155

**Boyle, Patrick**

**From:** Khanna, Meena
**Sent:** Thursday, September 15, 2011 10:38 PM
**To:** Karwoski, Kenneth
**Cc:** Boyle, Patrick; Martin, Robert
**Subject:** FW: Revised IAEA Summary Document
**Attachments:** IAEA Report No 66_Summary for Restart Actions_Rev2.docx

I had Billy put together a summary of the IAEA report. Fyi...

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**From:** Jessup, William
**Sent:** Thursday, September 15, 2011 9:06 AM
**To:** Khanna, Meena
**Subject:** Revised IAEA Summary Document

Meena,

I wanted to send you an updated version of the synopsis of the IAEA report I put together the other day due to some other niches I noticed within the report when I went back over it on Tuesday. Notably, the following two additions should be given consideration:

1) The report is a designed to provide comprehensive guidance on pre and post-earthquake actions at a nuclear power plant. As such, a lot of the emphasis in the report (i.e., Section 3, "Pre-Earthquake Planning") is on ensuring that a facility has a sufficient amount of baseline information available regarding pre-existing conditions (such as cracks in concrete) of SSCs in a facility. This ensures that post-earthquake damage is not confused with pre-existing damage. If a site does not have much of this information available, it may warrant additional inspections or analytical evaluations. That is to say, if there is any confusion about whether damage found after an earthquake is due to the earthquake itself or was already there, it would be conservative for the licensee to consider the damage as seismic-related.

2) The report suggests that an EL 3 earthquake (SSE-level or SL-2, as called in the report) be further characterized as either an EL 3a, EL 3b or EL 3c level earthquake. These three levels are dependent on the frequency characteristics of the ground motion, as measured at the site. As you probably know by now, depending on the frequency of the ground motion, SSCs may either be heavily affected or not really affected at all. Based on these frequencies and subsequently, whether the earthquake was designated as an EL 3a, EL 3b or EL 3c event, the facility may need to enter another action level. This could be coupled to the hidden damage "clause," due to the fact that at some frequencies, additional hidden damage could be caused by the event.

Those are my two main additions to the longer version of my synopsis. Otherwise, changes are minor.

While I did not include it in the report, also note that page 81 of the report concedes that, "Details of these actions, including scope and timing, are established, and these may need the approval of the regulatory body." This could also be helpful when discussing any NRC requirements which augment the IAEA guidance.

Thanks.

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**Guidance Regarding the Use of IAEA Safety Reports Series No. 66 "Earthquake Preparedness and Response for Nuclear Power Plants" As Applied to the Restart of North Anna Power Station**

As stated in the report's Forward section, there are recent instances where nuclear power facilities have experienced seismic events where the measured ground motions have exceeded the design or evaluation bases. While most facilities did not identify any significant damage following these events, the report acknowledges that there is a need for specific criteria and detailed procedures for addressing situations where seismic design bases are exceeded.

The objective of the IAEA report discussed here within is to provide updated and detailed guidance on the actions taken in preparation for and following a felt earthquake at a nuclear power facility, including those felt earthquakes which have exceeded the original seismic design basis. The report is based on IAEA Member States' seismic safety knowledge and experience gathered up to 2010. With respect to the NRC's operations, the report acknowledges that it may be used by regulatory bodies during the decision making process for continued operations, shutdown and plant restart following a felt earthquake. Of particular importance with, respect to the restart of the North Anna Power Station (NAPS) following the August 23, 2011, Mineral, VA, earthquake, the IAEA report places a great deal of emphasis on the steps for restarting a facility following a seismic event, including those which exceed a facilities design basis earthquake (defined in the report as an SL-2 level earthquake).

Section 2 of the IAEA report, "Overview of a Post-Earthquake Action Program," notes that the emphasis of the actions described within the report focus on the physical and functional condition of the plant when making the decision to restart, as opposed to the results of analytical evaluations which can often be performed after restart of the facility. The report provides a methodical approach for the shutdown and restart of a facility following a felt earthquake. This approach is a function of three primary parameters: the earthquake level (EL), which is defined for U.S. plants in Section 2.1.2 of the report as an SL-1 for operating basis earthquake (OBE) and SL-2 for a safe shutdown earthquake (SSE); the damage level incurred at the facility following the seismic event, which range from minimal damage (DL 1) to severe damage (DL 4), with a formal definition of significant damage and examples provided in Section 3.4 of the report; and the final parameter being the effects of the event on systems, structures and components (SSCs) important to safety and not important to safety, the latter of which is divided further into SSCs required for power generation and those not required for power generation.

Based on the magnitudes of these three parameters, Table 2 of the report defines eight different action levels for which a facility should be placed following a seismic event. For each action level, Section 5 of the report, "Actions for Restart," provides prescriptive procedures to demonstrate the safety of a facility before restarting. These procedures are based on a combination of a) initial focused inspections and tests, b) expanded inspections and tests, c) comparative analyses, d) non-destructive examinations and e) surveillance tests. The action level for which a facility is placed determines the appropriate combination of items a) through e), above, which should be performed prior to restart. For example, a facility which sees an SL-2 seismic event with no damage to either important to safety or not important to safety SSCs

would fall under Action Level 5. Action Level 5, as noted in the report, would only require the successful completion of initial focused inspections and tests (item a) above) before the plant restarts. It is worthwhile to note that if the DBE ground motion is exceeded (i.e., an SL-2 seismic event or EL-3 level earthquake), the report recommends that the EL 3 level should be further subdivided into one of three EL 3 levels; EL 3a, EL 3b or EL 3c. These sub-levels are based on the frequency characteristics of the ground motion and, depending on the damage identified immediately after the event, may place a facility in a higher action level.

In addition to the action levels and the corresponding post-earthquake inspection and analysis procedures associated with each action level, the report provides two additional points of technical interest which could be used to augment the post-earthquake actions prescribed by the appropriate action levels. These two points are aging management considerations and hidden damage. With respect to aging management, the report notes that the effects of a seismic event should be incorporated into the evaluation of SSCs within the facility's current aging management program (i.e., what effects did the event have on equipment displacements, component coatings and other items used for consideration in aging evaluations).

For hidden damage, the report cites two types of hidden damage as those which should be given consideration: damage to hidden parts and invisible and/or undetectable damage. The former refers to damage which can only be found by disassembly of an SSC, examples of which are provided under items (1)(i) through (1)(iii) in Section 2.1.5 of the report. The latter type of hidden damage refers to hidden structural damage to components resulting from a seismic event, including a loss of fracture toughness, increased fatigue usage in metallic components, plastic deformation and cracks inside concrete (i.e., around embedded anchorages). Of particular importance, when a facility has a felt earthquake exceeding the SL-2 level, the report recommends that the integrity of SSCs be confirmed by conducting analytical evaluations of representative SSCs (i.e., limiting SSCs) or by comparing the actual seismic response of SSCs to past qualifying test results.

An additional item of consideration which should be taken into account, when determining the ability of a facility to restart following a seismic event, is the baseline information available regarding the pre-existing conditions of SSCs. This information enables those performing post-earthquake walk downs to decipher between pre-existing damage and earthquake damage. If sufficient baseline information regarding damage in SSCs is not available, additional effort may be warranted to determine whether or not an anomaly is the result of a seismic event. There is a great deal of emphasis on this baseline information throughout the report, especially in the discussions regarding pre-earthquake planning, due to its ability to enable a plant to assess post-earthquake damage more efficiently.

Section 6 of the report addresses long term actions which, in general, can be completed after restart. These long term actions include 1) the evaluation of seismic hazard and definition of seismic ground motion for evaluation purposes, 2) the evaluation of the response of soil, rock, foundation, structure and subsystems and 3) upgrades. The report notes that, in general, any earthquake exceeding SSE (SL-2) requires these long term evaluations to be performed.