



RADIOFREQUENCY/MICROWAVE ENERGY EXPOSURE CONTROL PROCEDURE

1. PURPOSE

The purpose of this program is to ensure the protection and control the exposure of all authorized University of Notre Dame employees and contractors from the hazards associated with exposure to radiofrequency (RF)/microwave energy. This document contains requirements for practices and procedures to protect employees and contractors from the hazards associated with exposure to radiofrequency and microwave energy above the limits established by the Federal Communications Commission (FCC), 47 CFR 1.

2. SCOPE

Radiofrequency and Microwave energy is non-ionizing radiation that is produced in frequencies from 3kHz- 300GHz. At the University of Notre Dame, RF and microwave energy is produced by specific devices in specific locations that serve the communications needs for the University and other associated groups or businesses that provide communication driven or related services. The primary function of these devices include emergency services communications, business related communications, broadcast uplink, and general wireless communication.

It is the responsibility of the University of Notre Dame to control the expansion and location of those areas containing antennas where RF and microwave energy is produced. It is also the responsibility of the University of Notre Dame to identify those areas containing antennas capable of producing RF or microwave energy in excess of established exposure limits to employees and contractors and require that appropriate steps be taken to reduce and limit exposures.

3. DEFINITIONS

1. **Electric field strength (E):** A field vector quantity that represents the force (F) on an infinitesimal unit positive test charge (q) at a point divided by that charge. Electric field strength is expressed in units of volts per meter (V/m).
2. **Energy density (electromagnetic field):** The electromagnetic energy contained in an infinitesimal volume divided by that volume.
3. **Exposure:** Exposure occurs whenever and wherever a person is subjected to electric, magnetic or electromagnetic fields other than those originating from physiological processes in the body and other natural phenomena.
4. **Exposure, partial-body:** Partial-body exposure results when RF fields are substantially non-uniform over the body. Fields that are non-uniform over volumes comparable to the human body may occur due to highly directional sources, standing-waves, re-radiation sources or in the near field. See "RF spot".
5. **Gain (of an antenna):** The ratio, usually expressed in decibels, of the power required at the input of a loss-free reference antenna to the power supplied to the input of the given antenna to produce, in a given direction, the same field

strength of the same power density at the same distance. When not specified otherwise, the gain refers to the direction of maximum radiation. Gain may be considered for a specified polarization. Gain may be referenced to an isotropic antenna (dBi) or a half-wave dipole (dBd).

6. **Hertz (Hz):** The unit for expressing frequency, (f). One hertz equals one cycle per second.
7. **Magnetic field strength (H):** A field vector that is equal to the magnetic flux density divided by the permeability of the medium. Magnetic field strength is expressed in units of amperes per meter (A/m).
8. **Maximum permissible exposure (MPE):** The rms and peak electric and magnetic field strength, their squares, or the plane-wave equivalent power densities associated with these fields to which a person may be exposed without harmful effect and with an acceptable safety factor.
9. **Occupational/controlled exposure:** For FCC purpose, applies to human exposure to RF fields when persons are exposed as a consequence of their employment and in which those persons who are exposed have been made fully aware of the potential for exposure and can exercise control over their exposure. Occupational/controlled exposure limits also apply where exposure is of a transient nature as a result of incidental passage through a location where exposure levels may be above general population/uncontrolled limits (see definition above), as long as the exposed person has been made fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.
10. **Peak Envelope Power (PEP):** The average power supplied to the antenna transmission line by a radio transmitter during one radiofrequency cycle at the crest of the modulation envelope taken under normal operating conditions.
11. **Power density, peak:** The maximum instantaneous power density occurring when power is transmitted.
12. **Radiofrequency (RF) spectrum:** Although the RF spectrum is formally defined in terms of frequency as extending from 0 to 3000 GHz, for purpose of the FCC's exposure guidelines, the frequency range of interest is 300 kHz to 100 GHz.
13. **RF "hot spots":** A highly localized area of relatively more intense radio-frequency radiation that manifests itself in two principal ways:
 - The presence of intense electric or magnetic fields immediately adjacent to conductive objects that are immersed in lower intensity ambient fields (often referred to as re-radiation), and
 - Localized areas, not necessarily immediately close to conductive objects, in which there exists a concentration of RF fields caused by reflections and/or narrow beams produced by high-gain radiating antennas or other highly directional sources. In both cases, the fields are characterized by very rapid changes in field strength with distance. RF hot spots are normally associated with very non-uniform exposure of the body (partial body exposure). This is not to be confused with an actual thermal hot spot within the absorbing body.
14. **Short-term exposure:** Exposure for durations less than the corresponding

averaging time.

15. **Specific absorption rate (SAR):** A measure of the rate of energy absorbed by (dissipated in) an incremental mass contained in a volume element of dielectric materials such as biological tissues. SAR is usually expressed in terms of watts per kilogram (W/kg) or milliwatts per gram (mW/g). Guidelines for human exposure to RF fields are based on SAR thresholds where adverse biological effects may occur. When the human body is exposed to an RF field, the SAR experienced is in proportion to the squared value of the electric field strength induced in the body.

16. **Wavelength (λ):** The wavelength (λ) of an electromagnetic wave is related to the frequency (f) and velocity (v) by the expression $v = f\lambda$. In free space the velocity of an electromagnetic wave is equal to the speed of light, i.e., approximately 3×10^8 m/s.

4. RESPONSIBILITIES

4.1 University of Notre Dame:

4.1.1 It is the responsibility of any University department having or obtaining access to areas where antennas are present to notify their respective employees of the potential for exposure to RF and microwave energy and to require familiarization of the antenna locations and exposure distances.

4.2 Risk Management and Safety:

4.2.1 Develop the Radiofrequency/Microwave Energy Exposure procedure and revise as necessary.

4.2.2 Develop Radiofrequency/Microwave Energy Exposure training and provide to affected staff.

4.2.3 Provide technical support for employees and contractors when questions arise with regard to Radiofrequency/Microwave Energy Exposure.

4.2.4 Periodically audit work operations and documentation to evaluate the overall effectiveness of this program and ensure that employees participating are protected from non-permissible exposures.

4.3 Departments/ Supervisors:

4.3.1 Identify and report all work, inspections, and evaluations that will occur at or in close proximity to the areas listed in Section 6.

4.3.2 Identify personnel who may enter these areas and ensure they are familiar with and understand the procedure.

4.3.3 Ensure that any contractor performing work in the areas identified in Section 6 are familiar with this procedure.

4.3.4 Provide detailed instruction on the effects of exposure to radiofrequency/microwave energy exceeding the occupational exposure limits.

4.3.5 Periodically audit contractor performance in adherence to this policy.

4.4 Employees who may enter the radiofrequency / microwave energy areas identified in Section 6 shall:

4.4.1 Comply with this policy and the established exposure limits.

5. MAXIMUM EXPOSURE LIMITS
Occupational Exposure Limits for RF and Microwave Exposed

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m ²)	5 Averaging Time (min)
0.003 - 1	600	4.9		6
1 - 10	600/ <i>f</i>	4.9/ <i>f</i>		6
10 - 30	60	4.9/ <i>f</i>		6
30 - 300	60	0.163	10*	6
300 - 1500	3.54 ^{<i>f</i>0.5}	0.0094 ^{<i>f</i>0.5}	<i>f</i> /30	6
1500 - 15000	137	0.364	50	616000/ <i>f</i> ^{1.2}
15000 - 150000	137	0.364	50	616000/ <i>f</i> ^{1.2}
150000 - 300000	0.354 ^{<i>f</i>0.5}	9.4x10 ^{-4<i>f</i>0.5}	3.33x10 ^{-4<i>f</i>}	616000/ <i>f</i> ^{1.2}

*Power density limit is applicable at frequencies greater than 100 MHz.

Notes: 1. Frequency, *f*, is in MHz.

2. A power density of 10W/m² is equivalent to 1 mW/cm².

3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).



6. ANTENNA LOCATIONS

UNIVERSITY OF NOTRE DAME RF FIXED
TRANSMITTER INFORMATION

LOCATION	FREQUENCY (Megahertz)	EFFECTIVE Radiated Power (Watts)	USE
Galvin Life Science – Roof	461.9625	85	ND Trunk System
	462.0375	85	ND Trunk System
	464.7625	85	ND Trunk System
Grace Hall - Roof	461.2750	164	NDPD
	463.5500	175	ND Maintenance
		175	ND Maintenance
Hammes Mowbray Hall – Roof Peak	154.2500	30	NDPD
	154.4000	30	NDPD
	154.7100	30	NDPD
	155.2800	30	NDPD
	155.3700	30	NDPD
	155.4750	30	NDPD
	155.9850	30	NDPD
	156.0150	30	NDPD
	156.7300	30	NDPD



	158.9550	30	NDPD
	159.4500	30	NDPD
	458.5250	30	NDPD
	458.5720	28	NDPD
	458.6250	28	NDPD
	465.6500	28	NDPD
	466.2000	28	NDPD
	466.2750	28	NDPD
	468.5500	28	NDPD
	469.9250	28	NDPD
Hammes Mowbray – Sally Port Roof	154.2500	23	NDPD
	154.000	23	NDPD
	154.7100	23	NDPD
	154.2800	23	NDPD
	155.3700	23	NDPD
	155.4750	23	NDPD
	155.9850	23	NDPD
	156.0150	23	NDPD
	158.7300	23	NDPD
	159.4500	23	NDPD
	458.5250	23	NDPD
	458.5750	20	NDPD
	458.6250	20	NDPD



	466.2000	20	NDPD
	466.2756	20	NDPD
	469.4750	20	NDPD
	469.7750	20	NDPD
	469.9250	20	NDPD
Hesburgh Library - Roof	154.3700	172	NDPD
	161.7600	290	WNDU
	460.6250	198	NDPD
	453.6000	195	NDFD
Joyce Center	461.2000	16	NDPD
Stepan Chemistry Hall - Roof	452.0125	48	OIT
Football Stadium	153.950	110	Red Cross
	154.070	110	Red Cross
	453.600	45	Red Cross
Cellular Telephone Antennas			
DeBartolo Hall – Roof			Telecom
Lewis Hall – Roof			Telecom
Haggar Hall – Roof			Telecom
Hesburgh Library – Roof			Telecom
South Dining Hall – Roof			Telecom
Administration Building – Roof			Telecom
Eck Baseball – Roof			Telecom
Joyce Center – Arena			Telecom
Football Stadium – VIP Box			Telecom
Fisher O’Hara Grace			Telecom
Administrative Building - Dome			Telecom



Carroll Hall			Telecom
Fatima Center			Telecom
Legends			Telecom
Joyce Center Fieldhouse			Telecom
Bookstore			Telecom

7. EXPOSURE CONTROL

7.1 Current methods of exposure control include:

- 7.1.1 Continuous monitoring during potential exposures.
- 7.1.2 Measuring the output of all radiofrequency microwave antenna's and calculating safe working distances based on antenna output and maximum exposure limits.
- 7.1.3 For operational, maintenance and contractor safety, consistency and efficiency, the University has elected to measure the field strengths of all campus antennas including cellular telephone antennas and radio communication antennas. Specific results for cellular telephone antennas and results for radio antennas are included in the [Crown Castle Site and RF Information](#) drive.

8. MAINTENANCE/OIT/CONTRACTOR ANTENNA PROXIMITY

8.1 Cellular Telephone Antennas:

- 8.1.1 As indicated in [Crown Castle Site and RF Information](#) drive, the University has four (4) cellular antennas that, due to radiofrequency output, any exposure to the antenna at a distance of six (6) feet or less must be limited to 30 minutes. At six (6) feet or more, the radiofrequency exposure falls below the occupational exposure limit.
- 8.1.2 The cellular antenna locations include the Fatima Center, Lewis Hall, Haggar Hall and Legends.
- 8.1.3 Due to the density and locations of antennas, any time work is conducted on the roof of Legends contact must be made at least 48 hours in advance to the University's Office of Information Technology who will contact Crown Castle to have the Carrier service disconnected for the antennas.
- 8.1.4 Should it be necessary for Maintenance/OIT to perform any work closer than six (6) feet to the antenna for any time exceeding the 30 minutes on the roof of Fatima Center, Lewis Hall, or Haggar Hall; contact must be made at least 48 hours in advance to the University's Office of Information Technology who will contact Crown Castle to have the Carrier service disconnected for the antennas.
- 8.1.5 Should it be necessary for Contractors to perform any work closer than six (6) feet to the antennas for any time exceeding 30 minutes they must be trained in RF safety and equipped with RF monitors.



8.2 Radio Communication Antennas:

- 8.2.1 As indicated in [Crown Castle Site and RF Information](#) drive, maintenance/OIT/contractor exposure to radiofrequency output of these antennas should be limited to no closer than three (3) feet. At three (3) feet or more, the radiofrequency exposure falls below the occupational exposure limit.
- 8.2.2 Should it be necessary for Maintenance/OIT to perform any work closer than three (3) feet to any radio antenna, contact must be made at least 48 hours in advance to the University's Office of Information Technology who will contact Crown Castle to have the Carrier service disconnected for the antennas.
- 8.2.3 Should it be necessary for Contractors to perform any work closer than three (3) feet they must be trained in RF safety and equipped with RF monitors.

9. TRAINING

- 9.1 All University of Notre Dame personnel accessing roof tops mentioned in this procedure should be trained on the Radiofrequency Microwave Energy Procedure prior to accessing roof tops.
- 9.2 Training on the Radiofrequency Microwave Energy Procedure is located in the University's Learning Management System.

10. FREQUENCY OF REVIEW

- 10.1. This procedure shall be reviewed triennially and updated as needed to meet applicable regulatory changes.

11. REFERENCES

- 11.1. FCC, [47 CFR Part 1](#)
- 11.2. OSHA, [Radiofrequency and Microwave Radiation](#)
- 11.3. Occupational Health and Environmental Control, [29 CFR 1910, Subpart G](#)
- 11.4. Occupational Health and Environmental Control, [29 CFR 1910, Subpart J](#)
- 11.5. Occupational Health and Environmental Control, [29 CFR 1910, Subpart R](#)
- 11.6. Occupational Health and Environmental Control, [29 CFR 1926, Subpart D](#)

Revision History Table

History	Effective Date