RADIOISOTOPE THERMOELECTRIC GENERATOR RADIOLOGICAL SAFETY GUIDE

DEFARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND

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(Date)

(NAVFAC SPECIAL ASSISTANT FOR NUCLEAR PROGRAMS)

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Introduction

The Naval Facilities Engineering Command (NAVFAC) has been assigned the responsibility of coordinating the development and use of radioisotope thermoelectric generators (RTGs) for the Navy. This document when approved by the U.S. Nuclear Regulatory Commission describes the procedures which will be employed to insure compliance with the Naval Facilities Engineering Command's byproduct material license of broad scope. This license governs the receipt, storage, installation, operation, servicing, and transport of RTGs within the Navy.

I. Responsibilities

A. NAVFAC Special Assistant for Nuclear Programs

1. Responsibility as assigned by OPNAVINST 11310.2 is as follows:

"Commander, Naval Tacilities Engineering Command. Provide program and technical coordination for the development and use of radio-isotope power devices. In the development of these devices utilize Navy capability to maximum extent; cooperate with all DOD activities; and take advantage of developments achieved by the Nuclear Regulatory Commission, its contractors and its commercial licensees. Coordinate personnel requirements with the Chief of Naval personnel, and, in training personnel for the operation and maintenance of such devices, cooperate with the Army and Air Force in utilizing established training facilities. Issue and promulgate instructions as required in carrying out assigned responsibilities and delegate authority assigned as necessary for efficient and safe operation. When NRC licenses are required, coordinate the acquisition for the Naval Material Command (NMC)."

- Approving applications for the use of Navy RTGs based on the recommendations of the Radiological Safety Committee and Radiological Safety Officer.
- Assuring at least annually that facilities utilizing RTGs are conforming to procedures and regulations applicable to RTGs.
- 4. Securing the concurrence of the State Department for each use of RTGs in international waters and/or territories.

B. NAVFAC Radiological Safety Committee

- 1. The Radiological Safety Committee acts as an advisory committee to the Special Assistant for Nuclear Programs. The Committee conducts safety reviews of new or contractor-modified RTGs to assure that the standards established in the Nuclear Regulatory Commission Regulatory Guide 6.3 are met. This review is conducted prior to acceptance of the RTGs by the Navy. The Committee also reviews applications for use of RTGs and provides recommendations to the Special Assistant for Nuclear Programs. These reviews include but are not necessarily limited to an assessment of:
- a. The procedures to be used in transporting, implanting, using, storing, and retrieving RTGs to insure compliance with the license, and other applicable NRC and federal regulations.
- b. The safeguards to be employed to limit exposure of personnel during transportation, storage, use and servicing.
- c. The qualifications of individuals desiring to use and/or service RTGs to assure that the users and personnel servicing the RTG have sufficient education, training and/or experience to assure the safety of operations.

- d. The control to be exercised by the user to insure that the RTG has not been moved, or tampered with, and the control exercised by the user if the RTG fails. This would include any methods of signaling and the monitoring of the signal at acceptable periods of time (see Chapter IV).
- e. The effect of the location and surroundings on the RTG and the effect of the RTG on the location and surroundings.
- f. Possible accidents and the ability of the RTG, by virtue of its design, to withstand such accidents.
- g. The procedures to be employed in the event of a radiological accident.
- 2. The Radiological Safety Committee can request the assistance of specialists in appropriate fields on a consulting basis prior to recommending approval or disapproval of an RTG application.
- 3. The Radiological Safety Committee will prepare records of all actions taken regarding the use of any RTG. These records including the application for use, personnel qualifications and all pertinent data associated with the committee's actions will be maintained by the NAVFAC Radiological Safety Officer and be open for inspection by the NRC.
- C. NAVFAC Radiological Safety Officer. The Radiological Safety Officer is appointed by the Special Assistant for Nuclear Programs. The Radiological Safety Officer is responsible for:
- 1. Devising and implementing an adequate radiation safety program for all RTGs (as described in Chapter III). This includes establishing the basic guides for radiation protection and control of radiation hazards.
- 2. Acting as the liaison between the NAVFAC Radiological Safety Committee, the Special Assistant for Nuclear Programs, and the field activities for licensing and safety reviews.
- 3. Maintaining the byproduct material license of broad scope governing RTGs. Preparing the license application, amendments, renewals and reports as required by the NRC or other authority.
 - 4. The following action in case of a loss or theft of RTG(s):
 - a. Initiate an investigation to locate the RTG(s).
 - b. Fulfill the reporting requirements to the NRC.
- c. Advise the Special Assistant for Nuclear Programs when the search for material may be concluded.

- D. Naval Nuclear Power Unit. NAVFAC Instruction 5450.62 assigns tasks and functions in support of naval nuclear shore systems, including RTGs. Under the tasking of this instruction, the Naval Nuclear Power Unit is responsible for:
- 1. Coordinating the development, design, procurement, construction, and modification of RTGs for the Navy.
- Controlling the transport, storage, operation, test and evaluation, maintenance, installation, recovery, and disposal of RTGs for the Navy.
- 3. Reviewing operating data, performance test results, and other reports for identification of health, radiological safety, engineering, and operational problems relating to RTGs.
- 4. Providing technical support as required to RTG users in the areas of: RTG operation and safety plan preparation, RTG operation and installation, RTG/user hardware interface design and integration testing, radiological safety training, and health physics services during implant operations.
- 5. Assuring compliance with radiological safety regulations by all users of RTGs.
- 6. Maintaining a status of all RTGs including current location and condition.
- E. Installation Commanders. Installation Commanders are responsible for assuring the radiological safety of personnel working under their jurisdiction. Their responsibilities include:
- Obtaining NAVFAC approval before receiving, possessing, using, changing the use of or transferring RTGs.
- Assuring that RTGs are used only by individuals who are knowledgeable and observant of radiation safety regulations and who have been approved by the NAVFAC Special Assistant for Nuclear Programs.
- 3. Insuring compliance with the approved application for use of RTCs.
- F. Radioisotope Thermoelectric Generator Users. Each user of an RTG is responsible for:
 - 1. Complying with the approved application for use of the RTG(s).
- Reporting to the custodian or the installation commander or his designee accidents and incidents involving RTGs.
- 3. Performing all work with RTGs in such a manner as to minimize the exposure to himself and his coworkers.

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G. Radioisotope Thermoelectric Generator Custodians. The Custodian of an RTG(s) has the same responsibilities as a user. Additionally, he is responsible for the care and control of the RTG(s) assigned him and as such is accountable for their condition.

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II. Administrative Control Procedures

A. General. Administrative control over RTGs is exercised by a system of checks and balances which furnish assurance that work with RTGs is initiated and performed with due consideration for radiological safety. Written approval must be obtained from NAVFAC for procurement, use, or changes in previously approved operations or procedures involving RTGs. This approval is obtained by submitting an application to NAVFAC. This application is called a Request for Safety Review (RSR) and is shown in Appendix A. The Radiological Safety Committee and Radiological Safety Officer review the RSR and make recommendations on it to the Special Assistant for Nuclear Programs. The Special Assistant for Nuclear Programs then takes appropriate approval action.

B. Controls Over the Use of Radioisotope Thermoelectric Generators.

- 1. Installation Commanders must apply to NAVFAC prior to obtaining or using an RTG. The application, or "RSR", will be processed by NAVFAC and the initiator advised of the action taken. The RSR will contain sufficient information to enable the Radiological Safety Committee to conduct its review in accordance with Section I.B.1.
- 2. The most important prerequisite for working safely with RTGs is a carefully thought out and prepared plan of action. Accordingly, prior to the transfer of any RTG to a user, the user will be required to prepare a checklist which will be used during deployment of an RTG to insure that all operations are carried out in accordance with the approved RSR. This checklist will include, in chronological order, all events pertaining to radiological safety and handling of the RTG. Examples are: radiation surveys, contamination tests, leak tests, establishment of radiation areas, movement of RTGs (procedure and equipment requirements) and record keeping. Each item on the checklist will be initialed after its completion and the entire document will be forwarded to the Naval Nuclear Power Unit after the RTG is implanted.
- 3. Installations desiring to utilize RTGs that do not have a qualified radiological safety staff will request assistance from NAVFAC.

C. Controls Over the Radiological Safety Committee Membership.

- 1. The Special Assistant for Nuclear Programs appoints the Radiological Safety Committee members, alternate members, and designates the Chairman. The Committee is selected so that diversified professional skill will be available to review any proposed use of RTGs. The Committee will be qualified to evaluate the placement, utilization, control, and recovery of RTGs.
- 2. The Radiological Safety Committee consists of at least four members whose qualifications and experience are applicable to the proposed RTG application. The Radiological Safety Officer is a member and NAVFAC management is represented at all committee meetings.
- 3. Persons appointed to the Radiological Safety Committee must be senior engineers or scientists who have been actively engaged in or

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associated with nuclear operations and the radiological safety aspects of nuclear operations for a minimum of three years. Committee members must have experience in the control of radioisotopes, utilization of radioactive material, and shielding. Committee members must also have a thorough knowledge of radiation control procedures and measuring techniques and procedures resulting from formalized training and/or experience.

- 4. Alternate members will be approinted for each committee position and shall be equally competent in their field. The alternate committee members will sit as full members of the Radiological Safety Committee in the absence of the regular member for whom they are the alternate.
- 5. Members or alternate members of the Radiological Safety Committee may not sit as committee members when they have personally prepared any portion of the work which is to be reviewed.

D. Controls Over Radioisotope Thermoelectric Generator Users and Custodians.

- 1. A person must be approved by NAVFAC before he is allowed to use, or directly supervise the use of, an RTG. In requesting that a person be approved as an authorized user, the Installation Commander provides NAVFAC information on the individual's technical background and experience in radiological safety matters. The user must be fully cognizant of and must comply with all applicable procedures and regulations such as the approved RSR.
- 2. The custodian must first be an authorized user. Additionally, he has been designated by his Installation Commander to assume the responsibility of accountability for a specific RTG(s).
 - E. Controls Over Changes of Custodian, Users, Use, or Location.

APPROVAL FROM NAVFAC MUST BE OBTAINED PRIOR TO CHANGE OF CUSTODIAN, USERS, USE, OR LOCATION OF AN RTG.

- 1. Change of Custodian. In cases involving transfer of custodianship (either on a temporary or permanent basis), the proposed new custodian shall initiate an RSR which is signed by his Installation Commander and by the current custodian, and forwarded for approval by NAVFAC. As he did for the current custodian, the Installation Commander must provide information on the proposed custodian's technical background and experience in radiological safety matters. Should a custodian's employment terminate, an alternate custodian (if named) or the Installation Commander is responsible for the RTG(s).
- 2. Change of User(s). The custodian of the RTG shall initiate an RSR which is to be signed by his Installation Commander, and forwarded to NAVFAC for approval.
- 3. Change of Use or Location. Prior to a change of approved use or location, the custodian of an RTG(s) shall submit an RSR to NAVFAC for approval.
- 4. Controls Over the Transfer of RTGs to Non-Navy Activities.

 Transferring RTGs to non-Navy activities requires a formal application to NAVFAC accompanied by verification that the receiver is eligible under NRC license, contract agreement, or agreement state license to receive the RTG(s).

F. Controls Over Modifications to Radioisotope Thermoelectric Generators.

All modifications of RTGs shall receive approval by NAVFAC prior to ectual modification. Anticipated modifications shall not include the handling of heat source capsules but may include the changing of ancillary equipment such as thermoelectric modules or power conditioning equipment.

III. Radiological Safety

A. Definitions.

- 1. High Radiation Area. Any area in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.
- 2. Occupationally Exposed Personnel. Fersonnel who are routinely or occasionally assigned to duties or occupations (e.g., RTG users and custodians) requiring exposure to ionizing radiation or the handling of radioactive materials.
- 3. Radiation Area. Any area in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 2 millirem or in any seven consecutive days a dose in excess of 100 millirem.
- 4. Radioactive Materials Area. Any area or room in which radioactive materials are used or stored in quantities as specified in 10 CFR 20.203(e)(1) and (2).
- 5. Restricted Area. Any area access to which is controlled by the Installation Commander for purposes of protection of individuals from exposure to radiation and radioactive materials.

B. Permissible Doses, Levels, and Concentrations.

1. Dose Limits for Occupational Exposures. Occupationally exposed personnel shall not be permitted to receive in any one calendar quarter a dose in excess of that specified in the following Table:

REMS PER CALENDAR QUARTER

a.		r e u alia
	organs; lens of eyes; or gonads	1-1/4
ъ.	Hands and forearms; feet and ankles	18-3/4
	Skin of whole body	7-1/2

With specific authorization by the Radiological Safety Officer an individual may be allowed to receive a dose to the whole body greater than that stated in the Table above. Such specific authorization will be based on the requirements of 10 CFR 20.101(b).

- Personnel. No individual under 18 years of age or member of the general public shall be permitted to receive in any period of one calendar quarter a dose in excess of 10% of the limits specified in the above Table (.5 rem per year of .125 rem per quarter). This applies to visitors, messengers, riggers, equipment operators, and other personnel whose exposure to RTGs is truly sporadic and who are not otherwise involved with radioactive materials or equipment producing ionizing radiation.
- 3. Radiation Levels in Unrestricted Areas. RTGs shall not be used, maintained, stored, or transferred in such a manner as to cause any individual if continually present in an unrestricted area to receive a dose in excess of 2 millirem in any one hour or 100 millirem in any seven consecutive days.
- 4. Permissible Levels of Skin Contamination. Permissible levels for skin contamination are listed in the following Table:

	PERMISSIBLE CONTAMINATION LEVELS							
Location	Alpha	Beta Gamma						
BODY	0.1 dpm/cm ²	1 dpm/cm ² or 0.1 mrem/hr at 1 cm.						
HANDS ONLY (Approx. 200 cm ² in area - one side)	0.1 dpm/cm ²	2 dpm/cm ² or 0.2 mrem/hr at 1 cm.						
WOUNDS	None Permitted	None Permitted						

5. Permissible Levels of Surface Contamination.

- a. An object or surface is considered to be contaminated when the loose surface contamination exceeds 1000 disintegrations per minute of beta-gamma activity or 100 disintegrations per minute of alpha activity over an area of 100 cm², except:
- (1) Vehicles used for the transport of RTGs are considered to be contaminated when the loose surface contamination exceeds 2200 disintegrations per minute of beta-gamma activity or 220 disintegrations per minute of alpha activity over an area of 100 cm² or the exposure rate is more than 0.5 mr/hr at any accessible surface.
- 6. Permissible Levels for RTG Leak Tests. An RTG will be considered to have a leaking source capsule if more than .005 microcuries of activity are detected by leak testing the RTG.

C. Radiation Surveys.

- Radiation surveys using an AN/PDR-27 radiac meter or equivalent shall be made around an RTG.
- a. When it is received, but prior to offloading from the shipping vehicle.
 - b. When it is initially placed in storage or use.
- c. Prior to and after any authorized maintenance or repair to the RTG.
- d. After it is loaded on a shipping vehicle, but prior to shipment.
- e. Twice annually, while in storage or use, except for those RTGs located in remote, unihabited areas which are visited only when operational necessity requires. In this case, a radiation survey will be made whenever the RTG site is visited. Results of these surveys need not be submitted more frequently than once every six months (see paragraph III.I.2.(b)).
- required by paragraphs III.C.1.(b) & III.C.1.(e),

 2. For each survey, a sketch will be made showing the location
 of the RTG(s), the boundary of the radiation area, the location of caution
 signs, and other physical features in the vicinity of the RTG(s) such as
 walls, doors, etc. The type of instrument employed and its calibration
 date will also be included.
- D. Contamination Tests. Shipping vehicles shall be tested for contamination before an RTG is onloaded and after the RTG is offloaded.
- E. Leak Tests. Each RTG shall be leak tested at the time of receipt, shipment, and authorized maintenance or repair.

F. Personnel Monitoring.

1. Requirements. All occupationally exposed personnel who enter a radiation area shall wear a film badge or thermoluminescent dosimeter (TLD). All occupationally exposed personnel entering a high radiation area shall also wear a pocket dosimeter. Non-occupationally exposed personnel may wear a pocket dosimeter in lieu of film badges or TLD.. Groups of visitors may utilize a single film badge, TLD, or pocket dosimeter. A logbook shall be maintained for pocket dosimeter readings.

2. Control of Personnel Monitoring Devices.

a. <u>Issuance</u>. Film badges, pocket dosimeters, and TLDs are available from the Naval Nuclear Power Unit for one time use only. When a continuing requirement exists, the Installation Commander is responsible for procuring and issuing these devices in accordance with the Navy Radiation Health Protection Manual, NAVMED P-5055. Lost film badges/TLDs shall. be reported to the NAVFAC Radiological Safety Officer.

- b. Storage. When not in use, personnel monitoring devices shall be kept in a low background area which is readily accessible. Control badges/TLDs shall be stored at the same location.
- c. Use. Film badges, pocket dosimeters, and TLDs shall be used in accordance with NAVMED P-5055. They shall be worn on that part of the body expected to receive the greatest exposure. Film badges should never be placed inside a pocket or behind other obstructions except when necessary to prevent the badge from being contaminated or drenched with liquids. TLDs may be worn in a pocket.
- d. Processing. Installation Commanders will insure that film badges and TLDs are processed in accordance with NAVMED P-5055.

G. Caution Signs and Labels.

- 1. Radiation Area Signs. Each radiation area will be conspicuously posted with a sign or signs as required by 10 CFR 20.203.(b).
- 2. Radioactive Materials Area Signs. Each area or room in which an RTG is stored or in use shall be conspicuously posted with a sign or signs as required by 10 CFR 20.203.(e).
- 3. Labels. Each RTG shall bear a durable clearly visible label identifying its radioactive contents by isotope, activity, and date of activity determination. It shall also contain the radiation caution symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER RADIO-ACTIVE MATERIAL".
- H. Radiological Safety Training. All personnel who use or work with RTGs will receive a complete orientation and indoctrination in radiological safety. All RTG users will be made aware of the potential radiological hazards involved in their work, radiological safeguards, procedures, and regulations pertaining to RTGs and their resonsibilities with regard to radiological safety.

I. Records and Reports.

1. Personnel Exposure.

- a. Records. Radiation exposure data for occupationally exposed personnel shall be recorded on Form DD 1141, Record of Occupational Exposure to Ionizing Radiation. This form shall be maintained in the individual's medical record in accordance with NAVMED P-5055.
- b. Reports. Personnel exposure data shall be reported to the Naval Nuclear Power Unit on a quarterly basis in the format required by 10 CFR 20.407.(b).(2).

2. Radiation Surveys, Contamination Tests, Leak Tests.

- a. Radiation surveys, contamination tests, and leak tests for shipment and receipt of RTGs shall be reported to the Naval Nuclear Power Unit on NNPU 11310/1, RTG Transfer Document, Appendix B, whenever required by paragraphs III.C, III.D, and III.E. Contamination in excess of that allowed by paragraphs III.B.4 and III.B.5, RTG surface exposure rates in excess of 200 mR/hr, exposure rates at one meter from the RTG greater than 10 mR/hr and leakage in excess of .005 microcuries shall be reported immediately.
- b. Radiation surveys of RTGs in storage or use shall be reported to the Naval Nuclear Power Unit initially and updated as required by paragraph III.C.l.e.
- c. Leak test data shall also be reported to the Naval Nuclear Power Unit after performing authorized maintenance or repairs. Leakage in excess of .005 microcuries shall be reported immediately.
- 3. Loss or Theft and Any Other Radiological Accident/Incident
 Involving an RTG. Provisions will be made in the emergency procedures
 submitted as a part of the application for use of an RTG (Request for
 Safety Review) to have the RTG custodian or his designated alternate
 notify the Naval Nuclear Power Unit in the event of loss or theft of an
 RTG or RTG vandalism. The Naval Nuclear Power Unit will contact the NAVFAC
 Radiological Safety Officer and the Special Assistant for Nuclear Programs
 and advise them of the circumstances. NAVFAC will fulfill the NRC reporting
 requirements outlined in 10 CFR 20.402 and 10 CFR 20.403.

IV. Physical Security for Radioisotope Thermoelectric Generators.

A. Discussion.

As evidenced by OPNAVINST 3040.5A and OPNAVINST 3100.6 the Chief of Naval Operations is concerned with the possible consequences of a radiological accident, since even a minor accident could have a serious impact on the Navy. A radiological accident is defined as a loss of control of radioactive material which presents a hazard to life, health or property or which may result in any member of the general population exceeding limits for ionizing radiation...included are those events having domestic or international implications and those which are likely to give rise to inquiries by the public or press. Theft or vandalism are examples of actions which could result in a loss of control over RTGs. Therefore, it is essential that in every application using RTGs certain minimum measures of control over the radioactive material be employed during use and storage.

B. Requirements.

Users of RTGs must implement the following security requirements. Exceptions to these requirements must be justified in the application for use of RTG(s)(Request for Safety Review). Extreme inaccessibility combined with the unlikely probability of theft or vandalism is an appropriate type of justification for an exception. Special military requirements also may constitute grounds for an exception.

- 1. For RTG(s) in use on land or on a fixed platform at or above the ocean surface:
- a. Provide lockable standard security fence or equivalent lockable walled enclosure and
- b. Monitor by emitted signal or visually confirm presence of RTG(s) at least once every twenty-four hours.
- 2. For RTG(s) in use in a floating water surface system, in a subsurface system, or in a water-bottom-mounted system less than 6000 feet deep: Monitor by emitted signal at least once every twenty-four hours or more often, according to the time-to-recovery requirement in a system which, upon mooring failure, would drift from its original site.

3. For RTG(s) in storage:

- a. Provide lockable standard security fence or equivalent lockable walled enclosure and
- b. Provide periodic perimeter surveillance on a random frequency during the hours when the storage facility is not manned and
- · c. If storage is outside, provide floodlighting with activation during periods of darkness.

VFAC 11310/5 (Rev. 3-7 No. (NAVFAC will assign)
FROM:
TO: Commander (04N). Naval Facilities Phylinecring Command 200 Stovall Street, Alexandria, VA 22332 VIA: Officer in Charge, Naval Nuclear Power Unit, Port Huenema, CA 93043
ACTION REQUESTED (Check appropriate items)
Assignment of Radioisotope Thermoelectric Generators (RTGs)
Change of a. Custodian b. User c. Use d. Location e. Other:
DESCRIPTION OF RTG(s)
Model Number, Serial Number, Quantity, Isotope, Fuel Form, Activity (Attach additional sheets as required)
STATEMENT OF USE
Describe Proposed Use of RTG(s). Include description of project and site(s), radiation safety, security, transport, operational, and emergency procedures and responsibilities for implementation of these procedures. (Attach additional sheet as required).
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