UK EPR	Title: PCSR – Sub-chapter 10.1 – General Description
	UKEPR-0002-101 Issue 02

Total number of pages: 6	Page No.: I / III
Chapter Pilot: Ph CHAUMIN *Name/Initials* P. CHAUMIN *Date* 16-06-2009	
Approved for EDF by: A. PETIT *Name/Initials* *Date* 24-06-2009	Approved for AREVA by: C. WOOLDRIDGE *Name/Initials* C.Wooldridge *Date* 23-06-2009

REVISION HISTORY

Issue	Description	Date
00	First issue for INSA	11-12-2007
01	Integration of technical, co-applicant and INSA review comments	25-04-2008
02	PCSR June 2009 update: - clarification of text - inclusion of references	24-06-2009

For information address:

AREVA NP SAS
An AREVA and Siemens Company
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

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SUB-CHAPTER 10.1 – GENERAL DESCRIPTION

1. ROLE OF SECONDARY COOLING SYSTEM

The role of the secondary cooling system is to convert thermal energy produced by the nuclear steam supply system into electrical power. The thermal energy not converted into electrical power is rejected to the heat sink.

2. DESIGN BASIS

2.1. GENERAL DESIGN OF THE SECONDARY COOLING SYSTEM

The secondary water-steam system is a closed circuit.

Four steam generators produce steam in the secondary system to drive a turbine coupled to a three-phase alternator. The voltage is increased to 400 kV by transformers, for export to the power network.

The turbine exhaust steam is condensed by the water-cooled condenser, thus providing a heat sink for the thermal energy not converted to electrical power. The cooling water system is an open circuit that uses seawater.

When the turbine is unavailable, after a turbine trip or a fast reduction in load (e.g. house load operation), the steam produced by the steam generators can be exhausted through the turbine bypass system (GCT [MSB]) directly to the condenser.

VDA [MSRT] atmospheric dump valves can release steam into the atmosphere (see Sub-chapter 6.8), thus allowing for dumping of the steam produced by the steam generators when the condenser is unavailable.

2.2. DESIGN BASIS ASSUMPTIONS

The complete secondary cooling system is designed for a thermal power in the core of 4,500 MWth to which the power of the primary motor-driven pumps must be added (+24 MWth).

House load operation does not cause the reactor to automatically shut down nor does it trip the turbo-generator unit. It does not make any demand on the steam generator relief valves.

The following table provides main data for rated operating conditions:

Parameter	Rated operating conditions
Nuclear steam supply output	4500 MWth + 24 MWth (reactor coolant pumps)
Steam flow rate (mass flow per SG)	638.1 kg/s
Pressure at the turbine inlet	75.2 bar abs.
Water flow rate (mass flow per SG)	645 kg/s
Water temperature	230°C
Blowdown flow rate	1% water flow rate

3. PRELIMINARY SAFETY ANALYSIS

The secondary cooling system, excluding steam generators, has no direct safety role except for the following functions:

- VDA [MSRT]: atmospheric steam dumping,
- ARE [MFWS]: isolation of main feedwater system,
- VVP [MSSS]: steam isolation,
- Turbine trip.

The role of the secondary cooling system is as follows:

a) Removal of thermal energy:

- when the unit is connected to the grid by the turbo-generator,
- during normal transient operating conditions (start-up, shutdown, fast variations in unit load) through steam bypass to the condenser.
- during some hot shutdown phases, through steam bypass to the condenser or the VDA [MSRT] lines to the atmosphere.

In these three cases, the feedwater plant supplies water to the steam generators.

When the feedwater supply systems are not available, the steam generator feedwater is provided by the ASG [EFWS] system. In preparation for the start-up phase, the steam generators are filled with water by the ASG [EFWS] system. During the start-up or shutdown phases the AAD [SSS[1]] system is used.

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[1] SSS:Start-up and Shutdown System

b) Containment of radioactive substances

The secondary cooling system is not a containment barrier. Environmental protection in the event of a primary/secondary leak is performed by:

- The steam generator blowdown system (APG [SGBS]). This is designed to extract solid radioactive materials. After decontamination treatment, the blowdown water is sent back to the condenser or, should the condenser be unavailable, to the KER [LRMDS] system,
- The vacuum system (CVI). This is designed to extract non-condensable gases contaminated with radioactive gases. These are discharged into the atmosphere by the stack after monitoring and evaluation operations,
- The collection of water lost from the system (drainage water from the turbine hall) that is collected by the SEK [CILWDS] system and monitored before release,
- The maintenance of pressure in the cooling water circuit at a value greater than the pressure inside the condenser, which prevents any radioactive leaks through this channel.

Finally, risks of hazards to the nuclear island from the turbine hall are taken into account in the design or they are specifically analysed. Measures include:

- Orientation of the turbine hall axis to avoid risks of turbine disintegration missiles affecting the nuclear island.
- Additional measures regarding the safety of rotating machinery and various protection devices (fire),
- Application of seismic analysis to evaluate the risk to the safeguard and electrical buildings from failure of the turbine hall.