# Exposure to Radio Frequencies From Advanced Metering Infrastructure Devices

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Presented by

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# Topics

- Qualifications
- What is RF?
- Are there RF safety issues?
- Role of Federal Government
- The U.S. Exposure Standard
- Smart Meter Exposure Calculations
- Common Misconceptions
- References

# JB Schoedler Qualifications

- **Skills**
  - Analysis and prediction of RF exposures
  - Preparing RF exposure exhibits for the FCC
  - Conducting RF Field surveys
- **Experience**
  - Working with RF for >30 years
  - TV Chief Engineer since 1987 (KNBC TV, Rocky Mountain PBS)
  - Independent consulting practice since 2006
- **Qualifications**
  - BS Electronic Physics, La Salle University, 1976
  - MS Engineering, University of Pennsylvania, 1978

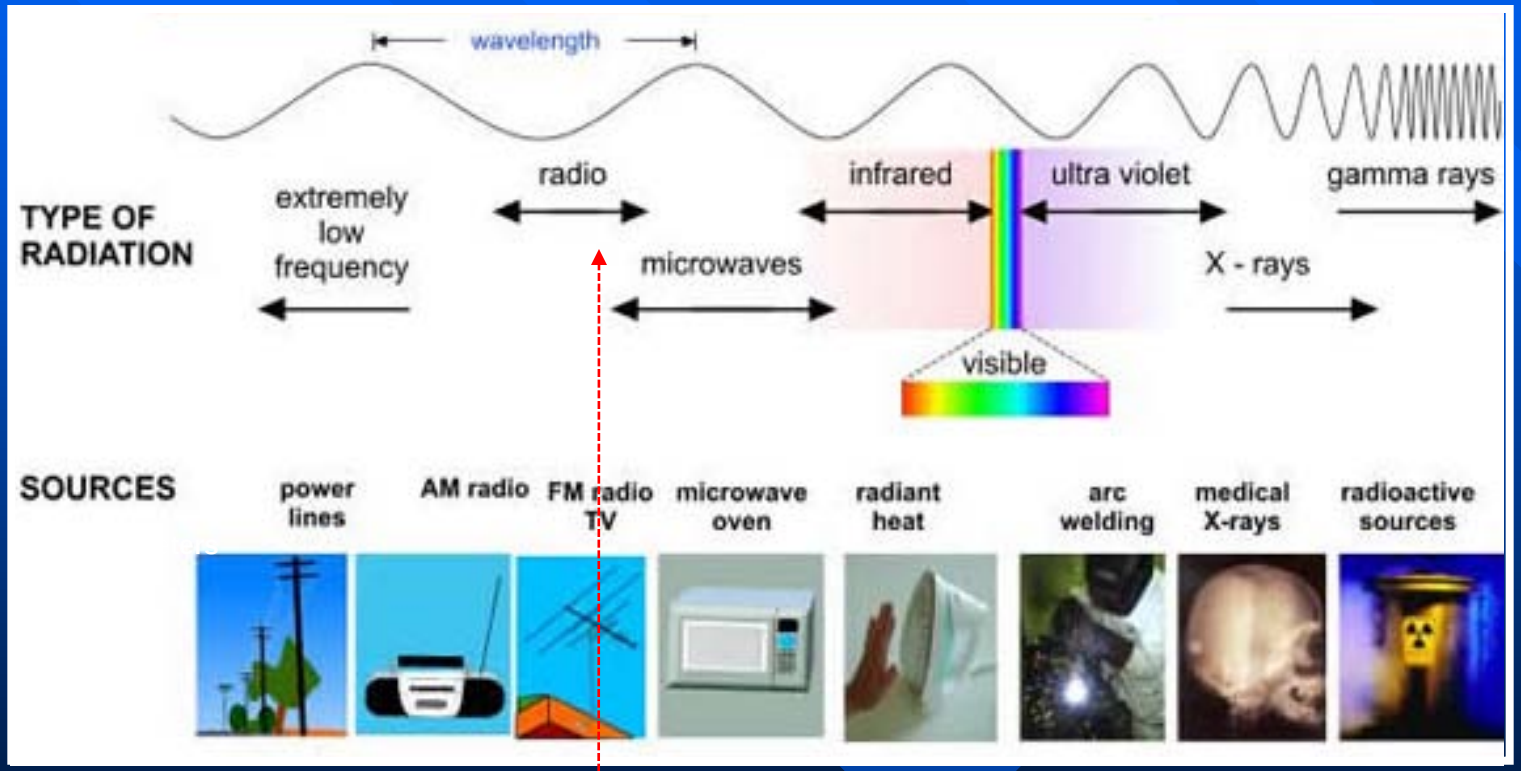
W&G EMR-300 Broadband Exposure Meter

# What is RF?

- RF (radio frequency) is a form of electro-magnetic (electric and magnetic) energy radiated through space

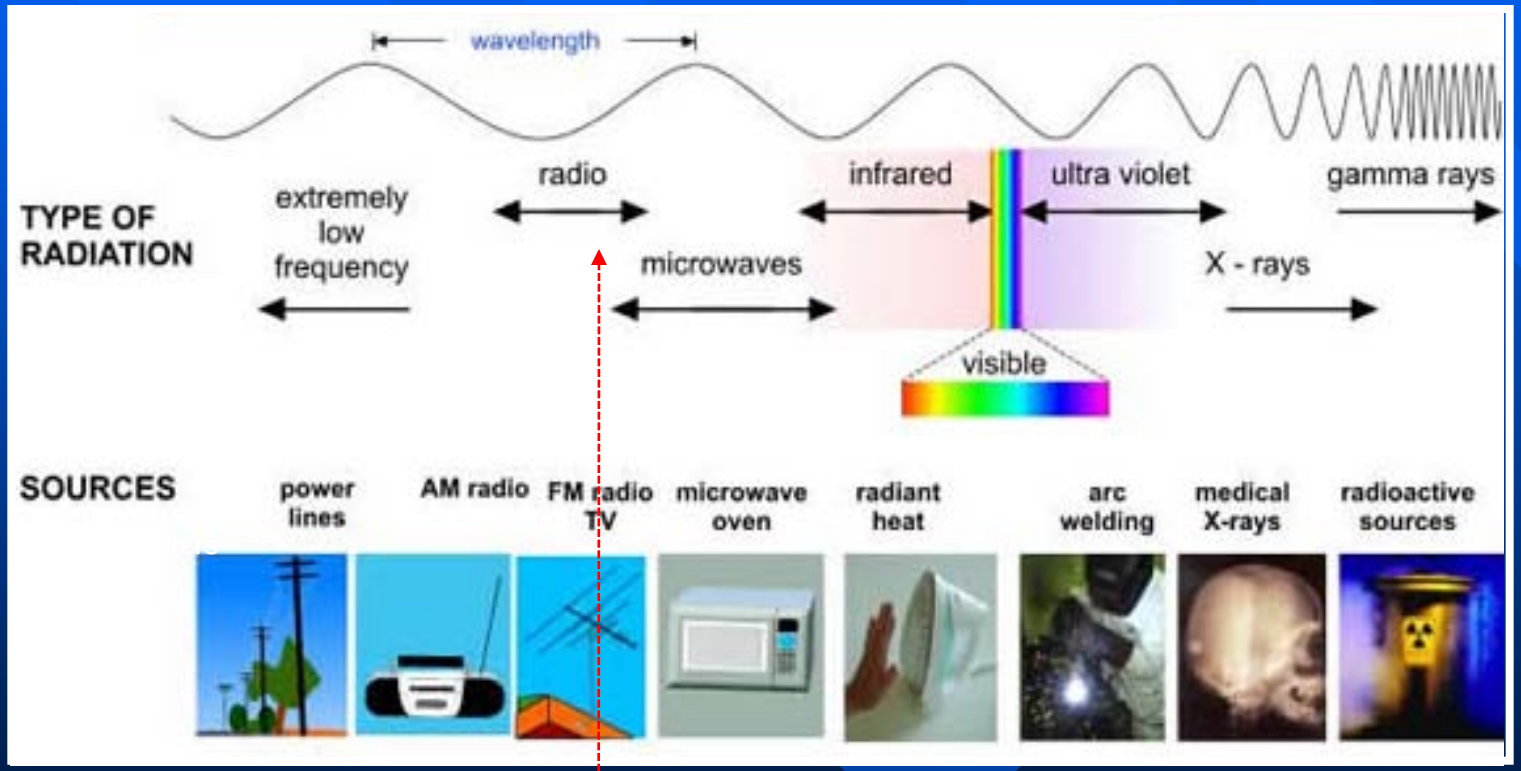
- Electromagnetic energy is all around us. Sources of electromagnetic energy include:
  - The sun
  - Fluorescent and incandescent lights
  - Home computers
  - Wireless Phones
  - Radio and TV Stations
  - Satellite Radio and TV

Electromagnetic energy can be categorized by frequency, which is the number of cycles per second (Hertz) at which the energy varies and wavelength, which is the distance the energy travels in 1 cycle.



Non-ionizing

Ionizing




Smart Meter

# RF Safety Issues

- Radio Frequency energy is non-ionizing, i.e. it lacks the energy necessary to cause direct damage to molecules in human body.
- The only demonstrated exposure effect is heating of body tissue at high levels of RF power.
- There are no identified health hazards associated with low levels of RF not sufficient to cause a rise in temperature. *(World Health Organization)*

# Federal Govt. Involvement

- The Federal Government has set limits to insure the public is not exposed to RF safety hazards.
- National Environmental Protection Act (NEPA) of 1969
  - Makes all Federal Government agencies responsible for environment
- Telecommunications Act of 1996
  - Makes FCC the controlling agency
- FCC OET 65 and appendices is the guiding document
  - FCC rules apply to radio sites and consumer radio devices
  - OSHA defers to FCC but may apply its own rules for implementation
  - Local governments must use the FCC standard

# The Exposure Standard

- **Controlled Environments**

  "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.

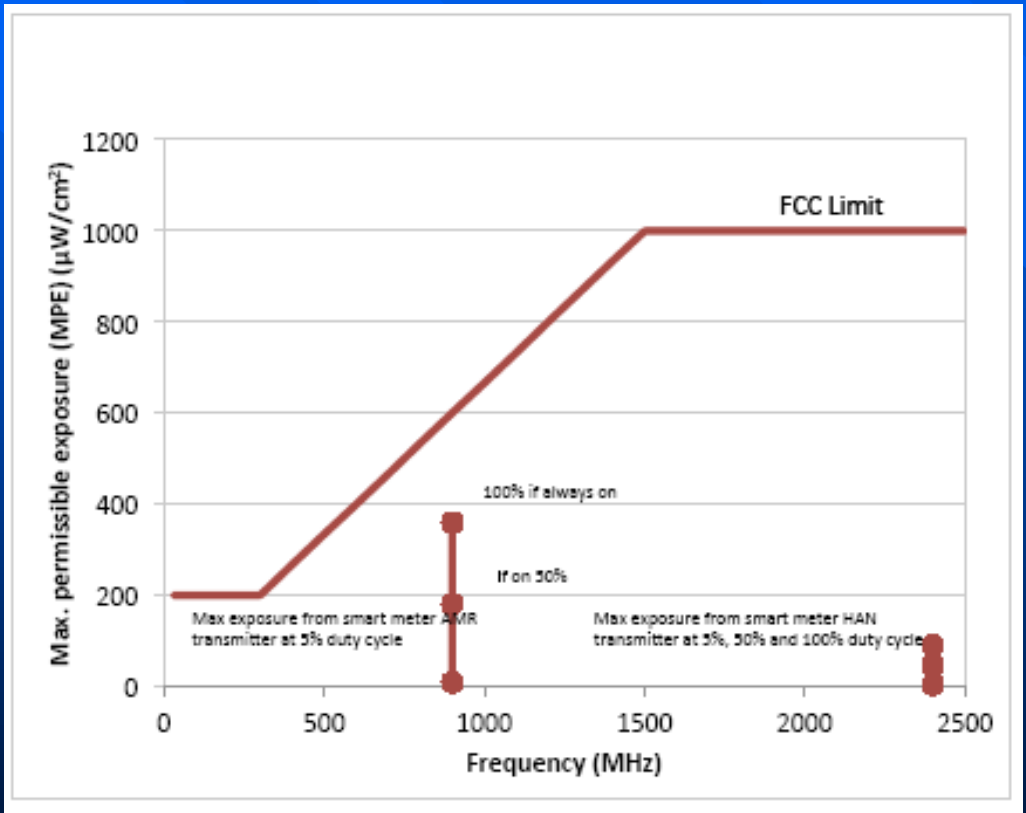
- **Uncontrolled Environments**

  "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."

- **FCC Maximum Permissible Exposure (MPE)**

# Maximum Permissible Exposure (Uncontrolled) at smart meter frequencies

## 915 MHz:  610 microwatts/sq. centimeter



# How Was The Standard Derived?

- Laboratory Experiments Demonstrated some behavior effects at 4 W/kg with a core temperature rise of 1 ° C after continued exposure. This was not necessarily dangerous, but an indication of the threshold at which effects were measured.
- Reduce exposure by Safety Factor of 10 to get 0.4 W/kg for controlled environments
- Include additional factor of 5 for general public to get 0.08 W/kg for uncontrolled environments
- *Public exposure limit is thus 50 times more stringent than the level that produced measureable effects!*

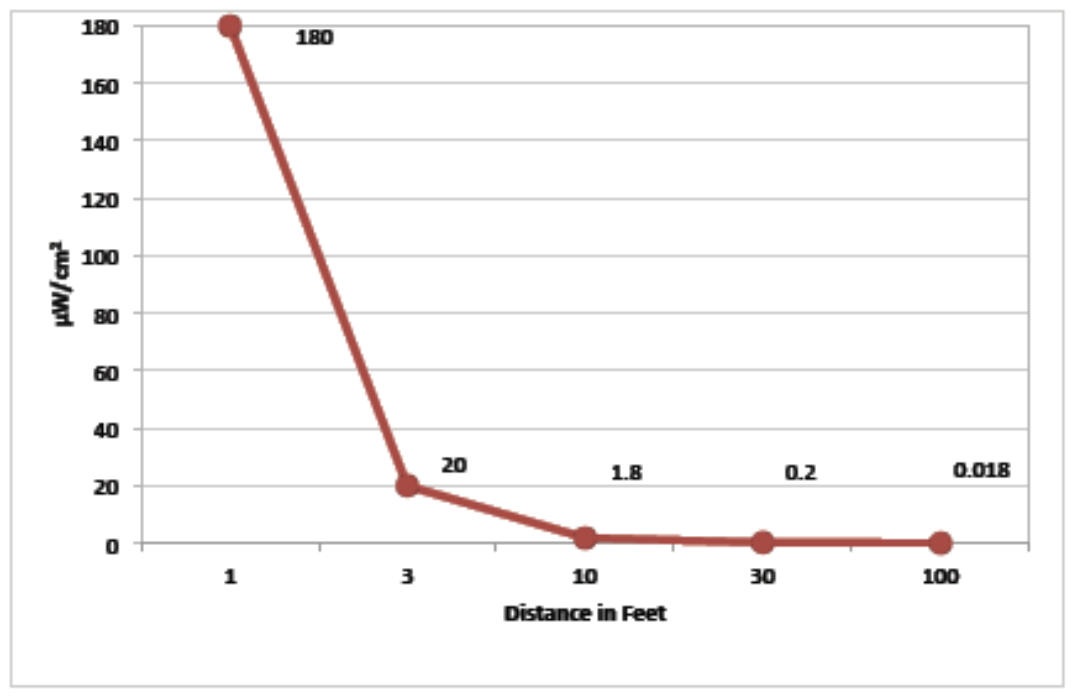
# About Time Averaging

- Averaging over time (e.g 30 minutes) is included in the standard because the human body does not react to RF energy instantaneously.
  - It takes time for body tissue to absorb energy and raise temperature
- However, in practice time averaging is not used for public exposure because of the uncontrolled nature of the environment:
  - Conservative approach is to assume continuous exposure
  - However, duty cycle (on/off time of transmitter) must be considered per FCC OET 65
  - Smart electric meters typically transmit for less than 1 minute per day
  - Smart water meters transmit even less to preserve battery life; 15 year battery life is the goal.

# Exposure Calculations

- **The field produced by a smart meter depends on a number of factors:**
  - **Transmitter power (limited to 1 watt by FCC; smart meters typically use less)**
  - **Antenna directivity and gain**
  - **Reflections from ground or nearby objects**
  - **Distance from antenna to observer**
  - **Attenuation caused by objects between antenna and observer**

# Note that field strength decreases as distance increases (inverse square law)



# Exposure Calculations

- Power Density (*S*) in microwatts per square centimeter:

$$S = \frac{A_r PGD}{4 \pi r^2}$$

where $A_r$ = power reflection factor (2.56 is recommended by FCC)

$P$ = the average transmit power when transmitter is on

$G$ = the antenna gain (in direction of observer)

D = the duty cycle, a number between 0 and 1

r = the distance from the antenna to the observer

# Itron Open Way Meter Certification Exhibit

Itron

The following table reflects the data contained within the Certification Exhibits for FCC Rule Part: 15.247 for Itron OpenWay Smart Meters:

| | |
|---|---|
| FCC ID | SK9AMI-xx |
| FCC Rule Part | 15.247 |
| Classification | Digital Transmission System Transmitter<br>Frequency Hopping Spread Spectrum Transmitter |
| Device Category | Mobile |
| Environment | General Population / Uncontrolled Exposure |
| Exposure Conditions: | Greater than 20 centimeters (8 inches) |
| Frequency bands | RF LAN 902 – 928 MHz<br>ZigBee 2,400 – 2,483.5 MHz |
| Transmitter Power* | RF LAN 24.83dBm (304.09 mW) at 902.25 MHz<br>ZigBee 18.94 dBm (78.34 mW) at 2,475 MHz |
| Antenna Gain* | RF LAN 2.2 dB (1.660 times) at 902.25 MHz<br>ZigBee 3.8 dB (2.399 times) at 2,475 MHz |

**Transmit Power .3 watts**

**Antenna Gain 1.66**

# Example 1

- A Worst Case Smart Meter:

  f = 915 MHz

  Exposure limit = 610 microwatts/sq. cm.

  $A_r$ = 2.56

  P = .3 Watt

  G = 1.66

  D = 1 (100%)

  r = 0.5 meters (20 inches)

- Power Density = 40.5 microwatts/sq. cm.

- Conclusion: this device is compliant (.066 MPE)

# Discussion

- How Does Worst Case Differ from Typical?
  - A smart meter will typically be mounted on exterior of building while most exposure conditions involve personnel inside the building. Building materials attenuate signal significantly.

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  - A smart meter will typically be mounted on exterior of building while most exposure conditions involve personnel inside the building. Building materials attenuate signal significantly.
  - Devices will not operate at 100% duty cycle during 30 minute averaging period.
- In the previous example, using the actual maximum duty cycle of the Itron smart meter (5%), the exposure would be approximately 2 microwatts/sq. cm. (.003 MPE).

# Example 2

- Example 2 – Panel of 10 Meters

  f = 915 MHz (average)

  Exposure limit = 610 microwatts/sq. cm.

  $A_r$ = 2.56

  P = .300 watts

  G = 1.66

  D = .05 (5%)

  r = 2x0.5m, 4x0.6m, 4x0.8m

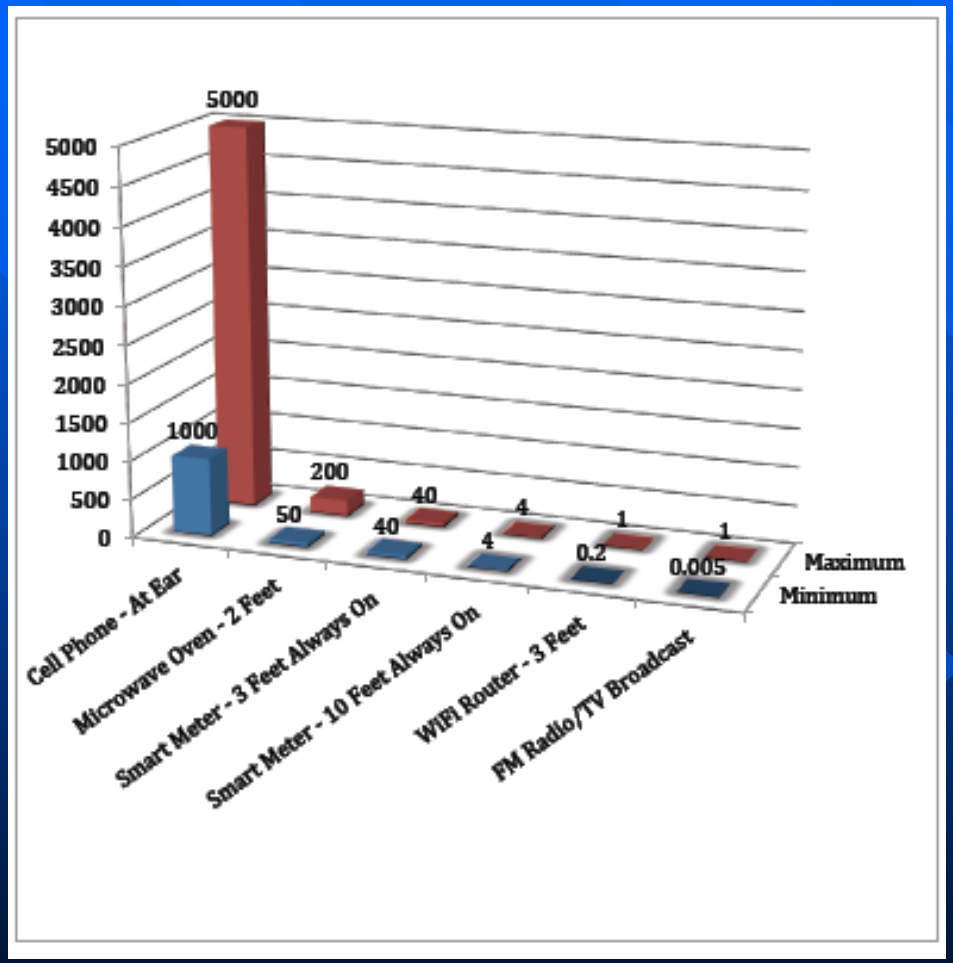
- Cumulative Power Density = 12.9 microwatts/sq. cm.

- Conclusion:  This panel is in compliance (.02 MPE)

# Misconceptions

- Smart Meters Create Greater Exposure Than Cell Phones
  - Cell Phones operate at higher power and are used closer to the body
- If Strong Power Densities Over Short Periods Are Harmful, Then Weak Power Densities Over Long Periods Must Also Be Harmful
  - There is no evidence to support this.
- Smart Meters emit energy similar to X-Rays.
- Cell Phones and Other Wireless Devices Are So New That We Really Don’t Understand The Effects.
- Levels Immediately Above the Standard Are Harmful

# A Comparison of RF exposure from various devices



# References


[1] ANSI C95.1-2005, "Safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz."

[2] OET Bulletin No. 65, FCC, "Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields," Edition 97-01, August 1997.

[3] ANSI C95.3-2002, "Recommended practice for the measurement of hazardous electromagnetic fields - RF and microwave."

[4] Code of Federal Regulation, Title 47, Parts 1.1307 - 1.1310, October 1, 2010.

[5] FCC OET Bulletin 56, 4th Ed., Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields, August, 1999.

[6] EPRI Report #1021126, An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter, December, 2010.

# Partial Vs. Full Body Exposure

- Partial Body Exposure
  - Applies to cell phones and handheld devices
  - 1.6 Watts/kilogram partial body, general public
  - 0.08 Watts/kilogram whole body, general public
  - Averaging time = 30 minutes
- Whole Body Exposure
  - Applies to devices more than 20 cm (8 inches) from human body
  - Limit is frequency-dependent
  - Measured by plane wave equivalent power density
  - Worst case (30-300 MHz) is 200 microwatts/sq. centimeter, public
  - Averaging time = 30 minutes
- Virtually all smart meter exposure is Whole Body Exposure because device is greater than 20 cm (8 inches) from the observer