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REDOX IN-LINE MONITORING INSTRUMENTS
INFORMATION MANUAL

By

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Research and Engineering
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INTRODUCTION

The in-line monitoring instruments presently installed in the Redox plant consist of six gamma monitors, a single channel gamma spectrometer, an alpha monitor, and a neutron counter. A gamma monitor on the steam condensate outlet line and a uranium monitor on the 2DFS stream are to be added at a later date.

The gamma monitors are designed to provide a rapid and continuous indication of the gamma activity of four intercycle streams (2EU, 1CU, 1BP, and 2BP) and two product streams (3BP and 3EU). The alpha monitor is to determine the plutonium concentration of the L-9 to D-14 stream, and the neutron counter is to determine the plutonium concentration of the L-16 tank. The gamma spectrometer is used to determine the fission product species of the intercycle and product streams.

All of the instruments except the neutron counter were installed by Project CG-686. The neutron counter was installed as a prototype instrument by Redox Technology Operation.

The first section of this information manual describes the in-line gamma monitors and gives operating instructions for them. The second section covers the alpha monitor, and the third section the neutron counter. Sections on the uranium monitor and the steam header gamma monitor will be added at a later date.

I. GAMMA MONITORSA. General Description

A gamma monitoring system consists of four functional components: (1) a sampling system, (2) a sensing unit, (3) a measuring system, and (4) a recording unit. Figure 1 is a schematic diagram of a current-type gamma monitoring system and Figure 2 shows a pulse-type system.

The sampling system uses a standard A or B-type sampler and an attached shielded box which houses the flow indicator and the sensing unit. The sampler jet pulls the sample stream from the sample pot, through the flow indicator and sensing unit, to the sample cup and then discharges the stream back to the sample pot. Operation of the sampler jet is controlled by a solenoid valve in the motive gas supply line.

The sensing unit consists of a thallium-activated crystal of sodium iodide optically coupled to an RCA Type 6655 photomultiplier tube. Gamma photons from the solution in the sensing cell interact with the crystal to produce brief pulses of visible light. These light pulses in turn interact with the photocathode of the photomultiplier tube to release photoelectrons. The photoelectrons are multiplied by the ten dynode stages of the phototube and are finally collected at its anode. The resulting amplified electron pulse is transmitted from the sample gallery through a coaxial cable to the silo operating gallery where it is fed into the measuring system.

The measuring system for the gamma monitors is either a current-type or pulse-type instrument. The current-type is used on the high activity streams - 2EU, 1CU, 2BP, and 1BP - and measures the flow of current from the photomultiplier tube by means of the voltage drop through fixed resistors in the range selector circuit.

The pulse-type system is used only on very low activity streams - 3EU and 3BP - and employs a linear amplifier to increase the pulse amplitude to usable levels before sending this amplified pulse to a counting rate meter which measures the gross gamma activity of the stream. Since plutonium in the 3BP stream emits gamma rays with energies up to 0.394 Mev, the 3BP count rate meter has been set to count only the gamma rays above 0.400 Mev energy. Thus, all the counts of the 3BP monitor are due to fission products only. Uranium-237 in the 3EU stream is also discriminated by counting only the gamma rays with energies above 0.400 Mev.

B. Operation

Before a gamma monitor can be placed in operation the sampling equipment in the sample gallery must be set so the sample stream can circulate through the sampling system. These pieces of equipment and their settings are:

1. The sample cup riser must be sealed by the riser cap.
2. The sampler block valve between the sample cup and sample jet must be open.
3. The manual valve in the inert gas supply line to the sampler jet must be open.
4. The pushbutton on the front of the sampler box must be unlocked and in the out position.

When the sampling equipment has been properly set, the 1BP, 2BP, 1CU, and 2EU monitors can be placed in operation by the following procedure:

1. Set the high voltage supply unit toggle switch to the "on" position.
2. Set the flow alarm toggle switch to the "on" position.
3. Set the power toggle switch for the vent valve timer to the "on" position.
4. Adjust the range selector switch so the recorder on K Panel reads between 10 and 30 percent of chart.

The 3BP and 3EU gamma monitors are pulse-type instruments and have two components which differ from the current-type monitors. To place these monitors in operation, the following steps must be completed:

1. Set the high voltage supply toggle switch to the "on" position.
2. Set the flow alarm toggle switch to the "on" position.
3. Set the power toggle switch for the vent valve timer to the "on" position.
4. Set the power toggle switch for the linear amplifier to the "on" position.
5. Set the power toggle switch for the linear count rate meter to the "on" position.
6. Adjust the range selector switches on the count rate meter so the recorder on K Panel reads between 10 and 30 on the chart.

When the vent valve timer is switched on it opens the solenoid valve in the inert gas supply line to the sampler jet. Once each hour the vent valve timer closes the solenoid valve in the inert gas supply line for a three to five-minute period. During this period the sample stream drains from the sensing cell and the background activity of the cell is recorded on the K Panel recorder. The gamma activity of the stream is determined by the difference in the full cell and empty cell readings.

A background check can be made at any time by pressing the vent valve timer pushbutton and allowing the sensing cell to drain.

Manual samples of the monitored streams can be taken using standard sampling equipment and normal sampling procedures, the only difference being that the sample circulation can be controlled by the pushbutton located on the front of the sampler box. This pushbutton also operates the solenoid valve in the inert gas supply line. When the pushbutton is pressed "in", the solenoid valve closes and the sample flow is stopped. When the pushbutton is released the solenoid valve opens and the sample stream circulates through the system. If the pushbutton is not released after a manual sample has been taken, the solenoid valve cannot be opened and the gamma monitor will be inoperative.

During the three to five-minute period when the vent valve timer is taking a background check, a manual sample cannot be taken because the solenoid valve is closed and cannot be opened until power is again supplied by the vent valve timer. A green indicating light mounted on the sample box is on during the periods when a manual sample can be taken and is out when the solenoid valve is de-energized and the sampler cannot be operated.

The flow alarm unit of each monitor indicates when the sample stream is circulating. The red light comes on when the sample stream flow stops and indicates one or more of the following:

1. The monitor is taking a background check.
2. The sampler suction leg is plugged.
3. The solenoid valve has failed.
4. The sampler jet is plugged.
5. The vent valve timer has been turned "off".

The red light is out when the sample stream is circulating normally.

The high voltage supply unit of each monitor provides a potential of 1000 to 1400 volts to the photomultiplier tube in the sample gallery. The exact voltage varies with each monitor and was set when the monitors were calibrated. Any change in the voltage setting changes the calibration of the instrument and, therefore, these settings should not be changed.

The gamma monitor recorders for the 1BP, 2BP, 1CU, and 2EU streams show the percent of full scale reading of the range setting. Since the recorder reading is meaningless without the range setting, it should be marked on the recorder chart once per shift and at any time the range setting is changed. The gamma activity of the stream can then be determined by dividing the difference of the full cell reading and the empty cell reading (background) by 100 and multiplying by the range setting. Following is an example:

1. The 2BP range switch is set on the 3×10^3 microcuries per gallon scale.
2. The full cell reading is 38% of chart.
3. The empty cell reading is 6% of chart.
4. The gamma activity of the 2BP stream is thus:

$$\frac{(38-6)(3000)}{100} = 960 \text{ microcuries/gallon.}$$

The gamma monitor recorders for the 3BP and 3EU streams show the percent of full scale reading of the range selected on the count rate meters. The range setting of the count rate meters should also be marked on the charts once per shift and at any time the range setting is changed. To determine the activity of the 3BP or 3EU stream the same procedure as explained above is used. However, the answer will be in gamma counts per minute. Since the instruments were calibrated so that 100 counts per minute was obtained when the activity was one microcurie per gallon, the counts per minute can be converted to microcuries per gallon by dividing the counts per minute by 100.

The gamma monitor samplers should be stopped any time the process stream being monitored is not flowing. This can be done by switching the vent valve timer power switch to the "off" position. The remaining sections of the gamma monitoring system should be left "on". When the process stream is started again, switching the vent valve timer to the "on" position will put the monitor back in service.

If a gamma monitor sampler has been off for two or more days the suction dip tube of the sampler may have become partially plugged and the sampler should be flushed with water. Since the gamma monitor samplers are equipped with standard flushing systems, the flushing is done in the same manner as the standard samplers. However, the gamma monitor samplers are equipped with a block valve between the sample cup and jet to divert the flush water down the suction leg if extra water pressure is necessary to break the plug. Before a sampler is flushed the solenoid pushbutton on the front of the box should be blocked in the "in" position to stop the sampler motive gas. After flushing, the pushbutton must be released or the solenoid valve cannot be opened.

If it is necessary to close the block valve to unplug the suction leg of the sampler, care must be exercised to prevent twisting or breaking the valve stem. After flushing, the block valve must be opened or the sample will not circulate.

C. Gamma Spectrometer

The gamma spectrometer is an instrument system for determining the fission product species of the intercycle and product streams. Its operation is based on the fact that the energy of the gamma rays emitted by each fission product is constant and in most cases of a different level than the other fission products in the stream being analyzed. By counting the number of gamma photons (rays) in small energy increments over the range from 0.0 to 1.0 Mev (million electron volts), and knowing the energies of the gamma photons of the fission products, the relative amounts of the principal fission products in a stream can be determined.

Figure 3 shows a typical gamma scan with peak counts at 0.73, 0.66, and 0.51 Mev, indicating the presence in the stream of the zirconium-95-niobium-95 couple, cesium-137, and ruthenium-103 and 106.

The gamma spectrometer is to be used by technical and supervisory personnel only. To take a gamma scan of a stream:

1. Check that the power toggle switches on the linear amplifier and log count rate meter are "on".
2. Set the gamma spectrometer selector switch to the stream to be scanned.
3. Set the "manual-automatic" toggle switch of the differential analyzer to the "automatic" position.
4. Set the chart drive toggle switch of the recorder to the "on" position.

The instrument automatically scans the energy levels of the gamma rays of the stream selected. The dial on the side of the recorder shows the energy of the gamma photon being counted at any one time as a percent of 1.00 Mev.

The oscilloscope and the pulse generator units located in the same cabinet with the gamma spectrometer are used to calibrate the gamma monitors and should be operated by qualified personnel only.

II. ALPHA MONITOR

A. General Description

The L-9 alpha monitor is an instrument system which automatically samples the L-9 to D-14 condensate stream, dries the sample, measures and records the alpha count rate, then discards the sample to a disposable box.

The system consists of: (1) a sampling and transfer mechanism operated by a sequence timer, (2) a sensing unit, (3) a measuring system, and (4) a recording unit. The sampling and sensing units are located in an enclosure near the D-14 sampler in the north sample gallery. The sequence timer and measuring system are installed in an instrument rack between the C Cell and D Cell control boards in the north operating gallery and the recorder is located in the 233-S control room.

The mechanical sampling and transfer mechanism consists of a tape press, tape drive, sampler, heating plate, tape shearer and a sheared tape guide which funnels the tape into a disposable box. Each unit is operated by an inert gas piston with the inert gas supply controlled by solenoid valves operated by the control unit (sequence timer).

A small sample stream is piped from the L-9 to D-14 condensate header through a rotameter and sampler valve in the enclosure and then to the D-14 sampler box. This portion of the L-9 stream drains to the D-1 tank.

Figure 4 is a schematic diagram of the alpha monitor and its sampling system. The aluminum tape shown in the diagram serves as a sample receiver, counting disk and carrier for the sample.

The first step of a cycle is the forming of a dimple in the aluminum tape to receive the sample. This is done by a gas-operated piston which presses the aluminum tape against a form. The piston is then withdrawn and the tape drive moves the dimple under the sampler. As the sample stream flows through the sampler valve a 0.2-ml sample is dropped into the dimple in the tape. A small flush of the valve from the wash tank is also dropped into the dimple. The water is evaporated from the sample by the heater block and the sample is transferred to the alpha sensing unit. An alpha count rate of the sample is determined by the sensing and measuring systems and is recorded in the 233-S control room. The tape drive then transfers the sample to the shearing section where the tape section containing the sample is cut off and dropped into the disposable box. When the box is filled, it is sealed and transferred to the burial ground for disposal.

The alpha sensing unit is a zinc sulfide crystal coupled to an RCA type 6655 photomultiplier tube. The high voltage supply unit in the north operating gallery instrument rack maintains a 600 volt potential on the photomultiplier

tube. Alpha particles from the sample interact with the crystal to produce light pulses which are multiplied by the photomultiplier tube in the same manner as in the gamma monitor tubes. The resulting electron pulse is transmitted through a coaxial cable to the measuring system located in the north operating gallery. The measuring system amplifies the signal to a usable level and determines the count rate by means of the log count rate meter.

The output from the count rate meter is transmitted to the 233-S control room where the count rate is recorded on the linear scale recorder located on the control panel.

B. Operation

Before the alpha monitor is placed in operation, the following items must be checked:

South Sample Gallery

1. The inert gas supply valve to the sampler enclosure must be open.
2. The manual valve in the sample stream line from the L-9 condensate header on the sampler enclosure must be open.
3. A disposable box must be in place beneath the sheared tape guide and any openings in the box or plastic sleeve must be taped shut to prevent the spread of plutonium concentration.

North Operating Gallery

1. The power supply toggle switches of the high voltage unit, linear amplifier unit, log count rate meter, and the flow alarm unit must be on.
2. The toggle switches on the alpha monitor control unit (sequence timer) must be set as follows: (See Figure 5.)
 - a. Heater and fan power - on
 - b. Alarm bell - off
 - c. Emergency stop - off
3. The timer operation switch must be set in the "Auto Run" position. In the "Auto Stop" position the sampler makes one complete cycle and stops, so this setting will not normally be used.
4. The Valve Operation switch must be set in the "Auto" position.

5. The Heater Block Temperature must be between 200° and 240°F. (The black pointer is the temperature indicator. The two red pointers are the Hi and Low temperature alarm set points.) If the sampler is operated before the block temperature is up to 200°F the sample will not be dried and will spill during transfer to the counting station.
6. The three alarm indicator lights must be out. The Solution Alarm indicates a spill in the sampler enclosure which must be cleaned up to prevent contamination of the equipment and a high alpha background. The tape alarm indicates the aluminum tape has fouled or jammed and the monitor cannot be operated until the tape is cleared and set for operation.
7. The Bypass Indicator lights must be out.
8. When the above items have been properly set, the alpha monitor sampling system can be started by switching the Valve Power toggle switch to the "on" position.
9. To stop the operation of the sampling system, the Valve Power switch should be turned to the "off" position.

NOTE: The manual operate button and the manual valve selector switch should not be operated when the valve operation switch is in the "manual" position. The sampler should not be operated manually as the tape may be jammed, excess sample solution may be dumped into the enclosure, the sample may not be dried, or the alpha detector may be contaminated by improper sequence or timing of the manual operations. Manual operation of the system should be limited to instrument mechanics doing maintenance and repair work on the system.

C. Background and Standardization

The three pushbuttons of the alpha monitor control unit marked Background, Return, and Standardize are used to check the alpha background activity of the sensing unit and to check that the sensing, measuring, and recording units are in calibration. These buttons should be operated by technical, supervisory or instrument personnel only.

To determine the background activity:

1. Switch the Valve Operation Switch to the "manual" position.

2. Press the pushbutton marked "Background".

A shield swings over the sample beneath the scintillation crystal and the background activity is indicated on the count rate meter and recorded on the 233-S recorder.

3. Press the pushbutton marked "Return".

The shield moves back to its normal position and the sample beneath the scintillation crystal can be counted in the normal manner.

4. Switch the Valve Operation Switch to the "Automatic" position.

To check the calibration of the system:

1. Switch the Valve Operation Switch to the "manual" position.
2. Press the pushbutton marked "Standardize".

A disc containing a standard alpha source swings under the scintillation crystal and the count rate meter should show a count rate of _____ counts per second.

3. Press the pushbutton marked "Return".

The disc moves back to its normal position and the sensing unit is ready for normal operation again.

4. Switch the Valve Operation Switch to the "Automatic" position.

A complete cycle of operations of the sampling system requires a minimum of 15 minutes. This time cycle can be increased by changing the gears in the sequence timer if it is desirable to do so..

The valve operation indicator lights show which operation of the cycle is in progress. The press and shearing operations are both done at the same time as are the sample and wash operations. The tape between the press and the shearer contains several samples at various stages in the cycle. While one sample is being counted the next sample is being dried and the tape has been pressed for a third sample. Beyond the sensing element, samples which have been counted, are ready for the shearing operation. The counting and drying operation requires 11 minutes while the other operations require only 10 seconds each.

If some malfunctioning of the sampling system should occur such as jamming of the tape, spilling of solution, etc., the sequence timer will stop and one of the alarm indicators of the control unit or the flow alarm indicator will light up and the trouble alarm signals - buzzer and flashing light - in the 233-S control room will come on. The buzzer and flashing light in

the 233-S control room can be stopped by pressing the reset button of the trouble alarm unit, but the lights in the trouble alarm unit will stay on bright until the trouble is corrected.

When the alarm sounds, the sampling system should be removed from service by switching the Valve Power toggle switch of the control unit to the "off" position until the trouble has been corrected.

The normal chart reading of the L-9 stream will be determined after the alpha monitor has been operated for a short period of time. When this chart reading has been determined, the recorder will be set to operate an alarm circuit on the 233-S control panel at any time the plutonium concentration in the L-9 stream exceeds the normal concentration range. A high plutonium concentration in the L-9 stream will indicate 233-S operating difficulties or a leak in one of the process vessels.

III. NEUTRON COUNTER

A. General Description

The neutron counter is to be used to help prevent exceeding the critical mass control limit in the L-16 tank and also to determine the plutonium concentration in that tank. It consists of the following instruments:

1. A neutron detector tube and preamplifier.
2. A high voltage supply.
3. A linear amplifier.
4. A count rate meter.
5. A count rate recorder.

A schematic diagram of the neutron counter system is shown in Figure 6.

The neutron detector is an aluminum tube 1-3/4 inches in diameter and 9 inches long with a tungsten wire anode mounted axially through the center of the tube. The tube is filled with boron trifluoride gas at a pressure of 25 cm. Hg. The boron of the gas has been enriched with the boron-10 isotope to about 95 percent, since it is this isotope which reacts with thermal neutrons.

A preamplifier is coupled to the detector tube to increase the signal from the tube and prevent attenuation of the signal by line losses.

The high voltage supply maintains a potential of 1500 to 2000 volts between the central wire anode and the cylindrical wall cathode of the BF₃ tube. Neutrons from the spontaneous fission of plutonium and from the alpha bombardment of oxygen atoms in solution are moderated (reduced to thermal

velocity) by the solution and enter the detector tube. The neutrons react with the boron nuclei releasing alpha particles which ionize the gas. Each alpha particle causes an avalanche of ions to the positive center wire anode and gives a small negative pulse. These pulses are fed to the linear amplifier where they are increased to usable levels and then sent to the counting rate meter. The counting rate is then recorded on the three-cycle log scale recorder located in the control room. Since the counting rate is proportional to the plutonium concentration in the solution, the total plutonium content of the L-16 tank can be determined. The curve of Figure 7 is a preliminary plot of the neutron count rate versus the plutonium concentration of the L-16 tank. When calibration of the neutron counter is completed, a new calibration curve will be issued.

B. Operation

The neutron counter is ready for operation when the power switches to the high voltage supply, linear amplifier, count rate meter and recorder are switched to the "on" position. Since the neutron counter is in continuous service these switches should be on at all times except when the instrument is being repaired.

Before a plutonium-bearing solution is added to the L-16 tank, 120 gallons of water should be added to the tank to shield the BF_3 tube from the neutrons from plutonium solutions in adjacent tanks, and to provide the moderator for the neutrons from the plutonium solution being added to the L-16 tank. After the water has been added to the L-16 tank, a specified amount of plutonium solution is then added and the plutonium concentration is determined by using the curve of Figure 7 to convert the neutron count rate to grams of plutonium per gallon. The total amount of plutonium in the tank is then found by multiplying the grams of plutonium per gallon by the total gallons of solution in the L-16 tank.

The neutron counter will be set to give an alarm when the neutron count rate exceeds 1200 counts per minute. This indicates the plutonium concentration has exceeded 3.1 grams of plutonium per gallon and the critical mass limit of the L-16 tank could be exceeded if the addition were to continue. A plutonium concentration of greater than 3.1 grams per gallon is permissible in the L-16 tank, but the liquid volume must be such that the total plutonium content does not exceed 750 grams. Any time the neutron counter exceeds 1200 counts per minute, additions to the L-16 tank must be stopped and the supervisor must be notified. The supervisor must then determine whether or not the critical mass limit will be exceeded by adding more plutonium solution before the addition may be resumed.

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H-2-30410	Wiring Diagram and Details - Gamma Monitor and Spectrometer
H-2-30411	Conduit Plan and Details - Alpha and Gamma Monitors
H-2-30412	Sample Box Piping Arrangement - "A" Type Sampler
H-2-30413	Gamma Monitor Support and Sampler - Piping Details
H-2-30416	Shielding Box Piping Arrangement - "A" and "B" Type Sampler
H-2-30417	Sample Gallery Arrangement and Piping
H-2-30418	"K" Panel Arrangement
H-2-30420	Sample Box Piping Arrangement - "B" Type Sampler
H-2-30421	Conduit Plans and Sections - Alpha and Gamma Monitors
H-2-30422	Wire Run List - Alpha and Gamma Monitors
H-2-30496	Conduit Plan - Power Supply - Alpha and Gamma Monitors
H-2-30401	Pipe Jumper - "E" Cell E-T-11 to E-2; E-G-38 to E-T-11-E-2, Part II
H-2-30402	Pipe Jumper - "E" Cell
H-2-30403	Pipe Jumper - "E" Cell E-G-38 to E-T-11-E-2, Part I
H-2-30423	Pipe Jumper - "E" Cell E-G-94-E-G-109 to E-T-47-E-10, Part I
H-2-30424	Pipe Jumper - "E" Cell E-G-94 - E-G-109 to E-T-47 - E-10, Part II
H-2-30425	Pipe Jumper - "E" Cell E-T-47 - E-10
H-2-40426	Pipe Jumper - "E" Cell E-T-47 - E-10 Nozzle No. 2 Vent
H-2-30427	Pipe Jumper - "F" Cell F-T-86 to F-5
H-2-30428	Pipe Jumper - "F" Cell F-G-81 to F-T-86 - F-5, Part II
H-2-30429	Pipe Jumper - "F" Cell F-G-81 to F-T-86 - F-5, Part I, and F-G-48 to F-T-67 - F-2, Part I

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H-2-30430	Pipe Jumper	"F" Cell F-T-86 - F-5 to F-5 Nozzle No. 2 Vent
H-2-30431	Pipe Jumper	"F" Cell F-G-62 to F-2
H-2-30432	Pipe Jumper	"F" Cell F-T-67 - F-2 to F-G-62 - F-2
H-2-30433	Pipe Jumper	"F" Cell F-G-48 to F-T-67 - F-2, Part II
H-2-30434	Pipe Jumper	"F" Cell F-T-67 to F-2
H-2-7947, Rev. 3	Piping - General Arrangement - Plan and Sections - North Sample Gallery - Sheet No. 1	
H-2-7948, Rev. 5	Piping - General Arrangement - Plan and Sections - South Sample Gallery - Sheet No. 1	
H-2-7953, Rev. 3	Piping - General Arrangement - Plan and Sections - South Sample Gallery, Sheet No. 2	
H-2-56443	Gamma Monitor Pig	
H-2-56464	Gamma Monitor Pig	
H-2-56466	Gamma Monitor Pig	
H-2-56465	Sample Cell	
H-2-56467	Sample Cell	
H-2-5746, Rev. 19	Plastic Hood	
H-2-5747	Flexible Coupling	
H-2-5748, Rev. 12	Sampler Riser Cap and Assembly	
H-2-54350, Rev. 5	Electrical One Line Diagram	
H-2-54352, Rev. 6	Electrical One Line Diagram	
H-2-54424, Rev. 4	Electrical One Line Diagram	
H-4-39001, Rev. 2	Scintillation Probe	
H-4-39021, Rev. 1	Precision Pulse Generator Alteration	
H-4-39025, Rev. 1	Linear Amplifier Alteration	
H-4-39028, Rev. 1	Differential Analyzer Alteration	
H-4-39039, Rev. 2	Vent Valve Timer	

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H-4-39055 Gamma Monitor Range Switch
H-4-39056 Flow Alarm Details
H-4-39144, Rev. 2 Gamma Monitor Cell Model IV and V
H-4-2119 Brown Bias Drive

Alpha Monitor

H-2-30408 Instrument Schematic (Alpha Monitor)
H-2-30464, Rev. 1 Sample Gallery Arrangement and Piping - Alpha Monitor
H-2-30409, Rev. 2 Electrical Instrumentation - Alpha Monitor - Wiring Diagram
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H-2-7951, Rev. 3 Piping - General Arrangement - Plan and Sections - North Sample
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H-4-39053 Alpha Monitor Programmer
H-4-39054 Monitor Box Interconnection
H-4-39057 Alpha Monitor Test Box
H-4-39058 Alpha Monitor Programmer Assembly
H-4-39063 Time Cycle Diagram
H-4-30964 Probe
H-2-56877 Wash Disposal Carton
H-2-3193 Five-Inch Plastic Port Ring
H-2-3246 to H-2-3268 Alpha Monitor Details

Neutron Monitor

H-3-7807 Proportional Counter Tube
H-4-2825 Proportional Counter Tube
H-2-3686 Pre-Amplifier Slug Can Mounted
H-2-30644 Block Diagram, Neutron Monitoring System, L-16 Tank
H-2-30645 Manhole Lucite Panel for L-16 Tank - Neutron Monitor Installation
H-2-30646 Neutron Monitor Probe (Well Assembly and Installation)
H-2-30647 Conduit Run - Neutron Monitoring System

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GAMMA MONITOR - PULSE TYPE

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FIGURE VII

L-16 Neutron Counter
Calibration Curve

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FIGURE 6

L-16 NEUTRON

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FIGURE 4

ALPHA MODEL

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