Instructions
and
Operating Manual
SERIES X90
POINT LEVEL MONITORS

RONAN

POINT LEVEL MONITORS
SERIES X90
Instructions and Operating Manual

Customer's Name ____________________

Customer's P.O. No.
____

Ronan Job No. ______________________

Warranty Ronan warrants equipment of its own manufacture to be free from defects in material and workmanship under normal conditions of use and service, and will repair or replace any component found to be defective, on its return, transportation charges prepaid, within one year of its original purchase. this warranty carries no liability, either expressed or implied, beyond our obligation to replace the unit which carries the warranty.

1.0 GENERAL DESCRIPTION

The Ronan Series X90 Point Level Monitor economically and reliably solves many process problems in which noise, temperature, abrasive or corrosive conditions preclude the effective utilization of sonic, capacitative, float or other techniques. This is a non-contact system.

Normally, a small Cesium-137 radioisotope source is housed in a lead-filled shielding enclosure known as the source holder. This holder is equipped with a shuttering mechanism and the means for containing the radiation and collimating or directing the radiated energy toward the sensor, which is directly opposite the source along a line or level to be measured. Radiation in all directions is attenuated to a safe value by the lead shielding. The source holder is mounted on or adjacent to the vessel whose content it is desired to monitor.

When the source holder shutter is opened, radiant energy is directed toward the sensor. In the absence of the process, this sensor sees only a small amount of radiation but, when the process is present, a large percentage of this radiation is absorbed. This absorption of radiation by the process causes a change in the radiation at the sensor. When this occurs, a relay contact signals that the level change has been observed.

The passage of radiant energy through the process causes no contamination and cannot make the process or container walls radioactive. These systems may be used anywhere, including the food processing industries.

For most applications, all components of the system are externally mounted. Therefore, installation is simple and requires no major mechanical modification or down-time.

The standard Ronan Model X90-301(V) gamma switch uses Cesium-137 as the source of gamma rays. Cesium -137 is a 0.66 MEV gamma ray emitter with a half-life of 30 years. The radioisotope material is sealed in a double -welded, stainless steel capsule. The source type and strength (activity) supplied depends on the individual application, and is printed on the yellow and magenta caution label affixed to the 3 source holder. The standard source holder is lead-filled and equipped with a two-position ON/**OFF shutter mechanism. The handle and shutter mechanism can, by means of a combination padlock, be securely locked in the** OFF position during shipping, installation, storage or process-down intervals.

Well sources are supplied with actuator rods, which can be used to extend the source into the vessel or retract the source into the storage source holder.

CAUTION: Any malfunction of the source holder must be immediately reported to Ronan Engineering for repair or replacement of the source holder. Under no circumstances may the source holder be taken apart.

Should it be necessary to ship the source holder back to Ronan, contact Ronan Engineering for detailed shipping instructions.

A Geiger-Mueller tube is used as the sensor for detecting the gamma radiation. The G-M tube consists of a gas-filled cylinder with a central anode. The anode is connected via a high ohmic resistance to a dc voltage of 500 V. Conduction occurs when the gamma radiation ionizes the gas in the tube. Each ionizing event produces a pulse, the rate of these pulses being proportional to the field strength of the ionizing radiation, i.e., incident field intensity. The output of the G-M tube is processed by an electronic circuit in the X90-301(V) module and the material level is indicated by either an ALARM or NORMAL signal.

2.0 SPECIFICATIONS (STANDARD)

The X90 is a solid-state instrument available in two designs. The Model X90 Detector with integral electronics has a combined detector and switch assembly located at the vessel. The Model X90-1004 Detector with remote electronics module may be field-located or remotely located in a control room

Detector: *Integral:* Geiger-Mueller tube *Remote:* Geiger-Mueller tube

Radiation at Detector: *Integral:* 0.1 mR/hr min. *Remote:* 0.1 mR/hr min.

Detector Housing: *Integral:* 4” Schedule 40 carbon steel pipe (type 304 stainless steel also available); mount to flat plate bracket *Remote:* Type 304 stainless steel; explosion-proof housing; mount with conduit clamp

Housing Classifications: *Integral:* Class I, Division 1, Groups A, B, C, D; Class II, Division 1, Groups E, F, G *Remote:* Class I, Division 1, Groups A, B, C, D; Class II, Division 1, Groups E, F, G

Ambient Temperature Range: *Integral:* -40° to 185°F (-40° to 85°C) *Remote:* -40° to 185°F (-40° to 85°C)

Overall Length: *Integral:* 20” (50.80 cm) *Remote:* 8” (20.32 cm)

Approximate Weight: *Integral:* 37.4 lbs. (17 kg) *Remote:* 4.4 lbs. (2 kg)

Power: *Integral:* 115/230 VAC ± 15%, 40/60 Hz *Remote:* 115/230 VAC ± 15%, 50/60 Hz

Power Consumption: *Integral:* 7 watts per alarm *Remote:* 7 watts per alarm point

Relay Output: *Integral:* DPDT 3 A at 30 VDC; 3 A at 120 VAC *Remote:* DPDT 3 A at 30 VDC; 3 A at 120 VAC

Analog Output: *Remote:* 0-1 V

Failure Alarm: *Integral:* Included *Remote:* Included

Time Delay Range: *Integral:* 0.5 to 20 seconds (10 or 20 seconds normal); jumper-selectable *Remote:* .05 to 20 seconds (10 or 20 seconds normal); jumper-selectable

Display: *Integral:* LED status indicator *Remote:* LED status indicator

Accuracy: *Integral* ± 1/8” *Remote:* ± 1/8”

All equipment approved by CSA.

3.0 THEORY OF OPERATION

The Ronan Series X90 gamma switches provide an alarm signal whenever the radiation field intensity at the detector (G-M tube) changes by more than its predetermined value. The variation in the field intensity may be due to either a change in the level (at the limit), or a change in the density of the process material in the radiation beam path. In a typical arrangement, the X90 detects the level of liquid in a vessel when it has exceeded a predetermined limit. The level limit is defined by an imaginary straight line drawn from the source to the detector.

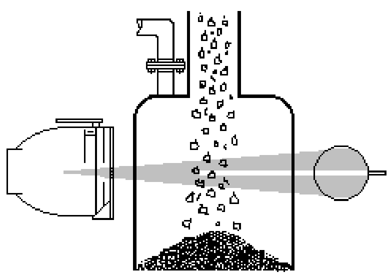


Figure 1: Source and Detector

When the feed valve is open, liquid is fed into the vessel and the liquid level rises. The liquid level will rise until it interrupts the gamma ray beam. There is then a change in the field intensity at the detector due to absorption by the process of some of the energy present in the beam, and the instrument puts out an alarm signal in the form of a relay contact changeover. This signal may be used to close the feed valve and/or activate an annunciator. As the liquid is used from the vessel, the level will fall, thus again exposing the detector to the gamma radiation and the feed valve will be opened when the contacts revert to normal.

This is an example of a high limit switch, i.e., the process level is not allowed to rise above a certain limit. Conversely, the source and the detector may be lowered to below the liquid level and the system functions as a low limit switch, in which case the system will produce an alarm when the liquid level falls below this low limit. The liquid itself may be under pressure at high temperature or even corrosive, but its characteristics will not affect the switch, since the system components are outside of the vessel.

A time delay based on the measurement controls the interval between radiation level change and alarm. A hysteresis band about the required level prevents fluttering and spurious alarm situations.

3.1 Optional Gaging Configurations

3.1.1 Model X90-1004 Remote Probe: The Ronan Model X90-1004 Remote Probe (located on vessel) with the X90-301(V) switch electronics may be located in a general purpose or Division II location. This is the most widely used configuration. The X90-1004X is a high-sensitivity tube, which may be specified for very weak fields (0.1 mR/hr. or less).

3.1.2 Model X90-1005 Integral Switch: The Ronan Model X90-1005 Integral Switch in a Model X90-1001XP housing is usually specified when the X90-301(V) switch electronics cannot be located in a general purpose or Division II area. It may be used when the vessel is easily accessible for calibration and maintenance.

The Model X90-1005 contains the G-M tube sensor and switch electronics on a single chassis and is mounted on or just off the vessel wall.

4.0 FUNCTIONAL OPTIONS

4.1 High-Limit Process Alarm

The Process alarm relay will change over when the level of process material rises above the set limit.

4.2 Low-Limit Process Alarm

The process alarm relay will change over when the process level falls below the set limit.

4.3 Failure Alarm

In the case of the high-limit switch, under normal conditions the G-M tube receives full radiation and produces an output. This output will fall, producing an alarm when either the radiation is interrupted by the process level rising to above the set limit or the G-M tube or its power supply fails. However, if the tube or power supply fails, a failure alarm will be actuated, indicating the problem is in the unit. If the tube output does not indicate a minimum background value (due to a malfunction in the G-M tube or its power supply) the process (and failure, if used) relay automatically changes over, indicating an alarm condition.

The failure alarm will occur anytime the output from the tube is zero.

5.0 TIME DELAY OPTIONS

The basic time constant is 0.5 seconds to 40 seconds, depending upon the span setting. Additional time delays available are 0.1, 5, 10 and 20 seconds.

For most applications, the 0.1 second jumper is used. If false alarms occur, the time delay should be increased. The delay is selected by a plug-in jumper located on the electronics chassis printed circuit board.

5.1 Relay Contacts

Two Form-C (SPDT) contacts are provided. Contact ratings are 3 A at 30 Ddc or 120 Vac resistive. Other forms of contacts may be provided on request.

If both sets of contacts are to be used for the process alarm relay, jumper A10, B-11 and C-12 (located on the X90-301(V) printed circuit board or X90-1005 printed circuit board for the integral version.) For the integral Model X90-1005, 10A contacts are provided as standard equipment.

If one set of contacts is to be used for a failure alarm relay, D10, E-11 and F12 are jumpered.

6.0 CIRCUIT DESCRIPTION

The X90-301(V) and X90-1005 circuitry consists of a stabilized ± 12 V and 500 V power supply, a voltage integrator, comparator and logic alarms.

The output pulses from the G-M tube are fed through an emitter follower to the input circuit. The pulses are + 12 V, 200 microseconds wide.

The G-M tube output is integrated and amplified by the input circuit. The zero and span controls are used to generate a 0 to 1 V output for low to high level conditions.

This output is monitored using a simple VTOM across the test points, AMP and TP GRN. A comparator circuit will trip the relay circuitry at 0.9 V and reset at 0.2 V. Jumpers on the circuit board are provided to make the switch function as a high-level or low-level limit alarm.

Complete circuit schematics and wiring diagrams are provided at the end of this manual.

7.0 INSTALLATION AND ELECTRICAL CONNECTION—GENERAL

All equipment manufactured by Ronan Engineering is carefully packaged and shipped to prevent shipping damage. Any discrepancies between shipping contents and invoice should be immediately reported to Ronan or the Ronan representative.

All Series X90 system components (source holder, integral switch and remote tube assembly) will tolerate normal industrial vibration. However, in cases where vibrators are attached directly to the vessel, the system components must be mounted on adjacent building framework or use special supports that provide a degree of isolation.

When the axis of the G-M tube is placed parallel to the surface of the process material and its side-facing source, relay contact changeover will be obtained when the set limit is exceeded by about one-half inch. When a coarser level limit is appropriate, a broad band of about five inches can be obtained by placing the detector axis perpendicular to the surface of the process material. In either case, an alarm is produced after the tube is obscured from (or exposed to) the radiation from the source.

Whenever possible, separate power sources should be used for the X90 and the alarm circuit. With this arrangement, the alarm will operate if the power to the X90 is interrupted (provided, of course, the alarm circuit has power available).

Local electrical codes must be followed for all wiring. All conduit entrances should be sealed to prevent condensed moisture or water from entering the enclosures. The cable used to connect the remote G-M tube should also be run through conduit. All explosion-proof housing covers must be replaced when the system is in operation.

7.1 Remote Probe (X90-1004)

The G-M tube with X90-1004 driver board is placed in an explosion-proof housing. This assembly is mounted in position at the required level or point of measurement and connected to the X90-301(V) module by a four-conductor, shielded cable supplied by Ronan Engineering.

Refer to drawing number C-1369-K for wiring of the remote detector assembly and refer to drawing number C-1359-K for designation of terminals on the X90-301(V) module.

7.2 Model X90GPE

The X90-301(V) modules are plugged into X90GPE surface-mount, single chassis enclosures. Access to input/output and power connections are from the front, beneath a convenient, snap-on cover. Connections are located in a separate compartment of the chassis and removal of the module is not necessary in order to change wiring. Grommeted holes are provided on the top and bottom surfaces of the chassis for cable entry and exit. Overall dimensions are 7.25” high X 4.5” wide X 5.75” deep (18.42 cm X 11.43 cm X 14.6 cm).

Refer to drawing number C-1359-K for terminal designations for power wiring and hook-up to the remote probe driver board.

7.3 Integral Model X90-1005

Refer to drawing A-1697-K for rear-panel input power wiring connections and relay contact wiring connections.

8.0 CALIBRATION CONTROLS

The following front-panel controls are used in the set-up procedure.

ZERO CONTROL is used to provide a zero voltage signal at TP-AMP with the process level below the point of measurement, under conditions of maximum radiation at the G-M tube.

SPAN is used to provide a + 1.0 voltage signal at TP-AMP when the process level is above the point of interest, under conditions of no radiation on the G-M tube.

Three light-emitting diode (LED) DISPLAYS are provided. These indicators will signal normal and level alarm for process conditions and failure alarm.

The AMP TERMINAL is the output of the voltage integrator. This output increases as the radiation on the tube decreases and *vice versa.*

Calibration should be attempted only after all system components have been securely mounted in position and power and other connections made where required. Check also that the correct jumpers have been installed on the X90-301(V) or X90-1005 printed circuit board.

9.0 CALIBRATION—GENERAL

The output at the AMP terminal is a measure of level present at the detector. This reading will be minimum or near zero when the detector is fully irradiated (no process) and the maximum or near 1.0 V when there is process material between the source and the detector.

Therefore, for calibration any option, two voltage readings are generated: 0.0 V with no process between the source and the detector and + 1.0 V with process between the source and the detector.

9.1 Calibration with Process Material

a) Switch on the power to the X90 and turn the shutter handle on the source holder to the ON position. Turn the SPAN control clockwise 20 turns; then 10 turns counterclockwise.

b) Lower the process level below the set limit and adjust the ZERO control so that the AMP terminal output is zero.

c) Raise the process level above the set limit and again measure the voltage at the AMP terminal.

d) Adjust the SPAN control to obtain a reading of + 1.0 V at the AMP terminal.

After the switch has been calibrated using the above method, the operation of the control relay, NORMAL and ALARM indicators should be checked by raising and lowering the process level about the set limit. If all these operate as required, the switch is considered calibrated.

9.2 Calibration without Process Material

a) Turn the source holder shutter to the ON position.

b) Turn the SPAN control clockwise 20 turns; then 10 turns counterclockwise.

c) Take voltage reading at the AMP terminal. Adjust the zero control to obtain an average 0.0 V reading at the AMP terminal.

d) Turn the source OFF.

e) Adjust the SPAN control for an average + 1.0 V reading.

f) Turn the source back ON for operation.

9.3 Time Delay

If false alarms occur, increase the time delay by moving the delay jumpers on the printed circuit board to a higher value.

9.4 Response Time

The response time of the amplifier is 0.5 to 40 seconds, depending on the SPAN setting.

Table 1: Jumper Select Options

Device	Install
High limit switch	High and G
Low limit switch	Low and G
Process alarm only	A-10, B-11, C-12
Process alarm and failure alarm	Failure relay and D-10, E-11, F-12
Delays	Select one: 0.1 sec., 5 sec., 10 sec., 20 sec.

10.0 TROUBLESHOOTING

The X90 is constructed to require the minimum of maintenance. Operated properly, it should not require any maintenance for a considerable period of time.

Any necessary troubleshooting should start with the power supplies. Ronan Engineering suggests that a voltmeter with a resistance of at least 20 kohm/V be used for measurement of voltages. Verify that the power supplies are working before starting with the rest of the circuitry. The operation of the main circuit may be checked by adjusting the ZERO control to change the amplifier voltage at the AMP terminal. Vary the voltage and check the operation of the relay. Use the circuit description and circuit schematic D-1357-K or D-1674-K for reference.

If the relay circuit works properly using the ZERO control, check the operation of the G-M tube with the source ON and OFF to see if the tube responds.

For any major faults, we suggest the X90 be returned to Ronan Engineering for service.

11.0 RADIATION SAFETY

The information in this section is intended for specific licensees. The regulations and instructions pertain to leak test and other procedures, which specific licensees are authorized to perform. For general licensees this section is included for information purposes only.

Most radioactive material used in gaging devices is regulated by the United States Nuclear Regulatory Commission (NRC). The NRC issues licenses to users and manufacturers of gaging devices utilizing radioactive materials and inspects sites where materials are used to determine compliance with the terms of the license.

The NRC has issued rules on:

a) instructions to employees (10 CFR part 19);

b) the licensing of radioactive materials and devices (10 CFR part 30); and

c) radiation safety (10 CFR part 20).

During 1962, the NRC began entering into agreements with individual states to transfer regulatory authority to them. Known as “agreement states,” their regulations closely parallel those of the NRC and are essentially identical, except that the agreement states usually regulate the use of all radiation-producing devices.

NOTE: Only those individuals specially licensed to mount, repair, relocate and/or remove the part of the gage containing the radioactive source may do so. Each specific licensee should carefully read his particular license to determine the exact conditions of his license.

Gamma-emitting radioactive material radiates electromagnetic energy which is similar to light, except that it readily penetrates opaque materials and is able to pass through several inches of steel or other dense material.

The ability to penetrate dense material can be used to advantage in the measurement of process variables such as density, level and thickness, where a change in detected radiation indicates a change in process variable.

Radiated energy is harmful to the human body when absorbed at an excessive rate. For example, a glowing incandescent lamp cannot be held in the hand without causing severe discomfort or a painful burn. The hand can be held close to the lamp for seconds, at a few inches for hours or several feet away continuously. By use of insulation surrounding the lamp or hand, the lamp could be held indefinitely without discomfort or injury.

Radioactive energy and radiation is analogous to light energy and radiation with the radioactive source taking the place of the incandescent lamp. Permissible human exposure to a radioactive source is dependent upon:

a) the number of millicuries of radioactive material in the source (similar to the wattage rating of a lamp);

b) distance from the source;

c) amount of absorber between source and body;

d) amount of portion of the body receiving the radiation.

The term *milliroentgen per hour* (mR/hr) is a measure of the radiation field intensity in air. When radiation is absorbed by the body, the term *rem* or *millirem* (0.001 rem) is used. This distinction is necessary because not all radiation affects the body in the same manner. For gamma radiation, the millirem (mrem) is equal to the milliroentgen.

The NRC limits the amount of radiation which a person should receive to 1.25 rem per calendar quarter. This is an average of about 100 mrem per week.

The 1.25 rem per calendar quarter limitation is a dose at which there is no possibility of injury. However, since the use of gamma radiation is relatively new, the history of injury is not complete. Thus, it is wise to receive as little radiation as possible. To guard against possible overexposure and to maintain a record of personnel routinely exposed to radiation, the NRC requires monitoring of persons who are apt to receive more than an average of 25 mrem per week or who are exposed to a radiation field greater than 100 mr/hr. When personnel monitoring is required, a record must be kept showing the dose received. When records are kept, and if an employee requests it, the employer must furnish a written report of radiation exposure annually and on termination of employment.

In the majority of Ronan installations, the source is contained in a lead-filled source holder with an ON/OFF mechanism. The holder is designed so that the radiation field is 5 mR/hr or less at a distance of 12 inches from the surface of the holder when is is in the OFF position. When the source holder is mounted on the pipe or vessel and turned to the ON position, the pipe walls, process material and mounting bracket absorb most of the radiation. Again, the field intensity is about 5 Mr./hr at a distance of 12 inches from the surface of the gage. Thus, a person would have to be within 12 inches of the gage for 20 hours per week to receive 100 mrem. A person would have to be within 12 inches of the gage for five hours per week before he would be required to have a personnel monitoring device, such as a film badge or a dosimeter.

Long experience in the nuclear gaging industry with hundreds of gages, where the source is contained in a source holder, indicates that the dose received by operators, maintenance personnel and supervisors averages less than 25 mrem per week. Thus, for gages where the source is contained in a source holder, it is usually not necessary to provide any personnel with monitors.

Whether or not monitoring devices are needed should be determined at the gage site at the time of installation in the form of an *occupancy evaluation.* Only those persons specially licensed by the NRC or an agreement state to install a radioactive device are qualified to make an occupancy evaluation.

In some installations, it is impossible to mount the source in a source holder. In these cases the source is usually mounted in a source well. Installation of the source in the well should be done as rapidly as possible. All necessary equipment should be assembled prior to opening the shipping box containing the source.

A trial installation using a dummy source is recommended. A dummy source can easily be fabricated from steel or brass using the outline drawing of the source supplied by Ronan Engineering. When an unshielded source is installed in a vessel or when it is wipe tested, the radiation field is usually greater than 100 mR/hr. Thus, personnel monitoring in the form of film badges or dosimeters is required. A record of the the film badge or dosimeter reading must be kept on Form NRC-5. Since records must be kept, the employer must furnish to the employee, if requested, a record of the employee's radiation exposure annually and on termination of employment.

Additional precautions are required when a gage is used on a vessel large enough to permit entry of personnel. With the source holder in the open position or when the source is not removed from the source well, the radiation field intensity inside the vessel can be high. A procedure *must* be established so that personnel cannot enter the vessel until the source holder is in the closed position or the source is removed from the source well. The use of padlocks on all man-way and access port covers is acceptable. The key or combination for the locks should be kept by the person responsible for radiation safety.

In some cases, when the vessel or pipe is empty, the radiation field intensity of the outside of the pipe or vessel will be such that personnel monitoring is required. For installations using source holders, this problem can easily be solved by turning the source holder to the OFF position. For installations using sources in source wells, where the radiation cannot be turned off, it may be desirable to remove the source temporarily and return it to its lead shielded shipping and storage container.

11.1 Field Intensity Calculation

The best method for determining the radiation field intensity is by measurement with a survey meter. However, the field intensity can be calculated fairly accurately without a survey meter.

$$D = \frac{k \ mCi}{(d)^2} \times 1000$$

The radiation field intensity can be calculated from:

D = dose rate, mR/hr

mCi = millicurie value of source

d = distance to source in inches

k = constant 0.023 for AM-241
0.5 for CS-137
2.0 for CO-60

Suppose that for a certain installation the estimated exposure time to the unshielded source is 10 minutes at an average body-to-source distance of

$$\text{Dose rate} = \frac{0.5 \times 10}{(20)^2} \times 1000 = \frac{5}{400} \times 1000 = 12.5 \text{ mr/hr}$$

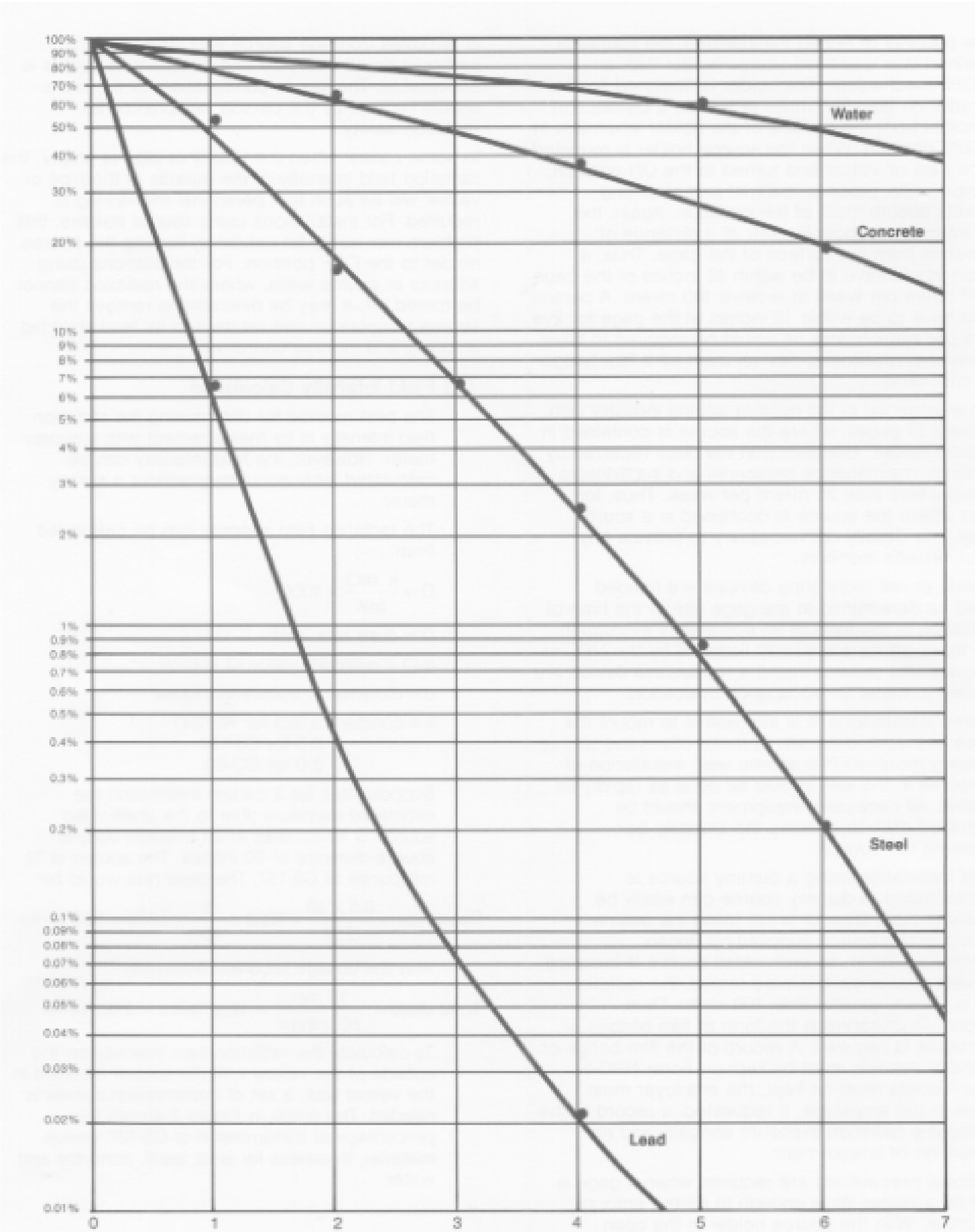
20 inches. The source is 10 millicuries of CS-137.

$$\text{Total dose} = \frac{10 \text{ min}}{60 \text{ min/hr}} = 12.5 \text{ mR/hr} = 2.08 \text{ mrem}$$

The dose rate would be:

And the dosage received would be:

To calculate the radiation field intensity on the



Thickness in inches

Figure 2: Radiation Transmission CS-137 for Various Materials

Calculate the radiation field intensity at 12 inches from the surface of the vessel shown in Figure 3. Total distance = 12 + 2 + 10 = 24 inches

Dose rate for unshielded source:

$$\text{Dose rate} = \frac{0.5 \text{ X } 10}{(24)^2} \text{ X } 1000 = \frac{5}{476} \text{ X } 1000 = 8.6 \text{ mr/hr}$$

Percent transmission of gamma radiation through two-inch steel (vessel wall), 0.25-inch source well wall = .18 X .83 = 0.517. Resultant field intensity = 8.6 X 0.517 = 4.45 mr/hr.

To estimate the dosage received by personnel working in the vicinity of the source, the occupancy must be known. Suppose that a man worked 24 hours per week within 12 inches of the vessel. He would receive a dose in excess of 100 mr. He would then require a monitoring device.

11.2 NRC Regulations

A current copy of the Title 10 Code of Federal Regulations, Parts 19, 20 and 30 should be obtained. These should be read thoroughly to become familiar with the laws governing the use of radioactive materials.

a) The "Individual User" listed on the "Application for By-product Material License" (Form NRC-313) is responsible for the source. If this person is transferred or is changed to a position where he is no longer responsible for the source, the license must be amended prior to the assignment of the new user. [30.32, 30.33, 30.34, 30.38]

b) Use of the source is usually licensed for a particular plant site. If the source is transferred to a different plant site the license must be amended prior to the transfer. [30.34 and 30.38]

c) A record of the initial radiation survey must be kept for reference. [20.40 1 b]

d) Records of the periodic leakage test must be maintained.

e) A label must be attached to the source holder, or source well, stating the type and quantity of radioactive material and the date of manufacture. The label must bear the conventional radiation symbol. An NRC-approved label is attached to the source holder by Ronan Engineering prior to shipment. For sources in source wells, and NRC-approved tag is placed on the source shipping and storage contained. [20.203]

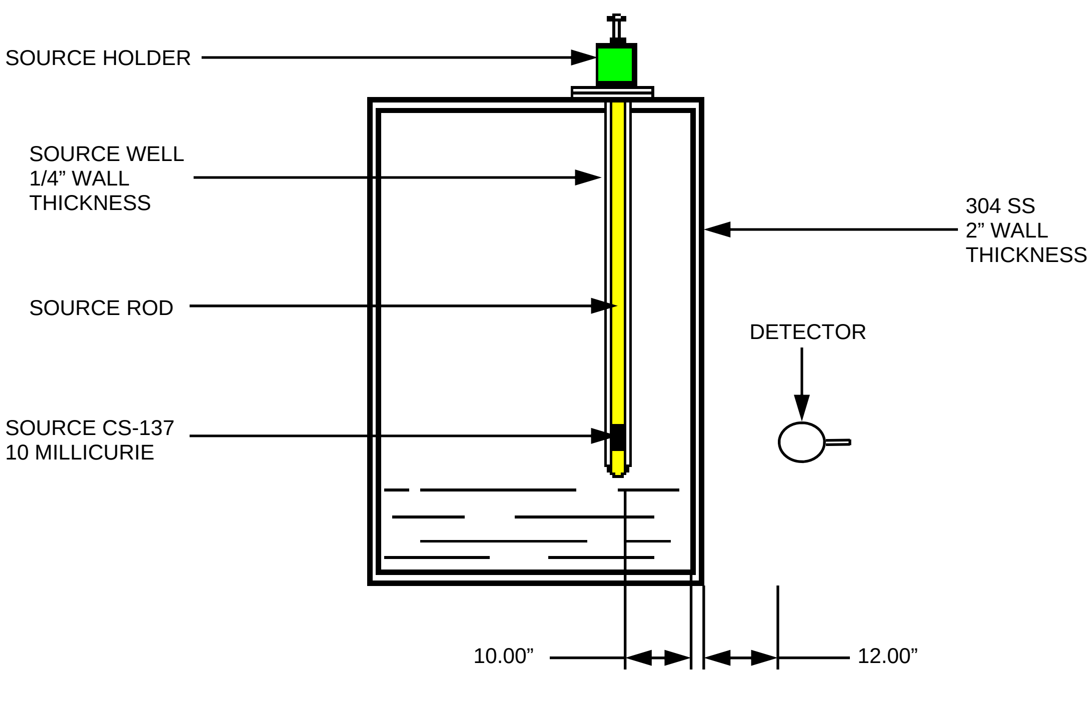


Figure 3: Dosage

f) The area in the vicinity of the source must be posted with a radiation warning sign, if the radiation field is greater than 5 mr/hr at a distance of 12 inches from the surface of the gage. [20.204a and 20.203]

g) Personnel monitoring is required when personnel are apt to receive a dose in excess of 23 mrem/wk or when they enter a radiation field greater than 100 mr/hr. [20.202a]

h) Whenever the source is to be discarded, it must be returned to Ronan Engineering for proper disposal. Ronan Engineering must be contacted for detailed shipping instructions. [20.301a]

i) The regional operations office of the NRC must be notified of any incident, such as a fire or explosion, which involves the radioactive material used in the gage. [20.403] (Ronan Engineering should also be notified.)

j) If personnel monitoring is required [20.202a], a record of the radiation exposure must be kept on Form NRC-5 [20.401a and 20.401c] and, if the employee requests it, written notification must be given annually or on termination of employment. [19.13]

k) If a person receives more than 1.25 rem per calendar quarter, he must be notified in writing of the exposure and the NRC must be notified. [20.405]

l) A restricted area is defined in 10 CRF 20.3A(14) and the permissible exposure to individuals in a restricted area is given in 10 CFR 20.101. An unrestricted area is defined in 10 CFR 20.3A (17) and the permissible level of radiation in an unrestricted area is given in 10 CFR 20.105(b). Any area where an individual, if continuously present, can receive a dose in excess of 2 mrem in any one hour or where he can receive more than 100 mrem in any seven consecutive days must be treated as a restricted area and access thereto be under the control of the licensee.

m) Employees working in, or frequenting, a restricted area must be advised of the restricted area by posting a Form NRC-3 19.11(c). The NRC regulations state that this form must be posted so than employees can "observe a copy on the way to or from their place of employment" in the restricted area. Thus, Form NRC-3 could be posted at or near the entry into the restricted area. If personnel do not work in, or frequent, a restricted area, Form NRC-3 need not be posted.

11.3 Periodic Leakage Test

Information about the periodic leakage test is covered in Section 12.

11.4 Radiation Publications

For those who desire further information on radiation safety and the handling of radioactive material, the following publications are recommended:

Radiation Dosimetery, Hine and Brownell (Academic Press, Inc., 111 Fifth Avenue, New York, NY 10003)

The following publications and National Bureau of Standards handbooks are available from the Superintendent of Documents, Washington, DC 98025:

Number	Title
92	*Safe Handling of Radioactive Materials*
73	*Protection Against Radiation from Sealed Gamma Sources*

11.5 Abandonment and Disposal

Abandonment or disposal is prohibited unless transferred to persons specifically licensed by the NRC or an agreement state. This means that the gage cannot be abandoned, sold for scrap, or placed in the trash bin. If the gage is no longer needed, it must be shipped to a person or company specifically licensed by the NRC or an agreement state to receive the gage for disposal.

11.6 Prohibition of Operation

Operation is prohibited if there is indication of failure of or damage to shielding or source containment. If there is any damage to the gage, or failure of the source rod mechanism, place the source rod in the OFF position (if possible) and telephone the field service manager at Ronan Engineering (606) 342-8500.

Care must be exercised when uncrating the gage. If the crate is damaged in such a manner that the gage might be damaged, Ronan Engineering should be contacted for advice. If the lock is missing, broken, or not locked, do not uncrate or mount the gage in position. Call Ronan Engineering for advice.

11.7 Mounting and Start-up

Anyone may mount the gages in position on the vessel or pipes, do the electrical wiring, and turn the electrical power switch ON, if the source holder is locked in the OFF position.

When mounting the source holder in position, take the necessary precautions to assure that it is not dropped or damaged. Refer to the outline drawing of the source holder in the back of this manual before mounting it in position.

Only a person specifically licensed by the NRC or an agreement state is allowed to remove the source holder from its mounting or to dismantle it.

After these preliminary services are performed, a person specifically licensed by the NRC or an agreement state must do the start-up of the gage. This involves unlocking the source holder and turning it ON; testing for proper operation of the source holder and position indicator; making the initial radiation field intensity survey; and initial testing for leakage of radioactive material. This specifically licensed person must determine that the gage is installed in such a manner that personnel working in the vicinity of the gage will not receive a radiation dose greater than 0.5 rem/yr.

The gage is shipped from the Ronan factory with the source holder locked OFF. The combination ill be given only to the specifically licensed person performing the start-up and placing the gage in service.

a copy of the tag attached to the lock follows:

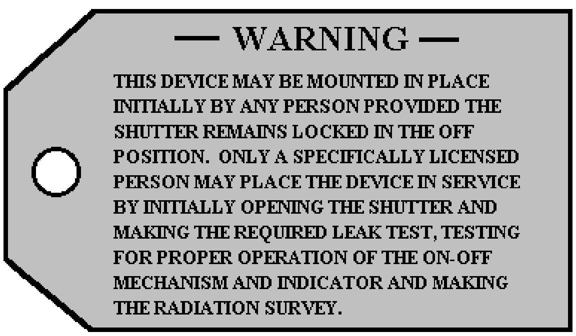


Figure 4: Warning Tag

Device shall be tested for radioactive leakage and proper functioning of source actuator rod at installation, at source replacement and thereafter at no longer than three-year intervals.

11.8 Well Source Holders SA-4, SA-10, SA-15

11.8.1 Source actuator: The actuator should always move freely. There will be some slight resistance to movement due to bearing friction of the gasketed filling, which keeps out moisture and dirt.

Do not force the source rod actuator.

If a portable radiation survey meter is available, the radiation field intensity can be measured at the back of the detector housing. With the source rod in the STORE position, the field intensity should be measurable. When the source is placed in the well, the field intensity should decrease.

11.8.2 Source insertion procedure:

a) Open shutter and pin open with lock pin.
b) Loosen CGB fitting at source rod.
c) Remove handle and attach source extender rod.
d) Attach handle to extender rod.
e) Push source rod until source bottoms out in well.
f) Tighten CGB fitting over source extender rod.

11.8.3 Source retraction procedure

a) Loosen CGB filling.
b) Pull source handle back until source rod locates inside source tube. Source will hit positive stop inside holder.
c) Push shutter to OFF. Lock with lock pin or padlock.
d) Remove extender rod.
e) Remove handle from extender rod and attach to source rod.

11.8.4 Wiping the test points: A wipe test and radiation survey must be made before the source is installed onto the vessel wall and before the source is inserted into the well. The radiation protection officer (RPO) or licensed personnel must supervise the installation, source insertion and retraction. The RPO must also classify the area based on the radiation survey and personnel occupancy in the vicinity of the gage.

The RPO must write control procedures for personnel not to work or occupy the area around the gage when the process is down, maintenance on the vessel is performed, or when the vessel is empty.

Anyone following the instructions of a leak test kit may perform the wiping procedure, but only a person or company specifically licensed by the NRC or an agreement state may do the analysis for radioactive material.

Using a cotton swab, wipe around the source rod extending out the top of the source holder and at all seams as shown in Figure 5. These areas are most likely to be contaminated if the source leaks. Do not touch the cotton-tipped end or allow it to touch other objects, as this would spread contamination if a leak is present.

After making the wipe test, replace the cotton swab in the vial with the cotton-tipped end at the bottom. Replace the cap on the vial, place the vial in the shipping tube and replace the top on the shipping tube. Send to: Ronan Engineering Company, 8050 Production Drive, Florence, KY 41042.

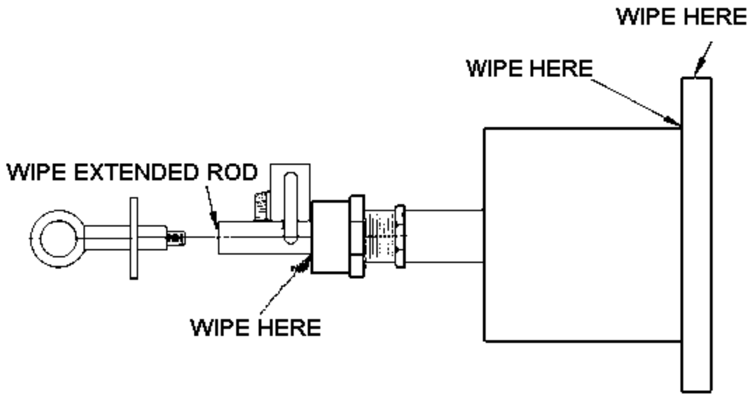


Figure 5: Wiping the Test Points (Well Sources)

11.9 Standard Sources SA-1, SA-8

11.9.1 ON/OFF mechanism: To test the ON/OFF mechanism, move the handle back and forth several times between the ON and a OFF positions. The handle should always move freely. There may be some slight resistance to movement due to bearing friction.

Do not force the handle.

If a portable radiation survey meter is available, the radiation field intensity can be measured at points around the detector housing.

11.9.2 Wiping the test point: Anyone following the instructions of a leak test kit may perform the wiping procedure, but only a person or company specifically licensed by the NRC or an agreement state may do the analysis for radioactive material.

Using a cotton swab, wipe around the rotor shaft on the top of the source holder and at all seams, as shown in Figure 6. These areas are most likely to be contaminated if the source leaks. Do not touch the cotton-tipped end or allow it to touch other objects, as this would spread contamination if a leak is present.

After making the wipe test, replace the cotton swab in the vial with the cotton-tipped end at the bottom. Replace the cap on the vial, place the vial in the shipping tube and replace the top on the shipping tube. Send to: Ronan Engineering Company, 8050 Production Drive, Florence, KY 41042.

11.10 Mandatory Reporting

Loss, theft or transfer of this device and failure of or damage to the shielding or the source containment, must be reported to the NRC or an agreement state.

In addition to notifying the NRC or the agreement state agency, Ronan Engineering should also be notified, so that proper help can be provided.

If the gage is involved in a fire or explosion, the area around the gage should be barricaded or roped-off until the situation can be evaluated by a specifically licensed person. Telephone Ronan Engineering at (606) 342-8500.

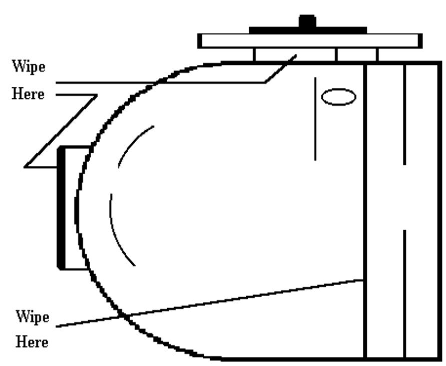


Figure 6: Wiping the Test Points (Standard Sources)

12.0 LEAK TEST PROCEDURES FOR SEALED SOURCES

12.1 Ronan Leak Testing Service

The NRC requires that all sealed sources be tested for leakage at specified intervals. Only Kr-85, tritium and certain sources of very small activity (10 CFR 30.18a) are exempted from leak testing.

Ronan Engineering provides for users' convenience and safety the "Leak Testing Service." The leak testing procedure detailed in these instructions applies only to the Ronan Model WK Leak Testing Kit supplied with the Ronan Leak Testing Service. The Ronan Model WK Leak Testing Kit is intended for use on all sealed sources that are not exempt from testing.

This service may be purchased from Ronan on a contract basis for five years when wipe testing at six-month intervals is required or on a one-time basis in the case of three-year wipe test intervals. The service must be purchased for each individual source. If the service is retained, Ronan will send the required number of leak test kits, consisting of:

a) A cotton swab ("Q-tip") saturated in radiac wash, contained in a small plastic tube.

b) Special instructions on its use.

c) Leak test forms.

After the sealed sources have been wiped by the customer, the kit is to be returned to Ronan for analysis. Ronan will analyze the leak test materials, issue a report based on the results and forward a copy of the results to the customer immediately.

12.2 Using the Leak Test Kit:

For instructions on using the Leak Test Kit see section 11.8.4 for well sources or section 11.9.2 for standard sources.

Return the shipping tube, prepaid, via United Parcel Services (UPS). Do *not* send the shipping tube via conventional mail, as postal regulations prohibit mailing of radioactive material in this form.

Upon receipt of the wipe, Ronan will perform a sensitive analysis to determine the presence of radioactive material. If the wipe is contamination-free, a notice will be sent via mail that the source is leak-free. If radioactive material exceeding .005 microcuries is detected on the wipe, an emergency notification will be sent via telegram or telephone, advising that the source holder must be taken out of service and sent back for repair. The emergency notification will contain detailed instructions for removal and shipment of source holder.

Ronan will maintain records of each leak test analysis performed. The records will include the name and address of the customer; the date the sample was collected; the individual collecting the sample; the person performing the analysis; the date the analysis was performed; the unique identification of the source being tested; the radioactive material and mass number contained in the source; and the results of the test expressed in microcuries.