CHAPTER 7

METEOROLOGICAL PRODUCTS AND TACTICAL DECISION AIDS

The tasks of the Aerographer have expanded tremendously in recent years. Aerographers provide on-scene commanders with a multitude of forecast aids that greatly influence the success of surface and airborne evolutions.

In this chapter we will discuss various computer-generated products that support the planning and execution of successful surface and land-based operations. We will be describing TESS 3 products that are useful as tactical decision aids, but other products of benefit as tactical decision aids may be found in the *Navy Oceanographic Data Distribution System* (NODDS) *Products Manual*, the *Naval Integrated Tactical Environmental Sub-System* (NITES), the *National Oceanography Data Distribution Exchange System* (NODDES), and the *Joint Maritime Combat Information System* (JMCIS).

The intent of this chapter is to provide the forecaster with an introduction to forecaster aids. The applications, limitations, assumptions, and functional descriptions of various aids to the forecaster will be discussed. For operator guidelines, functional descriptions, and technical references refer to the respective operator's manual or NAVMETOCCOM instructions.

First, we will discuss computer-generated aids that are referenced in the *Tactical Environmental Support System (TESS (3)) and Shipboard Meteortological and Oceanographic Observing System (SMOOS) Operator's Manuals.*

ELECTRONIC COUNTERMEASURES (ECM) EFFECTIVENESS

LEARNING OBJECTIVES: Interpret ECM effectiveness display parameters. Recognize optimum locations and flight paths. Identify applications, limitations, and assumptions. Analyze an example output display.

This program provides the capability to determine the optimum locations and flight paths of attack and tactical jamming aircraft by evacuating the effectiveness of a jamming device against a victim radar (user specified) under given atmospheric conditions. Mission planners use this program to determine optimum placement, and ECM outputs are also used to prepare aircrew briefs.

APPLICATION

The ECM effectiveness display program provides airborne jammer effectiveness against surface-based radars. Signal strength is calculated and displayed with respect to height for five equally spaced ranges. Input to the program consists of the victim radar and jammer of interest and a refractivity data set from the refractivity data file (RDF).

The victim radar and jamming characteristics are entered/edited using the platform and jammer options, respectively, from the electromagnetic system file (EMFILE). The refractivity data are entered via the Environmental Status option of the electromagnetic (EM) propagation suite of programs.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the ECM program areas follows:

- The ECM program assumes horizontal homogeneity of the atmosphere (horizontal changes in the refractivity structure of the atmosphere are not accounted for).
- The use of this program is valid only for radars and jammers with frequencies between 100 MHz and 20 GHz.
- Effects produced by sea or land clutter are not accounted for.
- No account is made for absorption of oxygen, water vapor, fog, rain, snow, or other atmospheric particulate matter. In general, the contribution of

absorption to propagation loss is small compared to refractive effects.

- ECM accounts for the ducting in evaporative ducts, surface-based ducts, and low-elevated ducts, provided the victim radar antennas are within the elevated duct. The program does not, however, properly account for the over-the-horizon region for low-elevated ducts when the bottom of the duct is above the antenna height.

- The victim radar must be surface-based.

- Prior to running this program, a primary refractivity data set must be selected.

- Output from this program is classified and labeled corresponding to the classification of the radar or jammer.

FUNCTIONAL DESCRIPTION

The ECM display program provides a plot of signal strength relative to the free-space value versus height for five equally spaced discrete ranges.

Figure 7-1 shows an example output of the ECM effectiveness display. The ECM output consists of five displays. The displays suggest optimum altitude at each range for most effective jamming. Jamming is most effective where the plotted line is farthest to the right on each display.

D-VALUES (DVAL)

LEARNING OBJECTIVES: Define the DVAL program. Recognize program inputs. Identify applications, limitations, and assumptions. Explain an example of the D-value profile.

The DVAL program is used to compute profiles of D-values. A D-value is defined as the difference between the actual height above mean sea level (MSL) of a particular isobaric surface and the height of the same pressure surface in the U.S. Standard Atmosphere. Program input consists of temperature and geopotential height profiles with respect to pressure, output altitude increment, and specification of units for which the output is desired.

APPLICATION

D-values are used by naval aviators to make pressure-bomb detonation altitude corrections.

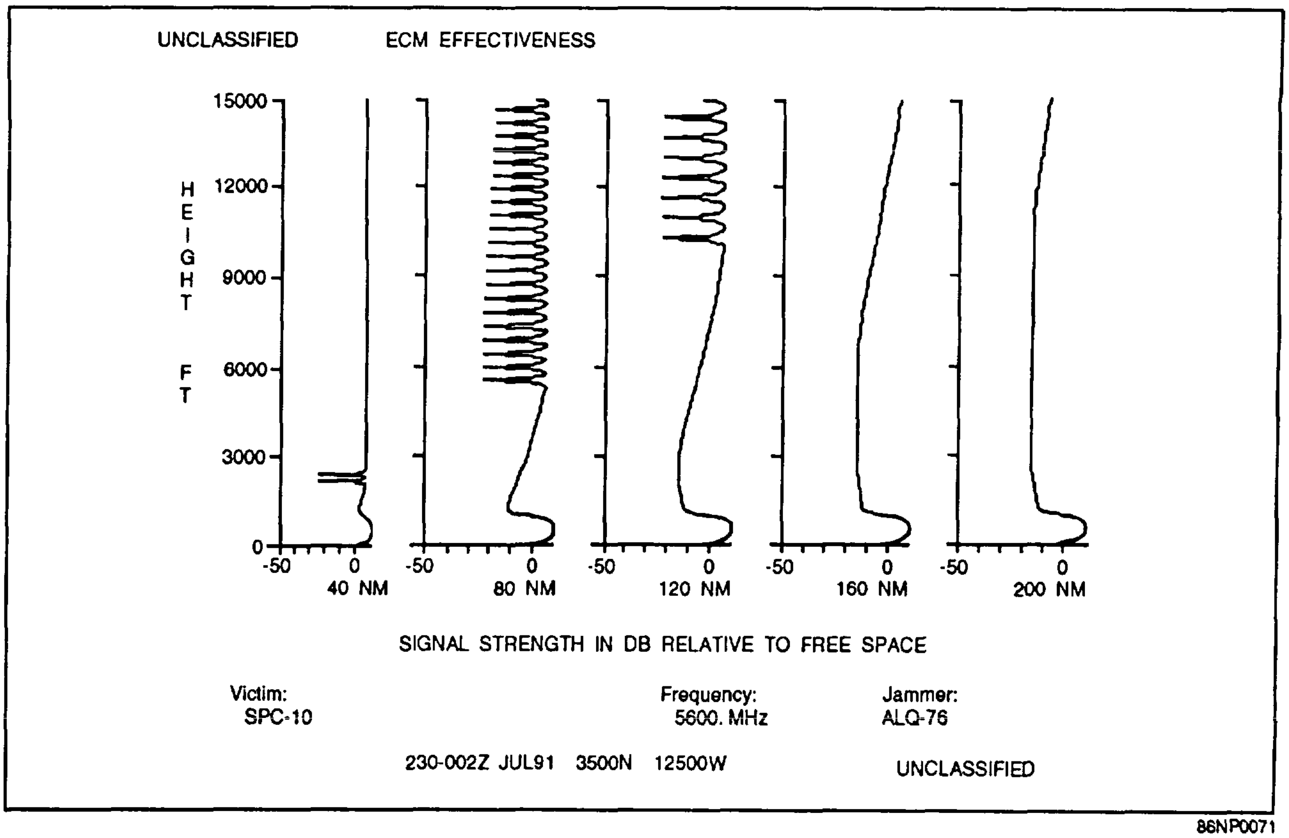


Figure 7-1.-Example output of the ECM effectiveness display.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the DVAL program areas follows:

- The algorithm used by this program applies to a maximum altitude of 11,000 geopotential meters.

- The D-value for MSL is determined by extrapolating the pressure and temperature data to MSL by using the data for the first two levels of the entered environmental profile. Caution should be exercised in determining over-water surface D-values using radiosonde data from a coastal location when the balloon-release height is >50 meters.

FUNCTIONAL DESCRIPTION

AD-value is defined as a difference in the observed height of a particular isobaric surface and the height associated with that isobaric surface in the U.S. Standard Atmosphere. Table 7-1 shows an example of the D-value profile.

Table 7-1.-Example Output of the D-Value Profile

UNCLASSIFIED		D-VALUE PROFILE			
ALT.(F)	D-VALUE(F)	ALT.(F)	D-VALUE(F)	ALT.(F)	D-VALUE(F)
.0	1.4	9500.0	28.8	19000.0	42.4
500.0	3.1	10000.0	29.7	19500.0	43.1
1000.0	4.8	10500.0	30.1	20000.0	44.0
1500.0	6.6	11000.0	30.6	20500.0	45.0
2000.0	8.3	11500.0	31.0	21000.0	46.1
2500.0	10.1	12000.0	31.5	21500.0	47.4
3000.0	11.9	12500.0	32.0	22000.0	48.9
3500.0	13.7	13000.0	32.6	22500.0	50.5
4000.0	15.5	13500.0	33.2	23000.0	52.3
4500.0	17.4	14000.0	33.8	23500.0	54.2
5000.0	18.9	14500.0	34.5	24000.0	56.1
5500.0	20.1	15000.0	35.2	24500.0	57.8
6000.0	21.2	15500.0	36.0	25000.0	59.4
6500.0	22.2	16000.0	36.9	25500.0	61.0
7000.0	23.3	16500.0	37.8	26000.0	62.5
7500.0	24.4	17000.0	38.8	26500.0	63.9
8000.0	25.5	17500.0	39.8	27000.0	65.2
8500.0	26.6	18000.0	40.9	27500.0	66.4
9000.0	27.7	18500.0	41.8	28000.0	67.6
		171255 UTC AUG86 3500N 01500E			
UNCLASSIFIED					

BATTLE GROUP VULNERABILITY (BGV)

LEARNING OBJECTIVES: Interpret BGV graphic depictions and identify their uses. Identify applications, limitations, and assumptions. Analyze an example of the BGV display.

BGV provides estimates of the vulnerability of the various platforms in a battle group to a specified electronic support measure (ESM) system under varying environmental conditions. The vulnerability estimate for an individual platform is expressed as the maximum intercept range of all active emitters on the platform. A graphic depicting the vulnerability of the battle group is displayed. Intercept ranges for surface-to- air, air-to-air, and air-to-surface can be calculated.

APPLICATION

The emission control (EMCON) planner uses BGV to assess the effectiveness of EMCON plans and to optimize platform position. The object is to minimize the battle group's vulnerability to counterdetection.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in running the BGV program are as follows:

- Make sure the environment selected from the refractivity data set is indicative of the location and time of interest. BGV is range- and time-independent.
- The maximum intercept range output is limited to 1000 km (541 nmi). The atmosphere is usually not horizontally homogeneous over these great distances.
- BGV doesn't account for absorption of electromagnetic (EM) energy, In general, the absorption of EM energy by things such as oxygen, water vapor, fog, rain, snow, and soon, adds little to the propagation loss. Refraction is considered the main factor in transmission.
- BGV is valid for frequencies between 100 MHz and 20 GHz.
- Sea-reflected interference is also considered only if the receiver or emitter is below 100 m.
- The effects of surface-based ducts are considered to dominate any contributions from the evaporative duct.
- BGV assumes the emitters are radiating at peak power.
- The probability of detection associated with the output ranges depend upon the probability of detection associated with receiver sensitivities.
- If you are attempting to verify ESM intercept ranges achieved by your own receiver, remember that BGV outputs maximum intercept range. If a platform's emitters are not turned on at that range, there will be nothing to intercept.

FUNCTIONAL DESCRIPTION

BGV computes the maximum ESM intercept range (ESMR) of an emitter. ESMR is computed only if the emitter's frequency falls within one of the frequency bands of the receiver.

Figure 7-2 shows an example of the BGV display. The center of axis corresponds to the formation center, and the top of the screen is north. Each platform's location is marked by an X. The shaded circle around each platform has a radius equal to the longest ESMR associated with that platform. The shaded area as a whole represents the battle group's area of vulnerability to ESM counterdetection.

ELECTROMAGNETIC PATH LOSS VERSUS RANGE (LOSS)

LEARNING OBJECTIVES: Interpret LOSS display parameters. Recognize optimum locations and flight paths. Identify limitations and assumptions. Explain functional description.

The LOSS program provides a display of one-way path loss vs. range or path loss for ESM intercept vs. range. The ESM systems, radar, communication, or sonobuoys are prepared for LOSS by the EMFILE maintenance program. The EM system's transmitter heights (if airborne) and the target or receiver heights are entered during the program run. The RDF is presented for refractive environment selection each time LOSS is run.

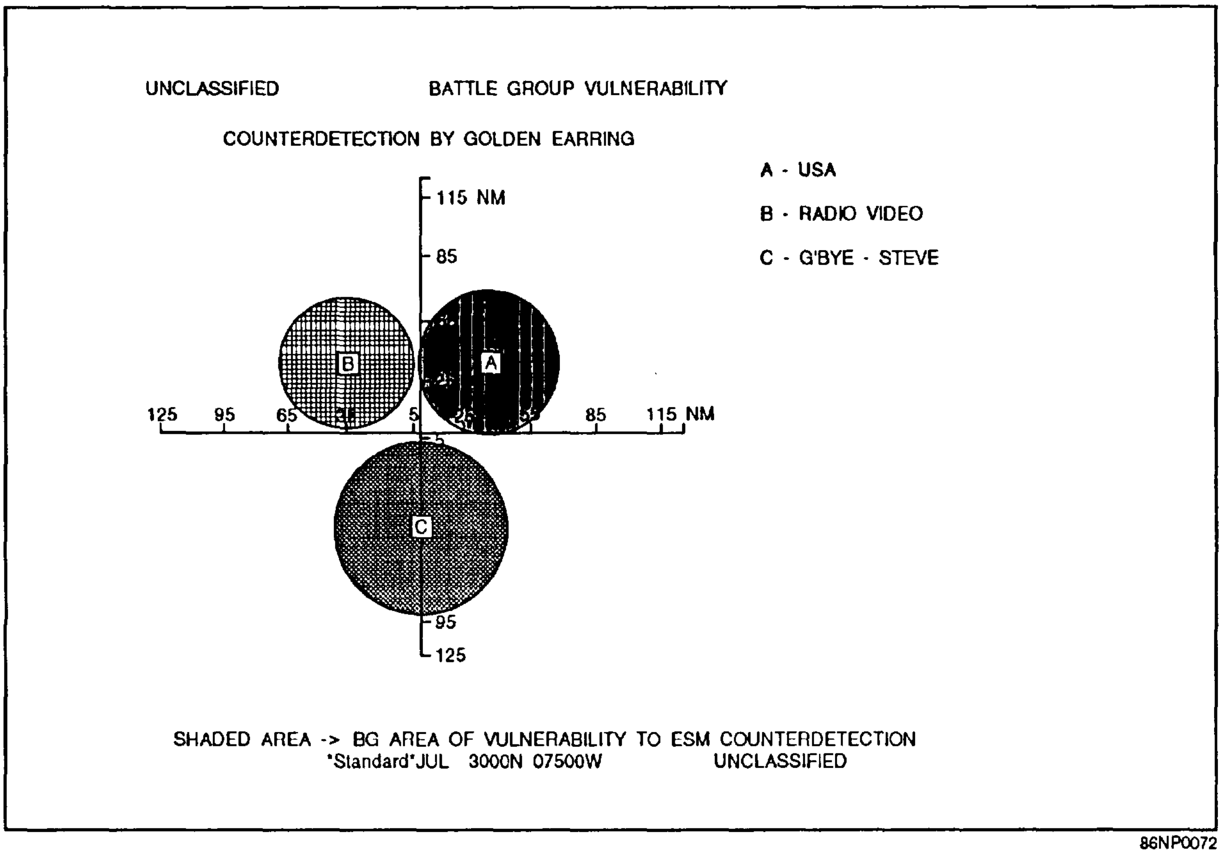


Figure 7-2.-Example output of the BGV display.

APPLICATION

The LOSS program is used to assess the performance of a user-specified EM system under given atmospheric conditions. Path loss vs. range is displayed with the system's path-loss thresholds (calculated from the user-specified freespace ranges if not entered), allowing the determination of maximum detection, communication, or intercept range.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the LOSS program are as follows:

- LOSS assumes horizontal homogeneity (horizontal changes in the refractivity structure of the atmosphere are not accounted for).

- LOSS is valid only for EM systems with frequencies between 100 MHz and 20 GHz.

- LOSS does not include any effects produced by sea or land clutter in the calculation of detection or communication ranges. This shortcoming may be important to air-search radars in the detection of targets flying above surface-based ducts or strong evaporation ducts, but it is not expected to significantly affect the predicted enhanced detection ranges within a duct. Specifically, for surface-based ducts, the actual detection capability at some ranges maybe reduced for air targets flying above the duct.

- The model that calculates the LOSS display for surface-based systems is valid only for antenna heights between 1 and 200 m inclusive, and the program will not accept heights outside these bounds, except in the case of sonobuoys where the height is nominally 0.5 m.

- The airborne-loss display model does not include sea-reflected interference effects, which could cause both reduced and enhanced path loss for low-flying radar or radar targets. The surface-loss display model does not account for sea-reflected interference effects. Only the minimum path loss within each lobe of the interference region is plotted when the spacing between lobes becomes very close.

- There is no account made for absorption of EM energy from oxygen, water vapor, fog, rain, snow, or other particulate matter in the atmosphere. In general, the contribution of absorption to propagation loss is small.

- LOSS accounts for ducting in evaporation ducts, surface-based ducts, and low-elevated ducts, provided the transmitter of the radar antenna is within the duct. The program does not properly account for the over-the-horizon region for low-elevated ducts when the bottom of the duct is above the transmitter or radar antenna height. The calculated path-loss values for the LOSS display will generally be greater than the corresponding actual values. The errors become less the higher the elevated duct is above the transmitter or radar antenna height and should be insignificant when the separation exceeds a few thousand feet.

- The LOSS display can be used for the following applications:

  — Long-range air-search radars, surface-based or airborne.

  — Surface-search radars when employed against low-flying air targets and surface-based combatants that are large in comparison to the sea state.

  — To determine the intercept range of radar, sonobuoy, or communications systems by an ESM receiver. The ESM receiver used in this application is chosen during preparation of the ESM system for LOSS.

  — Airborne surface-search radars when the surface radar target is large in comparison to the sea clutter. The target should also beat a considerable distance from the radar. LOSS considers targets as point sources. Close in-range targets are seen by the radar as distributed targets.

  — Surface-to-air or air-to-air communications systems.

- The LOSS display should not be used for the following applications:

  — Most types of gun or missile fire-control radar.

  — Small surface targets, for example, periscopes.

- Prior to running this program, a primary refractivity data set must be selected.

- Output from this program is classified and should be labeled corresponding to the classification of the EM system used to produce the display.

- Effects of wave splash, wave shadowing, bobbing, and rolling are not taken into account for sonobuoy output.

FUNCTIONAL DESCRIPTION

LOSS produces an EM path loss with respect to range display, and it plots the path-loss thresholds (computed using the user-specified free-space ranges if not entered) as horizontal lines on the display. The program is structured so that two processing paths exist, and the path taken depends upon the type of system used (surface-based or airborne).

Figure 7-3 shows an example of the LOSS display. The LOSS display is a graph of energy loss (dB) plotted along range (nmi or km). There can be up to four horizontal dotted lines present on the graph. These lines correspond to the computed or entered free-space ranges for the EM system. The intersections of the plotted line and the horizontal lines indicate the path-loss threshold values along the vertical axis and the range at which they occur on the horizontal axis. The path-loss threshold is the minimum amount of energy necessary for the EM system to detect, communicate, or be detected. The plotted line may crisscross the horizontal lines due to interference effects.

ELECTRONIC SUPPORT MEASURE (ESM) PROGRAM

LEARNING OBJECTIVES: Describe the necessary data for the ESM program and interpret the output. Identify limitations and assumptions. Interpret the ESM range tables.

The ESM program is used to calculate and display the maximum intercept ranges of U.S. and Russian surface emitters by user-specified ESM receivers. Input to the program consists of receiver and emitter characteristics from the data base file and a refractivity data set from the environmental data files (EDFs). The refractivity data set consists of a modified refractive index (M-unit) profile with respect to height, the height of the evaporation duct, and the surface wind speed.

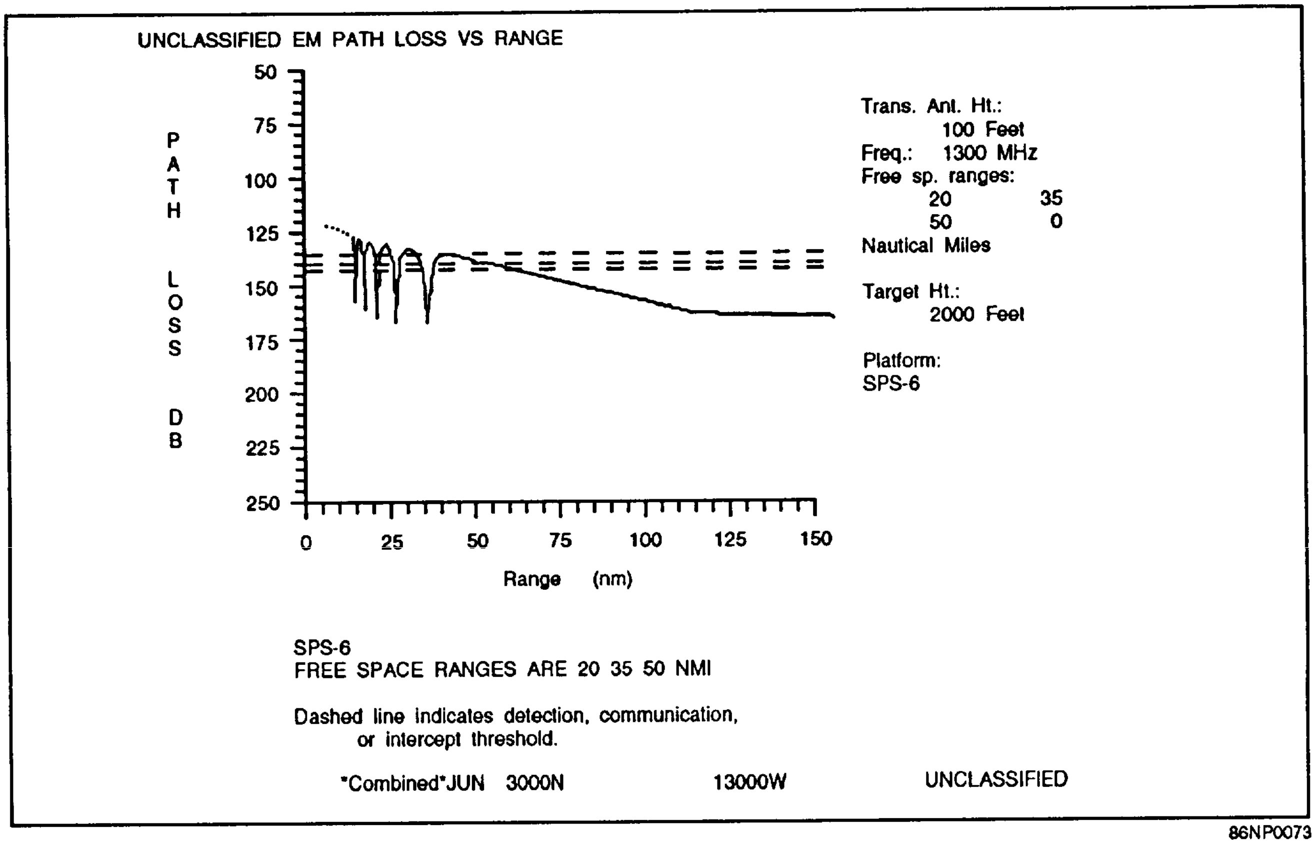


Figure 7-3.-Example output of the LOSS display.

APPLICATION

ESM range tables provide the capability to determine the probable effectiveness of various ESM receivers against a predefine set of both U.S. and Russian emitters. This allows the development of an ESM employment plan that maximizes the potential for detecting target emitters.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the ESM program areas follows:

- Make sure the environment selected from the refractivity data set is indicative of the location and time of interest. The ESM program is range- and time-independent.

- The maximum intercept range output is limited to 1000 km (541 nmi). The atmosphere is usually not horizontally homogeneous over these great distances.

- Emitters are limited to a preset list. If you wish to find the ESM intercept range of some other emitter, use the Platform Vulnerability (PV) program.

- Emitter frequencies are nominal frequencies. Intercept ranges of zero indicate that this nominal frequency does not fall within the prescribed receiver's bandwidth.

- The ESM program does not account for absorption of EM energy. In general, the absorption of EM energy by things such as oxygen, water vapor, fog, rain, or snow adds little to the propagation loss. Refraction is considered the main factor in transmission.

- The ESM program is valid for frequencies between 100 Mhz and 20 GHz.

- Sea-reflected interference is considered.

- ESM accounts for ducting in evaporation ducts, surface-based ducts, and low-elevated ducts, provided the antenna is within the elevated duct. This program does not properly account for the over-the-horizon region for low-elevated ducts when the bottom of the duct is above the antenna. Errors are small and should be insignificant when the separation exceeds a few thousand feet.

- The effects of a surface-based duct are considered to dominate any contributions from the evaporation duct.

- The ESM program assumes the emitters are radiating at peak power.

- The probability of detection associated with the output ranges depends upon the receiver sensitivities.

- If you are attempting to verify ESM intercept ranges achieved by your own receiver, remember that PV outputs maximum intercept ranges. If a platform's emitters aren't turned on at that range, there will be nothing to intercept.

FUNCTIONAL DESCRIPTION

ESM computes the maximum ESMR of an emitter. ESMR is computed only if the emitter's frequency falls within one of the frequency bands of the receiver. Table 7-2 shows an example of ESM range tables.

PLATFORM VULNERABILITY (PV)

LEARNING OBJECTIVES Interpret PV outputs to assess vulnerability of various emitters. Identify limitations and assumptions. Interpret an example output of the PV program.

PV provides estimates of the vulnerability of the various emitters on a platform to a specified ESM system under varying environmental conditions. ESM estimate is expressed as the maximum intercept range for each emitter. Intercept ranges for surface-to-air, air-to-air, and air-to-surface can be calculated.

Table 7-2.-Example Output of ESM Range Tables

CLASS		ESM RANGE TABLES			
		*** ESM INTERCEPT RANGE TABLE ***			
		RECEIVER: ESM receiver EMITTERS' COUNTRY: Country			
EMITTER	FREQ Mhz	INT RNG (max) km	EMITTER	FREQ Mhz	INT RNG (max) km
Emitter 1	150		Emitter 13	3082	117
Emitter 2	208		Emitter 14	3082	139
Emitter 3	840		Emitter 15	3923	129
Emitter 4	870		Emitter 16	3938	180
Emitter 5	920		Emitter 17	3950	180
Emitter 6	2442	197	Emitter 18	6530	229
Emitter 7	2770	175	Emitter 19	7092	191
Emitter 8	2798	223	Emitter 20	7800	463+
Emitter 9	2828	175	Emitter 21	8050	182
Emitter 10	2995	126	Emitter 22	8100	218
Emitter 11	2998	139	Emitter 23	8125	229
Emitter 12	3000	463+	Emitter 24	8136	214
Press "RETURN" for next page		031200 UTC APR85 2500N 09000W CLASS			

APPLICATION

The EMCON planner can use PV to assess the relative vulnerability of the various emitters on a platform versus their value in surveillance or communication. The object is to minimize the platform's vulnerability to counterdetection.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in listing the PV program areas follows:

- Make sure the environment selected from the refractivity data set is indicative of the location and time of interest. PV is range- and time-independent.

- The maximum intercept range output is limited to 1000 km (541 nmi). The atmosphere is usually not horizontally homogeneous over these great distances.

- PV doesn't account for absorption of EM energy, In general, the absorption of EM energy by things such as oxygen, water vapor, fog, rain, or snow adds little to the propagation loss. Refraction is considered the main factor in transmission.

- PV is valid for frequencies between 100 MHz and 20 GHz.

- Sea-reflected interference is also considered only if the receiver or emitter is below 100 m.

- The effects of a surface-based duct are considered to dominate any contributions from the evaporation duct.

- PV assumes the emitters are radiating at peak power.

- The probability of detection associated with the output ranges depends upon the probability of detection associated with the receiver sensitivities.

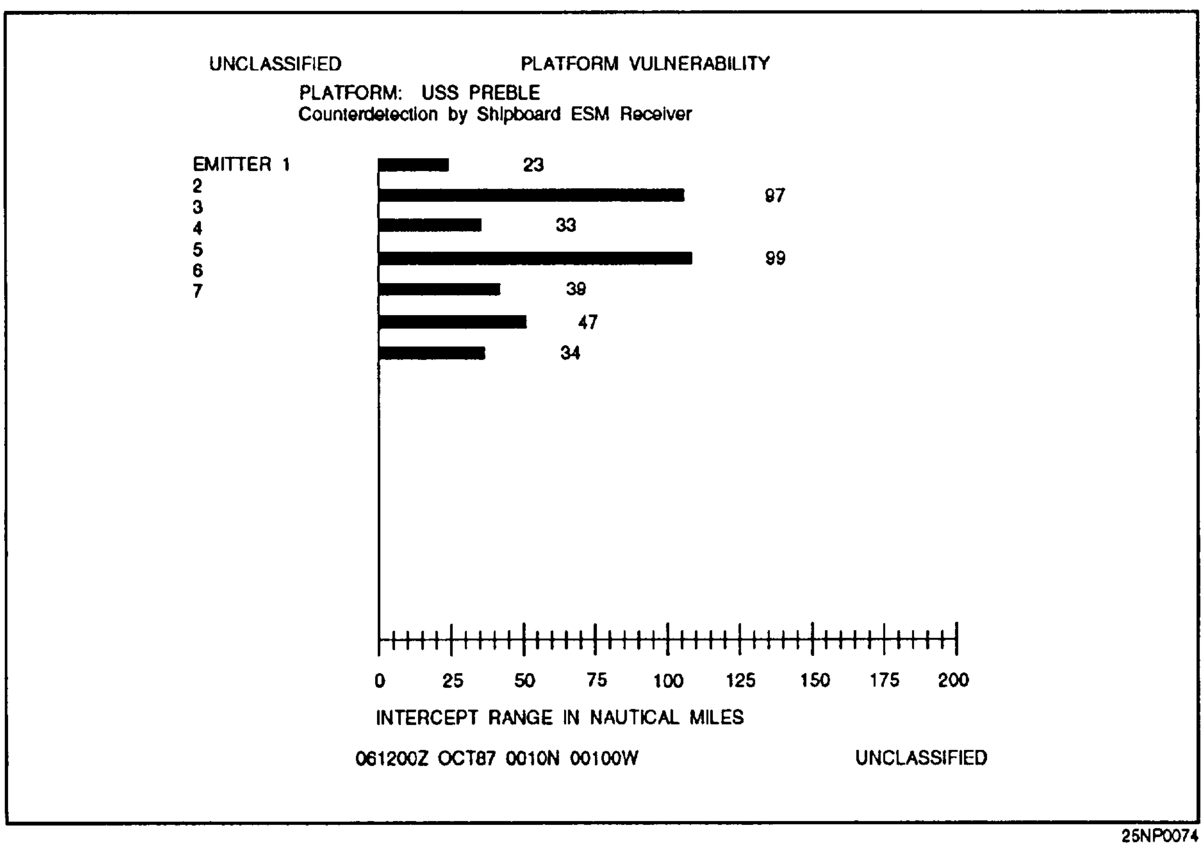
- If you are attempting to verify ESM intercept ranges achieved by your own receiver, remember that PV outputs maximum intercept range. If a platform's emitters aren't turned on at that range, there will be nothing to intercept.

FUNCTIONAL DESCRIPTION

PV computes the maximum ESMR of an emitter. ESMR is computed only if the emitter's frequency falls within one of the frequency bands of the receiver.

Table 7-3 shows an example output of the PV program. The bar graph shows the maximum range that

Table 7-3.-Example Output of the PV Program



the specified receiver can detect these emitters under the environmental conditions specified.

SURFACE-SEARCH RADAR RANGE (SSR)

LEARNING OBJECTIVES Interpret SSR tables to determine detection ranges of surface-search radars. Identify limitations and assumptions. Describe how the output of the SSR program is displayed.

The SSR program determines the effectiveness of a surface-search radar against a variety of ship classes. Input to the program consists of a user-specified radar antenna height, surface-search radar parameters from the data base (PDB) file, and a refractivity data set from the RDF. The retrieved surface-search radar ranges incorporate the characteristics of the user selected, surface-search radar and the targets' radar cross section. The refractivity data set is composed of a profile of a modified refractive index (M-unit) with respect to height, the height of the evaporation duct, and the surface wind.

APPLICATION

SSR determines the probable effectiveness of surface-search radar against different size targets. The determination is based on given atmospheric refractivity conditions. The detection ranges that are determined represent a 90 percent probability of detection. Based on the information output by this program, the tactical commander can alter the disposition of his or her forces, as necessary, to maximize the effectiveness of his or her surface-search effort.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the SSR program areas follows:

- The SSR Range Tables program assumes horizontal homogeneity of the atmosphere. (The program does not account for horizontal changes in the refractivity structure of the atmosphere.)

- There is no account made for the absorption of EM energy by oxygen, water vapor, fog, rain, snow, or other atmospheric particulate matter.

- This program accounts for ducting in evaporation ducts, surface-based ducts, and low-elevated ducts, provided the radar antenna is within the elevated duct. The program does not properly account for the over-the-horizon region for low-elevated ducts when the bottom of the duct is above the radar antenna height. Errors are small and should be insignificant when the separation between the base of the low-elevated duct and the radar antenna exceeds a few thousand feet.

- Prior to running this program, a primary refractivity data set must be selected.

FUNCTIONAL DESCRIPTION

Output from this program consists of a SSR table for the user-selected, surface-search radar. Output is provided in the user-selected units (metric or English), and is displayed on two screens. Detection ranges are represented by MIN, AVG, and MAX where MIN is the range expected if detecting from a bow or stem aspect, MAX is a broadside aspect, and AVG is a quartering aspect. Output from this program is classified and should be labeled as required.

ELECTROMAGNETIC COVER DIAGRAM (COVER)

LEARNING OBJECTIVES: Interpret COVER displays of radar detection or communication coverage. Identify limitations and assumptions. Interpret an example of a surface-system COVER diagram.

The COVER program provides a display of radar detection or communication coverage in the vertical plane. Input to the program consists of the radar or communication system of interest, the height of the system (if airborne), and a refractivity data set from the RDF.

The EM system is entered/edited using the platform option of the EMFILE maintenance program. The refractivity profile is entered via the environmental status option of the EM propagation suite of programs.

APPLICATION

COVER provides the capability to determine how a given EM system will perform under given atmospheric conditions in detecting or communicating with a given target or receiver. It provides the information necessary to plan flight profiles for airborne systems to achieve maximum probability of detecting targets. It is also used to plan the flight profile of attacking aircraft against a surface target to minimize the probability of the aircraft being detected by the target. Another use is to alert surface units to holes in their radar coverage against attacking aircraft or missiles. This capability provides the information on which to plan the disposition of surface units and to base requirements for airborne coverage.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the COVER program areas follows:

- COVER assumes horizontal homogeneity (horizontal changes in the refractivity structure of the atmosphere are not accounted for).

- COVER is valid only for EM systems with frequencies between 100 MHz and 20 GHz.

- COVER does not include any effects produced by sea or land clutter in the calculation of detection or communication ranges. This shortcoming may be important to air-search radars in the detection of targets flying above surface-based ducts or strong evaporation ducts, but it is not expected to significantly affect the predicted enhanced detection ranges within a duct. Specifically y, for surface-based ducts, the actual detection capability at some ranges may be reduced for air targets flying above the duct.

- The model that calculates the coverage display for surface-based systems is valid only for antenna heights between 1 and 100 m, and the program will not accept heights outside these bounds. The antenna heights for airborne systems are limited to the maximum height of the selected coverage system in the EM system data file.

- The airborne coverage display model does not include sea-reflected interference effects, which could cause both reduced and enhanced coverage for low-flying aircraft or radar targets. The surface coverage display model does account for sea-reflected interference effects. Only the maximum range within each lobe of the interference region is plotted when the spacing between lobes becomes very close.

- There is no account made for the absorption of EM energy by oxygen, water vapor, fog, rain, snow, or other particulate matter in the atmosphere. In general, the contribution of absorption to propagation loss is small compared to refractive effects.

- COVER accounts for ducting in evaporation ducts, surface-based ducts, and low-elevated ducts, provided the transmitter or radar antenna is within the elevated duct. The program does not properly account for the over-the-horizon region for low-elevated ducts when the bottom of the duct is above the transmitter or radar antenna height. The calculated ranges for the coverage display will generally be less than the corresponding actual ranges. The errors become less the higher the elevated duct is above the transmitter of radar antenna height and should be insignificant when the separation exceeds a few thousand feet.

- The coverage display can be used for the following applications:

  — Long-range air-search radars, surface-based or airborne

  — Surface-search radars when employed against low-flying air targets

  — Surface-to-air or air-to-air communication systems

  — Sonobuoys (only with the proper antenna height and frequency)

- The coverage display should not be used for the following applications:

  — Airborne or surface-based surface-search radars employed against surface targets

  — Most types of gun- or missile-fire control radar

- It is not the intent of the coverage display model to calculate the maximum radar range for a given radar and target, but rather to show the relative performance of a radar (or communications) system at different altitudes as affected by the environment. *It is up to the user to use free-space ranges that are appropriate for the application at hand.*

- Output from this program is classified and should be labeled corresponding to the classification of the EM system used to produce the display.

- Effects of wave splash, wave shadowing, bobbing, and rolling are not taken into account for sonobuoy output.

FUNCTIONAL DESCRIPTION

COVER diagrams are contours of constant electric field strength information in the vertical plane that indicates areas where radar targets might be detected.

The contours chosen for display represent radar receiver thresholds against a particular size (radar cross section) target. COVER diagrams are also used to assess very high frequency (VHF) or ultra high frequency (UHF) communications coverage.

The method used to construct the COVER diagram depends on whether the EM system is surface-based or airborne. Both methods employ raytracing, but for surface-based systems, coherent interference between direct and sea-reflected paths, sea-surface roughness, and diffraction effects are considered.

Figure 7-4 shows an example output of a surface-system COVER diagram. A surface-system COVER diagram is composed of up to four coverage lobes. A COVER diagram for an airborne system has one lobe, drawn by straight lines, emanating from the antenna height.

A lobe describes the vertical and horizontal limits of the radar coverage. The shape and size of the lobes are dependent on the antenna type and the computed or entered free-space ranges or path-loss thresholds. Each lobe is where the particular radar device would detect a certain size target at a specified probability of detecting that target. Also involved is whether the target is steady or fluctuating and the probability of receiving a false alarm on the radar screen.

SHIP ICE ACCRETION (SHIP ICE)

LEARNING OBJECTIVES: Interpret SHIP ICE program tabular displays. Identify limitations and assumptions. Explain how ice accretion rates are determined by the SHIP ICE program.

The SHIP ICE program provides estimates of ship ice accretion rates vs. time given the wind speed and the air and sea-surface temperatures at various forecast times. Ice accretion from sea spray upon the ship's superstructure can impair the operational capability and safety of the ship.

APPLICATION

This program can be used to predict the ice accretion on a ship's superstructure due to sea spray. It can assist in planning by considering the icing effects along an

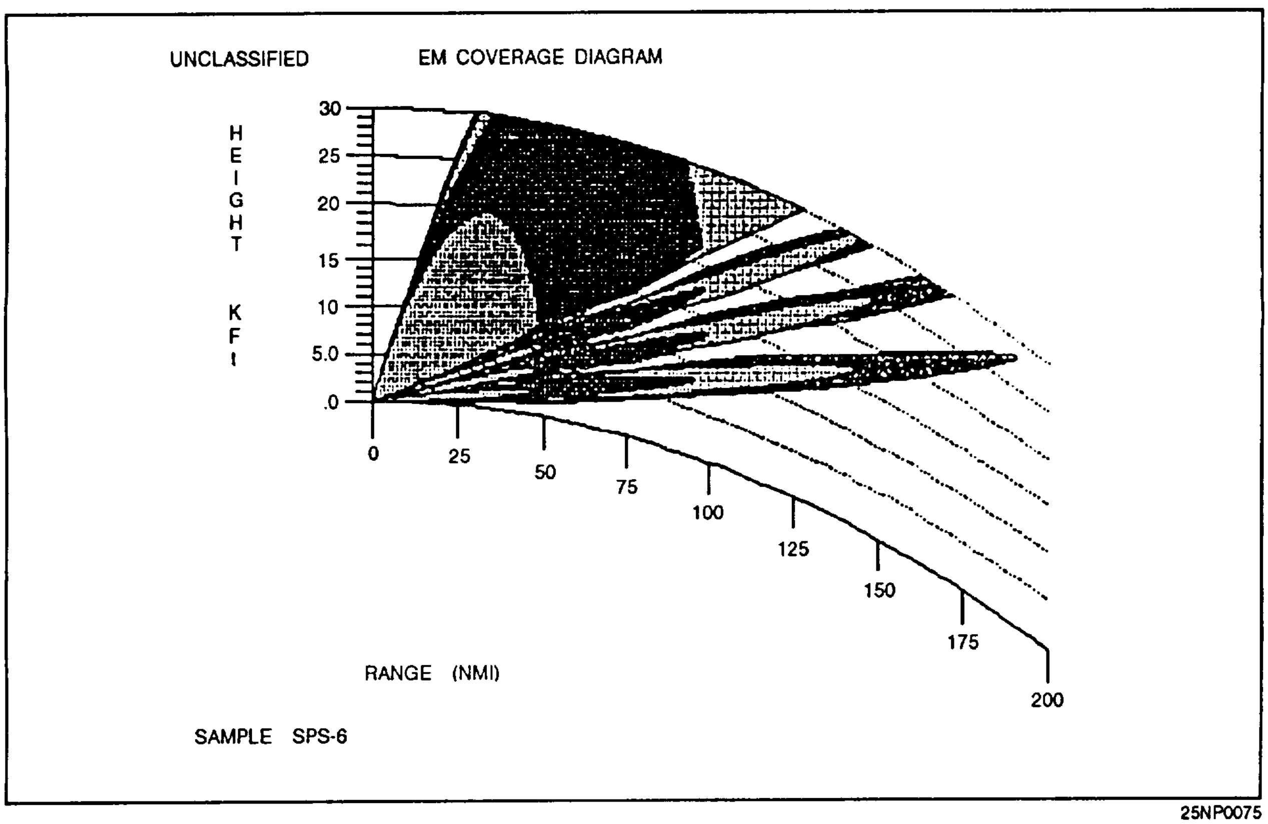


Figure 7-4.-Example output of the EM coverage diagram.

intended route, or determining how frequently the superstructure ice should be cleared.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the SHIP ICE program are as follows:

- The methods described here are best applied to smaller ships. Ship's characteristics, such as freeboard, waterline length, hull response, and ship's course and speed are not considered.

- Information relating to ice accretion thresholds is not available and must be developed independently by each user.

- Air temperature is entered in whole degrees (Celsius). For temperatures <-21°C, the SHIP ICE model assumes a constant accretion rate based on -21°C. The algorithm considers temperatures from -2°C to -21°C.

- Sea temperature is entered in whole degrees Celsius. The algorithm considers temperatures from 10°C to -2°C.

- Wind speed is entered in whole knots. The algorithm considers winds from 22 to 71 kt by the following categories:
  - Beaufort Force 6 and 7 (winds 22 to 33 kt)
  - Beaufort Force 8 (winds 34 to 40 kt)
  - Beaufort Force 9 and 10 (winds 41 to 56 kt)
  - Beaufort Force 11 and 12 (winds 57 to 71 kt)

- If the air temperature is >-2°C, then the ice accretion is considered to be 0.

- If the wind is <22 kt (BF 6) and the temperature is <-2°C, then the ice accretion is considered to be 1.5 cm per day.

FUNCTIONAL DESCRIPTION

The SHIP ICE program determines the ice accretion rates from look-up tables based on the wind category. For each category, there is an ice accretion matrix with an accretion rate for each combination of air-sea temperature (where the air temperatures are between -2°C and -21°C, and sea temperatures between 10 and -2°C.) Figure 7-5 shows an example of a SHIP ICE ACCRETION program.

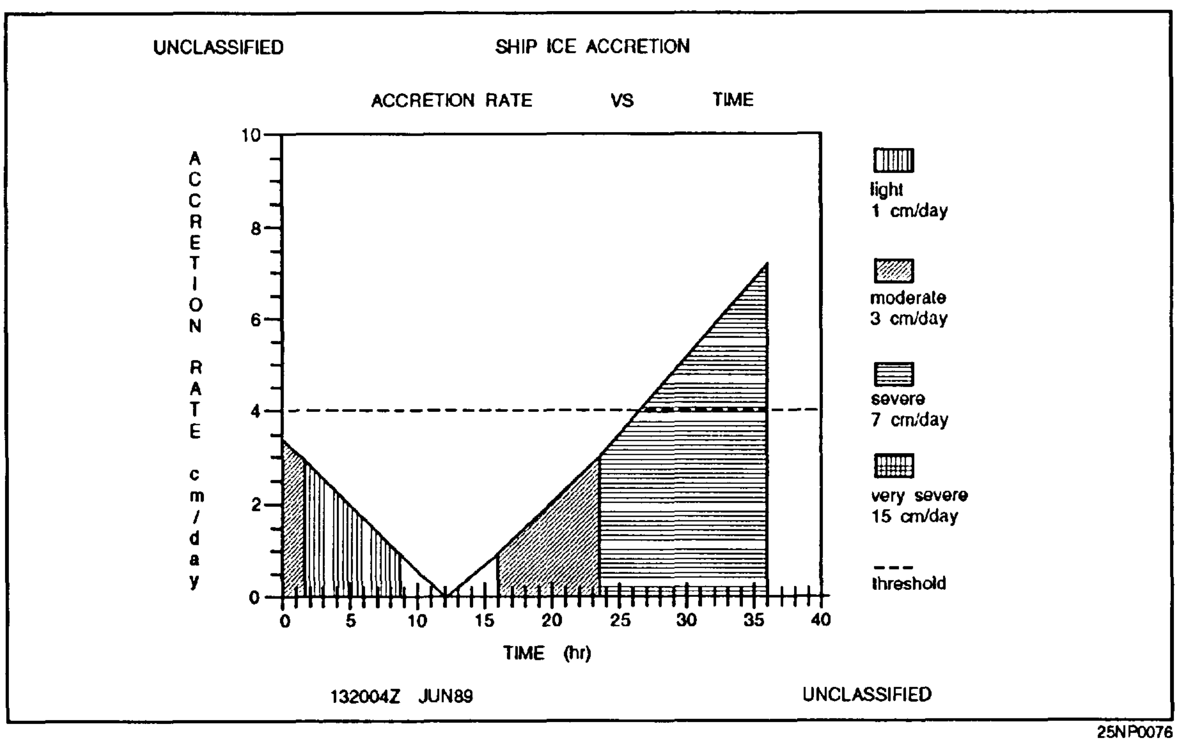


Figure 7-5.-Example output of the SHIP ICE program.

SOUND FOCUS (SOCUS)

LEARNING OBJECTIVES Interpret SOCUS noise prediction graphs. Identify limitations and assumptions. Explain an example output of the explosive noise prediction plot.

In the atmosphere, sound waves propagating from an explosive blast are frequentl refracted toward the surface. Under certain atmospheric conditions this energy may be focused, resulting in minor property damage, such as cracked plaster and broken windows at these points of focus (caustics). Large-scale refraction of blast waves toward the surface, even without the presence of caustics, can contribute to increased overpressure levels at distances greater than 50 km from the blast, resulting in numerous complaints fom area residents. These large-scale refractive and focusing conditions are caused by temperature inversions or strong vertical wind shears.

The SOCUS program provides the following forecast products:

- A sound speed profile with respect to height
- A profile of maximum explosive noise (peak overpressure) with respect to range from the explosive source
- The range from the explosive source of caustics
- The minimum and maximum aircraft ground speed versus height

These products are provided for an operator-specified bearing of interest. Program input includes profiles of temperature, wind speed, and wind direction (for the time and location of interest from the EDFs), the explosive weight of the charge, and the bearing of the explosive source.

APPLICATION

The SOCUS program allows METOC personnel to determine whether atmospheric conditions favor the formation of caustics (sound focus points) or the large-scale refraction of sound toward populated areas during explosive exercises. The appropriate action can then be taken to minimize the number of complaints or claims for minor property damage.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the SOCUS program areas follows:

- Sound focusing is quite sensitive to small temperature, wind direction, and wind speed variations with respect to height and time. Therefore, a valid sound focus forecast can be obtained only when accurate data from a sounding taken near the time and location of the explosive exercise are used.
- This SOCUS/Prediction model was developed using measurements of surface explosions where the airblast propagated several kilometers over water and then over flat land. The effects of barriers such as mountains or forests are not known when focusing is caused by low-altitude weather conditions. Channeling effects through mountains are also unknown.
- Maximum explosive noise levels in the vicinity of caustics are normally between 2 and 8 dB higher than the explosive noise levels plotted on the graphic output. (The locations of caustics are denoted by X's on the plot.)
- To compute maximum explosive noise levels for muzzle blasts from 5-inch naval gunfire, an equivalent explosive weight of 66 pounds is used.
- To compute explosive noise levels for muzzle blasts from 16-inch naval gunfire, an equivalent explosive weight of 330 pounds is used for a reduced charge.
- To compute noise levels for muzzle blast from 16-inch naval gunfire, an equivalent explosive weight of 660 pounds is used for a full charge.
- Noise levels resulting from impact explosions of the HE-ET/PD, Mk 19 Mod O, HC, and AP projectiles may be computed using the respective equivalent explosive weights: 155, 27, 155, and 41 pounds.
- Maximum noise levels are to be found in the direction of tire from 5-inch and 16-inch naval guns.
- Maximum subsonic ground speeds are only computed using a headwind/tailwind. Operators must make an interpolation for headings that differ from these.

FUNCTIONAL DESCRIPTION

There are two outputs from this product, figure 7-6 and figure 7-7. Figure 7-6 shows an example output of

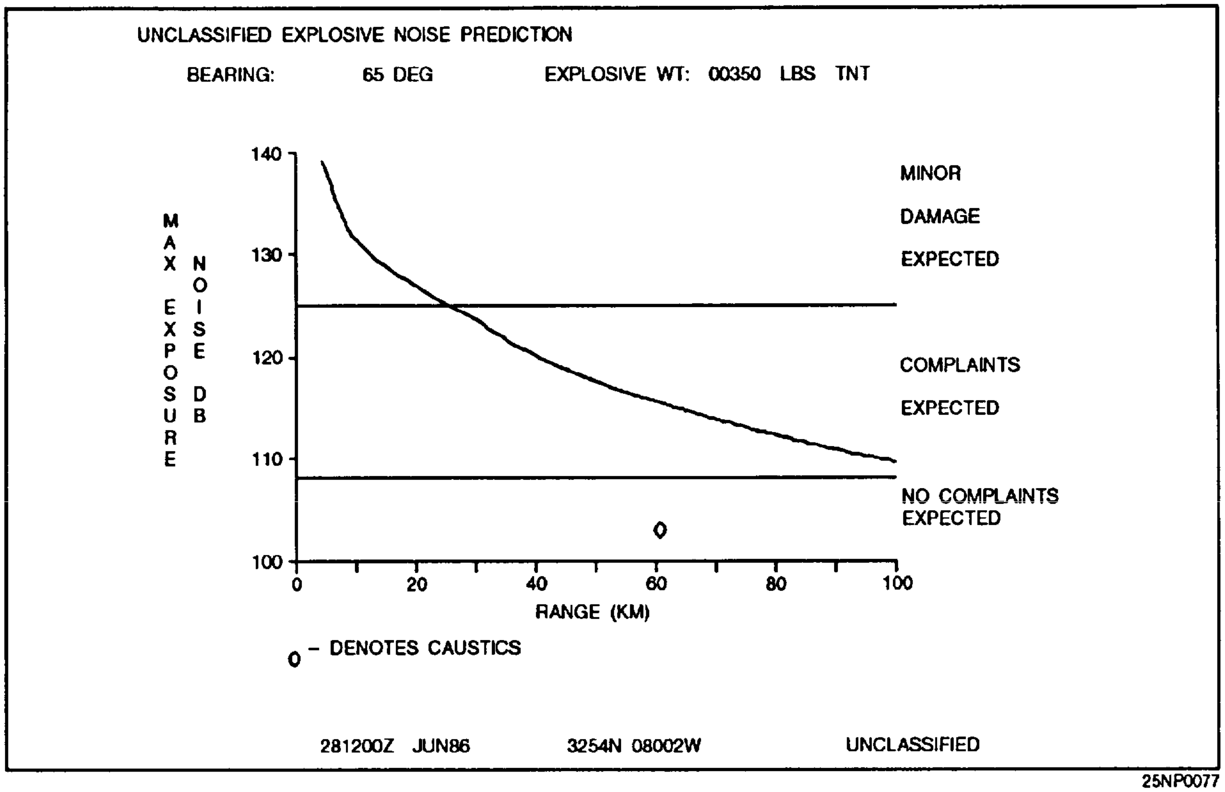


Figure 7-6.-Example output of the explosive noise prediction plot.

UNCLASSIFIED

MAXIMUM SUBSONIC AIRCRAFT GROUND SPEEDS				
	HEADWIND		TAILWIND	
Flt Level (feet)	Speed (knots)	Bearing (deg)	Speed (knots)	Bearing (deg)
5000	646	157	681	337
10000	637	165	678	345
15000	623	174	668	354
20000	607	183	659	3
25000	591	194	649	14
30000	573	204	638	24
35000	554	213	627	33
40000	533	219	615	39
45000	516	225	607	45
50000	515	231	619	51

101800 UTC MAY89 2800N 09300W UNCLASSIFIED

Figure 7-7.-Sample output of maximum subsonic aircraft ground speeds.

the explosive noise prediction plot. Output from this program consists of an explosive noise prediction plot that shows expected noise (dB) against range, sound speed profiles (total sound speed and speed due to wind) in the direction of interest with respect to height. Figure 7-7 shows an example of a tabular output of maximum subsonic aircraft ground speeds with respect to height. For instance, an aircraft flying at 681 knots at 5,000 feet with a tailwind, the explosive noise source would be 337° (relative) from the aircraft.

LASER RANGE PREDICTION (LRP)

LEARNING OBJECTIVES: Interpret LRP displays for low-level laser radiation. Identify limitations and assumptions.

The LRP displays range information for exposures to low-level laser radiation, both height vs. range and by differences between day and night conditions. The program also displays range vs. time of exposure for different levels of exposure to laser radiation.

APPLICATION

LRP produces ranges for exposures to laser radiation that could be hazardous to aircraft pilots or crewmembers in the line of sight of this radiation.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the LRP program are as follows:

- This program operates on a wavelength-specified basis. If the operator selects a wavelength that is available to the program, then the closest wavelength will be run for calculations.
- The power is the averaged power for a pulsed laser that pulses over a l-second period. Data-base computations select the pulse repetition frequency for maximum power of a particular radar.
- No power increase is taken into account in the calculations for the displays due to magnification effects (for example, binoculars).
- The vertical extent of the transmission models is 7 km in height for gaseous components and 2 km for aerosol components in the selected environment. This limits surface-to-surface results and possible outputs to other displays.
- The Night/Day display assumes one set of eye apertures for the night/twilight/day exposures.
- This program is not to be applied to air-to-air cases since the variation of the atmosphere with height will effectively change the resultant ranges.

FUNCTIONAL DESCRIPTION

The operator specifies a set of laser parameters or selects a laser from the laser database. The atmosphere and environment are then specified by the operator. Output from this program is classified and should be labeled as required.

BALLISTICS WINDS AND DENSITIES CORRECTIONS (BALWND)

LEARNING OBJECTIVES Interpret BALWND correction factors for U.S. and NATO gunfire support. Identify limitations and assumptions. List the types of forecast messages produced by the BALWND program.

The BALWND program computes ballistic wind and density correction factors for U.S. Navy and North Atlantic Treaty Organization (NATO) gunfire support. Correction factors are produced for the following types of gunfire: surface-to-surface <16-inch, surface-to-air >16-inch, surface-to-surface 16-inch full charge, and surface-to-surface 16-inch reduced full charge. Ballistic wind and density correction factors are output in standard U.S. Navy and NATO ballistic message format. User-specified input includes the duration of the ballistic forecast and a specification of the radiosonde data set to be used. The user-specified radiosonde data set is retrieved from the EDFs and contains the upper air and upper wind profiles necessary to produce a ballistic wind and density forecast.

APPLICATION

Ballistic correction factors are used by gunfire support personnel to correct for current or forecast atmospheric conditions. These correction factors are required to obtain close hits with initial firings of naval guns.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the BALWND program areas follows:

- This program requires that the user-selected radiosonde data set contain an upper wind profile.
- Care must be taken that a radiosonde data set representative of the area where naval gunfire is to take place is selected
- Ballistic wind and density correction factors are output only to the ballistic zone through which a complete set of environmental data is available.

FUNCTIONAL DESCRIPTION

All output from the BALWND program is classified and should be labeled as required, The program consists of the following messages:

- NATO surface-to-air ballistic forecast message.
- NATO surface-to-surface ballistic forecast message.
- U.S. Navy ballistic forecast message for surface-to-surface <16-inch gunfire.
- U.S. Navy ballistic forecast message for surface-to-air <16-inch gunfire.
- U.S. Navy ballistic forecast message for surface-to-surface 16-inch full-charge gunfire.
- U.S. Navy ballistic forecast message for surface-to-surface 16-inch reduced-charge gunfire.

RADIOLOGICAL FALLOUT (RADFO)

LEARNING OBJECTIVES Interpret RADFO forecasts for radiation doses produced by a nuclear detonation. Identify limitations and assumptions. Interpret an example output of the RADFO model, and an example of ATP-45 outputs.

The RADFO model generates forecasts of the accumulated radiation dose from fallout produced by the detonation of a nuclear device. This program replaces the radiological fallout templates in order to better assess early fallout from a radioactive cloud.

Output consists of an analysis of accumulated dose of radioactive energy in roentgens for a user-defined location, time, and forecast duration. Appropriate ATP-45 data, such as the radius of the nuclear cloud and the deposition boundary, are also output.

User-supplied input includes either the yield of the weapon or the height of the top of the nuclear cloud, the type of burst (land, sea, or air), the location (latitude and longitude) of surface zero, a specification of the prediction period with respect to time zero, and a specification of the contours to be plotted. The user also specifies a radiosonde data set, which contains an upper wind profile that is to be retrieved from the EDFs. If an applicable upper wind profile is not available, the user may enter one based on either height or pressure levels.

APPLICATION

The RADFO model forecasts a pattern of accumulated dose of radioactive energy caused by a specified type of nuclear detonation and dispersed by upper level winds. The forecast is produced in a timely manner for the ship's captain or staff, and it is used to determine ship and unit maneuvering to avoid potential nuclear radiation hazards.

LIMITATIONS AND ASSUMPTIONS

RADFO is used to forecast the pattern of accumulated dose of radiation caused by nuclear fallout after the detonation of a nuclear weapon. Care must be taken to select a radiosonde data set that contains an upper wind profile representative of the upper winds at surface zero. Care must also be taken to accurately estimate either the yield of the nuclear weapon or the height of the top of the nuclear cloud.

- Meteorological conditions are considered to be constant for the entire fallout period; no spatial or temporal variations of the upper wind are taken into account.
- This model does not assess radiation from other nuclear phenomena such as the thermal radiation, electromagnetic effects, or initial nuclear radiation emitted in the actual fission or fusion process. This model should only be used as a resource tool to better assess early fallout from the radioactive cloud. Early fallout from a radioactive cloud is normally defined as the fallout that is down within the first 48 hours.
- The RADFO model is meant to be used only for nuclear detonations that occur near the surface (those

that throw a significant amount of radiological fallout into the atmosphere). This model should not be used for high-altitude bursts or deep-water bursts.

- This model assumes a 100 percent fission yield through the complete spectrum of nuclear weapons, including thermonuclear weapons; this is a worst case estimate.

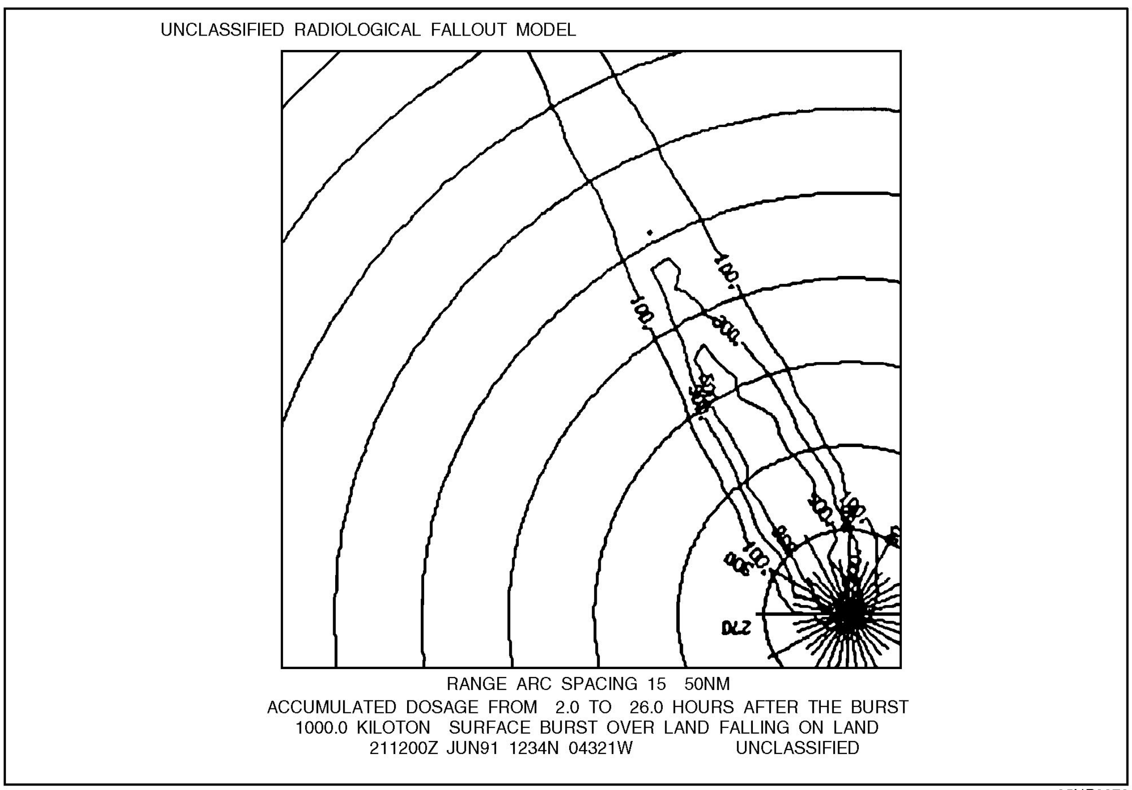
FUNCTIONAL DESCRIPTION

Output consists of an analysis of dosage of radioactive energy plotted on an appropriate geographic background. The speed and direction of the effective fallout wind are included on the display. ATP-45 output, such as the cloud radius and deposition boundary, is provided on a second screen. Figure 7-8 shows an example output of the RADFO model, and figure 7-9 shows an example of ATP-45 outputs.

FORWARD-LOOKING INFRARED (FLIR)

LEARNING OBJECTIVES: Identify applications, limitations, and assumptions of the FLIR program. Interpret FLIR tables for detection ranges for predefined altitudes and target types.

The FLIR System Prediction program determines the detection, categorization, and identification ranges of airborne FLIR sensors against surface targets. Ranges are given as a function of aircraft altitude and are for a 50 percent probability of detection, categorization, and identification of the target. The atmospheric data consisting of height, atmospheric pressure, air temperature, and dewpoint temperature come from the atmospheric environmental file (AEF). Surface wind speed and visibility are input from the keyboard when the program is run.



25NP0078

Figure 7-8.-Example output of the RADFO model.

UNCLASSIFIED	RADFO ATP-45 OUTPUT	
	ENGLISH	
CLOUD RADIUS	9.6	NM
EFFECTIVE DOWNWIND DIRECTION	332.	DEG
EFFECTIVE FALLOUT WIND SPEED	45	KNOTS
SECTOR ANGLE	40.	DEG
DISTANCE TO ZONE 1	154.6	NM
DEPOSITION BOUNDARY	1156.5 TO 1183.0	NM
	METRIC	
CLOUD RADIUS	17.7	KM
EFFECTIVE DOWNWIND DIRECTION	332.	DEG
EFFECTIVE FALLOUT WIND SPEED	83	M/S
SECTOR ANGLE	40.	DEG
DISTANCE TO ZONE 1	286.3	KM
DEPOSITION BOUNDARY	2141.6 TO 2190.7	KM
211200 UTC JUN91 1234N 04321W	UNCLASSIFIED	

Figure 7-9.-Example ATP-45 output.

Ranges may be predicted for several FLIR devices against surface or ASW targets.

APPLICATION

Users of the FLIR output include mission planners, pilots in the air wing, and the carrier group staff. The FLIR output can assist them in placing aircraft at altitudes to maximize FLIR detection of surface or ASW targets.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the FLIR program areas follows:

- The input environmental data are representative of the entire area of interest. Therefore, changes in the environment over time and over space are not accounted for.
- Radiation is absorbed by molecules and both absorbed and scattered by aerosols. Other effects such as attenuation by rain, fog, and haze are neglected.
- Targets are limited to rectangular bodies of fixed dimension with fixed target-to-background temperature differences, T_{eff}. The target dimensions and temperatures correspond to "effective" target parameters. For example, a "periscope detection" attempts to emulate detection of a target area larger than a periscope, corresponding more to detection of a

Table 7-4.-Effective Target Values

Target Type	Length (m)	Height (m)	T_{eff} (°C)
Large	170	18	5
Medium	136	14	5
Small	100	10	5
Submarine	50	5	5
Snorkel	5	0.5	20
Periscope	5	0.5	5

submarine-generated wake. Table 7-4 lists effective target values used by the FLIR program.

The effective dimensions produce more realistic ranges than use of actual target dimensions.

- An airborne FLIR sensor is viewing targets well inside the horizon against an essentially blackbody sea. That is, the FLIR program does not account for changes in viewing angle resulting in a new target background and thus a new T_{eff}.

- If the relative humidity calculated from the input dewpoint depression is <35 percent, then a minimum value of 35 percent relative humidity is used only to calculate the aerosol extinction. Design of the model prevents accurate aerosol extinction calculations below 35 percent relative humidity.

- All environmental data from the AEF must be quality controlled. Bad atmospheric data will produce unreliable results.

If -1 is entered for an unknown surface visibility, the aerosol extinction coefficient is calculated with a visibility computed from the atmospheric sounding. The calculated visibility is displayed on output; however, it may or may not be similar to visibility conditions observed. The computed visibility is a limited approximation of the true visibility.

If -1 is entered for unknown surface wind speed, the global average wind speed of 6.9 meters per second (about 14 knots) is used for calculations. Actual wind speeds lower than the global average generally yield longer ranges. Actual wind speeds higher than the global average will generally yield shorter ranges.

The FLIR program does not calculate ranges at altitudes greater than the maximum height of the sounding, This limits the height of the FLIR sensor to the top of the meteorological data.

FUNCTIONAL DESCRIPTION

Fifty percent FLIR detection ranges are output for predefine altitudes and target types in tabular form based on the FLIR device selected. The 50 percent detection range curve is also depicted graphically for each of the target types. Output from this program is classified and should be labeled as required

AIRCRAFT ICING (AIRICE)

LEARNING OBJECTIVES: Interpret AIRICE displays for potential aircraft icing vs. pressure levels. Identify limitations and assumptions.

The AIRICE program analyzes radiosonde data from the AEF for potential ice accumulation on aircraft. AIRICE checks each radiosonde level for potential icing starting from the lifting condensation level (LCL). If ice accumulation is possible, then the icing type and intensity are determined. The icing analysis (icing probability, type, and intensity) is displayed in tabular form along with radiosonde analysis data.

APPLICATION

The accumulation of ice on the exterior surfaces of aircraft has the potential of causing serious handling problems and can lead to a crash. Ice accretion also increases the weight of the aircraft and reduces its payload capacity and fuel efficiency. 'The main cause of aircraft ice accretion is freezing cloud droplets. The purpose of this function is to provide an aircraft icing assessment from which a naval forecaster can predict flight levels where hazardous icing conditions may occur.

LIMITATIONS AND ASSUMPTIONS

The restrictions as well as the principles taken for granted in using the AIRICE program areas follows:

- Icing conditions are indicated at actual radiosonde levels. The possibility of icing may exist between the level indicated and the next higher and next lower levels. The icing type and intensity apply to the layer indicated, but may be valid up to the next higher level.

• AIRICE begins the icing analysis at the LCL. In the case where surface conditions are unstable (LCL is undefined), the analysis begins at the surface. This latter condition can yield greater severity in the icing intensity.

• The possible icing types displayed are clear, mixed, rime, or engine induction.

• The possible icing intensities are trace, light, moderate, or severe.

• The possible icing probabilities displayed are 10, 20,50, and 100 percent.

• The operator has the capability to change the cloud base height of the level that is displayed. The only effect that changing the cloud base height has on the output is to change the icing intensity value. The radiosonde profile information, icing type, and probability are not changed.

FUNCTIONAL DESCRIPTION

Table 7-5 shows an example of the AIRICE product. The analysis may be in either English or metric units. The display may be shown on two screens if the sounding has many levels.

SUMMARY

In this chapter we have discussed a few of the many computer and climatological products available to aid the Aerographer's Mate in the analysis and forecasting of meteorological conditions, thus ensuring optimum support of surface and airborne operations.

Table 7-5.-Example Output of the AIRICE Product

UNCLASSIFIED			AIRCRAFT ICING ANALYSIS/TABULAR RESULTS-ENGLISH					
PRESS (hPa)	TEMP (F)	RH (%)	HEIGHT (F)	LAPSE RATE (F/KFT)	STAB	ICING PROB (%)	ICE TYPE	ICING INTENSITY
1013.0	43.0	94	32.8	.56	S			
1000.0	43.2	92	387.3	–1.39	S			
900.0	39.2	84	3258.0	–2.21	CU			
850.0	35.8	89	4793.8	–1.79	CU	50.0	IND	UNK
788.0	32.2	99	6802.6	–2.72	CU	50.0	IND	UNK
746.0	28.3	91	8234.8	–.85	S	100.0	RIME	SEV
700.0	26.9	59	9881.5	–2.13	CU			
564.0	15.3	69	15331.6	–1.77	CU	10.0	RIME	TRACE
524.0	12.1	95	17134.7	–2.29	CU	10.0	RIME	SEV
500.0	9.5	94	18270.7	–2.52	CU	10.0	RIME	SEV
400.0	–3.7	71	23506.6	–3.02	CU			
384.0	–6.5	67	24432.8	.00				
070900 UTC MAY87 0345N 06000W							UNCLASSIFIED	