

# Jammer Effectiveness Model

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## **PREFACE**

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Certain commercial equipment and programs are identified in this report to adequately explain the operation of the program. In no case does such identification imply recommendation or endorsement by the National Telecommunications and Information Administration, nor does it imply that the program or equipment identified is necessarily the best available for this application.



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# JAMMER EFFECTIVENESS MODEL

Janet Geikas and Nicholas DeMinco\*

The Jammer Effectiveness Model (JEM) is a Windows-based computer program which provides an integrated procedure for modeling propagation effects on telecommunication links and the effect of a jammer on communication links and networks. JEM provides the user with the ability to define equipment such as transmitters, receivers and antennas and then use these definitions in a variety of analyses. JEM can be used easily after only a short learning period.

Key words: jammer, jamming, propagation, communications system models, electronic warfare, countermeasures

## 1. INTRODUCTION

The Institute for Telecommunication Sciences (ITS) is involved in model development and analysis of the effectiveness of communication links. The first generation of such computer models was called ETSEM (EHF Telecommunication System Engineering Model) [1]. ETSEM modelled the cumulative distribution of bit error rate for digital systems and the signal-to-noise ratio in the worst voice channel for analog systems for terrestrial line-of-sight (LOS) communication links.

Though well-suited for its purpose, ETSEM lacked the potential for expanding to other types of communication paths or allowing modification of output options. The proliferation of personal computers (PCs) generated a need for a simple to use and easy to update computer program that would run on a PC. With this goal in mind, the Analysis of Microwave Operational Scenarios (AMOS) [2] was developed. AMOS is a DOS model which predicts system performance in the 1-100 GHz range. This model has analysis capability for cumulative distribution of clear air attenuation [1, 3, 4], cumulative distribution of rain attenuation [1, 3], cumulative distribution of multipath attenuation [5], diffraction [6], and troposcatter [7].

The size of AMOS stretched the resources of the DOS environment. Thus, with the advent of Windows and the desire to include jamming analyses, the Jammer Effectiveness Model (JEM) was developed. The user interface is programmed in Visual Basic, which is a Windows-based, event-driven programming tool. The analyses are written in FORTRAN and called from Visual Basic using Dynamic Link Libraries (DLLs). The Jammer Effectiveness Model includes all of the analysis capabilities of AMOS and additional jamming scenarios. (At this time, the analyses

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that were included in AMOS still run as a shell from Windows to DOS.) The jamming analyses in JEM are valid in a frequency range of 2 MHz to 20 GHz. At frequencies of 30 MHz or greater, losses are calculated by the Irregular Terrain Model (ITM) [8, 9]. For frequencies less than 30 MHz, ground wave losses are calculated using GW84 [10] and skywave losses are calculated using the Ionospheric Communications Analysis and Prediction Program (IONCAP) [11].

## **2. RUNNING ENVIRONMENT**

JEM requires Windows 3.1 running on an IBM-compatible PC with graphics resolution of 1024 x 768 and 256 colors. Because of speed considerations, it is suggested that the user have a 486 with at least 4 megabytes of RAM. VBRUN300.DLL, MHRUN300.DLL and any .VBX files supplied with JEM must reside in the WINDOWS\SYSTEM directory. The executable and data files that make up JEM must reside in a directory on the C drive named C:\VBEXE. These files add up to approximately 6.5 megabytes. The initial user database is a subdirectory of VBEXE named C:\VBEXE\US. Begin the program by running JEM.EXE.

## **3. DEFINITIONS**

### **3.1 Help**

An on-line help facility is available by clicking any window or button with the right mouse button. Use the left mouse button for all other operations. See Appendix A for a list of Visual Basic errors.

### **3.2 Scenarios**

A scenario is a collection of data on which the user may run an analysis. The data gives details that describe a transmitting site, a receiving site, and in the case of the Jamming and Jammer vs. Network scenarios, a jamming site. There are six scenario types. These include:

The scenarios valid at frequencies between 2 MHz and 20 GHz:

Jamming

Jammer vs. Network;

and those valid at frequencies between 1 and 100 GHz:

Earth-Satellite

Ground-Aircraft

Aircraft-Satellite

Terrestrial (Ground-Ground).

### 3.3 Types of Analyses

The analyses that are available within each scenario type are:

#### Jamming

**Jammer Footprint:** Produces a polar plot of the maximum distance at which the jammer is effective in jamming a receiver/transmitter pair separated by a user-specified distance.

**Isopower Contours:** Produces a plot of one or more user-specified constant jammer power density levels at the receiver versus azimuth angle about the jammer.

**Received Signal Power vs. Distance:** Computes received power level versus distance from a transmitter.

**Received Jammer Power vs. Distance:** Computes received power level vs. distance from a jammer.

#### Jammer vs. Network

**Jammer vs. Network:** Computes the effect of a jammer on a network of communication links.

#### Earth-Satellite

**Cumulative Distribution of Rain Attenuation:** Calculates the cumulative distribution of the rain attenuation over the range of months specified by the user for a fixed satellite location.

**Cumulative Distribution of Clear Air Attenuation:** Calculates the cumulative distribution of the clear air attenuation over the range of months specified by the user for a fixed satellite location.

#### Ground-Aircraft

**Attenuation & Received Signal Loss - Loop on Frequency:** Calculates the attenuation and RSL for a single point on a flight path for a range of frequencies specified by the user.

**Attenuation & Received Signal Loss - Loop on Flight Path:** Calculates the attenuation and RSL for a single operating frequency for a set of points in a user-specified aircraft flight path.

**Cumulative Distribution of Rain Attenuation:** Computes the cumulative distribution of the rain attenuation for a single point on the aircraft flight path and for a single operating frequency specified by the user.

**Cumulative Distribution of Clear Air Attenuation:** Computes the cumulative distribution of the clear air attenuation for a single point on the aircraft flight path and for a single frequency specified by the user.

## **Aircraft-Satellite**

**Attenuation & Received Signal Loss - Loop on Flight Path:** Calculates the attenuation and RSL for a single frequency for a set of points on an aircraft flight path.

**Attenuation & Received Signal Loss - Loop on Frequency:** Calculates the attenuation and RSL on a path between an aircraft and a satellite for a range of frequencies specified by the user.

**Attenuation & Received Signal Loss - Loop on Matched Paths:** Calculates the attenuation and RSL for a single frequency for a set of user specified matched points for an aircraft flight path and for an orbit path.

## **Terrestrial (Ground-Ground)**

**Cumulative Distribution of Rain Attenuation:** Calculates the cumulative distribution of rain attenuation over the range of months specified by the user.

**Cumulative Distribution of Multipath Attenuation:** Calculates the cumulative distribution of multipath attenuation over the range of months specified by the user.

**Terrain Profile & Ray Path Plot:** Uses the terrain profile data created by the user to define and plot the terrain of a terrestrial path. With this information, the user can then plot the path as well as the ray path and its user-specified Fresnel clearance envelope. The analysis also allows the user to calculate necessary antenna heights in order to ensure the specified Fresnel clearance for this path.

**Cumulative Distribution of Clear Air Attenuation:** calculates the cumulative distribution of clear air attenuation over the range of months specified by the user.

**Troposcatter Attenuation:** Calculates either the median long-term troposcatter loss or the median long-term diffraction loss for terrestrial paths that are beyond the horizon. It returns the attenuation of whichever propagation loss is lower.

**Link Margin Calculations:** Determines the link margin for a terrestrial path for each of the 12 months of the year.

### 3.4 Equipment

There are 15 kinds of equipment available in JEM. These are the building blocks of the scenario. Each piece of equipment is identified by a name given by the user. Below is a list of equipment types.

Ground Stations	Aircraft Platforms	Satellite Platforms
Receivers	Transmitters	Antennas
Air Jammers	Ground Jammers	Climate Profiles
Horizon Profiles	Atmospheric Profiles	Terrain Profiles
Aircraft Flight Paths	Satellite Orbits	Antenna Patterns

## 4. FILE OPERATIONS

### 4.1 Naming Equipment and Scenarios

Each piece of equipment and each scenario is identified by a name given by the user. The names for the following types of equipment are limited to 8 characters using only acceptable DOS characters: Atmospheric Profiles, Horizon Profiles, Aircraft Flight Paths, Orbit Profiles, Terrain Profiles and Antenna Patterns. These equipment files are distinguishable from the others because the files are indeterminate in length. JEM appends a suffix to these names and writes a DOS file. The user should not use a suffix in these names. For the other types of equipment and all the

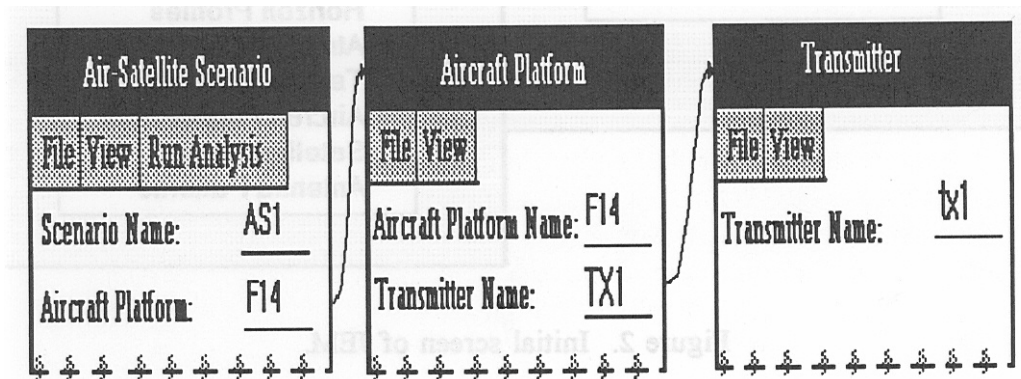


Figure 1. Building a scenario.

scenario types, the name can be 1-30 characters and may include spaces and special characters. Figure 1 is an example showing how a scenario is built using equipment. You see a partial listing of an Air-Satellite Scenario named AS1. This scenario asks for an Aircraft Platform name. The user has typed in F14. F14 refers to an Aircraft Platform which, in turn, refers to a transmitter named TX1. Notice that upper and lower case is not significant. As you build a scenario you may

enter equipment names that do not yet exist. Thus, it is not critical whether you define your scenarios or your equipment first. However, if a particular piece of equipment is undefined when the you try to perform an analysis, an error message will be displayed.

## 4.2 Displaying Equipment and Scenarios

The beginning screen in JEM is shown below in Figure 2. To quit, click on the "Quit" button at any time. For an explanation regarding the "Set Database" button, see Section 4.4. To display either a scenario or a certain equipment type, click twice on your choice.

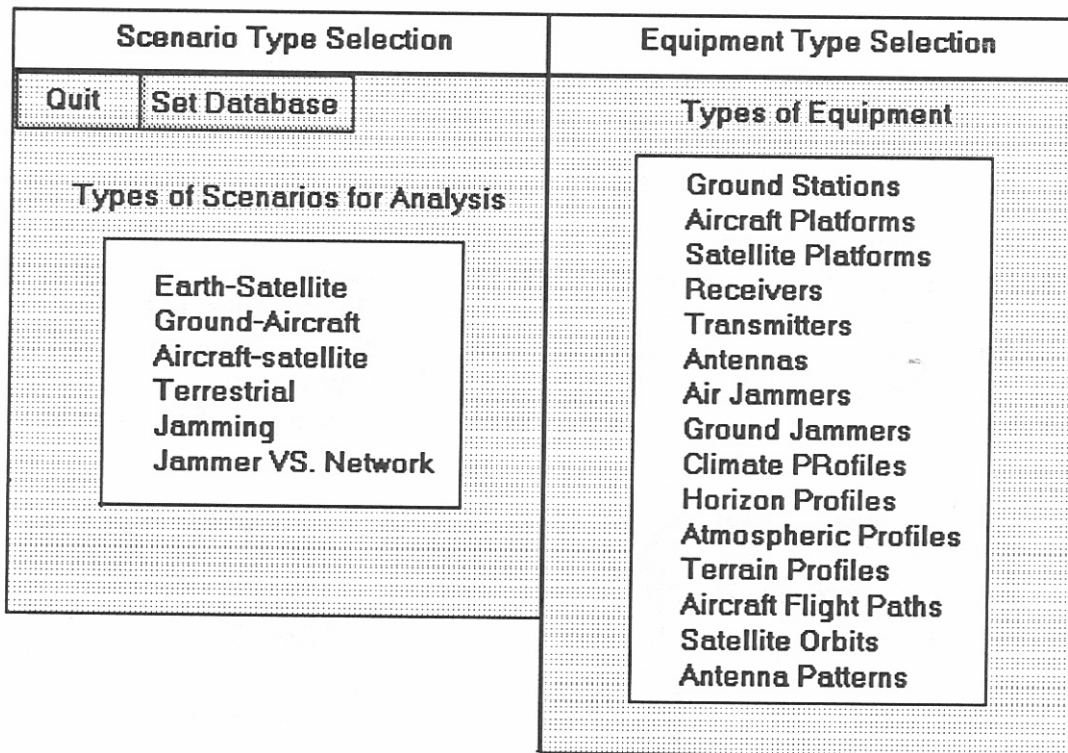


Figure 2. Initial screen of JEM.

The next window shown will be a list of those files that exist in the Current User Database. As an example, clicking twice on "Transmitters" in the Types of Equipment list will produce a list of transmitters such as the one shown below in Figure 3. This particular list indicates that there are three transmitters defined in the Current User Database. To view and edit anyone, click twice on your choice. To create a new transmitter, click on the button at the bottom. Notice the arrow

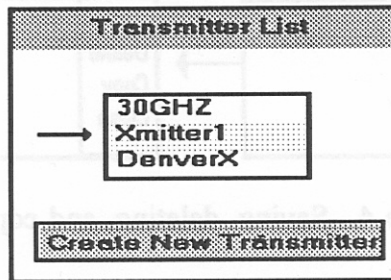


Figure 3. Example of files listed in current user database.

at the left of the list. It is pointing to the currently highlighted transmitter name and may be used to "drag and drop" (rather than type) this name into other equipment where a transmitter name is expected.

### 4.3 Saving, Deleting, and Copying

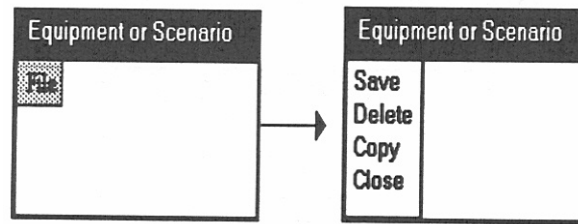


Figure 4. Saving, deleting, and copying

Every equipment and scenario window has a "File" button. Clicking that button with the left mouse button causes a menu to appear as shown above in Figure 4. Click twice on your menu selection.

**Save:** Writes the scenario or equipment file to the current User Database.

**Delete:** Removes the scenario or equipment file from the current User Database.

**Copy:** Copies the scenario or equipment file to another file within the current User Database or to a file in another User Database. The user may choose to rename the file.

**Close:** Closes the window.

### 4.4. User Database

Data within JEM is organized in files that detail scenarios and equipment types. These files are stored within User Databases (UDB). A User Database is a DOS directory specifically named within JEM as a User Database. There can be any number of User Databases and the directories can be located on any drive. Equipment and scenario names must be unique within a User Database, that is, there cannot be two transmitters in any User Database named Xmitter. However, a transmitter named Xmitter in UDB1 and a transmitter named Xmitter in UDB2 are distinct entities. The UDB from which JEM is working is called the Current User Database. JEM can interface only with files that are in the Current User Database, although files may be copied by JEM from one UDB to another. Note that the files are written in JEM format and the user should not try to edit any JEM file outside of JEM.



#### 4.4.1 Selecting, Creating, or Deleting a User Database

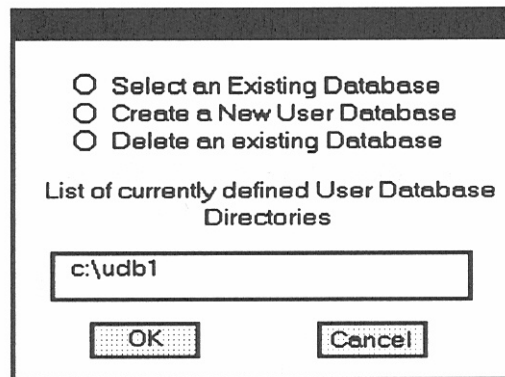


Figure 5. User database window.

Push "Set Database" (See Figure 2) to produce the window as shown above in Figure 5.

**Select a database:** To select a database (i.e. to make an existing database the Current User Database), click on "Select an Existing Database," highlight your choice from the list of currently defined User Database Directories, and click on OK.

**Delete a database:** To delete a database, click on "Delete an existing Database," highlight your choice from the list of currently defined User Database Directories, and click on OK. You will be given the option of erasing files and the directory.

**Create a new database:** To create a new UDB, click on "Create a New User Database" and click on OK. You will be shown a window as in Figure 6. To create a database in a directory that already exists, choose a drive from the Drive List, choose a directory from the Directory List, and click on OK.

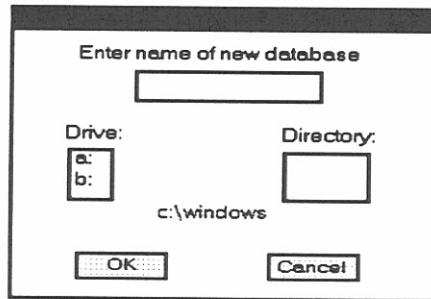


Figure 6. Naming a new database.

**Create a new database in a new directory:** To create a database in a directory that does not currently exist, choose a drive from the Drive List and choose a directory from the Directory List as above. The directory you are creating will be a subdirectory to the one chosen. Now, type in a directory name in the box at the top of the window and click on OK. In either case, the directory you have chosen is displayed in the lower center (C:\Windows in this example).

## 5. SCENARIO DEFINITIONS

Each scenario consists of certain data values and equipment names as described below. An analysis will retrieve the data that is included in a scenario and that which is contained within the equipment named by the scenario. Each scenario window has buttons named "File," "View," and "Run Analysis." The functions of the "File" button have been described in Section 4.3. Clicking on "View" presents a menu permitting the user to open a window containing a piece of equipment defined in the scenario. To run an analysis, click on "Run Analysis."

### 5.1 Jamming Scenarios

Jamming scenarios consist of 3 sites: a transmitter, a receiver, and a jammer. Each of these sites may be ground-based (stationary) or airborne (moving). The format of a jamming scenario is dependent upon these choices which are made at the time of scenario creation. You should

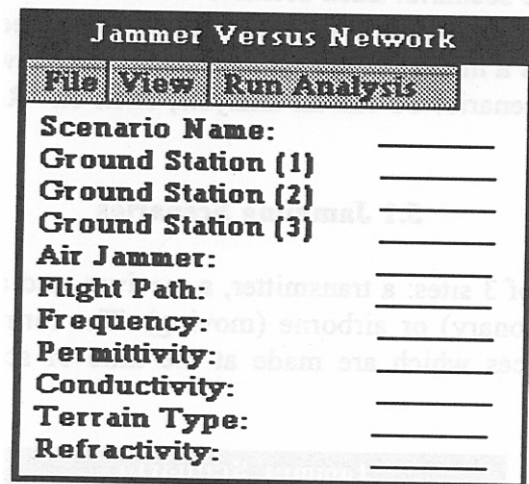
Jammer Scenario		
File	View	Run Analysis
Scenario Name:	_____	
Ground Station (TX):	_____	
Aircraft Platform (RX):	_____	
Ground Jammer:	_____	
Frequency:	_____	
Permittivity:	_____	
Terrain Type(X-R):	_____	
Terrain Type(J-R):	_____	
Refractivity:	_____	
Flight Path(RX):	_____	

Figure 7. Jamming scenario.

differentiate between a transmitting site or receiving site and between transmitter or receiver equipment type. Figure 7 above shows a Jamming scenario (before values have been filled in) with the transmitter on a ground site as indicated by the requirement of a Ground Station (Tx). The receiver is on an aircraft as indicated by the requirement of an Aircraft Platform (Rx). The jammer is on a ground site as indicated by the requirement of a Ground Jammer. Note that a flight path is required for each airborne site. See Section 5.4 for a description of each entry.

## 5.1 Jammer vs. Network Scenarios

A Jammer vs. Network scenario (Figure 8) consists of from two to five ground station sites called



The screenshot shows a software window titled "Jammer Versus Network". At the top, there is a menu bar with three items: "File", "View", and "Run Analysis". Below the menu bar is a form with the following fields and labels:

File	View	Run Analysis
<b>Scenario Name:</b>		
<b>Ground Station (1)</b>		_____
<b>Ground Station (2)</b>		_____
<b>Ground Station (3)</b>		_____
<b>Air Jammer:</b>		_____
<b>Flight Path:</b>		_____
<b>Frequency:</b>		_____
<b>Permittivity:</b>		_____
<b>Conductivity:</b>		_____
<b>Terrain Type:</b>		_____
<b>Refractivity:</b>		_____

Figure 8.  
Jammer vs. Network scenario.

nodes. Each node acts as both a transmitting and receiving site. The jammer may be either a ground jammer (stationary) or an air jammer (moving). The choices of number of nodes and jammer type are made at the time of scenario creation and cannot be changed later. A flight path is required if an air jammer is chosen. See section 5.4 for a description of each entry. After all equipment is fully defined, you may perform an analysis by clicking on the "Run Analysis" button.

### 5.3 Air-Satellite, Earth-Satellite, Ground-Air, and Terrestrial Scenarios

Ground-aircraft Scenario		
File	View	Run Analysis
Scenario Name:	_____	
Ground Station:	_____	
Aircraft Platform:	_____	
Frequency (GHz):	_____	
Transmitter is On:	_____	
Flight Path:	_____	
Atmospheric Profile:	_____	

Earth-Satellite Scenario		
File	View	Run Analysis
Scenario Name:	_____	
Ground Station:	_____	
Satellite Platform:	_____	
Frequency (GHz):	_____	
Transmitter is On:	_____	
Orbit Type (Low, Geo)	_____	
Orbit Name:	_____	

Terrestrial Scenario		
File	View	Run Analysis
Scenario Name:	_____	
Ground Station (Tx):	_____	
Ground Station (Rx):	_____	
Frequency (GHz):	_____	
Terrain Profile:	_____	

Air-Satellite Scenario		
File	View	Run Analysis
Scenario Name:	_____	
Aircraft Platform:	_____	
Satellite Platform:	_____	
Frequency (GHz):	_____	
Transmitter is On:	_____	
Flight Path:	_____	
Atmospheric Profile:	_____	
Orbit Type (Low, Geo)	_____	
Orbit Name:	_____	

Figure 9. Air-Satellite, Earth-Satellite, Ground-Air, and Terrestrial scenarios.

The four scenarios illustrated in Figure 9 above are characterized by a transmitting site and a receiving site. The location of these sites will determine your choice of scenario type. Thus, if one site is airborne and the other site is on the ground, you would elect to build a Ground-Aircraft scenario. To see equipment that is named in the scenario, click on "View." After all equipment is fully defined, you may perform an analysis by clicking on "Run Analysis." See Section 5.4 for a description of each entry.

### 5.4 Explanation of Entries

Once a particular scenario window is in view, you can enter or edit values by clicking on any line on the right of the window and typing in the appropriate values. Below are comments on the values to be entered. Note that each name refers to a piece of equipment that has been or will be created within the current database.

**Scenario Name:** Enter a name of your choice (30 characters or less), unique for this scenario type.

**Ground Station:** Enter a name (30 characters or less) that refers to a ground station. This is one end of the communications link for all scenarios except Air-Satellite.

**Aircraft Platform:** Enter a name (30 characters or less) that refers to an aircraft platform. This is one end of your communications link for Ground-Air, Air-Satellite, and some of the jamming scenarios.

**Satellite Platform:** Enter a name (30 characters or less) that refers to a satellite platform. This is one end of your communications link for Earth-Satellite and Air-Satellite scenarios.

**Air Jammer:** Enter a name (30 characters or less) that refers to an air jammer.

**Ground Jammer:** Enter a name (30 characters or less) that refers to a ground Jammer.

**Frequency:** Insert the frequency of your system. The default units are GHz, but you may type in MHz or kHz. The frequency of all equipment used to build a scenario must be identical.

**Transmitter is On:** This clarifies the site of transmission. Pressing any key when the focus is on this line will show a menu enabling you to specify your choice of sites.

**Flight Path:** Enter a valid DOSname that refers to an Aircraft Flight Path file. This file defines the path for an aircraft or air jammer named in the scenario.

**Atmospheric Profile:** Enter a valid DOS name that refers to an Atmospheric Profile that has been or will be created within the Current User Database.

**Climate Profile:** Enter a valid DOS name that refers to a Climate Profile that has been or will be created within the Current User Database.

**Horizon Profile:** Enter a valid DOS name that refers to a Horizon Profile that has been or will be created within the Current User Database

**Terrain Profile:** Enter a valid DOS name that refers to a Terrain Profile.

**Orbit Type:** Enter the word "Geo" (geosynchronous orbit) or "Low."

**Orbit Name:** Enter a valid DOS name that refers to a Satellite Orbit file.

**Permittivity/Conductivity:** The values of permittivity and conductivity are selected in tandem. Pressing any key when the cursor is on these lines causes a menu to appear. You make your selection by clicking and the values will automatically appear on the correct lines. Permissible values for permittivity and conductivity are:

	Relative Permittivity( $\epsilon_r$ )	Conductivity (Siemens/m)
Average Ground	15.	.005
Poor Ground	4.	.001
Good Ground	25.	.020
Fresh Water	81.	.010
Sea Water	81.	5.00

**Terrain Type:** Pressing any key when the cursor is on these lines causes a menu to appear. Permissible values for terrain type are:

	<u>Delta H</u>
Flat	
Plains	30
Hills	90
Mountains	200
Rugged Mountains	500

Delta H is a parameter used to characterize the statistical aspects of terrain irregularity for frequencies greater than 30 MHz.

**Refractivity:** Pressing any key when the cursor is on this line causes a menu to appear. Values for refractivity are:

	NS	K Factor
Equatorial	360	1.53
Continental Subtropical	320	1.38
Maritime Subtropical	370	1.58
Desert	280	1.29
Continental Temperate	301	1.33
Maritime Temperate	320	1.38
Maritime Temperate (over sea)	350	1.49

NS is the mean surface refractivity.

K Factor is the ratio of the effective earth's radius to the actual earth's radius.

## 6. EQUIPMENT

### 6.1 Ground Stations, Aircraft Platforms, and Satellite Platforms

The figure shows three software windows for configuring equipment. Each window has a title bar and a menu bar with 'File' and 'View' options.

- Ground Station:** Fields include Ground Station Name, Transmitter Name, Receiver Name, Tx Antenna Name, Rx Antenna Name, Latitude, Longitude, Altitude, Tx Antenna Height, Rx Antenna Height, Climate File, and Horizon File.
- Aircraft Platform:** Fields include Aircraft Platform Name, Transmitter Name, Receiver Name, Tx Antenna, and Rx Antenna.
- Satellite Platform:** Fields include Satellite Platform Name, Transmitter Name, Receiver Name, Tx Antenna, and Rx Antenna.

Figure 10. Ground Station, Aircraft Platform, and Satellite Platform windows.

The types of equipment shown in Figure 10 define the transmitting or receiving sites for a particular scenario. See Section 6.2 for comments on each entry.



## 6.2 Ground Jammers and Air Jammers

Ground Jammer	
File	View
Ground Jammer Name:	_____
Transmitter Name:	_____
Tx Antenna :	_____
Latitude:	_____
Longitude:	_____
Station Altitude:	_____
Antenna Height:	_____

Air Jammer	
File	View
Air Jammer Name:	_____
Transmitter Name:	_____
Tx Antenna Name:	_____

Figure 11. Ground Jammer and Air Jammer windows.

The types of equipment shown in Figure 11 define the jamming site. Use the ground jammer for a stationary jammer and the air jammer for a jammer which is moving. A flight path which defines points along the path, will be associated with the air jammer in the scenario.

**Ground Station Name:** Defines a name of your choice (30 characters or less), unique for ground stations within this database.

**Aircraft Platform Name:** Defines a name of your choice (30 characters or less), unique for aircraft platforms within this database.

**Satellite Platform Name:** Defines a name of your choice (30 characters or less), unique for satellite platforms within this database.

**Ground Jammer Name:** Defines a name of your choice (30 characters or less), unique for ground jammers within this database.

**Air Jammer Name:** Defines a name of your choice (30 characters or less), unique for air jammers within this database.

**Transmitter Name:** Defines a name of your choice (30 characters or less), unique for transmitters within this database.

**Receiver Name:** Defines a name of your choice (30 characters or less), unique for receivers within this database.

**Tx Antenna:** A name (30 characters or less) that refers to an antenna that has been or will be created within the Current User Database. The Tx antenna and Rx antenna may be the same.

**Rx Antenna:** A name (30 characters or less), that refers to an antenna that has been or will be created within the Current User Database. The Tx antenna and Rx antenna may be the same.

**Latitude:** Pressing any key will bring forth a template in which to enter the latitude in degrees, minutes, seconds, direction (DD,MM,SSD) format. However, jammer analyses ask for locations so you may choose not to enter it here.

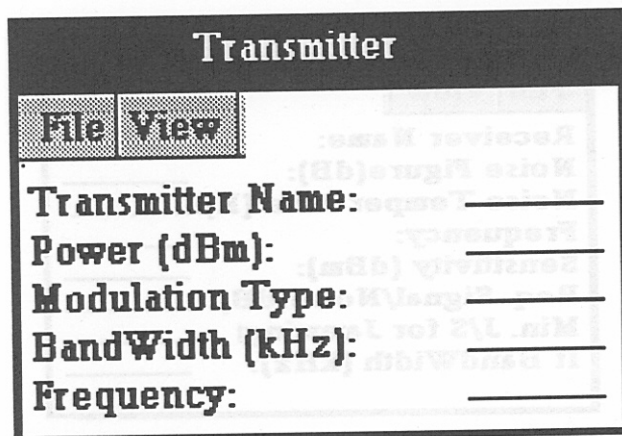
**Longitude:** Pressing any key will bring forth a template in which to enter the longitude in degrees, minutes, seconds, direction (DDD,MM,SSD) format. However, jammer analyses ask for locations so you may choose not to enter it here.

**Station Elevation:** Altitude of ground above mean sea level. Default units are meters, although feet are also acceptable (type feet or ft, e.g., 300 ft). You may choose not to enter this value here for jamming and jammer vs. network scenarios.

**Antenna Height:** Height above ground. Default units are meters, although feet are also acceptable (type feet or ft).

## 6.3 Transmitters

Figure 12 illustrates a transmitter window.



The image shows a software window titled "Transmitter". At the top, there is a menu bar with "File" and "View" options. Below the menu bar, there are five input fields, each with a label and a horizontal line for text entry. The labels are: "Transmitter Name:", "Power (dBm):", "Modulation Type:", "Bandwidth (kHz):", and "Frequency:". The background of the window is light gray with some faint, illegible text visible.

Figure 12. Transmitter window.

**Transmitter Name:** Enter a name of your choice (30 characters or less), unique for transmitters within this database. Use this name to refer to this transmitter in other equipment.

**Power:** Enter the power in dBm associated with this transmitter.

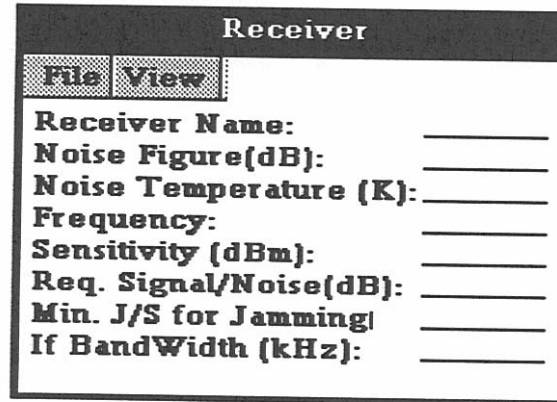
**Modulation Type:** Press any key when the cursor is on this line to see a menu of acceptable modulation types. Valid types are: CW, FM AM, RADAR, PULSE, BPSK, QPSK, CPFSK, and SS.

**Bandwidth:** Enter the instantaneous bandwidth for this transmitter in kHz.

**Frequency:** Insert frequency of this transmitter. The default units are GHz, but you may enter MHz or kHz. The frequencies of all equipment within a scenario must be equal.

## 6.4 Receivers

Figure 13 is an example of a receiver window.



The image shows a window titled "Receiver" with a menu bar containing "File" and "View". Below the menu bar, there are eight input fields, each with a label and a corresponding line for text entry:

- Receiver Name: \_\_\_\_\_
- Noise Figure(dB): \_\_\_\_\_
- Noise Temperature (K): \_\_\_\_\_
- Frequency: \_\_\_\_\_
- Sensitivity (dBm): \_\_\_\_\_
- Req. Signal/Noise(dB): \_\_\_\_\_
- Min. J/S for Jamming: \_\_\_\_\_
- IF BandWidth (kHz): \_\_\_\_\_

Figure 13. Receiver window.

**Receiver Name:** A name of your choice (30 characters or less), unique for receivers within this database. Use this name to refer to this receiver in other equipment.

**Noise Figure (NF):** This is ten times the log of the noise factor (dB).

**Noise Temperature (NT):** This is the temperature, in Kelvins, corresponding to the noise figure as defined above. These two values are interrelated so that if you enter one the other will change. The relationship is:

$$NF(dB) = 10 \text{ Log}(1 + NT/290).$$

**Frequency:** Insert frequency of this receiver. The default units are GHz, but you may enter MHz or kHz.

**Sensitivity:** The minimum signal in dBm that this receiver can detect.

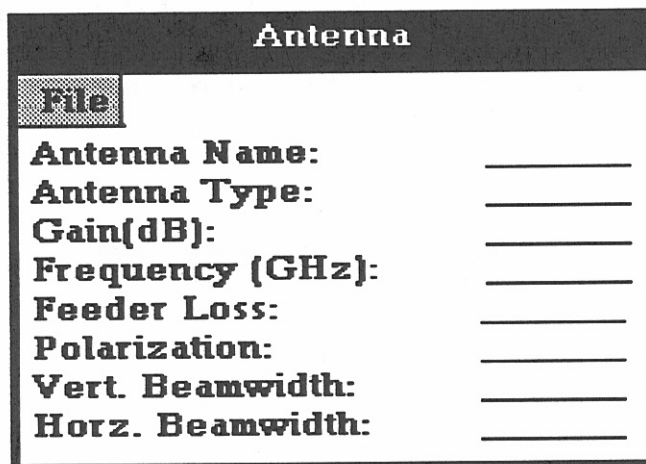
**Required Signal to Noise:** The ratio in dB of signal power in the occupied bandwidth to the noise power level required for communication.

**Minimum Jammer/Received Signal:** A ratio in dB of the minimum jammer signal power level to the signal power level at which the receiver can no longer operate.

**IF Bandwidth:** Enter the bandwidth for this receiver in kHz.

## 6.5 Antennas

Figure 14 reflects the window that defines an antenna.



The image shows a window titled "Antenna" with a "File" menu button. Below the menu are eight input fields, each with a label and a horizontal line for text entry:

- Antenna Name: \_\_\_\_\_
- Antenna Type: \_\_\_\_\_
- Gain(dB): \_\_\_\_\_
- Frequency (GHz): \_\_\_\_\_
- Feeder Loss: \_\_\_\_\_
- Polarization: \_\_\_\_\_
- Vert. Beamwidth: \_\_\_\_\_
- Horz. Beamwidth: \_\_\_\_\_

Figure 14. Antenna window.

**Antenna Name:** A name of your choice (30 characters or less), unique for antennas within this database. This name can be used in other equipment files to refer to this antenna.

**Antenna Type:** Pressing any key when focus is on this line will show a menu of available types which include Sloping Vee, Inverted L, Monopole, Half-Wave Dipole, Discone, Vagi and user input. If the frequency is 30 MHz or less, you must choose Sloping Vee, Inverted-L, Monopole, or Log Periodic. In this circumstance ( $f \leq 30$  MHz) JEM selects an antenna pattern based on antenna type, permittivity, conductivity and frequency.

**Gain:** This is the antenna gain over an isotropic antenna in decibels (dBi).

**Frequency:** Insert frequency of this antenna. The default units are GHz, but you may type in MHz or kHz.

**Feeder Loss:** Enter feeder loss of this antenna.

**Polarization:** Pressing any key when focus is on this line will show a menu enabling you to select horizontal or vertical polarization.

**Vert. Beamwidth:** Enter 3 dB vertical beamwidth. Not used in jamming scenarios.

**Hon. Beamwidth:** Enter 3 dB horizontal beamwidth. Not used in jamming scenarios.

## 6.6 Antenna Patterns

An antenna pattern reflects gain values for 360 degrees about an antenna (Figure 15). The interval of degrees at which gain values are entered is established at the time the antenna pattern is created. The interval may be 1, 2, 5, or 10 degrees. To edit the gain values, click on the degree value in the list and then edit the gain value in the gain box. If the Symmetrical Option is chosen, setting a gain value at a certain degree will cause the gain at it's reflexive position about the Y-axis to be set to the same value. Many antenna pattern files are supplied with JEM. You may

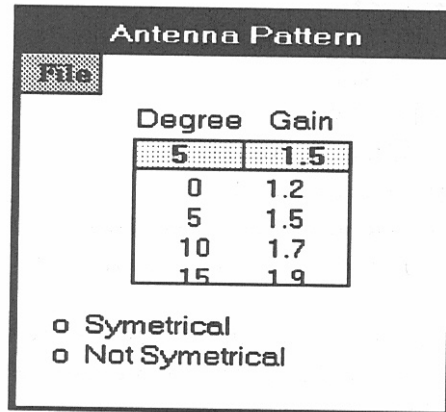


Figure 15. Antenna pattern.

view these files but not edit them. The names of these files are encoded according to the following two configurations. Configuration No. 1 is *Vtype* or *Htype*, where H and V stand for horizontal or vertical polarization and *type* is monopole, dipole, disccone, yagi, or logper(log periodic). "Hyagi" is an example of this type. JEM uses these patterns when frequency > 30 MHz and antenna type is as indicated.

Configuration No. 2 has the format HF $tt$ nFx where *tt* refers to the type, *n* refers to a permittivity/conductivity pair and *x* equals the frequency in MHz. See Table 1 for definitions of *tt* and Table 2 for definitions of *n*. JEM chooses these patterns for frequency  $\leq 30$  MHz according to type, permittivity/conductivity and frequency. Thus the name "HFIL3F24" indicates a pattern for an Inverted L antenna with frequency = 24 MHz, permittivity = 25, and conductivity = .02 s/m.

tt	type
IL	Inverted L
SL	Sloping Vee
LP	Log Periodic

Table 1. *tt* = Antenna Type

n	Perm.	Cond (s/m)
1	15	.005
2	4	.001
3	25	.02
4	81	.01
5	81	5.00

Table 2. *n* = Permittivity/Conductivity

### 6.7 Flight Paths

A Flight Path Profile is used to define points along a path for an air platform or air jammer (Figure 16). A profile may contain any number of points. Points can be defined in either of two ways: latitude, longitude and altitude or azimuth, range and altitude. Latitude and longitude values are decimal values. Altitude is meters above mean sea level.

Figure 16. Aircraft Flight Path Profile.

**To add a new set of values:** Click on the line after the last entry in the list.

**To edit values:** All editing of values is done in the five boxes labelled Latitude, Longitude, Altitude, Azimuth and Range. Clicking on any set of values in the list causes those values to be displayed in the boxes for editing.

**Using Azimuth/range mode:** In order to enter values in the azimuth-range mode, a ground reference point (latitude, longitude, altitude) must be defined. To do so, click the "Set Ground Reference" button. You will be given templates to help you enter your values. Your azimuth values will be degrees east of due north from the reference point to path point. Range is kilometers between the two points. When you enter azimuth-range values, JEM computes the latitude and longitude. JEM writes the file using latitude and longitude and then translates each entry to azimuth-range when the file is reopened. Thus, slight changes in value may occur because of computation.

### 6.8 Terrain Profiles

Terrain Profiles are used in Terrain (Ground Station to Ground Station) scenarios (Figure 17). This file defines the terrain along the path from transmitter station to receiver station. Each entry in the list defines one point. There may be any number of points.

The image shows a software window titled "Terrain Profile". At the top left is a button labeled "File". Below it are four input fields with labels: "Distance(Km)", "Elevation(m)", "Obstacle Ht.", and "Obstacle". Underneath these fields is a large rectangular area labeled "List". At the bottom center of the window is a button labeled "Delete this line".

Figure 17. Terrain Profile.

**Distance(km):** A positive decimal value specifying distance from transmitter.

**Elevation(meters):** A decimal value specifying elevation at this point.

**Obstacle Ht (meters):** A decimal value specifying height of obstacle if present.

**Obstacle:** An alpha field to identify obstacle. This field may be left blank.

**To add a new line of data:** Enter a new value for distance. That line will be placed in the appropriate spot (sorted according to distance).

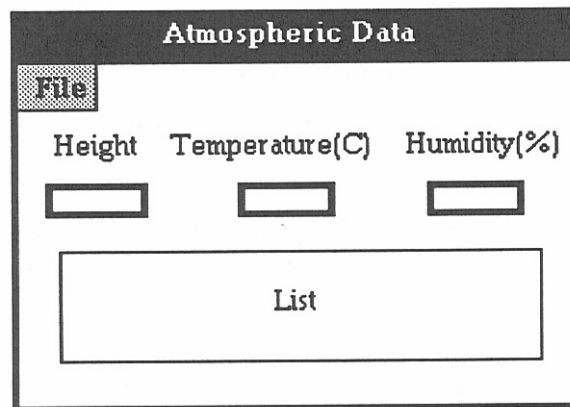


**To edit data on an existing line:** Click on the desired line so that it is highlighted. The current values will be shown in the boxes. You may edit the values in these boxes.

**To delete an existing line:** Click on the desired line so that it is highlighted. Then click the "Delete this line" button.

## 6.9 Atmospheric Profiles

An Atmospheric Profile is used in a Ground-Aircraft or Air-Satellite Scenario and describes the layers of atmosphere (Figure 18).



The image shows a software window titled "Atmospheric Data". Inside the window, there is a menu bar with a "File" option. Below the menu bar, there are three input fields labeled "Height", "Temperature(C)", and "Humidity(%)". Each label is positioned above its corresponding input box. Below these three input fields is a larger rectangular box labeled "List".

Figure 18. Atmospheric Profile.

**Height:** This is the height of the lowest point of this layer of the profile. Units are kilometers above the ground, not above sea level.

**Temperature:** The temperature is in degrees Celsius for this layer.

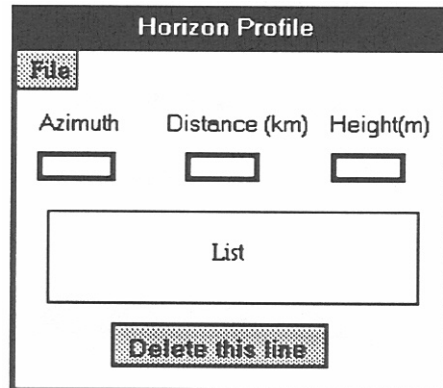
**Humidity:** Relative humidity in percent (0 to 100) for this layer. Do not enter the % sign.

**To add a new line of data:** Enter desired value in the Height box. The data is sorted according to height. JEM will place a new line at the appropriate place in the file according to the value entered.

**To edit and delete:** See instructions for terrain profiles, Section 6.8.

## 6.10 Horizon Profiles

Figure 19 shows the window which displays a Horizon Profile.



The screenshot shows a software window titled "Horizon Profile". At the top left is a "File" button. Below it are three input fields: "Azimuth", "Distance (km)", and "Height(m)". Below these fields is a large rectangular area labeled "List". At the bottom center is a button labeled "Delete this line".

Figure 19. Horizon Profile.

**Azimuth:** The angle in degrees east of true north from a specific location to the horizon in the desired direction of communication. The value must be an integer.

**Distance:** The distance (km) from the ground location to the horizon at the above specified azimuth.

**Height:** The height above mean sea level in meters of the horizon at the above specified azimuth.

**To add a new line of data:** Click on the Azimuth box and type the desired value. The data is sorted according to Azimuth. JEM will place a new line at the appropriate place in the file according to the value entered. JEM will further update this new line as you enter values for distance and height.

**To edit and delete:** See instructions for Terrain Profiles in Section 6.8.

## 6.11 Climate Profiles

A Climate Profile reflects the number of days with precipitation and storms, the mean temperature and rain rate, and the humidity for each month of the year (Figure 20).

Climate					
File	Fill From Database				
	Days of Precip	Days of Storms	Mean Precip	Mean Temp	Relative Humidity
Jan	—	—	—	—	—
Feb	—	—	—	—	—
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
Dec	—	—	—	—	—

Figure 20. Climate Profile.

The data may be entered manually by entering values on each line or you may allow JEM to interpolate the data from its own meteorological database by pressing "Fill From Database." The interpolation is performed based on latitude and longitude. The values are the average of the average daily maximums and the average daily minimums for each month.

**Days of Precipitation:** Number of days for each month that precipitation exceeds 3mm.

**Days of Storms:** Number of days of thunderstorms for each month.

**Mean Precipitation:** Amount of measurable precipitation (in mm) averaged for each month.

**Mean Temperature:** Temperature in degrees Celsius averaged for each month.

**Relative Humidity:** 0 to 100% (do not enter the % sign). The humidity values in the database are calculated using the average of all hourly relative humidity values observed in a specific month.

## 6.12 Orbit Profiles

An Orbit Path Profile is used to define points along a path of a satellite. A profile may contain any number of points. Points are defined by latitude, longitude, and altitude. Latitude and longitude values are decimal values. Altitude is meters above mean sea level. The Orbit Profile window is shown in Figure 21 below.

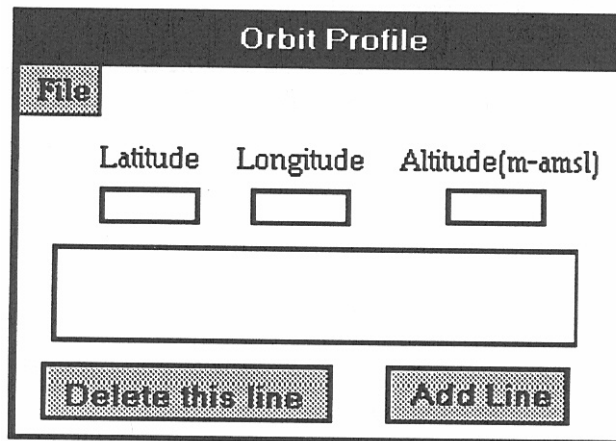


Figure 21. Orbit Path Profile.

**To add a new set of values:** Click on the line after the last entry in the list.

**To edit values:** All editing of values is done in the three boxes labelled Latitude, Longitude, and Altitude. Clicking on any set of values in the list, causes those values to be displayed in the boxes for editing.

## 7. JAMMING ANALYSES

### 7.1 Jammer Footprint

#### 7.1.1 Introduction

The Jammer Footprint is a polar plot of the minimum distance from the jammer at which a receiver/transmitter pair must be located to communicate in the presence of jamming vs. the azimuth angle about the jammer. Each plot consists of up to four contours of transmitter-to-receiver distances which you have chosen. The transmitter/receiver pair must be outside of the contour in order to be able to communicate.

#### 7.1.2 Program Input

Most of the data used to run a Jammer Footprint analysis is communicated by DOS file from a user-defined scenario in JEM. You will be asked for certain additional input by the analysis.

**Set Location of Jammer**

**Latitude**  
  
 North  
 South

**Longitude**  
  
 East  
 West

**Jammer Altitude(m-amsl)**

**Antenna Height (m)**

	Azimuth	Slant Range(Km)	Altitude	Antenna Ht.
Receiver Loc: wrt Jammer	0	1	0	0
	40.00,00N	104.53,00W	0	↓

Transmitter Loc: wrt Receiver	0	1	0	0
-------------------------------	---	---	---	---

Figure 22. Jammer Footprint: transmitter, receiver, and jammer location.

## Site Location

Figure 22 illustrates the window for entering the jammer, receiver and transmitter locations.

**Jammer Location:** The jammer location is central to a Jammer Footprint. The jammer latitude and longitude specified in JEM will be shown in the jammer location window at the top. Any value displayed in this window may be changed at this time by clicking on the desired box and entering a decimal value. Click on North or South, and East or West, as appropriate.

**Receiver Location:** The receiver location is defined by an azimuth in degrees east of due north and slant range in kilometers value with respect to the Jammer.

**Transmitter Location:** The transmitter location is defined by azimuth in degrees east of due north and slant range in kilometers with respect to the receiver. The transmitter location specified here is used only to locate the transmitter on the plot. The receiver-transmitter separations which are used to calculate the contours are input elsewhere. (See Transmitter-Receiver Separations on page 32)

If a site is airborne (air platform or air jammer), the points on the flight path are indicated as shown in the receiver location in Figure 22. Click on the gray down arrow to view a list containing each point. Click on the point of your choice. Jammer Footprint will calculate the azimuth and range and display these values in appropriate boxes.

## Antenna Direction

The main beam of each antenna can be set in the window shown in Figure 23 below. The transmitter, receiver, and jammer are located relative to the positions that you have set. Each is identified by a color-coordinated triangle as indicated in the upper left corner. Initially, the main beam of the transmitter and receiver are pointed at each other, while the main beam of the

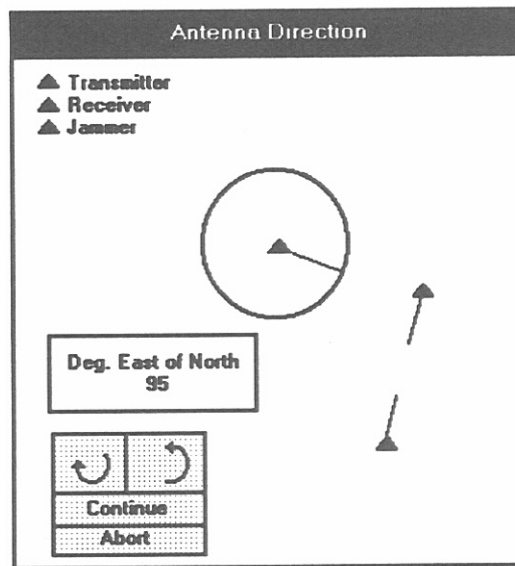


Figure 23. Setting antenna main beam direction.

jammer is pointed at the receiver. To move any of the main beams, click on the triangle representing that site. Then, either enter a decimal value in the box labelled "Deg. East of North" or click on the clockwise or counter-clockwise arrows to move the indicator. The "Deg. East of North" box may be moved if desired by clicking and dragging. Click on "Continue" when ready. Clicking on "Abort" will return processing to the location window.

## Transmitter-Receiver Separations

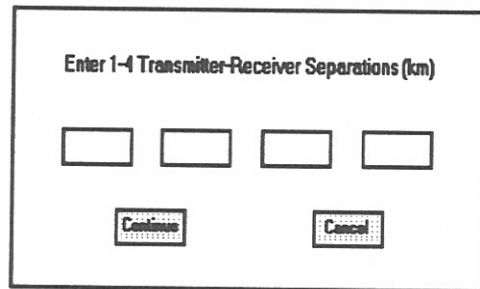


Figure 24. Inputting transmitter/receiver separations.

Jammer Footprint allows from one to four transmitter-receiver separations for each plot. Each value entered will be represented by a contour on the plot. Input these values in the window as illustrated above in Figure 24 by clicking on a box and typing. You may click on continue anytime after entering one to four values.

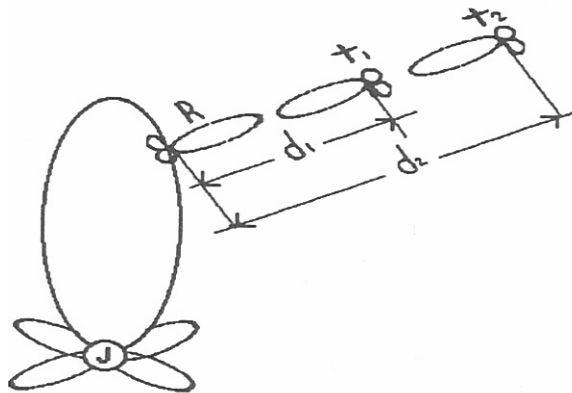


Figure 25. Relative receiver/transmitter positions.

During computation, the transmitters are located on the same fixed radial with respect to the receiver, but at different distances from the receiver. Thus the receiver antenna beam presents the same gain to the jammer for all positions about the jammer. Figure 25 above shows us a possible jammer antenna pattern. The relative positions of receiver and transmitters would remain the same as Jammer Footprint makes the calculations at each position on the jammer pattern.



## IONCAP Input

The IONCAP input window is a graphical user interface with several sections:

- Noise Level Selection:** A vertical list of radio buttons with corresponding noise levels:
  - Industrial Noise (-125 dBW)
  - Residential Noise (-136 dBW)
  - Rural Noise (-148 dBW)
  - Remote Noise (-164 dBW)
  - User InputA text input box next to "User Input" contains the value "-136".
- Month Selection:** A vertical list of radio buttons for each month:
  - January
  - February
  - March
  - April
  - May
  - June
  - July
  - August
  - September
  - October
  - November
  - December
- Input Time (LMT) 0 - 24:** A text input box containing "12" and a vertical slider below it.
- Input SunSpot (0 to 200):** A text input box containing "100" and a vertical slider below it.
- Ground Wave Only:** A radio button labeled "Ground Wave Only".
- Buttons:** Two buttons labeled "Continue" and "Abort" are located at the bottom right.

Figure 26. IONCAP input window.

If the frequency for the scenario is less than or equal to 30 MHz, Jammer Footprint includes calculations for the sky wave. In order to do this, Jammer Footprint runs the "Ionospheric Communications Analysis and Prediction" (IONCAP) program [11] which requires additional input. Figure 26 illustrates the input menu for these values.

**Noise Level:** Click on the noise level desired. This is the expected man-made noise level at the receiver in a 1-Hz bandwidth at 3 MHz. Selecting "User Input" causes a box to appear (as shown in Figure 26) in which you may enter any value.

**Time:** The time of day for which the analysis will to be performed. The hours are local mean time at the transmitter.

**Sunspot Number:** The sunspot number of the solar activity for the month of interest. It is the 12-month running average for the month specified. A sunspot number of ten is typical for low solar activity and sunspot numbers between 110 and 130 are typical of high solar activity. Values for time and sunspot may be entered by clicking on the box and typing or clicking on the increasing or decreasing arrows.

**Month:** Click on the desired month for the analysis. June and December are typical of seasonal extremes.

**Ground Wave Only:** You have the capability of bypassing IONCAP computations by clicking "Ground Wave Only." Calculations will then be based solely on ground wave propagation losses. Choosing "Ground Wave Only" may save significant processing time. However, IONCAP will be run one time to access the calculated noise figure, so even when choosing "Ground Wave Only," you should choose appropriate values in this window.

Click "Continue" to proceed. Clicking "Abort" will return processing to JEM.

### 7.1.3. Program Output

#### Data Output

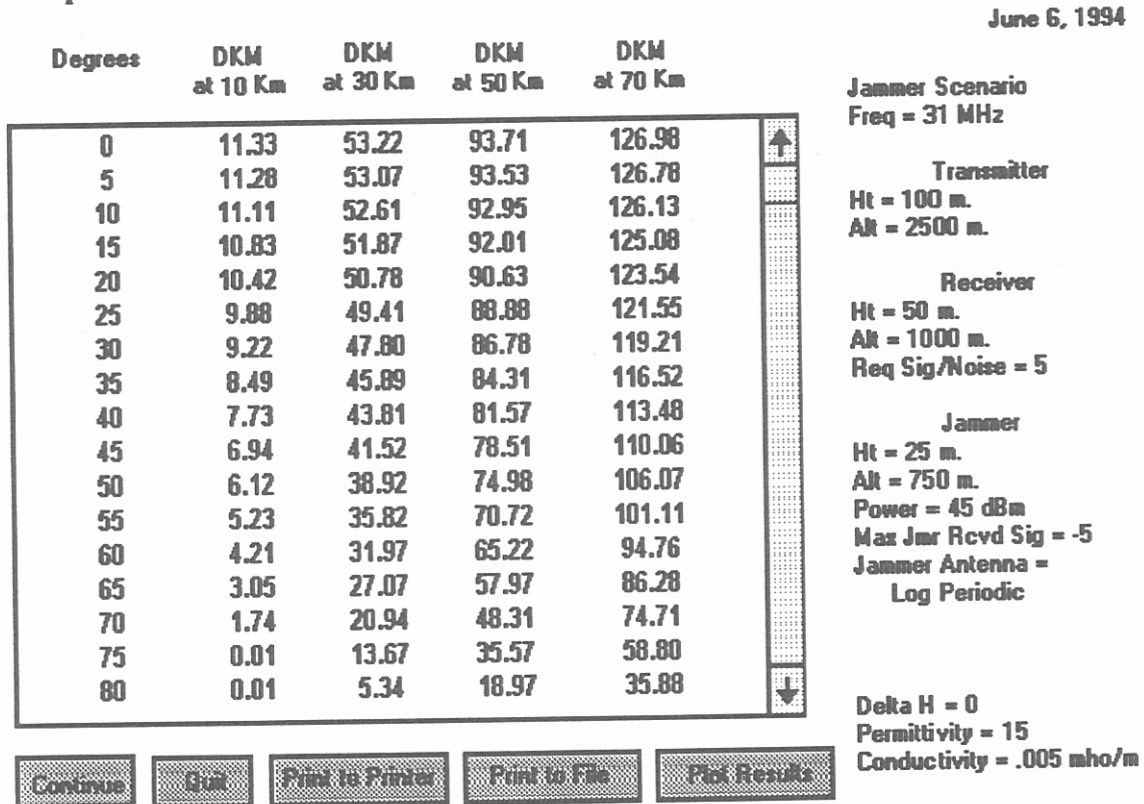


Figure 27. Jammer Footprint data output.

On the example of a Jammer Footprint shown in Figure 27, there are four contours. The user has chosen transmitter-receiver separations of 10, 30, 50, and 70 kilometers as indicated by column headers. The value shown by the contour at each degree is the maximum distance in kilometers the jammer can be from the receiver and still effectively jam communications.

The buttons along the bottom have the following functions.

**Continue:** Returns to the location window. You may change parameters and run the analysis again.

**Quit:** Returns processing to JEM.

**Print to Printer:** Prints the data to the printer associated with Windows.

**Print to File:** Prints data to a file you have chosen.

**Plot Results:** Shows Jammer Footprint plot of data.

## Plotted Output

Using the same example as Figure 27, Figure 28 illustrates the plotted output of Jammer Footprint. Note that the four contours labelled 10, 30, 50, and 70 indicate transmitter-receiver

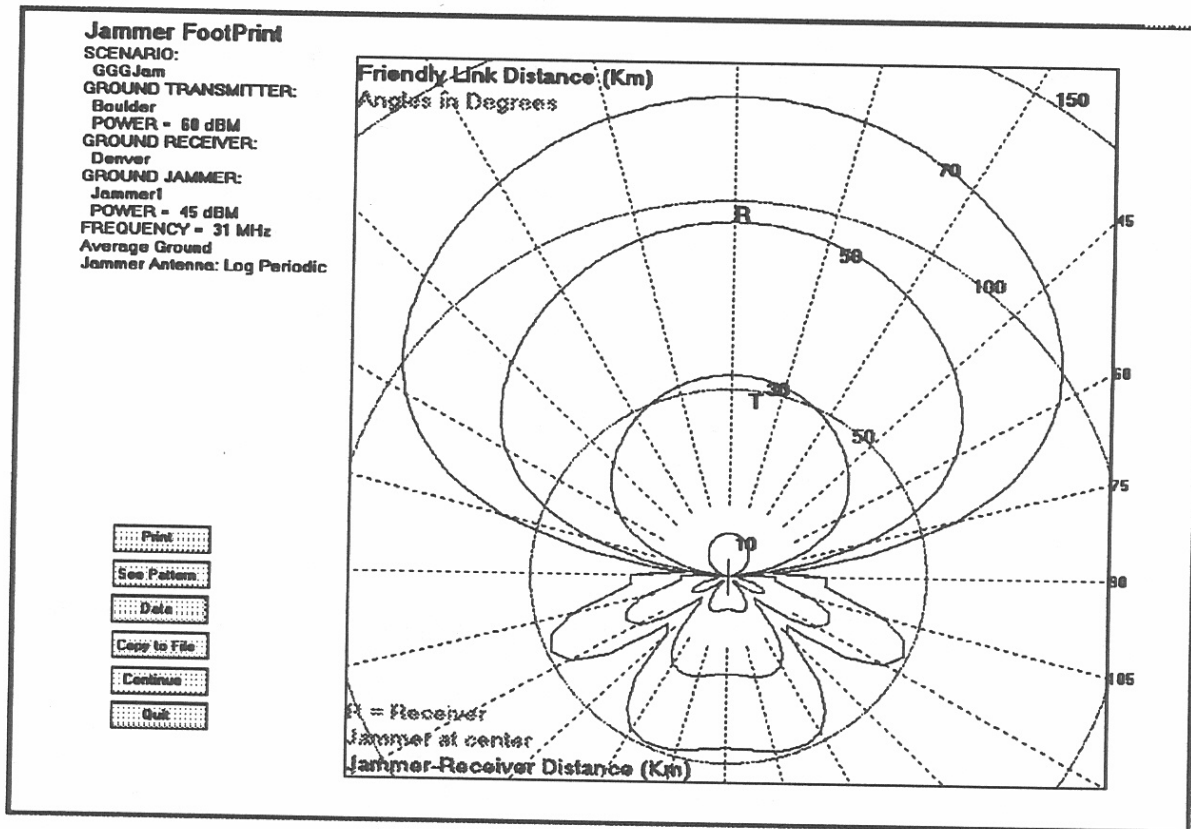


Figure 28. Jammer Footprint plotted output.

separations. The concentric circles with the jammer at the center reflect distances of 50, 100 and 150 km from the jammer. The radials are spaced every 15 degrees. The locations of the receiver and jammer as defined in the location window are shown by "R" and "T," respectively. This footprint tells us that given a transmitter-receiver separation of 30 km, the receiver needs to be approximately 50 km away from the jammer in order to receive transmission if the receiver is located along the jammer's main beam at 0 degrees north. Judging by the actual location of the receiver at 100 km from the jammer, and interpolating between the 50 and 70 km contours, the transmitter may be approximately 54 km away from the receiver and still maintain communication.

The buttons in Figure 28 have the following functions.

**Print:** Prints the plot to the printer associated with Windows. For landscape printing, make that selection in the Windows print driver accessible through the Control Panel icon. If your printer does not handle graphics, this choice may cause a general protection error.

**See Pattern:** Allows you to view a small diagram of the jammer antenna pattern.

**Data:** Brings up a window that displays answers in numerical form as shown in Figure 26.

**Copy to File:** Copies a bitmap image of the plot into a file of your choice.

**Continue:** Returns to the location window. User may change parameters which are set within Jammer Footprint and run the analysis again.

**Quit:** Returns processing to JEM.

## 7.2 Isopower Contours

### 7.2.1 Introduction

The Isopower Contour computation is a plot of one or more constant jammer power density levels at the receiver vs. azimuth angle about the jammer. It determines at what distances can the jammer generate certain discrete power density levels at the receiver for each azimuth angle.

### 7.2.2 Program Input

Most of the data used to run an Isopower Contour analysis is communicated by DOS file from a user-defined scenario in JEM. You will be asked for additional input as the analysis continues, as discussed below.

#### Site Location

The screenshot shows a window titled "Set Location of Jammer". Inside, there are two columns of input fields. The left column has "Latitude" with a value of "40.00", radio buttons for "North" (selected) and "South", "Jammer Altitude(m-asst)" with a value of "0", and "Receiver Altitude" with a value of "1000". The right column has "Longitude" with a value of "104.88", radio buttons for "East" and "West" (selected), "Antenna Ht (m)" with a value of "0", and "Antenna Height" with a value of "1000". At the bottom of the dialog, a summary bar displays "40,00,00N 104,53,00W 0" followed by a shaded rectangular area. The entire dialog is enclosed in a rectangular border.

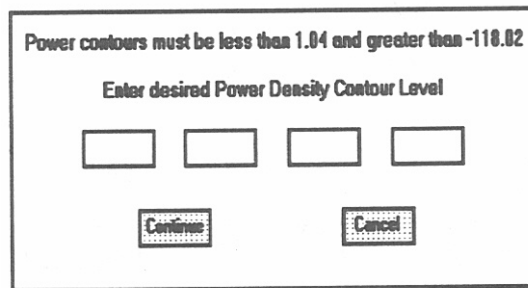
Figure 29. Isopower jammer location.

Isopower contours involve only a receiver and a jammer. Figure 29 above illustrates the window for entering jammer location and receiver altitude and height.

**Jammer Location:** The jammer latitude and longitude specified in JEM will be shown in the jammer location window at the top. The actual location of the jammer is important only if the frequency is 30 MHz or less, since ionospheric propagation depends on actual geographic location. This example shows an air jammer. The points of the flight path can be seen by clicking the down arrow at the right. Click on the point of your choice. The values chosen will be shown in the jammer latitude, longitude, and altitude boxes.

**Receiver Location:** Only the receiver height is needed since the calculations within Isopower Contours place the receiver at each azimuth angle about the jammer. The height includes the ground altitude (m-amsl) and the antenna height (meters above ground). Click on "Continue" when all locations have been set.

### Power Density Levels



Power contours must be less than 1.04 and greater than -118.02

Enter desired Power Density Contour Level

Figure 30. Power density input.

Isopower contours allow for one to four power density levels for each plot. Input these values in the power density window as illustrated in Figure 30 by clicking on a box and typing. The values you input must fall within the range as indicated at the top of the window. This is dependent on the gains and losses of your system. You may click "continue" anytime after entering at least one value.

### IONCAP Input

See IONCAP Input, Section 7.1.2 for a description of these parameters.

### 7.2.3. Program Output

#### Printed Output

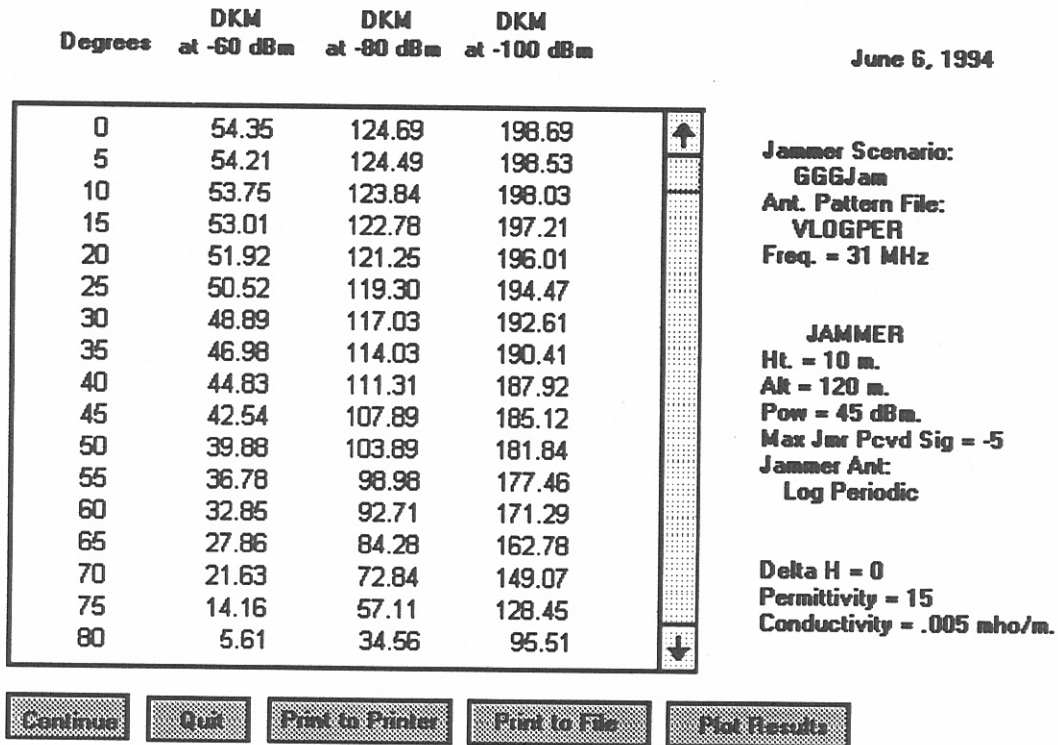


Figure 31. Isopower printed output.

In the example shown in Figure 31, there are three contours. The user has chosen power density levels of -60, -80, and -100 dBm / sq. meter as indicated by column headers. The value shown at each degree is the distance in kilometers from the jammer that the designated power density exists.

The buttons along the bottom have the following functions.

**Continue:** Returns to the location window. You may change parameters that were set within Jammer Footprint and run analysis again.

**Quit:** Returns processing to JEM.

**Print to printer:** Prints the data to the printer associated with Windows.

**Print to File:** Prints the data to a file you have chosen.

**Plot Results:** Shows Jammer Footprint plot of data.



## Plotted Output

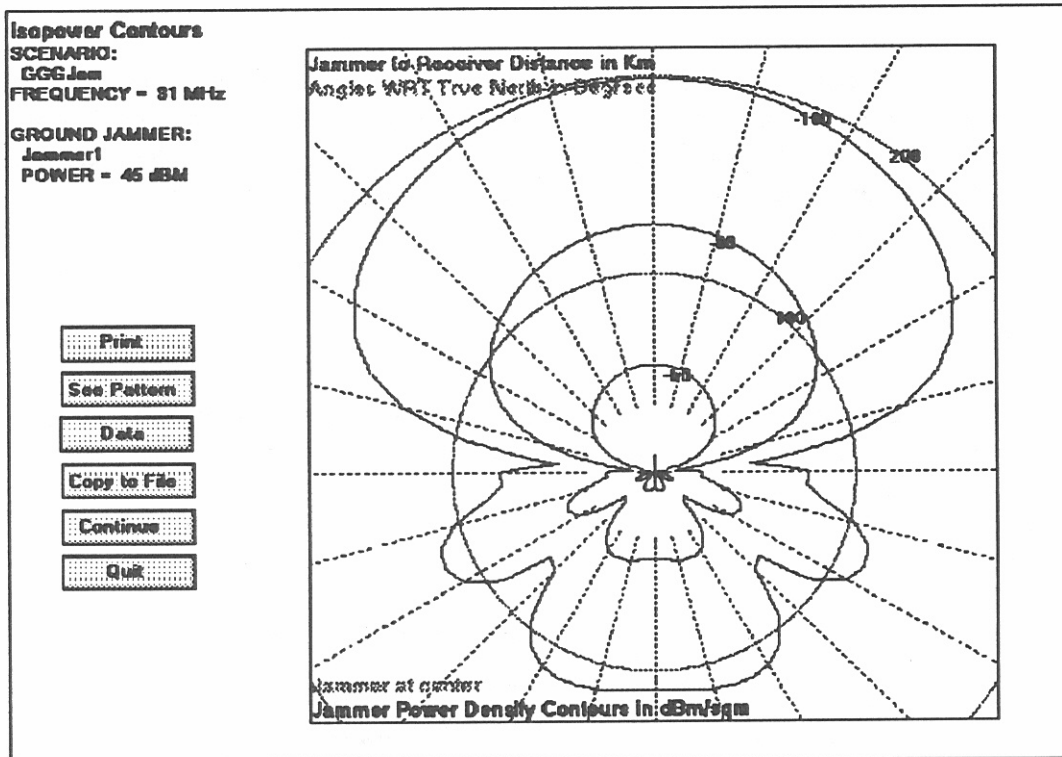


Figure 32. Isopower plotted output.

The data from Figure 31 is shown in a plot in Figure 32. Note the three contours labelled -60, -80, and -100 indicating power level densities. The concentric circles with the jammer at the center reflect distances of 100 and 200 km from the jammer. The radials are always every 15 degrees. The buttons have the following functions.

**Print:** Prints the plot to the printer associated with Windows. For landscape printing, make that selection in the Windows print driver accessible through the Control Panel icon.

**See Pattern:** Allows you to view a small diagram of the jammer antenna pattern.

**Data:** Brings up a window that displays answers in numerical form as shown in Figure 31.

**Copy to File:** Copies a bitmap image of the plot into a file you have chosen.

**Continue:** Returns to the location window. You may change parameters and run analysis again.

**Quit:** Returns processing to JEM.

## 7.3 Received Power

### 7.3.1 Introduction

There are two types of analyses which compute received power: Received Signal Power (RSP) computes the received power level vs. distance from a transmitter; and Received Jammer Power (RJP) computes the received power level vs. distance from a jammer. They are essentially identical except that one has a jammer and the other has a transmitter. The following is appropriate for both analyses.

### 7.3.2 Program Input

Most of the data used to run either received power analysis is communicated by DOS file from a user-defined scenario in JEM. You will be asked for certain additional input as the analysis continues, as discussed below.

#### Site location

Receiver Location			
Latitude	Longitude		
40.00	104.88		
<input checked="" type="radio"/> North	<input type="radio"/> East		
<input type="radio"/> South	<input checked="" type="radio"/> West		
Altitude(m-amsl)	Antenna Ht (m)		
0	0		
Transmitter Location			
Azimuth (Deg)	Slant Range (Km)	Altitude	Antenna Ht
40.00,00N	104.53,00W	0	

Figure 33. Location window for received power site.

Received Signal Power analyses involve a receiver and a transmitter. Received Jammer Power analyses involve a receiver and a jammer. Figure 33 shows an example of the location window for Received Signal Power. The latitude and longitude of the receiver which you have input in JEM, will be shown at the top. This may be changed if desired. The latitude and longitude location for the transmitter is located in the box with the down arrow. This location is defined relative to the receiver in the azimuth, slant range, and altitude boxes. You may edit the location in these boxes. Once the location is edited, the latitude and longitude is no longer shown because it is no longer valid. This example shows a transmitter located on an air platform. The points of

the flight path can be seen by clicking the down arrow at the right. Click on the point of your choice. The values chosen will be translated to azimuth, range, and altitude values relative to the receiver. The location window for Received Jammer power is identical except the location of the jammer is defined instead of the transmitter. Click on "Continue" when all locations have been set. To abort, use the minus sign in the upper left corner.

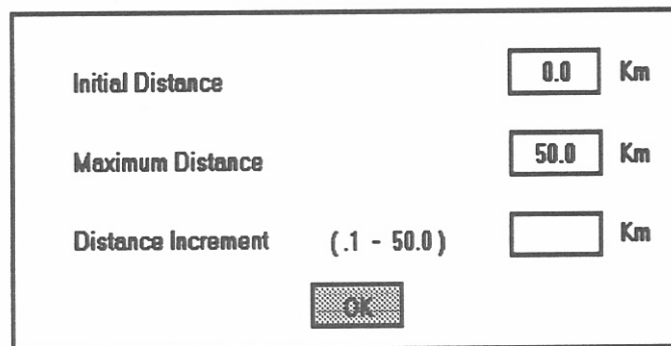
### Antenna Direction

See Antenna Direction in Section 7.1.2 for a description of setting the direction of antenna beams.

### IONCAP Input

See IONCAP Input in Section 7.1.2 for a description of these parameters.

### Range for Calculations



Initial Distance	<input type="text" value="0.0"/>	Km
Maximum Distance	<input type="text" value="50.0"/>	Km
Distance Increment	<input type="text" value=""/>	Km
	(.1 - 50.0)	
<input type="button" value="OK"/>		

Figure 34. Received power range input.

Calculations are made over the length of the path between the receiver and transmitter, or the jammer as defined by the slant range parameter. This distance is noted as "Maximum Distance." You can specify the initial distance and the increment within the limits specified (Figure 34).

### 7.3.3. Program Output

#### Data Output

Options		
Scenario Name: Gw (Ground wave only) 06-22-1994		
Jammer: New Town Lat: 38.5 Long: -104.9 Alt: 0 m		
Receiver: Other Town Lat 39.37 Long: -105.0 Alt: 0 m		
Frequency: 10 MHz Polarity: VERTICAL		
Refractivity: 320 Epsilon: 25 Sigma: .02		
Jammer Antenna: Log Periodic Jammer Power: 50dBm		
Receiver Antenna: Monopole		
Distance	Power	Losses
(Km)	(dBm)	(dB)
0.0	53.309	4.631
5.0	-26.098	87.236
10.0	-38.771	99.711
15.0	-46.198	107.138
20.0	-51.453	112.393
25.0	-55.578	116.518
30.0	-59.002	119.942
35.0	-61.948	122.888
45.0	-64.548	125.488
50.0	-66.887	127.827
55.0	-69.026	129.966
60.0	-71.004	131.944
65.0	-72.853	133.793

Figure 35. Received power printed output.

The numerical output from RJP and RSP displays the power and losses at each distance increment. For those scenarios with frequency less than or equal to 30 MHz, the output lists the power, ground wave, and sky wave components. In the example of Received Jammer Power shown above in Figure 35, the user has chosen to examine only the ground wave at increments of 5 km. Clicking on "Options" brings forth a menu with the following choices.

**Print to printer:** Prints the data to the printer associated with Windows.

**View Graph:** Shows plot of data.

**Create Data File:** Prints data to a file.

**Close Window:** Closes data window.

**New Profile:** Returns to the location window. You may change parameters which were set within analysis and run analysis again.

**Quit:** Returns processing to JEM.

## Plotted Output

Figure 36 shows an example of the plotted output from Received Signal Power. A plot from Received Jammer Power is similar.

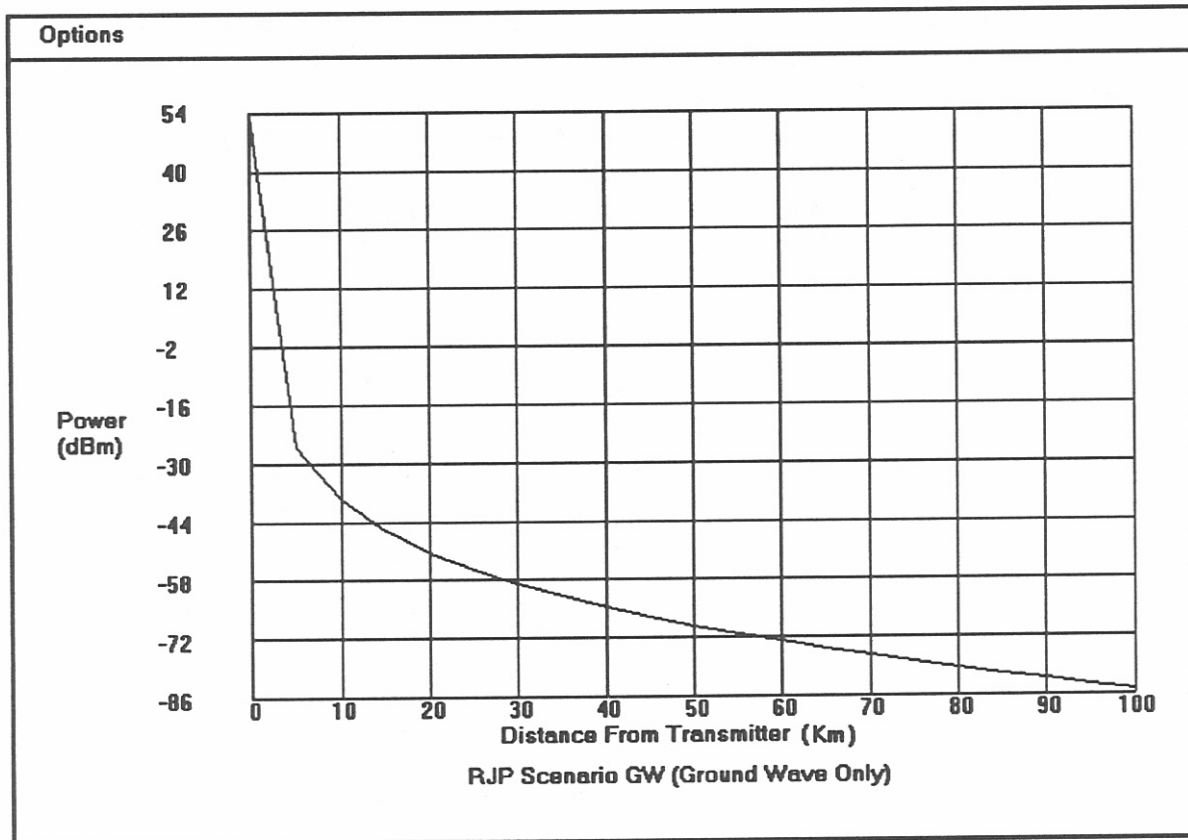


Figure 36. Received power plotted output.

Clicking on "Options" brings forth a menu with the following choices.

**Create Graph File:** Copies a bitmap image of the plot into a file which you have named.

**Close:** Closes the graph window. If the data window is not open, this command returns to JEM.

**New Profile:** Returns to the location window. You may change parameters set within the analysis and run the analysis again.

**Quit:** Returns processing to JEM.