OSHA Requirements for Tower Construction Related to RF Radiation

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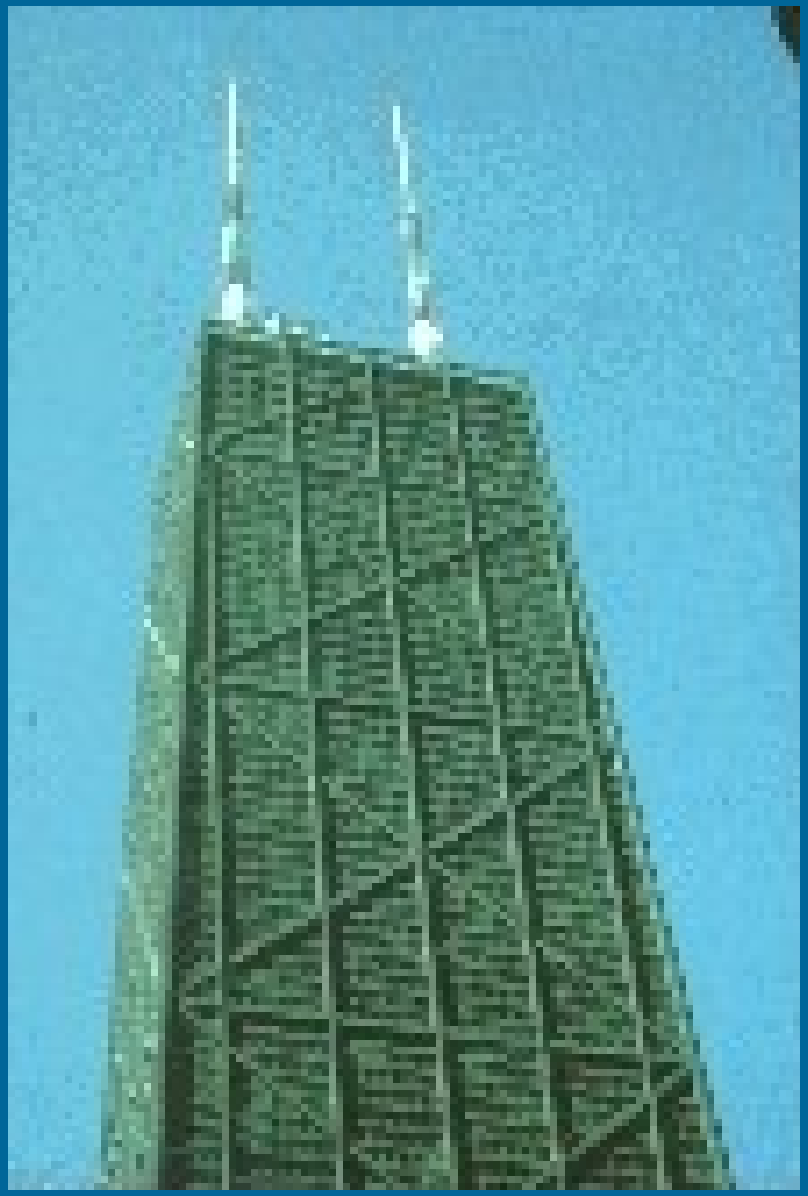


What Does OSHA Want? Site-Specific S&H Program

- Should include an RF Safety Program if potential exposures exceed limits for Uncontrolled Environments
- Draft standard requiring S&H Programs
  - OSHA's highest priority, because they work
- Using existing standards to encourage employers to adopt an RF S&H program

Safety and Health Program Core Elements

- Management leadership and employee participation
- Hazard identification and assessment
- Hazard prevention and control
- Information and training
- Evaluation of program effectiveness

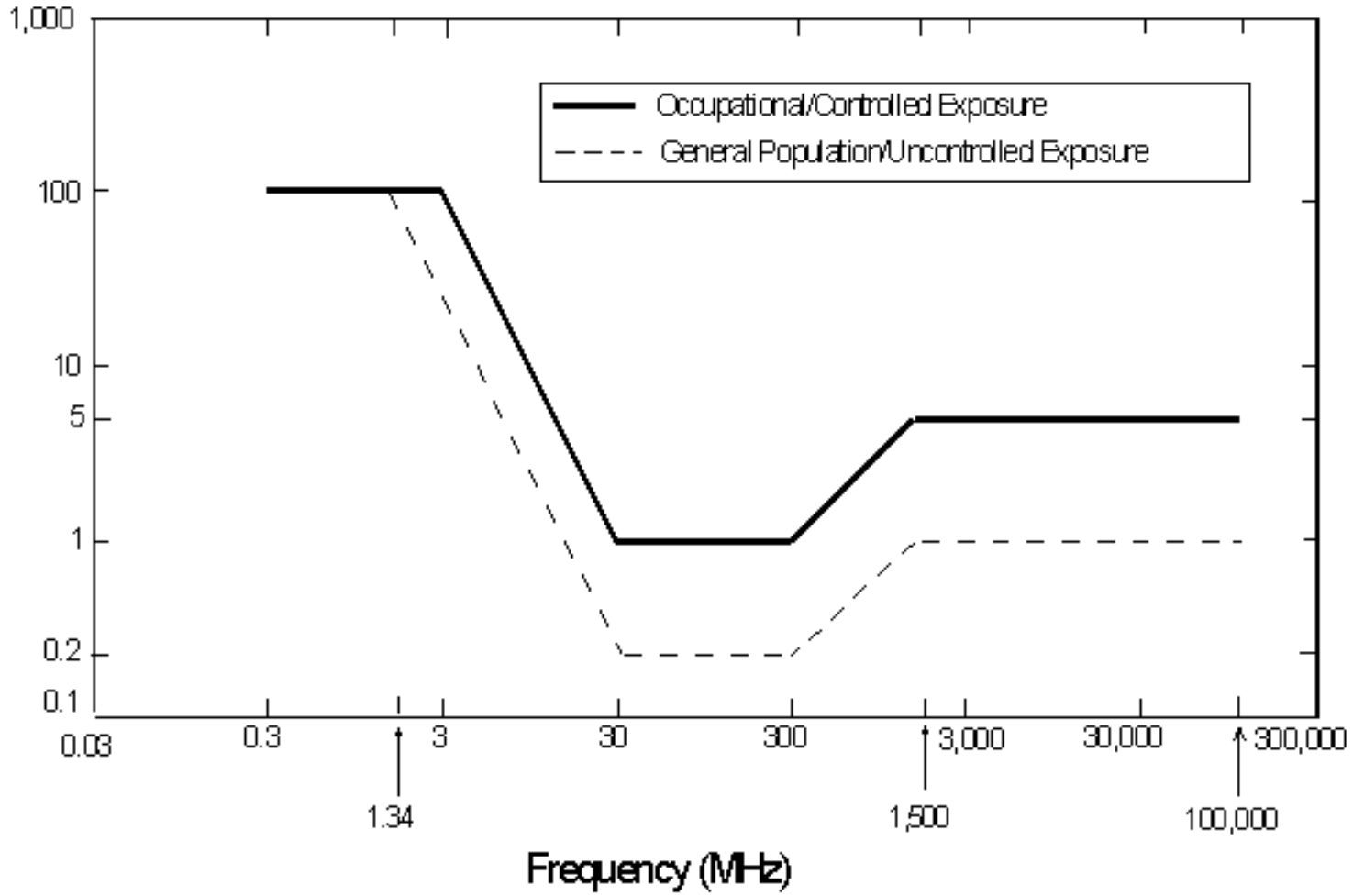
Management Leadership and Employee Participation

- Management commitment
- Assignment of duties
- Authority to enforce rules

Hazard Identification and Assessment

- Inventory of Sources
- Assessment of exposures to identify potential areas in excess of exposure limits.

Figure 1. FCC Limits for Maximum Permissible Exposure (MPE)



Use of ANSI vs. OSHA vs. FCC Standards

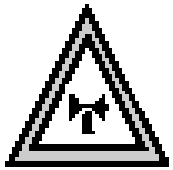
- Newer, more restrictive standards, are preferable
- Meeting SAR limits of new standards is often easier than meeting field limits
- New standards allow for spatial averaging, but include RF current limits
- Convenient to adopt FCC (with RF current limits)
- OSHA state programs may dictate, but usually defer to newer standards.

Hazard Assessment Options

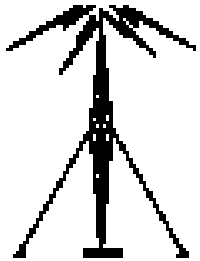
- Direct Measurement
- Indirect “Measurement” by comparing to similar site
- Model calculations

Federal Communications Commission
Office of Engineering & Technology

Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields



Additional Information for Radio and Television Broadcast Stations



Supplement A
(Edition 97-01)
to
OET Bulletin 65 (*Edition 97-01*)

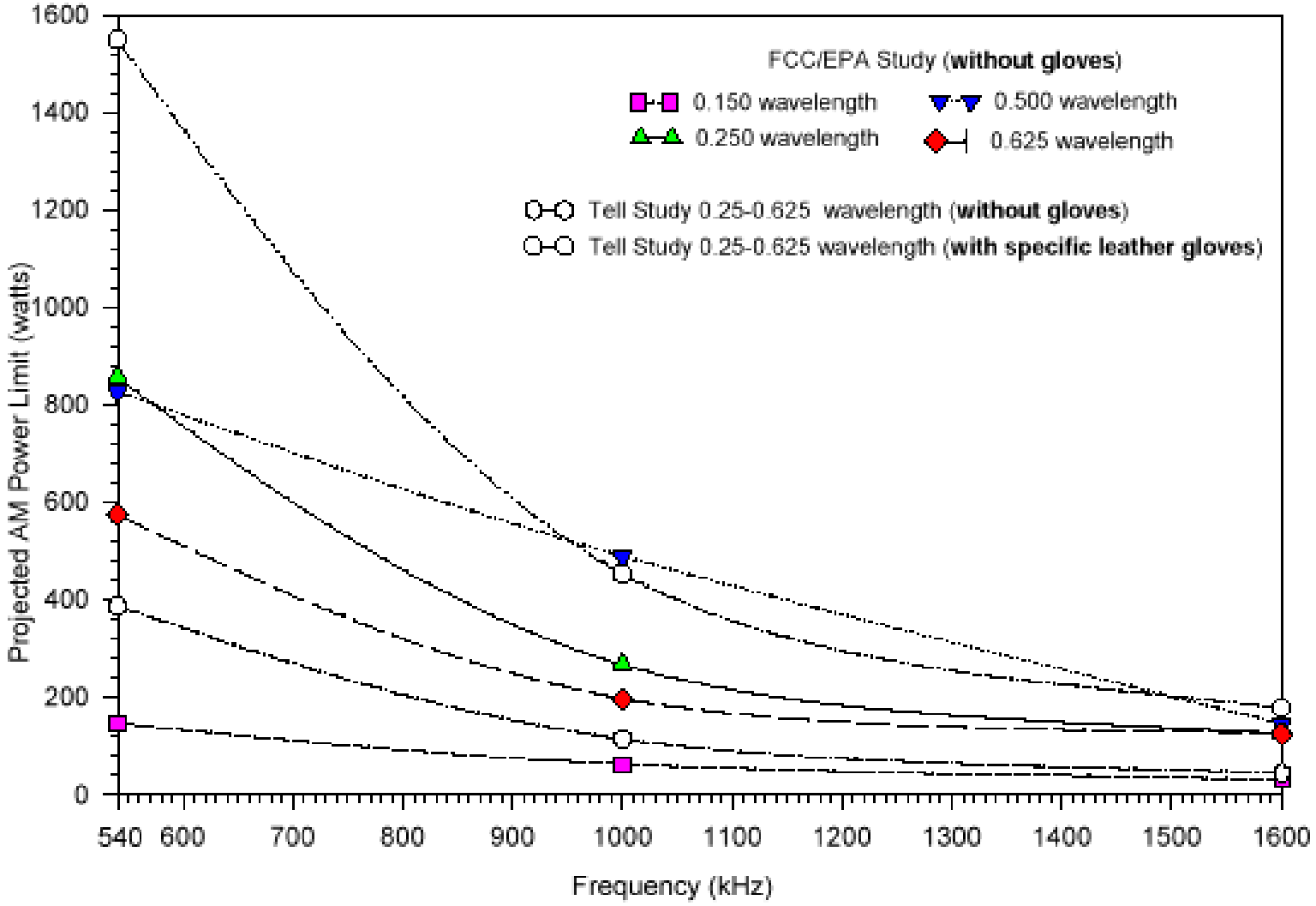


Figure 5. Estimated power levels to comply with occupational/controlled limits for ***on-tower*** exposure of persons climbing AM broadcast towers (applies ***only*** to exposure of persons climbing a transmitting AM radio tower).

TABLE 1. Predicted Distances for Compliance with FCC Limits: O.1 Wavelength

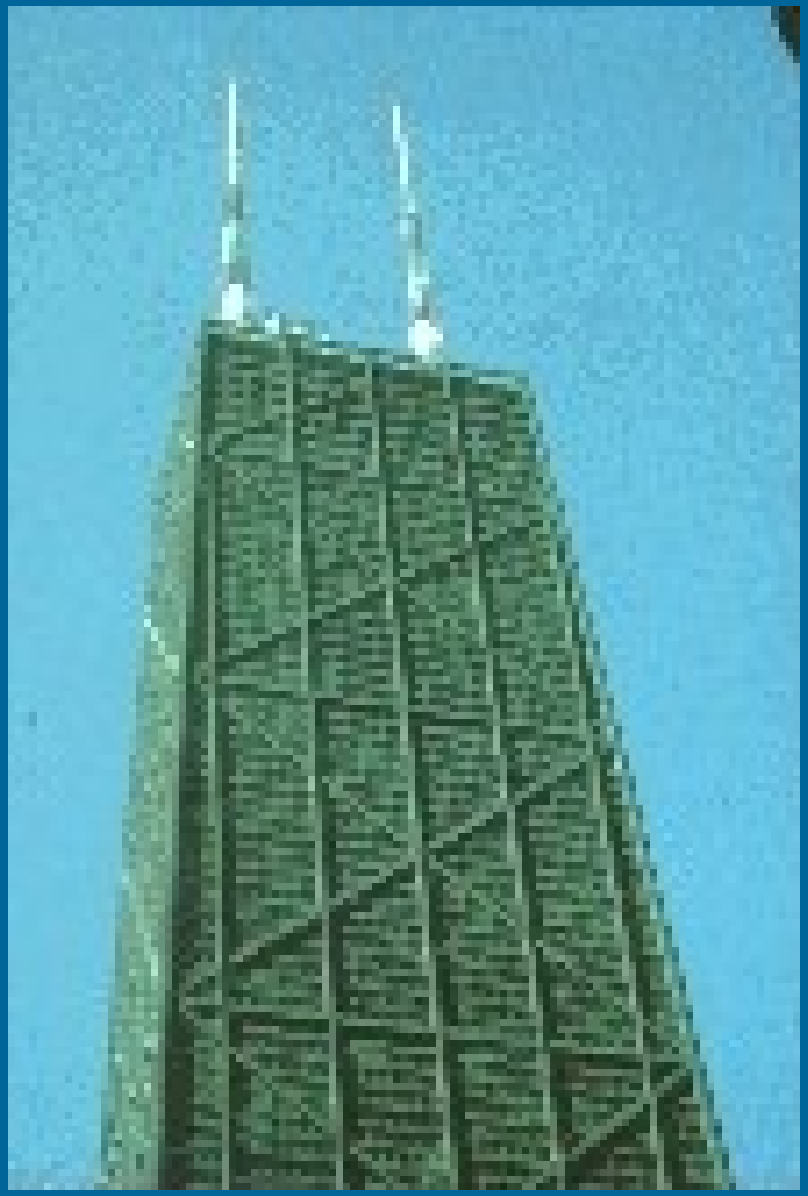
Frequency (kHz)	Transmitter Power (kW)			
	50	10	5	1
	Predicted Distance for Compliance with FCC Limits (meters)			
535-740	13	7	6	3
750-940	12	7	5	3
950-1140	11	6	5	3
1150-1340	10	6	5	3
1350-1540	10	6	5	3
1550-1705	10	6	5	3

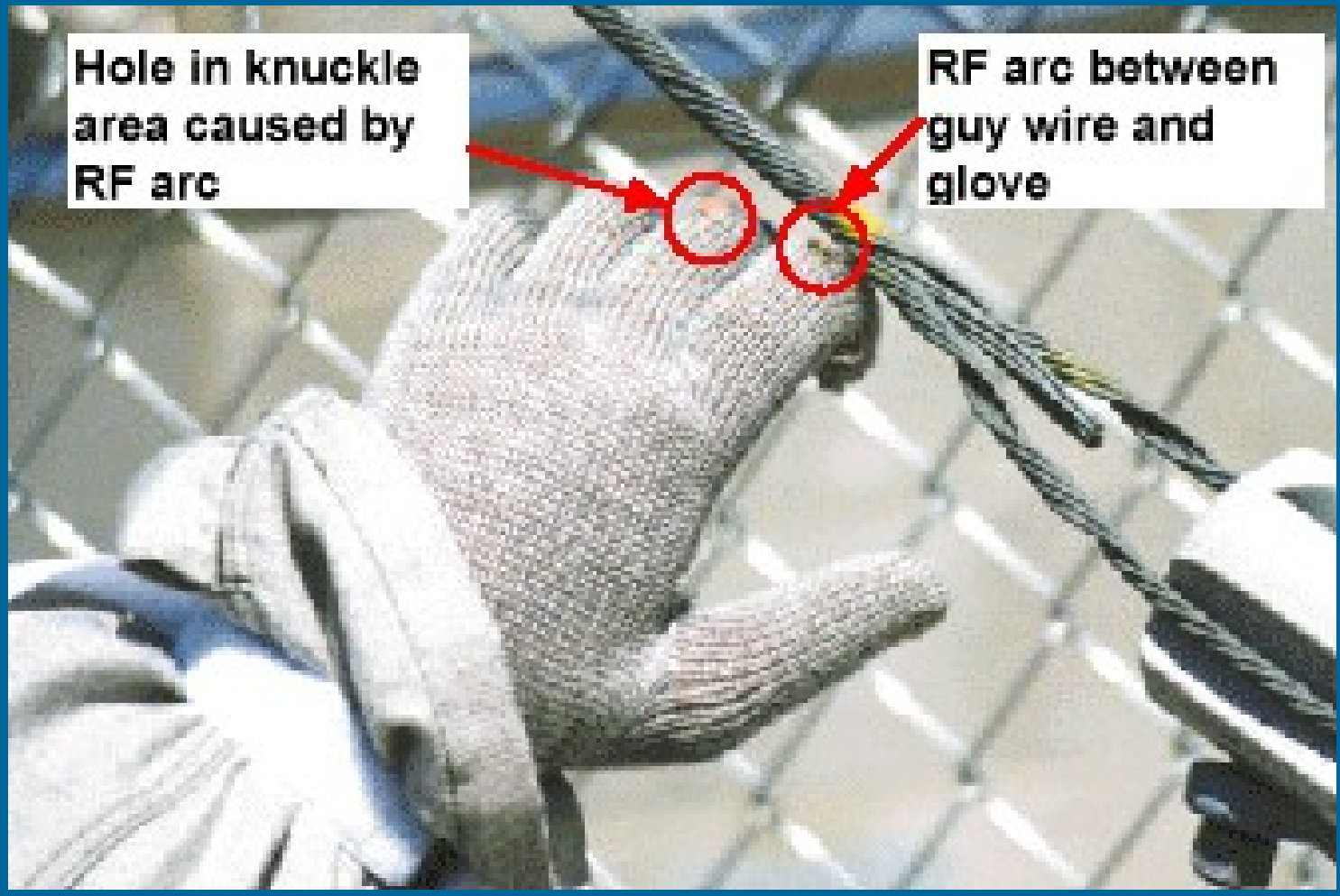
Hazard Prevention and Control

- Use good equipment
- Control hazard areas
- Limit exposures
- Medical surveillance and accident response

Control Options

- Lockout/Tag out
- Personal alarm
- Prevent access to hazardous locations
- Administrative control program
- Protective clothing




Hole in knuckle area caused by RF arc
RF arc between guy wire and glove

Information and Training

- Hazard Communication: A Primary Control for Non-Ionizing Radiation
- RF Safety Signs
- Draft responsibilities for multi-employer work sites

Hazcom Program should exist for “Uncommonly High” fields, such as:

>50 mG whole body ELF
>Uncontrolled limits of FCC

What to Teach

- Location of sources and potentially hazardous areas
- Health effects and current and proposed standards
- Extent of exposure compared to standards, common sources and background
- Required SOP’s and controls
- Optional controls employees may use

Suggested Placement of RF Safety Signs

- “Notice” at Perimeter of Uncontrolled Limits
- “Caution” at Perimeter of Controlled Limits
- “Danger” at Location in Excess of Peak Limits and to Identify Acute Burn Hazards

NOTICE

Radio frequency fields beyond this point may exceed the FCC general public exposure limit.

Obey all posted signs and site guidelines for working in radio frequency environments.

In accordance with Federal Communications Commission rules on radio frequency emissions 47 CFR 1.1307(b)

CAUTION

Beyond this point:
Radio frequency fields at this site may exceed FCC rules for human exposure.

For your safety, obey all posted signs and site guidelines for working in radio frequency environments.

WARNING

Beyond this point:
Radio frequency fields at this site exceed the FCC rules for human exposure.

Failure to obey all posted signs and site guidelines for working in radio frequency environments could result in serious injury.

In accordance with Federal Communications Commission rules on radio frequency emission (47 CFR 1.1307).

Draft Host Employer's Responsibilities

- Provide information about hazards, controls, safety and health rules, and emergency procedures to all employers at the workplace
- Ensure that safety and health responsibilities are assigned as appropriate to other employers at the workplace.

Draft Contract Employer's Responsibilities

- Ensure that the host employer is aware of the hazards associated with the contract employer's work and what the contract employer is doing to address them
- Advise the host employer of any previously unidentified hazards that the contact employer identifies at the workplace.

Evaluation of Program Effectiveness

- Audit schedule will depend on site.
- Interview employees
  - What are the hazards and controls?
  - What steps have been taken to enforce the rules?
- Determine what to change, add, and delete.

Applicable OSHA Standards

- 23 states have their own OSHA Standards
  - Standards must be at least as strict as Federal
  - Most copy Federal standards & interpretations
  - Some require a Safety and Health Program
- 1910.97 - Non-Ionizing Radiation
  - 10 mW/cm^2, 6 min. average, 10M-100GHz
  - No spatial averaging
  - Uses voluntary language of 1966 ANSI
  - Mandates look of RF Sign

Applicable OSHA Standards (cont.)

- 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
- 1926.54, 20 - **Construction Industry**
  - Includes tower erection, repairs and painting
  - Limits MW to 10 mW/cm^2. (no averaging)
  - Requires programs to provide safe work to employees and contractors; includes inspection

Applicable OSHA Standards (cont.)

- 1910.147 - **Lockout/Tagout of Power**
  - Requires lockout or tagout of power during maintenance to prevent excessive exposures
- 1910.132 - **Personal Protective Equipment**
  - Requires hazard assessment to select appropriate PPE
  - Interpretation letter addresses RF Clothing
- 1910.145, 1926.200 - **Signs and Tags**
  - Use signs to warn of hazards

Applicable OSHA Standards (cont.)

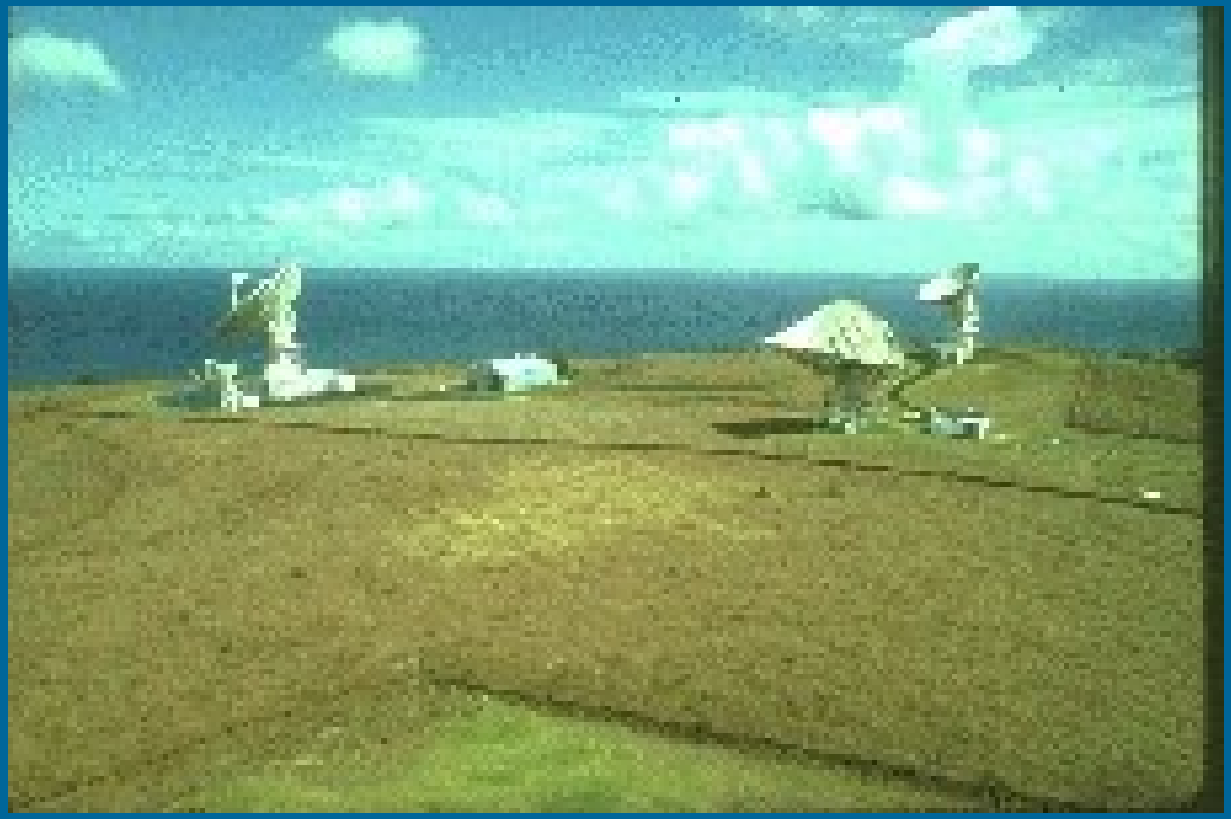
- 1904 - **Record Keeping**
  - Log of injuries and illnesses, accidents
- 1910.1020 - **Access to Employee Exposure and Medical Records**
- **Section 5(a)(1) of OSH Act**
  - Requires a safe and healthful workplace free of recognized serious hazards

Obviously Outdated

- **Exposure Limit** is from 1966 ANSI
  - Not frequency dependent
  - Does not address induced current limits
- Incomplete on **Hazard Communication**
  - Describes RF Sign but not where to use it
  - Once Warning sign for all conditions
- Incomplete on **RF Safety Program** Elements

OSHA Directive Covers Fall Protection and Safe Access to Communications Towers Under Construction

- The directive sets inspection policies to ensure uniform enforcement of OSHA provisions
- All employees climbing or otherwise accessing towers must be adequately trained (1926.21 or 1926.1060)
- Employees must be protected from falls with a fall arrest system (1926.502) or a ladder assist safety device (1926.1053(a))
- The directive covers worker access by hoists. Following the training of hoist operators and workers and after meeting specific criteria, employees may be lifted on hoist lines to reach work stations at heights greater than 200 ft. (60.6 meters). The criteria are as follows: (1) hoist lines must be equipped with a swivel to prevent the rotation of workers being hoisted, (2) the use of spin-resistant wire rope is prohibited, (3) workers must wear proper personal protective equipment, (4) when hoisting personnel, the hoist capacity load rating shall be reduced by half, and (5) riding the hoist line to work stations at heights less than 200 ft. (60.6 meters) is prohibited.
- Maintenance, retrofitting, and dismantling of existing towers are not addressed in the directive, but will be covered in future directives.



Inverse Square Law

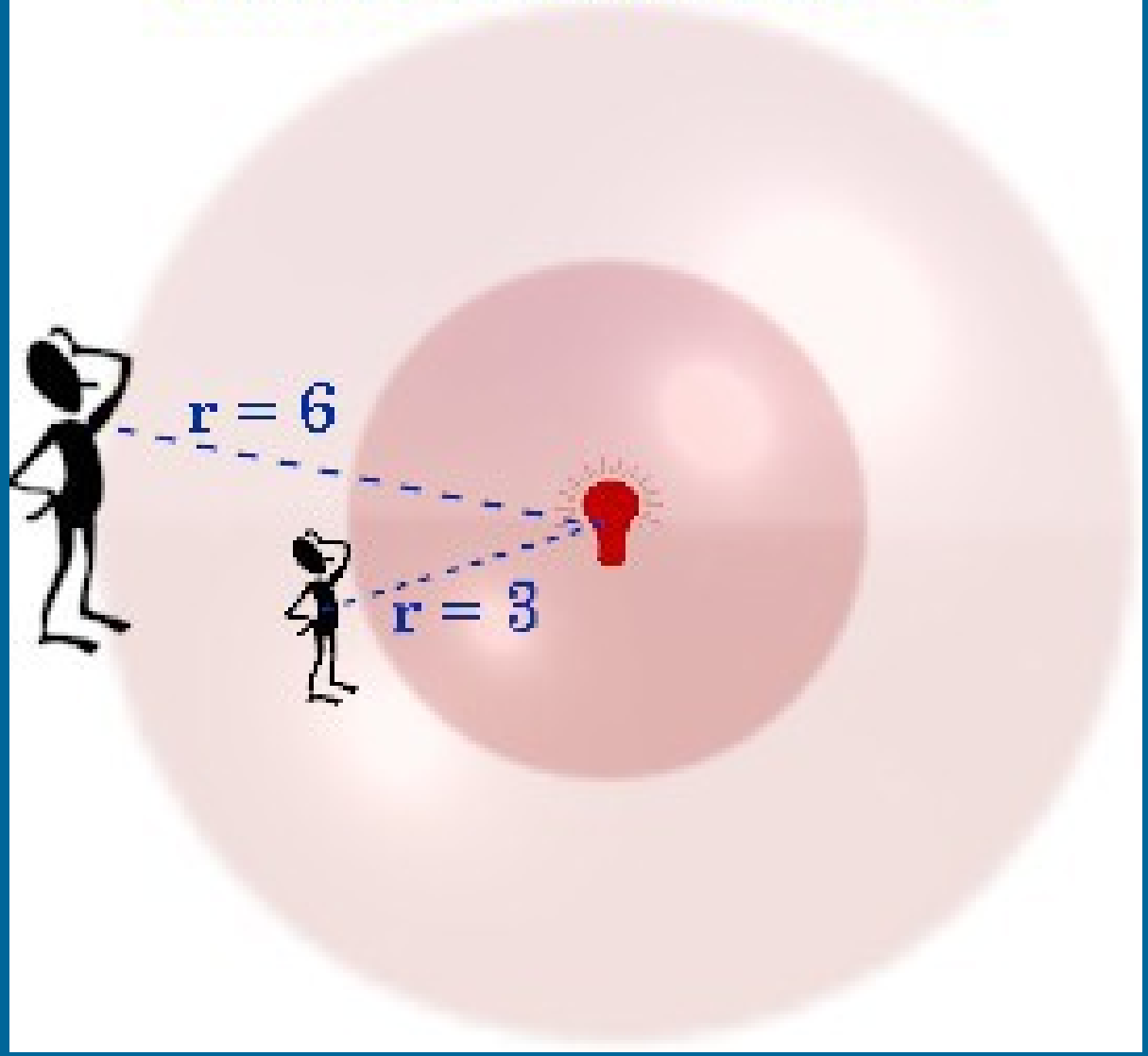


TABLE 2. Predicted Distances for Compliance with FCC Limits: O.25 Wavelength

Frequency (kHz)	Transmitter Power (kW)			
	50	10	5	1
	Predicted Distance for Compliance with FCC Limits (meters)			
535-740	4	2	2	1
750-940	4	2	2	1
950-1140	4	2	2	1
1150-1340	4	2	2	1
1350-1540	4	2	2	1
1550-1705	5	2	2	1

Basis of RF Standards

- Behavioral disruption threshold
- Limit temperature increase to 1 degrees C
- 1-4 W/kg SAR
- 10-fold safety factor

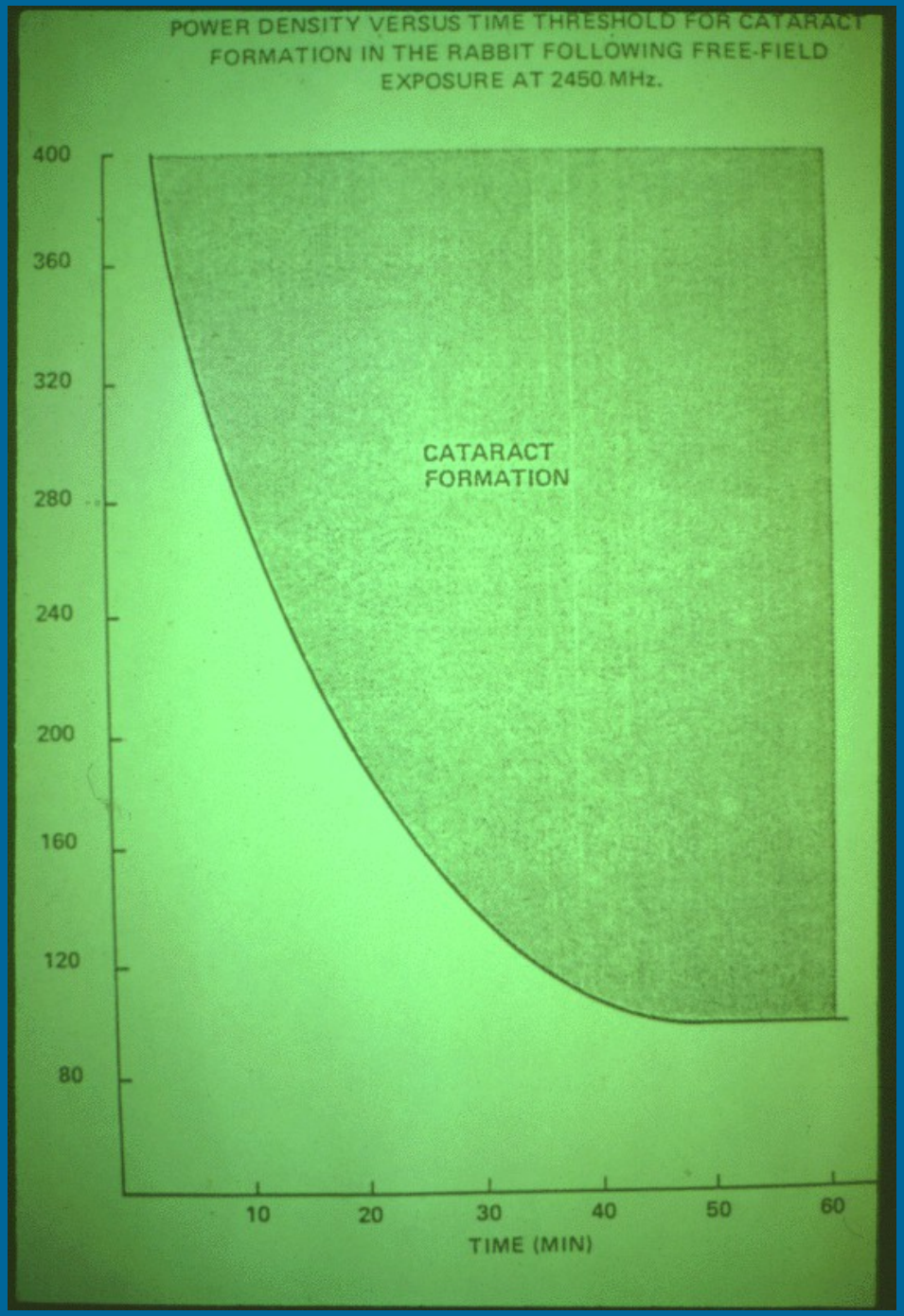

POWER DENSITY VERSUS TIME THRESHOLD FOR CATARACT FORMATION IN THE RABBIT FOLLOWING FREE-FIELD EXPOSURE AT 2450 MHz.
400
360
320
280
240
200
160
120
80
CATARACT FORMATION
10
20
30
40
50
60
TIME (MIN)

Table 1. LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $|E|^2$, $|H|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	($900/f^2$)*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $|E|^2$, $|H|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	($180/f^2$)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz

*Plane-wave equivalent power density

NOTE 1: ***Occupational/controlled*** limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2: ***General population/uncontrolled*** exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.