

# DEFENSE NUCLEAR FACILITIES SAFETY BOARD Staff Report

November 27, 2018

## Device Assembly Facility Seismic Hazard

The Defense Nuclear Facilities Safety Board's (Board) staff reviewed the recent 10-year seismic hazard assessment [1, 2] and plans by Nevada National Security Site's management and operating contractor, Mission Support and Test Services, LLC (MSTS), to perform a soil-structure interaction (SSI) analysis at the Device Assembly Facility (DAF). The staff review team conducted onsite discussions with MSTS and the National Nuclear Security Administration's Nevada Field Office (NFO) personnel on April 16–19, 2018, and reviewed additional information based on those discussions.

### Background.

As part of the 10-year assessment of the seismic hazard, the previous site contractor, National Security Technologies, LLC (NSTec), analyzed the seismic hazard for DAF in 2007 using a probabilistic seismic hazard analysis (PSHA) approach. In the 2007 PSHA [3], the ground motion response spectra significantly exceeded the previous 1995 analysis [4] for the design-basis earthquake response spectra in a sensitive frequency range for safety-related structures, systems, and components (SSCs). Safety-related SSCs are generally sensitive to ground motion between 1 and 10 Hz. The horizontal ground motion spectrum in the 2007 PSHA exceeds the horizontal seismic design spectrum at 3 Hz and above. The vertical spectrum in the 2007 PSHA also exceeds the corresponding design spectrum for the same frequency range. A comparison between the 2007 PSHA and design basis response spectra is provided in Figure 1.

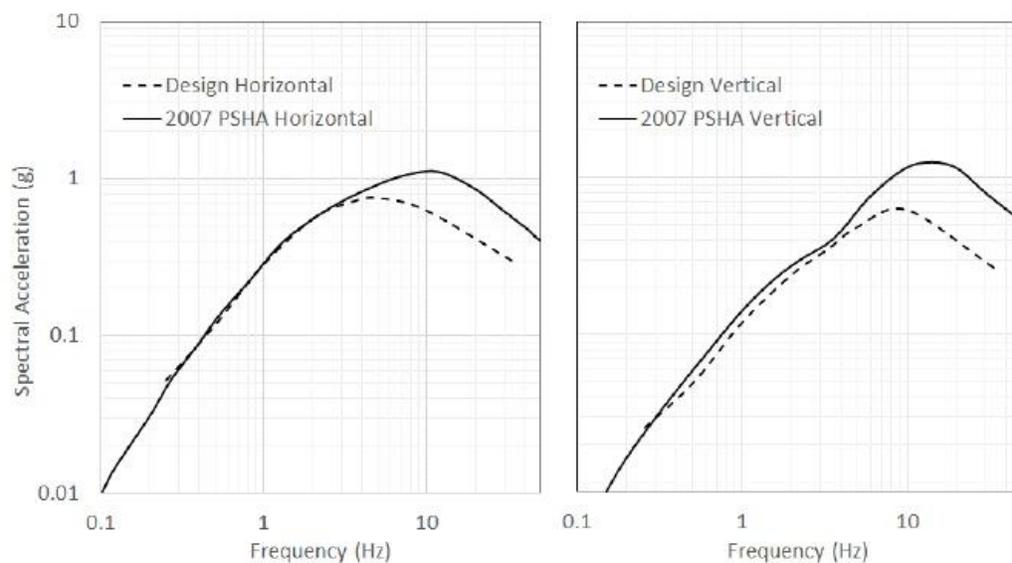


Figure 1 – Comparison of horizontal and vertical response spectra derived from [3] and [4].

Recognizing that the new ground motion exceeds the analyzed design-basis earthquake, NSTec initiated a dynamic SSI analysis using the System for the Analysis of SSI (SASSI) computer program to analyze the impacts of the increased seismic hazard. For a bermed facility such as DAF, evaluating SSI effects is necessary to obtain accurate seismic demands for the facility structure and SSCs within the facility. After the Board identified quality assurance issues with SASSI [5] in 2011, NSTec halted the DAF SSI analysis. In 2016, the Department of Energy (DOE) resolved the issues with SASSI and the Board closed the issues [6].

However, NSTec decided to delay the SSI analysis pending the 10-year seismic hazard assessment planned for 2017, given the potential that the seismic hazard could exceed the 2007 PSHA results. If the seismic hazard exceeded the 2007 PSHA results, a new SSI analysis would be required using updated PSHA results. In 2017, NSTec subcontracted Amec Foster Wheeler to perform the 10-year seismic hazard assessment [1, 2]. As part of the assessment, Amec Foster Wheeler analyzed the seismic hazard at the DAF site and compared it with the 2007 PSHA results. Based on results from this assessment, Amec Foster Wheeler concluded that the 2007 PSHA was bounding.

In October 2017, NSTec submitted a recommendation to NFO that concluded that the 2007 PSHA did not need to be updated [7]. The Board's staff team reviewed the recent 10-year assessment. Prior to the onsite interaction, Amec Foster Wheeler identified an error with the kernel density function (used recharacterizing non-uniform earthquake distribution in area sources) in its seismic hazard sensitivity tests. After Amec Foster Wheeler corrected the error [8], the seismic hazard increased. However, the 2007 PSHA results still envelope the updated seismic hazard curves from 2017 [1, 2] for the key frequencies. Therefore, the current site contractor, MSTs, does not recommend an update to the 2007 PSHA. After discovering the error in the sensitivity tests, MSTs plans to have the 10-year seismic hazard assessment, including the sensitivity tests, peer reviewed to ensure there are no additional errors. MSTs will not consider these two reports final until the peer review is complete. In September 2018, MSTs hired Carl J. Costantino & Associates to conduct the peer review. Once the peer review begins, MSTs anticipates that it will take six weeks to complete the review and issue its report.

NFO does not plan to review the recommendation on the PSHA update until after the peer review is complete and seismic assessment reports are finalized. MSTs will not start the SSI analysis until NFO accepts the recommendation to not update the PSHA.

Potential Safety Item: Unknown SSCs Performance for Seismic Events.

The Board's staff review team is concerned that DAF continues to operate without incorporating the increased seismic hazard and without analyzing its credited safety related SSCs to ensure that they can perform their safety function during and after a seismic event. In the DAF documented safety analysis.<sup>1</sup>

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<sup>1</sup> Carl J. Costantino & Associates completed the peer review in December 2018. Carl J. Costantino & Associates did not identify any errors in the assessment or sensitivity studies and

(DSA) [9], a high explosive violent reaction (HEVR), or a detonation of high explosives that are co-located with special nuclear material, has the highest public dose consequences that challenge the evaluation guideline and require safety class controls. An HEVR is initiated by mechanical, thermal, or electrical insults to the high explosives, which could be induced by a seismic event. For seismically induced HEVR accidents, the DSA credits the building structure, blast doors, blast valves, and the fire suppression system as safety classics to reduce the dose consequences to the public. The safety function for these SSCs requires the controls to meet performance category (PC) 3 seismic requirements. The DAF DSA also requires that support of overhead equipment withstand a PC-3 seismic event. This equipment includes lighting, electrical conduit, compressed air piping, vacuum piping, ventilation system ducts, and cranes. MSTS has not evaluated the capability of SSCs, including supports for overhead equipment, to meet applicable seismic criteria for the increased seismic hazard. The staff review team is concerned that these SSCs and overhead equipment may no longer be able to withstand the increased seismic hazard that was identified in the 2007 PSHA.

Therefore, the staff review team is concerned that a seismic event could cause safety SSCs or overhead equipment to fail and impact high explosives co-located with special nuclear material, causing an HEVR.

#### Potential Dose Consequences.

In the approved and implemented DSA, the unmitigated dose consequences from an HEVR induced from a design-basis earthquake during nuclear explosive operations could result in 22 rem total effective dose to the public. The DSA qualitatively determines that the unmitigated consequences to the worker to be high. Given that an HEVR challenges the Evaluation Guideline in DOE Standard 3009-94, Change Notice 3,<sup>2</sup> [12], the DSA credits the building structure, blast doors, blast valves, and fire suppression system as safety class SSCs to significantly reduce the dose consequences. However, as explained above, the staff review team is concerned that these controls may not survive the increased seismic hazard. The staff review team acknowledges that DOE has approved removal of the nuclear explosive operations mission from DAF [13], but MSTS has not updated the current DSA to reflect the removal of this mission. The removal of the nuclear explosive operations mission will likely result in a significant reduction in the limit of special nuclear material quantities co-located with high explosives and the overall limit of high explosives quantities. However, even with removal of the nuclear explosive operations mission, DAF still will have high explosives co-located with special nuclear material. Specifically, part of DAF's mission is to build subcritical experiments, which includes mating high explosives to special nuclear material. Therefore, the NFO has approved multiple change notices, and MSTS has implemented them, since the referenced DSA was approved and

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<sup>2</sup> Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses

implemented. The change notices were submitted due to new operations or to address deficient safety systems. The referenced DSA served as the base for all the recent change notices. However, the accidents discussed above have not changed because of these change notices.

The current basis for qualifying these SSCs is based on 1990s dynamic evaluations [10, 11] of the DAF structures that used the 1995 PSHA [4] as input. The structural evaluations did not account for SSI effects and did not develop in structure response spectra for qualifying appurtenances. Seismic demands were derived from peak accelerations instead of spectral accelerations and applied statically to the system being evaluated. It is not clear if these demands would bound loads derived from an SSI analysis.

[The] potential for seismically induced HEVR accidents is still credible at DAF. MSTs has not conducted an analysis to determine how the material (i.e., high explosives co-located to special nuclear material) will be reduced and what impacts the reduction will have on the dose consequences for HEVR accidents.

#### Conclusions.

As part of the 10-year assessment of the DAF seismic hazard, the previous site contractor, NSTec, analyzed the seismic hazard in 2007 using a PSHA approach. The 2007 PSHA found that the ground motion response spectra significantly exceeded the design-basis earthquake response spectra when compared to the previous analysis completed in 1995. Due to issues with the SASSI code, DAF contractors did not complete the SSI analysis. The Board's staff review team is concerned that DAF continues to operate with the increase in seismic hazard and MSTs has not adequately evaluated credited safety related SSCs to ensure that they can perform their safety function during and after a seismic event. Seismic accident scenarios at DAF could result in significant consequences to the offsite public. Since the impact of seismic events on DAF SSCs has not been adequately characterized, DAF continues to operate with unknown risk.

#### References

1. Amec Foster Wheeler, White Paper - Assessment of Need to Update the Seismic Hazard Analysis for the Device Assembly Facility, January 19, 2017.
2. Amec Foster Wheeler, White Paper - Seismic Hazard Sensitivity Analysis for the Device Assembly Facility, August 21, 2017.
3. Geo matrix Consultants, Inc., Probabilistic Seismic Hazard Analysis and Design Ground Motion for Device Assembly Facility Site, for Lawrence Livermore National Laboratory, Nevada Test Site, October 2007.
4. Geo matrix Consultants, Inc., Simplified Seismic Hazard Analysis for the Device Assembly Facility March 1995.
5. Defense Nuclear Facilities Safety Board Letter from P. Winokur to D. Poneman, Issues Related to the SASSI Computer Software, April 8, 11.
6. Defense Nuclear Facilities Safety Board Letter from J. Connery to E. Sherwood-Randall, Closure of SASSI Issue, January 5, 2016.

7. National Security Technologies, LLC, Letter from J. Holt to S. Lawrence, Recommendation for the Continued Use of the 2007 Device Assembly Facility (DAF) Probabilistic Seismic Hazard Analysis (PSHA), October 2017.
8. Amec Foster Wheeler, White Paper - Seismic Hazard Sensitivity Analysis for the Device Assembly Facility – Rev 1, May 4, 2018.
9. National Security Technologies, LLC (NSTec), Nevada National Security Site Device Assembly Facility Documented Safety Analysis, DAF-DSA-01, Revision 4, September 2015.
10. Ng, D.S., et al., Structural Evaluation for the Device Assembly Facility
11. , UCRL-ID-126251, June 1996. Ng, D.S., A Summary of the Seismic Evaluation for the Structures, Systems, and Components for the Device Assembly Facility, SM99-11, December 1999.
12. Department of Energy, Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses, DOE Standard 3009-94, Change Notice 3, March 2006.
13. Department of Energy, Approval of the Cessation of Nuclear Explosives Safety Change Control at the Device Assembly Facility (DAF), September 14, 2018