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Technical Manager Statement: Initials LJL

Reviewer is Independent.

Remarks:

The NGNP Conceptual Design Studies Baseline Document contained herein was prepared to direct design studies work performed by AREVA Next Generation Nuclear Plant (NGNP) Team under AREVA work plan – "Conceptual Design Studies for NGNP with Hydrogen Production", WBS 1.5, titled HTGR Component Test Facility (CTF) Recommendations.

This document represents conceptual design studies phase baseline document for the NGNP indirect steam cycle configuration with H_2 production. The conceptual design baseline has been created for use by the entire design team as the latest agreed upon listing of plant design parameters and configuration. This EIR is prepared under AREVA WI-13 procedure as the plant Technical Requirements Document. This document contains plant parameters necessary to guide special studies being conducted by the AREVA NGNP design team.

Total Pages :12 (Page 1 to 11 and page 1a)

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NGNP *Conceptual Design Studies Baseline* Document

for

Indirect Steam Cycle Configuration

BEA Contract No. 000 60209

AREVA NP Inc.

Record of Revisions

Revision	Date	Pages/Sections Changed	Brief Description
000	February 2008	All	Initial Issue
001	September 2008	Page 11	Revised layout

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1. INTRODUCTION AND PURPOSE OF THE DESIGN BASELINE

This document represents conceptual design studies baseline document that includes plant technical requirements for the Next Generation Nuclear (NGNP) indirect steam cycle configuration with Hydrogen production. This document is prepared as an EIR under AREVA WI-13 procedure it represents the plant Technical Requirements Document. As such it contains plant parameters necessary to guide special studies being conducted by the AREVA NGNP design team.

The baseline document consists of three parts. In Section 2.0 plant point design parameters are provided representing the steady state plant conditions. In Section 3.0 major plant characteristics are provided. In Section 4.0 the design duty cycles for the key structures, systems, and components are listed.

The baseline document is created for use by the entire AREVA NGNP design team as the latest agreed upon listing of plant design parameters, configuration, operation and performance. The contents of this document guides plant design and special studies being performed.

The NGNP is a modular high temperature gas-cooled reactor prototype plant. The role of the design baseline document at the conceptual design studies phase is to serve as a single document that contains plant configuration and parameters. This document will be updated as needed when choices concerning the NGNP plant design, configuration and operation become defined and available.

Please note that the data being provided are provisional and are intended for use and reference by the AREVA design team. Data provided in this document shall be used as follows:

- The design team members that are involved in studies to determining certain plant parameters and configuration should consider the data in this document ("February 2008 baseline") as initial estimates or the starting point for their investigation.
- The design team members that are not directly involved with the development of certain design feature or parameter should use the data as the best data available at the time this document is issued.
- The "range of assessment" is to be taken into account in the context of parametric evaluations. Plant parameter evaluation outside of the specified assessment range shall be approved by the AREVA NGNP Project Engineer.
- Others may use the data for information only.

The plant "Point Design" parameters represent the best estimate of plant steady state points at the time of document release concerning plant configuration and expected operating parameters. On the other hand the plant Design Duty Cycles is the plant designers' provisions for SSC design. If the designer determines it to be preferable to restrict the duty cycle to less than these values, these limits will be reevaluated. The number of duty cycles is not a prediction of how many of these cycles will occur but how many cycles these components shall be designed for. In most cases, it is desirable to operate in a manner which results in fewer duty cycles.

This document was prepared and issued by the System Integration function with concurrence from the NGNP Project Engineer.

<u>Note –</u> All values and text in the brackets [ ] are best estimates and are subject to change. Please advise the NGNP System Integration function (the preparer of this document) if you have difficulty complying with the information provided in this document. Once these values are adopted for NGNP; the brackets are removed in the next revision of the document.

The NGNP project is in conceptual design studies phase. The information in this document will be validated by formal design calculations in this and subsequent phases of the design. As the design progresses and references become available the values in the design baseline will be referenced to design calculations.

2. PLANT POINT DESIGN

The plant Point Design parameters are presented here. These parameters represent an operating point at steady state plant conditions.

Description	Range of Assessment	February 2008 Baseline
Nuclear Island		
Power level	500 to 600 MWth	565 MWth
Reactor Core		
Core inlet temperature	350 to 500°C	500°C
Core outlet temperature	750 to 950°C	900°C
Core pressure drop		[55 kPa]
Primary Heat Transport System		
Primary Pressure	5 to 9 MPa	[5.0 MPa]
Mass Flow		~ [272] kg/s]
Primary Circulator Power (each)		[8 MWe]
IHX-Type 1 – Heat Transport to H_2 Production Plant		
Process Heat Application (H_2 Plant)		[60 MWth]
Primary Side (Inlet-Outlet)		900°C – 500°C
Secondary Side (Inlet – Outlet) Temperature		[475°C – 875°C]
Pressure Drop		
Primary		TBD
Secondary		TBD
H_2 Plant Transfer Loop Mass Flow		~ [29 kg/s]
Circulator Power		[1.5 Mwe]
Type	Various Compact Heat Exchangers	Compact (PSHE)
IHX –Type 2 – Heat Transport to Electric		
Secondary Loop Heat Transfer		[290 MWth]
Primary Side (Inlet-Outlet)		900°C – 490°C
Secondary Side (Inlet – Outlet) Temperature		[415°C – 825°C]
Secondary Pressure		[5.5 MPa]
Pressure Drop		
Primary Side		[0.01 MPa]
Secondary Side		[0.2 MPa]
Secondary Mass Flow		[272 kg/s]
Secondary Circulator Power (each)		[16 MWe]
Steam Generator Unit		
SG Heat Transfer (each)		[306 MWth]
Gas side (Inlet – Outlet)		[825-405°C]
Steam-Water side (Inlet –Outlet)		[300 -550°C]
Steam Pressure		TBD
Pressure Drop (shell side)		[0.06 MPa]
Reactor Cavity Cooling System		

Description	**Range of Assessment**	**February 2008 Baseline**
Nominal heat load		[1.8 MWth]
Power Conversion System		
Main Steam		
Temperature		TBD
Pressure		TBD
Flow		TBD
Reheat Steam		
Temperature		TBD
Pressure		TBD
Flow		TBD
Circulating Water Temperature		[25 °C]

3. PLANT CHARACTERISTICS

In this section a listing of major plan design characteristics is provided.

Description	**Range of Assessment**	**February 2008 Baseline**
Nuclear Island		
Reactor		Prismatic Blocks
Construction		Below Grade – Silo
Reactor building		Vented & Filtered
Primary coolant/Heat transport media		Helium
Primary cycle		Indirect
Vessel System		
Reactor Vessel	SA-508/533 2 ¼ Cr 1Mo Mod 9Cr 1 Mo	Mod 9Cr 1 Mo [Partially insulated]
Cross Vessels		Metallic Vessel w/center hot duct [Partially insulated]
IHX Vessels		Metallic Vessel with Bottom Mounted Circulator [Fully insulated]
Reactor Core		
Fuel Form		Prismatic Blocks
Configuration	84, 66, or 102 Column	Annular core 102 column 10 blocks/column

Description	Range of Assessment	February 2008 Baseline
Moderator		Graphite
Reflector (inner and outer)		Graphite Blocks
Peak Fuel Temperature – Normal Operation		[<1350°C]
Peak Fuel Temperature – Design Bases Accidents		[<1600°C]
Fuel Enrichment		<20%
Fuel		
Fuel Design		TRISO Coated Particles
Fuel Kernel		UCO
Coating		TRISO (SiC)
Fuel Compact		Particle Fuel and Graphite Matrix Compacted in a Cylindrical Shape
Fuel Block		Hexagonal Graphite Block
System Configuration		Indirect Cycle [See Fig 1]
No of Loops (# of cross vessels)		Three Parallel Loops
No of cross vessels		Three
No of Type 2 IHXs to PCS header		Two
No of Type 1 IHX to H_2 Plant		One
No of Steam Generators		Two
Loop Configuration		
No of IHXs per loop		One
No of Primary Circulators per loop		One
No of Secondary Circulators		One
Primary Heat Transport System		
Primary Fluid		Helium
IHX-Type 1 – Heat Transport to H_2 Plant		
Heat Exchanger Type		Compact
Heat Transfer Medium (Primary-Secondary)		He to [He]
IHX –Type 2 – Heat Transport to Steam Generator		
Heat Exchanger Type		Tubular
Heat Transfer Medium (Primary-Secondary)		He to [He]
Steam Generator Unit – PCS or Process Heat Plant		
Steam Generator Type		Once-through helical coil with reheat
Heat Transfer Medium (Primary – Secondary)		He to Water/Steam
Secondary Heat Transport System		
Intermediate Heat Transport to H_2 Plant		One Loop with IHX-1

Description	Range of Assessment	February 2008 Baseline
Intermediate Heat Transport to Steam Generator		Two Loops with IHX-2
Shutdown Cooling System		
Thermal Capacity		TBD MWth
Circulator		TBD MWe
Heat Exchanger		Tube-type (He to Water)
Reactor Cavity Cooling System		
Type - Operational Conditions - Accident Conditions		Water Based Active Passive
Configuration		Water Tube Panel
No of Loops		2
Capacity		[2.5 MWth]
Refueling System		
Refueling Cycle		[18 months] Periodic – Remote Access
Basic Plant Control and Operations:		
Electrical Plant- Controls		
Unit power maneuvering – Integrated with the reactor and turbine controls		
Reactor power demand maneuvering – Control rod movement		
Hydrogen Plant controls		
Unit power demand maneuvering – Integrated with the reactor and H_2 plant controls		
Power Conversion System		
Configuration		Multi Stage Steam Turbine with Reheat Cycle
Total Power (gross)		[291 MWe]
Steam reheat cycle		[Yes]
Steam turbine		Multi Stage
Feedwater system		TBD
Gross cycle efficiency		[48%]
House load		[40 MWe]
Net module generation		[251MWe]
Net plant efficiency		[44%]

4. PLANT DESIGN DUTY CYCLE

This section contains plant Design Duty Cycles for which the designers should allow operations of the SSCs. If the designer determines it to be preferable to restrict the duty cycle to less than these values, these limits will be reevaluated.

Note - The number of duty cycles is not a prediction of how many of these cycles will occur. In most cases, it is desirable to operate the plant in a manner which results in fewer duty cycles.

Description	**February 2008 Baseline**
Normal and Anticipated Operational Occurrences	
Plant design life time	60 years
No of Plant Startups	[660]
No of Plant Shutdowns (normal)	[300]
Electric Plant	
Load follow	30 to 100% (full power)
Rate of power change	±10% per minute
No of Full load rejections	[120] without turbine trip
No of Reactor Trips	[360]
No of Circulator trips (each)	[120]
Hydrogen Plant	
Load follow	30 to 100% (full load)
Rate of load change	±10% per hour
No of full load rejections	[1500] without a reactor trip
Safety Events	
Single control rod withdrawal	[TBD]
Multiple control rod withdrawal	[TBD]
Depressurization events	[TBD]
Small	[TBD]
Medium	[TBD]
Large	[TBD]
Depressurized conduction cooldown (DCC)	[TBD]
Pressurized Conduction cooldown (PCC)	[TBD]
Partial loss of flow	[TBD]
Loss of total flow	[TBD]
Loss of off site power (LOOP)	[TBD]
Max seismic events	[TBD]
Transients without scram (TWS)	[TBD]

Figure 1 – Sample System Configuration