



Public Service Company of Colorado

P. O. Box 361, Platteville, Colorado 80651

APR. 18, 1975

April 8, 1975

Mr. E. Morris Howard, Director
Nuclear Regulatory Commission
Region IV
Office of Inspection and Enforcement
611 Ryan Plaza Drive
Suite 1000
Arlington, Texas 76012

REF: Facility Operating License
No. DPR-34

Docket No. 50-267

Dear Mr. Howard:

Enclosed please find a copy of Abnormal Occurrence Report No. 50-267/75/3A,
(additional information to the final), submitted per the requirements of
the Technical Specifications.

Very truly yours,

H. Larry Brey

H. Larry Brey
Superintendent-Operations
Fort St. Vrain Nuclear
Generating Station

HLB:il

cc: Mr. Angelo Giambusso

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inquiry

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COPY SENT REGION

REPORT DATE: 4-07-75

ABNORMAL OCCURRENCE

OCCURRENCE DATE: 1/23/75

FORT ST. VRAIN NUCLEAR GENERATING STATION
PUBLIC SERVICE COMPANY OF COLORADO
P. O. BOX 361
PLATTEVILLE, COLORADO 80651

REPORT NO. 50-267/75/3A

Final
ADDITIONAL INFORMATION

IDENTIFICATION OF
OCCURRENCE:

Failure of the Dew Point Moisture Monitors to initiate a reactor scram when moisture content of the primary coolant exceeded the trip setpoint.

This is identified as an Abnormal Occurrence per definition 2.1b of the Technical Specifications and a violation of Limiting Condition for Operation, LCO 4.2.11, Loop Impurity Levels, Low Temperatures.

CONDITIONS PRIOR
TO OCCURRENCE:

_____ Steady State Power	_____ Routine Shutdown
_____ Hot Shutdown	_____ Routine Load Change
_____ Cold Shutdown	<u>X</u> Other (specify)
_____ Refueling Shutdown	<u>Reactor critical at approximately</u>
_____ Routine Startup	<u>10⁻⁵% of Rated Thermal Power</u>
	<u>for training purposes.</u>

The major plant parameters at the time of the event were as follows:

Power	PTR <u>0</u>	MWth
	ELECT. <u>0</u>	MWe
Secondary Coolant	Pressure <u>1250</u>	psig
	Temperature <u>182</u>	°F
	Flow <u>~ 349,000</u>	#/hr.
Primary Coolant	Pressure <u>234</u>	psig
	Temperature <u>182</u>	°F Core Inlet
	<u>193</u>	°F Core Outlet
	Flow <u>2 x 10⁵</u>	#/hr.

DESCRIPTION
OF OCCURRENCE:

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On January 23, 1975, preparations were made to take the reactor critical for training purposes. Two helium circulators, A and B, were accelerated to approximately 2300 rpm at approximately 0130. Moisture levels in the primary coolant at this time were < 1000 ppmv, well within the limit of 5000 ppmv stated in LCO 4.2.11. An increase in moisture concentration was noted on the panametrics moisture monitors shortly following acceleration of the helium circulators. This was considered normal from our past experience under similar circumstances.

The reactor was taken critical at approximately 0630 hours and power raised to 10^{-5} %. It was noted that the moisture level was continuing to rise in the primary coolant but the trace on the chart indicated an approach to an equilibrium condition of about 1500 ppmv, still within the limits of LCO 4.2.11.

It should be noted that the panametric monitor on I-05 had alarmed at 500 ppm.

As the morning progressed, the indicated moisture level in the primary coolant stabilized at approximately 1500-2000 ppmv. At the same time it was noted that it was necessary to continuously adjust the control rods into the core to maintain the desired power level. This initial control rod movement was, at the time, thought to be due to overcooling of the core with helium flow. As core reactivity continued to change the mechanism causing it was not immediately obvious. The reactor was scrammed when the core reactivity reached .008AK greater than expected.

As a part of the investigation into the noted reactivity change, the two high level moisture monitors were switched to the indicate mode and both indicated 4500-4600 ppm moisture.

Because of the discrepancy noted between the dew point and panametric moisture monitors, samples of primary coolant were drawn and analyzed for moisture in the gas chromatograph. These analyses indicated moisture levels in excess of 10,000 ppm.

APPARENT CAUSE
OF OCCURRENCE:

<input checked="" type="checkbox"/> Design	<input type="checkbox"/> Unusual Service Cond. Including Environ.
<input type="checkbox"/> Manufacture	<input type="checkbox"/> Component Failure
<input type="checkbox"/> Installation/Const.	<input checked="" type="checkbox"/> Other (Specify)
<input type="checkbox"/> Operator	
<input checked="" type="checkbox"/> Procedure	

A check of the dewpoint moisture monitor mirror temperature setting indicated it was set at 105°F which corresponds to a moisture level of 5000 ppm at 220 psia. In reality, the primary coolant pressure was at 246 psia and at this pressure, the 105°F dewpoint temperature corresponds to 4800 ppm. This still did not explain the difference between the chromatograph reading and the dewpoint moisture monitor readings.

Apparently a representative sample of primary coolant was not reaching the moisture monitors.

ANALYSIS OF OCCURRENCE:

At the time of the incident in question, the PCRVR cooling water system was maintaining the concrete temperature at approximately 105°F. The sample lines to the dew point moisture monitors from the helium circulator outlets must come through the concrete and therefore, the sample line temperature is controlled by the PCRVR concrete temperature.

Assuming the concrete/sample line temperature to be 100-105°F, condensation of moisture would take place in the sample line at moisture concentrations of 4100-4800 ppm in the primary coolant. With this in mind, it is reasonable to assume the sample being received by the moisture monitors was saturated at some temperature between 100-105°F and that the monitor would never have indicated a moisture level higher than 4600 ppm until such time as the sample line condensation accumulated to the point that a drop of liquid water reached the monitor and caused it to trip.

The sample line for the Panametric moisture monitors also comes through the PCRVR wall and runs for a number of hundreds of feet through areas of the plant whose temperature is less than 100-105°F.

If we assume a minimum sample line temperature of 80°F, the maximum moisture concentration that could be indicated at 246 psia would be approximately 2000 ppm. It should be noted that after a number of hours, liquid water was seen flowing from the sample lines at both the dew point and panametric moisture monitors.

In conclusion, it can be said that the dew point moisture monitors were functioning properly and were correctly indicating the moisture concentration in the sample delivered to them. The limiting factor on the ability of the moisture monitors to see the correct concentration is the sample line temperature.

CORRECTIVE ACTION:

Summary

In summary, a review of the moisture monitoring system has indicated its acceptability for normal reactor operating conditions.

To facilitate determination of moisture concentrations in the primary coolant system beyond those that can be determined directly by the moisture monitors, a new procedure has been developed and incorporated into the plant procedures that uses information available from instrumentation already installed as a part of the helium purification system.

Discussion

Because of the problems experienced which pointed out the moisture monitor sample line temperature limitations, a review of the adequacy of the moisture monitoring system, as it relates to both normal and abnormal operating conditions, was instigated. A review of possible corrective measures was made to eliminate the sample line limitations.

Based upon the normal operating pressure of the primary coolant system of 700 psia and a PCRV (sample line) temperature of 100-105°F, the maximum moisture concentration of the primary coolant that can be determined is 1400-1600 ppmv. Insofar as normal operating moisture concentrations are required to be in the 0 - 10 ppmv range and the reactor scram is adjusted to take place at 500 ppmv (67°F at 700 psia) it is concluded that the moisture sampling and analysis system as a whole is adequate for normal reactor operation.

In reviewing the operation of the sampling system and possible modifications that could be incorporated to extend the moisture concentrations that could be measured at normal primary coolant system pressures, two basic corrective actions were considered:

1. Reduce the sample pressure before it is subjected to the cooler sample line temperatures.
2. Heat the sample line to eliminate the influence of the PCRV wall temperature.

Based upon a review of past testing and operating experience, it was concluded that the moisture monitor elements, both Dewpoint and Panametrics, determine with acceptable accuracy the moisture content in the gas sample supplied to them. This review again pointed out that the sample lines, not the detectors, are the limiting component of the system.

Because of the basic design of the sampling system and its location, cast into the 9' thick wall of the PCRV, no way could be determined to modify the present installation or to install a new heated sample probe.

The moisture monitor sample lines that samples the primary coolant system and supplies gas samples to the Panametrics Moisture Monitors of the Analytical Instrument System is subject to cold spot temperatures that are less than the temperature of the PCRV sidewall. To assure that these instruments will not be limited further in their ability to determine dew point temperatures at least as high as 90°F to 100°F, the sample lines are being heat traced. This will assure the "cold spot" in the sample line will be within the PCRV sidewall.

The Panametrics Moisture Monitors, although giving acceptably accurate moisture measurements, tend to respond slowly to decreases in moisture and because of their characteristics, are difficult to read at the very low, 10-25 ppmv, and very high, > 1000 ppmv, moisture levels.

For the above reasons, Public Service Company is purchasing two EG & G Model 440 Dewpoint Moisture with which to determine primary coolant moisture levels. These instruments have a dewpoint temperature range of -110°F to +140°F at 350 psia and have a very fast response time for both increasing and decreasing moisture concentrations.

Because of the sample line temperature limitations, the determination of primary coolant moisture levels, > 1300-1500 ppmv, cannot be made by the installed instrumentation if the primary coolant system is at normal operating pressure. At atmospheric pressure in the PCRV, the installed instrumentation can determine moisture concentrations up to approximately 85,000 ppmv (corresponds to approximately 90°F dewpoint temperature)

To facilitate determination of very high moisture concentrations with the system at pressure, a method of analytically determining the moisture concentration in the primary coolant system using information available from the Helium Purification System has been developed and is to be incorporated into the plant operating procedures. The procedure is included as Attachment 1.

Because of discrepancies in LCO 4.4.1, LCO 4.2.11, and LSSS 3.3 of the Technical Specifications which all concern allowable primary coolant moisture levels, a proposed revision for the Technical Specifications had been developed and submitted to the NRC for consideration.

This proposed Technical Specification revision takes into account the sample line temperature effects to assure a dew point monitor temperature trip setting of $\leq 90^{\circ}\text{F}$.

It should be noted that following removal of moisture from the primary coolant system and the reserve shutdown material from region one (1) of the core, the reactor was taken critical on 3/21/75. Critical rod height was determined to be within one-half inch of the predicted position indicating the anomaly has been corrected.

FAILURE DATA/
SIMILAR REPORTED OCCURRENCES:

Unusual Occurrences 50-267/74/7 and 8 dealt with spurious trips of these moisture monitors.

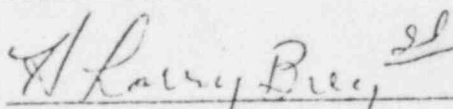
PROGRAMMATIC IMPACT:

The programmatic impact of this moisture monitor failure to initiate a scram is not significant; however, removal of moisture from the primary coolant is delaying continuation of the plant testing program.

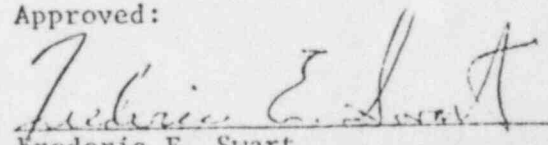
CODE IMPACT:

None

Recommended:


H. Larry Brey
Superintendent-Operations
Fort St. Vrain Nuclear
Generating Station

Approved:


Frederic E. Swart
Superintendent Nuclear Production
Public Service Company
of Colorado

ATTACHMENT 1

PCRV MOISTURE DETERMINATION
BASED ON HELIUM PURIFICATION
SYSTEM WATER REMOVAL RATES

PROCEDURE FOR PCRV MOISTURE DETERMINATION BASED
ON SYSTEM 23 WATER REMOVAL RATES

High moisture concentrations in the PCRV can be estimated if the helium flow through System 23, the Primary System, the temperature of the outlet of the System 23 front end coolers, and the water removed by these coolers are known. The four variables should be recorded approximately every hour during a dryout procedure. The first three may be recorded directly from existing plant instrumentation, and the fourth may be calculated from the level change in the front end cooler drain tank. A one inch change in this level corresponds to a 1.1 gallon change in the water collected.

More specifically, if Q is the helium flow through System 23 in ACFM, P is the primary system pressure in psia, and X is the volumetric fraction of water vapor in the PCRV, then the total water collected by the helium purification system, G , in gph, is given by equation (1). Deviation of this equation is shown in Appendix A.

$$G = .0216 P Q \frac{X}{1-X} \quad (1)$$

The total water collected by the helium purification system, G , is composed of the water removed by the front end cooler, G_1 , plus the water collected by the dryer, G_2 . As indicated above, the first can be obtained by multiplying the rate of increase of the water level in the cooler drain tank in inches per hour by the constant 1.1.

G_1 can be estimated by assuming that the flow leaving the front end cooler and entering the dryer is saturated with moisture. Thus, the moisture concentration of this gas, X_{sat} , is approximately given by:

$$X_{sat} = \frac{P_{sat} \text{ at } T}{P}, \quad (2)$$

where P_{sat} at T is the saturation pressure of water vapor at the front end cooler outlet temperature T .

X_{sat} can be substituted into X in equation (1), along with P and Q , to obtain the water removed by the dryer G_2 . Then, one can calculate the total amount of water removed, G , by adding G_1 and G_2 , as indicated above:

$$G = G_1 + G_2 \quad (3)$$

Finally, substituting G , P , and Q into equation (1) and solving for X , one can obtain the desired vessel moisture in per unit.

Consider the following example:

PCRV pressure = 153 psia $\rightarrow P = 153$ psia

Front end cooler outlet temperature = 72°F $\rightarrow T = 72^\circ\text{F}$

Helium flow through System 23 = 29 ACFM $\rightarrow Q = 29$ ACFM

Level change in drain tanks = 2.6 inches/hour $\rightarrow G_1 = 2.6 \times 1.1 = 2.86$ gph

Solution:

From the steam tables: P_{sat} at $72^{\circ}\text{F} = .388$ psia

Then, equation (2) yields

$$X_{\text{sat}} = \frac{.388}{153} = 2.53 \times 10^{-3},$$

which substituted in equation (1) yields:

$$G2 = .0216 \times 153 \times 29 \times \frac{2.53 \times 10^{-3}}{1 - 2.53 \times 10^{-3}} = .24 \text{ gph}$$

substituting $G1$ and $G2$ into (3) leads to:

$$G = 2.86 + .24 = 3.1 \text{ gph}$$

Finally, using equation (1) again with $G = 3.1$ and solving for X leads to the desired PCRV moisture level:

$$3.1 = .0216 \times 153 \times 29 \frac{X}{1-X}$$

$$X = .0313 \text{ volumetric fraction, or } 3.13\%, \text{ or } 31,300 \text{ ppm.}$$

The primary system pressure may be obtained from the data logger or from the control room instrumentation.

The System 23 helium flow may be obtained from FR-23112 on I-01.

The front end cooler outlet temperature is available at TI-2319 or TI-2320 on I-01.

Finally, the level in the front end cooler drain is available at LI-2377 or LI-2378 on I-01.

APPENDIX A

Deviation of the total water removal rate by System 23 (equation 1)

Let Q be the total helium flow (purified helium) through System 23, and let X be the volumetric concentration of water vapor in the PCRV. Then, the total flow at the inlet to the front end cooler is

$$F_t = Q \frac{1}{1-X} \text{ ACFM.}$$

and the partial volumetric flow of water vapor is

$$F_w = Q \frac{1}{1-X} \text{ ACFM} = 60 Q \frac{X}{1-X} \text{ ACFH} \quad (4)$$

From the ideal law of gases, which normally applies for vapor at the low partial pressures involved here, one obtains:

$$m = \frac{PVM}{RT} \quad (5)$$

where m is mass flow of water vapor in lbs/hour, P is total pressure in psia, V is partial volumetric flow of water vapor, M is the molecule weight of water, R is the ideal gas constant, and T is the absolute temperature of the water vapor.

Substituting equation (4), into (5), and assuming an approximate PCRV temperature of 90°F during a dryout procedure leads to:

$$\text{Water mass removed} = 60 Q \frac{X}{1-X} P \times 18 \frac{144}{1544 (460 + 90)} = 0.18 PQ \frac{X}{1-X} \text{ lbs.}$$

Finally, converting mass of water removed to gallons of water removed leads to:

$$G = 0.18 PQ \frac{X}{1-X} \text{ lbs/hr} \times .016 \times 7.48 \text{ gallons}$$

$$G = .0216 PQ \frac{X}{1-X}, \text{ which is the desired equation (1).}$$