SUPPLEMENTAL TECHNICAL EVALUATION REPORT

WOLF CREEK GENERATING STATION

STATION BLACKOUT EVALUATION

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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 Wolf Creek Generating Station (WCGS) to not comply with the rule. The staff issued (1) a safety evaluation (SE) report on January 16, 1992, requesting that the licensee respond to the recommendations outlined in the SE within 60 days. The licensee's response to the SE was provided by a letter from F. T. Rhodes, on March 24, 1992 to the Document Control Desk of U. S. Nuclear Regulatory Commission (2).

The licensee's responses to the NRC's SE were evaluated in accordance with the requirements of the SBO rule (3), and the guidance provided in Regulatory Guide (RG) 1.155 (4) and NUMARC 87-00 (5). The review approach is documented in References 3 through 5, and the technical evaluation report of the original licensee's submittal to the SBO rule (6). 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 below:

2.1 SE Issue, Tornado Frequency, (SE Section 2.1)

The licensee's use of a tornado frequency different from that provided in NUMARC 87-00, Table 3-3, resulted in a site severe weather (SW) classification of "2" and an offsite power characteristic "P1," needing a four-hour SBO coping duration with a 0.95 emergency diesel generator (EDG) target reliability. The licensee did not state why the tornado frequency that it used is different from that provided in NUMARC, and it did not respond to a request for additional information. Use of NUMARC data places the site in an SW group "3" resulting in a "P2" offsite power characteristics and an eight-hour SBO coping duration. Based on this finding, the NRC's SE stated that the licensee needs to change the EDG target reliability from 0.95 to 0.975 in order to remain a four-hour SBO coping duration plant. Alternatively, the licensee needs to re-evaluate the plant coping capability for an eight-hour SBO duration.

Licensee's Response

The licensee stated that based on the guidance of NUMARC 87-00, Section 3.2.1, the expected frequency of tornadoes with wind speeds greater than or equal to 113 miles per hour is estimated using site specific data. The licensee added that the tornado data were taken from a tornado frequency study appearing in NUREG/CR-4461 (7), and from one performed by the National Severe Storm Forecast Center (NSSFC). The licensee stated that its calculation of annual expected frequency of tornadoes (intensity level F2 and greater) using the information given in the two studies resulted in values ranging from 1.909 E-04 to

3.282 E-04 per year per square mile. Using the maximum calculated value for the tornado frequency [3.282 E-04], along with other parameters given in Table 3-3 of NUMARC 87-00, the site SW frequency was estimated to be 0.00946, which places the plant in an SW group "2," based on the criteria given in Table 3-4 of NUMARC 87-00. Therefore, WCGS would remain as a four-hour SBO coping duration plant with an EDG target reliability of 0.95.

Review of Licensee's Response

We reviewed the licensee's calculations of tornado frequency for the Wolf Creek site. The licensee used three tornado data summaries, one for Kansas State, and one for a 5° Box centered at 37.5° Latitude (or North) and 97.5° Longitude (or West), both given in the NUREG/CR-4461 report, and the third from NSSFC for tornadoes which occurred within 125 nautical miles of Burlington Kansas. Wolf Creek plant is located 4 miles northeast of Burlington Kansas, and it is within the 5° Box region chosen above. The licensee calculated the average tornado frequency per year per square mile using the following expression:

$$P = N / (A_T \times N_y) \qquad (1)$$

Where: P is the tornado strike frequency per year per square mile, N is the number of tornado events of F2 and higher category (corresponding to the tornadoes with wind speeds greater than or equal to 113 mph), A_T is the area of the region and N_y is the number of years in the period of record for which the tornado area is determined.

The method used by the licensee appears to be simplistic and non-conservative. However, further review of the acceptable techniques for calculating the tornado frequency, as explained below, indicate that the licensee's method is reasonable. The NUREG/CR-4461 report documents the average and the expected tornado

strike frequencies for different areas within the contiguous United States. The tornado strike frequency (per year), in a simple terms, is calculated using the following expression:

$$P_{si} = N_i \times E[A_i] / (A_T \times N_y); \quad i = 0,1,2,...,5 \qquad (2)$$

Where: P_{si} is the tornado strike frequency per year, N_i is the number of tornado events of category F_i, $E[A_i]$ is the expected (or the average) strike area of F_i category tornadoes, A_T is the area of the region and N_y is the number of years in the period of record for which the tornado area is determined.

The relation between expression (1) and (2) is as follows:

$$P = \sum P_{si} / E[A_i]; \text{ for } i = 2,...,5 \qquad (3)$$

It is clear from expression (3) that the method used by the licensee is consistent with that used in NUREG/CR-4461. Therefore, we conclude that the licensee's calculation of SW frequency to be correct, and the plant will remain in a four hour coping duration.

2.2 **SE Issue, Class 1E Battery Capacity, (SE Section 2.2.2)**

The NRC's SE stated that the licensee should describe the load profile, method and assumptions (e.g. temperature correction factor, design margin, aging factor) which were used to determine that the battery capacity is adequate for four hours. [If the calculation package provides this information, the licensee should provide the package for the staff review.]

Licensee's Response

The licensee stated that the worst case equipment load profile for Class 1E batteries, as shown in the plant Updated Safety Analysis Report (USAR) Table 8.3-2 and 8.3-3, was extended from 200 minutes to 240 minutes. This load profile is conservative for an SBO event. The licensee added that Batteries 1 and 4 are of NCX-1650 type which provide a total of 1650 ampere-hours in an eight hour period. Batteries 2 and 4 are of type NCX-900, providing 900 Ampere-hours in an eight hour period. The 200-minute load profile for Batteries 1 and 4 yields a battery demand of 737 Ampere-hours, which increases to 885 Ampere-hours for 240 minutes. Similarly, Batteries 2 and 4 have a 200-minute battery demand of 333 Ampere-hours, which increases to 400 Ampere-hours for 240 minutes. These demand capacities are much smaller than the battery capacities. The licensee added that after using a temperature correction factor of 1.11 (corresponding to a 60 °F temperature) and an aging factor of 1.25, an excess design margin of 12.8% and 36.2% will be available for the battery set No. 1 and No. 4, and the battery set No. 2 and No. 3, respectively.

Review of the Licensee's Response

The load profile given in USAR for batteries 1 and 4, which was extended to 240 minutes to verify that the batteries have sufficient capacity to support the needed SBO loads, assumes a set of transitory loads for circuit breaker operation, EDG field flashing, load shedder and emergency load sequencer, and EDG control panel to be occurring at 1, 139, 200, 240 minutes. (The USAR load profile only goes up to 200 minutes.) The licensee considered the sum of the transitory loads to be 84 Amperes, stating that the transitory loads are sequenced and therefore are not additive loads. Although we agree in principal with the licensee's statement, we cannot accept it without having a load signature which demonstrate the discrete timing of each transitory loads. In absence of such information, we

need to consider the transitory loads to be additive. On the other hand, we only need to consider the transitory loads to occur in the first minute and do not need to be repeated for the entire SBO event. Instead, we need to consider a random load to represent the load required to bring and/or provide AC power to the emergency buses at the end of an SBO event. This load is either that required for EDG to be started, or that required to perform circuit breaker operation to bring offsite power to the emergency buses, (at least one train of buses).

We performed an independent battery sizing calculation for the Wolf Creek batteries considering the loads provided by the licensee are accurate. In our calculation the load profile for Battery 1 and 4 was changed to capture the shortcomings discussed above. First we added all the transitory loads for a sum of 205 Amperes and added to the continuous load [214 A] during the first minute. Therefore, the new one-minute load is 121 Amperes more than that given by the licensee. Second, we added a total of 60 Amperes to the last minute load for a total of 280 Amperes, and considered a continuous load of 220 Amperes for the remaining period, i.e from 2 to 238 minutes. The last minute load, or the random load, is the sum of loads needed for circuit breaker operations which is more than the that required for the EDG operation [56 Ampere].

Knowing that Battery 1 and Battery 4 are of NCX-1650 type, we performed a sizing calculation using the recommended technique given in IEEE Std-485. Our calculation indicates that after using an aging factor of 1.25 and a temperature factor of 1.11, Battery 1 and Battery 4 will have an excess design margin of 8.48%. A calculation for Battery 2 and Battery 3 resulted in an excess margin of 36.8%. All the calculations were performed assuming the batteries will be discharged to 1.750 VDC per cell.

Based on the above we conclude that the batteries have sufficient capacity to support the loads for four hours. This conclusion is dependent on that the given

loads are accurate and contain the needed SBO loads. For example, the load listing does not identify the emergency lighting loads except for the control room lighting. We have considered that the plant is equipped with sufficient battery-pack lighting to eliminate the need for the Class-1E battery supported lighting. In addition, we have considered that the minimum battery voltage of 1.75 VDC/cell would not result in a battery terminal voltage below that required for proper operation of SBO equipment. The licensee needs to verify the accuracy of our considerations.

2.3 **SE Issue, Compressed Air (SE Section 2.2.3)**

The NRC's SE stated that the licensee should ensure that the habitability of areas where air operated valves will be manually operated during an SBO event.

Licensee's Response

The licensee stated that the air operated valves needed for the operation of the decay heat removal system, i.e. auxiliary feedwater (AFW) system, are either supplied with backup compressed air or fail in safe positions for the operation. The steam supply valves to the AFW turbine fail open upon loss of air, ensuring the steam supply to the turbine, and no manual action would be needed. The turbine discharge valves and the steam generator atmospheric dump valves (ADVs) have backup compressed gas supply.

The licensee added that the backup supply gas consists of four 25 cubic feet accumulators which are passively connected to the ADVs and AFW discharge valves air supply. If the normal air supply drops below 100 psig the accumulators will provide backup compressed gas. This backup system is designed to provide an eight hour supply of compressed gas. This time frame is based on 20 minute

cycling of AFW valves and 10 minute cycling of ADVs. This time frame exceeds the required coping duration, and no manual action of these valves are needed.

Review of Licensee's Response

We find the licensee's response to be in compliance with the SBO rule.

2.4 **SE Issue, Loss of Ventilation, (SE Section 2.2.4)**

Per NRC staff request no review of this issue was performed.

2.5 **SE Issue, Quality Assurance and Technical Specifications, (SE Section 2.5)**

The NRC's SE stated that the licensee should verify that the SBO equipment is covered by an appropriate QA program consistent with the guidance of RG 1.155, Appendix A. This evaluation should be documented as part of the documentation supporting the SBO rule/response.

Licensee's Response

The licensee stated that upon identification of any non-safety-related equipment or systems that are required to meet the requirements of 10 CFR 50.63, a special scope QA program to meet the requirements of RG 1.155, appendix A will be developed.

Review of Licensee's Response

The licensee's response does not clearly state the status of the action requested in SE by the staff. We interpreted the licensee's response to mean that, at present time, the plant SBO equipment is covered by the QA program of 10 CFR Part 50

Appendix B or Appendix R. The licensee needs to be direct in its response and state that all SBO equipment is covered, or if not, identify the component and provide an appropriate QA program.

2.6 **SE Issue, EDG Reliability Program, (SE Section 2.6)**

The NRC's SE stated that the licensee should confirm that its EDG reliability program will be in accordance with the guidance of RG 1.155, Section 1.2. If an EDG reliability program currently exists, the program should be evaluated and adjusted in accordance with RG 1.155. Confirmation that such a program is in place or will be implemented should be included in the documentation that is to be maintained in support of the SBO submittal.

Licensee's Response

The licensee stated that monitoring of EDG reliability at WCGS is performed in accordance with the administrative procedure ADM 01-244, "Emergency Diesel generator Reliability Monitoring Program." This procedure evaluates EDG start attempts to determine if a failure has occurred and compare failures in the last 20, 50, and 100 demands with trigger values as described in NUMARC 87-00, Appendix D. Escalating corrective actions are required based on the number of trigger values reached following a failure. This procedure meets the guidance of RG 1.155, Position 1.2.

Review of licensee's Submittal

The licensee stated that the current EDG reliability program is based on the guidance of NUMARC 87-00, Appendix D, and added that it meets the guidance of RG 1.155, Position 1.2. This statement is consistent with the recommended action. However, the licensee should be aware that the acceptable EDG

reliability procedure, pending resolution of the generic safety issue B-56, is the five steps identified in RG 1.155, Section 1.2. The licensee needs to confirm that these steps are covered in its EDG reliability program.

3.0 CONCLUSIONS

Our review of the licensee's responses to the staff's SE 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

Our review concludes that the batteries have sufficient capacity to support the loads for four hours. This conclusion is dependent on that the given loads are accurate and contain the needed SBO loads. For example, the load listing does not identify the emergency lighting loads except for the control room lighting. We have considered that the plant is equipped with sufficient battery-pack lighting to eliminate the need for the Class-1E battery supported lighting. In addition, we have considered that the minimum battery voltage of 1.75 VDC/cell would not result in a battery terminal voltage below that required for proper operation of SBO equipment. The licensee needs to verify the accuracy of our considerations.

2. Effects of Loss of Ventilation

Per staff request no review was performed.

3. Quality Assurance and Technical Specifications

The licensee's response does not clearly state the status of the action requested in SE by the staff. We interpreted the licensee's response to mean that, at present time, the plant SBO equipment is covered by the QA program of 10 CFR Part 50 Appendix B or Appendix R. The licensee

needs to be direct in its response and state that all SBO equipment is covered, or if not, identify the component and provide an appropriate QA program.

4. EDG Reliability Program

The licensee stated that the current EDG reliability program is based on the guidance of NUMARC 87-00, Appendix D, and added that it meets the guidance of RG 1.155, Position 1.2. This statement is consistent with the recommended action. However, the licensee should be aware that the acceptable EDG reliability procedure, pending resolution of the generic safety issue B-56, is the five steps identified in RG 1.155, Section 1.2. The licensee needs to confirm that these steps are covered in its EDG reliability program.

4.0 REFERENCES

1. "Wolf Creek Generating Station, Safety Evaluation Report in response to Station Blackout Rule," dated January 16, 1992.

2. Rhodes F. T. Letter to the Document Control desk of US Nuclear Regulatory Commission, "Response to request for additional information on the Station Blackout Analysis for the Wolf Creek Generating Station," dated March 24, 1992.

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

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

5. 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.

6. SAIC-91/1255, "Technical Evaluation Report, Wolf Creek Generating Station, Station blackout Evaluation," dated December 17, 1992.

7. NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," Prepared by J. V. Ramsdell and G. L. Andrews, dated May 1986.