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Thermal-Hydraulic Analysis of Total Loss of Steam Generator Feed Water in VVER-440 and VVER-1000 NPP

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Abstract

The results of the calculations with the CATHARE computer code of postulated accidents with Total Loss of Steam Generator Feed Water (TLFW) (reference plants : the Armenian NPP Metzamor Unit 2 (VVER-440/V270) and the Russian NPP Balakovo 3 (VVER-1000/V320)) are presented. These studies are carried out in the framework of TACIS projects, which objective is the support of the respective safety authorities in the assessment of the modernization of the plants and improvement of their safety. It has to be verified the effectiveness of the operator actions of primary system "Feed and Bleed" in order to reduce the primary pressure, actuate the safety injection and cool down the reactor system.

In case of TLFW, without application of the "Feed and Bleed" the pressure remains high, no safety injection pumps are actuated, the steam generators are lost as heat sinks, the heat from the primary system is removed by the cyclic opening and closing of the pressurizer safety valves, primary inventory is getting lost and finally core heat-up and dry-out occur in about 5 hours for VVER-440 and about 3 hours for VVER-1000.

To cope with the accident the operator can undertake:

- Feed by safety injection manual operation
- Bleed : - either by opening pressurizer safety valve (s) (VVER-440 and VVER-1000)
  - or by opening the valves of Gas Blow-off System (VVER-1000)

Sensitivity studies have been performed with combination of different number of pressurizer safety valves opened, different number of HPSI pumps started and with and without loss of power. More optimal cool down of the reactor system has been shown in order to cope with the accident. The CATHARE calculations of TLFW with the assumptions taken into consideration show that the operator has sufficient time for remedy measures and by proper accident management action of "Feed and Bleed" can carry out reliable cool down of the reactor system, avoid the dryout of the reactor core, the fuel cladding temperature rise and fuel meltdown.