

August 20, 2010

MEMORANDUM TO: Roy K. Mathew, Acting Chief
Electrical Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

FROM: Paul Gill, Senior Electrical Engineer */RA/*
Electrical Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

SUBJECT: ELECTRICAL ENGINEERING BRANCH – TECHNICAL
POSITION ON ONSITE (EMERGENCY DIESEL GENERATOR)
AND OFFSITE POWER SOURCES ALLOWED OUTAGE TIME
EXTENSIONS

Licensees are requesting one-time or permanent extensions for their emergency diesel generators (EDGs) and offsite power sources allowed outage time (AOT), from the current 72 hours to 7-14 days, to perform online maintenance of EDGs and corrective maintenance on offsite power source. The staff evaluates each licensee's request for AOT extension from a deterministic as well as a probabilistic risk assessment aspect. The Electrical Engineering Branch (EEEB) staff has granted AOT extensions for onsite or offsite power source provided that the AOT extension has no more than a small risk increase.

The enclosed technical position paper (staff guidance) documents the deterministic criteria the EEEB staff uses in reviewing such amendment requests. The purpose of the position paper is to provide this information to the staff as an interim staff guidance and to the licensees seeking AOT extensions. The staff will incorporate this staff guidance as a branch technical position in the next revision of the Standard Review Plan (NUREG 0800). The EEEB staff's criteria delineated in the position paper is not new and was used in the granting of onsite or offsite power source AOT extensions in the past.

Enclosure:
As stated

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ELECTRICAL ENGINEERING BRANCH
TECHNICAL POSITION ON ONSITE (EMERGENCY DIESEL GENERATOR)
AND OFFSITE POWER SOURCES ALLOWED OUTAGE TIME EXTENSIONS

Background

Licenses are submitting license amendments requesting one-time or permanent extensions for their emergency diesel generators (EDGs) and offsite power sources allowed outage time (AOT) from the current 72 hours to 7-14 days to perform online maintenance of EDGs and corrective maintenance on offsite power source. The purpose of this position paper is to provide deterministic criteria in reviewing such amendment requests.

Applicable Regulations

The staff applies the following regulatory requirements and guidance in reviewing the EDG or offsite power AOT extension amendments:

General Design Criterion (GDC) 17, "Electric power systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, requires, in part, that nuclear power plants have onsite and offsite electric power systems to permit the functioning of structures, systems, and components that are important to safety. The onsite system is required to have sufficient independence, redundancy, and testability to perform its safety function, assuming a single failure. The offsite power system is required to be supplied by two physically independent circuits that are designed and located so as to minimize, to the extent practical, the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. In addition, this criterion requires provisions to minimize the probability of losing electric power from the remaining electric power supplies as the result of loss of power from the unit, the offsite transmission network, or the onsite power supplies.

GDC 18, "Inspection and testing of electric power systems," requires that electric power systems that are important to safety must be designed to permit appropriate periodic inspection and testing.

10 CFR 50.36, "Technical specifications," requires a licensee's Technical Specifications (TSs) to establish limiting condition for operation (LCO) and surveillance requirements (SRs) for equipment that is required for safe operation of the facility. Specifically, Section 50.36(c)(3) stipulates the surveillance requirements.

10 CFR 50.65, "Requirements for monitoring the effectiveness of maintenance at nuclear power plants," requires that preventive maintenance activities must not reduce the overall availability of the systems, structures and components. It also requires that before performing maintenance activities, the licensee shall assess and manage the increase in risk that may result from the proposed maintenance activities.

Regulatory Guide (RG) 1.93, "Availability of Electric Power Sources," provides guidance with respect to operating restrictions (i.e., AOT) if the number of available alternate current sources is less than that required by the TS LCO. In particular, this guide prescribes a maximum AOT of 72 hours for an inoperable onsite or offsite power source.

Enclosure

Additionally, the regulatory evaluation that staff applies in its review of the licensee's request for proposed changes to 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," describes a risk-informed approach, acceptable to the NRC [Nuclear Regulatory Commission], 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," describes an acceptable risk-informed approach specifically for assessing proposed TS changes in AOTs. These RGs also provide acceptance guidelines for evaluating the results of such evaluations.

As noted in its approval of the policy statement on the use of PRA methods, 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 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.

Staff Position

The Electrical Engineering Branch staff may grant AOT extensions for onsite or offsite power sources to allow for on-line performance of manufacturer recommended preventive maintenance on EDGs that would normally be performed during refueling outages or maintenance of offsite power source(s) such as a transformer or bus. This would provide licensees the flexibility for performing various onsite or offsite power source maintenance and repair activities during power operation. It also reduces the risk for loss of power during plant refueling outages when complicated refueling activities are conducted. The staff evaluates each licensee's request for AOT extension from a deterministic as well as a PRA aspect. From a PRA perspective, the licensee must demonstrate that the AOT extension has no more than a minor risk increase. From a deterministic perspective, the staff requires that an extra power source 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 assuming a single failure during plant operation (Mode1). The results of the Reactor Safety Study (WASH-1400) showed that, for one of the two plants evaluated, a station blackout (SBO)

event could be an important contributor to the total risk from nuclear power plant accidents. Also, considering the changes in electric grid performance post-deregulation (NUREG-1784, "Operating Experience Assessment – Effects of Grid Events on Nuclear Power Plant Performance"), the duration of loss of offsite power (LOOP) events has increased and the probability of a LOOP as a consequence of a reactor trip has increased. The evaluation completed as part of this NUREG 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 power source for an inoperable EDG or offsite power source is to avoid a potential SBO event during the period of extended AOT.

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 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. Hence, the consequences of an SBO could be more severe than previously considered for compliance with 10CFR 50.65. The staff considers that a replacement alternating current (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 and to minimize the increases in core damage frequency or risk and be consistent with the intent of the Commission's Safety Goal Policy Statement. Therefore, the staff has limited granting AOT extensions to those licensees who have installed a qualified alternate alternating current (AAC)¹ power source (i.e., additional diesels, gas turbines, or other power sources) credited for SBO events which can be substituted for an inoperable EDG in the event of a LOOP. The AAC source should have enough capacity to carry all LOOP loads to bring the unit to a cold shutdown and perform its original license based functions on a multi-unit site.

In order to facilitate approval of an extended AOT for onsite or offsite power source, many licensees have 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 EDG as an AAC source for meeting the SBO rule requirements. In order for an existing Class 1E EDG to qualify as a supplemental AC source for the extended AOT, the EDG must have excess capacity to meet its original licensing bases and have spare capacity to support the unit in maintenance. Typically, in addition to meeting its design basis functions, it should have adequate capacity to mitigate an SBO in one unit and safe shutdown (cold shutdown)² of the other unit. The excess capacity should not be the capacity made available by load shedding or reduce the capability for powering LOOP loads to achieve cold shutdown in the non-SBO unit. The excess capacity of the EDG in the non-SBO unit for qualifying it as a supplemental AC source is that available capacity within the normal continuous rating (EDG load represented by the complete contingent

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1. The AAC power source is a supplementary AC power source, such as a 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.
 2. 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 AAC power source must have the capacity and capability to accomplish this function if needed.

of safety related and non-safety related loads (automatic and manual loads) normally expected to be available for the LOOP condition).

For some boiling water reactors, the Division III diesel generator (High Pressure Core Spray Pump (HPCS) diesel generator) may be used as a supplemental AC source. The staff's position is that the supplemental AC source can power safe-shutdown loads if a cross-connect capability is provided so that the HPCS diesel generator can be cross-connected to either Division I or Division II AC buses. In order for a HPCS diesel generator, with a cross connect capability, to be qualified as a supplemental AC power source during the period of extended outage, the HPCS diesel generator must have excess capacity to carry the loads of its required design basis or regulatory required safety functions and have the capacity to carry all the automatic and manual loads normally expected to be available for safe shutdown during the LOOP condition.

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, generally should not be more than 1 hour as demonstrated by test. To support the 1 hour time for making this power source available, plants must assess their ability to cope with an SBO for 1 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 temporary power source(s). As a minimum, the supplemental AC source should meet the requirements of NUMARC 87-00, Appendix B.

The EDG or offsite power AOT should be limited to 14 days to perform most of the major maintenance activities. This time period is based on industry operating experience; for example, a maximum of 216 hours (13.5 days, consisting of two shifts, each shift working 8 hours) is considered 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 + some 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 should contain Required Actions and Completion Times to verify applicable compensatory actions and configuration risk and management controls are satisfied. The TSs must be amended to include the following:

- The TS should contain requirements to demonstrate, before taking one onsite or offsite power source out of operation for an extended period that the supplemental power source is available and functional by testing. The availability of supplemental power source should be checked every 8-12 hours (once per shift).

The TS should require the power sources AOT to default to the original AOT (i.e., for next 3 days or 7 days depending on the currently approved TS) from the discovery time that the compensatory actions and configuration risk and management controls cannot be met. Additionally, the licensee must provide the following Regulatory Commitments, and compensatory measures:

- The extended AOT will be typically used to perform infrequent (i.e., once every 24 months) diesel manufacturer's recommended inspections and preventive maintenance activities or major maintenance on offsite power transformer and bus.

- The supplemental power source or equivalent with capacity equal to or greater than the capacity required to meet LOOP loads in the unit entering extended AOT (due to an inoperable EDG or an offsite power source), will be available . After entering the extended AOT, the supplemental AC source will be verified available every 8-12 hours (once per shift) and treated as protected equipment.
- The scheduling of preplanned maintenance should not be performed during severe weather conditions or during stressed grid conditions.
- The system load dispatcher shall be contacted once per day to ensure no significant grid perturbations (line or generation outages) are expected during the extended AOT. The system load dispatcher should inform the plant operator if conditions change during the extended AOT (e.g., unacceptable voltages as a result of a trip of the nuclear unit).
- Component testing or maintenance of safety systems and important nonsafety equipment including offsite power systems that increase the likelihood of a plant transient or LOOP will be avoided. In addition, no discretionary switchyard maintenance will be allowed.
- Technical specification requirements of verification that the required systems, subsystems, trains, components, and devices that depend on the remaining power sources are 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) will be controlled as “protected equipment.”

The approach described in the staff position above may also be used for granting AOT extension for direct current (DC) onsite power equipment such as Class 1E battery switches to the approach used for granting EDG or offsite power AOT extensions, additional DC power source (temporary or permanent) is required as a condition for approving AOT extensions for the onsite safety-related DC equipment.

Additional clarifications are provided in APPENDIX A of this position paper, with regard to AAC power sources.

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 AOT for a single inoperable EDG or offsite power source beyond the current 3 days (72 hours). In summary, 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 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 reduce the core damage frequency due to a LOOP.

The staff believes that the regulatory commitments to implement other restrictions and compensatory measures will ensure the availability of the remaining sources of AC power during the extended AOT.

APPENDIX A

Plants with AAC Power Source for SBO

Plants with qualified AAC power source installed for meeting the SBO rule can credit these when requesting AOT extensions. The AAC power source can be either a dedicated combustion or gas turbine, or hydro, or a spare EDG, or an EDG with excess capacity for multi-unit site. This power source can be credited as a supplemental power source which can be substituted for an inoperable EDG during the period of extended AOT in the event of a LOOP, provided the AAC source has enough capacity to carry all LOOP loads to bring the unit to a cold shutdown as discussed in the staff's position.

Single Unit Site:

For single unit site, the AAC power 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. A single unit site with two EDGs that are credited for meeting GDC17 cannot use the excess capacity of the EDGs when requesting extended AOT.

Multi-Unit Site:

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.

Plants without AAC Power Source for SBO

Plants that do not have qualified AAC power source for SBO must meet the following when requesting AOT extensions.

Permanent or Temporary Power Source - 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 power source has enough capacity to carry all LOOP loads to bring the unit to a cold shutdown.

HPCS Diesel – For BWR plants, this source can be credited as a supplemental power source if it can be cross-connected to Division 1 or Division 2 bus, which can be substituted for an inoperable EDG during the period of extended AOT in the event of a LOOP. The HPCS diesel generator must have capacity to carry the loads of its required design basis or regulatory required safety functions and the excess capacity to carry all of the automatic and manual loads normally expected to be powered for the LOOP condition to bring the unit to a cold shutdown. The cross connect from the HPCS diesel generator to the Division 1 or Division 2 bus must be capable of carrying the required loads for the Loop condition in the other unit

In addition to the above, other requirements applicable to extended AOT license amendment request for BWR/PWR include:

The TS should contain Required Actions and Completion Times to verify applicable compensatory actions and configuration risk and management controls as discussed in the Staff Position section are satisfied. Additionally, the licensee must provide Regulatory Commitments and compensatory measures in the license amendment request as discussed in the Staff Position Section.