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Emergency Response Procedures and Guidelines for Beyond Design Basis Events and Severe Accidents

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Nuclear Energy Institute

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This document was developed by the Boiling Water Reactor Owners Group (BWROG), the Pressurized Water Reactor Owners Group (PWROG) and the Nuclear Energy Institute (NEI). The lead/coordinating document contributors are presented below.

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NOTICE

EXECUTIVE SUMMARY

U.S. nuclear power plant licensees currently maintain the capability to implement beyond design basis accident mitigation and management strategies developed through several separate initiatives. Each strategy has been converted into implementing actions and recommendations within three separate sets of procedures and guidelines: Emergency Operating Procedures (EOPs), Severe Accident Management Guidelines (SAMGs), and Extensive Damage Mitigation Guidelines (EDMGs). In addition to these existing procedure and guideline sets, the industry is currently developing a new set of guidelines, referred to as FLEX Support Guidelines (FSGs), in response to Order EA-12-049 issued by the U.S. Nuclear Regulatory Commission (NRC)[1]. Having been developed separately, each of these procedure and guideline sets are subject to varying levels of regulatory requirements and industry commitments, as are the training, drills, and exercises intended to maintain the capability for effective implementation.

The EOPs were designed to restore and maintain safety functions, and place the plant in a safe shutdown condition. EOPs are required by Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," and are included in the administrative control sections of a licensee's technical specifications. The training requirements for EOPs are primarily contained within 10 CFR Part 55, "Operators' Licenses." Licensed operators are required to show sufficient knowledge of the EOPs on an initial written examination, in accordance with 10 CFR 55.41 (Reactor Operators) or 10 CFR 55.43 (Senior Reactor Operators), and the ability to implement the EOPs through an initial operating test that meets the requirements of 10 CFR 55.45. Licensed operators are required to continuously demonstrate that they have maintained their knowledge of the EOPs through the requalification program required by 10 CFR 55.59.

SAMGs provide guidance to operators and designated support staff for use in the event that accident conditions progress beyond the mitigation capabilities described in the EOPs (e.g., fuel damage is imminent or has occurred). The SAMGs were developed as a voluntary industry initiative in response to NRC Generic Letter 88-20, Supplement 2, *Accident Management Strategies for Consideration in the Individual Plant Examination Process*, dated April 4, 1990[2]. There is currently no regulatory requirement for licensees to develop, maintain, train, drill or exercise SAMGs.

Following the terrorist attacks of September 11, 2001, the NRC ordered licensees to develop strategies and specific implementing guidance for maintaining or restoring core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant due to explosions or fire. These extensive damage mitigation requirements were subsequently imposed as license conditions for individual licensees and then made generically applicable under 10 CFR 50.54(hh)(2) through the Power Reactor Security Requirements final rule (74 FR 13926; March 27, 2009). As a result, EDMGs were created to provide guidance to operating crews and other plant staff on the implementation of strategies for responding to an event involving a loss of large areas of the plant due to explosions or fire.

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[1] Refer to NRC Order EA-12-049, *Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events*, dated March 12, 2012; NRC ADAMS ML #12054A735.
[2] Refer to NRC ADAMS ML #031200551

On March 11, 2011, a magnitude 9.0 earthquake struck off the coast of the Japanese island of Honshu. Approximately 40 minutes after the earthquake, the first of several large tsunami waves inundated the Fukushima Dai-ichi Nuclear Power Plant site. The tsunami waves resulted in extensive damage to site facilities, and a complete and extended loss of AC electrical power at Fukushima Dai-ichi Units 1 through 5; one diesel generator remained functional on Unit 6. Despite the actions of the operators following the earthquake and tsunami, cooling was lost to the fuel in the Unit 1 reactor after several hours, the Unit 3 reactor after about 36 hours and the Unit 2 reactor after about 70 hours; fuel damage resulted in each unit shortly after the loss of cooling.

In the days following the Fukushima Dai-ichi accident, the NRC Chairman directed the staff to establish a senior-level agency task force to conduct a full review of the agency's processes and regulations in light of the events in Japan. This task force, referred to as the Near-Term Task Force (NTTF), was also directed to identify recommended improvements to agency policies and regulatory practices. The NTTF provided its recommendations to the Commission in a report dated July 12, 2011.[3] In Recommendation 8 of the NTTF report, the Task Force recommended strengthening and integrating the onsite emergency response capabilities described in EOPs, SAMGs, and EDMGs.

This document provides guidance for ensuring that EOPs, EDMGs, FSGs and SAMGs are integrated in a cohesive, effective and usable manner. It also addresses recommendations for the development of mitigation and management guidelines, and command and control structures, for responding to beyond design basis events and severe accidents. Guidance concerning the related aspects of training, drills and exercises is contained in NEI 13-06, *Enhancements to Emergency Response Capabilities for Beyond Design Basis Events and Severe Accidents*.

[3] Refer to NRC ADAMS ML #111861807

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EMERGENCY RESPONSE PROCEDURES AND GUIDELINES FOR BEYOND DESIGN BASIS EVENTS AND SEVERE ACCIDENTS

1 INTRODUCTION

Each nuclear power plant licensee maintains sets of operating procedures that provide direction for responding to a wide spectrum of off-normal and emergency events and conditions. Direction is provided for addressing events and conditions both within the plant design basis as well as certain events and conditions that are beyond the design basis. These procedure sets are typically known as Alarm Response Procedures (ARPs), Abnormal Operating Procedures (AOPs) and Emergency Operating Procedures (EOPs), and they instruct licensed operators on the steps necessary to maintain safe operation and protect fission product barriers during all modes of plant operation.

In response to the lessons learned from the accident at Three Mile Island, the nuclear industry developed Severe Accident Management Guidelines (SAMGs) as a voluntary initiative.[4] The SAMGs describe additional strategies meant to provide operators and the plant staff with the capability to manage accident sequences that progress beyond the capacity of the mitigating strategies contained in the EOPs (e.g., adequate core cooling cannot be maintained). In doing so, the strategy focus changes from preventing fuel damage to mitigating the consequences of fuel damage, including minimizing radiological releases and protecting personnel.

Existing site-specific EOPs and SAMGs are based on generic technical guidelines developed in response to NUREG-0737, Item I.C.1, "Guidance for the Evaluation and Development of Procedures for Transients and Accidents," and NEI 91-04, *Severe Accident Issue Closure Guidelines*, Revision 1, respectively. The generic technical guidelines were created by the Boiling Water Reactor (BWR) and Pressurized Water Reactor (PWR) Owners Groups, and, in the case of the SAMGs, utilize applicable technical research and bases materials provided by the Electric Power Research Institute (EPRI). Using these generic guidelines, each licensee has developed EOPs and SAMGs that are appropriate for their specific plant technology, and function as an integrated set of strategies and implementing instructions.

Following the terrorist attacks of September 11, 2001, the NRC ordered licensees to develop strategies and specific guidance for maintaining or restoring core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with a loss of large areas of the plant due to explosions or fire; the NRC order was eventually codified in 10 CFR 50.54 (hh). U.S. nuclear power plant operators developed their response strategies and guidelines in accordance with NEI 06-12, *B.5.b Phase 2 & 3 Submittal Guideline*. The guideline sets that resulted from these efforts are typically referred to Extensive Damage Mitigation Guidelines (EDMGs).

As a result of the review of the March 11, 2011, accident at the Fukushima Dai-ichi Nuclear Power Plant, the NRC Near-Term Task Force (NTTF) made several recommendations

[4] Refer to NRC Generic Letter 88-20, Supplement 2, *Accident Management Strategies for Consideration in the Individual Plant Examination Process*, dated April 4, 1990.

intended to strengthen and integrate the onsite emergency response capabilities described in EOPs, SAMGs, and EDMGs; these recommendations are referred to collectively as Recommendation 8. All aspects of Recommendation 8 were subsequently evaluated by the NRC staff and refined into a regulatory basis to support future rulemaking; see *Onsite Emergency Response Capabilities, Regulatory Basis to Address Nuclear Regulatory Commission Near-Term Task Force Recommendation 8*, dated October 1, 2013[5].

This document provides guidance for addressing three aspects of the regulatory basis associated with Recommendation 8 - procedure integration, requirements for SAMGs and supporting guidelines, and a command and control structure for responding to a beyond design basis event or severe accident. The guidance was developed for commercial nuclear power reactors operating in the United States as of 2014. Adoption or modification of this guidance by future operating plants should be based on discussions with the appropriate technology Owners Group and the NRC staff.

[5] Refer to NRC ADAMS ML #13101A344

2 PROCEDURE INTEGRATION

2.1 OVERVIEW

Each licensee should establish an overall framework for strategies that would be used to mitigate and manage the consequences of a beyond design basis event and severe accident. This framework should address the integrated use of emergency response procedures and guidelines such that they have been designed to work together to implement the best available strategy for preventing or mitigating fuel damage, and limiting radiological releases. The effective integration of procedures and guidelines is characterized by the attributes listed in Section 2.4, Integration of Procedure and Guideline Sets.

For purposes of this document, a "strategy" refers to a plan of action for maintaining or restoring a "safety function"[6] in order to mitigate the effects of a beyond design basis event or manage the consequences of a severe accident. A strategy can be implemented by one or more methods. As used here, a "method" is a series of actions designed to implement a specific strategy. As an illustrative example of all three terms, consider that a portable pump (a method) may be used to inject water into the reactor pressure vessel (a strategy) for the purpose of maintaining a safety function (core cooling).

It is recognized that the usage of the above terms in NRC and industry documents, although generally similar, has varied somewhat over the years depending upon the preferences of authors and the purpose of a particular document. It will therefore be necessary to carefully apply these terms within the context of site-specific documents (i.e., in cases where different terms are used for the concepts identified above).

2.2 PROCEDURES AND GUIDELINES

It is important to distinguish the difference between emergency response procedures and guidelines. Procedures are documents written as sequential instructions for performing a function or addressing plant conditions, and operators and plant staff are expected to follow the prescribed instructions in a step-by-step and verbatim manner. Exceptions to this expectation should be rare and necessary only in extraordinary circumstances.

As opposed to procedures, guidelines do not necessarily provide a prescribed set of instructions and may not be followed in a step-by-step manner. Rather, they provide suggested strategies and implementing methods that may be used to address an adverse event or condition, typically those beyond a plant's design basis. Within guidelines, operators and plant staff have the latitude to respond as necessary to unpredictable and dynamic situations. During a beyond design basis event or severe accident, guidance documents would be used to focus the attention and actions of the operators and plant staff on the most important threats to safety and provide suggested optimal strategies for addressing plant conditions.

[6] The safety functions of interest during a beyond design basis event or severe accident response are typically core cooling, containment and spent fuel pool cooling.

2.3 EMERGENCY RESPONSE PROCEDURE AND GUIDELINES SETS

This document employs the following terms when referring to procedure and guideline sets used by operators to respond to off-normal and emergency conditions. Depending upon Owners Group guidance, and fleet and site standards, a procedure and guideline set may be called by another name. Further, the decision to provide a given set of response instructions within a procedure or a guideline may vary from site-to-site. Each licensee should ensure that the appropriate site-specific document sets, and individual documents, are utilized when implementing the guidance contained in this document.

2.3.1 Abnormal Operating Procedures (AOPs)

AOPs are procedures that direct operator actions for restoring a function, system, or component to normal operating conditions following a transient or event. AOPs may also be used to mitigate an event or condition that is not severe enough to require use of an Emergency Operating Procedure (EOP), such as primary system leakage.

Further, AOPs may provide direction for responding to a wide range of off-normal and emergency conditions including, but not limited to, design basis-related events such as a Control Room evacuation, a fire, or a security threat; events initiated during shutdown or refueling operating modes; and natural and man-made hazardous conditions such as severe weather or toxic gas releases.

2.3.2 Emergency Operating Procedures (EOPs)

EOPs are procedures that direct operator actions for mitigating the consequences of transients and accidents that cause plant parameters to exceed reactor protection system or engineered safety features actuation setpoints. These procedures are developed using guidelines promulgated by the applicable Owners Group in response to NUREG-0737, *Clarification of TMI Action Plan Requirements*; Clarification Item I.C.1, "Guidance for the Evaluation and Development of Procedures for Transients and Accidents."

2.3.3 FLEX Support Guidelines (FSGs)

FSGs are guidelines that provide strategies relying upon the use of installed and portable equipment and resources to maintain or restore core cooling, containment, and SFP cooling capabilities during beyond design basis events. The strategies and capabilities reflected in these guidelines address the requirements of NRC Order EA-12-049, *Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events*. Guidance concerning the development of FSGs is contained in Nuclear Energy Institute (NEI) 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*.

2.3.4 Extensive Damage Mitigation Guidelines (EDMGs)

EDMGs are guidelines that provide strategies to maintain or restore core cooling, containment, and SFP cooling capabilities under the circumstances associated with the loss of large areas of the plant due to explosions or fire. These strategies and capabilities

address the requirements of 10 CFR 50.54(hh)(2). Guidance concerning the development of EDMGs is contained in NEI 06-12, *B.5.b Phase 2 & 3 Submittal Guideline*.

2.3.5 Severe Accident Management Guidelines

SAMGs are guidelines that provide strategies to manage the consequences of an accident or event which would be implemented upon receipt of specific plant parameter values indicative of imminent or actual damage to irradiated fuel (e.g., high core exit thermocouple temperatures or low RPV water level). These guidelines employ strategies intended to arrest the progression of fuel damage, maintain the capability of the containment as long as possible, and minimize radiological releases. Guidance concerning the development of SAMGs is contained in this document.

SAMGs may be referred to as Severe Accident Guidelines (SAGs) at some sites.

2.4 INTEGRATION OF PROCEDURE AND GUIDELINE SETS

Each licensee's emergency response procedure and guideline sets should address the following considerations.

- A programmatic control document describing the framework for integration of mitigation and management strategies in response to a beyond design basis event or severe accident should be developed and maintained. The site-specific framework should consider the generic technical guidance provided by the appropriate Owners Group. Deviations from the generic technical guidance should be documented along with the supporting rationale.

  For illustrative purposes, a simplified example framework is depicted in Figure 2.1.

- Strategies should be available to address potential or actual fuel damaging conditions present in the reactor core or the spent fuel pool.

- Strategies should be reviewed to identify potential gaps or inconsistencies.

- Each strategy should be included within a controlling procedure or guideline. Where appropriate, expectations concerning parallel processing of procedures and/or guidelines should be described.

- Criteria such as plant conditions and parameters that require a transition from one controlling procedure or guideline to another should be clearly identified.

- Criteria for implementing the actions described in a supporting procedure or guideline should be clearly identified in the controlling procedure or guideline.

- Strategies should be available to address a beyond design basis event or severe accident occurring during any mode of operation, consistent with the associated NRC staff-endorsed guidance. The degree to which a controlling procedure may or may not be fully applicable during some plant operating modes should be considered.

- Strategies should be available to address an event involving a loss of large areas of

the plant due to explosions or fire, including the possible loss of the Control Room command and control structure, consistent with the associated NRC staff-endorsed guidance in NEI 06-12. The degree to which a controlling procedure may or may not be fully applicable during some plant operating modes should be considered.

- Integration of EDMGs should reflect site-specific commitments made in response to NRC security orders.

- Integration of FSGs should reflect site-specific commitments related to NRC Order EA-12-049.

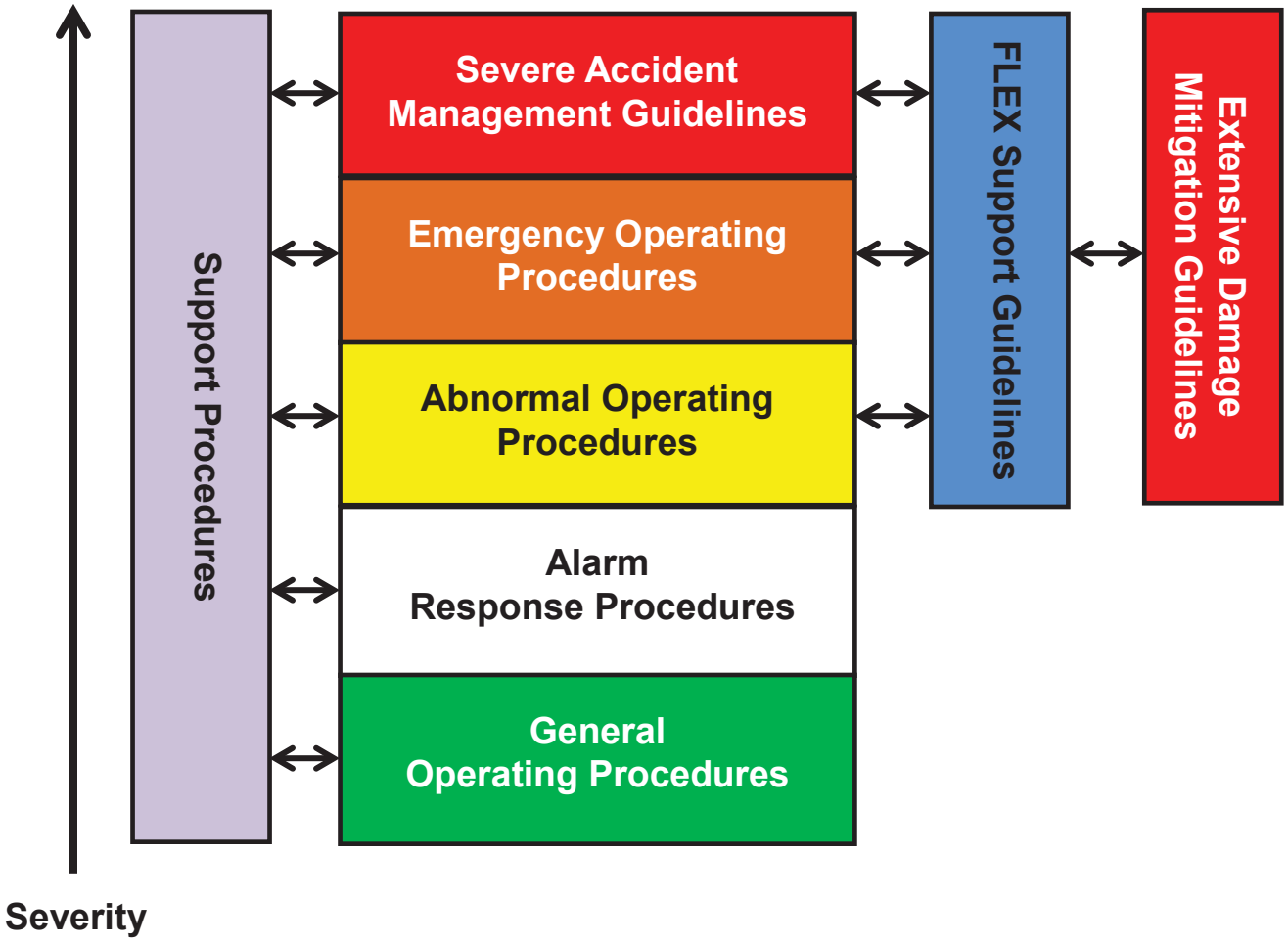
2.5 COORDINATION WITH FIRE RESPONSE STRATEGIES

SAMGs and FSGs provide a core set of strategies that can be used to respond to a variety of failures and concurrent events. SAMGs were developed to address plant conditions associated with a fuel damaging event and utilize a symptom-based approach to strategy selection. They provide a wide range of strategies and implementing methods, which, by design, can be adjusted during an emergency in response to plant conditions and concurrent events, such as a fire. FSGs provide strategies for mitigating the effects of an Extended Loss of AC Power (ELAP). Consistent with NRC staff–endorsed guidance, the development of FSG strategies assumed that there were no independent concurrent events, including a postulated fire.

Unlike analyses associated with design basis accidents, determining accident progression and consequences for beyond design basis events and severe accidents is problematic given the effectively unbounded nature of the accident sequences. This is particularly true when the coincident occurrence of two or more events or accidents is postulated (e.g., an ELAP and a fire). While recognizing that concurrent events such as a fire could occur during a beyond design basis event and severe accident, it is not possible to predict resulting strategy impacts in any reliable/certain manner beforehand. For this reason, programmatic documents, and/or procedures and guidelines, should provide direction for selecting the appropriate strategy at the time of the emergency. For example, the Emergency Response Organization position(s) holding Ultimate Decision-Maker (UDM) authority[7] could have guidance for selecting the appropriate strategy, and then determining the priorities and actions necessary for implementation.

[7] Discussed in Section 4 of this document.

Figure 2.1
Simplified Example Framework



Note – EDMG capabilities/methods may be referenced in Emergency Operating Procedures (EOPs) and/or Severe Accident Management Guidelines (SAMGs).

In addition, BWR "Support Procedures" include the Technical Support Guidelines which support implementation of EOPs and SAMGs.

3 REQUIREMENTS FOR SAMGS AND SUPPORTING GUIDELINES

3.1 OVERVIEW

Each licensee should maintain Severe Accident Management Guidelines (SAMGs) and supporting guidelines which consider the generic technical guidance provided by the applicable technology Owners Group. This includes the development of any additional guidance necessary for responding to a beyond design basis event or severe accident affecting the cooling of irradiated fuel stored in a spent fuel pool. With respect to guidance issued by the Nuclear Energy Institute (NEI), the material in this document supersedes that provided in Section 5 of NEI 91-04, *Severe Accident Issue Closure Guidelines*, for the development, implementation and maintenance of severe accident management programs.

3.2 SEVERE ACCIDENT MANAGEMENT GUIDELINES

3.2.1 Development of Generic Severe Accident Management Guidance

Following the March, 1979, accident at Three Mile Island, the Electric Power Research Institute (EPRI) engaged in an extensive research program to better understand the nature of nuclear power plant accidents that could result in significant damage of the fuel – referred to as severe accidents. Before the Three Mile Island accident, operator procedures and training had focused almost exclusively on preventing an upset condition from progressing to the point at which the fuel was damaged. To broaden the spectrum of emergency response guidance, EPRI developed generic accident management strategies and implementing methods that could be taken to limit the consequences of a severe accident. This guidance was issued in EPRI Technical Report TR-101869, *Severe Accident Management Guidance Technical Basis Report* (SAMG-TBR), dated April 1993.

The SAMG-TBR is organized into two volumes. Volume 1 defines severe accident damage conditions for the reactor core, spent fuel pool, and containment; identifies the Candidate High-Level Actions (CHLAs) that may be taken to best manage these conditions; and summarizes the effects that could result from implementation of each CHLA. Volume 2 is composed of appendices, each of which describes the physical behavior for one type of phenomenon relevant to severe accidents. These appendices also include the technical bases for calculation aids that can be used to estimate the plant response if an action is taken. Although these calculations are generally not intended to provide detailed results, they are sufficient to allow consideration of the relative benefits and possible undesired effects associated with each action.

In October, 2012, EPRI published an updated SAMG-TBR, Technical Report TR-1025295, to address lessons learned from the March, 2011, accident at Fukushima Dai-ichi, and incorporate other insights from research and analysis conducted over the intervening 20 years. While the actions described in the original report continue to represent appropriate responses to severe accident conditions, several new technical considerations arising from the Fukushima accident were incorporated (e.g., makeup

water quality, spent fuel pool actions, hydrogen buildup mitigation, etc.). EPRI also issued a separate report dealing with strategies to limit radiological releases following a severe accident; refer to Technical Report TR-1026539, *Investigation of Strategies for Mitigating Radiological Releases in Severe Accidents*, dated October 2012. The latter report is applicable to a Boiling Water Reactor with a Mk 1 or Mk 2 containment.

The Boiling Water Reactor Owners Group (BWROG) and Pressurized Water Reactor Owners Group (PWROG) have created generic technical materials to guide the development of site-specific SAMGs for each technology. These technical guidelines translate the insights from the above discussed EPRI reports into a template containing recommended technology-appropriate strategies, and implementing methods, for mitigating the consequences of a severe accident. The development of technical guidelines is based on reference plants, and utilizes engineering data derived from severe accident analyses, operating experience and phenomenological research.

3.2.2 Principles for SAMGs

The following principles should be applied to the development and implementation of SAMGs:

- Site-specific strategies and implementing methods should be based upon existing plant systems, structures and components, and available portable equipment. Modifications to the plant design are permitted but not required.
- Any plant system, structure or component, and available portable equipment, may be used to implement an accident management strategy, irrespective of safety classification or other design-related criteria. In addition, the normally-applied controls on the use or configuration of a plant system, structure or component may be altered if necessary to implement a strategy (e.g., establishing a system lineup not described in the facility licensing basis).
- The inclusion of a plant system, structure or component within a severe accident management strategy implementing method does not impose any additional design or maintenance-related requirements on that item (i.e., beyond those associated with the existing specifications and programs). For example, the design-basis safety classification of a plant system, structure or component – safety-related, important to safety, etc. – is not changed because of its employment within a strategy implementing method.
- Strategies should reflect a best-estimate understanding of accident progression and consequences.
- SAMG entry conditions and operator actions should be symptom-based and clearly linked to specific plant parameters. Identification of the initiating event should not be required in order to determine which strategy should be implemented.
- The best possible operational guidance should be specified to restore and maintain key plant parameters within limits which define controlled and stable plant conditions, irrespective of licensing or design basis assumptions or commitments.

- Operator actions and decision-making criteria (e.g., a parameter value or trend that prompts a given action) should be determined using best-estimate assumptions and calculations, irrespective of licensing or design basis analytical assumptions and calculations.

- The capability to assess decision-making criteria (e.g., a parameter value or trend that prompts a given action) should accommodate the use of any available indications. Potential uncertainties in instrumentation readings caused by anticipated severe accident environmental conditions should be considered during the development of decision-making criteria.

- SAMG strategies may employ implementing methods or capabilities described in FLEX Support Guidelines (FSGs) or Extensive Damage Mitigation Guidelines (EDMGs).

- Computational aides should be provided when direct diagnosis of key plant conditions cannot be determined solely from instrumentation.

3.2.3 Considerations for Site-Specific SAMGs

3.2.3.1 Document Development

Site-specific severe accident management strategies, and associated implementing guidance, should be based on the generic technical guideline documents developed by the applicable Owners Group. Strategies and implementing guidance should reflect the plant-specific technology, design and operating characteristics, and control parameters and values. The SAMG principles discussed above should also be considered during the development or revision of implementing guidance.

Document developers should assess the applicability and utility of each strategy, and related material, presented in the generic technical guidelines. If deviations from the guidelines are necessary, they should be identified, documented and supported with a technical basis. For example, a deviation may be necessary if a particular generic strategy cannot be reconciled with the plant design. The technical basis for a deviation should address the potential effects on other strategies and/or recommended implementing methods.

A licensee may also include an additional strategy(ies) and/or implementing method(s) within their accident mitigation and management guidance documents. As with other deviations, these additions should be identified, documented and supported with a technical basis.

Licensees electing not to use the generic Owners Group technical guidelines should prepare a technical basis for all strategies and implementing methods described in their site-specific guidelines. The technical basis for the SAMGs should cite relevant research and analysis, and address the lessons learned from industry events such as the Fukushima Dai-Ichi accident. It should also discuss investigated strategies and methods that might be taken to limit the

release of radioactive materials over an extended period following an accident.

Guidelines for responding to a severe accident should be developed in accordance with the appropriate fleet or site-specific programmatic requirements, including the applicable writer's guide. In cases where one does not exist, a writer's guide should be developed. A writer's guide should contain all the information necessary to develop the plant-specific guidelines, and provisions for documentation of deviations from the generic Owners Group guidance.

3.2.3.2 Document Verification and Validation

Guidelines for responding to a severe accident should be verified and validated in accordance with an applicable fleet or site procedure development process. This includes guidelines developed for use by operators as well as those intended for implementation by the accident management support staff (e.g., engineers in the TSC). Absent an appropriate verification and validation process, one should be developed.

Verification and validation processes should assess the technical accuracy and adequacy of the instructions, and the ability of personnel to follow and implement them. The verification process should confirm the compatibility of document instructions with referenced equipment, user-aides and supplies (e.g., portable equipment, posted job aids, strategy evaluation materials, etc.). The validation process should demonstrate that the document provides the instructions necessary to implement the guidance.

Guidelines should be verified and validated using existing plant capabilities. Increasing the capability of the plant-referenced simulator to specifically model the conditions of the reactor core or stored spent fuel during a beyond design basis event or severe accident is not required. As a consequence, the technical rigor applied to verification and validation activities may be different than that normally used for Abnormal Operating Procedures and Emergency Operating Procedures.

The verification and validation process should accommodate the differences between non-severe and severe accident conditions. In particular, the process should recognize that severe accidents are characterized by uncertainties in both their progression and consequences. Some other key differences include:

- There may be no clear outcome for an accident management strategy. For example, adding water to a damaged core undergoing melting may, or may not, result in arresting core damage and, in some cases, may introduce new accident management challenges.

- There may not be a "right" or "wrong" decision at any given point in time during a severe accident response. Every severe accident management strategy has the potential for both positive and negative consequences

related to its implementation and these consequences can be very situation dependent. In addition, there may be cases where a negative consequence can be mitigated through implementation of another strategy within some event-specific timeframe.

Due to the unbounded nature of severe accident sequences and potential resulting conditions, a limited number of scenarios should be developed for the SAMG validation process (i.e., a sample group). These scenarios should allow for reasonable assurance that key decision points and transition guidance will support implementation accident management strategies. The assumed conditions and data used in the validation process should be determined on a "best estimate" basis.

3.2.3.3 Document Updating and Maintenance

Review, revision, approval, distribution and placement of SAMGs should be performed in accordance with the appropriate fleet or site document control process. The need to make changes should be assessed whenever:

- Changes to the facility that may impact the capability to implement strategies are identified.[8]

- The applicable generic severe accident technical guidelines are updated (e.g., a change to a guideline) or revised.

Potential changes should be tracked by an appropriate fleet or site process (e.g., a corrective action program).

A revision to the applicable generic severe accident technical guidelines should be assessed and implemented within 2 refueling outages or 3 years of the publication date, whichever is greater.

3.2.3.4 User Aids

The development, verification and validation of user aids should be consistent with applicable fleet and/or site policies.

3.2.3.5 Priority Setting for Document Changes

Each licensee should update the condition screening and evaluation requirements described in their corrective action program(s) as needed to promote the appropriate prioritization of corrective actions associated with severe accident management response capabilities. In particular, work prioritization and the assignment of resources for these types of conditions should be properly balanced with other site needs, and commensurate with the anticipated benefits to overall accident or event response capabilities (e.g.,

[8] Programmatic controls should be implemented to identify these types of facility changes (e.g., proposed design changes, configuration controls, etc.).

changes offering lower relative or absolute benefits should be assigned lower priorities).

3.3 FLEX SUPPORT GUIDELINES

Following an assessment of the accident at Fukushima Dai-Ichi, the NRC issued Order EA-12-049, *Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events*, on March 12, 2012. On August 29, 2012, the NRC staff issued Interim Staff Guidance (ISG) JLD-ISG-2012-01, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events*, Revision 0.[9] This document assists nuclear power reactor applicants and licensees with the identification of measures needed to comply with requirements of the mitigating strategies order. The ISG endorses, with clarifications, the methodologies described in the industry guidance document, Nuclear Energy Institute (NEI) 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, Revision 0.

The development, verification, validation and maintenance of FSGs should be performed in accordance with each licensee's procedure/guideline development processes, and the guidance provided in NEI 12-06.

3.4 EXTENSIVE DAMAGE MITIGATION GUIDELINES

As a result of the terrorist attacks of September 11, 2001, the NRC issued an Interim Compensatory Measures (ICM) Order to all power reactor licensees on February 25, 2002. This Order required compliance with specified interim safeguards and security compensatory measures. Section B.5.b of the ICM Order required the development of specific guidance and strategies to maintain core cooling, containment, and SFP cooling capabilities using existing or readily available resources (equipment and personnel) that could be effectively implemented under the circumstances associated with loss of large areas of the plant due to explosions or fire. Eventually, the requirements of Section B.5.b of the ICM Order were codified in 10 CFR 50.54(hh)(2); refer to SECY-08-099 and SRM-M081217B. The NRC staff-endorsed guidance for complying with 10 CFR 50.54(hh)(2) is contained in NEI 06-12, *B.5.b Phase 2 & 3 Submittal Guideline*.

The development, verification, validation and maintenance of EDMGs should be performed in accordance with each licensee's procedure/guideline development processes, and the guidance provided in NEI 06-12.

[9] Refer to NRC ADAMS ML #12229A174

4 COMMAND AND CONTROL

4.1 OVERVIEW

Each licensee should ensure that their emergency command and control structures are capable of directing responses to a beyond design basis event or severe accident, including those affecting multiple units on a site, in accordance with established procedure and guideline sets.

4.2 COMMAND AND CONTROL KEY FUNCTIONS

Command and control structures should clearly identify the Emergency Response Organization (ERO) position(s) with the ultimate authority for making decisions necessary for the implementation of emergency response procedures and guidelines during a beyond design basis event or severe accident. For purposes of the guidance in this document, the position with this authority is referred to as the Ultimate Decision-Maker (UDM). The position(s) assigned the UDM function should have the authority and capability of performing the following key command and control functions:

- Selection of the procedure or guideline set(s) most appropriate to address the event and/or plant conditions.
- Determination of the strategy(ies) to be implemented, and the necessary conditions and timing for implementation.
- Direction of the onsite and offsite resources needed to implement the selected strategy(ies).
- Direction of an action not contained in, or contrary to, procedures or guidelines, if it is determined that the action will provide greater protection of public health and safety.
- Interface with the ERO position holding overall command and control authority within the site ERO (and fleet-level ERO, if applicable), if the two authorities are held by different positions.

The qualifications for an UDM are discussed in NEI 13-06, *Enhancements to Emergency Response Capabilities for Beyond Design Basis Events and Severe Accidents*.

4.3 COMMAND AND CONTROL STRUCTURE CONSIDERATIONS

Procedures or guidelines used by the ERO should provide for implementation of command and control structures consistent with the following considerations.

- The UDM authority and responsibilities should be integrated into ERO command and control structures and protocols. It is not necessary to create a new ERO position or title.

- The Shift Manager should serve as the UDM during the implementation of Abnormal Operating Procedures (AOPs) and Emergency Operating Procedures (EOPs).

- Following a transition into Severe Accident Management Guidelines (SAMGs), the UDM authority and responsibilities may be retained by the Shift Manager, or transferred to an UDM-qualified individual located in another facility. The instructions/guidance for transferring the UDM role to a location outside the Control Room should include an assessment of the availability of the supporting personnel and resources necessary to implement all the command and control key functions.

- Following the transfer of the UDM function to an ERO position-holder located outside the Control Room (e.g., in the TSC), the support staff assisting with strategy evaluation and selection should include at least one member who holds an active SRO license, or has successfully completed an SRO licensing or certification program in the past, applicable to the affected onsite unit(s).[10] If a site hosts different technologies, then at least one individual with the SRO background described above should be available for each different unit technology (e.g., a PWR and a BWR, or an active safety feature plant and a passive safety feature plant).

- Following an event associated with loss of large areas of the plant due to explosions or fire, and causing a loss of the Control Room command and control structure, a procedure or guideline should describe the position(s) that could assume command and control of the event response. Due to the contingent and short-term nature of this assignment, and the initial focus on implementation of pre-planned EDMG strategies, it is not necessary for this position(s) to hold a UDM qualification. A procedure or guideline should specify how command and control are subsequently transferred to a position which does possess a UDM qualification.

- The UDM is able to direct changes to a pre-planned fire response strategy if necessary to support implementation of an accident or event mitigation or management strategy.

- The UDM assignment(s) should be consistent with the licensee's staffing assessments performed in accordance with NEI 12-01, *Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities*, and the associated regulatory responses to NRC letter, *Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident*, dated March 12, 2012.

- The authorities and responsibilities necessary to coordinate the acquisition and delivery of offsite resources are defined.

- At sites operating within a fleet structure, fleet-level command and control capabilities should be integrated into the licensee's command and control structures if

[10] The SRO certification should meet the requirements of ANSI/ANS 3.1, Selection, Qualification and Training of Personnel for Nuclear Power Plants.

such support will be relied upon during a beyond design basis event or severe accident.

- Specific UDM authorities and/or responsibilities that may be delegated, if any, are defined.

- Where appropriate, procedures and guidelines should contain guidance concerning the implementation of emergency response actions in accordance with 10 CFR 50.54(x) and the associated approval of such actions in accordance with 10 CFR 50.54(y).

5 REFERENCES

- NUREG-0737, *Clarification of TMI Action Plan Requirements*, dated November 1980
- NRC Generic Letter 88- 20, Supplement 2, *Accident Management Strategies for Consideration in the Individual Plant Examination Process*, dated April 4, 1990
- NRC Report, *Recommendations for Enhancing Reactor Safety in the 21st Century [The Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident]*, dated July 12, 2011
- NRC Order EA-12-049, *Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events*, dated March 12, 2012
- NRC letter, *Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident*, dated March 12, 2012
- NRC JLD-ISG-2012-01, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events*, dated August 29, 2012
- NRC staff report, *Onsite Emergency Response Capabilities, Regulatory Basis to Address Nuclear Regulatory Commission Near-Term Task Force Recommendation 8*, dated October 1, 2013
- Electric Power Research Institute (EPRI) Technical Report, *Severe Accident Management Guidance - Technical Basis Report,* TR-101869, dated April 1993
- Electric Power Research Institute (EPRI) Technical Report, *Severe Accident Management Guidance - Technical Basis Report*, TR-1025295, dated October 2012
- Electric Power Research Institute (EPRI) Technical Report, *Investigation of Strategies for Mitigating Radiological Releases in Severe Accidents*, TR-1026539, dated October 2012
- NEI 91-04, *Severe Accident Issue Closure Guidelines*, Revision 1, dated December 1994
- NEI 06-12, *B.5.b Phase 2 & 3 Submittal Guideline*, dated July 2009
- NEI 12-01, *Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities*, dated May 2012
- NEI 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, dated August 2012

- NEI 13-06, *Enhancements to Emergency Response Capabilities for Beyond Design Basis Events and Severe Accidents*, dated September 2014