PSE&G

Public Service Electric and Gas Company P.O. Box 236 Hancocks Bridge, New Jersey 08038-0236

Nuclear Business Unit

OCT 04 1996

LR-N96296

United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Gentlemen:

EVALUATION OF EDG/FIRE SUPPRESSION SYSTEM INTERACTION ISSUE
INSPECTION REPORT UNRESOLVED ITEM 354/96-03-04
HOPE CREEK GENERATING STATION
FACILITY OPERATING LICENSE NPF-57
DOCKET NO. 50-354

Inspection Report 354/96-03 identified two concerns relative to the interaction between Emergency Diesel Generators (EDGs) and their associated fire suppression systems. The first concern questioned the adequacy of the existing fire suppression system detector setpoints with respect to the configuration of the ventilation system and lack of information regarding air temperature stratification. The second concern involved a postulated failure of the nonsafety-related fire suppression system affecting the ability of the EDGs to perform their function. Details of PSE&G's response to these concerns are contained in the attachment to this letter.

Sincerely,

D. R. Powell

D. R. Powell
Manager - Licensing and Regulation

Attachment

IE01

C Mr. H. J. Miller, Administrator - Region I
U. S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Mr. D. Jaffe, Licensing Project Manager - Hope Creek
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Mail Stop 14E21
Rockville, MD 20852

Mr. R. Summers
USNRC Senior Resident Inspector (X24)

Mr. K. Tosch, Manager IV
Bureau of Nuclear Engineering
33 Arctic Parkway
CN 415
Trenton, NJ 08625

Mr. J. Wiggins - Director - Division of Reactor Safety - Region I
U. S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

CEM/

BC Senior Vice President - Nuclear Operations (X04)
Senior Vice President - Nuclear Engineering (N19)
General Manager - Hope Creek Operations (H07)
Director - QA/NSR (X01)
Director - Nuclear Design Engineering and Projects (N25)
Director - Nuclear System Engineering (X07)
Operations Manager - Hope Creek (H01)
HC Design Engineering Manager (N51)
Manager - Nuclear Safety Review (N38)
Manager - Joint Owners/Ext Aff Interface (N28)
Onsite Safety Review Engineer - Hope Creek (H11)
Station Licensing Engineer - Salem (X09)
Station Licensing Engineer - Hope Creek (X09)
General Solicitor, R. Fryling, Jr. (Newark, 5G)
Mark J. Wetterhahn, Esq.
Records Management (N21)
Microfilm Copy
File Nos. 1.2.1, 3.1 (IR 354/96-03)

ATTACHMENT

EVALUATION OF EDG/FIRE SUPPRESSION SYSTEM INTERACTION ISSUE
INSPECTION REPORT UNRESOLVED ITEM 354/96-03-04
HOPE CREEK GENERATING STATION
DOCKET NO. 50-354
LR-N96296

I. INTRODUCTION

At Hope Creek, each of the four emergency diesel generator (EDG) rooms is provided with an automatic carbon dioxide total flooding system that is initiated either automatically via heat detectors located within the compartment or manually through a local panel. Fire dampers in the ventilation system supply and exhaust ducts of each room close automatically to maintain carbon dioxide concentration when the system is actuated. Closure of these dampers disables the ventilation for the affected room and the ventilation is no longer available to maintain the room temperature at the desired level for EDG operation. Under these conditions, the affected EDG would be removed from service if it is operating. If no fire has occurred, the EDG can be brought back into service after the carbon dioxide has been removed from the room and the carbon dioxide system and fire dampers have been reset.

Inspection Report 354/96-03, dated April 26, 1996, documented two concerns relative to interaction between the EDGs and their associated fire suppression systems. The first concern is addressed in Section II below, and the second concern is addressed in Section III below.

II. DETECTOR SETPOINT ISSUE

A. Description of Issue

The first of the two concerns was stated in the inspection report as follows:

"There was no assurance that the fire suppression system would not inadvertently actuate in one or more of the diesel rooms, while the EDGs were running. The configuration of the EDG room ventilation system, with intake and exhaust in the floor, could limit air circulation in the ceiling. Only minimal margin existed between the bulk temperature of the room and the actuation point of the fire suppression sensor (123°F and 150°F, respectively when instrument loop errors are considered). A large quantity of sensors was involved (28 for the four rooms) and there was no information regarding sensor actuation points and room air temperature stratification."

B. PSE&G Position

The detectors and their associated setpoints are appropriate for the expected temperatures and thermal conditions of the EDG rooms and replacement of the existing detectors is therefore not necessary. In addition, periodic verification of setpoints is not necessary. Background information associated with this position is provided in Section II.C and the basis for the PSE&G position is provided in Section II.D.

C. Background Information

1. Study of Room Temperature Conditions and Associated Results

a. Description of Detector Temperature Study

PSE&G performed a study to determine the temperatures of the thermal detectors in each of the four EDG rooms. The study was conducted during the scheduled monthly EDG runs using thermography (an infrared photo process) to determine the actual surface temperatures of each of the 28 thermal detectors (there are 7 detectors in each room). The study was completed in April for the "C" EDG and in July and August for the "A", "B", and "D" EDGs. The accuracy of the thermography equipment is plus or minus 2%.

The thermography photos were taken prior to start of the EDGs, near the end of the EDG runs, and after the EDG runs. Additional thermography was performed on the "A" and "B" EDGs during the run periods to establish temperature stability of the detectors (i.e. to assure the detector temperatures are at an equilibrium or steady state temperature condition). When the decision to perform the additional thermography was made, the thermography on the "C" EDG had already been completed, and although the "D" EDG thermography had not yet been conducted, sufficient time was not available to incorporate the additional thermography into the scope of the test. However, it is expected that the temperature profile of the detectors in the "C" and "D" rooms during the EDG runs would be very similar to the recorded temperature profiles of the detectors in the "A" and "B" rooms. This is based on similar temperature measurements for the detectors in all four rooms and on the similarity of the equipment, equipment performance, components, room layout, room size, and ventilation systems of all four EDG rooms.

A detailed recording of room air temperatures was performed during the "D" EDG run to provide a general indication of room temperature behavior. This

activity was performed only for the purpose of providing additional engineering data and was not intended to replace or supplement the recording of detector temperatures via thermography. A detailed recording of the air temperatures was not performed for the "A", "B", or "C" EDGs as room temperature profiles for these rooms are expected to produce similar results (all the EDG rooms are similar in terms of room size, equipment layout, equipment performance, and ventilation systems). The air temperature recordings for the "D" EDG were taken from the elevated platform near the ceiling with air temperature readings taken every 5 minutes.

The temperatures remained relatively stable during the one to two hour EDG runs. More detailed information on the temperature study results is provided below.

b. Study Results for Period Immediately After EDG Start

The results of the thermography and air temperature readings indicate that a rapid temperature drop occurs on the detectors within the first 10 to 15 minutes of the EDG runs as a result of the ventilation start. The temperature drops for detectors in the "A" EDG room were between 9.8°F and 14.3°F and, for the "B" EDG room detectors, between 2.9°F and 9.4°F. The air temperature recordings in the "D" EDG room also identified the rapid drop in temperature during the initial period of the EDG run.

c. Study Results for Period Immediately After Full Generator Load

The maximum temperature increase that occurred between the last reading taken with the EDG in a "no generator load" condition and the first reading taken with the EDG in a "full generator load" condition was 11.4°F on one detector in "B" EDG room (the other detectors in the "B" EDG room experienced changes ranging from -2.3°F to 5.6°F during this transition period). Similar results were obtained for temperature measurements for the detectors in the "A" EDG room with a maximum temperature increase of 7.1°F while the generator was loading (the other detectors in the room experienced temperature changes ranging from -1.4°F to 2.3°F during this same time period).

d. Study Results for Period Between Full Generator Load and End of Test

After the generator was loaded, the temperature of the "A" room detectors remained stable with detector temperatures fluctuating between a minimum

change of -5°F and a maximum change of 4°F. During this period, the temperature of the "B" room detectors remained stable with detector temperatures fluctuating between a minimum change of -3°F and a maximum change of 3.1°F. The air temperature recordings in the "D" EDG room also identified that the temperature remained stable during this period of time.

The maximum temperature that a detector experienced during the "A" EDG run was 99.8°F (101.8°F after incorporating instrument inaccuracy) while the minimum temperature was 86.2°F (84.5°F after incorporating instrument inaccuracy). The maximum temperature a detector experienced during the "B" EDG run was 102° (104°F after incorporating instrument inaccuracy) while the minimum temperature was 87.3°F (85.6°F after incorporating instrument inaccuracy). Thermography for the "C" and "D" EDGs identified a maximum detector temperature of 95.4°F (97.3°F after incorporating instrument inaccuracy) at the end of the "C" EDG run and 99.5°F (101.5°F after incorporating instrument inaccuracy) at the end of the "D" EDG run.

e. Analysis of Results from the Temperature Study

The highest temperature recorded for a detector was 112°F (114.2°F after incorporating instrument inaccuracy) prior to the start of the "C" EDG. The highest temperature recorded for a detector during an EDG run was 102°F (104°F after incorporating instrument inaccuracy) in the "B" EDG room. This temperature was recorded with a corresponding SACS temperature for the ventilation system at 80°F on the day of the test (SACS temperature was 80°F for the "A", "B", and "D" EDGs and 58°F for the "C" EDG on the days the thermography were performed).

Since the maximum design basis SACS temperature is 95°F, determination of a corresponding maximum detector temperature is required. A maximum detector temperature has been conservatively estimated by establishing a linear relationship between changes in SACS temperature and changes in detector temperature. Linear extrapolation is conservative because, as the temperature of the room increases, heat transfer between the heat producing objects in the room (the diesel engine and generator) and the detectors is reduced resulting in less temperature change between the detectors and objects in the room at higher temperatures. A linear relationship has been established between the maximum 102°F (104°F after incorporating instrument inaccuracy) temperature for a detector in the "B" EDG room at 80°F SACS temperature and the minimum 76°F (74.5°F after incorporating instrument inaccuracy) temperature for a

detector in the "C" Diesel room at 58°F SACS temperature. The equation used is in the form y = ax + c where a = (change in detector temperature) / (change in SACS) or (104-74.5)/(80-58)=1.341 and c=-3.2. The estimated maximum temperature for a detector using this method is 124°F (with SACS temperature at design basis maximum of 95°F). See the graph on Page 9 of this attachment.

2. Nominal Rating of Detectors

The nominal rating of the EDG room UL listed thermal detectors is 160°F with tolerances of +7 and -8°F as set by the manufacturer. Therefore, the lowest temperature setpoint for a detector is 152°F (160-8).

3. Requirements for and Experience with UL Listed Detectors

Fire detectors that are UL listed are known to be very reliable because of the extensive testing and listing process that they are required to pass. Detectors are required to meet the requirements described in UL Test Standard No. 521 (UL-521) before the detector can be UL listed. UL 521 contains numerous tests that the detectors are required to pass including setpoint tolerances and setpoint drift. In addition, UL requires manufactures to have a QA program to maintain consistent detector performance. These reasonable measures are sufficient to assure that the detectors will operate as required and expected, and as such, the need to field test (verify) setpoints for restorable detectors is not practiced or required by NFPA 72 ("National Fire Alarm Code").

This practice is consistent with past experience with UL listed thermal detectors by many utilities (users). This experience indicates no generic problems or concerns regarding setpoint drift in UL listed thermal detectors. The basis for this statement is that there are no known information notices, bulletins, recall notices, code changes or other publications identifying detector setpoint drift as a generic problem requiring additional considerations.

D. Basis for PSE&G Position

The results of the room temperature study conducted by PSE&G verifies the acceptability of the 160°F thermal detector setpoints for the carbon dioxide systems in the EDG rooms. The difference between the lowest detector setpoint of 152°F and the highest temperature a detector may reach is 152°F - 124°F or 28°F. A 28 degree margin between the maximum temperature a detector may experience and the setpoint of that thermal detector provides sufficient margin to

assure against false actuation. Also, the 28 degree margin is well within the industry practice of using a temperature margin of 20 to 35 degrees for detector setpoints relative to the maximum temperature to which the detector may be subjected.

PSE&G's position that a test program is not needed to validate the thermal detector setpoints is based on the reliability of UL listed detectors as demonstrated by industry performance and data.

III. FIRE SUPPRESSION SYSTEM/EDG INTERACTION ISSUE

A. Description of Issue

The second of the two concerns was stated in the inspection report as follows:

"Although the fire suppression system and the dampers had been seismically qualified, the use of nonsafety-related sources did not assure that source failure, such as a voltage transient (e.g., overvoltage) or a hot short, somewhere in the non-Q system could not inadvertently shut down the ventilation or isolate an EDG room."

An initial analysis of this concern was performed prior to the issuance of the inspection report. The inspection report identified the following regarding that analysis:

"... although hot shorts were discussed, a hot short of relay 3ZZ was not addressed. Similarly, transients on the nonsafety-related sources were not evaluated. A detailed evaluation of failure modes of nonsafety-related components and systems that interact somehow with safety-related components and systems is Appendix B program and their failure in any mode during an event, should be assumed. This is the basis for the 10 CFR 50, Appendix A, Criterion 3 requirement regarding interactions between safety- and nonsafety-related systems and the assurance that an interaction does not exist that could prevent a safety system from performing its accident mitigation function."

B. PSE&G Position

The design of the EDG fire suppression system is adequate and no modifications to the system are necessary. Background information associated with this position is provided in Section III.C and the basis for the PSE&G position is provided in Section III.D.

C. Background Information

1. Draft Safety Evaluation Report Open Item on Fire Suppression System EDG Interaction

Inadvertent actuation of fire suppression systems and the associated impact on safety-related equipment was an issue during the Hope Creek licensing process and was tracked as draft safety evaluation report (DSER) Open Item 243.

The response to DSER Open Item 243 was provided by PSE&G in a letter dated September 13, 1984. The response for the EDG rooms indicated that an inadvertent actuation of the fire suppression system in one of the EDG rooms would not affect any of the other EDGs and that shutdown of the plant requires only two EDGs in the same mechanical division.

The NRC subsequently documented their review of this response in Section 8.3.3.1.3 of Hope Creek safety evaluation report (SER). Section 8.3.3.1.3, "Protection or Qualification of Class 1E Equipment From The Effects of Fire Suppression System", states that the results of a single failure analysis had been provided that indicates that, with an inadvertent actuation resulting in loss of the Class 1E equipment in an EDG room, sufficient Class 1E equipment remains to safely shut down the plant with an additional independent single failure. On the basis of the results of this analysis, the NRC concluded that the design met the requirements of GDC 17 and was acceptable.

2. Applicable Licensing Basis Commitments

The Hope Creek electrical power system is designed to comply with IEEE 379-1972, "IEEE Trial-Use Guide for the Application of the Single-Failure Criterion to Nuclear Power Generating Station Protection Systems", as endorsed and modified by Regulatory Guide 1.53 and with the revised Sections 5.2 through 5.5 of IEEE 379-1977, "IEEE Standard Application of the Single Failure Criterion to Nuclear Power Generating Station Class 1E Systems." Hope Creek also complies with IEEE 308-1974 "IEEE Standard Criterion for Class 1E Systems for Nuclear Power Generating Stations" as endorsed and modified by Regulatory Guide 1.32 subject to the clarification of specified positions. Hope Creek took exception to the requirements of Paragraph C.7.i of BTP CMEB 9.5-1. The basis for this exception is documented in UFSAR Section 9.5.1.6.30 and was accepted by the NRC as documented in SER Section 9.5.1.

3. Subsequent Evaluation of the Capability to Shutdown with Different Combinations of EDGs

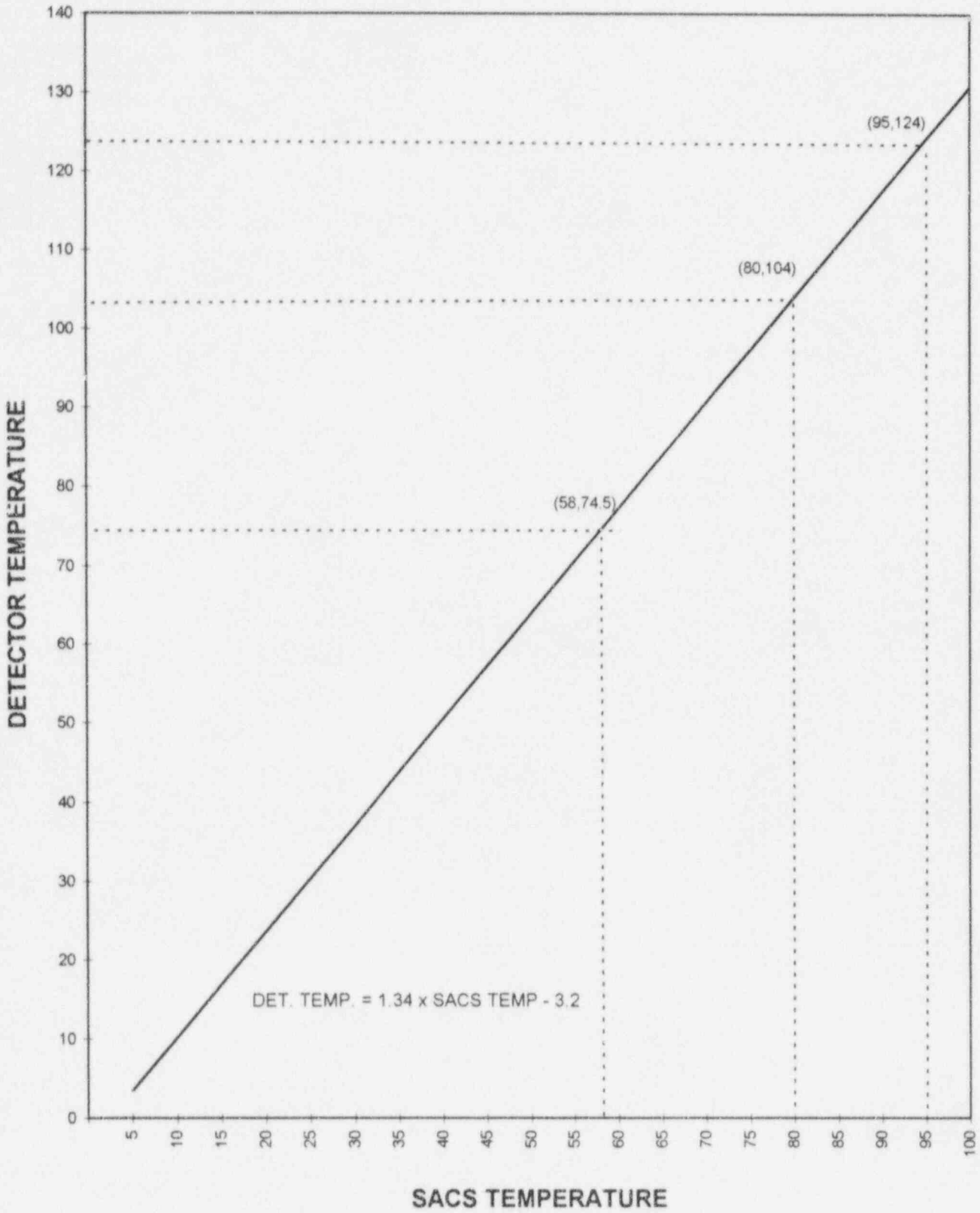
PSE&G has subsequently docketed information relative to the capability to shutdown the plant with various EDG combinations in justifying the extended allowed out of service times for the "C" and "D" EDGs. Although the September 13, 1984 letter indicated that shutdown of the plant requires only two diesel generator units in the same mechanical division (i.e., "A" and "C" or "B" and "D"), additional analysis has shown that the plant can be shutdown under LOP conditions with any two EDGs as long as one of the two is the "A" or "B" EDG (i.e., "A" and "B", "A" and "D" or "B" and "C" are also acceptable combinations).

4. Probability Information

A probabalistic safety assessment analysis has been performed to further support the acceptability of the docketed position provided by PSE&G in 1984. The probability of a LOP concurrent with an inadvertent actuation of an EDG fire suppression system concurrent with an additional single failure that results in both the "A" and "B" EDGs being unavailable is 2.5E-7 per fuel cycle (approximately one occurrence per 6 million years).

D. BASIS FOR PSE&G POSITION

Various documents include requirements and guidance associated with design of fire suppression systems and the impact of their inadvertent actuation on safety-related systems. Hope Creek is in compliance with its design and licensing basis for the EDG fire suppression system which includes docketed exceptions to provisions contained in some of the governing documents. PSE&G's position is that the design remains acceptable as is and that the basis for the exceptions remains valid.


DETECTOR TEMPERATURE
SACS TEMPERATURE
(95,124)
(80,104)
(58,74.5)
DET. TEMP. = 1.34 x SACS TEMP - 3.2
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100