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John C. Stennis Space Center
Nonionizing Radiation Program

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Approval/Concurrence

Signature on File — 07/20/2019

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Document History Log

Revision	Change Date	Originator/Phone	Description
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Rev. 1	04/13/2016	Katrina Wright, x 8-3263	Clarified training requirements, restructured the document to make requirements more applicable to Stennis operations, and replaced FOSC references with SOC references.
Rev 2	7/20/2019	Sam Engelhard	Annual review, exempt welding UV from the instruction, and general administrative edits.

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1.0 PURPOSE

This Instruction sets forth requirements for the Stennis Space Center (SSC) Nonionizing Radiation Program. The Program is designed to maintain and preserve the health of the workforce by eliminating unnecessary and accidental exposures and minimizing necessary exposures to nonionizing (laser, radio frequency, microwave, and ultraviolet light) radiation. Personnel exposures shall be kept As Low As Reasonably Achievable (ALARA).

The SSC Nonionizing Radiation Program functions through the NASA Health Physics Program Manager (HPPM) and the Stennis Operating Contract (SOC) Health Physicist. Nonionizing Radiation generating equipment is under the direct control of Area Laser Safety Officers (ALSOs), or a custodian/supervisor.

2.0 APPLICABILITY

This Instruction is directly applicable to all NASA/SSC organizations including civil service and support contractors and is applicable to other NASA tenants of the John C. Stennis Space Center to the extent formal agreement is reached between NASA and the tenant.

3.0 REFERENCES

a. American Conference of Governmental Industrial Hygienists (ACGIH), *Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs), (latest edition)*

b. American National Standards Institute, *American National Standards Institute For Safe Use of Lasers Outdoors: Z-136.6*

c. American National Standards Institute, *American National Standards Institute For Safe Use of Lasers: Z-136.1*

d. Institute of Electrical and Electronics Engineers (IEEE) C95.1, *Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 GHz*

e. Institute of Electrical and Electronics Engineers (IEEE) C95.2, *Radio-Frequency Energy and Current-Flow Symbols.*

f. Institute of Electrical and Electronics Engineers (IEEE) C95.3, *Recommended practice for the measurements and computations of radio frequency electromagnetic fields with respect to human exposure to such fields, 100 kHz - 300 GHz*

g. Institute of Electrical and Electronics Engineers (IEEE) C95.7, *Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz*

h. NASA Procedural Requirements, NPR 1800.1, *NASA Occupational Health Program Procedures, Chapter 4*

i. NASA Procedural Requirements, NPR 8715.3, *NASA General Safety Program Requirements, Chapter 3*

j. Occupational Safety and Health Administration, *OSHA Standards for General Industry, 29 CFR 1910.97, Nonionizing Radiation*

k. Occupational Safety and Health Administration, Construction Health and Safety Standards, 29 CFR 1926.54, *Nonionizing Radiation*

l. U.S. Code of Federal Regulations, Title 21, Part 1010, *Performance Standards for Electronic Products: General*

m. U.S. Code of Federal Regulations, Title 21, Part 1040, *Performance Standards for Light-Emitting Products*

n. Stennis Common Work Instruction 8715-0013, *Control of Hazardous Energy Lockout/Tagout and Non-Service/Maintenance Hazardous Energy Isolation.*

4.0 RESPONSIBILITIES

4.1 NASA Health Physics Program Manager (HPPM):

- Has the overall responsibility for this Instruction
- Periodically assesses activities
- Approves/disapproves Radiation Purchase Requests (SSC Form 889)
- Approves/Disapproves Radiation Use Authorizations (SSC Form 918)
- Has Stop Work Authority over all Health Physics activities at Stennis Space Center

4.2 SOC Health Physicist (HP)

The SOC Health Physicist is responsible for administering this Instruction in accordance with applicable directives and regulations; including the following:

- Complete annual audits of the effectiveness of the Nonionizing Radiation Program (lasers, ultraviolet light sources, and radiofrequency sources).
- Provide oversight of the ALSOs, and custodian/supervisors

- Periodically (at least once per year in addition to the annual audit) assesses the activities of SSC Contractor organizations
- Approves/disapproves Radiation Purchase Requests (SSC Form 889)
- Approves/disapproves Radiation Use Authorizations (SSC Form 918)
- Reviews each contractor's training material
- Provides a copy of all user qualifications to the HPPM
- Conduct an annual audit and periodically assess the effectiveness of the Health Physics Program for nonionizing radiation generating equipment, including radiofrequency/microwave sources. The audit report shall be submitted to the HPPM within 10 working days of the audit's completion.
- Has Stop Work Authority over all Health Physics activities at Stennis Space Center

4.3 Area Laser Safety Officer (ALSO)

Each Class 3b or Class 4 laser shall be under the control of the Area Laser Safety Officer (ALSO). Each Area Laser Safety Officer (ALSO) is responsible for the implementation of this Instruction in accordance with their licenses, permits, and procedures; including the following:

- Provide a current list of users and user qualifications to the SOC HP
- Update and provide a copy of inventories to the SOC HP quarterly
- Immediately report (within 24 hours) any significant changes to inventories or programs to the SOC HP and the HPPM
- Prior to initiating purchases/procurements of Class 3B or Class 4 lasers, the ALSO shall submit a Radiation Purchase Request (SOC Form 889) to the HPPM for approval/disapproval. Procurement of the source is prohibited until the Radiation Purchase Request is approved.
- Prior to using the Class 3b or Class 4 laser, the ALSO shall submit a Radiation Use Authorization Form (SSC Form 918) to the HPPM for approval/disapproval. Use of the laser is prohibited until the Radiation Use Authorization Form (SSC Form 918) has been approved by the HPPM.
- Ensure laser products are labeled by the laser product manufacturer.
- Provide a copy of current training materials to the SOC HP
- Take prompt corrective measures to eliminate hazards involving laser and non-laser optical radiation sources.

4.4 Custodian/Supervisor

Ultraviolet (UV) light sources and radiofrequency/microwave generating equipment shall be under the administrative control of the custodian/supervisor.

Each custodian/supervisor is responsible for the implementation of this Instruction; including the following:

- Update and provide a copy of inventories to the SOC HP quarterly
- Immediately (within 24 hours) report any significant changes to inventories or programs to the SOC HP and NASA HPPM
- Prior to initiating purchases of ultraviolet, radiofrequency, or microwave sources, the Custodian/Supervisor shall submit a Radiation Purchase Request (SOC Form 889) to the HPPM for approval/disapproval. Procurement of the source is prohibited until the Radiation Purchase Request is approved.
- Prior to using the ultraviolet, radiofrequency, or microwave source, the custodian/supervisor shall submit a Radiation Authorization Form (SSC Form 918) to the HPPM for approval/disapproval. Use of the source is prohibited until the Radiation Use Authorization Form (SSC Form 918) has been approved by the HPPM.
- Provide a copy of current training materials to the SOC HP
- Ensure activities involving nonionizing radiation sources are conducted in accordance with applicable OSHA, state, and NASA requirements
- Take prompt corrective measures to eliminate hazards involving nonionizing radiation sources
- Ensure that radiofrequency/microwave sources that operate within a frequency range of 3 kHz to 300 GHz be operated and maintained in accordance with the manufacturer's instructions.
- Ensure that only appropriately trained users operate specific devices or sources of radiofrequency/microwave radiation.

4.5 SSC Medical Clinic

SSC Occupational Medicine Clinic personnel are responsible for providing medical surveillance and post-exposure evaluation, as well as follow-up actions, in accordance with NPR 1800.1 and this Work Instruction. Records from such examinations/evaluations are to be retained for at least 30 years. Results of the examinations are to be discussed with employees as deemed necessary by the SSC Occupational Medicine Clinic personnel.

4.6 Employees

Each worker is responsible for satisfying training and other requirements in addition to working in a safe manner in accordance with established procedures.

Any known or suspected overexposures associated with nonionizing radiation shall be immediately referred to SSC Medical Services (or off-site medical provider) for evaluation and notification made to the SOC HP.

5.0 LASERS

NOTE: According to the Food and Drug Administration, some standard hand-held laser pointers such as those used in meeting presentations and demonstrations have been reported as being

overpowered (emitting more than 5 milliwatts output power). Overpowered lasers can cause irreversible eye injury and can irritate or even burn the skin.

Regardless of output power, do NOT aim or shine laser pointers at any person, pet, vehicle, or aircraft directly, or through reflection by mirrors or other shiny surfaces.

Use of outdoor lasers is prohibited unless approved by the Health Physicist and the HPPM.

5.1 Requirements

5.1.1 All Class 3b and 4 lasers shall be under the direct control of an Area LSO Safety Officer (ALSO) and their use shall be in strict accordance with the approved Radiation Source Use Authorization.

5.1.2 Class 3b and 4 lasers shall have written standard operating and alignment procedures that are approved by the ALSO. These procedures shall be made available to the SOC HP.

5.1.3 General laser operations and hazard evaluations shall conform to the principles and requirements set forth in ANSI Z136.1. All uses of ultraviolet (UV) sources shall be in strict accordance with the manufacturer's instructions.

5.1.4 Operators of lasers and laser systems shall follow the requirements of ANSI Z136.1, "American National Standard for Safe Use of Lasers".

5.1.5 Any known or suspected laser injury shall be immediately referred to SSC Medical Services (or off-site medical provider) for evaluation and notification made to the SOC HP.

5.1.6 Embedded lasers shall be controlled according to the classification of the embedded laser when engineering controls (e.g., enclosures, interlocks) are defeated.

5.1.7 Prior to ceasing operations covered by this Instruction, the ALSO shall notify the SOC HP and the HPPM to coordinate final clearance of the facilities.

5.2 Training Requirements

5.2.1 The designated ALSO for Class 3b and 4 lasers shall receive formal Laser Safety Officer (LSO) training.

5.2.2 All personnel working with Class 3b and Class 4 lasers shall be trained in safe work practices for controlling or mitigating personal exposures. The level of training shall correspond with the degree of potential laser hazards, both from laser radiation and non-beam hazards, in accordance with American National Standard for Safe Use of Lasers: Z-136.1. The training shall include but is not limited to the following:

- Fundamentals of laser operation (physical principles, construction, etc.)

- Bio-effects of laser radiation on the eye and skin
- Significance of specular and diffuse reflections
- Non-beam hazards
- Laser and laser system classifications
- Hazard evaluation (Beam hazard calculations)
- Control measures
- Overall responsibilities of management and employees
- Medical surveillance practices (if applicable)
- CPR for personnel servicing or working on lasers with exposed high voltages and/or the capability of producing potentially lethal electrical currents

5.2.3 Operators of construction lasers shall receive training on proper and safe use of the laser products they operate. This training shall be offered or coordinated by their employer and shall satisfy the OSHA construction standard for "Nonionizing Radiation." (29 CFR 1926.54).

5.3 Signs, Labels, and Posting

Signs shall be posted in visible locations at/near access points to facilities where Class 3b or 4 lasers are used in accordance with American National Standard for Safe Use of Lasers: Z-136.1.

Laser products without the laser product manufacturer's label are prohibited at SSC.

5.4 Construction Lasers

Power emissions of construction lasers are not to exceed Class 3a limits for visible lasers and not exceed Class 1 limits for other wavelengths.

Contractors who intend to use a laser(s) shall provide a written laser-use procedure; it shall be included in the safety plan written for the construction task. The contractor shall provide the OSHA-required proof of qualification for construction laser operator(s).

6.0 ULTRAVIOLET RADIATION (UV)

6.1 Requirements

6.1.1 Radiation protection controls shall be devised to reduce the possibility of injury to the eyes or skin from ultraviolet radiation.

6.1.2 Any known or suspected UV injury shall be immediately referred to SSC Medical Services (or off-site medical provider) for evaluation and notification made to the SOC HP.

6.1.3 The minimum level of ultraviolet radiation required for the application shall be utilized.

6.1.4 Engineering control measures (items incorporated into the optical device or optical system

by design) shall be given primary consideration for limiting access to optical radiation.

6.1.5 If engineering controls are impractical or inadequate, administrative and procedural controls and protective equipment shall be used to limit access to optical radiation. Administrative and procedural controls include, but are not limited to, access restrictions; eye protection; area controls; and education and training requirements for operators.

6.1.6 The following engineering controls should be utilized where applicable:

a. Protective housings shall be used where practicable to limit accessibility to the device emission. Protective housings which enclose ultraviolet sources shall either be provided with an interlock system which is activated when the protective housing is intended to be opened during operations and maintenance, or the equipment may only be accessed while under provisions of Lockout/Tagout (SCWI-8715-0013).

b. Viewing portals and display screens included as an integral part of an ultraviolet device shall incorporate a suitable means (filters, interlocks, attenuators) to maintain the optical emission at the viewing position at or below the applicable protection guide.

6.1.7 Written operating, maintenance, service, and emergency procedures shall be provided and maintained for ultraviolet devices or systems. These procedures shall be used for reference by operator, maintenance, and service personnel.

6.1.8 Ultraviolet devices and systems with accessible emission levels exceeding the appropriate protection guide shall be operated, maintained, and serviced only by employer authorized personnel.

6.1.9 Protective eyewear that are UVA and UVB resistant shall be worn whenever operational conditions may result in a potential radiation eye hazard.

6.2 Training Requirements

Operators, maintenance, or service personnel of UV devices shall have education and training that corresponds with the level of potential hazard.
Training shall include but is not limited to the following:

- The definition of ultraviolet radiation
- Sources of UV radiation
- Biological effects of UV
- Engineering and administrative controls
- Personal protective equipment (PPE)
- Warning signs and postings
- Emergency Response

7.0 RADIOFRQUENCY / MICROWAVE RADIATION

This Section (7.0) provides radiation protection requirements to prevent or control potential risks associated with exposure to electromagnetic fields from radiofrequency/microwave sources that operate in the frequency range of 3 kHz and 300 GHz.

Where there is a potential for the detonation of explosives as a result of radiofrequency or microwave energy, refer to NASA Standards, STD 8719.12, *Safety Standard for Explosives, Propellants, and Pyrotechnics.*

7.1 Requirements

7.1.1 All uses of radiofrequency/microwave sources shall be in strict accordance with applicable OSHA, state, IEEE, ACGIH, and NASA requirements.

7.1.2 All personnel likely to exceed 20 percent of the maximum permissible exposure limit for controlled environments shall be trained in safe work practices for controlling or mitigating personal exposures.

7.1.3 Operational procedures shall include controls for reducing exposure.

7.1.4 The beam height of radiofrequency and microwave transmitters shall be maintained at a level that does not intercept occupied facilities or structures, or personnel within the identified hazard distance.

7.1.5 Limits for maximum permissible exposure and induced and contact radiofrequency currents shall be derived in accordance with IEEE Standard C95.1.

7.1.6 Limits for lower frequency electromagnetic fields and static magnetic fields shall be in accordance with American Conference of Governmental Industrial Hygienists *(*ACGIH) threshold limit values and biological exposure indices.

7.1.7 Radiation protection controls shall be devised to reduce the possibility of exposure of personnel to hazardous levels of radiofrequency/microwave radiation and to other hazards associated with the operation of radiofrequency/microwave devices during normal operation and maintenance;

7.1.8 For all uses of radiofrequency/microwave systems, it is recommended the minimum level of radiofrequency/microwave radiation required for the application be utilized;

7.1.9 Radiofrequency/microwave transmitter beam height shall be maintained at a level not to intercept occupied facilities/structures and/or personnel within the identified hazard distance;

7.1.10 Engineering control measures (items incorporated into the radiofrequency/microwave system installation by design) shall be given primary consideration for limiting access to radiofrequency radiation; and

7.1.11 If engineering controls are impractical or inadequate, administrative and procedural controls and protective equipment shall be used to limit access to radiofrequency radiation.

7.2 Training Requirements

Custodians/supervisors, operators, maintenance, or service personnel shall have education and training comparable with the level of the potential hazard(s). Training shall include but is not limited to the following:

- General RF safety awareness information
- Explanation of RF exposure limits
- RF exposure mitigation controls
- Possibility of RF interaction with medical devices and implants considerations
- Over-exposure incident response information
- Electro-explosive device considerations (when present in the work environment)

7.3 Postings and Controls

Radiofrequency warning signs and labels shall be utilized as described in IEEE C95.2, *Radio-Frequency Energy and Current-Flow Symbols.*

Written operating, maintenance, service, and emergency procedures shall be provided and maintained with the radiofrequency/microwave system for reference by operator, maintenance, and service personnel.

7.4 Program Exemptions

7.4.1 Exemption of radiofrequency/microwave radiation devices from the authorization requirements of the Health Physics Program shall not be interpreted to exempt the user from other safety requirements relating to potential hazards associated with operation of the item, such as, electrical hazards.

7.4.2 In spite of the negligible potential radiation hazards characteristically represented by exempted sources, users shall avoid close or prolonged exposure to emissions of devices.

7.4.3 Individuals should consult with the SOC HP, if there is a question regarding applicability of program exemption to their particular situation or requirement.

7.4.4 A variety of commercially available consumer, business, and industrial application radiofrequency/microwave radiation devices are exempt from the authorization requirements of this Work Instruction because of their common usage and negligible potential for hazardous exposure under conditions of normal use. However, such exemption is valid only when certain

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conditions are met. The exemptions are:

a. Devices for voice communication with transmitter power of 7 watts or less and an antenna gain of unity (walkie-talkies, car phones, cellular phones), at frequencies between 100 kHz and 450 MHz;
b. Speed monitoring devices (radar guns);

c. Automotive radar detectors;
d. Microwave ovens designed for home use;

e. Radiofrequency/microwave radiation devices designed for and operated in a completely enclosed configuration where no open-air transmission is possible;

f. Radiofrequency/microwave radiation devices designed to operate in a hard-lined, closed loop configuration where no open air transmission is possible; and

g. Devices or systems which have been shown by documented worst case analysis that they are incapable of emitting radiation levels greater than one half (50%) of current applicable maximum permissible exposures levels.

7.4.5 The exemptions listed in 7.4.4 of this Work Instruction are valid for the general categories of equipment, instruments, and systems provided that:

a. The individual item is maintained in its original design configuration and utilized for its originally intended use over the useful life of the item;

b. The design and manufacture of the item is in accordance with the specifications of the Federal Performance Standard for Electronic Products (Title 21, CFR, Part 1010);

c. The item is operated in accordance with the manufacturer's recommended operating procedures; and

d. Maintenance, service, or repair activities which could expose personnel to accessible levels of radiation equal to or greater than the levels described or implied in IEEE C95.1 are performed only by appropriately authorized and qualified personnel.

7.4.6 Welding or cutting operations using arc type methods are exempt from controls in this procedure specifically the Ultra Violet (UV) controls. UV flash control is discussed in Weld shop procedures and Qualifications.

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8.0 ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ALARA	As Low As Reasonably Achievable
ALSO	Area Laser Safety Officer
ANSI	American National Standards Institute
BEIs	Biological Exposure Indices
CFR	Code of Federal Regulations
CHMO	Chief Health and Medical Officer
FAA	Federal Aviation Administration
FDA	Food and Drug Administration
GHz	Gigahertz
HP	Health Physicist
HPPM	Health Physics Program Manager
kHz	Kilohertz
LSO	Laser Safety Officer
mm	millimeter
MPE	Maximum Permissible Exposure
nm	nanometer
NIST	National Institute of Standards and Technology
NPR	NASA Procedural Requirement
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
SOC	Stennis Operating Contract
SSC	Stennis Space Center
TLV	Threshold Limit Values
UV	Ultraviolet

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