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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

South Texas Project Electric Generating Station
Units 1 and 2
Docket Nos. STN 50-498, STN 50-499
10CFR50.63, "Loss of All Alternating
Current Power" - Responses to NRC Questions

References: 1) M. A. McBurnett to Document Control Desk, dated April 17, 1989 (ST-HL-AE-3045)
2) M. A. McBurnett to Document Control Desk, dated March 30, 1990 (ST-HL-AE-3416)

Houston Lighting & Power Company (HL&P) submits this letter in response to questions from the NRC staff regarding the South Texas Project Electric Generating Station (STPEGS) implementation of the station blackout regulation. The questions and responses are provided as Attachment 1. HL&P's responses clarify, revise, and supplement information provided previously in the referenced correspondence.

The responses support the determination that STPEGS qualifies as an eight-hour coping duration plant in accordance with the criteria of NUMARC 87-00. (Note: For the purposes of this response in accordance with 10CFR50.63, Station Blackout is defined as complete loss of alternating current power to the essential and nonessential switchgear buses, but does not include loss of available AC power to buses fed by station batteries through inverters or by alternate AC sources.) Based on the design of STPEGS and its capability as an Alternate AC plant, HL&P plans no additional modifications or enhancements to address Station Blackout except as noted in this letter.

In addition, Attachment 2 includes a description of a procedure revision governing implementation of an alternate source of auxiliary feedwater to provide makeup to the steam generator. The revision changes the Auxiliary Feedwater Storage Tank level at which water is transferred to the tank from the Fire Water Storage Tank.

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If there are any questions, please contact either Mr. P. L. Walker at (512) 972-8392 or myself at (512) 972-7298.

A. W. Harrison
Manager,
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Attachments: 1) Responses to NRC Questions
2) Alternate Source of Auxiliary Feedwater
3) Revised Coping Study

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1) NUMARC 87-00 states that plant procedures should address a site-specific indicator to ensure safe shutdown two hours before anticipated hurricane arrival at the site (sustained winds in excess of 73 mph). HL&P must establish such a site-specific indicator, or reclassify STPEGS as an 8-hour coping duration plant.

Response

STPEGS procedures do not conform to Section 4.2.3(4)(a) of NUMARC 87-00, as 120 mph is used as a shutdown indicator rather than 73 mph, and the NRC has classified STPEGS as a P3 facility; thus, STPEGS should be classified as an eight-hour coping duration plant. However, as discussed in previous correspondence on Station Blackout, STPEGS has been designated as an Alternate AC Source plant. In revision to STPEGS' previous response to the SBO rule, STPEGS now is defined as an eight-hour coping duration plant, and is able to support equipment operation for a Station Blackout duration of eight hours via the chosen Alternate AC Source. A coping study has been performed which replaces that submitted in correspondence dated April 17, 1989 (ST-HL-AE-3045). The coping study is provided as Attachment 3.

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2) Two trains of HVAC are currently provided under normal conditions. HL&P is requested to confirm that HVAC is sufficient using only one train where equipment for mitigation of Station Blackout is active. This statement is to cover the Control Room as well as other plant areas.

Response

The capability to maintain design temperatures in the Electrical Auxiliary Building and the Control Room envelope with only one train of HVAC has been demonstrated by test. These tests were performed with only one train of HVAC operating (two sets of fans were operating in the Control Room envelope but only one cooling coil was active) while normal electrical loads were energized. Thus, the testing was conservative relative to the loads present under Station Blackout conditions.

Elsewhere in the plant, where a given train of station blackout mitigating equipment is active, a related train of HVAC is available. The exception is the IVC D train cubicle where the steam-driven Auxiliary Feedwater (AFW) train is located; the local room temperature without HVAC for the steam-driven AFW pump room after eight hours will not adversely impact equipment operability during a Station Blackout.

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3) Confirm that adequate decay heat removal can be provided using one train of AFW. Describe how AFW flow is cross-connected and modulated, especially with only one train of AC power. If local operator action is required in the Isolation Valve Cubicle (IVC), assure that the IVC will be habitable.

Response

With a single standby diesel generator available (the alternate AC source), two trains of AFW would be available. One such train would be powered by the standby diesel generator and the other powered by the steam-driven turbine. Power would also be available to the flow control valves. Under these conditions, the AFW cross-connect capability is not required. No local operator action is required for the AFW system.

Each steam generator is supplied by a separate AFW train. Normally closed, fail-closed cross-connections are provided between the four trains to permit flow from any pump to any steam generator. Provisions have been made for manual operation of these valves. The response to Question #2 addresses the effects of loss of ventilation in the steam-driven AFW pump room, the most limiting area of concern.

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4) HL&P stated that, in the event of station blackout, reactor coolant pump seal leakage of 3 gpm per pump would not be a concern. However, the NUMARC 87-00 guideline, "RCP seal leakage is assumed not to exceed 25 gpm per pump for the duration of the station blackout event," is interpreted by the NRC to mean that 25 gpm per pump must be assumed. Since leakage from the four pumps at that rate would exceed the flow available from the Positive Displacement Pump, determine how long before the core is uncovered.

Response

The maximum RCP seal leakage expected for the duration of the station blackout is 3 gpm per pump based on the seal leakoff rates during normal seal injection. Charging flow directed to the reactor coolant pumps for seal water is nominally 8 gpm. Nominally, 5 gpm enters the RCS through the labyrinth seals and thermal barrier. The remainder of the flow (3 gpm) is directed up the pump shaft to the no. 1 seal leakoff and then discharged either to the suction side of the charging pumps or to the volume control tanks.

Two centrifugal charging pumps are available to provide coolant to the RCS and seal injection to the RCPs. Normal charging flow is provided by one centrifugal charging pump. One such pump can be powered by the Train A standby diesel generator, while the other can be powered by the Train C standby diesel generator. Train B, however, does not power a centrifugal charging pump. Therefore, in the event both centrifugal charging pumps are out of service, RCP seal injection flow and reactor coolant boration capability can be maintained by a positive displacement pump powered by the non-Class 1E Technical Support Center diesel generator. In addition, cooling water flow to the RCP seal thermal barrier will be maintained by the CCW train powered by the Alternate AC source. Therefore, a change in seal leakage rate is not expected.

Assuming a seal leakage rate of 25 gpm per pump, plus the miscellaneous Tech Spec leakage of 10 gpm, results in a total leakage rate of 110 gpm. While the design flow for each centrifugal charging pump is 160 gpm, the capacity of the positive displacement pump is 35 gpm. With only the positive displacement pump, the plant must contend with a net outflow of 75 gpm. Plant procedures describe actions to be taken in this event. Activation of Safety Injection, which can be powered from the Alternate AC source, as described in Emergency Operating procedures will ensure that the reactor core will remain covered for a station blackout duration of eight hours.

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5) Confirm that one standby diesel generator can achieve long-term shutdown of the plant under loss of offsite power conditions. This concern applies primarily to Train B.

Response

As stated in the STPEGS USAR, Section 5.4.A, the safe shutdown design basis for STPEGS is hot standby. Train B can maintain hot standby conditions for the eight-hour coping period required by NUMARC 87-00. As discussed in the response to Question 4, power to enable Reactor Coolant Pump seal injection would be provided by the TSC diesel generator (the B diesel still powers CCW to the RCP thermal barrier) and makeup to the RCS inventory can be provided by Safety Injection. Trains A and C can also maintain hot standby conditions for the eight-hour coping duration. The capability to reach cold shutdown using only Train B is limited by the eventual loss of power supply to the Qualified Display Processing System (QDPS). As discussed in the response to Question 6, power to enable display of essential safe shutdown instrumentation in the Control Room can be provided for the eight-hour coping period by Class 1E batteries. However, continued availability of the QDPS beyond eight hours requires operability of either Train A or Train C.

The existing analysis of Cold Shutdown Capability, as reported in USAR Section 5.4.A, assumes only a single failure and thus utilizes two trains of essential AC power. The capability to achieve cold shutdown using only safety-related equipment controlled from the Control Room was demonstrated. Confirmation of ability to achieve long-term shutdown using one standby diesel generator train, with limited local operator action inside containment, would require further study.

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6) Address consequences of shutting down inverters to conserve battery capacity. Instrumentation needed for coping with a station blackout may be unavailable due to lack of redundancy between groups. Describe how loads are rotated between inverters. Describe how the battery load calculations were developed.

Response

The STPEGS design has been reviewed to ensure that adequate battery capacity is available to support decay heat removal during a station blackout for the required eight-hour coping duration. At STPEGS, each of the four Class 1E vital 120 VAC channels is backed by its own Class 1E battery. Calculations determined that the Channel II (Train D) battery is adequate for an eight-hour duration and the Channel III (Train B) battery is adequate for a four-hour duration, with no load shedding. Channel I (Train A) and Channel IV (Train C) are adequate for a four-hour duration provided that the 7.5 KVA NSSS inverters are switched off within thirty minutes of the start of the blackout.

Calculations to verify battery size were performed in accordance with IEEE 485-1978. For those channels where the projected duration was less than four hours, calculations assumed shedding of selected inverters until a minimum duration of four hours was achieved.

Since either Channel I or Channel IV power must be maintained to support Control Room display of safe shutdown plant parameters, these channels will be alternated to cover the required eight-hour duration. One channel will be maintained energized during the first four hours, with its NSSS inverter secured within the first thirty minutes. The other channel will be deenergized within the first thirty minutes of the blackout, and reenergized, less its NSSS inverter, at approximately four hours into the event. Note that this approach is necessary only if capability to recharge the batteries is not available.

Display of essential safe shutdown instrumentation in the Control Room requires that either Train A or Train C of the Qualified Display Processing System (QDPS) be operable. This will be accomplished by maintaining either Channel I or Channel IV energized. The availability of Channel II for the duration, and Channel III during the initial hours of the blackout, provides additional information. This is all accomplished without dependence on any of the normal AC power sources. Availability of one Class 1E diesel generator will ensure that the associated instrument bus can be maintained fully energized throughout the remainder of the blackout.

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Response (cont'd)

The attached table, "Station Blackout-Safe Shutdown Instrumentation Summary", provides a list of the battery-powered instruments categorized by the critical safety function they support. The instruments are then identified by the various instrument groups in which they appear. Note that a given instrument type does not necessarily appear in all instrument trains. Footnotes have been included which describe the redundancy provided within a given train where not all instruments are available for the function required. The table confirms that functional redundancy of battery-powered instrumentation is maintained if selected instrument trains are shed to extend available battery power.

Loads are not rotated between inverters. Each inverter powers a separate train of instrumentation so that, when an inverter is deenergized, the entire train is no longer powered. However, as described above, instrumentation available from the remaining trains is sufficient to support safe shutdown of the reactor.

From the instrumentation review shown in the attached Table, it is clear that the NSSS inverters, and not the TMI inverters, should be switched off. Operation of at least one of the two TMI inverters is essential to provide indication of parameters which are only displayed through QDPS. Operation of both TMI inverters provides additional reliability through redundancy in both sensor inputs and in signal processing and display.

Switching off one NSSS inverter should not cause any undesirable ESF actuations. Switching off a second NSSS inverter, or complete discharge of the battery to the point where the inverter ceases to function will generate ESF actuation signals, such as Safety Injection, based on 2-out-of-4 logic and 2-out-of-3 logic. This will have to be accounted for before the second NSSS inverter is deenergized.

Table 1

Safe Shutdown Instrumentation Summary

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SAFE SHUTDOWN INSTRUMENTATION SUMMARY

FUNCTION	INSTRUMENTS	TRAIN A	TRAIN B	TRAIN C	TRAIN D	REMARKS
Subcriticality	Neutron Flux Extended Range	T		T		T - TMI Inverter N - NSSS Inverter
	Source Range Nuclear Instrumentation	N (1)			N (1)	(1) This instrument provides alternate indication for Neutron Flux ER.
	Post Accident Sampling System		(1,2)			(2) Both Class 1E DC power for solenoid valves and non-Class 1E AC power for analyzers are required.
	Primary Sampling System		(1,2)	(1,2)		
Core Cooling	RCS Hot Leg Temperature W/R				N (3)	(3) The NSSS inverter powers the instrument; however, either the Train A or C TMI inverter is required to power the QDPS displays for indication.
	RCS Cold Leg Temperature W/R		N (3)			
	Core Exit Temperature	T (4)		T (4)		(4) Thermocouples are self-powered; AC power is required for QDPS

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SAFE SHUTDOWN INSTRUMENTATION SUMMARY

FUNCTION	INSTRUMENTS	TRAIN A	TRAIN B	TRAIN C	TRAIN D	REMARKS
						indication of T/C measurements.
	RCS Subcooling (5, 6, 7)	T		T		(5) Core Exit Thermocouples (CETs) [see Note (4) also] and 2 of 3 RCS Pressure signals [Trains B, C, & D] are required.
	Reactor Vessel Water Level (6, 7)	T		T		(6) Provides additional information; but is not essential for SBO. (7) Indication is provided via QDPS.
	Refueling Water Storage Tank (RWST) Water Level (6)		N (8)	N (3)	N (8)	(8) Control board indication is available; QDPS indication also requires operation of either Train A or C TMI inverter.

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SAFE SHUTDOWN INSTRUMENTATION SUMMARY

FUNCTION	INSTRUMENTS	TRAIN A	TRAIN B	TRAIN C	TRAIN D	REMARKS
Heat Sink	Steam Generator Water Level NR (10)	T (7)	N (3)	T (7)	N (8)	(9) Control Board indication is provided. (10) One transmitter is provided per train, per S/G.
	Steam Line Pressure	N or T (12)	N (8)	T (11)	N (8)	(11) Indication of all S/G is available via QDPS; only S/G C has indication powered from Train C. (12) Control board indication is available for Trains A & B via transmitters powered from the associated NSSS inverter; S/G A indication is also available directly from QDPS without the NSSS inverter.
	Auxiliar Feedwater Flow (13, 9)	T SG A	N SG B	T SG C	N SG D	(13) SG Level WR provides diverse indication.
	Steam Generator Water Level WR (14, 7)	T S/G B	N S/G C (3)	T S/G D	N S/G A (3)	(14) AFW Flow provides diverse indication.

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SAFE SHUTDOWN INSTRUMENTATION S'JMMARY

FUNCTION	INSTRUMENTS	TRAIN A	TRAIN B	TRAIN C	TRAIN D	REMARKS
	Steam Generator Power Operated Relief Valve Control	T S/G A	N S/G B	T S/G C	N S/G D (15)	(15) 480 VAC Train A is required for the hydraulic pump; the accuumulator provides 1⅓ strokes if AC power is lost.
	Auxil'ary Feedwater Storage Tank (AFST) Water Level (6)	T (7)	N (3)	T (7)		
Integrity	RCS Pressure		N (3)	T (7)	N (3)	
	Pressurizer Pressure (9, 16)	N	N	N	N	(16) Provides alternate indication to RCS Pressure over the 1700 - 2500 PSIG range.
Containment	Containment Pressure Wide Range (3)	N	N	N	N	
	Containment Pressure Extended Range (17)			T (7)	N (3)	(17) Provides alternate indication to Containment Pressure Wide Range.

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SAFE SHUTDOWN INSTRUMENTATION SUMMARY

FUNCTION	INSTRUMENTS	TRAIN A	TRAIN B	TRAIN C	TRAIN D	REMARKS
Inventory	Pressurizer Water Level	T (7)	N (8)	T (7)	N (8)	
	Reactor Vessel Water Level (6, 7)	T		T		

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Alternate Source of Auxiliary Feedwater

NUMARC 87-00 guidelines for responding to a station blackout state that:

> Plant procedures should ensure that a flowpath is promptly established for makeup flow from the CST to the steam generator/nuclear boiler and identify backup water sources to the CST in order of intended use. Additionally, plant procedures should specify clear criteria for transferring to the next preferred source of water.

HL&P's response, in part, stated that procedure 1POP05-EO-EC00, "Loss of All AC Power," identifies an alternate source of auxiliary feedwater (to provide makeup to the steam generator) utilizing a diesel-driven fire pump and a fire hose to pump from the Fire Water Storage Tank (FWST) to the Auxiliary Feedwater Storage Tank (AFWST). The response also stated that the procedure directs that this source of supply be implemented when the AFWST level approaches 50%. A study has been performed which indicates flow rates are such that the 50% level is unnecessarily premature as a criterion for transferring to another source of water. The alternate source can be made available before AFWST run-out if actions to connect the alternate source are initiated at an AFWST level of less than 50%. The minimum initiating AFWST level has been determined based on the amount of time needed to connect with the FWST. The Loss of All AC Power procedure has been revised to reflect a level criterion, based on the study, which will provide adequate time for connecting to the alternate water source.

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1. Condensate Inventory for Decay Heat Removal

The minimum permissible volume of water in the Auxiliary Feedwater Storage Tank is sized to support cooldown over 14 to 21 hours including 4 hours at hot standby until Residual Heat Removal is initiated. The duration varies with the initiating event and single failure considered. Therefore, STPEGS has adequate condensate available for decay heat removal during a station blackout of eight hours with Alternate AC power available.

2. Assessing the Class 1E Battery Capacity

The STPEGS design has been reviewed to ensure that adequate battery capacity is available to support decay heat removal during a station blackout for the required eight-hour coping duration. At STPEGS, each of the four Class 1E vital 120 VAC channels is backed by its own Class 1E battery. Calculations determined that the Channel II (Train D) battery is adequate for an eight-hour duration and the Channel III (Train B) battery is adequate for a four-hour duration, with no load shedding. Channel I (Train A) and Channel IV (Train C) are adequate for a four-hour duration provided that the 7.5 KVA NSSS inverters are switched off within thirty minutes of the start of the blackout.

Since either Channel I or Channel IV power must be maintained to support Control Room display of safe shutdown plant parameters, these channels will be alternated to cover the required eight-hour duration. One channel will be maintained energized during the first four hours, with its NSSS inverter secured within the first thirty minutes. The other channel will be deenergized within the first thirty minutes of the blackout, and reenergized, less its NSSS inverter, at approximately four hours into the event. Note that this approach is necessary only if capability to recharge the batteries is not available.

Display of essential safe shutdown instrumentation in the Control Room requires that either Train A or Train C of the Qualified Display Processing System (QDPS) be operable. This will be accomplished by maintaining either Channel I or Channel IV energized. Availability of Channel II for the duration, and Channel III during the initial hours of the blackout, provides additional information. This is all accomplished without dependence on any of the normal AC power sources. Availability of one Class 1E diesel generator will ensure that the associated instrument bus can be maintained fully energized throughout the

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remainder of the blackout. The load shedding requirements will be incorporated into plant procedures as part of the Emergency Operating Procedure Enhancement program expected to be completed by December 31, 1991.

3. Compressed Air

No air-operated valves are relied upon to cope with a station blackout. No further action is required.

4. Effects of Loss of Ventilation

Ventilation to all areas of concern is powered by the Alternate AC source. The exception is the HVAC for the turbine-driven auxiliary feedwater pump room which is powered from the Train A standby diesel generator. All equipment required to support operation of the turbine-driven auxiliary feedwater train is capable of operating in the room without ventilation for at least 24 hours. All necessary controls for the turbine-driven auxiliary feedwater train are available in the control room, so no local operator action is required.

While the original equipment sizing of HVAC equipment in the electrical auxiliary building and control room envelope was based on 2 of 3 trains operating, operating experience and testing has demonstrated that one train of HVAC is adequate to maintain design temperatures in these areas during normal operation. Since the station blackout scenario can only reduce the cooling requirements in these areas, the HVAC train powered by the Alternate AC source is adequate to maintain reasonable temperatures in these areas during a station blackout of eight hours duration.

Ventilation and/or room cooling in all other areas required to support operation of the Alternate AC power source or maintain the safe shutdown condition is separated by train and powered by the Alternate AC source.

5. Containment Isolation

An assessment was previously performed to ensure that appropriate containment isolation can be provided during a station blackout event. The plant list of containment isolation valves has been reviewed to verify that valves which must be capable of being closed or that must be operated (cycled) under station blackout conditions can be positioned

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(with indication) independent of the preferred and blacked-out unit's class 1E power supplies. No plant modifications and/or associated procedure changes were determined to be required to ensure that appropriate containment integrity can be provided under station blackout conditions.

Although the original review was based on a blackout of four hours duration, review of those results confirmed that increasing the duration to eight hours does not affect the valves which must be operated.

6. Reactor Coolant Inventory

The Alternate AC source powers the necessary make-up systems to maintain adequate reactor coolant system inventory to ensure that the core is cooled for the required coping duration of eight hours.