DEPARTMENT OF THE AIR FORCE
Headquarters US Air Force
Washington, DC 20330-1030

QTP 4B071-11
24 March 2015

Certified Current 20 MARCH 2024

AIR FORCE SPECIALTY CODE 4B071 BIOENVIRONMENTAL ENGINEERING

Electro-Magnetic Frequency (EMF)

QUALIFICATION TRAINING PACKAGE

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Realeasability: ***There are no releasability restrictions on this publication.***

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STS Line Item 4.9.4.4: Perform EMF risk assessment

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	QTP 4.9.4.5 QTP 4.9.4.6 QTP 4.9.4.7 QTP 4.9.4.10 QTP 4.9.4.11
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:	None
CDC Reference:	4B051
Training Support Material:	AF Form 2759 (or equivalent) for a select emitter
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given an EMF emitter information and the corresponding AF Form 2759 (or equivalent), understand the concepts of performing an EMF risk assessment..

Notes:

1. The following references were used to develop a standardized approach to conduct a health risk assessment for EMF surveys. The completion of the abovementioned prerequisites should be accomplished prior to this QTP.

AFOSH Std 48-9, *Electro-Magnetic Frequency (EMF) Radiation Occupational Health program*, 14 Dec 2011, pg 35-39

AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, pg 39-44.

TASK STEPS

1. Review installation inventory.
2. Identify new technology or changing equipment.
3. Conduct hazard evaluation.
4. Identify evaluation requirements.
5. Perform theoretical hazard evaluations.
6. Perform a site inspection.
7. Perform EMF measurement surveys.
8. Document results.
9. Use proper measurement techniques.
10. Evaluate hazard controls.
11. Assign final risk assessment rating to each source.
12. Utilize OEHMIS (DOEHRS or equivalent), as applicable.

LOCAL REQUIREMENTS:

NOTES:

TRAINEE REVIEW QUESTIONS

STS Line Item 4.9.4.4: Perform EMF risk assessment

1. Why should you evaluate operating procedures by observing work practices during a site inspection survey?

PERFORMANCE CHECKLIST

STS Line Item 4.9.4.4: Perform EMF risk assessment

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

DID THE TRAINEE…		YES	NO
1. Review installation inventory?			
2. Identify new technology or changing equipment?			
3. Conduct hazard evaluation?			
4. Identify evaluation requirements?			
5. Perform theoretical hazard evaluation?			
6. Perform a site inspection?			
7. Perform EMF measurement surveys?			
8. Document results?			
9. Use proper measurement techniques?			
10. Evaluate hazard controls?			
11. Assign final risk assessment rating to each source?			
12. Utilize OEHMIS (DOEHRS or equivalent), as applicable?			
Did the trainee successfully complete the task?			

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. Why should you evaluate operating procedures by observing work practices during a site inspection survey?

A:

Performing a Site Inspection Survey: There are many important aspects to consider during a site visit. This monitoring survey, coupled with the initial hazard estimations, should allow the BE to determine if there are any potentially hazardous areas accessible to personnel. Verify there are no other EMF sources in the same area or overlapping sources. In this survey BE should evaluate existing OIs for effectiveness and evaluate any existing control measures. Take time to note the work practices of shop personnel. Sometimes actual work practices vary considerably from their description!

(Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, pg 40)

STS Line Item 4.9.4.5: Determine electromagnetic frequency (EMF) radiation maximum permissible exposure (MPE) limit

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
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 100% accuracy..
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

STS Line Item 4.9.4.5: Determine electromagnetic frequency (EMF) radiation maximum permissible exposure (MPE) limit

1. Describe and differentiate the concepts of an upper and lower tier environment?

PERFORMANCE CHECKLIST

STS Line Item 4.9.4.5: Determine electromagnetic frequency (EMF) radiation maximum permissible exposure (MPE) limit

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

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?		

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. Describe and differentiate the concepts of an upper and lower tier environment?

A: Upper Tier (formerly, Controlled Environment) MPEs include the following:

3.1.1.1.1. Exposure that may be incurred by personnel who are aware of the potential for EMF exposures conjoined with their employment or duties.

3.1.1.1.2. Exposure of other cognizant individuals.

3.1.1.1.3. Exposure that is the incidental result of passage through such areas where analysis shows the levels may exceed those given in **Attachment 3, Table A3.2, Part E and F**, but do not exceed those values in **Table A3.1, Part E and F**.

3.1.1.2. Lower Tier (formerly, Uncontrolled Environment) MPEs. Lower Tier exposures can occur in areas where individuals would have no knowledge or control of their exposure. These locations include living quarters or workplaces where there are no expectations that the exposure levels may exceed those shown in **Attachment 3, Table A3.2**.

(Source: AFOSH STD 48-9)

STS Line Item 4.9.4.6: Calculate EMF hazard distance

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	Training Module 4.9.4.5 - Determine EMF Radiation Maximum Permissible Exposure (MPE) Limit
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:	
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 NO trainer assistance.
Notes:	

TASK STEPS

1. Determine MPE. [1]
2. Calculate duty factor (DF) and average power (P_{avg}). [2]
   - Continuous wave emitter
   - Pulsed emitter
3. Calculate absolute gain (G_{abs}). [3]
4. Calculate rotational reduction factor (RRF). [4]
   - Stationary emitters
   - Scanning emitters
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)

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
   - $P_{avg} = P_{peak} * DF$

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

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

STS Line Item 4.9.4.6: Calculate EMF hazard distance

Use the following parameters to answer the questions below:

- MPE: 42.2 W/m^2
- Frequency: 1265 MHz
- Antenna Gain (G_{abs}) - 41 dB
- Pulse Width (PW) - 0.12 µs
- Pulse Repetition Frequency (PRF) – 72 pps
- Peak Power (P_p) – 4 MW
- Beam width – 1.3
- Sector size - 360

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

STS Line Item 4.9.4.6: Calculate EMF hazard distance

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

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?			

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TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

Use the following parameters to answer the questions below:

- MPE: 42.2 W/m^2
- Frequency: 1265 MHz
- Antenna Gain (G_{abs}) - 41 dB
- Pulse Width (PW) - 0.12 µs
- Pulse Repetition Frequency (PRF) – 72 pps
- Peak Power (P_p) – 4 MW
- Beam width – 1.3
- Sector size - 360

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

A:

DF = PW * PRF = 8.64 x 10^{-4}

Pavg = 400000 W x 0.000864 = 3456 W

(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:

$$G_{abs} = 10^{(gain/10)} = 10^{(35/10)} = 3{,}162$$

RRF = beam width/sector size = 1.3 / 360 = 0.0036

(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:

$$D_{mpe} = \sqrt{\frac{P_{avg} * G_{abs} * RRF}{4 * \pi * MPE}} = \sqrt{\frac{(3456\ W) * (3162) * (0.0036)}{4 * \pi * 42\ W/m^2}} = 8.63 \text{ m or } 28 \text{ ft}$$

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

STS Line Item 4.9.4.7: Perform EMF measurement surveys

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
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 RFR site inspection survey successfully completing all checklist items with NO trainer assistance.
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
$\mathrm{CF_a}$ = CF for frequency listed *above* frequency of operation
$\mathrm{Frequency_b}$ = frequency listed *below* frequency of operation
$\mathrm{CF_b}$ = 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 $\mathrm{PD_{max}}$

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

Where:

$\mathrm{PD_{max}}$ = 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

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

STS Line Item 4.9.4.7: Perform EMF measurement surveys

1. Explain the purpose of an EMF pre-survey process?
2. Summarize the two types of surveys BE can accomplish (Emitter site inspection survey and Measurement survey)?

PERFORMANCE CHECKLIST

STS Line Item 4.9.4.7: Perform EMF measurement surveys

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

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 with zero trainer assistance?			

TRAINEE NAME (PRINT)

TRAINER NAME (PRINT)

ANSWERS

1. Explain the purpose of an EMF pre-survey process?

A: Below are a few examples/acceptable answers of tasks that need to be accomplished during the pre-survey:

- Coordinate arrangements for the survey
- Ensure other required safety controls are in place
- Perform calculations
- Check equipment

(Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, pg 68)

2. Summarize the two types of surveys BE can accomplish (Emitter site inspection survey and Measurement survey)?

A:

Emitter site inspection survey: Survey of an emitter site to determine accessibility of EMF emitters to personnel, how the emitter is used, and the condition of the control measures.

Measurement survey: Near and far-field calculations need to be done prior to surveying. In the event that calculations are not made prior to monitoring, special monitoring concerns will come into play when crossing from the far field and entering the near field. Separate measurements of both the electric and magnetic fields should be made until it is certain that one is well outside the near field before relying on a single probe. A single probe is used only when the electric and magnetic fields are proportional and interchangeable, that is, the ratio of the two remains constant through space (i.e. far field). Measurement surveys will be performed to determine levels of EMF in regions accessible to personnel.

(Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, p. 40)

STS Line Item 4.9.4.9: Investigate potential EMF overexposures or accidents

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	None
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:	Local checklist, if available
CDC Reference:	4B051
Training Support Material:	• EMF Radiation exposure scenario • Local checklist, if available • Paper • Writing utensil • Calculator • MPE tables from AFOSH Std 48-9
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given an EMF exposure scenario, perform an investigation successfully completing all checklist items with NO trainer assistance.
Notes:	

TASK STEPS

1. Report the incident to the ESOH Service Center at **https://kx.afms.mil/esoh /** or 1-800-473-3549 or DSN: 798-3764.
2. Complete and send in a DoD Tri-Service EMF accident/incident reporting form, per DoDI 6055.11 and AFOSH Std 48-9.
3. Determine if the exposure was 5 times the MPE? If so, proceed to next step
4. Perform field EMF measurements at the location for documentation of the EMF exposure. This is done to verify actual levels which can often be less the calculated levels.
5. Verify exposed member received a medical examination and review recommendations for medical follow-up.
6. Document the circumstances surrounding the exposure incident, statements from personnel involved in that incident, and recommendations to prevent similar occurrences.
7. Investigate.[1]
8. Prepare a report summarizing the investigation within 30 days following completion.[2]

LOCAL REQUIREMENTS:

NOTES:

1. Take care to protect yourself and your instrument while reconstructing the incident. Make measurements with the system set up, as nearly as possible, as it was when the incident occurred. It may be that the power density at the point of exposure is greater than the measuring capability of your instrument (Narda 8723D, Max Scale= 100 mW/cm2). If this is the case, you should make multiple measurements starting at, say, 10 mW/cm2 and move up in increments until you reach the limit. These data can be plotted on a spreadsheet and the actual exposure value can be estimated by extrapolation. Also, USAFSAM has Narda 8715 probes that allow measurements up to 2000 mW/cm2. These probes are being phased out, Narda's newest probes, part of the NBM Series, will similarly allow measurements up to 1500 mW/cm2.

   When determining the total exposure, you must know the duration of the exposure. This can be very tricky, because the time estimates of the exposee and witnesses can be and are usually very exaggerated. Ask the exposee to repeat his/her actions and use a stop watch to get a better idea of the actual exposure time. The shorter the time, the more important this becomes.

   Photographs are a very important part of your investigation. With the transmitter shut down, ask everyone to position themselves exactly as they were during the incident. Then take photographs from a few different angles. You can have the base photo lab do the photography, but you must tell them exactly what you want.

2. BE provides the report to supervision owning the EMF source and AF/SE, who then have <5 days to summarize the entire investigation (see AFOSH Std 48-9 for report requirements) and distribute it.

TRAINEE REVIEW QUESTIONS

STS Line Item 4.9.4.9: Investigate potential EMF overexposures or accidents

1. We must take the required actions for an EMF investigation when the exposure is expected to be what?
2. When investigations determine that personnel are found to be exposed at levels 5 times the MPE, explain the EMF investigation steps that must be done,

PERFORMANCE CHECKLIST

STS Line Item 4.9.4.9: Investigate potential EMF overexposures or accidents

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

DID THE TRAINEE…	YES	NO
1. Report the incident to the ESOH Service Center at **https://kx.afms.mil/esoh /** or 1-800-473-3549 or DSN: 798-3764?		
2. Complete and send in a DoD Tri-Service EMF accident/incident reporting form, per DoDI 6055.11 and AFOSH Std 48-9?		
3. Determine if the exposure was 5 times the MPE?		
4. Perform field EMF measurements at the location for documentation of the EMF exposure. This is done to verify actual levels which can often be less the calculated levels?		
5. Verify exposed member received a medical examination and review recommendations for medical follow-up.		
6. Document the circumstances surrounding the exposure incident, statements from personnel involved in that incident, and recommendations to prevent similar occurrences?		
7. Investigate?		
8. Prepare a report summarizing the investigation within 30 days following?		

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. We must take the required actions for an EMF investigation when the exposure is expected to be what?

   A: Five times greater than the MPE

   (Source: AFOSH STD 48-9, *Electro-Magnetic Frequency (EMF) Radiation Occupational Health program*, 14 Dec 2011, pages 42-43)

2. When investigations determine that personnel are found to be exposed at levels 5 times the MPE, explain the EMF investigation steps that must be done,

   A: Where investigations determine that personnel are found to be exposed at levels 5 times the MPE value, they must:

   a) Perform field EMF measurements at the location for documentation of the EMF exposure. This is done to verify actual levels which can often be less the calculated levels.

   b) Receive a medical examination and recommendations for medical follow-up. Public Health personnel will complete the AF FORM 190 and the EMF Overexposure Medical Format forms found in Appendix J of this Guide. These forms are also available through USAFSAM ESOH Service Center.

   c) Documentation must be provided with a description of the circumstances surrounding the exposure incident, statements from personnel involved in that incident, and recommendations to prevent similar occurrences.

   d) If desired, call EMF Hotline at 1-888-232-ESOH (3764), and discuss the incident with USAFSAM. They can help insure that there are no steps overlooked and advise you on how to proceed.

   (Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012 (pg 53)

STS Line Item 4.9.4.10: Use EMF instrumentation

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	None
Training References:	EMF meter user's manual AFRL-SA-WP-SR-2013-0003, Base-Level Guide for Electromagnetic Frequency Radiation, Dec 2012
Additional Supporting References:	AFOSH Std 48-9, Electro-Magnetic Frequency (EMF) Radiation Occupational Health program, 14 Dec 2011
CDC Reference:	4B051
Training Support Material:	• Conduct hands-on training and evaluation.
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given an electromagnetic frequency (EMF) meter, explain how to properly operate the meter successfully completing all checklist items with NO trainer assistance.
Notes:	

TASK STEPS

1. Identify EMF survey instruments on-hand.
2. Identify if the EMF survey instrument is a narrow band or broadband instrument.
2. Identify and explain functions of meter parts, operating controls and indicators.
3. Identify isotropic probes available and explain probe specifications.
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.

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 is a common cause 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

STS Line Item 4.9.4.10: Use EMF instrumentation

1. Explain the types of electric and magnetic meters (i.e. Field Strength Meters and Narrowband Meters)?

PERFORMANCE CHECKLIST

STS Line Item 4.9.4.10: Use EMF instrumentation

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

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?		

TRAINEE NAME (PRINT)

TRAINER NAME (PRINT)

ANSWERS

1. Explain the types of electric and magnetic meters (i.e. Field Strength Meters and Narrowband Meters)?

   A: Electric and Magnetic Field Strength Meters: Electric and magnetic field strength meters are narrowband devices. Examples of these Narda meters are noted below in Figure 18a. All the 8700 series meters have interchangeable probes for electric and magnetic fields. They consist of an antenna, cable(s) to carry the signal from the antenna, and a signal conditioning/readout instrument. Narda's newest broadband field meters plug-and-play probe interface with automatic probe parameter detection (see Figure 18b).

   Field strength meters may use linear antennas, such as monopoles, dipoles, loops, biconical or conical log spiral antennas, horns or parabolic reflectors. The appropriate field parameters can be determined from a measurement of voltage or power at the selected frequency and at the antenna terminal. The electric (or magnetic) field strength can be derived from information on the antenna gain or antenna factor and the loss in the connecting cable.

(Source: AFRL-SA-WP-SR-2013-0003, Base-Level Guide for Electromagnetic Frequency Radiation, Dec 2012, pg 49-50)

STS Line Item 4.9.4.11: Calculate probe burnout

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	QTP 4.9.4.5 and QTP 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 PD_{max} rating, determine if a probe will experience a burnout successfully completing all performance checklist items with NO trainer assistance.
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]
4. Determine if the probe has a potential to burnout.

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

STS Line Item 4.9.4.11: Calculate probe burnout

1. What is the burnout rating for the emitter listed below: Frequency: 5050 MHz PW: 14 us PRF: 220pps Peak Power: 100 mW Burnout Rating: 300,000 mW/cm^2 CF = 0.96
2. Using the PD_{MAX} answer in question 1, is there a potential for probe burnout if the overload value of the probe is 2160 W/m^2 ?

PERFORMANCE CHECKLIST

STS Line Item 4.9.4.11: Calculate probe burnout

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

DID THE TRAINEE…		YES	NO
Calculate Duty Factor?			
Identify burnout rating (BR) listed on the probe or in the manufacturer's operation and maintenance manual?			
Calculate PD_{max}?			
Determine if the probe has a potential to burnout?			
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: 5050 MHz
   PW: 14 us
   PRF: 220pps
   Peak Power: 100 mW
   Burnout Rating: 300,000 mW/cm^2
   CF = 0.96

   A:
   DF = PW x PRF
   DF = (14×10^{-6})(220 pps)
   DF = 3.08×10^{-3}

   $PD_{max=} \frac{DF \times BR}{CF}$ mW/Cm2 $PD_{MAX} = \underline{3.08 \times 10^{-3} \times 300{,}000\ mW/cm^2}$ $PD_{MAX} =$ 962

   Burnout rating = 0.96

2. Using the PD_{MAX} answer in question 1, is there a potential for probe burnout if the overload value of the probe is 2160 W/m^2 ?

Yes, PD_{max} = 962 mW/cm^2 = (9620 W/m^2 or 9.62 kW/m^2) > Overload value 2160 W/m^2

(Source: AFRL-SA-WP-SR-2013-0003, *Base-Level Guide for Electromagnetic Frequency Radiation*, Dec 2012, pg 47)