Attachment 1
SAIC-92/6674

# SUPPLEMENTAL TECHNICAL EVALUATION REPORT

# CRYSTAL RIVER UNIT 3

# STATION BLACKOUT EVALUATION

TAC No. 68535

Science Applications International Corporation
An Employee-Owned Company

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# SUPPLEMENTAL TECHNICAL EVALUATION REPORT

## CRYSTAL RIVER UNIT 3
## STATION BLACKOUT EVALUATION

## 1.0 INTRODUCTION

The Nuclear Regulatory Commission (NRC) staff's safety evaluation (SE) of the licensee's response to the requirements of the station blackout (SBO) rule found Crystal River Unit 3 (CR#3) to not comply with the rule. The staff issued (1) a safety evaluation (SE) report on August 23, 1990, requesting that the licensee respond to the recommendations outlined in the SE within 30 days. The licensee in a letter dated October 22, 1990 (2) responded to the SE recommendations and provided additional information to comply with the requirements of the SBO rule. The staff reviewed the licensee's response and issued a supplemental safety evaluation (SSE) (3) which agreed in principal with the response statements, but requested additional clarifications and commitment from the licensee to close the concerns. The licensee's responses to the SSE were provided by letters from P. M. Beard, Jr. on June 13, 1991, G. L. Boldt on July 3, 1991, and P. M. Beard, Jr. on October 28, 1991, all to the Document Control Desk of U. S. Nuclear Regulatory Commission (4, 5 and 6).

The licensee's responses to the NRC's SSE were evaluated in accordance with the requirements of the SBO rule (7), and the guidance provided in Regulatory Guide (RG) 1.155 (8) and NUMARC 87-00 (9). The review approach is documented in references 7 through 9, and the technical evaluation report of the original licensee's submittal to the SBO rule (10). The results of this evaluation is given in the following sections.

## 2.0 EVALUATIONS

The licensee's responses to each of the staff's recommendations and clarifications are evaluated bellow:

### 2.1 SSE Issue, EDG Reliability Program, (SSE Section 2.1)

The NRC's SSE stated that the licensee should confirm that its EDG reliability program will be in accordance with NUMARC 87-00, Appendix D, as documented in the currently approved (November 1987) version of this document, which is equivalent to RG 1.155, Section 1.2.

**Licensee's Response**

The licensee stated that in order to maintain the committed EDG reliability of 0.975 it has implemented an EDG reliability and unavailability program, PT-354, effective January 4, 1991, which fulfills elements 1 through 4 of RG 1.155, Section 1.2. Element 5, management oversight, although not addressed in PT-354, is carried out through management review of corrective action plans following any diesel generator start or load-run failure. The licensee added pending issuance of RG 1.9, Revision 3, it will continue to use PT-354 to monitor EDG reliability, and upon final resolution of generic safety issue B-56 it will review the document and adjust the program accordingly, if needed.

**Review of the Licensee's Response**

We find this response to be in compliance with the recommended action.

## 2.2. SSE Issue, Class 1E Battery Capacity, (SSE Section 2.2)

The NRC's SSE stated that the licensee should specifically state that the updated battery calculations (load profile) will equal or envelope the load profile imposed by the normal battery-backed plant monitoring and electrical system controls in the control room during the SBO event.

### Licensee's Response

The licensee stated that the SBO battery calculation is being updated to reflect the revised coping strategy which will be implemented following the installation of the non-1E battery. The updated battery calculation (load profile) will equal or envelope the load profile imposed by the normal battery-backed plant monitoring and electrical system controls in the control room needed for the SBO. The licensee added that some unneeded loads may be manually stripped as allowed by NUMARC 87-00. This manual stripping (if any) will be reflected in the battery calculations.

### Review of the Licensee's Response

In an earlier response dated October 22, 1990, the licensee stated (2) that the updated battery calculation will be completed by March 31, 1991. However, in its response on June [illegible], 1991, the licensee stated (4) that the battery calculation is being updated and that it will meet the staff's concerns. In addition in both responses the licensee stated that some unneeded loads may be manually stripped. These statements lead us to conclude that the licensee does not have a complete picture of what is going to do, or how is going to meet the staff's concerns. It is our understanding that the licensee is using load shedding as a means to meet the recommendation. But, it is not clear what load, and when, is going to be shed. The licensee needs to be more direct on what has been done and what is required

to meet the concerns. In its calculation of battery capacity, the licensee needs to conform to the IEEE Std-485 recommendations on aging factor (1.25), design margin factor (1.10 to 1.15) and a temperature factor corresponding to the lowest temperature experienced.

## 2.3 Effects of Loss of Ventilation

### 2.3.1 SSE Issue, Control Room, (SSE Section 2.4)

The NRC's SSE stated that the licensee must inform the staff specifically how the control room temperature will be maintained at an acceptable level for the operators and to assure SBO equipment operability.

**Licensee's Response**

The licensee stated that the temperature in the control room will be maintained at an acceptable level for the operators and to assure SBO equipment operability by opening the control room doors to allow fresh air from turbine building to enter and by removing a limited number of ceiling tiles, allowing greater air circulation within the control room. The requirements for these actions will be incorporated into the SBO procedure.

**Review of the Licensee's Response**

It appears that the licensee is relying on the natural circulation of air through door opening to maintain the control room temperature at an acceptable level for both operators and equipment operability. Nowhere in its responses has the licensee stated that an analysis has been performed to support the conclusion made. Without such analysis, we can not concur with the licensee. In addition, removing the ceiling tiles to increase the heat sink area, i.e. use ceiling as

- additional heat sink, requires an analysis to determine how many, and from where, ceiling tiles should be removed. The analysis needs to assume an initial control room temperature bounded by that imposed by an administrative control.

2.3.2 **SSE Issue, Inverter Room, (SSE Section 2.4)**

The NRC's SSE stated that the staff does not consider the Arrhenius analysis appropriate, unless substantiated by the test results, for assessing the operability of inverters at temperatures substantially above their design or qualified temperature. Although NUMARC 87-00, Appendix F, notes that a margin above the continuous rating of the equipment may exist, it specifically notes that margins for electronic equipment are smaller than that for electromechanical devices. NUMARC 87-00 does not suggest that an Arrhenius methodology is appropriate for determining this margin. The staff is concerned that a sudden failure, not an aging type failure, would occur for an inverter when it reaches temperatures substantially above its qualified rating. The licensee must resolve this concern by, for example, providing appropriate cooling to the inverters, or demonstrating by test, that the inverters will not fail at the expected temperature plus a reasonable margin.

**Licensee's Response**

The licensee stated that it has performed an industry search and obtained a copy of a test report for a similar inverter manufactured by the same vendor (Solidstate Controls, Inc. (SCI) ) as the inverter at CR#3. The licensee added that the report documents the successful completion of two tests of eight hours each at a temperature in excess of the temperature calculated in the most recent revision of the inverter room heat-up calculation. The applicability of the test report to the inverter at CR#3 has been assessed using part numbers, materials, and design of electronic components in the tested inverter to that at CR#3 inverters. The

- licensee concluded that the test report is applicable to the CR#3 inverters as well. The licensee provided a copy of the most recent heat-up calculation along with the test report for staff's review.

**Review of Licensee's Response**

We reviewed the most recent heat-up calculation for the inverter room and the justifications for the inverters operability at the calculated temperature. The calculation is slightly different from that provided by the licensee during August of 1989. This calculation uses an average wall temperature approach to determine an aggregate wall surface temperature, whereas in the previous analysis the calculation used a single wall temperature of 90°F. This new approach reduces the wall surface temperature by 2.12°F. This reduction in temperature results in a final temperature of 138.60 °F, or less than 140°F.

To support the operability of the inverters at 138.6°F temperature, the licensee found a qualification test report on a 7.5 kVA SCI inverter at 140°F. The test was performed by Wyle Laboratories. The report stated that operability tests were performed after the inverter and the connected load were exposed to 140°F and 100% non-condensing relative humidity for a duration of eight hours both before and after a seismic simulation. The report added that during each temperature plateau the inverter was kept operating with a constant input and output voltage. The report concluded that the inverter operated within the specification of maintaining the output within 3% of 120 VAC. The licensee stated that it had compared the equipment (components such as: print boards, capacitors electrolytes, resistors , silicon-controlled rectifies, etc.) used in the test and that exists at CR#3 inverters and determined that they are the same. The licensee concluded that the test results are applicable to the inverters at CR#3.

Based on the licensee's confirmation of similarity between the tested inverter and

the existing inverters at CR#3, it appears that the inverters will remain operational at 140°F. However, there are concerns that need to be resolved before concurring with the licensee. They are: what vintage (recent, or old, design) was the tested inverter in comparison to that at CR#3, should aging of the component be considered as a potential degradation of operability at high temperature, and was the test performed with the inverter back panel closed. The vintage of the inverter is an important issue because of the major advancement in electronic equipment which allows the operability at higher than qualified temperature. The status of the inverter back panel during the test is important since it will affect the operating temperature inside the inverters. If the back panel was closed then the test temperature can be used. If not, then the test temperature will not be applicable, since there is a 10°F to 15°F temperature difference between the ambient and that inside the inverter cabinet. The above concerns need to be addressed by the licensee.

Finally, the aging effect causes the equipment to be more sensitive to extreme changes in both temperature and loads. The licensee stated that under the current preventive maintenance (PM) program some of the temperature sensitive components are replaced at a shorter operating interval than that recommended by the manufacturer. In addition, every two years the inverters are cleaned for reducing dirt accumulation on the electronic circuit boards. The licensee claims this PM reduces the aging effect. This argument appears to be reasonable.

2.4 **SSE issue, Reactor Coolant Inventory, (SSE Section 2.6)**

"The NRC's SSE requested that the licensee provides a copy of the reactor coolant inventory analysis, or a summary of the assumptions used and results obtained, since this was not available during the staff's original audit.

## 3.0 CONCLUSIONS

Our review of the licensee's responses to the staff's SE and SSE recommendations, as documented in Section 2, finds the following concerns which the licensee needs to address in order to comply with the requirements of the SBO rule.

### 1. Class 1E Battery Capacity

The licensee's statements on battery capacity lead us to conclude that the licensee does not have a complete picture of what is going to do, or how is going to meet the staff's concerns. It is our understanding that the licensee is using load shedding as a means to meet the recommendation. But, it is not clear what load, and when, is going to be shed. The licensee needs to be more direct on what has been done and what is required to meet the concerns. In its calculation of battery capacity, the licensee needs to conform to the IEEE Std-485 recommendations on aging factor (1.25), design margin factor (1.10 to 1.15) and a temperature factor corresponding to the lowest temperature experienced.

### 2. Effects of Loss of Ventilation

a. Control Room

It appears that the licensee is relying on the natural circulation of air through door opening to maintain the control room temperature at an acceptable level for both operators and equipment operability. Nowhere in its responses has the licensee said that an analysis has been performed and that the analysis confirmed the conclusion made. Without such analysis, we can not concur with the licensee. In addition, removing the ceiling tiles to increase the heat sink area requires an analysis to determine how many,

and from where, ceiling tiles should be removed. The analysis needs to assume an initial control room temperature bounded by that imposed by an administrative control.

b. Inverter Room

The licensee re-calculated the inverter room heat-up using an average wall temperature approach to determine an aggregate wall surface temperature, and found the final room temperature to be 138.60 °F. To support the operability of the inverters at 138.6°F temperature, the licensee found a qualification test report on a 7.5 kVA SCI inverter at 140°F. The report added that during each temperature plateau the inverter was kept operating with a constant input and output voltage. The licensee stated that it had compared the equipment (components such as: print boards, capacitors electrolytes, resistors , silicon-controlled rectifies, etc.) used in the test and that exists at CR#3 inverters and concluded that they are the same, therefore, the results of the test report are applicable to CR#3 inverters.

Based on the licensee's confirmation of similarity between the tested inverter and the existing inverters at CR#3, it appears that the inverters will remain operational at 140°F provided that:

1. the inverter back panel was closed during the test, and

2. the vintage of the tested inverter is similar to that used at CR#3.

## 4.0 REFERENCES


1. "Crystal River Unit 3 - Safety Evaluation Response to Station Blackout Rule (TAC No. 68535)," dated August 23, 1990.

2. Beard, Jr. P. M. Letter to the Document Control desk of US Nuclear Regulatory Commission, "Station Blackout Rule Implementation," dated October 22, 1990.

3. "Supplemental Safety Evaluation of Crystal River Unit 3 Nuclear Power Plant Response to the Station Blackout Rule," dated June 6, 1991.

4. Beard, Jr. P. M. Letter to the Document Control desk of US Nuclear Regulatory Commission, "Station Blackout Rule Implementation," dated June 13, 1991.

5. Boldt, G. L. Letter to the Document Control desk of US Nuclear Regulatory Commission, "Station Blackout Rule Implementation," dated July 3, 1991.

6. Beard, Jr. P. M. Letter to the Document Control desk of US Nuclear Regulatory Commission, "Station Blackout Rule Implementation," dated October 28, 1991.

7. The Office of Federal Register, "Code of Federal Regulations Title 10 Part 50.63," 10 CFR 50.63, January 1, 1989.

8. U.S. Nuclear Regulatory Commission Office of Nuclear Regulatory Research, "Regulatory Guide 1.155 Station Blackout," August 1988

9. Nuclear Management and Resources Council, Inc., "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," NUMARC 87-00, November 1987.

10. SAIC-89/1150, Revision 1, "Technical Evaluation Report, Crystal River Unit 3, Station blackout Evaluation," dated July 11, 1990.

This completes our efforts on TAC No. M68535.

Sincerely,

/S/
Harley Silver, Sr. Project Manager
Project Directorate II-2
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosure:
Supplemental Safety Evaluation
w/attached TER

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