UK EPR	Title: PCSR – Sub-chapter 1.3 – Comparison with reactors of similar design
	UKEPR-0002-013 Issue 05

Total number of pages: 13	Page No.: I / III
Chapter Pilot: G. MARTIN *Name/Initials* *Date* *10-10-2012*	
Approved for EDF by: A. MARECHAL *Name/Initials* *Date* *10-10-2012*	Approved for AREVA by: G. CRAIG *Name/Initials* *Date* *10-10-2012*

REVISION HISTORY

Issue	Description	Date
00	First issue (includes technical, co-applicant and INSA review comments)	27-04-2008
01	Second issue (includes corrections and wording clarifications)	30-06-2008
02	PCSR June 2009 update: Design evolutions to account for December 2008 design freeze (primary and secondary flow rates, temperatures, SG water mass) and clarifications/ rewording.	22-06-2009
03	Consolidated Step 4 PCSR update: - Addition of non-computerised technology in I&C - Wording correction for Remote Shutdown Station	25-03-2011
04	Consolidated PCSR update: - Minor formatting changes	08-08-2012
05	Consolidated PCSR update: - UK EPR Main Primary System, “Accounting for break preclusion” updated to “HIC claim” - Minor typographical changes	10-10-2012

For information address:

AREVA NP SAS
Tour AREVA
92084 Paris La Défense Cedex
France

EDF
Division Ingénierie Nucléaire
Centre National d'Equipement Nucléaire
165-173, avenue Pierre Brossolette
BP900
92542 Montrouge
France

TABLE OF CONTENTS

The content of this document consists of a single table.

SUB-CHAPTER 1.3 – COMPARISON WITH REACTORS OF SIMILAR DESIGN

Sub-chapter 1.3 consists of a comparison table of the main data for the UK EPR against the equivalent data for the latest generations of reactors built in France (N4 Reactors) and Germany (KONVOI Reactors), from which the EPR design is derived.

SYSTEMS / PARAMETERS	UNIT	UK EPR	N4 Unit	KONVOI Reactor
GENERAL REMARKS				
Net electrical output	MW(e)	≈1630	1475	1365
Thermal power output (core)	MWth	4500	4250	3850
Efficiency	%	36	34.5	35.4
Service life	Years	60	40	40
Temperature programme		The average core temperature is constant in the upper power range (between 60% and 100% of the nominal power)	Linear reduction in average core temperature between 100% and 0% of power (the cold leg temperature varies slightly in a ≤4°C range)	The average core temperature is constant in the upper power range (between 50% and 100% of the nominal power)
MAIN PRIMARY SYSTEM (RCP) [RCS]				
Number of loops		4	4	4
Operating pressure of RCP [RCS]	MPa	15.5	15.5	15.8
Design pressure of RCP [RCS]	MPa	17.6	17.2	17.6
Vessel inlet temperature in nominal conditions	°C	295.6	292.1	291
Vessel outlet temperature in nominal conditions	°C	329.8	329.1	324.5
SECONDARY SIDE				
Feed water temperature at 100% power	°C	230	229.5	218
Steam pressure at SG outlet (abs) at 100% power	MPa	7.71	7.23	6.45
Main steam flow rate	kg/s	2552.4 (4x638.1)	2400	2050

SYSTEMS / PARAMETERS	UNIT	UK EPR	N4 Unit	KONVOI Reactor
REACTOR CORE				
Fuel assembly				
Control principles at Nominal Power		Mixed solution: X-N4 mode / S-Konvoi mode: Only “black” rods Separation of control rods / shutdown rods	X mode: 4 “grey” partially inserted units A mode: No control rods inserted deeply	S Mode: Only “black” rods No separation of control rods / shutdown rods
Geometry of fuel assemblies		17X17-24	17X17-25	18X18-24
Number of fuel assemblies		241	205	193
Number of control rods		89 (black control rods only)	73 (65 black control rods and 8 grey)	61 (black control rods only)
Active length of fuel assembly (in cold service conditions)	mm	4200	4270	3900
Total length of fuel assembly	mm	4800	4800	4830
Fuel rods				
Number of rods		63865 (265 rods / assembly)	54120	57900
External diameter	cm	0.95	0.95	0.95
Network pitch	cm	1.26	1.26	1.27
Gross average power density per unit length	W/cm	167.7	183.9	170.5
Cladding thickness	cm	0.057	0.057	0.0641
Fuel pellets				
Composition		UO_2 or MOX	UO_2	UO_2 or MOX
Max design enrichment U 235	%	5	5	4

SYSTEMS / PARAMETERS	UNIT	UK EPR	N4 Unit	KONVOI Reactor
Average discharge burnup	MWd /kgU	>55 (for 18-month cycles) to <65 (for 24-month cycles)	40	50
MOX capacity		30 % as design basis	No MOX operation on the N4 currently	yes (50 %)
Structure of core				
Core baffles		Heavy reflector	Bolted baffle	Welded baffles
Primary coolant flow rate				
Total mass flow rate under thermal-hydraulic conditions	kg/s	22235	19714	18800
Mass flow rate in core under nominal best estimate conditions	kg/s	23135	20193	19875
Core instrumentation				
Ex-core instrumentation		Neutron flux measurement channels	Neutron flux measurement channels	Neutron flux measurement channels
In-core instrumentation		"assembly on vessel head" 40 aero-ball probes 12 fixed Self Powered Neutron Detector fingers for a total of 72 neutron detectors and 36 (12x3) fixed core exit thermocouples	"assembly from bottom of vessel" *6 mobile fission measurement detectors* *60 instrumented fuel assemblies* 52 core exit thermocouples	"assembly on vessel head" 28 aero-ball probes 8 fixed neutron detector fingers 48 (8x6) detectors 24(8x3) core exit thermocouples
REACTOR PRESSURE VESSEL				
Vessel Design				
Design temperature	°C	351	343	350
Internal diameter at core level	Mm	4870	4486	5000

SYSTEMS / PARAMETERS	UNIT	UK EPR	N4 Unit	KONVOI Reactor
PRIMARY PUMPS				
Flow rate (Best Estimate – design value)	m^3/h	28320	24850	22700
STEAM GENERATORS				
Secondary pressure boundary design pressure	MPa	10.0	9.1	8.83
Steam pressure at hot shutdown (0%NP)	MPa	9.0	≈ 8.1	≈ 8.0
Saturation pressure at full power at SG tube bundle outlet	MPa	7.8	7.31	6.55
Water mass in secondary section of Steam Generator at full load	t	77.2	62	46
COOLING SYSTEM AT SHUTDOWN				
Location of cooling system at shutdown		Outside Reactor Building	Inside Reactor Building	Outside Reactor Building
Number of pumps		4 (LHSI pumps)	2	4 mixed with LHSI
PRESSURISER				
Surge line connection on the pressuriser		Axial Vertical	Axial Vertical	Lateral Horizontal
Internal volume (hot)	m^3	75	60	65
MAIN PRIMARY SYSTEM				
Accounting for Break Preclusion		HIC claim	No	Yes
DESIGN OF RIS/RRA [SIS/RHRS]				
Medium-Head Safety Injection (MHSI) pumps				
Number of pumps		4	2 via a header	4
Injection of the MHSI		In cold leg	In cold leg	In cold leg / hot leg

SYSTEMS / PARAMETERS	UNIT	UK EPR	N4 Unit	KONVOI Reactor
Low-Head Safety Injection (LHSI) pumps				
Number of pumps		4	2 via a header	4
Injection of the LHSI		In cold leg (short term) and hot leg (long term)	In cold leg for the short term (hot and cold for the long term)	In cold and hot leg
Accumulators				
Number of accumulators		4	4	8
Location of injection		In cold leg	In cold leg	In cold and hot leg
BORATION SYSTEM				
System used in normal operation		Chemical and Volume Control System (RCV) [CVCS]	Chemical and volume control system (RCV) [CVCS]	Chemical and volume control system (RCV) [CVCS]
Safety system		Extra Boration System (2 trains) RBS [EBS]	Chemical and volume control system (RCV) [CVCS] Use of RCV [CVCS] for long-term phase (manual phase) medium-pressure RIS [SIS] system and RCP [RCS] discharge (through pressuriser safety valve if the RCV [CVCS] is unavailable or ineffective)	Additional boration system (4 trains)
FEEDWATER SYSTEMS				
Under normal operation		Main Feed Water Supply system (ARE) [MFWS]	Main Feed Water Supply system (ARE) [MFWS]	Main Feed Water Supply (ARE) [MFWS]
In the shutdown and startup phases		Dedicated AAD [SSS] system for shutdown and startup operations (1 pump)	Use of ASG [EFWS] emergency supply system	Dedicated system for shutdown and startup operations with 2 pumps, both supplied by a backed-up power supply

SYSTEMS / PARAMETERS	UNIT	UK EPR	N4 Unit	KONVOI Reactor
Incidental and accidental conditions		Emergency Feed Water Supply system (ASG [EFWS]) 4 separate, independent trains with passive headers The pumps are driven by electric motors backed up by the emergency diesel generators and the two SBO diesel generators	Emergency Feed Water Supply system (ASG [EFWS]) 4 pumps via headers (2 by 2) 2 electrical pump-motor units 2 turbo-pumps	Emergency Feed Water Supply system 4 separate, independent trains with passive headers Each pump is driven by: - diesel (directly) and - electric motor (without backup supply)
SPENT FUEL POOL COOLING SYSTEM (PTR [FPCS])				
Volume of fuel pool	m^3	≈ 1590	1150	
Number of pumps		2 main lines (2 pumps per main line) and an emergency line (1 pump)	2 lines (1 pump for each train)	
Nominal mass flow rate	Kg/s	Cooling pumps for main lines: 222 Backup pump: 153	Cooling pumps: 105.6	
COMPONENT COOLING WATER SYSTEM (RRI [CCWS])				
		4 trains (1 pump per train, 1 x100% heat exchanger per train)	2 lines (2 pumps per train, 2 x 50% heat exchangers per train)	
ESSENTIAL SERVICE WATER SYSTEM (SEC [ESWS])				
Number of pumps		4 (4 trains)	4 (2 trains, 2 x 100% pumps / train)	
ELECTRICAL SYSTEMS				
Supply under normal operation		4 independent trains in 2 divisions	2 independent trains in 2 divisions	4 independent trains in 4 divisions

SYSTEMS / PARAMETERS	UNIT	UK EPR	N4 Unit	KONVOI Reactor
Emergency supplies		Concept of 4 trains, 4 divisions 4 Emergency Diesels Generators with a power yield of about ≈ 7MWe each located in two geographically separated buildings (10 kV) 2 Station Black Out (SBO) Diesels (690 V). Diversity through different generators' designs (10kV, 690 V) and fuelling	Concept of 2 trains, 2 divisions 2 diesel generators each of 8MWe in two separate buildings Diversity of 2 diesels through the addition: of a 135kW turbine generator for short-term operation supplied by secondary steam and of a 7MWe gas turbine for the long term	Concept of 4 trains, 4 divisions 4 diesel generators (each of 5MWe) in dedicated buildings and 4 ultimate diesels (each of 0.96kVA) in completely protected separate buildings Diversity through size of the different diesel generators

SYSTEMS / PARAMETERS	UNIT	UK EPR	N4 Unit	KONVOI Reactor
INSTRUMENTATION AND CONTROL				
Technology		Digital (preferably "market" components) and non-computerised (NCSS)	Digital	Analogous, hard-wired. Digital and computer technology for certain applications
Main Control Room		Control through computer screens (except for the safety control panel) Protected against external hazards	Control through computer screens (except for the safety control panel) Protected against external hazards	Conventional with a digital assistance system Protected against external hazards
Remote shutdown station		Remote shutdown station with computer screens to bring the reactor to and maintain it in a safe state should the Main Control Room be unavailable Protected against external hazards	Remote shutdown station to bring the reactor to and maintain it in a safe state should the Main Control Room be unavailable Protected against external hazards	Backup control room (in a separate building) to keep the reactor in a safe state should the main control room be unavailable Protected against external hazards
CONTAINMENT				
Internal containment		Pre-stressed concrete with steel liner	Pre-stressed concrete no liner	Spherical steel containment
External wall		Reinforced concrete Annulus space at sub-pressure	Reinforced concrete Annulus space at sub-pressure	Reinforced concrete Annulus space at sub-pressure
Containment spray operation for PCCs		No	Yes 2 (100%) lines – pumps and heat exchangers outside containment	No
Pressure control system for Severe Accidents		Containment Heat Removal System 2 trains	Containment venting with filtering	Containment venting with filtering
Internal volume	m^3	≈ 80000	72700	70000

SYSTEMS / PARAMETERS	UNIT	UK EPR	N4 Unit	KONVOI Reactor
WATER STORAGE TANK				
Location		In-Containment Refuelling Water Storage Tank (IRWST) located inside the Reactor Building	PTR [FPPS/FPCS] tank located outside the Reactor Building	Inside the annulus
Number		1	1	4