SUB-CHAPTER B.3 COMPARISON TABLE – COMPARISON WITH REACTORS OF SIMILAR DESIGN (N4 AND KONVOI)

A comparison table of the main data of the French N4 and the German Konvoi series with the EPR is provided below.

SYSTEMS / PARAMETERS	UNIT	EPR (FA3)	N4 Unit	KONVOI Reactor
GENERAL REMARKS				
Net electrical output	MWe	≈1630	1475	1365
Thermal power output (core)	MWth	4500	4250	3850
Yield	%	36	34.5	35.4
Service life	Years	60	40	40
Temperature programme		The average core temperature is constant in the high section of the load 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 high section of the load range (between 50% and 100% of the nominal power)
MAIN PRIMARY SYSTEM (RCP) [RCS]				
Number of loops		4	4	4
Operating pressure of CPP [RCPB](abs)	MPa	15.5	15.5	15.8
Dimensioning pressure of CPP [RCPB] (abs) in T/H conditions	MPa	17.6	17.2	17.6
Input temperature of the reactor in T/H conditions	°C	295.7	292.1	291
Vessel output temperature in T/H conditions	°C	329.9	329.1	324.5
Feed water temperature at 100% power	°C	230	229.5	218
Steam pressure on output from steam generators (abs)	MPa	7.71	7.23	6.45
Main steam flow rate	kg/s	2552 (4x638.1)	2400	2050

SYSTEMS / PARAMETERS	UNIT	EPR (FA3)	N4 Unit	KONVOI Reactor
MECHANICAL DESIGN OF CORE				
Fuel assembly				
Control principles at nominal power		Mixed solution: X-N4 mode / S-Konvoi mode: - Only “black” units - Separation of control units / shutdown units	X mode: 4 “grey” partially inserted units A mode: No control rods inserted deeply	S Mode: Only “black” units No separation of control units / shutdown units
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
Not in network	cm	1.26	1.26	1.27
Average density of power per unit length	W/cm	163.4	179.5	166.6
Thickness of duct	cm	0.057	0.057	0.0641
Fuel pellets				
Composition		UO_2 or MOX	UO_2	UO_2 or MOX
Enrichment (max) U 235	%	≤ 5	3.4	4.0
Average discharge burnup rate	MWd /kgHM	>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 %)
Grid				
Rod network		17 x 17	17 x 17	18 x 18
Structure of core				

SYSTEMS / PARAMETERS	UNIT	EPR (FA3)	N4 Unit	KONVOI Reactor
Partitioning of core		Heavy reflector	Screwed partitioning	Welded partitioning
Primary coolant flow rate				
Total mass flow rate under nominal conditions	kg/s	22225	19714	18800
Mass flow rate in core under nominal conditions	kg/s	21002	20193	19875
Core instrumentation				
Excore instrumentation		Flow measurement channels	Flow measurement channels	Flow measurement channels
Incore instrumentation		"assembly on vessel's lid" 40 aero-ball measurement glove fingers 12 fixed detection glove fingers for a total of 72 neutron detectors and 36 (12x3) fixed core output thermocouples	"assembly from bottom of vessel" 6 mobile fission measurement detectors 60 instrumented fuel assemblies 52 core output thermocouples	"assembly on vessel's lid" 28 aero-ball measurement glove fingers 8 fixed detection glove fingers 48 (8x6) detectors 24(8x3) core output thermocouples
VESSEL				
Dimensioning of the vessel				
In-service dimensioning pressure (abs)	MPa	17.6/15.5	17.2/15.5	17.6/15.8
Dimensioning temperature	°C	351	343	350
Internal diameter at core level	mm	4870	4486	5000

SYSTEMS / PARAMETERS	UNIT	EPR (FA3)	N4 Unit	KONVOI Reactor
PRIMARY PUMPS				
Rate (Best Estimate – dimensioning value)	m^3/h	28315	24850	22700
STEAM GENERATORS				
Secondary envelope dimensioning pressure (abs)	MPa	10.0	9.1	8.83
Steam pressure at hot shutdown (0%PN) (abs)	MPa	9.0	≈ 8.1	≈ 8.0
Saturation pressure (abs)	MPa	7.8	7.31	6.55
Weight of water in secondary section of Steam Generator at full load	Mg	77.8	62	46
COOLING SYSTEM AT SHUTDOWN				
Location of cooling system at shutdown		Outside containment	Inside containment	Outside containment
Number of pumps		4 (RIS BP [SIS LP] pumps)	2	4 mixed with ISBP [LHSI]
PRESSURIZER				
Fastening of surge line		axial	axial	Lateral
Internal volume (hot)	m^3	75	60	65
MAIN PRIMARY SYSTEM				
Taking exclusion of rupture into account		Yes	No	Yes
DESIGN OF RIS/RRA [SIS]/[RHRS]				
Medium-pressure safety injection pumps				
Number of pumps		4	2 via a header	4
Injection of the medium-pressure RIS[SIS] systems		In cold leg	In cold leg	In cold leg / hot leg
ISBP[LHSI] low-head safety injection pumps				
Number of pumps		4	2 via a header	4
Injection of the low-pressure RIS [SIS]systems		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				

SYSTEMS / PARAMETERS	UNIT	EPR (FA3)	N4 Unit	KONVOI Reactor
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		Additional boration system (2 trains)	Chemical and volume control system (RCV) [CVCS] Use of RCV for long-term phase (manual phase) medium-pressure RIS [SIS] system and CPP **[RCPB]**discharge (through pressurizer safety valve if the RCV is unavailable or ineffective)	Additional boration system (4 trains)
Water supply				
Under normal operation		Main water supply system (ARE) [MFWS]	Main water supply system (ARE) [MFWS]	Main water supply system (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
Incidental and accidental conditions		emergency supply system 4 separate, independent lines with standardisations The pumps are driven by electric motors backed up by the main diesel generators and the two last-resort diesel generators	emergency supply system 4 pumps with standardisation (2 by 2) 2 electrical pump-motor units 2 turbo-pumps	emergency supply system 4 separate, independent lines with standardisations Each pump is driven by: - diesel (directly) and - electric motor (without backup supply)

SYSTEMS / PARAMETERS	UNIT	EPR (FA3)	N4 Unit	KONVOI Reactor
POOL COOLING SYSTEM				
VOLUME OF FUEL POOL	m^3	≈ 1486	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 OUTPUT	kg/s	Cooling pumps for main lines: 222 Backup pumps: 153	Cooling pumps: 105,6	
COMPONENT COOLING SYSTEM FOR THE RRI [SIS]NUCLEAR ISLAND				
		4 lines (1 pump per line, 1 exchanger per train)	2 lines (2 pumps per line, 2 half-exchangers per train)	
ESSENTIAL SERVICE-WATER SYSTEM SEC [ESWS]				
NUMBER OF PUMPS		4 (4 trains)	4 (2 trains, 2 100% pumps / trainn)	
ELECTRICAL SYSTEMS				
Supply under normal operation		4 independent trains in 2 divisions	2 independent trains in 2 divisions	4 independent trains in 4 divisions
Emergency supplies		Concept of 4 trains, 4 divisions 4 diesels with a power yield of about ≈ 7MWe each in geographically separated buildings (10 kV) 2 small diesel generators of last resort (690 V) Diversity through different sizes of diesel generator and different voltages (10kV, 690 V)	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 diesels of last resort (each of 0.96kVA) in completely protected separate buildings Diversity through size of the different diesel generators

SYSTEMS / PARAMETERS	UNIT	EPR (FA3)	N4 Unit	KONVOI Reactor
Control				
Technology		Digital (preferably "market" components)	digital	Analogue, cable connections digital and computer technology for certain applications
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 connect to the reactor and keep it in a safe state should the control room be unavailable Protected against external hazards	Remote shutdown station to connect to the reactor and keep 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		Prestressed concrete with a metallic surface	Prestressed concrete no surface	Spherical steel enclosure
External enclosure		Reinforced concrete Space between containment walls under negative pressure	Reinforced concrete Space between containment walls under negative pressure	Reinforced concrete Space between containment walls under negative pressure
Pressure control system for serious accidents		(sump spray and cooling system) 2x50% lines outside containment for the short term and 2x100% for the long term	Decompression of containment by venting with filtering	Decompression of containment by venting with filtering
Internal volume	m^3	≈ 80 000	72 700	70 000
Containment spraying				
Provided in the context of PCC events		No	2 (100%) lines outside containment	No

SYSTEMS / PARAMETERS	UNIT	EPR (FA3)	N4 Unit	KONVOI Reactor
PTR [FPPS/FPCS]TANK				
			External tank in stainless steel	
Location		Inside containment	Outside containment	The annulus
Number		1	1	4
TURBINE GENERATOR SET				
Turbine				
Number		1 per unit	1 per unit	1 per unit
Rotation speed	rpm	1500	1500	1500
Architecture		Option A: 1 cylindrical dual flow HP 3 cylindrical dual flow LP Option B: 1 cylindrical single flow HMP, 3 cylindrical dual flow LP	1 high-pressure turbine cylinder 1 medium-pressure turbine cylinder 3 low-pressure turbine cylinders	
Turbine length	m	≈ 50 m	50.4	
Drawing off steam	/	7	6	