Tier 3 - NTTF Recommendation 5.2

Reliable Hardened Vents for Other Containment Designs

Purpose

The purpose of this status summary is to provide a rationale for deferring further regulatory action to enhance containment overpressure protection for other containment designs (i.e., containment designs other than BWR Mark I and Mark II containments).

NTTF Recommendation and Other Direction

In SECY-11-0093, the NTTF recommended that the Commission direct the staff to:

> Reevaluate the need for hardened vents for other containment designs [i.e., containment designs other than BWR Mark I and Mark II containments], considering the insights from the Fukushima accident. Depending on the outcome of the reevaluation, appropriate regulatory action should be taken for any containment designs requiring hardened vents.

This recommendation was prioritized as Tier 3 in SECY-11-0137 because longer term staff evaluation was required to support a decision on the need for regulatory action. In SRM-SECY-11-0137, the Commission supported the prioritization of NTTF Recommendation 5.2 as Tier 3.

Regulations and Guidance

1. Section 50.55a of Title 10 of the Code of Federal Regulations (10 CFR) and General Design Criterion (GDC) 1, "Quality Standards and Records," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that containment being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed.

2. GDC 2, "Design Bases for Protection against Natural Phenomena" requires containments to be able to withstand the most severe natural phenomena such as winds, tornadoes, floods, and earthquakes and the appropriate combination of all loads.

3. GDC 16, "Containment Design," requires that reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

4. GDC 38, "Containment Heat Removal," requires systems to be provided to remove heat from the reactor containment. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

5. GDC 50, “Containment Design Basis,” requires containments to be designed with sufficient margin of safety to accommodate appropriate design loads.

6. Paragraph (hh)(2) of 10 CFR 50.54 requires licensees to develop and implement guidance and strategies to maintain or restore containment capabilities under the circumstances associated with loss of a large area of the plant due to explosions or fire; expectation B.2.e of the B.5.b Phase 1 Guidance Document dated February 25, 2002 (designated Safeguards Information) and Section 3.4.8 of the NRC-endorsed Phase 3 guidance in NEI 06-12, Revision 2, “B.5.b Phase 2 & 3 Submittal Guidance,” both specify that an acceptable means of meeting the 10 CFR 50.54(hh)(2) requirements includes the development of a procedure or strategy to allow venting primary containment to secondary containment, without AC power, as an alternate method to remove heat from the primary containment for BWR licensees. All currently operating BWR licensees, including those with BWR Mark I, Mark II, and Mark III containment designs, adopted this approach to meeting the requirements of 10 CFR 50.54(hh)(2). There are neither current NRC regulations that require this capability for other severe (beyond-design basis) accidents, nor design criteria for the vent paths used in this strategy.

7. Section 50.34(f) of 10 CFR requires that licensees be able to demonstrate containment integrity of applicable plants for loads associated with an accidental release of hydrogen generated from metal-water reaction of the fuel cladding, accompanied by hydrogen burning or added pressure from post-accident inerting.

8. Section 50.44 of 10 CFR requires that licensees be able to demonstrate the structural integrity of BWRs with Mark III type containments, all PWRs with ice condenser containments, and all containments used in future water-cooled reactors for loads associated with combustible gas generation.

9. NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Sections 6.2.1 through 6.2.2 describe methods that are acceptable to the NRC staff for assessing the functional design of containments, their ability to withstand pressurization loads, and remove heat under post-accident conditions.

Staff Assessment and Basis for Prioritization

Over the past 30 years, the NRC has evaluated the merits of venting containments for all reactor designs. The historical focus on containment venting has been on nuclear power plants with Mark I and II containment designs. This is due, in part, to the relatively small containment free volume of the Mark I and II containments, and the manner in which these plants respond to particular accident sequences.

A particular challenge to nuclear power plants with Mark I and II containments are postulated accident sequences in which the reactor core would be successfully cooled but the containment cooling function would be impaired (i.e., so-called “TW” sequences – or transients with loss of containment cooling). In these accident sequences, cooling of the reactor core would be achieved by transferring decay heat to the suppression pool via various safety systems. If cooling were not provided for the suppression pool in these accident sequences, the containment pressure would rise. For this reasons, a hardened vent is provided to vent the containment to prevent containment pressure from exceeding the primary containment pressure

limit, while the reactor core is still being cooled. This capability was the subject of the March 12, 2012, order EA-12-050 to nuclear power plants with Mark I and II containment designs.

Nuclear power plants with other types of containment designs are not susceptible to the same overpressurization concerns. This is due to fundamental differences in designs, and the manner in which the various designs remove decay heat from the reactor core following a transient. As an example, following a transient, pressurized water reactors transfer decay heat to steam generators, which ultimately transfer heat to the environment. As a result, reactor safety studies conducted over the years have not identified significant benefits in venting pressurized water reactors for accident sequences associated with preventing core damage.

Following a core damage accident, the containment atmosphere of all containment designs would contain a large concentration of radioactive material. This radioactive material could be released in the event that a hardened reliable containment vent was opened following core damage. This is why the Commission directed the staff in SRM-SECY-11-0137 to evaluate the merits of new requirements that address operability of reliable hardened vents under severe accident conditions. The staff is also evaluating the merits of requiring the installation of hardened reliable containment vent filters for nuclear power plants with Mark I and II containments. Given the existing assessments of the merits of containment venting for all containment designs, the staff believes that it should continue to put a higher priority on resolving this issue for nuclear power plants with Mark I and II containment designs. Following the Commission decisions on the need for severe accident venting or filtered venting for plans with Mark I and II containments, the staff would reassess the merits of venting for other containment designs [i.e., containment designs other than BWR Mark I and Mark II containments]

Staff Recommendations

The staff recommends that consideration of venting for other containment designs [i.e., containment designs other than BWR Mark I and Mark II containments] be deferred until the Commission reaches a decision on the need for severe accident venting and filtered venting for BWR Mark I and Mark II containments.

Unique Implementation Challenges

The staff's efforts have been focused on resolving whether reliable hardened containment vents for BWR Mark I and Mark II containments should include filters and should also be operable under severe accident conditions. Given the limited resources in these specialized disciplines, the staff believes priority consideration should continue to be placed on resolving issues for BWR Mark I and Mark II containment designs. Once these issues are resolved, the staff would evaluate the merits of requiring venting for other containment designs.