

RF Safety & Compliance Issues of Telecommunication Sites

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AT&T

Environment, Health & Safety

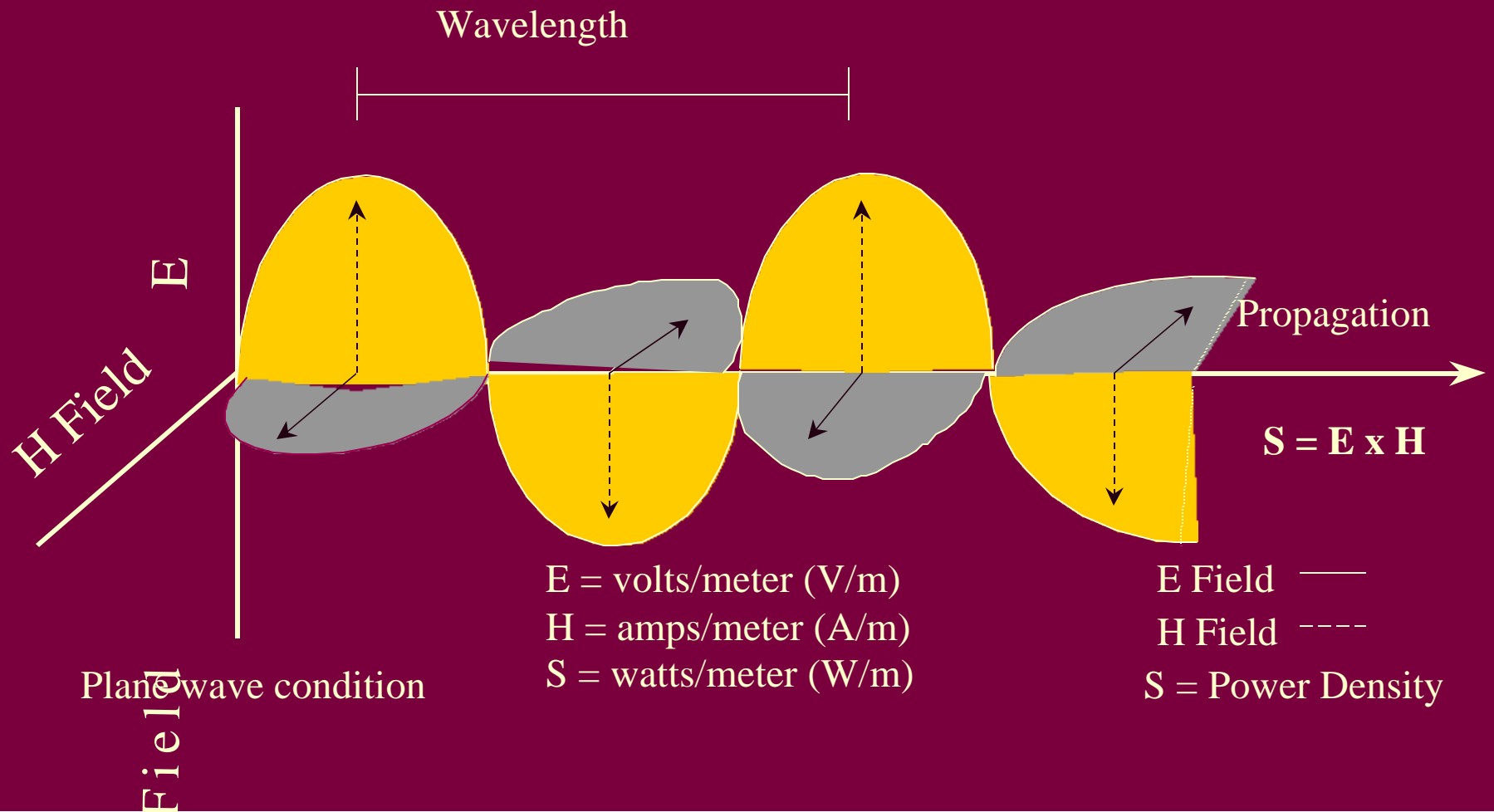
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ILSC 2001 - Providence, RI

Objective

- Federal RF Compliance Activities
 - FCC RF Exposure Limits, 47 CFR § 1.1310
 - FCC OET Bulletin 65 (Compliance Guidelines)
- Evaluating Exposure Compliance
 - Prediction Methods and Field Measurements
- Worker RF Safety Awareness Training
 - Basic elements and advanced levels
- Standard Activities/Resource Information

Electromagnetic Waves



Electromagnetic Spectrum

Non-ionizing

Ionizing



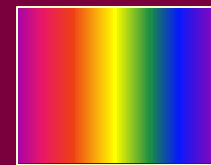
Home appliances

- AM: 535-1605 kHz
- CB Radio: 27 MHz
- Cordless Phones: 49 MHz
- TV(2-6): 54-88 MHz
- FM: 88-108 MHz
- TV (7-13): 174-216 MHz
- UHF (14-69): 470-800 MHz
- Antitheft Devices: 10-20 kHz or 915 MHz
- Cellular, SMR, Paging: 806-946 MHz
- Intrusion alarms/door openers: 10.5 GHz
- PCS: 1800-2200 MHz
- Microwave Radio: 1-40 GHz
- Satellite Com: 100 MHz - 275 GHz

AC Power Frequency

Heat

Visible



Diagnostic X-rays
Nuclear Medicine

60 Hz

3 kHz

1 MHz

300 GHz

Frequency (Hz) →

RF Exposure Limits

Consensus Standards/Guidelines

- American National Standards Institute
 - ANSI / IEEE C95.1-1992
- National Council on Radiation Protection and Measurements
 - NCRP Report No. 86

Government Regulations

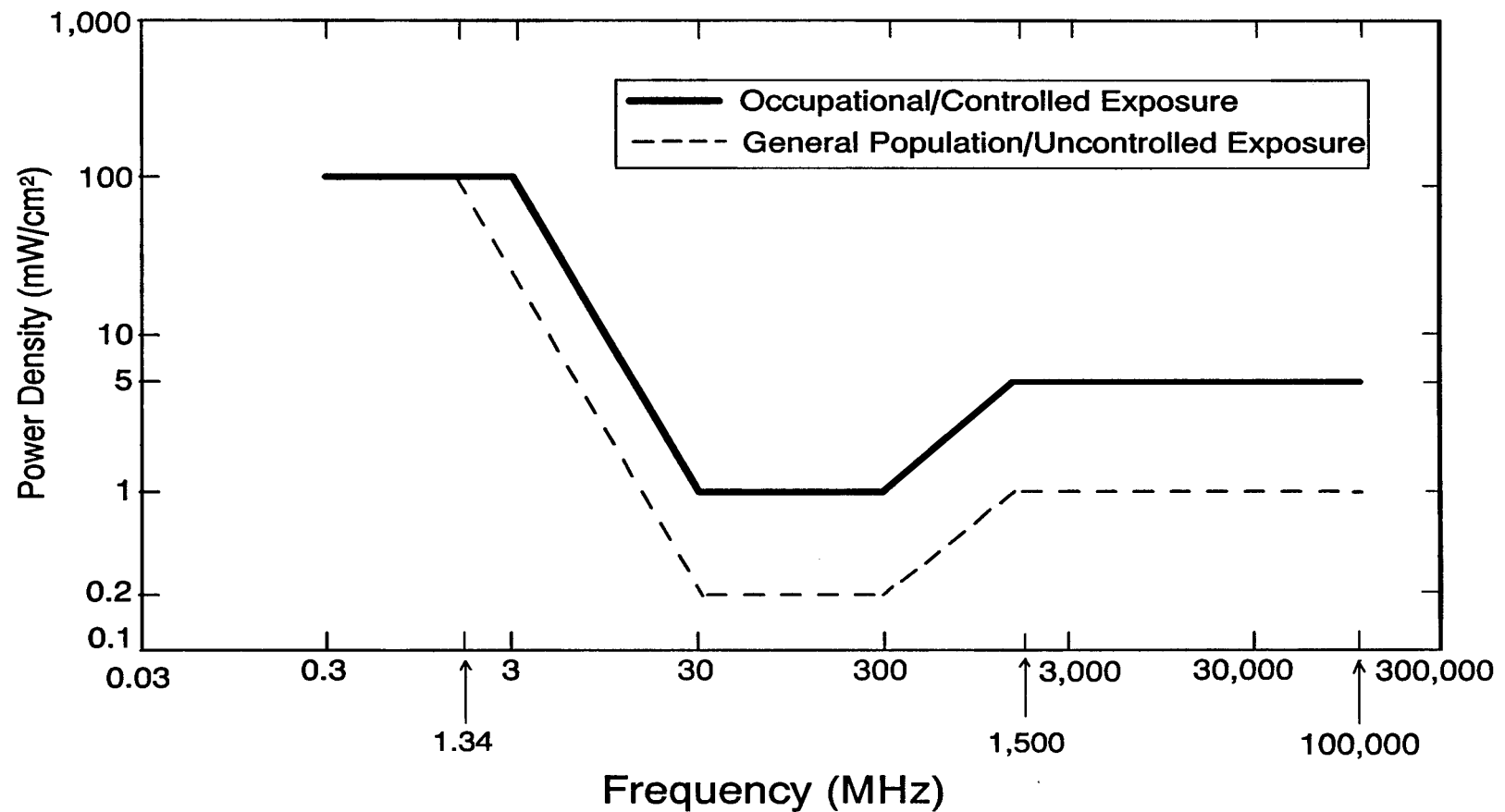
- Federal Communications Commission (FCC)
- Occupational Health and Safety Administration (OSHA)
- Various State Agencies

RF Safety Standards

- Limit the rate at which your body absorbs energy
 - internal limits: Specific Absorption Rate (SAR)
- To do this ... limit the intensity of RF fields to which you are exposed
 - external limits: Maximum Permissible Exposure (MPE) limits
 - Whole-body / time-averaged values

FCC MPE Limits - Graph

Figure 1. FCC Limits for Maximum Permissible Exposure (MPE)
Plane-wave Equivalent Power Density



FCC - RF Exposure Limits

- Whole-Body, Time-averaged values
- *Accessibility* is key to determining compliance !!

Occupational/Controlled Limits

VS

General Population/Uncontrolled Limits

- Distinguished by the individual's level of Awareness

RF Control Measures

Necessary if accessible areas can potentially exceed “**Action**” level - *General Population/Uncontrolled MPE limit*

- Control Guidelines:
 - Access Restrictions (fence, ladder lockout, etc.)
 - RF Hazard Postings (unaware individuals)
 - Engineering / Procedural Controls (ex. de-energize system prior to entry)
 - RF Awareness Training

FCC - Occupational Exposure Limits

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time (Min)
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

f = frequency in MHz

* Plane-wave equivalent power density

FCC - General Public Exposure Limits

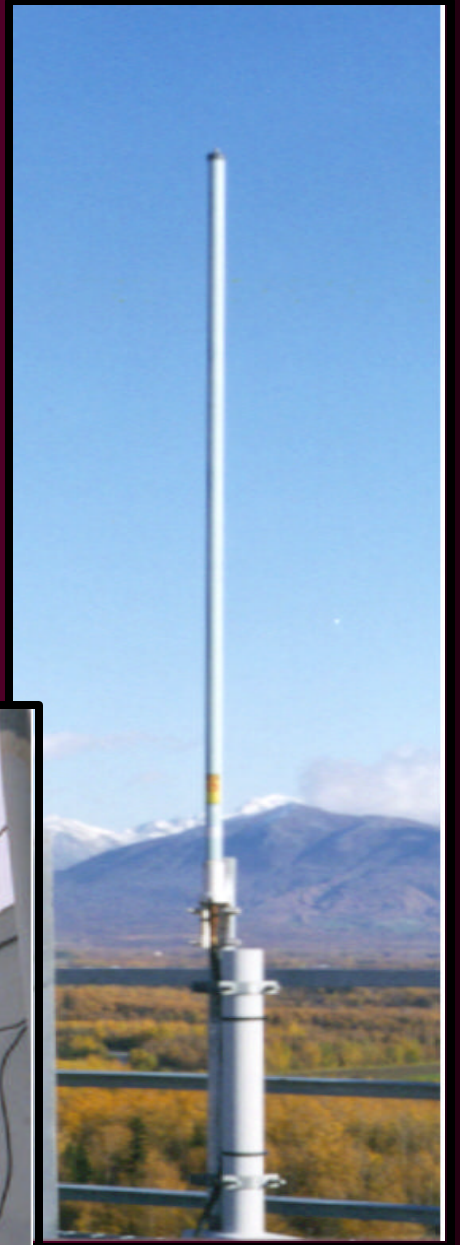
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time (Min)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824 / f	2.19 / f	(180 / f ²)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f / 1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz

* Plane-wave equivalent power density

MPE Compliance

- Prediction Models - Conservative estimate for evaluating a particular exposure situation
 - various antenna types
 - “worst-case” operating conditions
 - single or multiple-transmitter environments
- Direct Field Measurements
 - broadband, portable instruments

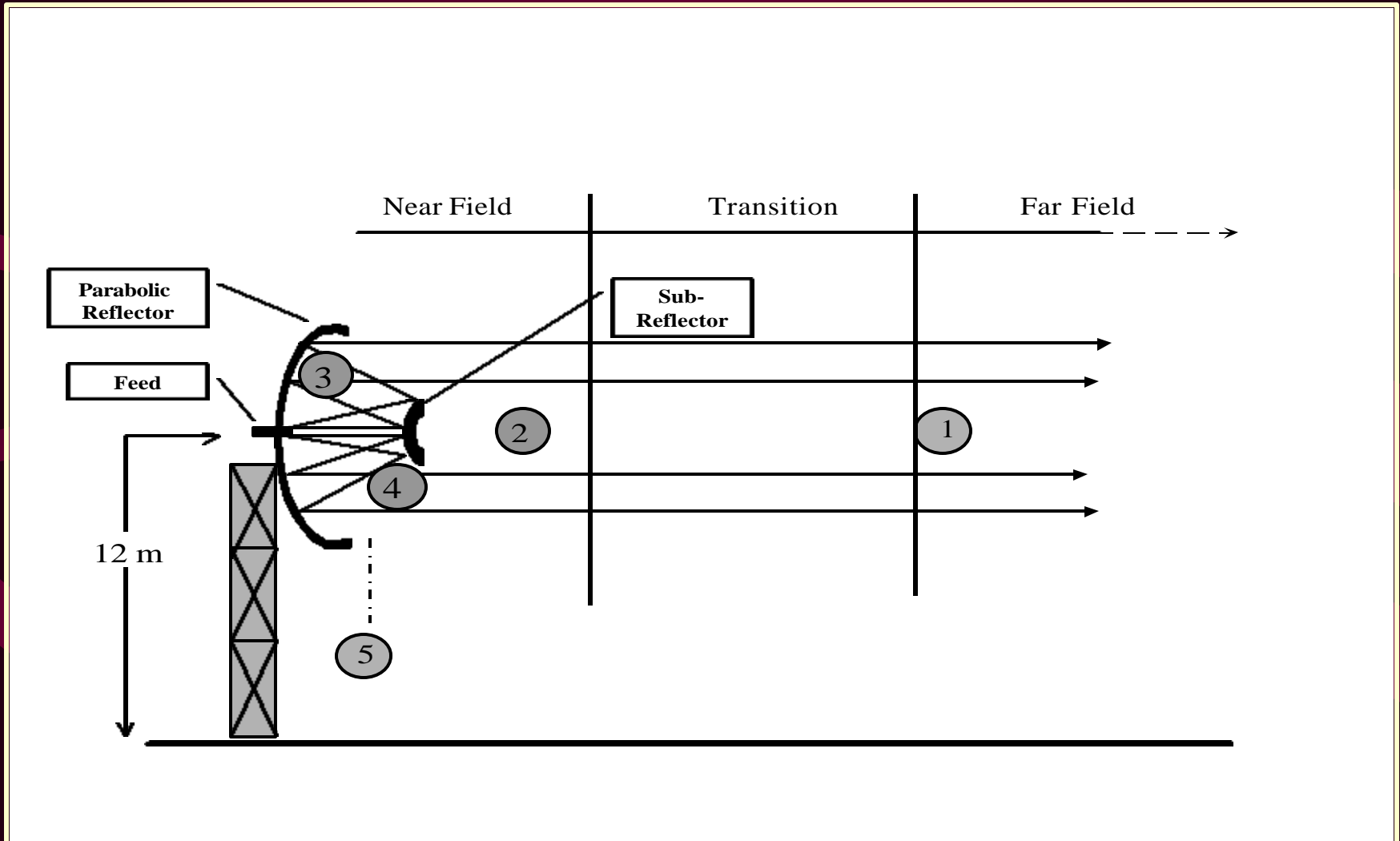


FCC - OET Bulletin 65

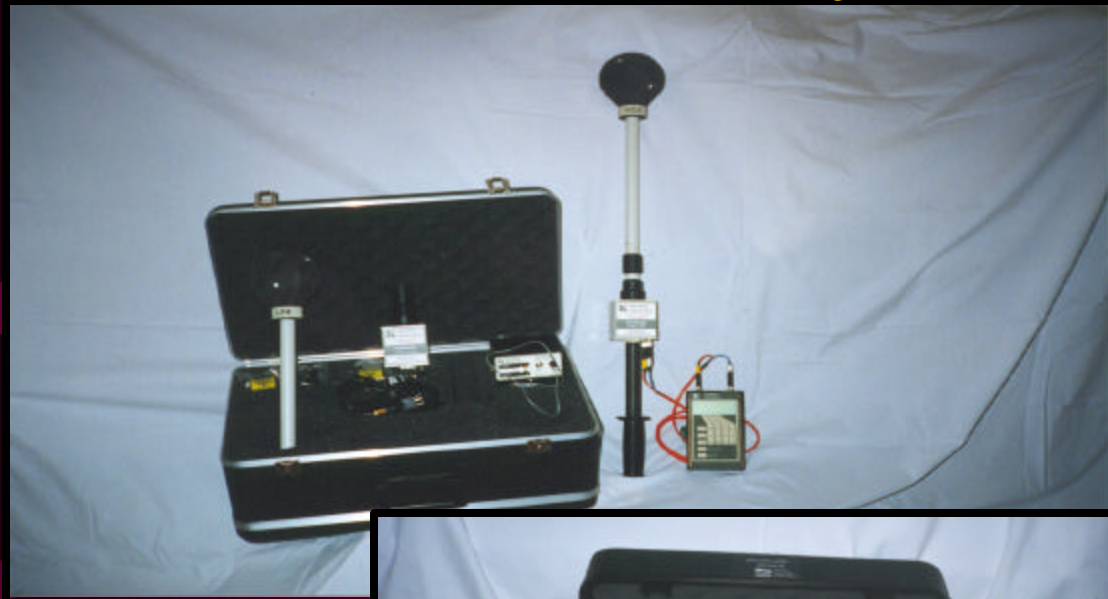
Guidelines for evaluating compliance w/ FCC exposure limits - *not intended to establish mandatory procedures*

- Section 2, pg. 18: Prediction Methods
- Section 4, pg. 52: Controlling Exposure to RF fields
- Table 2, pg. 69: “Categorically Excluded” - based on service type, antenna height, and operating power

Prediction Models



RF Survey Instruments



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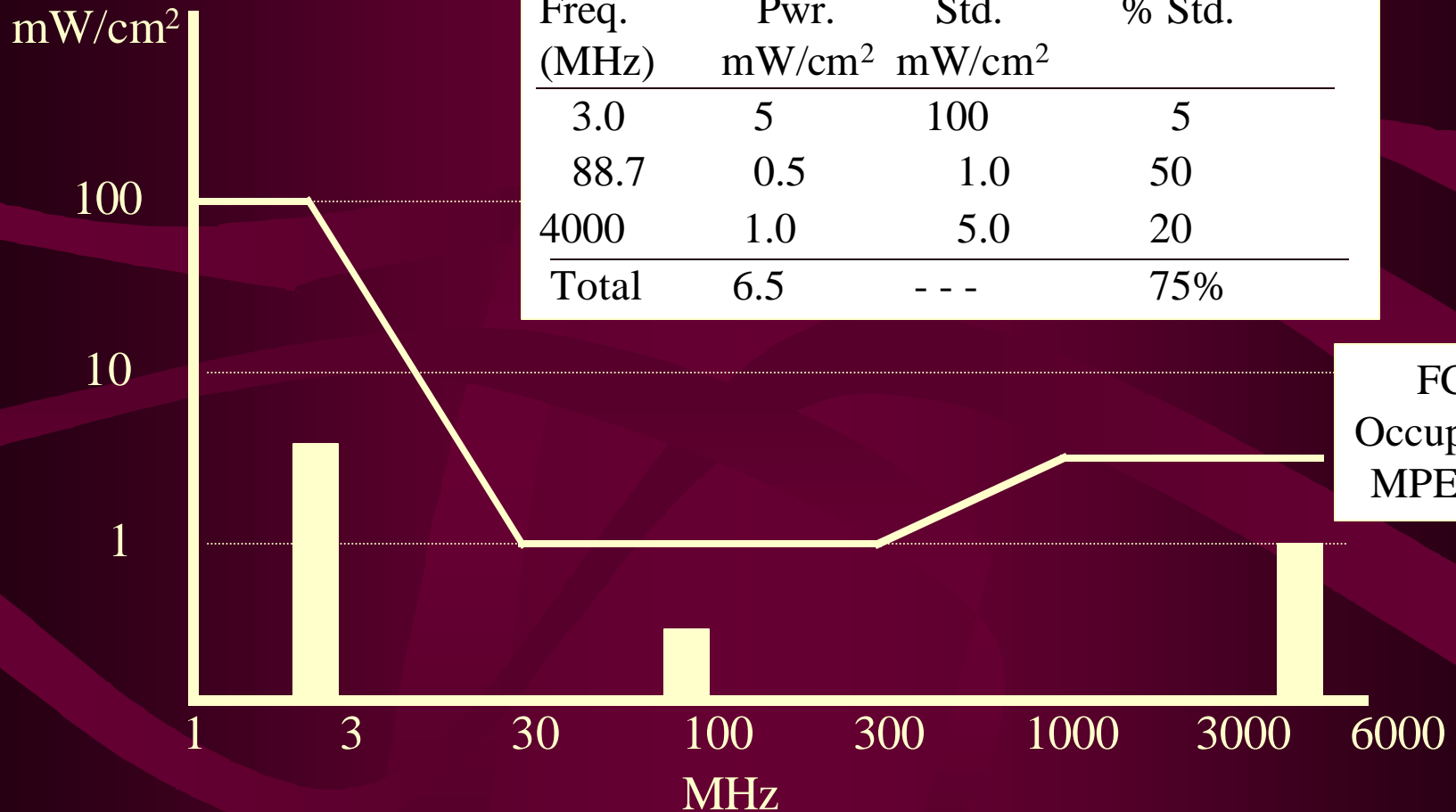
RF Survey Instruments

- *Meter*
 - Analog [needle/bar graph] vs Digital
 - portable, battery operated
- *Probe Selection*
 - Frequency-rated (Broadband) range
 - Isotropic, Electric (E) or Magnetic (H) field
- *System Performance*
 - Temperature, stability, uncertainty, special functions (time/spatial averaging)
 - general survey or leakage points

RF Survey Instruments

- *Measurement Artifacts*
 - static charge; “Out-of-band” response; body reflections or re-radiators <300 MHz; etc.
- *Frequency response*
 - “**flat**” equally responsive to energy within its frequency range, units in mW/cm^2
 - “**Shaped**” multi-signal energy weighed in proportion to a particular standard, units in “% of Standard”

RF “Shaped” Probes



RF Survey Measurements

General Considerations

- Select appropriate instrument
 - above 300 MHz, E-field only
 - below 300 MHz, E-field and H-field strengths
 - below 100 MHz, include RF induced/contact current levels
- Incidental Hazards
 - high voltage, ionizing radiation, strong magnetic (static) fields
 - survey techniques/measurement points

RF Safety Training





Tower and Building-mounted
Environments: *Consider direct
and in-direct workers!!*

RF Safety Training

- Basic RF Safety Awareness
 - Fundamental concepts of RF energy
 - Biological effects and MPE limits
 - Basic types and exposure aspects of transmitting antennas; Methods to minimize exposure
 - Use of Personal RF monitors
- Advance training elements
 - RF instruments and measurement techniques
 - Compliance determination

RF Personal Monitor

General Operation

- broadband frequency range
 - various models available
- alarm threshold
 - “%” of exposure standard or flat-response
 - audible and visual indicators
- audible alarm rate dependent on intensity level
- directional detection limits
- “fail-safe” design

Resource Information

- Federal Communications Commission
 - Office of Engineering and Technology
[www.fcc.gov/oet]
www.fcc.gov/oet/info/document/bulletins/oet56.pdf
- ANSI/IEEE [www.ieee.org]
 - SCC28/SC2 C95.6 “RF Safety Programs” *Draft*
 - C95.1-1999 “Safety Levels to Exposure to RF Fields”
 - C95.3-1991 “Measurement of RF Fields”

Resource Information

- ETSI 101 870 “Guidelines for Working Conditions” *Draft* [www.etsi.org]
- Electromagnetic Energy Association (EEA)
[www.elecenergy.com]
- OSHA [www.osha-slc.gov]
 - Elements of an RF Safety Program
- NCRP No. 119 “Practical Guide for Determining Exposure to RF Fields”