Range
Commanders
Council

DOCUMENT 383-95

METEOROLOGY GROUP

CATALOG OF ATMOSPHERIC ACOUSTIC PREDICTION MODELS

WHITE SANDS MISSILE RANGE
KWAJALEIN MISSILE RANGE
YUMA PROVING GROUND
DUGWAY PROVING GROUND
COMBAT SYSTEMS TEST ACTIVITY

ATLANTIC FLEET WEAPONS TRAINING FACILITY
NAVAL AIR WARFARE CENTER WEAPONS DIVISION
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
NAVAL UNDERSEA WARFARE CENTER DIVISION, NEWPORT
PACIFIC MISSILE RANGE FACILITY

30TH SPACE WING
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AIR FORCE FLIGHT TEST CENTER
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DOCUMENT 383-95

CATALOG OF ATMOSPHERIC ACOUSTIC PREDICTION MODELS

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Prepared by

METEOROLOGY GROUP
RANGE COMMANDERS COUNCIL

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PREFACE

Many range meteorology support units are required to provide predictions for acoustic overpressures resulting from high explosive and gun blasts, missile launches, and sonic booms. The Air Quality Committee of the Range Commanders Council (RCC) Meteorology Group (MG), in assessing these requirements, concluded that a catalog of available models, similar to the one published by the Office of the Federal Coordinator for Meteorological Services and Supporting Research for atmospheric transport and diffusion models, would be useful to all ranges or to organizations planning to use member ranges for an activity that could result in generation of high acoustic or blast levels.

This document contains, in its early chapters, some background information on acoustic propagation effects, explosion characteristics, and atmospheric effects of explosions as well as a brief explanation of sonic booms and their effects. In the latter chapters, summaries and descriptions of a number of models currently in use at various member ranges have been provided.

Any information from users which might assist in improving this document is appreciated. Correspondence reporting new models not incorporated in this document or changes in models already incorporated should be addressed to the Meteorology Group through the Secretariat, Range Commanders Council. The Meteorology Group Committee responsible for preparation of this document was composed of the following individuals:

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Mr. C. Clough, U.S. Army Combat Systems Test Activity

Additionally, the Air Quality Committee wishes to thank all who provided data for the survey, and those who reviewed the document.

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CHAPTER 1

INTRODUCTION

There are a number of member ranges currently engaged in high-explosive blast testing or activities that result in high acoustic levels and others who are anticipating such activities. These acoustic waves generated from the blast impulses could have adverse impacts on nearby communities. This document is designed to allow meteorologists, environmental engineers, and safety personnel to use models to predict acoustic overpressures and high intensity sound levels, thus predicting potential damage or nuisance to people and property. These models can serve as tools to (1) determine short-term operational predictive decisions, (2) select blast sites based on location and local climatology to determine if environmental damage criteria are likely to occur at selected distances and radials, (3) determine inputs for environmental assessment and impact statements, and (4) provide guidance in assessing the verity of damage claims resulting from high-level blasts.

The original intent of this report was to present a listing of candidate models which have been designed for operational or research and developmental use in assessing the impacts of acoustic waves from high-explosive blasts. While compiling information on the models in this document, the authors decided it would also be helpful to include some background information on the nature of high-explosive blasts and on the attendant acoustic waves along with their potential environmental impacts.

While a number of texts and documents address the topic of acoustic propagation and the environmental impacts of acoustic waves, a useful overall document we have encountered is a Defense Nuclear Agency publication entitled High Explosive Field Tests: Explosion Phenomena and Environmental Impacts. The first few sections of this report quote extensively from DNA 6187F. In particular, chapter 3, Explosive Characteristics of Airblast is taken almost verbatim from DNA 6187F.

In general, conservative assumptions regarding the magnitude of explosion phenomena and their effects are used to avoid underestimating the environmental impact of the phenomena. If significant impact is indicated, less conservative assumptions can be used in a careful analysis to provide a more realistic assessment.

A variety of measurement units is used in this report, depending on how the particular types of data are customarily given. In general, however, output for users of this document are presented in metric units, except higher explosives (HE) charge sizes which are given in TNT-equivalent weight; that is, the weight of TNT (with explosive energy of 10^9 gram calories/ton) that would produce approximately the same magnitude of a particular phenomenon as the specific explosive charge in question. Table 1-1 shows the factors to convert to other measurements systems.

TABLE 1-1. UNIT CONVERSION FACTORS

To Convert	Into	Multiply by
Gravitational units of acceleration (g's)	Centimeters per Second^2 (cm/sec^2)	981
Cubic feet (ft^3)	Cubic meters (m^3)	2.832×10^{-2}
Cubic meters (m^3)	Cubic feet (ft^3)	35.31
Grams (g)	Pounds (lb)	2.205×10^{-3}
Pounds (lb)	Grams (g)	453.6
Feet (ft)	Meters (m)	0.3048
Meters (m)	Feet (ft)	3.281
Pascals (Pa)	Pounds per square inch (psi)	1.451×10^{-4}
Pounds per square inch (psi)	Pascals (Pa)	6894
Pound per square foot	Pascals (Pa) [Newtons per m^2]	48
Square feet (ft^2)	Square meters (m^2)	9.290×10^{-2}
Square meters (m^2)	Square feet (ft^2)	10.76

Calculation

Sound Pressure Level = SPL = $(20 \log p/p_0)$ dB

Using $p_0 = 2 \times 10^{-5}$ Pa implies SPL = $(20 \log p + 94)$ dB

For $p = 1$ lb/ft^2 = 48 Pa, SPL = $(20 \log 48 + 94)$ dB = 128 dB

CHAPTER 2

ATMOSPHERIC ACOUSTIC PROPAGATION EFFECTS

INTRODUCTION

The atmosphere is not a homogeneous fluid. Wind and temperature at different heights will usually have different values. A picture of the wind field taken at various heights above the ground at a specific time is called a wind profile. A temperature profile normally cools with increasing height above the ground. These vertical changes in wind and temperature are referred to as wind and temperature gradients. Sound propagation is refracted by wind and temperature gradients, resulting in the sound wave being bent from a straight line.

The basic problem of atmospheric acoustic propagation is the variability of the atmospheric boundary layer (ABL), also called the planetary boundary layer. The ABL is that part of the earth's atmosphere directly influenced by the presence of the earth's surface. The ABL varies in depth from as little as 100 m (328 ft.) at night to as much as 2 km (6562 ft.) or more on hot sunny days. Atmospheric sound transmission varies with time of day, prevailing weather conditions, and source/receiver orientation with respect to the wind direction or azimuth. These conditions will cause the sound levels to be enhanced or diminished from those otherwise expected. Some of the types of conditions found are based on conditions noted earlier. Sound intensities can vary as much as 30 dB in magnitude over significant distances (5 km (16 400 ft.) or more) and is caused by the variation of the speed of sound profile where, in one instance, the sound being propagated is bent over and focused toward the earth's surface and, in the other, sound is propagated upward in the atmosphere and dispersed.

EFFECT OF THE SPEED OF SOUND PROFILE

The atmosphere refracts sound well. The changes in the speed of sound with height are a function of temperature and wind. In the absence of wind, the sound speed equation is as

$$C = 331.6 \sqrt{(1 \div T/273)} \qquad (2\text{-}1)$$

where C = sound speed in meters per second
T = temperature in degrees Celsius

The component of wind in the direction of propagation adds to the sound speed as

$$C = 331.6 \sqrt{(1 + T/273)} + W \cos \Theta$$

where W = magnitude of the wind in meters per second
Θ = the angle between the direction of propagation and the direction of the wind.

Both wind speed and temperature vary with altitude, and the resulting directed sound speed profile determines how sound will propagate in a given direction. Figure 2-1 provides examples to illustrate this point. If sound speed decreases with height, sound waves are refracted away from the ground. Conversely, if sound speed increases with height, sound waves will bend back toward the ground; even sound waves with original upward elevation may bypass obstructions because of the downward refraction.

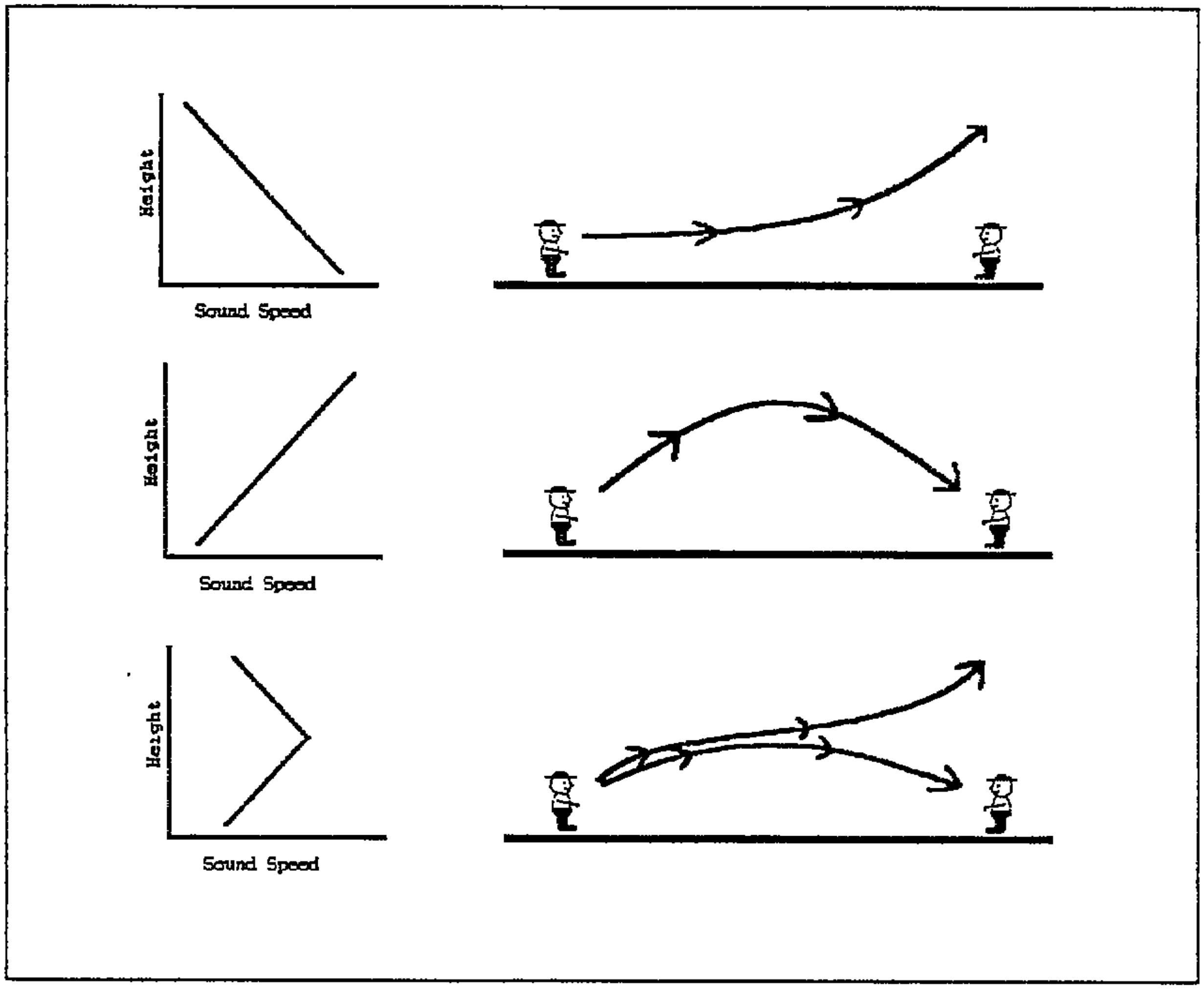

Figure 2-1. Sound speed profiles and their effects on acoustic propagation.

A sound duct results when the speed of sound above a given level equals or exceeds that at a lower level. When the lower level is the ground, the duct is called a surface-based duct. Surface-based ducts can result from the speed of sound first decreasing and then increasing with height or just increasing with height. Typical nighttime inversions are examples of the latter case. A variety of meteorological conditions produce enhanced propagation conditions as well as decreased propagation conditions. Two kinds of meteorological conditions that result in surface-based ducts are illustrated in figure 2-2. Note that the dashed line in the temperature drawings represents the normal cooling rate with height for the atmosphere; it is called the dry adiabatic lapse rate where the temperature decreases 9.8 °C for a change of 1000 m (3281 ft.) in altitude, the upper temperature picture shows a temperature inversion with a dry adiabatic lapse rate aloft. The lower picture shows heating of the air near the ground, resulting in what is called a superadiabatic lapse rate where the temperature decrease is greater that 9.8 °C for each 1000 m (3281 ft.) of altitude with a dry adiabatic lapse rate aloft.

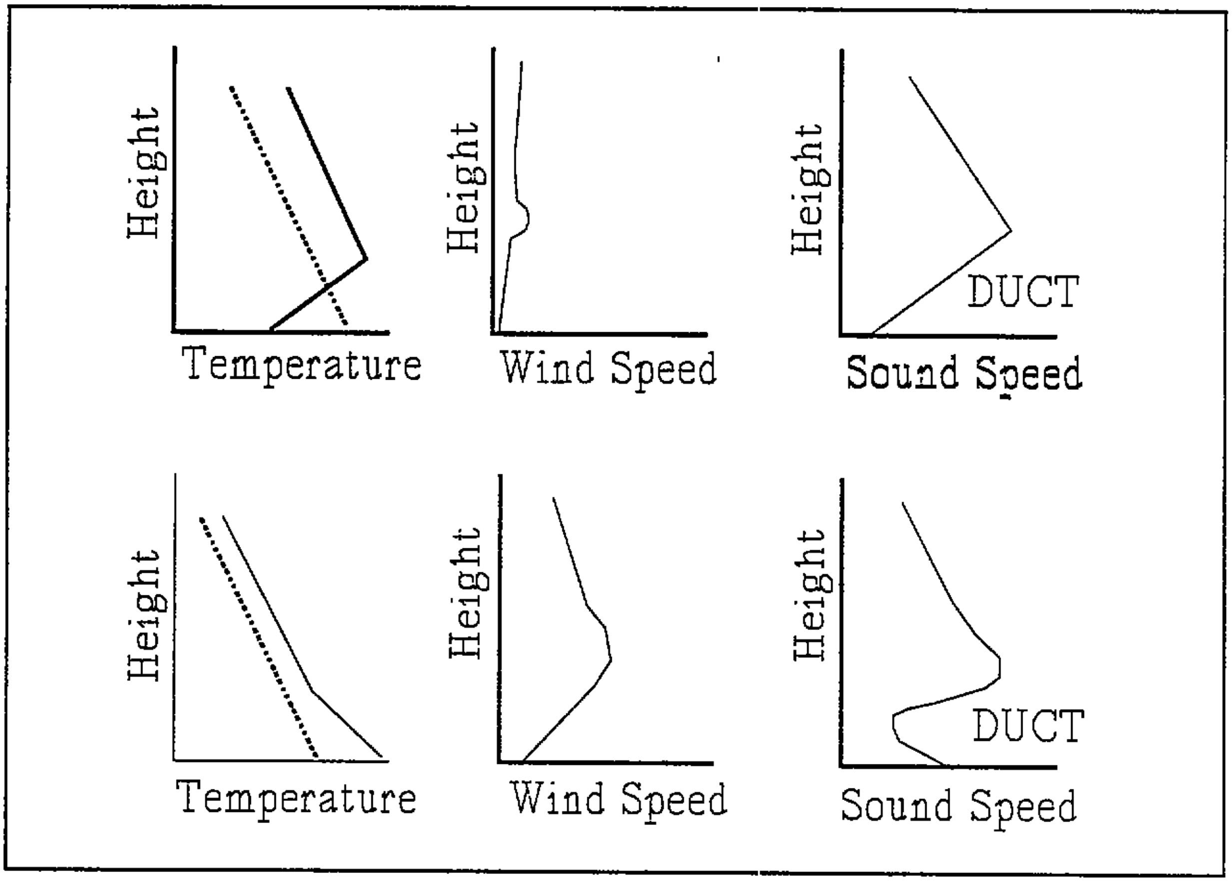

Figure 2-2. Wind and temperature profiles that result in sound ducts.

GENERAL ACOUSTIC EFFECTS

Other general acoustic effects included spherical spreading, atmospheric sound absorption, ground impedance, and turbulence scattering.

Spherical Spreading

The sound pressure level spreads spherically in the absence of wind. Spherical spreading is commonly referred to as the "1 over R spreading" (1/R) where R is the distance from the source. (For sound intensity or energy, use R^2.) Another way of expressing spherical spreading is for each doubling of distance from a source, the sound pressure decreases by 6 dB. (The 3-dB decrease represents one-half the previous value.) If there are 10 doublings of distance from 1 m (3.3 ft.) to 1024 m (3360 ft.) (1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024), a decrease of 60 dB results from the source sound strength. Various authors have stated that a quiet countryside has a background sound pressure level of about 10 dB (reference pressure is 2×10^{-5} Pa), and a typical city has a background sound pressure level of about 60 dB indicating that in the absence of ducting or forward refraction a 130-dB source could be heard approximately 4 km (13,000 ft.) in a city environment, and this same source will be heard 8 km (26,000 ft.) if the signal-to-noise ratio is increased by 6 dB. On the other hand, a 90-dB sound should be audible less that 1/2 km (1600 ft.), unless there is a significant wind to transport the sound.

Atmospheric Sound Absorption

The atmosphere absorbs sound energy; however, this effect is not a significant factor for sound of less than 500 Hz. For instance, at 10 Hz approximately 0.04 dB is lost to absorption over a 10 km (33,000 ft.) path, while at 100 Hz about 3.5 dB is lost. By contrast, a 1000 Hz sound would lose approximately 100 dB over a 10 km (33,000 ft.) path. What is important is the blast impulse from a large weapon firing or explosion is not greatly absorbed by the atmosphere, because the frequency content of the energy is primarily at the lower frequencies, less than 0.5 Hz.

Ground Impedance

Ground impedance, as used in outdoor acoustics, is a measurement of the extent to which an acoustic or blast wave traveling in the atmosphere would be absorbed into the ground upon contacting it. The acoustic energy that is not absorbed by the ground is reflected back into the atmosphere. The condition where most of the acoustic energy of a given frequency is absorbed by the ground is called low impedance. Soft sands like those found at beaches or fresh powdery snow are examples of a low impedance surface. Medium impedance surfaces reflect a majority of the acoustic energy that strikes the ground with the amount of absorption being a function of the frequency content of the acoustic energy.

Medium impedance grounds provide an adequate surface for long range propagation of acoustic energy in a surface duct. Most of the lands of the United States are classified as a medium impedance surface for low frequencies; those less than 200 Hz. High impedance surfaces reflect all or almost all of the acoustic energy striking on them. Water and concrete surfaces and mountains with rock outcroppings are examples of high impedance surfaces and would reflect all the energy. Therefore, attention should be paid to the surface type the energy would be propagating over, whereby higher impedance surfaces could result in greater propagation distances because of little energy loss from reflected acoustic waves.

Turbulence Scattering

Turbulence created by thermals or wind flow over the terrain causes sound to be scattered into shadow zones or zones of silence created by the atmospheric refraction paths. The degree that turbulence effects the propagation of acoustic energy is not well understood but is presently the subject of intense investigation through modeling and data collection efforts. Some data collected to date indicate that turbulence may be able to cause amplitude variation as great as 6 to 10 dB depending on the turbulence conditions.

SUMMARY

The ability of the atmosphere to transport sound is dependent on the meteorological conditions between the source and receiver. Any combination of wind and temperature profiles that result in a sound duct provides an enhanced condition for long range sound propagation. Sound energy may be depleted as it travels through the atmosphere and interacts with the ground. Scattering of sound by turbulence causes amplitude and phase variations resulting in variance of the sound about some mean level. Ground impedance affects the sound amplitude levels of the absorption of sound striking a soft sandy surface and the reflection of a sound wave off a concrete or water surface. For sound with frequencies below 200 Hz, spherical spreading is the primary cause for sound reduction over medium or high impedance surfaces. Sound can be enhanced or decreased by refraction causing the focusing of sound towards the surface or upward into the atmosphere.

CHAPTER 3

EXPLOSION CHARACTERISTICS OF AIRBLAST

INTRODUCTION

The detonation of a charge of high explosive near the earth's surface produces airblast and noise, a crater, ejecta and missiles, ground shock, explosive products, and buoyant clouds that will carry dust and explosive products downwind. This section addresses the magnitude of airblast and noise estimated for explosive charge weights ranging for 454 to 454,000 kg (1/2 to 500 tons, typical for field tests) exploded on or near the ground surface.

AIRBLAST AND NOISE

Airblast (the explosion shock wave in air) is usually of greatest concern in HE field tests, because damage can occur at relatively long distances from the explosion. Damage is caused by various airblast mechanisms but is usually related to the peak overpressure of the airblast wave. Table 3-1 shows TNT-equivalent weight factors for some explosives. The airblast phenomena discussed in this section include close in airblast, long distance airblast and noise, and refracted atmospheric propagation.

TABLE 3-1. TNT-EQUIVALENT WEIGHTS OF EXPLOSIVE FOR AIRBLAST PEAK OVERPRESSURE

Explosive Type	TNT-Equivalent Weight Factor[a]	Explosive Type	TNT-Equivalent Weight Factor[a]
TNT	1.00	RDX-Cyclonite	1.17
Tritonal	1.07	Nitromethane	1.00
Nitroglycerine	1.23	Ammonium Nitrate	0.84
Pentolite	1.42	Black Powder	0.46
PETN	1.27		

[a] To determine the TNT-equivalent weight of an explosive, multiply the weight of the explosive by the equivalent weight factor, e.g., at a given distance, 1 ton of ammonium nitrate is required to produce the peak overpressure equivalence to that from 0.84 ton of TNT.

Source: Event DIAL PACK Preliminary Report, Volume 1

Close-in Airblast

Figure 3-1 shows measured values of airblast peak overpressure as functions of distance for four field tests in which large, semihemispherical charges of TNT were detonated on the ground surface. The measurements have been adjusted to convert all results to 1 pound of TNT at sea level and standard atmospheric conditions. As can be seen, these results agree very well and were predictable. Also, except for charges elevated significantly above the earth's surface (at least tens to hundreds of feet for charge sizes of interest), figure 3-1 is a slightly conservative estimate of airblast overpressure. Field tests conducted at higher altitudes result in peak overpressures somewhat less than those indicated in figure 3-1. Burying a charge also tends to reduce the peak overpressures. Thus it can be assumed that, except for significantly elevated charges, the airblast overpressure will not be greater than indicated by figure 3-1.

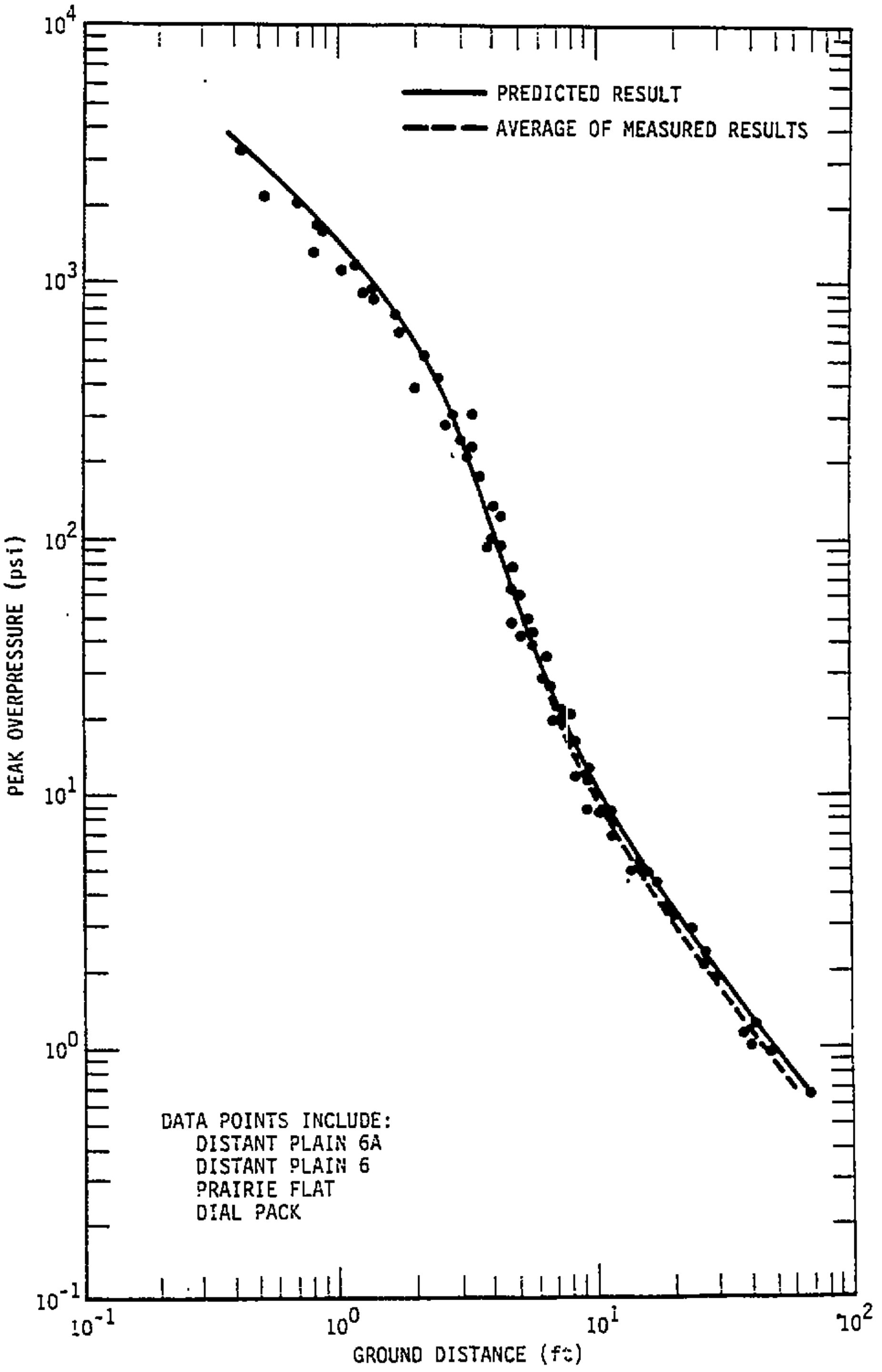

Figure 3-1. Peak airblast overpressure measurements from large TNT surface explosions (scaled to 1 pound of TNT at sea level and standard atmospheric conditions).

The distance at which any particular peak overpressure occurs varies in proportion to the cube root of the charge weight; for example, increasing a charge weight by a factor of 8 increases the ground distance for a given overpressure by a factor of 8, that is 2 (cube root of the charge weight). The curves shown in figure 3-2 for typical weights of field test HE charges are obtained from figure 3-1 by plotting overpressures of environmental concern (below 140 kPa (20 psi)) versus the product of ground distance and the cube root of the charge weight.

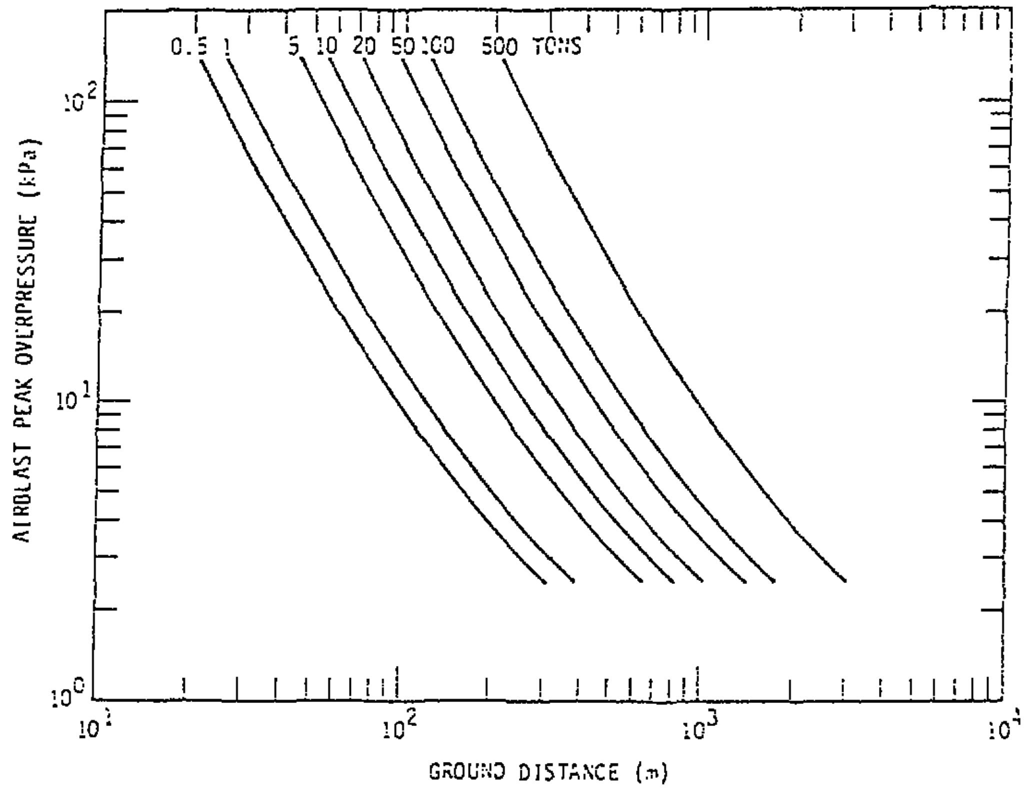

Figure 3-2. Airblast peak overpressures versus ground distance for charges exploded on or near the ground surface.

Long Distance Airblast

As the peak overpressure decreases at increasing distances from the explosion, the airblast front slows down to a speed approaching the speed of sound. As the airblast approaches an acoustic wave, it is refracted by temperature and windspeed gradients in the air. At distances where the airblast peak overpressure is less than approximately 2.5 kPa (0.4 psi), meteorological conditions usually predominate to cause anomalous propagation; airblast is refracted toward or away from the ground resulting in peak overpressures either greater or less than would occur in a nonrefracting atmosphere. Peak overpressures at long distances may vary by an order of magnitude or more depending on whether the meteorological conditions are favorable or unfavorable. Long-distance airblast is of concern because very low peak overpressures can crack windows and cause excessive noise.

Based on a large amount of empirical data, relationships have been formulated for estimating the overpressure at long distances from explosions. For a large chemical explosion on or near the ground surface with the airblast propagating through a homogeneous, nonrefracting atmosphere, the peak overpressure at long distances near the ground surface is approximately

$$\Delta p = 668\ (2W)^{0.37}\ D^{-1.1}\ (P/P_0)^{0.63} \qquad (3\text{-}1)$$

where

Δp = incident peak overpressure (Pa)

W = TNT-equivalent weight of the explosive charge (tons) (The factor of 2 is to account for ground surface producing distant blast pressures equivalent to those from a free-air burst about double in size.)

D = Distance from the explosion (km)

P = Ambient atmospheric pressure at the test site (mb)

P_0 = Standard sea-level atmospheric pressure (1000 mb)

Equation 3-1 is plotted in figure 3-3 for explosive yields of interest at standard sea-level ambient atmospheric pressure.

Long Distance Noise

An explosion produces impulsive, predominantly low-frequency sound of sufficient intensity to be heard at long distances. The measure of sound intensity is the unweighted Sound Pressure Level (SPL) expressed in decibels (dB), which are dimensionless units proportional to the square of the pressure ratio (relative to a reference pressure of 2×10^{-5} Pa):

$$\mathrm{SPL(dB)} = 20\log_{10}(\Delta p/0.00002) = 20\log_{10}(\Delta p) + 94 \qquad (3\text{-}2)$$

where Δp = peak pressure change in Pa. The sound level in decibels are shown on the right-hand scale of figure 3-3.

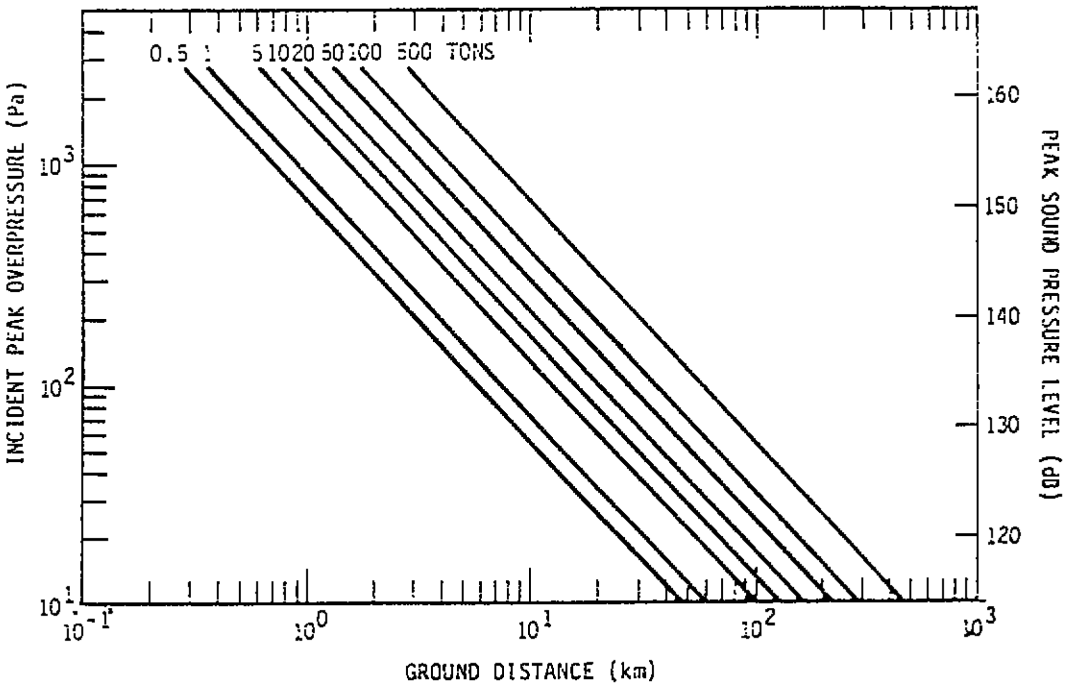

Figure 3-3. Long distance airblast and noise from surface (idealized, nonrefracting atmosphere).

Explosive charges produce a sound energy spectrum that is predominately low frequency at distances of interest, approximately 10 Hz or less for large charges. The energy concentration is displaced toward the low end as explosive yield increases. Also at greater distances, the spectrum is displaced toward lower frequencies as higher frequencies undergo greater attenuation and the shock wave loses its impulsive characteristics. At long distances, the sound of an explosion is often a rumble.

Refracted Atmospheric Propagation

Vertical gradients of wind and temperature in the atmosphere will refract low-pressure airblast. A decrease in temperature with altitude (the usual daytime condition) refracts airblast away from the ground, so the overpressure at a given ground distance will be less than shown in figure 3-3 for the case of no refraction. Conversely, an increase in temperature with altitude or an inversion refracts airblast toward the ground, thus increasing the overpressure that would be expected at a given ground distance. An increase in wind speed with altitude (the usual condition) refracts upwind airblast away from the ground and downwind airblast toward the ground, thus tending to increase downwind overpressures and decrease upwind overpressures. Conversely, decreasing wind speeds with altitude tend to refract upwind airblast toward the ground and downwind airblast away from the ground, which tend to increase peak overpressures upwind and decrease peak overpressures downwind. The combined effects of wind and temperature variations with altitude must be considered when analyzing long range propagation of airblast and noise.

The standard atmosphere (temperature decreasing with altitude) and no wind corresponds to a weak gradient condition; that is, overpressures will be somewhat less than indicated by figure 3-3. With a strong gradient, that is, rapid decrease of temperature with height, overpressures vary approximately inversely with the square of the distance resulting in strong refraction away from the ground and greatly reduced distant blast pressures. To reduce the possibility of window breakage by airblast, gradient conditions are usually sought and obtained when detonating a large explosive charge in a field test.

The meteorological conditions that lead to amplification of long distance airblast and the relative location and magnitude of such amplification are summarized from a large amount of data. The three conditions of concern are (1) boundary layer ducting and focusing, (2) jet stream ducting and focusing, and (3) downwind ozonosphere propagation.

In a temperature inversion, warm air overlies cooler air near the ground surface with the result that acoustic waves are trapped and ducted to propagate along the ground. The magnification of overpressure at distances is further enhanced in the downwind direction because of normal downward refraction resulting from the usual condition of increasing wind speed with altitude. Based on the available data, it appears inversion or downwind conditions may produce boundary layer ducting that enhances the unrefracted overpressures shown in figure 3-3 by a factor of 3 or more.

The jet streams (high speed winds at several tens of thousands feet altitude) can strongly refract acoustic waves back to the earth. Amplification of the peak overpressure by somewhat less than an order of magnitude can be expected where such refracted waves are focused back to the earth's surface. Typically, such focusing occurs approximately 65 to 85 km (40 to 50 miles) away, in the direction of the jet stream flow.

In northern temperate climates, winds at altitudes of about 50 km (30 miles) usually blow from east to west in summer and west to east in winter. Since temperature and sound speed at 50 km (30 miles) altitude are near their values at ground surface, the result is enhanced blast pressures approximately 200 km (125 miles) downwind from these high altitude winds and reduced blast pressures upwind.

As indicated by the previous discussion, the long distance airblast magnitude at any particular point can vary by more that an order of magnitude, depending on the particular meteorological conditions. Under some meteorological conditions, a relatively small explosive charge can produce airblast at long distances in excess of that from a large charge exploded under gradient conditions. The prediction of the pattern of long distance airblast and noise magnitudes on the ground requires specialized skills and meteorological measurements that are normally part of field tests. The scheduling of field tests to reduce the possibility of window breakage is based on such measurements and predictions with the result that little damage has occurred from previous large field tests.

Special Test Configurations

The preceding discussion applies for most test configurations, where the charge is exploded relatively near the ground surface. A significantly elevated or buried charge can produce different magnitudes of airblast than shown in figures 3-2 and 3-3.

Exploding a charge at a shallow depth-of-burst may increase airblast magnitude at long distances because of more efficient conversion of explosive energy to shock energy when an explosion is confined. The assumption of no reduction in airblast or noise from burying a charge is usually warranted for environmental assessment. If this assumption indicates that significant environmental damage may occur from close-in airblast and if the depth-of-burst is deeper than about one charge radius, it may be desirable to have the airblast phenomena calculated by a specialist who can include depth-of-burst effects.

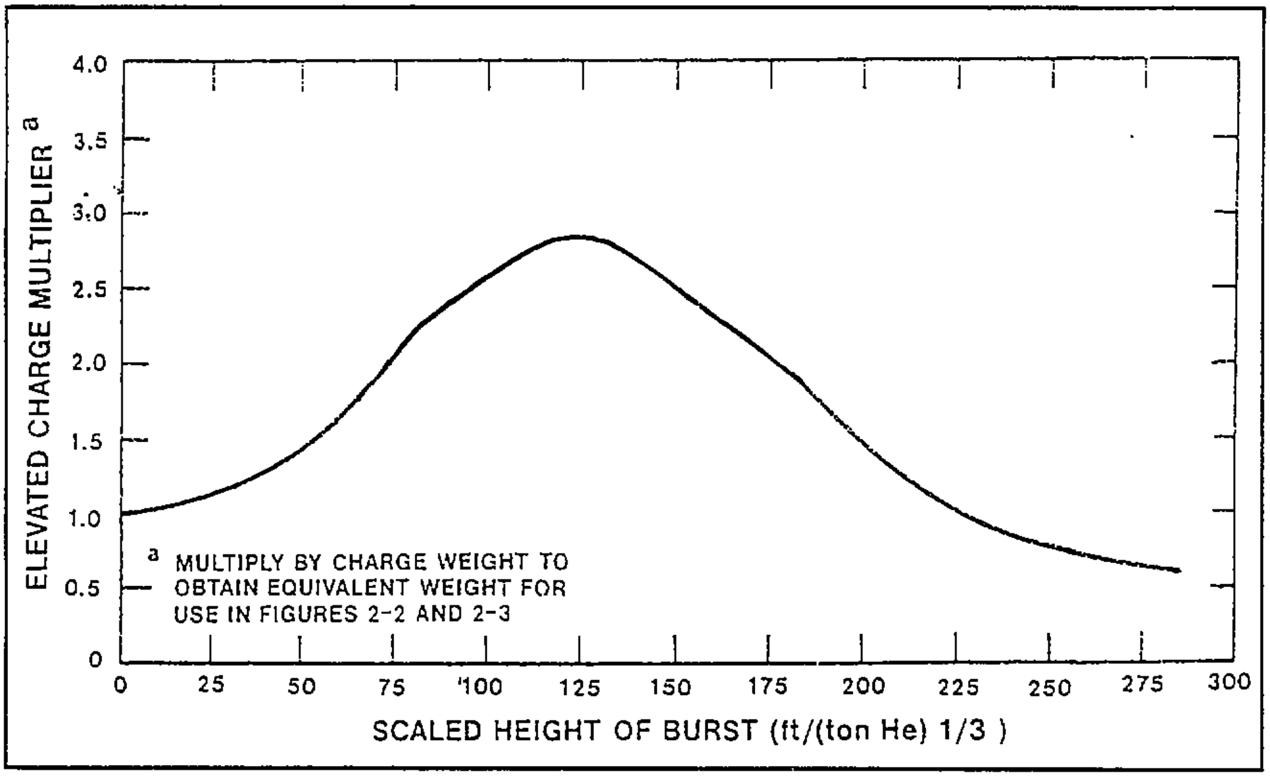

Figure 3-4. Height-of-burst multiplying factor.

When a charge is exploded above the ground surface, shock waves reflected from the ground surface merge with the direct shock wave to enhance the magnitude of the peak overpressure at any given distance. As shown in figure 3-4, the effect of elevating a charge is to make it appear that the charge is increased in weight. At the optimum height-of-burst for airblast enhancement, a charge appears to be increased in weight approximately 2.8 times so that the distance to a given overpressure (by cube root scaling) is about 1.5 times that from a charge of the same height exploded on the ground surface. Height-of-burst is measured from the center of gravity of the explosive charge to the ground surface; therefore, zero height-of-burst means the charge is half buried in the ground.

Figure 3-4 can be used to estimate the increase in airblast magnitude for an elevated charge. The product of the TNT-equivalent charge weight and the multiplying factor should be used in figures 3-2 and 3-3 to estimate the airblast magnitude as a function of distance. Substantial elevation is required to significantly extend the distance of a given peak overpressure. For example, a 900 kg (1 ton) charge would have to be elevated approximately 20 m (60 ft.) above ground level to extend a given overpressure 10 percent farther.

If more than one charge is exploded at nearly the same location and time so that the shock waves interact, the airblast environment is complex. Outside the array of charges and depending on the distance (as shown with the MISERS BLUFF multicharge event), the airblast may appear as a series of explosions or as a single explosion of larger size than any of the individual explosions. The conservative assumption for a distant blast is that the individual shocks will merge to produce a single shock equivalent to that from a single charge with a weight equal to the sum of the weights of the individual charges and located at the center of the array.

CHAPTER 4

MODEL SUMMARIES

This chapter contains summaries of acoustic models which have been identified through personal contact and through literature searches. Developers and current points of contact are provided when known. Information on application, inputs, processes, and outputs are also provided within very general guidelines. Limitations and additional comments are provided as required.

There are two types of models used to calculate sound pressure levels. The first is ray trace which uses a refractive equation to define the propagation, and the second is an analytical method which uses the wave equation to determine acoustic transmission losses. Any of the various models listed in this catalog are variations of the above and depend on various assumptions and the amount of detail specified in making the calculations. For example, all of the models calculate transmission loss caused by spherical spreading and absorption. Very few can be used to calculate turbulence and ground impedance which can have an appreciable effect on the sound pressure level. The more rigorous treatment of losses are computed using the wave equation; however, they are much more complex and require much greater computer resources. The ray trace models lose their accuracies at the lower frequencies, because the sound speed may vary over the wavelength of the propagating sound. In the case of impulse noise, this loss of accuracy could be minimized using empirical data where transmission loss for blasts are calculated using the ANSI standard S2.20-1983, Airblast Characteristics for Single Point Explosions in Air With a Guide to Evaluation of Atmospheric Propagation and Effects.

In dealing with high altitude explosions, the same refractive atmosphere has to be taken into account. The bending of rays now takes place at much higher altitudes by the troposphere, and for very large explosions, the refracting effects take place in the stratosphere, 20 to 45 km (65,620 to 147,645 ft.). In these latter cases, the propagation path takes place over many hundred of kilometers.

In the case of large blast explosions, the pressure levels are measured with microbarographs and the unit of measurement is in pascals (Pa) or pounds per square inch (psi) over pressure. For continuous noises or small blasts, the pressure levels are measured with microphones and the unit of measurement is dBm of acoustic energy.

NAME OF MODEL: ASOPRAT

DEVELOPER: University of Mississippi

POINT OF CONTACT: Dr Hank Bass

Address: Acoustic Laboratory
Univ. of Mississippi, MS 38677

Phone Number: (601) 232-5840
Fax: (601) 232-7494

TYPE: Operational __ Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast __ Sonic Boom __ Moving Source on Surface __
Other Source on Surface

LIMITATIONS: __

THEORY: Ray Trace __ Full Wave __ Empirical __ Other Hybrid, ray trace & full wave

METEOROLOGICAL INPUT: Sfc Temp __ Surface Winds __ Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other __

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Sound pressure in dB

OUTPUT TYPE: Numerical X
Specific Azimuth __ Ranges X
dB X Other __

Graphic X
Contours X
dBX Other __

ADDITIONAL COMMENTS:

Survey updated: 31 Aug 94

NAME OF MODEL: BLASTC (used for either flat or uneven terrain)

DEVELOPER: ACTA Inc.

POINT OF CONTACT: Mr Alan Bodner

Address: ACTA Inc. 23430 Hawthorne Blvd, Suite 300
Torrance, CA 90505-4723

Phone Number: (310) 378-6254
Fax: (310) 375-0663

TYPE: Operational X Research __ Other __

TYPE OF SOURCE: Point X
Above Ground __ Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface _
Other __

LIMITATIONS: _

THEORY: Ray Trace X Full Wave __ Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp __ Surface Winds __ Surface Pressure __
Vert Temp Profile __ Vert Wind Profile __
Rawin Data X Other Tower & DASS

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI X
Percent Broken Windows X
Other Expected casualties

OUTPUT TYPE: Numerical X
Specific Azimuth X Ranges X
dB __ Other __

Graphic __
Contours Limited (requires additional graphic software to interface with BLASTC output)
dB __ Other __

ADDITIONAL COMMENTS: FORTRAN 77 - PC
Ada: UNIX workstation

Survey updated: 29 Aug 94

NAME OF MODEL: BLASTMAP

DEVELOPER: US Army CERL Acoustic Team

POINT OF CONTACT: Michael J. White

Address: US Army Construction Engineering Research Lab
PO Box 9005, Champaign, IL 61826-9005

Phone Number: (217) 352-6511 ext 7436
Fax: (217) 373-7251

TYPE: Operational __ Research __ Other Environmental Assessment

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried X
Sonic Boom _ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other __

LIMITATIONS: __

THEORY: Ray Trace __ Full Wave X Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure _
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other __

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Sound Exposure Level

OUTPUT TYPE: Numerical X
Specific Azimuth __ Ranges __
dB __ Other __
Graphic X
Contours X
dB X Other _

ADDITIONAL COMMENTS: Uses Operational Data from Range.

Survey updated: 21 Sept 94

NAME OF MODEL: BLASTO Ver 9

DEVELOPER: Mr Jack Reed
POINT OF CONTACT: Mr Jack Reed
Address: JWR Inc, 5301 Central Ave, NE, Suite 220
Albuquerque, NM 87108
Phone Number: (505) 265-6550
Fax: (505) 255-2946
TYPE: Operational X Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried X
Sonic Boom _ Moving on Surface _

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other _

LIMITATIONS: __

THEORY: Ray Trace __ Full Wave X Empirical X Other _

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure X
Vert Temp Profile X Vert Wind Profile X
Rawin Data X Other Standard Atmosphere

OUTPUT UNITS: Overpressure in Pascals X Overpressure in PSI __
Percent Broken Windows X (when shot point & target locations specified. Target window survey are entered in the target list file, or an estimate of pane counts is made from census population report entries (19 panes per capita). When no weather or target list is provided, a window breakage probability is provided as a function of overpressure in the overpressure-distance tables. When weather and target are provided, window breakage is calculated for the target and its weather-dependant overpressure.
Other SI Units

OUTPUT TYPE: Numerical X
Specific Azimuth X Ranges X
dB _ Other _
Graphic _ Contours ___
dB _ Other Does not contain internal graphics

ADDITIONAL COMMENTS: PC Based - FORTRAN 77
Provides for underwater explosion sources. Inputs made with DOS version 5 and above, while retaining ACE Editor capability if DOS-3 is used. A modified WXCODE translator for European raob code format is being completed.

Survey updated: 25 Aug 1994

NAME OF MODEL: BLASTX (is used for flat terrain)

DEVELOPER: ACTA, Inc

POINT OF CONTACT: Karl Overbeck

Address: Acta Inc, 505 North Orlando Ave
Cocoa Beach, FL 32931-3166

Phone Number: (407) 868-0508
Fax: (407) 783-8339

TYPE: Operational X Research __ Other __

TYPE OF SOURCE: Point X
Above Ground __ Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other __

LIMITATIONS: __

THEORY: Ray Trace X Full Wave __ Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp __ Surface Winds __ Surface Pressure __
Vert Temp Profile __ Vert Wind Profile __
Rawin Data X Other Tower

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI X
Percent Broken Windows X
Other Expected casualties

OUTPUT TYPE: Numerical X
Specific Azimuth X Ranges X
dB __ Other __
Graphic __
Contours Limited
dB __ Other __

ADDITIONAL COMMENTS: FORTRAN77: PC, CYBER 860

Survey updated: 29 Aug 94

NAME OF MODEL: BNOISE

DEVELOPER: US Army CERL Acoustic Team

POINT OF CONTACT: Michael J. White

Address: US Army Construction Engineering
Research Lab -ECA
PO Box 9005, Champaign, IL 61826

Phone Number: (800) 872-2375 ext 7436
Fax: (217) 373-7251

TYPE: Operational ___ Research ___ Other Envr Assessment

TYPE OF SOURCE: Point ___
Above Ground ___ Surface X Buried ___
Sonic Boom ___ Moving on Surface ___

APPLICATIONS: Blast X Sonic Boom ___ Moving Source on Surface ___
Other ___

LIMITATIONS: ___

THEORY: Ray Trace ___ Full Wave ___ Empirical X Other ___

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure ___
Vert Temp Profile X Vert Wind Profile ___
Rawin Data ___ Other ___

OUTPUT UNITS: Overpressure in Pascals ___ Overpressure in PSI ___
Percent Broken Windows ___
Other Sound exposure level in dB (change)

OUTPUT TYPE: Numerical X
Specific Azimuth ___ Ranges X
dB X Other ___
Graphic X
Contours X
dB ___ Other ___

ADDITIONAL COMMENTS:

Survey updated: 1 Sep 94

NAME OF MODEL: BOOM (Blast Operational Overpressure Model)

DEVELOPER: Donald A. Douglas (adapted from work by Richard Lorenz)

POINT OF CONTACT: Lt Col Roadcap

Address: PL/WE
Kirtland AFB NM 87117-6008

Phone Number: DSN 246-4722 Com (505) 846-4722
Fax: DSN 246-4394 Com (505) 846-4394

TYPE: Operational X Research __ Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other __

LIMITATIONS: Prediction Equation adjusted to fit Kirtland AFB data -- may not perform well at other areas.

THEORY: Ray Trace __ or Full Wave __ Empirical X Other __

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure X
Vert Temp Profile X Vert Wind Profile X
Rawin Data X Other Pibal Data

OUTPUT UNITS: Overpressure in Pascals X Overpressure in PSI __
Percent Broken Windows __
Other __

OUTPUT TYPE: Numerical X
Specific Azimuth X Ranges X
dB __ Other __

Graphic __
Contours __
dB __ Other __

ADDITIONAL COMMENTS: PC Based - BASIC

Survey updated: 25 Aug 94

NAME OF MODEL: Crank Nichlson Parabolic Equation

DEVELOPER: Univ. of Mississippi

POINT OF CONTACT: Michael White .

Address: US Army Construction Engineering Research Lab
PO Box 9005, Champaign, IL 61826-9005

Phone Number: 1-800-USA-CERL ext 7436
Fax: Com (217) 373-7251

TYPE: Operational __ Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast __ Sonic Boom __ Moving Source on Surface X
Other X

LIMITATIONS: Less than 45° angle of propagation for source

THEORY: Ray Trace __ Full Wave X Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp __ Surface Winds _ Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data _ Other __

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Transmission loss (dB)

OUTPUT TYPE: Numerical __
Specific Azimuth __ Ranges __
dB X Other 2D Transmission loss in height & range

Graphic __
Contours __
dB __ Other __

ADDITIONAL COMMENTS

Survey updated: 7 Sept 94

NAME OF MODEL: Green's Function Parabolic Equation (GFPE)

DEVELOPER: Pennsylvania State University

POINT OF CONTACT: David Marlin

Address: US Army Research Lab, Battlefield Environment
White Sands Missile Range, NM 88002-5501

Phone Number: DSN 258-5447 Com (505) 678-5447
Fax: DSN 258-8366 Com (505) 678-8366

TYPE: Operational __ Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast __ Sonic Boom __ Moving Source on Surface X
Other X

LIMITATIONS: Less than 45° angle of propagation from source

THEORY: Ray Trace __ Full Wave X Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp __ Surface Winds __ Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other X (Pressure & Humidity profiles)

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Transmission Loss (dB)

OUTPUT TYPE: Numerical X
Specific Azimuth X Ranges X
dB X Other 2D Transmission Loss in Height & Range

Graphic __
Contours __
dB X Other __

ADDITIONAL COMMENTS: Models turbulence in upward radiative atmosphere

Survey updated: 9 Sept 94

NAME OF MODEL: HARPA

DEVELOPER: Wave Propagation Lab

POINT OF CONTACT: Tom Georges

Address: NOAA WPL
325 Broadway, Boulder, CO 80303

Phone Number: (303) 497-6437
Fax: (303) 497-3577

TYPE: Operational X Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other any point source

LIMITATIONS: Geometrical acoustics

THEORY: Ray Trace X Full Wave __ Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp _ Surface Winds _ Surface Pressure _
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other 3D temp & wind field

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other None

OUTPUT TYPE: Numerical __
Specific Azimuth X Ranges X
dB __ Other range vs. time, range vs. elev. angle, eigen rate finder, machine readable points
Graphic X
Contours __
dB __ Other Computes ray paths

ADDITIONAL COMMENTS: Ray trace caustics only, no transmission losses are calculated. Complete documentation available with source code in FORTRAN (downloadable by FTP). (Underwater version available)

Survey updated: 25 Aug 94

NAME OF MODEL: HI-PE

DEVELOPER: University of Salford

POINT OF CONTACT: Martin West or Geoff Kerry

Address: University of Salford
Salford M5 4WT UK

Phone Number: (from US) 44-61-745-5582
Fax: (from US) 44-61-745-5427
TYPE: Operational __ Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other Continous source

LIMITATIONS: __

THEORY: Ray Trace __ Full Wave X Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other __

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Peak SPL dB versus distance

OUTPUT TYPE: Numerical __
Specific Azimuth X Ranges __
dB X Other __

Graphic __
Contours __
dB __ Other __

ADDITIONAL COMMENTS: PC based FORTRAN77
Requires SALFORD SOFTWARE FTN77 compiler
and GTEK7 graphics library

Survey updated: 21 Sept 94

NAME OF MODEL: KNAPS (Kirtland Noise Assessment and Prediction System)

DEVELOPER: WSMR's ASL (Modified NAPS Model)

POINT OF CONTACT: John Noble

Address: US Army Research Lab, AMSRL-BE-S
White Sands Missile Range, NM 88002-5501

Phone Number: DSN 258-3751 Com (505) 678-3751
Fax: DSN 258-8366 Com (505) 678-8366
TYPE: Operational X Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other __

LIMITATIONS: __

THEORY: Ray Trace X Full Wave __ Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure X
Vert Temp Profile X Vert Wind Profile X
Rawin Data X Other Relative Humidity

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Ray trace trajectories at a given azimuth.
Surface plots (sound contours) in dB.

OUTPUT TYPE: Numerical X
Specific Azimuth X Ranges X
dB X Other __

Graphic X
Contours Vertical/Horizontal Plots
dB X Other Ray trace trajectory plots

ADDITIONAL COMMENTS: Great Internal Graphics. PC based - FORTRAN 77

Survey updated: 13 Sep 94

NAME OF MODEL: LARKHILL

DEVELOPER: University of Salford

POINT OF CONTACT: Geoff Kerry

Address: University of Salford
Salford M5 4WT UK

Phone Number: (from US) 44-61-745-5582
Fax: (from US) 44-61-745-5427

TYPE: Operational X Research __ Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other __

LIMITATIONS: __

THEORY: Ray Trace X Full Wave __ Empirical X Other __

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data X Other __

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other 360 Surface Distribution Map of Sound Levels in dB -- Hand Contouring Required.

OUTPUT TYPE: Numerical __
Specific Azimuth __ Ranges __
dB __ Other __

Graphic X
Contours __
dB X Other __

ADDITIONAL COMMENTS: PC based BASIC

Survey updated: 21 Sept 94

NAME OF MODEL: LARRIAPPS

DEVELOPER: University of Salford

POINT OF CONTACT: Martin West or Geoff Kerry

Address: University of Salford
Salford M5 4WT UK

Phone Number: (from US) 44-61-745-5582
Fax: (from US) 44-61-745-5427

TYPE: Operational X Research __ Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other __

LIMITATIONS: Flat Land

THEORY: Ray Trace X Full Wave __ Empirical X Other __

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data X Other __

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Peak SOL dB

OUTPUT TYPE: Numerical __
Specific Azimuth X Ranges __
dB X Other __

Graphic X
Contours X
dB X Other High quality radial contouring

ADDITIONAL COMMENTS: PC based FORTRAN77
Requires SALFORD SOFTWARE FTN77 and
GTEK7 graphics library

Survey updated: 21 Sept 94

NAME OF MODEL: LAP (Livermore Atmospheric Propagation) Code

DEVELOPER: Modified CIPS Cods

POINT OF CONTACT: Sang Wook Kang

Address: L-194 Lawrence Livermore Lab
Livermore, CA 94550

Phone Number: (510) 422-7233
Fax: (510) 422-5397

TYPE: Operational __ Research X Other __

TYPE OF SOURCE: Point X
Above Ground __ Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other __

LIMITATIONS: __

THEORY: Ray Trace X Full Wave __ Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other __

OUTPUT UNITS: Overpressure in Pascals X Overpressure in PSI X
Percent Broken Windows __
Other __

OUTPUT TYPE: Numerical __
Specific Azimuth __ Ranges __
dB __ Other __

Graphic X
Contours Plots ray traces (can plot any azimuth direction)
dB __ Other __

ADDITIONAL COMMENTS: LAP used with BLASTO. Runs on CRAY or VAX.
Prints out sonic speeds. Identifies focus points.

Survey updated: 29 Aug 94

NAME OF MODEL: Low Frequency Long Range Acoustic Propagation Prediction Subroutine

DEVELOPER: Georgia Tech Research Institute

POINT OF CONTACT: Arnold W. Mueller
Address: NASA, Langley Research Center
Hampton, VA 23681
Phone Number: (804) 864-5277
Fax: (804) 864-8290

TYPE: Operational __ Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface __ Buried __
Sonic Boom __ Moving on Surface __

It estimates the losss sustained by an acoustic signal propagation over tens of kilometers. It is based on the use of "look-up" tables for 528 different combinations of signals interpolated between 8 unique frequencies (8.0, 16.0, 31.5, 63.0, 125.0, 500.0. or 1000.0 Hz); propagating over grass or desert; for weather profile type of lapse, ground inversion, or elevated inversion; for 0, +12, or-12 knots of wind speed at source heights of 5, 30, 135, 150, or 300 meters.

APPLICATIONS: Blast __ Sonic Boom __ Moving Source on Surface __
Other X

LIMITATIONS: Requires input to be interpolated between 8 frequencies and 3 weather profiles. Does not have isothermal or wind lapse case.

THEORY: Ray Trace __ Full Wave X Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp __ Surface Winds __ Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other __

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other standard reference acoustic pressure

OUTPUT TYPE: Numerical X
Specific Azimuth __ Ranges __
dB X Other __
Graphic __
Contours __
dB __ Other __

ADDITIONAL COMMENTS: Detailed operational information may be obtained from Charles D. Smith, Lockheed Engineering & Sciences, c/o NASA Langley Research Center (804-864-5275)

Survey updated: 15 Sep 94

NAME OF MODEL: NAPS (Noise Assessment and Prediction System)

DEVELOPER: WSMR's ASL

POINT OF CONTACT: John Noble

Address: US Army Research Lab, AMSRL-BE-S
White Sands Missile Range, NM 88002-5501

Phone Number: DSN 258-3751 Com (505) 678-3751
Fax: DSN 258-8366 Com (505) 678-8366

TYPE: Operational X Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other __

LIMITATIONS: __

THEORY: Ray Trace X Full Wave __ Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure X
Vert Temp Profile X Vert Wind Profile X
Rawin Data X Other Relative Humidity

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Ray trace trajectories at a given azimuth.
Surface plots (sound contours) in dB .

OUTPUT TYPE: Numerical X
Specific Azimuth X Ranges X
dB X Other __

Graphic X
Contours Vertical/Horizontal Plots
dB X Other Ray trace trajectory plots

ADDITIONAL COMMENTS: Great Internal Graphics. PC based - FORTRAN 77
Has terrain.

Survey updated: 13 Sep 94

NAME OF MODEL: NIFD/PE

DEVELOPER: West Point Military Academy

POINT OF CONTACT: LTC Jack Robertson

Address: US Military Academy, Dept of Mathematics
West Point, NY 10996-1787

Phone Number: DSN 688-2453 Com (914) 938-2453
Fax: DSN 688-2409 Com (914) 938-2409

TYPE: Operational __ Research X Other __

TYPE OF SOURCE: Point __
Above Ground __ Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other Continuous source

LIMITATIONS: __

THEORY: Ray Trace __ Full Wave X Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp __ Surface Winds __ Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other __

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Sound pressure level in dB

OUTPUT TYPE: Numerical X
Specific Azimuth __ Ranges X
dB X Other __

Graphic X
Contours __
dB X Other __

ADDITIONAL COMMENTS:

Survey updated: 14 Sep 94

NAME OF MODEL: PC BOOM3: Single Event Sonic Boom Model

DEVELOPER: Wyle Laboratories

POINT OF CONTACT: Micah Downing

Address: AL/OEBN, 2610 Seventh Street
Wright-Patterson AFB, OH 45433-7901

Phone Number: DSN 785-3664 Com (513) 255-3664
Fax: DSN 986-7680 Com (513) 476-7680

TYPE: Operational X Research X Other __

TYPE OF SOURCE: Point __
Above Ground __ Surface __ Buried __
Sonic Boom X Moving on Surface __

APPLICATIONS: Blast __ Sonic Boom X Moving Source on Surface __
Other __

LIMITATIONS: __

THEORY: Ray Trace X Full Wave __ Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp __ Surface Winds __ Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other __

OUTPUT UNITS: Overpressure in Pascals X (& psf) Overpressure in PSI __
Percent Broken Windows __
Other Overpressure in C-weighted Sound Exposure Level (CSEL) in dB

OUTPUT TYPE: Numerical X
Specific Azimuth __ Ranges __
dB X (CSEL) Other or psf

Graphic X
Contours X (& Footprints)
dB X (CSEL) Other psf or Pa

ADDITIONAL COMMENTS: Written in FORTRAN 77. PC based program.
386 or higher with math coprocessor recommended.
Menu based used interface.

Survey updated: 29 Aug 94

NAME OF MODEL: RAYTR

DEVELOPER: Penn State University

POINT OF CONTACT: Dr Dennis Thomson, Dept of Meteorology
Address: 503 Walker Bldg
Penn State University
University Park, PA 16802

Phone Number: (814) 865-0478
Fax: (814) 865-3663

TYPE: Operational __ Research X Other __

TYPE OF SOURCE: Point __
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface X

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface X
Other __

LIMITATIONS: __

THEORY: Ray Trace X Full Wave __ Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data X Other Sfc RH and vert profile of RH

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other sound pressure levels in dB

OUTPUT TYPE: Numerical X
Specific Azimuth X Ranges X
dB X Other __

Graphic X
Contours of sound pressure levels at fixed times
dB X Other __

ADDITIONAL COMMENTS: Can be used for one or more sources on or above the ground. Inputs also include the 2D topography and arrays of surface temperature, wind and relative humidity. Output is time dependent sound pressure levels in dB at specified locations in the grid. Software dated, output capablity current.

Survey updated: 29 Aug 94

NAME OF MODEL: Scanning Fast Field Program (SCAFFIP)

DEVELOPER: US Army Research Lab -- Battlefield Environment

POINT OF CONTACT: Dr. John Noble

Address: US Army Research Lab
Battlefield Environment
AMSRL-BE-S
White Sands Missile Range, NM 88002-5501

Phone Number: DSN 258-3751 Com (505) 678-3751
Fax: DSN 258-8366 Com (505) 678-8366

TYPE: Operational __ Research X Other __

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried __
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface X
Other __

LIMITATIONS: __

THEORY: Ray Trace __ Full Wave X Empirical __ Other __

METEOROLOGICAL INPUT: Sfc Temp __ Surface Winds __ Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data __ Other Vert. Pressure & Humidity Profile

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other Transmission Loss (dB

OUTPUT TYPE: Numerical __
Specific Azimuth X Ranges X
dB X Other 360° scan in fixed azimuth increments

Graphic __
Contours __
dB __ Other __

ADDITIONAL COMMENTS:

Survey updated: 8 Sept 94

NAME OF MODEL: Sound Prop

DEVELOPER: US Army CERL Acoustic Team

POINT OF CONTACT: Michael J. White

Address: US Army Construction Engineering Research Lab
PO Box 9005, Champaign IL 61826-9005

Phone Number: (217) 352-6511 ext 7436
Fax: (217) 373-7251

TYPE: Operational X Research X Other Environmental Assessment

TYPE OF SOURCE: Point X
Above Ground X Surface X Buried X
Sonic Boom __ Moving on Surface __

APPLICATIONS: Blast X Sonic Boom __ Moving Source on Surface __
Other Continuous Wave (Either)

LIMITATIONS: __

THEORY: Ray Trace __ Full Wave __ Empirical __ Other X

METEOROLOGICAL INPUT: Sfc Temp X Surface Winds X Surface Pressure __
Vert Temp Profile X Vert Wind Profile X
Rawin Data X Other __

OUTPUT UNITS: Overpressure in Pascals __ Overpressure in PSI __
Percent Broken Windows __
Other dB

OUTPUT TYPE: Numerical X
Specific Azimuth X Ranges __
dB X Other 1/3 Octave Spectrum

Graphic X
Contours __
dBX Other 1/3 Octave Spectrum

ADDITIONAL COMMENTS: Allows for a barrier, and for an arbitrary source spectrum

Survey updated: 7 Sept 94

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