U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

BRANCH TECHNICAL POSITION ~~(BTP)~~ 8-8

ONSITE (EMERGENCY DIESEL GENERATORS) AND OFFSITE POWER SOURCES ALLOWED OUTAGE TIME EXTENSIONS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for electrical engineering

Secondary - None

A. BACKGROUND

Regulatory Guide (RG) 1.93 [Reference 1] provides guidance with respect to operating

USNRC STANDARD REVIEW PLAN

This Standard Review Plan (SRP), NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission (NRC) staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The ~~Standard Review Plan~~ SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The ~~standard review plan~~ SRP sections are numbered in accordance with corresponding sections in Regulatory Guide (RG) 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide (RG) 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on ~~Regulatory Guide~~ RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by e-mail to NRR_SRP@nrc.gov

.

Requests for single copies of SRP sections (which may be reproduced) should be made to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Reproduction and Distribution Services Section, or by fax to (301) 415-2289; or by e-mail to DISTRIBUTION@nrc.gov. Electronic copies of this section are available through the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0800/ , or in the NRC's Agencywide Documents Access and Management System (ADAMS), at http://www.nrc.gov/reading-rm/adams.html , under Accession # ~~ML111180521~~ML113640140.

restrictions, that is Allowed Outage Time (AOT), if the number of available onsite emergency diesel generators (EDGs) and offsite power sources is less than that required by the Technical Specifications (TS). In particular, this RG prescribes a maximum AOT of 72 hours for an inoperable onsite or offsite power source.

USNRC STANDARD REVIEW PLAN

This Standard Review Plan (SRP), NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission (NRC) staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan SRP sections are numbered in accordance with corresponding sections in Regulatory Guide (RG) 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide (RG) 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by e-mail to NRR_SRP@nrc.gov

.

Requests for single copies of SRP sections (which may be reproduced) should be made to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Reproduction and Distribution Services Section, or by fax to (301) 415-2289; or by e-mail to DISTRIBUTION@nrc.gov. Electronic copies of this section are available through the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0800/ , or in the NRC's Agencywide Documents Access and Management System (ADAMS), at http://www.nrc.gov/reading-rm/adams.html , under Accession # ML111180521ML113640140.

Additionally, the regulatory evaluation that staff applies in its review of the licensee's request for proposed changes to Limited Condition for Operations ~~(LCOs)~~ were developed consistent with the objectives of the Commission's Probabilistic Risk Assessment (PRA) Policy Statement, "Use of Probabilistic Risk Assessment Methods in Nuclear Activities: Final Policy Statement," for enhanced decision making and will result in more efficient use of resources, improvement in safety, and reduction of unnecessary burden.

The following regulatory guidance provides the staff position:

a. RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," [Reference 2] describes a risk-informed approach, acceptable to the NRC, for assessing the nature and impact of proposed licensing-basis changes by considering engineering issues and applying risk insights.

b. RG 1.177, "An approach for Plant-Specific, Risk-Informed Decision making: Technical Specifications," [Reference 3] describes an acceptable risk-informed approach specifically for assessing proposed TS changes in AOTs.

c. RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities."

These RGs also provide PRA quality and acceptance guidelines for evaluating the results of such evaluations.

As noted in its approval of the final policy statement on the use of PRA methods ("Use of Probabilistic Risk Assessment Methods In Nuclear Regulatory Activities," [60 Federal Register 42622]), the Commission stated an expectation that "the use of PRA technology should be increased to the extent supported by the state of the art in PRA methods and in a manner that complements the U.S. Nuclear Regulatory Commission's (NRC's) deterministic approach and supports the NRC's traditional defense-in-depth philosophy." The staff has defined an acceptable approach to analyzing and evaluating changes requested by licensees for AOT extensions. The staff approach supports the NRC's desire to base its decisions on the results of traditional engineering evaluations, supported by insights (derived from the use of PRA methods) about the risk significance of the proposed changes. Decisions concerning proposed changes are expected to be reached in an integrated fashion, considering traditional deterministic engineering evaluation that is supplemented by risk insights information. As stated in RG 1.177, the licensee should determine how the change impacts defense-in-depth aspects of the plant's design and operation and should determine the adequacy of safety margins following the proposed change. The licensee should consider how plant and industry operating experience relates to the proposed change, and whether potential compensatory measures could be taken to offset any negative impact from the proposed change.

NRC staff has been receiving license amendment~~s requesting~~ requests for one-time or permanent AOT extensions for the EDGs and offsite power sources ~~AOT~~ from the current ~~72 hours to 7-14 days~~AOT up to 14 days to perform online maintenance of EDGs and offsite power

sources. Maintenance may include both planned and unplanned activities. The purpose of this Branch Technical Position (BTP) is to provide guidance from a deterministic perspective in reviewing such amendment requests.

B. BRANCH TECHNICAL POSITION

The Electrical Engineering Branch (EEB) staff evaluates AOT extension requests for onsite or offsite power sources to allow on-line maintenance on EDGs that would normally be performed during refueling outages or maintenance of offsite power source(s) such as a transformer or bus. The on-line maintenance can help reduce the risk for loss of power during plant refueling outages when ~~complicated~~ refueling activities are conducted. The staff evaluates the licensee's request for AOT extension from deterministic as well as ~~Probabilistic Risk Assessment (~~PRA~~)~~ perspectives. The risk-impact evaluation is performed by the PRA Licensing Branch. The traditional deterministic evaluation is performed by ~~Electrical Engineering Branch~~EEB.

Consistent with the Commission's final policy statement, it is expected that ~~ana~~ ~~LAR~~license amendment request ~~request~~ for an onsite or offsite AOT extension will contain a PRA assessment. However, t~~T~~his ~~BTP~~BTP specifically discusses the defense-in-depth aspects for onsite and offsite power sources from a deterministic perspective. A supplemental power source should be available as a backup to the inoperable EDG or offsite power source, to maintain the defense-in-depth design philosophy of the electrical system to meet its intended safety function. The supplemental source must have capacity to bring a unit to safe shutdown (cold shutdown)[1] in case of a loss of offsite power (LOOP) concurrent with a single failure during plant operation (Mode 1). According to NUREG-1784 [Reference 4], considering the changes in electric grid performance post-deregulation, the duration of LOOP events has increased and the probability of a LOOP as a consequence of a reactor trip has increased. This evaluation was done before the August 14, 2003, Blackout in the Northeast. The lessons learned from this Blackout event indicate that restoration of offsite power will take longer than previously considered indicating that post-deregulation conditions challenge grid reliability. The staff's objective of requiring an extra (i.e., supplemental) power source for an inoperable EDG or offsite power source is to avoid a potential extended Station Blackout (SBO) event during the period of an extended AOT and to enable safe shutdown (cold shutdown) of the unit if normal power sources cannot be restored in a timely manner.

The current design of boiling-water reactor (BWR) and pressurized-water reactor (PWR) safety systems, required for reactor core decay heat removal and containment heat removal, are dependent on alternating current (AC) power. The projected time for restoration of offsite power is now considered to be more than the time previously evaluated for the SBO rule. The staff considers that a replacement (i.e., supplemental) AC power source is needed to backup an inoperable EDG or offsite power source during an extended AOT to maintain the defense-in-depth of the electrical power sources. The staff has previously granted AOT extensions to

1. By "cold shutdown" it is not implied that the plant needs to go to cold shutdown during LOOP. The unit can remain in either hot shutdown or hot standby in accordance with its licensing basis for the short term. However if the offsite power is not recovered in a timely manner it may become necessary for the unit to go to cold shutdown, therefore the supplemental or AAC power source must have the capacity and capability to accomplish this function if needed.

those licensees who have installed an alternate alternating current (AAC)[2] power source (i.e., additional diesels, gas or combustion turbines, hydro units, or other power sources) credited for SBO events which can be substituted for an inoperable EDG in the event of a LOOP, provided the power source has enough capacity to carry all LOOP loads to bring the unit to a cold shutdown without any load shedding.

In order to facilitate approval of an extended AOT for onsite or offsite power source, some licensees have provided a detailed PRA risk-informed evaluation and installed commercial-grade diesel generators capable of supplying power to the required safe-shutdown loads on the train removed from service for the maintenance outage. Some licensees at multi-unit sites have qualified their existing EDGs as an AAC source for meeting the SBO rule requirements (see Reference 5 for qualifications of the AAC source). For existing Class 1E EDGs to qualify as a supplemental AC source in the adjacent unit (provided with cross-connection within the same division of loads) for extending the AOT, the EDGs must have excess capacity to meet its unit LOOP safe shutdown loads (without load shedding) while complying with the single failure criteria, and have spare capacity to support the other unit in maintenance to bring the plant to cold shutdown without any load shedding.

The permanent or temporary power source can be either a diesel generator, gas or combustion turbine, or power from nearby hydro units. This source can be credited as a supplemental source, which can be substituted for an inoperable EDG during the period of extended AOT in the event of a LOOP, provided the risk-informed and deterministic evaluation supports the proposed AOT and the power source has enough capacity to carry all LOOP loads to bring the unit to a cold shutdown.

Multi-unit sites that have installed a single AAC power source for SBO cannot substitute it for the inoperable diesel when requesting AOT extensions unless the AAC source has enough capacity to carry all LOOP loads to bring the unit to a cold shutdown as a substitute for the EDG in an extended AOT and carry all SBO loads for the unit that has SBO event without any load shedding. The staff rationale is that if LOOP should occur during the period of extended AOT, the single AAC power source for SBO must be dedicated to the unit without the extended AOT to meet the SBO rule. Therefore for the unit in extended AOT, the licensee must provide a permanent or a temporary power source as a substitute for the EDG in an extended AOT to maintain the same level of defense-in-depth for safe shutdown of the plant. The staff believes that relying on a single AAC power source for an SBO in one unit and an inoperable EDG in the adjacent unit erodes the defense-in-depth aspects of the plant's design and operation and thereby reduce the safety margins due to a planned extended AOT.

For some ~~boiling water reactors~~BWRs, the Division III diesel generator (High Pressure Core Spray Pump (HPCS) diesel generator~~)~~ may be used as a supplemental AC source. The staff has determined that the HPCS diesel generator can be considered a supplemental AC source provided cross-connect capability exists so that the HPCS diesel generator can be cross-connected to either Division I or Division II AC buses to power safe-shutdown loads. All support systems for HPCS diesel generator should be verified to be available during the

2. The AAC power source is a supplementary AC power source, such as non-safety diesel or gas turbine that can be substituted as a replacement power source for an EDG to power one train of LOOP loads to take the plant to cold shutdown if necessary.

extended AOT. The HPCS diesel generator should have the capacity to power LOOP loads to bring the unit to cold shutdown without any load shedding.

For plants using AAC or supplemental power sources discussed above, the time to make the AAC or supplemental power source available, including accomplishing the cross-connection, should be approximately one hour to enable restoration of battery chargers and control reactor coolant system inventory. The availability of AAC or supplemental power source should be verified within the last 30 days before entering extended AOT by operating or bringing the power source to its rated voltage and frequency for 5 minutes and ensuring all its auxiliary support systems are available or operational. To support the one-hour time for making this power source available, plants must assess their ability to cope with loss of all AC power for one hour independent of an AAC power source. The plant should have formal engineering calculations for equipment sizing and protection and have approved procedures for connecting the AAC or supplemental power sources to the safety buses.

The EDG or offsite power AOT should be limited to 14 days to perform maintenance activities. This time period is based on industry operating experience; for example, a maximum of ~~216~~ 216 hours (13.5 days, consisting of two shifts, each shift working 8 hours) is considered to be sufficient for a major EDG overhaul or offsite power major maintenance. The licensee must provide justification for the duration of the requested AOT (actual hours plus margin based on plant-specific past operating experience). An EDG or offsite power AOT license amendment of more than 14 days should not be considered by the staff for review.

The TS must contain Required Actions and Completion Times to verify that the supplemental AC source is available before entering extended AOT. The availability of AAC or supplemental power source shall be checked every 8-12 hours (once per shift). If the AAC or supplemental power source becomes unavailable any time during extended AOT, the unit shall enter the LCO and start shutting down within 24 hours. This 24-hour period will be allowed only once within any given extended EDG AOT. Additionally, the staff expects that the licensee will provide the following Regulatory Commitments:

- The extended AOT will be used no more than once in a ~~24-~~24-month~~s~~ period (or refueling interval) on a per diesel basis to perform EDG maintenance activities, or any major maintenance on offsite power transformer and bus.

- The preplanned maintenance will not be scheduled if severe weather conditions are anticipated.

- The system load dispatcher will be contacted once per day to ensure no significant grid perturbations (high grid loading unable to withstand a single contingency of line or generation outage) are expected during the extended AOT.

- Component testing or maintenance of safety systems and important non safety equipment in the offsite power systems which can increase the likelihood of a plant transient (unit trip) or LOOP will be avoided. In addition, no discretionary switchyard maintenance will be performed.

- TS required systems, subsystems, trains, components, and devices that depend on the

remaining power sources will be verified to be operable and positive measures will be provided to preclude subsequent testing or maintenance activities on these systems, subsystems, trains, components, and devices.

- Steam-driven emergency feed water pump(s) in case of PWR units, and Reactor Core Isolation Cooling ~~(RCIC)~~ and High Pressure Coolant Injection ~~(HPCI)~~ systems in case of BWR units, will be controlled as "protected equipment."

In summary, in light of the recent experiences in grid outages, it is the staff's position that the availability of an additional power source is a condition for approval of the extended EDG or offsite power AOT. Therefore, a supplemental power source must be available when extending the current AOT allowed by the plant TS for a single inoperable EDG or offsite power source ~~beyond the current 3 days (72 hours)~~ up to 14 days provided the extended AOT is also supported by a risk-informed evaluation. License amendments requesting an extended EDG or offsite power AOT without a risk-informed evaluation must include adequate justification for the requested AOT based solely on deterministic criteria. Licensees requesting an extension of the onsite or offsite AOT should either install permanently, or make available on a temporary basis, a supplemental AC source capable of powering the inoperable onsite or offsite power source bus LOOP loads during the period of AOT extension. Although~~,~~ this extended AOT is allowed for pre-planned maintenance activities, it~~this~~ could be used for corrective maintenance on ~~a~~ limited bases, provided the licensee meets risk-informed criteria, the maintenance rule availability/reliability requirements, and the reactor oversight process performance indicator criteria for availability/reliability.

Although the installation of a supplemental power source could be temporary for only the time duration of the AOT, a permanent source would maintain multiple independent AC sources capable of providing power to necessary equipment needed for safe shutdown and ~~also~~ could also reduce the risk of core damage frequency due to a LOOP.

C. REFERENCES

1. RG 1.93, December 1974, "Availability of Electric Power Sources"

2. RG 1.174, ~~November 2002~~May 2011, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed~~.~~ Decisions on Plant-Specific Changes to the Licensing Basis"

3. RG 1.177, ~~August 1998~~May 2011, "An Approach for Plant-Specific, Risk-Informed ~~Decisionmaking~~Decision-making: Technical Specifications"

4. RG 1.200, March 2009, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities."

5~~4~~. NUREG-1784, December 2003, "Operating Experience Assessment – Effects of Grid Events on Nuclear Power Plant Performance"

65. RG 1.155, August 1988, “Station Blackout”

7. Commission Policy Statement: “Use of Probabilistic Risk Assessment Methods ~~In~~in Nuclear Regulatory Activities; Final Policy Statement” (60 Federal Register 42622, August 16, 1995)