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MAY 27 1977

MEMORANDUM FOR: Karl R. Goller, Assistant Director for Operating Reactors, DOR

FROM: Darrell G. Eisenhut, Assistant Director for Operational Technology, DOR

SUBJECT: LIQUID EFFLUENT CONTROL MONITORS

50-269

Our review of a proposed amendment for the Oconee Nuclear Power Station has brought to our attention a possible generic problem involving liquid effluent control monitors. The proposed Oconee amendment would have allowed discharges at concentrations up to 35 times those specified in 10 CFR Part 20, Appendix B, Table II, for unrestricted areas. The basis for the proposed amendment was that the high background at the liquid effluent control monitor and the inability of station personnel to correlate the monitor's readings with effluent concentrations prevented the monitor from responding to concentrations near the valves specified in 10 CFR Part 20, Appendix B, Table II.

The licensee had stated that the monitor readings could not be correlated with the effluent concentrations because of the widely varying types of effluent from the three units on the site. This problem has been discussed at length with A. Gibson and A. Kowalczuk of I&E, Region II, and the licensee. Because there was a difference of opinion between Region II and the licensee as to whether this problem could be solved EEB/DOR requested P. Stoddart, ETSB/DSE (who has special expertise in this area) to visit the site. On March 16, 1977 P. Stoddart visited Oconee Station Units 1, 2 and 3 to discuss with station personnel the problems that they have had in correlating the liquid effluent concentrations with the liquid effluent control monitor readings (trip report enclosed).

During the visit, P. Stoddart was informed that station personnel have recently discovered defects in the NaI crystals in the liquid effluent control monitor including crystal fracture, separation of the crystal-glass interface and discoloration of crystals. This has resulted in a decrease in gross count against standard radiation sources and a shift in peak positions in the energy spectrum. These defects are believed to

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be caused by very rapid heating and cooling of the crystal during the discharge of liquid effluents. The crystal is in good thermal contact with the discharge pipe. It is not insulated. The discharge of heated liquid radwaste has raised the temperature of the crystal as much as 30°F in a few minutes which is an order of magnitude greater than the manufacturer's specification. Flushing the pipe immediately after discharge then lowers the temperature rapidly.

Raising the temperature combined with the observed defects of the NaI crystal during discharge will reduce the sensitivity of the effluent monitor during discharge. This will affect the correlation between the effluent monitor readings and the effluent concentrations, i.e., the monitor calibration. This reduced sensitivity of the monitor may allow discharges of concentrations in liquid effluents in excess of the concentrations listed in 10 CFR Part 20, Appendix B, Table II. To be effective, the NaI crystal should be maintained at a near-constant temperature during discharge and at a temperature which is compatible with the temperature at which the monitor was calibrated.

We recommend that this temperature problem for NaI crystals in effluent control monitors be investigated at other facilities. The method licensees could use to determine if a NaI crystal is cracked is to compare the responses of the monitor to a single solid source placed at five different locations on the front face of the crystal. The source would be placed along the circumference at top center, left center, right center and bottom center, and at the center of the crystal (see attachments of the enclosed trip report). If the responses for the different locations around the circumference are significantly different or if the response for the center location is lower than those for the circumferential locations, the NaI crystal is suspect.

We suggest issuance of an IE information circular with followup by IE inspectors as an appropriate way to proceed in this matter. We are proceeding with the review of the Oconee amendment as a separate matter.

Darrell G. Eisenhut, Assistant Director
for Operational Technology
Division of Operating Reactors

Enclosure:
As stated

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VISIT TO OCONEE NUCLEAR PLANT
MARCH 16, 1977, BY P. G. STODDART
EFFLUENT TREATMENT SYSTEMS BRANCH, DSE
(TAR-6406)

On March 16, 1977, I met with members of the staff of Oconee Nuclear Station, Unit Nos. 1, 2, and 3, and with representatives of Duke Power Company, as requested by EEB under TAR-6406. The purpose of this meeting was to discuss effluent radiological monitoring problems associated with the radioactive liquid effluent discharge line. I also sat-in on a meeting of a staff task force on radiation monitoring held on March 16, 1977.

Members of the Duke Power and Oconee plant staff in attendance at the morning meeting were:

Bob Koehler	Mary Birch
Mike Tuckman	Bryan Burton
Charles Putnam	Ted McMeekin

Attending the afternoon meeting were:

Bob Koehler	Ted McMeekin
Charles Putnam	Bill McLean
Mary Birch	Jim Long
Bryan Burton	Don Rogers

Steve DeGange

The following is a summary of the points discussed:

1. Background of Liquid Waste Monitoring Problem

The liquid radwaste system effluent from all three units are discharged to the tailrace of Keowee Hydro Station. The hydro station is used approximately 5% of the time; during those periods, the flow is on the order of several hundred thousand gallons per minute, which allows adequate dilution to dilute effluent concentrations on the order of 10^{-4} uCi/ml down to 10^{-10} to 10^{-11} uCi/ml. Approximately 20%

of releases can be timed to coincide with Keowee Hydro Station operating periods. When the hydro station is not operating, leakage flow from valves, gates, etc., is on the order of 40 cfs, or approximately 20,000 gpm. During such periods, the only dilution flow is the 20,000 gpm leakage. With radwaste system discharges at 10 to 100 gpm, this represents a dilution flow of as much as 2,000:1 or as little as 200:1. If the radwaste system discharge is 100 gpm at 10^{-4} uCi/ml, the effective dilution is 200:1, and the effective concentration is 5×10^{-7} uCi/ml, which, for a typical mix of nuclides, approximates the limits set forth in 10 CFR Part 20.

The Oconee staff found that radioactive contamination was building-up in the discharge pipe and in the detector well, causing an increase in radiation background count at the detector and making it difficult to set the monitor to alarm at 10 CFR Part 20 limits. On November 18, 1976, Oconee requested that NRC approve a Technical Specification change which would allow the liquid effluent monitor to be set at a value which would be equivalent to 35 times 10 CFR Part 20 limits, based on a 40 cfs dilution flow.

As part of Oconee's justification for requesting the Tech Spec change, they noted that a new liquid monitor had been procured and installed. It was noted that the new monitor had a replaceable inner chamber or liner which could be removed for decontamination.

2. Incidental Radiation Monitoring Problems

In Oconee's investigation of problems associated with the liquid effluent monitor, a number of factors were observed which may well be of a generic nature rather than being specific to Oconee.

a. Plateout. At the present time, Oconee's liquid radwaste treatment consists of one stage of evaporation. The resultant condensate is typically about 10^{-5} to 10^{-7} uCi/ml. The activity that is present, however, appears to be of an ionic nature and tends to deposit or plateout on the walls of the discharge pipe and on the walls of the liquid waste effluent radioactivity monitor chamber. The contamination builds up gradually over a period of time and is firmly fixed to whatever surface is present. Station personnel have tried polishing the inner surfaces of the monitor chamber and also have experimented with lining materials such as Teflon; in each case, the contamination buildup rate is about the same and the contaminent is firmly fixed to the surface. The new liquid effluent monitor noted above has a polished stainless steel chamber liner which can be removed; Oconee has two replacement liners which permit exchange and decontamination with minimum downtime.

The use of the replacement liners in the new liquid effluent monitor represents an interim solution to the problem of plateout with respect to the level of buildup of background radioactivity and the corresponding reduction in sensitivity of the monitor. Oconee is in the process of re-piping their liquid radwaste treatment system to permit the use of a mixed-bed polishing demineralizer downstream of the radwaste evaporator. It is considered that this augment would remove the ionic contaminants with a high degree of efficiency and should substantially reduce the plateout problem.

b. Scintillation Crystal Degradation. Attempts by licensee staff to correlate analysis results with liquid effluent monitor readings showed variations and deviations which could not be accounted for by expected statistical errors. Investigation into causes of the observed discrepancies resulted in the discovery of several cases of defects in the scintillation detector crystal assemblies, including crystal fracture, separation of crystal-glass interfaces, and discoloration of crystals due to internal hydration. The outward symptoms of the conditions described were a decrease in gross count against standard radiation sources and a shift in energy peak positions in energy spectrum analysis. Although not confirmed by experimental data, it is believed that the defects are caused by thermal shock in the liquid waste monitoring application. Under typical conditions, the monitor is at an ambient temperature of about 70°F. Liquid effluent is discharged from the condensate tanks at 90 -100°F, following which a flush using lake water at about 50°F is used to purge the discharge line. The Harshaw Chemical Company, manufacturer of the scintillation crystals used, recommends that the rate of change of temperature of the crystal not exceeded 1°C per minute. In reviewing the catalog literature of two liquid effluent monitor manufacturers using similar crystals, we note that the literature does not specify a limitation on temperature change, specifying only an operating range of 0°C to 50°C (32°F to 120°F).

It is my opinion that the licensee's position that the crystal degradations are due to thermal shock is correct. I recommend that a bulletin be issued to all operating plants describing the problem and asking each licensee to immediately inspect all detector crystals which are subject to such temperature changes and to report any occurrence of damaged crystals. A procedure for routine testing to identify damaged crystals without disassembly of the detector probe is shown in Attachment A to this memorandum. A routine testing procedure using a pulse height analysis device is shown in Attachment B.

Regular inspection of detector assemblies should be required on a schedule to be determined on the basis of the number of defects encountered. On the basis of Oconee experience, quarterly inspection would seem warranted.

On the basis of Oconee experience, it would appear that the use of multi-channel analyzers in liquid waste monitors to initiate the closure of discharge valves is not appropriate. A small degradation in the detector crystal could result in shift of the spectral peak to a point outside the pre-determined window, making such a monitor ineffective as a safety device. Operation in a gross count mode would make detection of abnormal releases more reliable.

Oconee has proposed a modification in detector probe design which would encase the crystal in a jacket of plastic with good thermal insulating qualities. Such a jacket should reduce the rate of change of temperature to the crystal. This is only a potential modification and may not be practicable. Another possible solution is pre-heating of the sample stream before entering the detector chamber; at low flow rates, as in the case of offline monitors this could be done electrically.

At this point in time, the problem has been identified and means have been developed to identify defective crystals; however, the probable cause of the problem remains and nothing has been done to mitigate the problem. The problem has widespread generic implications and should be resolved at the earliest possible date.

c. Temperature Sensitiviy of Liquid Effluent Monitors. The Oconee staff also reported observation of a temperature-dependent readout on the new liquid radwaste monitor. In one test involving measurements at only two temperatures, observed count rates at 87°F and 95°F for a single test source were as follows:

87°F	57,814 cpm
95°F	43,500 cpm

The results indicate a decrease in count rate of about 1,800 cpm/°F, or about 5% per °F. This observation was reported to be quite recent and no confirmatory work had been done as of March 16, 1977.

This observation has not been confirmed and may or may not be valid. It is a point which should be resolved since it has generic significance in liquid radwaste monitoring.

d. Correlation of Varying Inputs to Liquid Radwaste Discharge Monitor. One difficulty that Oconee has had in calibrating of the liquid effluent monitor is variation of the average energy of wastes from the three Oconee plants. The applicant reports that the average energy in wastes varies from 0.2 Mev to about 2 Mev, depending on the source.

It is my opinion that while this may present difficulties in calibrating a monitor to read directly in terms of effluent concentration, there should be no difficulty in preparing a calibration curve relating energy to instrument response. While setting the monitor alarm to respond at different meter settings for each batch of liquid discharged may be a nuisance, it should not be an insurmountable problem.