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United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. George W. Knighton, Chief
Licensing Branch 3
Division of Licensing

Reference: (a) Construction Permits CPPR-135 and CPPR-136, Docket Nos. 50-443 and 50-444

Subject: Open Item Response (SRP 5.2.5; Auxiliary Systems Branch)

Dear Sir:

In response to the open item regarding detection of leakage from the reactor coolant pressure boundary, we have enclosed a revised version of the following FSAR pages:

1.8-17, 5.2-24, 5.2-25, 5.2-26, 5.2-27, 5.2-28, 5.2-29, 5.2-30, 5.2-31

The enclosed revised FSAR pages will be incorporated in OL Application Amendment 49.

Very truly yours

YANKEE ATOMIC ELECTRIC COMPANY

John DeVincentis
Project Manager

JDeV/smh

cc: Atomic Safety and Licensing Board Service List

B001

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Regulatory Guide 1.45 (Rev. 0, 5/73) — Reactor Coolant Pressure Boundary Leakage Detection System

The design ~~criteria for~~ OF the reactor coolant pressure boundary leakage detection system ~~comply~~ COMPLIES with Regulatory Guide 1.45. The regulatory position taken in the guide has been considered and incorporated into the design of the leakage detection system.

~~Compliance with IEEE-279-71 is limited to providing the capability for testing and calibration of the leak detection instruments only. Leak detection instruments, such as temperature, flows and humidity, have capability for periodic testing during refueling outage. The airborne radioactivity detector has the capability for periodic testing during power operation.~~

~~Regarding Section C.5:~~ DELETE

~~The response time of containment airborne particulate radioactivity monitoring devices to detect a one gpm leakage rate may vary from the given requirement, depending on equilibrium conditions in containment at the inception of the leak.~~ 44

For additional discussion on this subject, see Subsection 5.2.5.

Regulatory Guide 1.46 (Rev. 0, 5/73) — Protection Against Pipe Whip Inside Containment

The design against pipe whip is in full compliance with Regulatory Guide 1.46, as discussed in Section 3.6.

Regulatory Guide 1.47 (Rev. 0, 5/73) — Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems

Provisions have been made in the design of the plant safety systems to meet the intent of Regulatory Guide 1.47.

Automatic indication, at the system level, of bypassed and inoperable status of the protection systems has been provided in the control room. Once activated, the system-level indicator will remain on until the activating condition is cleared. Each system-level indicator is also capable of being manually activated in the control room.

Additional discussion on this subject is presented in Section 7.1

Regulatory Guide 1.48 (Rev. 0, 5/73) — Design Limits and Loading Combinations for Seismic Category I Fluid System Components

NSSS components are designed using the stress limits and loading combinations presented in Sections 3.9(N).1 and 5.2 for Code Class 1 components and in

b. Pressurizer Relief Tank (PRT)

The PRT condenses and cools the discharge from the pressurizer safety and relief valves. Discharge from the smaller relief valves located inside the containment is also piped to the PRT.

5.2.5.2 Unidentified Leakage to Containment

The majority of leakage from sources within the reactor containment is ultimately collected in the containment drainage sumps. Drainage trenches on the floor of the containment channel leakages and condensation to the sump. The leakage rates can be established and monitored during plant operation. Unidentified leakage to the containment atmosphere is kept to a minimum to permit the leakage detection systems to detect positively and rapidly a small increase in the leakage. Identified and unidentified leakages are separated so that a small unidentified leakage will not be masked by a comparatively larger identified leakage.

5.2.5.3 Leakage Detection Methods

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The RCPB leakage detection is implemented using the following monitoring methods so that continuous monitoring of both identified and unidentified leakage is made possible. Figure 5.2-2 identifies the various monitoring instruments employed for this purpose. ← INSERT A

a. Design Bases

The following design bases were established to satisfy the requirements of General Design Criterion 30 for design diversity and redundancy for the RCPB leak detection systems.

1. Leakage to the atmosphere from systems containing radioactive fluid, which would result in an increase in overall containment radioactivity levels, are detected by the use of airborne radioactivity monitors.

2. Indications of an increase in local humidity and temperature from any source releasing hot liquid to the atmosphere is provided by the humidity and air temperature monitors.

3. Temperature monitors are provided to indicate temperature flux vs. flow of leakage in drainage and relief lines and tanks, e.g., reactor vessel flange, pump seal and primary valve leakoffs which discharge to the RCDT and the PRT.

4. Liquid level monitors are provided for drainage sumps and tanks to monitor the leakage.

(3)

INSERT A PAGE 5.2-24

The RCPB leakage detection is implemented by using continuous monitoring methods and/or a periodic RCS water inventory balance method. These methods provide a means for detection of both identified and unidentified leakage.

5. The systems are designed to reliably annunciate increasing leakages. The radiation monitors are provided with failure alarms that will indicate any instrument troubles.

6. The monitors provided shall supply sufficient information to enable deduction of leakage rates, differentiation, identification and general location of leaks.

b. Monitoring System

The reactor coolant leakage ~~detection~~ MONITORING systems consist of the following ~~categories of monitors and detectors.~~ INSTRUMENTATION.

1. Containment Drainage Sump Liquid Inventory Monitor

As indicated in Subsection 5.2.5.2, leakage is collected in containment drainage sumps. Sump level monitoring is provided to inventory the drainage handled. Level switches are used to maintain the sump level between pre-determined levels, by cycling the sump pump. Leaks are indicated by the computer log and trend of the sump level and pump operation. Continuous sump level monitoring is available in the main control room.

2. Containment Airborne Radioactivity Monitor

This channel monitors a sample drawn from the containment atmosphere for particulate and gaseous radioactivity. Iodine monitoring is done in batch mode by analyzing the charcoal cartridge periodically in the laboratory. A sample which is representative of the containment atmosphere is drawn by an integral pumping system, from containment to a moving paper particulate filter, an iodine cartridge and a noble gas chamber. The air sample is then discharged back to the containment. One radiation detector is used to monitor the particulate filter and the second radiation detector monitors the noble gas. The detectors are of Beta Scintillator type. The detector outputs are converted into microcuries per cubic centimeter by the microprocessor. During maintenance, portable monitors will be utilized.

3. Containment Humidity Monitors

The humidity detector system offers another means of detecting leakage into the containment. Six humidity sensors are located in various areas of the containment structure. As there is no leakage of moisture from the outside, any increase of humidity is a ~~measure~~ indication of leakage inside the containment.

4. Reactor Vessel Flange Leakoff

The reactor flange and head are sealed by two metallic O-rings. Leakoff connections are provided between the O-rings and beyond the outer O-ring. The leakage is piped to the RCDT. A high temperature measurement by an RTD mounted in the piping indicates the reactor coolant leakage.

5. Reactor Coolant Drain Tank

The various sources of leakage to the RCDT are identified in Subsection 5.2.5.1.a. The RCDT is provided with temperature, pressure and level indications by which leakage is determined.

6. Reactor Coolant Pump Seal Leakoff

Refer to Subsection 5.4.1.3 for a complete discussion of the reactor coolant pump shaft seal leakage. Seal water enters the pumps through a connection on the thermal barrier flange, and is directed to a plenum between the thermal barrier housing and the shaft. Here the flow splits: a portion flows down the shaft to cool the bearing and enters the RCS; the remainder flows up the shaft through the No. 1 seal, a controlled leakage seal. After passing through the seal, most of the flow leaves the pump via the No. 1 seal leakoff line. Minor flow passes through the No. 2 seal and leakoff line. This flow is monitored by a flow switch. A back flush injection from a head tank flows into the No. 3 seal between its "double dam" seal area. At this point, the flow divides with half flushing through one side of the seal and out the No. 2 seal leakoff while the remaining half flushes through the other side and out the No. 3 seal leakoff which uses a standpipe. Excessive leakage backs up in the standpipe until it overflows out the top, with the overflow directed to containment sump A. A high level of the upper standpipe is alarmed, indicating excess leakage.

7. Pressurizer Relief Tank (PRT)

The leakages directed to PRT are identified in Subsection 5.2.5.1.b. During normal operation, the leakage to the PRT is expected to be negligible, since all the valves are designed to minimize leakage at the normal system operating pressure. Temperature detectors are provided in the discharge piping of each valve to indicate possible leakage. PRT level, temperature and pressure indications and alarms are provided to indicate the leakage.

8. Containment Ambient Temperature Monitors

Platinum resistance temperature detectors are strategically located throughout the containment to detect local temperature changes and will assist in localizing a leak.

C. RCS Water Inventory Balance

The periodic RCS water inventory balance is designed to be conducted during steady state conditions with minimal T-AVG variance. In the course of this inventory the following parameters are monitored:

1. Time
2. T-Avg
3. Pressurizer Level
4. VCT Level
5. PRT Level
6. RCDT Level
7. BAB Flow Totalizer

Changes in inventory due to sampling, draining, and steam generator tube leakage are accounted for separately. During the conduct of this inventory every effort is made to avoid additions to the RCS, pump down of the RCDT, or diversion from letdown to the VCT.

Changes in the parameters are calculated over a convenient time period (the longer the period the more accurate the results). The inventory change rate is determined by summing the volume change associated with each parameter and dividing this value by the time interval. The difference between the containment sump leakage rate and the inventory change rate will indicate leakage from sources other than the primary system.

ADD

SEE PREVIOUS PAGE

8. Containment Ambient Temperature Monitors

Platinum resistance temperature detectors are strategically located throughout the containment to detect local temperature changes and will assist in localizing a leak.

5.2.5.4 Intersystem Leakage Detection

The following three types of detection methods are employed to monitor systems connected with the RCPB for signs of intersystem leakage:

a. Primary Component Cooling Water System Radiation Monitors

These are gamma sensitive scintillation detectors. Liquid sample is drawn from the discharge side of the primary component cooling water pumps and returned back to the suction side. This system monitors primary component cooling water for radioactivity indicative of a leak from the reactor coolant system or from one of the radioactive systems which exchanges heat with the primary component cooling system. These detectors are provided with the relevant flow information, so as to get the radioactivity in terms of microcuries per cubic centimeter.

b. Condenser Air Evacuation Monitors

This method is employed for detection of steam generator tube leaks. Noble gases present in the steam generator tube or tube sheet coolant leakage leave solution in the steam generator and are ultimately vented along with other non-condensables. This detector is a gross beta scintillator. The detector is directly mounted in the discharge line of the three air evacuation pumps.

c. Steam Generator Blowdown Sample Monitors

These monitors provide indications of primary to secondary leaks in the steam generators by analyzing the liquid phases of the four steam generator secondary sides. These are of the gamma sensitive scintillation type. Pressures and temperatures are reduced for detection purposes.

5.2.5.5 Sensitivity and Response Time of Detectors

The sensitivity and response time of each leakage detection method PROVIDED TO COMPLY WITH THE ~~employed for monitoring the leakage to the containment is discussed below. Those methods capable of detecting a leakage rate (or its equivalent) to the containment of 1 gpm in less than one hour are indicated.~~ GUIDANCE in Regulatory Guide 1.45, position C5 for detecting unidentified leakage to the containment is discussed below.

The drainage sump instrumentation system has a sensitivity of 1 inch and an accuracy of ±5%

The containment air particulate monitor has a sensitivity of 10^{-10} µ Ci/cc and an accuracy of ±20%

a. Containment Drainage Sump Inventory Monitoring

Normal leakage from all the unidentified sources within the containment is estimated to be in the range of 20 to 40 gallons per day. RCPB leaks on the order of 1 gpm are very large in comparison and are easily detected by log and trend of containment sump level. Additionally, the level transmitters have sufficient resolutions to detect change in level due to a flow of as little as 1 gpm. Leakages of the order of 0.05 gpm are detected in a few hours with the expected background leakage. ~~Thus,~~ Leakage of 1 gpm can be detected in ~~approximately (later)~~ [less than 60] minutes.

b. Containment Air Particulate Monitor

The containment air particulate monitor is one of the most sensitive instruments available for detection of reactor coolant leakage into the containment. The measuring range is 10^{-10} to $10^{-6}\,\mu$ Ci/cm^3. The ~~sensitivity~~ [response time] is the ~~greatest~~ [shortest] where the base line leakage is low. The base line airborne activity is kept low by adjusting the valve packings and pump seals properly. The air particulate monitor is capable of detecting leakage of 1 gpm in ~~(later)~~ [less than 60] minutes, if the reactor is operating with 0.12% fuel defects (reference Subsection 11.1.7.1) and a coolant corrosion product level of $2.3 \times 10^{-2}\,\mu$ Ci/gm (reference Table 11.1-1), assuming ~~no~~ [a] base line leakage activity [of 1% per day of reactor coolant mass]. However, during the initial period of operation, and following refueling when the coolant activity is low, response time will be longer than those of other types of monitors which do not rely on coolant activity for detection.

c. Containment Radioactive Gas Monitor

Gaseous activity in the containment atmosphere results from fission gases (various Kr and Xe isotopes) in coolant leakage and from Ar-41 produced by activation of air around the reactor vessel. ~~The sensitivity of~~ The gas monitor ~~depends on the coolant activity level~~ [has a sensitivity of 10^{-6} µ Ci/cc and an accuracy of ±20%]. The range of the monitor is 10^{-6} to 10^{-2} μ Ci/cm^3. The gas monitor is able to detect a leakage of 1 gpm in ~~(later)~~ [less than 60] minutes if the reactor is operated with 0.12% fuel defects (reference Subsection 11.1.7.1). ~~This provides a useful backup to other RCPB leakage detectors.~~

~~d. Containment Humidity Monitors~~

~~The sensitivity of the humidity detectors varies with containment atmospheric conditions. It is sensitive to both radioactive and non-radioactive discharge. The humidity detector has a sensitivity of 0.1°F dew point temperature. The response time is approximately (later) minutes for a (later) gpm leakage. The system is an indirect indication of leakage to the containment. If the humidity monitor detects an increase in containment~~ delete moisture without a corresponding increase in activity level, the indicated source of leakage would be judged to be a non-radioactive system.

e. Containment Temperature Monitors

The temperature sensors have an accuracy of ± (later) °F. Their sensitivity and response time is dependent on the distance of the sensor from the leak and the amount of mixing of the containment atmosphere. The temperature sensors are an aid in determining the location of a leak from a high temperature system.

f. Primary Component Cooling Liquid Radiation Monitor

The detector range is 10^{-7} to 10^{-3} $\mu Ci/cm^3$. The monitor response time is dependent upon the leakage rate and the amount of fission product and corrosion product activity in the primary coolant. With 0.12% failed fuel (reference Subsection 11.1.7.1), and a coolant activity of 3.8×10^0 $\mu Ci/gm$ excluding H-3 and N-16, (reference Table 11.1-1) a leakage rate of 1 gpm is detected in 60 minutes. Sequential isolation of various components after detection of leakage can be used to identify the point of leakage within a relatively short time. Even in the absence of failed fuel, the monitors provide an effective means of detection and identification of the source of 1 gpm leak. 46

g. Condenser Air Evacuation Gas Monitor

The range of the monitor is 10^1 to 10^6 counts/minute (which is equivalent to a range of 10^{-6} to 10^{-2} $\mu Ci/cm^3$, assuming 0.5% failed fuel). Sensitivity varies with the reactor coolant activity. Thus, for a coolant activity of 3.8×10^0 $\mu Ci/gm$ excluding H-3 and N-16 (reference Table 11.1-1) and 0.12% clad defects (reference Subsection 11.1.7.1), a leakage of 1 gpm can be detected in 60 minutes. 46

h. Steam Generator Blowdown Monitors

The steam generator blowdown monitors have a range of 10^{-6} to 10^{-2} $\mu Ci/cm^3$. Design basis steam generator tube leakage is expected to be approximately 12 gpd. The monitor response time is dependent upon mixing time in the steam generator secondary side water volume, steam generator blowdown rate, abnormal leakage rate and the amount of fission product and corrosion product activity in the primary coolant. Thus, for 0.12% failed fuel (reference Subsection 11.1.7.1) and a coolant activity of 3.8×10^0 $\mu Ci/gm$ excluding H-3 and N-16 (reference Table 11.1-1) and assuming no base line leakage activity, this monitoring system will respond to a sudden occurrence of a 20 gpm primary-to-secondary leak in about 20 minutes.

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i. Reactor Coolant Drain Tank

The reactor coolant pump seal (No. 2) leakage of 12 gph accounts for the majority of normal leakage to the RCDT. Valve stem leakage contributes a fraction of a gallon per hour, while the other sources have negligible leakage. The leakage leading to the RCDT from the RCPB is detected by trends of RCDT temperature, pressure and level.

5.2.5.6 Seismic Capability

The containment airborne radioactivity monitor and containment drainage sump level instrumentation is classified seismic Catgory I, and satisfies the requirement of NRC Regulatory Guide 1.45, for seismic qualification.

5.2.5.7 Indicators and Alarms

Positive indication of RCPB leakage is provided in the main control room by the instruments located there, in association with the RCPB leakage detection subsystems. All indicators, recorders, annunciators and computer logs are readily available to the main control room operators. The operators are provided with the procedures for interpreting the indications to identify the leakage source, and with criteria for plant operation under leakage conditions.

Continuous sump level monitor is available to the plant computer. The computer monitors the sump level as well as the running of the sump pump in order to determine the leakage. Sump level high and low level alarms are also available.

For the humidity monitors, absolute humidity indications at various locations in the containment with high alarm points are provided at the main control room via the Main Plant Computer System (MPCS).

For PRT and RCDT, temperature and level detectors are provided so that high and low level indications and high temperatures are alarmed. Temperature detectors are provided in the discharge piping of each safety and relief valve, reactor vessel flange, leakoff piping pressurizer vent, and reactor vessel head vent, to indicate possible leakage. Temperature detectors at various areas of containment monitor any high ambient temperature, aiding in locating the leakage source. A high temperature of reactor vessel flange leak at the main control room will indicate inner and outer seal leaks. High flow indication in Seal No. 2 leakoff and high level indication in stand pipe connected to Seal No. 3 will alert the control room operator to reactor coolant pump seal leaks.

For all radiation monitoring systems, local indication of activity and high level alarm are provided locally at the monitor. By means of the RDMS, indication and alarms are provided at the main control room. Equipment failure alarms are also available.

5.2.5.8 Testing

Calibration and functional testing of the leak detection systems, i.e., ~~containment humidity detection,~~ sump level detection, containment air and particulate monitoring~~, etc~~. will be performed prior to initial plant start-up.

During normal plant operation, periodic readings of leakage detection system instrumentation will indicate leakage trends. Periodic inspection and calibration of leak detection instruments (CAN BE PERFORMED DURING NORMAL OPERATION AND) will ensure accuracy and dependability.

For all radiation monitors, a primary calibration is performed on a one-time basis, utilizing typical isotopes of interest to determine proper detector response. Secondary standard calibrations are performed with multiple radiation sources to confirm the channel sensitivity obtained on primary calibration. This single point calibration confirms the channel sensitivity. Each monitor has a diagnostic program built into its microprocessor. This program continuously conducts a diagnostic routine within the monitor and provides an alarm input to the RDMS when a failure is detected. Each monitor is equipped with a "check source" that is inserted upon the command of the RDMS. Each time the check source is inserted, the microprocessor measures and stores the effect of the check source and compares it to the previous reading to obtain an indication of calibration trends. A circuit calibration test is accomplished by inputting a precalibrated pulse signal to the channel. Proper indication at the meter will verify the calibration of the circuitry.

5.2.5.9 Technical Specification

The technical specification is provided in Chapter 16, Section 3/4.4.7.

5.2.6 Reactor Coolant Vent System

5.2.6.1 Design Basis

The reactor coolant vent system is designed to allow venting the large quantities of non-condensible gases that can be generated within the reactor following core damage. It provides a vent path to the containment atmosphere via the pressurizer relief tank to insure that non-condensible gases cannot accumulate in the core to the point where core cooling would be interrupted and further core damage occur.

5.2.6.2 System Description

This system (see Figure 5.1-1, Sheets 1 and 6*) provides the capability to vent the reactor coolant system from two locations: the reactor vessel head and the pressurizer steam space. The vent valves will be manually operated from the control room. The function of these vents is to vent any non-condensible gases that may collect in the reactor vessel head and in the pressurizer following core damage.

* Undergoing revision 44