

CHAPTER B9

RADIATION SAFETY

B0901. DISCUSSION

a. This chapter outlines Navy safety and occupational health policies and procedures designed for levels of command which comprise the naval afloat establishment to minimize personnel exposure to radiation from sources other than nuclear power systems and nuclear weapons that have their own radiation protection and control programs. This chapter also excludes those individuals, who as patients must undergo diagnostic or therapeutic procedures involving use of ionizing radiation.

b. Per paragraph A0103b, the Director, Naval Nuclear Propulsion Program (CNO (NOON)) is responsible for the control of radiation and radioactivity associated with naval nuclear propulsion plants. As such, the requirements of this chapter do not apply to the naval nuclear propulsion program. Issues concerning radiation and radioactivity associated with naval nuclear propulsion plants should be addressed via the chain of command.

c. Radiation is commonly divided into two categories: ionizing and non-ionizing. Ionizing radiation has sufficient energy to strip electrons from atoms in the media through which it passes. Less energetic radiation that is incapable of electron stripping is termed non-ionizing radiation.

d. Ionizing radiation can be in the form of energetic particles (such as neutrons, betas, alphas, protons) or in the form of electromagnetic radiation (EMR). Ionizing radiation in the form of EMR, sometimes referred to as a photon, is conventionally referenced by its energy, with about 40 electron volts (eV) being the smallest amount of energy necessary to liberate an electron from an atom (i.e., ionize an atom). The production of ionizing radiation can occur in a variety of ways. For example, from the spontaneous decay of natural or man-made radioactive materials or from devices that directly produces EMR such as X-ray machines, or indirectly, such as from particle accelerators.

e. Some devices containing radioactive material, such as radioactive calibration source materials, may require a naval radioactive material permit (NRMP) to possess and use them. NRMPs are issued to Navy and Marine Corps commands by the Naval Radiation Safety Committee (NRSC), per references B9-1, B9-2, and B9-3. The NRSC is chaired by the Director, Environmental Readiness Division, Office of the Chief of Naval Operations (N45). Under the master materials license issued by the Nuclear Regulatory Commission (NRC) to the Naval Radiation Safety Committee, a NRMP is equivalent to a NRC license.

f. Non-ionizing radiation is energy that propagates through space in the form of electromagnetic waves but possesses insufficient energy to ionize the material through which it passes. Non-ionizing radiation comprises the lower energy portion of the EMR spectrum as shown in figure B9-1.

Figure B9-1: A Summary of the Electromagnetic Spectrum and Relationships of Wavelength (λ), Frequency (ν), and Energy (E).

		$\lambda \nu = C$				$E = h \nu$		Approximate Description
		Wavelength		Frequency		Energy		
		λ		ν		E		
ELECTROMAGNETIC RADIATION	NON-IONIZING	∞	km	0	Hz	Direct Current	eV	Voltage = Current x Resistance
		10,000	km	30	Hz	1.2E-13	eV	Radiowaves
		100	mm	3	GHz	1.2E-05	eV	
		100	mm	3	GHz	1.2E-05	eV	
		0.1	mm	3000	GHz	1.2E-02	eV	Microwaves
	LASER	10,000	nm	3.0.E+04	GHz	0.1	eV	Infra-Red
		700	nm	4.3E+05	GHz	1.8	eV	Visible
		400	nm	7.5E+05	GHz	3.1	eV	Ultra-violet
		180	nm	1.7E+06	GHz	6.9	eV	
	IONIZING	31	nm	9.6E+06	GHz	40	eV	Lowest Ionization Energy
		0.06	nm	4.8E+09	GHz	20	keV	Mammography X-rays
		2.5E-02	nm	1.2E+10	GHz	50	keV	Dental/Medical X-rays
		4.1E-03	nm	7.2E+10	GHz	300	keV	
		1.9E-03	nm	1.6E+11	GHz	662	keV	Cs-137 Gamma Ray
9.9E-04		nm	3.0E+11	GHz	1.25	MeV	Co-60 Gamma Ray	
1.2E-04		nm	2.4E+12	GHz	10	MeV	Cosmic Rays	

Note: "C" is the speed of light in a vacuum equal to 3×10^8 meters per second. "h" is Planck's constant equal to 3.34×10^{-34} Joule seconds.

g. As shown in Figure B9-1, non-ionizing radiation can be further divided into two sub-categories: radio frequency radiation (RFR) and laser radiation.

h. RFR is conventionally referenced by its frequency and includes frequencies from approximately 0 hertz (Hz) to 3000 gigahertz (GHz). Communication transmitters, radars, and radio frequency heat sealers emit RFR.

Note:

A Hz equals 1 cycle per second.

i. Laser radiation is conventionally referenced by its wavelength and includes wavelengths from approximately 10^4 nm (Infra-red) to 180 nm (Ultra-Violet). This includes the visible wavelengths between approximately 700 nm (red) to 400 nm (violet), with all the other colors in between these wavelengths (note the order - red, orange, yellow, green, blue, indigo, violet - pneumatic "ROY G. BIV").

Note:

nm is the abbreviation for nanometers. 1 nm equals $1 \times (10)^{-9}$ meters.

j. For all EMR (ionizing and non-ionizing), wavelength (λ) and frequency (ν) are related such that their product is equal to the speed of light in a vacuum (c), where c equals 3×10^8 meters per second.

$$\lambda \nu = c$$

k. For all EMR (ionizing and non-ionizing), the energy is equal to product of Planck's constant (h) and the frequency (ν), where h equals 3.34×10^{-34} Joule seconds.

$$E = h \nu$$

l. Potentially hazardous sources of ionizing and non-ionizing radiation exist aboard Navy ships. Examples of ionizing radiation sources include radioactive materials and x-

ray generating equipment. Examples of non-ionizing radiation sources include communication transmitters, radar systems, radio frequency heat sealers, and lasers.

m. The mechanism for potential harmful biological effects from personnel exposure to ionizing radiation involves the possibility of directly ionizing cellular DNA (deoxyribonucleic acid) or other cellular materials (such as cytoplasm) that result in the production of reactive oxidizing agents that can potentially affect cell function. There are four possible outcomes if this occurs; the cell can repair itself (majority of the time), the cell can be damaged and unable to reproduce, the cell can be damaged and reproduces corrupt daughter cells, or the cell dies. The occupational ionizing radiation control levels imposed by the Navy are typically 10 times lower than the Federal limits and keep worker exposures as low as reasonably achievable (ALARA). While any exposure, no matter how small, involves some risk, the risk is small compared with normal hazards of life. For further information and a perspective about the risks associated with occupational exposure to ionizing radiation see appendix M of reference B9-4.

n. The mechanism for potential harmful biological effects for radio frequency (RF) non-ionizing radiation depends on the frequency and magnitude of exposure. Predominant mechanisms for potential harmful biological effects as a function of frequency are; (0 to 1 Hz) magnetohydrodynamic effects (forces on flowing blood and other body fluids potentially stressing circulatory systems), (1 Hz to 5 MHz) electrostimulation (potentially causing involuntary muscle contraction thereby potentially causing falls), (100 kHz to 300 GHz) tissue heating (with potential thermal damage; for deep tissues between 100 kHz and 3 GHz and surface heating (skin) between 3 GHz and 300 GHz). The Navy adopts radio frequency (RF) radiation controlled maximum permissible exposure (MPE) limits that are consistent with non-governmental consensus-based standards (reference B9-5 for 0 kHz to 3 kHz and reference B9-6 for 3 kHz to 300 GHz).

Note:

Reference B9-7 is under revision to reflect the current MPE limits listed in references B9-5 and B9-6.) The RF exposure limits for controlled environments represent scientifically derived values to limit absorption of RF

energy in the body, and to restrict the magnitude of RF currents induced in the body. This means that the amount of energy absorbed is insufficient to produce or cause adverse effects on health, even under repeated or long-term exposure conditions. The Navy also establishes maximum levels to prevent hazards from electromagnetic radiation to fuels (HERF) and hazards from electromagnetic radiation to ordnance (HERO).

o. The mechanism for potential harmful biological effects for laser (non-ionizing radiation) is excessive energy deposition to parts of the eyes or to the skin leading to tissue damage. For laser exposures that are within the MPE limits, no adverse biological effects are expected to occur even under repeated or long-term exposure conditions. The Navy adopts laser MPE limits that are consistent with non-governmental consensus-based standards (see references B9-8 and B9-9). Laser incidents are rare due to rigorous Navy laser safety and training programs.

B0902. RESPONSIBILITIES

a. Ionizing Radiation:

(1) **The Commanding Officer shall:**

(a) Appoint a radiation safety officer (RSO) for industrial uses of radiation, when required, and ensure that they are properly trained per reference B9-1.

(b) As applicable, ensure compliance with the requirements of references B9-10, B9-11, B9-12, B9-13, B9-1, B9-2, and naval radioactive material permits (NRMPs) specifically issued to the command, and the applicable NRMPs (issued to another command) when possessing the devices noted in paragraph B0903a.(2).

(2) **The Radiation Safety Officer shall:**

(a) Establish, implement, and maintain an effective radiation safety program per reference B9-1 and NRMPs specifically issued to the command.

(b) Ensure that the appropriate communication processes are established to provide direct access to the highest levels of the chain of command to provide program status reports, notification of major evolutions, non-conformance issues, or any concern that may impact safety, readiness, or mission objectives.

b. Non-Ionizing Radiation (RF):

(1) **The Commanding Officer shall:**

(a) Request a radiation hazard (RADHAZ) survey when:

1. Emitter systems have been added, relocated, or upgraded as a result of scheduled ship alteration (SHIPALT) or alteration (ALT) installation since the last RADHAZ survey.

2. Watch stations or work areas are moved or established in the proximity of emitter systems.

3. Gasoline storage or transfer stations are relocated in the proximity of emitter systems.

4. Personnel are injured as a result of exposure to RF radiation and the command requires assistance in re-evaluating the current RADHAZ survey.

5. The current RADHAZ survey was conducted prior to 1995.

(b) Submit a confirmation letter to COMNAVSEASYSKOM (Code SEA 05K2B), stating that the recommended control measures provided in the hazards of electromagnetic radiation to personnel (HERP) survey report have been implemented to obtain a NAVSEASYSKOM letter of certification, per reference B9-14.

(c) Ensure personnel are trained to be familiar with potential RF exposure hazards and appropriate protective measures.

(2) **Division Officers (responsible for work-centers and areas with identified radiation hazards) shall:**

(a) Ensure RF radiation hazard areas are posted with

the appropriate warning signs and deck markings in accordance with appendix B9-A.

(b) Ensure that awareness and hazard recognition training is given for all personnel assigned to work or stand duty in RADHAZ areas to prevent exceeding MPE limits.

(c) Investigate, document, and report all suspected RF incidents or mishaps involving suspected RF overexposures to personnel exposure in accordance with the governing references listed in paragraph B0903.

c. Non-Ionizing Radiation (Lasers):

(1) **The Commanding Officer shall:**

(a) For the use of any class of military exempt lasers or the use of commercial class 3b or commercial class 4 lasers, establish a laser safety program per references B9-15 and B9-16 and designate a laser system safety officer (LSSO) to manage the program.

(b) Ensure the LSSO is properly trained and qualified per references B915 and B9-16.

(c) Ensure other personnel are trained to be familiar with potential laser exposure hazards and appropriate protective measures.

(2) **Division Officers (responsible for work-centers and areas with identified radiation hazards) shall:**

(a) Ensure that the LSSO has posted laser hazard areas with the appropriate warning signs in accordance with appendix B9-A.

(b) Investigate, document, and report all suspected Laser incidents or mishaps involving suspected Laser overexposures to personnel exposure in accordance with the governing references listed in paragraph B0903.

(3) **Laser System Safety Officer (LSSO) shall:**

(a) Establish, implement, and maintain an effective

laser safety program per reference B9-15 and B9-16.

(b) Ensure that the appropriate communication processes are established to provide direct access to the highest levels of the chain of command to provide program status reports, non-conformance issues, or any concern that may impact safety, readiness, or mission objectives.

(c) The LSSO is responsible for labeling lasers and posting laser hazard areas.

B0903. GUIDANCE

a. Ionizing Radiation

(1) **Industrial Radiography.** Sources of ionizing radiation are used onboard tenders, in shipyards, and at intermediate maintenance activities for non-destructive testing (NDT) of materials. A NRMP specifically issued to the command is required to possess and use radiographic devices containing radioactive material. X-ray machines are used on carriers, large amphibious assault ships, and at naval air stations for NDT procedures conducted on aircraft. Each command performing industrial radiography must have a formal radiation safety program instruction. The ship's radiological safety officer (RSO) is responsible for all aspects of the program described in the governing instructions.

(2) **Radioactive Material Under a NRMP Issued to Another Command**

(a) Devices used to detect chemical warfare agents, explosives, and radioactive material (RADIACs) may contain small amounts of radioactive material. These devices are regulated by NRMPs (issued to other commands) that allow ships to use and possess them under specific conditions including inventory requirements, leak testing, and other control procedures. Each command possessing one of these devices must have a copy of the applicable NRMP that describes in greater detail the conditions for possession. To get a copy of the applicable NRMP, contact NAVSEADDET RASO.

(b) Depleted uranium is used as penetrators in some munitions. Ships are authorized to possess these munitions

under a NRMP issued to NSWC Crane. Each command possessing depleted uranium munitions must comply with the procedures outlined in the NRMP. Contact NAVSEADDET RASO to obtain a copy of the NRMP.

(c) The laser target designator used on the FA-14 and FA-18 aircraft and the in-flight blade inflation system (IBIS) used on some helicopters contain radioactive material under NRMPs issued to Naval Air Systems Command. Squadrons possessing these devices must comply with the procedures outlined in the NRMP. Contact NAVSEADDET RASO to obtain a copy of the NRMP.

(3) Other Radioactive Material

(a) Luminous markers, clocks, smoke detectors, compasses, depth gauges, and electron tubes may contain small quantities of radioactive material. The evaluation of such items shall consist of a simple inspection for physical damage. Reports of damaged devices should be made to NAVSEADDET RASO.

(b) Some aircraft and missile construction material contains magnesium-thorium alloys. Altering this material through cutting or grinding by ship crewmembers is prohibited. Only commands specifically authorized by a NRMP may alter these materials per reference B9-1. Thorium containing welding rods are exempt from radioactive material permitting.

Note:

The small quantities, low specific activity, and physical form of radioactive materials used aboard ships usually make them non-hazardous. However, breakage and spread of even small quantities of some radioactive materials can lead to internal contamination (by ingestion, inhalation or wound contamination) in excess of allowable limits. Therefore, report all incidents of suspected or actual contamination through the cognizant medical department representative (MDR) per reference B9-10 and notify NAVSEADDET RASO of any such incidents.

(4) **Medical Radiography.** Medical x-ray units (fixed or mobile) ashore and on hospital ships are evaluated annually.

All other fixed x-ray units afloat require 24-month evaluation. Deployed units may delay unit evaluation until returning to homeport if meeting the 24-month window would interfere with operational obligations. Dental fixed and portable x-ray units require 36-month evaluation. All radiation protection surveys shall be conducted by a qualified Navy medical radiological surveyor in accordance with the Navy Radiological Systems Performance Evaluation Manual (Reference B9-12). The medical officer shall request the survey from the nearest medical activity with a RHO or contact the Navy Environmental Health Center (NAVENVIRHLTHCEN), Radiation Health Team.

(5) Governing Instructions

(a) Industrial: NAVSEA S0420-AA-RAD-010 (reference B9-1)

(b) Medical/Dental:

1. NAVMED P-5055 (reference B9-10)

2. BUMEDINST 6470.22 (reference B9-11)

(6) Points of Contact

(a) Industrial: NAVSEADET Radiological Affairs Support Office (RASO), P.O. Drawer 260, Naval Weapons Station, Yorktown, VA 23691-0260; Commercial: (757) 887-4692 DSN: 953-4692 FAX: (757) 887-3235

(b) Medical/Dental: Radiation Health Team, Navy Environmental Health Center (NAVENVIRHLTHCEN), 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 23708-2103 DSN: 377-0766. Commercial: (757) 953-0766. Fax: (757) 953-0685.

b. Non-Ionizing Radiation Radiofrequency (RF) and Microwaves (MW)

(1) Radar, communication equipment (transmitters), and radiofrequency (RF) heat sealers

(a) These devices may emit hazardous levels of RF radiation. In addition to causing biological changes,

RF/microwave radiation can induce electrical currents/voltages that may cause shocks and burns, premature activation of electro-explosive devices (EEDs) in ordnance, and arcs, which may ignite flammable materials. Information on the hazards of RF (electromagnetic) radiation to personnel, fuels, and ordnance is available in reference B9-17. Hazards of electromagnetic radiation to fuels (HERF) and for ordnance (HERO) can be found in volume II of reference B9-17. The hazards of electromagnetic radiation to personnel (HERP) can be found in Volume I of reference B9-17. However, volume I of reference B9-17 will be amended to reflect the current RF MPE limits listed in reference B9-5 for 0 kHz to 3 kHz and reference B9-6 for 3 kHz to 300 GHz. (Note: reference B9-7 is also under revision to reflect the current MPE limits listed in references B9-5 and B9-6). Refer to appendix B9-A for a discussion of controlled and uncontrolled MPE limits.

(b) Commander, Naval Sea Systems Command (COMNAVSEASYSKOM) is the lead agent for coordinating electromagnetic safety programs for naval ships. Commander, Space and Naval Warfare Systems Command (COMSPAWARSYSKOM) is the lead agent for coordinating electromagnetic safety programs for shore facilities.

(c) Commands shall determine RF levels for all areas in which personnel could receive exposures in excess of the exposure limits. Commands must use proper RF measurement techniques and application of the RF exposure limits to avoid imposing unnecessary restrictions on operations or establishing overly restrictive protective boundaries.

(d) A comprehensive RF hazard evaluation for major platforms, such as warships or communication stations, where multiple RF emitters exist in close proximity to each other, requires considerable technical familiarity with electromagnetic fields. Such surveys may involve determination of boundary locations for protective fences or enclosures, or specifying operational conditions or restrictions necessary for protection of personnel, (see points of contacts (POCs) below for activities that perform these evaluations, which are primarily an engineering-type survey).

(e) Following a survey and implementation of the recommended control measure provided in the HERP survey report

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of B9-14, submit a confirmation letter to COMNAVSEASYS COM (Code SEA 05K2B) requesting a NAVSEASYS COM letter of certification (POC information below).

(f) Activities shall provide RF safety training to personnel who routinely work directly with RF equipment or whose work environments contain RF equipment that routinely emits RF levels in excess of the exposure limits for controlled environments. Activities shall conduct training before assignment to such work areas, and shall focus on awareness of the potential hazards of RF fields, established procedures and restrictions to control RF exposures, and personnel responsibility to limit their own exposures. Activities may incorporate RF safety training in periodic safety training programs to satisfy command-training objectives.

(g) The Navy does not authorize RF-shielded protective clothing for routine use as a means of protecting personnel. This does not preclude use of other protective equipment, such as electrically insulated gloves and shoes for protection against electrical shock or RF burn, or for insulation from the ground plane.

(h) Electric and magnetic fields exist around power lines, electrical devices and appliances. The intensity of these fields decreases rapidly with distance. While questions have been raised about the possibility of health effects from exposure to electric and magnetic fields at levels that are commonly encountered in homes and most work places, findings issued by various scientific review panels have not confirmed that such fields pose a risk to health.

(i) Since the body is a conductor, time varying magnetic fields, or body movement in a static magnetic field, induce electric fields and current flow inside the body. For commonly encountered fields near high voltage transmission lines, power distribution systems, office equipment, and household appliances, the magnitude of these induced currents will typically be below levels which are perceptible. Existing guidelines given in reference B9-5 have been established to limit induced current densities in body tissues. This rationale has been used to set a biological endpoint since no other definable risk criterion has been identified for establishing a health standard for electric and magnetic fields.

(2) Governing Instructions

(a) MPE Limits - see references B9-5 (0 kHz to 3 kHz) and B9-6 (3 kHz to 300 GHz).

(b) Training and reporting requirements - see reference B9-7.

(c) HERP, HERF, HERO operational guidance - see reference B9-17.

(d) Electromagnetic environmental effects - see reference B9-18.

(e) Medical management of non-ionizing casualties - see reference B9-19.

(f) Institute of Electrical and Electronics Engineers (IEEE) C95 Series of Standards, Guides, and Recommendations - see references B9-5, B9-6, B9-20 thru B9-23.

(3) Points of Contact

(a) For Technical Assistance and Reporting Authority.
Naval Sea Systems Command (SEA 62), Commander, Naval Sea Systems Command Headquarters, Washington, D.C., 20362, commercial: 202-781-3140.

(b) For measurement surveys and technical assistance for shipboard RF emitting systems. Systems Electromagnetic Effects Branch (Code J-52), Naval Surface Warfare Center Dahlgren Division, 17320 Dahlgren Road, Dahlgren, VA 22448-5100, DSN 249-8594, commercial 540-653-3487, or 401-832-5552, fax 540-653-7494.

(c) For RF bio-effects and medical research issues, or assistance in evaluating personnel overexposure incidents.
Naval Health Research Center-Detachment Directed Energy Bioeffects Laboratory, Brooks City Base, 8315 Navy Road, Brooks City Base TX 78235-5365, DSN 240-4699/6532, commercial 210-536-4699/6532, fax: 210-536-6439.

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(d) For RF health hazards, personnel exposures and exposure incidents from industrial and medical RF emitting sources. Navy Environmental Health Center (NEHC), 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 23708-2103 DSN: 377-0766. Commercial: (757) 953-0766. FAX: (757) 953-0685.

(e) For guidance on RF exposure limits and health issues. Non-Ionizing Radiation Health Branch, Bureau of Medicine and Surgery (Code M342), 2300 E Street NW, Washington DC 20372-5300, DSN 762-3448/3444, commercial 202-762-3448/3444, fax 202-762-0931.

(f) For site certification and measurement surveys for shore-based RF emitting systems. Space and Naval Warfare Systems Center (SPAWARSYSCEN) Charleston (Attn: Code 323), P.O. Box 190022, North Charleston, SC 29419-9022, DSN 588-4228, or commercial 843-218-4228. For shore facilities within PACNAVFACENGCOM geographical region, contact Space and Naval Warfare Systems Activity Pacific (SPAWARSYSACT PAC) (Attn: Code 2915), 675 Lehua Avenue, Pearl City, HI 96782-3356, DSN 315-474-7330, commercial 808-474-7330, fax: 808-474-5511.

c. Non-Ionizing Radiation. Lasers (class IIIb, class IV, and Military Exempt Lasers Only).

(1) Laser range finders, laser guided munitions, communications equipment, fiber optics, scoring systems, landing systems and training aids.

(a) The Navy has adopted a system for categorizing the hazards of lasers, which provides a practical means for determining safety requirements appropriate for different types of lasers. These categories range from a class I laser that is safe to view under all conditions, to the class IV laser which can cause eye damage under most viewing conditions. Appendix B9-A provides information on laser classification, types of laser warning signs and labels.

(b) For most lasers used in medical, laboratory, research and industrial applications, the use of the classification system precludes the necessity for performing any laser measurements or calculations. Reference B9-24 requires manufacturers to classify and label their laser systems. Laser measurements or laser safety calculations will usually be

required only for lasers operating on outdoor ranges or in open areas when it is necessary to define a laser nominal hazard zone (NHZ).

(c) Lasers or laser systems designated for combat, combat training or classified in the interest of national security may be exempted from compliance with some or all of the provisions of reference B9-24. To obtain military exemption status, the contractor must have written authorization from the military contracting activity, and the laser product must be certified to conform with requirements in reference B9-15, B9-25, and have been approved by the Navy Laser Safety Review Board (LSRB).

(d) Military laser systems are reviewed by the LSRB during their development to ensure that adequate safety criteria have been incorporated. LSRB review is required at appropriate stages of development and prior to introduction of prototype or production units into the fleet for testing or initial use. An important function of the Navy laser safety program is a determination of the nominal ocular hazard distance (NOHD) or safe viewing range, for each operational laser system used in the Navy. LSRB review also applies to class IIIb and class IV commercial lasers and laser systems that are not intended solely for laboratory or medical use. Reference B9-15 contains general guidance for materials necessary and procedures followed by the LSRB review.

(e) Commands shall maintain a current inventory of all military exempt lasers, class IIIb lasers, and class IV lasers for submission to the administrative lead agent (ALA) (BUMED Code M342) as requested. Commands wishing to dispose of lasers shall obtain approval from BUMED following guidance in references B9-15 and B9-25.

(f) Commands operating class IIIb or class IV commercial or military exempt lasers shall establish a laser safety program and designate a laser system safety officer (LSSO) per reference B9-15. The laser safety program shall include an inventory of all commercial class IIIb, class IV and all classes of military exempt lasers that are assigned to the command lasers for submission to the administrative lead agent as requested.

NOTE:

Some commercially available laser pointers are categorized as class IIIa lasers with output levels that are not considered safe for all viewing conditions. A formal laser safety program is not required for class IIIa laser pointers; however, the user needs to recognize that care must be exercised to control its accessibility (kept out of the hands of children or others who are unaware of the hazardous nature of lasers), and to avoid directing the pointer at those in the audience. Class II laser pointers do not pose a hazard during normal viewing, and their use is not restricted.

(g) Laser MPE limits are published in reference B9-8. For laser exposures that are within the MPE limit, no adverse biological effects are expected to occur even under repeated or long-term exposure conditions. Only trained and technically qualified personnel shall apply these exposure limits in determining laser safe viewing conditions, since an improperly conducted laser hazard evaluation may pose serious risks to a person's eyes.

(h) Laser exposure limits are set to protect tissue from damage and are not the equivalent of comfortable viewing levels. Operators of lasers need to be aware of secondary laser safety concerns. For example, intrabeam viewing of visible wavelength lasers, even at or below the permitted safe level, will still be perceived as an intense light source capable of producing disabling glare or visual after-images. These temporary visual effects can interfere with performing critical tasks such as operating vehicles or aircraft. Similarly, intrabeam viewing of lasers at or below the permitted exposure limits can still damage or "saturate" night vision viewing devices because of the high amplification of incident light levels provided by the devices. Wearing of laser protective eyewear can also lead to other safety concerns, such as the potential for blocking or filtering out the color of some warning or alarm indicator lights.

(i) Commands shall provide laser system safety officer (LSSO) laser safety training through the completion of a course approved by ALA (BUMED-M342) and the Lead Navy Technical Laboratory at the Naval Surface Warfare Center, Dahlgren Division. There are four categories of LSSOs, administrative

laser safety officer (ALSO), technical laser safety officer (TLSO), laser safety specialist (LSS), and range laser safety specialist (RLSS). Re-testing at the LSSO's highest certification level is required to maintain certification for all categories of LSSO every 4 years. If the LSSO fails the re-certification examination, the LSSO will have to be re-certified by attending the appropriate course. Commanding officers should determine which category of LSSO is appropriate for their command considering their mission, types of lasers being used, and size of the laser safety program. Laser safety-training requirements at medical treatment facilities for the medical LSSO and designated medical personnel are contained in reference B9-16.

(j) Laser range safety officers, laser maintenance personnel and industrial laser supervisors shall complete a formal command laser safety training course as outlined in reference B9-15. Commands shall provide formal classroom training on the potential hazards associated with accidental exposure to laser radiation to all personnel in areas operating class IIIb (and class IIIa with danger logo) or class IV lasers. In particular, the vulnerability of the eyes to being damaged by lasers shall be emphasized. Commands shall conduct annual refresher training per reference B9-15. For employee training, the following laser safety training videotapes are available from the Norfolk Regional Electronic Media Center: Laser Hazards and Control, 804245DN, Hazards and Control of Military Lasers, 804246DN, and Laser Safety in Medical Treatment Facilities, 803198DN.

(k) Specific laser safety-training requirements at medical treatment facilities for the medical LSSO and designated medical personnel are contained in reference B9-16.

(l) Broadband optical sources such as germicidal lamps, phototherapy, sun lamps, backlights, arc lights, projector lamps, high intensity discharge lamps and infrared arrays are also used in many medical and industrial applications. These types of light sources may require controls to prevent possible acute effects such as skin burns, photokeratitis, cataracts or retinal burns. Exposure guidance can be found in the American Council of Government Industrial Hygienists - Threshold Limit Values and Biological Exposure Indices (www.acgih.org/). Obtain assistance in the evaluation of broadband optical sources, where personnel

are considered to be at ocular risk, from an industrial hygienist or radiation health officer.

(2) **Governing Instructions**

(a) Policy and guidance in the identification and control of laser radiation hazards - see reference B9-15.

(b) Laser safety for medical facilities - see reference B9-16.

(c) Military exempt lasers - see reference B9-25.

(d) Laser safety on ranges and in other outdoor areas - see reference B9-26.

(e) Food and Drug Administration (FDA) performance standards for light emitting products - see reference B9-27.

(f) American National Standards Institute (ANSI) Z136 series of standards, guides, and recommendations - see references B9-8, B9-9, and B9-27 thru B9-31.

(g) Medical management of non-ionizing casualties - see reference B9-19.

(3) **Points of Contact**

(a) **For medical and industrial laser operations.**
Bureau of Medicine and Surgery (BUMED) (Code M342), 2300 E Street NW, Washington, DC 20372-5300, DSN: 762-3448. Commercial: 202-762-3448. Fax: 202-762-0931.

(b) **For all laser operations; other than medical, military exemption of lasers, and certification surveys of laser firing ranges.** (Funding for services shall be provided by the requesting command). Laser System Evaluation and Range Surveys: Naval Surface Warfare Center Dahlgren Division, G-72, 17320 Dahlgren RD Dahlgren, VA 22448, DSN: 249-1060/1149/2442, Commercial 540-653-1060/1149/2442, Fax: 540-653-8824
<http://www.navylasersafety.com/>

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(c) **Laser Range Surveys.** Naval Surface Warfare Center Corona Division (Code SE-41), 2300 Fifth St, Norco, CA 92860 mailing address P.O. Box 5000 Corona, CA 92878-5000, DSN: 933-4090, Commercial: 909-273-4090 or Fax: 909-273-5089.

(d) **For laser bio-effects and medical research issues, or assistance in evaluating laser-induced injuries.** Naval Health Research Center-Detachment Energy Bioeffects Laboratory, Brooks City Base 8315 Navy Road, Brooks AFB, TX 78235-5365, DSN: 240-4699/6552, Commercial: (210) 536-4699/6552, Fax: (210) 536-6439.

(e) **For guidance on laser exposure limits and health issues.** Non-Ionizing Radiation Health Branch, Bureau of Medicine and Surgery (Code M342), 2300 E Street NW, Washington DC 20372-5300, DSN: 762-3448/3444, Commercial: 202-762-3448/3444, Fax: 202-762-0931.

B0904. RADIATION HAZARD AREAS

a. Ionizing Radiation. Ionizing radiation hazard signs are required at access points to radioactive material storage areas and where the radiation levels could exceed the exposure limit for the general public. The type and wording of each sign is dependent upon the type of radiation area. Reference B9-11, provides specific guidance for posting ionizing radiation hazard areas. Medical X-ray units will be posted per reference B9-13 and B9-4.

b. Radiofrequency Radiation (RFR) Hazard Areas. RFR hazard warning signs are required at all access points to areas where the RFR levels may exceed the MPE. Obtain NAVSEA-approved warning signs and labels through the standard stock system (see appendix B9-A). When military operational considerations prevent the posting of such signs, a waiver must be obtained from cognizant safety and occupational health professionals depending upon the RFR source. Where the RFR levels may exceed 10 times the MPE limit, additional warning devices and controls such as flashing lights, audible signals, barriers, and interlocks may be required, depending on the potential risk for exposure. These areas will be noted in the ship's RADHAZ and baseline industrial hygiene survey reports.

(1) **Radar and Communications.** The ship's RADHAZ report provides detailed posting and deck marking information for radar

and communications RFR hazard areas. These are also described in appendix B9-A.

(2) **Heat Sealers and Other RFR Sources.** The baseline industrial hygiene survey will provide posting requirements for other RFR hazard areas.

c. Lasers (Class IIIb, Class IV, and all Military Exempt Lasers). The LSSO is responsible for labeling lasers and posting laser hazard areas. See appendix B9-A.

B0905. MEDICAL SURVEILLANCE

The baseline industrial hygiene survey identifies those work-centers that require medical surveillance for exposure to radiation.

a. Ionizing Radiation. Medical surveillance of personnel exposed to ionizing radiation shall follow reference B9-13.

b. RF Radiation

(1) Workers who have implanted medical devices such as pacemakers or defibrillators or use certain medical devices such as apnea monitors or electrically powered wheelchairs should be aware of the potential for interference from various emitters of RF energy. This condition is called radiofrequency interference (RFI) or electromagnetic interference (EMI). The consequences of these potential failures range from inconvenience to serious injuries and death.

(2) It is impossible to state that there will be no observable effects for all devices. This is because electronic devices can be extremely sensitive to EMI and there are no regulatory standards by the Food and Drug Administration (FDA) or the Federal Communications Commission (FCC) forcing manufacturers to harden their products against EMI. Therefore the Navy cannot make any guarantees that all medical or consumer electronic devices won't experience EMI, even at RF levels well below the MPE limits for biological effects.

(3) Therefore, it is each worker's responsibility to discuss with their physician the EMI risks associated with each medical device that they may be using and determine if they are

able to work within the RF environment of their command. It is also the worker's responsibility to inform their chain of command of any medical devices they may be using and to discuss any safety concerns they may have with those devices.

c. Lasers

(1) Enrollment in a laser radiation medical surveillance program is limited to those personnel who are clearly at risk from exposure to laser radiation. The nature of such risks is associated with accidental injuries resulting from excessive exposure to laser levels and not as a result of chronic exposures. The command LSSO determines which personnel should be enrolled in the surveillance program using the following guidance:

(a) Laser workers requiring medical surveillance are those individuals who routinely work with class IIIb or class IV lasers under conditions where there is a likely potential for accidental exposures to excessive levels. These workers require a pre-placement and termination laser eye examination per reference B9-15.

(b) The following personnel generally require medical surveillance: (1) Research and development (R&D) and laboratory personnel who routinely work with unenclosed class III and class IV laser beams. (2) Maintenance personnel who routinely repair or align class III or class IV laser systems. (3) Operators (personnel behind the laser) and down-range personnel who routinely work with class III or class IV engineering laser transits, geodimeters and alignment laser devices. (4) Operators who routinely work with class IIIb and class IV industrial lasers where access to an unenclosed beam path is possible.

(c) Other laser workers or personnel where the potential for accidental exposure is deemed very unlikely generally do not require medical surveillance. For example: (1) Personnel who work with class I or class II lasers, or with laser systems containing class III or class IV lasers when there is little or no potential for exposure to the open laser beam. (2) Visitors or other personnel involved infrequently in laser testing, demonstrations or training when the LSSO has ensured such personnel will be protected from exposure to levels of laser radiation greater than the MPE limit. (3) Supervisory,

clerical and custodial personnel working in laser areas where laser safety procedures preclude their exposure to levels of laser radiation above the MPE limit. (4) Operators of fielded military laser systems when operations are conducted on established laser ranges, or as part of training operations where prescribed laser safety procedures are enforced. (5) Personnel involved in "force-on-force" laser training exercises where appropriate protection is established, either in the form of administrative controls or procedures, or where laser protective eyewear is provided.

B0906. RADIATION INCIDENTS

a. Ionizing Radiation. In the event of a radiation incident involving ionizing radiation, notify NAVSEADDET RASO for incidents associated with industrial operations and NAVENVIRHLTHCEN for medical and dental incidents.

b. Radiofrequency Radiation

(1) Commands shall investigate and document all suspected RF incidents or mishaps involving personnel exposure to excessive RF levels, in accordance with reference B9-7 and B9-15 such as:

(a) Personnel injury has been sustained or physical symptoms are experienced by the individual(s) that are believed to be associated with RF exposure.

(b) Personnel exposure has been determined to have exceeded the appropriate MPE limit in terms of power density by a factor of five or more. (For exposure determinations, provisions for time averaging and spatial averaging can be used in conjunction with transmitter duty factors and antenna rotation or scanning rates to establish maximum likely exposure levels).

(c) Inadvertent exposure occurred to members of the general public or to other non-involved personnel as a result of naval operations that have exceeded the appropriate MPE limit.

(d) Exposure circumstances or the severity of the incident or mishap are such that inquires from news media are

anticipated, or are deemed to be of interest to the chain of command.

(2) Investigation of incidents involving alleged or actual RFR exposures that are five times the MPE or greater shall include, as a minimum:

(a) A listing of all involved personnel.

(b) Measurements of RFR exposure levels.

(c) Results of appropriate medical examinations.

(d) A detailed description of the circumstances surrounding the incident.

(e) Recommendations for more detailed medical follow-up (if necessary).

(f) Recommendations to prevent future recurrence of the incident.

(3) The command exercising operational control of the RF source has the primary lead for conducting the RF exposure investigation and for ensuring the appropriate report is filed.

(4) Commands shall refer personnel reporting physical symptoms, or suspected of having been exposed to levels in excess of five times the MPE limit, for a medical evaluation or follow-up. Since medical evaluations following RF exposures have been infrequently required and physical signs of injury are usually not manifested, medical personnel should be advised to refer to reference B9-19, for information on RF biological effects.

(5) Commands shall make initial notification for the occurrence of an RF incident by telephone, fax, message or e-mail to the appropriate technical assistance point listed in this chapter with copy to the Bureau of Medicine and Surgery (Code M342). Discussions following this initial notification can determine whether a more extensive investigation will be necessary and whether a site visit should be scheduled to assist in making RF measurements or an exposure evaluation. Central to the command's investigation will be a determination of the

degree of RF exposure incurred since such incidents often involve emotional or health concerns which cannot be easily addressed when measurement data is not available. Performing RF measurement assessments are often beyond the technical capabilities of the local command or the nearby medical facility.

(6) If exposure incident results in a service member receiving medical treatment, loses workdays, or is placed on light or limited duty, a mishap report must be submitted in accordance with reference B9-32.

(7) In cases where it is necessary to reconstruct events or reestablish equipment configuration for conducting an RF exposure assessment, the accuracy of the recreation is crucial to the validity of the subsequent RF measurements. The command's investigating officer should apply particular attention to obtaining written statements from those involved giving detailed descriptions of the sequence of events, exposure times and equipment set-ups, as well as obtaining appropriate charts, diagrams or photographs indicating the locations of exposed personnel.

(8) The command shall submit a final report on the RF incident to the Commander, Naval Safety Center and to the Bureau of Medicine and Surgery (Code M342), with copies to appropriate headquarters and systems commands. The command will also include in the report to BUMED pertinent medical records and identification data for personnel who were exposed. BUMED is tasked with maintaining a permanent repository for RF exposure incidents.

c. Laser Radiation

(1) If eye damage from laser exposure is suspected or observed, and in all cases of exposure to levels in excess of five times the laser exposure limits of this chapter, the cognizant activity shall ensure the individual receives a medical examination by an ophthalmologist as soon as possible. While laser injuries associated with military operations have been rare, limited experience indicates that the extent of eye damage from an accidental laser exposure may not be readily or initially apparent to either the individual or to local medical personnel. Since early medical intervention may lessen the severity of the damage or subsequent retinal scarring from the

laser injury, efforts should be made to have the individual promptly seen by an ophthalmologist or at the ophthalmology department of a hospital on a walk-in emergency basis.

(2) Commands shall investigate and document all suspected laser incidents or mishaps involving personnel exposure to excessive laser energy. The command exercising operational control of the laser has the primary lead for conducting the laser exposure investigation and for ensuring the appropriate report is filed.

(3) Commands are required to report exposure incidents and investigate exposure levels for the following situations: (1) Personnel injury has been sustained or physical symptoms are experienced by the individual(s), which are believed to be associated with laser exposure. (2) Inadvertent exposure occurred to members of the general public or to other non-involved personnel as a result of naval operations, which have exceeded the MPE limit. (3) Exposure circumstances or the severity of the incident or mishap are such that inquires from news media are anticipated, or are deemed to be of interest to the chain-of-command.

(4) Commands shall refer personnel reporting physical symptoms or suspected of having been exposed to levels in excess of the MPE limit for a medical evaluation or follow-up.

(5) Commands shall make initial notification for the occurrence of a laser incident by telephone, fax, message or e-mail to the appropriate technical assistance point listed in this appendix with copy to the Bureau of Medicine and Surgery (Code M342). Discussions following this initial notification can determine whether a more extensive investigation will be necessary and whether a site visit should be scheduled to assist in making laser measurements or an exposure evaluation. Central to the command's investigation will be a determination of the degree of laser exposure incurred since such incidents often involve emotional concerns or health worries, which cannot be easily addressed when measurement data is not available. Performing laser measurement assessments are often beyond the technical capabilities of the local command or the nearby medical facility.

(6) In cases where it is necessary to reconstruct events or reestablish equipment configuration for conducting a laser exposure assessment, the accuracy of the recreation is crucial to the validity of the subsequent measurements. The command's investigating officer should apply particular attention to obtaining written statements from those involved giving detailed descriptions of the sequence of events, exposure times and equipment set-ups, as well as obtaining appropriate charts, diagrams or photographs indicating the locations of exposed personnel.

(7) The command shall submit a final report on the laser incident to the Commander, Naval Safety Center, and to the Bureau of Medicine and Surgery (Code M342), with copies to appropriate headquarters and systems commands within 30 days of the incident.

(8) Investigation of incidents involving alleged or actual laser exposure shall include as a minimum the following:

- (a) List of personnel involved.
- (b) Estimation of exposure(s) as related to the applicable MPE.
- (c) Details of immediate and subsequent medical findings.
- (d) Narrative account/summary of exposure incident—to include wavelength, mode of operation(s) and energy/power output.
- (e) Details regarding safety procedures and equipment used.
- (f) The command shall also include in the report to BUMED pertinent medical records, retinal photographs and identification data for personnel who were exposed.

(9) If exposure incident results in a service member receiving medical treatment, loses workdays, or is placed on light or limited duty, a mishap report must be submitted in accordance with reference B9-32.

CHAPTER B9

REFERENCES

- B9-1. NAVSEA S0420-AA-RAD-010, Radiological Affairs Support Program (RASP) Manual (NOTAL)
- B9-2. OPNAVINST 6470.2A
- B9-3. OPNAVINST 6470.3
- B9-4. NAVSEA 389-0288, Radiological Controls for Shipyards (NOTAL)
- B9-5. ANSI C95.6, IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 to 3 kHz (NOTAL)
- B9-6. ANSI C95.1, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (NOTAL)
- B9-7. DoD Instruction 6055.11, Protection of DoD Personnel from Exposure to Radiofrequency Radiation
- B9-8. ANSI Z136.1, The American National Standard for the Safe Use of Lasers (NOTAL)
- B9-9. ANSI Z136.3, The American National Standard for the Safe Use of Lasers in Health Care Facilities
- B9-10. NAVMED P-5055, Radiation Health Protection Manual
- B9-11. BUMEDINST 6470.22, Navy Radiological Systems Performance Evaluation Program
- B9-12. Navy Environmental Health Center Technical Manual NEHC - TM 6470.03-1, Navy Radiological Systems Performance Evaluation Manual

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- B9-13. BUMEDINST 6470.10B, Initial Management of Irradiated or Radioactively Contaminated Personnel
- B9-14. DoD 6055.5-M, Occupational Health Surveillance Manual
- B9-15. OPNAVINST 5100.27A/MCO 5104.1B
- B9-16. BUMEDINST 6470.19A, Laser Safety for Medical Facilities
- B9-17. NAVSEA OP 3565/NAVAIR 16-1-529/NAVELEX 0967-LP-624-6010, Electromagnetic Radiation Hazards (Hazards to Personnel, Fuel, and other Flammable Material)
- B9-18. MIL-STD-464A, Electromagnetic Environmental Effects Requirements for Systems
- B9-19. BUMEDINST 6470.23, Medical Management of Non-Ionizing Radiation Casualties
- B9-20. ANSI C95.2, IEEE Standard for Radio-Frequency Energy and Current Flow Symbols (NOTAL)
- B9-21. ANSI C95.3, IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to such Fields, 100 kHz t 300 GHz (NOTAL)
- B9-22. ANSI C95.4, IEEE Recommended Practice for Determining Safe Distances from Radio Frequency Transmitting Antennas when Using Electric Blasting Caps (NOTAL)
- B9-23. ANSI C95.7, IEEE Recommended Practice for Radio Frequency Safety Programs (NOTAL)
- B9-24.21 CFR Part 1040, FDA Performance Standards for Light Emitting Products
- B9-25. SECNAVINST 5100.14C
- B9-26. MIL-HDBK-828A, Laser Safety on Ranges and in Other Outdoors Areas

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B9-27. ANSI Z136.7, The American National Standard for Laser Eye Protection and Protective Devices (NOTAL)

B9-28. ANSI Z136.2, The American National Standard for the Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources (NOTAL)

B9-29. ANSI Z136.4, The American National Standard for Laser Safety Measurements and Instrumentation (NOTAL)

B9-30. ANSI Z136.5, The American National Standard for the Safe Use of Lasers in Educational Institutions

B9-31. ANSI Z136.6, The American National Standard for the Safe Use of Lasers Outdoors (NOTAL)

B9-32. NAVSEA S9040-AA-GTP-010/SSCR, Shipboard Systems Certification Requirements for Surface Ship Industrial Periods (Non-Nuclear) (NOTAL)

Appendix B9-A

**CHAPTER B9 RADIATION INSTRUCTIONS, STANDARDS,
REGULATIONS, MANUALS, AND HANDBOOKS**

A. THOSE CONTAINING IONIZING RADIATION GUIDANCE:

NAVMED P-5055, Radiation Health Protection Manual

This manual provides the radiation health requirements applicable to Navy and Marine Corps radiation protection programs. A radiation protection program may be defined as the sum of all methods, plans, and procedures used to protect the health and environment of personnel from exposure to sources of ionizing radiation. It includes the radiation health program and radiological controls program.

These regulations are intended for observance during peacetime by all Navy and Marine Corps activities possessing or using sources of ionizing radiation which may affect the health of personnel. These standards do not apply to the exposure of an individual to ionizing radiation when used for the diagnosis or treatment of medical or dental conditions of that individual. Personnel not employed by the Department of the Navy shall comply in all respects with these regulations when engaged in a Navy sponsored program or operation. It is recognized that these regulations may not be applicable to procedures initiated after an attack in which nuclear weapons are used; however, the provisions of these regulations, insofar as they are feasible, shall remain in effect after such an attack.

**BUMEDINST 6470.22, Navy Radiological Systems Performance
Evaluation Program**

This instruction provides guidance on the radiological safety management of all diagnostic imaging systems in Navy Medicine that use ionizing radiation. This instruction applies to all naval facilities and commands, ashore or afloat, and Navy Medical Department sponsored operations having medical and dental radiological systems. For implementation procedures this instruction references

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the Navy Environmental Health Center Technical Manual (NEHC) TM 6470.03-1, "Navy Radiological Systems Performance Evaluation Manual."

Navy Environmental Health Center Technical Manual NEHC -TM 6470.03-1, Navy Radiological Systems Performance Evaluation Manual

This manual provides the surveyor with standard procedures for acceptance testing and periodic testing of medical diagnostic medical equipment that employs ionizing radiation for ships and shore stations. This manual establishes periodicity of surveys, parameters to be measured, training and qualification of surveyors, and reporting requirements. This manual does not address therapeutic medical equipment that employs ionizing radiation.

BUMEDINST 6470.10B, Initial Management of Irradiated or Radioactively Contaminated Personnel

To provide direction to the Medical Department, civilian medical personnel of the naval services, and Navy and Marine Corps commands for the initial exposure assessment, management, and treatment of individuals who are irradiated or externally or internally radioactively contaminated.

This instruction applies to all naval facilities or commands and Navy-sponsored operations in which there exists a known potential for radioactive contamination or excessive ionizing radiation exposure and to all medical treatment facilities (MTFs), fixed and non-fixed. This instruction applies to the period from actual exposure, contamination, or injury to the time when the individual is either returned to full-duty or, if a seriously injured individual is on a course of recovery at an MTF with definitive care capability. Although applicable to personnel irradiation or contamination following a nuclear weapon detonation in a time of war, the procedures outlined in this instruction are intended for use in occupational or accidental exposure environments.

NAVSEA 389-0288, Radiological Controls for Shipyards

This manual presents the limits and protection measures applicable to ionizing radiation and radioactivity associated with constructing, servicing, and decommissioning U.S. naval nuclear propulsion plants; it does not cover control of radiation from nuclear weapons, medical uses, or other employment of radiation. The procedures and limits in this manual are applicable to shipyards, Fleet Maintenance Activities (FMAs), and naval reactors prototype sites.

NAVSEA TW120-AA-PRO-010, Nuclear Weapons Radiological Controls Program

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 exposure from weapon detonation, fallout, naval nuclear propulsion plants, industrial or medical sources. The requirements of this manual apply to each ship, station or facility that stows, maintains, or handles nuclear weapons.

NAVSEA S9213-33-MMA-000/(V), Radiological Controls for Ships

This manual provides the radiological safety standards, procedures, and requirements for nuclear powered ships and in-hull propulsion plant operations and routine maintenance at naval reactor prototypes.

NAVSEA S0420-AA-RAD-010, Radiological Affairs Support Program (RASP) Manual

The RASP applies to all sources of ionizing radiation with the Navy and Marine Corps except nuclear propulsion, nuclear weapons, and medical-dental sources. Ships and shore stations shall comply with the standards and procedures of this manual and maintain effective radiation protection programs for any operation involving RASP ionizing radiation sources.

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DoD Instruction 6055.8, Occupational Radiation Protection Program

DoD Instruction 6055.8 implements the United States Environmental Protection Agency "Radiation Protection Guidance to Federal Agencies for Occupational Exposure" of January 1987.

Applies to the Office of the Secretary of Defense (OSD), the military departments (including the Reserve components), the Joint Staff, the Unified and Specified Commands, the Defense Agencies, the DoD Field Activities, and the Army and Air Force Exchange Service (hereafter referred to collectively as "DoD Components"). Applies during peacetime to all DoD civilian and military personnel who are exposed to ionizing radiation worldwide, except personnel who, as patients, undergo diagnostic or therapeutic radiological procedures in medical or dental treatment facilities.

OPNAVINST 6470.2A, Occupational Radiation Protection Program

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.

OPNAVINST 6470.3, Navy Radiation Safety Committee

This instruction establishes the Navy radiation safety committee as a means for controlling the use of radioactive material within the Navy and Marine Corps.

This instruction applies to all Navy and Marine Corps activities engaged in the use of Nuclear Regulatory Commission (NRC) regulated byproduct material, special nuclear material, source material, and naturally occurring or accelerator-produced radioactive material. It does not apply to radioactive materials transferred from the Department of Energy (DOE) to the Department of Defense (DoD) in accordance with section 91B of the Atomic Energy Act of 1954. Nor does it apply to radioactive materials

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produced as a consequence of the construction, operation, servicing or maintenance of naval nuclear propulsion plants.

B: THOSE CONTAINING BOTH RF AND LASER RADIATION GUIDENCE UNDER ONE DOCUMENT:

OPNAVINST 5100.23G, Navy Safety and Occupational Health (SOH) Program Manual, chapter 22, Non-Ionizing Radiation, and appendix 22 A and B.

This chapter implements SOH procedures for non-ionizing (RF and Laser) radiation protection requirements, exposure standards and safety guidelines for all levels of command (OPNAVINST 5100.19D is the implementing document for forces afloat). Provisions of this chapter do not apply to exposures administered to patients undergoing medical diagnostic or therapeutic procedures.

BUMEDINST 6470.23, Medical Management of Non-Ionizing Radiation Casualties

The purpose of this instruction is to issue MPE limits, medical surveillance requirements, and casualty management procedures for personnel exposed to non-ionizing (RF and Laser) electromagnetic radiation. It applies to all Departments of the Navy activities using sources of non-ionizing radiation that may affect the safety or health of personnel. Personnel not employed by the Department of the Navy must comply in all respects with this instruction when engaged in a Navy-sponsored program or operation, or when visiting Navy ships, aircraft, or stations. This instruction does not apply to the exposure of individuals to non-ionizing radiation when used for the diagnosis or treatment of medical or dental conditions of those individuals.

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C: THOSE CONTAINING ONLY LASER RADIATION GUIDANCE:

OPNAVINST 5100.27A/MCO 5104.1B, Navy Laser Hazards Control Program

The purpose of this instruction is to prescribe Navy and Marine Corps policy and guidance in the identification and control of laser radiation hazards. The scope and provisions of this directive are mandatory for all Navy and Marine Corps activities. They apply to the design, use, and disposal of all equipment and systems capable of producing laser radiation including laser fiber optics, with the exception of medical and industrial lasers.

BUMEDINST 6470.19A, Laser Safety for Medical Facilities

This instruction provides laser safety guidance for medical facilities. It applies to all medical treatment and laboratory activities using lasers or laser systems. This instruction does not apply to the use of lasers or laser systems for military, industrial, or non-medical research applications.

SECNAVINST 5100.14C, Military Exempt Lasers

The purpose of this instruction is to implement DoD Instruction 6055.11, provide policy, and assign responsibilities per SECNAVINST 5100.10G for individual Navy laser products that are exempt from portions of the radiation safety performance standards of code of federal regulations, title 21. Actions required by this instruction apply to all Navy and Marine Corps activities that procure, fabricate, possess, use, store or dispose of laser products that are designed for combat, combat training or classified in the interest of national security. Laser products used in research, development, test or evaluation and which are components of systems intended for combat, combat training or classified are included. All other laser products must comply fully with code of federal regulations, title 21 and are not within the scope of this instruction.

MIL-HDBK-828A, Laser Safety on Ranges and in Other Outdoors Areas

The purpose of this handbook is to provide uniform guidance in evaluations for the safe use of military lasers and laser systems on DoD military reservations or military-controlled areas worldwide. It is intended to supplement each military service's established range procedures. It applies to all DoD ranges or operation test facilities where lasers are used and all DoD laser operations conducted on non- DoD controlled ranges or test facilities and all laser systems that have been evaluated by the health and safety specialists of each Service.

21 CFR Part 1040, FDA Performance Standards for Light Emitting Products

Classifies laser products and defines design features, labeling, and test requirements. Access on line at:
<http://www.navylasersafety.com/>

ANSI Z136.1, The American National Standard for the Safe Use of Lasers

This is the fundamental commercial user standard that has been approved and adopted by the DON. This standard is meant for users, not manufacturers (commercial designers/manufacturers of lasers use FDA's 21 code of federal regulations (CFR) chapter I, subpart J, Part 1040). The ANSI standard provides guidance by defining control measures for each of the four laser classifications. It is applicable to lasers with wavelengths from 180 nm to 1 mm, and provides information on laser hazard evaluation.

ANSI Z136.2, The American National Standard for the Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources

ANSI Z136.3, The American National Standard for the Safe Use of Lasers in Health Care Facilities

ANSI Z136.4, The American National Standard for Laser Safety Measurements and Instrumentation

ANSI Z136.5, The American National Standard for the Safe Use of Lasers in Educational Institutions

ANSI Z136.6, The American National Standard for the Safe Use of Lasers Outdoors

ANSI Z136.7, The American National Standard for Laser Eye Protection and Protective Devices

D: THOSE CONTAINING ONLY RF RADIATION GUIDANCE:

DoD Instruction 6055.11, Protection of DoD Personnel from Exposure to Radiofrequency Radiation

This instruction provides MPE limits to RF EMF. This instruction also covers training requirements and over exposure reporting procedures. This instruction applies to all DoD civilian and military personnel who may be exposed to RF EMF, except for patients undergoing diagnostic or therapeutic procedures in medical and dental treatment facilities. This instruction applies during peace time and to the maximum extent possible during wartime, to limit personnel exposure to RF EMF.

NAVSEA OP 3565/NAVAIR 16-1-529/NAVELEX 0967-LP-624-6010, Electromagnetic Radiation Hazards (Hazards to Personnel, Fuel, and other Flammable Material)

The purpose of this volume is to prescribe operating procedures and precautions to prevent injury to personnel and ignition of volatile vapors from exposure to environmental electromagnetic radiation (EMR) to assist commanding officers in carrying out their responsibilities for EMR safety. The sources of this EMR include communications transmitters, radars, electronic countermeasures transmitters, and lasers. This manual also provides technical data and information concerning non-ionizing radio frequency (RF), hazards to personnel, fuel, and other flammable material, as well as laser hazards to personnel. The procedures and precautions prescribed herein apply in every instance within the naval establishment where a person or a flammable vapor mixture is exposed to RF fields of potentially hazardous intensity.

Operational commanders may waive compliance with any provision when essential under emergency conditions. When noncompliance with restrictions contained herein is essential, emergency procedures are suggested and background information is provided in order to explain and minimize the risks involved.

MIL-STD-464A, Electromagnetic Environmental Effects Requirements for Systems

This standard established electromagnetic environmental effects (E3) interface requirement and verification criteria for airborne, sea, space, and ground systems, including associated ordnance. This standard contains two sections, the main body and an appendix. The main body of the standard specifies a baseline set of requirements. The appendix portion provides rationale, guidance, and lessons learned for each requirement to enable the procuring activity to tailor the baseline requirement for a particular application.

ANSI C95.1, IEEE Standard for Safety Levels with Respect to Human Exposure to Radiofrequency Electromagnetic Fields, 3 kHz to 300 GHz

ANSI C95.2, IEEE Standard for Radiofrequency Energy and Current Flow Symbols

ANSI C95.3, IEEE Recommended Practice for Measurements and Computations of Radiofrequency Electromagnetic Fields with Respect to Human Exposure to such Fields, 100 kHz to 300 GHz

ANSI C95.4, IEEE Recommended Practice for Determining Safe Distances from Radiofrequency Transmitting Antennas when Using Electric Blasting Caps

ANSI C95.6, IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 to 3 kHz

ANSI C95.7, IEEE Recommended Practice for Radiofrequency Safety Programs

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E: OTHER RELATED DOCUMENTS:

OPNAVINST 5102.1D/MCO P5102.1B, Navy and Marine Corps Mishap and Safety Investigation, Reporting, and Recordkeeping Manual

This instruction provides procedures for investigating and reporting material (property) damage, personnel injury/death, Navy civilian occupational injuries and illnesses, motor vehicle, explosive, and diving mishaps.

NAVSEA S9040-AA-GTP-010/SSCR, Shipboard Systems Certification Requirements for Surface Ship Industrial Periods (Non-Nuclear)

DoD 6055.5-M, Occupational Health Surveillance Manual