The Light company
Houston Lighting & Power South Texas Project Electric Generating Station P. O. Box 289 Wadsworth, Texas 77483

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

South Texas Project Electric Generating Station
Unit 1
Docke* No. STN 50-498
Special Report Regarding
Standby Diesel Generator #12 Non-Valid Failure

Pursuant to the South Texas Project Electric Generating Station (STPEGS) Technical Specifications 4.8.1.1.3 and 6.9.2, Houston Lighting & Power submits the attached Special Report regarding a Standby Diesel Generator (SDG) #12 non-valid failure which occurred on January 13, 1994.

If you should have any questions on this matter, please contact Mr. S.M. Head at (512) 972-7136 or myself at (512) 972-8787.

T.H. Cloninger
Vice President,
Nuclear Engineering

LRW/eg

Attachment: Special Report Regarding SDG #12 Non-Valid Failure

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c:

Regional Administrator, Region IV
U. S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

Lawrence E. Kokajko
Project Manager
U. S. Nuclear Regulatory Commission
Washington, DC 20555 13H15

David P. Loveless
Sr. Resident Inspector
c/o U. S. Nuclear Regulatory Comm.
P. O. Box 910
Bay City, TX 77404-910

J. R. Newman, Esquire
Newman & Holtzinger, P.C., STE 1000
1615 L Street, N.W.
Washington, DC 20036

K. J. Fiedler/M. T. Hardt
City Public Service
P. O. Box 1771
San Antonio, TX 78296

J. C. Lanier/M. B. Lee
City of Austin
Electric Utility Department
721 Barton Springs Road
Austin, TX 78704

G. E. Vaughn/T. M. Puckett
Central Power and Light Company
P. O. Box 2121
Corpus Christi, TX 78403

Rufus S. Scott
Associate General Counsel
Houston Lighting & Power Company
P. O. Box 61867
Houston, TX 77208

Institute of Nuclear Power
Operations - Records Center
700 Galleria Parkway
Atlanta, GA 30339-5957

Dr. Joseph M. Hendrie
50 Bellport Lane
Bellport, NY 11713

D. K. Lacker
Bureau of Radiation Control
Texas Department of Health
1100 West 49th Street
Austin, TX 78756-3189

U. S. Nuclear Regulatory Comm.
Attn: Document Control Desk
Washington, D. C. 20555

South Texas Project
Unit 1
Docket No. STN 50-498
Supplemental Special Report Regarding
Standby Diesel Generator #12 Non-Valid Failure

DESCRIPTION OF EVENT

On January 13, 1994 at 0759 hours Unit 1 was in Mode 4. During the performance of Surveillance Procedure 0PSP03-DG-0002, Standby Diesel Generator 12 output breaker tripped after being at 100% load for 1 hour and 21 minutes. The diesel continued to run. All engine parameters were verified to be normal by the System Engineer except for generator brush arcing which was observed to be slightly greater than normal. The diesel was cycled through a normal five minute cooldown and subsequently declared inoperable.

Control Room Indications were observed following the trip as follows:

- "Reverse Power" alarm at local annunciator
- 67/50D (Reverse) Directional Overcurrent relay flagged at 4160v bus E1B
- SDG 12 continued to operate 4160v, 60hz with no local relays flagged.

Diesel shutdown and cooldown sequences were conducted with no abnormal indications observed.

A review of the ERFDADS computer data taken just prior to the time of the event revealed the following:

- A step drop in E1B bus voltage from 4257v to 3973v
- A step drop in SDG 12 KVAR loading from +2678 to -1363
- An increase in SDG 12 KW load of about 160 Kw
- An increase in SDG 12 output current of about 30 Amps

There are three potential failure mechanisms described as follows:

1. A momentary overload of the E1B ESF transformer due to a load transient created by a switchyard or grid voltage fluctuation, or the concurrent unloading of SDG 23.

Analysis: A momentary overload of the EIB ESF transformer was determined not to have occurred. SDG 23 was not unloaded until 40 seconds following the trip and ERFDADS data revealed that no other load transients or grid disturbances occurred on the other buses fed from the same distribution grid at the time of the trip.

2. Failure of the Directional Overcurrent relay combination (67/32 and 67/50D) at the 4160v bus E1B.

Analysis: The Directional Overcurrent relay combination (67/32 and 67/50D) was verified to be functioning as designed following this event. A calibration check indicated that the as found trip values were within specification.

3. A loss of magnetic field on the generator rotor. This loss of magnetic field can be caused by a loss of excitation current or a loss of field windings (shorted or open).

Analysis: The rotor windings were meggered and their resistance was taken using a Wheatstone Bridge. The results were within the normal expected range. The generator brushes and slip rings were inspected. A discontinuity in the normal coating was noted on the slip rings. This discontinuity was in the shape of a brush and has been noted on other diesels. It occurs when the brushes come to rest at the same spot and remain stationary. The coating is re-established following diesel operation at power. This was the cause of the arcing noted by the system engineer following the trip.

The generator internal rotor field winding connections were inspected for open or shorted windings. All connections appeared normal with no signs of overheating. The Instantaneous Pre-Position board relay was checked for high contact resistance and was found to be normal. Static checks of the voltage regulator power diodes and the shorting SCR's were checked and found to be normal. Static checks of the voltage regulator and the generator field current loop failed to show any anomalies that would account for reduced excitation current. Suspected control relays were also tested with satisfactory results.

During investigative testing of the automatic/manual mode control relay (3AM), an incident occurred that resulted in the damaging of the relay due to shorting. This complicated the troubleshooting efforts, in that analysis showed that this relay could have caused the initial indications if it had malfunctioned. All of the possible supporting evidence was destroyed by the arcing damage. A melted test equipment probe tip was found on the relay which indicates that the short was caused by an electrician inadvertently shorting across two adjacent terminals which were of opposite polarity. This relay was replaced and following testing (described below) verified that the original problem still existed indicating that this relay was not the cause of the breaker trip.

On January 18, 1994 an unloaded test of the diesel generator was performed which included monitoring of all voltage regulator parameters with test equipment and a strip chart recorder. Initial performance of the voltage regulator was good with respect to control of output voltage; however, examination of the firing pulses showed some instability. After 34 minutes of testing, a noticeable sporadic changing of field amps was observed with an accompanying change in output voltage of 300v peak to peak. This occurred while the operator was raising voltage to the top of the tolerance band. This instability lasted about 30 seconds and steadied out. Further testing for an additional hour failed to reproduce the instability.

This testing indicated that either the voltage regulator module or the power-driven potentiometer (PDP, changeable non-emergency voltage reference device) were not functioning properly. Testing of the PDP revealed smooth traces through the range of operation eliminating the PDP as a contributor. The voltage regulator module was then replaced.

An unloaded and loaded test of the diesel generator was reperformed January 19, 1994 following the voltage regulator replacement activity. The test was run for approximately 3 hours, monitoring the same points as in the first test. No instabilities were noted in the meters or the traces, and examination of the firing pulses showed stable operation. After removal of the test equipment a follow up Post Maintenance Test was satisfactorily performed. Following this, a full 4 1/2 hour surveillance test was completed on the diesel with no anomalies or equipment malfunctions.

From this analysis it is concluded that the voltage regulator was responsible for the breaker trip.

CAUSE OF EVENT

Voltage regulator failure was analyzed using the ERFDADS computer data. Two cases were analyzed, KW positive and KW negative. KW negative was dismissed because had KW been negative at the time of the trip, then the generator reverse power relay would have been actuated. This relay was not actuated during this trip sequence.

The KW positive scenario is supported by the fact that bus reverse power trip was actuated. The bus reverse power trip is caused by two relays acting together, the ITE-32 Positive Sequence directional relay (67/32) and the 67/50D overcurrent relay. The purpose of this relay combination is to protect the E1B transformer from being overloaded by the diesel generator. The ITE-32 Positive Sequence Directional relay compares the direction of the positive sequence current relative to the positive sequence voltage. The relay is set for 0 degrees torque angle. Therefore as long as a component of positive sequence current and the positive sequence voltage is in phase then this relay will enable the 67/50D relay. As long as the diesel generator is driving power through the EIB transformer into the grid, the 67/50D relay is enabled. The 67/50D relay is an overcurrent relay set for 1008 amps with a 0.5 sec. delay. The 67/50D relay is the relay that tripped the DG-12 output breaker.

All causal factors of this event have been eliminated with the exception of those related to the electronics of the voltage regulator. The voltage regulator was shipped to the voltage regulator vendor (N.E.I. Peebles) on February 4, 1994. Upon receipt inspection, it was noted that the top circuit board on the voltage regulator was bent. This occurred in shipping since it was not noted before leaving the South Texas Project.

The Vendor was tasked with establishing the failure mechanism of the voltage regulator module. This module has been tested for over 40 hours on a test motor generator set. It has shown no signs of the instability that was observed on site. Individual components of the voltage regulator module will be tested to determine if they are still within original manufacturer specification.

ANALYSIS OF EVENT

The Standby Diesel Generators are part of the Class 1E 4.16 KV AC Power System which is composed of three trains designed to provide a reliable source of power to safety-related equipment essential to all modes of plant operation including emergency shutdown following any design basis event. Upon a loss of offsite power, each of the three SBDGs start automatically to supply back-up power to its associated 4.16 KV bus.

When the diesel generator is operating in parallel with offsite power, the voltage regulator is operating in the droop mode. The droop mode allows the diesel generator to share KVAR (Reactive Power) loading with the grid.

In emergency mode operation, the voltage regulator is automatically switched to the isochronous mode allowing voltage to be controlled at a predetermined setpoint without droop, thus allowing both faster response to voltage change and tighter tolerance control. In isochronous, the observed 7% voltage variation would have been lower. Even if the voltage variation of 7% had occurred in the emergency mode, the Technical Specification requirement of 4160 (plus or minus 416 volts) would have been satisfied. This event has been classified as a non-valid failure since additional laboratory testing of the voltage regulator under controlled conditions verified that it would have continued to perform it's design function and thus would have allowed SDG #12 to satisfy emergency AC Power System requirements.

CORRECTIVE ACTIONS

- The final test report from the voltage regulator vendor [N.E.I. Peebles] will be evaluated to determine if additional actions are required to increase the reliability of the voltage regulator module.
- Any significant information regarding the results of the voltage regulator testing will be provided to the industry via Nuclear Network.

ADDITIONAL INFORMATION

The failed component is Voltage Regulator Model No. 72-05000-100, Serial No. 3433 9H1401 Part No. 2-04E-204-016 manufactured by N.E.I. Peebles. At the time of this event there were 0 valid failures in the last twenty (20) valid tests and 3 valid failures in the last one hundred (100) tests for Standby Diesel Generator #12. Therefore, the testing frequency remains the same (monthly).