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PROPOSED REDOX SAND FILTER MONITOR AND STACK MONITORS

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PROPOSED REDOX SAND FILTER MONITOR AND STACK MONITORS

INTRODUCTION

Document HW-72200, "Serious Radiation Event Current Capabilities and Action Plan, Hanford Atomic Products Operation," lists three items pertaining to the Redox Facility, which require action. These are:

1. Update existing fission product activity measuring instrumentation at the Redox sand filter inlet with more up-to-date and reliable components.
2. Procure and install an audible alarm on the stack gas iodine monitor at Redox.
3. Modify existing Redox ruthenium-rhodium stack monitor to measure gross beta-gamma and install an audible alarm.

The existing Redox stack monitoring equipment is a system which is overly complex for the function it now performs. Maintenance costs have been quite high and reliability has not been good. As a result the Redox Operation has indicated that they desire complete new equipment to sample the stack gas, to detect and to readout separately I131 and gross fission products. (1)

In view of the above-mentioned document a study has been conducted to determine what modifications, if any, should be made to the Redox exhaust gas sampling equipment to improve present methods of monitoring for excessive amounts of fission product activity. The following proposal is the result of this study.

PURPOSE

To review existing Redox exhaust gas sampling equipment and to propose modifications and additions where appropriate.

RECOMMENDATIONS

The following changes are recommended:

1. Sand Filter Inlet Monitor

- a. Remove existing filter tape transport sampler and replace with a redesigned version which will detect radiation level changes more rapidly.
- b. Retain existing electronics system with the exception of the pre-amplifier and preamplifier B+ voltage supply.

2. Stack Beta-Gamma Monitor

- a. Remove existing filter tape transport sampler and replace with a redesigned version.
- b. Replace existing electronics system, which measures ruthenium-rhodium content, with a system which will measure gross beta-gamma. Provide an audible alarm in the Redox dispatcher's office.
- c. Provide facilities (a fixed filter sampler) whereby Regional Monitoring personnel may collect samples for laboratory analysis.

3. Stack Iodine Monitor

- a. Remove existing scrubber sampler and replace with a sample cell (chamber). Provide for a programmer which automatically flushes the chamber at preset intervals to remove particulate contaminants.
- b. Replace existing electronics system with a solid state system which utilizes a single channel analyzer. Provide an audible alarm in the Redox dispatcher's office.
- c. Provide facilities (a scrubber sampler) whereby Regional Monitoring personnel may collect samples for laboratory analysis.

DISCUSSION

A. Existing Systems

1. Sand Filter Inlet Monitor

As this system is now operating a sample of the stack gas is drawn through an isokinetic probe to a sample manifold in the sand filter sample shack (see Figure #1). Within this shack a sample is pulled through a strip filter paper transport mechanism where the sample is collected and detected. The detector signal, from this sampler, is applied to an electronics system in the SWP lobby, 202-S Building. The electronics system consists of a linear amplifier, count rate meter, high voltage supply, recorder and an audible alarm in the dispatcher's office.

The disadvantage of this system, as it now exists, is that it is possible for a "burst" of fission product activity to occur and go undetected for as long as one-half hour.

2. Stack Monitor

The stack monitoring system presently installed is a system which was developed by HLO to give a quantitative readout of I^{131} , Ru^{103} ,

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and Ru106. At the time the system was developed, it was believed that an automatic, quantitative analysis was a necessity and as a result the system is quite complex. A brief explanation of the system follows. A sample of the stack gas is pulled through a probe located at the 20-foot level on the stack. The probe consists of a 3-inch pipe perforated with five equally spaced 1" x 2" openings. The probe is located across the diameter of the stack liner. A 70 CFM sample is drawn through the probe and through approximately 50 feet of 3-inch pipe by a steam jet to a sampling manifold in the stack sample shack. One sample is taken from this manifold and fed to a strip filter sampler and another is taken and fed to a scrubber sampler. The general flow of information is indicated in Figures 1 and 2. The gas samples are passed through the two samplers where radiation activity is detected by scintillation detectors. The information from the detectors is applied to amplifiers and discriminators and then to the computing circuits. The computer output, indicated on 3 registers and one four channel recorder, shows the relative stack emission quantities of three radioisotopes. All electronics are remotely located in the east end of the north operating gallery, 202-S Building.

In addition to the above-described automatic monitoring system, there are provisions for collecting two samples for laboratory analysis. One of these samples is taken from a fixed filter sampler and the other is a liquid sample from the caustic scrubber. These samples are collected daily by Regional Monitoring personnel and are sent in for a quantitative laboratory analysis.

B. General Design Considerations

The sand filter inlet monitor is primarily of interest to the Redox Operation only. The monitor is used as an indication of process operation, as an aid in isolating the source when an excessive amount of activity is seen at the stack and as an aid in determining sand filter efficiency. Per verbal conversation with those concerned at Redox, the main interest is in trends rather than a quantitative analysis.

The two proposed stack monitors (I131 and gross fission) are of concern to two groups, the Redox Operation and the Regional Monitoring Group, HLO. The Redox Operation uses the readouts as an indicator of relative stack emission. The Regional Monitoring Group does not utilize the readouts for their quantitative analysis. Instead, they utilize a liquid sample from a scrubber sampler (I131) and the filter paper from a fixed filter.

To summarize, the essential requirements for the three systems are: They should be of proven reliability, should have fast response times to any

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radiation changes and should be easily maintained. In the case of the sand filter inlet monitor a relative indication is all that is required, while in the case of the stack monitors both a relative indication and a quantitative analysis are required. In addition, all three monitors (sand filter and two stack monitors) must have an adjustable set point audible alarm.

C. Proposed Design

1. Sand Filter Inlet Monitor

The system for the sand filter inlet monitor shall consist of a redesigned strip filter tape transport mechanism, a scintillation detector, a solid state preamplifier, a linear amplifier, a count rate meter, a B+ voltage supply (for the preamplifier), a high voltage supply, a single channel recorder and an audible alarm (see Figure 3).

The filter tape transport mechanism shall be a redesigned version of the unit presently being used. (2) The unit shall be redesigned and new drawings issued. The required modifications are:

- (a) Change the sampling rate from 30 minutes to 5 minutes in order to improve the response time of the system.
- (b) Increase the size of the feed and take-up reels until they are of sufficient size to handle a full roll of filter paper as it comes from the vendor. As received, these rolls contain 300 feet of filter paper and are 1-1/2 inches wide by 10-1/2 inches in diameter. Since the tape moves 3 inches each time it steps, a new roll of filter paper would be a four-day supply.
- (c) Redesign the detector shield. The Equipment and Instrument Development Unit of FEO, CPD, has designed a shield for this purpose and should be contacted in regard to the new design.
- (d) Enlarge the transport mechanism's enclosure in order to handle the modified reels.
- (e) Provide for air-tight seals on enclosure doors.

The existing electronics systems (with the exception of the pre-amplifier) is considered to be adequate and shall be retained. A new solid state preamplifier and preamplifier B+ voltage supply will be required.

The filter tape transport mechanism and the preamplifier shall be located in the sand filter sample shack and shall occupy the position

where the system presently operating is now installed (see Figure 4). It will connect into existing piping with minor modifications to routing in the immediate vicinity of the transport. The existing electronics system shall remain where it is presently located and the new preamplifier B+ voltage supply shall be installed in the same rack.

2. Stack Monitors

The proposed stack gas monitor shall consist of two basically independent monitors. One monitor shall sample for particulate matter (beta-gamma) and shall utilize a modified strip filter tape transport.

The other monitor shall sample for I¹³¹ and shall utilize a scintillation detector mounted in a gas chamber. A block diagram showing both monitors may be seen in Figure 5.

a. Beta-Gamma Monitor

The monitor for particulate matter (beta-gamma) shall utilize a filter tape transport sampler identical to the one to be used in the proposed sand filter inlet monitor. A scintillation detector shall detect the radiation and a solid state preamplifier shall drive the remotely located electronics. A B+ voltage supply will be required for the solid state preamplifier. The output of the preamplifier shall drive a solid state, combination linear amplifier and count rate meter. The amplifier-count rate meter shall be solid state and of conventional design. It shall have provisions for an adjustable, preset, audible alarm. A Tracerlab RM-10B transistor precision linear ratemeter is a typical example of such an instrument. The output of the count rate meter shall be recorded on one channel of a dual channel recorder. A high voltage supply shall be supplied for the scintillation detector.

All of the above-mentioned equipment, with the exception of the filter tape transport, is available commercially. The filter tape transport drawings shall be suitable for either on-site or off-site fabrication (as is the case of the sand filter inlet tape transport mechanism).

The filter tape transport mechanism and preamplifier shall be located in the stack monitor shack and shall occupy the position where the system presently operating is now installed. It will connect into existing piping with minor modifications to routing in the immediate vicinity of the transport. The combination

linear amplifier and count rate meter, the preamplifier B+ voltage supply, the recorder and the high voltage supply shall be remotely located in the east end of the north operating gallery in the 202-S Building. Existing wiring from the old system shall be used to connect the preamplifier to the linear amplifier and B+ voltage supply, and photo-multiplier tube to the high voltage supply. The audible alarm shall be located in the dispatcher's office, 202-S Building. In order to get the alarm circuit from the count rate meter to the dispatcher's office, it will be necessary to pull new wire to the Redox mainframe. From this point existing spare wires shall be used to get to the dispatcher's console. Since all available annunciator units are in use on the console, the installation of a new annunciator panel will be required. There are two blank panel positions at the present time and either one may be used.

b. Iodine Monitor

The stack iodine monitor will be a system very similar to a system presently being used at the Purex Facility on the C-1 dissolver off-gas line. (3) The system has proven to be satisfactory in this installation.

As may be seen from Figures 5 and 6, the same gas sample is used for this monitor as was used for the particulate monitor. The gas first goes through the filter tape transport and then into the gas chamber. Since the gas sample must be filtered before entering the gas chamber (in order to remove particulate contaminants) the filter tape transport serves this purpose quite well. In order to prevent the I^{131} from dropping out on the filter paper, in the event the gas moisture content should become quite high, the gas sample is heated just prior to its passing through the filter paper.

The sample gas chamber shall be a one-half liter stainless steel cylindrical beaker. The interior surfaces of the chamber and all piping immediately connected to it shall be coated with fluorothene. The fluorothene coating has shown a minimum tendency to absorb and retain active contaminants in other installations. Cooling water shall be provided to the chamber in order to keep the photomultiplier tube at a relatively constant temperature. In addition, provisions shall be made for an automatic programmer. The programmer shall, at preset intervals, automatically perform the following functions (for programmer wiring diagram and time cycle see Figures 7 and 8).

- (1) Turn the gas sample off and air flush the chamber for a background reading.

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- (2) Water flush the chamber to remove any particulate matter which might be adhering to the walls.
- (3) Air dry the chamber and again look at background.
- (4) Return the system to its normal state.

The detector in this monitor shall be a sodium iodide crystal, optically coupled to a photomultiplier tube. The signal from the photomultiplier tube shall be fed to a solid state pre-amplifier and from there to a remotely located, solid-state, combination linear amplifier, single channel analyzer and count rate meter. The "window" of the single channel analyzer shall be adjusted so as to count I131. In addition, the count rate meter shall have an adjustable set point alarm circuit. A Tracerlab RM-10BS transistor precision ratemeter with spectrometer input is a typical example of such an instrument. From the output of the count rate meter the signal shall go to one channel of the dual channel recorder used for stack particulate monitoring. A high voltage supply and a B+ voltage supply shall be supplied for the photomultiplier tube and preamplifier respectively.

The sample gas chamber, preamplifier, and programmer shall be located in the stack monitor shack. The piping changes required will be quite extensive and shall be as shown in Figure 6. At the present time, water and a contaminated drain (going to a catch tank) are available in the stack monitor shack, but will have to be connected into the system. Instrument air is available at the 291-A turbine house and will have to be extended on approximately 50 feet to the stack monitor shack. The combination linear amplifier, single channel analyzer and count rate meter, the high voltage supply, the preamplifier B+ supply and the recorder shall be located in the east end of the north operating gallery in the 202-S Building. Existing wiring from the old system shall be used to connect the preamplifier to the linear amplifier, the preamplifier to the B+ voltage supply and the photomultiplier tube to the high voltage supply. The audible alarm shall be located in the dispatcher's office, 202-S Building. The same wire routing shall be used as was described for the stack particulate monitor alarm.

c. Manual Samplers

In addition to the above described automatic stack monitoring system, there shall be provisions for collecting samples for laboratory analysis.

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Provisions shall be made to pull a sample of the stack gas through a fixed filter sampler and then into a scrubber sampler. A recorder shall record pressure differential across a restricting orifice thereby giving an indication of flow rate (see Figure 6).

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EXISTING SYSTEM

CLOCK GAS

FOR STACK GAS MONITOR AND SOLID FILTER INLET MONITOR

BY SUBMITTING CHANNELING INFORMATION

STA - MONITOR SYSTEM

END OF N. OPERATING GALLERY - 202-S Bldg.

SOLID FILTER SAMPLER SHACK

SWP LOBBY, 202-S Bldg.

FIGURE #1

BLOCK DIAGRAM OF THE STACK EFFLUENT MONITOR ELECTRONICS SYSTEM (EXISTING)

FIGURE #2

FIGURE # 3

PROPOSED SAND FILTER INLET MONITOR

Block Diagram Showing the Channeling of Information

SHEET NO. 1 OF 1

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FIGURE #4

PIPING ARRANGEMENT FOR SAND FILTER INLET MONITOR (PROPOSED)

FIGURE # 5

PROPOSED STACK MONITOR

PIPING ARRANGEMENT FOR STACK MONITOR (PROPOSED)

FIGURE 1

V_1 = GAS IN VALVE - N.O.
 V_2 = GAS OUT VALVE - N.O.
 V_3 = WATER VALVE - N.C.
 V_4 = AIR VALVE - N.C.
 V_5 = DRAIN VALVE - N.C.

T_1 = TIMER - SINGLE SWITCH - 2 HOUR TIME CYCLE
 T_2 = TIMER - SEVEN SWITCH - 15 MINUTE TIME CYCLE

PROGRAMMER FOR STACK IODINE MONITOR FIGURE # 7

TIMER T1

TIMER T2

PROGRAMMER TIME CYCLE DIAGRAM

FIGURE # 3

END

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