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BIOENVIRONMENTAL ENGINEERING

Electro-Magnetic Frequency (EMF)

QUALIFICATION TRAINING PACKAGE

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Line Item 4.9.4.5: Determine EMF Maximum Permissible Exposure (MPEs) limits

TRAINER GUIDANCE

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.
Prerequisites:	None
Training References:	AFOSH Std 48-9, *Electro-Magnetic Frequency (EMF) Radiation Occupational Health program*, 14 Dec 2011
Additional Supporting References:	AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012
CDC Reference:	4B051
Training Support Material:	AFOSH Std 48-9, *Electro-Magnetic Frequency (EMF) Radiation Occupational Health program*, 14 Dec 2011: Tables A3.1. MPEs for the Upper Tier and A3.2. MPEs for Lower Tier
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given electro-magnetic frequency (EMF) emitter parameters and listed references, determine EMF Maximum Permissible Exposure (MPE) limits successfully completing all checklist items with limited trainer assistance on only the hardest parts.
Notes:	

TASK STEPS

1. Review/collect emitter data and parameters.[1]
2. Determine the appropriate field(s) to measure.[2]
3. Determine upper and lower tier environment(s).
4. Determine the MPE.[3]
5. Utilize OEHMIS (DOEHRS or equivalent), as applicable.

LOCAL REQUIREMENTS:

NOTES:

1

- Type of system (pulsed or continuous wave)
- Operating frequency (or frequency range)
- Peak power (Pp)/average power
- Pulse repetition frequency (PRF)
- Pulse width (PW)
- Gain

2

- AFOSH STD 48-9 A4.1.3.6.4. All systems operating between 0.003 and 100 MHz shall be evaluated to determine if induced current or contact current limits may be exceeded. Consult with USAFSAM, for a determination regarding the potential for exceeding current limits.
- AFOSH STD 48-9 A4.1.3.6.5. Generally both the E and H fields must be determined for frequencies less than 300 MHz. For frequencies equal to or less than 30 MHz, assessments can only be accomplished by the independent measurement of both field components. The need to measure both E and H fields below 300 MHz derives from a consideration of the spatial variation in E and H field strengths in the reactive near field of an antenna. Both probes are required to measure these fields. Contact USAFSAM for assistance in obtaining required equipment if it is not locally available. For frequencies between 30 and 300 MHz, it may be possible through analysis to show that measurement of only one of the two field components is sufficient.
- AFOSH STD 48-9 A4.1.3.6.6. For frequencies above 300 MHz, only one field component need be measured, usually the E field. MPE boundary locations are to be established by determining the farthest distance from the radiating source that a MPE value (E or H field) can be exceeded using appropriate measurement techniques for the conditions of measurements.
- E = electric field /electromagnetic wave (volts/meter)
- H = magnetic field/electromagnetic wave (amps/meter)
- < 300 MHz both E and H required
- ≤ 30 MHz both E and H independently required
- ≥ 300 MHz usually the E field

3

- Use AFOSH STD 48-9 Tables A3.1. MPEs for the Upper Tier and A3.2. MPEs for Lower Tier

- For an exposure duration *less than* the averaging period, the maximum permissible exposure level is:

$$\text{MPE} * (T_{avg}/T_{exp})$$

T_{exp} is the actual exposure duration in that interval expressed in the same time units as T_{avg}

- If a frequency is not in units of MHz, then it must be converted to MHz before using Tables A3.1 and A3.2 from AFOSH Std 48-9 (i.e., 1 GHz = 1000 MHz).

TRAINEE REVIEW QUESTIONS

Line Item 4.9.4.5: Determine EMF Maximum Permissible Exposure (MPEs) limits

1. Into what two categories are EMF MPEs separated?
2. Which EMF environment would describe the exposure for customers at a golf course near an emitter?
3. Using Tables A3.1 and A3.2 in AFOSH Std 48-9, find the MPE for a four minute exposure to an emitter operating in an upper tier environment at 500 Mhz.

PERFORMANCE CHECKLIST

Line Item 4.9.4.5: Determine EMF Maximum Permissible Exposure (MPEs) limits

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.

DID THE TRAINEE…		YES	NO
1. Review/collect emitter data and parameters?			
2. Determine the appropriate field(s) to measure?			
3. Determine upper and lower tier environment(s)?			
4. Determine the MPE?			
5. Utilize OEHMIS (DOEHRS or equivalent), as applicable?			
Did the trainee successfully complete the task?			

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. Into what two categories are EMF MPEs separated?

A: Upper and Lower Tier

(Source: AFOSH Std 48-9, *Electro-Magnetic Frequency (EMF) Radiation Occupational Health Program*, 14 Dec 2011, p. 10)

2. Which EMF environment would describe the exposure for customers at a golf course near an emitter?

A: Lower Tier

(Source: AFOSH Std 48-9, *Electro-Magnetic Frequency (EMF) Radiation Occupational Health program*, 14 Dec 2011, p. 10)

3. Using Tables A3.1 and A3.2 in AFOSH Std 48-9, find the MPE for a four minute exposure to an emitter operating in an upper tier environment at 500 Mhz.

A: MPE (T_{avg}/T_{exp})= $f_M/30$ (6 min/4 min) = 500/30 (6/4) = 25 W/m^2

(Source: AFOSH Std 48-9, *Electro-Magnetic Frequency (EMF) Radiation Occupational Health program*, 14 Dec 2011, pp. 25-26)

Line Item 4.9.4.6: Calculate EMF hazard distances

TRAINER GUIDANCE

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.
Prerequisites:	4.9.4.5 - Determine EMF Maximum Permissible Exposure (MPEs)
Training References:	AFOSH Std 48-9, *Electro-Magnetic Frequency (EMF) Radiation Occupational Health program*, 14 Dec 2011 AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012
Additional Supporting References:	
CDC Reference:	4B051
Training Support Material:	• EMF emitter specifications • Paper • Writing utensil • Calculator • AFOSH Std 48-9, *Electro-Magnetic Frequency (EMF) Radiation Occupational Health program*, 14 Dec 2011: Tables A3.1. MPEs for the Upper Tier and A3.2. MPEs for Lower Tier
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given electro-magnetic frequency (EMF) emitter parameters, maximum permissible exposure (MPE), and listed references, calculate the hazard distance for an EMF emitter, successfully completing all checklist items with limited trainer assistance on only the hardest parts.
Notes:	

TASK STEPS

1. Determine MPE. [1]
2. Calculate duty factor (DF) and average power (P_{avg}). [2]
3. Calculate absolute gain (G_{abs}). [3]
4. Calculate rotational reduction factor (RRF). [4]
5. Calculate hazard distance (D_{mpe}). [5]
6. Utilize OEHMIS (DOEHRS or equivalent), as applicable.

LOCAL REQUIREMENTS:

NOTES:

1. See 4.9.4.5 - Determine EMF Maximum Permissible Exposure (MPEs)

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2. The DF represents the emitter's total "on time". The P_{avg} represent the average power output between given the percentage of "on time".

The DF for a continuous wave emitter is 1 and the P_{avg} is the rated power of the emitter.

The DF and P_{avg} for a pulsed emitter are calculated as: DF = PW * PRF

- PW is the pulse width; the length of time, in seconds, that each pulse lasts
- PRF is the pulse repetition frequency; the number of pulses that occur in a second
- $P_{avg} = P_{peak} * DF$

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3. Gain of an antenna, also called directivity, is the antenna's ability to concentrate energy in a particular direction expressed in units of decibels (dB).

G_{abs} is a unitless number calculated using the gain: $G_{abs} = 10^{(gain/10)}$

4. RRF is a unitless number indicating the fraction of time an emitter illuminates a given point.

For stationary emitters, the RRF is 1.

For rotating emitters: RRF = beam width/sector size

- beam width is the width of the beam, in degrees
- sector size is the size of the total path of the beam, in degrees

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5.

$$D_{mpe} = \sqrt{\frac{P_{avg} * G_{abs} * RRF}{4 * \pi * MPE}}$$

- D_{mpe} (meters, m)
- P_{avg} (watts, W)
- G_{abs} (unitless)
- RRF (unitless)
- MPE (W/m^2)

D_{mpe} can be converted from meters to feet: D_{mpe} (ft) = D_{mpe} (m) * 3.28

TRAINEE REVIEW QUESTIONS

Line Item 4.9.4.6: Calculate EMF hazard distances

Use the following parameters to answer the questions below.

- MPE - 10 W/m^2
- Antenna Gain (G_{abs}) - 41 dB
- Pulse Width (PW) - 0.32 μs
- Pulse Repetition Frequency (PRF) - 640 pps
- Peak Power (P_p) - 250 kW
- Beam width - 16
- Sector size - 180

1. Calculate the duty factor (DF) and average power (P_{avg}).

2. Calculate absolute gain (G_{abs}) and rotational reduction factor (RRF).

3. Calculate the hazard distance.

PERFORMANCE CHECKLIST

Line Item 4.9.4.6: Calculate EMF hazard distances

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.

DID THE TRAINEE…		YES	NO
1. Determine MPE?			
2. Calculate duty factor (DF) and average power (P_{avg})?			
3. Calculate absolute gain (G_{abs})?			
4. Calculate rotational reduction factor (RRF)?			
5. Calculate hazard distance (D_{mpe})?			
6. Utilize OEHMIS (DOEHRS or equivalent), as applicable?			
Did the trainee successfully complete the task?			

TRAINEE NAME (PRINT)

TRAINER NAME (PRINT)

ANSWERS

Use the following parameters to answer the questions below.

- MPE - 10 W/m^2
- Antenna Gain (G_{abs}) - 41 dB
- Pulse Width (PW) - 0.32 μs
- Pulse Repetition Frequency (PRF) - 640 pps
- Peak Power (P_p) - 250 kW
- Beam width - 16
- Sector size - 180

1. Calculate the duty factor (DF) and average power (P_{avg}).

A:

DF = PW * PRF = $0.32\text{x}10^{-6}$ (s) * 640 (pps) = $2.048\text{x}10^{-4}$

$P_{avg} = P_{peak}$ * DF = 250 (kW) * $2.048\text{x}10^{-4}$ = 0.0512 kW

(Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, pp. 10-11)

2. Calculate absolute gain (G_{abs}) and rotational reduction factor (RRF).

A:

$$G_{abs} = 10^{(\text{gain}/10)} = 10^{(41/10)} = 12{,}589$$

RRF = beam width/sector size = 16 / 180 = 0.0889

(Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, pp. 15, 88)

3. Calculate the hazard distance.

A:

$$D_{mpe} = \sqrt{\frac{P_{avg} * G_{abs} * RRF}{4 * \pi * MPE}} = \sqrt{\frac{(51.2\ \text{W}) * (12{,}589) * (0.0889)}{4 * \pi * 10\ \text{W/m}^2}} = 21.4\ \text{m or } 70\ \text{ft}$$

(Source: AFRL-SA-WP-SR-2013-0003, Base-Level Guide for Electromagnetic Frequency Radiation, Dec 2012, pp. 87)

Line Item 4.9.4.7: Perform EMF measurement surveys

TRAINER GUIDANCE

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.
Prerequisites:	4.9.4.5- Determine MPE 4.9.4.6 - Calculate EMF hazard distances 4.9.4.11- Calculate probe burnout
Training References:	• AFOSH Std 48-9, Electro-Magnetic Frequency (EMF) Radiation Occupational Health program, 14 Dec 2011 • AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012
Additional Supporting References:	• IEEE C95.3-2002 - *IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz-300 GHz* (http://standards.ieee.org/getieee/C95/download/C95.3-2002.pdf)
CDC Reference:	4B051
Training Support Material:	• AF Form 2759 (or equivalent) for a select emitter • EMF meter • Calculator
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given an EMF emitter location and the corresponding AF Form 2759 (or equivalent), perform an EMF site inspection survey successfully completing all checklist items with limited trainer assistance on only the hardest parts.
Notes:	

TASK STEPS

1 Review emitter data and parameters (OEHMIS report, if available). [1]
2 Determine emitter hazard potential. [2]
3 Coordinate a visit with shop supervision.
4 Select/Inspect survey meter.
  4.1 Select the probe that is compatible with the field (E or H) being measured and emitter frequency. [3]
  4.2 Check calibration date.
  4.3 Perform battery/function checks per manufacturer's instructions.
5 Perform pre-survey calculations.
  5.1 Determine the MPE (4.9.4.5) and hazard distance (4.9.4.6).
  5.2 Calculate the reading the meter will display at the MPE. [4]
  5.3 Calculate probe burnout (PD_{max}) for pulsed emitters. [5] (4.9.4.11)
6 Zero the EMF meter in EMF-free area.
7 Prepare the emitter. [6]
8 Provide a complete and proper safety briefing to all personnel involved in the survey
9 Conduct the survey. [7]
10 Utilize OEHMIS (DOEHRS or equivalent), as applicable [8]

LOCAL REQUIREMENTS:

NOTES:

1.

- Before a hazard evaluation can be conducted, potential hazards need to be identified. During the recognition identification phase each emitter should be reviewed to determine the necessity and priority for performing further surveys and measurements during the evaluation phase.
  - Review past surveys of the emitter or similar systems. Workplace folders, DOEHRS, and the EMF Emitter Inventory may be able to provide previous survey data.
  - Review technical orders on the systems and look for parameters and other hazard distance information.
- Use of the EMF Survey Checklist staring on page 68 of AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012 will help to prevent missing any critical information

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2.

- **Ground level hazard emitters** are systems capable of producing power density levels at or above the MPE in areas accessible to personnel at or near ground level. Many aircraft mounted radar and electronic countermeasures (ECM) systems will fall into this category.
- **Climbing hazard emitters** are systems capable of producing levels of EMF in excess of the MPE, but only in areas that require climbing.
- **Inaccessible emitters** are systems capable of producing levels in excess of the MPE, but are not accessible to personnel.
- **Short duration emitters** are systems capable of producing levels in excess of the MPE, but the transmission time is relatively short when compared to the MPE averaging time, under normal operating conditions.

3.

- Generally both the E and H fields must be determined for frequencies less than 300 MHz. For frequencies equal to or less than 30 MHz, assessments can *only* be accomplished by the independent measurement of both field components.
- For frequencies above 300 MHz, only one field component need be measured, usually the E field.

4.

- Find the correction factor (CF) on the probe handle; locate the frequency of the emitter being evaluated, and read the CF for that frequency
- If exact frequency is not listed;
  - If the actual frequency and correction factor frequency are within 10% of each other, chose CF for the closest frequency listed
  - If difference is greater than 10%, do a linear interpolation to determine the CF

$$\mathrm{CF} = \left[\frac{(\mathrm{Frequency} - \mathrm{Frequency_b})(\mathrm{CF_a} - \mathrm{CF_b})}{(\mathrm{Frequency_a} - \mathrm{Frequency_b})}\right] + \mathrm{CF_b}$$

Where:

Frequency = frequency of operation
CF = CF for frequency of operation
$\mathrm{Frequency}_a$ = frequency listed *above* frequency of operation
CF_a = CF for frequency listed *above* frequency of operation
$\mathrm{Frequency}_b$ = frequency listed *below* frequency of operation
CF_b = CF for frequency listed *below* frequency of operation

- Correction factors are multiplied by the meter reading to obtain actual power density; so the reading the meter will display at the MPE = MPE / CF

5.

NOTE: A probe burnout calculation and rating are dependent on the specific instrumentation. Narda Meters (8700, NBM Series) have built in safety mechanisms (alarms) that prevent exceeding the allowable power density that the probe can manage. To determine if you have a burnout rating for your instrument, please reference the manufactures instruction manul. If a burnout rating exists, the calculation below will determine the probe burnout rating. If a burnout rating DOES NOT exist, use the probe overload ratings.

- Calculate duty factor (DF)

$$\mathrm{DF} = \mathrm{PW} \times \mathrm{PRF}$$

Where:

PW = pulse width of emitter
PRF = pulse repetition frequency of emitter

- Identify burnout rating (BR) listed on the probe
- Calculate PD_{max}

$$\mathrm{PD_{max}} = \frac{\mathrm{DF} \times \mathrm{BR}}{\mathrm{CF}}$$

Where:

PD_{max} = maximum meter reading you can have before burnout occurs.
BR = probe burnout rating
CF = probe correction factor (at frequency of operation)

6.

- Worst case operating parameters should be used to define the location of action level MPEs whenever possible (fixed position, highest peak power, highest duty factor, and highest gain), unless the system has been previously measured
- Maintain absolute control thru the emitter operator
- Ensure that no other interfering EMF sources are being operated in the area
- For aircraft mounted radar and electronic countermeasures (ECM) systems
    - Ensure aircraft is positioned with ample clear area in front to preclude unnecessary radiation of other objects
    - Stop antenna dead ahead in azimuth and at zero degrees or slightly above in elevation, if possible

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7.

- Visit the site to determine accessibility, locations, and conditions that present potential hazards.
- Verify the conclusions drawn during the recognition phase.
- To prevent zero drift, connect and turn instrumentation "on" at least 10 minutes before survey measurements are made to allow the electronics to reach equilibrium.
- Measure to identify actual hazard locations and to define controls for these hazards.
- Measurements should be conducted to determine two hazard distances, one for the Upper Tier MPE one for the action level MPE (above the Lower Tier).
- Approach the beam from a safe distance (> calculated/theoretical D_{MPE} distance)
- Avoid placing any body part or the instrument probe between the feedhorn and the reflector during the survey
- Find the beam using the proper probe orientation (out in front and slightly off center)
    - If using an isotropic survey meter, probe handle must be parallel with beam
- Take small steps forward toward the emitter, periodically stopping to determine the beam size, shape, and characteristics
- Conduct measurements using "spatial averaging" technique
- Periodically check the zero of an instrument during survey measurements, especially in one is moving between areas of significantly different ambient temperatures
- Once the meter reaches the reading the meter will display at the MPE, note the location of the probe
- Have the operator shut off the emitter
- Measure distance from the emitter to the location that the MPE was reached (this will be the actual Dmpe)
- Turn on emitter (insure outside actual D_{mpe})
- Survey the area immediately surrounding the antenna looking for hazardous levels of energy
    - Identify reflections, hot spots, side lobes, back scatter etc.
    - Check transmission lines
- Where multiple EMF emitters may be collocated in fixed arrangements, EMF evaluation data should include a determination of the weighted contribution from expected simultaneously operated emitters (unity calculation).

8.

- The inventories will include at a minimum the following categories: Work Center, Point of Contact (POC), POC Phone Number, Emitter Nomenclature (i.e. AN/GRT-21), Emitter Description (i.e. TACAN), Quantity, Frequency Range, Upper Tier and Lower Tier MPEs, and Hazard Distances
- Documentation Requirements.
    - Include a brief hazard assessment narrative summarizing the potential hazards involved with the use and operation of the specific emitter.
    - The exact locations where the MPEs can be exceeded for both Upper and Lower Tier areas should be included and demonstrated in a diagram or photograph.
    - Facilities responsible for the use and operation of emitters capable of producing levels at or above the MPE should also have an entry in DOEHRS.
- Records of surveys, reports, calculations, and control measures imposed shall be maintained for each fielded EMF emitter which is capable of exceeding the MPEs in Attachment 3, Table A3.2 of AFOSH Std 48-9

TRAINEE REVIEW QUESTIONS

Line Item 4.9.4.7: Perform EMF measurement surveys

1. What is the purpose of the hazard distance calculations?
2. What can result from exceeding probe peak power limits during a survey?
3. How should an emitter be configured when performing measurements?

4. If the meter with the information provided below is reading 17 W/m^2 for an emitter operating at a frequency of 933 MHz, what the the true power density?

Frequency	Correction Factor
800	0.67
1000	0.81

PERFORMANCE CHECKLIST

Line Item 4.9.4.7: Perform EMF measurement surveys

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.

DID THE TRAINEE…		YES	NO
1. Review emitter data and parameters (OEHMIS report, if available)?			
2. Determine emitter hazard potential?			
3. Coordinate a visit with shop supervision?			
4. Select/Inspect survey meter			
4.1. Select the probe that is compatible with the field (E or H) being measured and emitter frequency?			
4.2. Check calibration date?			
4.3. Perform battery/function checks per manufacturer's instructions?			
5. Perform pre-survey calculations?			
5.1. Determine the MPE (4.9.4.5) and hazard distance (4.9.4.6)?			
5.2. Calculate the reading the meter will display at the MPE?			
5.3. Calculate probe burnout (PD_{max}) for pulsed emitters?			
6. Zero the EMF meter in EMF-free area?			
7. Prepare the emitter?			
8. Provide a complete and proper safety briefing to all personnel involved in the survey?			
9. Conduct the survey?			
10. Utilize OEHMIS (DOEHRS or equivalent), as applicable?			
Did the trainee successfully complete the task?			

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. What is the purpose of the hazard distance calculations?

   A: To determine the necessity for performing a survey of the emitter and to determine the distance to begin the survey if needed.

(Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, pp. 39, 42)

2. What can result from exceeding probe peak power limits during a survey?

   A: Probe overload or burnout.

(Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, p. 46)

3. How should an emitter be configured when performing measurements?

   A: Worst case operating parameters under fixed-beam conditions should be used to define the location of action level MPEs whenever possible.

   (Source: AFOSH Std 48-9, Electro-Magnetic Frequency (EMF) Radiation Occupational Health program, 14 Dec 2011, p. 37 and AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, p. 68)

4. If the meter with the information provided below is reading 17 W/m^2 for an emitter operating at a frequency of 933 MHz, what the the true power density?

   A:

Frequency	Correction Factor
800	0.67
1000	0.81

$$\mathrm{CF} = \left[\frac{(\mathrm{Frequency} - \mathrm{Frequency_b})(\mathrm{CF_a} - \mathrm{CF_b})}{(\mathrm{Frequency_a} - \mathrm{Frequency_b})}\right] + \mathrm{CF_b} = \left[\frac{(933 - 800)(0.81 - 0.67)}{(1000 - 800)}\right] + 0.67$$

CF = 0.76

Actual power density = meter reading * CF

= 17 W/m^2 * 0.76 = 12.92 W/m^2

(Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, p. 46)

Line Item 4.9.4.10: Use EMF instrumentation

TRAINER GUIDANCE

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step by step procedures for doing the task.
Prerequisites:	None
Training References:	EMF meter user's manual AFRL-SA-WP-SR-2013-0003, Base-Level Guide for Electromagnetic Frequency Radiation , Dec 2012 AFOSH Std 48-9, EMF Radiation Occupational Health Program
Additional Supporting References:	
CDC Reference:	4B051
Training Support Material:	• EMF meter • EMF meter user's manual
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given an electromagnetic frequency (EMF) meter, properly operate the meter successfully completing all checklist items with limited trainer assistance on only the hardest parts.
Notes:	

TASK STEPS

1. Identify EMF survey instruments on-hand.
2. Identify and explain functions of meter parts, operating controls and indicators
3. Identify isotropic probes available and explain select probe specifications (to be identified by trainer).
4. Select the appropriate probe (based on emitter specifications provide by trainer).
5. Connect the probe.
6. Prepare the instrument per the user's manual (i.e., turn on, perform battery check, zero the probe, etc.).
7. Zero the instrument per the user's manual.[1]
8. Demonstrate proper probe orientation during use.
9. Take measurements and record the results.

LOCAL REQUIREMENTS:

NOTES:

1. Zero Drift: Zero drift is inherent with instrumentation that utilizes thermocouples and temperature sensitive components. Premature commencement of a survey without allowing the electronics to reach equilibrium and a change in ambient temperature during a survey are common causes of zero drift. To reduce errors from zero drift, perform the following if needed:

   Connect and turn instrumentation "on" at least 10 minutes before survey measurements are made. Locate instruments in the same environment you intend to survey; it doesn't make much sense to equilibrate instrumentation indoors if one intends to survey outdoors at a different temperature.

   Periodically check the zero of an instrument during survey measurements, especially in one is moving between areas of significantly different ambient temperatures (sunny vs. shaded). To re-zero instrumentation during a survey one can:

   (a) Completely leave the EMF field.

   (b) Completely shield the probe in a metal can or Narda instrument case if it provides shielding.

   (c) Shield the probe with your body. Your body will effectively absorb signals with frequencies higher than 1,000 MHz.

TRAINEE REVIEW QUESTIONS

Line Item 4.9.4.10: Use EMF instrumentation

1. How do you reduce zero drift concerns?

PERFORMANCE CHECKLIST

Line Item 4.9.4.10: Use EMF instrumentation

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.

DID THE TRAINEE…		YES	NO
1. Identify EMF survey instruments on-hand?			
2. Identify and explain functions of meter parts, operating controls and indicators?			
3. Identify isotropic probes available and explain select probe specifications (to be identified by trainer)?			
4. Select the appropriate probe (based on emitter specifications provide by trainer)?			
5. Connect the probe?			
6. Prepare the instrument per the user's manual (i.e., turn on, perform battery check, zero the probe, etc.)?			
7. Zero the instrument per the user's manual?			
8. Demonstrate proper probe orientation during use?			
9. Take measurements and record the results?			
Did the trainee successfully complete the task?			

TRAINEE NAME (PRINT)

TRAINER NAME (PRINT)

ANSWERS

1. How do you reduce zero drift concerns?

A:

(1) Connect and turn instrumentation "on" at least 10 minutes before survey measurements are made. Locate instruments in the same environment you intend to survey; it doesn't make much sense to equilibrate instrumentation indoors if one intends to survey outdoors at a different temperature.

(2) Periodically check the zero of an instrument during survey measurements, especially in one is moving between areas of significantly different ambient temperatures (sunny vs. shaded). To re-zero instrumentation during a survey one can:

(a) Completely leave the EMF field.

(b) Completely shield the probe in a metal can or Narda instrument case if it provides shielding.

(c) Shield the probe with your body. Your body will effectively absorb signals with frequencies higher than 1,000 MHz.

(Source: AFRL-SA-WP-SR-2013-0003, Base-Level Guide for Electromagnetic Frequency Radiation, page 48)

Line Item 4.9.4.11: Calculate probe burnout

TRAINER GUIDANCE

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.
Prerequisites:	4.9.4.5 and 4.9.4.6
Training References:	• AFOSH Std 48-9, Electro-Magnetic Frequency (EMF) Radiation Occupational Health program, 14 Dec 2011 • AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012
Additional Supporting References:	• IEEE C95.3-2002 - *IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz-300 GHz* (http://standards.ieee.org/getieee/C95/download/C95.3-2002.pdf)
CDC Reference:	4B051
Training Support Material:	• Calculator
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given an EMF probe burnout rating, perform a probe burnout calculation successfully completing all checklist items with limited trainer assistance on only the hardest parts.
Notes:	

TASK STEPS

1. Calculate Duty Factor.[1]
2. Identify burnout rating (BR) listed on the probe or in the manufactures operation and maintenance manual.[2]
3. Calculate PD_{max}.[3]

LOCAL REQUIREMENTS:

NOTES:

NOTE: A probe burnout calculation and rating are dependent on the specific instrumentation. Narda Meters (8700, NBM Series) have built in safety mechanisms (alarms) that prevent exceeding the allowable power density that the probe can manage. To determine if you have a burnout rating for your instrument, please reference the manufactures instruction manul. If a burnout rating exists, the calculation below will determine the probe burnout rating. If a burnout rating DOES NOT exist, use the probe overload ratings.

1. Calculate duty factor (DF)

$$\mathrm{DF} = \mathrm{PW} \times \mathrm{PRF}$$

Where:
PW = pulse width of emitter
PRF = pulse repetition frequency of emitter

2. Identify burnout rating (BR) listed on the probe

3. Calculate PD_{max}

$$\mathrm{PD}_{\mathrm{max}=}\frac{\mathrm{DF} \times \mathrm{BR}}{\mathrm{CF}}$$

Where:
PD_{max} = maximum meter reading you can have before burnout occurs.
BR = probe burnout rating
CF = probe correction factor (at frequency of operation)

TRAINEE REVIEW QUESTIONS

Line Item 4.9.4.11: Calculate probe burnout

1. What is the burnout rating for the emitter listed below:

Frequency: 6000 MHz
PW: 2 us
PRF: 360pps
Peak Power: 20 mW
8723D Burnout Rating: 300,000 mW/cm^2

PERFORMANCE CHECKLIST

Line Item 4.9.4.11: Calculate probe burnout

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.

DID THE TRAINEE…		YES	NO
Calculate Duty Factor?			
Identify burnout rating (BR) listed on the probe or in the manufactures operation and maintenance manual?			
Calculate PD_{max}?			
Did the trainee successfully complete the task?			

TRAINEE NAME (PRINT)

TRAINER NAME (PRINT)

ANSWERS

1. What is the burnout rating for the emitter listed below:

    Frequency: 6000 MHz
    PW: 2 us
    PRF: 360pps
    Peak Power: 20 mW
    8723D Burnout Rating: 300,000 mW/cm^2

A:

DF = PW x PRF
DF = (2×10^{-6})(360 pps)
DF = 7.2×10^{-4}

$PD_{max=} \frac{DF \times BR}{CF}$ $PD_{MAX} = \frac{7.2 \times 10^{-4} \times 300{,}000\ mW/cm^2}{1.08}$ $PD_{MAX} =$ 200 mW/Cm2

(Source: Steps from QTP)