PROCEDURE 17 - Ionizing and Non-Ionizing Radiation

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Synopsis

The purpose of this procedure is to provide guidelines to reduce potential exposure to hazards associated with ionizing and non-ionizing radiation. This procedure applies to all NWS facilities, work locations, and employees

Initial Implementation Requirements:

- **Analyze Site Operations versus Requirements of the Procedure**
- **Develop/Obtain Documentation/Information required for Site**
  - Develop a list of all Ionizing Radiation Sources on site. *(17.3.1b)*
  - Develop a list of all Non-ionizing Radiation Sources on site.*(17.3.2b)*
  - Develop Training Records. *(17.3.1f, 17.3.2g)*
- **Designate Person to Administer Ionizing & Non-Ionizing Radiation Program Requirements**
- **Provide Local Training of Site Personnel**
  - Awareness Training on Ionizing Radiation. *(17.3.1f)*
  - Awareness Training on Non-Ionizing Radiation. *(17.3.2g)*
- **Inventory Material/Equipment (Procure as required)**
  - Safety Postings (RDA, WSR, etc.)*(17.5.2e, 17.3.1e)*
  - Barriers. *(17.5.2e, 17.3.2f)*
  - Interlocks. *(17.5.2e, 17.3.2f)*

Recurring and Annual Task Requirements:

- **Review/Update Documentation/Information required for Site**
  - Maintain a list of all Ionizing Radiation Sources on site. *(17.3.1b)*
  - Maintain a list of all Non-ionizing Radiation Sources on site. *(17.3.2b)*
  - Maintain Training Records. *(17.3.1f, 17.3.2g)*
- **Provide Refresher Training of Site Personnel (as needed)**
  - Awareness Training on Ionizing Radiation. *(17.3.1f)*
  - Awareness Training on Non-Ionizing Radiation. *(17.3.2g)*
- **Inspect/Replace/Maintain Material/Equipment**
  - Safety Postings (RDA, WSR, etc.)*(17.5.2e, 17.3.1e)*
  - Barriers. *(17.5.2e, 17.3.2f)*
  - Interlocks. *(17.5.2e, 17.3.2f)*

Ionizing and Non-ionizing Radiation Checklist

Requirements	Reference	YES	NO	N/A	Comments
Is initial and annual review of this procedure conducted and documented?	17.4.2				
Has this facility developed and maintained a list of ionizing and non-ionizing radiation sources on site?	17.3.1b 17.3.2b				
Are all employees subjected to a total cumulative dose of less than 100 mRems per calendar year?	17.3.1d				
Are all sources of ionizing radiation properly labeled and shielded?	17.3.1e				
Are all employees who work with or in the vicinity of ionizing radiation properly trained in the hazards and protective measures associated with the radiation?	17.3.1f				
Is work, requiring licensing by NRC, being performed in accordance with this procedure?	17.3.1g				
Are shields installed prior to transmitter operations?	17.3.1h				
Have field strength measurements been conducted on sources of non-ionizing radiation at the facility?	17.3.2c				
Is annual and periodic inspection of waveguards performed?	17.3.2d				
Are transmitters being operated only when all waveguide components are in place and all coaxial cables are properly terminated?	17.3.2j				
Are all employees who work with or near non-ionizing radiation sources properly trained?	17.3.2g				

Requirements	Reference	YES	NO	N/A	Comments
During servicing, are all sources of significant non-ionizing radiation adequately locked out/tagged out in accordance with the facility Lockout/Tagout program?	17.3.2h				

17 IONIZING AND NON-IONIZING RADIATION

17.1 Purpose and Scope

As part of its goal to provide a safe and healthful workplace, the National Weather Service (NWS) is promulgating this procedure related to hazards associated with ionizing and non-ionizing radiation. This procedure applies to all NWS facilities, work locations, and employees.

17.2 Definitions

ACGIH. American Conference of Governmental Industrial Hygienists.

BEI. Biological Exposure Index.

Electromagnetic Radiation. OSHA 29 CFR 1910.97 defines electromagnetic radiation as restricted to that portion of the spectrum commonly defined as the radio frequency region, which for the purpose of the standard shall include the microwave frequency region.

Field Office. A Field Office may include the following: Weather Forecast Office (WFO), River Forecast Center (RFC), Weather Service Office (WSO), and a Data Collection Office (DCO).

High Radiation Area. Any area, accessible to personnel in which there exists radiation at such levels that a major portion of the body could receive a dose in excess of 100 millirem in any one (1) hour.

Ionizing Radiation. Waves at frequencies greater than 10^{15} Hz (Hertz) and energy levels greater than 10 electron volts interact with bio-systems at the atomic level by generation of free charge. Includes alpha rays, beta radiation, gamma rays, neutrons and other atomic particles.

NLSC. National Logistics Supply Center.

Non-Ionizing Radiation. Waves at frequencies less than 10^{15} Hz (Hertz) and energy levels less than 10 electron volts interact with the molecular or cellular level without ionization. Includes electromagnetic radiation in the sub-radio frequency, radio frequency, microwave, infrared, visible light and ultraviolet ranges. The wavelength ranges from approximately 1,000 km to 100 nanometers (nm).

Operating Unit. For the purpose of this procedure, Operating Unit includes the National Centers for Environmental Prediction (NCEP), National Data Buoy Center (NDBC), NWS Training Center (NWSTC), National Reconditioning Center (NRC), Radar Operations Center (ROC), or the Sterling Field Support Center (SFSC).

OSHA. Occupational Safety and Health Administration.

Qualified Person. A person who has the education, training and experience to assess radiation hazards and determine if hazardous levels of radiation are present.

Radioactive Material. Defined by OSHA as any material which emits, by spontaneous nuclear disintegration, corpuscular or electromagnetic emanations.

Restricted Area. Defined by OSHA as any area to which access is controlled by the employer for the purpose of protection of individuals from exposure to radiation or radioactive materials.

Rad (Radiation Absorbed Dose). OSHA defines as a measure of the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit of mass of the tissue. One (1) Rad is the dose corresponding to the absorption of 100 ergs per gram of tissue.

Rem (Roentgen Equivalent in Man). OSHA defines as a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one (1) roentgen of X-rays. The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions of irradiation. For example:

a. A dose of one (1) roentgen due to X- or gamma radiation.

b. A dose of one (1) rad due to X-, gamma or beta radiation.

Station Manager. For the purpose of this procedure, the Station Manager shall be either the NWS Regional Director; Directors of Centers under NCEP (Aviation Weather Center, NP6; Storm Prediction Center, NP7; and Tropical Prediction Center, NP8); Directors of the NDBC, NWSTC, and Chiefs of NRC, ROC and SFSC facilities; or Meteorologist in Charge (MIC), Hydrologist in Charge (HIC), or Official in Charge (OIC).

TLV. American Conference of Governmental Industrial Hygienists Threshold Limit Value.

Unrestricted Area. Defined by OSHA as any area access to which is not controlled by the employer for purposes of protection of individuals from exposure to radiation or radioactive materials.

17.3 Procedure

17.3.1 Ionizing Radiation

a. The Safety or Environmental/Safety Focal Point shall be informed of any ionizing radiation source which is present or which is brought on to the site.

b. The Safety or Environmental/Safety Focal Point shall develop and maintain an inventory of all ionizing radiation sources present at the facility. Currently, the only source of ionizing radiation in the NWS is extremely low-level x-rays emitted from the WSR-88D Klystron.

c. It is the policy of the NWS to adhere to all provisions of 29 CFR 1910.1096, “Ionizing Radiation.”

d. Adequate control measures shall be implemented to ensure that no NWS employee receives ionizing radiation exposure in excess of the Department of Energy (DOE) maximum levels for ionizing radiation for the general public. The maximum level is 100 milliRems per year.

NOTE: The Klystron generates extremely low-intensity x-rays (ionizing radiation). The transmitter contains lead shielding to further reduce the x-ray levels. The WSR-88D was originally designed to limit x-ray emissions to below 2 mR/hour at one foot from the Klystron surface which is below permissible exposure levels. Based upon this design, development testing, and periodic testing at field sites, routine testing of the ionizing radiation levels from the WSR-88D is not required. Measurements taken six inches from the Klystron surface measured a maximum x-ray level of 0.03 mR/hour. The level dropped to zero outside of the transmitter cabinet. Normally, routine testing for ionizing radiation for NWS Klystron equipment is not required.

e. All radiation and high radiation areas as well as radiation source storage areas shall be labeled in accordance with 29 CFR 1910.1096.

f. All employees who work in the immediate area of radiation sources or in regulated areas shall be trained in safe work practices, protective measures and on the nature of the sources. Training records shall be maintained by the Safety or Environmental/Safety Focal Point.

g. Any work requiring licensing by the Nuclear Regulatory Commission (NRC) shall be performed in accordance with 10 CFR 20, "Ionizing Radiation."

h. Transmitters shall not be operated unless all shielding is in place. NWS personnel shall not modify any NEXRAD transmitters in a manner that might decrease radiation shielding.

17.3.2 Non-Ionizing Radiation

a. The Safety or Environmental/Safety Focal Point shall be informed of any non-ionizing radiation source which is present or which is brought on to the site.

b. The Safety or Environmental/Safety Focal Point shall develop and maintain an inventory of all non-ionizing sources present at the facility.

c. The Safety or Environmental/Safety Focal Point or his/her designee (Qualified Person) in cooperation with respective Regional Program Manager shall verify field strengths of radio and microwave frequency sources at the facility.

d. No NWS employee shall be exposed to radio or microwave frequency radiation in excess of the OSHA maximum level or the ACGIH TLV, whichever is more restrictive for the frequency involved. For 10 MHz to 100 GHz, OSHA mandates a maximum exposure to personnel of 10 milliwatts (mW) per square centimeter, as averaged over any possible 0.1 hour period. ACGIH TLV's for a particular frequency are calculated in Table 1, "Radiofrequency and Microwave TLV's" of the Non-Ionizing Radiation and Fields section of Threshold Limit Values for Chemical Substances and Physical Agents.

NOTE: The RF generated by the NEXRAD transmitter represents non-ionizing radiation and the maximum permitted levels within the RDA shelter are 10 mW per cm^2 for the OSHA standard and 5 mW per cm^2 for the FCC standard. However, measurements taken within the RDA shelter in the vicinity of the Klystron and the waveguide joints have measured essentially no RF leakage within the RDA shelter. It should be noted that the interlocks prevent the transmitter from operating in a degraded mode in most cases. Testing for non-ionizing radiation is required as follows: (1) Annually within the RDA equipment; (2) When local maintenance procedures require it to be accomplished; (3) Whenever any waveguide component is disassembled and reassembled such as replacing the klystron or waveguide switch; and (4) Whenever an RF leak is suspected and the following symptoms that are not corrected by normal corrective maintenance procedures are present: wavy interference patterns on the RDA maintenance display, LIN/LOG CHANNEL CLUTTER REJECTION DEGRADED alarms (leaks around the waveguide switch), low antenna power with high transmitter power, low transmitter power, high VSWR, hard drive crash, illumination of the neon fuse indicators in the transmitter fuse box in the center bay of the transmitter, even though the fuses are still good, loud noise in the phone system when in operate, unsolicited wideband disconnect when the transmitter is placed in operate, and receiver interference. The transmitter flexible waveguide can develop small pinhole RF leaks that do not produce equipment alarms.

17.3.3 All employees who work in the immediate area of non-ionizing radiation sources (e.g., NEXRAD, NWR) shall be trained in safe work practices, protective measures and on the nature of the sources. Training records shall be developed and maintained by the Safety or Environmental/Safety Focal Point.

a. When potential sources of radio or microwave frequency (non-ionizing) radiation are being serviced, the equipment shall be de-energized and locked out in accordance with the facility Lockout/Tagout Program.

b. For non-radio or microwave frequency radiation, all non-ionizing radiation exposures shall be below the appropriate ACGIH TLV.

c. Transmitters shall not be operated unless all waveguide components are in place and all coaxial cables are properly terminated.

17.4 Quality Control

17.4.1 Regional or Operating Unit Environmental/Safety Coordinators

a. Shall perform an annual assessment of the regional headquarters facilities or operating unit to monitor and promote compliance with the requirements of this procedure.

b. Shall perform assessments or designate personnel to perform assessments of all field offices to monitor and promote compliance with the requirements of this procedure every two years.

17.4.2 Station Manager

Shall review, or delegate review, of this procedure on an annual basis to ensure that the facility is complying with its requirements. Confirmation of this review shall be forwarded to the Regional or Operating Unit Environmental/Safety Coordinator.

17.4.3 NWS Headquarters (NWSH)

a. The NWS Safety Office shall perform an annual assessment of the NWSH facilities to ensure that the facilities are in compliance with this procedure.

b. The NWSH Safety Office shall periodically perform an assessment of the regional headquarters and field offices to ensure compliance with this procedure. The frequency of these regional and field office assessments shall be determined by the NWSH Safety Office.

c. Requests for clarification concerning this procedure shall be directed to the NWSH Safety Office.

17.5 Responsibilities

17.5.1 Regional or Operating Unit Environmental/Safety Coordinators*

Shall monitor and coordinate to promote compliance with the requirements of this procedure for the regional headquarters, and field offices or operating units.

17.5.2 Station Manager*

a. Shall have oversight over the implementation of this procedure, and ensure that the requirements of this procedure are followed by individuals at the NWS facility.

b. Shall ensure that the Safety or Environmental/Safety Focal Point maintains an inventory of all radioactive sources present at the site.

c. Shall ensure that all personnel working with radioactive sources or in regulated areas are properly trained.

d. Shall delegate the duty of conducting field strength measurements of radio and microwave frequency radiation generated at the facility.

e. Shall ensure that initial and periodic inventory of safety postings, barriers, interlocks and other safety equipment is accomplished and adequate stock is maintained.

17.5.3 Safety or Environmental/Safety Focal Point*

Shall ensure that any responsibilities delegated to them by the Station Manager are implemented in accordance with the requirements of this procedure.

17.5.4 Employees

a. Individual employees affected by this procedure are required to read, understand and comply with the requirements of this procedure.

b. Report unsafe or unhealthful conditions and practices to their supervisor or safety focal point.

NOTE:	* - Reference NWS PD 50-11 for complete list of responsibilities http://www.nws.noaa.gov/directives/050/pd05011a.pdf .

17.6 References

Incorporated references. The following list of references is incorporated as a whole or in part into this procedure. These references can provide additional explanation or guidance for the implementation of this procedure.

17.6.1 American Conference of Governmental Industrial Hygienists, TLV's and BEI's, Threshold Limit Values for Chemical Substances and Physical Agents, Current Edition.

17.6.2 U.S. Department of Energy, 10 CFR 20, "Standards for Protection Against Radiation."

17.6.3 U.S. Department of Energy, 10 CFR 835.208, "Occupational Radiation Protection."

17.6.4 U.S. Department of Labor, Occupational Safety and Health Administration, 29 CFR 1910.97, "Non-Ionizing Radiation."

17.6.5 U.S. Department of Labor, Occupational Safety and Health Administration, 29 CFR 1910.1096, "Ionizing Radiation."

17.6.6 Federal Communications Commission (FCC) Office of Engineering and Technology (OET) Bulletin No. 65, "Evaluating Compliance With FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields."

17.7 Attachments

Attachment A. Inventory of Radiation Sources at WFO Springfield, MO
Attachment B. Radiation Survey for WFO Springfield, MO

ATTACHMENT A
Inventory of Radiation Sources at WFO Springfield, MO
January 20, 2000

Sources of Ionizing Radiation:

1) WSR-88D Klystron (X-rays)

Sources of Non-Ionizing Radiaiton:

1) NEXRAD transmitter (RF)

2) Water Tech Water Purifier (UV)

3) ASOS (RF)

4) NWR (RF)

5) Wind profiler (RF)

6) Some river gauges (MW)

7) UHF Radio Link (RF)

8) Cell phones (MW)

ATTACHMENT B
Radiation Survey for WFO Springfield, MO

On January 13, 2000, radiation testing was conducted in the RDA Shelter at the Springfield WFO. The purpose of the testing was to identify the potential for radiation exposure for NWS personnel.

X-rays levels (mR/h) for the WSR-88D Klystron were measured using a Victoreen Meter, Model 440RF/D, S/N 733. The x-rays levels were less than the level of detection or essentially zero.

The non-ionizing RF (mW/cm^2) generated by the NEXRAD transmitter was measured using a Raham Radiation Hazard Meter, Model 481B, Serial #231365. Table 1 shows the results of the testing for RF.

Table 1, Measured Levels of RF Generated by the Springfield NEXRAD Transmitter

Location Within RDA Facility	(Radiation, mW/cm^2) **X** (Frequency Correction Factor of 0.635)	Corrected Radiation Levels (mW/cm^2)
Outside of WRS-88D with the door closed.	0.0 X 0.635	0.0
At the waveguide switch.	0.1 X 0.635	0.064
At the WSR-88D with the door open.	0.5 X 0.635	0.032

Per OET Bulletin 65, the limit to non-ionizing radiation is 5 mW/cm^2 for the frequency range associated with the NEXRAD transmitter. Note that the RDA Shelter is an un-manned facility. Additionally, the waveguide switch is well above working height, and the transmitter is off-line when the unit is serviced.

The low levels of radiation measured in the Springfield RDA Shelter in conjunction with similar results at other NWS facilities supports the position that routine radiation testing of Doppler Radar equipment is unnecessary.