ENCL (1)

DEPARTMENT OF THE NAVY
COMMANDING OFFICER
USS SIERRA (AD-18)
FPO MIAMI 34084

SIERRAINST 4033.1B
60:jlc
14 August 1980

USS SIERRA (AD18) INSTRUCTION 4033.1B

Subj: Quality Assurance Measures in the Packing and Shipment of Radiographic Sources; procedures for

Ref: (a) United States Nuclear Regulatory Commission Rules and Regulations, Title 10-Energy, part 10, Standards for Protection Against Radiation
(b) United States Nuclear Regulatory Commission Rules and Regulations, Title 10-Energy, part 71, Packaging of Radioactive Material for Transport and Transportation of Radioactive Material under Certain Conditions
(c) Department of Transportation (DOT) Hazardous Materials Regulations Title 49, CFR Parts 100-199
(d) COMNAVSURFLANTINST 9090.1, Commander Naval Surface Force, U. S. Atlantic Fleet, Quality Assurance Manual
(e) SIERRAINST 5100.8E, Operating and Emergency Procedures for GAMMA Radiography

Encl: (1) Checklist for packaging and shipment of Radiographic Sources

1. Purpose. To promulgate guidance for assuring proper packaging and shipment of radiographic sources from USS SIERRA and to ensure compliance with requirements set forth in references (a) through (e).

2. Cancellation. USS SIERRA Instructions 4855.1A and 4033.1A are hereby cancelled and superceded.

3. Organization.

a. The final responsibility for the Quality Assurance (QA) Program for part 71 requirements rests with USS SIERRA. Design and fabrication shall not be constructed under this QA program. The QA program is implemented using the following organization:

Commanding Officer

Executive Officer

Repair Officer

Radiographic Safety Officer

Senior Radiographer (Assistant Radiographic Safety Officer)

Radiographer

4. Discussion.

a. All shipments or transfers of radioactive materials over public areas, including shipments made with private or government vehicles, must comply with appropriate Federal, State and local transportation requirements. This instruction is provided to ensure SIERRA complies with references (a) through (e) with regards to shipment of radiographic sources.

b. Radiographic Isotopes are capable of inflicting serious bodily harm if used improperly or without regard for safety.

c. Organizational responsibilities for these Quality Assurance functions and audit guidance are set forth in references (d) and (e) and supplemented by reference (a).

5. Responsibility. The Senior Radiographer is responsible for completion of enclosure (1) and for direct supervision of the preparation of all shipments of radioactive isotopes from USS SIERRA. The Radiographic Safety Officer will be responsible through the chain of command for ensuring that the Commission Regulations, the provisions in NRC license and these instructions are complied with, and shall witness compliance during preparations of the shipment and completion of enclosure (1). The Repair Officer, in his capacity as local Government Inspector, shall conduct audits at least semi-annually to ensure compliance.

6. Action. The Senior Radiographer shall maintain completed copies of enclosure (1) with certificates of compliance and supporting documentation in an auditable fashion. The Radiographic Safety Officer will ensure that all radiographic personnel are provided with a copy of this instruction and its enclosure, and that all radiographic personnel comply with them.

S. S. KINGSLEY

Distribution:
List I
R-6 Division Officer

CHECKLIST FOR PACKAGING AND SHIPMENT OF RADIOGRAPHIC SOURCES

SIERRAINST 4033.1B
60:jlc

1. Discription of shipment:

NOTE: All "Part" reference is IAW DOT REG. Title 49 CFR

a. Shipping Name, Part 172.101 _____

b. Shipping Class, Part 172.101 _____

c. Transport Group, Part 172.101 _____

d. Type Quality, Part 173.390 _____

e. Special/Normal Material, Part 173.389 (1) _____

f. Total Curies _____

g. Radioactive Nuclide, Part 173.389 _____

Completed: _____
Senior Radiographer

2. Radioactive sealed source will be transferred from the exposure device to the shipping container IAW enclosure (2) of reference (e).

Completed: _____
Senior Radiographer

3. Compare unit with certificates of compliance and supporting documentation to insure correct package is being utilized.

Completed: _____
Senior Radiographer

4. Verify that the organization to which material is being shipped is authorized to receive radioactive material.

Completed: _____
Senior Radiographer

5. Place material for transportation in package in accordance with procedures set forth in reference (c)

Completed: _____
Senior Radiographer

6. Take and record radiation levels at a distance of three feet and on contact with package.

Three Feet _____MR/HR
Contact _____MR/HR

Completed: _____
Senior Radiographer

7. Prepare requisition and invoice/shipping document (DD-1149).

a. Fill out parts 1, 2, 3, 4, 5, 6, 8 and 10 as with a normal shipment.

b. Parts (a) through (k) will consist of the following statements in sequence:

(1) Shipping name.

(2) Shipping class.

(3) Total quantity of material in curies as appropriate.

(4) Type of packing.

(5) Name of radionuclide.

(6) Discription of physical and chemical form and serial number, if applicable.

(7) Transport index.

(8) Category of label applied.

(9) The statement "PACKAGE REQUIRES RADIOLOGICAL CONTROLS FOR UNPACKING. RETURN RECEIPT REQUIRED."

(10) The statement "This is to certify that the above named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to applicable regulations of the Department of Transportation."

(11) A statement of receipt.

Completed:_____
Senior Radiographer

8. If a commercial shipper receives custody of material pierside, insure that receipt block of DD-1149 is signed and shipper's NRC license number is recorded on DD-1149 and this enclosure.

NRC License Number - _____

Completed:_____
Senior Radiographer

9. After shipment is turned over to Navy Supply for future receipt by an authorized organization, enter shipment on tickler sheet in front of action pending file held by Senior Radiographer. Send copy of shipping

papers together with letter to receiving organization to inform them of shipment.

Serial and Date of letter - _____

Completed: _____
Senior Radiographer

10. Assemble all documents produced during the completion of the enclosure and file in action pending file of Senior Radiographer.

Completed: _____
Senior Radiographer

Witnessed and Reviewed:

_____
Radiographic Safety Officer

11. Upon receipt of conformation of receipt of shipment by licensed addressee, remove pending documents and file in completed source shipment file, along with this completed enclosure.

Shipment Completed:

_____
Senior Radiographer

CHANGE 1 ENTERED

DEPARTMENT OF THE NAVY
COMMANDING OFFICER
USS SIERRA (AD-18)
FPO MIAMI 34084

SIERRAINST 5100.8E
60:jlc
14 August 1980

ENCL (2)

USS SIERRA (AD-18) INSTRUCTION 5100.8E

From: Commanding Officer, USS SIERRA (AD-18)

Subj: GAMMA Radiography, Operating and Emergency procedures for

Ref: (a) Title 10, Code of Federal Regulations
(b) SIERRAINST 4033.1B, Quality Assurance Measures in the Packing and Shipment of Radiographic Sources; procedures for

Encl: (1) Definition of Terms
(2) Procedures for the use of Personnel Monitoring Instruments
(3) Limits of Personnel Exposure and Reporting Procedures for Overexposure
(4) Radiation Surveys, Posting, Security and Radiation Survey Instruments
(5) Operating Instructions for source change using the Automation Industries Source Changer, Model 500-SU and Automation Industries Iriditron Model 520
(6) Receipt of Radioactive Sealed Sources
(7) Emergency Procedures
(8) Inspection and Maintenance Procedures
(9) Transportation of Radiographic Sources and Exposure Devices
(10) Operating Procedures for Field Exposure
(11) Radiographic Records
(12) Training Requirements
(13) Leak Test Procedure
(14) Radiography Program Audit

1. Purpose. To promulgate instructions for the control of radioactive isotopes used for radiography and the radiation protection procedures required for these sources.

2. Cancellation. SIERRAINST 5100.8D

3. Discussion.

a. The procedures set forth herein are designed to control the use of radioactive sealed sources used for gamma radiography and stowed onboard USS SIERRA (AD-18). These instructions are based on the Nuclear Regulatory Commission's (hereafter called the NRC) requirements, and are on file with the NRC and must be adhered to without exception. Where questions arise concerning these regulations or any questions pertaining to radiation safety, clarification will be obtained from or by the Radiation Safety Officer. Any change made to enclosure (1) through (14) will be routed via the Chain of Command to the NRC for approval.

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b. The posting and control for all exposure and source changes will be conducted under the guidlines for a Temporary Radiation Area, and Storage as contained in reference (a) Part 20.203 and Part 20.207.

4. Responsibility.

a. The Repair Officer is responsible for the radioactive sealed sources onboard. He will be assisted by the Quality Assurance Officer and the Radiation Safety Officer.

b. The Medical Officer is responsible for the Medical support and for the Administration of Radiation dose control and record keeping as specified in enclosures (2) and (3).

c. The Quality Assurance Officer is responsible to the Repair Officer for all non-destructive testing and is assigned to Quality Assurance Division (hereafter called QA Division).

d. The Radiation Safety Officer is responsible for ensuring that the NRC regulations, license provisions, and operating and emergency procedures are complied with by the Radiographers and will ensure that only qualified personnel operate and handle radiographic sources. Specifically he will:

(1) Develop, promulgate, conduct and/or monitor training of radiographic personnel to ensure they are properly instructed in the hazards associated with the radiation sources being used and radiography procedures using enclosure (12) as a guide.

(2) Periodically monitor radiography evolutions to ensure that personnel are performing the operations correctly and in a safe manner.

(3) Stop any radiography operation in which personnel are not operating the equipment in a safe manner.

(4) Take charge of the recovery operations in the event of a casualty or malfunction of the equipment which could cause excessive exposure to personnel.

(5) Insure that adequate investigations of accidents involving licensed radioactive materials are conducted and reported properly.

(6) At least quarterly conduct unscheduled surveillances and scheduled inspections to ensure that the procedures are being complied with.

(7) Insure all radiographic personnel are provided with complete personal copies of this instruction and 10 CFR 19, 20, 21 and 34.

(8) Conduct quarterly source inventory.

e. The Senior Radiographer shall:

(1) Allow only those personnel currently certified as Radiographers to assume custody of a sealed source. Radiographers and Radiographer's Assistants must adhere to the procedural requirements for handling and use of sealed sources and related control equipment as established in enclosure (10). Any personnel who are tired and have worked excessively will not be permitted to assume custody of or operate radiography equipment.

(2) Require personnel to perform source replacement and source tagging operations in accordance with enclosure (5).

(3) Ensure that radiography personnel comply with the requirements of enclosure (4) for posting and conducting surveys of radiation areas and containers housing sealed sources, including direct surveillance of radiation areas during source exposure.

(4) Maintain security of all licensed sealed sources. Control access keys to source storage areas, exposure devices and storage containers housing licensed sealed sources. Ensure radiographers comply with the source storage requirements in enclosure (4).

(5) Require radiography personnel to follow the procedures established in enclosure (4) to control radiation exposure.

(6) Ensure radiographers follow the procedures in enclosure (9) when transporting radiographic equipment.

(7) Ensure that emergency procedures established in enclosure (7) are invoked when containers housing sealed sources are involved in vehicular accidents, fire, flooding, or when the source is in the exposed position and cannot be retracted to its safe storage position within the shield. Immediately, notify the Radiographic Safety Officer when any of these conditions exist.

(8) Ensure that required records are maintained in accordance with reference (a) and (b). Conduct a monthly review of records for completeness and accuracy. Examples of required records are contained in enclosure (11).

(9) Require Radiographers and Radiographer's Assistants to comply with the Inspection and Maintenance Program established in enclosure (8).

(10) Ensure that all Radiographers and Radiographer's Assistants understand the radiographic terms applicable to this instruction.

(11) Assign one Radiographer the responsibilities of the "On-Site Radiographer," who must be in attendance when the sealed source is exposed to direct and supervise radiographic operations. The assigned Radiographer is directly responsible for ensuring compliance with the Code of Federal Regulations and conditions of the license.

(12) Ensure full compliance with this instruction, including the keeping of necessary records.

f. Radiographers and Radiographer's Assistants shall:

(1) Handle and use radiographic exposure devices and storage containers housing sealed sources following the procedures established in enclosure (10).

(2) Follow the procedures in enclosure (5) when performing source replacement and source tagging operations.

(3) Establish temporary radiation areas, post signs, conduct surveys, and maintain surveillance as specified in enclosure (4).

(4) Follow the procedures in enclosures (4) and (10) for storage of exposure devices and storage containers housing licensed sealed sources, ensuring sources are in the stored position within the device, removing and returning exposure devices and storage containers from their assigned storage area. A physical radiation survey of the device must be made to ensure sources are in the stored position. The Radiographer assuming source custody is responsible for locking the storage area, security of the key to the storage area and the device housing the source, and for returning both keys to the Senior Radiographer.

(5) Follow the procedures established in enclosure (4) to control radiation exposure.

(6) Follow the procedures in enclosure (9) when transporting radiography equipment between source storage areas and work sites. Hand carry exposure devices or storage containers housing licensed sealed sources between source storage areas, transport vehicle and work sites. Radiac survey meters must accompany all transporting operations.

(7) Invoke the emergency procedures established in enclosure (7) when there is fire or flooding in or near the radiographic work area, when containers housing sealed sources are involved in vehicular accidents, or when the source is lost or in the exposed position and cannot be retracted to its safe position within the container.

(8) Complete required records in a legible manner, maintaining accuracy as specified in enclosure (11).

(9) Conduct pre-use inspections of radiographic equipment as specified in enclosure (8). Ensure radiographic equipment being used has a current inspection.

(10) Be familiar with the radiographic terms defined in enclosure (1).

(11) Comply with all aspects of this instruction and the provisions of the byproduct license.

(12) (On-Site Radiographer) Direct and supervise radiography operations. Assume the responsibility for complying with 10 CFR and the provisions of this and other related instructions.

S. S. KINGSLEY

Distribution:
List I
List III (Less A-G and R-X)
CDO Folder

SIERRAINST 5100.8E
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1. Calendar Quarter. Calendar quarters for the purpose of this instruction begin on 1 January, 1 April, 1 July, and 1 October.

2. Dose.

a. Roentgen (R). Unit of exposure of X or Gamma radiation only, measured by energy absortion in air.

b. Rad. The unit of absorbed dose.

c. Absorbed Dose. Energy per unit mass imparted to matter by ionizing radiation. The unit of absorbed dose is the Rad.

d. Rem. Unit of dose of ionizing radiation in terms of its biological effects relative to man, the Rem is the unit of dose for record purposes.

e. Dose Equivalent. The dose (in Rads) multiplied by appropriate modifying factors which account for variation in biological effect of various types of radiation. For practical application one Roentgen of X or Gamma radiation measured in air is considered to deliver a dose equivalent of one Rem to body tissue. For Neutron of unknown energy, one Rad is considered to deliver a dose equivalent to 10 Rems to body tissue. Additionally, for Alpha, one Rad is considered to deliver a dose equivalent to 20 Rems to body tissue.

3. Dose Rate. Dose per unit time. Common units of dose rate are Rem per hour (Rem/Hr). Gamma or X-Ray dose rate is commonly expressed in Roentgen per hour (R/Hr) and Milliroentgen per hour (Mr/Hr).

4. Exposure Device. Any equipment used to contain a radioisotope source for the purpose of making radiographic exposures. This is usually a lead or uranium-shielded container.

5. High Radiation Area. Any area accessible to personnel, in which there exists radiation originating in whole or in part from licensed source material at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 MR. The perimeter on each high radiation area shall be calculated and conspicuously posted with a sign or signs bearing the symbol and the words: "CAUTION - HIGH RADIATION AREA" .

6. Radiation Area. Any area accessible to personnel, in which there exist radiation, originating in whole or in part from licensed material sources, at such levels that a portion of the body could receive in any one hour a does in excess of 5 MR, or in any five (5) consecutive days a dose in excess of 100 MR. For the purpose of this instruction the "Radiation Area" will be posted, at the "Restricted Area" 2 MR/HR line, by signs bearing the radiation caution symbol and the words:

CAUTION
RADIATION AREA

7. Radiation Health Officer. A Medical Service Corps Officer or equivalent who is qualified by training and experience. He shall insure that radiation medical examination, radiography and dosimetry records are completed in accordance with NAVMED P-5055 Radiation Health Protection manual.

8. Radiography. The examination of the structure of materials by nondestructive methods, utilizing sources of by-product materials.

9. Radiographer. The qualified individual performing the radiography or personally supervising the radiographic operation. He is responsible for full compliance with all regulations pertaining to radiological control and license requirements.

10. Radiographer's Assistant. Any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools, or radiation survey instruments in radiography.

11. Radiographic Personnel. Personnel assigned to Repair Department Non-Destructive Laboratory and engaged in the actual handling and use of sealed radiography sources and equipment.

12. Radiographic Source. Any quantity of Radioactive material sealed in a container or capsule which is used for making radiographic inspections.

13. Restricted Area. Any area to which access is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted Areas" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area. The radiation level at the boundary of the restricted area shall be limited such that an individual, who is continuously present, cannot receive more than 2 millirem in any one hour or 100 millirem in any seven consecutive days. See "Radiation Area."

14. Sealed Source Storage Vault. For the purpose of this instruction, the X-Ray shooting vault is designated as the Radioactive Material Storage Vault.

15. Senior Radiographer. That individual assigned by the Radiographic Safety Officer to serve as his representative for assignments of qualified personnel to conduct operations involving radioactive isotopes.

16. Source Changer. Any container in which radioactive material is stored for the purpose of source change and transportation.

17. Temporarily Controlled Area. Shop, shipboard or field site areas used for radiography, and posted with radiation warning signs and barriers only during such use. Such areas shall not remain established for more than 30 days.

18. Unrestricted Area. Any area, access to which is not controlled by the licensee for purpose of protection of individuals from exposure to radiation and radioactive materials, and any area used for personnel living quarters.

PROCEDURES FOR THE USE OF
PERSONNEL MONITORING INSTRUMENTS

SIERRAINST 5 00.8E
60:jlc
14 August 1980

1. Film Badges.

a. Film badges shall be worn by all radiographic personnel when engaged in radiography or when entering a radiation area. The film badge will be attached to the front, upper portion of the body (belt or shirt pocket).

b. Each film badge shall be maintained in a film badge rack located in the NDT Lab when not in use.

c. Each film badge will be issued by number to the wearer and the number will be etched on the case. Only the man issued the badge will wear it.

d. Film will be issued monthly by Medical Officer.

e. At the end of each month, film used will be forwarded to the Medical Officer via the Senior Radiographer and the Radiographic Safety Officer.

f. The Medical Officer will maintain all records concerning film identification, the effective dates of the film and information concerning dose received by Radiographic personnel. The dose information will be forwarded to the Radiographic Safety Officer as soon as practical.

g. The following precautions will be followed in handling the film badges:

(1) The film badges will not be opened by unauthorized personnel. The film packet is loaded for proper interpretation after developing.

(2) The film badge will be protected from excessive heat or moisture that can affect the film.

(3) The film packet will not be written on, scratched or rubbed through the open window of the film holder. These marks could affect the film.

h. In case of damage to the film packet, immediately return it to the Radiographic Safety Officer or in his absence, the Senior Radiographer.

i. In the event of loss of film badge or suspected damage from any reason, immediately cease radiographic operations and report to the Radiographic Safety Officer or, in his absence, the Senior Radiographer.

2. Pocket Dosimeters.

a. All personnel engaged in radiographic operations will wear two (2) currently calibrated dosimeters, Navy Model IM-9 which will measure the amount of exposure to "X" and GAMMA radiation up to 200 MR.

b. Pocket dosimeters shall be worn beside the film badge.

c. Pocket dosimeters shall be charged daily prior to entering any radiation area.

d. Pocket dosimeter readings will be entered daily on the Pocket Dosimeter Log which is in the NDT Lab. Only the highest reading for the day's operations will be entered. No entry is required if radiographic operations were not performed.

e. Pocket dosimeters are delicate instruments and will be treated as such. Jarring or dropping the dosimeter may cause a high reading. Excessive humidity or accumulation of dirt on the insulator may also cause a high reading. If damage to dosimeter is suspected, this should be reported to the Radiographic Safety Officer at once.

f. Pocket dosimeters shall be checked periodically during all radiographic operations to ensure that all personnel are made aware of any exposure which they may have received.

g. Should one pocket dosimeter read 150 MR or more, the individual will leave the radiation area and report to the Radiographic Safety Officer or Senior Radiographer for further instructions. If both pocket dosimeters become fully discharged, the individual shall immediately leave the radiation area and all radiographic operations will cease and a survey will be conducted. The individual with fully discharged pocket dosimeters will inform and deliver his film badge to the Medical Officer via the Radiographic Safety Officer or Senior Radiographer. The Medical Officer shall deliver the film badge to the ~~Naval Regional Medical Center~~ RADIATION SAFETY SERVICE (RSS), NATIONAL NAVAL MEDICINE CENTER, BETHESDA, MARYLAND and request immediate processing and interpretation. A written report will be prepared by the individual setting forth all pertinent facts regarding the incident and shall be delivered to the Radiographic Safety Officer. The Senior Radiographer shall make whatever comments and recommendations he may deem appropriate on this report. The individual shall be restricted from further exposure until it has been established that he has not exceeded any radiation exposure limits.

CH 1.

3. Pocket Dosimeter Charger Model PP-4276C/PD, Operation of.

a. Insert the pocket dosimeter into the charger socket.

b. Press the pocket dosimeter down firmly and hold it in contact against the spring pressure of the internal connectors.

c. Look into the dosimeter and turn the charging knob clockwise or counter-clockwise, as required to bring the hairline to "0".

d. Remove the pocket dosimeter from the charger and recheck the hairline position by looking into the dosimeter while pointing it at a source of bright light.

LIMITS OF PERSONNEL EXPOSURE AND
REPORTING PROCEDURES FOR OVEREXPOSURE

SIERRAINST 5100.8E
60:jlc
14 August 1980

1. Personnel radiation exposure shall be limited as specified below:

a. Weekly. For administrative control, no person shall receive more than 100 MR whole body exposure in a calendar week.

b. Quarterly. In accordance with NAVMED P-5055, no person shall receive more during any calendar quarter than the following:

(1) Whole body, lens of eye.....1.25 Rem

(2) Hands and forearms, feet and ankles....18.75 Rem

(3) Skin.....7.50 Rem

(4) Thyroid.....7.50 Rem

c. Annually. For administrative purposes, no person shall exceed 3 Rem in a calendar year.

d. Exceptions. Whole body radiation exposure may exceed the limits above provided that:

(1) The exposure does not exceed 3 Rem in a calendar quarter.

(2) The individual's prior exposure history is known and the accumulated occupational exposure to the whole body does not exceed 5(N-18) Rem when N equals the individual's age in years.

(3) The Commanding Officer has personally authorized exceeding the administrative limits above and has specified revised administrative control limits.

2. The below listed agencies shall be informed in the event of any of the following cicumstances:

a. Region II, Office of Inspection and Enforcement, USNRC, Suite 3100, 101 Marietta Street, N. W. Atlanta, Georgia 30303.

b. BUMED Code 53 with a copy to Naval Energy and Environmental Activity, Port Hueneme, California 93043.

(1) If an individual has received a whole body dose of more than 3 Rem in any calendar quarter, a report shall be made within 30 days from the determination of such exposure.

(2) If an individual has received a whole body dose of more than 5 Rem in any single incident, a report shall be made within 24 hours from determination of such an exposure.

(3) If any individual has received a whole body dose of more than 25 Rem in a single incident, immediate notification shall be made by telephone and telegraph. In addition, a detailed written report furnishing all information available on the overexposure, the reason for such overexposure, the general status of health and physical condition of the individual and a summary of treatment rendered or recommendation of treatment to be rendered and corrective steps planned will be submitted as early as practicable after the initial report.

3. Incident Involving Exposure to Non-Monitored Personnel.

a. In the event an incident involving exposure of non-monitored personnel:

(1) Detain the exposed person or persons.

(2) Record the names, rates and social security numbers of Navy personnel or addresses (badge number of Navy employees) or civilian personnel.

(3) Record any data pertaining to the situation, including:

(a) Distances personnel were from the source at the time of exposure and source strength at that distance.

(b) Time spent at those distances.

(C) Any shielding that would reduce exposure to non-monitored personnel.

(4) Notify the following:

(a) The Radiographic Safety Officer and Command Duty Officer.

(b) The Repair Officer and Repair Duty Officer.

(c) The Medical Officer.

(d) Parent Command of Detained Personnel.

(5) The exposed personnel shall be taken to Sick Bay or a dispensary and held for observation and further action by a Medical Officer.

(6) The Radiographic Safety Officer shall prepare reports of the accident and will submit them in accordance with current Naval Directives and the Code of Federal Regulations, Title 10, Part 20.405 - Reports of Overexposure and Excessive Levels and Concentrations.

(7) The Radiographic Safety Officer will give his permission to recommence radiographic operations when he feels the situation is safe.

NOTE: In any of the above instances a copy of information concerning such exposure must be furnished to the individual.

RADIATION SURVEYS, POSTING, SECURITY
AND RADIATION SURVEY INSTRUMENTS

SIERRAINST 5100.8E
60:jlc
14 August 1980

1. Radiation Survey Instruments.

a. At least two AN/PDR-27's and one AN/PDR-43 which are operable and reflect current calibration dates will be used during all exposures, movement of sealed sources and radiation surveys.

b. The Radiographer in Charge is responsible to ensure all personnel involved with the radiographic operation are familiar with the radiation survey instruments.

c. All radiac instrument calibration will be accomplished by a NAVELESYSCOM calibration facility approved by NRC. The Senior Radiographer will maintain a log showing dates of calibration and accountability for each instrument.

d. Before each use, radiation instruments will be checked for:

(1) Date of last calibration (within 3 months).

(2) Battery condition (shall be checked at least once an hour during continuous operation).

(3) Response to radiation.

e. If any of the checks is unsatisfactory or if any instrument is saturated beyond 100% of any scale, the instrument will be tagged "OUT OF COMMISSION" and reported to the Radiographic Safety Officer and the instrument will not be used until it is repaired or recalibrated.

2. Surveys.

a. Two AN/PDR-27's and one AN/PDR-43 radiacs will be used during any exposure of the sealed source. These instruments shall be put into service prior to each opening of the sealed source vault, prior to sealed source exposure and shall stay on while the source is exposed.

b. Determine area to be posted larger than necessary for the actual exposure from calculation of the source strength, distance and shielding. Line off and post areas in accordance with paragraph (3) of this enclosure. During radiographic operations the radiographer will ensure boundaries are continuously monitored.

c. Monitor the exposure device prior to and at the completion of each exposure or movement in accordance with the following:

(1) Movement - Radiographic exposure devices such as the Iridiitron Model 520 have shielding which measures less than four inches from the sealed source storage position to any exterior surface of the device.

This exposure device shall have no radiation levels in excess of 50 MR/HR at six inches from any exterior surface.

(2) Worksite Vehicle - The outer surface of a worksite vehicle must be treated as a restricted area when the vehicle is in use. A physical radiation survey of the vehicle must be made after the exposure device is secured in the vehicle to ensure that the radiation level on any exterior surface does not exceed 2 MR/HR. A survey of the inside of the passenger compartment of the vehicle must be taken to ensure that the radiation level does not exceed 2 MR/HR. If radiation levels are in excess of 2 MR/HR, the exposure device must be provided with sufficient shielding to reduce radiation level to 2 MR/HR within the cab. A record of this survey will be maintained utilizing radiographic survey record forms contained in enclosure (11).

3. Posting.

a. Areas in which GAMMA radiography is being performed or a radioactive source is being stored shall be conspicuously posted or monitored in accordance with the following:

(1) High radiation area (100 MR/HR) each high radiation area will be posted with a sign or s[illegible] bearing the radiation caution symbol and the words:

CAUTION
HIGH RADIATION AREA

CH 1

(2) Radiation Area (2 MR/HR) - Each radiation area (restricted area) shall be posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION
RADIATION AREA

The signs shall display the conventional three-bladed design with the blades colored magenta or purple on a yellow background. Appropriate lettering to accompany the radiation symbol shall be 2" high. The exposure site must be roped off (should use yellow and magenta line) and the Radiographer or Radiographer's Assistant shall maintain a direct surveillance of the operations to protect against unauthorized entry.

(3) A flashing red light shall be placed adjacent to the posted sign in any dimly lighted location.

(4) The storage vault located in compartment B-0109-E (NDT Lab) shall be posted in accordance with the following:

(a) Conventional three-bladed design with the blades colored magenta or purple on a yellow background and shall read as follows:

CAUTION

RADIOACTIVE MATERIAL

(b) A sign containing information on radiation level, kind of material stored, estimate of activity and date of estimate. The information shall be updated on the first of each month or when a new source has arrived.

(5) A vehicle used to transport a radioactive source will have a sign reading "RADIOACTIVE" posted on all four sides of the vehicle.

4. Security.

a. Radiographic sealed sources in the custody of the Repair Department shall not be used for any purpose other than GAMMA radiography and shall not be taken from the SIERRA without express consent of the Radiographic Safety Officer who will inform the Repair Officer during working hours and the Duty Repair Officer and Command Duty Officer after working hours.

b. All sealed sources shall be kept in shielded source containers which will be stored in the storage vault located in compartment B-0109-E (NDT Lab). The storage vault shall be kept locked at all times unless attended by radiographic personnel. The key to the vault will be maintained in the custody of the Radiographic Safety Officer or the Senior Radiographer in his absence. One duplicate key will be maintained in the Command Duty Officer's safe attached securely to a metal tag which shall read as follows:

RADIOACTIVE MATERIAL STORAGE
VAULT KEY - DO NOT ISSUE
UNLESS EMERGENCY
CONTACT R-6 DIV. OFFICER OR
REPAIR OFFICER IMMEDIATELY

NOTE: No other duplicate keys shall be made.

c. When a radiographic job is undertaken, the source will not be moved until all other preparations for the job are complete. During each radiographic operation the radiographer shall maintain direct surveillance of the operation and source exposure device.

d. Prior to commencing any radiographic operation notify when applicable, tended ship's duty officer, SIERRA's duty officer, station duty officer and the duty officer of any ship alongside, one day in advance if practicable. Information shall include the intended time of exposure, the approximate location of the radiation restricted area, and the expected duration of the radiographic operation. Similarly, upon completion of radiographic operations, notify the previously named people when the area is no longer restricted. Source movement sheet, figure 3, enclosure (11) will be utilized.

e. Establish a preliminary calculated restricted area, post in accordance with paragraph 3 of this enclosure.

(1) To confirm the true location of the boundary line (2MR/HR), expose the source in accordance with enclosure (10), and survey the perimeters of the roped off area making adjustments to the boundary of the restricted area as appropriate to maintain radiation levels at or below 2 MR/HR. The restricted area is now considered firm. Record results of the radiation survey on the Radiation Survey Map. Now subsequent exposures may be held while the 2 MR/HR line is continuously monitored.

OPERATING INSTRUCTIONS FOR SOURCE
CHANGE USING THE AUTOMATION INDUSTRIES SOURCE
CHANGER MODEL 500-SU
AND AUTOMATION INDUSTRIES IRIDITRON
MODEL 520

SIERRAINST 5100.8E
60:jlc
14 August 1980

1. Establish and post restricted area and high radiation area. In accordance with paragraph 3 of enclosure (4).

2. Ensure AN/PDR-43 and AN/PDR-27 radiac instruments are at the scene and in proper operating condition, In accordance with paragraph (1) of enclosure (4).

3. Locate the source changer within two feet of the shielded head.

4. Remove plug from Model 520 Iriditron.

5. Remove round plug from source changer, save (new) number plate.

6. Connect the short source changer tube (supplied) to the exposure device and to the source changer outlet of the empty chamber.

7. Connect source control cable to exposure device lock box and position external control so that the operator is a full 25 feet from exposure device. The 25 foot distance can be reduced if shielding presently installed would make the position of the operator in a lower radiation field.

8. Ensure area is clear of personnel and unlock exposure device.

9. Run decayed source into source changer by turning control handle clockwise rapidly until source stops in the changer.

10. Survey exposure device and short source tubes to insure sealed source is in source changer.

11. Keep radiac instrument available and in sight. Disconnect short source change tube at source changer, and disengage disconnects, being careful not to pull out source.

12. Replace round plug securing decayed source in changer.

13. Remove hex head plug from the source changer which contains the new sealed source. Keep radiac instruments available and in sight.

14. Carefully pull the source cable disconnect only enough to allow joining of disconnect.

15. Join disconnects on the control cable and source cable.

16. Connect short source change tube to source changer outlet.

17. Ensure area is clear of personnel and then rapidly crank the new sealed source into the exposure device by turning the control handle counter-clockwise until the sealed source is in its shielded position.

18. Ensure sealed source is in shielded position exposure device with radiac instrument indicated of a reading less than 50 MR/HR at any point 6 inches from the surface of the Iriditron.

19. Press the barrel of the lock down until it latches. Move the control crank handle back and forth to make sure that the source is locked in position.

20. Disconnect the source tube from the changer and exposure device.

21. Replace the hex head plug in the empty source changer hole.

22. Remove the decayed source number plate from the plate holder on exposure device and replace with new source number plate. Attach old source number plate to source changer cap plug by placing seal wire (provided) through number plate when sealing decayed source.

23. Reseal outlets on source changer with lead seal wire provided.

24. Source shall be prepared for shipment in accordance with reference (b).

RECEIPT OF RADIOACTIVE SEALED SOURCE

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1. A Radiactive Sealed Source shall be received only during working hours.

2. Radiation Safety Officer and the Senior Radiographer will screen all shipping documents for completeness.

3. The package (shipping container) shall be monitored upon receipt to ensure radiation levels do not exceed 10 millirem per/hr at three feet and to check for radioactive contamination of the surface of the container.

4. If radiation levels are found in excess of 10 millirem per/hr at three feet, immediately notify by telephone and telegraph, mailgram or facsmile, the Nuclear Regulatory Commission Regional Office listed in Appendix "D" part 20 NRC rules and regulations and the final delivering carrier.

5. Upon receipt of the sealed source a swipe test shall be taken on the outside surfaces of the shipping container in accordance with the following,

a. Using rubber gloves to protect the hands and gauze pads to make the swipes, swipe a 100 square centimeter area (approximiately four square inches) on each side, top and bottom of the shipping container.

b. After each swipe, place the gauze in a proper containment.

c. After completing the swipe test, seal the containment.

d. Place the source shipping container in a yellow poly bag.

e. Place the rubber gloves in the poly bag, along with the source shipping container. Use extreme caution when removing the gloves to avoid touching the outside surface of the gloves and contaminating the hands, if contamination is present.

f. Seal the yellow poly bag and transport the source shipping container to the Non-Destructive Testing Laboratory.

g. Place the source shipping container in the storage vault located in the NDT LAB, and lock the vault.

6. Enter required information on Radiographic Accountability Log contained in enclosure (11) figure 8.

7. Have swipes read by the nearest Naval Electronics System Command managed Radiac Repair Facility.

8. If the results of the swipe test indicate there is no contamination present in excess of 0.01 microcuries per 100 square centimeters of package surface, the sealed source shall be transferred, as outlined in enclosure five (5).

9. If removable radioactive contamination in excess of 0.001 microcurries per 100 square centimeters of the shipping container external surface is found, the Radiographic Safety Officer shall immediately notify the final delivering carrier and by telephone and telegraph, mailgram, or facsimile, the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office shown in Appendix "D" of part 20 NRC Rules and Regulations.

10. The transfer of a source will be in accordence with reference (b)

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1. Reporting of Accidents and Incidents. Over-exposure and notification of over-exposure of personnel will be handled in accordance with enclosure (3).

2. Theft of Radioactive Source. If the source cannot be located, and theft is apparent, immediately notify the nearest USNRC Regulatory Operations Regional Office by telephone. Within 30 days, a written report shall be submitted to the Director of Regulatory Operations, USNRC, Washington, D. C. 20555 with a copy to the nearest USNRC Regulatory Operations Regional Office describing material involved, circumstances under which loss occurred, statement of the disposition or probable disposition of licensed material involved, action which have or will be taken to recover the material, and measures which have or will be taken to prevent recurrence of loss of material. The Radiation Safety Officer will initiate an appropriate naval message to the appropriate chain of command (possible OPREP 3 - Navy Blue) with info addee, Naval Energy Enviromental Support Activity, Port Hueneme, CA.

3. Work-Site Emergency (Fire, Flooding, Explosion or Personnel Casualty) in an Area Adjacent to Radiography Operations which does not immediately endanger the Radiography Exposure Device.

a. Return the source to its shielded position in the exposure device.

b. Disconnect the source guide tube and control cables.

c. Remove the exposure device from the area of the casualty, and if possible, return it to its storage location. If unable to return the device to its storage location, it must remain in the custody of a qualified radiographer.

d. Once the source is properly secured, the restricted area signs should be removed as soon as possible.

e. If the radiographic personnel are the only ones present to report the emergency, they should immediately notify the Radiographic Safety Officer, CDO and the Duty Officer/CDO of the ship(s)/command(s) involved. Steps a. through d. above can be performed by one man. The Radiographic personnel present should report the emergency and begin appropriate corrective action.

f. In all cases, the Radiographic Safety Officer, the Command Duty Officer, Repair Officer and Repair Duty Officer shall be notified immediately of the emergency and the action taken.

g. If the exposure device cannot be removed from the danger area, the procedures enumerated in paragraph 4 shall be followed.

4. Work-Site Emergency (Fire, Flooding or Explosion) in the Area of Radiographic Operations which immediately endangers the Radiographic Exposure Device.

a. Immediately perform as many of the following steps as possible:

(1) Return the source to the shielded position in the exposure device.

(2) Perform a physical radiation survey of the device and source guide tube with an AN/PDR-27 to ensure that the source is in its shielded position, then lock the device.

(3) Disconnect the source guide tube and control cables.

b. Maintain or re-establish the restricted area around the source to the maximum extent possible. Radiographic personnel shall remain at the scene to maintain the restricted area and to brief emergency personnel of possible radiation hazards.

c. If the radiographic personnel are the only ones present to report the emergency, they should immediately notify the Radiographic Safety Officer, Command Duty Officer and the Duty Officer/CDO of ship(s)/command(s) involved, and begin corrective action. Step (a) of this paragraph can be performed by one man. The other radiographic personnel present shall report the emergency and take all appropriate corrective action.

d. In the event of damage to the exposure device, radiographic personnel shall remain at the scene and maintain the restricted area.

e. The Radiographic Safety Officer will direct restoration activities.

f. In the event of damage to the radiographic exposure device, the Radiographic Safety Officer will make immediate notification in accordance with Code of Federal Regulations, Title 10, Part 20.403, Notification of Incidents.

5. Emergencies Involving Damage to or Malfunction of Radiographic Exposure Devices.

a. In the event of an accident to the exposure device or source, such as a falling object striking the device, do the following:

(1) If the device is capable of being operated:

(a) Return the source to its shielded position in the exposure device.

(b) Conduct a physical radiation survey of the device and source guide with an AN/PDR-27 to ensure that the source is fully housed, then lock the exposure device.

(c) Disconnect the source guide tube and control cables.

(d) Notify the Radiographic Safety Officer, Command Duty Officer (CDO), Repair Officer, Repair Duty Officer and the Duty Officer/OOD of the ship/command involved.

(e) Do not use the exposure device until the Radiographic Safety Officer has inspected the device and grants approval for its use.

(2) If the source cannot be returned to its shielded position:

(a) Set up, maintain, or modify the restricted area as necessary.

(b) Do not allow anyone to enter the restricted area.

(c) Notify the Radiographic Safety Officer, the Command Duty Officer, the Repair Officer and Repair Duty Officer, and Duty Officer/OOD of the ship/command involved.

(d) Maintain the restricted area.

(e) The Radiographic Safety Officer will direct restoration operations.

6. Leaking Sources. When a source is determined to be leaking, other than receipt as covered by enclosure (6) of this instruction, the following steps will be taken:

(1) Secure the area the source is located in.

(2) Contact the Radiation Safety Officer.

(3) Assemble proper detection equipment, personal protective clothing.

(4) Under direction of the Radiation Safety Officer, establish extent of contamination, put contaminated equipment in proper containment, decontaminate area.

(5) A report shall be filed within five (5) working days of the date the source was determined to be leaking with the USNRC, Region Directorate of Regulatory Operations with copy to Naval Energy and Enviromental Activity, Port Hueneme, CA. The report should include the equipment involved, test results and corrective action taken.

7. Loss of Source.

a. In the event a source is lost:

(1) Notify the Radiographic Safety Officer, the Command Duty Officer, the Repair Officer and the Repair Duty Officer.

(2) The Radiographer in charge of the operation will reconstruct the circumstances occurring since the source was last positively accounted for, including exposure device locations and transport routes.

(3) The areas of possible source location will be established as restricted areas and checked with either an AN/PDR-27 or AN/PDR-43 radiac or any appropriate survey meters the Radiographic Safety Officer may think will be of assistance to determine the location of the lost source. Danger areas shall be posted or roped off whenever possible.

(4) Additional personnel that are needed to guard restricted areas will be requested from the Command Duty Officer.

(a) Standby personnel will be in locations that have been surveyed and are safe for occupancy.

(b) They will be instructed in limits of the restricted areas, and their duties as guards.

(5) While awaiting the arrival of the Radiographic Safety Officer, the radiographer in charge of the operations will use survey meters to attempt to find the general location of the source.

(6) The Radiographic Safety Officer shall direct the search, using appropriate survey meters.

(7) When the source has been located, the Radiographic Safety Officer will direct restoration operations.

(8) Any non-monitored personnel who may have been exposed during the incident will be detained as in paragraph 3 of enclosure (3).

(9) The Radiographic Safety Officer shall report the incident, if source cannot be located or retrieved safely, as prescribed in Code of Federal Regulations, Title 10, Part 20.402 - (Reports of Theft or Loss of License Material), and paragraph 2 of this enclosure.

8. Vehicular Accidents. In the event of a vehicular accident involving radiographic sources:

(1) A restricted area should be established around the accident site as required.

(a) If the survey meters are operable use them to establish the perimeter of the restricted area.

(b) If the survey meters are inoperable, establish the perimeter of the restricted area assuming that the source is in the exposed position.

(c) In the case of a minor accident when it can be positively determined that the source is safely housed in the shielded position in the exposure/shipping container, no restricted area is necessary or desirable.

(2) Notify the Radiographic Safety Officer, Command Duty Officer, Repair Officer and the Repair Duty Officer of the accident. After establishing the restricted area, if required, the casualty should be corrected under the direct supervision of the Radiographic Safety Officer and the Radiological Controls Officer.

(3) Keep personnel out of the restricted area and send for an AN/PDR-27 and AN/PDR-43 to establish that the source is in the housed position.

(4) If the source is exposed and it can be positively determined the source is exposed and the exposure device is broken or inoperable, then the Radiographic Safety Officer shall make reports in accordance with current Naval Directives and the Code of Federal Regulations, Title 10, Part 20.403 - Notification of Incidents.

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14 August 1980

1. Inspection/Maintenance.

a. The Radiographic Safety Officer shall be responsible for ensuring that the inspection, maintenance, and repair program is carried out in accordance with this enclosure.

b. Copies of the applicable inspection form, pages 2,3, and 4 of this enclosure, shall be used for pre-use and quarterly inspections. Prior to using a source, a pre-use inspection shall be performed by the radiographer using the source. The Senior Radiographer shall perform a quarterly inspection in accordance with this enclosure and direct any maintenance which is required. The quarterly inspection shall include all items on the pre-use inspection plus those items required on the quarterly inspection. Any discrepancies noted during any inspection, or during operations of the equipment shall be brought to the attention of the Senior Radiographer, and the Radiation Safety Officer. If any discrepancies exist, the equipment shall be removed from service until corrective action has been accomplished.

c. Inspections Required at Source Change: Complete visual inspection of camera and control cable shall be accomplished at each source change, utilizing procedures described in the applicable technical manual and this check-off sheet as guide and record.

d. A survey of the projector and source changer will be conducted before any inspection or maintenance procedures are accomplished.

PRE-USE CHECKOFF SHEET

(1) Pre-Use Inspection of Radiographic Equipment.

(a). Proper operation of the source position indicator mechanism. SAT/UNSAT
(b). Proper operation of crank mechanism. SAT/UNSAT
(c). Proper operation of locking mechanism. SAT/UNSAT
(d). Source and drive-cable wear or damage. SAT/UNSAT
(e). Damaged or worn source drive-cable tube and connector. SAT/UNSAT
(f). Rust, dirt or sludge build-up in the source tube. SAT/UNSAT
(g). Any abnormal radiation emitting from the device. SAT/UNSAT
(h). Proper positioning of source inside the shield. SAT/UNSAT
(i). Shifting of the shield inside the projector housing. SAT/UNSAT
(j). Proper connection of all mating components. SAT/UNSAT
(k). Damage to the device, which may impair its operation. SAT/UNSAT
(l). Cable drive gear-box damage and wear. SAT/UNSAT
(m). Proper labeling (Source I.D. tags, etc.) SAT/UNSAT
(n). Dust plugs in place. SAT/UNSAT
(o). On the Model 520, check drive cable connector ~~gap with a gauge prior to use. Connector gap shall be .005" + .004" - .00".~~ SAT/UNSAT
(p). On the Model 520, the connector nut on the drive cable has 2 pins which hold it in place. Inspect nut to insure they are not missing. SAT/UNSAT

CH 1

List of Items found defective (List On Reverse).

Date and signature of radiographer who performed inspections.

Date _____ Signature _____

Corrective Action taken on defective items (List On Reverse). Signature of Radiographic Safety Officer, if detective items were found and corrective action taken:

_____
Radiographic Safety Officer

PRE-USE CHECKOFF SHEET

(2). Pre-Use inspection of Model 520 exposure device with tungsten beamer.

(a). Check the bolt action drive mechanism for any apparent wear or damage. SAT/UNSAT

(b). Check drive cable connector gap with a gauge prior to each use. ~~Connector gap shall be .005" +.004"/-.000".~~ SAT/UNSAT CH 1

(c). Check the tungsten beamer/collimator for damage to threads or any other damage. SAT/UNSAT

List of Items found defective (List On Reverse).

Date and signature of radiographer who performed inspections.

Date _____ Signature _____

Corrective Action taken on defective items (List On Reverse). Signature of Radiographic Safety Officer, if defective items were found and corrective action taken:

_____
Radiographic Safety Officer

(3). Pre-Use Inspection of Source Changer for:

(a). Proper positioning of source(s) within the container. SAT/UNSAT

(b). Possible shielding defects, such as cracks, resulting from shifting of shielding material. SAT/UNSAT

(c). Damage to the container which may impair its use. SAT/UNSAT

(d). Proper operation of locking mechanism. SAT/UNSAT

(e). Lock wire seals. SAT/UNSAT

(f). Proper label. SAT/UNSAT

(g). Damage to connectors and source securing devices on source changers, SAT/UNSAT

List of Items found defective (List On Reverse).

Date and signature of radiographer who performed inspections.

Date _____ Signature _____

Corrective Action taken on defective items (List On Reverse).
Signature of Radiographic Safety Officer, if defective items were found and corrective action taken:

_____
Radiographic Safety Officer

(4). Pre-Use inspection of source leak-test tool.

(a). Condition of polyfoam insert. SAT/UNSAT

(b). Any damage to threads. SAT/UNSAT

(c). Check to ensure device is clean and free from any dirt, oil, etc. SAT/UNSAT

List of Items found defective (List on Reverse).

Date and signature of radiographer who performed inspections.

Date _____ Signature _____

Corrective Action taken on defective items (List of Reverse).
Signature of Radiographic Safety Officer, if defective items were found and corrective action taken:

_____ _____
Radiographic Safety Officer

QUARTERLY INSPECTION OF RADIOGRAPHIC EQUIPMENT:

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(1). Inspect GAMMA alarm for proper operation. SAT/UNSAT

(2). Inspect audible alarm on vault for proper operation. SAT/UNSAT

(3). Inspect vault doors operation mechanism for proper operation or damage. SAT/UNSAT

(4). Check to ensure signs have not been removed or covered on vault. SAT/UNSAT

(5). Inspect vault locking device. SAT/UNSAT

(6). Lubricate source drive cable assembly in accordance with the technical manual for the applicable equipment. SAT/UNSAT

(7) Check clearance in source guide tubes. A steel ball 11/32" in diameter should pass freely through the entire length of the tubes. SAT/UNSAT

List of items found defective:

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

Date and signature of radiographer who performed inspections.

DATE _____ Signature _____

Corrective Action taken on defective items (List on Reverse).
Signature of Radiographic Safety Officer, if defective items were found and corrective action taken:

_____
Radiographic Safety Officer

TRANSPORTATION OF RADIOGRAPHIC SOURCES
AND EXPOSURE DEVICES

SIERRAINST 5100.8E
60:jlc
14 August 1980

1. General Precautions.

a. A radiographer will be in constant attendance during any exposure device movement.

b. The exposure device will not be moved unless the device connection plugs are all in place and the device is locked.

c. Radiographic sealed sources shall not be transported from USS SIERRA aboard other commands without permission of the Command Duty Officer of that command and SIERRA Repair Officer/Radiographic Safety Officer during working hours and CDO after working hours. Radiographic source transport request (figure 3 of enclosure (11)) will be filled out and applicable signatures will be obtained before source is transported.

d. The source will be kept locked in the shielded position during all transfers, as the ideal shield is the exposure device that is designed for a specific source with a specific activity.

e. An operable AN/PDR-27 and AN/PDR-43 shall accompany the device.

f. No exposure device shall be transported unless the safety plugs are in place and the device is locked.

2. Transportation in the Immediate Vicinity of the Command.

a. For radiographic purposes, the term "Immediate Vicinity of the Command" shall mean onboard USS SIERRA (AD-18) and onboard U. S. Navy vessels tended by USS SIERRA (AD-18).

b. Movement in the immediate vicinity of the command may be accomplished by the careful use of hand trucks, hand-carrying, or government vehicle.

c. Exposure devices will be hand-carried unnecessarily.

d. Extreme caution will be exercised so that exposure devices are not dropped or jarred while moving them, especially when carrying them on steep ladders, through doors and hatches, on brows, and decks where trip hazards may exist.

e. The route to be taken from the vault to the exposure site will be checked by the radiographic personnel who will actually transport the device, noting in particular any obstacles or trip hazards, prior to the actual transportation of the exposure device over the route.

f. When the exposure device must be transported across a brow between two vessels, or the pier, one end of a 1/4 inch nylon 40 foot line will be attached securely to the device and the other end attached securely to a floatation marker.

g. Should any accident, such as dropping the exposure device or a falling object striking the device occur, the applicable emergency procedures will be initiated at once, as outlined in enclosure (7).

h. The Officer of the Deck of vessels upon which the exposure device will be used, and of vessels which the device must cross, will be notified before doing so.

3. Transporting by Motor Vehicle.

a. Only a government-owned vehicle will be used.

b. The vehicle will be posted in accordance with Department of Transportation (DOT) regulations on both sides, front and rear, with a standard sign reading "radioactive," NSN 75[illegible]-01-028-5135.

c. The radiographic device will be firmly secured in the vehicle by use of straps or line, so as to prevent any bouncing or movement of the device.

d. The radiographic device will not be any closer than four (4) feet to any passenger, or driver of the vehicle.

e. A survey will be made of the passenger compartment in accordance with enclosure (4). To assure the radiation level does not exceed 2 MR/HR.

f. The following minimum equipment will be placed in the vehicle prior to departing:

(1) At least two (2) AN/PDR-27 and one (1) AN/PDR-43 radiation detection instruments that have been calibrated within three (3) months of the expected date of return.

(2) At least 500 feet of line.

(3) At least eight (8) "CAUTION - RADIATION AREA" signs.

(4) At least three (3) "CAUTION - HIGH RADIATION AREA" signs.

(5) At least four (4) stanchions for supporting barrier lines.

(6) The radiographic device and all necessary equipment and accessories.

g. The vehicle used for transporting the radiographic device must not, at the same time, be used for transporting explosives or other dangerous material.

OPERATING PROCEDURES FOR
FIELD EXPOSURE

SIERRAINST 5100.8E
60:jlc
14 August 1980

1. Operating Procedures for Automation Industries Inc., Iriditron Model 520, aboard USS SIERRA (AD-18) and ships tended.

a. General Instructions.

(1) Sealed sources shall be transported in accordance with enclosure (9).

(2) The exposure device shall be surveyed with an AN/PDR-27, radiation survey meter, before it is put into operation. This is to assure the radiographer that the source is in the device and in its shielded position.

(3) The radiographer shall perform inspection and maintenance of radiographic equipment in accordance with enclosure (8) prior to each use.

(4) Radiography areas shall be posted and restricted in accordance with enclosure (4).

b. Specific instructions for making an exposure with the Model 520 Iriditron and using the 23' or 10' source tube.

(1) Transport the Iriditron and associated equipment to the exposure site in accordance with enclosure (9).

(2) Position the closed end of the source tube where it is desired to expose the source.

(a) The closed end of the source tube may be held in position by using the accessory tripod, tape, test tube clamp, wooden blocks with a hole, or any other suitable means.

(3) Run the open end of the source tube from where the closed end is positioned to an area where the Iriditron can be placed.

(a) Ensure that there are no sharp bends or kinks in the source tube. Ensure the bend radius of the source tube is not less than 20 inches.

(4) Place the Iriditron and an AN/PDR-27 at the open end of the source tube.

(a) Have the AN/PDR-27 set on the 0 to 50 MR/HR scale.

(5) Extend the control cable to its fullest length with the control handle as far as possible from the end of the source tube where the Iridium source will be exposed. Take advantage of installed shielding (i.e., bulkheads, machinery, etc.).

(6) Attaching the control cable to the loaded Iriditron:

(a) Unscrew the lockbox plug. The source-cable coupling should protrude about 1/2 inch, this is normal. Store the lockbox plug in the threaded receptacle provided on the end plate of the head.

(b) Turn the crank handle of the control cable assembly clockwise until the control cable disconnect is fully exposed.

(c) Connect the control cable disconnect coupling to the source-cable coupling. They must be engaged at a right angle and then straightened.

(d) Screw the swivel fitting on the control cable conduit until the swivel fitting is snug in the lockbox barrel.

WARNING
DO NOT UNLOCK THE LOCKBOX
AT THIS POINT

(7) Connecting the source guide tube to the loaded Iriditron.

(a) Remove the outlet plug assembly from the Iriditron and store it in the hole in the end plate.

(b) Screw the fitting at the open end of the source tube into the threaded outlet hole of the Iriditron.

WARNING
CHECK RADIATION AREAS AGAIN TO ENSURE THERE
ARE NO UNAUTHORIZED PERSONNEL IN THE AREAS.

(8) If the exposure is ready to be made, unlock the lockbox. The key shall be kept in the radiographer's possession.

WARNING
KEEP A CONSTANT SURVEILLANCE OF RADIATION AREA
BOUNDARIES TO ENSURE UNAUTHORIZED ENTRES ARE
NOT MADE

(9) Pick up the AN/PDR-27 and move away from the Iriditron for the full length of the control cables, and preferably, stand behind a shield, bulkhead, machinery, etc., in order to be in the safest possible position during the exposure.

(10) The exposure can now be made by rapidly cranking the control crank handle clockwise until the source capsule hits the cap at the end of the source tube. To ensure the source is at the end of the source guide tube in the exposed position, count the number of revolutions of

the control handle. This will take approximately 30 revolutions of the handle with the 23 foot long source tube. At this point the radiographer shall check his AN/PDR-27 to insure he remains in a safe position during the exposure. Note the time of exposure for entry on Radiographic Utilization Log.

(11) Check the radiation area boundary at this time and adjust as necessary ensuring there are no unauthorized personnel within.

(12) At the end of the exposure time, rapidly crank the control crank handle counter-clockwise until a firm stop is felt. To ensure the source is housed in the Iriditron count the revolutions of the control crank handle until a firm stop is felt. This will take approximately 30 revolutions of the handle with the 23 foot long source tube. Also while cranking the source back into the Iriditron keep an eye on the AN/PDR-27. As the source moves into the shielded position in the Iriditron the meter reading should rapidly drop off to "0" or near "0".

(13) When approaching the Iriditron, an AN/PDR-27 survey meter must be carried to verify safety. Move the survey meter along the length of the source tube to make sure that the source has not become disconnected from the control cable and stuck in the source tube. Also, check the Iriditron to make sure that the source is in a safe position within the shielded head (indicated by a reading of less than 50 MR/HR at any point 6 inches from the surface of the Iriditron).

WARNING
IF THE SOURCE CANNOT BE RETURNED TO A SHIELDED POSITION,
TAKE ACTION SPECIFIED IN THE EMERGENCY PROCEDURES.
ENSURE RADIATION AREAS ARE MAINTAINED.

(14) To lock source, press the barrel of the lock down until it latches. Move the control crank handle back and forth to make sure that the source is locked in position.

(15) Enter required information on Radiographic Utilization Log contained in enclosure (11) figure 3

(16) If more exposures are required repeat steps (9) through (16).

(17) If more exposures are not required, remove the source tube and screw the outlet plug back in place.

(18) Removing the control cable assembly from the Iriditron:

(a) Check that the lockbox is locked (lock barrel "in" and key removed) and that the outlet plug assembly is screwed all the way into the outlet of the Iriditron.

(b) Remove the control cable conduit by unscrewing the swivel fitting at the lockbox.

(c) When the threads are disengaged, disconnect the source cable from the control cable, ~~by pushing the control cable 90 degrees to the source-cable coupling.~~ (The source-cable coupling will remain exposed approximately 1/2 inch. Do not attempt to push it in.)

CH 1

(19) Remove the lockbox plug from the plate and screw it into the lockbox housing.

(20) In no case shall the Iriditron be left unattended.

(21) Return the Iriditron and associated equipment to the NDT Lab and lock the Iriditron in the storage vault in accordance with enclosure (9).

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60:jlc
14 August 1980

1. The records and logs listed below will be kept in association with the Radiography Program. And will be filed as indicated:

	LOG TITLE	RESPONSIBILITY
a.	Quarterly Source Inventory Records (figure 1 of this enclosure)	Quality Assurance Division (Two years) as required by SIERRAIST 5100.8E Para d.(8)
b.	Radiographic Utilization Log (Figure 2 of this enclosure)	Quality Assurance Division (Two years) as required by Para. 1.b.(15), Encl. 10
c.	Radiographic Source Transport Request (Figure 3 of this enclosure)	Quality Assurance Division as required by Para. 4. d, Encl. 4
d.	Radiation Survey Records (Figure 4 of this enclosure)	Quality Assurance Division (Two years, except personnel exposure determination) as required by Para 1. c. Encl. 4)
e.	Calibration Records for Survey Instruments (Figure 5 of this enclosure)	Quality Assurance Division (Two years as required by Para. 1. c. Encl. 4
f.	Annual Personnel Radiation Exposure Record (NAVMED Form 6470/1)	Medical Department as required by Para. 1. f., Encl. 2
g.	Record of Exposure to Ionizing Radiation (Form DD-1141) (Figure 6 of this enclosure)	Medical Department as required by Para. 1. f., Encl. 2
h.	Source Leak Result Records (No specific forms)	Quality Assurance Division
i.	Pocket Dosimeter Log (Figure 7 of this enclosure)	Quality Assurance Division as required by Para. 2. d., Encl. 2
j.	Radiographic Accountability log (Figure 8 of this enclosure)	Quality Assurance Division as required by Para. 6. Encl. 6 and Ref. (b)

2. All records associated with radiography shall be maintained by the responsible division for a minimum of two years with the following exceptions:

a. Exposure records and pocket dosimeter records shall be maintained until disposition is authorized by the Nuclear Regulatory Commission.

b. Radiation survey records used to establish personnel exposure shall be maintained until disposition is authorized by the Nuclear Regulatory Commission.

SIERRAINST 5100.8E
60:jlc

Date _____

From: Repair Officer, U.S.S. SIERRA (AD 18)
To: Commanding Officer, U.S.S. SIERRA (AD 18)

Subj: Sealed Source used for Radiography: Quarterly Inventory of

Ref: (a) Title 10 code of Federal Regulations, Part 34, Section 34.106
(b) U.S.S. SIERRA (AD 18) Instruction 5100.8E

1. In accordance with references (a) and (b), a quarterly physical inventory of sealed sources used for radiography was conducted this date. Results were as follows:

a. Location _____

b. Type of By-product material _____

c. Model Number _____

d. Serial Number _____

e. Strength of Source this date _____

f. Survey meter readings at 6" from

(1) Storage Container _____

(2) Exposure Device _____

_____ _____
Radiographic Safety Officer

_____
Repair Officer

Copy to:
Repair Officer
Radiographic Safety Officer
Radiography Files

FIG. 1

RT UTILIZATION LOG

SURVEY NUMBER	DATE	SOURCE SERIAL NUMBER	MR BEFORE EXP.	DEVICE USED	RADIO-GRAPHER	SITE USED	TIME OUT	TIME IN	MR AFT. EXP	MR STOR	REMARKS

SIEMAINST 5100.8E
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FIG. 2

SIERRAINST. 5100.8E
60:jlc

Radiographic Source Transport Request

NDT File #_____ Date:_____

From: Non-Destructive Test Lab, U.S.S. Sierra (AD 18)
To: Radiographic Safety Officer, U.S.S. Sierra (AD 18)

Via: (1) Command Duty Officer, U.S.S. _____
(2) Command Duty Officer, U.S.S. SIERRA (AD 18)
(3) Officer of the Deck, U.S.S. SIERRA (AD 18)

Subj: Radiography to be performed on board U.S.S. _____
Compartment #_____ Frame _____ Port Stbd C/L
Noun Name of Compartment _____
Job Order # _____ Noun Name of Job _____

Source Type	Source Strength	Source Serial	Dose Rate Exposed at 1 Foot/Calculated

Radiographer	Assistant Radiographers
Radiation Safety Officer Sig:	
_____	

Command Duty Officer Signature Date
U.S.S. SIERRA AD 18 _____ _____ _____
Time of Departure

Officer of the Deck: Enter In Log
U.S.S. SIERRA (AD 18) _____ _____ _____
Time of Departure

Command Duty Officer Signature Date
U.S.S. _____
_____ _____ _____
Time of Arrival

Radiographic Operations have been completed on board
U.S.S. _____
Command Duty Officer Signature Date
U.S.S. _____ _____ _____ _____
Time of Departure

Officer of the Deck: Enter in Log
U.S.S. SIERRA AD 18 _____ _____ _____
Time of Arrival

Radiographic Operations have been completed or board the U.S.S. _____ and the Radiographic Source has been returned to the Vault on U.S.S. SIERRA AD 18.
Signature of the Senior Radiographer at the Job Site:

_____

Acknowledgement:
Command Duty Officer Date Time
U.S.S. SIERRA AD 18
_____ _____ _____

Fig. 3

Acknowledgement;
Radiographic Safety Officer/
Duty Repair Officer:
U.S.S. SIERRA AD 18 Signature Date Time

_____ _____ _____

SIERRAINST 5100.8E
60:jlc

RADIOGRAPHIC SURVEY RECORD

ND" #_____ DATE_____ TIME_____

SHIP_____ COMPT_____

_____SHOTS AT _____MINUTES _____SECONDS

LIST RADIOGRAPHERS, ASSISTANTS, FIELD PERSONNEL AND RADIAC INSTRUMENTS USED ON REVERSE.

==========

Survey Sketch

FIG. 4

Senior Radiographer _____

Radiographer(s) _____
(include assistants, _____
and other personnel _____
needed.) _____
_____
_____
_____
_____
_____

Radiac Instruments _____
_____

(include type used _____
and serial no.) _____
_____
_____
_____
_____
_____
_____

SURVEY INSTRUMENT CALIBRATION RECORD

A. Model Number:_____ Serial Number:_____

B. Date of Calibration:_____ Calibration Agency:_____

C. Radiation Safety Officer's Initial:_____

D. Additional Remarks:_____

_____

_____

_____

_____

_____

_____

FIG. 5

SIERRAINST 5100.8E
60:jlc

RECORD OF OCCUPATIONAL EXPOSURE TO IONIZING RADIATION

FOR INSTRUCTIONS, SEE REVERSE OF SHEET

1. IDENTIFICATION NUMBER	2. NAME (Last, first, middle initial)	3. SOCIAL SECURITY NUMBER	4. RANK/RATE TITLE OF POSITION	5. DATE OF BIRTH (Day, month, year)

PLACE WHERE EXPOSURE OCCURRED	PERIOD OF EXPOSURE		DOSE THIS PERIOD (rem) 1. Method of monitoring is presumed to be film badge reading unless otherwise specified under Item 16, "REMARKS."				ACCUMULATED DOSE (rem)		INITIAL
ACTIVITY	FROM (Day-Mo-Yr)	TO (Day-Mo-Yr)	SKIN DOSE (Soft)	GAMMA AND X-RAY	NEUTRON	TOTAL THIS PERIOD	TOTAL LIFETIME	PERMISSIBLE LIFETIME 5(N-18)	PERSON MAKING ENTRY
6	7	8	9	10	11	12	13	14	15

16. REMARKS (Continue on additional sheet if necessary)

INSTRUCTIONS FOR PREPARATION OF DD FORM 1141

ITEM

1. Enter file, service, badge, check, or clock number by which individual is currently identified.

2. Enter last name, first name, and middle initial. If the combination of last name and first name exceeds 19 spaces, enter last name and initials only.

3. Enter Social Security number.

4. Enter in not more than 10 spaces, rank, rate, grade, title or position that the individual is currently holding. Use standard service abbreviations, e.g., CAPT, MC; HMCS, HM1; SSGT; LCPL, etc. Abbreviate civilian occupation titles as necessary, e.g., Radiological Physicist to Rad Physic, Radiation Physiologist to Rd Physiol, Electrical Welder to Elec Wldr, etc.

5. Enter date of birth by day, month, and year, e.g., 21 Sep 1918.

6. Enter name of activity or unit.

7 and 8. "Period of Exposure." Enter the day, month, and year, e.g., 1 Oct 62.

7. Enter the day, month, and year exposure period began.

8. Enter day, month, and year exposure period ended.

9 through 12. "Dose This Period." Enter radiation dose received this period to three decimal places, e.g., 0.345 rem. All entries shall be made using five digits including zeros as necessary.

9. Enter skin dose (soft) which includes low energy gamma and x ray of less than 20 KEV effective energy and beta radiation. Total skin dose is the visual addition of columns 9 and 12.

10. Enter gamma and x-ray dose greater than 20 KEV effective energy in rem.

11. Enter Neutron dose in rem.

12. Enter sum of items 10 and 11.

13. Add item 12 to previous item 13; enter total in item 13.

14. Enter permissible dose calculated from the age formula 5(N-18) rem, where N equals the present age in years.

15. Recorder certify entries by initialling.

16. Enter other pertinent information such as known exposure from internally deposited radioactive material or from any external radioactive sources. Describe briefly any activity or assignment bearing a potential for exposure and estimate dose-time relationships, if feasible. If this form is used for other than whole body and skin of whole body, specify the use; i.e., hands and forearms, feet and ankles, thyroid, etc. When recorded dose is not obtained from film badge readings, specify whether estimates were obtained from pocket dosimeters, area or air monitoring, bioassay, etc.

NOTE:

This record is required on all individuals who are employed by or are members of the Armed Forces and who have been or are being occupationally exposed to ionizing radiation. It shall be the responsibility of each activity of the Department of Defense having personnel so exposed to initiate and maintain this record in accordance with AR 40-14/BUMEDINST 6150.15 series/AFR 161-8/DSAR 4145.24. (29 Sept. 1966)

SIERRAINST 5100.8E
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MONTH AND YEAR _____

POCKET DOSIMETER LOG

NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL

_____

SENIOR RADIOGRAPHER

FIG 7

RADIOGRAPHIC SOURCE ACCOUNTABILITY RECORD

GSECRAINST 5100.8E
GO:jlc

SOURCE TYPE	AMOUNT	DATE REC'D	ARRIVAL MR READING		REC'D FROM	DATE SHIPPED	SHIPPED TO	SHIPPING MR READING		SOURCE SER. Nº	RAD. SAF. OFF. INIT.
			CONTACT	AT 3 FT				CONTACT	AT 3 FT		

FIG 8

THE ACCOUNTABILITY RECORD SHALL BE KEPT IN A BOUND, HARD COVER LEDGER, ALL ENTRIES SHALL BE ENTERED IN INK, AND NO ERASURES SHALL BE PERMITTED.

1. The Radiation Safety Officer will conduct refresher training for radiographic personnel at least annually. The general outline of this refresher training will be as follows:

a. Qualification Indoctrination

b. Basic Atomic Structure

c. Fundamentals of Ionization, Radiation, and Radiation Exposure

d. Radiation Exposure Limits, Hazards of Excessive Exposure, and Biological effects of Radiation.

e. Personnel Monitoring Devices

f. Stay time and Exposure Control

g. Operation and Emergency Procedures

2. A written examination will be administered annually. The examination will be made up using the following guidlines:

a. Examination shall have a minimum of twenty five questions.

b. At least ten questions will be of the fill-in type.

c. The recommended number of questions on each subject area are:

1. Biological effects of Radiation (2)

2. Radiation Survey Instruments and Personnel Monitoring Devices (3)

3. Radiation Survey Requirements (4)

4. Access Control for Radiographic Areas (2)

5. Security of Radiographic Sources (2)

6. Emergency Procedures (4)

7. Inspection and Maintenance Requirements (4)

8. Transportation of Radiographic Sources (1)

9. Operating Procedures (2)

10. Basic Atomic Physics (1)

d. A passing grade of 80% must be obtained. Any individual who does not acheive a passing grade will be instructed in deficient areas and re-examined.

e. Any question that is missed, will be reviewed with the individual to ensure he has the required knowledge level.

3. The instrutor guides contained in tabs (a) through (g) to this enclosure will be used to ensure all areas mentioned in paragraph 1. of this enclosure are covered. All instructor guides will be reviewed by the Senior Radiographer and Radiation Safety Officer at least annually for updating.

DISCUSSION POINTS | RELATED INSTRUCTION ACTIVITIES | TRAINING AIDS

TOPIC 1

QUALIFICATION INDOCTRINATION TRAINING

I. Learning Objectives;

a. Upon successful completion of this course each worker will have a full understanding of how to work in radiation and be able to handle radioactive sources safely. This will be accomplished by an end of course written exam and a minimum score of 80% will be required for successfull completion.

II. Enabling Objectives:

The Radiographers or Assist Radiographer will be able to properly:

a. Handle and operate radioactive sources used in industrial radiography in a safe and proper manner.

b. Properly fill out a dosimeter log.

c. Read pocket (self reading) dosimeter.

d. Know the difference between the energy units.

e. Understand and explain the importance of stay time.

f. State the limits for whole body penetrating radiation.

g. Know the penalties for violating radiation warning signs.

h., Understand the importance of keeping track of his exposure to radiation.

DISCUSSION POINTS	RELATED INSTRUCTION ACTIVITIES	TRAINING AIDS

TOPIC I

QUALIFICATION INDOCTRINATION TRAINING

(1) Daily

(2) Weekly

(3) Quarterly

(4) Yearly

DISCUSSION POINTS | RELATED INSTRUCTION ACTIVITIES | TRAINING AIDS

TOPIC 2

BASIC ATOMIC STRUCTURE

I. Learning Objectives:

The purpose of this topic is to provide those personnel involved in Radiography with knowledge and/or review (refresher training) in the fundamental physics involved in the use of radioactive isotopes for radiography.

The student will acquire knowledge of:

a. What an atom is.

b. The composition of an atom.

c. Where radiation originates in the atom.

d. What radioactivity is.

II. Presentation:

A. Structure of Matter:

1. Early Concepts

a. Speculation Begins about 460 B.C.

(1) Demoritus - Greek Philosopher. who believed matter to be made up of very small invisible particles.

(2) Aristotle - Did not accept these ideas.

(a) Considered matter to be composed of four qualities.

1. Hot

2. Cold

3. Wet

4. Dry

(b) Dryness & Hotness made Fire

(c) Dryness & Coldness made Earth

(d) Wetness & Coldness made Water

(e) Theories persisted until the 17th century.

(3) Cassendi of France - put forth the theory that tiny invisible balls of matter, had tiny hooks, by which they connected together to join a substance.

(4) Newton - believed that solids, liquids, gases and light were composed of atoms or small particles that could not be subdivided.

(5) Lavoisier - In 1774 proved that air was composed of two substances:

(a) Oxygen

(b) Hydrogen

(c) Later went on to discover and identify 20 elements.

b. Mendeleev in 1869 developed periodic table of elements.

c. Geissler showed that electricity could flow through space.

d. Roentgen in 1895, showed that rays, unknown to him caused certain Chemicals to become fluorescent and could penetrate solid substance.

e. The Curies isolated, from pitchblend a bit of material that they called radium.

(1) The rays produced from radium affected photographic film - They called this effect Radioactivity.

2. Compounds - A chemical combination of elements:

Compounds are broken down into molecules.

Example of Compounds

a. Wood

b. Rock

c. Rubber

d. Salt

e. Water

3. Molecules - Made of elements.

4. Elements - Chemical substances that cannot be divided into simpler substances by Chemical means.

a. Smallest particle of an element is called an atom.

5. Atom: The smallest unit of matter which may enter into a chemical reaction.

DISCUSSION POINTS	RELATED INSTRUCTOR ACTIVITIES	TRAINING AIDS

TOPIC 2

a. Structure of the atom

Draw:
Diagram of the atom

Chalkboard and chalk:
Preferably two colors

(1). Nucleus: The heart of the atom, which is similar to the sun in our solar system. Composed of two parts.

(a) Proton - A particle carrying a unit positive electrical charge.

Draw proton and neutron into the nucleus

(b) Neutron - Electrically neutral particle having approximately the same mass as the proton.

(2). Electron or Electron field - Which is similar to the planets traveling around the sun. A particle carrying a unit negative electrical charge.

(a) Positron - A particle having the same mass as the electron but with a unit positive electrical charge.

b. Physical nuclear states of the atom.

(1) Rest or stable - Nucleus is quiet like a calm clay.

(2) Unrest or Unstable - Nucleus is raging, such as lighting & thunder during a bad summer storm.

c. Radiation: Born, created, or generated when the nucleus of an atom is in the unrest state.

DISCUSSION POINTS	RELATED INSTRUCTOR ACTIVITIES	TRAINING AIDS

TOPIC 2

(1) Unrest state signifies that there is an excess of energy in the nucleus of the atom.

(a) Energy must be given off to gain or regain a rest state.

(b) Excess energy may pass off as.

1. Gamma Radiation

2. Beta Radiation

3. Neutron Radiation

4. Alpha Particals

(c) This radiation may pass off as a single unit or as any combination as mentioned above.

(d) When an un-rest atom passes off energy, the process is called disintegration.

1. Disintegration will continue until the nucleus gains or regains its rest or stable state.

2. The nucleus of an atom may gain an excess of energy by natural cause or by being affected by other disintegrating atoms.

III. Summary:

A. Structure of Matter

1. Early Concepts

2. Compounds

3. Molecules

4. Elements

5. Atom

a. Structure of the Atom

b. Physical nuclear States of the Atom

c. Radiation

TOPIC 3

FUNDAMENTALS OF IONIZATION, RADIATION, AND RADIATION EXPOSURE UNITS

I. Learning Objectives: Upon successful completion of this topic the trainee will be able to:

A. Define what Ionization is and develope an understanding of Ionization.

B. Understand and define radiation fundamentals.

C. Define the Radiation Exposure Units.

II. Presentation:

A. Radiation Fundamentals:

1. Natural background contributes about 200 millirem of Radiation exposure to the human body at sea level each year of our lives.

2. Natural Background Radiation.

a. Cosmic Radiation: From the solar system contributes 33 to 35 MREMS a year.

b. The Earth's Crust: The land we live on, the car we drive, and the house we live in contribute 40 MREMS a year.

c. Our Own Bodies: Contributes 25 MREMS a year.

d. People who live 5000 feet above sea level will get approximetly 35 MREM a year more from cosmic radiation than people who live at sea level. This amounts to about 100 MREM per year.

3. Other sources of ionizing radiation which affect us are:

a. Medical X-Ray

b. Release of radioactive material by mining, milling etc.

c. Nuclear Weapons development

4. All ionizing radiation that interacts with our bodies does some biological damage even though we cannot detect the effects of low limit radiation exposure, or even prove that damage is really done at all. We have been affected by low level exposure all our lives without noticeable affects.

B. Basic Fundamentals of Ionization;

1. Ionization Process.

a. Any action which disturbs the electrical balance of the atoms, that make up matter, is referred to as ionization.

Draw diagram of ionization Ref: page 25 figure 4.1 Industrial Radiography Manual

C/B Industrial Radiography Manual

b. Atoms, molecules, and various sub-atomic particles which have a positive or negative electrical charge are called ions.

c. Free electrons, not attracted to any parent atom, are called negative ions.

d. An alpha particle carries a plus two positive ion.

e. Dislodged electrons may cause other electrons to be driven from their orbits in what is called secondary IONIZATION.

(1) Process may continue in fact, until the energy of the dislodged electron is below that necessary to drive other electrons from their orbits.

(2) This particular process is the principal reason behind the various biological effects of radiation.

e. Radiation, either particles or electromagnetic, has the ability to Ionize.

C. Ionization by Particles.

Draw diagram of ionization by particle radiation Ref: page 25 figure 4.2 Industrial Radiography Manual

Chalkboard, Industrial Radiography Manual

1. There is an energy transfer from particle to orbital electrons.

2. In this process the moving particle is slowed down.

a. Energy of particle falls below that needed to ionize (ability to dislodge orbital electrons) particle may still impart some energy, or excite electrons.

3. Alpha Particles - Travel about 2"

a. Alpha Particle is relatively large & slow moving.

b. These factors cause it to have a high ionizing effect.

c. Positive charge cause alpha particles to dislodge nearby electrons due to COULOMBIC ATTRACTION.

Explain Coulomb's Law

4. Beta Particles - Travels much farther in matter than Alpha.

a. Much smaller than a alpha particle of the same energy.

b. Travels at high rate of speed.

c. Less electrical charges than Alpha Particles.

d. Low specific ionization effect

e. Speed - Ranges are proportional to its energy.

5. Neutron - Does not ionize directly. Has no charge.

a. Neutron passing through matter has a negligible effect upon orbital electrons.

b. The neutron could strike the nucleus of an atom and cause a reaction which will ionize.

(1) Nucleus may absorb the neutron and then emit particles, thus causing ionization.

(2) Nucleus, which is a charged particle, may record and produce some ionization.

D. Ionization by Electromagnetic Radiation.

1. Gamma and X-Rays are not particles.

2. No mass or weight.

a. Therefore they do not produce ionization directly by collision as do Alpha and Beta Particles.

b. Rays travel at the speed of light.

(1) Do not lose their energy as readily.

(2) Lose their energy to atoms by:

(a) Photoelectrical Absorption.

(b) Compton scattering.

(c) Pair production.

(3) Atom absorbs by one of these processes.

(a) Charged Particle is emitted.

(b) Usually an electron.

(c) May then produce ionization in a manner similiar to that of other ionizing particles.

3. Photoelectrical Absorption Process. Show diagram of this process

a. Energy will be used to dislodge the electrons from its orbit.

b. Remainder will be used to give the electron kinetic energy or a velocity.

4. Compton Effect. Show diagram of this process on C/B

a. Photon does not lose all of its energy to an orbital electron.

b. Dislodged electron is emitted at an angle to the path of the original photon.

c. Also a lower energy photon is scattered at an angle to original photon.

5. Pair Production.

a. In this process, a high energy photon approaches the nucleus of an atom and converts from energy into an electron - positron pair. Show diagram of this process on C/B

E. Radiation Exposure Units.

1. Roentgen.

a. Roentgen (R) is the quanity of Gamma or X-Radiation which will produce a specific amount of ionization in a cubic centimeter of air.

b. Radiation Absorbed Dose (RAD). A RAD is used for all types of absorbed radiation in material. Unlike the Roentgen, the Rad is used to measure X and Gamma radiation only.

c. Roentgen Equivalent Man (REM). A REM is the unit which expresses the biological effect produced in humans for any type of radiation.

d. Relative Biological Effectiveness (RBE). The RBE is a factor used to express in equivalent terms the effects, that the various types of radiation have on the body.

(1)

TYPE	DOSE	RBE	TOTAL
X & Gamma	1R	1	1REM
High Speed Neutron	1R	10	10REM
Alpha	1R	20	20REM

TOPIC 4

RADIATION EXPOSURE LIMITS, HAZARDS OF EXCESSIVE EXPOSURE WITH BIOLOGICAL EFFECTS OF RADIATION

I. Learning Objective - Upon successful completion of this topic, the trainee will know:

A. The Radiation Exposure Limits.

1. As set forth by the Nuclear Regulatory Commission.

2. As set forth by Navy Medical P5055 and Sierra Instruction 5100.8E

B. The Hazards and Biological Effects of Excessive Exposure.

II. Presentation:

A. Radiation Exposure Limits.

1. Radiation Exposure Limits have been established to keep exposure at a minimum.

a. Reason for protection Limits.

(1) Serious Biological Damage.

(2) May cause death.

2. Nuclear Regulatory Exposure Limits and requirements.

a. All radiographers, and radiographer assistants shall be at least 18 years of age.

b. Accumulative Dose will be computed at the rate of 5 REM for every year above the age of 18.

c. A maximum of 1.25 REM can be received per calender quarter to the whole body. This can only be exceeded under certain conditions.

(1) Accumulated Occupational Dose must be known.

(2) Permissible Accumulated Dose.

(3) Individuals must have an excess in their accumulative bank.

3. Radiation Protection Limits for U.S.S. SIERRA.

a. Weekly - For administrative control, no person shall receive more than 100 MR whole body exposure in a calendar week.

b. Quarterly - In accordance with NAVMED P-5055, no person shall receive more during any calendar Quarter than the following.

(1) Whole body, lens of eye 1.25 REM

(2) Hands and forarms, feet and ankles 18.75 REM.

(3) Skin 7.50 REM.

(4) Thyroid 7.50 REM.

(5) Exceptions. Whole radiation exposure may exceed the limits above provided that:

(a) The exposure does not exceed 3 REM in a calendar quarter.

(b) If the individual's prior exposure history is known and the accumulated occupational exposure to the whole body does not exceed 5(N-18) REM where N equals the individual's age in years.

(c) The Commanding Officer has personally authorized exceeding the administrative limits above and has specified revised administrative Control limits.

B. The Dose size that causes biological problems.

1. Acute Doses of 0-25 (REM) no detectable clinical effects. No increased risk of Genetic change.

2. 25-50 (REM) - Possible, slight transient blood changes. No other detectable clinical effects. Genetic effects slightly higher risk of genetic change over spontaneous mutation.

3. 130-170 (REM) - Vomiting and Nausea for about one (1) day, followed by other symptoms of radiation sickness in about 25% of personnel exposed. No deaths anticipated.

4. 170-220 (REM) - Depression of practically all blood components. Reduced vitality. Nausea and vomiting in about 50% of personnel exposed. Convalescent period of three to six months. Fatal to 5% in two to six weeks. Significant delayed effects. Genetic change at least twice the spontaneous rate.

5. 270-330 (REM) - Vomiting and nausea in nearly all personnel on the first day followed by other symtoms of radiation sickness. Fatal to 20% in two to six weeks following exposure. Significant delayed effects. Recovery period of three to six months. Genetic change two to three times the spontaneous rate.

6. 400-500 (REM) - Immediate incapacitation. Fatal to 50% in two to six weeks. Major delayed effects. High percentage of permanent disability. Possible permanent sterility in some instances. Recovery period six to eight months.

7. 550-750 (REM) - Immediate incapacitation. Fatal to 50% to 95% within thirty days.

8. 1000 (REM) - Probably 100% fatal within fourteen to thirty days.

9. 5000 (REM) - Fatal to all personnel within seven days.

10. 10,000 (REM) - Disruption of the central nervous system and cardiovascular function. Death within minutes or hours.

11. 100,000 (REM) - Spastic seizures, death within seconds.

C. Hazards of Excessive Exposure.

1. Radiation produces its effects by altering the functions of the cells of the body. The serious aspect of radiation damage is that radiation can penetrate to any cell of the body and an over exposure to high energy radiation can cause radiation sickness which often leads to death, though a slow recovery is sometimes possible.

2. The human being even an adult, who is no longer experiencing overall growth has many tissues whose cells must undergo division througout life.

   a. Hair and finger nails grow constantly as a result of cell division at their roots.

   b. The outer layers of the skin are steadily lost through abrasion and are replaced through constant cell division in the deeper layers.

   c. Lining of the mouth, throat, stomach, and intestine tissue is constantly replaced by cell division and blood cells are constantly breaking up and must be replaced in vast numbers.

3. If radiation kills the mechanism of division in only some cells, it is possible for the remaining cells to divide and replace or do the work of those that can no longer divide.

   a. Past a critical point, when too many cells are made incapable of division, symptoms will:

      (1) Appear as a loss of hair.

      (2) Misshaping or loss of fingernails.

      (3) Reddening and hemorrhaging of the skin.

      (4) Ulceration of the mouth.

      (5) The lowering of the blood cell count.

      (6) Eventual death.

4. A study of the effects of radiation on the human body indicates that the following organ and tissue groups are affected most by radiation.

   a. Blood and bone marrow.

   b. Lymphatic System (spleen and other tissues).

   c. Skin and hair follicles (cells).

   d. Alimentary canal (guts).

   e. Adrenal gland.

   f. Thyroid gland.

   g. Lungs.

   h. Urinary tract.

   i. Liver and gall bladder.

   j. Bone.

   k. Eyes.

   l. Reproductive organs.

5. Effects on human organs and systems.

   a. Skin.

      (1) The immediate effects of external radiation exposure are seen most often as changes in the skin.

      (2) The rate of appearance, extent, and severity of these changes is related to the energy and quantity of radiation received.

(3) The clinical symptoms associated with radiation injury to the skin have been described as follows.

(a) ERYTHEMA (reddening of the skin) appears on exposure to more than 200 or 300 Rem. It is equivalent to a mild sunburn or a thermal burn of the first degree. A temporary reddening may be present within hours after exposure, assosiated with a sensation of warmth or itching. The major redness appears two or three weeks later. The time interval depends on the dose received. In the lower dose range no further changes may occur, and medical care beyond careful observation is not necessary. A similar reaction has been observed in the white of the eye and front chamber of the eye within 30 minutes after irradiation. The erythema reaches a peak in about one day and ends in about one week.

(b) Depilation, or loss of hair, may occur after exposure to any form of radiation in doses of about 200 Rems or more. Regardless of the dosage, it generally becomes apparent two or three weeks after exposure. Associated skin or scalp tenderness may occur one or two days preceding the actual hair loss. With doses greater than about 500 Rems, depilation may be complete. If the exposure is much greater than 600 rads, hair may not regrow.

(c) Transepidermal injury is equivalent to a thermal burn of the second degree blister form. The blisters will break open, leaving raw, painful wounds that are very vulnerable to infection. They may occur within one or two weeks after exposure, depending on the dose received. The burns are accompanied or preceded by erythema or depilation. Recognizable injuries of this grade require skin doses in excess of 1,000 Rem. The amount of medical care depends on the size and severity of the burn. With higher doses, probably on the order of 5,000 Rem, a more serious version of transepidermal injury occurs, in which the injury resembles a scalding or chemical burn. Pain is prompt and intense. The raw area may be very slow in healing or may not heal until surgical resection and skin grafting is performed.

(d) Measurements of the level of circulating blood cells is one of the most useful and simplest indicators of radiation effect. The fluctuations in the count are the result of changes in production and the destruction rates, as well as in the life span of the particular cell line. These levels are associated with various degrees of radiation injury. The changes themselves are non - specific. However, when combined with the exposure history or clinical information, they are useful indicator of radiation overexposure. In moderate injuries where survival is possible, the blood cell count begins to fall within 3 to 5 days after exposure. This drop continues until its low point is reached between 25 to 35 days following the exposure. The recovery period begins about the 40th day and continues for about

the next 3-4 months. In severe injury cases, where survival is unlikely, the blood elements drop radically within 8 to 36 hours. Death soon follows from massive, overwhelming fevers, infection and hemorrhage. Radiation is harmful to body tissue and exposure to large doses may result in death. However, with modern knowledge of radiation, one may work in the presence of radiation without harmful effects.

III SUMMARY:

A. Radiation Exposure Limits

1. Radiation Exposure Limits have been established to keep exposure at a minimum.

2. Nuclear Regulatory Exposure Limits and requirements

3. Radiation Protection Limits for U. S. S. SIERRA

B. The dose size that causes biological problems.

I. Learning Objectives: Upon completion of this lesson the trainee will be able to explain how, why, and where personnel montoring devices are worn by the radiation worker, in order for the devices to do an adequate job of collecting exposure data.

Presentation:

A. Monitoring devices are used to estimate exposure dose and collect exposure data for records.

B. Types of monitoring Devices.

1. Self Reading Dosimeter.

Show Pocket Dosimeter

a. Estimates exposure data.

(1) To avoid over exposure.

(2) To maintain an exposure estimate record for protection.

Pocket Dosimeter

b. Affected by:

(1) Shock.

(2) Heat.

(3) Leakage of charge.

c. May be read by:

(1) Place in front of a light source and look through the lens and observe the scale.

INSTRUCTOR DEMONSTRATE

Enclosure (12)

d. Type of dosimeter used.

(1) Low range (0-200 MR).

e. Dosimeter measures photon radiation only.

(1) X - Radiation.

(2) Gamma Radiation.

f. How to read the scale factors.

Instructor demonstrate how to read scale using the C/B

C/Board

(1) Low range.

2. Photographic Film Dosimetry.

a. Collects exposure data for permanent legal document.

(1) Not a self reading device.

(2) Film must be developed and compared to a chart of known exposures.

b. Affected by.

(1) Heat

(2) Light.

(3) Moisture

C. Personnel Monitoring Devices must be worn together between the neck and waist.

1. Never greater than two inches apart.

2. Must not be placed elsewhere.

3. Shirt pocket or belt most practiable.

D. SUMMARY

1. Personnel monitoring devices are instruments to gather exposure data.

   a. Film Badges - legal record.

   b. Pocket Dosimeter - self reading estimate of current exposure.

2. Monitoring devices must be worn between the neck and waist, not more than two inches apart.

3. Monitoring devices must be protected from excessive heat, moisture, shock and abrasion by rubber and plastic, and must not be tampered with.

   a. Make certain that you can read any pocket dosimeter you are issued in terms of MREM.

   b. Protect dosimeter against sharp raps; take every precaution to prevent dropping or losing them.

   c. Promptly read any dosimeter you have dropped or which has been struck or otherwise handled roughly. Rough handling tends to discharge the dosimeter and give false readings.

   d. In radiation areas, frequently read the dosimeter in order to prevent it from going "off scale".

e. Promptly leave the area anytime you note a dosimeter.

(1) Off scale.

(2) Close to your CAN-GET limit.

(3) Apparently leaking or drifting.

(4) Reading approximately 3/4 of its full scale.

NOTE: Report any and all the above discrepancies to your supervisor.

f. Film badges must be protected from excessive heat, dampness, breakage of paper wrapper or loss. Again, report any discrepancies to your supervisor.

g. The film badge must be returned to its proper storage rack when not actually worn for the purpose of entering a radiological control area.

DISCUSSION | RELATED INSTRUCTOR ACTIVITIES | TRAINING AIDS

TOPIC 6

STAY TIME AND EXPOSURE CONTROL

I. Learning Objectives: Upon successful completion of this topic, the worker will know and understand:

A. How Dose rate is reduced by:

1. The distance from a radiation source.

2. The time that is spent in a field of radiation.

3. Shielding the radiation from the source.

B. How to calculate stay time and that, stay time assists the worker in avoiding overexposure beyond his permissible limits.

II. Presentation:

A. There are three basic methods to control exposure to ionizing radiation. They are:

1. Distance - The farther we are from a source of radiation, the less exposure we will receive in some unit of time.

a. May be accomplished by:

(1) Predetermine or calculate the radiation field intensity. This should be accomplished prior to use so as to afford the RAD worker the greatest distance possible from the source of radiation.

(2) Frequently use survey meters to verify proper calculations.

(2) Concrete - 1'9" = 1 HVL using IR 192

(3) Steel - .53" = 1 HVL using IR 192

(4) Using CO 60, 1 HVL of lead = .5"

(5) Using CO 60, 1 HVL of Concrete = 2'7"

(6) Using CO 60, 1 HUL of Steel = .87"

Write on C/B Table of HVL's using IR 192 & CO - 60

3. Time in a radiation field is the last resort to control a radiation worker's exposure. This method is used when distance and/or shielding cannot be applied in sufficient quantities.

a. The time control method does not reduce the dose rate per unit time in a radiation field.

b. The time control method suggests how long a radiation worker may stay in a certain radiation field without exceeding his maximum permissible exposure.

c. Stay-time is the factor used to determine how long a person may remain on a certain location in a radiation field without going over his permissible exposure.

(1) Stay-time is important because it is useful to:

(a) Avoid over-exposure

(b) Determine the length of time a radiation worker may remain on the job.

(2) Stay-time is calculated by the following formula:

EXAMPLE: Stay-time = $\frac{\text{Desired dose x 60 min.}}{\text{field strength}}$

If a radiation worker can get 300 mrem/week and he must work in a field that is reduced by shielding to 900 mr/hr, how much time can be spent on-the-job?

Example: Stay-time = $\frac{\text{300 mr x 60 min/hr}}{\text{900 mr/hr}}$

S.T. = $\frac{\text{300 x 60 min.}}{\text{900}}$

S.T. = $\frac{\text{18000 min.}}{\text{900}}$

S.T. = 20 min.

III. SUMMARY

A. The three basic methods of reducing exposure to ionizing radiation are time, distance, and shielding.

B. The order of importance to use for exposure control is:

1. Distance from the source.

2. Shielding to reduce the dose-rate.

3. Time allowed on the job without exceeding the permissible dose.

4. Time is the only method of expcsure control that will not reduce the dose-rate to the radiation worker.

5. The stay-time formula is:

Stay-time = $\frac{\text{Desired dose x 60 min.}}{\text{Field strenth}}$

TOPIC 7

OPERATING AND EMERGENCY PROCEDURES

I. Learning Objectives: Upon successful completion of this topic the trainee will understand SIERRA'S operating and emergency procedures. Trainee will also become thoroughly familiar with the contents of this procedure.

II. Presentation and Instructors Activities

A. Utilize each individual's Copy of the Operating and Emergency Procedures, SIERRAINST 5100.8E. Familiarize each trainee with each portion of this Procedure.

LEAK TESTING OF SEALED SOURCES

SIERRAINST 5100.8E
60:jlc
14 August 1980

1. All sealed sources shall be tested for leakage at intervals not to exceed six (6) months and upon receipt if not accompanied by a leak test record. The Senior Radiographer shall perform or personally supervise the actual swiping of all sealed sources. All swipe testing shall be conducted in the storage vault. The swipe tests shall be accomplished as follows:

a. The camera operation shall be in accordance with enclosure (5).

b. The swipe test tool (see attached drawing) shall be connected to the camera or storage container (as appropriate).

c. The sealed source shall then be run through the gauze covered disk and the returned back to the housed position.

d. Monitor the camera (or storage container) to insure that the source is retracted to the housed position.

e. Disconnect the swipe test tool from camera (or storage container) and remove from vault area.

f. Disassemble the swipe test tool over an area covered with disposable paper. NOTE: Rubber gloves shall be worn during this operation.

g. While still wearing the rubber gloves, place the gauze in an envelope or suitable container that is marked and identifies:

(1) Source type

(2) Serial number

(3) Date

(4) Command and address

(5) License number

h. Remove rubber gloves and isolate along with the swipe test tool and disposable paper until the test results are returned and indicates that the amount of removable contamination is less than .005 microcuries.

I. Hand carry the envelope containing the gauze to the nearest Naval Electronics Systems Command managed Radiac Repair Facility for processing.

2. Should the swipe test results be 0.005 microcuries or more of removable contamination, the source and all associate equipment shall be isolated. All areas that the source camera (or storage container) have come in contact with shall then be monitored for contamination. The source shall be disposed with IAW NRC regulations. The disposal shall be handled by the nearest NAVELEX Systems Command managed Radiac Repair Facility.

3. The Senior Radiographer shall maintain records of the source swipe dates and results in an auditable fashion.