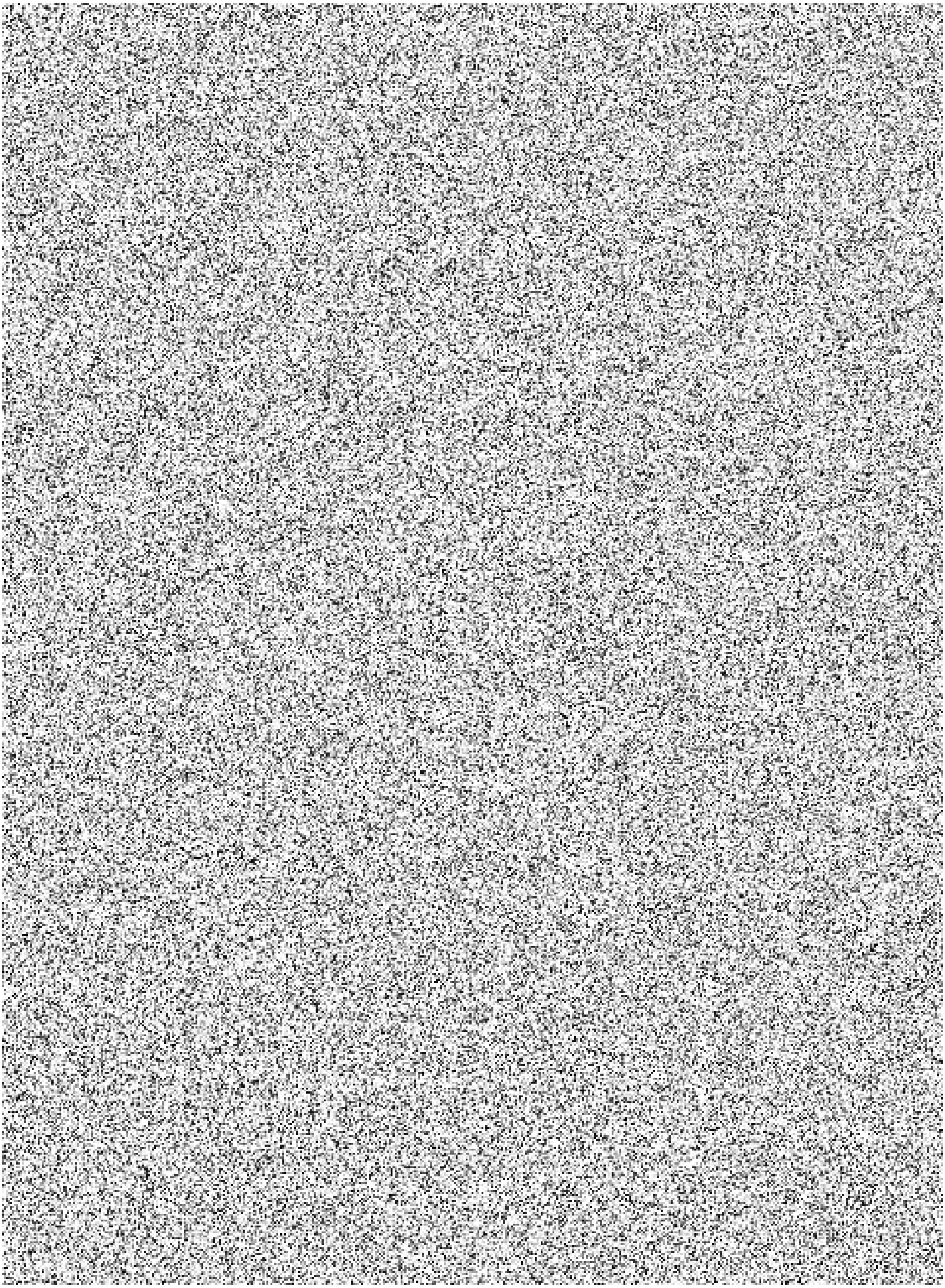
The design of heating, ventilation and air conditioning system providing indoor environment comfort shall consider inter alia installation cost, ease of maintenance and energy efficiency.

The Owner* prefers radiant heating and radiant cooling rather than conventional methods such as radiators (mostly convection heating).

The heating and cooling system shall provide individual room control and consider openable windows detecting when window is open or closed.

The indoor minimum temperature shall be 22°C and maximum 27°C. Temperature regulation shall be ensured by heating, ventilation and air conditioning (HVAC).

The internal sound pressure level shall be max. 50 dB. The soundproof in the rooms shall be ensured by sound insulation (walls, floors, ceilings, etc.).



[redacted]

4.7.6.H
The office building shall be designed and constructed to meet the mechanical resistance and stability, fire safety, the protection of human and animal health, healthy living conditions and the environment, noise protection, safety in use, energy saving, and thermal protection as required by the Authorities* and the Rules*.

4.7.6.I
The office building shall be designed as barrier-free for use by immobile persons in accordance with Decree No. 398/2009 Coll., as amended., see the Technical Requirements Document*, Chapter 2.5.

4.7.6.J
The architectural design and interior layout of the office building shall be approved by the Owner* pursuant the Supplier's* architectural design competition submitting to the Owner* design proposals including 3D models.

JA
The architectural design competition guidelines shall be elaborated by the Supplier* mutually agreed by the Owner*.

[redacted]

4.7.7 REPAIR SHOPS

4.7.7.A
The Supplier* shall provide repair shops.

4.7.7.B
Repair shops shall be located inside the Limited Access Area* in a close vicinity of a storage facility.

4.7.7.C
The repair shops shall be completed and fully operable in accordance with the Contractual Time Schedule*, in accordance with the Licensing and Permitting, Safety and Quality Document*.

4.7.7.D
Functional requirements on repair shops are described in the Operation and Maintenance Document*, Section 3.5.1.

4.7.7.E
The clean repair shops (outside of the controlled area) shall include a locker room for maintenance personnel, where they can change their clothes and a sanitary facility with showers.

4.7.8 FACILITIES FOR SPARE PARTS SUPPLY, STORAGE AND CONTROL

4.7.8.A
The Supplier* shall provide facilities for spare parts supply storage and control.

4.7.8.B
Such facilities shall be located both

- inside the Limited Access Area* for long term storage of all goods (spare parts, consumables, etc.) – at least 8.000 m2 as part of Supplier's* scope of supply,
- outside of the Limited Access Area* for temporary storage of goods delivered to the Plant* - at least 600 m2 as part of Owner's* scope of supply.

BA
The area for the temporary storage of goods outside of the Limited Access Area* shall be proposed and designed in layout plan also with regard to:

- the storage shall be located at Construction Areas*, outside the Limited Access Area* with close distance to Main gate house,
- transport infrastructure (road communications, parking and parking lots, etc.),
- appropriate foundation conditions.

The Supplier* shall consider possibility to increase the reserved area.

BB
When designing the Plant*, the Supplier* shall consider, to the maximum extent practicable, the integration of the storage outside of the Limited Access Area into the Plant*, i.e. the Plant* shall be equipped with appropriate spare capacity in the Plant* technical infrastructure, such as electrical distribution, HVAC, and other systems, as applicable.

4.7.8.C
Functional requirements on facilities for spare parts supply storage and control are described in the Operation and Maintenance Document*, Section 3.5.3.

4.7.9 OUTDOOR LIGHTING

4.7.9.A
The Supplier* shall provide outdoor lighting of Plant*.

4.7.9.B
The Supplier* shall design and construct outdoor lighting according to CSN CEN/TR 13201-1, CSN EN 13201-2, CSN EN 13201-3, CSN EN 13201-4 as amended, see the Technical Requirements Document*, Chapter 2.5.

4.7.9.C
Outdoor lighting shall cover all outdoor areas of the whole Plant*, i.e. areas outside and inside the Limited Access Area* where the Plant* objects are located.

4.7.9.D
The Supplier* shall design and construct outdoor lighting in way to minimize light pollution while meeting requirements for the physical protection.

4.7.10 TRANSPORT INFRASTRUCTURE

4.7.10.A
The Supplier* shall provide transport infrastructure.

4.7.10.B
These civil structures shall be located on the Construction Area* inside and outside the Limited Access Area* and it shall cover transport infrastructure including roads, railway siding, sidewalks, parking areas, bus platforms, heliport, paved areas and facilities designated for maintenance including four (4) garages for freight (cargo) machinery and eight (8) garages for personnel vehicles and fuel station.

4.7.10.C
Road network and parking lots shall be designed to withstand standard heavy vehicles together with the expected traffic frequency and shall be provided with a hard surface.

CA
Design of the roads shall take into account necessary space for heavy transport associated with equipment maintenance and replacement.

4.7.10.D
The Supplier* shall provide parking lots for Plant* personnel and subcontracted companies, it shall be provided for approx. 1500 parking lots and it shall be located on the Construction Area* outside the Limited Access Area*. The amount of parking lots will be changed according to the final site layout.

DA
The parking shall be provided with power supply 2 × 5 MVA for future implementation of electric car chargers.

4.7.10.E
The all transport infrastructures shall be completed and fully operable in accordance with the Contractual Time Schedule*, in accordance with the Licensing and Permitting, Safety and Quality Document*.

4.7.11 GATEHOUSE

4.7.11.A
The Supplier* shall provide two gatehouses (main and supplementary) and each of them shall have its own access road.

AA
The final location of the gatehouses shall be subject to the Owner's* approval.

4.7.11.B
The gatehouse shall be located at the Limited Access Area* border enabling controlled access of personnel and freight (cargo) transportation to the Plant*.

4.7.11.C
The gatehouse shall be equipped and furnished in order to fulfill its function as a part of Physical Protection System*.

CA
The gatehouse shall be provided with space for one working shift of the guards (such as changing rooms, restrooms, etc.).

CB
Card issuing office: spaces include waiting space (approx. 20 m2), office space (approx. 20 m2) and archive (approx. 15 m2). The office should be accesible outside of LAA

4.7.11.D
The gatehouse shall be completed and fully operable at least six (6) months before the start of the Active Testing*, in accordance with the Contractual Time Schedule*, in accordance with the Licensing and Permitting, Safety and Quality Document*, Section 2.4.

4.7.11.E
The capacity of the main gatehouse shall be designed taking into account number of all the operational and maintenance personnel and expected cargo entering the Limited Access Area* (including outage activities).

4.7.12 MAIN AND SUPPLEMETARY PHYSICAL PROTECTION CONTROL ROOMS

4.7.12.A
The Supplier* shall provide one main and one supplementary physical protection control room for the Plant* together with secured areas for physical protection department.

4.7.12.B
Such physical protection control rooms and areas shall be located inside Protected Area* (preferably) or in the Limited Access Area*.

4.7.12.C
Functional requirements on physical protection control room are described in the Technical Requirements Document*, Section 2.8.2.15 and Licensing and Permitting, Safety and Quality Document* Section 2.4.

4.7.13 POLICE STATION

4.7.13.A
The Supplier* shall provide the Owner* with police station building or incorporate police station in another appropriate Plant* building.

4.7.13.B
The primary function of the police station is to provide a full functional and comfortable workplace for the police squad ensuring security of the Plant* during its operation phase.

4.7.13.C
[redacted]

4.7.13.D
The police station shall be located at Construction Area*, within Protected Area* or the Limited Access Area* considering accessibility and infrastructure connectivity during operation phase.

4.7.13.E
The Supplier* shall consider merging the police station and fire station in one place.

4.7.14 DOCUMENT STORAGE FACILITY

4.7.14.A
The Supplier* shall provide either structure or its part for document storage.

[redacted]

4.7.14.D
The document storage facility shall be sized to store entire volume of hardcopies of Documents* produced during the Project* (e.g. design development, SSC manufacture, construction, erection, installation, Commissioning*, etc.) and during whole operation time period (at least 60 years) of the Plant*.

4.7.14.E
The document storage facility shall be located at Construction Areas* within the Limited Access Area* considering accessibility and infrastructure connectivity (utilities and transportation) during the Plant* operation.

4.7.15 MEDICAL CENTRE

4.7.15.A
The Supplier* shall provide a dedicated medical centre building or incorporate medical centre in another appropriate Plant* building. The medical centre shall provide the necessary space and facilities for personnel health care, physicians, rehabilitation, pharmacy.

4.7.15.B
The Supplier* shall design and construct the medical centre according to Rules*, see Chapter 2.5.

4.7.15.C
The medical centre shall be designed with connection to all necessary services and shall be provided with furniture and technical infrastructure such as HVAC, electrical installations, water and sewage distribution, security alarm systems, IT infrastructure, fire protection system etc. as applicable.

4.7.15.D
The medical centre shall be located at the Construction Area* outside the Limited Access Area*, considering easy accessibility and infrastructure connectivity from other parts of the Plant*, in order to minimize walking distances.

[redacted]

4.7.16 SERVICE BUILDING

4.7.16.A
The Supplier* shall provide Owner* with the service building or several service buildings.

4.7.16.B
The primary function of the service building is to provide a full functional and comfortable workplace for the operation personnel of the Plant* (e.g. operation, maintenance, technical support, quality management, security, modification).

4.7.16.C
The service building shall be located on the Construction Area* inside of the Limited Access Area*.

4.7.16.D
The service building shall be connected to the technical infrastructure including consumption measuring facilities and transport infrastructure with sufficient parking capacity necessary for its operation and maintenance.

4.7.16.E
All rooms inside the service building shall be suitably sized for the intended equipment and use.

EA
[redacted]

The offices within the service building shall be designed in such way to accommodate different levels of personnel.

- offices for one employee in case of managers,
- offices for up to three employees in case of working level employees

Open space is not allowable solution, offices shall be separate.

EB
The space for serving of hot meals, dining room and buffet shall be designed and equipped with necessary ventilation and cleaning facilities. All tables, chairs, cooking utensils, crockery and cutlery will be provided by the Owner*.

EC
The dining room shall also have separate male and female toilets.

4.7.16.F

The indoor environment comfort shall be designed in accordance with primary function of service building and in compliance with the Rules* avoiding the sick building syndrome (headache; eye, nose, or throat irritation; dry cough; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odours).

FA

The design of heating, ventilation and air conditioning system providing indoor environment comfort shall consider inter alia installation cost, ease of maintenance and energy efficiency.

The Owner* prefers radiant heating and radiant cooling rather than conventional methods such as radiators (mostly convection heating).

The heating and cooling system shall provide individual room control and consider openable windows detecting when window is open or closed.

The indoor minimum temperature shall be 22°C and maximum 27°C. Temperature regulation shall be ensured by heating, ventilation and air conditioning (HVAC).

The internal sound pressure level shall be max. 50 dB. The soundproof in the rooms shall be ensured by sound insulation (walls, floors, ceilings, etc.).

4.7.16.H
The service building shall be designed and constructed to meet the mechanical resistance and stability, fire safety, the protection of human, healthy living conditions and the environment, noise protection, safety in use, energy saving, and thermal protection as required by the Authorities* and the Rules*.

4.7.16.I
The service building shall be designed as barrier-free for use by immobile persons in accordance with Decree No. 398/2009 Coll. as amended, see Chapter 2.5.

4.7.17 SECURITY OPERATIONS CENTRE

4.7.17.A
In order to meet the requirements of the Act No. 181/2014 Coll., as amended and Decree No. 82/2018 Coll., as amended, the Plant* shall be equipped with the Security Operations Centre*.

The Supplier* shall design and provide fully equipped Security Operations Centre* of the Plant*, including SW and HW provisions.

4.7.17.B
The Security Operations Centre* of the Plant* shall be gradually commissioned together with the installation of monitored systems and technologies. The Security Operations Centre* shall be in full operation at least three months prior the Physical Start-up* of the earlier Unit* (together with the activation of PPS).

4.7.17.C
The Security Operations Centre* shall be situated in the Limited Access Area* of the Plant*, shall be suitable for 24/7 operation and shall be equipped with the appropriate surveillance technology. The Security Operations Centre* shall be designed and constructed in accordance with the requirements of the Rules*, IAEA document “Computer Security Incident Response Planning at Nuclear Facilities” and relevant requirements and recommendations of CSN EN ISO/IEC 270xx series and ISO/IEC 270xx series.

4.7.17.D
The Security Operations Centre* of the Plant* shall monitor both the Information Technology and Operational Technology, including Control Systems surveillance.

DA
The Information Technology monitoring shall include the protection of information, services and data communication of the employees and other network users (IT), including the protection of this network against external threats.

DB
The Operational Technology shall include the Instrumentation and Control (I&C) systems and other information and communication systems supporting the operation of the Plant*.

Note DB
For additional requirements on one-way data transfer from I&C system to the Security Operations Centre* see also Technical Requirements Document*, Section 2.10.5.4.2.2 IA.

DC
The final scope of the above-mentioned systems monitoring shall follow the documentation for the License for Construction*, mainly the Preliminary physical protection assurance plan, according to the Annex 1 to the Czech Atomic Act*, letter 1. b) 11.

4.7.17.E
Technical equipment available in the SOC shall allow, but not be limited to:

- protection of integrity of communication networks,
- user authentication,
- access permission control as well as anti-malware control,
- recording activity on critical information infrastructure and important information systems, their users and administrators,
- cyber-security detection,
- collecting and evaluating cyber-security events,

- encryption,
- ensuring the availability of information,
- Control Systems surveillance.

4.7.17.F
Central collection and evaluation of security logs and other digital inputs shall be ensured. Continuous evaluation of SIEM (Security Incident and Event Management) logs shall be provided.

4.7.17.G
The Supplier* shall provide a plan and a program for a Security Operations Centre* (SOC). The plan and program shall be guided by the IAEA recommendations, in particular by the IAEA document “Computer Security Incident Response Planning at Nuclear Facilities”.

Note G
See Section 1.2.4.2 of Attachment 3 of the Project Management Document*.

4.7.17.H
The SOC shall have the technical capability and the authority to handle all cybersecurity related events. The Supplier* shall continuously develop and maintain a list of assets to protect. The list shall include, but shall not be limited to, physical devices including Control Systems and components, any connected IT related services, databases, source codes, credentials, and other internal information systems. The SOC shall be designed to allow maintaining that list on an ongoing basis. Protection of assets, detection and remediation of threats shall be an ongoing task performed 24/7 by the SOC. Threats shall include attacks, compromised systems, compromised or leaked data, and vulnerabilities.

4.7.17.I
The design of the SOC shall be suitable for the continuous presence of a Computer Security Incident Response Team which shall be able to handle the events described by IAEA “Computer Security Incident Response Planning at Nuclear Facilities” section 3.5 Operator Processes and Procedures. The CSIRT shall have the capability to exchange information about threats, including but not limited to Indicator of Compromises, with other CSIRT organizations.

4.7.17.J
The plan and the program for the Security Operations Centre* shall include information about the 3 following sections (JA to JC) as part of a high-level cybersecurity strategy. The plan shall be suitable to protect all the assets of the Plant*.

JA
Collection & Monitoring
a. Internal network

1. The SOC shall be able to collect and monitor cyber security related events, both automatically but also manually. As a minimum required, a Security Information and Event Management system shall be used to collect and monitor events. IT and I&C hardware, where possible or required, shall be chosen and configured to report relevant events to the Security Information and Event Management system.

2. The Supplier* shall provide a system to allow any employee to report internally a variety of incidents. The minimum requirements are an interface that is accessible by the employees, to include a form for indicating the type of incident, allow to provide an additional attachment, contact information and additional information about the incident.

b. Externally

1. The Supplier* shall provide a system to allow the reporting of events from external sources, including but not limited to vulnerability reports and data breach notifications. An externally accessible email address or web form is considered sufficient.

JB
Analysis

a. Threats shall be classified into risk and computer security incident categories that guide the type and urgency of response.
b. Risk categories:
   1. Informational
   2. Low risk
   3. Medium risk
   4. High risk
c. Computer security incident categories (or equivalent):
   1. Illegal access
   2. Illegal interception
   3. Data interference
   4. System interference
   5. Misuse of devices

JC
Actions

1. Based on IAEA document “Computer Security Incident Response Planning at Nuclear Facilities”, Section 3.5 Operator Processes and Procedures, the SOC shall have established procedures for responding to the threat.
2. If immediate remediation is not possible, there shall be a procedure of isolating and containment of the threat.
3. The SOC shall have established procedures to escalate threats when necessary.
4. Information about threats shall be shared with other CSIRTs in both directions.

4.7.17.K
The SOC shall be equipped with a separate network and separate computers that safely allow the analysis of threats (including the analysis of viruses, and potentially malicious email attachments). This separate network shall be physically separated from any other internal networks but shall have an independent internet connection to allow sharing and receiving of Indicator of Compromises and other relevant information.

KA
There shall be a secure one-way data transfer (unidirectional gateway) to this separate network to allow sharing of potential malicious files (including emails, email attachments, and other files). A data diode is sufficient for this purpose.

4.7.17.L

Inventory System of SOC

The plan and the program for the Security Operations Centre*, shall contain a list for an inventory for any IT related hardware and software to be provided within SOC, including but not limited to:

- Computers (stationary and non-stationary), servers, tablets, phones
- Telephone systems, fax, etc.
- Network routing devices: Switches, routers, gateways etc.
- Network security devices: Firewalls, proxies, load balancers, etc.
- IP cameras, printers, other peripherals.

4.7.17.M

The plan and the program for the Security Operations Centre* shall contain information about the software version, software license type, and include a list of 3rd party core components and libraries for each software. The software inventory shall include information about the organization responsible for maintaining the listed software, including contact information and where available references to the original online location of the software as well as the location of provided updates.

Note M

The plan and the program for the Security Operations Centre* shall be updated continuously by the Supplier*. For additional details see Project Management Document*, Attachment 3, Section 1.2.4.2.

4.7.17.N

Security Operations Centre* shall be tested appropriately prior the operation.

Note N

See Section 2.10.7.2 of Technical Requirements Document* and Chapter 3 of Construction and Commissioning Document* for additional details.

4.7.18 CENTRAL CHANGING ROOM

4.7.18.A

The Owner* shall design and construct the building of Central changing rooms. The Central changing room shall contain appropriate amount of locker rooms, showers, toilets (for both men and women) required for at least 1000 personnel. The building shall be close to main gate house, outside of the Limited Access Area.

AA

The Supplier* shall reserve an area for Central changing room - at least 1600 m2.

AB

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

- transport infrastructure (road communications, parking and parking lots, etc.),
- appropriate foundation conditions.

The Supplier* shall consider free space around the reserved area for possibility to increase the area of Central changing room with temporary structures during the outages - at least 500 m2.

AC

When designing the Plant*, the Supplier* shall consider, to the maximum extent practicable, the integration of the Central changing room into the Plant*, i.e. the Plant* shall be equipped with appropriate spare capacity in the Plant* technical infrastructure, such as electrical distribution, HVAC, and other systems, as applicable.

EPC CONTRACT

CONTRACT SPECIFICATIONS

DOCUMENT NAME:	**TECHNICAL REQUIREMENTS DOCUMENT VOLUME 4 POWER GENERATION PLANT, BALANCE OF PLANT AND SUPPORT FACILITIES REQUIREMENTS CHAPTER 4.8 EXTERNAL INFRASTRUCTURE**
VERSION DATE:	**March 2025**

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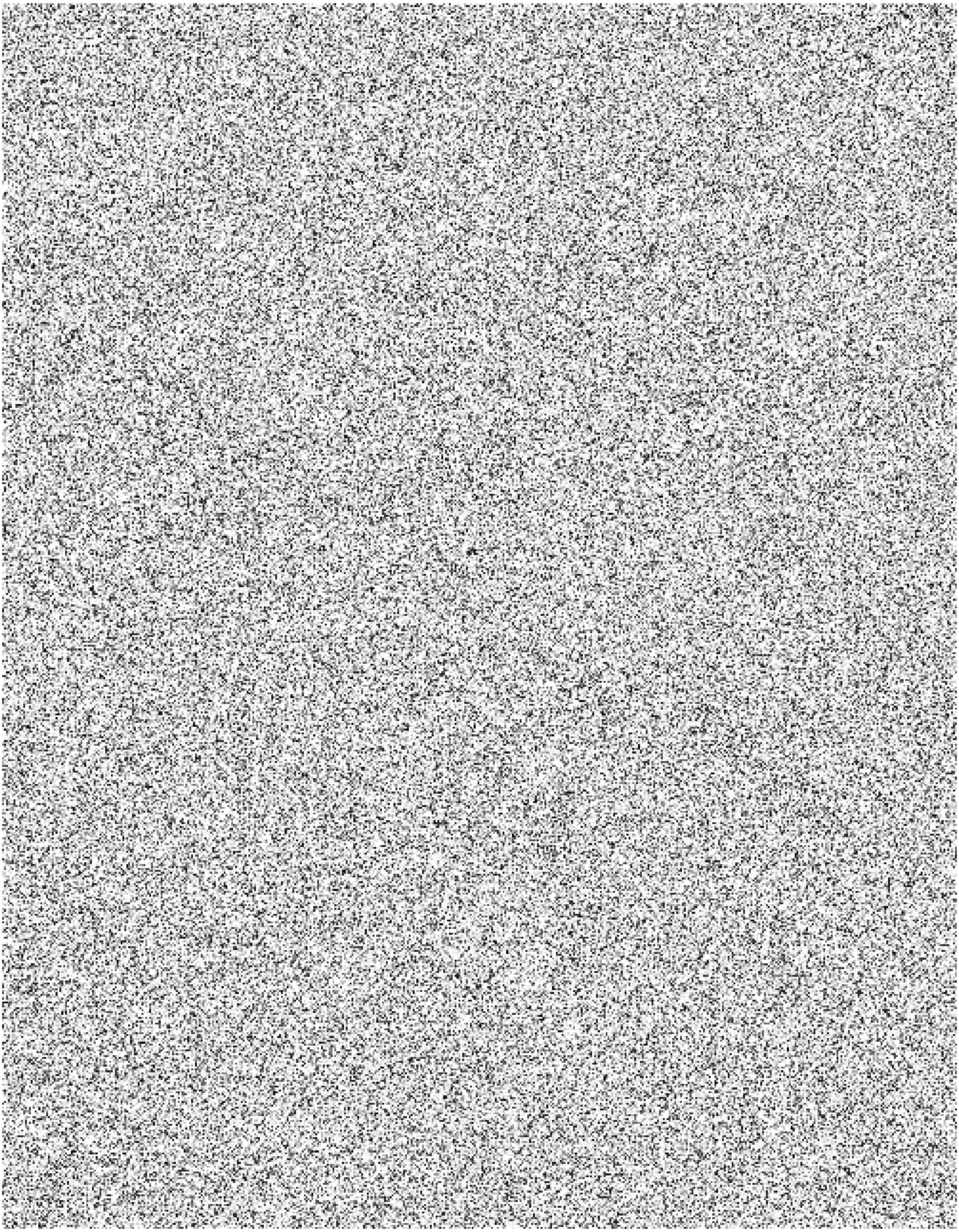

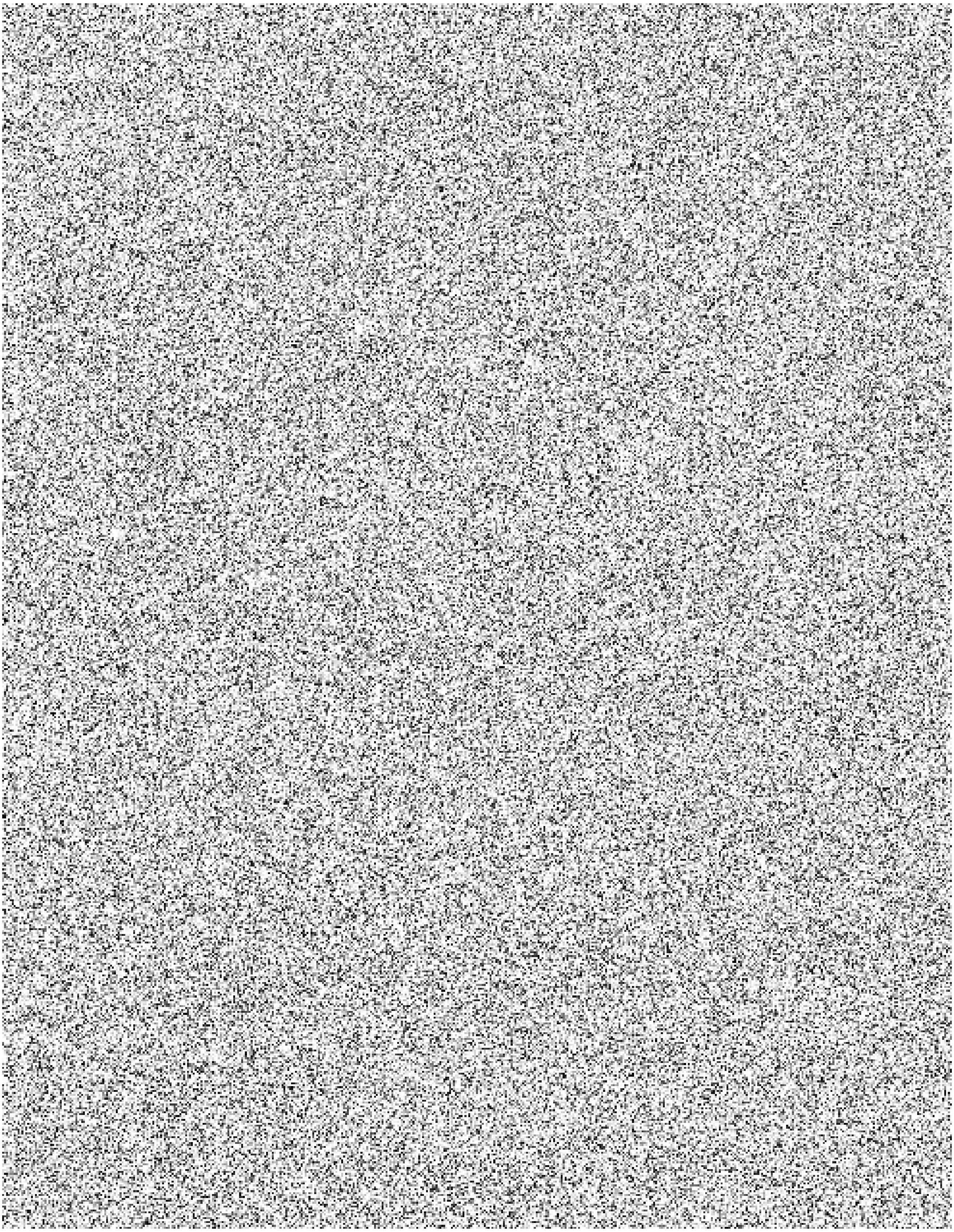

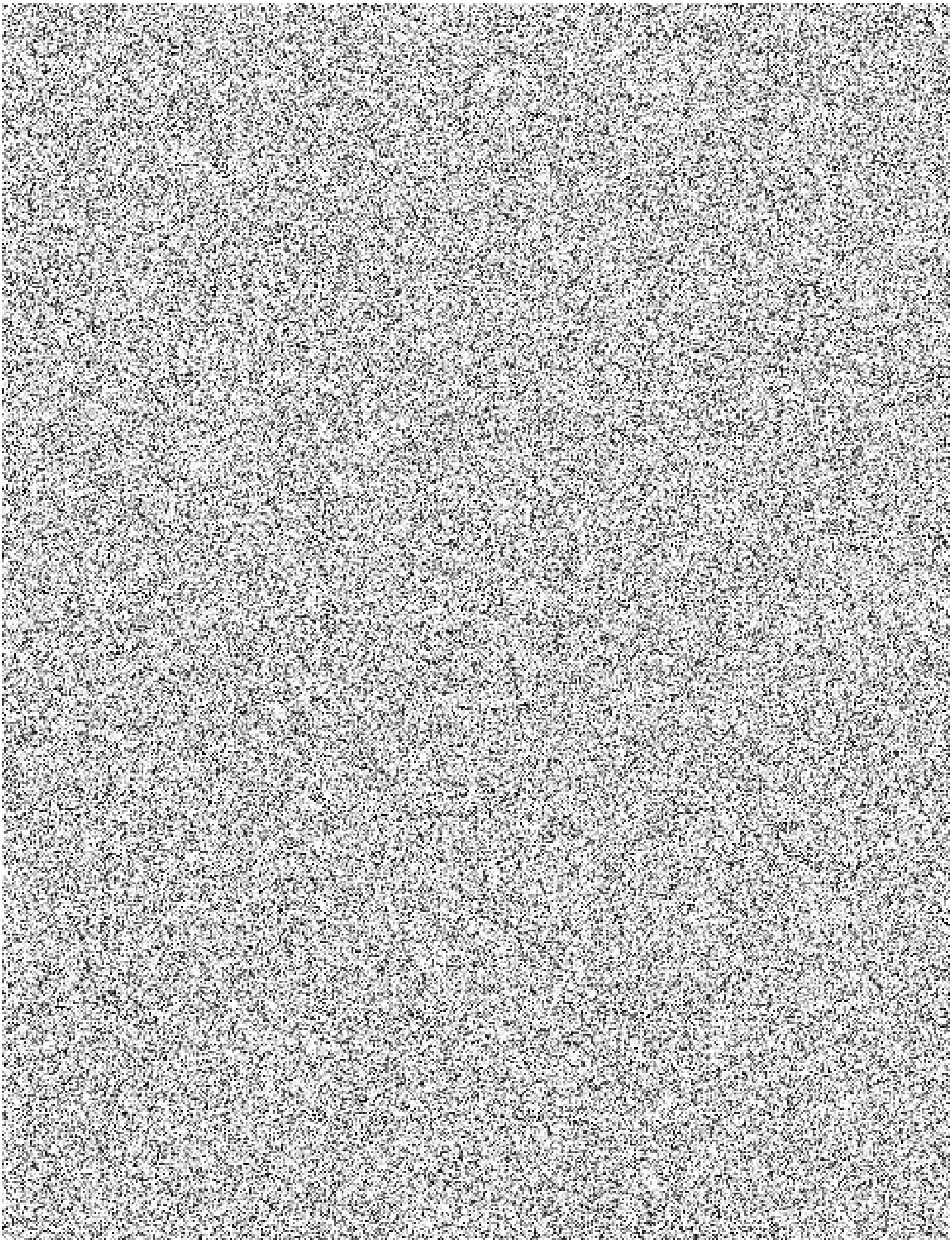

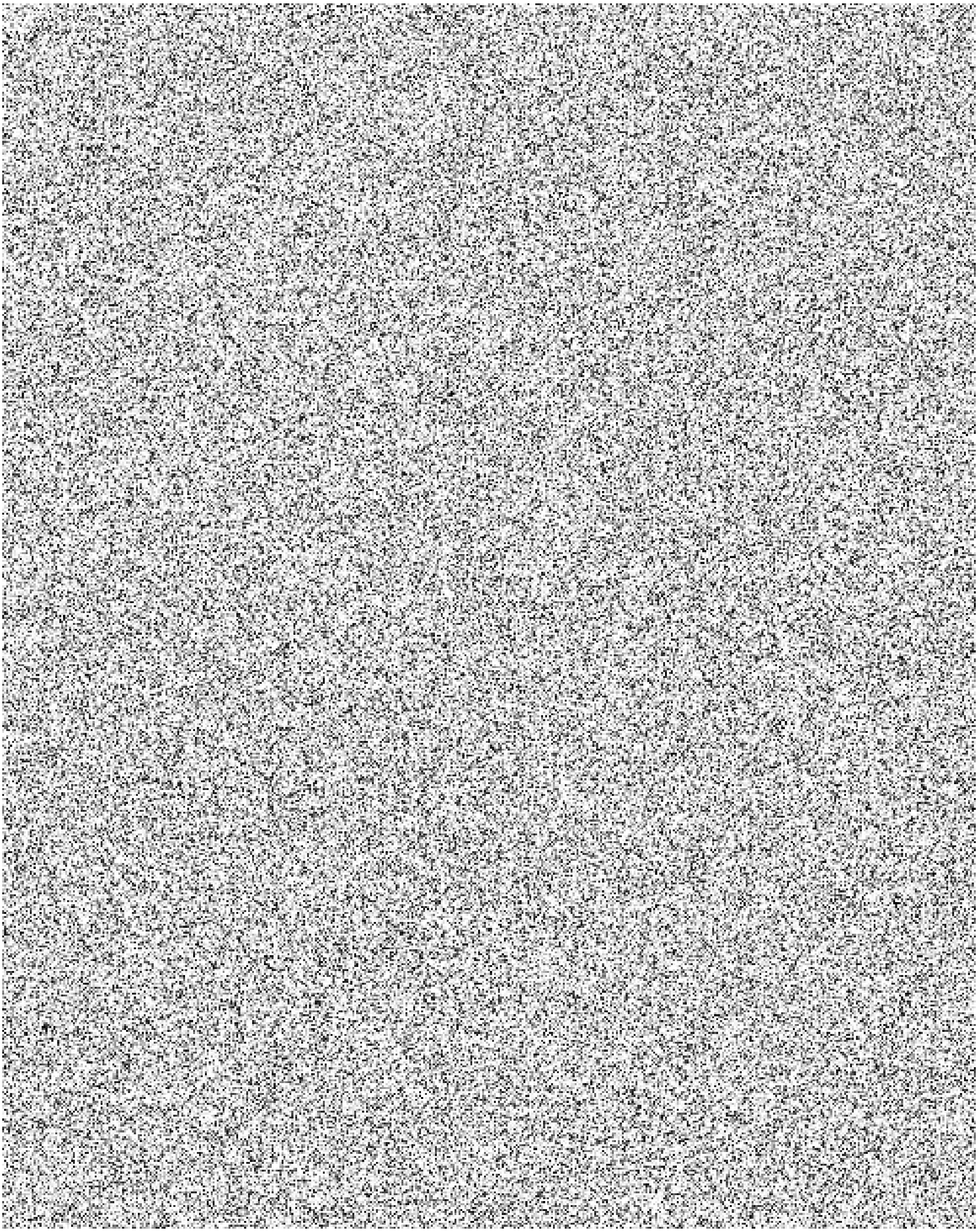

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