SAFETY RESEARCH FOR NUCLEAR REACTORS AT FORSCHUNGSZENTRUM KARLSRUHE, GERMANY

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Abstract. *In Germany 17 nuclear power plants are generating 23% of the electrical energy at present (21 GW). A government decree from the year 2000 limited the permitted plant life to 32 years, respectively a corresponding total power output, which means that all plants must be shut down within the next 14 years. Nevertheless research on nuclear topics continues, especially on nuclear safety and waste management issues.*

The design basis for a nuclear reactor includes specifications which ensure that challenging events, accidents and external hazards may occur without resulting in a large release of radioactive material into the environment. The melting of the core is not taken into consideration. Since the TMI-2 accident in 1979 we know that a severe accident with melting of the core is possible, and consequently research was initiated, to acquire knowledge about the progression and consequences of a severe accident. The objectives of the research were to determine if the present plants were sufficiently safe or they required backfits, both for the prevention of the initiation of accidents and to mitigate their consequences if they do start. The emphasis was placed on the integrity of the containment, which serves as the last barrier to prevent the release of radioactive fission products to the environment, either airborne as gas or aerosols or as melt pool through the basemat (China Syndrome) threatening the contamination of the water. In order to tackle the problem of the potential loads on the containment, but also to prevent or limit excessive loads by accident management measures, an understanding of the whole chain of events is needed, starting with the lack of cooling and the melting of the first fuel rods down to the behavior of melt-concrete interactions.

The proposed lifetime extension of existing reactors and the introduction of new reactor designs (generation-3) requires new safety assessments including severe accidents in order to obtain public acceptance. The public demands assurances of safety, which guarantee that no dangerous radioactive contamination will occur outside the nuclear plant at all events. In order to optimize the use of available means and to harmonize safety requirements in the European Union, a Severe Research Accident Network (SARNET) was established, which has gathered 51 organizations representing most of the actors involved in severe accident research in Europe and Canada. Forschungszentrum Karlsruhe (FZK) is one of the main institutions in Germany engaged in this research. An overview will be given on the SARNET project and the activities pursued at FZK related to safety of existent nuclear power plants in Europe. The work performed in the 'Accident Analysis Section' of the Institute for Nuclear and Energy Technologies at FZK will be presented in more detail. The work includes the investigation of critical heat flux (CHF) at prototypic conditions, the emergency core cooling system (ECCS)during a loss of coolant accident in a pressurized water reactor (PWR)dealing with counter current gas-liquid flow, and several issues at core melt accidents in PWRs, concerning in-vessel and ex-vessel corium behavior.