U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Containment Design

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ARDC 16 Containment Design

- NRC proposes to use the current GDC.

Rationale:

~~For non-LWR technologies other than SFRs and mHTGRs, designers should use the current GDC to develop applicable principal design criteria.~~

Designers may propose using the SFR-DC-16 as appropriate.

Use of the mHTGR- DC 16 will be subject to a policy decision by the Commission.

NRC Proposed Update to SFR-DC 16

A reactor containment consisting of a high strength, low leakage, pressure retaining structure surrounding the reactor and its primary cooling system, shall be provided to control the release of radioactivity to the environment and to assure that the reactor containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

The containment leakage shall be restricted to be less than that needed to meet the acceptable onsite and offsite dose consequence limits as specified in 10 CFR Part 50.34 for postulated accidents.

Proposed NRC Rationale for SFR-DC 16

The Commission approved the staff's recommendation to restrict the leakage of the containment to be less than that needed to meet the acceptable onsite and offsite dose consequence limits [Ref. SRM, SECY-93-092, ML003760774].

Therefore, the Commission agreed that the containment leakage for advanced reactors, similar to and including PRISM, should not be required to meet the "essentially leak tight" statement in GDC 16. [Ref: NUREG-1368, ML063410561, 1994].

Proposed NRC Rationale for SFR-DC 16 (cont.)

~~Also, ARDCs and SFR-DCs 38, 39, 40, 41, 42,~~

~~43, 50, 51, 52, 53, 54, 55, 56, and 57 in the DOE report refer to containment in the traditional sense in that these SFR-DCs specify traditional containment systems design, inspection, and testing (including leakage rate testing).~~

Furthermore, all past, current, and planned SFR designs use a high strength, low leakage, pressure retaining containment concept which aims to provide a barrier to contain the fission products and other substances and to control the release of radioactivity to the environment.

Proposed NRC Rationale for SFR-DC 16 (cont.)

Reactions of sodium with air or water, sodium fires, and hypothetical reactivity accidents caused by sodium voiding or boiling, could release significant energy inside the reactor containment structure. Therefore, a high strength, low leakage, pressure retaining structure surrounding the reactor and its primary cooling system is required. Note that a design could have a low design pressure for the containment.

Several technical reports and presentations support the need for a pressure retaining structure surrounding SFRs.

Proposed NRC Rationale for SFR-DC 16 (cont.)

- "Experimental Facilities for Sodium Fast Reactor Safety Studies, Task Group on Advanced Reactors Experimental Facilities (TAREF), 2011, PP 22 and 54." This report indicates that it is necessary that structures withstand the thermo-mechanical load caused by sodium fire in order to avoid fire propagation and dispersion of aerosols.

- "Safety Design Criteria for GEN IV Sodium-Cooled Fast Reactor Systems." SDC-TF/2013/01, May 2013, P. 57. This report notes that the design basis for containment shall consider pressure increase and thermal loads due to sodium fire.

Proposed NRC Rationale for SFR-DC 16 (cont.)

- Tanju Sofu, "SFR Technology Overview," IAEA Education & Training Seminar on Fast Reactor Science &Technology, 2015. The technical expert noted: a low design pressure for containment is due to heat produced by a potential sodium fire.

- "NAFCON -SF: A sodium spray fire code for evaluating thermal consequences in SFR containment," Annals of Nuclear Energy, 2016, notes that Beschreibung der Forschungsanlage zur Untersuchung nuklearer Aerosole (FAUNA) spray fire experiments in Germany showed peak pressures in containment over 3.5 bars within the first 5 seconds, gradually tapering downwards to less than 3.5 bars at 25 seconds.

NRC Proposed Update to mHTGR-DC 16

A reactor functional containment, consisting of multiple barriers internal and/or external to the reactor and its cooling system, shall be provided to control the release of radioactivity to the environment and to assure that the functional containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.