



GSFC/Wallops
Flight Facility

*Wallops Flight Facility
Safety and Health Training Course*

***RF & Microwave Radiation
Hazard Awareness***

Presented By:
**Safety and Mission Assurance
Code 803.2**

RF Radiation

- ***Radiation- is energy transmitted through space in the form of electromagnetic waves or sub-atomic particles***
- ***Examples include:***
 - ***Radiofrequency (RF) Radiation, Microwaves***
 - ***Infrared, Visible, Ultraviolet Light***
 - ***X-rays and Gamma Rays***



RF Radiation

The term “Electromagnetic Radiation” is restricted to that portion of the spectrum commonly defined as the radio frequency region, which for our purposes also includes the microwave frequency region.



RF Radiation

Acronyms:

- *Hazards of Electromagnetic Radiation to Personnel (HERP)*
- *Hazards of Electromagnetic Radiation to Ordnance (HERO)*
- *Electro Magnetic Interference (EMI)*



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RF Radiation

HERP

- ***Observed Thermal effects (areas exceeding the MPE) :***
 - *Heating of the body (Developing fetus is at no greater risk than mother)*
 - *Cataracts*
 - *Reduced sperm count in males*
 - *Perception*
 - *Auditory (>100 mW/cm²) buzzing, clicking, hissing*
 - *Work Disturbance (based on animal studies)*
- ***RF Current Effects***
 - *Shocks or Burns*
 - *Neural Stimulation (Extremely Low Frequency – (0-3 kHz)
(tissue damage at 10 x MPE)*



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RF Radiation

- ***Signs and Symptoms of possible over exposure may include:***
 - ***Confusion***
 - ***Vertigo***
 - ***Headache***
 - ***Blurred vision***
 - ***Overall nauseous feeling***
 - ***Body heating (Heat Stress)***
 - ***Shocks and burns***
 - ***Bad or metallic taste in mouth***



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RF Radiation

- ***Most documented harmful effects associated with RF are due to hyperthermia (increased body temperature)***
 - ***The eyes and testicles are of primary concern due to their inability to dissipate heat***
 - ***The lens of the eye is vulnerable to heating and can lead to cataracts (clouding of the lens)***
 - ***Testicular function is strongly influenced by temperature and an increase in temperature decreases sperm cell survival***

RF Radiation

- **RF shock or burns**
 - **May occur when you come into contact with either an RF radiator like an antenna. Many antenna designs cause RF current to flow in their metallic components, which in turn, is radiated into space. Touch one of these surfaces, and the energy will flow through your body to ground.**
 - **Similarly, the same thing can happen if you touch a re-radiator. Any ungrounded, conductive (usually metal) object that is in the field of a strong RF source can be illuminated by the RF field and re-radiate the energy back into space.**

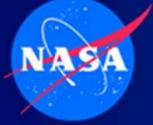


RF Radiation

- *When you touch a re-radiator, you provide a path to ground through you. A surge of energy occurs at the point of contact. This results in a shock and, in many cases, an RF burn.*
- *The primary factors that determine if you will receive a shock or burn should you contact a conductive object are*
 - *the strength of the electric field,*
 - *the frequency,*
 - *how well grounded you are, and*
 - *how much of your body touches the object.*
- *Severe burn-hazard conditions may exist where the RF field level may be less than 1 percent of the MPE limit!*

RF Radiation

- **HERO**
 - ***Premature activation of electro-explosive devices (EED). Safe distances are calculated and based on worse case most sensitive devices.***
- **EMI**
 - ***Interference with other electronic equipment. Control focuses on avoidance of buildings and equipment.***



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RF Radiation

- ***Exposure limits are specific for locations that are defined as either controlled or uncontrolled environments.***
- ***Controlled environments are areas where exposure may be incurred by personnel who are aware of the potential for RF exposure as a result of employment or duties; by individuals who knowingly enter areas where higher RF levels can reasonably be anticipated to exist; and by exposure incidental to transient passage through such areas. (Wallops Is.)***
- ***Uncontrolled environments generally include public areas, living quarters and work places where there is no expectation that higher RF levels should be encountered. (Main Base)***

RF Radiation Standards

- **OSHA 29 CFR 1910.97 (a)(2)(i)**
 - ***For normal environmental conditions and for incident electromagnetic energy of frequencies from 10 MHz to 100 GHz, the radiation protection guide is 10 mW/cm². (milliwatts per square centimeter) as averaged over any possible 0.1 hour period (6 minute period)***

Standards

- **OSHA 1910.268 - Telecommunication Industry**
 - *Primarily safety requirements, such as electrical*
 - *Mandates 1910.97 compliance for 1-300 GHz*
 - *Describes “Tagout” of antenna 3-300 MHz*
- **OSHA 1926.54, 20 - Construction Industry**
 - *Includes tower erection, repairs and painting*
 - *Limits MW to 10 mW/cm². (no averaging)*
 - *Requires Programs to provide safe work to employees and contractors; includes inspection*



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Related Standards

- ***OSHA 1910.147 - Lockout/Tagout of Power***
 - ***Requires lockout / tagout of power during maintenance to prevent excessive exposures***
- ***OSHA 1910.132 - Personal Protective Equipment***
- ***OSHA 1910.145, 1926.200 - Signs and Tags (Hazard Warning Signs)***



Consensus Standards:

The following organizations provide information and guidelines regarding RF use and protection.

- American Conference of Governmental Industrial Hygienists (ACGIH) provides Threshold Limit Values for RF/Microwave Radiation***
- Institute of Electronics and Electrical Engineers (IEEE) /American National Standards Institute (ANSI) (U.S.)***
- International Commission for Non-Ionizing Radiation Protection (ICNIRP)***



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Controls:



Controls

- ***Utilize low exposure equipment & site configuration***
 - ***Use and maintain equipment in good condition***
 - ***Control hazard areas***
 - ***Limit exposures***
- ***Access Restriction***
- ***Maintenance of Controls***

Controls

- *Lockout/Tagout Procedures*
- *Signal Blocking or Blanking*
- *Prevent access to hazardous locations (Signs & Fences)*
- *Standard Operating Procedures*
- *Protective Clothing (PPE)*

RF Safety Program Exposure Categorization

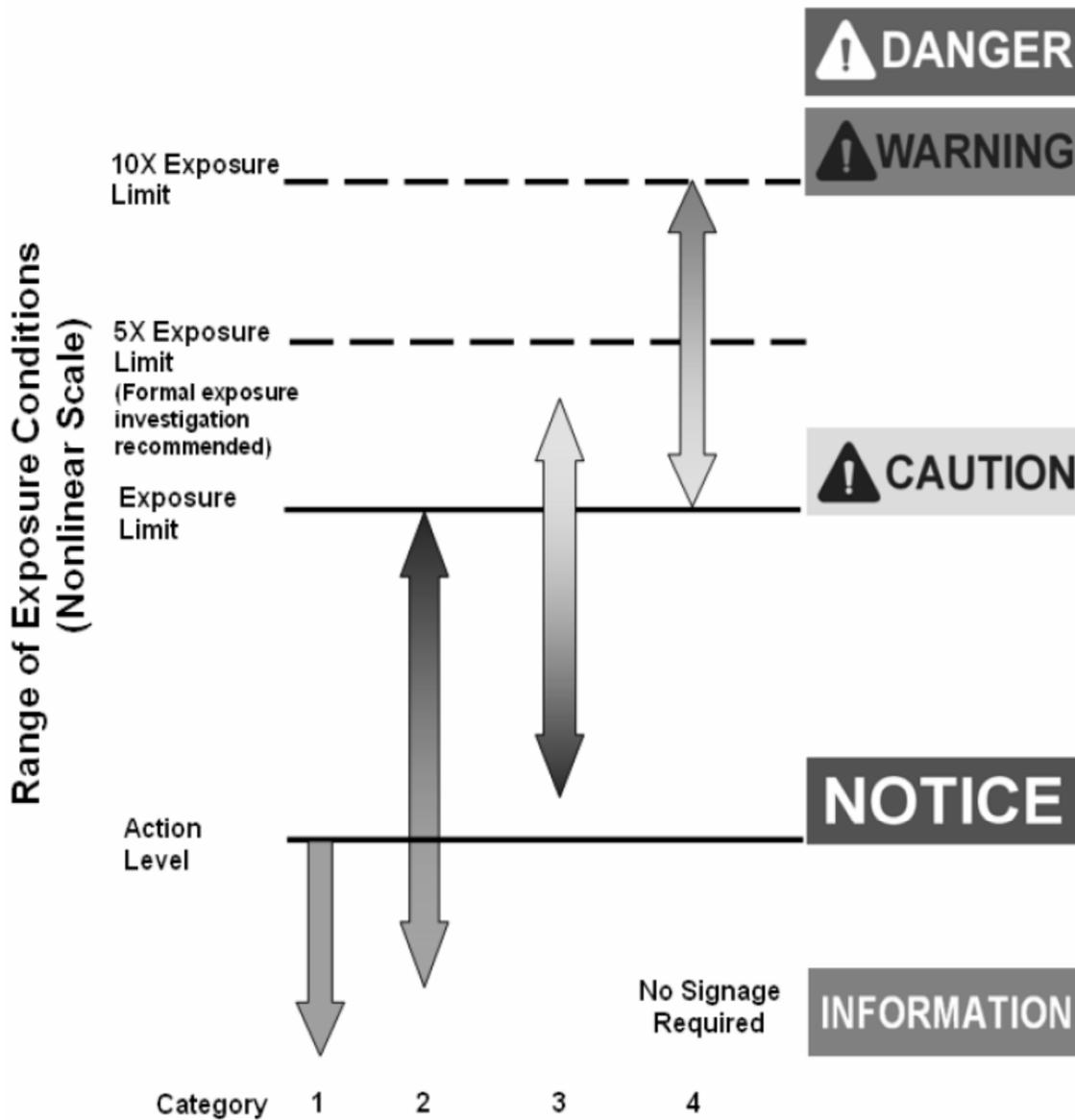
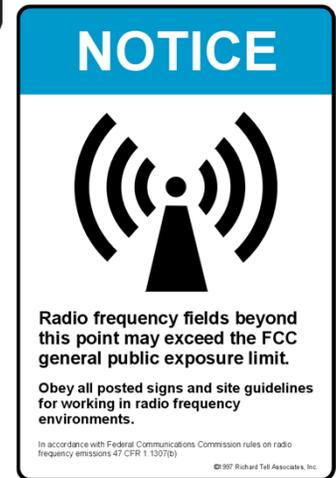


Figure 1—Graphical representation of the RF safety program categorization process corresponding to Table 1 Categories 1-4.



NOTE: At WFF signs will reference IEEE standard not FCC rules





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GSFC WFF Safety Program

RF Protection Program

- ***Radio Frequency Radiation Safety is addressed in GSFC 1860.3***
 - ***RF source equipment are required to meet applicable RF standards when new and during its lifetime.***
 - ***RF hazard identification and periodic surveillance is performed by a competent person.***
 - ***RF Hazard Areas are Identified and Controlled.***
 - ***Controls and SOPs to reduce RF exposures to levels in compliance with applicable guidelines are mandatory.***



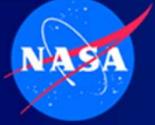
RF Protection Program

- RF safety and health training is conducted to ensure employees understand the hazards and control methods used.*
- Periodic reviews of the program are conducted to identify and resolve deficiencies.*
- Workers are encouraged to notify the Safety Office or their local representative whenever potential hazards or concerns are identified.*



RF Protection Program

- New RF sources are evaluated by the Wallops Frequency Utilization Management Working Group (WFUMWG)*
- WFUMWG consists of the Spectrum Manager, WFF Test Director (TD), NOAA Frequency Manager, NAVY SCSC Frequency Manager, and the Wallops RF Safety Officer*
- WFF employees (RF users and system custodians) are required to be trained in RF Safety and document training using the GSFC form 23-35RF*



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Emergency

- *In the event of an emergency contact 911 from a base phone or 824-1333 from a cell phone.*
- *For Close Calls or Hazard Reporting contact the Safety Office @ 2559 or 2518.*



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WFF Sources

AREA <i>(Main Base)</i>	BLDG	RF SOURCE
• Radar 18	A-41	1 Mw
• 11 Meter	SE of N-162	200w
• LEO-T	SE of N-162	200w
• EMI Chamber	F-7 Test chamber	200–450w

w- watts

Kw – Kilowatts

Mw - Megawatts

Information courtesy of NENS



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WFF Sources

Area (Island)	BLDG	RF Source
• Radar 3	Y-55	1 Mw
• Radar 4 (Spandar)	U-30	5 Mw
• Radar 5	U-70	3 Mw
• UHF	U-25	8 Mw
• Command Transmitter	U-55	
– OPHIR (2)		1 Kw

Information courtesy of NENS



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WFF Sources

Mobile Radars

- *Radar 2*
- *Radar 8*
- *Radar 11*
- *NPOLE*
- *TOGA*

Local Staging Area

Y-60- Mobile
V-100- Mobile
U-20- Mobile
Mobile (near N159)
Near U-30

RF Source

1 Mw
1 Mw
1 Mw
850 Kw
250 Kw

Information courtesy of NENS



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WFF Sources



NPOLE radar temporarily
located north of N159

LEO-T locate to left in ray
dome 11 meter antenna on the
right





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WFF Sources



Radar 18 at A-41 (foreground)

OPHIR (2) and RS4 (2) at U-55
Command Destruct





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WFF Sources



Radar 5 at U70

Radar 11 at U20





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WFF Sources



UHF antenna at U25

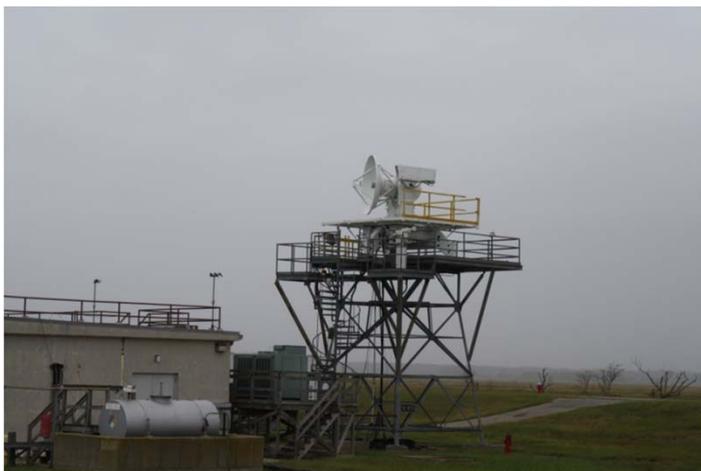
Radar 3 at Y55





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WFF Sources



Radar 2 near Y 60

Radar 8 near V100





What Next?

- ***After completing this awareness training the worker and supervisor need to complete GSFC form 23-35RF and forward it to the Safety Office – Bldg. E-107 room 109. The form can be found at:***

<https://gs279gdmsias.gsfc.nasa.gov/home.jsp>

Click on the libraries tab – then go to Forms Master List – and open Goddard Forms GSFC - next open and print form 23-35RF