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AUTH.NAME AUTHOR AFFILIATION
FITZPATRICK,E. Indiana Michigan Power Co. (formerly Indiana & Michigan Ele
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SUBJECT: Submits response to GL 96-06, "Assurance of Equipment Operability & Containment Integrity Design-Basis Accident Conditions."

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Power Company
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INDIANA
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January 28, 1997

AEP:NRC:1256A

Docket Nos.: 50-315
50-316

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentlemen:

Donald C. Cook Nuclear Plant Units 1 and 2
NRC GENERIC LETTER 96-06 ASSURANCE OF
EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY
DURING DESIGN-BASIS ACCIDENT CONDITIONS

Generic letter (GL) 96-06 requested licensees to determine:

1. "if containment air cooler cooling water systems are susceptible to either waterhammer or two-phase flow conditions during postulated accident conditions;

2. if piping systems that penetrate the containment are susceptible to thermal expansion of fluid so that overpressurization of piping could occur."

In a letter dated October 24, 1996, we committed to complete the requested actions within the time period specified in the GL. This letter provides the 120 day written response. The attachment documents the detailed results of our review.

Cook Nuclear Plant is not susceptible to either waterhammer or two-phase flow for containment air coolers, because the plant's ice condenser containment design does not include containment ventilation systems with a heat removal function that are required to operate post-accident.

Thermally induced overpressurization of piping systems that penetrate containment was also considered. The majority of the fluid filled systems penetrating the containments either already have overpressure protection, or pressure relief can be predicted to limit pipe stresses below FSAR allowable stresses for emergency conditions. Where overpressure protection is not presently included in the design, and pressure relief cannot be predicted to limit pipe stresses below FSAR allowable stresses for emergency conditions, we will perform additional analyses after which we will either conclude these systems are acceptable as is, or modifications are warranted.

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A072/,

These analyses will be completed by July 31, 1997. If plant modifications are warranted, they will be performed during the first refueling outages which occur after January 1998. Operability determinations have been successfully completed for systems for which further analysis is planned.

Sincerely,

E. E. Fitzpatrick

E. E. Fitzpatrick
Vice President

SWORN TO AND SUBSCRIBED BEFORE ME

THIS 28th DAY OF JANUARY, 1997

Jan Watson
Notary Public

My Commission Expires: JAN WATSON
NOTARY PUBLIC, BERRIEN COUNTY, MI
MY COMMISSION EXPIRES FEB. 10, 1999

jmb

Attachment

cc: A. A. Blind
A. B. Beach
MDEQ - DW & RPD
NRC Resident Inspector
J. R. Padgett

ATTACHMENT TO AEP:NRC:1256A

RESPONSE TO GENERIC LETTER 96-06

ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT

INTEGRITY DURING DESIGN-BASIS ACCIDENT CONDITIONS

Generic letter (GL) 96-06 requested licensees to determine:

1. "if containment air cooler cooling water systems are susceptible to either waterhammer or two-phase flow conditions during postulated accident conditions;

2. if piping systems that penetrate the containment are susceptible to thermal expansion of fluid so that overpressurization of piping could occur."

<u>Containment Air Cooler Cooling Water Systems</u>

A review was undertaken to determine if containment air cooler cooling water systems are susceptible to either waterhammer or two-phase flow conditions during postulated accident conditions.

The designs of Cook Nuclear Plant units 1 and 2 do not include safety-related containment air coolers. Both Cook Nuclear Plant units employ an ice condenser containment design. The primary function of the ice condenser is the absorption of thermal energy released abruptly in the event of a loss-of-coolant accident (LOCA), main steam line break (MSLB), or feedwater line break (FWLB) inside containment, for the purpose of limiting the initial peak pressure in the containment. A secondary function of the ice condenser is the further absorption of energy after the initial incident, causing containment pressure to be maintained below the design pressure of 12 psig. Long term post-accident containment cooling is provided by both the emergency core cooling system and the containment spray system.

Cook Nuclear Plant design does include non-safety-related containment ventilation units and other non-safety-related ventilation systems to maintain temperatures in the various portions of containment within acceptable limits for operation of equipment and personnel access. Each unit's containment includes four upper compartment ventilation units and four lower compartment recirculation/ventilation units. These fans are vaneaxial type with cooling coils supplied from the non-safety-related non-essential service water (NESW) system. These fans are not required to operate following a LOCA or MSLB. The containment isolation valves for the NESW system automatically isolate on a containment isolation signal.

It should be noted that the containment ventilation units would be utilized following a loss of offsite power (LOOP) to provide containment heat removal and prevent containment pressurization. Under maximum containment heat load conditions, a loss of NESW to the containment ventilation system could eventually result in a temperature and pressure rise high enough to initiate containment isolation signals. For this reason, following a LOOP, operating procedures provide that NESW and containment ventilation are re-energized promptly to provide containment heat removal and prevent containment pressurization. Given the slow rate of containment temperature increase following a LOOP compared to accident scenarios (as described in the GL example for Diablo Canyon Plant), and the prompt restoration of NESW and containment ventilation provided by operating procedures, these ventilation systems are not considered susceptible to waterhammer and two phase flow.

The only safety-related ventilation system within containment is the containment air recirculation/hydrogen skimmer system (CEQ fans). This system functions in the event of a phase B containment isolation signal (2.9 psig containment pressure). The CEQ fan's primary function is the post-accident recirculation of air and

other non-condensables from upper containment to lower containment, reducing pressure in upper containment. The system also prevents the accumulation of hydrogen gas and redistributes fission products. This system does not perform a containment environment heat removal function, and therefore does not include cooling coils. Cooling water is supplied to the CEQ fan motor air cooler from the safety-related component cooling water (CCW) system. The CCW piping to the CEQ fans is protected from overpressurization with safety valves at each CEQ fan.

In summary, Cook Nuclear Plant design does not include safety related containment fan coolers. Furthermore, the non-safety related containment ventilation units are not relied upon post-accident for containment heat removal. Therefore, Cook Nuclear Plant does not have containment air cooler cooling water systems that are susceptible to either waterhammer or two-phase flow conditions during postulated accident conditions.

Susceptibility of Overpressurization of Piping Penetrating Containment Due to Thermal Expansion

A review was conducted to determine if piping systems that penetrate containment are susceptible to thermal expansion of fluid so that overpressurization of piping could occur. This review focused both on penetrations whose piping systems perform safety related functions and on penetrations whose piping systems perform non-safety related functions, and it considered the potential for the scenarios specifically described in the GL. This review indicated that piping systems penetrating containment fall into one of three categories: (1) those where overpressure protection is already provided; (2) those where pressure relief can be predicted and piping stresses remain below FSAR allowable stresses for emergency conditions; and (3) those where pressure relief cannot be predicted to limit piping stresses below FSAR allowable stresses for emergency conditions. For systems in categories (1) and (2), no additional analysis is planned. For systems in category (3), additional analyses are being performed, after which we will either conclude these systems are acceptable as is, or modifications are warranted. These analyses will be completed by July 31, 1997. If plant modifications are warranted, they will be performed during the first refueling outages which occur after January 1998. Operability determinations have been successfully completed for systems for which further analysis is planned.

The following describes the results of this review for fluid systems susceptible to thermal expansion, i.e., those where over-pressure protection is not currently included in the system design.

1. Non-Essential Service Water (NESW) System Containment Services

   This non-safety related system provides cooling/service water to several components inside containment for normal plant operation, including upper and lower containment ventilation units, reactor coolant pump motor air coolers, and instrument room ventilation units. The system has no post-accident function. The series of supply and return lines to containment for these services each has two air-operated containment isolation (diaphragm) valves in series outside containment. These diaphragm valves close on a containment isolation signal, isolating the system inside containment. The piping system design pressure at the penetration is 125 psig, and no pressure relief mechanism is provided for the

non-safety related system inside containment. This configuration is similar for both units 1 and 2.

Following closure of the containment isolation valves outside containment and isolation of the water filled piping system inside containment, the stagnant water in the piping system would be heated by the post-accident containment environment. As the volume of water inside the piping system is heated and expands, the system pressure would increase until the force of the system pressure against the bottom of the valve diaphragms overcomes the actuator spring closing force on the valve diaphragms. This would occur at a system pressure below the pressure at which pipe stresses would exceed FSAR allowable stresses for emergency conditions. At this point, the valve diaphragms would momentarily lift off their seat to relieve the system pressure to the rest of the open NESW system. This would continue until system pressure reduces to a point where the actuator spring would reseat the valve diaphragm. Because pressure relief can be predicted at a pressure below the pressure at which the pipe will exceed FSAR allowable stresses for emergency conditions, no additional actions are planned for this system.

2. Reactor Coolant Pump Seal Water Return Line

This 4" line returns reactor coolant pump seal leak-off to the chemical and volume control system (CVCS) for normal plant operation. The line has one motor-operated containment isolation (gate) valve inside containment and a second motor-operated containment isolation (gate) valve in series outside containment. These gate valves close on a containment isolation signal, isolating the line passing through the containment penetration. The piping system design pressure at the penetration is 150 psig, and no pressure relief mechanism is provided for the piping between the two containment isolation valves. Overpressure protection is provided for the piping system inside containment upstream of the inboard containment isolation valves via a safety valve. This configuration is similar for both units 1 and 2.

Because pressure relief cannot be predicted for the piping penetrating containment between the two containment isolation valves on each unit, an analysis has been performed to determine operability relative to these penetrations. The piping was assumed to be water solid between the isolation valves and at normal operating temperature and pressure prior to the accident. Following closure of the inboard and outboard containment isolation valves, the stagnant water volume is heated from the initial conditions to 250°F (post-accident, the containment temperature reaches an initial peak, then recovers to less than 250°F within a few minutes, and then slowly declines). As this volume of water expands, the associated piping will also expand until an equilibrium condition is reached. Initial analysis indicates the pipe will yield to achieve this equilibrium, but will not fail (stress well below ultimate stress). A similar evaluation of the associated containment penetration was also performed which provided assurance of the integrity of the containment boundary. We will perform additional analyses of these systems after which we will either conclude they are acceptable as is, or modifications are warranted. These additional analyses will be completed by July 31, 1997. If plant modifications are warranted, they will be completed

during the first refueling outages which occur after January 1998.

3. Reactor Coolant Letdown Line

This 2" line returns reactor coolant to the CVCS for reactor coolant system cleanup during normal plant operation. The line has one air-operated containment isolation (globe) valve inside containment and a second air-operated containment isolation (globe) valve in series outside containment. These globe valves close on a containment isolation signal, isolating the line passing through the containment penetration. The piping system design pressure at the penetration is 600 psig, and no pressure relief mechanism is provided for the piping between the two containment isolation valves. This configuration is similar for both units 1 and 2.

Following closure of these valves and isolation of the water filled piping system inside containment, thermal overpressure protection of the system inside containment is provided by a safety valve upstream of the inboard containment isolation valve. As for the piping system that passes through the containment penetration between the two closed containment isolation valves, the stagnant water would be heated by the post-accident containment environment. As the volume of water inside the piping system is heated and expands, the system pressure would increase until the force of the system pressure against the bottom of the outboard containment isolation valve overcomes the spring closing force on the valve. This would occur at a system pressure below the pressure at which pipe stresses would exceed FSAR allowable stresses for emergency conditions. At this point, the valve would momentarily lift off its seat to relieve the system pressure to the adjoining system outside containment, which is protected with a safety valve. The globe valve would relieve until system pressure reduces to a point where the actuator spring would reseat the valve. Because pressure relief can be predicted at a pressure below the pressure at which the pipe will exceed FSAR allowable stresses for emergency conditions, no additional actions are planned for this system.

4. Safety Injection Test Line and Accumulator Test Line

This 3/4" line is used for filling the accumulators, and can also be used to provide a test flow path for the safety injection pumps. The line has a normally closed manual globe valve outside containment and a series of normally closed air-operated globe valves on its branch lines inside containment. The piping system design pressure is 1750 psig, and no pressure relief mechanism is provided for the isolated piping penetrating containment.

Post-accident, the stagnant water within the system inboard of the closed containment isolation valve would be heated by the containment environment. As the volume of water inside the piping system is heated and expands, the system pressure would increase until the force of the system pressure against the bottom of one of the valve plugs overcomes the spring closing force on the valve plug. This would occur at a system pressure below the pressure at which pipe stresses would exceed FSAR allowable stresses for emergency conditions. At this point, the valve would momentarily lift

off its seat to relieve the system pressure to the accumulators, which are protected with a safety valve. This would continue until system pressure reduces to a point where the actuator spring would reseat the valve. Because pressure relief can be predicted at a pressure below the pressure at which the pipe will exceed FSAR allowable stresses for emergency conditions, no additional actions are planned for this system.

5. Primary Water to Containment

This 4" line provides primary water for both reactor coolant pump seal standpipe make-up and the pressurizer relief tank sprays. The line has a normally closed air-operated containment isolation (diaphragm) valve outside containment which closes on a containment isolation signal, and a check valve inside containment. Downstream of the check valve, inside containment, there are a series of normally closed air operated globe valves on the various primary water branch lines. The piping system design pressure is 136 psig, and no pressure relief mechanism is provided for the isolated piping between the containment isolation valve outside containment and the various normally closed air-operated globe valves.

The stagnant water within the system inboard of the closed containment isolation valve would be heated by the post-accident containment environment. As the volume of water inside the piping system is heated and expands, the system pressure would increase until the force of the system pressure against the bottom of one of the globe valve plugs overcomes the spring closing force on one of the globe valve plugs. This would occur at a system pressure below the pressure at which pipe stresses would exceed FSAR allowable stresses for emergency conditions. At this point, the valve would momentarily lift off its seat to relieve the system pressure to the pressurizer relief tank. This would continue until system pressure reduces to a point where the actuator spring would reseat the valve. Because pressure relief can be predicted at a pressure below the pressure at which the pipe will exceed FSAR allowable stresses for emergency conditions, no additional actions are planned for this system.

6. Reactor Coolant Drain Tank Outlet to Reactor Coolant Drain Pumps

This 4" line provides a path from the reactor coolant drain tank and pressurizer relief tank inside containment to the reactor coolant drain pumps in the auxiliary building. The 4" line penetrating containment has two air-operated containment isolation (globe) valves in series outside containment and either normally closed air-operated (globe or diaphragm) valves or check valves on the branch lines inside containment. The containment isolation valves close on a containment isolation signal, isolating the system inside containment up to the containment isolation valves outside containment. The piping system design pressure at the penetration is 25 psig, and no pressure relief mechanism is provided for the system inside containment up to the containment isolation valves outside containment. This configuration is similar for both units 1 and 2.

Following closure of these containment isolation valves and isolation of the water filled piping system inside

containment, the stagnant water would be heated by the post-accident containment environment. As the volume of water inside the piping system is heated and expands, the system pressure would increase until the force of the system pressure against the bottom of the valve diaphragms overcomes the spring closing force on the valve diaphragms. This would occur at a system pressure below the pressure at which pipe stresses would exceed FSAR allowable stresses for emergency conditions. At this point, the valve diaphragms would momentarily lift off their seat to relieve the system pressure to a sump inside containment. This would continue until system pressure reduces to a point where the actuator spring would reseat the valve. Because pressure relief can be predicted at a pressure below the pressure at which the pipe will exceed FSAR allowable stresses for emergency conditions, no additional actions are planned for this system.

7. Primary Water to Containment Hose Connections

This 4" line supplies demineralized water from the primary water pumps located in the auxiliary building to hose connections inside containment. The line has two air-operated containment isolation (diaphragm) valves in series outside containment which close on a containment isolation signal. Inside containment, single manual globe valves at each hose connection are normally closed. The piping system design pressure is 159 psig, and no pressure relief mechanism is provided for the system inside containment up to the containment isolation diaphragm valves outside containment. This configuration is similar for both units 1 and 2.

Following closure of these containment isolation valves and isolation of the water filled piping system inside containment, the stagnant water would be heated by the post-accident containment environment. As the volume of water inside the piping system is heated and expands, the system pressure would increase until the force of the system pressure against the bottom of the valve diaphragms overcomes the spring closing force on the valve diaphragms. This would occur at a system pressure below the pressure at which pipe stresses would exceed FSAR allowable stresses for emergency conditions. At this point, the valve diaphragms would momentarily lift off their seat to relieve the system pressure to the primary water (PW) system, which recirculates back to the PW storage tank (open to atmosphere). This would continue until system pressure reduces to a point where the actuator spring would reseat the valve. Because pressure relief can be predicted at a pressure below the pressure at which the pipe will exceed FSAR allowable stresses for emergency conditions, no additional actions are planned for this system.

8. Containment Sump Pump Discharge to Waste System

This 3" line connects the discharge of the various containment sump pumps (lower containment sump, reactor cavity sump, and pipe tunnel sump) to the station drainage waste holdup tank. The line has two air-operated containment isolation (diaphragm) valves in series outside containment, which close on a containment isolation signal. Inside containment, there is a check valve at the discharge of each of the aforementioned sump pumps. The piping system design pressure is 60 psig, and no pressure relief mechanism is

provided between the discharge of the sump pumps inside containment and the containment isolation diaphragm valves outside containment. This configuration is similar for both units 1 and 2.

Following closure of these containment isolation valves and isolation of the water filled piping system inside containment, the stagnant water would be heated by the post-accident containment environment. As the volume of water inside the piping system is heated and expands, the system pressure would increase until the force of the system pressure against the bottom of the valve diaphragms overcomes the spring closing force on the valve diaphragms. This would occur at a system pressure below the pressure at which pipe stresses would exceed FSAR allowable stresses for emergency conditions. At this point, the valve diaphragms would momentarily lift off their seat to relieve the system pressure to the open station drainage system. This would continue until system pressure reduces to a point where the actuator spring would reseat the valve. Because pressure relief can be predicted at a pressure below the pressure at which the pipe will exceed FSAR allowable stresses for emergency conditions, no additional actions are planned for this system.

9. <u>Accumulator Sample Line</u>

This 1/2" line is a common sample line from the 4 accumulator tanks. The line has two air-operated containment isolation (globe) valves in series outside containment, which close on a containment isolation signal. Inside containment, there are normally closed air-operated globe valves located at each accumulator tank. The piping system design pressure is 600 psig, and no pressure relief mechanism is provided between the normally closed accumulator sample valves inside containment and the containment isolation valves outside containment. This configuration is similar for both units 1 and 2.

Following an accident, the stagnant water within the system inboard of the closed containment isolation globe valves would be heated by the post-accident containment environment. As the volume of water inside the piping system is heated and expands, the system pressure would increase until the force of the system pressure against the valve bellows assembly causes the valve to momentarily lift off its seat. This would occur at a system pressure above the pressure at which pipe stresses would exceed FSAR allowable stresses for emergency conditions. At this point, the valve would relieve the system pressure to the accumulator tanks inside containment. This would continue until system pressure reduces to a point where the actuator spring would reseat the valve. Because pressure relief cannot be predicted to limit pipe stresses to less than FSAR allowable values, analyses have been performed to determine operability relative to these penetrations. Initial analyses indicate the stresses will exceed yield, but will be below that corresponding to ultimate stress. We will perform additional analyses of these systems after which we will either conclude they are acceptable as is, or modifications are warranted. These additional analyses will be completed by July 31, 1997. If plant modifications are warranted, they will be completed during the first refueling outages which occur after January 1998.

10. <u>Reactor Coolant System Sample Lines</u>

These three 1/2" sample lines (pressurizer liquid space, pressurizer steam space, and hot leg samples) from the reactor coolant system all share a common configuration. Each line has two air-operated containment isolation (globe) valves in series outside containment, which close on a containment isolation signal. Inside containment, there are normally closed air-operated valves from each sample point. The piping system design pressure is 2485 psig, and no pressure relief mechanism is provided between the normally closed sample valves inside containment and the containment isolation valves outside containment. This configuration is similar for both units 1 and 2.

Following an accident, the stagnant water within the system inboard of the closed containment isolation globe valves would be heated by the post-accident containment environment. As the volume of water inside the piping system is heated and expands, the system pressure would increase until the force of the system pressure against the valve bellows assembly causes the valve to momentarily lift off its seat. This would occur at a system pressure above the pressure at which pipe stresses would exceed FSAR allowable stresses for emergency conditions. At this point, the valve would relieve the system pressure to the reactor coolant system inside containment. This would continue until system pressure reduces to a point where the actuator spring would reseat the valve. Because pressure relief cannot be predicted to limit pipe stresses to less than FSAR allowable values, analyses have been performed to determine operability relative to these penetrations. Initial analyses indicate the stresses will exceed yield, but will be below that corresponding to ultimate stress. We will perform additional analyses of these systems after which we will either conclude they are acceptable as is, or modifications are warranted. These additional analyses will be completed by July 31, 1997. If plant modifications are warranted, they will be completed during the first refueling outages which occur after January 1998.

<u>Assessment of Impact of System Leakage to Relieve Pressure</u>

In several cases, credit has been taken for valve leakage to adjoining piping systems outside containment to relieve system pressure. The impact of this leakage was considered. Pressure increases in these systems are the result of thermal expansion of fluid inside isolated systems which are intact, by definition (able to be pressurized). Since fluid inside isolated, intact systems would not be exposed to the post-accident containment environment, there is no radiological significance associated with this leakage. Furthermore, this leakage is finite and small relative to the overall system volumes, given the low compressibility of water.