ASTEC SIMULATION OF A SBO WITH RE-FLOOD IN A GERMAN KONVOI NPP

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ABSTRACT

This work describes the ASTEC simulation of a station black-out (SBO) scenario in a German 1300 MW_{el} KONVOI NPP with subsequent re-flood of a partly degraded core performed in the frame of the European research project CESAM in the 7th framework program. During the assumed SBO sequence no electrical supply is available on the main voltage levels including the failure of all electrical emergency systems.
The simulation results of ASTEC show the capability of the system code to depict the occurring phenomena and the accident scenario reasonably. Uncertainties can be seen in the simulation of degradation phenomena, especially depicting the re-flooding phase, whereas the general behavior of the calculated NPP is kept. Furthermore, the severe accident management (SAM) measure, the restore of electricity and high pressure injection (HPI), is capable to transfer the system into stable conditions after the desired accident.

KEYWORDS
Plant Application, KONVOI, SBO, SAM, ASTEC, CESAM

1. INTRODUCTION

Since the accident in the nuclear power plant (NPP) TMI-2 occurred 1979 in Harrisburg much emphasis was put in the nuclear safety research activities to understand the phenomena during severe accident progressions. Experiments facing these different phenomena were carried out in several international research programs where new knowledge in the degradation phase during an accident was gained and applied in the development of simulation codes. As the severe accident in the Fukushima-Daiichi NPP occurred in March 2011 this gave again an impact on the nuclear safety research resulting in national stress-tests and international projects. In the European project CESAM (Code for European Severe Accident Management) activities are performed to investigate phenomenological behaviors and assumed accident progressions in NPPs in Europe applying and developing the European Severe Accident Analysis Code ASTEC.
This work describes the ASTEC simulation of a station black-out (SBO) scenario in a German 1300 MW_{el} KONVOI NPP with subsequent re-flood of a partly degraded core performed in the frame of CESAM. During the assumed SBO sequence no electrical supply is available on the main voltage levels including the failure of all electrical emergency systems. The remaining water in the steam generators (SG) and battery capacities capable to keep open the SG relieve valves for around 2 h obtain a heat removal off the primary system not enough to expel the decay heat. The pressurizer safety valves limit the primary pressure increase to around 169 bar. As the pressure cannot be decreased by any other system this initiates loss of coolant into the containment through these valves. Therefore, the loss of coolant cannot be stopped heading towards an accelerated evaporation and core uncover. The core heat-up leads to severe

5. CONCLUSIONS

The given scenario is calculated with an on each other reasonably depending sequence of events. Especially the thermal hydraulic behavior appears consistent in the given context of the postulated scenario with exceptions inside the reactor pressure vessel as water remains on upper elevations in the core not flowing down during the re-flood (s. Fig. 10). Uncertainties can be seen in the simulation of the beginning accident late phase when core degradation starts. The reactor core starts to heat-up from the central upper region with a reliable heat distribution decreasing to outer radii. During the further heat-up the hottest core region shifts outwards and to lower elevations resulting in an uneven distribution. The respective material degradation and relocation follows this shift. This behavior appears unlikely in the given configuration and will be part of further investigations, in particular accounting heat transfer mechanisms in the core, like the radiation modelling. Furthermore, the cool-down of accumulated degraded materials appears to be simulated relatively slow. This will be part of further ongoing studies of the coolability of degraded structures with further improved versions of ASTEC. Overall the assumed SAM measure, the restore of electricity and HPI, is capable to cool-down widest parts of the reactor core and to transfer the NPP into stable conditions, stopping the generation of hydrogen and the emission of radioactive fission products.

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SEVENTH FRAMEWORK PROGRAMME

cesam

CODE FOR EUROPEAN SEVERE ACCIDENT MANAGEMENT

European Commission

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