Office of Health, Safety and Security
Operating Experience Level 1

OE-1: 2013-01 April 2013

Improving Department of Energy Capabilities for Mitigating Beyond Design Basis Events

PURPOSE: The purpose of this Operating Experience (OE) document is to (1) provide results from U.S. Department of Energy (DOE), including the National Nuclear Security Administration, initiatives related to beyond design basis events (BDBEs), and (2) provide direction for enhancing capabilities for mitigating BDBEs at DOE sites.

BACKGROUND: After the March 2011 Fukushima Daiichi nuclear plant accident in Japan, DOE embarked upon several initiatives to investigate the safety posture of its nuclear facilities relative to BDBEs. These initiatives included issuing Safety Bulletin 2011-01, *Events Beyond Design Safety Basis Analysis*, conducting pilots to refine possible process improvements, and conducting two DOE nuclear safety workshops. DOE issued two reports documenting the results of these initiatives: *Review of Requirements and Capabilities for Analyzing and Responding to BDBEs*, August 2011, and *BDBE Pilot Evaluations, Results and Recommendations for Improvements to Enhance Nuclear Safety at DOE Nuclear Facilities*, January 2013[1].

RESULTS OF BDBE CAPABILITIES REVIEWS: DOE instituted requirements in the early 1990s for evaluating BDBEs as part of the development of nuclear facility safety analyses. These requirements include periodically updating natural phenomena hazards (NPH) assessments, and developing and implementing emergency management plans for severe accidents, including BDBEs.

Facility reviews performed in accordance with DOE's Safety Bulletin 2011-01 guidance as well as pilot studies conducted at four DOE nuclear facilities concluded that DOE had put into place appropriate emergency management, safety analysis, and safety control requirements to mitigate severe accidents, including those caused by BDBEs. Additionally, insights gained from the pilot studies on the potential effects of BDBEs across multiple facilities at a site helped to improve planning for an integrated site response to such events. However, further analysis of DOE's most hazardous nuclear facilities would be beneficial. Details on the results of the prior pilot studies can be found in the 2013 report on the BDBE pilot evaluations.

REQUIRED ACTIONS: In order to provide greater assurance that DOE has appropriate provisions in place to mitigate BDBEs and to enhance safety, the following actions shall be taken.

Action 1: All Program Offices, in coordination with responsible contractors, shall evaluate their site emergency management programs' response to severe accidents/events (including BDBEs) that could have a site-wide impact, using the guidance in Attachment 1, and make appropriate enhancements. This review and appropriate enhancements, if not already accomplished, shall be completed by the end of Calendar Year (CY) 2014.

Action 2: Program Offices shall direct contractors responsible for hazard category 1 and 2 nuclear facilities that have the potential to exceed DOE's 25 rem public dose evaluation guideline based on an unmitigated accident analysis, to conduct an evaluation using the guidance in Attachment 2 in conjunction with the 2015 annual update of their Documented Safety Analyses (DSAs). This action is not applicable to Transportation DSAs.

Program offices shall provide a consolidated report on the all actions taken to their respective Under Secretary no later than December 31, 2015.

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[1] These reports can be found at www.hss.doe.gov/nuclearsafety/

Attachment 1
Emergency Management Guidance and Lessons Learned

The purpose of this guidance is to describe a process for incorporating Fukushima lessons learned into Department of Energy (DOE) emergency management programs. The guidance applies to all DOE Program Offices, including the National Nuclear Security Administration (NNSA), and which are required by DOE Order 151.1C, *Comprehensive Emergency Management System,* to have an Operational Emergency Base Program.

Insight gained from the BDBE Pilot Evaluation and the Targeted Emergency Management Reviews show that DOE's emergency management requirements already dictate consideration of all potential severe accidents, including BDBEs. The pilot evaluations and reviews did not identify any significant issues and confirmed that the existing hazards survey/emergency planning hazards assessment process is sound. All sites had base level of preparedness for severe natural phenomena events and most DOE/NNSA process activities reviewed do not require significant emergency actions to place facilities in a safe shutdown condition. Consideration of the lessons learned provided below could serve to enhance the sites emergency management base program.

Analyze emergency planning needed to respond to severe events

DOE Order 151.1C requires each DOE/NNSA facility/site or activity to have an Operational Emergency Base Program that is comprehensive and addresses all hazards and that provides the framework for response to serious events or conditions that involve the health and safety of workers and the public, the environment, and safeguards and security. This forms the basis of an emergency management program that provides capabilities for an all-emergency response. This approach should now be reviewed, commensurate with the hazards present, to ensure an appropriate emergency response to severe events is available at each DOE/NNSA facility/site, or activity. The hazards survey shall be updated, in accordance with the existing maintenance requirement, to include additional multi-facility, site wide events identified through lessons learned from the Fukushima nuclear accident, and the Operational Emergency Base Program should be adjusted accordingly. The base program should also consider preparations to initiate "self-help" emergency response activities for severe events that effectively isolate a site from outside response assistance and infrastructure support. These preparations should not represent extensive planning, but should be sufficient to activate/ initiate a self-help response, e.g. locations of medical and life sustaining supplies on site.

DOE Order 151.1C requires the Operational Emergency Hazardous Material Program be technically based on an emergency planning hazards assessment (EPHA). According to DOE Guide 151.1-2, *Technical Planning Basis,* the EPHA analyses address a spectrum of potential events ranging from low-consequence, high-probability events to high-consequence, low-probability events, including those considered to be beyond the design basis in the facility's Documented Safety Analysis (DSA). As a result of lessons learned from Fukushima, DSA BDBE analyses may change. As part of the existing EPHA maintenance requirements, facilities should ensure that the range of severe events addressed in their EPHA is maintained consistent with these DSA changes. In case of a severe event, there may be basic, and possibly time-urgent initial response actions that could be taken to stabilize a hazardous material situation, delay safety degradation, or prevent further damage. These actions are considered shutdown or "walk-away" strategies, and should be identified and evaluated for inclusion as essential initial response actions. Responsibilities between Facility Operations management and Site Emergency Management should be clearly assigned so that the organization responsible for taking appropriate actions throughout the event progression is readily understood at all times, and any transfer of responsibility is preplanned based on established criteria.

Plan for the response to simultaneous accidents at multiple facilities

Where multiple facilities exist across a DOE/NNSA site, severe event planning should consider scenarios where the same severe event triggers hazardous material releases from multiple facilities. In accordance with the existing requirements and guidance, the EPHA should contain information about the impact of simultaneous or sequential hazardous material releases on collocated facilities on the site. For nuclear facilities, the DSA BDBA evaluation identifies facility specific event responses to which Site support is expected, along with the anticipated post-event response time constraints to aid in integrated severe event planning across the Site.

Coordinate site, facility, and community emergency plans

A severe event is likely to affect both a DOE/NNSA site and the surrounding community and overwhelm the capabilities of the site and the surrounding offsite mutual aid organizations. In these situations, the need for emergency management becomes critical, as scarce assets must be used prudently to accomplish the National Response Priorities (i.e., safety of human life, stabilization of the situation, and minimization of adverse impacts on the environment), and to integrate the DOE/NNSA site response into the National Response Framework (references can be located at the Federal Emergency Management Agency web site, www.fema.gov). The DOE/NNSA site should also coordinate planning for the evacuation of the site under severe event conditions.

Integrate the site's emergency management, security, and continuity of operations (COOP) activities

COOP plans identify mission essential functions that may be of use in determining priorities for restoration/mitigation efforts in a severe event scenario. DOE/NNSA requires that COOP plans contain pre-determined delegations of authority for situations where the normal management channels are disrupted. These delegations reinforce the understanding that on shift personnel are expected to make operational and safety decisions when severe events disrupt the normal lines of communication.

Conduct emergency drills and/or exercises for severe events

Emergency drills and exercises at DOE/NNSA facilities/sites, focused on severe events, should include events that impact multiple facilities and can cause the loss of infrastructure capabilities, e.g., onsite and offsite power, communications, and roadways, and the unavailability of mutual aid. Scenarios should also include secondary or compounding severe events occurring during critical stages of initial response or later remediation efforts.

Attachment 2
Documented Safety Analysis (DSA) Guidance

The purpose of this guide is to provide expectations for performing an enhanced evaluation of beyond design basis events (BDBEs) as a part of the annual DSA updates. It is generally expected that existing DSAs subject to the criteria of Action 2 already include an evaluation of BDBEs as required by DOE-STD-3009. The enhanced evaluation incorporates an analytical approach that was developed during the BDBE pilots, but documents the results of the analysis in the same manner as described in STD-3009. The enhanced evaluation process should incorporate lessons learned as described in, *A Report to the Secretary of Energy: Beyond Design Basis Event Pilot Evaluations, Results and Recommendations for Improvements to Enhance Nuclear Safety at Department of Energy Nuclear Facilities,* January 2013.

As with any DSA preparation and update activity, the BDBE evaluation should be conducted by a qualified team leader and a multidisciplinary team consisting of experts in the areas of facility operations, facility safety analysis, structural/mechanical engineering, NPH, and emergency management, the last of which is particularly relevant to the objective of this evaluation. The intent is to perform an expert-based and qualitative evaluation.

The facility's DSA should serve as a starting point for the evaluation of BDBEs. The DSA is expected to include a discussion of the BDBEs considered, and may include a discussion of analyses or enhancements made to the facility to meet DOE Order 420.1C, *Facility Safety,* requirement to evaluate the impact of changes in NPH data and/or analysis methodologies every ten years. The new analyses and enhancements should identify how the design has "evolved" to provide assurance of safety under events that are beyond the original design basis. As described in the HSS report to the Secretary referenced above, it is prudent for the team to perform a walkdown of the facility to support a qualitative evaluation of how a BDBE may impact the facility (the qualitative evaluation is discussed in the next section of this attachment) and to look for potentially unknown vulnerabilities to BDBEs (e.g., unsealed penetrations or low-lying electrical equipment in the case of flooding accidents). This walkdown also ensures the reviewers are familiar with facility's size, key features and distances to other structures and potential temporary service connections (like fire hydrants or well water sources).

This enhanced BDBE evaluation is intended to identify BDBEs that may cause a release of radioactive material beyond that analyzed in the unmitigated accident analysis in the DSA and/or to disable important controls relied on to mitigate the release of radioactive material shall be evaluated. The types of BDBEs that should be evaluated include:

- Seismic events
- Floods
- Fires
- Lightning
- Wind and tornadoes
- Snow and ice
- Ash fall
- Accidental aircraft crash
- Station blackout, as an initiating event or as a consequence from any of the above events
- Cascading effects of design basis events analyzed in the DSA that were previously ruled out because of the low likelihood of associated multiple failures.

If BDBE's from the above list are excluded, the rationale for exclusion should be documented. The general categories of failures to be considered for each BDBE listed above include:

- Collapse of building structure and interior walls
- Breach of water storage pools or collapse of storage racks
- Loss of electrical power and emergency power equipment (e.g., transformers, switchgear, or motor control centers)
- Loss of electrical distribution systems (e.g., conduit or cable trays)
- Operational failure of active mechanical equipment (e.g., pumps, compressors, or fans)
- Loss of pressure boundary of static equipment (e.g., tanks, vessels, or gloveboxes)
- Failure of distribution systems (e.g., piping, tubing, or ducts)
- Failure of alarms
- Loss of an emergency response center.
- Adverse spatial seismic interaction (e.g., failure of adjacent buildings or failure of adjacent stacks)

- Adverse flood-inducing interaction (e.g., failure of an adjacent water tank)

The enhanced BDBE evaluation should provide a gross estimate of the bounding impacts associated with BDBEs. It is qualitative in that it relies on a simple "what if" type of hazard evaluation technique where a multidiscipline team participates in a brainstorming session to methodically evaluate the potential failures in facility systems, structures, and components (SSCs) that could be caused by each type of BDBE. The evaluation should estimate the consequences associated with failures of SSCs that provide safety functions such as confinement, energy removal (e.g., decay heat removal or fire suppression), or prevention of energetic reaction (e.g., explosion). The evaluation may draw upon existing unmitigated accident analysis performed in the DSA.

This qualitative evaluation process is applied to each type of BDBE so different failure modes and associated effects can be understood. Although a seismic event will typically present the worst-case consequences, it is important to step through all applicable BDBEs using the same structured "what if" brainstorming technique. This information can be important when considering potential mitigation strategies.

SSCs identified as mitigating BDBE consequences should be subjected to a margins assessment (MA) to provide insights into their margin-to-failure. This should be a qualitative assessment based upon expert judgment. Civil/structural engineers should perform the MA by reviewing existing design basis analyses and supporting calculations for SSCs. This information should then be used as a baseline to compare against a SSC's expected response to higher level stresses. A MA can be difficult to accomplish if facility design information is not available, i.e., for older DOE facilities. In this case, the MA may have to rely on bounding, simplified assumptions and judgments by subject matter experts, supported by the results of structured walkdowns. For NPH events, the margins assessment should be accomplished by analyzing the facility for higher stress levels than the systems' design (for example, the next higher seismic performance or design category) based on qualitative expert judgment.

Descriptions of performance capabilities of the existing SSCs should also be added to or referenced in the DSA, as new and relevant information is learned from above BDBE evaluation. SSCs that provide protection against BDBEs, are typically safety class controls, or a subset of these controls, credited in the DSA for design basis events. If the BDBE evaluation identifies non-credited SSCs, it is not expected that these SSCs would be classified as safety class or safety significant based solely on BDBE consequences, and, therefore, additional technical safety requirements for these SSCs would not be created. These may include facility features such as temporary utility connections (power or water) and critical parameter instrumentation readings that permit monitoring after a BDBE occurs. The DSA should identify these SSCs as important for providing additional mitigation of BDBEs, and these SSCs should be maintained within the facility configuration management and maintenance programs in the same manner that other non-safety class and safety significant DSA controls are treated to preserve their safety function. PSOs should establish for their facilities whether the Unreviewed Safety Question program should be used to determine the approval authority for changes to BDBE controls, or whether more general provisions of maintenance and configuration control should be relied upon.

Based on the results of the enhanced BDBE evaluation, existing DSA descriptions of BDBE accident scenarios should be updated as necessary to clarify important assumptions needed to develop abnormal or emergency operating procedures. This may include details such as potential accident conditions associated with the range of BDBEs, cascading effects of certain scenarios, time-frames associated with scenario development, and time-critical mitigative actions. Additionally, emergency management plans for responding to BDBEs (updated using the guidance in Attachment 1) could also identify potential facility design changes for consideration. An example would be the addition of standardized connections, outside the facility, that could be used to supply cooling water, deliver fire suppression water, or provide electrical power using resources obtained through emergency management mutual aid agreements. These improvements should also be conveyed as part of the DSA annual update.