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MEMORANDUM FOR: B. Grimes, Ch[illegible], Environmental Evaluation Branch, DOR

THRU: J. Collins, Chief, Effluent Treatment Systems Branch, DSE

ORIGINAL SIGNED BY JOHN T. COLLINS

FROM: P. Stoddart, Effluent Treatment Systems Branch, DSE

SUBJECT: TAR-6406, TRIP REPORT, VISIT TO OCONEE STATION, MARCH 16, 1977

In response to your request, I visited the Oconee Station to discuss effluent monitoring problems with station personnel. The enclosed report summarizes the results of that meeting.

Original signed by:

P. G. Stoddart, Nuclear Engineer
Applications Section
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Enclosure:
Trip Report

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DATE ▶	03/23/77	03/24/77	03/25/77	03/25/77		

Form AEC-318 (Rev. 9-53) AECM 0240 ☆ U. S. GOVERNMENT PRINTING OFFICE: 1974-526-166

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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
Mi 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 CFP 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 deimineralizer 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 Sensitivity 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.

ATTACHMENT A

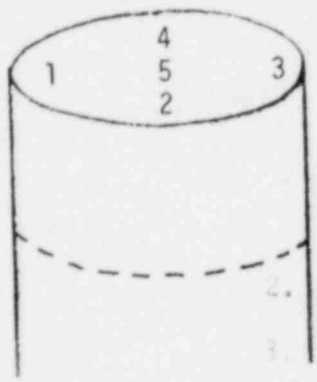
PROCEDURE FOR TESTING SCINTILLATION COUNTER CRYSTALS TO DETERMINE CRYSTAL FRACTURE OR DEGRADATION

Materials needed: Small check source consisting of gamma emitter such as Cs-137. Source should be small in physical size, i.e., about 0.25" x 0.25".

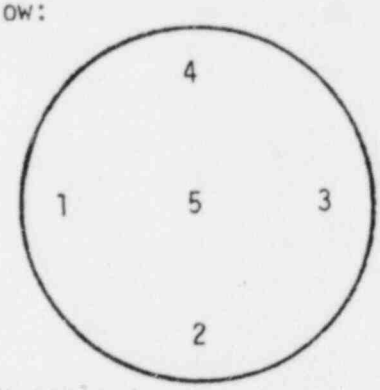
Procedure

1. Remove detector assembly from monitor well. Detector cable assembly should remain connected to monitor.

2. Place source in first position as in diagrams, below:



CRYSTAL END OF DETECTOR ASSEMBLY



3. Make count determination, i.e., count rate, for position #1. Record count rate.

4. Repeat step 3 for positions 2, 3, 4, and 5.

Interpretation

Count rates at positions 1, 2, 3, and 4 should be approximately equal. Count rate at position 5 should be somewhat higher.

If count rate at any point varies substantially, this is indicative of either crystal internal fracture or separation of crystal from glass face plate. To verify, disconnect detector assembly from monitor cable and disassemble components. Inspect crystal visually for defects. Any visible crack in the crystal, any separation of crystal from glass face plate as evidenced by bubbles under glass, or apparent discoloration (yellowing of crystal) indicates a defective crystal and that crystal should be replaced.

ATTACHMENT B

PROCEDURE FOR ROUTINE TESTING OF SCINTILLATION COUNTER CRYSTALS TO DETERMINE DEGRADATION

Materials needed:

a. Small check source consisting of gamma emitters such as Cs-137. Source should be small in size, i.e., about 0.25" x 0.25".

b. Gamma pulse height analyzer (Ludlum makes small hand portable model).

Procedure

1. Remove detector assembly from monitor. Disconnect detector assembly cable from monitor.

2. Connect detector assembly cable to gamma pulse height analyzer.

3. Place source in position 1 as in Attachment A.

4. Determine pulse height analyser settings for maximum gamma peak. Record analyzer settings. Record count rate.

5. Repeat for each position 2 through 5, per Attachment A.

Interpretation

1. If PHA settings vary substantially between source locations, disassemble detector and visually inspect for cracks, bubbles, or discoloration.

2. If PHA settings or observed count rate vary substantially from values recorded during prior tests, disassemble detector and visually inspect.