WOLF CREEK
NUCLEAR OPERATING CORPORATION

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Vice President Engineering

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ET 97-0004

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

Reference: 1) NRC Generic Letter 96-06, dated September 30, 1996
2) WCNOC Letter ET 96-0083, dated October 25, 1996, from R. Muench, WCNOC, to NRC

Subject: Docket No. 50-482: Final Response to Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions

Gentlemen:

Reference 1 involves NRC concerns with equipment operability and containment integrity during design-basis accident conditions, and requested Licensees to provide two responses; one within 30 days, and another within 120 days, of the date of the reference. Reference 2 provided the requested 30-day response for the Wolf Creek Nuclear Operating Corporation (WCNOC). This letter provides the requested 120-day response for WCNOC. The requested information is provided in the attachment.

If you have any questions concerning this response, please contact me at (316) 364-8831, extension 4034, or Mr. Richard D. Flannigan at extension 4500.

Very truly yours,

Richard A. Muench

RAM/jad

Attachment

cc: L. J. Callan (NRC)
W. D. Johnson (NRC)
J. F. Ringwald (NRC)
J. C. Stone (NRC)

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COUNTY OF COFFEY)

Richard A. Muench, of lawful age, being first duly sworn upon oath says that he is Vice President Engineering of Wolf Creek Nuclear Operating Corporation; that he has read the foregoing document and knows the content thereof; that he has executed that same for and on behalf of said Corporation with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By [signature]
Richard A. Muench
Vice President
Engineering

SUBSCRIBED and sworn to before me this 29th day of Jan. , 1997.

[signature]
Notary Public

ANGELA E. WESSEL
Notary Public - State of Kansas
My Appt. Expires 07/03/99

Expiration Date July 3, 1999

Final Response to Generic Letter 96-06

The following issues were identified in Generic Letter 96-06 as concerns that need to be evaluated and resolved by operating nuclear power plants:

1. Water hammer in the containment cooler cooling water system post-LOCA

2. Flashing or two-phase flow in the containment cooler cooling water system

3. Potential overpressurization of isolated water filled sections of piping, with emphasis on the containment penetrations.

The Wolf Creek Nuclear Operating Corporation (WCNOC) has completed its evaluation of the above issues, as they relate to the Wolf Creek Generating Station (WCGS), and the information requested by Generic Letter 96-06 is provided below.

Water Hammer in the Containment Cooler Cooling Water System Post-LOCA

WCGS has previously experienced water hammer in the essential service water system (ESWS) at the containment coolers. The WCGS containment coolers are normally cooled by the service water system, which uses a lake for its water source. In the event of a loss of coolant accident (LOCA), the service water pumps trip and the ESWS pumps start. In the event of a LOCA and loss of off-site power (LOOP), the start of the ESWS pumps is delayed to allow the emergency diesel generators to start and provide sufficient power to run the ESWS pumps. Inside the containment the service water and ESWS use the same piping, so the system is not isolated during this transition period. The containment coolers are the high point of these systems, so during this transition period water in the coolers drains toward the lake. When the ESWS pumps start, the system refills and a water hammer may occur when the water columns in the inlet piping and discharge piping rejoin. This scenario existed during a test in 1994 of the LOCA Sequencer at WCGS, and a water hammer did occur.

An analysis performed by Engineering in 1994 showed that ESWS pipe support loads had increased from previous analyses, but that the pipe stresses were satisfactory at all locations. It was determined that some supports would need to be modified for the increased loads. This is documented in our performance improvement request (PIR) 95-0558 and design change package (DCP) 05818. In the eighth refueling outage, in the spring of 1996, modifications were made to the ESWS piping supports inside the containment in the vicinity of the containment coolers. These modifications were made to enhance the capability of the piping supports to withstand the effects of a water hammer. In addition, the containment coolers were stiffened in all directions to provide additional protection for the coolers at the initiation of a water hammer event.

As a result of the concerns described in Generic Letter 96-06, another analysis was performed to verify the results of the first analysis. This analysis was expanded to include the consideration of LOCA conditions occurring simultaneously with a LOOP. This combination of events led to another water hammer mechanism, that of steam condensation, to be evaluated in

addition to the water hammer caused by column closure. This is documented in WCNOC Engineering Study G.L. 96-06. The results of this analysis show that the stresses in the piping will remain below the ASME Boiler and Pressure Vessel Code stress allowables for faulted conditions following a simultaneous LOOP and LOCA for all postulated water hammer events. It also shows that the piping supports can withstand the effects of the postulated water hammer events.

Therefore, the WCGS ESWS is capable of withstanding the effects of any credible hypothesized water hammer event. This includes the water hammer caused by a rejoining of the water columns in a LOOP without LOCA event, and the water hammers which could be caused by condensation of steam and water column rejoining in a LOCA with LOOP event.

Flashing or Two-Phase Flow in the Containment Cooler Cooling Water System

Two effects may impact the restoration of design heat removal capability to the containment coolers. These are the potential for restricted flow due to two-phase flow, and the time required to fill the supply side void and refill the containment coolers once the pumps are restarted.

The conditions described in Generic Letter 96-06 concerning two phase flow during containment cooler restart has been analyzed for the WCGS design, and no two-phase flow will occur at WCGS. However, during this analysis, it was discovered that design heat removal capability will be delayed by about 6 seconds more than the present safety analysis assumes.

Upstream of the containment coolers the water is not significantly heated, since the coolers void quickly and the water drains down to a level outside the containment. There are no significant flow restrictions upstream of the coolers. In the coolers, the advancing water would flash to steam as it enters the hot tubes. However, the steam would cause a system resistance to flow and the system pressure would increase. The increase in system pressure would cause the steam specific volume to decrease and allow more water to progress into the cooler. The cooler would fill in only 0.7 seconds longer than if the leading edge of the water did not flash to steam. This time is insignificant. The water stays above the saturation pressure at the LOCA orifice, and also at the UHS backpressure orifices. Therefore, two-phase flow would not occur.

However, a flow transient calculation was also performed in this analysis to determine the time required to fill the containment coolers. Within 32 seconds of event initiation, the A train ESWS pump will start and begin pumping water through the containment cooler coils. Within 37 seconds of event initiation, the B train ESWS pump will start and begin pumping water through the B train containment cooler coils. Within 47 seconds of event initiation, the containment cooler fans will restart in slow speed. Full design flow through the containment coolers will be achieved within 65.2 seconds of event initiation.

The current licensing basis analyses, which were performed to ensure containment integrity, calculate the peak containment pressure following a LOCA or steam-line break. One of the assumptions considered in these analyses

is that no heat is removed from the containment by the coolers for 60 seconds. This calculation will have to be reevaluated in detail to determine the effect on peak containment pressure of this new calculated delay caused by the system refilling. However, the current calculation indicates that there is more than 10 psi margin from the calculated peak pressure to the design pressure of the containment, and that the operation of the containment coolers has little effect on the peak containment pressure. The additional time delay for containment cooler heat removal will not have a significant impact on the calculated peak pressure. Thus, sufficient margin still exists and containment integrity is not affected by this change. The licensing basis analysis will be updated to take into account this new data by February 21, 1997.

Potential overpressurization of isolated water filled sections of piping

WCNOC has completed a review of all piping entering the primary containment and has determined that some piping will be subjected to thermally induced pressurization as described in Generic Letter 96-06. A review of all piping penetrating the containment was performed. WCGS has 106 fluid-filled containment penetrations. Twenty-three of these penetrations are subject to the conditions discussed in Generic Letter 96-06 that could cause thermally induced pressurization. An analysis of the affected systems associated with these 23 penetrations indicated that the only post-accident function of the affected piping sections is to maintain containment integrity. None of these systems are required to be placed into active service following a LOCA to mitigate the effects of the accident.

The systems that are affected by the potential overpressurization are:

- Fuel Pool Cooling and Cleanup system -- 4 penetrations associated with the refueling pool.
- Chemical and Volume Control system -- one penetration associated with the normal letdown line.
- Reactor Make-up Water system -- one penetration associated with the Reactor Coolant Pump seal standpipe.
- Liquid Radwaste system -- two penetrations associated with the Reactor Coolant Drain Tank (RCDT) drain pump discharge and the normal containment sump pump discharge.
- Hydrogen system -- one penetration associated with the hydrogen cover on the RCDT.
- Safety Injection (SI) system -- two penetrations associated with the SI accumulator fill lines and the Emergency Core Cooling System test line to the Refueling Water Storage Tank.
- Post Accident Sample system -- two penetrations associated with the Reactor Coolant System water sample.
- Normal Sample system -- 6 penetrations associated with the pressurizer vapor space sample line, the steam generator blowdown sample lines, and the SI accumulator sample line.
- Steam Generator Drain system -- one penetration associated with the Steam Generator drain line.
- Component Cooling Water System -- three penetrations associated with the containment inlet and outlet lines.

In addition to the containment penetrations, there may be other sections of safety related piping which may be susceptible to the overpressurization concern. An investigation was made of all safety related systems and nine piping sections which are not containment penetrations were identified where thermally induced pressurization could occur. An analysis has determined that none of these piping sections are required to be placed into active service following a LOCA to mitigate the effects of the accident. The only function of these sections of piping is to maintain the ASME code pressure boundary.

Five of the piping sections affect three systems: the Residual Heat Removal System (one section per train, between the shutdown cooling suction valves BBHV8702A & B and EJHV8701A & B); the Chemical and Volume Control System (two sections on the normal letdown line); and the Emergency Core Cooling System (the test line to the refueling water storage tank). The remaining four sections are the steam generator drain lines.

In all the cases above, the conditions needed for overpressurization to occur in the penetrations or in the piping sections are: the penetration, or piping section, isolation valves are closed at the start of a LOCA or are closed due to the LOCA; water is entrapped between the valves with no compressible gas; and the LOCA is sufficiently large to cause the wat temperature to increase more than approximately 30 degrees Fahrenheit.

Another analysis was performed to determine if the affected systems would perform their post-accident functions. As stated above, the only post-accident function of these portions of the affected systems is to maintain containment integrity. The analysis indicates that the piping would strain at most 3% before the pressure would be relieved. The Material Specifications in the ASME code section 2 require, at minimum, an elongation (strain) for carbon steel of 14.5% before failure. Therefore, the piping would retain its integrity under the worst case conditions and the pressure boundary will not be violated. Since the pressure boundary would not be violated, the integrity of the containment would not be challenged due to this condition following a LOCA.

WCNOC will further investigate the affected sections of piping and prepare modifications for those sections of piping in which ASME code allowable stresses for primary stress could be exceeded. All evaluations will be completed by December 31, 1998. Any necessary modifications will be completed prior to returning to power from the eleventh refueling outage, in the Fall of 2000. These modifications may involve the procurement of ASME class 1 and 2 material with long lead times and preparation of new stress analyses for the affected sections of piping and their supports. While many of these modifications might be implemented during power operations, there are a few that will require the plant to be shutdown to implement. It is estimated that the cost for designing and implementing modifications for all of the susceptible locations, if necessary, will exceed $600,000.

In addition to evaluating the penetrations and other sections of piping that may be automatically isolated in the event of an accident, a review was undertaken to identify those sections of piping which could be manually isolated during normal operations. Manually isolating sections of piping could cause the same condition of overstressing the piping in the event of an

environmental increase of temperature. There are several systems that could have sections isolated manually for maintenance activities during normal conditions and later experience an increase of environmental temperatures. Operations clearance order procedure, AP-21E-001, has a step that directs the tagging crew to vent and drain any sections of piping which may be susceptible to thermally induced pressurization. Therefore, any section of pipe that is manually isolated at WCGS is protected from overpressurization.