

A Guide to Radio Frequency Hazards with Electric Detonators

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To obtain additional copies of this book, or if you have questions about N.C. occupational safety and health standards or rules, please contact:

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Additional sources of information are listed on the inside back cover of this book.

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Foreword

The Mine and Quarry Bureau of the North Carolina Department of Labor prevents work-related injuries and illnesses by offering training in the safe use of explosives and blasting devices. *A Guide to Radio Frequency Hazards with Electric Detonators* contributes to that objective. It describes hazards of radio frequency energy to the loading and firing of electrically initiated blasting operations and sets forth precautions that should be taken during such operations. Many of these hazards are covered by the state's Occupational Safety and Health Division's (OSHNC) standards.

In this state, the North Carolina Department of Labor consultants and inspectors administer the federal OSHA laws through a plan approved by the U.S. Department of Labor. All current OSHA standards are enforced. Many educational programs, publications (including this guide), and other services are also offered to help inform people about their rights and responsibilities regarding OSHA.

As you look through this guide, please remember that OSHA's mission is greater than just enforcement. An equally important goal is to help citizens find ways to create safe and healthy workplaces. Reading and using the information in this booklet, like other educational materials produced by the North Carolina Department of Labor, can help.

Cherie K. Berry
Commissioner of Labor

Introduction

The purpose of this guide is to promote safe work practices by assisting persons who use electric detonators in assessing hazards of the initiation of commercial electric detonators by radio frequency (RF) energy. This guide also provides tables of safe distances from RF sources for the use of electric detonators.

Part 1 identifies major RF sources. Part 2 offers tables for safe distances between particular RF sources and the use of electric detonators. Adherence to the tables in part 2 provides the user of electric detonators a high degree of assurance that the blasting layout should be safe from RF initiation.

This guide applies to commercial electric detonators. It does not apply to military electric firing devices. It is recommended that, prior to market introduction, any imported electric detonators be tested for safety properties by an authorized United States laboratory, such as the U.S. Bureau of Mines or Bureau of Explosives.

Information in this guide derives from sources reflecting competent analysis and research and is believed to be accurate. Nevertheless, the reader cannot be guaranteed that the guide will apply to every application or variation in the use of electric detonators. The references section of this guide includes additional sources of information for unusual situations in which electric detonators are used.

The information contained in this guide is based upon many years of practical experience and the latest and most widely accepted publications available in the field. As such, it is believed that all data presented are both accurate and reliable. However, the North Carolina Department of Labor makes no warranties, expressed or implied, to the user of this publication. All risks associated with the use of the information are assumed by the user, and the North Carolina

Department of Labor hereby expressly denies any and all liability for use of this information. This publication is not to be taken as a license to operate or recommendation to infringe any patent.

Though this guide is not intended to be inconsistent with OSH or MSHA standards, if an area is considered by the reader to be inconsistent, the standard should be followed.

1

Electric Detonators and Hazards Posed by Radio Frequency Energy

The normal method of firing an electric detonator is to apply electric energy from a power source such as a blasting machine or power line to the blasting circuit or to the open ends of the detonator wires. This electrical energy flows through the wires to the detonator and causes the resistance wire inside the detonator to heat the primary explosives to the burning (explosion) temperature.

Initiation of Electric Detonators by Radio Frequency Energy

The possibility of premature explosions of electric detonators due to RF energy is remote. Each year throughout the continental United States approximately 100 million such detonators are used with few mishaps. However, there have been authenticated cases in which detonators were prematurely initiated by RF transmission to the detonator wires. Subsequent investigations revealed that the instances would not have occurred if proper safe distances from the RF sources had been maintained.

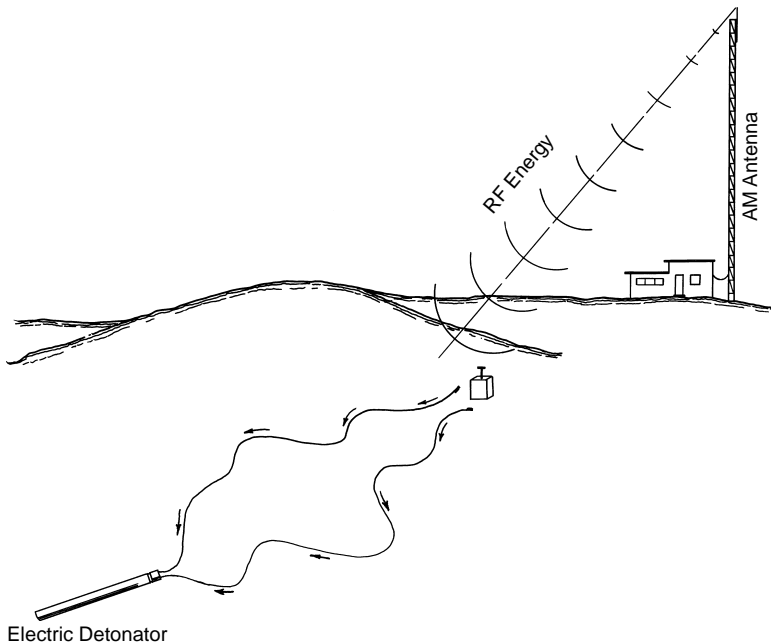
How RF Energy Initiates Electric Detonators

If the electric detonator wires are located in a strong RF field (near a transmitter that is radiating RF power), the usually insulated but unshielded leg wires or circuit wires will act as an antenna similar to that on a radio or TV set. That is true whether the circuit wires are connected to a blasting machine or not, or whether they are shunted (short circuited ends) or not shunted (open

ends). This antenna will absorb RF energy from the transmitter RF field and the electric current transmitted to the detonator wires will flow into the detonator. (See figure 1.) Depending on the strength of the RF field and the antenna configuration formed by the detonator wires and its orientation, sufficient RF energy may be induced in the wires to fire the electric detonator.

Figure 1

RF Energy Absorbed by Detonator Leg Wires



Radio Frequency Energy Sources

Radio frequency transmitters include citizens band (CB) radios, cellular telephones, AM and FM radios, radar, and television. These transmitters create powerful electromagnetic fields, which decrease in intensity with distance from the transmitter antenna. Tests have demonstrated that electric detonator wires, under particular conditions and

circumstances, may absorb enough electrical energy from such fields to cause their explosion.

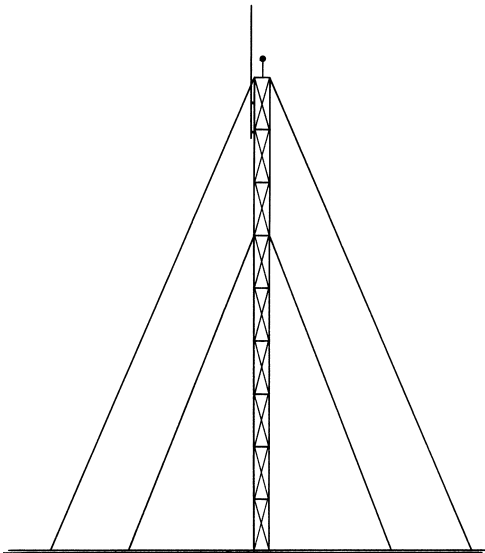
Mobile cellular telephones and CB radios pose unusual problems. In recent years their use has greatly expanded. Mobile cellular telephones transmit RF energy during sending and receiving. Additionally, modern technology has provided pagers that transmit and receive RF energy. Safe distances are recommended for the Federal Communications Commission-approved, double sideband (4 watts maximum output power) and single sideband (12 watts peak envelope power) units in table VI.

Commercial AM Broadcast Transmitters

Commercial AM broadcast transmitters [0.535 to 1.605 MHz (Megahertz)] are potentially the most hazardous RF energy source. They combine high power and low frequency so that there is little loss of induced RF energy in the detonator lead wires. (See figure 2.)

Figure 2

Commercial AM Broadcast Transmitter (Vertically Polarized)



Frequency-modulated FM and TV Transmitters

Frequency-modulated FM and TV transmitters are not likely to create hazardous situations. Although their power is extremely high and the antennas are horizontally polarized, their high frequency currents are rapidly attenuated in the detonator or leg wires. This RF source employs antennas on very high towers, which have the additional effect of reducing the electromagnetic field at ground level. (See figure 3.)

Figure 3

*Frequency-modulated FM and TV Transmitters
(Horizontally Polarized)*

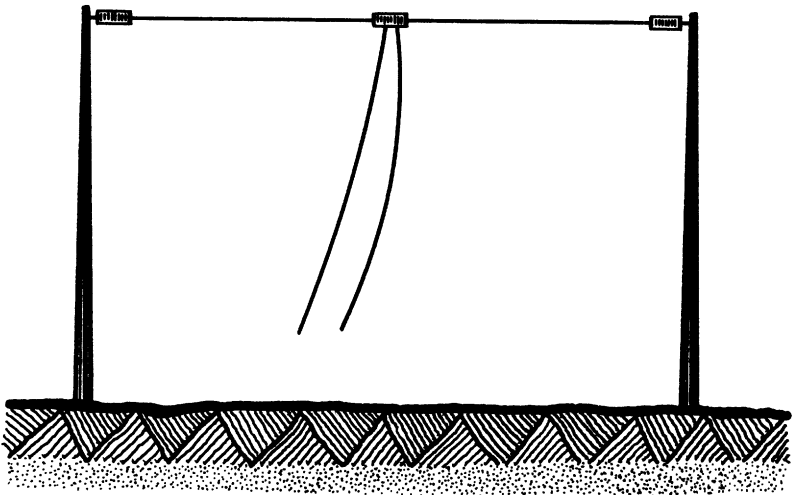
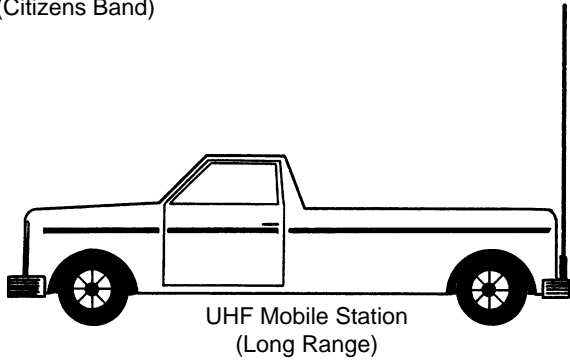
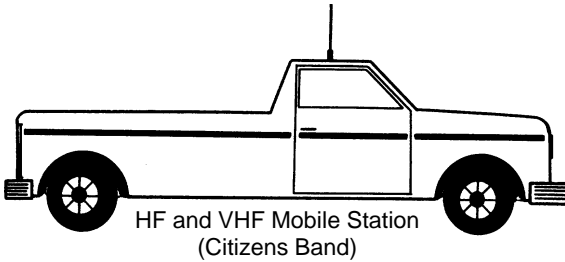


Figure 4
Mobile Radios



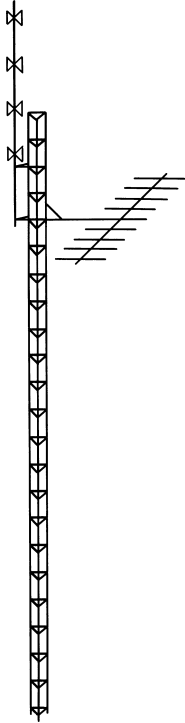
Mobile Sources of RF Energy

Mobile radios and cellular telephones that transmit RF energy must be rated as a high potential hazard because, although their power is low, they can be brought directly into a blasting area. (See figure 4.) Transmitting pagers also need to be considered.

Figure 5 depicts other types of antennas associated with radio services.

Figure 5

Antennas Associated with Radio Services



Mobile Service Base Station



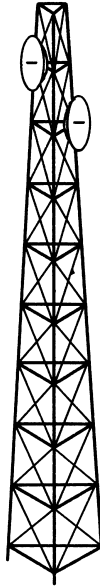
Mobile Service Base Station

Microwave Relays

The hazards of RF energy from microwave relays are small because they operate at a very high frequency, have a restricted radiation pattern, and are not normally located within a blasting area. (See figure 6.)

Figure 6

A Microwave Relay

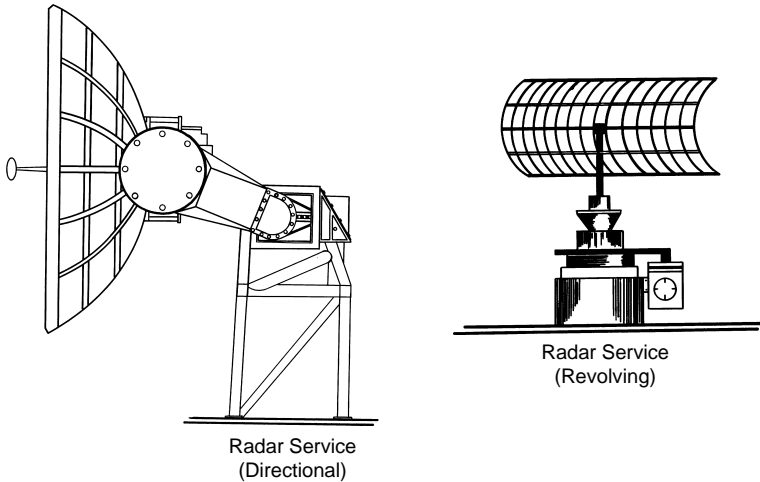


Radar Installations

Radar installations pose a hazard if blasting is done within the radar beam range. Radar installations radiate high power levels through the use of high gain antennas. (See figure 7.)

Figure 7

Radar Installations



Radio Frequency Pickup Circuits

Electric detonator wire layout can act as RF pickup circuits for the radio frequencies used in AM radio broadcasting and mobile operations. Two sensitive RF pickup circuits that might be created by lead wire configuration at electric blasting operations are known as the dipole circuit and the long wire circuit.

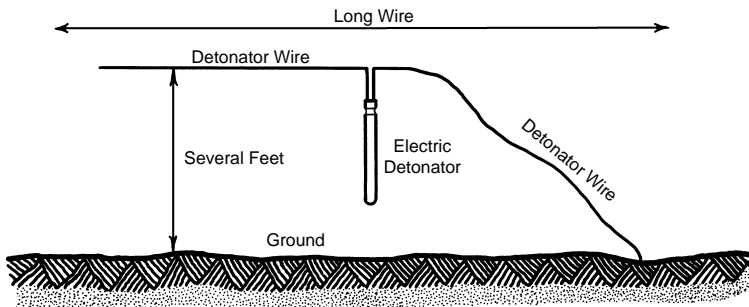
Dipole Pickup Circuit

The dipole circuit is depicted in figure 8. The dipole circuit presents the most hazardous conditions when:

- The circuit wiring and/or electric detonator leg wires are elevated several feet off the ground
- The length of this wiring is equal to one-half the wave length of the radio wave
- The electric detonator is located at a point where the RF current in the circuit wiring is at a maximum

Figure 8

Dipole Pickup Circuit



Long Wire Pickup Circuit

The long wire circuit is shown in figure 9. The long wire circuit condition occurs when the electric detonator is at one end of the wiring that:

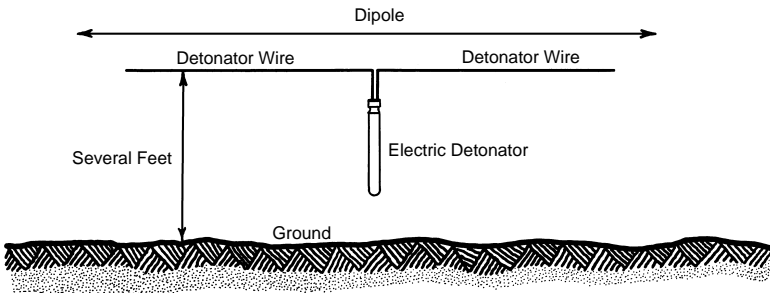
- Is elevated in the air
- Has a length equivalent to one-quarter of the wavelength of the radio wave
- Is grounded to the earth through the electric detonator

To determine the approximate radio wavelength, the transmitter frequency in megahertz (MHz) is divided into 1,000. For example, a CB transmitter operates on a frequency of 26.96 to 27.33 MHz. This, divided into 1,000, yields a wavelength of 36.6 to 37.1 feet.

Both of the previous circuits require that the lead line or detonator wires be suspended above the ground. Both of the circuits (antennas) achieve their maximum current pickup when they are (1) parallel to a horizontal transmitting antenna (FM, TV, or amateur radio) or (2) pointed toward a vertical antenna (AM, mobile, etc.).

Figure 9

Long Wire Pickup Circuit



Loop Pickup Circuit

Another sensitive RF pickup circuit, and one commonly encountered in blasting operations, is the loop circuit. This circuit is sensitive to the magnetic portion of the electromagnetic wave. The loop circuit receives the maximum pickup when its long axis is placed in the direction of the transmitting antenna. Safe distance tables for AM broadcast transmitters and mobile transmitters (both using vertical antennas) were derived from the loop configuration. Figure 10 shows a preferred case loop pickup circuit.

Figure 10

Loop Pickup Circuit—Preferred Case

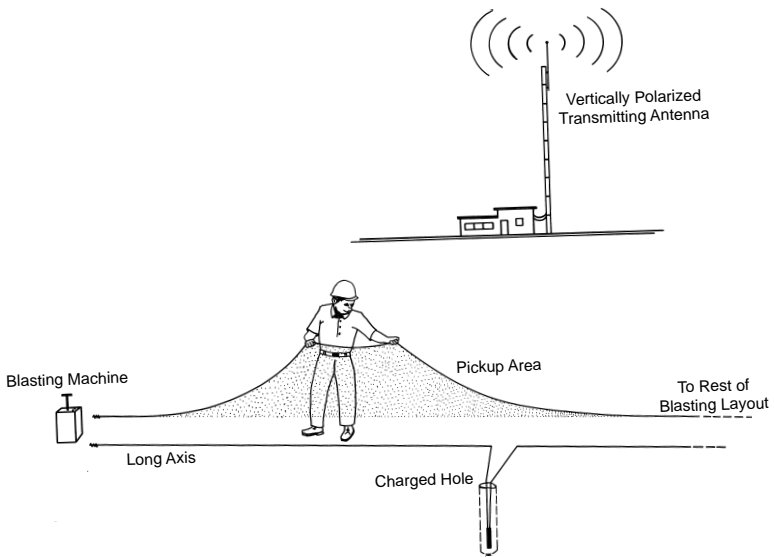
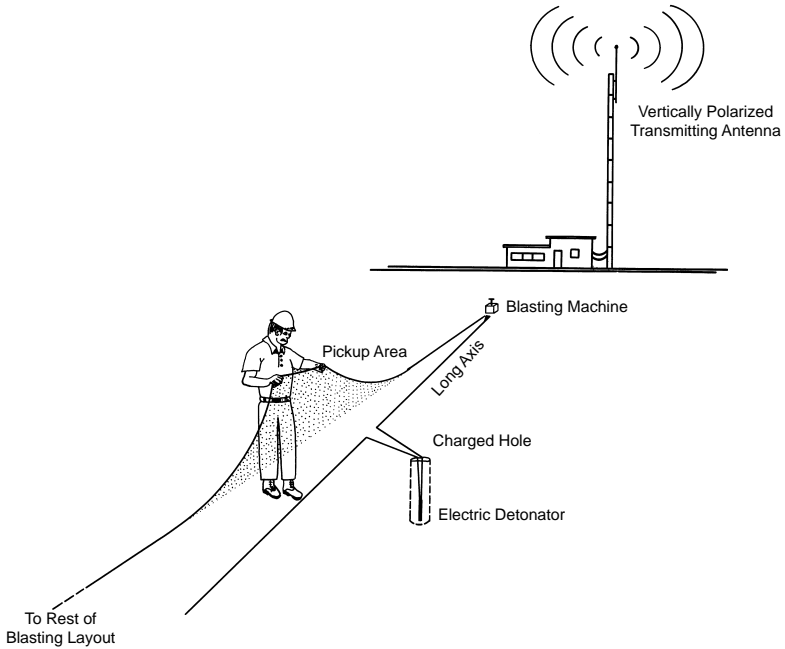


Figure 11 shows an acceptable but less desirable configuration of loop and transmitting antenna. In general, the loop areas can be reduced by picking up both lead wires as in a duplex wire circuit and making all wire splices as close to the ground as possible.

Figure 11

Loop Pickup Circuit—Acceptable but Less Desirable



General Precautions against RF Energy Sources

The following list of precautions will reduce hazards and increase safety for employees associated with blasting operations near RF energy sources.

1. When blasting electrically at a fixed location such as a mine, quarry, or construction site, check to see whether any radio transmitters are located closer to your blasting site than the applicable separation recommended in part 2 of this guide. Always be on the alert for new transmitters. If possible, check each transmitter before it goes into service, to ensure it will not pose a hazard to your blasting operation.
2. Keep mobile transmitters away from blasting areas. If transmitters are allowed on or near the blasting area, a strict policy must be set to ensure that the transmitters are always turned off. This precaution should be followed no matter what frequency or energy (watts) the transmitter employs.
3. If there is a choice, use the higher frequency bands (450-470 MHz) for mobile transmitters. RF pickup is less efficient at these frequencies than at the lower frequencies.
4. Avoid large loops in blasting wiring by running the lead wires parallel to each other and close together.
5. If loops are unavoidable, keep them small and orient them broadside towards the transmitting antenna.
6. Keep wires on the ground in blasting layouts. Bare connecting points should be elevated slightly to prevent current leakage.
7. Arrange all lead lines out of the beam of directional devices such as radar or microwave relay stations.
8. If there is any doubt as to the RF hazards in relation to your blasting operations, a non-electric blasting system should be used until you have consulted with a person qualified in RF energy as it relates to blasting operations.

Transportation of Electric Detonators

The transportation of electric detonators does not create a hazard from radio energy as long as the detonators are in their original containers. In their original containers, the leg wires of the detonators are folded or coiled so as to provide effective protection against current induction. Also, the metal body of a vehicle virtually eliminates the penetration of RF energy.

If vehicles equipped with radio transmitters are used to transport electric detonators to and from a job: (1) the caps should be carried in an enclosed metal box lined with a non-sparking material and (2) the transmitter should be turned off when the caps are removed from the box.

Citizens Band Transmitters and Cellular Telephones

CB radios are the most common radio communication in existence today, but cellular telephone use is rapidly increasing. These radios often are in operation in both mobile and base units within close proximity of blasting operations. The units are used constantly on the highways, which are at times close to blasting operations. CBs are used by haul truck drivers, employees, and company officials.

Although the power (maximum 5 watts) is low on CB radios and cellular telephones, precautions should be taken in their use around electric blasting operations. CB radios and cellular telephones should not be operated by anyone on the property during blast hole loading operations. In areas close to public roads where it is impossible to control their usage, mine operators and construction crews should restrict the use of electric detonators and use a non-electric blasting system.

2

Tables of Distances—RF Sources and Electric Detonators

The tables in this part of the guide are offered to assist mine and quarry operators and commercial blasters. The tables include all of the obvious type of RF transmitters that would be encountered around mines, quarries, and other blasting operations.

The tables were derived from analytical “worst case” calculations. They are based on an assumed 40-milli-watt no-fire level of commercial detonators. Field tests have shown the tables to be conservative, as would be expected. There are numerous uncertainties involved in field tests respecting the efficiency of RF energy pickup and its delivery to the detonator. Thus, both the North Carolina Department of Labor and the Institute of Makers of Explosives strongly recommend that the tables in this guide be followed.

Table I

***Recommended Distances for Commercial
AM Broadcast Transmitters***

(0.535 to 1.605 MHz)

Transmitter Power^a	Minimum Distance
(watts)	(feet)
Up to 4,000	800
5,000	900
10,000	1,300
25,000	2,000
50,000 ^b	2,900
100,000	4,100
500,000	9,100

a. Power delivered to antenna

b. Maximum power of U.S. broadcast transmitters in this frequency range

Table II

Recommended Distances for Transmitters up to 50 MHz

(Excluding AM Broadcast—Calculated for a Specific Loop Pickup Configuration)^{a,b}

Transmitter Power^c	Minimum Distance
(watts)	(feet)
100	800
500	1,700
1,000	2,500
5,000	5,500
50,000	17,000
500,000 ^d	55,000

-
- a. Based on the configuration shown in figure 11 using 20.8 MHz, which is the most sensitive frequency
 - b. This table should be applied to international broadcast transmitters in the 10–25 MHz range
 - c. Power delivered to antenna
 - d. Present maximum for international broadcast

Table III

Recommended Distances for VHF TV and FM Broadcasting Transmitters

Effective Radiated Power (watts)	Minimum Distance (feet)		
	Channels 2 to 6	FM Radio	Channels 7 to 13
Up to 1,000	1,000	800	600
10,000	1,800	1,400	1,000
100,000 ^a	3,200	2,600	1,900
316,000 ^b	4,300	3,400	2,500
1,000,000	5,800	4,600	3,300
10,000,000	10,200	8,100	5,900

-
- a. Present maximum power channels 2 to 6 and FM
 - b. Present maximum power channels 7 to 13

Table IV

Recommended Distances for UHF TV Transmitters

Effective Radiated Power	Minimum Distance
(watts)	(feet)
Up to 10,000	600
1,000,000	2,000
5,000,000 ^a	3,000
100,000,000	6,000

a. Present maximum power channels 14 to 83

Table V
Radio Transmitting Stations^a

Type	Frequency (Megahertz)	Wavelength (feet)	Maximum Transmitter Power (watts)	Reference Table for Safe Distance
<i>Commercial</i>				
Standard Broadcast (AM)	0.535–1.605	1,820–615	50,000	I
Frequency Modulation (FM)	88–108	11.2–9.1	550,000 ^b	III
TV (Channels 2–6)	54–88	18.2–11.2	100,000 ^b	III
TV (Channels 7–13)	174–216	5.6–4.5	316,000 ^b	III
TV (Channels 14–83)	470–890	2.1–1.1	5,000,000 ^b	IV
<i>Amateur</i>				
160-Meter Band	1.8–2.0	545–490	1,000	II
80-Meter Band	3.5–4.0	280–246	1,000	II
40-Meter Band	7.0–7.3	140–135	1,000	II
20-Meter Band	14.0–14.4	70.0–68.2	1,000	II
15-Meter Band	21.10–21.25	46.3–46.0	1,000	II
Citizens Band	26.96–27.23	36.6–36.0	5	VI
10-Meter Band				
• Mobile	28.0–29.7	35.1–33.0	1,000	VI
• Fixed	28.0–29.7	35.1–33.0	1,000	II
6-Meter Band	50.0–54.0	19.7–18.2	1,000	VI
2-Meter Band	144–148	6.8–6.65	1,000	VI
1½-Meter Band	220–225	4.46–4.36	1,000	VI ^c

<i>Automobile Telephone</i>					
VHF Fixed Station	150-160	2.0-1.875	100	VI	
VHF Mobile Station	159	1.89	30	VI	
UHF Fixed Station	450-470	0.67-0.64	175	VI	
UHF Fixed Station	470-512	0.64-0.59	60	VI	
UHF Mobile Station	459	0.65	35	VI	
<i>Cellular (also others in 420-30,000 MHz range)</i>					
	825-890	0.36-0.33	3	VI	
<i>2-Way Communications</i>					
HF Range Central Station	25-50	39-20	500	II	
Mobile Unit	25-50	39-20	500	VI	
VHF Range Central Station	148-174	6.6-5.6	600	VI	
Mobile Unit	148-174	6.6-5.6	180	VI	
UHF Range Central Station	450-470	2.2-2.1	180	VI	
Mobile Unit	450-470	2.2-2.1	180	VI	
LF Range (Aviation)	0.2-0.4	5,000-2,500	2,000	I	
HF Range (Aviation)	4-23	250-44	50,000	II	
VHF Range (Aviation)	118.0-135.9	8.3-7.2	50	100 feet	
UHF Range (Aviation)	225-500	4.4-2.0	100	50 feet	
Radio Telegraph	6-23	164-43	50,000	II	

a. Partial list

b. Present maximum effective radiated power

c. Use 150.8-161.6 MHz column

Table VI
Recommended Distances of Mobile Transmitters Including Amateur and Citizens Band

Transmitter Power ^a (watts)	(Minimum Distance [feet])			
	MF 1.6–3.4 MHz Industrial	HF 28–29.7 MHz Amateur	VHF 35–36 MHz Public Use 42–44 MHz Public Use 50–54 MHz Amateur	UHF 450–470 MHz Public Use Cellular, Auto- mobile Tele- phones above 800 MHz
5	30	70	60	10
10	40	100	80	20
50	90	230	180	40
100	120	320	260	60
180 ^b	170	430	350	80
250	200	500	410	90
500 ^c	280	710	580	120
600 ^d	300	780	640	140
1,000 ^e	400	1,010	820	180
10,000 ^f	1,240	3,200	2,600	560
				990

Citizens Band, Class D Transmitters, 26.96-27.41 MHz

Type	Recommended Hand-Held	Minimum Distance Vehicle-Mounted
<ul style="list-style-type: none"> a. Power delivered to antenna b. Present maximum power for two-way mobile units in VHF (150.8–161.6 MHz range) and for two-way mobile and fixed station units in UHF (450–460 MHz range) c. Present maximum power for major VHF two-way mobile and fixed station units in 35–44 MHz range d. Present maximum power for two-way fixed station units in VHF (150.8–161.6 MHz range) e. Present maximum power for amateur radio mobile units f. Present maximum power for some base stations in 42–44 MHz band and 1.6–1.8 MHz band 	<ul style="list-style-type: none"> 5 ft. 20 ft. 	<ul style="list-style-type: none"> 65 ft. 110 ft.

Due to recent changes made in amateur radio, 1,500 watts of peak power output is now permissible on all radio frequencies assigned to the amateur radio service. Additional high frequency bands have also been assigned to the 30-meter band.

Appendix

Standards and Regulations for the Use of Electric Detonators around Radio Frequency Hazards

North Carolina Occupational Safety and Health Standards for the Construction Industry	North Carolina Occupational Safety and Health Standards for General Industry	Federal Occupational Safety and Health Standards	National Fire Code
Subpart U—Blasting and the Use of Explosives: 29 CFR 1926.900(k)—Due precautions shall be taken to prevent accidental discharge of electric blasting caps from current induced by radar, radio transmitters, lightning, adjacent powerlines, dust storms, or other sources of extraneous electricity. These precautions shall include: (1) Detonators shall be short-circuited in holes which have been primed and shunted until wired into the blasting circuit. (3)(i) The prominent display of adequate signs, warning against the use of mobile radio transmitters, on all roads within 1,000 feet	Subpart H—Hazardous Materials: 29 CFR 1910.109(e)(vii)—Due precautions shall be taken to prevent accidental discharge of electric blasting caps from current induced by radar, radio transmitters, lightning, adjacent powerlines, dust storms, or other sources of extraneous electricity. These precautions shall include: (b) The posting of signs warning against the use of mobile radio transmitters on all roads within 350 feet of the blasting operations.	Same as N.C. Occupational Safety and Health Standards for General Industry, 29 CFR 1910.109(e)(vii) and (e)(vii)(b) and the N.C. Occupational Safety and Health Standards for the Construction Industry, 29 CFR 1926.900(k).	Chapter 7—Use of Explosive Materials for Blasting: 7-1.15 Precautions shall be taken to prevent accidental discharge of electric detonators from current induced by radar and radio transmitters, lightning, adjacent powerlines, dust storms, or other sources of extraneous electricity. These precautions shall include: (a) The posting of signs warning against the use of mobile radio transmitters on all roads within 350 feet (107 m) of blasting operations. (b) Observance of the latest recommendations with regard to blasting in the vicinity of radio transmitters or powerlines, as

**North Carolina
Occupational Safety and
Health Standards for the
Construction Industry**

of blasting operations. Whenever adherence to the 1,000 foot distance would create an operational handicap, a competent person shall be consulted to evaluate the particular situation, and alternative provisions may be made which are adequately designed to prevent any premature firing of electric blasting caps. A description of any such alternatives shall be reduced to writing and shall be certified as meeting the purposes of this subdivision by the competent person consulted. The description shall be maintained at the construction site during the duration of the work, and shall be available

**North Carolina
Occupational Safety and
Health Standards for
General Industry**

**Federal Occupational
Safety and Health
Standards**

National Fire Code

set forth in IME Safety Library Publication No. 20, Safety Guide for the Prevention of Radio Frequency Hazards in the Use of Electric Blasting Caps.

**North Carolina
Occupational Safety and
Health Standards for the
Construction Industry**

**North Carolina
Occupational Safety and
Health Standards for
General Industry**

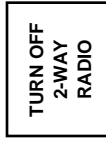
**Federal Occupational
Safety and Health
Standards**

National Fire Code

for inspection by representatives of the Commissioner of Labor. (3)(ii) Specimens of signs which would meet the requirements of subdivision (i) of this subparagraph (3) are the following:



About 48" X 48"



About 42" X 36"

- (4) Ensuring that mobile radio transmitters which are less than 100 feet away from electric blasting caps, in other than original container, shall be deenergized and effectively locked.

**North Carolina
Occupational Safety and
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(5) Compliance with the recommendations of the Institute of Makers of Explosives with regard to blasting in the vicinity of radio transmitters as stipulated in Radio Frequency Energy—A Potential Hazard in the Use of Electric Blasting Caps IME Publication No. 20.

**North Carolina
Occupational Safety and
Health Standards for
General Industry**

**Federal Occupational
Safety and Health
Standards**

National Fire Code

Glossary

Amateur Service. A service of intercommunications and technical investigations carried on by duly authorized persons interested in radio techniques.

Aviation Services. Services of fixed and land stations and mobile stations on land and on board aircraft primarily for the safe expedition and economical operation of aircraft.

Broadcasting Service. A radio communication service in which the transmissions are intended for direct reception by the general public.

Citizens Band Radio. A radio communication service of fixed, land, and mobile stations intended for personal or business radio communication, radio signaling, (and) control of remote objects or devices.

Fixed Service. A service of radio communication between specified fixed points.

Fixed Station. A station in the fixed service.

International Broadcast Service. A service whose transmissions are intended to be received directly by the general public in foreign countries.

Land Station. A station in the mobile service intended to be used while in motion or during halts at unspecified points.

Maritime Services. Services intended for maritime radio communication and including fixed stations, land stations, and mobile stations on land and on board ships.

Megahertz. 1,000,000 cycles per second.

Mobile Service. A service of radio communication between mobile and land stations, or between mobile stations.

Mobile Station. A station in the mobile service intended to be used while in motion or during halts at unspecified points.

Standard Frequency Terms and Bands.

High Frequency Band (HF): 3–30 MHz

Gigahertz (GHz): 1 GHz = 1,000,000,000 cycles per second

Medium Frequency Band (MF): 0.3–3 MHz

Megahertz (MHz): 1 MHz = 1,000,000 cycles per second

Ultra High Frequency Band (UHF): 300–3,000 MHz

Very High Frequency Band (VHF): 30–300 MHz

References

Atlas Powder Company. *Handbook of Electric Blasting*.
Dallas, Texas, 1985.

E.I. Dupont de Nemours. *Dupont's Blasters' Handbook*.
175th Anniversary Ed. Wilmington, Delaware, 1977.

Institute of Makers of Explosives. *Safety Library*
Publication No. 20. Washington, D.C., 1988.

National Fire Code. *Use of Explosive Material for*
Blasting. Chapter 7.

North Carolina OSHA Standards for General Industry.
29 CFR 1910.

North Carolina OSHA Standards for the Construction
Industry. 29 CFR 1926.

The following industry guides are available from the N.C. Department of Labor's Division of Occupational Safety and Health:

- #1. A Guide to Safety in Confined Spaces*
- #2. A Guide to Procedures of the Safety and Health Review Board of North Carolina*
- #3. A Guide to Machine Safeguarding*
- #4. A Guide to OSHA in North Carolina*
- #5. A Guide for Persons Employed in Cotton Dust Environments*
- #6. A Guide to Lead Exposure in the Construction Industry*
- #7. A Guide to Bloodborne Pathogens in the Workplace*
- #8. A Guide to Voluntary Training and Training Requirements in OSHA Standards*
- #9. A Guide to Ergonomics*
- #10. A Guide to Farm Safety and Health*
- #11. A Guide to Radio Frequency Hazards With Electric Detonators*
- #12. A Guide to Forklift Operator Training*
- #13. A Guide to the Safe Storage of Explosive Materials*
- #14. A Guide to the OSHA Excavations Standard*
- #15. A Guide to Developing and Maintaining an Effective Hearing Conservation Program*
- #17. A Guide to Asbestos for Industry*
- #18. A Guide to Electrical Safety*
- #19. A Guide to Occupational Exposure to Wood and Wood Dust*
- #20. A Guide to Crane Safety*
- #21. A Guide to School Safety and Health*
- #23. A Guide to Working With Electricity*
- #25. A Guide to Personal Protective Equipment*
- #26. A Guide to Manual Materials Handling and Back Safety*
- #27. A Guide to the Control of Hazardous Energy (Lockout/Tagout)*
- #28. A Guide to Eye Wash and Safety Shower Facilities*
- #29. A Guide to Safety and Health in Feed and Grain Mills*
- #30. A Guide to Working With Corrosive Substances*
- #31. A Guide to Formaldehyde*
- #32. A Guide to Fall Prevention in Industry*
- #33. A Guide to Office Safety and Health*
- #34. A Guide to Safety and Health in the Poultry Industry*
- #35. A Guide to Preventing Heat Stress*
- #36. A Guide to the Safe Use of Escalators and Elevators*
- #37. A Guide to Boilers and Pressure Vessels*
- #38. A Guide to Safe Scaffolding*
- #39. A Guide to Safety in the Textile Industry*
- #40. A Guide to Emergency Action Planning*
- #41. A Guide to OSHA for Small Businesses in North Carolina*

Occupational Safety and Health (OSH) Sources of Information

You may call 1-800-NC-LABOR to reach any division of the N.C. Department of Labor; or visit the NCDOL home page on the World Wide Web, Internet Web site address: <http://www.nclabor.com>.

N.C. Division of Occupational Safety and Health

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 3rd Floor)
Local Telephone: (919) 807-2900	Fax: (919) 807-2856

For information concerning education, training and interpretations of occupational safety and health standards contact:

Bureau of Education, Training and Technical Assistance

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 4th Floor)
Telephone: (919) 807-2875	Fax: (919) 807-2876

For information concerning occupational safety and health consultative services and safety awards programs contact:

Bureau of Consultative Services

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 3rd Floor)
Telephone: (919) 807-2899	Fax: (919) 807-2902

For information concerning migrant housing inspections and other related activities contact:

Agricultural Safety and Health Bureau

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 2nd Floor)
Telephone: (919) 807-2923	Fax: (919) 807-2924

For information concerning occupational safety and health compliance contact:

Safety and Health Compliance District Offices

Raleigh District Office

Telephone: Safety (919) 662-4597	Fax: (919) 662-4709
Health (919) 662-4711	

Charlotte District Office

(901 Blairhill Road, Suite 200, Charlotte, NC 28217-1578)
Telephone: Safety (704) 342-6163 Fax: (704) 342-5919

Winston-Salem District Office

(901 Peters Creek Parkway, Winston-Salem, NC 27103-4551)
Telephone: Safety (336) 761-2700 Fax: (336) 761-2326
Health (336) 761-2700 Fax: (336) 761-2130

Wilmington District Office

(1200 N. 23rd St., Suite 205, Wilmington, NC 28405-1824)
Telephone: (910) 251-2678 Fax: (910) 251-2654

Asheville District Office

(204 Charlotte Highway, Suite B, Asheville, NC 28803-8681)
Telephone: (828) 299-8232 Fax: (828) 299-8266

*****To make an OSHA Complaint, OSH Complaint Desk: (919) 807-2796*****

For statistical information concerning program activities contact:

Planning, Statistics and Information Management

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 2nd Floor)
Telephone: (919) 807-2950	Fax: (919) 807-2951

For information about books, periodicals, vertical files, videos, films, audio/slide sets and computer databases contact:

N.C. Department of Labor Library

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 5th Floor)
Telephone: (919) 807-2848	Fax: (919) 807-2849

N.C. Department of Labor (Other than OSH)

4 W. Edenton St.
Raleigh, NC 27601-1092
Telephone: (919) 733-7166 Fax: (919) 733-6197