NAVSEA TW120-AA-PRO-010

NUCLEAR WEAPONS RADIOLOGICAL CONTROLS PROGRAM

Further dissemination only as directed by COMNAVSEASYSCOM or higher DoD Authority

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NAVAL SEA SYSTEMS COMMAND- NAVY DEPARTMENT

Change 1 (JAN 2004)

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
1333 ISAAC HULL AVE SE
WASHINGTON NAVY YARD DC 20376-0001

IN REPLY TO

8128
Ser 04N/001
20 January 2004

From: Commander, Naval Sea Systems Command

Subj: CHANGE 1 to REVISION 6 OF NAVSEA TW120-AA-PRO-010, "NUCLEAR WEAPONS RADIOLOGICAL CONTROLS PROGRAM"

Encl: (1) NAVSEA TW120-AA-PRO-010 "Nuclear Weapons Radiological Controls Program", Change 1 to Revision 6 (JAN 2004) (Electronic Media Format)

1. Purpose. To promulgate Change 1 to Revision 6 of NAVSEA TW120-AA-PRO-010, "Nuclear Weapons Radiological Controls Program".

2. Discussion. Change 1 to Revision 6 of NAVSEA TW120-AA-PRO-010 incorporates rewrites of selected articles and appendices. In addition to editorial corrections, this revision includes the following significant changes:

a. Institutes an option for facilities to use NAVSEA Form 8128/6 for briefing documentation requirements for non-radiation workers. (Articles 104,107, 206)
b. Changes the non-radiation worker briefing requirements to annual vice each TLD issue period. (Article 206)

3. Action. All Navy activities that handle, stow or maintain nuclear weapons, or that actively support such activities shall implement Change 1 to Revision 6 upon receipt. In the event of conflict between this manual and guidance promulgated by other directives, the provisions of this manual shall be followed and the conflict promptly reported to COMNAVSEASYSCOM (SEA-04N) for resolution.

4. This publication is not available through Navy publication channels. Requests for addition to, or deletion from the "Distribution List", as well as request for changes in the number of copies provided, should be submitted to Officer in Charge, Naval Surface Warfare Center, Indian Head Division Detachment McAlester, 567 Army Ammunition Plant Road F, McAlester OK, 74501-5190.

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REFERENCES

Chapter 10 Code of Federal Regulations Part 20	Nuclear Regulatory Commission Standards for Protection from Radiation
Department of Defense Instruction 6055.8	Occupational Radiation Protection Program
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SECTION I INTRODUCTION

CONTENTS

In order to make the text of this manual easier to read and understand, the use of the singular pronoun “he” or “him” and the singular possessive “his” will be used. This usage should not be interpreted to indicate any disregard or lack of respect for gender, but rather reflects the difficulties associated with reading highly technical manuals. This manual contains many requirements for individuals, and these are more easily understood if the grammar is clear and unambiguous. The requirements of this manual are binding on all personnel of either gender, unless specifically addressed.

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101. INTRODUCTION AND PURPOSE

1. This manual establishes the requirements for the Navy's Nuclear Weapons Radiological Controls Program. This program is concerned with radiation exposure received during stowage, maintenance or handling of nuclear weapons and is not involved with radiation exposures from weapon detonation, fallout, Naval nuclear propulsion plants, industrial or medical sources. The Nuclear Weapons Radiological Controls Program was instituted as part of Department of the Navy policy to verify that radiation exposure to personnel does not exceed established limits and to ensure that exposure is as low as reasonably achievable (ALARA).

Because nuclear weapons have radioactive components, personnel near stowage areas and personnel who handle or maintain nuclear weapons may be exposed to low levels of radiation. This exposure is primarily external exposure from gamma and neutron radiation. Radiation protection associated with nuclear weapons is achieved through the implementation of the Radiation Health Program established by NAVMED P-5055 and this manual.

Throughout the history of handling, stowing, and maintaining nuclear weapons in the Navy, no individual involved in these activities has exceeded Federal radiation exposure limits. The Navy has improved both the measures to control radiation exposure and the ability to demonstrate that proper control is maintained.

2. The requirements of this manual apply to each ship, station or facility that stows, maintains, or handles nuclear weapons.

3. The Nuclear Weapons Radiological Controls Program, hereafter referred to as the Radiological Controls Program, was established by the Chief of Naval Operations, who directed action from the Chief of Naval Material (disestablished in 1985); Commander, Naval Sea Systems Command; Fleet and Type Commanders; and Commanding Officers. The Radiological Controls Program is sponsored by the Chief of Naval Operations (N-455). The Chief of Naval Operations designated Commander, Naval Sea Systems Command (SEA-04N) as program manager for the Radiological Controls Program in accordance with OPNAVINST 6470.2A.

4. DoD Instruction 6055.8 implements the United States Environmental Protection Agency "Radiation Protection Guidance to Federal Agencies for Occupational Exposure" of January 1987. OPNAVINST 6470.2 formalizes the uniform occupational radiation protection program for the Department of the Navy, required by DoD Instruction 6055.8, to preserve and maintain the health of personnel while performing duties involving occupational exposure to sources of ionizing radiation.

5. The Radiation Health Program is an essential element of Navy radiation protection efforts, and includes such areas as medical examinations, medical and dosimetry records, and administrative reports. Relevant sections of the Radiation Health Manual, NAVMED P-5055, have been included in this manual for clarity. This program is the responsibility of the unit's Medical Department or medical facility. The Radiation Health Program is discussed in Appendix D of this manual to assist the Nuclear Weapons Radiological Controls Officer in reviewing the Radiological Controls Program.

6. Radiation exposure is reported in units of "rem" or "mrem" (one thousandth of a rem), which allows the addition of exposures to different radiation types into a single quantity. While the effectiveness of absorbed radiation is dependent on the type of radiation, the energy involved, and the specific body tissues affected, the rem represents the equivalent overall body damage within the range of occupational doses. These factors are accounted for in the individual exposure report that each command receives from the Naval Dosimetry Center.

7. The provisions of this manual shall not be used to impede the entry of emergency response personnel (e.g., response to fire, flooding, or a security violation) into nuclear weapons stowage or maintenance areas. If emergency response personnel require entry, follow-on actions may include estimation of radiation exposures, internal monitoring, bioassays, and determination of the need for medical consultation and counseling of personnel involved.

8. The purpose of the Radiological Controls Program is to:

A. Reduce the total man-rem (collective dose) and maintain individual exposure from nuclear weapons to ALARA by monitoring and evaluating nuclear weapon radiation exposure levels inside and outside nuclear weapons stowage and maintenance areas and to ensure that established exposure limits are not exceeded.

B. Provide training and knowledge of the effects of low-level radiation to all nuclear weapons workers, their supervisors and all support personnel whose duties may require them to be in close proximity to nuclear weapons.

C. Establish and maintain the documentation to ensure that the nuclear weapons radiation exposure records are available to the individual and the Navy.

D. Continually assess the adequacy of work practices, shielding, protective measures, man-rem reduction actions and special design equipment for radiation protection in the nuclear weapons environment.

E. Ensure that Radiological Controls Program functions are consistent with the objectives of the Navy Occupational Protection Program and are effectively coordinated with the functions of the Radiation Health Program.

F. Control of radioactive waste.

102. DEFINITIONS

The following definitions are provided to ensure that terms used in this manual are understood. When used in the Nuclear Weapons Radiological Controls Program, the following definitions apply:

- Annual Limit on Intake (ALI). The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion within a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a CEDE of 5 rem or a CDE of 50 rem to any individual organ or tissue.
- As Low As Reasonably Achievable (ALARA). The concept or idea of minimizing personnel exposure to radiation within each command to the lowest practicable level, consistent with operational requirements, using the concepts of time, distance and shielding.
- Committed Dose Equivalent (CDE). The dose equivalent to organs or tissues of reference that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.
- Committed Effective Dose Equivalent (CEDE). The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.
- Control TLD. Unissued, but designated TLDs identified by the Nuclear Weapons Radiological Controls Officer and stored in a known low radiation area. Control TLDs are selected from each batch of TLDs for an issue period and are processed with exposed TLDs. Exposure data from the control TLDs is used to provide background radiation levels for comparison with the TLDs worn by exposed personnel.
- Deep Dose Equivalent (H_d). The dose equivalent at a tissue depth of 1.0 cm. Applies to external whole-body exposure to penetrating gamma rays and neutrons.
- Derived Air Concentration (DAC). The concentration of a radioactive material in air which, if breathed 40 hours per week for 50 weeks (2000 hr work year) will give a CEDE of 5 rem whole body.
- Exclusion Area. (Applies to both ships and shore facilities) Any designated area containing one or more nuclear weapons/systems. Aboard submarines this is defined as the missile compartment or torpedo room in areas where the two-person concept is enforced. At shore activities, exclusion areas refer to nuclear weapons magazines and associated production buildings when nuclear weapons are present.
- Limited Area. (Applies only to shore facilities) A security area containing one or more exclusion areas. Within the limited area guards or internal controls can prevent access by unauthorized persons to the exclusion areas. For most shore activities, the perimeter barrier defines the limited area.
- Maintenance Activities. Refers to shore facilities that perform maintenance on nuclear weapons.
- Man-Rem. The numerical quantity obtained by adding the exposure received by each individual member of the command. Man-rem expresses the total radiation

exposure for any given period (e.g., man-rem per year, per quarter). This also is referred to as collective dose.

- Members of the General Public. Individuals who are not occupationally exposed to ionizing radiation. Examples include: individuals who live and work outside the perimeter of a base or activity; family members of an employee or crew member who live on a base, but are outside the limited area; and visitors who will not enter nuclear weapon maintenance or storage areas. Escorted personnel who enter a nuclear weapons maintenance or stowage area for the purpose of servicing or replenishing vending machines or maintaining office equipment are considered members of the general public and are not occupationally exposed.
- Nuclear Weapons Non-Radiation Workers. Employees or crew members who may receive very low levels of radiation exposure from nuclear weapons incidental to their employment at a command or activity but not as an integral part of their skill, trade, or work assignment (e.g., crane operators, pier handling personnel, missile compartment roving patrol watchstanders, crew members bunking in areas in close proximity to a nuclear weapons magazine (i.e., SSBN missile compartment)
- Nuclear Weapons Stowage or Maintenance Areas. Refers to those locations where nuclear weapons are either permanently or temporarily stored, or areas where actual maintenance on nuclear weapons is performed. These areas include, but are not limited to, magazines, production areas, and maintenance areas. Aboard submarines, the following shall be considered nuclear weapons stowage areas: the area between the tubes in the missile compartment upper level, the equipment section of a missile, and the areas in the torpedo room within six feet of a nuclear weapon.
- Nuclear Weapons Radiation Worker. Individuals who receive exposure to ionizing radiation from nuclear weapons in the normal course of their employment or duties and are identified by their Command as being occupationally exposed. Normally, these individual's routine duties require working directly with sources of ionizing radiation and have a significant potential for worker exposure. These individuals receive medical examinations in accordance with Article 213 and training in accordance with Article 106 of this manual.
- Total Effective Dose Equivalent (TEDE). The sum of all external deep doses (from gamma rays and neutrons) and the dose from internal radiation caused by inhalation, ingestion, or absorption of radioactive material. (CEDE + H_d = TEDE)

103. RELATED INSTRUCTIONS AND DIRECTIVES

1. Instructions under the authority of the Chief, Bureau of Medicine and Surgery (CHBUMED) related to radiation health are NAVMED P-5055, "Radiation Health Protection Manual"; BUMEDINST 6470.10 series, "Initial Management of Irradiated or Radioactively Contaminated Personnel"; and NAVMEDCOMINST 1500.5, “Radiation Health Training for Designated Medical Department Personnel". These instructions provide the Radiation Health Program requirements for personnel exposed to radiation from nuclear weapons. The requirements of Chapters 4 through 7 of NAVMED P-5055 are incorporated into this manual with BUMED concurrence.

2. Radiological controls for the Naval Nuclear Propulsion Program are under the direction of Commander, Naval Sea Systems Command (SEA-08) and are contained in NAVSEA 389-0088, "Radiological Controls", NAVSEA 389-0288, “Radiological Controls for Shipyards" and NAVSEA S9213-33-MMA-000/(V), “Radiological Controls for Ships". The radiological controls programs for nuclear propulsion and nuclear weapons are separate and distinct. However, both are based on the same fundamental concepts and Federal limits and are consistent with each other as far as practicable.

2. Nuclear weapons accident and incident procedures are directed by the Chief of Naval Operations in OPNAVINST 3440.15, "Department of the Navy Nuclear Weapon Accident Response Management”, as well as DoD 3150.8-M, "Nuclear Weapons Accident Response Procedures”, applicable special weapons ordnance publications (SWOPS) and Type Commander directives.

4. If a conflict exists between the above documents or other radiological control directives with this manual, the provisions of this manual shall be followed and the conflict promptly reported to Commander, Naval Sea Systems Command (SEA-04N) for resolution.

104. SUMMARY OF RESPONSIBILITIES

A. FLEET COMMANDERS, TYPE COMMANDERS AND COMMANDER, NAVAL SEA SYSTEMS COMMAND

1. Fleet Commanders, Type Commanders and Commander, Naval Sea Systems Command (COMNAVSEASYSCOM) are required by the Chief of Naval Operations (CNO) to include, during each Nuclear Weapons Acceptance Inspection (NWAI) and each Navy Technical Proficiency Inspection (NTPI), a review of the Radiological Controls Program and Radiation Health Program. This requirement is not included in SWOP 25-1, "DoD Nuclear Weapons Technical Inspection System," and accordingly is not inspected during the Defense Nuclear Surety Inspections (DNSI). Commands undergoing a DNSI are inspected in the Radiological Controls and Radiation Health Program areas by the Service inspection team conducting the Augmenting NTPI. A summary of Nuclear Weapons Technical Inspection review items is included in Appendix D.

2. Fleet Commanders have directed the Trident Training Facilities (TTF) to develop and maintain a Nuclear Weapon Radiological Controls Officer (NWRCO) training course. The objective of this course is to train ship and station Nuclear Weapons Radiological Control Officers. The TTF develops material for the Radiological Controls Program that is included in existing nuclear weapons “A” school training courses and the Prospective Commanding Officer/Prospective Executive Officer training course. COMNAVSEASYSCOM (SEA-04N) provides guidance on the development of the materials, and must provide final approval of the curricula.

3. Type Commanders and COMNAVSEASYSCOM are required to ensure that each ship, station, and facility that stows, maintains, or handles nuclear weapons has an

effective Radiological Controls Program. The CNO has required each Type Commander to appoint a Nuclear Weapons Radiological Controls Officer to coordinate the Radiological Controls Program with technical support from COMNAVSEASYSCOM (SEA-04N).

B. RESPONSIBILITIES OF THE COMMANDING OFFICER

1. The Commanding Officer of an activity that stows, maintains, or handles nuclear weapons is required to:

a. Designate a Nuclear Weapons Radiological Controls Officer (NWRCO) and an alternate NWRCO in writing, and ensure that these individuals have met the training requirements of Article 109 of this manual.

b. Designate an adequate number Nuclear Weapons Radiological Controls Technicians in writing and ensure that they meet the training requirements of Article 108 of this manual. (Shore facilities only)

c. Furnish dosimeters, when required, to all personnel, including visitors, who enter nuclear weapons stowage and maintenance areas when nuclear weapons are present.

d. Reduce personnel exposure to radiation from nuclear weapons to ALARA.

e. Limit personnel in the vicinity of nuclear weapons to those essential to safely conduct handling, maintenance, inspections, and other operations.

f. Ensure that nuclear weapons stowage areas are not used for meetings, training that could be conducted elsewhere, or any other activity not essential to nuclear weapons work.

g. Return all Radiological Controls Program related material as directed by COMNAVSEASYSCOM (SEA-04N) upon permanent decertification, and, reinstitute all programs, if regenerated.

h. Notify COMNAVSEASYSCOM (SEA-04N) by message or letter within 15 days of reactivation if the nuclear capability of an activity is restored.

i. Ensure radiation surveys of all spaces are performed and documented upon permanent closure of nuclear weapons stowage or maintenance spaces.

j. Ensure a radiological controls audit and surveillance program has been established.

k. (Shore facilities) Ensure a radiological controls drill program has been established per Article 106.6 of this manual.

2. The Commanding Officer shall ensure that personnel are counseled when appropriate to prevent unwarranted concern about exposure to ionizing radiation. When counseling does not relieve such concerns, the Type Commander and COMNAVSEASYSCOM (SEA - 04N) should be informed.

C. RESPONSIBILITIES OF THE NUCLEAR WEAPONS RADIOLOGICAL CONTROLS OFFICER (NWRCO)

1. The Nuclear Weapons Radiological Controls Officer fills a key position in the command's effort to reduce exposure to radiation associated with the stowage, maintenance, or handling of nuclear weapons. The Nuclear Weapons Radiological Controls Officer shall:

a. Coordinate and direct the command's effort in man-rem (collective dose) reduction using methods described in Article 231 and inform the Commanding Officer of the status of these efforts. This requires the NWRCO to review each radiation exposure record from the Naval Dosimetry Center before the exposures are entered into the individual health records. This review includes assessing unusual exposures (higher or lower than anticipated) and determining the trend of total man-rem associated with the command's Radiological Controls Program. The result of each review shall be documented and retained for a minimum of three years.

b. Supervise all training associated with the program.

c. Supervise the process of authorizing ship and facility personnel (other than nuclear weapons workers), visiting nuclear weapons workers, and visitors (other than nuclear weapons workers) to receive exposure from nuclear weapons. The radiation records NAVSEA Form 8128/5 or NAVSEA Form 8128/6 are designed to assist in this process.

d. Answer questions concerning biological effects on personnel and the risks associated with low-level radiation exposure.

e. Review the Nuclear Weapons Radiological Controls and Radiation Health Programs at least every twelve months. The results of this detailed review shall be documented and retained for a minimum of three years. Appendix D is provided to assist in this review. These results of this review should contain a listing of all individual areas of review with findings and corrective action required.

f. Ensure radiation medical examination scheduling with the Medical Department is accomplished to ensure those personnel requiring medical examinations, in accordance with Article 213, receive the appropriate examinations as specified in NAVMED P-5055.

g. Ensure radiation surveys are conducted in spaces adjacent to or in close proximity to weapons stowage or maintenance areas and calculate the hourly and yearly exposure based on the survey, frequency of use and occupancy rate. Utilize these calculations to ensure the exposure limit for non-radiation workers and the general public is not exceeded.

h. Conduct audits and surveillances as directed.

i. (Facilities only) Prepare and administer a radiological controls drill program to include semi-annual drills.

2. The NWRCO shall supervise the disestablishment of the Radiological Controls Program upon permanent removal from capabilities listed in the Naval Atomic Planning, Support and Capabilities Report (SWOP 25-2), and shall supervise the re-establishment of the Radiological Controls Program if regeneration is ordered.

3. Upon decommissioning of facilities where nuclear weapons were stowed or maintained, the NWRCO shall initiate and supervise the performance of detailed radiation surveys of these spaces. COMNAVSEASYSCOM (SEA - 04N) shall be consulted for additional survey guidance and requirements. Submit survey plan and all closeout surveys to COMNAVSEASYSCOM (SEA - 04N) for approval.

D. RESPONSIBILITIES OF PERSONNEL

Each individual is responsible for maintaining his own radiation exposure ALARA. Each individual's actions directly affect his exposure and the exposure of others. Therefore, those personnel working in a nuclear weapons stowage or maintenance area shall observe the following rules to minimize radiation exposure. They shall:

1. Obey posted, verbal and written radiological controls instructions.

2. Wear the personnel dosimeter as directed and ensure that the dosimeter is not tampered with or used in other than the prescribed manner.

3. Know their current, annual and lifetime total effective dose equivalent (TEDE), the radiation control level, and the external radiation exposure limits applicable to the Radiological Controls Program.

4. Use the concepts of time, distance and shielding when working in the presence of radiation sources to maintain their exposures ALARA.

5. Avoid loitering in nuclear weapons stowage and maintenance areas.

6. Notify the NWRCO of faulty radiation detection instruments and lost or damaged personnel dosimeters.

7. Notify the Medical Department and the NWRCO if they have had recent administration of radioactive isotopes for medical purposes or if they wore a dosimeter while undergoing an x-ray or fluoroscopic procedure.

8. All female personnel are required to inform the NWRCO immediately if they become pregnant. This will ensure that the specific exposure limits associated with the unborn are initiated.

9. Ensure that radiological controls requirements are not violated.

105. RADIOLOGICAL CONTROL TRAINING REQUIREMENTS

A. VISITING NUCLEAR WEAPONS WORKER TRAINING STANDARD

DISCUSSION:

Personnel from other commands or organizations, who by the nature of their duties, require routine entry into nuclear weapons stowage and maintenance areas to perform or observe work directly on nuclear weapons, are trained equivalent to the host command nuclear weapons workers as required by Article 106. Examples of such personnel include inspectors, contractors, technical representatives, and Navy personnel who require access to the equipment section of a missile on an SSBN or are involved in maintenance or readying routines onboard an SSN (when nuclear weapons are present). The parent command of the visiting workers must have a functioning Radiological Controls Program, otherwise, these individuals will be treated as visiting non-weapons workers. The primary responsibility for the conduct of this training rests with the parent or sponsoring command or organization.

REQUIREMENTS

1. Those personnel from other commands and organizations who routinely enter nuclear weapons stowage and maintenance areas to perform or observe work on nuclear weapons shall be trained in accordance with the requirements of Article 106 by their parent command or sponsoring command. As an alternative, the host command may choose to assist the parent or sponsoring command by providing this training.

2. NAVSEA Form 8128/5 shall be used by the host command to document an individual's training status at his parent command or organization. NAVSEA Form 8128/5 shall be signed prior to entry into the stowage or maintenance area to verify that the individual is a member of a Radiological Controls Program, and that the training required by Article 106 has been received. A separate form need not be filled out every time an individual enters a nuclear weapons stowage or maintenance area if entry is required several times a day or on consecutive days (e.g., multiple visits during an

availability period). For those repeated visits the inclusive dates shall be recorded on one form, which may be used for a time period not to exceed one LiF TLD issue period. A subsequent briefing and NAVSEA Form 8128/5 is required for each additional issue period in which a visitor is monitored with a LiF TLD.

B. VISITING PERSONNEL OTHER THAN NUCLEAR WEAPONS WORKERS TRAINING STANDARD

DISCUSSION:

Personnel visiting from other commands or organizations who make infrequent entries into nuclear weapons stowage or maintenance areas when nuclear weapons are present but do not perform work on nuclear weapons are briefed prior to entry. Examples of such personnel include shipyard or contractor personnel performing work other than on nuclear weapons in a nuclear weapons stowage or maintenance area.

Visiting personnel who do not enter a nuclear weapons stowage or maintenance area do not need any special training or briefings related to the Navy Radiological Controls Program.

REQUIREMENTS

1. Prior to entering a nuclear weapons stowage or maintenance area, visiting personnel shall be instructed on the wearing of the dosimeter, to obey radiological controls boundaries, and to minimize time spent close to nuclear weapons. A statement that the visitor has received and understood the briefing shall be signed. NAVSEA Form 8128/5 shall be used for this purpose. This requirement applies whether or not the visitor is exposed to radiation in some other program and whether or not the visitor provides his own LiF TLD. This briefing may be used for one LiF issue period. A subsequent briefing is required for each additional issue period in which a visitor is monitored with a LiF TLD. Copies of the signed NAVSEA Form 8128/5 shall be retained for three years.

2. Personnel who are escorted while inside the limited area at shore facilities and do not enter nuclear weapons stowage or maintenance areas when nuclear weapons are present do not require the briefing described in this Article. These individuals include vending machine personnel, certain civilian contractors, and others under the direct control of permanently assigned individuals who have received training in accordance with Article 105 or 106.

C. UNBORN CHILD TRAINING

DISCUSSION:

Exposure of a female worker to ionizing radiation may also involve exposure of an embryo or fetus. Because a number of studies have indicated that the embryo and fetus are more sensitive to ionizing radiation than the adult, particularly during the first three months after conception, special precautions are taken to limit exposure when an occupationally exposed woman is pregnant. It is assumed by scientists that any amount of radiation exposure to the unborn child no matter how small, might involve some risk; however, exposure of the unborn child within accepted limits represents a risk that is small compared to other risks to the unborn child. All station and facility nuclear weapons workers should receive training on the nature of the potential risk to the embryo and fetus resulting from occupational exposure of the pregnant woman.

REQUIREMENTS:

1. All nuclear weapons workers shall receive instruction about prenatal exposure risks to the developing embryo and fetus. This instruction shall include the requirements of Article 204 of this manual and the applicable information in Appendix B. Female nuclear weapons workers will also be informed of their responsibility to notify their command of their pregnancy in order to limit the potential radiation exposure of the embryo/fetus from sources associated with duties as a nuclear weapons worker. This training shall be given prior to initial entry into a nuclear weapons stowage or maintenance area and issuing personnel dosimetry.

2. The training required by this Article shall be repeated annually. Written testing on this matter and subsequent documentation is required in accordance with Article 106 of this manual.

106. NUCLEAR WEAPONS RADIATION WORKER TRAINING STANDARD

DISCUSSION:

Ship and station nuclear weapons workers are defined as personnel whose duties require them to be exposed to ionizing radiation by working directly with nuclear weapons, or because their duties require routine entry into nuclear weapons stowage or maintenance areas (e.g., quality control personnel observing maintenance operations). Nuclear Weapons Radiological Controls Officers and Technicians are required to be fully trained and qualified radiation workers. Periodic radiological controls training is necessary to ensure that each worker understands the general and specific radiological conditions that may be encountered, understands his responsibility to the Navy and the general public for the safe handling of radiation sources, and understands the

responsibility to minimize his own exposure to radiation. The NWRCO is directly responsible for the supervision of this training.

REQUIREMENTS

1. All ship and facility nuclear weapons radiation workers shall receive the following training :

a. The types of radiation and radioactive materials associated with Navy nuclear weapons, the hazards associated with each type of radiation and radioactive material, precautions to take in the event of release of these materials, and the units of radiation and radioactivity.

b. The objectives of the Radiological Controls Program as stated in Article 101 of this manual.

c. The personnel responsibilities as stated in Article 104.D of this manual.

d. The biological effects and risks associated with low-level radiation exposure discussed in Appendix A of this manual.

e. The biological effects and risks to fetuses and embryos from prenatal radiation exposure as discussed in Appendix B of this manual (see Article 204 for additional requirements).

f. The radiation control level, internal exposure limits and the external radiation exposure limits for the Radiological Controls Program, as discussed in Articles 201 through 206 of this manual.

g. The personnel dosimetry and medical examination requirements for the Radiological Controls Program as discussed in Articles 211, 212, 213 and Appendix E of this manual.

h. The purpose of radiation signs, radiation surveys, and area monitors in the Radiological Controls Program as discussed in Articles 221, 223, 224 and 225.

i. The man-rem (collective dose) reduction concepts discussed in Article 231 of this manual.

j. Command specific radiological controls requirements.

2. The training required by the above paragraphs may be provided through oral and written classroom instruction or by using the following training tapes:

a. The Nature of Radiation (Training Film DN800162)
b. The Effects on Biological Systems (Training Film DN800163)

c. The Risks of Working with Radiation (Training Film DN800164)
d. The Radiological Controls Program (Training Film DN800165)

These training films are available through the Naval Technical Training Center, Pensacola in accordance with OPNAVINST 5290.1 series.

Upon permanent decertification of a command, training videos should be returned to Naval Technical Training Center, Pensacola.

Additional requirements and information contained in this manual revision or that differ from the training tapes shall be identified and reported to COMNAVSEASYSCOM (SEA-04N).

3. The training required by this article shall be given prior to initial entry into nuclear weapons stowage or maintenance areas and prior to the initial issuance of personnel dosimetry. Each nuclear weapons worker shall receive refresher training addressing the topics listed in this Article at least annually and no later than the anniversary date of the initial training.

4. All workers must pass a written examination. The examination shall include questions that address each of the topics listed in this Article. A minimum passing grade of 75% for workers and 80% for supervisors is required.

5. Records of training shall be maintained as part of each unit's Radiological Controls Program. Training records shall include, as a minimum, the date (s) training was conducted, persons conducting the training, a list of the participants, individual examination results and a master copy of the examination given for each training session. A master Instructor Guide (IG) must be retained if the training films listed above are not used. NAVSEA-04N maintains a master IG that meets the minimum requirements for Article 106 training. This master is available with this manual's CD. These training records are to be retained for a minimum of three years or until individuals are permanently removed from the command's Radiological Controls Program, whichever has precedence.

6. Shore facilities shall prepare and administer a quarterly casualty drill program to evaluate whether personnel retain the knowledge and ability to respond to a radiological casualty. The program shall include the following:

a. The majority of the radiological drills shall be conducted in the actual radiological work areas to provide the proper degree of realism to the drills and to improve the training effectiveness of these drills.

b. The scenarios used for radiological drills shall cover the spectrum of casualty complexity. One purpose of conducting drills of varying levels of complexity is to

ensure personnel not overreact to simple casualty situations and do not under react to complex casualty situations.

c. The results of drills shall be evaluated for trends and problem areas, and the results incorporated into initial or continuing training programs. These results shall be retained for a period of two years.

107. NUCLEAR WEAPONS NON-RADIATION WORKER TRAINING STANDARD

DISCUSSION:

Personnel assigned to the ship or facilities whose routine duties do not require exposure to radiation from nuclear weapons include those personnel who make infrequent entries into nuclear weapons stowage and maintenance areas. Senior command personnel, who by virtue of their duties require entry into the nuclear weapons stowage or maintenance areas on an infrequent basis, may choose to either: (1) be treated in accordance with this Article or (2) receive training in accordance with Article 106 as a ship or facility nuclear weapons worker.

Also included in this standard are ship or facility personnel who do not enter nuclear weapons stowage or maintenance areas and selected personnel who perform duties indirectly associated with the stowage, maintenance and handling of nuclear weapons (e.g., security force personnel, administrative personnel, public works personnel and others who have access to limited areas). This training will explain the low risk associated with exposure to low-level radiation exposure. This information is given during the initial indoctrination for newly reporting personnel and annually thereafter. Because all nuclear submarine ship's force are monitored for radiation exposure, Submarine Force Commanding Officers may elect to have the entire ship's company, with the exception of propulsion plant personnel, trained in accordance with Article 106. At their discretion, facility Commanding Officers may also exercise this option. Facility personnel, who enter weapons maintenance and stowage areas as part of employee indoctrination and whose duties will not require subsequent entry, i.e., administrative assistants, etc., do not fall under the requirements of Article 107, but should be trained in accordance with Article 105.2.

REQUIREMENTS (This article does not apply to those submarines or facilities that have opted to train the entire crew in accordance with Article 106):

1. Ship's force and facility personnel who make infrequent entries into nuclear weapons stowage or maintenance areas shall be briefed on how to wear the dosimeter properly, as well as the requirements to obey radiological controls boundaries and minimize time in close proximity to nuclear weapons. The briefing shall be given prior to entry into nuclear weapons stowage or maintenance areas. NAVSEA Form

8128/5 shall be signed by the individual to verify that the briefing statement is understood. Facility and submarine crews may use optional DD Form 8128/6 for briefing groups of two or more. This briefing requirement is annual. This requirement applies whether or not the individual is exposed to radiation in some other radiation safety or radiological controls program, and whether or not the individual provides his or her own dosimeter. Copies of signed forms shall be retained for one year.

2. Radiological Controls Program information shall be provided quarterly to those personnel assigned to nuclear weapons areas but not directly involved in the stowage, maintenance or handling nuclear weapons.

3. Information shall also be provided to all shipboard personnel who do not enter nuclear weapons stowage or maintenance areas. This information shall be provided during initial indoctrination for newly reported personnel and at least annually thereafter (e.g., Plan of the Day or Week notes, or through closed circuit TV training). Documentation of this training shall be retained for a minimum of two years (e.g., Plan of the Day copy). At a minimum this information shall include the following items:

a. A statement that personnel will not receive more radiation from shipboard nuclear weapons than allowed a Non-Radiation Worker as long as they remain outside nuclear weapons stowage and maintenance areas posted with radiation signs;

b. A statement that, when nuclear weapons are present, entry into nuclear weapons stowage and maintenance areas posted with radiation signs requires the wearing of personnel dosimetry (see Article 211.3 for exceptions);

c. A statement that the purpose of the Radiological Controls Program is to ensure radiation exposure from nuclear weapons is known and controlled; and;

d. A point of contact for additional information on the ship's Radiological Controls Program.

The following unclassified statement may be used at briefings, in training or indoctrination sessions or placed at the entrance to or within a limited area;

A variety of radiation sources and ionizing radiation-producing equipment are located on board this command. Studies have indicated that personnel will not receive more radiation than allowed a member of the general public as long as they remain outside those areas posted with the familiar yellow and magenta radiation warning signs. Entry into these posted areas requires personnel dosimetry. A radiological controls program is in effect to ensure radiation exposures are known and controlled. If you have further questions contact (Insert the name of the NWRCO)

108. NUCLEAR WEAPONS RADIOLOGICAL CONTROLS TECHNICIANS

DISCUSSION:

Trained radiation workers at facilities where nuclear weapons maintenance is performed shall be designated and trained to be Nuclear Weapons Radiological Controls Technicians using the standards of this article. These technicians perform radiation surveys and report directly to the NWRCO for these duties. Commands are encouraged to appoint as many Nuclear Weapons Radiological Controls Technicians as required by command needs.

REQUIREMENTS

1. Each facility performing intermediate or depot level maintenance on Navy nuclear weapons shall designate in writing as many Nuclear Weapons Radiological Controls Technicians as deemed mission essential by the Commanding Officer.

2. Nuclear Weapons Radiological Controls Technicians shall successfully complete training prior to assuming the duties of a Nuclear Weapon Radiological Controls Technician. Site training plans must be approved by NAVSEA-04N. This training shall be conducted by facility personnel and shall encompass, as a minimum, the following items:

A. Units of Radiation and Radioactivity

(1) Describe the basic structure of an atom.
(2) Define the rem. Explain how the rem differs from the rad and the roentgen.
(3) Define the effective dose equivalent and explain how it allows adding external exposure to internal exposure.
(4) Define “quality factor”. Know the approximate quality factor for the following types of radiation: alpha, beta, gamma, fast neutron, and the thermal neutron.
(5) Define the curie and explain that the curie is a unit of radioactivity.
(6) Convert numerical amounts of radioactivity between curies, millicurie, microcuries, and micromicrocuries (picocuries).
(7) Explain the difference between dose and radiation level.
(8) Show the ability to apply the thumb rule relating curies to radiation level (1 curie= 1 rem/hr at 1 meter) by solving simple problems.

B. Types of Radiation and Shielding

(1) Indicate understanding of the four types of radiation (alpha, beta, gamma, neutron) by discussing:
    (a) Charge and relative mass of each.
    (b) Relative penetrating power of each in air and tissue.

(c) Principle sources of each.
(d) Materials used for attenuation.
(e) Method of interaction of each with matter.

(2) Be able to solve radiation level problems using a combination of shielding and distance from a source.

(3) Know the relationship between time in a radiation field and total dose. Be able to solve simple problems involving this relationship.

C. Radiation Detection

(1) Explain the principles of operation of gas ionization counters (i.e., ionization, Geiger-Mueller, and proportional) and scintillation counters.

(2) Explain the principles of operation for the LiF TLD. Explain how the TLD measures neutron exposure.

(3) Describe how neutron survey meters detect neutron radiation and discuss the relationship between the meter reading and the actual neutron field.

D. Biological Effects of Radiation and Radioactivity

(1) Explain the general effects of various levels of short-term exposures, for example, 100 millirem, 10 rem, 100 rem, and 1000 rem.

(2) Explain why there is a difference between the effects of short-term and long-term exposures to radiation.

(3) Give the basic limit to which penetrating radiation is controlled. Explain how internal exposure is added to external exposure. Give the basis for this limit.

(4) Explain how internal exposure to radioactivity may occur and how it is prevented.

(5) Discuss how internally deposited radioactivity is measured. Define somatic effects.

(6) Define genetic effects.

(7) Discuss the biological effects of internally deposited radioactivity.

(8) Explain the risk associated with personnel radiation exposure. Be able to include numeric estimates of the risk. Know that any amount of radiation exposure no matter how small might involve some risk; however, exposure within accepted limits represents a risk that is small compared to normal hazards of life.

(10) Know the prenatal exposure risks to the developing embryo and fetus.

E. Exposure Control

(1) State the Navy radiation exposure limits for the whole body, skin, extremities, lens of the eye, and individual organ, and the unborn child. Explain the basis for these exposure limits. Explain who establishes legal limits for radiation exposure.

(2) Explain why the limits for skin, extremities, lens of the eye, and individual organs are higher than for the whole body.

(3) Know your organization's local exposure control levels. Know that the local exposure control levels are established to maintain personnel radiation exposure to as low as reasonably achievable (ALARA).
(4) Discuss the guidelines that are used for controlling radiation exposure during emergency situations.
(5) Know that gamma and neutron exposure contribute to whole body dose and that beta exposure contributes to skin dose and exposure to the lens of the eye.
(6) State the requirements and location for wearing a LiF TLD.
(7) Know the administrative procedures and the radiation surveys required for weapons maintenance areas.
(8) Know when monitoring for internally deposited radioactivity is required.
(9) Know that individuals are required to report to radiation health personnel any occupational exposure from past or current outside programs.

H. Radiological Surveys

(1) General Survey Requirements

(a) List the RADIAC instruments used for the following categories of radiological surveys: low range beta-gamma surveys, alpha surveys, neutron surveys, airborne surveys. Know the type of detector employed by each instrument.
(b) Be able to convert RADIAC meter readings to appropriate units.
(c) Know the minimum sensitivity and range of each RADIAC.
(d) Describe the effect on RADIAC meter indication from types of radiation other than the type of radiation that the RADIAC is designed to measure. Discuss failure modes for each RADIAC, such as saturation and low battery power.
(e) For instruments with multiple probes, discuss the use and survey techniques for each probe.
(f) Know the battery, source, and calibration check frequencies for each RADIAC instrument. Discuss how to battery check and source check each instrument as required.
(g) State the required frequency for each of the radiation, contamination, and airborne radiological surveys required by this manual.
(h) Discuss in detail the specific procedures for each type of survey including reasons for each of the steps and techniques employed.
(i) Discuss the requirements for documenting radiological surveys and for completing radiological survey records.
(j) Explain how to review and interpret the results of radiological surveys. Know the levels normally expected for routine surveys and the procedures to be followed if unusual measurements are identified during routine radiological surveys.
(k) Discuss when an audible response is used with radiological surveys instruments.

(2) Radiation Surveys

(a) Discuss the methods and techniques used for performing general area radiation surveys.

(3) Radioactive Contamination Surveys

(a) Discuss why dry swipes are used and the basis for 100 cm^2 swipe area.
(b) Know the limit for airborne activity. Discuss the basis for this limit. Discuss the areas in the facility where the application of this limit is appropriate.
(c) Know the approximate times required to draw air samples.
(d) Discuss the operation of tritium detectors.
(e) Know the location of the tritium sampling points.

(I) Radiological Casualties

(1) For casualty situations, discuss the procedure to be followed, discuss how each procedural step would be implemented, discuss the relative priorities of each procedural step, and be able to calculate radiation exposure received by personnel, contamination levels on personnel, airborne radioactivity levels, and radiation levels, if appropriate.
(2) Know that in the following situations emergency response actions take precedence over radiological controls:
(a) medical treatment of injured personnel
(b) extinguishing fires
(c) responding to security alarms
(d) evacuating personnel due to an announced casualty
(3) Know how to contact medical personnel. Know that radiological controls technicians shall lend any and all assistance requested by medical personnel.
(4) Know that BUMEDINST 6470.10 contains the procedures for personnel decontamination. Know decontamination methods used in the field.

(J) Qualification Practical Demonstrations

(1) Survey Technique Demonstration: (Applicable to initial qualification only) Demonstrate the ability to perform the following surveys and document the survey results. This practical demonstration shall include the following:

(a) Use the following instruments (or their equivalent) including the performance of a source check procedure, if applicable:

(1) AN/PDR-56
(2) AN/PDR-70
(3) AN/PDR-27, IM-265/PDQ, or DT680/PDQ
(4) AN/PDR-PDQ-1 and AN/PDQ-2
(5) ADM-300

(b) Airborne radioactivity surveys at a work site.

(K) Testing

(1) All workers must pass a written examination. The examination shall include questions that address each of the topics listed in this Article. A minimum passing grade of 75% for workers and 80% for supervisors is required.

109. NUCLEAR WEAPONS RADIOLOGICAL CONTROLS OFFICER TRAINING STANDARD

DISCUSSION:

The NWRCO and alternate NWRCO shall be designated by the Commanding Officer in writing. These individuals, preferably members of the Weapons Department, are responsible for implementation and management of the command Radiological Controls Program. This position shall not be filled by a Radiation Health Officer or any person involved in the administration of the Radiation Health program. Assignment and designation shall be consistent with the scope and authority necessary to fulfill the responsibilities outlined in Article 104. The NWRCO will attend the Nuclear Weapons Radiological Controls Officer course conducted by the local Trident Training Facility (TTF) and be a qualified Radiation Worker. This Course of Instruction will be approved by NAVSEA-04N. In addition, at shore facilities, the NWRCO will be qualified as an Article 108 Nuclear Weapons Radiological Controls Technician. This course addresses the following areas:

- The nature of radiation
- Potential hazards of material associated with nuclear weapons
- Radiological levels and limits
- Effects of low-level radiation exposure on personnel
- Historical background on radiological concerns
- Answering questions on radiation and radiation risks
- Surveying, monitoring, and posting of radiation spaces
- Records and reports
- Instrumentation and dosimetry
- Man-rem (collective dose) reduction

REQUIREMENT

1. Each ship or facility that stows, maintains or handles nuclear weapons shall have a Nuclear Weapons Radiological Controls Officer, designated in writing who has successfully completed Radiological Controls Program training (CIN Number A-8A-0913) conducted by the Trident Training Facility at Kings Bay, GA or Bangor, WA.

2. In addition, each shore facility NWRCO will be qualified Nuclear Weapons Radiological Controls Technician, in accordance with Article 108.

SECTION II EXTERNAL RADIATION

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SECTION II EXTERNAL RADIATION

PART 1 EXTERNAL RADIATION EXPOSURE LIMITS

201. GENERAL RADIATION CONTROL LEVEL

DISCUSSION:

The Radiological Controls Program has established a radiation control level of 0.5 rem Total Effective Dose Equivalent (TEDE) per year for external and internal whole body radiation exposures for the purpose of reducing total man-rem (collective dose) from stowing, maintaining or handling nuclear weapons. This radiation control level is one tenth the Federal limit for occupational exposure. Although all radiation exposures cause risk, this radiation control level is such that no detectable biological effects are expected even if exposures are continued for a lifetime at this annual level. This manual emphasizes maintaining exposures as low as reasonably achievable, even below the radiation control level, as a method of reducing total man-rem.

The Radiological Controls Program has been designed so that during nuclear weapons operations, it is unlikely that personnel will exceed this radiation control level. However, because of some maintenance operations and stowage in some configurations, there is a small possibility that a limited number of personnel may be required to exceed 0.5 rem per year. Since this level is administrative in nature, exceeding it does not measurably increase the risk associated with exposure to radiation. Maintaining exposures at or below this radiation control level, unless unusual circumstances arise, is required of every command.

The radiation control level of 0.5 rem TEDE per year is an “alert level”. When one or more individuals approach this level, the command should initiate a review of work practices and personnel assignments in the light of the workload before authorizing individuals to exceed the radiation control level. If similarly trained personnel are available, it is reasonable to make substitutions to prevent workers from exceeding the control level. However, the substitution of untrained personnel or the delay of mission required maintenance should not occur merely to keep qualified personnel from exceeding 0.5 rem TEDE per year. Use of a less skilled team may actually increase total man-rem, since the lack of proficiency may result in more time to perform the same task. If substitute personnel are not available, authorization to exceed the control level may be permitted. Wherever possible, additional personnel should become qualified to perform such work. In cases where the radiation control level must be exceeded, the limits of Articles 202 and 203 apply. A sample authorization letter for exceeding the radiation control level is provided in Appendix C.

Due to the nature of the radiation sources, external exposures received by personnel in the Radiological Controls Program are low. Experience has shown that unusually high external exposures are the result of either misused or improperly worn

dosimeters. Exposures greater than 0.5 rem TEDE per issue period should be considered suspect. Aggressive investigation is required to establish the true nature of such exposure so that the correct value is reported in the individual's exposure record. Assistance with these investigations may be requested from COMNAVSEASYSCOM (SEA-04N).

Unusual or unexpected dosimetry results identified during the processing of TLDs, including exposures exceeding 0.5 rem TEDE, will be reported to the command by message from the Naval Dosimetry Center, with copies to Chief, Bureau of Medicine and Surgery (MEF7) COMNAVSEASYSCOM (SEA-04N) Naval Environmental Health Center, Portsmouth, Virginia and the Type Commander or Immediate Superior in the Chain of Command (ISIC).

REQUIREMENTS

1. The radiation control level is hereby established as 0.5 rem Total Effective Equivalent Dose (TEDE) per calendar year for the purpose of reducing total man-rem (collective dose) from stowing, maintaining and handling Navy nuclear weapons.

2. The radiation control level shall not be exceeded without prior written approval of the individual's Commanding Officer. A sample letter approving an individual to exceed the control level is included in Appendix C. If an individual equals or exceeds the control level due to a planned, unplanned or unexpected exposure, the need for that individual to continue to perform weapons related work for the remainder of the calendar year shall be determined. If continued use of the worker is necessary because of skill level or lack of a replacement, approval to exceed the exposure level should be granted. A copy of the extension letter shall be retained for three years. If continued exposure is not needed, the individual shall be reassigned, if necessary, until the end of the calendar year to prevent further exposure.

3. When visiting personnel are likely to exceed the radiation control level while at a host command, the parent command shall determine the necessity of assigning the individual to the duties. Visiting personnel who have either exceeded the radiation control level or are likely to exceed it while at a host command shall ensure that the radiation record NAVSEA Form 8128/5 is marked to reflect this. Host commands shall accept the statement that the visiting individual is authorized to exceed the radiation control level to allow the performance of duties. Documenting this condition is not required of the host command.

4. Activities receiving reports of unusual or suspect dosimetry results and/or actual or suspected internal contamination shall investigate such reports and forward a summary of their investigation to COMNAVSEASYSCOM (SEA-04N), Naval Dosimetry Center, Chief, Bureau of Medicine and Surgery (MED-M3F7) and the Type Commander or ISIC. This summary report shall be forwarded by message within 5 working days of receipt of the message from the Naval Dosimetry Center.

When operational commitments prevent this response, the report shall be submitted as soon as practicable.

202. OCCUPATIONAL EXPOSURE LIMITS

DISCUSSION:

The exposure limits in this article are consistent with BUMED and Federal limits for controlling whole body radiation exposures. These limits have never been exceeded in the stowage, maintenance and handling of Navy nuclear weapons. If the Commanding Officer approves exceeding the radiation control level of Article 201, then the following occupational exposure limits shall apply.

REQUIREMENTS

1. Radiation Workers: The occupational dose of ionizing radiation shall not exceed 5 rem Total Effective Dose Equivalent (TEDE) per calendar year, provided that the person is at least 19 years of age and is considered a Radiation Worker as defined in NAVMED P-5055. TEDE is the sum of all deep dose equivalents and internal exposure (Committed Effective Dose Equivalent).

2. Quarterly Limit: Radiation Workers: 3 rem (TEDE) per calendar quarter not to exceed 5 rem (TEDE) per calendar year. Persons between 18 and 19 years of age are restricted to 1.25 rem (TEDE) per calendar year.

3. Non-radiation Workers: Personnel defined as Non-radiation Workers shall not exceed 0.5 rem (TEDE) per calendar year.

4. General Public: Any person defined as a member of the General Public (e.g., vendors, family members visiting a ship, etc.) shall not exceed 0.1 rem (TEDE) per year.

5. Exposure to the skin (shallow dose equivalent), any organ and /or any tissue (Committed Dose Equivalent) shall not exceed 50 rem per calendar year.

6. Exposure to the lens of the eye shall not exceed 15 rem per calendar year.

7. If a person reporting to an activity does not know his current yearly exposure, the yearly limit listed above shall be reduced by ¼ for each calendar quarter in which exposure cannot be documented. For example, a Sailor reports for duty as a Radiation Worker on 01 Jul but has no documentation for exposure received this calendar year. The Sailor's limit for the remainder of the year would be 2.5 rem (TEDE). (2 qtrs. x .25 = .5, .5 x 5 rem= 2.5 rem)

8. Internal Limits: Exposure to the whole body or any organ or tissue shall not exceed 10% of the Annual Limit of Intake (ALI) or Derived Air Concentration

(DAC), as defined in NAVMED P-5055. Any instance in which a person may have inhaled, ingested, or absorbed radioactive material shall be reported to COMNAVSEASYSCOM (SEA-04N) and BUMED (M3F7) within 24 hours of the occurrence. BUMED will direct actions to be taken and ensure the Committed Dose Equivalent for any internalized materials are calculated and returned for entry into the individual's health record. COMNAVSEASYSCOM (SEA-04N) will oversee this process and ensure its completion.

9. Reports of incidents where yearly or quarterly occupational exposure limits are exceeded shall be forwarded to CHBUMED as required by NAVMED P-5055. COMNAVSEASYSCOM (SEA-04N) and the Type Commander or ISIC shall be promptly informed so that a thorough evaluation and review can be conducted.

203. OCCUPATIONAL EXPOSURE TO THE EXTREMITIES

DISCUSSION:

In certain operations at maintenance activities, external radiation exposures to the extremities, defined as elbow and below for arms, knee and below for legs, may be higher than the whole body radiation exposures. In such cases, separate radiation exposure limits for the extremities may be needed. Monitoring the extremities should rarely be needed and is performed in accordance with Article 212. The extremities may receive higher radiation exposures than the whole body because of the absence of blood forming organs and the relative insensitivity of the extremities to radiation.

REQUIREMENT

Occupational radiation exposure to the extremities shall not exceed 50 rem per calendar year.

204. RADIATION EXPOSURE CONTROL FOR THE EMBRYO/FETUS

DISCUSSION:

The policy of the Radiological Controls Program is (1) that particular efforts shall be made to keep radiation exposure to the embryo/fetus as low as reasonably achievable, (2) that it is the responsibility of both the Navy and the workers to minimize exposure to the unborn, and (3) that radiation considerations do not prevent assigning women to nuclear weapons duties. It is the responsibility of the worker to declare her pregnancy in order to limit the exposure to an embryo/fetus.

Article 105 of this manual contains additional training requirements.

REQUIREMENTS

1. All reasonable efforts shall be made to keep ionizing radiation exposure to the embryo/fetus as low as practicable. It is the responsibility of the female worker to notify her command (e.g., supervisor, the Nuclear Weapons Radiological Controls Officer) of her pregnancy in order to limit exposure to the embryo/fetus. The following declaration shall be prepared on an SF 600 (Chronological Record of Medical Care), signed by the service member or employee, witnessed by a Medical Department representative and placed in her health record:

I hereby make notification that I am pregnant. My estimated date of conception is: _____. I understand that by declaring my pregnancy, my occupational exposure to ionizing radiation will be controlled as prescribed in Chapter 4 of NAVMED P-5055, "Navy Radiation Health Protection Manual".

Signature: _____

Printed Name: _____

Date: _____

Witnessed: _____
Signature Printed Name Date

2. Once a declaration of pregnancy is received by a command, action shall be taken to limit the exposure of the pregnant worker to less than 0.5 rem TEDE during the entire gestation. The command shall take action to ensure any exposure received by a pregnant worker after declaration of pregnancy shall not exceed 50 mrem TEDE per month during the remainder of the pregnancy. If the dose equivalent to the embryo/fetus exceeds 0.5 rem or is within 0.05 rem of this dose by the time the worker declares the pregnancy, the command shall be deemed in compliance if the additional dose does not exceed 0.05 rem to the embryo/fetus.

3. It is not necessary to remove female workers from radiation worker status solely based on the condition of pregnancy. Individuals are expected to maintain current qualifications as radiation workers unless physically restricted by the pregnancy for reasons other than radiation exposure.

4. For military personnel, the Navy specifies that the female member maintain radiation worker qualification. Her duties may require additional limitations because of physical restrictions resulting from pregnancy for reasons other than radiation exposure. In accordance with OPNAVINST 6000.1 "Management of Pregnant Servicewoman", additional limitations will be determined by the Commanding Officer in consultation with the health care provider and the occupational health professional. Request for voluntary reassignment to duties not involving ionizing radiation will be accommodated when possible.

For civilian personnel, management may accommodate female employee requests for voluntary reassignment to duties not involving radiation exposure if other jobs are available and the employee is otherwise qualified, and the organization has the resources available to compensate for the reassignment. It should be made clear to the employee that if management honors her request for a voluntary reassignment, the reassignment may involve some impact (i.e., loss of overtime or a change in shifts).

5. The date of conception will be used to calculate the TEDE for the fetus. After completion of the pregnancy an entry will be made in the remarks section of the member's "Record of Occupational Exposure to Ionizing Radiation" (NAVMED Form 6470/10) stating the period of exposure of the fetus, the TEDE in rem and the fact that this exposure was to an unborn child.

6. Any instance where the exposure level to the fetus is exceeded shall be reported to CHBUMED as required by NAVMED P-5055. COMNAVSEASYSCOM (SEA 04N) and the Type Commander or ISIC shall be promptly informed so that a thorough evaluation and review can be conducted.

205. RADIATION CONTROL LEVEL FOR VISITING NUCLEAR WEAPONS WORKERS

DISCUSSION:

Visiting nuclear weapons workers, defined in Article 105.A, are governed by the radiation control level of Article 201, as they are members of a Radiological Controls Program. Their status as "visitor" introduces additional responsibilities on the host command to ensure that radiation exposures received are controlled and kept as low as reasonably achievable. These visiting nuclear weapons workers complete NAVSEA Form 8128/5 to document for the host command their status as members of a Radiological Controls Program at their parent command or organization.

REQUIREMENTS

1. Visiting nuclear weapons workers shall comply with the provisions of Articles 201 and 202.

2.Prior to entering nuclear weapons stowage or maintenance areas, visiting nuclear weapons workers shall complete and sign NAVSEA Form 8128/5 to document their status at their parent command or organization. The use of a single form for repeated visits applies in the same manner as in Article 105.2. Visitors whose exposure is unknown will be limited in accordance with Article 202.7.

206. RADIATION CONTROL LEVEL FOR VISITING PERSONNEL OTHER THAN NUCLEAR WEAPONS WORKERS

DISCUSSION:

Visiting personnel other than nuclear weapons workers, defined in Article 105.2 are controlled such that the exposures they are allowed to receive, when added to other exposures (other than medical or natural background), shall not exceed the limit for a Non-Radiation worker. Before entering nuclear weapons stowage or maintenance areas, these individuals are questioned to determine their known or estimated exposure for the current calendar quarter and year. They are also questioned to identify potentially disqualifying medical conditions (such as undergoing extensive radiation treatments) that restrict exposure to radiation. Special consideration for personnel who receive exposure in other radiation safety or radiological control programs is provided in this article.

REQUIREMENTS:

1. Visiting personnel other than nuclear weapons workers shall not receive radiation exposures which, when added to previous exposure, will exceed the radiation control level of Article 201. The radiation control level, described in Article 201, shall be explained to the visitor.

2. Visiting personnel shall complete either NAVSEA Form 8128/5 or NAVSEA Form 8128/6 prior to entering a nuclear weapons stowage or maintenance area where nuclear weapons are present.

3. Visiting personnel who document that they receive exposure to radiation in some other radiation safety or radiological control program shall be controlled such that radiation exposures received are as low as reasonably achievable and shall not exceed the occupational exposure limits of Articles 202 and 203. Visitors whose current quarterly or yearly exposure is unknown will be controlled in accordance with Article 202.7

PART 2 PERSONNEL MONITORING FOR RADIATION EXPOSURE

211. CHIEF, BUREAU OF MEDICINE AND SURGERY (CHBUMED) PERSONNEL DOSIMETRY PROGRAM

DISCUSSION:

Personnel dosimetry used in the Radiological Controls Program is supplied and processed by the Naval Dosimetry Center. The personnel dosimetry requirements of the

Navy Nuclear Weapons Radiological Controls Program are found in NAVMED P-5055 as amended by this Article and Article 212.

Personnel who receive the majority of their radiation exposure from nuclear weapons are monitored with lithium fluoride thermoluminescent dosimeters (TLD). The dosimeter consists of a computer-encoded card containing lithium fluoride chips. Supplied with the TLD card is a plastic holder that is designed with a belt loop. Proper operation of the TLD requires that the plastic holder be placed next to the body with the belt loop of the plastic holder towards the body.

Direct body contact is essential. The body may be thought of as part of the dosimeter, since the dosimeter depends on the body to scatter neutrons back toward the dosimeter. The neutron sensitive TLD chip responds to the neutrons that enter the body and are reflected back out of the body into the chip through the rear surface of the dosimeter. This need for a large backscattering volume (the wearer's body) makes the TLD in its standard holder poorly suited for monitoring extremity exposures (hands, forearms, etc.). For this reason, requests for extremity monitoring are coordinated with COMNAVSEASYSCOM (SEA 04N) as required by Article 212.12. In addition, the dosimeter will not function properly if worn with the belt loop facing out. Additional information is available in Appendix E.

The dosimeters are always worn in nuclear weapon stowage and maintenance areas with nuclear weapons present. Normally, issued dosimeters are stored in a low radiation area with control TLDs and unisssued TLDs when they are not being worn. However, it is permissible to wear the TLD to monitor radiation exposures from other radiation sources including radiation associated with Naval nuclear propulsion plants outside of the reactor compartment or outside high radiation areas. For example, an Engineering Officer of the Watch (EOOW) qualified weapons officer who routinely stands watch in maneuvering may be monitored with the TLD if the majority of his exposure to radiation results from working near nuclear weapons.

At the end of the issue period TLDs shall be collected and forwarded to the Naval Dosimetry Center in accordance with NAVMED P-5055 and as described in Appendix E.

The Medical Department is responsible for documenting personnel dosimetry results on each individual's "Record of Occupational Exposure to Ionizing Radiation", NAVMED Form 6470/10, Form 6470/11 and/or DD Form 1141 as applicable using software supplied by the Naval Dosimetry Center. In preparing an individual's exposure record, establishing the prior exposure history is required by NAVMED P-5055. This consists of obtaining records of previous exposures by corresponding with Naval Dosimetry Center, previous commands and/or former employers and recording these documented occupational exposures to ionizing radiation with dates, locations, exposures and appropriate references to the sources of the annotations. In those instances when occupational exposure records for non-weapons related duties are incomplete or not available, radiation exposures are estimated in accordance with the instructions in NAVMED P-5055. For time periods when personnel dosimetry was not provided and the

only exposure was from Navy nuclear weapons related duties, no assumed or estimated entries are made on the exposure record in the individual's health record.

Experience has shown that recording assumed doses on the Exposure Record Form causes entries that are unrealistically high for individuals involved in stowing and maintaining Navy nuclear weapons. Further, data required to estimate past exposures is not usually available at the organizational level. Techniques for dose estimation based on dates, specific weapons systems and assigned duties are available from Naval Dosimetry Center and NAVSEASYSCOM. In unusual circumstances, if it should become necessary to reconstruct exposures from nuclear weapons duties (not weapons testing) for time periods prior to the implementation of the Naval Dosimetry Center TLD program, an Addendum NAVMED Form 6470/10 is completed with the following information: name, rank/rate, duty station(s) of potential exposure and unclassified amplifying statements in the remarks section. This Addendum Exposure Record is not filed in the individual's health record. It is forwarded to CHBUMED with the reason for requesting the dose estimation. This guidance does not apply to an Addendum Exposure Record Form prepared for other purposes described in NAVMED P-5055.

REQUIREMENTS:

1. Commands that stow, handle, or maintain nuclear weapons shall operate a personnel dosimetry program in accordance with NAVMED P-5055, this article and Article 212. Other commands and organizations whose staff routinely require entry into nuclear weapons stowage and maintenance areas should operate a personnel dosimetry program.

2. TLDs shall be processed only as directed by Naval Dosimetry Center, and are normally issued and processed twice a quarter or in conjunction with submarine patrol cycles, unless otherwise authorized by CHBUMED.

3. The TLD shall be worn on the trunk of the body, normally on the belt at the front with the belt loop of the plastic holder towards the body. Under conditions where a suitable belt cannot be worn, the TLD holder must be firmly in place in direct contact with the body with the belt loop of the plastic holder towards the body. Exceptions to the manner and location for wearing the TLD for unique nuclear weapons applications, other than specifically authorized by weapon handling publications, require the written approval of COMNAVSEASYSCOM (SEA-04N).

4. TLDs shall not be misused.

5. Lost or damaged TLDs will have the exposure estimated in accordance with NAVMED P-5055 and the provisions of this Article.

6. Except as noted in Article 202, COMNAVSEASYSCOM does not require copies of annual and situational reports required by CHBUMED.

7. For time periods prior to the implementation of the Nuclear Weapons Radiological Controls Program and when other personnel dosimetry are not provided, if the only exposure was from nuclear weapons related duties, no assumed or estimated dose entries shall be made on the "Record of Occupational Exposure to Ionizing Radiation", NAVMED Form 6470/10 in the individual's health record.

8. In some cases estimations may be needed for past periods of occupational exposure (not weapons testing) in the Navy nuclear weapons program when personnel dosimetry was not worn or records are unavailable. In these cases available information shall be entered on an Addendum Exposure Record Form and forwarded to CHBUMED for dose estimation.

212. NUCLEAR WEAPONS RADIOLOGICAL CONTROLS PROGRAM PERSONNEL DOSIMETRY PROCEDURES

DISCUSSION:

All personnel who enter nuclear weapons stowage or maintenance areas when nuclear weapons are present, and all individuals who could possibly receive a dose in excess of the radiation control level of 0.5 rem TEDE per year from radiation associated with the Navy nuclear weapons program, are monitored by TLDs for deep dose photon and neutron exposures. A few locations outside nuclear weapons stowage or maintenance areas have been identified where individuals could potentially exceed 0.5 TEDE per year if they are present for extended periods of time. These are the superstructure areas of SSBNs around the missile tubes and topside on the SSBNs in close proximity to open missile tube muzzle hatches when tactical missiles are in place. Radiation levels and occupancy periods in those areas are evaluated using radiation survey results and exposure data generated from Neutron Area Monitors described in Article 224.

Because available neutron dosimeters respond differently depending on neutron energies, a neutron dosimetry program should match the neutron energy levels of the source used to calibrate the dosimeter as closely as possible to the neutron energy levels encountered in the work place. To be conservative, TLDs are calibrated such that the response will tend to overestimate the exposure rather than underestimate the exposure. This approach will occasionally produce an inconsistent result that indicates an unexpected exposure. For this reason, Article 104.C.1.a requires a Nuclear Weapons Radiological Controls Officer to review the dosimetry report prior to the results being entered into the individual's "Record of Occupational Exposure to Ionizing Radiation", NAVMED Form 6470/10. During this review, unusual results that are suspect are identified. Examples of "high or low" results are: (1) reported results and expected exposure differ by 100% or more and the reported result is greater than or equal to 30 mrem of neutron exposure; (2) reported and expected exposures differ by 30 mrem and the reported exposure is less than 30 mrem of neutron exposure. Suspect dosimetry results may require rejecting the reported exposure and estimating the exposure in

accordance with the procedures outlined in Articles 5 and 6 of NAVMED P-5055 and Appendix E of this manual.

Experience has demonstrated that elevated readings are sometimes observed on some unisssued and controlled TLD cards. These elevated values are usually associated with storing the cards too close to potential radiation sources or from background accumulated on cards held beyond the normal issue period. It is possible that the condition which caused the elevated control readings also affected the accuracy of the reading of the issued TLDs. Control and unisssued TLD card readings that exceed 0.025 rem gamma or 0.015 rem neutron for a normal six to seven week issue period shall be investigated. Usually this indicates the need to find an alternate storage location farther away from potential sources of radiation. Higher than expected values may also be caused by TLD cards from older shipments which were not returned to the Naval Dosimetry Center.

REQUIREMENTS:

The following are in addition to the requirements on Article 211:

1. All personnel, including visitors, who enter nuclear weapons stowage or maintenance areas when nuclear weapons are present shall be monitored with Naval Dosimetry Center provided TLDs, except as noted in Articles 211.2, 212.2, 212.3, and 212.4. Visitors and contractors are required to wear Navy TLDs.

2. Defense Threat Reduction Agency personnel serving on Defense Nuclear Surety Inspection teams may wear their own dosimeters in lieu of Naval Dosimetry Center provided TLDs.

3. Explosive Ordnance Disposal (EOD) personnel assigned to weapons stations or whose primary duties involve support of a nuclear weapons program shall be issued TLDs by their sponsoring activity.

4. When radiography is performed in a nuclear weapons stowage or maintenance area, the personnel dosimeter normally worn by the radiographer shall be used since the majority of any radiation exposure received would be from radiography operations.

5. Issued TLDs shall be stored in a low background area when not being worn. If practical, this may be with the control and unisssued badges. TLDs may be worn continually if frequent access to nuclear weapons stowage or maintenance areas is required. In addition, TLDs may be used to monitor exposures to radiation associated with other programs for personnel who receive the majority of their radiation exposure from nuclear weapons.

6. The area for storage of control and unisssued TLDs shall be selected so that control TLD exposures greater than 0.025 rem gamma and 0.015 rem neutron would not be expected if the TLDs were left there throughout the normal six-to-seven week issue

period. Control TLDs shall be stored with unisssued TLDs. Issued but not worn TLDs may be stored in the same location or in other low background areas.

7. Personnel requiring dosimeters, other than ship or station nuclear weapons workers, shall complete either NAVSEA Form 8128/5 or NAVSEA Form 8128/6, receive their TLDs from the Medical Department representative or other authorized individual, and return TLDs to the issuing location unless otherwise directed.

8. Personnel in the Radiological Controls Program attached to the command shall be informed of their exposure upon request and each time an exposure report (NAVMED 6470/3) with data (including zero exposures) on the individual is returned to the command. This may be accomplished by posting a copy of the results listed on the exposure report. Annually, each individual shall be informed in writing of his annual and total lifetime dosage.

9. Visiting nuclear weapons workers, as defined by Article 205, shall be encouraged to use TLDs provided by their parent command, or they may be issued a TLD by the host command. If the host command issues a TLD, the worker's parent command or organization shall be informed of their radiation exposure, even if zero. This may be accomplished by forwarding a completed copy of NAVSEA Form 8128/5.

10. Personnel from other commands and organizations (Articles 205 and 206) who are issued dosimeters shall have their parent command or organization informed of their radiation exposure, even if zero. This may be accomplished by forwarding a completed copy of NAVSEA 8128/5 to the custodian of the individual's medical record. Exposures to individuals whose parent organization does not submit exposure reports to the Naval Dosimetry Center shall be submitted to Naval Dosimetry Center on a Situational report as required by Article 5-12 of NAVMED P-5055.

11. Ships offloading nuclear weapons to enter overhaul, extended repair availability periods or due to decertification may suspend the TLD personnel dosimetry program after the nuclear weapon offload is complete. The Naval Dosimetry Center shall be given a minimum of thirty days notice for suspending and restarting the personnel dosimetry program. Copies of the correspondence or message request shall be provided to COMNAVSEASYSCOM (SEA-04N).

12. If extremity monitoring is necessary, detailed procedures shall be submitted to COMNAVSEASYSCOM (SEA 04N) prior to commencing operations for approval.

213. RADIATION HEALTH REQUIREMENTS

DISCUSSION:

Medical examinations in conjunction with occupational exposure of personnel to ionizing radiation are prescribed by CHBUMED in Chapter 2 of NAVMED P-5055.

Radiation medical examinations consist of four types: preplacement, reexamination, situational, and termination.

REQUIREMENTS:

1. The following personnel associated with the Radiological Controls Program shall receive a preplacement radiation medical examination in accordance with Chapter 2, NAVMED P-5055:

a. Personnel who perform or supervise maintenance on nuclear weapons or are assigned to training programs for such duties. Personnel who are frequently in close proximity to the maintenance being performed shall also receive radiation medical examinations even though they do not actually perform the work (e.g. quality control personnel observing the maintenance operation). Preplacement radiation medical examinations shall be conducted prior to issuance of personnel dosimetry to ship and facility nuclear weapons workers.

b. Submarine ship's force that perform duties involving maintenance between the missile tubes in the upper level missile compartment of SSBNs and duties associated with maintenance of nuclear weapons during refit periods and patrols for SSBNs.

c. Missile Compartment Roving Patrol (MCRP) watchstanders on board SSBNs will not normally require radiation medical examinations provided their sole duties involving nuclear weapons are as a MCRP.

d. Personnel not previously required to have a preplacement medical examination who receive more than 0.5 rem TEDE from Navy nuclear weapons per calendar year. Radiation medical examinations for these personnel shall be scheduled promptly whenever it is discovered that the person has or is thought to have exceeded 0.5 rem TEDE. The radiation medical examination shall be performed within one month after the person exceeds 0.5 rem TEDE or as soon thereafter as operational requirements permit.

2. Visiting personnel who complete NAVSEA Form 8128/5 and have a radiation exposure for the current calendar year greater than 0.5 rem TEDE shall document that they have a current radiation medical examination prior to entering a nuclear weapons stowage or maintenance area.

3. Explosive Ordnance Disposal team members assigned to nuclear weapons support missions are not required to have preplacement radiation medical examinations unless the provisions of 1.d above have been met.

3. Reexamination, situational, and termination radiation medical examinations shall be performed in accordance with Chapter 2 of NAVMED P-5055.

PART 3. RADIATION SURVEY EQUIPMENT AND REQUIREMENTS

221. RADIATION AREA SIGNS

DISCUSSION:

All nuclear weapons stowage and maintenance areas shall be conspicuously posted with radiation area signs as shown in Figure II-1. The added wording "when nuclear weapons are present" ties the requirement for dosimetry to the actual presence of weapons, eliminating the need to remove or cover the signs when nuclear weapons are temporarily removed. The purpose of the posted radiation area signs is to make people aware that they are in an area where they could be exposed to radiation and to serve as a reminder that dosimetry is required in those posted areas when nuclear weapons are present. For forces afloat, locations are indicated in Supplement 1 to this manual. The locations for the signs should be carefully chosen so that individuals outside the Radiological Controls Program do not interpret the presence of the sign as an indication that weapons are present.

Initial issue and replacement signs are available only from Naval Surface Warfare Center, Indian Head Division Detachment McAlester, 567 Army Ammunition Plant Road F, McAlester, OK 74501-5190. Requests may be made in writing and should state the number of signs required.

REQUIREMENTS:

1. Aboard ships. Signs shall be posted inside nuclear weapons stowage and maintenance areas in the vicinity of the warheads and inside the entry to the nuclear weapons stowage and maintenance areas where a sign shall be immediately visible to anyone who enters. Signs shall not be placed inside the missile tubes or attached to nuclear weapons. To avoid unnecessary inquiries regarding the presence of nuclear weapons and potential shipboard security problems, signs shall not be placed outside the nuclear weapons stowage and maintenance areas where they would be visible to individuals who have not passed through a security control station. In those cases where the entrance to the nuclear weapons stowage and maintenance areas can be seen only after having passed through a security control station, signs shall be placed on the outside of those areas. The posting of other types of radiation signs is not authorized without written approval from COMNAVSEASYSCOM (SEA-04N). The locations and numbers of signs are specified in the applicable Supplement 1.

2. At shore activities. Signs shall be posted inside nuclear weapons stowage areas where they can be observed immediately upon entry. For security reasons, signs shall not be posted outside of buildings. If necessary, signs posted at the entrance to nuclear weapons stowage and maintenance areas may either be covered or removed when nuclear weapons are not present, at the discretion of the NWRCO and Commanding Officer. Written procedures shall be used to ensure that radiation-warning signs are visible when nuclear weapons are present.

3. If an activity is permanently decertified or decommissioned, radiation signs may be destroyed, by obliterating the face prior to disposal. However, signs may be transferred to another activity that has retained its nuclear weapon program .

222. RADIATION SURVEY INSTRUMENTS

DISCUSSION: Only instruments listed in this manual are approved for use. Use of any other instrument must be specifically approved by NAVSEA 04N.

The AN/PDR-27 is a general purpose beta-gamma low-range survey meter. The basic unit consists of: two Geiger-Mueller (G-M) detector probes, a radiacmeter, a carrying case, a harness and a headset. There is a large and a small G-M detector probe. The large G-M detector measures gamma radiation up to 5 mR/hr and is capable of detecting beta radiation. The small G-M detector measures gamma radiation up to 50 mR/hr. Over its calibrated energy range, this survey meter is accurate to within + or – 20%. The AN/PDR-27 is designed and calibrated such that when it is used to measure gamma radiation, the scale reading given in mR/hr is directly equivalent to mrem/hr.

Surveying nuclear weapons spaces with the AN/PDR-27 for gamma radiation does not detect the total radiation present, as the AN/PDR-27 does not measure neutrons. Since surveys using the AN/PDR-27 provides no information on neutrons, routine surveys for gamma radiation alone are not encouraged.

The AN/PDQ-1 and AN/PDQ-2 are multi-function radiacs now being implemented into fleet usage, as the associated probes become available. The instruments have detection capabilities up to 1000R/hr. Currently, the beta-gamma probe is available. Neutron and x-ray probes will be issued after development is complete.

The AN/PDR-70 survey meter is used to measure neutrons in units of millirem/hr. The basic instrument consists of a neutron detector probe connected to a radiacmeter, a carrying case, a harness and a headset. This instrument is issued only to nuclear weapons shore facilities, although nuclear powered ships have such instruments for reactor plant monitoring. Tripod survey stands are provided by COMNAVSEASYSCOM (SEA-LR to all shore facilities for use with the AN/PDR-70 during surveys.

A pulse integrator is used with the AN/PDR-70 to increase the accuracy of measuring low levels of neutron radiation. The precision of the measurements depends on the number of counts collected. For example, if 100 counts are collected, the precision of the measurement indicates that approximately 68% (1 standard deviation) of all subsequent measurements and produce counts of 100 +/- 10 counts or 10%, or 10% precision at 400 counts the precision for 1 standard deviation is +/- 20 counts or 5%, and at 1000 counts, precision is improved to +/- 3 %. Improving the accuracy of the survey data requires longer counting times. An effective balance must be struck between the value of the increased precision in exposure rate survey data and the time required to collect that number of counts at each measurement location. For routine periodic

surveys, a minimum of 100 counts is collected, providing that the counting time does not exceed one hour.

Pulse integrators are issued to nuclear weapons maintenance facilities for use by the Nuclear Weapons Radiological Controls Technician. Qualification training in the use of the pulse integrators is provided by the facilities. Cables to connect the pulse integrator to the AN/PDR-70 must be obtained locally.

The AN/PDR-56, which is the Navy's standard alpha radiation survey instrument, may cause confusion when used for surveys around nuclear weapons. These instruments have been known to respond to types of radiation other than alpha radiation. Caution must be exercised to avoid confusion when using the AN/PDR-56 RADIAC near a nuclear weapon.

REQUIREMENTS:

These requirements shall be followed whenever survey instruments are used.

1. Instruments shall be operated, maintained and calibrated in accordance with applicable technical manuals and instructions.

2. Prior to conducting a survey, the operator shall verify that the instrument has a calibration sticker indicating that the calibration is current.

3. The instrument shall be checked using the battery check position switch to assure that the batteries are fully functional.

4. When a pulse integrator is used with the AN/PDR-70, 100 or more counts shall be collected. However, the counting time shall be limited to no more than one hour at each survey location, even if 100 counts cannot be collected.

223. RADIATION SURVEYS

DISCUSSION:

Radiation Surveys are conducted by shore stowage and maintenance facilities to assess radiation levels in selected areas.

Surveys are conducted under COMNAVSEASYSCOM (SEA-04N) direction for a representative ship of each class that is assigned organizational level maintenance responsibilities. The survey results are included in the applicable Supplement 1 to this manual.

When used with the man-rem (collective dose) reduction practices in Article 231, survey results are an important management tool to assist the NWRCO in reducing personnel exposures to as low as reasonably achievable (ALARA). Surveys also verify

that unmonitored personnel in areas outside nuclear weapons stowage and maintenance areas do not exceed the limits for Non-Radiation Workers or Members of the General Public. Activities with survey capabilities should perform surveys outside of nuclear weapons stowage and maintenance areas.

Survey results support man-rem reduction for personnel who perform nuclear weapons maintenance and are in close proximity to nuclear weapons for extended periods. Analysis of radiation levels in locations where nuclear weapons maintenance is performed can result in modifications to work practices by identifying locations with lower radiation levels, which allow workers to perform weapons maintenance while receiving less radiation exposure.

Although historical surveys have been performed previously in nuclear weapons stowage areas, these data are of less value in man-rem reduction because of continued changes in work practices and weapons arrangements. For these areas, aggressive enforcement of collective dose reduction work practices has been the best way to keep exposures as low as reasonably achievable

The following apply when planning surveys:

- Maintenance area survey points should be concentrated where people typically are located when performing nuclear weapons maintenance, as well as potential alternate locations. When a weapon undergoes changes in configuration or orientation during maintenance (e.g., from horizontal to vertical), locations occupied by personnel during the complete operation should be evaluated.

- The greater the number of survey points taken, the more complete the knowledge of the radiation levels. Although no minimum number of survey points can be established for a given operation, there should be enough points to include all assigned working locations and all potential alternate working locations (e.g., a detailed maintenance survey should be able to verify that the location of the check sheet reader is at the lowest radiation level within proximity to the weapon.

- Ambient radiation levels are a function of the radiation pattern generated by a given weapon, as well as, the proximity, type, and number of any adjacent weapons. Typically, locations forward or aft of a horizontal weapon are lower in radiation intensity than locations at either side, and are thus more desirable for locating people. Weapons in vertical orientation tend to exhibit more symmetrical radiation patterns, with radiation levels a function of distance from the weapon rather than position around the weapons. These considerations should be factors when surveying maintenance work locations and identifying alternate locations.

- Surveys external to nuclear weapons stowage and maintenance areas ashore and afloat which are occupied by unmonitored personnel are intended to ensure that these people do not exceed the exposure limits for Non-Radiation Workers or Members of the General Public. For unmonitored personnel at fixed locations, such as guards or sentries, survey data should verify that expected exposures would not exceed 100 millirem in a year (e.g., millirem/hr times the number of occupancy hours per year for any one person). Where exposure levels could result in exposure greater than 100 millirem in a year, occupancy controls must be established to prevent exceeding this level. For Non-Radiation Workers in work areas or berthing areas next to nuclear weapons stowage and maintenance areas who are not issued TLDs, survey data should verify that they will not exceed 500 millirem in a year. Where exposure levels could result in exposure to an unmonitored Non-Radiation Worker at an adjacent work site greater than 500 millirem in a year, either occupancy controls or an alternate work site must be established.

REQUIREMENTS:

1. Ships and facilities that do not perform nuclear weapon maintenance are not required to perform radiation surveys.

2. Shore facilities shall perform initial neutron and gamma radiation surveys when nuclear weapons maintenance is being performed for each assigned weapons type.

NOTE: The initial maintenance survey should be conducted with the weapon(s) in the position(s) and configuration(s) in which maintenance is performed. If other weapons must be in close proximity to the weapons undergoing maintenance, the survey should be conducted with a typical maintenance area weapons arrangement. After completing a initial survey of a given weapons type, subsequent surveys are not required provided maintenance procedures remain unchanged and there are no significant changes in maintenance area weapons arrangements.

3. Neutron and gamma radiation surveys in areas external to nuclear weapons stowage and maintenance facilities shall be performed at locations where unmonitored personnel are in close proximity to such facilities. Surveys shall be performed when the stowage or maintenance facility contains typical or representative numbers of weapons in their normal arrangements. Based on actual or expected occupancy factors, each survey point shall verify that no unmonitored person exceeds the limits of Non-Radiation Workers or Members of the General Public. Surveys performed to document compliance with Article 202 shall have the yearly estimated exposure for each survey point prominently displayed on the survey sheet, or on an addendum if additional space is needed. Where radiation levels are high enough that an unmonitored person could exceed the limit, changes in occupancy time or work sites shall be made.

NOTE: After a survey at a given location has been completed, subsequent surveys are not required, provided there are no significant changes in weapon numbers, types, or arrangements within the stowage or maintenance area.

4. In addition to the situational surveys required afloat and ashore, surveys shall be conducted when considered necessary by the NWRCO.

5. Surveys shall be performed in sufficient detail to provide a composite representation of neutron and gamma levels at all points of interest.

6. Survey data shall by reviewed by the NWRCO in order to make informed decisions regarding work practices and appropriate man-rem reduction actions for each area of interest.

7. Technicians performing surveys shall maintain proficiency in survey techniques and procedures through periodic training as directed by the NWRCO.

8. Copies of all survey information regarding weapons stowage and maintenance areas shall be retained for a period of three years. Survey information for areas where unmonitored personnel have access (e.g., berthing spaces adjacent to a weapons magazine) shall be retained indefinitely. Survey information shall be recorded on NAVSEA Form 8128/4 (Appendix C). This form may be reproduced locally.

9. All radiation surveys shall be forwarded to COMNAVSEASYSCOM (SEA-04N) upon permanent decertification of the activity.

10. The design of nuclear warheads makes the presence of any radiological contamination extremely unlikely. Prior to permanent decertification of an activity for stowage, transport and/or maintenance of nuclear weapons a radiological assessment shall be performed of all spaces, i.e. magazines, and production bays, where nuclear weapons or weapons components bearing radioactive materials were stored or maintained. The first phase of this assessment, a Historical Radiological Assessment (HRA), shall include a review of local documentation such as fire department logs, and public works building maintenance records, which may assist in describing the prior history of the spaces and with special emphasis on reports of radiological incidents such as leaks, spills or accidents. A copy of this HRA shall be forwarded to COMNAVSEASYSCOM (SEA-04N) for review. The NWRCO shall develop a radiological survey plan using the following criteria:

All proposed spaces for decertification shall be surveyed for radiation and radioactive contamination using gamma survey instrumentation. In addition to a gamma survey, locations for dry swipe samples of approximately 100 cm^2 (4 in. x 4 in.) shall be identified for selected surfaces such as exit door handles, telephone handsets, inside exhaust ventilator grates, floor drains and electric light switch plates in each space to be decertified. In locations where it would be impossible to collect a full 100 cm^2, the best representative area available for swiping shall be proposed and identified on the survey

data sheet accordingly. Additional radiological information such as collection of solid samples for a detailed radioactivity analysis may be required depending on future disposition of the spaces or suspicion of past radiological events. Requests for technical assistance in developing survey plans, training local personnel, loan of portable instrumentation and assistance for conducting surveys should be directed to COMNAVSEASYSCOM (SEA-04N) . The proposed survey plan shall be forwarded for review and approval. Upon completion of the survey, a report of the survey findings including copies of survey data sheets shall be submitted to COMNAVSEASYSCOM (SEA-04N) for final review and approval.

224. NEUTRON AREA MONITORS

DISCUSSION:

The Neutron Area Monitor (NAM) (Fig. II-2 and Fig II-3) is used primarily in the Radiological Controls Program to monitor gamma and neutron radiation levels in berthing and other occupied spaces outside nuclear weapon stowage and maintenance areas afloat and ashore. NAM exposure data are used to verify that radiation levels in those spaces do not exceed the limits for Non-Radiation Workers. Since Neutron Area Monitors are also used for nuclear propulsion and radiac calibration requirements, nuclear propulsion and nuclear support ships maybe equipped with monitors for these applications in addition to nuclear weapons monitoring.

All nuclear weapons maintenance facilities have unique characteristics regarding weapons numbers, types, stowage patterns and space configurations that require permanent installation of Neutron Area Monitors. Submarines are sufficiently similar within each class to permit Neutron Area Monitor data from a selected ship of the class to apply to the class as a whole. The class specific Supplement 1 contains this data . Since there are limited numbers of monitors, when ships enter weapons offload periods the monitors may be transferred to other ships of the class. Neutron Area Monitors are installed at waist level on bulkheads of working or berthing areas outside nuclear weapons stowage and maintenance areas. When possible, they are installed so that the dosimetry drawers are in the horizontal plane. They are positioned with one of the four large monitor surfaces facing the nuclear weapons stowage or maintenance areas. Monitor’s are not marked or otherwise identified so that they will not be associated with nuclear weapons.

The same dosimeter is used in Neutron Area Monitors as that used to monitor nuclear weapons workers and visitors, and to obtain location specific exposure information. This information is compared with expected occupancy factors to estimate exposure levels for unmonitored personnel. NAM exposure data are included in Supplement 1 as a historical record of actual exposure levels aboard commands storing or maintaining nuclear weapons.

COMNAVSEASYSCOM (SEA-04N) is responsible for Neutron Area Monitor management, and provides guidance on transfer, installation, and reporting to cognizant Type Commanders.

REQUIREMENTS:

1. Designated ships and stations shall install Neutron Area Monitors at locations specified by COMNAVSEASYSCOM (SEA-04N). Any relocation of Neutron Area Monitors (e.g., due to ship alterations) must be identified to and approved by COMNAVSEASYSCOM (SEA-04N) before the change occurs.

2. Neutron Area Monitor installation and accountability shall be directed by the NWRCO.

3. Each Neutron Area Monitor shall be mounted in a fixed location, with one of the four large surfaces facing the nuclear weapons stowage or maintenance area, and with the dosimetry drawers normally in the horizontal plane.

4. Neutron Area Monitors shall not be modified, painted or, identified in any way as being associated with nuclear weapons.

5. The dosimetry inside each NAM shall be returned to the Naval Dosimetry Center with the normal personnel dosimetry of the issue cycle, using NAVMED Form 6470/3. NAM data shall be entered after the control TLD and personnel dosimetry data in accordance with the instructions on the reverse side of NAVMED Form 6470/3.

6. If a ship is to be decommissioned or permanently decertified all NAMs are to be returned to Naval Surface Warfare Center, Carderock Division, ATTN: Receiving Officer, 9500 MacArthur Blvd., Bethesda, MD 20817-5700. Care should be taken removing NAMs from bulkheads.

225. UTILIZATION OF SUPPLEMENT 1

DISCUSSION:

Supplement 1 to this manual is a ship-class man-rem (collective dose) reduction planning tool. Supplement 1 issues have been developed for each class of nuclear weapons capable ship. Each Supplement 1 is a self-contained document with a letter of promulgation. A record of changes and revisions filed within the manual to allow ready reference by the Nuclear Weapons Radiological Controls Officer and others charged with man-rem reduction responsibilities.

Each Supplement 1 contains deck plans with the following information illustrated:

- The number and location of radiation area signs in nuclear weapons stowage and maintenance areas.

- Deep dose neutron and gamma radiation levels at specific points of interest in nuclear weapons stowage and maintenance areas, as well as, at selected locations outside these areas, such as offices and other occupied spaces where Non-Radiation Workers are close to nuclear weapons. Survey values are based on COMNAVSEASYSCOM (SEA-04N) evaluations with standard or typical nuclear weapons loads present. Because the number and types of weapons aboard or within a command may change over time, the illustrated survey radiation levels are considered typical and may require updating as weapon types and loads change within a command.

- Locations, serial numbers and recorded deep dose neutron and gamma radiation levels (including calculated rem/yr) of Neutron Area Monitors installed in spaces external to nuclear weapons stowage and maintenance areas. As NAM radiation exposure data are accumulated, this information is included in periodic changes to each Supplement 1.

The current change status for each Supplement 1 is updated as necessary in Navy SWOP 0-1B.

REQUIREMENTS:

1. Radiation area signs, numbers and installation locations shall be in accordance with Supplement 1.

2. Neutron Area Monitor locations (if installed) shall be in accordance with Supplement 1.

3. A request for Supplement 1 shall be directed to COMNAVSEASYSCOM (SEA-04N). Activities that are decertified will not be issued periodic updates to Supplement 1 unless regeneration is ordered.

PART 4. CONTROLLING EXPOSURE DURING OPERATION, MAINTENANCE AND REPAIR

231. MAN-REM REDUCTION

DISCUSSION:

Reduction of personnel exposure to ionizing radiation is one of the goals of the Radiological Controls Program and shall be actively pursued by all personnel with

program management or nuclear weapons supervisory responsibilities. Individual responsibilities for man-rem reduction are described in Article 104.

Time, distance and shielding are the fundamental concepts used to reduce man-rem as low as reasonably achievable. Management of an aggressive ALARA policy must be based on integrating these concepts into work practices, as well as balancing man-rem reduction practices against work production rates and safety and security requirements. Extreme applications of time, distance and shielding concepts could result in a reduction of man-rem at the expense of operational readiness and technical proficiency. Accordingly, man-rem reduction must be a dynamic process, which considers the means to reduce exposures as low as reasonably achievable, consistent with the nuclear weapons mission of the command. Since man-rem reduction practices involve training personnel in work practices, procedures, and techniques which decrease exposure during nuclear weapon handling and maintenance operations, these practices should be used when working with training weapons as well as war reserve weapons to develop and reinforce familiarity with them.

To be effective, man-rem reduction work practices must be an integral part of nuclear weapons handling processes. Supervisors and workers must understand and apply the concepts of time, distance and shielding until they become a practiced and natural part of the overall philosophy for performing nuclear weapons work. Work practices should be continually reviewed to see how they affect work efficiency. The time and distance concepts, in particular, can provide immediate and meaningful man-rem reduction because all workers and supervisors can apply them in virtually all work situations. The single most important man-rem reduction tool is knowing where radiation levels are highest, and minimizing the number of personnel present in these areas. Each supervisor and worker must recognize that radiation levels are functions of weapon type and number , and the distance and orientation of the worker to the radiation pattern in the area. Because the weapon itself can function as shielding , a horizontal nuclear weapon tends to have higher radiation levels at the sides of the warhead than forward or aft of the warhead at a given distance. A weapon that is stowed, handled or maintained in a vertical position presents a nearly symmetrical radiation level at a given distance. For these applications, distance rather than worker orientation to the weapon is the primary consideration in man-rem reduction.

REQUIREMENTS:

1. TIME. Exposure is directly proportional to the time spent in proximity to a radioactive source. This is of particular value in reducing exposure because it is the concept over which personnel can exercise much control. Careful review of work practices and procedures at the command can identify actions that reduce exposures by reducing the time spent near nuclear weapons. The following principles shall be included in ALARA planning :

a. Plan the work to be performed, including specific work requirements for each team member prior to starting work.

b. Gather necessary tools, references and materials for the task before starting the work .

c. Delete unnecessary work.

d. Where practicable, consolidate work requirements to minimize total work required in the nuclear weapons areas.

e. Provide careful supervision to ensure that tasks are completed on time.

2. DISTANCE. For typical work applications, exposure is inversely proportional to the square of the distance from a radioactive source. Maintaining the maximum practicable distances between workers and nuclear weapons can significantly reduce exposures. Although the configuration of weapons stowage and maintenance areas, as well as the nature of work being performed impose limits on the application of the distance concept, the following general principles shall be included in ALARA considerations:

a. Know where radiation areas are highest and minimize the number of people who must be present in these areas.

b. Keep team composition to the minimum necessary to complete the work.

c. Evaluate the use of fewer workers for operations.

d. Keep excess and unnecessary personnel out of areas close to nuclear weapons.

e. Work no closer than necessary to nuclear weapons, consistent with procedural, safety and security requirements.

f. Where possible, remove the weapons being maintained from the proximity of other weapons.

3. SHIELDING. Space limitations aboard ships and work production requirements at certain shore commands create environments where neither time nor distance concepts are adequate to reduce radiation exposure to desired levels. As part of the effort to reduce personnel radiation exposures, COMNAVSEASYSCOM (SEA-04N) evaluates existing and planned weapons and their handling, stowage and maintenance configurations, both afloat and ashore, to determine where shielding is appropriate.

Depending on the intended application, shielding may be installed or used in a variety of ways to reduce personnel exposures. Examples include the following:

- Special designs in bulkhead and deck structures in new construction ships;

- Integral or modified weapons stowage, maintenance and handling equipment;

- Portable covers

- Movable partitions

REQUIREMENTS: Where authorized and installed, the following general guidelines shall be followed to maximize the effectiveness of shielding:

a) Shielding will be used for its intended design application.

b) Shielding shall not be modified or altered without written authorization COMNAVSEASYSCOM (SEA-04N) .

c) Shielding shall not be disassembled, except as part of authorized operations.

d) The description, operation, maintenance procedures and illustrated parts breakdown for portable Navy shielding may be found in Navy SWOP RS-1.

e) Activities whose nuclear capabilities are permanently removed with no potential for regeneration shall turn in portable shielding to Naval Surface Warfare Center, Indian Head Division Detachment McAlester, 567 Army Ammunition Road F, McAlester, OK. 74501-5190. Permanently installed shielding shall not be removed without specific approval by COMNAVSEASYSCOM (SEA-04N).

SECTION III INTERNAL RADIATION EXPOSURE

CONTENTS

SECTION III INTERNAL RADIATION EXPOSURE

301. INTERNAL RADIATION EXPOSURE GOAL

DISCUSSION:

Navy nuclear weapons contain sealed radiation sources. This prevents direct contact with radioactive material except in a limited number of maintenance operations and in accident situations. Therefore, contact with solid and airborne particulate matter is not likely.

REQUIREMENTS:

1. The goal is that personnel shall have no detectable internal radiation exposure from material associated with the stowage, maintenance or handling of Navy nuclear weapons.

2. Any instance of a valid positive exposure shall be reported to COMNAVSEASYSCOM (SEA-04N) within 24 hours of discovery.

3. BUMED (M3F7) will direct the estimation of all exposure from the inhalation, ingestion and internalization of radioactive materials.

302. TRITIUM

DISCUSSION:

Tritium ($_1H^3$ or T), the heaviest and only radioactive isotope of hydrogen, has a physical half-life of about 12.3 years. Tritium spontaneously decays to $_2H^3$, accompanied by the emission of a low energy beta particle and an antineutrino as shown below:

$$_1H^3 \rightarrow {}_2He^3 + \beta^- + \bar{\nu}$$

The beta particles from tritium decay are emitted in a low energy spectrum. The low decay energy makes tritium unique for two reasons: the beta electron is difficult to detect since it can not penetrate the detector window of most radiation monitors or radiation dosimeters; and once tritium is inside the body, all of the beta particle energy is readily absorbed in nearby (within 6 mm) tissue cells. Also beta particles from tritium decay do not penetrate the container in which tritium is stored.

Chemically, a tritium atom behaves exactly like hydrogen and may replace any existing hydrogen atom in a molecule. Two reactions of particular interest are the

exchange of tritium atoms in gaseous hydrogen to form a gas (HT), and the exchange of a tritium atom with a hydrogen atom resulting in a tritiated water molecule, HTO. Tritium readily oxidizes to form HTO in the presence of heat, spark, or flame. Tritium in the environment oxidizes to form HTO at a rate that varies from 1% per hour to 1% per 24 hours. The oxidation rate is a complex function of many factors such as temperature, relative humidity, and materials present.

Tritium is one of the least radiotoxic radioisotopes, but its decay energy is capable of producing biological damage. It is, therefore, potentially hazardous once inside the body. Tritium is effective at producing ionization in a localized area of the body because of the extremely short range of the tritium beta particle in body tissue. Cellular damage in living tissue is often repairable since the regeneration of cells is a normal biological process. This cellular repair and renewal sequence takes place whether the cause of the cell damage is physical, chemical, or radiological.

Tritium can enter the body through three pathways: inhalation, ingestion and skin absorption. In the elemental gas form (HT), tritium is a negligible hazard. In the oxide form (HTO), the rate of tritium uptake by the body is approximately 25,000 times greater than for the gaseous form. Thus, any dose from tritium is dominated by dose from HTO.

When an individual inhales gaseous tritium, most is expelled by the lungs. However, a very small fraction is converted to tritiated water (HTO) (about 0.004%) and retained as free water. The uptake of tritium by inhalation of HTO is more efficient: 99% of tritium inhaled is taken into the body water within seconds. In addition, skin uptake of HTO can approximate the intake by inhalation. Ingested tritiated water is almost completely absorbed from the gastrointestinal tract and quickly appears in the blood. Within minutes after inhalation, ingestion, or absorption, tritium can be found in varying concentrations in organs, fluids, and tissues. Because tritium is incorporated into body water as HTO and this water is constantly being eliminated through the normal bodily waste cycle, the effective half-life of tritium in the body is about 10 days.

Since tritium spreads rapidly within the body's water pool, its presence in the urine can be detected 20 to 30 minutes after uptake. In fact, tritium dose in workers is determined by urinalysis (bioassay). Thermoluminescent dosimeters (TLDs) worn by workers do not record tritium exposure because the low energy beta particle that tritium emits will not penetrate the TLD.

Certain procedures that increase the potential for exposure to tritium are performed only at intermediate maintenance facilities. The use of the AN/PDR-73 Radiac Set or other approved monitoring procedures has shown that tritium is not detectable during maintenance operations. The guidance for alarm level setting is contained in SWOP 20-7 and in paragraph 2 below. Procedures for operating the AN/PDR-73 or other approved instruments are given in the appropriate instrument technical manual.

The tritium for a nuclear warhead is contained in a gas reservoir that is replaced periodically. Radiation from the decay of tritium within the reservoir is not detectable on its external surface. However, due to the slow migration (permeation and offgassing) of tritium through the reservoir walls, welds, etc., low levels of contamination may be detected on the reservoir surface.

Navy policy requires tritium air monitoring aboard submarines in order to detect unintended release of tritium into the sealed submarine environment. No tritium release has occurred to date.

REQUIREMENTS:

1. Activities possessing tritium monitors shall ensure that they are operated, maintained and calibrated in accordance with the applicable technical manuals and instructions.

2. The AN/PDR-73 Radiac Set or other approved tritium detector used during air monitoring operations shall be set to alarm at **100 microcuries per cubic meter**.

3. Activities which suspect that actual levels have exceeded 100 microcuries per cubic meter, shall contact COMNAVSEASYSCOM (SEA 04N).

4. Rubber gloves (latex surgical or waterproof material or the equivalent) shall be worn by personnel who handle tritium bearing components or items that may have been exposed to tritium. Gloves shall be considered to be contaminated with low level radioactivity and discarded in accordance with applicable command directives.

5. BUMED (M3F7) will direct the estimation of all exposure from the inhalation, ingestion and internalization of radioactive materials.

303. AIRBORNE CONTAMINATION

DISCUSSION:

Since the radioactive sources in nuclear weapons are sealed, the probability of radioactivity becoming airborne and, therefore, inhaled or ingested is extremely remote.

REQUIREMENTS:

1. Any instance resulting in a valid positive exposure shall be reported to COMNAVSEASYSCOM (SEA-04N) within 24 hours of discovery.

2. BUMED (M3F7) will direct the estimation of all exposure from the inhalation, ingestion and internalization of radioactive materials.

304. SURFACE CONTAMINATION

DISCUSSION:

Navy nuclear weapons are designed so that the nuclear materials are contained within sealed barriers not accessible to personnel during normal maintenance and handling evolutions. Thus, these nuclear materials can only escape during accident or incident conditions. The tritium for a nuclear warhead is contained in a gas system that is replaced periodically. Radiation from the decay of tritium inside the gas system is not detectable on weapon external surfaces. However, due to the slow migration (permeation and offgassing) of tritium through the gas system walls, welds, etc., low levels of tritium present as loose tritium surface contamination may be detected on the surfaces of the system, other surrounding components, on interior weapons surfaces, and within component shipping containers. Loose tritium surface contamination can be spread by contact with the above items and as a result, associated tools, surfaces, and processing materials should be considered potentially contaminated until proven otherwise.

REQUIREMENTS:

1. Maintenance facilities shall develop procedures to verify that work surfaces, work areas, decks, deck drains, door handles, exhaust vents, etc., inside nuclear weapons work areas are free of contamination prior to work and on completion. Verification shall be accomplished by swiping these surfaces in accordance with Section 3 of SSP OD 62088 as excerpted in Appendix F of this manual.

2. Commands who believe they have handled unsealed radioactive sources associated with Navy nuclear weapons shall contact NAVSEASYSCOM (SEA-04N) for guidance.

3. BUMED (M3F7) will direct the estimation of all exposure from the inhalation, ingestion and internalization of radioactive materials.

SECTION IV WASTE DISPOSAL AND TRANSPORTATION

CONTENTS

SECTION IV WASTE DISPOSAL AND TRANSPORTATION

400. RADIOACTIVE WASTE

DISCUSSION:

There is no definition of radioactive waste generally accepted by regulatory agencies. Radioactive wastes are classified and described by what they are not, rather than what they are in the Code of Federal Regulations, 10 CFR 20. In general, definition and classification of radioactive waste does not consider the actual hazard or toxicity of the waste. Rather, radioactive waste is property that has become contaminated to the extent that decontamination is economically unsound.

Navy nuclear weapons are designed to contain all radioactive materials within sealed volumes, and unless the boundaries of these volumes are breached during an accident there is no personnel access to the radioactive materials. Consequently, there is no significant high-level radioactive waste associated with the normal stowage, maintenance and deployment of Navy nuclear weapons. However, certain components handled during warhead maintenance may acquire detectable loose surface low-level radioactive contamination caused by their proximity to the radioactive components in the warhead. Federal, state and local government regulations do not acknowledge any radioactive contamination level below regulatory concern that permits free disposal of items having low-level detectable loose surface contamination. Navy disposal regulations for radioactive waste require the disposal of some materials as radioactive waste to satisfy legal requirements and public concerns although the materials do not represent an environmental public health risk. NAVSUP 573 and NAVSUPINST 5101.6 address the transportation and disposal of low-level radioactive waste.

Navy nuclear weapons program offices have reviewed all operations during the stowage, maintenance and employment of these weapons, and have established weapon-specific guidelines to identify items which could be potentially contaminated and consequently require controls for their disposal or special controls for shipment to other Navy activities, DOE facilities or civilian contractors.

REQUIREMENTS:

Disposal of all potentially radioactively contaminated items identified by maintenance manuals or program office directives shall be conducted in accordance with all Federal, Navy wide, and locally generated waste management environmental compliance directives.

401. LIQUID WASTE

DISCUSSION:

Liquid radioactive waste is not normally generated in Navy nuclear weapons maintenance operations with the exception of used scintillation material. As a result, there are no requirements for special handling of such material. Disposal of used scintillation liquids is addressed in 10 CFR20. 2005. If liquid waste is generated, NAVSEADET RASO should be contacted for further direction.

402. SOLID WASTE

DISCUSSION:

Information and guidance related to the generation of low-level solid waste and appropriate disposal of such waste will be handled on a case-by-case basis by NAVSEADET RASO.

403. TRANSPORTATION

DISCUSSION:

The requirements for the movement of nuclear weapons and nuclear weapons components are contained in SWOPs 45-51, Basic and A through D. DoD Directive C5210.41M, 'Nuclear Weapons Security Manual" specifies the security requirements for nuclear weapons and component movement. This security manual imposes sufficient controls that additional requirements for radiological protection are not considered necessary. NAVSUP 573 and individual Naval Supply System instructions coupled with Federal (49 CFR), state and local regulations define the specific packaging, marking and transportation requirements for movement of low-level radioactive waste materials. Request for further information or clarification on transportation issues should be addressed to COMNAVSEASYSCOM (SEA 04N).

APPENDIX A

EFFECTS OF RADIATION ON PERSONNEL

Control of ionizing radiation exposure in the Navy Nuclear Weapons Radiological Controls Program, hereafter referred to as the Radiological Controls Program, is based on the assumption that any exposure, no matter how small, involves some risk. Numerous studies have indicated that exposure within the accepted exposure limits represents a small risk when compared with the normal hazards of life. Recently, some scientists have questioned the existence of negative health effects at low doses.

Exposure to Radiation May Involve Some Risk

Historically, scientists have speculated that occupational exposure to ionizing radiation, when added to that from natural background, may involve some additional risk. The National Council on Radiation Protection and Measurements in 1954 and the International Commission on Radiological Protection in 1958 both recommended that exposures should be kept as low as reasonably achievable. and that unnecessary exposure should be avoided to minimize risk. In 1964 the International Commission on Radiological Protection explained assumed risk as follows:

> "The basis of the Commission's recommendations is that any exposure to radiation may carry some risk. The assumption has been made that, down to the lowest level of dose, the risk of inducing disease or disability in an individual increases with the dose accumulated by the individual, but is small even at the maximum permissible levels recommended for occupational exposure." (Reference 1)

A number of subsequent studies reinforced these conclusions.

The consensus from these reports is that radiation exposure to personnel should be minimized. This is not a new conclusion. It has been, and continues to be, a major driving force of the Radiological Controls Program.

COLLECTIVE DOSE

Collective dose, defined as the sum of all individual exposures, is a measure of the theoretical effect on the group of personnel occupationally exposed from the Radiological Controls Program, and is an indicator of the effectiveness of the overall program effort to minimize radiation exposure.

The total occupational radiation exposure of 5.35 man-rem received by all personnel in the Radiological Controls Program in 2001 can be compared to the many other sources of radiation exposure received by the U.S. population. Examples include :

- 20,000,000 rem to the population of the U.S. each year from natural background radiation, (an average of 0.15 rem per person).
- 17,000,000 rem to the population of the U.S. each year from medical and dental radiation.
- 650,000 rem to the population of the U.S. each year from radioactivity in natural gas used for cooking.
- 100,000 rem that the one million inhabitants of Denver could save each year if they moved to a region such as Washington, D.C. which has lower natural background radiation levels.
- 12,000 rem total to airline passengers in the United States from increased exposure to cosmic radiation at the higher altitudes used by airplanes.

From the preceding comparisons, it can be concluded that occupational exposure to individuals working in the Radiological Controls Program is insignificant when compared to the exposures received from other sources.

Studies of the Effects of Radiation on Humans

Observations on the biological effects of ionizing radiation began soon after the discovery of x-rays in 1895 and have continued until the present day.

Numerous references are made in early reports concerning biological effects of exposure to ionizing radiation. These effects have been studied for over 100 years. Although there is uncertainty about the precise level of risk from exposure to low-level ionizing radiation, the National Academy of Sciences has stated: "It is fair to say that we have more scientific evidence on the hazards of ionizing radiation than on most, if not all, other environmental agents that affect the general public." (Reference 2) Much experimental evidence for radiation effects on biological systems has come from laboratory studies on cell systems and laboratory animals. However, what distinguishes the extensive knowledge of the effects of radiation on humans from that of other hazards is the evidence obtained from human populations exposed to radiation . The health effects demonstrated from studies on people exposed to high doses of radiation (that is, significantly higher than occupational limits) include the induction of cancer, cataracts, sterility and developmental abnormalities from prenatal exposure. Animal studies have demonstrated the potential for genetic effects in the offspring of exposed animals.

High Dose Studies

A number of human population studies have contributed information about the biological effects of radiation exposure. Study groups include the survivors of Hiroshima and Nagasaki, x-rayed tuberculosis patients, victims of various radiation accidents, patients that have received radiation treatment for a variety of diseases, radium dial painters, and inhabitants of South Pacific islands who received unexpected doses of radiation from fallout due to early nuclear weapons tests. All these populations received high or very high exposures.

The studies of atom bomb survivors have provided the single most important source of information on the immediate and delayed effects of whole body exposure to ionizing radiation. The studies have been supported for over 55 years by the U.S. and Japanese governments and analyze the health of over 100,000 survivors of the bombings. Continued follow-up of the Japanese survivors has changed the concern from genetic effects to the induction of cancer.

The induction of cancer is the major late effect of radiation exposure in the atomic bomb survivors. The tissues most sensitive to the induction of cancer are the bone marrow, thyroid gland and female breast. Other cancers linked to radiation include cancers of the lung, colon, bladder and esophagus. A wave-like pattern of leukemia induction was seen over time beginning two years after exposure and diminished to near baseline levels after 30 years. For other cancers, a statistically significant excess was observed ten or more years after exposure, and the excess risk continues to rise slowly with time.

While it has been alleged that radiation causes all forms of cancer, many forms of cancer actually show no increase among atomic bomb survivors. These include chronic lymphocytic leukemia, Hodgkin's disease and cancers of the liver, pancreas, prostate and testis.

To understand the impact of cancer induction from the high doses associated with the atomic bombings, it is necessary to compare the survivor cancer rate to that expected in a similar sized unexposed group. In a study sub-group of over 40,000 survivors with doses in the range of 1 rad to 400 rads from the bombings, 3,435 had died from cancer by 1985. Of these, only 340 cancer deaths are attributed to radiation exposure. The cancer mortality experience of the other human study populations exposed to high doses is generally consistent with the experience of the Japanese atomic bomb survivors.

About 50 years ago, the major concern regarding the effects from radiation exposure centered on possible genetic changes. Ionizing radiation was known to cause such effects in many species of plants and animals. However, intense study of nearly 70,000 offspring of atomic bomb survivors failed to identify any genetic effects. Based on a recent analysis, humans appear less sensitive to genetic effects from radiation exposure than previously thought.

Radiation-induced cataracts have been observed in atomic bomb survivors and in people treated with very high doses of x-rays to the eye. Over 40 years ago, cataract induction was a matter of concern. However, research indicates that induction of cataracts by radiation requires a very high threshold dose. The National Academy of Sciences reported that the threshold for a vision-impairing cataract under conditions of protracted exposure is approximately 800 rem, which greatly exceeds the amount of radiation that can be reasonably accumulated by the lens of the eye through occupational exposure.

Radiation damage to the reproductive organs due to very high doses can result in sterility. Impairment of fertility requires a dose large enough to damage or deplete most of the reproductive cells, which is close to a lethal whole body dose . The National Academy of Sciences estimates the threshold dose necessary to induce sterility in humans is approximately 350 rem in a single dose. As in the case of cataract induction, this dose far exceeds the dose that can be received from occupational exposure under normal working conditions.

Developmental abnormalities were observed among children of the atomic bomb survivors who were exposed in utero. These abnormalities included stunted growth, small head size, and mental retardation. Recent analysis suggests that during the 8^{th} to 15^{th} week of pregnancy the developing brain appears to be especially sensitive to radiation.

The most important effect to occupationally exposed workers is the potential for induction of cancer. The other effects will not occur in affect an occupationally exposed individual.

Low Dose Studies

The cancer-causing effects of radiation on the bone marrow, female breast, thyroid, lung, stomach and other organs reported in the atomic bomb survivors are similar to those reported for other irradiated human populations. With few exceptions the effects have only been observed at high doses and high dose rates. Studies of populations chronically exposed to low-level radiation have not shown consistent or conclusive evidence of an increased risk of cancer. Attempts to detect increased cancer in human populations exposed to low doses of radiation have been unsuccessful .

One problem with such studies is the large number of people needed to provide sufficient statistical power. As the dose to the exposed group decreases, the number of people needed to detect an increase in cancer increases dramatically. For example, for a group exposed to 1 rem it would take more than 500,000 people to detect an excess in lung cancers based on current estimates of the risk. This is more than ten times the number of persons who have been in the Radiological Controls Program. As discussed earlier , data from the atomic bomb survivors indicates a long latency period between the time of exposure and the expression of the disease.

Another confounding problem is that the term cancer is a generalization for a group of over 300 discrete diseases, many of which are rare and are caused by many different agents . It is difficult to eliminate the possibility that some factor other than radiation may be causing an apparent increase in cancer incidence. This is found in studies of lung cancer victims, in whom smoking or exposure to smoke (primary causes of lung cancer) is common, but in whom other contributing traits are poorly characterized . Because cancer induction is statistical in nature, low dose studies are limited by the fact that a small observed increase in a cancer may be due to chance alone.

Nevertheless, low dose studies perform an important function, as they are the only means available for testing the validity of risk assessments derived from higher doses and dose rates.

Groups exposed to low levels of radiation that have been studied include groups exposed by medical procedures, groups exposed to fallout from nuclear weapons testing; people living near nuclear installations; people living in areas of high natural background radiation; and people occupationally exposed to low doses of radiation. The National Academy of Sciences has reviewed a number of low dose studies and concluded that:

> "Studies of populations chronically exposed to low-level radiation, such as those residing in regions of elevated natural background radiation, have not shown consistent or conclusive evidence of an associated increase in the risk of cancer." (Reference 3)

Studies recently completed support that conclusion. In 1990, the National Cancer Institute published a study of cancer in populations living near 62 nuclear facilities prior to 1982. The study included commercial nuclear power plants and Department of Energy facilities . The study concluded that:

> "There was no evidence to suggest that the occurrence of leukemia or any other form of cancer was generally higher in the counties near the nuclear facilities than in the counties remote to nuclear facilities."(Reference 4).

At the request of the Three Mile Island Public Health Fund, independent scientists studied changes in the pattern of cancer in the 10-mile area surrounding the Three Mile Island nuclear plant after the TMI-2 accident in March 1979, and whether the changes were related to radiation releases from the plant. One conclusion of this study was:

> " For accident emissions, the author failed to find definite effects of exposure on the cancer types and population subgroups thought to be the most susceptible to radiation. No associations were seen for leukemia in adults or for childhood cancers as a group." (Reference 5)

In 1987, the Yale University School of Medicine completed a study sponsored by the U.S. Navy Bureau of Medicine and Surgery on the health of Navy personnel assigned to nuclear submarine duty between 1969 and 1981. The objective of the study was to determine whether the enclosed environment of submarines had any impact on the health of submariners . Although not strictly designed as a study of cancer in a low dose population, the study did examine cancer mortality related to radiation exposure. The study concluded that submarine

duty has not adversely impacted the health of the crewmembers. The observations compared death rates between the approximately 86,000 officer and enlisted submariners (all who served between 1969 and 1981) and an age-matched peer group.

In 1989, an article in Navy News and Undersea Technology incorrectly reported on the results of the Yale study . The is article alleged that sailors in fleet ballistic missile submarines (SSBNs) had an elevated cancer rate compared to national rates, but the authors misinterpreted the data. The article considered the cancer mortality of enlisted sailors from SSBNs who had been discharged from the Navy, and reported an increase in the number of cancers versus the number expected (54 observed versus 39 expected). However, the article failed to recognize that the Navy medically discharges service members with serious diseases who are no longer fit for duty. Thus, cancer mortality data for the active duty SSBN sailors was skewed low (4 observed versus 28 expected), and the discharged group was skewed high. Data for both groups must be combined to allow a valid comparison with civilian control groups. Table A-1, taken from the Yale study results, shows the comparison for enlisted submariners. The officer data shows similar trends. Note that the SSBN population was larger that the fast attack submarine (SSN) population, hence the larger number of expected cancer deaths. Also, SSBN and SSN category is defined as service aboard both types of submarines. As seen in Table A-1, cancer deaths among SSBN and SSN sailors are actually less than the cancer deaths among their age group controls in the civilian population.

TABLE A-1
YALE STUDY RESULTS

ENLISTED SUBMARINERS	CANCER DEATHS OBSERVED	CANCER DEATHS EXPECTED
SSBN	58	67
SSN	23	42
SSBN & SSN	3	18
TOTAL	84	127

Numerical Estimates of Risk from Radiation

One of the major purposes of radiation epidemiology studies is to develop numerical estimates of the risk of radiation exposure. These risk estimates are used to address how hazardous radiation exposure is, evaluating and setting radiation protection standards, and helping resolve claims for compensation by exposed individuals.

Numerical risk estimates have many uncertainties. As noted above, excess cancers attributed to radiation exposure can only be observed in populations exposed to high doses and dose rates. As a result, the risk estimates derived from the high dose studies must be extrapolated to low doses , which introduces a significant source of uncertainty. The numerical risk factors derived from this extrapolation are thus a matter of hypothesis (i.e., assumption) rather than observation.

Risk Comparisons

Table A-2 compares risks calculated from occupational exposure in the Weapons Radiological Controls Program to other occupational risks. This allows evaluation of the relative hazard of this risk compared to risks normally accepted in the workplace. The radiation risk is calculated from risk estimates, whereas other occupational risks are based on actual death statistics for the occupation.

TABLE A-2

LIFETIME OCCUPATIONAL RISK OF DEATH FROM CANCER

OCCUPATION	RISK PERCENT INCREASE[a]
Mining	2.8
Agriculture	2.2
Construction	1.8
Transportation and Public Utilities	1.3
All Industries Average	0.5
Government	0.4
Services	0.3
Manufacturing	0.3
Trade	0.2
Radiation exposure associated With Naval nuclear weapons	0.04

a- Assumes working from 18 to 65 years of age. (47 yrs.) Further perspective on the lifetime risk from radiation exposure in the Naval Nuclear Radiological Controls Program may be gained by comparison to other everyday risks as shown in Table A-3.

TABLE A-3
SOME COMMONPLACE LIFETIME RISKS OF DEATH FROM CANCER

RISK	RISK PERCENT INCREASE[a]
Smoking	12
Motor Vehicle Accidents	1.3
Home Accidents	0.79
Falls	0.45
Drowning	0.26
Fires	0.20
Accidental Poisoning	0.10
Firearms	0.07
Electrocution	0.04
Radiation exposure associated With Naval nuclear weapons	0.04

a- smoking assumes at risk from 32 to 72 years of age (40 years) and Motor Vehicle Accidents assume risk from 18 to 72 years of age (54 years). Other risks assume at risk for lifetime (72 years).

Low-Level Radiation Controversy.

In the study of low-level radiation exposure consequences, as in other areas, it is easy to frighten people by stating that the effects are not well understood. This as been repeated so often that it has almost become an article of faith that no one knows the effects of low-level radiation on humans. Critics make this statement because the human studies of low-level radiation exposure are unable to conclusively prove or disprove whether an effect exists in an exposed group. The reason low dose studies cannot be conclusive is because the risk, if it exists at these levels, is too small to be seen against the background of all the other risks of life.

The fact that a controversy exists suggests that the radiation risk is small.

In summary, the effect of radiation exposures at occupational levels is extremely small. There are scientific limitations to precisely determining the size of the risk, but it is known to be small.

This discussion is intended to allow the worker to better answer the question, “Is radiation safe?” If “safe” is defined to mean no effect, the only conclusion would have to be that radiation might be unsafe. But such a definition is not logically or scientifically defensible, since all human activities entail some degree of risk. By such a rigorous definition, background radiation and medical radiation would also have to be considered unsafe.

"Safety" is a relative term that is defined subjectively by each individual. Risk, on the other hand, is an objective term that can be quantified. Comparisons between risks are necessary for actual meaning. For a worker, safe means the risk is small compared to other risks accepted in normal work activities. Outside of work, **safe** means the risk is small compared to other risks routinely accepted in life.

APPENDIX A REFERENCES

(1) International Commission on Radiological Protection Publication 6, "Recommendations of the International Commission on Radiological Protection," Pergamon Press, 1960.

(2) A.C. Upton," The Biological Effects of Low Level Ionizing Radiation," Scientific American, Feb 1982.

(3) National Academy of Sciences-National Research Council," Health Effects of Exposure to Low Levels of Ionizing Radiation," Report of the Advisory Committee on the Biological Effects on Ionizing Radiation, 1990.

(4) National Cancer Institute, "Cancer in Population Living Near Nuclear Facilities, "NIH Publication No. 90-874, July 1990

(5) M.C. Hatch, et al, "Cancer near the Three Mile Island Nuclear Plant: Radiation Emissions," American Journal of Epidemiology, September 1990

US NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE 8.29

"INSTRUCTION CONCERNING RISKS FROM OCCUPATIONAL RADITION EXPOSURE"

APPENDIX B
U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE 8.13

"INSTRUCTION CONCERNING PRENATAL RADIATION EXPOSURE"

APPENDIX C

RECORDS, REPORTS, AND FORMS

DISCUSSION:

This appendix contains forms and formats for use in the Radiological Controls Program. It does not contain all forms or reports that may be required by this manual.

RADIATION RECORD NAVSEA Forms 8128/5 and 8128/6

These forms are used by ships and facilities to consolidate and manage information on those individuals who require entry into nuclear weapons stowage and maintenance areas (as discussed in Article 212). These individuals include ships force or facility personnel who make one time or sporadic entries into nuclear weapons stowage and maintenance areas. Also included are all personnel from other commands and organizations, separated into those who do and those who do not perform work on nuclear weapons. Form 8128/6 is designed for submarine training records.

The Radiation Record has been designed to record information on a single form, regarding the individual, the parent or sponsoring command for visitors, the person's radiation exposure history, verification that the training or briefing requirement has been met, issued dosimetry data, and reporting of radiation exposures as required by NAVMED P-5055. Local reproduction of these forms is authorized.

APPROVAL FOR EXCEEDING THE ANNUAL RADIATION CONTROL LEVEL

This page provides a sample format for documenting the Commanding Officer's approval for a Radiation Worker to exceed the Article 201 control level of 0.5 rem TEDE per year.

NAVMED 6470/3 RADIATION EXPOSURE

This page provides a reproducible copy of the form required by NAVMED P-5055 when submitting TLDs to the Naval Dosimetry Center.

RADIOLOGICAL CONTROL SURVEY RECORD NAVSEA Form 8128/4

This form provides the format and required information for documenting neutron and photon radiation surveys, as required by Article 223. Forms may be reproduced locally.

RADIATION RECORD NAVSEA FORM 8128/5

<table>
<tr><td rowspan="5">Section I

Visitor Command and Exposure Information</td><td colspan="3">Name of Ship/Facility Where Exposure will Occur</td><td>UIC of Host Command</td></tr>
<tr><td>NAME (Last, First, MI)</td><td>Rank/Grade/Civ</td><td>SSN</td><td>DOB</td></tr>
<tr><td colspan="2">Parent/Sponsoring Command</td><td colspan="2">Mailing Address & Phone Number of Parent Command</td></tr>
<tr><td colspan="4">(Circle as appropriate)

Do you receive exposure from other radiological controls programs? (Radiography, Propulsion, etc.)
YES NO

Are you a member of a nuclear weapons radiological controls program?
YES NO

Do you have your own dosimeter?
YES NO

I DO/DO NOT certify I have not exceeded the annual TEDE limit. (CO letter required if limit has been exceeded)</td></tr>
<tr><td colspan="4">Before completing this form, read the briefing and Privacy Act statement on the reverse side
Signature | Date</td></tr>
<tr><td>Section II

Radiological Controls Representative Training and Issuing Certification</td><td colspan="4">Individual Training Verification (Must check a category)

Ship/Facility Non-radiation Worker (Article 107) ☐ | Visiting Weapons Worker (Article 105 A) ☐ | Visitors other than Weapons Workers (Article 105 B) ☐</td></tr>
<tr><td colspan="4">(Circle as appropriate)
This individual IS/IS NOT eligible to receive exposure at this command.

Dosimeter issue IS/IS NOT required.</td></tr>
<tr><td colspan="4">TLD Serial # | Date Issued | Date Collected | MDR/RADHEALTH Department Signature Date</td></tr>
<tr><td>Section III

Exposure Data And Data Disposition</td><td colspan="4">Deep Dose Photon (REM) | Deep Dose Neutron (REM) | TEDE (REM)

Entered on NAVMED Form 6470/10, 6470/11 or DD 1141 ☐
or
Forwarded to Parent or Sponsoring Command ☐

MDR/RADHEALTH Department Signature | Date</td></tr>
</table>

RADIATION RECORD NAVSEA FORM 8128/5

I understand that radiation exposures must be maintained as low as reasonably achievable (ALARA). A radiation control level of 0.5 REM whole body dose per year has been established by this radiological control program to reduce total man-REM. This radiation control level is one-tenth the Federal limit for occupational exposure. Although all radiation exposure may involve potential risk, the radiation control level is such that no biological effects are expected even if exposures continue for a lifetime at this annual level.

I know of no potential disqualifying medical conditions (such as history of extensive radiation treatments), which should prevent my receiving radiation exposure within prescribed Federal limits.

If pregnant, I must immediately inform the radiological controls representative to permit proper exposure control.

I understand the necessity of obeying radiological controls limits and requirements, of maintaining time spent close to sources of radiation and properly wearing my dosimeter.

Privacy Act Statement

Pursuant to 5 U.S.C. 552 a(e) (3) of the privacy act of 1974 as amended (Public Law 93-579) Executive Order 9379 "Numbering System for Federal Accounts Relating to Individual Persons", 5 U.S.C. 301, and NAVMED P-5055 "Radiation Health Protection Manual," the information collected herein is maintained in Department of the Navy Systems of Records N06150-1. This information will be used to measure and document radiation exposure as well as ensure that a person's total radiation exposure (excluding medical and natural background) will not exceed allowable limits. The data on your exposure to radiation is available upon your request. Routinely, this information may be used for maintenance of safe occupational/environmental protection standards as well as maintenance of exposure history for employers, employees and visitors. You are not required to provide the information, however, failure to do so may result in denial to enter restricted areas.

RADIATION RECORD FORM 8128/6

I understand that radiation exposures must be maintained as low as reasonably achievable (ALARA). A radiation control level of 0.5 REM whole body dose per year has been established by this radiological control program to reduce total man-REM. This radiation control level is one-tenth the Federal limit for occupational exposure. Although all radiation exposure may involve potential risk, the radiation control level is such that no biological effects are expected even if exposures continue for a lifetime at this annual level.

I know of no potential disqualifying medical conditions (such as history of extensive radiation treatments), which should prevent my receiving radiation exposure within prescribed Federal limits.

I understand the necessity of obeying radiological controls limits and requirements, of maintaining time spent close to sources of radiation and properly wearing my dosimeter.

Date of training:_____

Print	Signature	Print	Signature

APPROVAL FOR EXCEEDING THE ANNUAL RADIATION CONTROL LEVEL

Date:

From: Commanding Officer, _____
To: _____

Subj: AUTHORITY TO EXCEED THE ANNUAL RADIATION CONTROL LEVEL

Ref: (a) NAVSEA TW120-AA-PRO-010

1. Approval is granted to exceed the reference (a) radiation control level of 0.5 rem TEDE for 20__. The new radiation control level is set at _____rem TEDE for 20__.

2. This approval is granted in accordance with Article 201.2 of reference (a) for continued performance of your assigned duties.

3. The occupational exposure limits of Articles 202 and 203 of reference (a).

4. You are directed to continue to maintain your radiation exposure as low as reasonably achievable (ALARA) consistent with your assigned duties.

Original- Radiological Controls Officer
Copy to Member

APPENDIX D

NUCLEAR WEAPONS RADIOLOGICAL CONTROLS PROGRAM REVIEW ITEMS

The items listed in this appendix are intended to assist the Nuclear Weapons Radiological Controls Officer in reviewing the Nuclear Weapons Radiological Controls and Radiation Health programs. Inspectors may use this appendix during Nuclear Weapons Technical Inspections. Article numbers are provided to assist in this review. NWRCOs shall document the scope of their Article 104 mandated reviews to include as a minimum: recording specific records reviewed, list all personnel interviewed, a list of questions used during interviews, a list of significant findings and resolution of those findings.

I. APPOINTMENT AND TRAINING OF THE NUCLEAR WEAPONS RADIOLOGICAL CONTROLS OFFICER AND ALTERNATE

1.) Have the individuals been designated by name? (104)
2.) Has the required course been successfully completed at the Trident Training facility? (109)
3.) Are the individuals familiar with their duties and responsibilities? (104)
4.) Are the individuals knowledgeable about man-rem dose for the individuals and the total man-rem (collective dose) for the command? (104.C)
5.) Is the man-rem (collective dose) reduction program effective? (104.C)

II. APPOINTMENT AND TRAINING OF THE RADIOLOGICAL CONTROLS PROGRAM TECHNICIANS (FACILITIES ONLY)

1.) Have the individuals been designated by name? (104)
2.) Has the required training been completed at the facility? (108)
3.) Are the individuals familiar with the duties and responsibilities? (108,223)
4.) Can the individuals demonstrate the ability to perform gamma and neutron surveys and discuss in detail the reasons for the specific procedures used in performing these surveys? (223)

III. TRAINING OF NUCLEAR WEAPONS WORKERS AND OTHERS AS REQUIRED

1.) Have the nuclear weapons workers received the proper training? (106)

a.) Is the training repeated on a continuous basis such that personnel receive this training at least every twelve months? (106.3)
b.) Do Instructor Guides, if used to conduct training, include the topics listed in Article 106 ?(106.5)

2.) Have all ship and facility nuclear weapons workers received training on prenatal exposure risks? Is this instruction documented by testing? (105.C)

3.) Is there an ongoing program ashore to provide information to personnel assigned duties in limited areas but not directly involved in the stowage and maintenance of nuclear weapons? (105)

4.) Do shipboard personnel who do not enter nuclear weapon stowage and maintenance areas receive initial indoctrination and periodic training? (105)

5.) Are training and indoctrination records maintained properly? (105 and 106)

6.) Are nuclear weapons workers able to:

- a.) Describe their responsibilities listed in Article 104.D.
- b.) State the radiation control level and their current and annual radiation exposure. (104)
- c.) Demonstrate knowledge of the biological effects of radiation. (106)
- d.) Explain the risk associated with personnel exposure to radiation both internal and external to the body. (106)
- e.) Discuss the specific methods used to minimize radiation exposure. (104 and 231)
- f.) Demonstrate how to wear the TLD properly. (104 and 211)
- g.) Describe the seriousness of violating radiological control requirements and tampering with or intentionally exposing the TLD. (104)
- h.) Describe the radiological hazards associated with nuclear weapons. (106)
- i.) Describe the type of radiation and radioactive materials associated with Navy nuclear weapons; the hazards associated with each type of radiation and radioactive material; and precautions to take in the event of the release of radioactive materials (106)

7.) Do written examinations test the level of knowledge of each topic listed in Article 106?

IV. IMPLEMENTATION OF THE PERSONNEL DOSIMETRY PROGRAM

1.) Has a personnel dosimetry program been implemented? (211) Are all radiation exposure records generated by computer? If not, is the command authorized in writing by NAVDOSCTR to use manual entries? (P-5055)

2.) Have all required personnel been issued a TLD? (212)

- a.) Has Article 106 initial training been completed prior to the issuance of personnel dosimetry to ship or station nuclear weapons workers?
- b.) Have preplacement radiation medical examinations been completed prior to the issuance of personnel dosimetry to ship and station nuclear weapons workers? (213)

3.) Are the control, unissued, and issued-but-not-worn TLDs stored in a low radiation area? (212.6)

4.) Are the results of control TLDs reported in NAVMED 6470/3 at or below 0.025 rem photon and 0.015 rem neutron? (212.6)

5.) Are TLDs worn on the front of the body, with the belt loop against the body? (211.3)
6.) Is the exposure information on the NAVMED 6470/3 reviewed by the Nuclear Weapons Radiological Controls Officer prior to transcription to NAVMED 6470/10,"Record of Occupational Exposure to Ionizing Radiation"? (104.C.1.a) Are the results of this review documented and retained for a minimum of three years? (104.C.1.a)
7.) Is the exposure information on the NAVMED 6470/3 correctly transcribed to the NAVMED 6470/10? (211 and NAVMED P-5055)
8.) Have at least 1% but not fewer than five individuals' exposure records been verified for accuracy semi-annually? (NAVMED P-5055)
9.) Have all personnel who have been terminated since the last inspection, and have requested a termination letter in writing, been issued a termination letter with a copy to the Naval Dosimetry Center? (NAVMED P-5055)
10.) Is the radiation control level and the occupational exposure limits obeyed? (201,202, and 203)
11.) For Radiation Workers who exceed the radiation control level, is there written approval of the Commanding Officer? (201.2)
12.) Are visitors briefed and issued dosimetry prior to entry into nuclear weapons stowage and maintenance areas? (105 and 212.1)
13.) Are dosimetry results forwarded for visitors and personnel from other commands? (212.10)
14.) Are annual and situational reports submitted as required by NAVMED P-5055?
15.) Are personnel informed of their exposures:
    a.) After each issue period? (212.8)
    b.) In writing at least yearly? (212.8)
    c.) On written request? (212.8)
16.) Are exposures estimated in accordance with the procedures in NAVMED P-5055 for lost or damaged TLDs and suspect dosimetry results? (211.5, 212, and NAVMED P-5055)
17.) When estimated exposures have been entered on DD Form 1141s, NAVMED Form 6470/10 and/or NAVMED Form 6470/11 have the procedures of Article 211 and NAVMED P-5055 been followed? (211 and NAVMED P-5055)

V. PERFORMANCE OF REQUIRED RADIATION MEDICAL EXAMINATIONS

1.) Are radiation medical examinations being conducted on required personnel? (NAVMED P-5055 and 213)
2.) MILITARY AND CIVILIAN PERSONNEL Does the SF 88 Report of Medical Examination or BUMED Form 6470/13 contain the following: (NAVMED P-5055, Chapter 2)
    a.) A clear statement that the individual is qualified for "IONIZING RADIATION WORK"?
    b.) A completed differential blood count and urinalysis (P-5055Article 2-3 (2))?

c.) Signature of reviewing medical officer/physician and date of review in Block 82?

3.) Does the SF 93 (Report of Medical History) include the following? (NAVMED P-5055, Article 2-3(2)(a)):
    a.) History of occupational or accidental exposure to ionizing radiation?
    b.) Personal history of cancerous or precancerous lesions?
    c.) Personal history of anemia?
    d.) Personal history of cataracts?
    e.) History of radiation therapy?
    f.) History of radiopharmaceuticals received for therapeutic or experimental purposes?
    g.) History of work involving the handling of unsealed radium sources or other unsealed sources?

VI. POSTING OF REQUIRED RADIATION AREA SIGNS

1.) Are signs posted in all nuclear weapons stowage and maintenance areas? (221)
2.) Are these signs posted where they will be immediately visible to anyone who enters? (221)
3.) Are signs posted in locations prescribed by Supplement 1, if applicable? (221 and Supplement 1)

VII. PERFORMANCE OF SURVEYS REQUIRED AT SHORE FACILITIES

1.) Are radiation surveys of nuclear weapons maintenance and stowage areas performed for each assigned weapon type? (223.2)
2.) Are radiation surveys performed in all areas where unmonitored personnel could exceed:
    a.) 500 millirem in a year for Non-Radiation workers? (223.3)
    b.) 100 millirem in a year for Members of the General Public? (223.3)
3.) Are surveys performed in sufficient detail to provide a composite representation of Deep Dose neutron and Deep Dose photon levels in the area of interest? Are yearly average doses calculated and documented on the survey form or an attached addendum? (223.5)
4.) Is survey data reviewed by the Nuclear Weapons Radiological Controls Officer and evaluated for man-rem (collective dose) reduction actions? (223.6)
5.) Are survey technicians proficient in survey techniques and procedures? (223.7)
6.) Are survey results classified appropriately and retained:
    a.) At least three years for surveys in maintenance and stowage areas? (223.8)

b.) Indefinitely for surveys performed to demonstrate compliance with the limits of NAVMED P-5055? (223.8 and NAVMED P-5055)

VIII. POSTING OF NEUTRON AREA MONITORS (Designated ships and facilities)

1.) Are the required Neutron Area Monitors installed in the proper locations? (224.1)
2.) Are Neutron Area Monitors properly installed and not marked or otherwise identified as being associated with nuclear weapons? (224.3 and 224.4)

IX. OPERATION OF A MAN-REM (COLLECTIVE DOSE) REDUCTION PROGRAM

1.) Are work practices consistent with man-rem (collective dose) reduction concepts? (231)
2.) Are personnel aware of those areas and operations that contribute significantly to their exposures? (231)
3.) Is shielding (where provided) being used for its designed purpose? (231.3)

X. CONTROL OF POTENTIAL LOW LEVEL RADIOACTIVE WASTE AND PREVENTION OF SPREAD OF POTENTIAL LOW LEVEL RADIOACTIVE CONTAMINATION

1.) Is there a clear understanding of local requirements to identify and properly dispose of potential contaminated low level radioactive waste that may be produced during routine maintenance on Navy nuclear weapons?
2.) Has the activity implemented Navy and local directives to demonstrate control of the spread of potential low level radioactive contamination.

APPENDIX E

LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETRY PROGRAM MANAGEMENT

I. Introduction

Dosimetry is an essential element of the Radiological Controls Program. Dosimetry results document actual individual exposures from nuclear weapons. This demonstrates compliance with applicable Federal statutes and provides medical/legal documentation. In addition, dosimetry results in conjunction with radiological survey data are used to determine (collective dose) reduction actions to maintain exposures As Low As Reasonably Achievable (ALARA).

Dosimeters must be worn properly and exposure results must be accurately maintained. Suspect results and dose estimations require careful attention to detail, because they will be used when individual exposure data is not available or of questionable validity. Documented exposure values form permanent records that could be used in the future to justify radiological controls management practices for the individual concerned.

This appendix provides additional guidance concerning the lithium fluoride thermoluminescent dosimetry (LiF TLD) program used in the Radiological Controls Program to monitor personnel for exposure to photon and neutron radiation. This dosimetry is described in detail in Chapter 6 of NAVMED P-5055 and in Articles 211 and 212 of this manual. This appendix will cover the operation of the dosimeter, management considerations of the local LiF TLD program, and dose estimation and investigation considerations. It also provides additional information for all personnel who wear dosimeters, and particularly for those responsible for managing dosimetry programs and maintaining dosimetry records and reports. A copy of this appendix should be provided to medical personnel supporting the Radiological Controls Program in your command.

II. Operation of the LiF TLD

Thermoluminescent dosimetry is the measure of radiation using a crystalline substance sensitive to radiation. When the crystal is heated light is produced that is proportional to the amount of radiation exposure. Ionizing radiation imparts energy to the substance and creates free electrons and hole pairs in impurities in the crystal structure. When the irradiated substance is heated in a controlled manner, the electrons give off energy in the form of visible light. The total amount of light is proportional to the energy absorbed from the ionizing radiation.

The lithium fluoride thermoluminescent dosimeter, referred to as the LiF TLD, is capable of detecting beta, gamma, x-ray, and neutron radiation. LiF is extremely sensitive to low level radiation exposure, including background radiation.

The DT-702 TLD (copper-doped) card consists of four LiF:Mg, Ti, Cu P TL elements of different thickness and composition mounted between two Teflon sheets on an aluminum substrate. The TLD card holder covers each TL chip with filter providing different radiation absorption thicknesses to allow evaluation of deep and shallow dose equivalents. Chips 1, 2, and 3 are Li-7, which is sensitive to photon and beta radiation. Chip 4 is Li-6, which is sensitive to photon, beta and neutron radiation.

When TLD cards are received at the Naval Dosimetry Center , they are evaluated in automated readers, which heat each chip and measure the light that is emitted as a result of the electron rearrangement that takes place. This allows dropped electrons, which are displaced by exposure to radiation, to return to their parent atoms. The light output is proportional to the amount of radiation absorbed. The reading process also zeros the TLD cards for reuse.

In order to obtain the best assessment of radiation dose, the DT-702 must be worn properly. Radiation from nuclear weapons contains neutrons with a variety of energies. The DT-702 is only sensitive to very low (thermal) neutron energies. For the dosimeter to measure neutron exposure, the neutrons of the weapon's spectrum must be slowed down or "moderated." The more energetic neutrons entering the body near the dosimeter are moderated by interactions with atoms in the body and a portion of them is reflected back into the back of the dosimeter where they can be detected. The person wearing the dosimeter therefore becomes a part of the dosimeter. This is referred to as "albedo" or reflected dosimetry. The dosimeter is calibrated for this interaction. To obtain a true dose by this technique, it is essential that the dosimeter be worn <u>in contact with the body</u>.

If the TLD is not worn properly, or if it is exposed to neutrons without the moderation provided by the body, neutron dose cannot be assessed accurately from the standard calibration.

III. LiF TLD Program Management

Each command is required to have a dosimetry program in place at the time of weapons loadout. At least thirty days in advance of weapons loadout the command must notify the Naval Dosimetry Center to start (or restart) shipments of TLDs. The program may be suspended during extended off-load periods by notifying the Naval Dosimetry Center, providing restart notice is given prior to loadout. This prevents the command from having to account for sets of Unissued TLDs.

The issue period for TLDs is 6 to 7 weeks. The exception is SSBNs on patrol, for which the issue period is the duration of the patrol cycle. The Naval Dosimetry Center will automatically ship an exchange set of TLDs prior to the end of the issue period. If they are not received in a timely fashion, the command should extend the issue period of the current dosimeters <u>and</u> notify the Dosimetry Center. No issue period may exceed 150 days without approval from the Dosimetry Center. When the new TLDs arrive, all dosimeters of the previous shipment must be returned to the Dosimetry Center, <u>by traceable means,</u> within 5 days of collection.

Each shipment of TLDs is considered a complete set, and must not be mixed with any other shipment. Each shipment has been checked and zeroed as a set. Natural background radiation slowly builds up with time, so that the mixing of sets could result in TLDs being exposed to different levels of background radiation. This makes subtraction of background control TLD doses difficult or impossible.

If the TLDs cannot be collected all at one time because personnel are on leave or TAD, at least two of the unissued TLDs from the same shipment should be kept aside to serve as controls for the stragglers. The remainder of the dosimeters shall be returned promptly for evaluation. These supplemental control TLDs and straggler TLDs should be returned as soon as collected. It is not correct to use the controls from the main submission to evaluate the stragglers, since control TLDs monitor the shipment's progress as well as the storage while at the command. Similarly, straggler TLDs should not be held until the next full submission, since the natural background on these TLDs is different. Ideally, the command should plan ahead and collect dosimeters from personnel who will not be available at exchange time and will not be using their dosimeters.

Visitor TLDs shall be handled and submitted exactly like those issued to personnel assigned to the command. They are taken from the same "issue set", share the same control dosimeters, and should be sent together with those for assigned personnel. All visitor TLDs should be identified by name and SSN in columns 4 and 5, on the NAVMED Form 6470/3. A visitor requiring repeated monitoring may be issued the same TLD for the duration of the issue cycle. The Radiation Record, NAVSEA Form 8128/5, should show the inclusive dates of monitoring for such a visitor. Under no circumstance is a dosimeter to be used by more than one individual in an issue period.

Under no circumstances may more than one set of TLDs be retained unless it is due to overlap of the exchange period. Each issue period begins with the exchange of dosimeters and ends with the return shipment. Issue periods are designed to allow approximately two issue periods per quarter (6-7 weeks in duration).

IV. Dose Estimation and Investigation

A dosimetry investigation must be performed for the following situations:

a. The loss, damage, or destruction of the dosimeter during routine issue, so there is no TLD available for evaluation of the individual's dose.
b. A dosimeter, properly submitted, is found to be technically defective during readout at Naval Dosimetry Center. This will be noted on the NAVMED 6470/3 returned, and no dose will be assigned to that corresponding individual's TLD.
c. A dose assignment on the NAVMED 6470/3 is considered "suspect." .

The performance and documentation of dose estimates is described in Chapter 5 of NAVMED P-5055. Doses may be estimated from those of co-workers performing similar tasks, prior doses received by the same individual while performing similar work, and from survey data and stay times in the work areas. The dose estimation report must be retained indefinitely by the command but may not be placed in the individual's medical records. A footnote should be added to the individual's NAVMED Form 6470/10 and to the Annual or Situational Report (NAVMED Form 6470/1). This should contain a brief summary that includes the estimated dose, the reason for the estimate, method used to determine the estimate and the period covered.

"Suspect" doses are a more complex problem. There are two categories: (1) those doses of credible magnitude which are inconsistent with the command's recent dose history, being either higher or lower than expected; and, (2), doses sufficiently large and unexpected as to suggest that tampering with the dosimeter may have occurred. In either case, two questions must be answered:

a. Did the individual actually receive the indicated dose? If it is likely that the worker did receive the dose, then a reason for the dose and a plan to prevent a recurrence must be included If the dose is not likely to be real, a dose estimate must be initiated.
b. What was the source of the dose to the TLD?

When the dose reported is inconsistent with the command history, the Naval Dosimetry Center results should be questioned. The NAVMED 6470/3 provides the radiation dose to the TLD. The review of individual radiation exposures listed on the NAVMED Report 6470/3 by the Nuclear Weapons Radiological Controls Officer (NWRCO), mandated by this manual, is the essential link in the process. Only the NWRCO can correlate the work assignments with the recorded dose. From this periodic review, radiation health and radiological controls personnel should develop a familiarity with typically assigned doses and with the normal variability of these doses. When dosimetry results fall outside this pattern, particularly when a reading is higher than normal, a review of exposure circumstances is warranted. However, there cannot be a specific numerical "trip wire" criterion assigned and each case must be evaluated individually. Attention to past local histories and recent work requirements is helpful.

The doses assigned by Naval Dosimetry Center are reviewed for technical accuracy before release. Technical procedures, QA programs and internal and external audits assure that the assigned doses are accurate within the limits of current technology. Therefore, reported dosimetry results cannot be arbitrarily changed or discounted without CHBUMED authorization. If significant reason exists to question the assignment of the TLD dose to the individual, appropriate documentation must support the estimate. Results of the local review, including a copy of the proposed estimate, if applicable, should be submitted to Naval Dosimetry Center, with a copy to COMNAVSEASYSCOM (SEA-04N).

Doses that are large and unexpected present a more serious problem. While it is relatively easy to estimate the true dose to the individual, discovering the source of the

dose to the TLD may be quite difficult. Historically, many high TLD doses that are unexpected and do not agree with the work history have been associated with intentional tampering with the TLD. If anyone tampered with the TLD so as to place it secretively in close proximity to a weapon, it may suggest a violation of the two-man rule, collusion with other workers, or surreptitious acts during normal evolutions. The potential Personnel Reliability Program and security aspects of such an investigation could require detailed study.

These estimation and investigative procedures take time and effort that could be better used for mission work. These occurrences can be minimized by following required procedures. Proper training of all personnel will help avoid most problems.

APPENDIX F

TESTING FOR TRITIUM CONTAMINATION

DISCUSSION:

One of the most common causes of contamination found during the maintenance of nuclear weapons is tritium. Detection of tritium is a difficult analytical problem. There are several types of RADIACs used to determine the amount of removable surface contamination on a solid surface. Most RADIACs detect the ionization caused by alpha, beta, or gamma radiation that results from the decay of a radioactive material. The low energy of the tritium beta particle will not penetrate the membrane or window enclosing the sensitive volume of the detector. Therefore, typical beta/gamma RADIACs are unable to detect tritium.

Most portable tritium monitors require collecting the tritium into an ion chamber. This type of instrument is primarily used for detection of airborne tritium. When a solid surface is contaminated with tritium, a different detection method must be used. A dry paper or cloth swipe is rubbed across the contaminated area resulting in the transfer of some removable surface contamination to the swipe material (swipes are usually round or square paper or cloth pads 1 1/2 to 2 inches in diameter). The contaminated swipe is then placed in a small vial to allow measurement of radioactivity using a Liquid Scintillation Analysis (LSA) instrument.

When the vial containing the swipe is filled with scintillation fluid, the beta particles from tritium cause fluorescent flashes of light, which are detected by photomultiplier tubes and electronically counted in the LSA instrument.

The reading of swipes in accordance with SSPINST 8020.1A is accomplished by collecting removable tritium contamination on a swipe, and placing the swipe in non-toxic, non-hazardous liquid scintillation fluid for counting in an LSA instrument.

Swipes vary in effectiveness for removing surface contamination depending on their composition. Various swipe materials also differ in physical sturdiness. Some are manufactured from soft materials that are effective at picking up loose surface tritium contamination, but are easily abraded by rough surfaces and tend to leave residues. Residues may be unacceptable for some applications and a more durable material may be required. The weapons facilities should use those swipe and scintillation materials authorized by the LSA manufacturer.

REQUIREMENTS:

The following procedure is to be used when taking swipes:

NOTE

Rubber gloves (latex surgical or waterproof material, or equivalent) shall be worn when taking swipes.

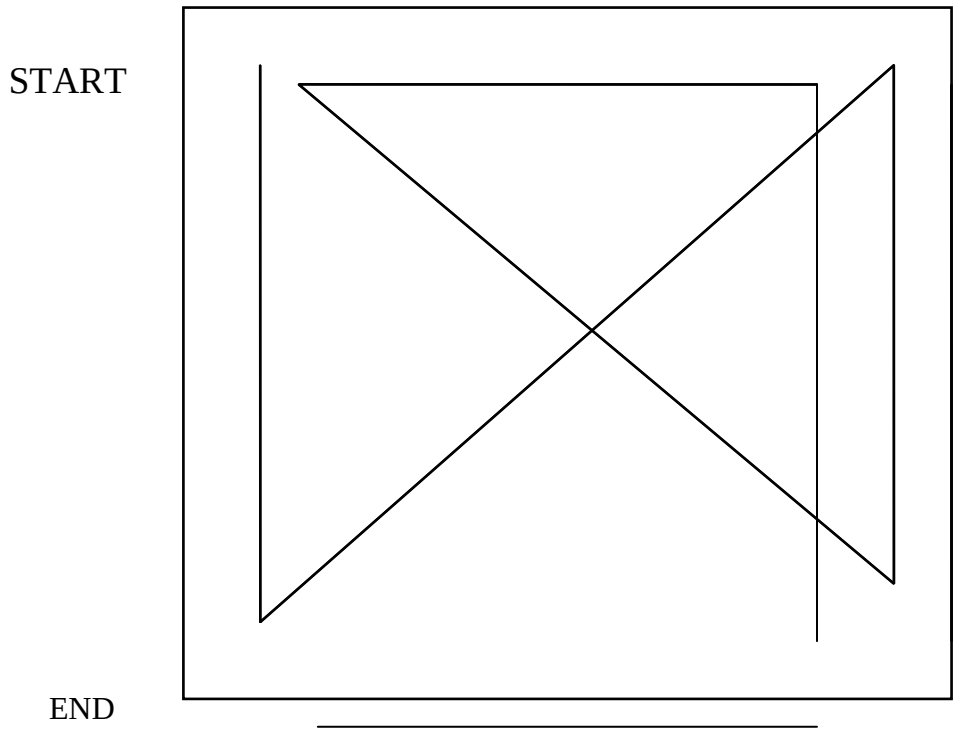
1. Using moderate pressure, swipe the area to be analyzed for contamination.

   a. The swipe is held in the fingers to ensure that the maximum area possible is held in direct contact with the surface being swiped.

   b. Only one side of the swipe pad should be passed over the area to be tested. Moderate pressure should be used when moving the swipe across a surface. If a hole is worn in the swipe, or if material is abraded, too much pressure is being used. A surface that consistently abrades the swipe, even with less pressure, requires a sturdier swipe material.

   c. When possible, at least a 100 cm^2 (~ 4 in. x 4 in.) area should be swiped. Swiping the material in the manner indicated in Figure F-1 provides a consistent basis of comparison with other measurements.

   d. If it is not practical to swipe a full 100 cm^2, analysis can still be performed. If the actual area cannot be measured, the result will merely indicate the presence or absence of contamination (dpm) and not the level of contamination (dpm/100 cm^2). When possible, the actual area swiped should be determined and the results converted (proportionately, based on the actual area swiped) to the correct units (dpm/100 cm^2). The results can then be compared to other samples where the full 100 cm^2 area was swiped.



100 cm^2
(~ 4 in. x 4 in.)

Figure 3-1. Standard Swipe Area

NOTE

If the vial will not be counted immediately, it should be filled with scintillation fluid immediately after inserting the swipe to prevent tritium on the swipe from vaporizing and escaping when the vial is opened later.

NOTE

In order to reduce the risk of the equipment becoming contaminated, personnel who perform the swiping shall not handle the vials or operate the LSA equipment.

2 . When the swiping is complete, fold or roll the swipe pad without creasing, clean side out, and insert it into a scintillation vial. Fill the vial with scintillation fluid and

cap it immediately. With the cap secured gently shake vial to thoroughly wet the swipe, thereby capturing the tritium in the fluid.

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