Newport News Shipbuilding
A Tenneco Company

4101 Washington Avenue
Newport News, Virginia 23607
(804) 380-2000

November 13, 1985

U. S. Nuclear Regulatory Commission
Nuclear Materials Licensing Section
Suite 2900
101 Marietta Street, NW
Atlanta, Georgia 30323

Applicant Dec 2nd
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Attention: Paul R. Guinn

Dear Sir:

Please amend Industrial Radiography License 45-09428-02 as stated in Enclosure (1).

Our operating and emergency procedures will be revised as soon as we receive the requested amendment from the Nuclear Regulatory Commission.

I have enclosed the following proposed changes to our procedures:

Enclosure (2) Rules and Regulations Concerning the Safe Use of Radioactive Isotopes and X-Ray in Industrial Radiography, SOP 031-18.357

Enclosure (3) Inspection and Maintenance of Radiographic Facilities and Equipment, SOP 031-7.361

Enclosure (4) Swipe Testing of Radioactive Sources and Equipment Utilized for Industrial Radiography, SOP 031-18.365

Enclosure (5) Receipt, Transportation, and Shipment of Radioactive Sources Utilized in Industrial Radiography, SOP 031-18.375

I have also enclosed a copy of Tech/Ops Model 616 Instruction Manual, Enclosure (6), to show you how we have revised our procedures from their recommendations.

No one shall be allowed to operate this piece of equipment until they are thoroughly familiar with it and its operating instructions. No Model 616 exposure device shall be used until the proposed changes are incorporated into the Newport News Shipbuilding standard operating procedures (SOPs).

50815

We have enclosed a $230.00 check (Enclosure (7)) for the amendment fee and would greatly appreciate an expedited review and approval of the request.

Yours truly,

A. J. Mobery
Manager, Laboratory Services
Chief Industrial Radiation
Safety Officer

HWC
HWCJr/paj

Copy: 1 - Nuclear Materials Licensing Section
1 - R. D. Wallace, Manager, Dept. 038, Newport News Shipbuilding

Enclosures: 7

6.	Byproduct, source, and/or special nuclear material	7.	Chemical and/or physical form	8.	Maximum amount that Licensee may possess at any one time under this license
6.N.	Iridium 192	7.N.	Technical Operations Model 58101-8 sealed sources	8.N.	No single source to exceed 200 curies

9. Authorized Use

9.N. For use in Technical Operations Model 616 Exposure Devices for industrial radiography, and Technical Operations Model 715 shipping containers which serve as the transport devices for the Model 616 exposure devices used for storage and replacement of sources.

5.a.(3) Operator's Procedure for Checking the Model 616 Exposure Device

(a) Perform a radiation survey of the exposure device. (Check the survey meter on both the 0-5 and 0-50 mr/hr scales.) The radiation levels 6 inches from the surface should not exceed 50 mr/hr.

(b) Visually inspect the exposure device for signs of damage. Check for the presence and legibility of the name plate.

(c) Visually inspect the control unit for signs of damage.

(d) Test for vacuum leaks by turning the vacuum control valve to OFF and pumping a vacuum of 20 to 25 inches. The vacuum gauge should remain steady. A falling gauge indicates a leak in the control unit and must be repaired.

(f) Perform the following steps inside the radiographic restricted area.

i. Position the exposure device so that the beam is directed away from all personnel. Put a survey meter in front of the beam part.

ii. Assemble the system and keep the exposure device locked.

iii. Pump the hand pump until the vacuum gauge indicates a pressure of 20-25 inches. Then turn the vacuum control valve to EXPOSE.

iv. Observe the survey meter. It should indicate no increase in the radiation level. If the radiation level increases, the lock is defective and must be replaced.

v. Observe the vacuum gauge. It should remain steady. A falling gauge indicates a leak in the control hose or source actuator and must be repaired.

vi. Press the vacuum control valve to OFF and disconnect the control hose.

vii. Unlock the exposure device, making sure the control hose has been disconnected from the source actuator and the control valve is in the OFF position.

viii. Reconnect the hose to the source actuator.

ix. Pump the hand pump until the vacuum gauge indicates 20-25 inches, and turn the vacuum control valve to the EXPOSE position. The radiation level should increase.

x. Press the vacuum control valve to the OFF position until the vacuum gauge reads zero inches. The radiation level should decrease to the previous background level.

xi. Steps vii. through x. can be performed in the first radiation exposure of the shift. In any case, if the system fails to function properly, notify the shift supervisor immediately.

5.b.(1)(b) Maintenance Procedure for Inspecting the Model 616 Exposure Device

i. The same inspection performed by the radiographic operator each shift shall also be performed by the maintenance section every three months, steps 5.a.(3)(a) through (f).

ii. Since the Model 616 exposure device is a sealed unit, disassembly, source replacement, and repairs can be done by Tech/Ops only. Never remove the source actuator cover, as this will expose the source.

iii. See Section VI. of the Model 616 Instruction Manual, parts B. and C., for replacing a defective part of the Model 694 control unit.

5.b. LEAK TEST PROCEDURE FOR SEALED SOURCES USED IN EXPOSURE DEVICES

(1) Turn on survey meter.

(2) Remove plug from source tube end of exposure device or remove pad lock on open-air exposure device.

NOTE: Since the Model 616 exposure device is a closed system, the outside of the exhaust filter (located just above the lock plunger) shall be swiped. The swiping rod shall be used for this swipe and then steps 5.b.(5) through (10) shall be followed.

(3) Insert swiping rod, with NU-CON SMEAR attached, into source tube end of exposure device and wipe interior surface. For the open-air exposure device, raise the lid slightly and insert the swiping rod, swiping the surface of the source with the NU-CON SMEAR. Do not every wipe a radioactive source, itself, while holding the NU-CON SMEAR with your fingers.

(4) Remove rod from exposure device and replace plug or pad lock for the open-air exposure device. The swipe of the gamma probe source should take about 5 seconds.

(5) Place notched end of swiping rod with NU-CON SMEAR into 3" x 5" yellow plastic bag.

(6) Touching only the outside of the plastic bag, remove the NU-CON SMEAR from the notched end of the swiping rod.

NOTE: If the swipe must be touched with fingers, use rubber gloves.

(7) Remove swiping rod from yellow plastic bag and place notched end of rod into a green poly bag or a yellow poly bag when contamination is present or suspected.

(8) Wrap the end of the yellow plastic bag containing the swipe with the wired tag.

(9) Frisk bag containing the swipe to see if there is any apparent contamination. If there is contamination present, take several swipes of the surrounding area to make sure the contamination is still confined to the exposure device. Frisk hands and body to make sure no contamination has inadvertently gotten on you. Call an IRSO or have

someone else call him if he isn't already present. If contamination is found to have spreaded to other areas, isolate the affected area, inform other personnel and wait for the IRSO to arrive. The IRSO shall call RadCon if their help is needed.

(10) Having frisked the bag containing the swipe and having found no apparent contamination, place yellow plastic bag containing swipe into larger yellow plastic bag and have swipe counted by RadCon, section 5.e.

5.e. SHIPMENT OF RADIOACTIVE SOURCES FROM NNS

(1) Radioactive sources, excluding those used in the Model 616 exposure device, shall be placed in appropriate shipping containers (source changers) by personnel designated by the NDT Manager and approved by the Chief IRSO. (See Reference (f) for further details.) The designee shall secure the sources in place by lacing lead seal wire to the source changer car plugs, making sure to attach the proper identification plates to the sources. He shall make sure a current leak test certificate is put in the container. He shall then label the containers with the proper Radioactive II or III label, stating the number of curies and transport index. The outside of the container shall then be secured by means of a lead seal.

(2) When shipping the Model 616 exposure device, the following steps must be done:

(a) Survey the exposure device to ensure radiation levels do not exceed 50 milliroentgens per hour at a distance of 6 inches from the surface. Check that the exposure device is locked; the lock must be in the depressed position with the key removed.

(b) Place the exposure device in the Model 715 shipping container. Place the top section of the molded filler over the exposure device. Place the top section of insulation in the container and cover the container top with the lid.

(c) Place the clamp ring in place and tighten the bolt. Attach a tamper-proof security seal.

(d) Label the containers with the proper Radioactive II or III label, stating the number of curies and transport index.

(3) For all shipments, an IRSO or his designee will then inspect and survey the shipping containers to make sure the containers are properly labeled and sealed. He shall also perform radiation and swipe surveys (Reference (e)) of the container. He will then fill out he applicable shipping instructions on NN Form 298 (Figure 1) with the following information:

(a) Date

(b) Purchase Order Number

(c) Material Location

(d) Name and Address of Consignee

(e) Special Marking and Handling Instructions

(f) Transportation Selection

(g) Charge Number

(h) Changer Number

(j) Source Number

(k) Curie Content

(m) Package Label (Radioactive Yellow II or III label)

(n) Transport Index

(p) Radiation Level at Contact

(q) Radionuclide

(r) Shipping Name of Radioactive Material

(s) Weight of Shipping Container

(t) Specification Container used or USA Certificate of Compliance Number

(u) Statement attesting to the fact: Less than 0.001 microcuries per 100 square centimeters radioactive contamination on shipping container.

(4) Once the shipping instructions are complete, an IRSO or his designee and a NDT representative will transport the shipping containers via truck to Warehouse #4 for shipment.

(5) Upon arrival at Warehouse #4, an IRSO or his designee will give the MS Clerk the original copy of the shipping instructions for the containers and the MS Clerk will sign a "copy" of the shipping instructions, verifying receipt and storage.

(6) The MS Clerk will concur with an IRSO or his designee that the radioactive material that is stored in the Radioactive Material Cage (Warehouse #4) is within permissible radiation levels for that confine.

(7) After surveys are completed, the MS Department will prepare a shipping notice, incorporating any corrections necessary and send a copy to an IRSO.

(8) The MS Department will stamp the lead seal on the outside of the shipping container with the NNS serialized lead seal.

(9) The shipping container will be prepared for shipment by the MS Department in accordance with Reference (c).

(10) Shipping papers, routings, and bill of lading will be prepared in accordance with applicable Federal Regulations.

Note: Signature service is required on all shipments.

(11) The carrier will be required to sing the Bill of Lading showing proof of receipt of the radioactive material from the MS Shipping Section.

(12) The Traffic Analyst assigned to the Central Traffic Office will be responsible for maintaining a current itinerary of the shipment from the time shipping releases it to the carrier until it arrives at its destination. The itinerary will be maintained on a NN Form 71-5, Telephone Memo (Figure 2). The Traffic Analyst will contact the local Terminal Tracing Clerk; if the Tracing Clerk is not available, he shall request to speak to the Dispatcher; if unable to contact either the Tracing Clerk or Dispatcher, he shall request the necessary information listed below from the Terminal Manager:

(a) Waybill Number of Pro Number assigned to shipment

(b) Trailer Number

(c) Time shipment arrived at local terminal and expected time of departure

(d) Designated terminal stop after departure from local terminal and estimated time of arrival to that point.

(13) Upon proof of receipt by the consignee, the Traffic Analyst will annotate the NN Form 71-5 with time, data and name of company's representative who verified receipt of material. He shall then send a copy of the NN Form 71-5 showing receipt to the MS Shipping Supervisor and an IRSO.

(14) The consignee of radioactive material for disposal should send written verification (Disposal Records) of received material within 30 days after receipt to an IRSO.

MODEL 616

INSTRUCTION MANUAL

Draft: 26 February 1981

NOTICE

This gamma radiography system is used as a radiographic exposure device for Tech/Ops, Inc. sources. The user should become thoroughly familiar with the instruction manual before attempting operation of the equipment.

In order to use this equipment or perform source changes, the user must be specifically licensed to do so. Applications for a license should be filed on Form NRC-313R with the Materials Licensing Branch, Division of Fuel Cycle Material Safety, Officer of Nuclear Safety and Safeguards, U. S. Nuclear Regulatory Commission, Washington, DC 20555, or with the appropriate Agreement State Office.

Prior to the initial shipping of the exposure device, the user should register with the Transportation Certification Branch, Office of Nuclear Safety and Security, U. S. Nuclear Regulatory Commission. The user should have in his possession a copy of Certificate of Compliance No. 9039 issued for the shipping container, which may be obtained from Tech/Ops upon request. This paragraph also applies to users from agreement states.

SECTION I

GENERAL INFORMATION

A. General

The Model 616 portable gamma radiographic system, shown in Figure 1.1, is used primarily for industrial radiography. It is suitable for the radiography of steel, brass and copper in the thickness range 0.50 to 3.5 inches (13 to 89mm) and lighter alloys over 2.5 inches (63mm).

The mobility feature of the system provides maximum operator protection, and operating flexibility. In use, the system produces a beam of radiation 30° x 60°. The system may be used with iridium^{192} sources up to a maximum of 200 curies.

Control of the device is accomplished by using a Model 694 vacuum control unit, a simple, sturdy, manually operated control.

B. System Safety

The system is designed to provide maximum operator safety. To prevent accidental exposure, a key operated lock is provided on the source actuator assembly. The lock will only operate when the source is in the stored position, eliminating the possibility of locking the source in the exposing position.

The Model 616 is a directional beam device, and source travel is limited to within the exposure device. The source never leaves the exposure device even while making an exposure, thereby eliminating the possibility of a detached source.

Operator safety is further optimized by the fail safe principal of this device. The source is spring loaded to the stored position, therefore, any failure of the vacuum hose (i.e., disconnection or severance) would result in the source automatically returning to the stored position.

C. System Components

All components of the gamma radiography system are identified in Figure 1.1.

1. Gamma Ray Exposure Device Model 616

The gamma ray exposure device is shown in Figure 1.2. The exposure device serves as the storage container and, when packaged inside the Model 715 shipping container, serves as the transport device for the radioactive source assembly. The exposure device consists of a steel shell sealed against tampering or the entrance of dirt, and contains approximately 29 pounds (13.2kg) of "depleted uranium" shielding material cast in one piece. The shield is rigidly supported within the housing. When the source is properly stored in the exposure device, the shielding properties of the depleted uranium reduce radiation intensities in the vicinity of the exposure device to levels well below regulatory limits. The source tube inside the shield contains the source and provides a pathway through which the source can be moved from the stored position to the beam aperture, or port.

Motion of the source is accomplished by a source rod of shielding material and a vacuum actuator. The actuator is spring loaded to the stored position so that a failure of the vacuum immediately returns the source to the stored position.

A lock prevents the exposure of the source by unauthorized personnel. The unit can only be locked in the stored position. The exposure device contains a fixed carrying handle and has a tapped hole for an additional handle. Two lugs are also provided for quick positive attachment to a pipe saddle or floor stand.

The total weight of the Model 616 is 45 pounds (20.4kg). It measures 11.7 inches (292mm) high and is 6.3 inches (160mm) in diameter.

2. Model 694 Control Unit

The Model 694 Vacuum Control Unit, included in the system, is contained in a metal chest with a lid latch and carrying handle. A compartment is provided for storage of the 25ft. vacuum control hose. The controls in the unit consist of a manual pumping handle, a vacuum gauge, and a vacuum control valve which exposes and stores the source. To operate the unit the radiographer manually pumps the vacuum and switches the valve to EXPOSE. After the exposure is complete, the radiographer switches the valve to OFF and the source retracts into the shield. The Model 694 weighs 18 pounds (8.2kg) and is 10.5 inches (267mm) high by 10.5 inches (267mm) long by 7.5 inches (191mm) wide.

3. Pipe Saddle

A pipe saddle mount is provided as a part of the standard equipment in the system. It has a chain for clamping the exposure device onto the piece to be radiographed, and a quick release fastener to expidite the attachment of the mount to the object. There are two prongs on the mount that fit into holes drilled in the flanges of the exposure device, a set screw secures the exposure device onto the mount. The pipe saddle weighs 8 pounds (3.6kg).

D. Radioactive Source Assembly (Model B60006)

The radioactive iridium^{192} source must be ordered separately from other system components. The system can operate with various activity sources up to a maximum of 200 curies (+20%) of iridium^{192}. The radioactive material is sealed in a stainless steel capsule which is secured to the source rod by an integral, positive connector.

NOTE: Sources for the Model 616 must be changed at the Tech/Ops, Inc. laboratory in Burlington, Massachusetts, U. S. A.

When returned for source replacement, the exposure device is thoroughly inspected and cleaned. Any necessary replacements, repairs or adjustments are also made to assure trouble-free operation when the exposure device is returned to the user.

E. System Optional Accessories

Model No.	Description
D58104-15	Mounting stand with four 36 inch detachable legs
534	Slide-rule type exposure calculator with leather case
492D	GAMMALARM radiation monitor
492E	GAMMAFLASHER used with 493D GAMMALARM

F. Specifications

1. Source Data

Isotope: iridium^{192} (Model 58101-8)

Maximum Activity: 200 Curies

Shielding: 29 pounds (13.2kg) depleted uranium

2. Dimensions

	Metric Equivalent
Exposure Device	
Diameter: 6.25"	16cm
Length: 11.5"	29cm
Weight: 45 Pounds	20.4kg

694 Control Unit

Length: 10.5"	267mm
Height: 10.5"	267mm
Width: 7.5:	191mm
Length (Vacuum Control Tube): 25 Feet	7.6m
Pipe Saddle	
Weight: 8 pounds	3.6kg
Length (Chain): 96"	2.5m
Mounting Stand (Optional)	
Height: 36"	914mm
Weight: 18 Pounds	8.2kg

SECTION II

PERSONNEL MONITORING

Pursuant to NRC and state regulations, all personnel who enter a restricted area or are present during radiographic operations are required to wear a direct reading pocket dosimeter with a range of zero to at least 200 milliroentgens and either a film badge or thermoluminescent dosimeter (TLD). The pocket dosimeter must be recharged at the beginning of each shift. The operator should frequently check the pocket dosimeter reading throughout the shift. Records of the initial and final readings of the pocket dosimeter must be kept for inspection by the NRC until it authorizes their disposal.

In the event that a person's pocket dosimeter is found to be off scale, that person must stop all work with radiation immediately. His film badge (or TLD) must be sent in immediately for processing, and he must not reenter a restricted area until it has been determined that he received less than the maximum allowed occupational exposure as defined in 10CFR Part 20.101.

Radiography personnel should also have a calibrated survey meter capable of measuring from 2mR/hr to at least 1000mR/hr to determine radiation levels when performing radiographic operations.

SECTION III

ACCESS TO RESTRICTED AREAS

Since this gamma radiographic system can emit high levels of radiation when being operated, it is necessary to identify boundaries around the site where the radiography is being done. If a permanent radiographic installation is being used, it must have appropriate personnel access control devices as defined in 10CFR20.203. Otherwise, certain areas must be set off as follows:

Access to the restricted area must be controlled. A restricted area is defined in 10CFR20.105 as the area where the radiation exposure level exceeds two milliroentgens in any one hour, or 100 milliroentgens in seven consecutive days or 500 milliroentgens in one year. The restricted area should also be posted with signs reading "Caution (or Danger) - Radiation Area." Signs reading "Caution (or Danger) - High Radiation Area" should be posted around the perimeter where radiation exposure levels can exceed 100 milliroentgens in any one hour. A physical survey with a survey meter should be performed while the source is at its exposing position to confirm the radiation exposure rate at the perimeter of the Restricted Area. In order to minimize radiation exposure to the surveying personnel, a survey is <u>not</u> required and <u>should not</u> be done to confirm the High Radiation Area Boundary.

The radiographer or radiographer's assistant must guard against unauthorized entrance into these areas at all times. No personnel should be allowed into the restricted area without a direct reading pocket dosimeter and either film badge or TLD.

SECTION IV

TRANSPORTATION

A. Receiving Radioactive Material

The consignee of a package of radioactive material must make arrangements to receive the package when it is delivered. If the package is to be picked up at the carrier's terminal, it must be done expeditiously upon notification of its arrival.

The Model 616 exposure device is shipped in a Model 715 Type B shipping drum, and the control unit and accessories are shipped in a crate. Inspect the crate for signs of external damage. If damage is evident, the carrier's agent should be present while unpacking. Survey the shipping drum with a survey meter as soon as possible, preferably at the time of pickup and no more than three hours later if it was received after nomal working hours. Radiation levels should not exceed 200 milliroentgens per hour at the surface of the exposure device nor 10 milliroentgens per hour at a distance of three feet from the surface. Actual radiation levels should be recorded on the receiving report. If the radiation levels exceed these limits, the container should be secured in a Restricted Area, and the appropriate personnel notified.

Open the crates and remove the remaining system components. They are:

a) Model 694 Vacuum control unit with 25 feet of control hose

b) Pipe saddle mount with chain

c) (Optional) mounting stand, with four 36 inch long detachable legs

These parts should be inspected for physical damage.

B. Shipping Radioactive Material

The Model 616 gamma ray exposure device packed in the Model 715 shipping container meets the requirements for a Type B shipping container under the regulations of the U.S. Nuclear Regulatory Commission, the U.S. Department of Transportation, and the International Atomic Energy Agency. The container has been assigned USNRC Certificate of Compliance No. 9039 for domestic shipment and IAEA Certificate No. USA/9039/B(U)T for international shipments.

When shipping the exposure device, the following steps must be done. These comply with NRC Regulations 10CFR Part 71 and DOT Regulations 49CFR Parts 171-179.

1) Survey the exposure device to ensure that radiation levels do not exceed 50 milliroentgens per hour at a distance of 6 inches from the surface. Check that the exposure device is locked; the lock must be in the depressed position with the key removed.
2) Place the exposure device in the Model 715 shipping container. Place the top section of the molded filler over the exposure device. Place the top section of insulation in the container and cover the container top with the lid.
3) Place the clamp ring in place and tighten the bolt. Attach a tamperproof security seal with an identification mark to the unit and bolt.
4) Perform a radioactive contamination wipe test of the shipping package. This consists of rubbing filter paper, a cotton swab or other absorbent material, using heavy finger pressure, over an

area of 100cm ($16in^2$) of the package surface. The activity of the material should not exceed 0.001μCi of removable contamination.

5) Survey the package with a survey meter at the surface and at a distance of three feet from the surface to determine the proper radioactive shipping labels to be applied to the package as required by 49CFR Part 172.403. The radiation exposure limits for each shipping label are given in Figure 4.1. If radiation levels above 200mR/hr at the surface or 10mR/hr at three feet from the surface are measured, the container should not be shipped.

6) Properly complete two shipping labels indicating the radioactive isotope, activity and the Transport Index. The Transport Index is used only on Yellow II and Yellow III labels and is defined as the maximum radiation level in milliroentgens per hour measured at a distance of three feet from the surface of the package. Put these two labels on opposite sides of the container after making sure any previous labels has been removed. The package should be marked with the proper shipping name (Radioactive Material, Special Form, n.o.s.). Mark the shipping container "INSIDE PACKAGE COMPLIES WITH PRESCRIBED SPECIFICATIONS TYPE B USA/9039/B(U)".

7) Complet the appropriate shipping papers - Examples are shown in Figures 4.2 and 4.3.

C. Carrying Radioactive Material

Any vehicle that is to be used in transporting radioactive material should be in good operating condition and carry the normal complement of safety equipment such as "Radiation Area" signs, rope, a spare tire, a fire extinguisher,

set of vehicle tools, and a set of flares. The glove compartment should have the vehicle's registration certificate and a working flashlight. Additionally, the driver must have a calibrated survey meter and be wearing a dosimeter and a film badge or TLD.

Before placing the container in the vehicle and securing it against movement, the operator should ensure that the container is properly packaged, marked, and labeled, and proper shipping papers are completed according to Part IV.B. The operator should survey the driver's compartment to ensure that radiation levels are below two milliroentgens per hour. In the event that the vehicle is used for storage, a survey must be conducted to ensure radiation levels are less than two milliroentgens per hour at a distance of 18 inches from the surface of the vehicle. Also, if the vehicle is used for storage, it should be posted with "Caution - Radioactive Material" signs.

If the vehicle is transporting a package bearing a "Radioactive Yellow III" label, 49CFR Part 172.504 requires that the vehicle be posted on all four aides with a "RADIOACTIVE" placard. It should be noted that operation of a vehicle which is required to be placarded must comply with the Federal Motor Carrier Safety Regulations, 49CFR 390-397.

D. Hand Carrying

In order to minimize radiation exposure, it is recommended that care be taken when hand carrying the unit. Dosimeter and film badge should be worn on the side of the body closest to the exposure device. If more than one person is present, it is good practice to alternate the hand carrying between them to minimize radiation doses to any one individual. Likewise, no person should be permitted to sit on or lounge against the exposure device.

E. Storage

When storing the system, the exposure device must be kept physically secured to prevent tampering or removel by unauthorized personnel. The storage area must be secured such that no unauthorized personnel are allowed entrance where radiation exposure levels exceed 2mR in any one hour. When storing the system between uses, 10CFR Part 34.22 requires that the exposure device be kept locked, and the storage plug be inserted.

SECTION V

OPERATION

A. Principles of Operation

The source is connected via the source rod to the piston in the source actuator housing. The piston is spring loaded to the OFF (shield) position. (See Figure 5.1 (a)). To perform a source exposure, the hand pump on the control unit is pumped and the control valve is set to EXPOSE. This creates a partial vacuum in the actuator housing. The net pressure difference on the piston forces it towards the opening in the actuator housing, which moves to the source to the EXPOSE position. (See Figure 5.1 (b)).

To terminate the exposure, the control valve is pressed to the OFF position, which exposes both sides of the piston to atmospheric pressure. The force of the compression spring inside the actuator housing moves the piston back to its storage position, and shields the source, as in Figure 5.1 (c).

Note that if the vacuum control hose ever becomes severed or disconnected during an exposure, the effect would be the same as pressing the control valve to the OFF position, and the source would become shielded.

B. Safety Precautions

This system may be operated only by a qualified radiographer and/or his assistant. The radiographer must be physically present and in direct surveillance at all times when the exposure device is being used.

Since the source emits high levels of radiation, it is good practice to operate the system from as great a distance as possible and, if possible, from behind a radiation shield. Typical shields are made of concrete, steel and lead.

Some possibilities would be steel structures or the corner of a building. The radiography must be done in a Restricted Area which is marked with the appropriate radiation signs and secured against unauthorized entrance. While assembling the system, it is important to keep the exposure device locked. It should be kept locked at all times except when operating, The radiographer and radiographer's assistant should at all times have a pocket dosimeter, either a film badge or TLD, and a survey meter capable of measuring from 2mR/hr to at least 1000mR/hr.

C. Daily Inspection

Daily inspection of the system is required to ensure that the equipment is in proper operating condition. The inspection should be performed prior to the start of each shift.

1. Exposure Device Inspection

   1) Perform a radiation survey of the exposure device. The radiation levels 6 inches from the surface should not exceed 50mR/hr (for a 200 curie ^{192}iridium source).

   2) Visually inspect the exposure device for signs of damage. Check for the presence and legibility of the nameplate.

   3) Make an operational check of the exposure device lock in a properly secured Restricted Area. A survey meter should be used to ensure that the source is not accidentally exposed when doing this.

2. Control Unit Inspection

   1) Visually inspect the control unit for signs of damage.

2) Test for vacuum leaks by turning the vacuum control valve to OFF and pumping a vacuum of 20 to 25 inches. The vacuum gauge should remain steady. A falling gauge indicates a leak in the control unit and must be repaired.

3. System Check

1) The system check must be done in a properly secured Restricted Area. All personnel must have the proper montitoring equipment.

2) Position the exposure device so that the beam is directed away from all personnel. Put a survey meter in front of the beam port.

3) Assemble the system and keep the exposure device locked.

4) Pump the hand pump until the vacuum gauge indicates a pressure of 20-25 inches. Then turn the vacuum control valve to EXPOSE.

5) Observe the survey meter. It should indicate no increase in the radiation level. If the radiation level increases, the lock is defective and must be replaced.

6) Observe the vacuum gauge. It should remain steady. A falling gauge indicates a leak in the control hose or source actuator and must be repaired.

7) Press the vacuum control valve to OFF and disconnect the control hose.

8) Unlock the exposure device, making sure the control hose has been disconnected from the source actuator and the control valve is in the OFF position.

9) Reconnect the hose to the source actuator.

10) Pump the hand pump until the vacuum gauge indicates 20-25 inches, and turn the vacuum control valve to the EXPOSE position. The radiation level should increase.

11) Press the vacuum control valve to the OFF position until the vacuum gauge reads zero inches. The radiation level should decrease to the previous background level.

12) Steps 8-11 may be incorporated in the first radiation exposure of the day. If the system fails to function properly, it must be serviced before further use.

D. Assembly

1. Survey the exposure device on all sides to ensure that the source is in the properly stored position, and to check the survey meter for calibration. The radiation levels should not exceed 50mR/hr at a distance of 6 inches from the surface of the exposure device.

2. Position the exposure device with the beam port facing the object to be radiographed. Ensure that the exposure device is positioned securely to prevent movement. When measuring the proper focal distance from the source to the film, note that the source is 3-1/8 inches (8cm) from the surface of the beam port. Figure 5.2 illustrates typical methods for positioning the exposure device.

3. Determine where the control unit will be operated from. It should be as far away as possible and out of the way of the radiation beam. It is good practice to have the control unit behind a radiation shield if possible.

4. Ensure that the vacuum control valve is in the OFF position, then lay the vacuum control hose from the control unit to the exposure device making sure there are no bends that would disturb the air flow through the hose.

5. Remove the protective plug from the source actuator and wipe away any foreign matter. Insert the vacuum fitting into the source actuator housing.

6. Unlock the exposure device while observing the survey meter to ensure the source does not become accidently exposed. The survey meter should not indicate any increase in the radiation level. The source is now free to move.

E. Operation

1. Return to the control unit. With the vacuum control valve in the OFF position, pump the handle until the vacuum gauge indicates a vacuum of 20-25 inches.

2. Initiate the exposure by putting the vacuum control valve in the EXPOSE position. As this is done, the vacuum gauge will indicate an initial drop of about 8 inches, then hold steady. If the gauge continues to fall, there is a vacuum leak in the system.

3. Observe the survey meter as the source is exposed. It will rise from background level to a higher level, which depends on distance from the source, shielding, positioning of the beam and source activity. The radiation level should hold constant throughout the exposure.

4. Figure the specimen exposure time from the time the vacuum control valve is set to EXPOSE.

5. During the exposure, as little time as possible should be spent in the Restricted Area in order to minimize personnel exposure.

6. At the end of the exposure time, press the vacuum control valve to the OFF position and hold it down until the vacuum gauge indicates zero net pressure. As this is being done, the survey meter should drop from the level indicated during exposure to the initial background level.

7. Survey the exposure device to ensure that the source is shielded. The surface radiation levels should be the same as observed in step 1 of assembly. If the radiation levels are significantly higher, it is possible that the source is still exposed. In that case, return to the control unit, then expose and retract the source.

8. If the source cannot be properly retracted, do not try to retrieve the source. Treat the situation as an emergency, and notify Technical Operations, Inc. for help if necessary.

9. If the source has properly returned, lock the source in place by depressing the lock cylinder. Remove the vacuum hose and insert the protective stopper into the actuator housing.

F. Disassembly

1. Check that the exposure device lock is in the "DOWN" position and radiation levels are normal.

2. Disconnect the vacuum hose from the exposure device and install the rubber protective stopper in the source actuator housing.

3. Coil the vacuum hose and store it in the control box.

4. Remove the exposure device and the pipe saddle from the subject that was radiographed.

5. Store the system in the appropriate storage area, as outlined in Part IV, operation.

SECTION VI

MAINTENANCE

A. Model 616 Gamma Ray Exposure Device - Source Replacement

The Model 616 exposure device is a sealed unit. Therefore, disassembly and repairs can be done by Tech/Ops only. Never remove the source actuator cover, as this will expose the source. The exposure device must be returned to Tech/Ops for source replacement. When this is done, the exposure device is fully disassembled, cleaned and inspected, and any worn parts are replaced.

B. Model 694 Control Unit

The control unit should be disassembled only to replace a defective part. To disassemble, refer to Figure 6.1. The parts are numbered for order of removal and for component identification when ordering new parts.

To inspect the check valves (16) remove them and force air through them at 25psi maximum. Air should flow through them in one direction, but not the other. Reinstall such that air will not flow towards the vacuum gauge.

To check the hand pump, block off both openings in the barb fitting (23) and pull up on the pump. There should be strong resistance. If not, the pump must be replaced.

To replace the vacuum control valve, follow these steps:

1. Remove the tygon tubing from the hose fittings (22) and remove the street elbows (25) and filter (17) from the valve (5).
2. Unscrew the set nuts on the control valve, and remove the valve.

3. Position the new valve, and secure the set nuts.

4. Put permatex on the threads of the street elbows (25) and secure them to the valve.

5. Attach the tygon tubing to the proper hose fittings.

6. Check the unit for proper operation, then seal the control valve with epoxy to prevent rotation by filling the area inside the set nuts.

7. Refer to Figure 6.1 for reassembly. After servicing the control unit, check for leaks by pumping the hand pump until the vacuum gauge indictes a pressure of 20-25 inches and leaving the vacuum control valve in the OFF position. The vacuum gauge should not drop more than one inch per hour.

C. Final Inspection

1. Check the control unit for proper reassembly. Check all connections and fittings for tightness.

2. Survey the exposure device on all sides to ensure that radiation levels do not exceed 50mR/hr at a distance of six inches from the surface.

3. Check the exposure device for proper labels.

D. Leak Testing

The source assembly must be leak tested at intervals not to exceed six months. This can be done using a Tech/Ops Model 518 leak test kit. The test must be performed in a properly secured Restricted Area with the appropriate monitoring equipment.

1. Moisten the wipe test swab with EDTA solution.
2. Wipe the outside of the exhaust filter (located just above the lock plunger) with the wipe test swab.
3. Place the wipe test swab in the plastic envelope.
4. Set the survey meter on its most sensitive range and place the meter in an area with low background radiation. Move the wipe test swab towards the meter, and observe the radiation level indication.
5. If the radiation level increases less than 0.2mR/hr above background, place the plastic envelope into the mailing box and mail to Tech/Ops, Inc. Be sure to complete and return the identification sheet.
6. If the meter indicates a higher radiation level, do not mail the wipe test patch and do not use the exposure device. Contact Tech/Ops for further instructions.

e. Pipe Saddle

Refer to Figure 6.2 for component identification of the pipe saddle.

List of Figures

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Section 5.c.(8) USE OF THE MODEL 616 EXPOSURE DEVICE

(a) Survey the exposure device on all sides to ensure that the source in the properly stored position; and check both the 0-5 mr/hr and the 0-50 mr/hr scales for the AN/PDR-27R meter.

(b) Position the exposure device with the beam port facing the object to be radiographed. Ensure that the exposure device is positioned securely to prevent movement.

(c) Determine where the control unit will be operated from. It should be as far as possible and out of the way of the radiation beam, behind a radiation shield if possible.

(d) Ensure that the vacuum control valve is in the OFF position, then lay the vacuum control hose from the control unit to the exposure device making sure there are no bends that would disturb the air flow through the hose.

(e) Remove the protection plug from the source actuator and wipe away any foreign matter. Insert the vacuum fitting into the source actuator housing.

(f) Unlock the exposure device while observing the survey meter to ensure the source does not become accidently exposed. The survey meter should not indicate any increase in the radiation field. The source is now free to move.

(g) Return to the control unit. With the vacuum control valve in the OFF position, pump the handle until the vacuum gauge indicates a vacuum of 20-25 inches.

(h) Initiate the exposure by putting the vacuum control valve in the EXPOSE position. As this is done, the vacuum gauge will indicate an initial drop of about 8 inches, then hold steady. If the gauge continues to fall, there is a vacuum leak in the system.

(j) Observe the survey meter as the source is exposed. It will rise from background level to a higher level, which depends on distance from the source, shielding, positioning of the beam and source activity. The radiation level should hold constant throughout the exposure.

(k) At the end of the exposure, press the vacuum control valve to the OFF position and hold it down until the vacuum gauge indicates zero net pressure. As this is being done, the survey meter should drop from the level indicated during exposure to the initial background level.

(m) Survey the exposure device to ensure that the source is shielded. (Check both the 0-5 and 0-50 mr/hr scales of the AN/PDR-27R survey meter.) The surface radiation levels should be the same as observed, in step 1 of assembly. If the radiation levels are significantly higher, it is possible that the source is still exposed. In that case, return to the control unit, then expose and retract the source.

(n) If the source cannot be properly retracted, contact the radiographic shift supervisor immediately and treat the condition as a hung-out source.

(p) If the source has properly returned, lock the source in place by depressing the lock cylinder. Remove the vacuum hose and insert the protective stopper into the actuator housing.

(q) Check to see that the exposure device lock is in the "DOWN" position and radiation levels are normal.

(r) Disconnect the vacuum hose from the exposure device and install the rubber protective stopper in the source actuator housing.

(s) Coil the vacuum hose and store it in the control box.

(t) Remove the exposure device and the pipe saddle from the subject that was radiographed.

(u) Store the system in the appropriate storage area.