From: Wilson, George
To: Martin, Robert
Subject: fyi
Date: Tuesday, September 06, 2011 7:38:57 AM

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http://www.iaea.org/newscenter/news/pdf/kashiwazaki011208_vol1.pdf

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Regulatory Guide 1.166 - PRE-EARTHQUAKE PLANNING AND IMMEDIATE NUCLEAR POWER PLANT OPERATOR POSTEARTHQUAKE ACTIONS

The Electric Power Research Institute has developed guidelines that will enable licensees to quickly identify and assess earthquake effects on nuclear power plants. These guidelines are in EPRI NP-5930, "A Criterion for Determining Exceedance of the Operating Basis Earthquake," July 19882; EPRI NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake," December 19892; and EPRI TR-100082, "Standardization of the Cumulative Absolute Velocity," December 1991.2

Regulatory Guide 1.167 - RESTART OF A NUCLEAR POWER PLANT SHUT DOWN BY A SEISMIC EVENT

C. REGULATORY POSITION

After a plant has been shut down by an earthquake, the guidelines for inspections and tests of nuclear power plant equipment and structures that are in EPRI NP-6695, depicted in Figure 3-2 and specified in Sections 5.3.2, 5.3.3, and 5.3.4; the documentation specified in Section in 5.3.5 to be submitted to the NRC; and the long-term evaluations that are specified in Section 6.3, with the exceptions specified below, are acceptable to the NRC staff for satisfying the requirements in Paragraph IV(a)(3) of Appendix S to 10 CFR Part 50.

10 CFR PART 50 Appendix S IV(a)(3) - The required safety functions of SSC's must be assured during and after the vibratory ground motion associated with the SSE ground motion through design, testing, or qualification methods

EXCEPTIONS TO SECTION 6.3.4.1 OF EPRI NP-6695

1.1 Item (1) should read: If the calculated stresses from the actual seismic loading conditions are less than the allowables for emergency conditions (e.g., ASME Code Level C Service Limits or equivalent) or original design bases, the item is considered acceptable, provided the results of inspections and tests (Section 5.3.2) show no damage.

1.2 The second dashed statement of Item (3) should read:

-An engineering evaluation of the effects of the calculated stresses on the functionality of the item. This evaluation should address all locations where stresses exceed faulted allowables and should include fatigue analysis for ASME Code Class 1 components and systems.

2. LONG-TERM EVALUATIONS

Coincident with the long-term evaluations, the plant should be restored to its current licensing basis. Exceptions to this must be approved by the Director, Office of Nuclear Reactor Regulation.

EPRI NP -6695 - Guidelines for Nuclear Plant Response to an Earthquake

<u>(For significant earthquakes the long term evaluations will need to be completed prior to startup)</u>

The combination of the recommended short-term, post-shutdown, and long-term actions provides a rational, experience-based approach for determining the real damage potential of a felt or recorded earthquake, a systematic methodology for assessing plant readiness for restart based on physical inspections and tests, and realistic criteria for assuring the long-term integrity of the plant. They also minimize the likelihood of prolonged plant shutdowns following non-damaging seismic disturbances and place primary emphasis on the physical and functional condition of the plant as a measure of restart readiness as opposed to relying primarily upon analytical evaluations.

<u>Long Term Actions – If SSE exceeded these should be needed prior to restart</u>

Calculation of seismic loads (i.e., floor response spectra based on actual ground motion records from the earthquake).

Comparison of calculated seismic loads with design loads at locations of interest.

Seismic re-evaluation of equipment and structures where calculated loads may have exceeded design loads.

Calculation of Seismic Loads-

<u>Conventional Method</u>. The conventional method consists of applying the actual recorded acceleration time-history to existing dynamic building models. The time-history response of each floor is calculated and the resulting floor response spectra are then generated. This method is the preferred method if time-history records for the earthquake are available.

<u>Direct Generation Method</u>. The direct generation method consists of generating floor response spectra directly from the actual recorded ground (free-field) spectra using existing dynamic building models (i.e., transfer functions). Methods for generating floor response spectra by the direct method are described in References 3 and 4. This method should be used only if time-history records are not available.

Comparison of Actual vs. Design Loads

The calculated floor response spectra based on the actual earthquake record should be compared with the SSE floor response spectra. If the calculated floor response spectra for any floor elevation are enveloped by the SSE floor response spectra (i.e., are less than the SSE floor response spectra at all frequencies of interest), then the design basis for floor mounted equipment and piping on that floor has not been exceeded, and seismic re-evaluation of equipment and piping on that floor is not required. However, if the calculated floor response spectra for any floor elevation exceeds the SSE floor response spectra at any frequency, then the design basis for floor mounted equipment and piping, as well as the structure itself, may have been exceeded and further evaluations should be performed.

Seismic Re-Evaluations

Select items with natural frequencies in the range of exceedance.

Select items with the highest calculated stresses based on previous stress analysis results.

Select items which are representative of equipment, piping, and structures located on floors with exceedance.

Initial Checks

Check for leaks in piping systems, especially at flanged or threaded connections and branch lines.

Check for damage to low pressure tanks, particularly ground or floor mounted vertical storage tanks.

Check for damage to switchyard equipment.

Check fluid levels in tanks. Level switches may have been activated due to sloshing of the contained fluid (an actual but momentary change in level).

Check for high vibration, high bearing temperature, and unusual nois in rotating equipment such as pumps and fans.

Check for damage to equipment and structures due to impact with adjacent equipment and falling objects.

Check the condition of a sampling of the equipment anchorage including deformation or loosening of anchor bolts, pullout or shear of anchor bolts, rocking, sliding, or misalignment of equipment.

Check for damage to attached piping including hoses, tubing, and electrical conduit.

Check for damage to pipe, and check pipe and component supports for evidence of excessive displacement.

Check for distortion of electrical and control cabinets including a brief visual check of a sampling of internally mounted components such as relays and circuit breakers.

Check for major cracks or spalling in reinforced concrete structures Hairline cracks in reinforced concrete structures are not considered significant.

Check the operational status of important relays, breakers, and other potentially sensitive electric gear (in particular, those in protective and seal-in/lockout circuits whose change in state could affect operability of equipment and systems).

Check for portable equipment which may have fallen on safe shutdown equipment.

- Decay heat removal system, including pumps and heat exchangers
- Major sources of water
  - Borated water storage tank (PWRs only)
  - Refueling water storage tank (PWRs only)
  - Condensate storage tank
- Delivery systems
  - Makeup water system
  - Auxiliary feedwater system (PWRs only)
- Station emergency electrical system, including the diesel generators, station batteries, AC and DC buses, and associated breakers and relays

Instrumentation to control systems to regulate or monitor the above systems