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Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Comparison of ANO-2 Reactor Coolant System Leak
Detection to Regulatory Guide 1.45 in Support of Permanent
Reactor Pressure Vessel Seal Plate Installation

Gentlemen:

Entergy Operations plans to install a permanent reactor pressure vessel seal plate over the reactor vessel annulus in Arkansas Nuclear One, Unit-2 (ANO-2). The new permanent reactor pressure vessel seal plate is expected to reduce personnel radiation exposure rates long term by eliminating the need to install and remove the existing seal plate each refueling outage. It is also expected to reduce outage times by reducing the time it takes to establish a good seal and restore the reactor vessel annulus to its normal operating condition. The permanent reactor pressure vessel seal plate design and installation requires a re-evaluation of ANO-2's compliance with General Design Criterion (GDC) 4 of Appendix A to 10CFR50.

Revised GDC-4 permits the use of analyses that demonstrate the probability of rupturing pressurized water reactor primary coolant piping is extremely low under design basis conditions which is referred to as "leak-before-break" (LBB) technology. On October 30, 1990, the Staff issued a safety evaluation on Topical Report CEN-367, "Leak-Before-Break Evaluation of Primary Coolant Loop Piping in Combustion Engineering (CE) Designed Nuclear Steam Supply Systems," in support of the ANO-2 analysis. Since the permanent reactor vessel seal plate will restrict the vent path around the reactor pressure vessel annulus assumed in the current containment subcompartment analysis, the use of LBB methodology is required to ensure the primary shield wall design differential pressures are not exceeded during a high energy line break in the reactor pressure vessel cavity.

CEN-367 provided bounding analyses for the participating CE Owner's Group (CEOG) members of which ANO-2 was included. The CEOG proposed to eliminate the dynamic effects of postulated primary loop pipe ruptures from the design basis using the "leak-before-

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break" technology. The Staff concluded that the CEOG plants' primary loop piping was in compliance with the revised GDC-4, with the stipulation that licensees must submit information to demonstrate that leakage detection systems installed are consistent with Regulatory Guide (RG) 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems."

In accordance with the Staff's request, attached is a comparison of the leakage detection systems installed at ANO-2 to the individual items contained in the regulatory position of RG 1.45. This information demonstrates that the ANO-2 leakage detection systems are consistent with the recommendations of RG 1.45.

Entergy Operations is planning to install the permanent reactor pressure vessel seal plate during the next ANO-2 refueling outage (2R11) which is currently scheduled for the fall of 1995. In order to support the permanent reactor pressure vessel seal plate installation, Entergy Operations requests NRC concurrence with LBB applications for ANO-2 by September 15, 1995. Should you have any questions, please contact me.

Very truly yours,

Dwight C. Mims

Dwight C. Mims
Director, Licensing

DCM/nbm
Attachment

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Comparison of ANO-2 RCS Leak Detection Systems to RG 1.45

The following discussion demonstrates that the reactor coolant system (RCS) leakage detection systems installed at ANO-2 are consistent with the guidelines of Regulatory Guide (RG) 1.45 by providing a comparison of the ANO-2 systems to the requirements specified in the regulatory position of RG 1.45.

The RG 1.45, regulatory position states: The source of reactor coolant leakage should be identifiable to the extent practical. Reactor coolant pressure boundary (RCPB) leakage detection and collection systems should be selected and designed to include the following:

1. **Leakage to the primary reactor containment from identified sources should be collected or otherwise isolated so that:**

   a. **the flow rates are monitored separately from unidentified leakage, and**

   b. **the total flow rate can be established and monitored.**

RESPONSE

The leakage detection systems installed at ANO-2 are described in the safety analysis report (SAR) section 5.2.7. Known leakage is accounted for in the reactor coolant system (RCS) inventory balance calculation performed at least once every 72 hours of steady state operations. The known leakage is defined in the station approved inventory balance procedure and is specifically considered in the procedure calculation.

2. **Leakage to the primary reactor containment from unidentified sources should be collected and the flow rate monitored with an accuracy of one gallon per minute (gpm) or better.**

RESPONSE

See response to item 5.

3. **At least three separate detection methods should be employed and two of these methods should be (1) sump level and flow monitoring, and (2) airborne particulate radioactivity monitoring. The third method may be selected from the following:**

   a. **monitoring of condensate flow rate from air coolers, and**

   b. **monitoring of airborne gaseous radioactivity.**

Humidity, temperature, or pressure monitoring of the containment atmosphere should be considered as alarms or indirect indication of leakage to the containment.

RESPONSE

The three separate leak detection methods primarily employed at ANO-2 are described in SAR Section 5.2.7.1. The operability and surveillance requirements for the primary leak detection systems are found in TS 3/4.4.6. The primary leak detection systems are:

- Containment sump level monitoring system
- Containment atmosphere particulate radioactivity monitoring system
- Containment atmosphere gaseous radioactivity monitoring system

The indirect leak detection methods available at ANO-2 include but are not limited to:

- Containment pressure monitoring system
- Containment temperature monitoring system
- Containment humidity monitoring system

The leak detection methods listed above are consistent with the recommendations of RG 1.45 with the exception of sump flow monitoring.

Although not specifically identified by RG 1.45, ANO-2 also employs a leakage detection method based on performing an RCS inventory balance. ANO-2 considers this method the most accurate leak detection method. This method is capable of providing indication of small (less than 1 gpm) RCS leakage during steady state operation.

Although not specifically identified by RG 1.45, the following parameters are also monitored for indications of RCS leaks:

- Pressurizer relief temperatures and quench tank level
- Reactor vessel head leakage temperature
- Sample sink flow from RCS sample lines
- RCS and chemical and volume control system (CVCS) piping such as relief valves, test connections, drains and vents
- Component cooling water surge tank level
- Volume control tank level
- Letdown flow
- Safety injection tank level and pressure
- Radiochemistry samples of containment atmosphere
- Secondary system radiation monitoring instrumentation

4. **Provisions should be made to monitor systems connected to the RCPB for signs of intersystem leakage. Methods should include radioactivity**

monitoring and indicators to show abnormal water levels or flow in the affected area.

RESPONSE

Intersystem leaks could show up in the following systems:

A. Secondary system
B. Service water system
C. Component cooling water system
D. Shutdown cooling system
E. Safety injection system including high pressure safety injection (HPSI), low pressure safety injection (LPSI), and safety injection tanks (SITs)

The methods for detecting RCS leakage into each system is as follows:

A. Secondary System

A primary to secondary leak will usually occur when a U-tube(s) in a steam generator structurally fails (pipe thinning, etc.), allowing the higher pressure RCS water to enter the lower pressure secondary side. The steam generator tube leakage detection methods employed at ANO-2 depend on radiation monitors installed in systems that have steam from the steam generators either directly or indirectly routed through them. The radiation monitors are installed in the following locations:

• Steam generator sample cooler/blowdown system	2RE-5854, 2RE-5864
• Main condenser air discharge system (offgas)	2RE-0645
• Steam lines (N-16 monitors)	2RE-0200, 2RE-0201
• Main steam line radiation monitors	2RE-1007, 2RE-1057

The steam generator radiation monitor signals provide indication and alarms in the control room and are recorded.

B. Service Water System

The service water system circulates water through heat exchangers that interface with radioactive systems thereby causing the potential for leakage from the RCS into the normally non-radioactive service water system. SAR section 5.2.7.1.4 states, "Every heat exchanger that has the possibility of releasing radiation to the service water system via a tube leak is monitored." Indication of high radiation is monitored and alarmed in the control room. The radiation level is also recorded in the control room. The heat exchangers monitored for radiation are:

• Containment cooling coils	2RE-1513-2, 2RE-1519-1

- Shutdown cooling heat exchanger 2RE-1453, 2RE-1456
- Fuel pool heat exchanger 2RE-1525

C. Component Cooling Water System

The component cooling water (CCW) system circulates water in a closed loop which provides cooling for several plant processes including the reactor coolant pumps. There are two radiation monitors associated with the CCW system that will detect leakage of radioactive water into the CCW system. Indication of high radiation is monitored and alarmed in the control room. The radiation level is also recorded in the control room. The radiation monitors are located in the two pipes that direct CCW to the CCW heat exchanger header. The radiation monitors and associated piping are as follows:

- Pipe 2JBD-94-10" 2RE-5200
- Pipe 2JBD-91-12" 2RE-5202

D. Shutdown Cooling System

The shutdown cooling system is isolated during RCS system high pressure (i.e., >300 psig) operations. The leakage detection system utilized to detect leakage past the two normally closed isolation valves (2CV-5084-1 & 2CV-5086-2) is a pressure transmitter loop with high pressure alarm annunciated in the control room. The use of a pressure sensing loop is a reliable method since the normal pressure at the sensing tap location is approximately 0 psig. The primary purpose for monitoring RCS leakage at this point is to ensure the pressure rating of the shutdown cooling piping (300 psig) is not exceeded at any time. The use of the pressure sensing loop for RCS leakage detection from a LBB perspective should be considered a secondary monitoring purpose.

E. Safety Injection System

The safety injection system (SIS) consists of the following subsystems:

- High pressure safety injection
- Low pressure safety injection
- Safety injection tanks

The piping for the SIS is arranged to provide injection into each of the RCP discharge cold legs from the respective SITs or other injection system lineups. The high pressure (RCS)/low pressure (SIS) system isolation provided during normal plant operation is via check valves and motor operated valves. In order to detect leakage of high pressure fluid into low pressure piping, a pressure transmitter loop monitors the low pressure side of the high/low pressure interface check valve. The use of the pressure sensing loop for RCS leakage detection from

a LBB perspective should be considered a secondary monitoring purpose. High pressure/low pressure leakage into the SITs will be indicated by increasing pressure and/or level in the SITs.

5. **The sensitivity and response time of each leakage detection system in regulatory position 3 above employed for unidentified leakage should be adequate to detect a leakage rate, or its equivalent, of one gpm in less than one hour.**

RESPONSE

Containment Sump

The containment sump is instrumented with a single level detector which provides a level signal to the control room indicator and alarm. The indicator scale is 0-100% which is equivalent to 0-56 inches. The sump contains 69.8 gallons per inch; therefore, 1 gpm of liquid collected into the sump will result in a 1.5% increase (i.e., 60 gallons) on the indicator in one hour. The resolution of the indicator is 1%; therefore, 1 gpm of liquid collected into the sump should be detectable in one hour.

It is important to note that sump level is indicative of leakage from any of the fluid systems located in the containment building such as RCS, service water, component cooling water, feedwater, or condensation of humidity within the containment atmosphere. Further actions (i.e., chemical analysis) are required to determine the source of the fluid.

Airborne Particulate Monitor

The sensitivity of the air particulate monitor for various isotopes is as follows:

Isotope	Sensitivity as a Function of a 1.25 MeV Background Generated by Co-60
I-131	$1.29E-10 \frac{\mu Ci/cc}{mr/hr}$
Cs-137	$1.46E-10 \frac{\mu Ci/cc}{mr/hr}$
Cs-134	$6.95E-11 \frac{\mu Ci/cc}{mr/hr}$
Sr-85 (I-133 substitute)	$1.44E-10 \frac{\mu Ci/cc}{mr/hr}$

The monitor sensitivities exceed the sensitivity of $1.0E-9\,\mu Ci/cc$ recommended by RG 1.45.

The 1 gpm leak will be detectable within 1 hour by virtue of the fact that the monitor sensitivity level will be exceeded by several orders of magnitude provided certain assumptions are made such as A) perfect mixing of the activity in the containment, and B) maximum TS allowable levels of activity are present in the reactor coolant. The control room monitor will allow the operator to note an increasing trend in activity in the containment building. However, since ANO-2 operates with as little coolant activity as is reasonably achievable, the time period required to increase the concentration of a radioisotope in the containment atmosphere to the particulate monitor sensitivity level may be greater than 1 hour. Therefore, this leak detection method should be considered an alternate detection method to the inventory balance method.

Airborne Radiogas Monitor

The sensitivity of the radiogas monitor for various isotopes is as follows:

Isotope	Sensitivity as a Function of a 1.25 MeV Background Generated by Co-60
Kr-85	$3.02E-8\frac{\mu Ci/cc}{mr/hr}$
Xe-133	$1.06E-6\frac{\mu Ci/cc}{mr/hr}$

As demonstrated by the table, the monitor sensitivities are consistent with the sensitivity of $1.0E-6\,\mu Ci/cc$ recommended by RG 1.45.

The 1 gpm leak will be detectable within 1 hour by virtue of the fact that the monitor sensitivity level will be exceeded by several orders of magnitude provided certain assumptions are made such as A) perfect mixing of the activity in the containment, and B) maximum TS allowable levels of activity are present in the reactor coolant. The control room monitor would allow the operator to note an increasing trend in activity in the containment building. However, since ANO-2 operates with as little coolant activity as is reasonably achievable, the time period required to increase the concentration of a radioisotope in the containment atmosphere to the gaseous monitor sensitivity level may be greater than 1 hour. Therefore, this leak detection method should be considered an alternate detection method to the inventory balance method.

Inventory Balance

Although not one of the primary leak detection methods required for consistency with RG 1.45, the inventory balance procedure is routinely performed once per 24 hours during steady state conditions but will be performed more frequently if other monitored parameters indicated possible unknown RCS leakage. Once the performance of the inventory balance procedure has been initiated, the time to obtain results is less than 60 minutes. Therefore, it can be concluded the inventory balance procedure is capable of detecting a 1 gpm RCS leak within one hour.

6. **The leakage detection systems should be capable of performing their functions following seismic events that do not require plant shutdown. The airborne particulate radioactivity monitoring system should remain functional when subjected to the safe shutdown earthquake (SSE).**

RESPONSE

IEEE 344-1975, "Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," provides the directions for establishing procedures that verify that Class 1E equipment can meet its performance requirements during and following one SSE preceded by a number of operating basis earthquakes (OBEs). The equipment listed below is tested in accordance with standard IEEE 344-1975. Based on meeting the above requirements, the leak detection equipment satisfies the seismic requirements stated in RG 1.45. A summary of each detection system's conformance to IEEE 344-1975 is provided below:

Equipment Tag #	Description	IEEE 344-1975 Qualified
2LE-5641-2	Containment Sump Level	YES
2LT-5641-2	Containment Sump Level	YES
2LIS-5641-2	Containment Sump Level	YES
2RE-8231-1A	CAMS Air Particle Monitor	YES
2RITS-8231-1A	CAMS Air Particle Monitor	YES
2RE-8231-1B	CAMS Radio-Gas Monitor	YES
2RITS-8231-1B	CAMS Radio-Gas Monitor	YES
2RE-8271-2A	CAMS Air Particle Monitor	YES
2RITS-8271-2A	CAMS Air Particle Monitor	YES
2RE-8271-2B	CAMS Radio-Gas Monitor	YES
2RITS-8271-2B	CAMS Radio-Gas Monitor	YES

7. **Indicators and alarms for each leakage detection system should be provided in the control room. Procedures for converting various indications to a common equivalent should be available to the operators. The calibration of the indicators should account for needed independent variables.**

RESPONSE

The sump level instrument loop provides control room indication and alarm. The airborne particulate and gaseous radioactivity monitors also provide control room indication and alarm. The parameters required to support the performance of the inventory balance method of leakage detection are alarmed and/or indicated in the control room. The inventory balance (RCS leak rate) procedure provides the method for utilizing various plant parameters to generate a common leakage equivalent.

Direct numerical correlation between inventory balance, sump level and radiation monitoring for conversion to a common leakage equivalent (i.e., gpm of RCS) will not be meaningful because the methods are based on different principles. Sump level may be indicative of leakage from any of the systems located in the containment building such as RCS, service water, component cooling water, feedwater, or condensation of humidity within the containment atmosphere. The containment radiation monitoring system provides readings that are indicative of RCS leakage into the containment, but the correlation to a common leakage equivalent depends on containment atmospheric conditions, containment air mixing, plateout factors, RCS activity levels and the leak location. The only method for determining true RCS leakage is the RCS inventory balance method which is indicative of total RCS leakage, whether into the containment or into a connected system (i.e., CVCS). ANO-2 considers the sump level and radiation methods as a means to indicate a "change" (i.e., upward trend) in the RCS leak rate which would lead to increased leak rate monitoring by the inventory balance method.

8. The leakage detection systems should be equipped with provisions to readily permit testing for operability and calibration during plant operation.

RESPONSE

Containment Air Monitoring Systems

Technical specification 4.4.6.1.a provides the surveillance requirements for the containment atmosphere particulate and gaseous monitoring systems (CAMS). The TS states that performance of a channel check, channel calibration and channel functional test is required at the frequencies specified in TS Table 4.3-3. The surveillances are described as follows:

Channel Check - The channel check is accomplished during performance of the operations logs per procedure 1015.003B. The instrument indication and status is recorded on a once per shift basis during the TS required operating modes.

Channel Functional Test - The channel functional test is accomplished on a monthly basis using station approved procedure 2304.016. The test involves subjecting the radiation detector to an installed check source and verifying the detector responds to the subsequent increased radiation level by monitoring the associated indicator. The functional test also verifies the alarm setpoints are set as required and the alarm is operational. A functional test for the air particulate detector is also performed to test the air sampling portion of the CAMS. The paper drive, sample air pressure and sample air flow settings are tested per station approved procedure 2304.026.

Channel Calibration - The channel calibration is accomplished on a refueling (18 month) basis using station approved procedure 2304.006. The calibration involves the following checks:

- Operational verification (meter response to check source)
- Meter zero verification
- Electronics check and adjustment
- Alarm bistable adjustment
- Isotopic (high voltage) check and adjustment
- Recorder calibration

Containment Sump

Technical specification 4.4.6.1.b provides the surveillance requirements for the containment sump level monitoring system. The TS states that performance of a channel calibration is required at least once per 18 months. The surveillance is described as follows:

Channel Calibration - The channel calibration is accomplished on a refueling (18 month) basis using station approved procedure 2304.024. The calibration involves the following checks:

- Control room level indicator calibration
- Alarm annunciation functional test
- Verification of alarm at high level setpoint
- Isolation module for computer input calibration
- Local (transmitter) indicator mechanical zero check
- Calibration check of the detector
- Transmitter calibration
- Environmental qualification maintenance (if required)

9. **The technical specifications should include the limiting conditions for identified and unidentified leakage and address the availability of various types of instruments to assure adequate coverage at all times.**

RESPONSE

Technical specification 3.4.6.2 provides the limiting condition for operation (LCO) and TS 4.4.6.2.1 provides the surveillance requirements for identified and unidentified RCS leakage. Technical specification 3.4.6.1 provides the LCO and TS 4.4.6.1 provides the surveillance requirements for the primary leakage detection systems described in the item 3 response.