NEI 06-12

B.5.b Phase 2 & 3 Submittal Guideline

NUCLEAR
ENERGY
INSTITUTE

Revision 3

September 2009

Prepared by:

ERIN®
An SKF Group Company
Engineering and Research, Inc.

2175 N. California Blvd., Suite 810
Walnut Creek, CA 94596

SUITE 400 1776 I STREET, NW WASHINGTON, DC 20006-3708 202.739.8000

FOREWORD

This guideline has been developed to assist licensees in developing regulatory submittals that describe their approach to addressing the mitigating strategies committed in the industry proposal for closing Phase 2 and Phase 3 of Section B.5.b of the 2002 ICM. The Phase 2 proposal was described in an NEI letter to the NRC dated January 24, 2006 [Ref. 1]. The Phase 3 proposal was described in an NEI letter to the NRC dated June 27, 2006 [Ref. 2].

The plant conditions evaluated in this guideline are beyond design basis and outside of the regulatory scope. This guideline and the conditions considered are not generally considered Safeguards Information. ~~However, some of the information contained herein is sensitive and should be handled in accordance with 10 CFR § 2.390.~~

TABLE OF CONTENTS

Section	Page

1.0 INTRODUCTION 1

2.0 SPENT FUEL POOL STRATEGIES 2

2.1 Background 2
- 2.1.1 Strategy Implementation 2

2.2 Diverse SFP Makeup Source (Internal Strategy) 5
2.3 Flexible, Power-Independent Makeup Source (External Strategy) 7
- 2.3.1 SFP Makeup Capability 8
- 2.3.2 SFP Spray Capability 12

2.4 Additional Site-Specific SFP Makeup Strategies 18
2.5 Leakage Control Strategies 19

3.0 REACTOR AND CONTAINMENT STRATEGIES 21

3.1 Background 21
3.2 Command and Control Enhancements 23
- **3.2.1 Boundary Conditions** 26
- **3.2.2 Off-Site and On-Site Communications** 27
- **3.2.3 Notifications/ERO Activation** 28
- **3.2.4 Initial Operational Response Actions** 30
- **3.2.5 Initial Damage Assessment** 31

3.3 Enhanced Site Response Strategies for PWRs 32
- **3.3.1 Makeup to RWST** 34
- **3.3.2 Manually Depressurize SGs to Reduce Inventory Loss** 36
- **3.3.3 Manual Operation of Turbine (or Diesel)-Driven AFW Pump** 37
- **3.3.4 Manually Depressurize SGs and Use Portable Pump** 39
- **3.3.5 Makeup to CST** 41
- **3.3.6 Containment Flooding with Portable Pump** 43
- **3.3.7 Portable Sprays** 44

3.4 Enhanced Site Response Strategies for BWRs 46
- **3.4.1 Manual Operation of RCIC or Isolation Condenser** 48
- **3.4.2 DC Power Supplies to Allow Depressurization of RPV & Injection with Portable Pump** 50
- **3.4.3 Utilize Feedwater and Condensate** 53
- **3.4.4 Makeup to Hotwell** 53
- **3.4.5 Makeup to CST** 55
- **3.4.6 Maximize CRD** 57
- **3.4.7 Procedure to Isolate RWCU** 58

3.4.8 Manually Open Containment Vent Lines 58
3.4.9 Inject Water into the Drywell 59
3.4.10 Portable Sprays 61
3.5 Disposition of Site-Specific Enhancement Strategies 63
4.0 REFERENCES 66
4.0 REFERENCES 79

Appendix A Licensee Response Templates

A.1 Response Template for Transmittal Letter
A.2 Response Template for SFP Strategies
A.3 Response Template for Command and Control Enhancements
A.4 Response Template for PWR Reactor and Containment Strategies
A.5 Response Template for BWR Reactor and Containment Strategies
A.6 Response Template for Disposition of Site-specific Strategies

Appendix B Example Equipment Specs

B.1 Kidde Fire Example Pump Package
B.2 Rain for Rent Example Pump Package
B.3 Example Monitor Nozzles

Appendix C Example EDMG Templates

C.1 PWR EDMG Example
C.2 BWR EDMG Example

Appendix D Mitigative Strategies Description and Plans Required by 10 CFR 52.80(d)

1.0 INTRODUCTION

Nuclear power plants are designed and operated based on the concept of design basis events. In the security area, nuclear power plant licensees are responsible for providing assurance that their sites are capable of withstanding design basis security threats and for taking reasonable measures to assure that available resources are used effectively in responding to beyond design basis threats. With the potential spectrum of beyond design basis terrorist threats being essentially unlimited, it is not feasible to define a "bounding" scenario. Thus, a pragmatic approach is required.

In light of this situation, all nuclear utilities undertook an evaluation of potential damage to their facilities in an effort to enhance plant-specific mitigation capability for damage conditions potentially affecting systems important to preventing core damage and release caused by a large explosion or fire. The objective of these site-specific assessments was to utilize a threat-independent methodology to identify potential plant-specific strategies for preventing or mitigating damage to the fuel. These assessments have identified a wide spectrum of potential plant-specific enhancements for consideration, and a collective review of these assessments yielded some important high-level insights:

- Prediction of precise damage states, plant conditions, and associated plant response is not possible, even on a site-specific basis.
- Bounding damage states are of little value in assessing and enhancing plant capabilities.
- The potential endless combinations and permutations of potential damage states are imponderable.
- Some potential damage scenarios can impact the normal command and control structure due to personnel impacts and/or loss of control room.
- A flexible response capability is desirable. Such a capability provides the industry with an increased potential to address these extreme conditions.
- The value of costly new fixed hardware capability is not guaranteed, as the damage state could just as easily disable any new fixed capability as well as the existing capability.
- Identified response capabilities will not ensure success under the full spectrum of potential damage states.

With this enhanced level of understanding of the situation, the following four components have been identified for implementation to address B.5.b Phases 2 and 3:

- Internal SFP Makeup Strategy
- External SFP Makeup & Spray Strategy
- Enhanced Initial Command and Control for Reactor Challenges
- Enhanced Response Strategies for Reactor Challenges

2.0 SPENT FUEL POOL STRATEGIES

2.1 BACKGROUND

In 2005, as part of the Industry Spent Fuel Pool Mitigation Strategy (Phase 2) Study sponsored by NEI, each site has developed a site specific assessment of mitigation strategies for spent fuel pool damage scenarios. The NRC conducted a site specific assessment of mitigation strategies as well. Both NEI and NRC issued site specific report outlining potential enhancement strategies.

In January 2006, the nuclear industry proposed to enhance the spent fuel mitigation capability of every operating nuclear power plant [Ref. 1], as an alternative to the site specific assessments. The industry approach was developed by a Chief Nuclear Officer (CNO) Review Panel. After reviewing the results of the industry and NRC Phase 2 studies, it became apparent to the CNO Review Panel that a combination internal and external strategy is the most efficient and effective way to address this issue and offers the best chance for success from a spectrum of potential scenarios. The most attractive feature of the two strategies is the flexibility they provide for responding to the wide range of potential scenarios.

The internal strategy involves implementation of a diverse makeup capability within the plant that can provide at least 500 gpm of SFP makeup. The external strategy involves the use of a portable SFP makeup and spray capability that enhances the robustness and flexibility of site response. The implementing guidance for the external strategy must include steps to assist the plant staff in determining whether use of the external strategy in the makeup mode is preferred, or if use in the spray mode is appropriate.

Subsequent interactions between the NRC and NEI further clarified the elements of the SFP mitigation capabilities [Ref 3, 4]. This section describes the objectives, performance requirements and submittal elements that each site must provide to close out Phase 2 of the B.5.b response. Additional guidance is provided on each aspect of the submittal in order to facilitate strategy development and submittal preparation. In addition, an industry template for response on SFP mitigation is provided in Appendix A.2. Providing a response in accordance with this guideline addresses all of the response elements requested by the NRC in Enclosure 3 of the site-specific Phase 2 letters. NOTE: These strategies are not required for sites that have spent fuel pools that are below grade and can not be drained. These plants have been notified by the NRC.

2.1.1 Strategy Implementation

The implementation of these SFP mitigation strategies significantly enhances the overall response capability of each site. In order to effectively deploy these strategies, it is anticipated that sites will develop procedures/guidance that directs the deployment of the appropriate strategy. A generalized decision process for implementing the internal and external makeup and spray strategies is provided in Figure 2-1.

The entry conditions for this process should be outside the normal makeup capability. That is, the normal makeup capability is still considered to be sufficient for all design basis considerations and the internal and external strategies would only be called for if the normal makeup systems are insufficient, or if their effectiveness cannot be determined due to the damage state.

The first step of the decision process is to determine whether the area around the spent fuel pool is accessible. Accessibility can be impacted by the local damage condition (e.g., degraded conditions due to structural or fire-related impacts), or by radiation dose (e.g., due to fuel uncovery). If the area is not accessible, then makeup to the spent fuel pool should be initiated using all available means. If local spray is available (i.e., spraying of the fuel in the spent fuel pool from the area around the spent fuel pool), then it should be deployed. If not, then external spray should be deployed (i.e., spray from outside the structure to cool fuel and/or reduce radionuclide release).

If the area around the spent fuel pool is accessible, then a determination of the spent fuel pool leakage rate should be made. This determination should focus on the relative rate of loss of inventory is excessive (i.e., does pool level indicate that the leak rate is likely greater than 500 gpm, or is dose rate excessive due to fuel uncovery). If it can be determined that the leakage rate is not excessive, then makeup should be initiated using the internal strategy, supplemented by the external makeup strategy, as necessary to maintain or restore water level. If those makeup sources are ineffective and spent fuel pool level is dropping, then the option for spray should be considered.

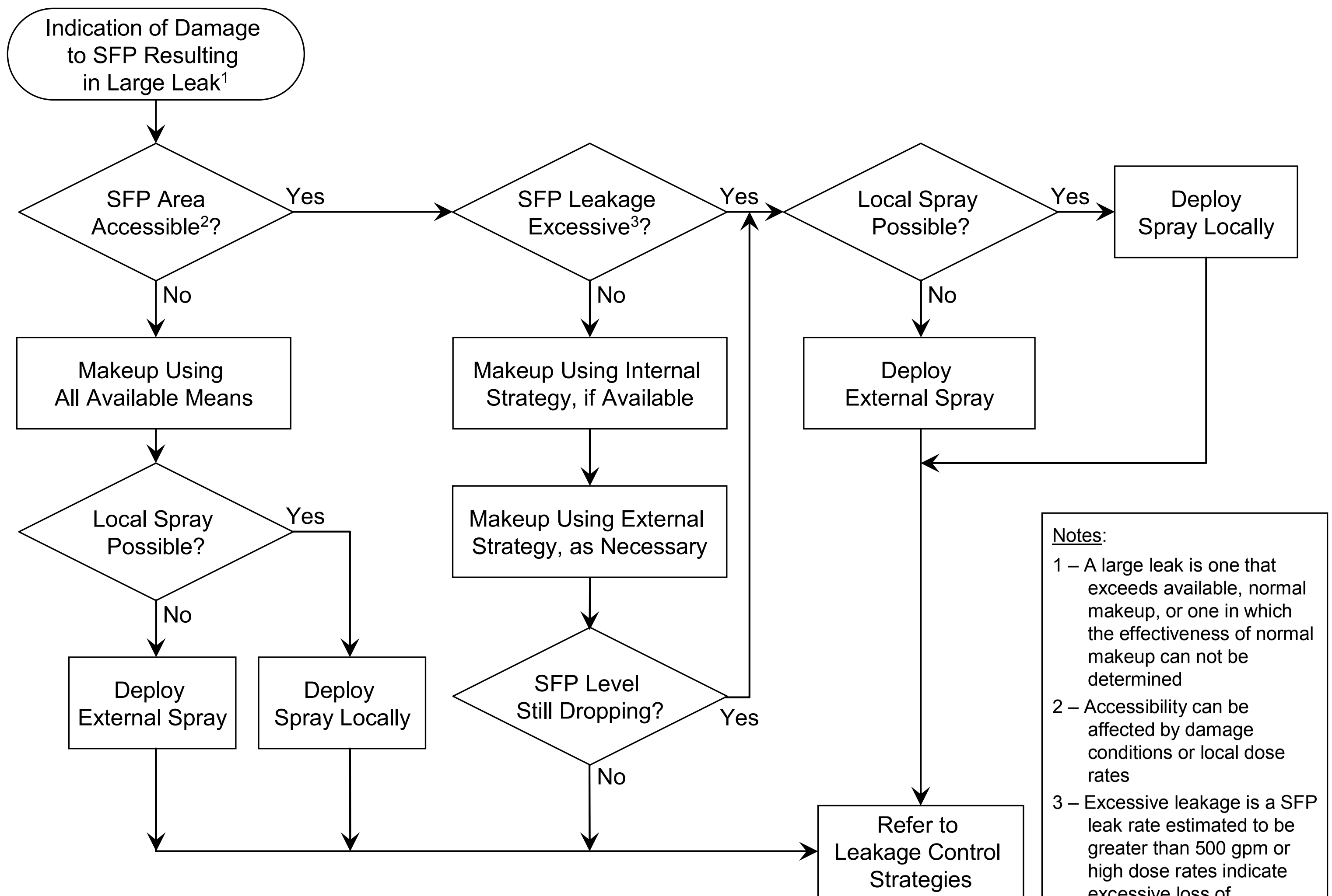
This option applies either when the leakage rate has been determined to be excessive, or when internal/external makeup sources are ineffective in restoring SFP level. In these cases, the preference is for local spray, but if local spray can not be deployed, then external sprays are called for.

In cases where water level is not maintained, leakage control strategies should be considered.

The appropriate site-specific approach to be taken to implement this set of strategies in plant procedures/guidance is left to the site to determine.

Figure 2-1

Generalized Decision Process for SFP Makeup vs. Spray



Notes:

1 – A large leak is one that exceeds available, normal makeup, or one in which the effectiveness of normal makeup can not be determined

2 – Accessibility can be affected by damage conditions or local dose rates

3 – Excessive leakage is a SFP leak rate estimated to be greater than 500 gpm or high dose rates indicate excessive loss of inventory.

2.2 DIVERSE SFP MAKEUP SOURCE (INTERNAL STRATEGY)

Objective:

Establish a diverse means of SFP makeup with at least a concurrent makeup capability of 500 gpm beyond the normal SFP makeup capability.

Performance Attributes:

1. The concurrent SFP makeup capability of 500 gpm is the total flow rate of water that can be simultaneously supplied to the pool beyond the normal SFP makeup capability. This total concurrent makeup capability can be accomplished with multiple systems beyond the normal makeup system, but all must be diverse from the normal makeup system. NOTE: Line losses need to be considered in estimating flow rates. The site should have an engineering basis that provides reasonable assurance that the intended makeup rate and capacities can be provided. This basis should be auditable, but does not have to be a quality related calculation.
2. The term "diverse" means that the makeup source does not rely upon any of the same components or piping as the normal makeup source. This includes power supplies that are located in the same building as the SFP. An obvious example of a potentially diverse makeup source might be the fire water system headers in the vicinity of the spent fuel pool with a sufficient number of fire hoses as a means to provide SFP makeup.

Response Elements:

- Provide a general description of diverse Spent Fuel Pool (SFP) makeup capability, including the necessary personnel actions.
- Describe how this capability meets the NEI guidance as "diverse".
- Describe the locations of the primary equipment involved in implementing this strategy.
- Estimate flow rates expected to be delivered to the SFP and identify the capacity of water supplies.

Submittal Guidance:

The evaluation of this strategy should begin with the existing SFP makeup capability that already exists beyond the normal SFP makeup system. If the plant has an existing diverse makeup capability beyond the normal SFP makeup system that exceeds 500 gpm, then no additional enhancement strategies need to be implemented. The existing capabilities should be documented in the submittal using the template provided in Table A.2-1.

In the event the site does not have a diverse concurrent makeup capability beyond the normal SFP makeup system that exceeds 500 gpm, then the site assessment reports compiled by ERIN Engineering and Research, Inc. and the NRC should be reviewed to identify potential enhancement strategies to establish 500 gpm of diverse makeup. Due to the fact that these enhancement strategies were identified without detailed technical review, each site should evaluate each identified enhancement strategies to determine the true feasibility and benefit of each with consideration of at least the following:

- Whether the strategy represents a diverse makeup capability from the normal makeup system (i.e., makeup pathway not dependent on components or piping of the normal makeup system).
- Whether the strategy provides additional tangible makeup capability beyond that already available (i.e., the 500 gpm criteria).
- Whether the strategy can feasibly be accomplished in the time available and plant conditions that may exist.
- Whether the strategy can be incorporated into plant procedures and training without unduly impacting the existing training regimen.

If the diverse concurrent makeup capability is less than 500 gpm beyond the normal SFP makeup capability, then the site must identify and implement additional mitigation strategies. Attachment A of Reference 1 provides a generic list of candidate mitigation enhancement strategies identified in the NEI and NRC Phase 2 studies. Sites requiring additional concurrent makeup capability may review this list and brainstorm plant-specific options for establishing a diverse means of providing a minimum of 500 gpm of concurrent makeup capability in excess of the normal SFP makeup system. In some cases, this may involve identification of strategies not included in the original studies. In other cases, minor plant modifications may be necessary. In either case, sites are expected to assure that a diverse concurrent makeup capability of at least 500 gpm can be provided to the SFP. The selection of the makeup capability option to utilize in enhancing makeup capability will be left to the site's discretion. It is recognized that some items in Attachment A may share SFP makeup piping and components at some plants and would not qualify as diverse.

The enhanced SFP makeup capabilities should be documented in the submittal using the template provided in Table A.2-1.

Additional Considerations:

1. For the purposes of this strategy, it is acceptable to utilize makeup sources that would require access to areas around the spent fuel pool, including the spent fuel pool deck area.
2. In identifying strategies, there is no need to consider additional concurrent events at the site. Thus, all plant systems can be considered available as options, including fire protection systems.
3. If flexible hoses (e.g., fire hoses) are to be relied upon to deliver flow to the SFP, then some means to secure the hose is required to assure that the water is delivered into the pool. (e.g. tie downs or unmanned nozzle)
4. There is no need to consider the potential for equipment to be out of service for routine maintenance activities. This also means that there is no need to provide redundancy in the means of makeup.
5. Strategy can be implemented through guidance or procedures, consistent with the site's chosen approach. Steps are expected to be general in nature, consistent with the need for flexibility in deployment. That is, there is no need to develop scenario-specific procedures.
6. Level of training on implementing procedures/guidance is expected to be consistent with SAMG-type actions and consistent with utility commitments made under B.5.b Phase 1.
7. Prior to the event, the plant systems are assumed to be in a nominal configuration with the reactor at 100% power.
8. Implementation of this strategy is not expected to require extraordinary or heroic actions. In an event, the utility emergency response organization (ERO) will decide on the potential benefit and feasibility of the strategy in light of plant conditions. For example, it is expected that dose rates and other accessibility considerations will be addressed at the time of the event, in light of the actual plant conditions. This input will be considered by the ERO in directing plant response actions.

2.3 FLEXIBLE, POWER-INDEPENDENT MAKEUP SOURCE (EXTERNAL STRATEGY)

The external strategy actually contains two functional objectives: SFP makeup and SFP spray capability. The first objective is aimed at providing yet another means to provide makeup to the SFP. The second objective is to provide spray to the pool in the event the pool water level can not be maintained. Spray flow needs to be coordinated with hot fuel dispersal. The external strategies are not required to be implemented simultaneously and may rely on the same pumping capability and water sources.

Appendix B provides supplementary information on examples of commercially available pumping systems and monitor nozzles.

2.3.1 SFP Makeup Capability

Objective:

Establish a flexible means of SFP makeup of at least 500 gpm using a portable, power-independent pumping capability.

Performance Attributes:

1. Portable pumping capability sufficient to supply pool makeup directly at a rate of at least 500 gpm. NOTE: Line losses need to be considered in estimating flow rates. The site should have an engineering basis that provides reasonable assurance that the intended makeup rate and capacities can be provided. This basis should be auditable, but does not have to be a quality related calculation.
2. The external strategies are not required to be implemented simultaneously and may rely on the same pumping capability.
3. For dual unit sites that share a spent fuel pool the flow rate is at least 500 gpm of direct makeup to the SFP. This may rely on the same pumping capability as the SFP spray.
4. For dual unit sites that have spatially separated pools the flow rate will be required to be at least 500 gpm of direct makeup to the SFP for each pool and is not required to be implemented simultaneously. This may rely on the same pumping capability as the SFP spray.
5. This capability could be in the form of an on-site fire pumper truck or an onsite, external portable pump. The pump is anticipated to be diesel driven, but an alternative could be an AC powered pump using jumper cables from an onsite emergency power source that is spatially separated from the vicinity of the spent fuel pool.
6. While an independent pumper truck or portable pump is required to be available for this strategy, the external fire protection system ring header is an acceptable water source to supply the pump, provided damage to the header and distribution piping in the vicinity of the spent fuel pool structure can be isolated. NOTE: Since deployment of the external makeup strategy using firewater could in many cases be quicker, if available, it can be considered as part of the strategy.
7. Sufficient fuel for the pumping source to operate for 12 hours without off-site supplies.

8. Adequate suction supply piping to allow the portable pumping capability to be located such that the potential makeup/spray deployment locations can be serviced.
9. A means to assure that sufficient water sources are available to operate the system for at least 12 hours at the flow rate anticipated to be provided. At an anticipated makeup rate of 500 gpm, this is equivalent to 360,000 gallons.
10. Sufficient hose to allow makeup directly to the SFP at a rate of at least 500 gpm from each accessible side of the structure containing the SFP (may require multiple hoses). This includes a means to secure the hoses at or near the SFP to ensure the hose directs the water into the SFP.
11. The system should be capable of being deployed within 2 hours from the time plant personnel diagnose that external SFP makeup is required.
12. Example specifications for portable, power-independent pumps are included in Appendix B.1.

Response Elements:

- Provide a general description of alternate SFP makeup capability, including the necessary personnel actions.
- Describe the general locations of the primary equipment involved in implementing this strategy.
- Estimate flow rates expected to be delivered to the SFP and identify the capacity of water supplies.
- Confirm that procedure/guidance has been or will be developed for implementing this strategy.

Submittal Guidance:

It is impossible to predict the specific damage condition that might occur as a result of a beyond design basis security threat. Further, conditions may prevent the implementation of the diverse SFP makeup internal strategy for providing pool cooling. Therefore the industry approach is for each site to have a flexible, deployable, external mitigation capability on-site. Such an alternate capability should be devised to provide sufficient makeup capability for a spectrum of potential conditions, and take advantage of site design features that can be beneficial in responding.

The water makeup capability will be employed by connecting hoses to the discharge of a portable pump and manually routing the hoses to support a discharge flow rate of at least 500 gpm into the spent fuel pool.

As the range of possible damage states cannot be predicted, adverse environmental and radiological conditions may impose significant challenges to the mitigation response teams implementing the proposed strategy. In a real event, environmental and radiological conditions will be monitored to assess safe access and exposure of the mitigation response teams. The ability to perform the strategy will be determined by this assessment.

The external SFP makeup capability should be documented in the submittal using the template provided in Table A.2-2.

<u>Additional Considerations</u>:

1. For the purposes of this strategy, it is acceptable to assume access to areas around the spent fuel pool, including the spent fuel pool deck area.
2. This strategy assumes that the leakage rate from the pool is not so excessive to prevent the strategy from being initially deployed due to high radiation levels.
3. The external strategies (i.e., SFP makeup and spray) are not required to be implemented simultaneously and may rely on the same pumping capability.
4. While an independent pumper truck or portable pump is required to be available for this strategy, the external fire protection system ring header is an acceptable water source to supply the pump, provided damage to the header and distribution piping in the vicinity of the spent fuel pool structure can be isolated. NOTE: Since deployment of the external makeup strategy using firewater could in many cases be quicker, if available, it can be considered as part of the strategy. It is recognized that fire system at many sites is the most flexible system that can be employed to mitigate many of the elements associated with this effort. If portions of the fire system must be relied on for implementation of this strategy the management of the system should be outlined in site procedures/guidelines. Guidance should include methods to isolate potentially damaged headers and if possible guidance for ring header sectionalization. Connection to the fire ring header should be approximately 100 yards or more from the target area. It can be assumed that the fire header itself is not damaged. However, the fire system management strategy should address isolation of fire headers inside structures that may be target areas. The pump used to charge the ring header should be located more than approximately 100 yards from the target area. If this separation does not exist, then some justification for pump survivability (e.g., intervening structures, nearly 100 yards away from key plant areas, contained in a reinforced concrete structure, etc.) should be provided in the submittal. Document the fire system management strategy in the submittal in Table A2-6.

5. If flexible hoses (e.g., fire hoses) are to be relied upon to deliver flow to the SFP, then some means to secure the hose is required to assure that the water is delivered into the pool (e.g., tie downs or unmanned nozzle).
6. There is no need to consider the potential for equipment to be out of service for routine maintenance activities. This also means that there is no need to provide redundancy in the means of makeup.
7. Equipment associated with the external strategy is not to be treated as safety-related equipment. As such, it is not subject to any new special treatment requirements under 10 CFR (e.g., QA, seismic, EQ, etc.).
8. Equipment associated with the external strategy will meet standard industry practices for procuring and maintaining commercial equipment.
9. Strategy can be implemented through guidance or procedures, consistent with the site's chosen approach. Steps are expected to be general in nature, consistent with the need for flexibility in deployment. That is, there is no need to develop scenario-specific procedures.
10. In assessing deployment times, assume access is not inhibited to the areas required for strategy implementation.
11. Level of training on implementing procedures/guidance is expected to be consistent with SAMG-type actions and consistent with utility commitments made under B.5.b Phase 1.
12. The implementing guidance for the external strategy must include steps to assist the plant staff in determining whether use of the external strategy in the makeup mode is preferred, or if use in the spray mode is appropriate.
13. The portable pumping capability will need to be stored on-site approximately 100 yards or more away from the SFP in order to assure survivability and availability for the spray function. Connecting devices and hoses that will be employed in the vicinity of the SFP can be stored on the spent pool deck or in stairwells.
14. It is acceptable for the portable pumping source to also be used for fire fighting (e.g., an onsite fire pumper truck).
15. It is acceptable for the portable pumping source to be periodically taken offsite (e.g., for fire fighting training). However, if the location offsite would preclude deployment within the required time, the amount of time the pump is unavailable should be limited based on site work control processes.
16. Prior to the event, the plant systems are assumed to be in a nominal configuration with the reactor at 100% power.
17. Implementation of this strategy is not expected to require extraordinary or heroic actions. In an event, the utility emergency response organization (ERO) will decide on the potential benefit and feasibility of the strategy in

light of plant conditions. For example, it is expected that dose rates and other accessibility considerations will be addressed at the time of the event, in light of the actual plant conditions. This input will be considered by the ERO in directing plant response actions.

2.3.2 SFP Spray Capability

Objective:

Establish a flexible means of providing at least 200 gpm per unit of spray to the spent fuel pool using a portable, power-independent pumping capability.

Performance Attributes:

1. Portable pumping capability sufficient to supply one or more monitor nozzles located to spray the SFP at a flow rate of at least 200 gpm per unit.
2. The external strategies are not required to be implemented simultaneously and may rely on the same pumping capability.
3. For dual unit sites that have separate pools the flow rate will be required to be at least 200 gpm of spray to the SFP for each pool and is not required to be implemented simultaneously. These may rely on the same pumping capability as the SFP makeup.
4. For dual unit sites that share a spent fuel pool the flow rate will be required to be at least 400 gpm of spray to the SFP. This higher flowrate is required for two reasons. First, dual unit pools are generally larger than single unit pools. Second, a dual unit pool generally has a higher overall heat load due to the second unit. This may rely on the same pumping capability as the SFP makeup.
5. This capability could be in the form of an on-site fire pumper truck or an onsite, external portable pump. The pump is anticipated to be diesel-driven, but an alternative could be an AC-powered pump using jumper cables from an onsite emergency power source that is spatially separated from the vicinity of the spent fuel pool and the other critical areas of station associated with Phase 3.
6. Sufficient fuel for the pumping source to operate for 12 hours without off-site supplies.
7. Adequate suction supply piping to allow the portable pumping capability to be located such that the potential makeup/spray deployment locations can be serviced.

8. A means to assure that sufficient water sources are available to operate the system for at least 12 hours at the above specified flow rate, i.e. 200 gpm for separate pools and 400 gpm for shared pools.
9. Sufficient hose to spray the SFP at a rate of at least 200 gpm per unit from each accessible side of the structure containing the SFP. This may require multiple hoses.
10. When fuel is stored in an undispersed configuration, the system should be capable of being deployed within 2 hours from the time plant personnel diagnose that external SFP makeup is required. Once the fuel is dispersed, then the system should be capable of being deployed within 5 hours from the time plant personnel diagnose that external SFP makeup is required.
11. Example specifications for oscillating monitor nozzles are included in Appendix B.3. Other spray dispersal methods are also acceptable (e.g., water curtains), provided that they meet the other requirements of this strategy.
12. Sufficient portable spray monitor nozzles and associated hoses to provide a spray over the entire spent fuel pool (assuming freshly discharged fuel has been distributed). This may best be accomplished with oscillating monitor nozzle(s).
13. Implementing guidance should identify that spray flows to the SFP should be maximized in the event the damage occurs prior to the recently discharged fuel being distributed.
14. The implementing guidance for the external strategy must include steps to assist the plant staff in determining whether use of the external strategy in the makeup mode is preferred, or if use in the spray mode is appropriate.
15. Capability to position the monitor nozzles internally on the spent fuel pool floor to spray into the pool for situations where the pool leakage rates and plant conditions permit this option.
16. Capability to lift/locate the monitor nozzle such that the spray can be externally directed into the spent fuel pool (e.g., from an adjacent building roof, fire truck extension ladder). The lifting capability (e.g., crane or fire truck with extension ladder) may be located off-site as long as the site has confidence (e.g., through an MOU) that it will be available for use on-site within the required timeframe (i.e., 2 hours or 5 hours). This may require a modification to the lifting device to allow the monitor nozzle to be affixed. Note: for sites with top of active fuel in the SFP that is at or below grade level, a lifting device may not be required.

<u>Response Elements</u>:

- Provide a general description of alternate SFP spray capability, including the necessary personnel actions. Description needs to include both distributed and non-distributed recently discharged fuel.
- For pools with top of active fuel above grade, describe the means to be used to direct spray on to the top of the spent fuel, if necessary (e.g., suspended platforms). See Item 2 of Additional Considerations.
- Describe the general locations of the primary equipment involved in implementing this strategy.
- Describe the general agreements or understandings with off-site resources and the provisions made for the lifting capability.
- Estimate flow rates expected to be delivered to the fuel in the SFP and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

The SFP spray capability would be employed for situations where the leakage rate exceeds the makeup rate, resulting in a drained pool. The measure would be employed by connecting hoses to the discharge of the pump and then to one or more oscillating monitor nozzles to provide a spray over the top of the pool. Conservatively, 200 gpm is a sufficient amount of spray water. For conditions following a refuel outage where recently discharged fuel from the reactor has not been dispersed to allow optimization of cooling alternatives, the implementing guidance should direct maximizing spray flow rates.

In cases where the leak rate does not significantly exceed the makeup rate, there may be sufficient time to set up the oscillating monitor nozzle on the SFP floor. As described in the external makeup strategy, similar hose arrangements could be employed. The spray provided by the nozzle is believed to provide the best cooling method for the spent fuel.

As the range of possible damage states cannot be predicted adverse environmental and radiological conditions may impose significant challenges to the mitigation response teams implementing the proposed strategy. Access to the spent fuel pool floor and its building may not be possible. It is assumed that in most situations the damage state would allow for spray into the Spent Fuel Pool through a hole caused by the event. The spray would be directed through the hole in the building by employing ladders or spraying from the roof of an adjacent building or by other means directed by the utility procedures and processes or as the event requires. Though unlikely, for those situations in which conditions and damage states do not allow spray into the pool it is not intended for the site to pre-position access points or modify containment structures to allow spray directly into the pool. For these situations spray would be directed at the point of release or on to the building. It is also recognized that unique site attributes and layouts may not allow all areas and damage states to be addressed. If inaccessibility of SFP can be anticipated in certain damage states (e.g., SFP surrounded by reinforced concrete structure and unable to spray entire pool) then indicate any immediate actions or actions that will be taken to pre-stage equipment near the SFP deck to maximize probability of spray strategy deployment. Identify the site limitations and actions in Table A.2.3 under the Notes section.

The external SFP makeup capability should be documented in the submittal using the template provided in Table A.2-3.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that areas immediately around the spent fuel pool and deck may not be accessible either due to damage or due to radiation levels.
2. It is understood that not all conceivable scenarios can be mitigated by sprays. The objective is for each site to work to identify means to spray the pool.

   For plants with sheet metal siding above the spent fuel pool deck, it can be always be assumed that the event sufficiently dislodged the sheet metal to allow a stream of external spray to be targeted at the spent fuel pool.

   For plants that have reinforced concrete walls above the area surrounding the spent fuel pool and the top of active fuel is above grade, it is possible to envision damage scenarios where the SFP leakage occurs below the top of active fuel and an external spray through the event-induced hole would not be sufficient to provide spray distribution. In these cases, the site should investigate creative means to provide spray flow to the pool while minimizing access requirements. This may include spraying through rollup doors or building vents, or utilizing stairwells in adjacent buildings to access the spent fuel pool deck briefly to initiate sprays locally, Sites are not required to modify structures to create an access point for external sprays.
3. In cases where the reinforced concrete structure does not allow the external strategy to spray the spent fuel and the top of active fuel is above grade, the site should review the NRC's site-specific Phase 2 report to determine whether any of the RAMs identified would be beneficial for these circumstances (i.e., the RAM would provide large flowrate makeup sources or spray capability with limited or no access to the area around the spent

fuel pool). The results of this review should be documented in the NOTES section of Table A.2-3.

4. While an independent pumper truck or portable pump is required to be available for implementing this strategy, the external fire protection system ring header is an acceptable water source, provided damage to the header and distribution piping in the vicinity of the spent fuel pool structure can be isolated. NOTE: Since deployment of the external makeup strategy using firewater could in many cases be quicker, if available, it can be considered as part of the strategy. Guidance should include methods to isolate potentially damaged headers and if possible guidance for ring header sectionalization. Connection to the fire ring header should be approximately 100 yards or more from the target area. It can be assumed that the fire header itself is not damaged. However, the fire system management strategy should address isolation of fire headers inside structures that may be target areas. The pump used to charge the ring header should be located more than approximately 100 yards from the target area. If this separation does not exist, then some justification for pump survivability (e.g., intervening structures, nearly 100 yards away from key plant areas, contained in a reinforced concrete structure, etc.) should be provided in the submittal. Document the fire system management strategy in the submittal in Table A2-6.

5. The portable pumping capability, necessary hoses, and monitor nozzles will need to be stored on-site in an area approximately 100 yards or more away from the SFP in order to assure survivability and availability for the spray function.

6. A site specific assessment of the number of spray nozzles and their locations should be performed in order to assure that 200 gpm per unit of spray is reaching the SFP and that the entire SFP is sprayed.

7. There is no need to consider the potential for equipment to be out of service for routine maintenance activities. This also means that there is no need to provide redundancy in the means of spray.

8. Equipment associated with the external strategy is not to be treated as safety-related equipment. As such, it is not subject to any new special treatment requirements under 10 CFR (e.g., QA, seismic, EQ, etc.).

9. Equipment associated with the external strategy will meet standard industry practices for procuring and maintaining commercial equipment.

10. Strategy can be implemented through guidance or procedures, consistent with the site's chosen approach. Steps are expected to be general in nature, consistent with the need for flexibility in deployment. That is, there is no need to develop scenario-specific procedures.

11. In assessing deployment times, assume access is not inhibited to the areas required for strategy implementation.
12. Level of training on implementing procedures/guidance is expected to be consistent with SAMG-type actions and consistent with utility commitments made under B.5.b Phase 1.
13. It is acceptable for the portable pumping source to also be used for fire fighting (e.g., an onsite fire pumper truck).
14. It is acceptable for the portable pumping source to be periodically taken offsite (e.g., for fire fighting training). However, if the location offsite would preclude deployment within the required time, the amount of time the pump is unavailable should be limited based on site work control processes.
15. For some SFPs (e.g., elevated pools), it may be necessary to rely on a spray capability provided from offsite, it must be controlled under an MOU and can be implemented onsite within the time constraints for this strategy. In these cases, it is acceptable to use the portable onsite pump as the motive force for spray, or use a pump contained in the offsite spray equipment, or both,
16. Plants with spent fuel pools enclosed in a structure that is entirely reinforced concrete should approach this strategy in the following manner:
    a. Provide a means to spray the fuel in the SFP in the manner described above from a location external to the structure, assuming that the damage that caused loss of SFP inventory extends above top of active fuel (TAF).
    b. For cases where the postulated damage does not extend above the TAF, identify and implement alternative means to provide fuel cooling. This may include as many of the following strategies as are applicable. NOTE: These strategies should consider staging hoses, spray nozzles, etc. at various locations within the structures employing both internal and external elements to maximize the likelihood of deployment:
        - Consider direct dispersement of spent fuel (in preferred configuration) discharged from the reactor during refueling outages, where possible.
        - Utilizing creative means to spray from an external location (e.g., through blowout panels, doors, or building vents)
        - Spray from the SFP deck, by accessing the area from an adjacent structure.
        - Spray from the SFP deck, by accessing the area from all stairwells within the structure containing the SFP.

- Providing procedures/guidance to ehance air cooling of fuel in the SFP, in the event spray cooling can not be established (realize that the only time this would be required is when SFP integrity has already been compromised, such that containment of fission products cannot be assured).
- Spray the hole and/or spent fuel structure as a last resort.

17. Prior to the event, the plant systems are assumed to be in a nominal configuration with the reactor at 100% power.
18. Implementation of this strategy is not expected to require extraordinary or heroic actions. In an event, the utility emergency response organization (ERO) will decide on the potential benefit and feasibility of the strategy in light of plant conditions. For example, it is expected that dose rates and other accessibility considerations will be addressed at the time of the event, in light of the actual plant conditions. This input will be considered by the ERO in directing plant response actions.

2.4 ADDITIONAL SITE-SPECIFIC SFP MAKEUP STRATEGIES

Objective:

Retain the useful insights from the site-specific SFP mitigation assessments for reference in the event an SFP threat occurs.

Performance Attributes:

1. All NRC strategies should be reviewed to consider their viability.
2. List the viable strategies in plant procedures/guidance.

Response Elements:

- Identify which additional enhancement strategies were found to be viable.
- Confirm that procedures/guidance will, at a minimum, list the viable strategies that could be used by plant personnel (e.g., Emergency Response Organization)

Submittal Guidance:

The site-specific Phase 2 assessments performed generally identified a number of possible strategies that could enhance each site's existing capability. Many of the enhancements involved physical plant modifications. Others, however, involved minimal changes for implementation and were considered to be readily available. As such, these potential readily available enhancement strategies represent a valuable resource that would be beneficial to retain for future reference by emergency response personnel. The industry has committed to retain the viable strategies by listing them in plant procedures or guidance [Ref. 4].

The viability of each mitigation enhancement strategy should be evaluated with consideration of at least the following:

- Whether the strategy provides additional tangible makeup capability beyond that already available (e.g., a substantial fraction of 500 gpm). Thus, while potentially feasible, a strategy that provides a low makeup rate would not be considered viable.
- Whether the strategy can feasibly be accomplished with existing onsite plant equipment in the time available and plant conditions that may exist. Thus, a strategy that requires a long time to establish or requires access to many areas of the plant near and around the SFP would not be considered viable.

Each of these enhancements that are found to be viable should be identified in a plant procedure or guidance. It is sufficient to provide a list of the strategies retained. It is not necessary to specify the steps necessary for implementation.

The enhancements that will be incorporated into plant procedures/guidance should be documented in the submittal using the template provided in Table A.2-4.

2.5 LEAKAGE CONTROL STRATEGIES

Objective:

Identify for emergency response organization the on-site resources that could be used to reduce or stop leakage from a damaged spent fuel pool.

Performance Attributes:

1. There is no minimum requirement for these resources. This is simply identification of the types of existing resources that may be onsite and could be beneficial.

Response Elements:

- In general, identify the types and location of materials maintained on-site that could be used to reduce leakage rates.
- Confirm that procedures/guidance will, at a minimum, list the capabilities that may be available for use by plant personnel (e.g., Emergency Response Organization).

Submittal Guidance:

Provide a list of the typical materials that might be expected to be available onsite. Examples of typical on-site resources that might be included in such a list include:

- Plate steel
- Marine plywood
- Normal plywood
- Waterproof sealants
- Piping or lengths of lumber that could be used to shore up metal plates or plywood
- Lumber/plywood for shoring/wedges/hinged wooden plates, or
- Inflatable plugs.

The general types of leakage control capabilities should be documented in the submittal using the template provided in Table A.2-5.

Additional Considerations:

1. The purpose of this enhancement is to provide decisionmakers with a list of the types of materials that may be available and where they would be expected to be found. It is not necessary to maintain a minimum inventory of leakage control capabilities at all times. Likewise, there is no requirement to store these materials a specific distance from the target area.

3.0 REACTOR AND CONTAINMENT STRATEGIES

3.1 BACKGROUND

In June 2006, the nuclear industry proposed to enhance the mitigation capability of key safety functions associated with every operating nuclear power plant in the United States [Ref. 5]. This proposal was derived from an industry supported plant specific assessment process outlined in Reference 6, known as the Industry (Phase 3) Mitigation Strategy Study. The industry approach described in this proposal was developed by a Chief Nuclear Officer (CNO) Review Panel.

After reviewing the results of the Industry Phase 3 Studies, it became apparent to the CNO Review Panel that an approach similar to Phase 2 is appropriate and offers an efficient, as well as an effective way to achieve success, when challenged with the large spectrum of potential scenarios. While it is possible to postulate scenarios for which this proposal is not fully successful, any other reasonable approach would potentially have limited success because of the wide range of possible scenarios and outcomes as well as a high degree of uncertainty of event circumstances. Recognizing this, the CNO Panel determined that a critical feature of this proposal should be flexibility to facilitate response efforts, over a wide range of potential scenarios.

The Panel identified two critical elements of a robust industry response:

- Command and control enhancements aimed at improving initial site operational response before the Emergency Response Organization (ERO) is fully activated, and
- A specific set of mitigation strategies for all BWRs and PWRs to implement.

As part of the Industry Mitigation Strategy Study sponsored by NEI [Ref. 6], each site has developed a site-specific list of candidate enhancement strategies (CES). These strategies grew from a stylized, but structured, review of the site and existing capabilities, followed by a formal brainstorming session to identify potential candidate enhancement strategies.

Candidate enhancement strategies were identified at each plant for the following key safety functions:

BWR Safety Functions	PWR Safety Functions
• **RPV Level Control**	• **RCS Inventory Control**
• **Containment Isolation**	• **RCS Heat Removal**
• **Containment Integrity**	• **Containment Isolation**
• **Release Mitigation**	• **Containment Integrity**
	• **Release Mitigation**

One of the major insights gleaned from this effort was that most of these CES were of relatively low confidence and would only work for very specific damage conditions and would therefore be of limited value and not worthy of expending plant resources to implement. In nearly all cases, establishing a new high confidence capability typically involved extensive plant modifications. However, similar to the conclusions of Phase 2, this exercise did identify a set of flexible, deployable generic enhancement strategies that could be beneficial in responding to a broad spectrum of damage states. Most of these involve procedure/guidance enhancements, minimal procurement, and/or very minor plant modifications to non-safety related systems. Several of the strategies rely upon the power-independent pump discussed in Section 2. It is expected that these strategies become part of the utility "toolbox" that could be used in responding to beyond design basis events. Thus, these strategies must be interfaced with existing SAMGs so that potential competing considerations associated with implementing these and other strategies are appropriately addressed.

When developing the implementing procedures/guidance for these strategies, it may be beneficial to discuss how each strategy might be useful for mitigation of other beyond design basis conditions. Utility PRA groups can evaluate the potential scenarios identified in plant-specific PRAs that may be addressed by these strategies. Thus, there may be some benefit in considering entry conditions for the implementing procedures/guidelines beyond large fires and explosions.

The CNO Panel recommended [Ref. 5] and the NRC accepted [Ref. 7] the development of enhanced command and control guidance and a total of ten mitigation strategies for BWRs and seven mitigation strategies for PWRs:

BWR Mitigation Strategies

- **Manual Operation of RCIC or Isolation Condenser**
- **DC Power Supplies to Allow Depressurization of RPV & Injection with Portable Pump**
- **Utilize Feedwater and Condensate**
- **Makeup to Hotwell**
- **Makeup to CST**
- **Maximize CRD**
- **Procedure to Isolate RWCU**
- **Manually Open Containment Vent Lines**
- **Inject Water into the Drywell**
- **Portable Sprays**

PWR Mitigation Strategies

- **Makeup to RWST**
- **Manually Depressurize SGs to Reduce Inventory Loss**
- **Manual Operation of Turbine (or Diesel)-Driven AFW Pump**
- **Manually Depressurize SGs and Use Portable Pump**
- **Makeup to CST**
- **Containment Flooding with Portable Pump**
- **Portable Sprays**

It should be noted that the implementation of these strategies can be considered independently. That is, there is no need to be able to concurrently implement multiple strategies. The purpose of these strategies is to provide an enhanced "toolbox" of capabilities to be used by the emergency response organization, as appropriate to the actual plant conditions. In the event the actual situation generates competing demands for the same equipment, it will be the responsibility of the emergency response organization to evaluate and choose the best use of the equipment. Additional equipment, while neither required nor expected, may be beneficial if water is to be pumped simultaneously to multiple places (e.g., to fill the steam generators from the condensate storage tank and simultaneously to refill the CST).

3.2 COMMAND AND CONTROL ENHANCEMENTS

Experience with large scale incidents has shown that command and control execution can be a key factor to mitigation success. The industry has invested extensively in establishing command and control structures for emergency conditions. However, the extent and type of damage postulated for some beyond design basis security threats may create unique challenges. Normal command and control structures may be interrupted creating implementation issues associated with procedurally required actions, communications, and organizational factors that could further complicate mitigation response for these types of postulated events.

One primary dimension of enhancing command and control for these beyond design basis conditions is providing guidance for use in such circumstances. Establishing guidelines for initial site operational response would allow utilities to "pre-think" their strategy if normal command and control is disrupted. Extensive Damage Mitigation Guidelines (EDMGs) is the generic term used by the industry introduced in Reference 6. The term, "extensive damage," is used to connote the potential for spatial impacts that are quite broad. Such damage may not only affect equipment, but may affect the ability of plant operators to monitor plant conditions and gain access to equipment in portions of the plant. In addition, due to the nature of some beyond design basis threats, it is possible to envision combinations of failures which might be considered of negligible probability in traditional severe accident analysis. Thus, the boundary conditions applied for EDMGs are substantially different from those used in defining plant operating procedures and even severe accident management guidelines (SAMGs). EDMGs are not a replacement for normal emergency operating procedures (EOPs) or SAMGs. Rather, EDMGs are developed on a plant-specific basis to allow the site to define the kinds of responses that may be appropriate in the event such conditions occurred. In the performance of the NEI sponsored site assessments, there were two types of EDMGs considered; Initial Response EDMGs and Technical Support Center (TSC) Response EDMGS. Initial Response EDMGs are the focus of the industry closure process and are described in this guidance. The strategies described in Sections 3.3 and 3.4 are not considered EDMGs and may reside in plant procedures, SAMGs, or other guidance documents, as deemed appropriate.

The scope of these Initial Response EDMGs would include:

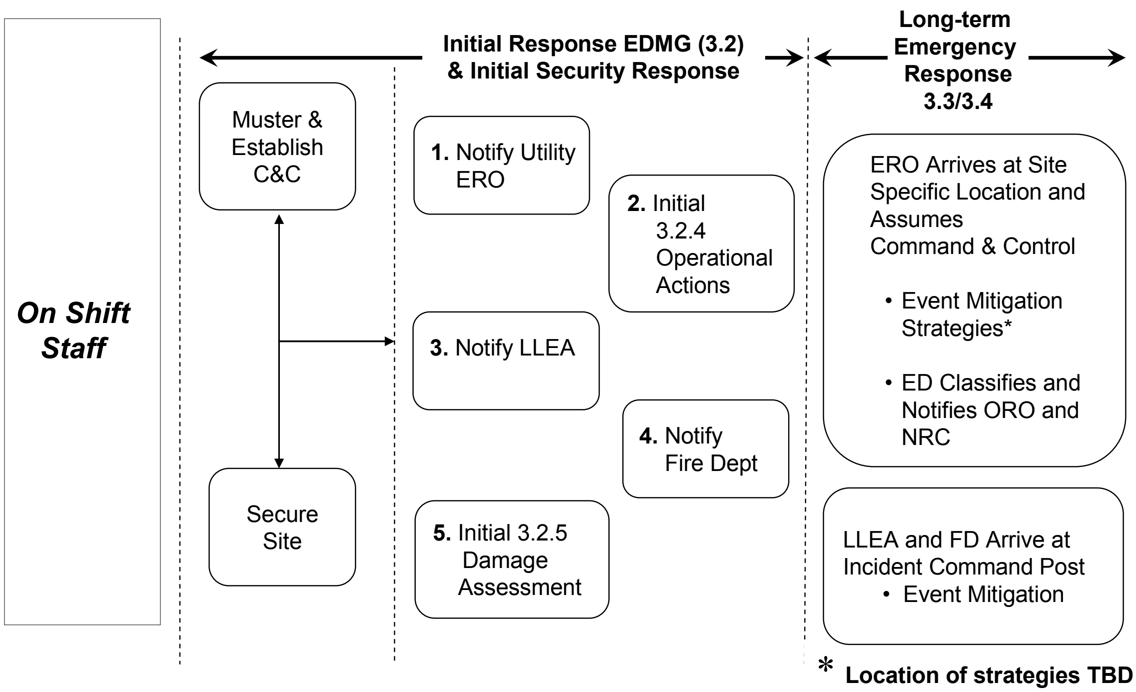
- An assessment of on-site and off-site communication in light of potential damage to normal methods available to the ERO.
- Methods for notifications of the utility ERO/ERO activation to mobilize additional resources to the site in a timely manner
- Basic initial response actions needed to potentially stabilize the situation or delay event degradation, including key mitigation strategies to help manage critical safety functions in the near term.
- Initial damage assessment to provide the ERO with information on plant damage conditions and status, as feasible.

The initial response EDMGs are not a type of emergency operating procedures (EOPs), nor are they intended to be a replacement for EOPs. They are, in fact, intended to be used when the normal command and control structure is disabled and use of EOPs is not feasible.

The initial response EDMGs are intended to provide a bridge between normal operational command and control and the command and control that is provided by the emergency response organization. The relationship between the initial response EDMGs, the initial security response, and other long-term response actions is shown below in Figure 3-1.

Figure 3-1

Initial Response EDMG Flowchart



3.2.1 Boundary Conditions

The purpose of the initial response EDMGs is to define the actions to be taken in the event normal procedures and/or command and control structures are not available. The entry conditions for this EDMG might include loss of plant control and monitoring capability due to a large explosive or fire. This could take the form of damage to the control room and alternate shutdown capabilities, or loss of all AC and DC power, or all of these. An example of such a condition might involve a large fire or explosion that affected the main control room, control room personnel, and alternate shutdown capability. In such a condition, it is possible that remote instrumentation may not be available and the availability of main control room personnel may be in question. In such a condition, a number of immediate actions could be required, without the benefit of normal command and control functions.

For the purposes of developing the initial response EDMGs, the following basic assumptions should be utilized:

1. Imminent threat warning does not occur.
2. Loss of access to the control room.
3. Loss of any equipment/supplies normally located in the control room and/or the building housing the control room.
4. Loss of access to the building containing the control room.
5. Loss of all personnel normally in the control room.
6. Loss of all AC and DC power required for operation of plant systems (i.e., both 1E and non-1E sources).
7. Minimum site staffing levels (i.e., weekend/back shift)
8. Other on-site control rooms and personnel in separated buildings are unaffected.
9. Operations personnel not normally located in the control building can be assumed to be available for EDMG implementation. This includes auxiliary operators that may, from to time, be in the control building for shift turnover, briefs, or breaks. There is no requirement for a minimum number of personnel to be maintained outside of the control building to support EDMG implementation. The assumption of availability should be based on nominal personnel locations based on their operational assignments, not bounding assumptions about the potential for periodic co-location of personnel.
10. Actions taken can be by non-licensed personnel, typically an auxiliary operator.

11. Level of training on implementing procedures/guidance is expected to be consistent with SAMG-type actions and consistent with utility commitments made under B.5.b Phase 1.
12. Prior to the event, the plant systems are in a nominal configuration with the reactor at 100% power.

One of the difficult aspects of enhancing command and control for beyond design basis conditions is balancing the need to be prepared with the potential for widespread damage. It is always possible to postulate worse damage conditions. Likewise, it is possible to postulate lesser damage. The purpose of the above assumptions is to frame the problem. If one of these beyond design basis events ever occurs, the plant staff and the equipment will respond (both operationally and systemically) to the best of their/its ability. The goal of this effort is to provide the plant staff with additional capabilities that could provide benefit. While these assumptions frame the situation, it would be inappropriate to assume that plant would always be in such a condition. Thus, utilities are encouraged to look for creative ways to achieve success while relying on minimal staff and command and control capabilities.

3.2.2 Off-Site and On-Site Communications

Objective:

Improve the initial response of the available plant operational resources and enhance the capability for those resources to communicate with off-site resources.

Performance Attributes:

1. Establish a mustering location to organize available resources.
2. Establish pre-plans for on-site and off-site communications.
3. Establish a means to coordinate operations and security responses.
4. Identify communication resources given postulated widespread damage to each key plant structure.

Response Elements:

- Describe the diverse methods available to communicate with off-site personnel that could be effective for the conditions assumed.
- Describe the approach for mustering the available plant resources in the event the control room/staff are substantially affected.

- Describe Operations/Security pre-plans for re-establishment of communications immediately following a large fire or explosion.
- Describe how operations and security personnel will coordinate activities immediately following a large fire or explosion.

Submittal Guidance:

The B.5.b Phase 1 effort included elements related to communications. In addition, the site-specific Phase 3 assessments performed by NEI generally included a more explicit consideration of the potential impacts of large fires and explosions on the communications capability of each site.

The onsite and offsite communications capabilities should be documented in the submittal using the template provided in Table A.3-1.

Additional Considerations:

1. The example EDMG templates provided in Appendix C provide a tabular format for documenting the communications methods and potential impacts of large explosions and fires in specific buildings on those capabilities.
2. Under the postulated conditions, traditional communications assets may become overloaded, so identify various diverse methods to provide increased confidence in communications.

3.2.3 Notifications/ERO Activation

Objective:

The postulated damage to the command and control structure makes early notification of the utility emergency response organization (ERO) and ERO callout of great importance. This aspect of the initial response EDMGs is intended to provide an enhanced level of assurance that the proper notifications of the utility ERO occur and the ERO callout is initiated in a timely manner, despite the postulated condition.

Performance Attributes:

1. Define the command and control structure given the postulated damage and potential for casualties affecting normal command and control.
2. Define how command and control will be established given the postulated damage to the command and control structure.

3. Establish guidance for offsite notifications of the utility ERO and ERO callout using minimal personnel outside the remaining unaffected staff, given the postulated damage and potential for casualties

Response Elements:

- Describe the command and control structure that will be established prior to arrival of offsite resources, in the event the control room/staff are substantially affected
- Describe the approach(es) for making the appropriate off-site notifications of the utility ERO and ERO callout in the event the control room/staff are substantially affected
- Confirm that a procedure/guidance and training will be developed for ERO and personnel expected to make notifications to the utility ERO.

Submittal Guidance:

The B.5.b Phase 1 effort included elements related to command and control. In addition, the site-specific Phase 3 assessments performed by NEI generally included a more explicit consideration of the potential impacts of large fires and explosions on the command and control capability of each site.

The command and control capabilities should be documented in the submittal using the template provided in Table A.3-1.

Additional Considerations:

1. Consider identification of multiple (alternate) personnel who have appropriate knowledge, skills, and abilities that may not be affected by damage state. This may include use of personnel from adjacent units, or qualified personnel that are normally in physically separated work locations.
2. Consider alternate personnel outside the of control room/staff (e.g., security personnel) to perform notifications of the utility ERO given certain entry criteria (i.e., large explosion or fire).

3.2.4 Initial Operational Response Actions

Objective:

Early actions to assure core cooling can minimize the potential for core damage or can assist in significantly delaying damage timelines. Given the potentially limited on-site resources, it is important to focus on the key actions that may be able to prevent or delay a release as well as be reasonably accomplished in adverse conditions.

Performance Attributes:

1. Minimum PWR Actions:
   - Attempt to confirm reactor scram
   - Attempt to confirm start and injection of at least one AFW pump into at least one SG
2. Minimum BWR Actions:
   - Attempt to confirm reactor scram
   - Attempt to confirm start and injection of RCIC into the RPV, or isolation condenser operation

Response Elements:

- Describe the entry conditions for the procedure/guidance on initial operation response actions
- Provide a general description of the initial operational response actions
- Describe the general locations of the primary equipment involved in implementing these actions
- Confirm that a procedure/guidance and training will be developed for initial operations response actions

Submittal Guidance:

The site-specific Phase 3 assessments performed by NEI generally included explicit consideration of the initial operational responses to large fires and explosions for each site. The specific approach to be taken in the development of guidance for the initial operational response actions is necessarily site-specific. The guidance must be developed in accordance with site procedures and practices and interfaced with the appropriate implementing procedures. The initial operational response actions should be summarized in the submittal using the template provided in Table A.3-1.

Additional Considerations:

1. The example EDMG templates provided in Appendix C provide a general format and content for documenting the initial operational response actions. These generalized formats were adapted from site-specific guidance collected in the NEI Phase 3 work and are provided as examples only. There is no requirement to utilize these formats. Appendix C.1 includes procedure-style guidance typical of many PWRs. Appendix C.2 includes flowchart style guidance typical of many BWRs.
2. There is no need to submit the actual procedures as part of this submittal.
3. It is the intent of this effort to make use of existing personnel. There is no intent or expectation that plants will add on-shift personnel.
4. The resulting procedure/guideline should be written knowing that limited personnel resources may exist, but they should also consider that additional resources may be available.

3.2.5 Initial Damage Assessment

Objective:

In the postulated conditions, normal instrumentation may not be available. The purpose of this aspect of the initial response EDMGs is to utilize the available onsite resources to perform an assessment of the plant and equipment conditions in order to assist the arriving ERO personnel in decision-making and development of specific strategies.

Performance Attributes:

1. Condition of reactor and core cooling systems.
2. Condition of containment.
3. Condition of ECCS equipment.
4. Condition of key support systems (AC/DC power, cooling water, air, etc.).
5. Condition and accessibility of key buildings.

Response Elements:

- Provide a general description of the damage assessment to be provided to the ERO.

- Confirm that a procedure/guidance and training will be developed for initial damage assessments.

Submittal Guidance:

The specific approach to be taken in the development of guidance for the initial damage assessment is necessarily site-specific. The guidance must be developed in accordance with site procedures and practices and interfaced with the appropriate implementing procedures. The initial damage assessment should be summarized in the submittal using the template provided in Table A.3-1.

Additional Considerations:

1. The example EDMG templates provided in Appendix C provide a general format and content for documenting the initial damage assessment. These generalized formats were adapted from site-specific guidance collected in the NEI Phase 3 work and are provided as examples only. There is no requirement to utilize these formats. Appendix C.1 includes procedure-style guidance typical of many PWRs. Appendix C.2 includes flowchart style guidance typical of many BWRs.

3.3 ENHANCED SITE RESPONSE STRATEGIES FOR PWRS

A total of seven PWR reactor and containment mitigation strategies have been identified for sites to implement. In some cases, the site will already have implemented an acceptable mitigation strategy. In other cases, additional effort such as procedure/guidance enhancements, minimal procurement, and/or very minor plant modifications will be required. These strategies are not considered EDMGs. Rather, they are strategies that are to be established for plant use at each plant. They may be implemented using plant procedures, SAMGs, or other guidance documents, as deemed appropriate.

General Guidance on Strategies:

1. Unlike the initial response EDMGs discussed above, for the purposes of implementing these strategies, it can be assumed that the normal command and control structure is in-place and functioning.
2. There is no need to consider the potential for equipment to be out of service for routine maintenance activities. This also means that there is no need to provide redundant strategies.
3. Equipment associated with these strategies is not to be treated as safety-related equipment. As such, it is not subject to any of new special treatment requirements under 10 CFR (e.g., QA, seismic, EQ, etc.).

4. Equipment associated with these strategies will meet standard industry practices for procuring and maintaining commercial equipment.
5. These strategies can be implemented through guidance or procedures, consistent with the site's chosen approach. Steps are expected to be general in nature, consistent with the need for flexibility in deployment. That is, there is no need to develop scenario-specific procedures.
6. Level of training on implementing procedures/guidance is expected to be consistent with SAMG-type actions and consistent with utility commitments made under B.5.b Phase 1.
7. It is not necessary to consider the EDMG boundary conditions (Section 3.2.1) when devising approaches to these specific strategies. Rather, the general boundary conditions are described for each strategy under the heading of Additional Considerations. In many cases, the implied damage conditions which drive these strategies involve a loss of internal power distribution (LIPD). For cases involving an assumed LIPD condition, the strategies would be implemented without any off-site or on-site AC or DC power.
8. Borated or treated water sources, although preferable in some conditions, are not required. The objective is to provide water from available water source for cooling.
9. These strategies should be interfaced with existing SAMGs so that potential competing considerations associated with implementing these and other strategies are appropriately addressed.
10. Prior to the event, the plant systems are assumed to be in a nominal configuration with the reactor at 100% power.
11. Implementation of the strategies is not expected to require extraordinary or heroic actions. In an event, the utility emergency response organization (ERO) will decide on the potential benefit and feasibility of the strategy in light of plant conditions. For example, it is expected that dose rates and other accessibility considerations will be addressed at the time of the event, in light of the actual plant conditions. This input will be considered by the ERO in directing plant response actions.

3.3.1 Makeup to RWST

Objective:

Provide a large volume makeup source to the reactor water storage tank (or equivalent) in order to supply ECCS long-term.

Performance Attributes:

1. Provide a means to makeup at least 300 gpm of water to the RWST for a period of 12 hours. This could utilize the Phase 2 pump, or other existing sources. On a site-specific basis, makeup rate of less than 300 gpm can be justified.
2. Provide procedure/guidance to implement makeup source.

Response Elements:

- Provide a general description of how the RWST refill will be accomplished.
- Describe the general locations of the primary equipment involved in refilling the RWST.
- Estimate flow rates expected to be delivered to the RWST and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

It is possible to postulate damage to containment that could affect ECCS recirculation capability. This strategy is aimed at providing a source of makeup to the RWST in order to provide an extended supply of water for core cooling.

The RWST makeup capability should be documented in the submittal using the template provided in Table A.4-1.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that areas immediately around the RWST will be accessible.
2. Since makeup would only be needed in the event the ECCS pumps are operating, it is reasonable to assume that 1E electrical power is available.

3. While makeup with borated water is preferable, it is not required. Consistent with PWR SAMGs, the use of unborated water for ECCS injection is preferable over having no water for ECCS injection.

4. In implementing this strategy, the fire protection system may be used provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and makeup capabilities. It is recognized that fire system at many sites is the most flexible system that can be employed to mitigate many of the element associated with this effort. If portions of the fire system must be relied on for implementation of this strategy the management of the system should be outlined in site procedures/guidelines. Guidance should include methods to isolate potentially damaged headers and if possible guidance for ring header sectionalization. Connection to the fire ring header should be approximately 100 yards or more from the target area. It can be assumed that the fire header itself is not damaged. However, the fire system management strategy should address isolation of fire headers inside structures that may be target areas. The pump used to charge the ring header should be located more than approximately 100 yards from the target area. If this separation does not exist, then some justification for pump survivability (e.g., intervening structures, nearly 100 yards away from key plant areas, contained in a reinforced concrete structure, etc.) should be provided in the submittal. Document the fire system management strategy in the submittal in Table A2-6.

5. If a portable pumping capability is relied upon, the pump and necessary hoses will need to be stored on-site in an area approximately 100 yards or more away from the target area in order to assure survivability.

6. On a site-specific basis, plants may justify an RWST makeup rate of less than 300 gpm. The makeup rate must be 100 gpm greater than the rate necessary to remove decay heat by boiling in the RCS.

7. The purpose of this strategy is to provide a means to provide a water supply to an operating ECCS pump. Therefore, makeup may be provided directly to the ECCS suction line or the RWST. If makeup is provided to the ECCS pump, the hoses and connections may be stored locally at the intended connection point.

3.3.2 Manually Depressurize SGs to Reduce Inventory Loss

Objective:

Provide a power-independent means to depressurize steam generators by locally manually opening atmospheric dump valves (or SGs PORVs) in order to reduce SG pressure and RCS temperature/ pressure.

Performance Attributes:

1. Many plants already have procedures/guidance for station blackout conditions.
2. Confirm availability of procedures/guidance.
3. Confirm availability of any necessary supplies either in the local area where action would be taken or in an area that is physically separate from the Auxiliary, Turbine and Control Buildings (e.g., in an on-site warehouse).

Response Elements:

- Provide a general description of how the Steam Generators will be depressurized.
- If relying on an existing procedure for this action, confirm applicability to the postulated conditions.
- Describe the general locations of the primary equipment involved in implementing the strategy.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

This strategy has two benefits. First, the depressurization of SGs will, in turn, reduce RCS temperature and pressure. This will reduce RCS leakage and reduce the stresses on RCP seals. The second potential benefit is that depressurization of the SGs will allow other low pressure makeup sources to support decay heat removal (See Section 3.3.4).

Many plants already have procedures that address this strategy. For example, the Emergency Contingency Actions for Westinghouse plants generally address this in ECA 0.0 for Station Blackout conditions. For those plants, this may be largely a confirmation. However, there are two potentially unique considerations for this condition: (1) DC power is assumed to be unavailable and (2) plants should evaluate the location of any equipment necessary to accomplish the SG depressurization.

The steam generator depressurization capability should be documented in the submittal using the template provided in Table A.4-2.

<u>Additional Considerations</u>:

1. For the purposes of this strategy, it should be assumed that areas immediately around the steam generator relief valves and atmospheric dump valves will be accessible.
2. Any equipment (e.g., air bottles, cheater bars, etc.) necessary to support depressurization of the steam generators should either be stored in the vicinity of the location where the action must be taken, or in an area well removed from that location (e.g., a warehouse) so that access to other parts of the plant structure is not required.
3. The implementation of this strategy should assume that this is a LIPD condition and there is no on-site or off-site AC or DC power available.
4. The procedure/guidance for implementation of this strategy should consider potential controls on degree and rate of SG depressurization. In addition, guidance should address reclosure of the SG ADVs/PORVs in the event core damage is imminent in order to prevent a challenge to SG tube integrity.

3.3.3 Manual Operation of Turbine-Driven (or diesel-driven) AFW Pump

<u>Objective</u>:

Provide a power-independent means to provide core cooling and prevent or delay core damage.

<u>Performance Attributes</u>:

1. Provide a procedure/guidance that describes the plant-specific steps necessary to start and operate an AFW pump without AC or DC power.
2. Identify a means for reasonably managing SG level using available, non-powered instrumentation and/or operator aids such as a pressure-flow curve.

Response Elements:

- Provide a general description of how the manual operation of the AFW pump will be accomplished.
- Describe the general locations of the primary equipment involved in implementing the strategy, including any valves that must be manipulated.
- Estimate flow rates expected to be delivered to the SGs and identify the capacity of water supplies.
- Describe any non-powered instrumentation or operator aids that will be used to manage SG level.
- Confirm that a procedure/guidance will be developed for implementing this strategy prior to SG dryout.

Submittal Guidance:

This strategy is one part of the EDMGs discussed in Section 3.2. Many plants already have procedures to start and run turbine-driven or diesel-driven AFW pumps without AC or DC power. One difference in this strategy is the focus on plant operators being able to reasonably manage SG level without AC and DC power.

The capability to manually operate AFW should be documented in the submittal using the template provided in Table A.4-3.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that areas immediately around the AFW pump will be accessible at the time the pump needs to be started. In developing the procedures/guidance and operator aids, consideration should be given to the potential accessibility of the pump rooms after extended operation without AC or DC power (e.g., without room cooling).
2. The implementation of this strategy should assume that this is a LIPD condition and there is no on-site or off-site AC or DC power available.
3. The Initial Response EDMGs will address this strategy as an immediate action
4. Control of the makeup rate to the steam generator(s) needs to be considered. Operator aids to assist in setting and controlling SG makeup to prevent overfill or underfeed conditions should be developed. There is a significant volume in the SGs, and precise control of SG level is not required. However, overfill can lead to damage of steamline piping and/or

tripping of a turbine-driven AFW pump. Likewise, under-filling the SGs can lead to RCS heat up and eventual core damage, if not protected against. Depending on plant capabilities, the potential options for these aids might include:

- Existing non-powered instrumentation,
- Procedures for directly reading SG level at the instrumentation penetration to containment,
- Strap-on flow meters,
- Operator aids based on pump flow curves, or
- Operator aids based on CST depletion rates

5. The goal of this strategy is to enhance the likelihood of long-term operation of the pump and control of SG level. However, it is understood that this may not be feasible for some plants. Just starting a turbine-driven pump and letting it run to overfill can provide a significant delay in the progression of events. Thus, there is no specific requirement for how long SG level control can be assured.

3.3.4 Manually Depressurize SGs and Use Portable Pump

<u>Objective</u>:

Utilize Strategy #2 (Section 3.3.2) in combination with a low pressure makeup source to provide SG makeup and core cooling.

<u>Performance Attributes</u>:

1. Provide a means to makeup at least 200 gpm of water to the SG for a period of 12 hours. A makeup rate of less than 200 gpm may be justified on a site-specific basis.
2. Provide procedure/guidance to implement makeup source.

<u>Response Elements</u>:

- Provide a general description of how the portable pump will be used to provide SG feed.
- Describe the general locations of the primary equipment involved this strategy, including any valves that must be manipulated.
- Estimate flow rates expected to be delivered to the SGs and identify the capacity of water supplies.

- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

This strategy is intended to be a backup to the use of the AFW system.

The steam generator depressurization and portable pump capability should be documented in the submittal using the template provided in Table A.4-4.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that areas immediately around the turbine-driven or diesel-driven AFW pump will be inaccessible (otherwise, AFW would be used for decay heat removal). Thus, the preferred location for any hose connections would be in areas of the plant as far away from the AFW system as possible. However, if the only feasible locations are on the AFW system, the connections should normally be as far away as possible from the AFW pump vicinity. Areas required to manually depressurize the SGs can be assumed to be accessible (per Section 3.3.2).
2. The implementation of this strategy should assume that this is a LIPD condition and there is no on-site or off-site AC or DC power available to support the operation of the pump and manipulation of valves. However, it can be assumed that some sort of SG cooling has been available for some time in order to allow this strategy to be deployed (e.g., manual operation of the TDAFW pump was successful for some time). Furthermore, it can be assumed that the cooldown of the RCS and depressurization of the SGs was initiated during this period.
3. This strategy could utilize the Phase 2 pump, or other existing portable pumping sources. The fire protection system may be used as a water source to the pump provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and makeup capabilities. The connections could be accomplished by making use of vent and drain lines or other existing connection points on systems connected to SG makeup systems, or by providing a replacement valve bonnet that would have a flange/connector capable of accepting one or more hoses.
4. Even when depressurized, SG pressure may remain somewhat elevated in order for decay heat to be rejected via the SG PORVs/ADVs. The SG pressure will be a function of the number of SGs depressurized and fed, the number of SG PORVs/ADVs opened, and the relative size of the SG PORVs/ADVs. Typically, the required SG pressure will be much less than

100 psig. The portable pump and hose arrangement must be capable of providing the required flow at such pressures, including consideration of line losses which may be significant, depending on the routing. The site should have an engineering basis that provides reasonable assurance that the intended makeup rate and capacities can be provided. This basis should be auditable, but does not have to be a quality related calculation.

5. On a site-specific basis, plants may justify an SG makeup rate of less than 200 gpm. The makeup rate must be at least the rate necessary to remove decay heat from the RCS.
6. The procedure/guidance for implementation of this strategy should consider potential controls on degree and rate of SG depressurization.
7. Impementing guidance should address reclosure of the SG ADVs/PORVs in the event core damage is imminent in order to prevent a challenge to SG tube integrity.

3.3.5 Makeup to CST/AFWST

Objective:

Provide a high volume makeup source to the condensate storage tank (CST)/auxiliary feedwater storage tank (AFWST) in order to supply AFW long-term.

Performance Attributes:

1. Provide a means to makeup at least 200 gpm of water to the CST/AFWST for a period of 12 hours. This could utilize the Phase 2 pump, or other existing sources. A makeup rate of less than 200 gpm may be justified on a site-specific basis.
2. Provide procedure/guidance to implement makeup source.

Response Elements:

- Provide a general description of how the CST/AFWST refill will be accomplished.
- Describe the general locations of the primary equipment involved in this strategy.
- Estimate flow rates expected to be delivered to the CST/AFWST and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

It is possible to postulate damage that could affect normal CST/AFWST makeup capability. This strategy is aimed at providing a source of makeup to the CST/AFWST in order to provide an extended supply of water for secondary cooling.

The CST/AFWST makeup capability should be documented in the submittal using the template provided in Table A.4-5.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that areas immediately around the CST/AFWST will be accessible.
2. Since manual operation of an AFW pump could allow SG makeup without AC or DC power, the implementation of this strategy should assume that this is a LIPD condition and there is no on-site or off-site AC or DC power available.
3. While makeup with clean sources of water is preferable, it is not required.
4. In implementing this strategy, the site should assume that the fire protection system may be used provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and makeup capabilities. It is recognized that fire system at many sites is the most flexible system that can be employed to mitigate many of the element associated with this effort. If portions of the fire system must be relied on for implementation of this strategy the management of the system should be outlined in site procedures/guidelines. Guidance should include methods to isolate potentially damaged headers and if possible guidance for ring header sectionalization. Connection to the fire ring header should be approximately 100 yards or more from the target area. It can be assumed that the fire header itself is not damaged. However, the fire system management strategy should address isolation of fire headers inside structures that may be target areas. The pump used to charge the ring header should be located more than approximately 100 yards from the target area. If this separation does not exist, then some justification for pump survivability (e.g., intervening structures, nearly 100 yards away from key plant areas, contained in a reinforced concrete structure, etc.) should be provided in the submittal. Document the fire system management strategy in the submittal in Table A2-6.
5. If a portable pumping capability is relied upon, the pump and necessary hoses will need to be stored on-site in an area approximately 100 yards or more away from the target area in order to assure survivability and availability for the CST/AFWST refill function.

6. Each site should consider that this makeup capability can be implemented prior to steam generator dryout following depletion of the CST/AFWST, assuming that the CST/AFWST is the only water available to remove decay heat.
7. On a site-specific basis, plants may justify a CST/AFWST makeup rate of less than 200 gpm. The makeup rate must be at least the rate necessary to remove decay heat from the RCS.
8. The purpose of this strategy is to provide a means to provide a water supply to an operating AFW pump. Therefore, makeup may be provided directly to the AFW suction line or the CST/AFWST. If makeup is provided to the AFW pump, the hoses and connections may be stored locally at the intended connection point.

3.3.6 Containment Flooding with Portable Pump

Objective:

Provide a power-independent means to inject water into the containment to flood the containment floor and cover core debris.

Performance Attributes:

1. Provide a means to makeup at least 300 gpm of water to the containment for a period of 12 hours. A makeup rate of less than 300 gpm may be justified on a site-specific basis.
2. Provide procedure/guidance to implement makeup source.

Response Elements:

- Provide a general description of how the portable pump will be used to flood containment.
- Describe the general locations of the primary equipment involved in flooding containment with the portable pump, including any valves that must be manipulated.
- Estimate flow rates expected to be delivered to the containment and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

This strategy is intended to be a backup to the use of the containment spray or ECCS injection systems.

The capability to flood containment using a portable pump should be documented in the submittal using the template provided in Table A.4-6.

<u>Additional Considerations</u>:

1. For the purposes of this strategy, it should be assumed that this is a LIPD condition and there is no onsite or offsite AC or DC power available.
2. Since the objective is to put water into the containment in order to flood the core debris after vessel failure, the injection can be routed through the containment spray system, ECCS injection systems, or any other system that can route the water into the containment. This strategy could utilize the Phase 2 pump, or other existing portable pumping sources. The connections could be accomplished by making use of vent and drain lines or other existing connection points on systems, or by providing a replacement valve bonnet that would have a flange/connector capable of accepting one or more hoses.
3. Containment pressure may be elevated (~design pressure), so the portable pump must be capable of providing the required flow at such pressures, including consideration of line losses which may be significant, depending on the routing. The site should have an engineering basis that provides reasonable assurance that the intended makeup rate and capacities can be provided. This basis should be auditable, but does not have to be a quality related calculation
4. The portable pumping capability and necessary hoses will need to be stored on-site in an area approximately 100 yards or more away from the target area in order to assure survivability and availability for the containment flooding function.
5. In implementing this strategy, the fire protection system may be used provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and spray capabilities.
6. On a site-specific basis, plants may justify a makeup rate to the containment of less than 300 gpm. The makeup rate must be at least 100 gpm greater than the rate necessary to remove decay heat from the RCS.

3.3.7 Portable Sprays

<u>Objective</u>:

Provide a means to reduce the magnitude of any fission product releases by spraying

Performance Attributes:

1. Provide procedure/guidance on use of the portable spray capability provided for SFP mitigation in the event of a release from the Containment/Auxiliary Building.

Response Elements:

- Provide a general description of how the portable pump will be used to spray a radiological release including a description of portions of affected plant structures that cannot be sprayed due to physical layout or equipment limitations. This is intended to be a qualitative description of the portions of structures that are expected to be sprayable assuming there are no accessibility constraints.
- Describe the general locations of the primary equipment involved in use of portable sprays.
- Estimate spray flow rates expected to be delivered and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

The purpose of these sprays is to mitigate any release of fission products from the containment.

The capability to spray containment using a portable pump should be documented in the submittal using the template provided in Table A.4-7.

Additional Considerations:

1. The purpose of this strategy is to spray a release coming from a damaged or failed containment. For the purposes of this strategy, it should be assumed that areas immediately around the containment will be accessible.
2. In implementing this strategy, consideration should be given to containing the runoff from the sprays. This may include providing a means to close off storm drains and/or providing materials to route runoff to a desired area. Guidance on deployment of the sprays should consider the amount of spray water that can be contained.

3. In implementing this strategy, the fire protection system may be used as a water source to the pump provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and makeup spray capabilities. Guidance should include methods to isolate potentially damaged headers and if possible guidance for ring header sectionalization. Connection to the fire ring header should be approximately 100 yards or more from the target area. It can be assumed that the fire header itself is not damaged. However, the fire system management strategy should address isolation of fire headers inside structures that may be target areas. The pump used to charge the ring header should be located more than approximately 100 yards from the target area. If this separation does not exist, then some justification for pump survivability (e.g., intervening structures, nearly 100 yards away from key plant areas, contained in a reinforced concrete structure, etc.) should be provided in the submittal. Document the fire system management strategy in the submittal in Table A2-6.
4. The portable pumping capability, necessary hoses, and monitor nozzles will need to be stored on-site in an area away from the containment in order to assure survivability and availability for the spray function. In general, storage of equipment should be approximately 100 yards or more from the target area.
5. Utility PRA personnel can be consulted to identify the more likely release points from containment. These should be considered when specifying the spray nozzles and pumping capability. Releases that occur through a containment vent or through the site elevated release point are not expected to be sprayed.
6. In the event spray is to be used to mitigate a release, the implementing procedure/guideline should direct the spray flow rate be maximized to the extent the spray water can be contained. However, this does not imply that spray should/would be terminated in a real event simply because the capability to contain spray runoff is exceeded. In a real event, such decisions would be made by the ERO, based on the actual conditions.

3.4 ENHANCED SITE RESPONSE STRATEGIES FOR BWRs

A total of ten BWR reactor and containment mitigation strategies have been identified for sites to implement. In some cases, the site will already have implemented an acceptable mitigation strategy. In other cases, additional effort such as procedure/guidance enhancements, minimal procurement, and/or very minor plant modifications will be required. These strategies are not considered EDMGs. Rather, they are strategies that are to be established for plant use at each plant. They may be implemented using plant procedures, SAMGs, or other guidance documents, as deemed appropriate.

.

General Guidance on Strategies:

1. Unlike the initial response EDMGs discussed above, for the purposes of devising implementation approaches for these strategies, it can be assumed that the normal command and control structure is in-place and functioning.
2. There is no need to consider the potential for equipment to be out of service for routine maintenance activities. This also means that there is no need to provide redundancy.
3. Equipment associated with these strategies is not to be treated as safety-related equipment. As such, it is not subject to any new special treatment requirements under 10 CFR (e.g., QA, seismic, EQ, etc.).
4. Equipment associated with these strategies will meet standard industry practices for procuring and maintaining commercial equipment.
5. These strategies can be implemented through guidance or procedures, consistent with the site's chosen approach. Steps are expected to be general in nature, consistent with the need for flexibility in deployment. That is, there is no need to develop scenario-specific procedures.
6. Level of training on implementing procedures/guidance is expected to be consistent with SAMG-type actions and consistent with utility commitments made under B.5.b Phase 1.
7. For each strategy, the general boundary conditions are described. In many cases, the implied damage conditions which drive these strategies involve a loss of internal power distribution (LIPD). For cases involving an assumed LIPD condition, the strategies would be implemented without any off-site or on-site AC or DC power.
8. These strategies should be interfaced with existing SAMGs so that potential competing considerations associated with implementing these and other strategies are appropriately addressed.
9. Prior to the event, the plant systems are assumed to be in a nominal configuration with the reactor at 100% power.
10. Implementation of the strategies is not expected to require extraordinary or heroic actions. In an event, the utility emergency response organization (ERO) will decide on the potential benefit and feasibility of the strategy in light of plant conditions. For example, it is expected that dose rates and other accessibility considerations will be addressed at the time of the event, in light of the actual plant conditions. This input will be considered by the ERO in directing plant response actions.

3.4.1 Manual Operation of RCIC or Isolation Condenser

Objective:

Provide a power-independent means to provide core cooling and prevent or delay core damage.

Performance Attributes:

1. Provide a procedure/guidance that describes the plant-specific steps necessary to start and operate RCIC or the Isolation Condenser without AC or DC power.
2. Identify a means for reasonably managing RPV level using available, non-powered instrumentation and/or operator aids such as a pressure-flow curve.

Response Elements:

- Provide a general description of how the manual operation of RCIC or the Isolation Condenser will be accomplished.
- Describe the general locations of the primary equipment involved in manually operating RCIC/IC, including any valves that must be manipulated.
- For RCIC:
  - estimate flow rates expected to be delivered to the RPV and identify the capacity of water supplies, and
  - Describe any non-powered instrumentation or operator aids that will be used to manage RPV level.
- For isolation condensers (IC),
  - Provide the time to loss of effectiveness of the IC without makeup, and
  - Describe any non-powered instrumentation or operator aids that will be used to manage shell side IC water level.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

This strategy is one part of the Initial Response EDMGs discussed in Section 3.2. Many plants already have procedures to start and run RCIC or the IC without AC or DC power. One difference in this strategy is the focus on plant operators being able to reasonably manage RPV (or IC) level without AC and DC power.

The capability to manually operate RCIC or the IC should be documented in the submittal using the template provided in Table A.5-1.

<u>Additional Considerations</u>:

1. For the purposes of this strategy, it should be assumed that Reactor Building will be accessible at the time the pump needs to be started/IC needs to be initiated. In developing the procedures/guidance and operator aids, consideration should be given to the potential accessibility of the RCIC pump room or areas of the plant required to be accessed after extended operation without AC or DC power (e.g., without room or area cooling).
2. The implementation of this strategy should assume that this is a LIPD condition and there is no on-site or off-site AC or DC power available.
3. The Initial Response EDMGs will also address this strategy as an immediate action
4. For RCIC, control of the makeup rate to the RPV needs to be considered. Monitoring of reactor water level with local instrumentation or operator aids to assist in setting and controlling RPV level to prevent overfill or underfeed conditions should be developed. There is a significant volume in the RPV, and precise control of RPV level is not required. However, overfill can lead to damage of steamline piping and/or the RCIC pump. Likewise, under-filling the RPV can lead to core uncovery and eventual core damage, if not protected against. Depending on plant capabilities, the potential options for these aids might include:

    - Existing non-powered instrumentation (e.g., Yarways, if available),
    - Procedures for directly reading RPV level at the instrumentation penetration to containment,
    - Strap-on flow meters,
    - Operator aids based on pump flow curves, or
    - Operator aids based on CST depletion rates.

5. For ICs, make up to the IC shell side needs to be provided in the LIPD condition. This may include use of the portable pump and hoses.
6. For ICs, monitoring of reactor water level with local instrumentation should be considered. Depending on plant capabilities, the potential options for

these aids might include:

- Existing non-powered instrumentation (e.g., Yarways, if available),
- Procedures for directly reading RPV level at the instrumentation penetration to containment,

7. The goal of this strategy is to enhance the likelihood of long-term operation of the pump and control of RPV level control system (RCIC or IC). However, it is understood that this may not be feasible for some plants. In the case of RCIC, just starting a turbine-driven pump and letting it run to overfill can provide a significant delay in the progression of events or in the case of ICs, just using the available cooling without make up can delay the progression of events. Thus, there is no specific requirement for how long RPV level control can be assured.

3.4.2 DC Power Supplies to Allow Depressurization of RPV and Injection with Portable Pump

Objective:

Provide a means to depressurize the RPV and provide makeup with low pressure systems or the portable pump provided under the Phase 2 closure process.

Performance Attributes:

1. Provide a means to locally energize SRV solenoids at the appropriate containment penetration(s). The number of SRVs to be energized should be sufficient to depressurize the RPV below the shutoff head of low pressure pumps (LPCI or LPCS) at decay heat levels.
2. Identify existing connection points for the Phase 2 portable pump to provide makeup to the RPV. This could be accomplished by making use of vent and drain lines or other existing connection points on systems connected to RPV injection systems, or by providing a replacement valve bonnet that would have a flange/connector capable of accepting one or more fire hoses.
3. Provide a means to makeup at least 300 gpm of water to the RPV for a period of 12 hours. This could utilize the Phase 2 pump, or other existing sources. A makeup rate of less than 300 gpm may be justified on a site-specific basis.
4. Provide procedure/guidance for implementation of this strategy.

Response Elements:

- Provide a general description of how the RPV will be depressurized using portable DC power supplies and how the portable pump will be used to provide RPV injection.
- Describe the general locations of the primary equipment involved in implementing this strategy, including any valves that must be manipulated.
- Estimate flow rates expected to be delivered to the RPV and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

Loss of power conditions can inhibit the ability to depressurize the RPV to gain access to low pressure RPV makeup systems. The goal of this strategy is to provide a flexible means to depressurize the RPV and in order to use the portable pumping capability to provide RPV makeup.

In general, this would be expected to involve creating the capability to locally energizing the ADS/SRV solenoid valves at the containment penetration. This would require a portable DC power supply. This could be accomplished by providing a dolly capable of transporting and connecting multiple vehicle batteries to various locations or by utilizing a portable AC power supply with a rectifier.

The capability to depressurize and inject to the RPV should be documented in the submittal using the template provided in Table A.5-2.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that Reactor Building will be accessible.
2. The implementation of this strategy should assume that this is a LIPD condition and there is no on-site or off-site AC or DC power available. Spatially separated batteries from another unit could also be considered. However, if power is to be supplied from another unit, it should be provided from a location that is sufficiently spatially separated from the normal power supply and cable routing to provide confidence that the alternate power will be available.
3. Given access to the Reactor Building, it can be assumed that the strategy for manually operating RCIC (Section 3.5.3) is also viable. This provides additional time for this strategy to be implemented.

4. This strategy could utilize the Phase 2 pump, or other existing portable pumping sources. The connections could be accomplished by making use of vent and drain lines or other existing connection points on systems, or by providing a replacement valve bonnet that would have a flange/connector capable of accepting one or more hoses.
5. RPV pressure and decay heat profiles should be reviewed to determine what the portable pump must be capable of in order to provide the required flow. Include consideration of line losses which may be significant, depending on the routing. The minimum debris retention injection rate should be considered to determine required flow rates. The site should have an engineering basis that provides reasonable assurance that the intended makeup rate and capacities can be provided. This basis should be auditable, but does not have to be a quality related calculation.
6. The portable pumping capability, necessary hoses, and portable power supplies will need to be either stored in the vicinity of where they will be used or elsewhere on-site in an area at approximately 100 yards or more away from the target area, in order to assure survivability and availability for RPV injection.
7. Depending on the implementation, the approach taken to aligning the RPV makeup may also suffice for drywell flooding (Section 3.4.9)
8. A flowrate of 300 gpm is expected. However, under some circumstances, exceptions may be justified down to an RPV injection rate of 200 gpm. Examples of potential justifications which may be considered by the NRC include cases where costly plant modifications are required to achieve 300 gpm, implementation of the higher RPV makeup strategy would be substantially delayed injection, or substantially higher level of confidence can be established for a flowrate between 200 and 300 gpm.
9. Energizing the SRV solenoids from a location other than the containment penetration(s) may be acceptable. However, since cabling can be compromised by the large fire or explosion, it is preferable to energize them as close to the penetration as practical. If the SRV solenoids are energized remote from the containment penetration, a justification should be provided in the Notes section of Table A.5-2, for consideration by the NRC.

3.4.3 Utilize Feedwater and Condensate

Objective:

Provide a means to makeup to RPV from a source external from the Reactor Building.

Performance Attributes:

1. All BWRs already include this strategy in EOPs.

Response Elements:

No specific response required.

3.4.4 Makeup to Hotwell

Objective:

Provide a high volume makeup source to the hotwell in order to supply FW/condensate long-term.

Performance Attributes:

1. Provide a means to makeup at least 300 gpm of water to the condenser hotwell for a period of 12 hours. This could utilize the Phase 2 pump, or other existing sources. A makeup rate of less than 300 gpm may be justified on a site-specific basis.
2. Provide procedure/guidance to implement makeup source.

Response Elements:

- Provide a general description of how makeup to the hotwell will be accomplished.
- Describe the general locations of the primary equipment involved in makeup to the hotwell.
- Estimate flow rates expected to be delivered to the hotwell and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

It is possible to postulate damage to the plant that could affect RPV makeup using ECCS systems. This strategy is aimed at providing a source of makeup to the hotwell in order to provide an extended supply of water for RPV makeup by the feedwater and/or condensate systems.

The hotwell makeup capability should be documented in the submittal using the template provided in Table A.5-4.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that areas immediately around the condenser and hotwell will be accessible.
2. Since feedwater and condensate are operating, normal (non-1E) AC and DC power can be assumed to be available.
3. While makeup with clean sources of water is preferable, it is not required.
4. In implementing this strategy, the fire protection system may be used as a water source provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and makeup capabilities. If portions of the fire system must be relied on for implementation of this strategy the management of the system should be outlined in site procedures/guidelines. Guidance should include methods to isolate potentially damaged headers and if possible guidance for ring header sectionalization. Connection to the fire ring header should be approximately 100 yards or more from the target area. It can be assumed that the fire header itself is not damaged. However, the fire system management strategy should address isolation of fire headers inside structures that may be target areas. The pump used to charge the ring header should be located more than approximately 100 yards from the target area. If this separation does not exist, then some justification for pump survivability (e.g., intervening structures, nearly 100 yards away from key plant areas, contained in a reinforced concrete structure, etc.) should be provided in the submittal. Document the fire system management strategy in the submittal in Table A2-6.
5. If a portable pumping capability is relied upon, the pump and necessary hoses will need to be stored on-site in an area at approximately 100 yards or more away from the target area in order to assure survivability and availability for the function.
6. Each site should consider that this makeup capability can be implemented prior to core uncovery following depletion of the hotwell, assuming that the

hotwell is the only available water source to remove decay heat (i.e., the CST and suppression pool are not available).

7. On a site-specific basis, plants may justify a makeup rate to the hotwell of less than 300 gpm. The makeup rate must be at least 100 gpm greater than the rate necessary to remove decay heat.

3.4.5 Makeup to CST

Objective:

Provide a large volume makeup source to the condensate storage tank (CST) in order to supply ECCS long-term.

Performance Attributes:

1. Provide a means to makeup at least 300 gpm of water to the CST for a period of 12 hours. This could utilize the Phase 2 pump, or other existing sources. A makeup rate of less than 300 gpm may be justified on a site-specific basis.
2. Provide procedure/guidance to implement makeup source.

Response Elements:

- Provide a general description of how the CST refill will be accomplished.
- Describe the general locations of the primary equipment involved in providing makeup to the CST.
- Estimate flow rates expected to be delivered to the CST and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

It is possible to postulate damage to the plant that could affect normal CST makeup capability. This strategy is aimed at providing a source of makeup to the CST in order to provide an extended supply of water for RPV makeup.

The CST makeup capability should be documented in the submittal using the template provided in Table A.5-5.

Additional Considerations:

1. BWRs with Isolation Condensers (ICs) are not required to implement this strategy, if they do not have a RCIC system. Those sites will instead be managing IC heat exchanger level per Section 3.4.1.
2. For the purposes of this strategy, it should be assumed that areas immediately around the CST will be accessible.
3. Since manual operation of an RCIC pump could allow RPV makeup without AC or DC power, the implementation of this strategy should assume that this is a LIPD condition and there is no on-site or off-site AC or DC power available.
4. While makeup with clean sources of water is preferable, it is not required.
5. In implementing this strategy, the fire protection system may be used as a water source provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and makeup capabilities. It is recognized that fire system at many sites is the most flexible system that can be employed to mitigate many of the element associated with this effort. If portions of the fire system must be relied on for implementation of this strategy the management of the system should be outlined in site procedures/guidelines. Guidance should include methods to isolate potentially damaged headers and if possible guidance for ring header sectionalization. Connection to the fire ring header should be approximately 100 yards or more from the target area. It can be assumed that the fire header itself is not damaged. However, the fire system management strategy should address isolation of fire headers inside structures that may be target areas. The pump used to charge the ring header should be located more than approximately 100 yards from the target area. If this separation does not exist, then some justification for pump survivability (e.g., intervening structures, nearly 100 yards away from key plant areas, contained in a reinforced concrete structure, etc.) should be provided in the submittal. Document the fire system management strategy in the submittal in Table A2-6.
6. If a portable pumping capability is relied upon, the pump and necessary hoses will need to be stored on-site in an area at approximately 100 yards or more away from the target area in order to assure survivability and availability for the function.
7. Each site should consider that this makeup capability can be implemented prior to core uncovery following depletion of the CST, assuming that the CST is the only water available to remove decay heat.

8. On a site-specific basis, plants may justify a makeup rate to the CST of less than 300 gpm based on the flow rate required to meet their site-specific MDRIR curve at the time of CST depletion. The makeup rate must be at least 100 gpm greater than the minimum MDRIR flowrate.

3.4.6 Maximize CRD

Objective:

Provide a means to makeup to RPV from a source independent of ECCS systems.

Performance Attributes:

1. All BWRs already include this strategy in EOPs. However, guidance to maximize CRD flow by starting the second pump, opening additional flow paths, and bypassing filters should be verified as these can significantly increase makeup flow rates.
2. For those sites that received “NRC June 20, 2006 Issuance of Order Requiring Compliance with Key Radiological Protection Mitigation Strategies (EA-06-137)”, confirm implementation of this as part of their imminent threat procedures.

Response Elements:

- Provide a general description of how CRD flow will be maximized.
- Describe the locations of the primary equipment involved in maximizing CRD.
- Maximum estimated flow rates expected to be delivered to the RPV and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

This strategy is already part of the BWR Emergency Procedure Guidelines. However, the manner in which it is implemented may vary from plant to plant. In addition, the location of the CRD pumps and filters varies substantially.

The capability to maximize CRD should be documented in the submittal using the template provided in Table A.5-6.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that areas where the CRD pumps and valves are located will be accessible.
2. Maximizing CRD flow should involve starting the second pump, opening the flow control valves 100%, opening the second filter for each pump, and opening any bypass lines.
3. The maximum benefit from low flow systems like CRD comes when the action is taken promptly. So, procedural guidance for maximizing CRD flows should rapidly lead to these actions.

3.4.7 Procedure to Isolate RWCU

Objective:

Provide procedural direction to proactively isolate RWCU to minimize the risk of a LOCA outside containment.

Performance Attributes:

1. Confirm implementation of this as part of their imminent threat procedures.

Response Elements:

None required.

3.4.8 Manually Open Containment Vent Lines

Objective:

Provide a power-independent means to remove heat from containment by locally opening containment vent pathways.

Performance Attributes:

1. If manual operation of the valve is required, confirm availability of a means to open the valve and potentially to re-shut the valve, if conditions permit and termination of containment venting is warranted. Confirm availability of on-site air/N2 bottles either at the local pathway or in an area that is physically separate (approximately 100 yards or more from the target area).
2. Provide guidance on use of bottles to vent containment.

Response Elements:

- Provide a general description of how the containment vent lines will be opened/closed without normal air and power.
- Describe the general locations of the primary equipment involved in implementing the strategy.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

The goal of this strategy is to provide a means to relieve pressure from the containment in the event of a long-term loss of containment heat removal. The most likely cause of this is a LIPD event, but other scenarios can be envisioned (e.g., loss of essential service water with loss of control air or power). The most likely way that containment vent valves would be opened is by using a portable motive force (e.g., either air bottles or portable DC power supplies, depending on the type of valves involved).

The capability to manually open containment vent valves should be documented in the submittal using the template provided in Table A.5-8.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that Reactor Building and any other locations where vent valves are located will be accessible.
2. The implementation of this strategy should assume that this is a LIPD condition and there is no on-site or off-site AC or DC power available.
3. Any equipment (e.g., air bottles, portable power supplies, etc.) necessary to support opening the vent valves should either be stored in the vicinity of the location where the action must be taken, or in an area well removed from that location (e.g., a warehouse) so that access to other parts of the plant structures is not required.

3.4.9 Inject Water into the Drywell

Objective:

Provide cooling of the core debris and scrubbing of fission products, in the event core damage and vessel failure can not be prevented.

Performance Attributes:

1. Provide an AC-power-independent means to inject at least 300 gpm of water to the drywell for a period of 12 hours. The water injection can be directly to the drywell, or through lines connected to the RPV. This could utilize the Phase 2 portable pump or other existing sources. A makeup rate of less than 300 gpm may be justified on a site-specific basis.
2. Provide procedure/guidance to implement drywell injection capability.

Response Elements:

- Provide a general description of how the portable pump will be used to inject water into the drywell.
- Describe the general locations of the primary equipment involved in injecting water into the drywell, including any valves that must be manipulated.
- Estimate flow rates expected to be delivered to the drywell and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

Submittal Guidance:

This strategy is intended to be a backup to the use of the drywell spray or RPV injection systems.

The capability to inject water into the drywell using a portable pump should be documented in the submittal using the template provided in Table A.5-9.

Additional Considerations:

1. For the purposes of this strategy, it should be assumed that this is a LIPD condition and there is no on-site or off-site AC or DC power available.
2. Access to the Reactor Building can be assumed for this strategy. Given access to the Reactor Building, it can be assumed that the strategy for manually operating RCIC (Section 3.5.3) is also viable. This provides additional time for this strategy to be implemented
3. Since the objective is to put water into the drywell in order to flood the core debris after vessel failure, the injection can be routed through the drywell spray system, ECCS injection systems, or any other system that can route the water into the drywell. This strategy could utilize the Phase 2 pump, or

other existing portable pumping sources. The connections could be accomplished by making use of vent and drain lines or other existing connection points on systems, or by providing a replacement valve bonnet that would have a flange/connector capable of accepting one or more hoses.

4. Containment pressure may be elevated (~design pressure), so the portable pump must be capable of providing the required flow at such pressures, including consideration of line losses which may be significant, depending on the routing. The site should have an engineering basis that provides reasonable assurance that the intended makeup rate and capacities can be provided. This basis should be auditable, but does not have to be a quality related calculation
5. The portable pumping capability and necessary hoses will need to be stored on-site in an area at approximately 100 yards or more away from the target area in order to assure survivability and availability of drywell injection.
6. Depending on the implementation, the approach taken to aligning the drywell makeup may also suffice for RPV makeup (Section 3.4.2)
7. On a site-specific basis, plants may justify a makeup rate to the drywell of less than 300 gpm. The makeup rate must be at least 100 gpm greater than the rate necessary to remove decay heat.

3.4.10 Portable Sprays

<u>Objective</u>:

Provide a means to reduce the magnitude of any fission product releases by spraying.

<u>Performance Attributes</u>:

1. Provide procedure/guidance on use of the portable spray capability provided for SFP mitigation in the event of a release from the Reactor Building/Containment.

<u>Response Elements</u>:

- Provide a general description of how the portable pump will be used to spray a radiological release including a description of portions of affected plant structures that cannot be sprayed due to physical layout or equipment limitations. This is intended to be a qualitative description of the portions of structures that are expected to be sprayable <u>assuming there are no accessibility constraints</u>.

- Describe the general locations of the primary equipment involved in use of portable sprays.
- Estimate spray flow rates expected to be delivered and identify the capacity of water supplies.
- Confirm that a procedure/guidance will be developed for implementing this strategy.

<u>Submittal Guidance</u>:

The purpose of these sprays is to mitigate any release of fission products from the Reactor Building/Containment.

The capability to spray using a portable pump should be documented in the submittal using the template provided in Table A.5-10.

<u>Additional Considerations</u>:

1. The purpose of this strategy is to spray a release coming from a damaged or failed containment. For the purposes of this strategy, it should be assumed that areas immediately around the containment will be accessible.
2. In implementing this strategy, consideration should be given to containing the runoff from the sprays. This may include providing a means to close off storm drains and/or providing materials to route runoff to a desired area. Guidance on deployment of the sprays should consider the amount of spray water that can be contained.
3. In implementing this strategy, the fire protection system may be used as a water source provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and makeup capabilities.. It is recognized that fire system at many sites is the most flexible system that can be employed to mitigate many of the element associated with this effort. If portions of the fire system must be relied on for implementation of this strategy the management of the system should be outlined in site procedures/guidelines. Guidance should include methods to isolate potentially damaged headers and if possible guidance for ring header sectionalization. Connection to the fire ring header should be approximately 100 yards or more from the target area. It can be assumed that the fire header itself is not damaged. However, the fire system management strategy should address isolation of fire headers inside structures that may be target areas. The pump used to charge the ring header should be located more than approximately 100 yards from the target area. If this separation does not exist, then some justification for pump survivability (e.g., intervening structures, nearly 100 yards away from

key plant areas, contained in a reinforced concrete structure, etc.) should be provided in the submittal. Document the fire system management strategy in the submittal in Table A2-6.

4. The portable pumping capability, necessary hoses, and monitor nozzles will need to be stored on-site in an area approximately 100 yards or more away from the target area in order to assure survivability and availability for the spray function.

5. Utility PRA personnel can be consulted to identify the more likely release points. These should be considered when specifying the spray nozzles and pumping capability.

6. Releases that occur through a containment vent or through the site elevated release point are not expected to be sprayed.

7. In the event spray is to be used to mitigate a release, the implementing procedure/guideline should direct the spray flow rate be maximized to the extent the spray water can be contained. However, this does not imply that spray should/would be terminated in a real event simply because the capability to contain spray runoff is exceeded. In a real event, such decisions would be made by the ERO, based on the actual conditions.

3.5 DISPOSITION OF SITE-SPECIFIC ENHANCEMENT STRATEGIES

This step involves the review of the candidate enhancement strategies (CES) documented in the NRC's letter to each site on the closure of B.5.b Phases 1, 2, and 3. Those CES that were determined to be "High Confidence" and only involved implementation of Readily Available Measures (RAM) should be considered. In this context, Readily Available Measures are those that involve procedure/guidance enhancements, minimal procurement, and very minor modifications to safety-related and non safety-related systems. Due to the fact that these measures were identified without detailed assessment, each site should evaluate each identified CES that is considered a RAM to determine the true feasibility and benefit.

The assessment of CES that are RAM should include consideration of at least the following:

- Whether the RAM provides additional capability beyond that already available.
- Whether the RAM can be accomplished in the time available and plant conditions that may exist.
- Whether the RAM should be listed in site procedures or incorporated into plant procedures and training without unduly impacting the existing training regimen.

The collection of generic enhancement strategies and the high confidence plant-specific enhancement strategies that are found to be applicable and useful should be listed in site procedures or implemented by each site. These along with the collection of generic enhancement strategies will help to improve the sites flexibility to facilitate response efforts.

A listing of any other candidate enhancement strategies identified by the NRC that do not require modifications to the facility and are not adopted may be appended to plant implementing procedures/guidance for consideration by response personnel if conditions warrant. However, there is no intent to develop implementing procedures or to conduct training on these additional enhancements.

<u>Response Elements</u>:

For high confidence RAM strategies, procedures/guidance are to be developed for implementation.

For low confidence RAM strategies identified in the site assessments:

- Identify which additional enhancement strategies for each key safety function that were found to be viable.
- Determine if the strategy will be listed or implemented
- Identify where these strategies are identified for use by plant personnel.

The viability of each mitigation enhancement strategy should be evaluated with consideration of at least the following:

- Whether the strategy provides additional tangible capability beyond that already available.
- Whether the strategy can feasibly be accomplished with existing plant equipment in the time available and plant conditions that may exist. Thus, a strategy that requires a long time to establish or requires access to many areas of the plant may not be viable.

Each of these enhancements that are found to be viable should be identified in a plant procedure or guidance. It is sufficient to provide a list of the strategies retained. It is not necessary to specify the steps necessary for implementation; appropriate judgment should be used.

The enhancement strategies that will be listed or implemented into plant procedures/guidance should be documented in the submittal using the template provided in Table A.6-1.

Additional Considerations:

1. It may be useful to include plant PRA personnel in the evaluation of the identified strategies, as some readily available capabilities could be beneficial in reducing plant risks from causes other than security threats.

4.0 ACTIONS FOR NEW PLANTS

4.1 Background

The Nuclear Regulatory Commission has issued 10CFR 50.54 (hh)(2)) that requires licensees to develop guidance and strategies for addressing the loss of large areas of the plant due to explosions or fires from a beyond-design basis event through the use of readily available resources and by identifying potential practicable areas for the use of beyond-readily-available resources. These strategies would address licensee response to events that are beyond the design basis of the facility.

These requirements originated in the ICM order of 2002. Ultimately, these mitigation strategies were further developed and refined through extensive interactions with licensees and industry. The NRC recognizes that these mitigation strategies will be beneficial for the mitigation of all beyond-design basis events that result in the loss of large areas of the plant due to explosions or fires. Current reactor licensees comply with these requirements through the use of the following 14 strategies that have been required through an operating license condition.

These strategies fall into the three general areas identified by 10 CFR 50.54(hh)(2)(i), (ii), and (iii). These strategies are:

Fire fighting response strategy with the following elements:
1. Pre-defined coordinated fire response strategy and guidance.
2. Assessment of mutual aid fire fighting assets.
3. Designated staging areas for equipment and materials.
4. Command and control.
5. Training of response personnel.

Operations to mitigate fuel damage considering the following:
1. Protection and use of personnel assets.
2. Communications.
3. Minimizing fire spread.
4. Procedures for implementing integrated fire response strategy.
5. Identification of readily-available, pre-staged equipment.
6. Training on integrated fire response strategy.
7. Spent fuel pool mitigation measures.

Actions to minimize release to include consideration of:
1. Water spray scrubbing.
2. Dose to onsite responders.

The NRC considered specifically including these 14 strategies in the text of 10 CFR 50.54(hh)(2). However, the NRC decided that the more general performance-based language in 10 CFR 50.54(hh)(2) was a better approach to account for future reactor facility designs that may contain features that preclude the need for some of these strategies. New reactor licensees are also required to employ similar strategies to address core cooling, spent fuel pool cooling, and fission product barrier integrity. The strategies need to account for, as appropriate, the specific features of the plant design, or any design changes made as a result of an aircraft assessment performed per 10 CFR 50.150. The NRC regards the two rulemakings to be complementary in scope and objectives. The aircraft impact rule focuses on enhancing the design of future nuclear power plants to withstand large commercial aircraft impacts, with reduced use of operator actions. 10 CFR 50.54(hh) focuses on ensuring that the nuclear power plant's licensees will be able to implement effective mitigation measures for large fires and explosions including (but not explicitly limited to) those caused by the impacts of large, commercial aircraft.

Specifically, 10 CFR 50.54(hh)(2) requires that:

Each licensee shall develop and implement guidance and strategies intended to maintain or restore 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, to include strategies in the following areas:

(i) Fire fighting;
(ii) Operations to mitigate fuel damage; and
(iii) Actions to minimize radiological release.

The Commission issued guidance (Safeguards Information) to current reactor licensees on February 25, 2005, and additionally endorsed NEI 06-12, Revision 2, by letter dated December 22, 2006. The NRC considers that these two sources of guidance provide an acceptable means for developing and implementing the above strategies. The purpose of this section of this guideline is to provide guidance to new plants for implementing the proposed rule.

4.2 General Approach

The requirements of the rule are consistent with the resolution of B.5.b for current US operating plants. B.5.b was divided into three phases for current plants and this guideline follows this same approach:

- Phase 1 – Enhanced fire fighting capabilities
- Phase 2 – Measures to mitigate damage to fuel in the spent fuel pool
- Phase 3 – Measures to mitigate damage to fuel in the reactor vessel and to minimize radiological release

4.2.1 Phase 1

New plants should address Phase 1 as operating plants have done; by implementing the guidance in NRC guidance document "Developing Mitigating Strategies/Guidance for Nuclear Power Plants to Respond to Loss of Large Areas of the Plant in Accordance with B.5.b of the February 25, 2002, Order" dated February 25, 2005.

4.2.2 Phase 2

Section 2.0 of this guideline should be used by new plants to mitigate damage to fuel in the spent fuel pools. Guidance for implementing the mitigation strategy shall be developed, documented and available for NRC inspection to meet the requirements of 10CFR50.54(hh)(2). *All of the boundary conditions, objectives, performance attributes, response elements, submittal guidance and additional considerations of Section 2.0 apply with the exception of the following elements:*

- **SECTION 2.2: DIVERSE SFP MAKEUP SOURCE (INTERNAL STRATEGY**

  The industry and NRC are not performing site-specific Phase 2 studies for new designs to identify candidate water makeup strategies for the spent fuel pools. Therefore, in the event the new plant design does not have a diverse concurrent makeup capability beyond the normal SFP makeup system that exceeds 500 gpm, the candidate strategies identified in Attachment A to the NEI Letter from Marvin Fertel to Luis Reyes on Closure of Phase 2, January 24, 2006 (Reference 1 to NEI 06-12) should be reviewed to explore potential enhancement strategies based on their design to establish 500 gpm of diverse makeup.

- **SECTION 2.3: FLEXIBLE, POWER-INDEPENDENT MAKEUP SOURCE (EXTERNAL STRATEGY**
  For the external makeup and external spray strategy (NEI 06-12 Sections 2.3.1 and 2.3.2), new plants have the option of incorporating standpipes, instead of just hoses, to establish a flow path from the external water source to the spent

fuel pool elevation to establish external water makeup and spray capability. If standpipes are used, they are exempt from the requirement to be located at least 100 yards from the spent fuel pool structure provided at least two standpipes are employed. The two or more standpipes should be diversely located (i.e., on opposite sides of the spent fuel pool) to reduce the chances of losing both standpipes from a fire or explosion. The external standpipes should employ a fire hose connection at ground level to provide flow for the spent fuel pool makeup strategy and/or spray strategy from the ground level pump.

For the spent fuel pool spray system described in Section 2.3.2, designs that use a monitor type nozzle should provide a minimum of 200 gpm delivered effectively to the SFP. Designs that employ a designed spent fuel pool spray system should justify a flow rate consistent with their design.

- **SECTION 2.4: ADDITIONAL SITE-SPECIFIC SFP MAKEUP STRATEGIES**

  Industry and NRC are not performing site-specific Phase 2 studies for new designs to identify candidate water makeup strategies for the spent fuel pools. Therefore, new plants should consider the strategies identified in Attachment A to the NEI Letter from Marvin Fertel to Luis Reyes on Closure of Phase 2, January 24, 2006 (Reference 1 to NEI 06-12) for meeting the requirements of NEI 06-12, Section 2.4 to develop additional strategies.

4.2.3 Phase 3

Section 3.0 of this guideline should be used by new plants to mitigate damage to fuel in the reactor vessel and to minimize radiological releases. *All of the boundary conditions, objectives, performance attributes, response elements, submittal guidance and additional considerations of Section 3.0 apply with the exception of the following element:* Section 3.5, "Disposition of Site-Specific Enhancement Strategies" is not applicable to new plants.

It is recognized that new plants typically have more safety trains that are more spatially separated than for current US operating plants. Additionally, some new designs employ passive features that may be more or less susceptible to damage from the effects of large fires and explosions. Therefore, new plants may not need all of the mitigation strategies identified in Sections 3.3 and 3.4 or may need additional strategies to satisfy the key safety functions. The following steps should be taken by new plants to determine the need for the mitigation strategies employing readily available equipment described in Sections 3.3 and 3.4. Figure 4-1 provides a flow diagram of the process.

4.2.3.1 Identification of Key Safety Functions

A generic list of "Key Safety Functions" was identified for current BWRs and PWRs in Section 3.1 and is displayed below:

BWR Safety Functions	PWR Safety Functions
RPV Level Control	RCS Inventory Control
Containment Isolation	RCS Heat Removal
Containment Integrity	Containment Isolation
Release Mitigation	Containment Integrity
	Release Mitigation

Each NSSS vendor should review the generic key safety functions identified above and determine if those functions apply to their design. Identify if there are any different or additional key safety functions that are design specific. New plants should compare the final set of key safety functions selected with those in the design-specific PRA to ensure all functions are adequately covered.

NSSS vendors that choose to seek credit for design features should follow sections 4.2.3.2 through 4.2.3.6. NSSS vendors that do not choose to credit design features may go directly to section 4.2.3.6.

4.2.3.2 Identify Functional Attributes

For each key safety function, identify the minimal set of equipment for both the primary and alternate means of satisfying the key safety function (including necessary support equipment such as power, cooling water, ventilation, etc.). The design specific PRA success criteria for meeting the function is recommended as it credits both safety-related and non safety-related equipment, which is an appropriate approach for a beyond design basis event. Repeat for each key safety function.

4.2.3.3 Identify Equipment Locations

Identify the physical locations of the equipment and support equipment needed to satisfy each key safety function. The objective of this step is to determine the degree of physical separation that exists between redundant equipment that is capable of satisfying the safety function. Repeat for each safety function.

4.2.3.4 Credit Existing Design Features

New plant designs typically have design features that may provide substantial separation between redundant equipment capable of satisfying the safety functions. The key to survival of redundant equipment exposed to large fires and explosions is the degree of spatial separation and/or barriers that exist between the equipment. The greater the separation and/or barriers between redundant equipment, the less likely it is that a large fire or explosion will impact both sets of equipment. At some point, the degree of separation and/or barriers provides a reasonable level of assurance of survival of one of the sets of equipment.

In evaluating the degree of separation, it is also necessary to assess the degree of separation and/or barriers of necessary support equipment. For example, two trains of equipment in separate buildings may provide adequate separation provided there is not a common support system that, if lost, would prevent both trains from being available. Key support equipment typically includes:

- Internal Power Distribution (AC and DC);
- Component Cooling;
- Instrumentation and Control; and,
- Instrument Air / Control Air

Existing design features can be credited provided there is adequate separation and/or barriers between the primary and alternate means of satisfying the safety function. For the purposes of this study, adequate spatial separation and/or barriers are assumed to exist when the primary and alternative system components are separated in one of the following ways:

- Mitigating mechanical and electrical equipment for primary and alternate means of satisfying the key safety function is located in buildings that are at least 100 yards apart. (See Figure 4.2)
- Mitigating mechanical and electrical equipment for primary and alternate means of satisfying the key safety function are located in buildings that are at least 10 feet apart provided the equipment is not located in compartments that face each other and is not protected by only the external walls of the two buildings. (See Figure 4.3)
- Mitigating mechanical and electrical equipment for primary and alternate means of satisfying the key safety function is located in adjacent compartments on the same side of the same building but there is at least one 18" reinforced concrete wall separating the equipment laterally and at least one 18" thick wall in addition to the external wall protecting the alternate means in the transverse direction. This criterion applies to loss of primary means due to external threats only. (See Figure 4.4) CAUTION: The external threat affects all elevations of

the exposed face of the building; therefore, alternate equipment located on different elevations must satisfy the above criteria at each above grade elevation. Additionally, electrical equipment and power and control cables may be subject to damage from fire spread at both above and below grade elevations. The following rules should be applied to determine the extent of fire spread:

1. No credit can be given for electrical equipment and power and control cables for the alternate means of satisfying the key safety function if located at the same elevation as the primary means.

2. No credit can be given for electrical equipment and power and control cables for the alternate means of satisfying the key safety function that is located in the two compartments below and the compartment above the compartment containing the primary means.

- Mitigating mechanical and electrical equipment for primary and alternate means of satisfying the safety function is located in different compartments at the same elevation that are separated by at least two 18” thick walls protecting the alternate means. This criterion applies to loss of primary means due to internal threats only. (See Figure 4.5)

4.2.3.5 Assessment of Key Safety Functions

After crediting equipment that meets the criteria of Section 4.2.3.4, determine if the success criteria for meeting the key safety function is satisfied by existing redundant spatially-separated equipment. Repeat for each key safety function. Any key safety function that is satisfied does not require the mitigation strategy identified in Section 3.3 or 3.4. Implementation guidance using the credited design feature should be developed.

4.2.3.6 Mitigation Strategies

For any key safety function that is not satisfied in Section 4.2.3.5, develop objectives, performance attributes, response elements and additional considerations similar to the guidance in Sections 3.3 or 3.4 as appropriate in developing mitigation strategies. Adjustments to the mitigation strategies may be necessary based on new plant design features that differ from current plants.
.
For designs that identified different key safety functions and those key safety functions were not satisfied by Section 4.2.3.5, develop mitigation strategies that are similar in scope and detail to those identified in Sections 3.3 and 3.4. Guidance for

implementing the mitigation strategy shall be developed, documented and available for NRC inspection to meet the requirements of 10CFR50.54(hh)(2).

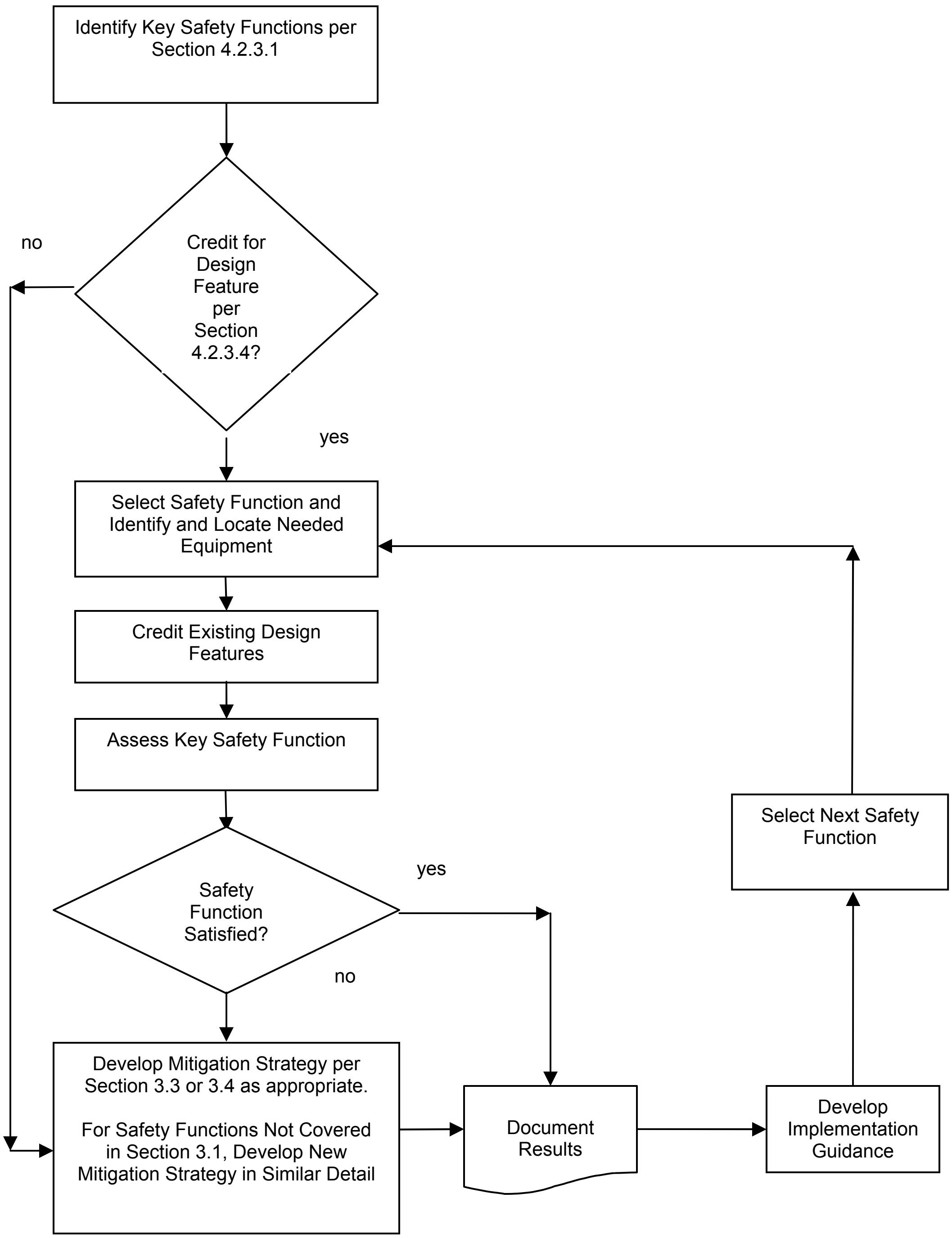
4.3 Mitigation Strategies Description and Plan

Each COL applicant shall prepare and submit to the NRC a description of each mitigation strategy and its implementation plan following the templates contained in Appendix D.

Figure 4.1

PROCESS FLOW DIAGRAM

SECTION 4.2.3 PHASE 3



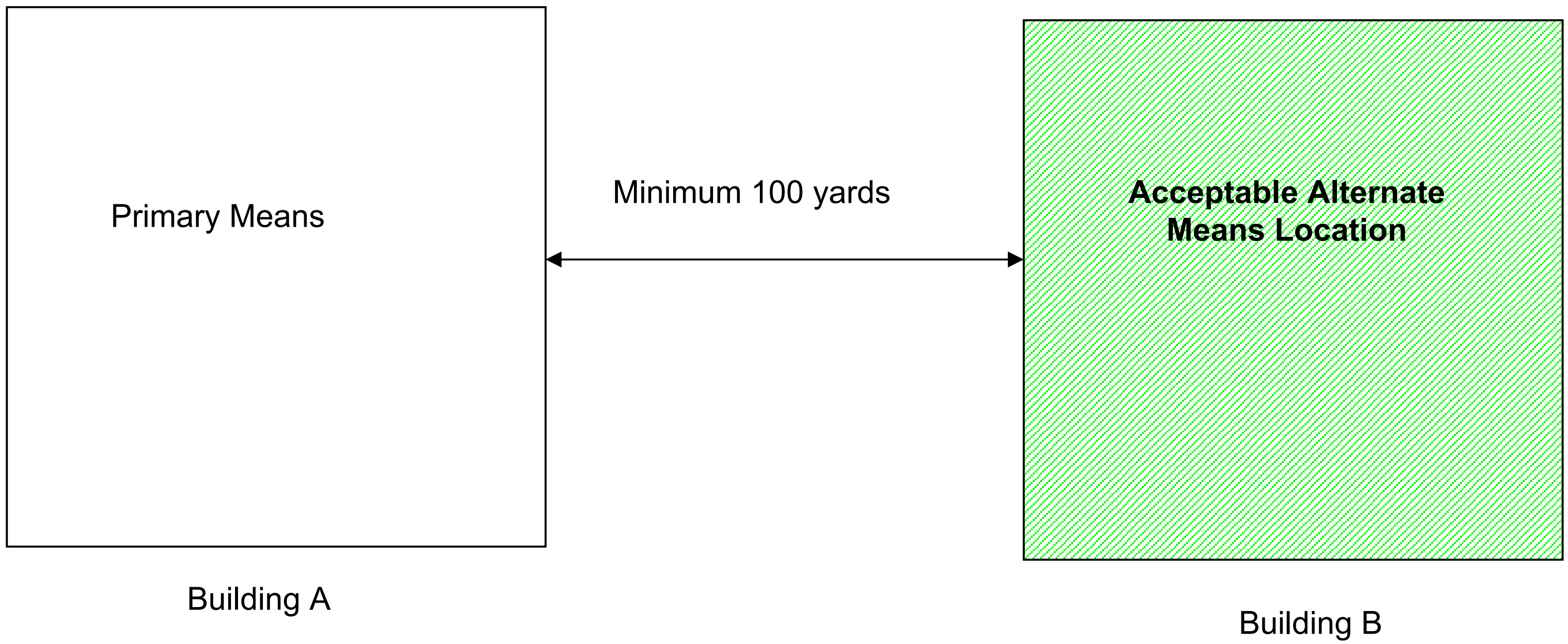


Figure 4.2
Separate Building Criteria

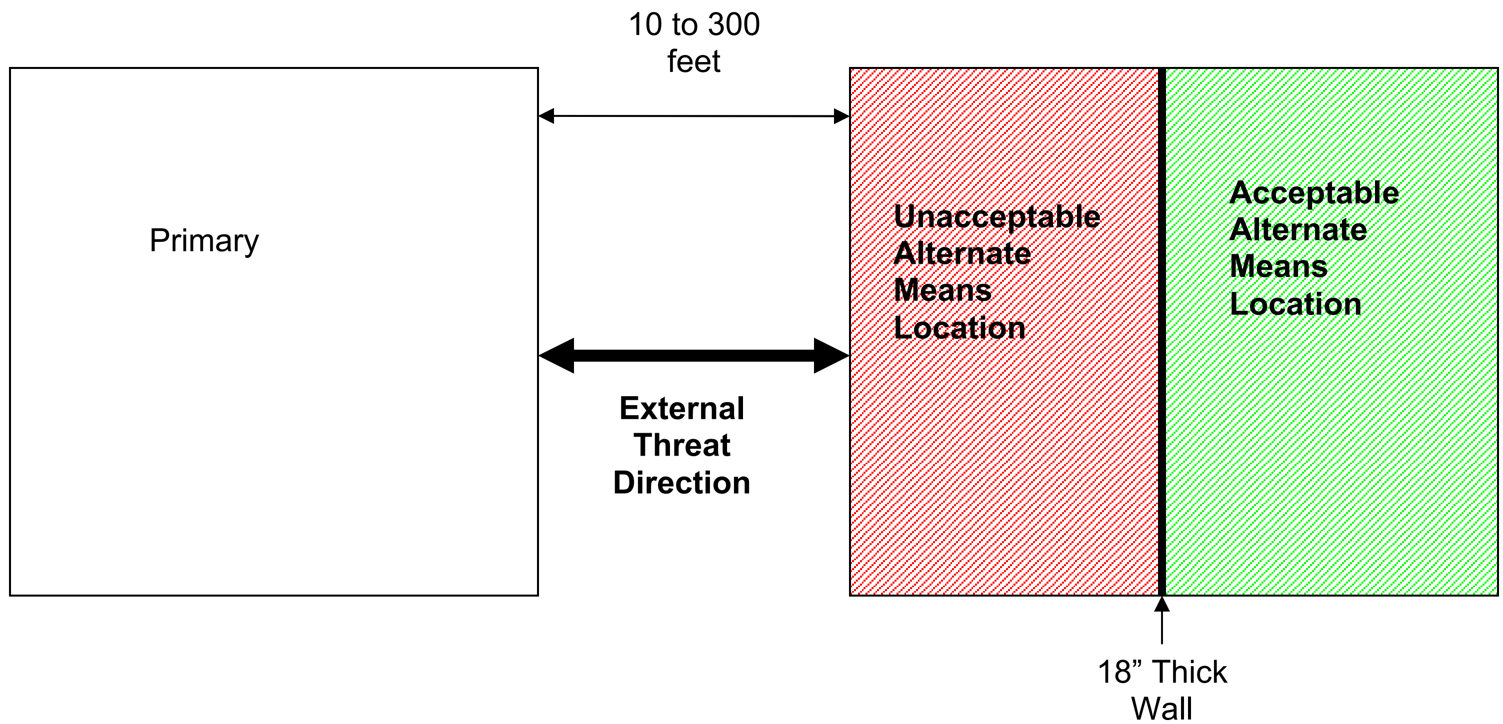


Figure 4.3
Nearby Building Criteria
External Threats

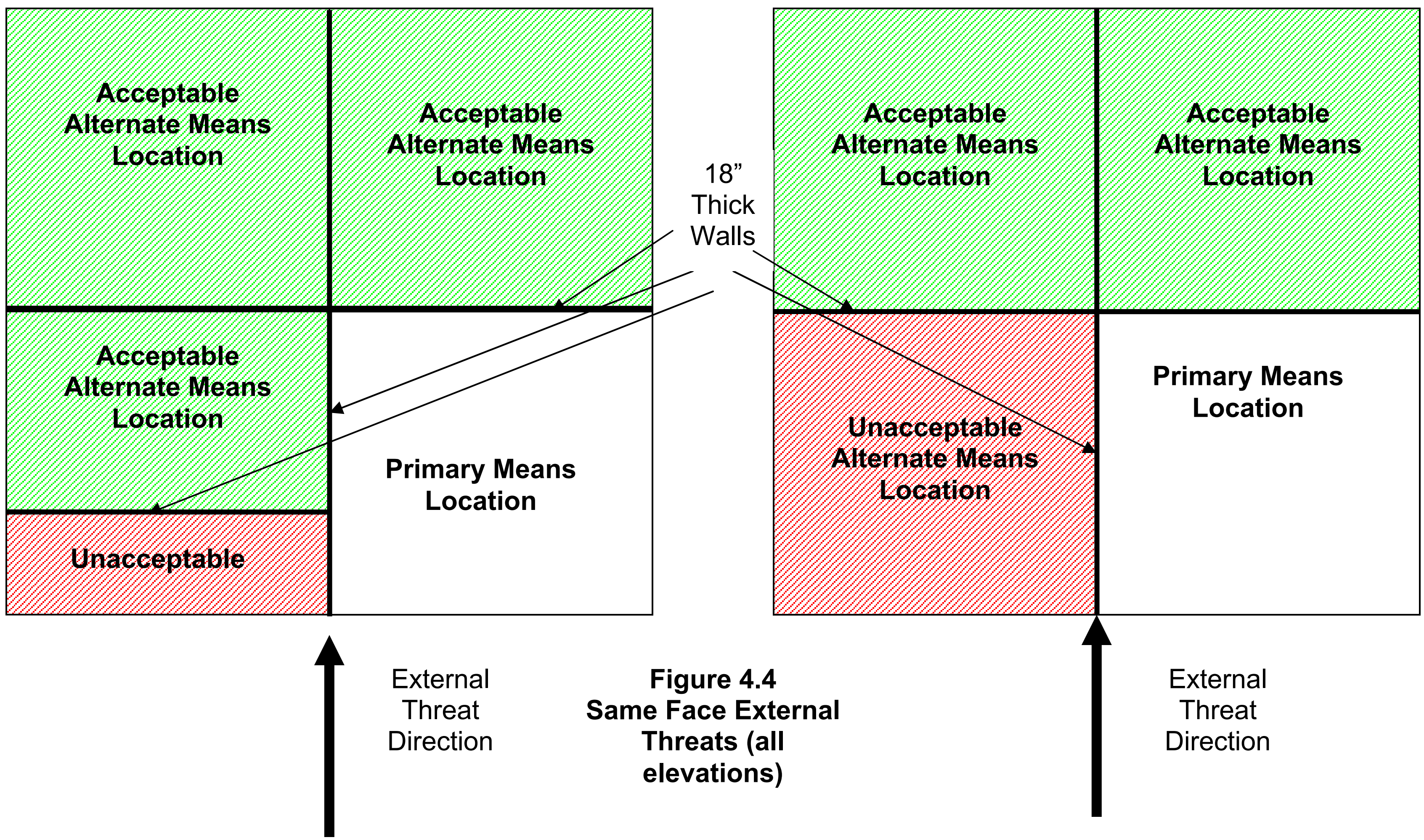


Figure 4.4
Same Face External Threats (all elevations)

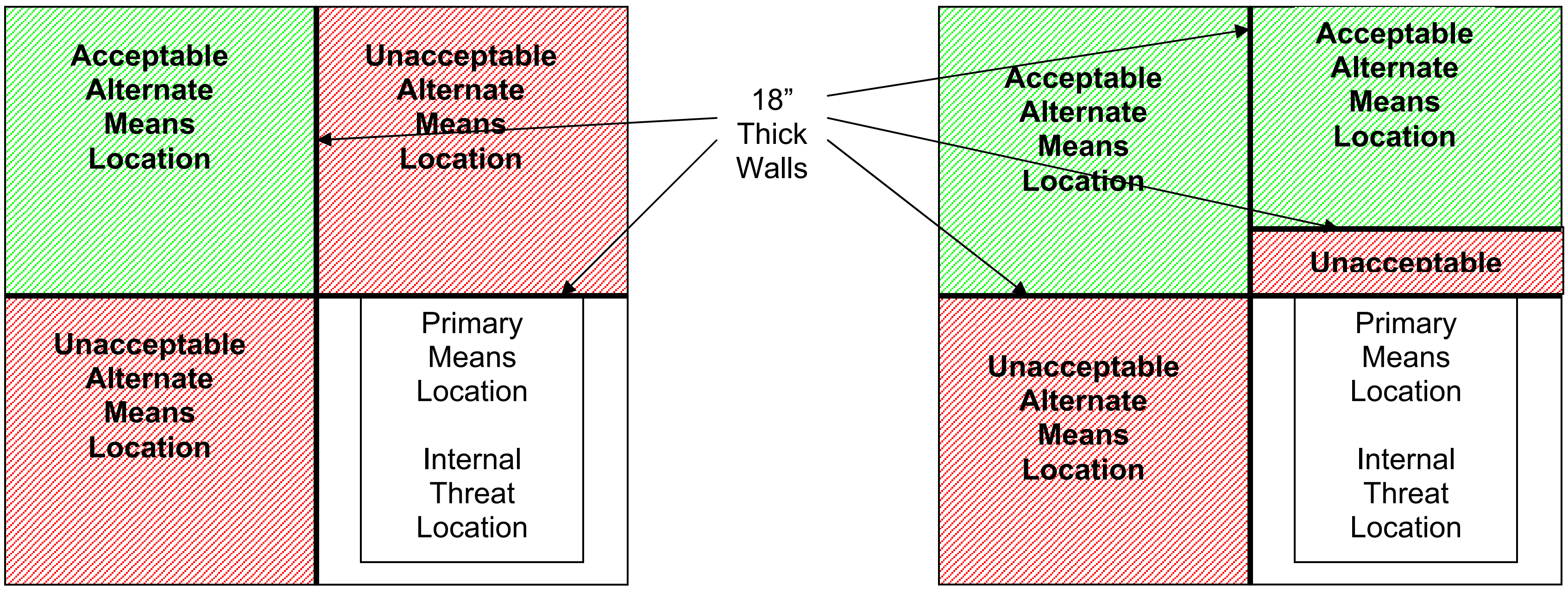


Figure 4.5
Internal Threat Separation Criteria

5.0 REFERENCES

1. NEI Letter from Marvin Fertel to Luis Reyes on Closure of Phase 2, January 24, 2006.
2. NEI Letter from Marvin Fertel to Luis Reyes on Closure of Phase 3, May 15, 2006.
3. NRC Letter from J.E. Dyer to Marvin Fertel on Phase 2 Closure, June 15, 2006.
4. NEI Letter from Marvin Fertel to William Kane on Closure of Phase 2, June 27, 2006.
5. NEI Letter from Marvin Fertel to William Kane on Closure of Phase 3, June 27, 2006.
6. NEI 05-07, "Industry Mitigation Strategy Study Guideline, Revision 1", December, 2005.
7. NRC Letter from J.E. Dyer to Marvin Fertel on B.5.b Closure, June 29, 2006.

APPENDIX A

Licensee Response Templates

A.1 Response Template for Transmittal Letter

A.2 Response Template for SFP Strategies

A.3 Response Template for Command and Control Enhancements

A.4 Response Template for PWR Reactor and Containment Strategies

A.5 Response Template for BWR Reactor and Containment Strategies

A.6 Response Template for Disposition of Site-specific Strategies

A.1 Response Templates for Cover Letter

Appendix Not Included in this Revision

A.2 Response Templates for SFP Enhancement Strategies

Table A.2-1

PLANT: ___________

SFP Makeup – Internal Strategy	
GENERAL DESCRIPTION:	
Provide a general description of diverse Spent Fuel Pool (SFP) makeup capability, including the necessary personnel actions	
DIVERSITY OF MAKEUP:	
Describe how this capability meets the NEI guidance as "diverse"	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in implementing this strategy	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates and capacities	
Flow Rate to SFP:	
Water Source & Capacity:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation including guidance on decisions to makeup vs. spray.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.2-2

PLANT: ___________

SFP Makeup – External Strategy	
GENERAL DESCRIPTION:	
Provide a general description of Spent Fuel Pool (SFP) makeup capability	
EQUIPMENT LOCATIONS:	
Describe the locations of the primary equipment involved in implementing this strategy	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates and capacities	
Maximum Pump Flow Rate:	
Flow Rate to SFP:	
Water Source & Capacity:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation including guidance on decisions to makeup vs. spray.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.2-3

PLANT: ___________

SFP Spray – External Strategy	
GENERAL DESCRIPTION:	
Provide a general description of alternate Spent Fuel Pool (SFP) spray capability	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in implementing this strategy	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates and capacities	
Maximum Pump Flow Rate:	
Number of Monitor Nozzles:	
Capacity of Each Nozzle:	
Rate of Spray to SFP:	
Water Source & Capacity:	
BASIS FOR SPRAY ADEQUACY:	*Describe basis for providing 200 gpm per unit of spray to the SFP*
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation including guidance on decisions to makeup vs. spray and when to maximize spray.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.2-4

PLANT: ___________

Viable Site-specific SFP Mitigation Strategies	
Strategy	**List/Implement**
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.2-5

PLANT: ___________

SFP Leakage Control Strategies	
GENERAL DESCRIPTION:	
• *Provide a list of the types of leakage control capabilities currently available on site and their general location* • • • •	
PROCEDURE/GUIDANCE:	
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.2-6

PLANT: ___________

Fire System Management Strategies	
GENERAL DESCRIPTION:	
• *Generally describe the capabilities available to isolate the site fire header from major structures in the event damage to the structure compromises the integrity of the fire protections system. For example, describe how the fire header feeding the structure containing the SFP can be isolated.* *If the site fire header is intended to be used for reactor mitigation strategies, the capability to isolate other structures may also need to be described (e.g., Auxiliary Buildings, Reactor Buildings, Control Buildings, etc.).*	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

A.3 Response Templates for Command and Control Enhancement Strategies

Table A.3-1

PLANT: ___________

<table>
<tr><th colspan="2">Command and Control Enhancements</th></tr>
<tr><td colspan="2">ONSITE & OFFSITE COMMUNICATIONS:</td></tr>
<tr><td colspan="2">- Provide a general description of the diverse methods available to communicate with off-site personnel that could be effective for the conditions assumed
- Provide a general description of the approach for mustering the available plant resources in the event the control room/staff are substantially affected
- Provide a general description of Operations/Security pre-plans for re-establishment of communications immediately following a large fire or explosion
- Provide a general description of how operations and security personnel will coordinate activities immediately following a large fire or explosion</td></tr>
<tr><td colspan="2">NOTIFICATIONS OF THE UTILITY ERO:</td></tr>
<tr><td colspan="2">- Provide a general description of the command and control structure that will be established prior to arrival offsite resources, in the event the control room/staff are substantially affected
- Provide a general description of the approach(es) for making the appropriate off-site notifications of the utility ERO and ERO callout in the event the control room/staff are substantially affected
- Confirm that a procedure/guidance and training exists or will be developed for ERO and offsite notifications of the utility ERO for the postulated conditions.</td></tr>
<tr><td colspan="2">INITIAL OPERATIONAL RESPONSE ACTIONS:</td></tr>
<tr><td colspan="2">- Provide a general description of the entry conditions for the procedure/guidance on initial operation response actions
- Provide a general description of the initial operational response actions addressed
- Confirm that a procedure/guidance and training exists or will be developed for the initial operational response under the postulated condition.</td></tr>
<tr><td colspan="2">EQUIPMENT LOCATIONS:</td></tr>
<tr><td colspan="2">Describe the general locations of the primary equipment involved the initial operational response actions</td></tr>
<tr><td><u>Equipment</u></td><td><u>Location</u></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">INITIAL DAMAGE ASSESSMENT:</td></tr>
<tr><td colspan="2">- Provide a general description of the damage assessment to be provided to the ERO
- Confirm that a procedure/guidance and training exists or will be developed for initial damage assessments</td></tr>
</table>

A.4 Response Templates for PWR Reactor and Containment Enhancement Strategies

Table A.4-1

PLANT: ___________

PWR Enhancement Strategy #1 **RWST Makeup**	
GENERAL DESCRIPTION:	
Provide a general description of how makeup to the RWST will be accomplished	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in providing makeup to the RWST	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates and capacities	
Flow Rate to RWST:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.4-2

PLANT: ___________

<table>
<tr><td colspan="2"><u>PWR Enhancement Strategy #2</u>

Manually Depressurize SGs to Reduce RCS Inventory Loss</td></tr>
<tr><td colspan="2">GENERAL DESCRIPTION:</td></tr>
<tr><td colspan="2">Provide a general description of how the
manual depressurization of the SGs will be accomplished

If relying on existing procedures, confirm applicability to postulated conditions</td></tr>
<tr><td colspan="2">EQUIPMENT LOCATIONS:</td></tr>
<tr><td colspan="2">Describe the general locations of the primary equipment
involved in manual depressurization</td></tr>
<tr><td><u>Equipment</u></td><td><u>Location</u></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>PROCEDURE/GUIDANCE:</td><td>Confirm that procedure/guidance exists or will be developed to support implementation.</td></tr>
<tr><td colspan="2">NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):</td></tr>
</table>

Table A.4-3

PLANT: ___________

PWR Enhancement Strategy #3 **Manual Operation of Turbine-driven (or Diesel-driven) AFW Pump**	
GENERAL DESCRIPTION:	
Provide a general description of how manual operation of the AFW pump will be accomplished	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in manual operation of AFW	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates expected to be delivered to the SGs and identify the capacity of water supplies	
Flow Rate to SGs:	
Capacity of Water Source:	
INSTRUMENTATION/ OPERATOR AIDS:	*Describe approach to be taken to managing SG level including instrumentation and/or operator aids to be employed*
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.4-4

PLANT: ___________

<table>
<tr><td colspan="2"><u>PWR Enhancement Strategy #4</u>

Manually Depressurize SGs and Use Portable Pump</td></tr>
<tr><td colspan="2">GENERAL DESCRIPTION:</td></tr>
<tr><td colspan="2">Provide a general description of how the portable pump will be used.

If different than strategy #2, describe how manual depressurization of the SGs will be accomplished</td></tr>
<tr><td colspan="2">EQUIPMENT LOCATIONS:</td></tr>
<tr><td colspan="2">Describe the general locations of the primary equipment involved in use of the portable pump and depressurizing the SGs</td></tr>
<tr><td><u>Equipment</u></td><td><u>Location</u></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">CAPACITIES & FLOWRATES:</td></tr>
<tr><td colspan="2">Estimate flow rates expected to be delivered to the SGs and identify the capacity of water supplies</td></tr>
<tr><td>Flow Rate to SG(s):</td><td></td></tr>
<tr><td>Capacity of Water Source:</td><td></td></tr>
<tr><td>PROCEDURE/GUIDANCE:</td><td>Confirm that procedure/guidance exists or will be developed to support implementation.</td></tr>
<tr><td colspan="2">NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):</td></tr>
</table>

Table A.4-5

PLANT: ___________

PWR Enhancement Strategy #5 **Makeup to CST**	
GENERAL DESCRIPTION:	
Provide a general description of how makeup to the CST will be accomplished	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in makeup to the CST	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates expected to be delivered to the CST and identify the capacity of water supplies	
Flow Rate to CST:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.4-6

PLANT: ___________

PWR Enhancement Strategy #6 **Containment Flooding with Portable Pump**	
GENERAL DESCRIPTION:	
Provide a general description of how makeup containment flooding will be accomplished with the portable pump, including the flow pathway into containment.	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in flooding containment	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates expected to be delivered to the containment and identify the capacity of water supplies	
Flow Rate to Containment:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.4-7

PLANT: ___________

PWR Enhancement Strategy #7 **Portable Sprays**	
GENERAL DESCRIPTION:	
Provide a general description of how portable sprays will be used including a description of portions of affected plant structures that cannot be sprayed due to physical layout or equipment limitations	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in the use of portable sprays	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate spray flow rates and identify the capacity of water supplies	
Estimated Spray Flow Rate:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

A.5 Response Templates for BWR Reactor and Containment Enhancement Strategies

Table A.5-1

PLANT: ___________

BWR Enhancement Strategy #1 **Manual Operation of RCIC or Isolation Condenser**	
GENERAL DESCRIPTION:	
Provide a general description of how manual operation of the RCIC pump or Isolation Condenser (IC) will be accomplished	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in manual operation of RCIC/IC	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates expected to be delivered to the RPV and identify the capacity of water supplies	
Estimated Flow Rate to RPV (RCIC):	
Estimated Makeup Rate to IC (IC):	
Capacity of Water Source:	
INSTRUMENTATION/ OPERATOR AIDS:	*Describe approach to be taken to managing RPV/IC level including instrumentation and/or operator aids to be employed*
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.5-2

PLANT: ___________

<table>
<tr><td colspan="4"><u>BWR Enhancement Strategy #2</u>
DC Power Supplies to Allow Depressurization of RPV & Injection With Portable Pump</td></tr>
<tr><td colspan="4">GENERAL DESCRIPTION:</td></tr>
<tr><td colspan="4">Provide a general description of how DC Power supplies will be used to allow depressurization of RPV & injection with portable pump</td></tr>
<tr><td colspan="4">EQUIPMENT LOCATIONS:</td></tr>
<tr><td colspan="4">Describe the general locations of the primary equipment involved in depressurizing and using the portable pump</td></tr>
<tr><td colspan="2"><u>Equipment</u></td><td colspan="2"><u>Location</u></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="4">CAPACITIES & FLOWRATES:</td></tr>
<tr><td colspan="4">Estimate flow rates expected to be delivered to the RPV and identify the capacity of water supplies</td></tr>
<tr><td>Flow Rate to RPV:</td><td colspan="3"></td></tr>
<tr><td>Capacity of Water Source:</td><td colspan="3"></td></tr>
<tr><td>PROCEDURE/GUIDANCE:</td><td colspan="3">Confirm that procedure/guidance exists or will be developed to support implementation.</td></tr>
<tr><td colspan="4">NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):</td></tr>
</table>

Table A.5-3

PLANT: ___________

BWR Enhancement Strategy #3 **Utilize Feedwater & Condensate**
No response required for this strategy

Table A.5-4

PLANT: ___________

BWR Enhancement Strategy #4 **Makeup to Hotwell**	
GENERAL DESCRIPTION:	
Provide a general description of how makeup to the hotwell will be accomplished	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in makeup to the hotwell	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates expected to be delivered to the hotwell and identify the capacity of water supplies	
Flow Rate to Hotwell:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.5-5

PLANT: ___________

BWR Enhancement Strategy #5 **Makeup to CST**	
GENERAL DESCRIPTION:	
Provide a general description of how makeup to the CST will be accomplished	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in makeup to the CST	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates expected to be delivered to the CST and identify the capacity of water supplies	
Flow Rate to CST:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.5-6

PLANT: ___________

BWR Enhancement Strategy #6 **Maximize CRD**	
GENERAL DESCRIPTION:	
Provide a general description of how CRD flow to the RPV will be maximized	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in maximizing CRD	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates expected to be delivered to the RPV and identify the capacity of water supplies	
Maximum Estimated Flow Rate to RPV:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.5-7

PLANT: ___________

BWR Enhancement Strategy #7 **Procedure to Isolate RWCU**	
GENERAL DESCRIPTION:	
Confirm that procedures exist to isolate RWCU in the event of an imminent threat	
PROCEDURE/GUIDANCE:	*Identify which procedure/guidance is used.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.5-8

PLANT: ___________

BWR Enhancement Strategy #8 **Manually Open Containment Vent Lines**	
GENERAL DESCRIPTION:	
Provide a general description of how containment vent lines will be manually opened/closed.	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in manually venting containment	
Equipment	**Location**
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.5-9

PLANT: ___________

BWR Enhancement Strategy #9 **Inject Water Into the Drywell**	
GENERAL DESCRIPTION:	
Provide a general description of how the portable pump will be used to inject water into the drywell	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in injecting to the drywell	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate flow rates expected to be delivered to the drywell and identify the capacity of water supplies	
Flow Rate to Drywell:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

Table A.5-10

PLANT: ___________

BWR Enhancement Strategy #10 **Portable Sprays**	
GENERAL DESCRIPTION:	
Provide a general description of how portable sprays will be used including a description of portions of affected plant structures that cannot be sprayed due to physical layout or equipment limitations	
EQUIPMENT LOCATIONS:	
Describe the general locations of the primary equipment involved in the use of portable sprays	
Equipment	**Location**
CAPACITIES & FLOWRATES:	
Estimate spray flow rates and identify the capacity of water supplies	
Estimated Spray Flow Rate:	
Capacity of Water Source:	
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

A.6 Response Templates for Disposition of Site-specific Strategies

Table A.6-1

PLANT: ___________

Viable Site-specific Reactor/Containment Mitigation Strategies	
Strategy	**List/Implement**
PROCEDURE/GUIDANCE:	*Confirm that procedure/guidance exists or will be developed to support implementation.*
NOTES (INCLUDE DEVIATIONS/JUSTIFICATIONS):	

APPENDIX B

Example Equipment Specifications

Disclaimer

The example equipment specifications included in this Appendix represent commercially available equipment that is generally expected to meet or exceed the requirements at most sites. Commercial grade water pumping and fire fighting equipment is widely available. Inclusion of specific products by individual companies is not meant to be a specific endorsement of individual products or companies, but rather is provided to serve as examples of products and services that individual utilities may find useful.

Table B-1

POTENTIAL STRATEGIES UTILIZING PORTABLE PUMP

Strategy	Minimum Flow Requirements	Other Factors
SPENT FUEL POOL MITIGATION		
SFP Makeup	500 gpm to Spent Fuel Pool	• Elevation of SFP • Line losses
SFP Spray	200 gpm/unit to Spent Fuel Pool	• Elevation of SFP • Line losses
PWR REACTOR MITIGATION		
RWST Makeup	300 gpm to RWST or Rate Sufficient to Exceed Decay Heat	• Line losses
Steam Generator Makeup	200 gpm to SG or Rate Sufficient to Remove Decay Heat	• SG Pressure • Line losses
CST Makeup	200 gpm to SG or Rate Sufficient to Remove Decay Heat	• Line losses
Containment Flooding	300 gpm to Containment or Rate Sufficient to Exceed Decay Heat	• Elevated containment pressure (design pressure) • Line losses
Release Mitigation (Spray)	$\geq$200 gpm	• Line losses • Elevation of likely release points
BWR REACTOR MITIGATION		
Hotwell Makeup	$\geq$300 gpm or Rate Sufficient to Exceed Decay Heat	• Line losses
CST Makeup	$\geq$300 gpm or Rate Sufficient to Exceed Decay Heat	• Line losses
RPV Injection with SRVs open via temporary Power Supply	$\geq$300 gpm to RPV or Rate Sufficient to Exceed Decay Heat	• Line losses • Number of SRVs and corresponding Reactor Pressure
Drywell Injection	300 gpm to Containment or Rate Sufficient to Exceed Decay Heat	• Elevated containment pressure (design pressure) • Line losses
Release Mitigation (Spray)	$\geq$200 gpm	• Line losses • Elevation of likely release points

B.1 Kidde Fire Example Pump Package

B.2 Rain For Rent Example Pump Package

B.3 Example Monitor Nozzles

APPENDIX C

Example EDMG Templates

C.1 PWR EDMG Example

Example PWR EDMG

Guideline Usage:

This document is a Guideline. This Guideline should NOT be used unless entry has been directed from PROCEDURE1

Verbatim compliance with the steps of this Guideline is not required.

This Guideline should be used by the implementers to aid in making the necessary decisions to combat a severe accident involving beyond design basis conditions.

Use of opposite unit personnel may be called for, depending on the situation at the affected unit.

Steps, procedure limitations and precautions selected at the discretion of the User.

Example PWR EDMG

1. Purpose
   1.1. The Guideline provides initial actions and alternative methods of plant operation for responding to an event that results in a total loss of unit power (AC and DC), or prevents operation from the Control Room or the Remote Shutdown Panel.

2. Entry Conditions
   2.1. This guideline is entered from PROCEDURE1 after it has been determined that control of plant equipment cannot be established from the Control Room or the Remote Shutdown Panel.
   2.2. Declaration of 50.54(x) is required.

3. Scope
   3.1. Communciations (Attachment A)
   3.2. Notifications/ERO Callout
   3.3. Immediate local actions should be taken to verify reactor tripped and an auxiliary feedwater pump running, if verification from the Control Room is not possible.
   3.4. The TDAFW Pump is the primary method for providing feed flow to SGs during a complete loss of power. This pump has a design flow rate of 600 gpm, and can maintain some flow as long as steam supply pressure is greater than 50 psig.
   3.5. PROCEDURE2 provides the steps necessary to start the TDAFW Pump with no AC/DC power available.
   3.6. The TDAFW flow control valves fail open/closed on loss of power, so it will be necessary to establish an alternate method of flow control to prevent underfeeding/overfill of the steam generators.

Example PWR EDMG

<u>Instructions</u>

> **NOTE**
>
> Continue action steps begun in the EOP network unless specifically stopped by a recommendation from the TSC.

4.1. Assess Plant Damage Condition

4.1.1. Determine if control room is accessible and useable

4.1.2. Determine primary area of damage

4.2. Invoke Appropriate Regulatory Requirements

4.2.1. Refer to PROCEDURE3, "Control Room Emergency Operation," and determine applicability of 10CFR50.54(x) invocation.

4.2.2. Refer to PROCEDURE4, "Classification and PARs," and request unaffected unit complete the required NRC notifications.

4.3. Determine Communication Options

4.3.1. Use Attachment A to determine potential communication options if normal communication methods are affected

4.4. Perform Local Immediate Actions

Table 1 – Conditions Necessary to Perform Local Immediate Actions

Condition	Requirement	Special Tools/Equipment
Access to Auxiliary Bldg and Turbine Bldg	Confirm it is safe to access.	Portable lighting may be required

4.4.1. Verify Reactor Trip

a) Locally check reactor trip breakers – OPEN

1) <u>IF</u> reactor trip breakers are <u>NOT</u> OPEN, <u>THEN</u> manually trip breakers.

2) <u>IF</u> reactor trip breakers do <u>NOT</u> manually open, <u>THEN</u> open both MG set output contactors locally.

Example PWR EDMG

4.5. Locally Start TDAFP

4.5.1. DETERMINE conditions necessary to operate TDAFW Pump.

Table 2 – Conditions Necessary to Operate TDAFW Pump		
Condition	**Required**	**Special Tools/Equipment**
Access to BUILDING1	Confirm that radiation levels and temperatures permit access	Portable lighting required may be required.
Steam supply from at least one SG	Steam supply pressure >X1 psig	N/A
Speed indication	If instrument power is lost, use local speed indication.	Handheld strobe light tachometer
Cooling	Not required	Block doors open to provide ventilation, if necessary
	TDAFW Pump Available	**Yes / No**

4.5.2. Refer to PROCEDURE2 and locally start TDAFP in manual.

4.6. Check Plant Status

4.6.1. Complete Attachment B

4.7. Implement Actions as Directed by TSC

- Desired lineups
- Imposed limitations
- Special parameter monitoring
- Tank refilling

Example PWR EDMG

References

PROCEDURE1 – Procedure directing entry into this guideline

PROCEDURE2 – Procedure for Operating TDAFW pump without power

PROCEDURE3 – Procedure for invoking 50.54(x)

PROCEDURE4 – Procedure for Event Classification

PROCEDURE5 – Procedure for standard lineup of AFW suction water source

PROCEDURE6 – Procedure for alternate supply to AFW suction water source

ATTACHMENT A of PWR EDMG

Communication Options

Example PWR EDMG

COMMUNICATIONS ASSESSMENT FOR DAMAGE TO KEY STRUCTURES

------ EXAMPLE ONLY -----

Structure Affected	Plant Radios	Plant Pagers	Plant Telephones	Plant Pager	Plant Process Computer	Satellite Phone
Turbine	Operable May be affected in damage zone due to loss of antennas.	Operable May be affected in damage zone due to loss of antennas.	Operable for calls within the station until batteries deplete.	Operable except in affected areas.	Not Available	Operable
Control	Not Operable	Not Operable	Not Operable	Operable except in affected areas.	Not Operable	Operable
Auxiliary	Not Operable	Operable May be affected in damage zone due to loss of antennas.	Operable except in affected areas.	Not Operable	Operable except in affected areas.	Operable
Intake Structure	Operable May be affected in damage zone due to loss of antennas	Operable May be affected in damage zone due to loss of antennas.	Operable except in affected areas.	Operable except in affected areas.	Operable except in affected areas.	Operable
Containment	Operable May be affected in damage zone due to loss of antennas	Operable May be affected in damage zone due to loss of antennas.	Operable except in affected areas.	Operable except in affected areas.	Operable except in affected areas.	Operable

Example PWR EDMG

etc.

Example PWR EDMG

ATTACHMENT B of PWR EDMG

Plant Damage Assessment

DAMAGE ASSESSMENT OF KEY STRUCTURES

------ EXAMPLE ONLY -----

Building	Elevation	Visible Damage	Accessibility	Equipment Status/System Integrity
Containment	n/a			
Control	57’			
	77’			
	111’			
	139’			
Auxiliary	21’			
	57’			
	77’			
	111’			
	139’			
Turbine	66’			
	92’			
	115’			
	145’			
Intake Structure	All			

PAGE LEFT BLANK

Example PWR EDMG

C.2 BWR EDMG Example

Example BWR EDMG

BWR EXTREME DAMAGE MITIGATION GUIDELINE

ENTRY CONDITIONS

A large area of the station has been damaged due to explosive OR fire. This procedure should be entered from events resultant from an entry into **PROCEDURE1**

General Instructions

Verbatim compliance with the steps of this Guideline is not required.

This Guideline should be used by the implementers to aid in making the necessary decisions to combat a severe accident involving beyond design basis conditions.

Use of opposite unit personnel may be called for, depending on the situation at the affected unit.

Steps, procedure limitations and precautions selected at the discretion of the User.

Consider invocation of 50.54(x) per **PROCEDURE3**

If the event has NOT already been classified and the emergency plan activated, classify the event and activate the emergency plan in accordance with **PROCEDURE4**

Based on communication systems availability establish alternate means of communication with offsite authorities and site personnel, refer to Attachment A.

Enter and execute all application SAPs/EOPsSOPs concurrently with this procedure.

INITIAL ASSESSMENT

- Determine where primary damage has occurred in order to assess options that may be available

Highest Priority should be given to the following:

- Reactor Building
- Control Building
- Turbine Building

CORE COOLING RESPONSE STRATEGY

- Confirm Reactor Trip
- Confirm Automatic Start of RCIC

  If RCIC did not start, then Use **PROCEDURE2** to manually start and control RCIC

INITIAL DAMAGE ASSESSMENT

- Perform initial damage assessment using Attachment B

Highest Priority should be given to the following:

- Reactor Building
- Control Building
- Turbine Building

Example BWR EDMG

COMMUNICATIONS ASSESSMENT FOR DAMAGE TO KEY BWR STRUCTURES
------ EXAMPLE ONLY -----

Structure Affected	Plant Radios	Plant Pagers	Plant Telephones	Plant Pager	Plant Process Computer	Satellite Phone
Turbine	• Operable • May be affected in damage zone due to loss of antennas.	• Operable • May be affected in damage zone due to loss of antennas.	• Operable for calls within the station until batteries deplete.	• Operable except in affected areas.	• Not Available	• Operable
Control	• Not Operable	• Not Operable	• Not Operable	• Operable except in affected areas.	• Not Operable	• Operable
Reactor	• Not Operable	• Operable • May be affected in damage zone due to loss of antennas.	• Operable except in affected areas.	• Not Operable	• Operable except in affected areas.	• Operable
Intake Structure	• Operable • May be affected in damage zone due to loss of antennas	• Operable • May be affected in damage zone due to loss of antennas.	• Operable except in affected areas.	• Operable except in affected areas.	• Operable except in affected areas.	• Operable
etc.	•	•	•	•	•	•

Example BWR EDMG

DAMAGE ASSESSMENT OF KEY BWR STRUCTURES

------ EXAMPLE ONLY -----

Building	Elevation	Visible Damage	Accessibility	Equipment Status/System Integrity
Control	57’			
	77’			
	111’			
	139’			
Reactor	21’			
	57’			
	77’			
	111’			
	139’			
Turbine	66’			
	92’			
	115’			
	145’			
Intake Structure	All			

APPENDIX D

Mitigative Strategies Description and Plans Required by 10 CFR 52.80(d)

[APPLICANT/UTILITY NAME]

[Plant / Unit Name]

LOSS OF LARGE AREAS OF THE PLANT
DUE TO EXPLOSIONS OR FIRE

Mitigative Strategies Description and Plans

Required by 10 CFR 52.80(d)

Revision [#]
[MONTH YEAR]

Table of Contents

1.0 Introduction 1
2.0 Background 1
3.0 Approach 2
4.0 Phase 1 Mitigative Strategies 2
4.1 Feeding Fire Protection Ring Header 2
4.2 Communication Enhancements 3
5.0 Fire Protection System (FPS) to Facilitate Phase 2 and Phase 3 Mitigative Strategies 3
5.1 Fire Protection System (FPS) 3
6.0 Phase 2 Mitigative Strategies 5
6.1 Diverse Spent Fuel Pool (SFP) Makeup Source (Internal Strategy) 5
6.2 Diverse Spent Fuel Pool (SFP) Makeup Source (External Strategy) 6
6.3 SFP Leakage Control Strategies 7
7.0 Phase 3 Mitigative Strategies 7
7.1 Command and Control 8
7.2 Makeup to RWST 8
7.3 Manually Depressurize SGs to Reduce Inventory Loss. 9
7.4 Manual Operation of Turbine Driven Pump 9
7.5 Manually Depressurize SGs and use Portable Pump 9
7.6 Makeup to CST/AFWST 9
7.7 Containment Flooding with Portable Pump 10
7.8 Portable Sprays 10
7.9 Manual Operation of RCIC or Isolation Condenser 10
7.10 DC Power Supplies to Allow Depressurization of RPV and Injection with Portable Pump 11
7.11 Utilize Feedwater and Condensate 11
7.12 Makeup to Hotwell 11
7.13 Maximize CRD Flow 11
7.14 Procedure to Isolate RMCU or Other Lines outside Containment 11
7.15 Manually Open Containment Vent Lines 11
7.16 Inject Water into the Drywell 12
7.17 New Strategy for Safety Function not Satisfied 12
7.18 New Plant Safety Function Mitigative Strategy 12
7.19 New Plant Safety Function Mitigative Strategy 12
7.20 New Plant Safety Function Mitigative Strategy 12

8.0 Conclusion 12

1.0 Introduction

The primary purpose of this Mitigative Strategies Report is to identify strategies that [site] will implement in the event that a large area of the facility is lost due to explosions or fire. Initiating events classified as Loss of Large Areas (LOLA) are beyond the design basis for existing and proposed new nuclear power plants. Existing nuclear power plants have evaluated these beyond design basis events and implemented changes and operational programs to assist in coping with LOLA events. The operational and programmatic elements of responding to LOLA events will be addressed by [site] prior to fuel load. These elements are described in the attached Mitigative Strategies Table (MST).

[Enter any unique information or features here for the design or site being presented in this document.]

2.0 Background

The LOLA mitigative strategies required by 10 CFR 50.54 (hh)(2) are summarized in this report and are submitted to the NRC in accordance with 10 CFR 52.80(d). The Statements of Consideration for § 52.80(d) states that the Commission decided that the most appropriate and efficient process is to review the procedures and guidance for § 50.54 (hh)(2) strategies as part of the review of operations procedures and beyond design basis guidelines similar to operational programs. Therefore, this report is written at the programmatic level for licensing approval and the implementation details and documentation will be available for inspection prior to fuel load.

[Site] approached the LOLA event evaluations in a phased approach similar to the existing plants. Phase 1 focuses on the operational aspects of responding to explosions or fire including items such as prearranging for the involvement of outside organizations, planning and preparation activities (e.g., pre-positioning equipment, personnel, and materials to be used for mitigating the event), and developing procedures and training for the event. These items apply to programmatic aspects of a plant once it is operational and procedures are written and in-place to control processes. Many of the items addressed within the referenced guidance documents involve assessments, evaluations, action plans and procedural development that cannot be accomplished until a plant is near the completion of construction.

Phase 2 LOLA event evaluations focus on issues associated with mitigating an event involving the spent fuel pool (SFP). They include issues such as fuel configuration within the pool and focus on alternative sources of water that could be provided to the SFP for cooling, heat removal, and inventory makeup. The SFP for [[site] [describe general characteristics of the pool and explain why it is subject to Phase 2 evaluations or why it screens out using the previous Phase 2 NRC assessment guidance]].

Phase 3 LOLA event evaluations focus on methods to provide sources of alternative cooling water to critical systems as well as mitigating the impact of a radiological release. In addition, they focus on alternative methods to operate critical systems or components in a manner to assist with the mitigation of the event. Safety functions are identified and a mitigative strategy is developed for each of those functions in order to maintain or restore core cooling, containment cooling, and spent fuel pool cooling capabilities.

3.0 Approach

This report is based on a review of current regulatory guidance; experience gained from the existing nuclear fleet as they addressed B.5.b issues, the [name of standard design] standard plant design, and the site specific design of [site]. It is written using the guidance of NUREG-0800, Section 13.6.5 and NEI 06-12, Revision 3. The format and evaluations performed for the report are primarily based on NEI 06-12, Rev. 3, as the NRC has stated in the statements of consideration (SOC) related to the new 10 CFR 50.54(hh)(2) that NEI 06-12 provides an acceptable means for developing and implementing Phase 2 and Phase 3 mitigation strategies.

In developing appropriate mitigative strategies, existing Nuclear Power Plants often relied on providing a large volume of water from an alternate, independently powered system to help mitigate a LOLA event. This resulted in a critical review and implementation of procedures for utilizing the facility's fire protection system in various support configurations. This approach, when combined with a portable independently powered pumping system, generally meets the requirements to help mitigate events following a LOLA. This same approach has been followed in developing this report. The design of the fire protection system for [site] includes enhancements that could improve the capability of the system to be available and to provide sufficient water, if needed, to mitigate a LOLA event.

4.0 Phase 1 Mitigative Strategies

Phase 1 of the B.5.b assessments focused on enhancement of a plant's fire-fighting response capability to respond to losses of large areas of the plant due to fire or explosions. The NRC issued guidance for meeting the different expectations of Phase 1 of B.5.b in a document titled, "Developing Mitigating Strategies/Guidance for Nuclear Power Plants to Respond to Loss of Large Areas of the Plant in Accordance with B.5.b of the February 25, 2002, Order." That guidance document identified numerous items to be assessed on an individual plant site basis, such as onsite fire fighting capability, off-site fire fighting resources, accelerant-fed fire fighting capabilities, hoses and self-contained pumps for moving water for fire fighting and core cooling, etc. Most of these items involve assessments, evaluations, action plans and the development of procedures that cannot be accomplished until the facility is near the completion of construction. These items are nonetheless Phase 1 expectations listed in the enclosed Mitigative Strategies Table (MST) with a description on how [site] meets each expectation.

4.1 Feeding Fire Protection Ring Header

One of the Phase 1 fire-fighting mitigative strategies is to develop a means to supply an alternate water source feed for the fire protection yard main loop in the event that the normal supply source (typically a fire water storage tank) is lost. To facilitate and support this enhancement, the underground yard ring header is designed to provide [a minimum of two (2) external connections that can be used to connect an external water source and pumping capability. The external water sources are various tanks, cooling tower basin, etc.] Procedures address the actions necessary to provide staged on-site water sources and an alternate off-site feed path to the ring header. [Describe any other design features to the ring header that may be appropriate to your site here.]

4.2 Communication Enhancements

Another Phase 1 Mitigative Measure is to provide communication equipment, such as radios, cell phones, etc., to facilitate the response to a LOLA event. The radios are used for effective command and control of responses during a LOLA event. The mitigative action of providing and maintaining additional radios, cell phones, etc. is a programmatic issue to be addressed as each unit is nearing operational status. Through operating experience, several current plants have identified that radios are often inoperable or not as functional once an individual enters a robust building during a beyond design basis LOLA event involving a loss of all alternating current (AC) and direct current (DC) power.

Nuclear plant sites have a range of communication systems, including a plant radio system with portable hand-held radios and an independent power supply system, for non-portable communications equipment. The detailed design of the internal communication systems considered these beyond design basis conditions with the intent of improving communications within the structures for portable equipment. This includes the addition of items that would support the internal communication system[s] such as repeaters, antennas, back-up power sources, leaky coax cables, etc. [Describe any other design features for the communications that may be appropriate to your specific site here.]

5.0 Fire Protection System (FPS) Features to Facilitate Phase 2 and Phase 3 Mitigative Strategies

The B.5.b evaluations performed by operating Nuclear Power Plants often credited the fire protection system (FPS) as a potential source of water from an alternate, independently powered system to help mitigate a LOLA event. For [site], the FPS, which includes the fire pumps, fire water storage tanks, and the underground yard main loop, provides the water delivery for the fire protection system.

For [site] the FPS is designed to facilitate Phase 1, 2, and 3 mitigative strategies. The FPS is sized such that it [contains sufficient water for two-hour operation of the largest sprinkler system plus a ### gpm manual hose stream allowance to support fire suppression activities. Design features include two 100 percent capacity fire pumps (one electric and one diesel), redundant fire water storage tanks (minimum capacity of ###,### gallons each), refill capability for one fire water storage tank, an underground fire water yard main loop supply piping with post indicator valves that provide sectionalized control and isolation of portions of the loop, standpipe and hose stations with minimum ### feet of hose, and manual and automatic suppression systems. Additional fire protection system features are described below.]

5.1 Fire Protection System (FPS)

5.1.1 Physical Location of Equipment

[The FPS water supply pumps and water storage tanks are physically located a minimum of 100 yards (300 feet) from the key plant target areas, e.g., the reactor buildings and containments. This positioning assists with meeting various aspects associated with LOLA. Spatial separation improves the possibility that the diesel fire pump and a water source will be available when needed. This distance from key plant areas locates the equipment outside of the anticipated damage zone as discussed in NEI 06-12, Rev. 3.] The design of the fire protection system has isolation valves for each branch header from the yard main loop. These are post indicating valves (PIV) located outside that will isolate the FPS as it enters into each building. A building may have more than one feeder header from the yard loop based on the size and demand for the building. The remaining yard main loop header system is provided with additional isolation valves to permit isolation of portions of the yard main loop for maintenance and repair.

5.1.2 Pump Redundancy

The fire pump house contains both an electric pump and a diesel-driven pump. The diesel-driven fire pump can be used for supplying water during a LOLA event assuming loss of AC and DC conditions. The diesel-driven fire water pump has a fuel supply sufficient to operate for a minimum of [##] hours.

[Site] also retains an independently powered portable pump to provide an alternative means of moving water under various conditions, including use during a LOLA event. This portable pump is for emergency use only and, as such, provides defense-in-depth to make water available if the diesel-driven fire pump is lost. This portable pump has a fuel tank capacity for [##] hours of operation. The water source for the portable pump may be the FPS, if available, or alternate water sources, such as [cooling tower basins, reactor water storage tanks, condensate storage tanks, etc.]

5.1.3 Fire Water Storage Tank Refill Station

[For vendor/site] the design basis refill capability is provided specifically for the fire water storage tank[s] located on the [???? side] of [site]. Fire water storage tank refill capability is necessary to meet fire protection design basis guidance in [Regulatory Guide (RG) 1.189]. Based on this guidance, the fire water storage tank[s] require the refill of one tank (with a minimum of [###,###] gallons capacity) within eight hours after a design basis fire event. This requires a refilling capacity of approximately [###] gpm. The water source for the refill station is [describe the water source]. [Describe the refill capability under conditions of loss of normal AC power.] This provides defense in depth for responding to a LOLA event by making more fire protection water available.

5.1.4 Fire Protection System Management

The fire protection system at many sites is the most flexible system that can be employed to mitigate many of the elements associated with LOLA events. Since portions of the fire protection system are relied on for implementation of event strategies, the management of the system is outlined in [site] procedures/guidelines. In implementing LOLA strategies, the fire protection system may be used as a water source provided the site procedures provide guidance on sharing/ balancing the use of these resources between fire fighting and supporting the LOLA strategy. Guidance developed to manage the FPS includes methods to isolate potentially damaged headers and if possible ring header sectionalization. The fire system management strategy addresses isolation of fire headers inside structures that may be target areas. The pump[s] used to charge the ring header is located more than approximately 100 yards from the target areas to assure it is available after a LOLA event.

6.0 Phase 2 Mitigative Strategies

Phase 2 of § 50.54(hh)(2) mitigative strategies concerns Spent Fuel Pool (SFP). NEI 06-12, Rev. 3, identifies different strategies to mitigate damage to fuel in the SFP for a LOLA event. [Site] has developed mitigative strategies using guidance from NEI 06-12, Rev. 3, and has design enhancements to facilitate the implementation of these mitigative measures that eliminate or reduce reliance on operator actions. The enclosed MST for Phase 2 lists each of these mitigative strategies and identifies how [site] will implement each strategy.

6.1 Diverse Spent Fuel Pool (SFP) Makeup Source (Internal Strategy)

The existing operating fleet has typically addressed an alternative makeup capability for the SFP by manually installing fire hoses from the fire protection standpipes located in stairwells near or adjacent to the SFP elevation and running those hoses to the pool. SFP leakage could be time critical to maintaining fuel coverage and reducing heat buildup in the fuel assemblies. The [site] design approach eliminates some of the operational aspects of the strategy employed by the present operating fleet, including the need for multiple hose connections, lengthy fire hose runs from various elevations, and additional connection fittings to accommodate hose sizes.

The primary makeup to the SFP is [describe the primary makeup system including flow path, water source, and motive force.] The alternative diverse makeup discussed in NEI 06-12 is another permanently installed system [describe an alternative makeup source including the water source, flow path, and motive force. Describe why it is diverse.]

[The [site] mitigative strategy provides a diverse makeup source of 500 gpm from either of the [## inch] connectors on the fire protection system standpipes in the stairwells on either side of SFP, with no reliance on any components or piping used for the normal SFP makeup system. The source of water for this diverse cooling of the SFP is the two fire water storage tanks, discussed above, which will provide more than [##] hours of cooling water for the SFP. Each of two standpipes on either side of the SFP at [elevation of the SFP in the reactor building] is fitted with a [##-] inch isolation valve and a [four-inch] quick-connect fitting for hoses such as [a hose connector]. This design allows a [larger ##-inch diameter] hose to be connected directly to the standpipe and then field routed to the SFP to provide for the desired 500 gpm flow without the need for multiple hoses. The connection also enables operators to quickly connect the hose, minimizing their radiation exposure times. Commercial items will be purchased for the hoses to eliminate the need to physically attach the hoses to structural components. Stairwells are expected to be provided with storage cabinets for [##-inch diameter hoses] with appropriate connections. Also, doorway access from each stairwell is provided into the SFP area.]

[Hose connections to the standpipes at ground elevation external to the building are provided for a portable pump or fire department pumper truck to connect to the standpipe at ground elevation and provide the makeup flow to the pool operating floor.]

6.2 Diverse Spent Fuel Pool (SFP) Makeup Source (External Strategy)

6.2.1 Establish a flexible means of SFP makeup of at least 500 gpm using an AC power-independent pumping capability.

The present operating fleet typically addressed this requirement by manually routing fire hoses from the exterior of the building to the SFP elevation. The pumping source was an AC independent-powered pump connected to the fire protection system yard ring header via hydrants. SFP leakage is time-critical to maintaining fuel coverage and reducing heat buildup in the fuel assemblies. [[Site] design approaches this issue with the intent of eliminating some of the operational aspects of this challenge. The SFP is physically located on the [compass direction (e.g., north, northeast, southwest)] side of the certified design with the [Describe the wall that constitutes an outside wall.] wall an outside wall. A dry-pipe system consisting of two separate trains is provided that is physically located in opposite corners of the SFP and is routed from ground elevation to the SFP elevation. The hard piping system is [##-inch diameter.] At ground elevation, the pipe extends outside of the reactor building and is supplied with a cap. This allows a connector to be easily installed upon removal of the cap. At the SFP, a [##-inch valve and connector] is provided. [Additionally, the dry-pipe system is supplied with the appropriate isolation valves to maintain the reactor building envelope.] The use of a portable pump is still anticipated. The fire protection water storage tank[s], or alternate water source, as determined by the site, provides sufficient water capacity for a [##-] hour duration.

This design eliminates the need to carry hoses from ground elevation to the SFP elevation. Two branches provide redundancy and are spatially separated to avoid damage to both during an event. A small section of [##-inch hose] may still be required on the SFP elevation if blockage were to occur in front of the piping. This hose section will be in close proximity to the piping connection. [Alternatively, the detailed design of the plant allows for routing the piping in the concrete floor within the SFP room and has it directly discharge water into the SFP.]] Detailed design considers friction losses in the piping system so that appropriate water flow is supplied to the SFP.

Overall, this external strategy design provides for shorter installation times, decreasing radiation exposure time to plant operators.

6.2.2 Establish a flexible means of providing at least 200 gpm per unit of spray to the SFP using an AC power-independent pumping capability.

Operating plants typically address this requirement by manually routing fire hoses from the exterior of the building to the SFP elevation. The pumping source is an AC power-independent pump connected to the fire water supply system yard ring header via hydrants. SFP heat up could be time critical to the fuel assemblies.

[[Site] design approaches this issue with the intent of eliminating some of the operational aspects of this mitigative strategy. Similar to the SFP fill strategy described above, a dry-pipe system consisting of two separate trains is routed from ground elevation to the SFP elevation. This piping system is physically located in opposite corners of the SFP. The system is [##-inch diameter steel pipe]]. At ground elevation, the pipe extends outside of the [reactor building] and is supplied with a cap. This allows a connector to be easily installed upon removal of the cap. [At the SFP, a permanent monitor nozzle is provided on the end of each standpipe and aimed at the SFP. Each standpipe contains a check valve to prevent back flow of air or water and to maintain the reactor building envelope. Also, there are connections to the standpipe at the SFP operating deck and/or other building inside locations which will allow the connection of fire hoses from internal hose stations to provide spray using internal connections and water sources.]

[This piping system is expected to be in the opposite corners from the first dry-pipe system described in Subsection 6.#.# above. The use of a portable pump is still anticipated. To account for water losses from a spray system, the system is designed to provide ### gpm from each standpipe to provide at least 200 gpm to the SFP.]

This design eliminates the need to carry hoses from ground elevation to the SFP elevation. Two branches provide redundancy and spatial separation to avoid damage to both during an event. The fire protection water storage tank[s], or alternate water source, as determined by the site, provide sufficient water capacity for a [##] hour duration.

6.3 SFP Leakage Control Strategies

The SFP leakage control strategies provided in NEI 06-12, Rev. 3, are based on operational actions. The SFP for [site] is designed to have thick, heavily reinforced concrete walls and floor. Nonetheless, appropriate SFP leakage control strategies and procedures are identified in the attached MST.

7.0 Phase 3 Mitigative Strategies

Phase 3 of the LOLA mitigative strategies are intended to restore or maintain core and containment cooling in order to mitigate potential damage to fuel in the reactor system and to mitigate potential radiological releases through the containment or other walls. The Phase 3 efforts for the industry identified changes based on reactor type, and NEI 06-12, Rev. 3 identified different mitigation strategies for PWRs and for BWRs.

[[Site] has identified the key safety functions for their design. The Phase 3 evaluations performed for [Site] are based on the mitigative strategies identified for those functions in NEI 06-12, Rev. 3, other strategies that have been added based on the new plant design and key safety functions that were not covered by the listed 06-12 strategies.]

[For the [plant design] the following new safety functions were identified using NEI 06-12, Rev. 3, Chapter 4 and the evaluation criteria in Chapter 4 were utilized to determine the appropriate mitigative strategy for each safety function discussed in Sections 7.18 through 7.20.

- (place the list of the new safety functions here)
-]

[Site] standard plant design already includes design enhancements that address some of the LOLA Mitigative Measures in NEI 06-12, Rev. 3, and the evaluation below credits design enhancements to [site] to better respond to the LOLA event. The operational and programmatic aspects for Phase 3 Mitigative Measures, including the principal human actions and command and control measures specified in Section 3.2 of NEI 06-12, Rev. 3, are addressed in the enclosed MST.

7.1 Command and Control

The industry has invested extensively in establishing command and control structures for emergency conditions. However, the extent and type of damage postulated for some beyond design basis security threats may create unique challenges. Normal command and control structures may be interrupted, thereby creating implementation issues associated with procedurally required actions, communications, and organizational factors that could further complicate mitigation response for these types of postulated LOLA events. A primary aspect of enhancing command and control for these beyond design basis conditions is providing guidance for use in such circumstances. Establishing guidelines for initial site operational response would allow utilities to plan their strategy if normal command and control is disrupted. Extensive Damage Mitigation Guidelines (EDMG) is the generic term used by the industry. These guidelines are, in fact, intended to be used when the normal command and control structure is disabled and use of EOPs is not feasible. The MST identifies how [site] will develop the EDMG provided in NEI 06-12, Rev. 3.

[The following mitigative strategies are derived by following NEI 06-12, Rev. 3, and determining which strategies apply based on the design of the plant. Each strategy must be addressed or a justification written in each location as to why the strategy is not needed. If the strategy does not apply then enter “This strategy does not apply because [then discuss the rationale as to why the strategy does not apply].” Ensure that there is a strategy identified for all key safety functions.]

7.2 Makeup to RWST

[The objective of this mitigative strategy is to provide a source of makeup water of at least 300 gpm to the reactor water storage tank (or its equivalent) for a period of 12 hours to provide for an extended supply of water for long-term emergency core cooling system (ECCS) cooling. This makeup will come from [source of water] using [describe piping system flow path] and the motive force supplied by [discuss the forcing capability]. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.3 Manually Depressurize Steam Generators to Reduce Inventory Loss

[The [reactor technology] design includes a means to manually depressurize the steam generators (SG). There is a main steam bypass line, power-operated relief valves (PORVs), or vent line that allows an individual to manually depressurize a SG. Both motor-operated and air-operated valves are provided for the lines. The design arrangement is that either the main motor-operated valve combined with the air-operated valve would need to open or the main motor-operated valve combined with the bypass motor-operated valve allows depressurization of the associated steam generator. The air-operated and motor-operated valves are physically located to provide access from the reactor building. In addition, they have been procured with hand levers to allow manual operation if needed. The preferred method would be to use the PORVs but the main steam bypass line could also be used. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.4 Manual Operation of Turbine-Driven Pumps

[The [reactor technology] design provides for a turbine-driven feedwater (FW) pump and two motor-driven FW pumps. Each of the motor-driven pumps are sized to supply the FW flow required to remove 50 percent of the decay heat from the reactor core at full power and the turbine-driven pump flow is 100 percent. Therefore, the turbine-driven pump is an electric power-independent means to provide sufficient cooling for the reactor core. The turbine-driven pump is sized to provide the required flow of 400 gpm to the SG for the removal of decay heat. One important aspect of this strategy is the focus on plant operators being able to reasonably manage SG level without AC and DC power. Operator guidance and training includes items such as operation of the turbine and associated governor valve, the working environment as well as local "wide-range" level instrumentation to monitor SG water levels that can be powered from an independent power source. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.5 Manually Depressurize SGs and Use Portable Pump

[The capability to manually depressurize the SGs is discussed above. The SGs will be depressurized to a level such that the portable pump will be able to provide SG makeup and core cooling through the addition of water to the FW System flow path. To implement this mitigative strategy, the portable pump will be used to provide water to the FW System once the SGs are depressurized.

[Site] design has connections to the FW System that contain blind flanges at two separate locations downstream of the FW pumps. The location of the flange connections each of which can be isolated, is readily accessible by plant personnel so that the blind flanges can be removed during an emergency and external water source connected (such as the fire protection water supply system or alternate water source) provided through the use of the portable pump.

In addition, the water level instrumentation system is designed with the ability to easily obtain wide-range level indication on each SG (feed water side) by the use of a portable power supply. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.6 Makeup to CST/AFWST

[The objective of this mitigative strategy is to provide a means to makeup at least 200 gpm of water to the CST/AFWST for a period of 12 hours. This strategy may utilize the Phase 2 pump, or other existing sources such as the fire protection ring header. The purpose of this strategy is to provide a means to provide a water supply to an operating FW pump. Therefore, makeup may be provided directly to the FW suction line or the CST/AFWST. If makeup is provided to the FW pump, the hoses and connections may be stored locally at the intended connection point.

In implementing this strategy, [site assumed that the fire protection system may be used for this strategy]. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.7 Containment Flooding with Portable Pump

[This strategy is intended to provide a power-independent means to inject water into containment to flood the containment floor and cover core debris. The containment spray system is the normal system for flooding the reactor cavity under severe conditions. [Site] design has an alternate flow path to provide cavity flooding through the spray ring header. The FPS can inject water directly into the spray ring header taking suction from the fire water storage tanks through a flanged connection upstream of the spray pump discharge. The FPS makeup will supply at least 300 gpm of water to the containment for a period of 12 hours. [Site] has the needed valves located so as to provide access for personnel and are provided with hand wheels to allow manual operation. This strategy provides a power-independent method of supplying water to the containment vessel because the motive force for moving water is the FPS. The capability to flood containment using a portable pump is also available using the FPS ring header and connections. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.8 Portable Sprays

[The FPS has standpipe hose connections as required by NFPA 14 and RG 1.189. Standpipes are installed within each stairway and exit corridors as required. Also, standpipes and hose connections are provided for manual firefighting in areas containing equipment required for safe plant shutdown and in yard areas of the plant. Therefore, it is expected that the standpipe connections may be used to supply water to portable monitor nozzles for use in spraying the containment wall or other potential release paths to reduce fission product releases. A portable pump is also available and will be used to spray a radiological release including plant structures that cannot be sprayed from the FPS due to physical layout or equipment limitations. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.9 Manual Operation of RCIC or Isolation Condenser

[At [site] a procedure/guidance that describes the plant-specific steps necessary to start and operate RCIC or the Isolation Condenser without AC or DC power has been developed. A means for reasonably managing RPV level using available, non-powered instrumentation and/or operator aids such as a pressure-flow curve is available.

For RCIC, control of the makeup rate to the RPV has been considered. Monitoring of reactor water level with local instrumentation or operator aids to assist in setting and controlling RPV level to prevent overfill or underfeed conditions has been developed. There is a significant volume in the RPV, and precise control of RPV level is not required. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.10 DC Power Supplies to Allow Depressurization of RPV and Injection with Portable Pump

[A means to locally energize safety relief valve solenoids at the appropriate containment penetration(s) is provided using a DC battery with jumper cables. The number of SRVs to be energized at [site] is [three] in order to depressurize the RPV below the shutoff head of the low pressure pumps (LPCI or LPCS) at decay heat levels. Injection is accomplished using the portable pump. At [site] the connections for the portable pump to provide makeups to the RPV are [vent line xxxx and drain line xxxx.] These connection points are provided with fire hose connections that allow makeup at least 300 gpm of water to the RPV for a period of 12 hours. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.11 Utilize Feedwater and Condensate

[This strategy should utilize the feedwater and/or condensate system to pull water from the hotwell and inject into the reactor vessel. Some options may also allow the portable pump to provide water directly to the suction of either the feedwater pumps or the condensate pumps or the FPS to provide the water delivery to the suction. This flow path needs to provide at least 300 gpm of water to the vessel.]

7.12 Makeup to Hotwell

[It is possible that a LOLA will cause damage to the plant that could affect RPV makeup using the installed ECCS systems. This strategy is aimed at providing a source of makeup to the hotwell in order to provide an extended supply of water for RPV makeup utilizing the feedwater and/or condensate systems. [Site] provides a high volume makeup source to the hotwell by using the fire protection system in order to supply FW/condensate long-term. This makeup is at least 300 gpm of water to the condenser hotwell for a period of 12 hours using a flanged connection equipped with a hose connector. If the fire protection system is not available the portable pump will be used taking suction from [identify a local water source]. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.13 Maximize CRD Flow

[This strategy is already part of the BWR Emergency Procedure Guidelines. However, the manner in which it is implemented may vary from plant to plant. In addition, the location of the CRD pumps and filters varies substantially. Maximizing CRD flow will be accomplished by starting the second pump, opening the flow control valves 100%, opening the second filter for each pump, and opening the bypass lines. Procedural guidance for maximizing CRD flows will assure rapid actions. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.14 Procedure to Isolate RWCU or Other Lines outside Containment

[Since the Reactor Water Cleanup Unit has a direct path to outside containment this strategy provides procedural direction to proactively isolate the RWCU to minimize the risk of a LOCA outside containment. The attached MST addresses the procedural guidance to be developed for this isolation, including the necessary human actions.]

7.15 Manually Open Containment Vent Lines

[There are situations when a LOLA event may require the venting of containment in order to protect the integrity of the containment walls. This strategy provides a power-independent means to remove heat from containment by locally opening a containment vent pathway(s). Two vent lines have a means to open valves manually and to re-shut the valves, if conditions permit and termination of containment venting is warranted. The description of this strategy is contained in the attached MST, including the necessary human actions.]

7.16 Inject Water into the Drywell

[In some LOLA events core damage and vessel failure can not be prevented and cooling of the core debris and scrubbing of fission products will be necessary within the drywell. This strategy provides an AC-power-independent means to inject at least 300 gpm of water into the drywell for a period of 12 hours. Water is injected directly into the drywell using line NNNNN, which has a flanged connection outside for connecting a fire hose. This strategy utilizes the portable pump and several available sources of water. This strategy is described in the attached MST, including the necessary human actions.]

7.17 New Strategy for Safety Function Not Satisfied

[If a strategy listed in NEI 06-12 for a safety function is not applicable due to plant design, then describe here the new strategy that is applied to satisfy the needed mitigation. Discuss the basic aspects of the strategy similar to other NEI 06-12, Rev. 3, strategies. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.18 New Plant Safety Function Mitigative Strategy

[Discuss here any new safety function that is identified using NEI 06-12, Rev. 3, Chapter 4 guidance and the associated mitigative strategy that has been determined to address that safety function. Discuss the basic aspects similar to other NEI 06-12, Rev. 3, strategies. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.19 New Plant Safety Function Mitigative Strategy

[Discuss here any new safety function that is identified using NEI 06-12, Rev. 3, Chapter 4 guidance and the associated mitigative strategy that has been determined to address that safety function. Discuss the basic aspects similar to other NEI 06-12, Rev. 3, strategies. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

7.20 New Plant Safety Function Mitigative Strategy

[Discuss here any new safety function that is identified using NEI 06-12, Rev. 3, Chapter 4 guidance and the associated mitigative strategy that has been determined to address that safety function. Discuss the basic aspects similar to other NEI 06-12, Rev. 3, strategies. The attached MST identifies how this strategy is implemented, including the necessary human actions.]

8.0 Conclusion

[Site] design utilized the industry developed guidance in NEI 06-12, Rev. 3 to address LOLA events for this new reactor plant. Multiple design enhancements are identified, and are implemented, with the objective of reducing the burden on plant personnel during a LOLA event. By adding these design features, the capabilities of the plant and emergency response personnel to respond to LOLA events have been enhanced. The strategies identified in NEI 06-12, Rev. 3 have been considered and those that apply have been developed. [Where listed strategies could not be applied due to the plant design, a new strategy was developed. Also, new key safety functions were identified and corresponding mitigative strategies were developed.] The operational and programmatic aspects of responding to LOLA events are addressed in facility procedures prior to fuel load.

Mitigative Strategies Table		
Item	Expectation/Safety Function	Commitment/Strategy
	Phase 1	
	FIRE FIGHTING RESPONSE STRATEGY	
1	Establishment of a staging area for pre-positioned equipment and materials at appropriate location (onsite or nearby offsite) that would not be expected to be affected by the event itself.	[Describe the staging areas either onsite or offsite or both for pre-positioned firefighting equipment and materials.]
2	Pre-event notification may allow for staging personnel in alternative areas to maximize survivability of onsite personnel.	[Describe procedural guidance that will guide the staging of personnel if pre-event notification is received.]
3	Identifying airlifted resources (personnel and equipment) for fire fighting.	[Describe any airlifted resources that can be available within the time frame needed to be effective.]
4	Evaluate the command and control functions needed to ensure that the responding assets follow the established preplanned strategies, and that the evaluation takes into account the necessary technical assistance aspects of the command and control functions.	[Briefly describe the command and control structure that will be used for a LOLA event. This is not the EDMG that is discussed under Phase 3 below but assuming normal emergency systems are available and staffing of the ERO is available.]
5	Identifying outside organizations that may have the required knowledge, skills, and abilities to support response actions.	[Describe the organizations that will be used during a LOLA event to support response actions.]
6	Establish Memorandum of Understandings (MOUs), or other agreements which have a limited cost impact, with mutual aid organizations that are within reasonable distance to the site for fire fighting capabilities including accelerant fed fires.	[Describe the arrangements and/or agreements for local and mutual air entities to provide additional fire fighting capabilities to the site.]
7	Provide in either MOUs/agreements already established, or new agreements that are to be put in place as a result of newly evaluated measures, those arrangements established to address the roles and responsibilities of the	[Describe how the external responding fire and medical resources will be integrated into the overall fire fighting strategy and treatment of medical needs.]

Mitigative Strategies Table		
Item	Expectation/Safety Function	Commitment/Strategy
	responders and their integration into the overall fire fighting strategy.	
8	As part of a Coordinated fire fighting response strategy provide for the plant coordination with offsite local fire departments to support plant recovery efforts, including using these facilities as a staging area for specialized equipment and material; and coordination of large, nearby municipal fire departments (i.e., if not already in a mutual aid agreement), specialized fire fighting equipment at nearby industrial facilities, nearby airports and military bases, national fire fighting assets (e.g., USDA Forest Service), and private fire fighting companies.	[Describe any other large fire fighting capabilities or specialized equipment at nearby airports, other facilities, or county and state agencies that are not identified above.]
9	Provisions for controlling the large number of emergency response vehicles that may arrive at the plant in response to the event, such as, arrangements for establishing a staging area. Pre-event coordination should include local law enforcement agencies to ensure that responding fire fighting assets are not restricted from the staging areas or locations directed by plant operators. Provisions for security and radiological protection should be maintained.	[Describe the pre-planned mustering areas for emergency response vehicles and how these vehicles will be coordinated to assist in mitigating the results of the LOLA event. Discuss provisions for radiological protection and security access into the site areas.]
10	The following communications enhancements: (1) providing pagers for potential responders to receive dispatch notices both on and off shift; (2) checking for interoperability of radios to ensure that fire and rescue organizations have compatible equipment; and (3) availability of batteries/chargers to support the use of radios during an event of extended duration.	[Describe the notification and recall of plant personnel for the event response. Discuss how the communications protocol will occur for the event response. Discuss any staging of radios, batteries, dosimetry, or other communication devices to support event response.]
11	Provisions for treatment of casualties.	[Discuss how the triage area will be established and medical needs will be

Mitigative Strategies Table		
Item	Expectation/Safety Function	Commitment/Strategy
		handled.]
12	Alternate site assembly areas for personnel.	[Identify primary and alternate assembly areas for plant personnel so this can be communicated in a timely manner.]
13	Provide plant personnel responsible for fire fighting with general training knowledge about an accelerant fed fire and appropriate training to ensure effective implementation of actions that are part of the coordinated response strategy. Event responders that are part of the mutual aid considerations should, as a minimum, receive site familiarity training, and planning for a site exercise with their involvement should be considered. When site exercise training is not feasible for identified mutual aid organizations, use of table top exercise training (preferably provided at the site as part of site familiarity training) should be considered.	[Briefly describe training that will be conducted on a LOLA event response.]
14	Develop means to supply the fire protection ring header using off-site resources and a staged on-site licensee purchased portable diesel driven pump.	[Describe the pre-planned positioning of off-site pumper trucks to assist in mitigating the results of the LOLA event by repressurizing the FPS ring header. Discuss provisions for repressurizing the header with the portable pump and a water source.]
	PLANT OPERATIONS TO MITIGATE FUEL DAMAGE	
1	Provide for the pre-defined positioning and dispersal of personnel at the site to support fire fighting and recovery operations, in addition considerations for staff augmentation should include: (1) planning to share personnel at multi-unit facilities; (2) verifying that existing callout plans provide rapid response by teams by personnel in the areas of operations, fire fighting, maintenance and engineering, and their reliefs (3)	[Describe the pre-planned positioning of personnel if advanced warning is received of an attack on the plant. For responding to a LOLA discuss how rapid callout will be accomplished and how the responding resources will be staged and utilized appropriately.]

Mitigative Strategies Table		
Item	Expectation/Safety Function	Commitment/Strategy
	arranging for receiving facilities at the site should the deployment of a rapid response team be necessary, including identifying nearby landing zones for helicopters.	
2	Providing communication capabilities that ensures that established communications can facilitate the focus of fire/response teams on those plant operations necessary to mitigate fuel damage.	[Describe the pre-planned positioning of communication devices to assure responding resources can be properly directed to augment plant resources in the mitigation of fuel damage.]
3	Evaluate the adequacy of established plant procedures or the need to establish other procedures or SAMGs like format documents that would be used to document the details of the strategies and guidance for fire fighting and recovery operations. Included within these documents should be ways to refill coolant makeup tanks and the identification of penetrations communicating with the primary system that could be isolated remotely from the control room and/or remote locations to minimize coolant loss.	For new plant sites, SAMG-like guidance is available to operators and the Emergency Response Organization to implement the mitigative strategies that are discussed in this report. That guidance addresses equipment locations, hoses, connection points and other necessary details for implementing the strategy.
4	Evaluate vulnerable buildings and equipment to determine if core cooling could be maintained or restored using existing or newly developed procedures and existing and staged equipment.	[Describe the impact and response of vulnerable buildings to a LOLA event and how strategies will still be implemented.]
5	Develop a procedure to allow venting primary containment to secondary containment, without AC power, as an alternate method to remove heat from the primary containment, and providing the feed of the vessel by flooding the steam lines using condensate pumps when no reactor vessel level indication is available.	[Describe this strategy or refer to similar strategies discussed below.]
6	Develop an additional "Operational Contingency Action Guidance to be considered for compensatory functions in the event of loss of normal and	[Describe the contingency actions in the event of loss of normal and emergency plant systems taking credit for those strategies listed below.]

Mitigative Strategies Table		
Item	Expectation/Safety Function	Commitment/Strategy
	emergency plant systems (e.g., directions to mechanically start RCIC upon loss of all power, and directions on use of other Unit 2 divisional batteries to supply Unit 1 Divisional DC busses).	
7	Modify procedures for starting an EDG without DC power, use of the RCIC without DC power, and use of the site fire pumper as an alternate supply of low pressure water for core cooling and providing a supply of water to the SFP. Provide a portable diesel and portable transformer.	[Describe these strategies or refer to those below that cover the starting of EDGs, RCIC, and the use of a portable pump.]
8	Compartmentalization of areas of the plant by securing access pathways during normal operations to minimize the spread of combustible liquids.	[Describe the plant layout and how the structures have been designed to minimize the spread of combustible liquids from a LOLA event.]
9	Consider equipment survivability and personnel accessibility within plant areas potentially affected by the fire or explosion.	[Describe equipment for responding to a LOLA event will survive and be available.]
10	Implement strategies for relying on portable and offsite equipment (some onsite and some offsite).	For new plant sites, the Phase 2 and 3 strategies that utilize portable and/or offsite equipment are discussed as part of that strategy.
11	Establish supplemental methods for responding to events. A good practice by one licensee involved establishing contracts with drilling companies to drill a well and pump water to the Ultimate Heat Sink if needed.	For new plant sites, supplemental methods for adding water to the core, spent fuel pool, and ultimate heat sink (if applicable) are established and preplanned.
12	Provide a contract water supply within 12 hours to cool the component cooling water heat exchanger upon loss of normal cooling water.	For new plant sites, alternative water supplies are available and can be used to cool various plant heat loads.
13	Spent Fuel Pool Mitigative Measures 1. Strategically dispersing higher decay power fuel amongst the older low decay power fuel by symmetrically surrounding the highest decay power fuel (from the most recent offload) by four	[Describe the pre-planned positioning of fuel in the pool to maximize air cooling. Also discuss the pool leakage control measures.]

Mitigative Strategies Table		
Item	Expectation/Safety Function	Commitment/Strategy
	assemblies of low decay power; 2. Highest decay power assemblies should not be located in rack cells positioned above the rack feet; 3. Maintenance of an empty space area in the SFP (e.g., the shipping cask lay down area) to provide for a downcomer effect (size of empty space to be determined based upon conditions at each SFP); 4. Enhancing natural circulation air cooling of spent fuel in the pool by promoting passive ventilation of the bulk air space above the pool with the environs (e.g., opening doorways or blowout panels after an event); and 5. Providing for emergency pool water makeup, and pool leakage reduction and/or emergency repair measures, as well as implementing actions to address adverse radiological conditions.	
14	Provide appropriate training consistent with the actions necessary to accomplish the mitigation strategy developed for preventing fuel damage.	For new plant sites training material on mitigation strategies to prevent fuel damage is designed, developed, and conducted. Training on mitigation strategies is incorporated into initial and requalification licensed operator training programs. Training material for operators is developed using the Systematic Approach to Training (SAT).
	ACTIONS TO MINIMIZE RELEASES	
1	Provide a means for water spray scrubbing using fog nozzles and the availability of water sources, and address runoff water containment issues (sandbags/portable dikes) as an attenuation measure for mitigating radiation releases outside containment.	[Describe the strategy for using a water spray to mitigate any radioactivity release.]

Mitigative Strategies Table		
Item	Expectation/Safety Function	Commitment/Strategy
2	Provide for the pre-staging of water spray scrubbing equipment.	[Describe where the spray equipment will be staged.]
3	Evaluate existing dose projection models for their adequacy in projecting doses to event responders onsite under the conditions envisioned for this event.	[Discuss the impact from dose that was considered in the development of these mitigative strategies.]
	Phase 2 [consider each of these and complete those that apply. If strategy does not apply then enter "Does not apply see report for reason."]	
1	Diverse SFP Makeup (Internal Strategy)	[Describe the installed diverse makeup capability including water source, flow path, and motive force with the rationale of how it is diverse.]
2	SFP Makeup Capability(External Strategy)	[Describe the mobile makeup capability including water source, flow path, and motive force.]
3	SFP Spray Capability (External Strategy)	[Describe the mobile makeup capability including water source, flow path, and motive force with the rationale of how it is accomplished.]
4	Leakage Control Strategies	[Describe the leakage control measures that will be implemented.]
	Phase 3 [consider each of these and complete those that apply. If strategy does not apply then enter "Does not apply see report for reason."]	
1	Command and Control EDMG	For new plant sites, SAMG-like procedure/guidance is developed for Command and Control (initial response EDMG) and for accomplishing the following safety functions: Reactor Coolant System (RCS) Inventory Control, RCS Heat Removal, Containment Isolation, Containment Integrity, and Release Mitigation.
2	Makeup to RWST	[Identify how this makeup will be accomplished including the water source, flow path, and motive force.]
3	Manually Depressurize SGs to Reduce Inventory Loss	[Describe how the SGs will be depressurized through manual operations to help reduce inventory loss.]
4	Manual Operation of TDAFW Pump	[Describe how the TDAFW will be manually operated and what flow and level data will be locally available.]

Mitigative Strategies Table		
Item	Expectation/Safety Function	Commitment/Strategy
5	Manually Depressurize SGs and Use Portable Pump	[Describe how the SGs will be manually depressurized and how the portable pump will be connected and water pumped into the SGs.]
6	Makeup to CST	[Identify how this makeup will be accomplished including the water source, flow path, and motive force.]
7	Flooding Containment with Portable Pump	[Identify how this flooding will be accomplished including the water source, flow path, and motive force.]
8	Portable Sprays	[Identify how this spray scrubbing will be accomplished including the water source, flow path, and motive force.]
9	Manual Operation of RCIC or Isolation Condenser	[Describe how RCIC will be manually operated and what flow and level data will be available.]
10	DC Power to Depressurize RPV & Inject with Portable Pump	[Describe how the RPV will be depressurized and how the portable pump will be used to inject water into the vessel.]
11	Utilize Feedwater and Condensate	[Describe how feedwater and condensate can be used to cool the core and what flow and level data will be available.]
12	Makeup to Hotwell	[Identify how this makeup will be accomplished including the water source, flow path, and motive force.]
13	Maximize CRD Flow	[Describe how CRD flow will be increased and how much extra flow can be expected.]
14	Isolation of RWCU or Other Lines Outside Containment	[Describe the procedural guidance that will be developed to implement this isolation in rapid fashion.]
15	Manually Open Containment Vent Lines	[Provide a general description of how the containment vent lines will be opened/closed without normal air and power and describe the general locations of the primary equipment involved in implementing the strategy.]
16	Inject Water into Drywell	[Identify how this injection of water will be accomplished including the water source, flow path, and motive force.]
17	New Strategy Not Covered	[Identify how this strategy will be accomplished including the water source, flow path, boundary conditions assumed, performance attributes, and motive force.]

Mitigative Strategies Table		
Item	Expectation/Safety Function	Commitment/Strategy
18	New Plant Safety Function Mitigative Strategy	[Identify how this strategy will be accomplished including the water source
19	New Plant Safety Function Mitigative Strategy	[Identify how this strategy will be accomplished including the water source
20	New Plant Safety Function Mitigative Strategy	[Identify how this strategy will be accomplished including the water source