WOLF CREEK
NUCLEAR OPERATING CORPORATION

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Chairman, President and
Chief Executive Officer

March 26, 1996

WM 96-0042

U. S. Nuclear Regulatory Commission
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Washington, D. C. 20555

Reference: Letter dated March 7, 1996, from J. L. Callan NRC, to N. S. Carns WCNOC
Letter WM 96-0038 dated March 15, 1996, from N. S. Carns WCNOC, to USNRC

Subject: Docket No. 50-482: Wolf Creek Generating Station Icing Event Restart Issues

Gentlemen:

Wolf Creek Nuclear Operating Corporation (WCNOC) is submitting this letter to provide additional information related to restart issues 1, 2, and 3, which was identified and discussed in the above referenced documents. This information provides: the details contained in the March 15, 1996, WCNOC Letter for restart issues 1, 2, and 3. In addition this letter provides: 1) correction of the incorrect Essential Service Water flow rate discussed in the previously issued response restart issue 1; 2) Supporting information for restart issue 2, related to the apparent impromptu alignment of the Essential Service Water System on January 30, 1996; and 3) The revised root cause evaluation for the improper positioning of an ESW Warming Line Valve.

If you should have any questions regarding this response, please contact me at (316) 364-8831, extension 4100, or Mr. William M. Lindsay at extension 8760.

Very truly yours,

Neil S. Carns

Neil S. Carns

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NSC/jad

Attachment

cc: L. J. Callan (NRC), w/a
W. D. Johnson (NRC), w/a
J. F. Ringwald (NRC), w/a

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Restart Issue No. 1: "Essential service water system; adequacy of design and operation for anticipated weather"

WCNOC Reply:

Root Cause and Contributing Factors:

Root Cause:

The root cause of this event is the inadequate design of the Essential Service Water (ESW) system to operate in a cold environment that leads to frazil ice formation. There was insufficient Warming Line flow for the Warming Line temperature to prevent the formation of frazil ice.

During the original design, the potential for frazil ice formation was recognized, but was thought to be addressed adequately by the design of the ESW Warming Line and the spacing of the trash rack bars. During April and May of 1976, the Architect Engineer (A/E) performed an evaluation on the potential for frazil ice formation at the Wolf Creek Generating Station (WCGS) ESW Pumphouse. As a result of this evaluation, the A/E changed the location of the Warming Lines to position them directly in front of the trash racks. A design calculation performed during this evaluation assumed an ESW Warming Line temperature of 35°F. With this assumption, the calculation determined a flow of 4000 gpm was required. Later, a design calculation determined that actual flow would be 4800 gpm with the additional assumption that the pipes would be full of water. The above assumptions were incorrect. The Warming line temperature on the morning of January 30, 1996, was approximately 33°F. It was also discovered that the Warming Line and the ESW to Ultimate Heat Sink (UHS) return line piping diameters and elevations are such that portions of these lines operate with partial pipe flows. This condition was apparently not foreseen by the piping designer, and makes the calculation methodology used for sizing the Warming Line invalid with resulting non-conservative errors. Actual flows were not able to be accurately measured, but all estimates of flow indicated insufficient heat addition to prevent frazil ice.

Contributing Factors:

The incorrect ESW valve line-up for several hours during this event and the subsequent failure to verify and correct this misalignment in a timely manner were contributing causes to the ice build-up at the ESW trash racks. During the approximately six hour period preceding the first time "A" ESW pump had to be secured due to the ice blockage, ESW return to service water (SW) return cross tie isolation valves were open and the ESW return to the UHS valve was throttled. This caused some of the ESW return flow to be diverted from UHS through the normal SW discharge line.

Short Term Corrective Actions:

Personnel were dispatched to the ESW Pumphouse to determine the cause and implement actions to restore the pump suction bay level.

These subsequent actions included: the erection of a temporary shelter over the external bays to minimize heat losses; the procurement and installation, on an interim basis, of portable space heaters and heater blowers to warm the air in the ESW Pumphouse and suction bays; the procurement and installation of portable air compressors, an air bubbler system, and portable water boilers. These items were used to inject air and warm water into the outside bays of the ESW Pump to aid in the agitating/breakup and removal of the frazil ice. After briefing and training a team of individuals, WCNOC established a 24 hour watch of the temporary equipment installed at the ESW Pumphouse and bays to assure continuous proper operation of the equipment and to inform the Control Room of any equipment degradation.

With the knowledge gained from the investigation, the incident investigation team (IIT) has recommended additional compensatory enhancements to ensure frazil ice blockage of the ESW intake trash racks does not occur until a permanent design solution can be implemented. Incorporation of these enhancements gives additional interim assurance for frazil ice mitigation into the ESW Pumphouse:

1. Verify proper valve and system lineup to maximize warming flow to the ESW bays whenever ESW Pump are running.
2. Install temporary heating equipment in the ESW screen bay area to reduce the likelihood of ice formation on the traveling screens.
3. Provide a means to clean the front of the ESW trash racks. This can be accomplished by installing temporary air sparging in each bay to "broom" the front of the trash rack and/or by use of a trash rack rake.
4. To provide early detection of active frazil ice formation while the ESW Pump are running, immerse a metal chain several feet into the trash rack bay water and monitor for ice accumulation.
5. Install tents over the grating of the bay to provide wind protection for personnel assigned to monitor ESW bay conditions and to help prevent surface ice formation. This is to assist in detection and cleaning of the trash racks should frazil ice begin to form.

6. Station a dedicated cognizant individual at the ESW Pumphouse while the ESW Pump are operating. This individual will: 1) Monitor the sparging air compressors, 2) Monitor the tents, and 3) Watch for formation of ice on the traveling screens, screen wash discharge, and trash racks. Notification of the Control Room will occur immediately upon compressor failure, tent degradation or detection of ice formation.
7. Install high intensity lights for observing and cleaning of trash racks and traveling screens.

Recommendations 1 through 7 were incorporated, with implementing details, into a "Contingency Plan For Ice Prevention Measures At The ESW Intake," dated February 24, 1996.

From the experience gained from the icing event, performance of these measures provides assurance that these temporary measures are adequate compensation until the design deficiency can be corrected.

Long Term Corrective Actions:

1. A Design Change Package (DCP 06349) will be developed to ensure adequate Warming Line flow. The hydraulics of the ESW discharge to the UHS and the Warming Line to the ESW Pumphouse will be changed to distribute the proper amount of flow to the ESW suction bay. Due to the low amount of heat (~3/4°F) available from the unloaded safety train, a higher flow rate than the original design 4,000 gpm will be required. The upper bound for this Warming Line flow will be dictated by the UHS cooling characteristics and the temperature range chosen for this mode of operation. To achieve the proper flow, back pressure on the ESW discharge to the UHS will be raised downstream of the Warming Line tee. The back pressure orifices, Flow Element 3 and 4 (FE-3/4), located upstream in the ESW discharge lines, will be re-sized, so that flow through the ESW System is not reduced to an unacceptable level. Back pressure in the Warming Line will also be raised to achieve full pipe flow without sending too much water through the Warming Line. A computer analysis of the ESW System out to the UHS and the Warming Line has been completed. Numerous variables are being fine tuned to determine the size of both the UHS orifice and the new FE-3/4 orifices as well as the expected throttle positions of key valves. The final sizing is expected to be complete before the end of March. The desired goal is to develop full pipe flow with approximately 5000 gpm through the Warming Line. DCP 06349 will establish the new design basis for these flow rates and related temperatures. The design is underway and will be implemented in both trains as soon as practical, but not later than October 1, 1996.

2. Lake water temperature indication is being incorporated into the WCNOC design basis by DCP 06447. This DCP will also include pump suction temperature and Warming Line flow temperatures. The potential for frazil ice is significant when bulk lake water temperature is at 33°F and decreasing. Very small changes in temperature when the water is in the 32°F range can trigger frazil ice production. It is WCNOC's intent to install the most accurate and precise indication reasonably attainable. This design is underway and will be implemented on or before October 1, 1996.
3. The Probabilistic Safety Assessment (PSA) model for ESW did not include the Warming Lines in the fault tree. The ESW/SW model will be revised to include the Warming Lines and a total loss of all service water (ESW & SW). This will be done by the end of June 1996.
4. Other issues are being evaluated at this time to determine the cost/safety benefit and feasibility of implementing them. The first is permanent flow monitoring of the Warming Line. The configuration is less than ideal and periodic use of a Controlatron or similar test instrument may be a better option. Another issue is the need for a permanent air bubbler design. It is WCNOC's intent to avoid the formation of frazil ice in its entirety. If this can be confidently achieved, air bubblers are not needed. Development of a cover for the trash racks is also being evaluated. This evaluation will also include any required area lighting, bay level indication or non-safety related general area supplemental heat. These evaluations are underway and will be implemented, as deemed appropriate, on or before October 1, 1996.

Projected Completion Date:

All activities related to this restart issue will be worked aggressively. On or before October 1, 1996, the ESW System will be modified to function properly in a cold weather environment conducive to frazil ice formation.

Restart Issue No. 2: "Essential service water system misalignment on January 30, 1996; corrective actions to address impromptu alignment, lack of self-checking, shift turnover and command and control weaknesses, teamwork weakness, incomplete operations shift communications (including relief crew communications), lack of questioning attitude by operators and supervisors"

WCNOC Reply:

Root Cause and Contributing Factors:

Background:

The starting of the ESW System was performed by reference to alarm response procedure ALR 00-008B, "Service Water Pressure HI LO." Prior to the event, this procedure directed that ESW be placed in service in accordance with system operating procedure SYS EF-200, "Operation of the ESW System." The Shift Supervisor determined that the delay which would be encountered by printing SYS EF-200 from the filenet computer or using a reference procedure would allow additional unnecessary degradation of plant conditions, and directed that ESW be placed in service immediately. This directive carried with it the Shift Supervisor's understanding that the SYS EF-200 would be used to verify system alignment at a later time. The ESW System was aligned improperly. The valve misalignment was discussed during turnover, and subsequently corrected by a different crew after shift turnover.

WCNOC's Evaluation (Impromptu Alignment):

Operation of systems/equipment in an impromptu manner is not an acceptable practice at Wolf Creek Generating Station (WCGS).

The Essential Service Water (ESW) System is normally in a standby condition with the ESW loads supplied from the Service Water System (SW).

The Shift Supervisor (SS) directed the Reactor Operator (RO) to immediately start ESW in order to split safety-related heat loads (ESW) from nonsafety-related heat loads (SW). As a consequence of this directive the heat load on the SW System was reduced. Had this expectation been met, the ESW System would have been aligned in its safeguards configuration (EF HV-23, 24, 25, and 26 closed, ESW Pumps running, EF HV-37 and 38 open, EF HV-39, 40, 41 and 42 closed). The SS on duty at the time of the event re-confirmed his intent to place the ESW System in the safeguards configuration in a telephone conversation March 20, 1996 at 0845 hours.

The RO who performed the alignment believed he was placing the ESW System in a configuration allowed by plant procedures. The WCNOC Incident Investigation Team (IIT) review of the event determined that no procedure existed to support this ESW System configuration.

During interviews conducted by the IIT, the RO stated that he felt the ESW lineup helped the SW System. Starting ESW and isolating ESW from SW protects the safety related components and reduces the heat load on the SW System. After starting ESW, the safety-related heat loads are placed on the ESW System leaving only the nonsafety-related heat loads on SW. To further clarify this statement, the RO on duty at the time of the event was contacted at 1300 on 3/20/96.

The RO felt that the configuration he placed the system in was acceptable and covered by a procedure. He specifically stated that he never intended to operate the plant outside a procedurally approved configuration. The RO was fully aware that with EF HV-37 and 38 closed, the valves were actually in a throttled position (90% and 65% respectively). With EF HV-37 and 38 in the throttled condition, the RO believed there was considerable warming line flow. This was later determined to be incorrect. After the ESW System was aligned, the RO began to look at the ESW SYS procedures to verify the lineup was allowed by procedure. His attention was diverted from this task when the SS directed the crew to commence a power reduction.

There is no indication that the SS or SO intended to operate the ESW System in other than its safeguards condition. An error in the system alignment did occur and opportunities to promptly correct the misalignment were missed. The misalignment was discovered and subsequently corrected after shift turnover. The root cause, contributing factors, and corrective actions for the failure to promptly verify system alignment are discussed below.

Root Cause:

The root cause of the misaligned system was a failure to follow-up using an approved procedure, after aligning the ESW System for operation.

Contributing Factors:

A failure to correct the misalignment during the turnover process.

A failure to provide the necessary actions in the ALR, instead of referencing the SYS Procedure.

Weak teamwork skills, incomplete communications, lack of self-checking, inconsistent questioning attitude, incomplete shift turnover and command and control weaknesses.

Short Term Corrective Actions:

Administrative Procedure (AP) 15C-002, "Procedure Use and Adherence," has been revised to strengthen Management's expectations regarding follow-up activities by specifying the Shift Supervisor or Supervising Operator may direct operating personnel to take expedient actions which minimize the possibility for personal injury or damage to equipment. If these actions are performed without referencing an approved procedure, the Shift Supervisor shall ensure that the following actions are implemented:

1. Engineering evaluations of the effects of any abnormal equipment/system operation, as soon as practical.
2. Return equipment/system to an approved lineup or initiate appropriate procedure changes, as soon as practical.
3. Magnetic lamacoid "follow-up buttons" have been provided in the Control Room for use by the operating crews in identifying items for which a follow-up review is required.

Operations Management will re-enforce the procedure use expectations with the operating crews. This briefing will discuss the following expectations from AP 15C-002, "Procedure Use and Adherence," and AP 21-001, "Operations Watchstanding Practices:"

1. Continuous use versus reference use requirements (AP 15C-002; paragraphs 6.1, 6.2)
2. General requirements for procedure use (AP 15C-002, paragraph 6.3)
3. Use of "not applicable," (N/A) (AP 15C-002, paragraph 6.6)
4. Shift relief and turnover (AP 21-001, paragraph 6.1)
5. Conduct of operations personnel (AP 21-001, paragraph 6.4)
6. Communications (AP 21-001, paragraph 6.4.2)
7. Main control board walkdowns (AP 21-001, paragraph 6.4.5)
8. Control Room board awareness (AP 21-001, paragraph 6.4.6)
9. Supervisory monitoring and coaching (AP 21-001, paragraph 6.4.8)
10. WCNOC's self checking program [Stop Think Act Review (STAR)] (AP 21-001, paragraph 6.4.9)

This briefing will also address the issues of communications and teamwork, with augmented crews. In addition, Management will re-enforce the use of operations' divisional standards (STAR, safety, communications, questioning attitude, attention to detail, and housekeeping). A seventh operations division standard, follow-up, has been added.

Long Term Corrective Actions:

An upgrade of Control Room ALRs has been initiated. The goal of this review is to identify all ALRs which refer to other procedures for specific instructions on how to align systems. ALRs which require short term operator actions important to aligning the system promptly, will be revised to include the specific actions or steps required. This will replace the reference to a SYS Procedure. Each ALF which fits this criteria will be evaluated to determine the acceptability of continued reference to other procedures. To date, fifteen ALRs which include those important to mitigating events that could occur during eighth refuel outage, have been revised. This number also includes all ALRs which address ESW, CW, or SW.

To further strengthen communications, a "codeword" is being developed for use by any operator. When implemented, an operator who states the codeword, will immediately become the focus of attention for the Control Room. At that time, the operator will state the concern. An evaluation of that concern will be made by shift supervision, and appropriate follow-up actions put in place. The "follow-up buttons" previously mentioned will be utilized to identify items which cannot be immediately addressed. The use of the "codeword" concept will be reviewed after six months to determine its effectiveness.

Training will be provided to re-enforce current Management expectations (operations watchstation practices, procedure use and adherence, and divisional standards), and to re-enforce the use of the "follow-up button" and "codeword" concepts. A pilot program will develop a protocol of behavior that recognizes and appropriately responds to the unexpected. This will involve the interjection of some pre-planned inappropriate action or verbal response by a crew member. The intent is to establish recognition of the inappropriate action or response, and subsequently gain control of the situation with the correct verbal and procedural response. This pilot program will complement the "training for success" concept of our systematic approach to training, with a "training for failures" theme which will also help assure that proper actions are taken.

Specifically, simulator scenarios will be developed which involve complex, multiple casualties which will require different crew members to concentrate on different issues. At a predetermined time, the scenario will be stopped. The purpose of stopping the scenario is to evaluate the effectiveness of the crew communication, after each crew member has had an opportunity to focus on individual issues. These scenarios will begin with some event in progress (not steady state). Simulator training in this manner is expected to allow the operations personnel to practice communication skills within the crew (making sure that each crew member is kept apprised of the others' activities and priorities), practice use of the codeword, utilize the follow-up tool and stress the value of complete, precise turnover. The use of these techniques will be reviewed after 6 months to determine their effectiveness.

Enhancements:

Short Term:

A briefing paper has been provided to all Operating Crews to reinforce management expectations in the areas of procedure use and watchstanding practices. This paper will be used to brief the Operating crews as part of the Reactor Startup training

Management guidance has been provided to all Operating Crews to ensure there is no misunderstanding of the expectation that safety-related systems are not to be aligned to support the operation of nonsafety-related systems.

Management expectations have been issued to all Operations personnel as required reading package (OP 960000025).

Long Term:

Plant and Industry Events training will be conducted to discuss this event and the lessons learned. In addition, the management expectations regarding operation of safety-related systems will be reviewed.

Future simulator training will reinforce the use of the follow-up buttons and the control room code word.

Projected Completion Date:

Short Term Actions: Prior to Mode 2
Long Term Actions: October 1, 1996

Restart Issue No. 3: "Improper positioning of a manual isolation valve (EFV0263) in the Train B essential service water warming line in November 1995; corrective actions to prevent recurrence"

WCNOC Reply:

Root Cause And Contributing Factors:

Background:

The valve shaft of EFV0263 became locked due to silt build-up and corrosion at the bottom bearing in April 1991. A contributing factor to this condition is that this Warming Line Valve (one of four in this family of Warming Line Valves) is infrequently operated, typically only two times per year. In addition, the valve shaft orientation was vertical, contributing to corrosion product accumulation at the bottom bearing.

As part of a Service Water Self Assessment, it was identified that the valves' infrequent operation may be contributing to their failures. Part of the corrective action recommended was to exercise the valves more frequently. It was decided not to exercise them until they were repaired due to the potential of creating operability concerns if the valves locked in the closed position.

Historical correspondence records indicate that the use of power operated actuators on the Warming Line Valves was considered during their original design. At some point though, this concept was terminated and the existing design resulted. In addition, no information could be found with respect to the reasoning behind designing two valves in series when only one valve would have been required for isolation purposes.

In the Spring of 1995, System Engineering performed a formal work request history search on principal systems to identify past significant component problems and reoccurring failures. The principal systems are those that are important to operational safety, reliability or power production. The review encompassed thousands of work requests statused as open, closed, or vaulted. Numerous issues and problems were identified from the review and a multitude of PIRs were generated for evaluation and corrective action. Warming Line Valve EFV0263 was identified as being locked in a throttled position. However, this valve had already been scheduled to be worked in the eighth refueling outage (RFVIII) because the time necessary for the refurbishment was considered to be longer than that limited by a 72 hour Technical Specification Limiting Condition For Operation (LCO).

Root Cause:

Engineering did not believe that the condition of the valve was an operability concern based on engineering judgment that the reduction in flow at this disk position would not affect the minimum required design flow due to the throttling characteristics of this butterfly valve at nominal design flow. There was no indication or reason to believe that the Warming Line flow was not per design. The operability evaluation made at that time has been reviewed and although the level of rigor and documentation does not meet today's standards, the technical conclusion would have been valid if the original design information was correct.

Contributing Factor:

A spare valve or parts to correct the problem were not available in a short duration.

Short Term Corrective Actions:

All of the Warming Line Valves were removed from the system and refurbished or replaced during RFVIII. This included reinstalling them, so the shafts are installed horizontal, instead of vertical (CCP 05843). Warming Line isolation valves EFV0263 and 0265 were scheduled, in advance, to be reworked in RFVIII. Warming Line isolation valves EFV0262 and 0264 were scheduled for the ninth refueling outage (RFIX). However, due to the recent icing concerns, EFV0262 was refurbished and EFV0264 was replaced in RFVIII. Rotating the valves such that the stem was in the horizontal position to increase their reliability was also accomplished, as part of the long term corrective action.

In order to validate current System Engineering practices for action request reviews, as discussed below, Engineering is currently performing another review of open action requests to identify any components or equipment which have not had appropriate timely corrective action based on the significance of the component's or equipment's importance to plant safety and reliability.

Long Term Corrective Actions:

System Engineering will closely monitor these Warming Line Valves for additional problems in the future and pursue the appropriate corrective action. This is an on-going activity within the System Engineering group.

To ensure outstanding corrective maintenance action requests are appropriately being evaluated in a timely manner, a process will be established to review those requests for safety-related systems that are older than six months. This review will be performed by the Plant Safety Review Committee (PSRC) and will ensure that adequate periodic reviews are being performed on open issues that could impact those components considered to be important to operational safety, reliability or power production. This process will be implemented by June 1, 1996.

Further actions may be required for the Warming Line Valves as part of the long term corrective actions as discussed in Restart Issue No. 1.

Projected Completion Date:

Short Term Actions: Prior to restart from RFVIII
Long Term Actions: June 1, 1996

On-going Actions By System Engineering To Prevent Similar Corrective Action Problems On A Generic Basis:

The implementation of the corrective action program at WCNOC has changed since 1991. Expectations for this program have drastically increased since that time and there is a heightened awareness in System Engineering with respect to reoccurring failures and the appropriate corrective action. The work request history review, as discussed above, is one proactive example of where re-enforcement of this expectation has been successfully pursued by System Engineering.

Review of action requests on a daily basis is performed by System Engineering in accordance with procedure AI 23-005, "Action Request Review," to identify operability concerns and reoccurring failures. The purpose of this procedure is to provide guidance for an independent, timely review of recently initiated action requests. In addition, the formulation of maintenance rule activities and processes will be utilized in reviewing and monitoring system health and performance.

System Engineers also perform a review and prioritize open work on their systems in order to ensure high priority jobs are being worked commensurate with their importance to plant safety and reliability. This process provides an on-going assessment of outstanding work activities and system health.

In addition, System Engineers are challenged to look ahead for long term enhancements to their systems and to establish long term corrective action which will prevent actual component failures in the future and enhance system performance.