

AD-A012 847

COMPUTER PROGRAM FOR PREDICTING CASUALTIES AND DAMAGE  
FROM ACCIDENTAL EXPLOSIONS

T. A. Zaker

Department of Defense Explosives Safety Board  
Washington, D. C.

May 1975

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**TECHNICAL PAPER**

218060

**NO. 11**

AD A012847

**COMPUTER PROGRAM FOR PREDICTING CASUALTIES  
AND DAMAGE FROM ACCIDENTAL EXPLOSIONS**

**DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD**



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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DDESB TP 11	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Computer Program for Predicting Casualties and Damage from Accidental Explosions	5. TYPE OF REPORT & PERIOD COVERED RDT&E	
	6. PERFORMING ORG. REPORT NUMBER TP 11 <i>and Supplement</i>	
7. AUTHOR(s)  T. A. Zaker	8. CONTRACT OR GRANT NUMBER(s)  NA	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Defense Explosives Safety Board Forrestal Building, GB 270 Washington, D. C. 20314	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS  4A765702M857	
11. CONTROLLING OFFICE NAME AND ADDRESS  Same as Item 9	12. REPORT DATE May 1975	
	13. NUMBER OF PAGES 58	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified	
	16. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report)  This document is approved for public release; its distribution is unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Fragment Effects                      Computer Program Blast Effects Casualties House Damage		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  A computer program has been prepared in Fortran language for calculating expected numbers of casualties by blast and fragment injury in a population of unprotected persons, and damage to unstrengthened residential buildings by blast from explosions. The program generates tables of injury probability, percent casualties, and percent building damage as functions of distance from block stacks of miss-detonating bombs and projectiles described in the input data.		

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Technical Paper 11

*and  
Supplement*

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## FOREWORD

This paper was prepared by the Technical Programs Division, Department of Defense Explosives Safety Board, in response to the need for techniques for rapidly estimating blast and fragment hazards for specific ammunition storage situations. The paper draws extensively upon weapons effects data compiled by the Board staff and its contractors, as indicated by the literature cited. It is hoped that the paper will be of value to those concerned with analyzing the potential effects of accidental explosions of stored ammunition when normal quantity-distance standards cannot be met.



P. F. KLEIN  
Captain, USN  
Chairman

May 1975

## PREFACE

A computer program has been prepared in Fortran language for calculating expected numbers of casualties by blast and fragment injury in a population of unprotected persons, and damage to un-strengthened residential buildings by blast from explosions. The program generates tables of injury probability, percent casualties, and percent building damage as functions of distance from block stacks of mass-detonating bombs and projectiles described in the input data.

The program is based on simple representations of explosion effects data current at the time of this publication. Although injury and damage mechanisms due to explosive blast are considered rather well understood, estimates of fragment effects are based on extrapolation of single-weapon test data to large numbers of weapons and long distances from the explosion source. The code, however, can be readily modified by appropriate substitution of improved treatments of injury mechanisms in the program, or better characterization of weapon properties in input data, as they become available.

While the results do not reduce the need for strict compliance with published explosives safety standards, they may be of assistance in evaluating the protection afforded by the standards and in assessing the risks connected with deviations from them when waiver or exemption requests are evaluated or granted.

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## COMPUTER PROGRAM FOR PREDICTING CASUALTIES AND DAMAGE FROM ACCIDENTAL EXPLOSIONS

### INTRODUCTION

This paper describes a computer program for calculating expected numbers of casualties from blast and fragments in a population of unprotected persons, and damage to typical unstrengthened residential buildings by blast, as functions of distance from hypothetical accidental explosions of rectangular stacks of mass-detonating bombs and projectiles. In what follows explosive blast and fragmentation effects data which form the basis for calculations performed by the code are summarized. Procedures utilized in the code for computing probabilities of human injury or fatality from the combined effects of blast and fragments are discussed. Input data format, program operation, and typical results are described. A Fortran listing of the code is appended, together with a sample output table for a particular case.

### EXPLOSION SOURCE FUNCTIONS

Blast and fragment effects are calculated from the equations of curves fitted to data on these effects as functions of distance from the source. Blast effects are referenced to a bare TNT hemisphere on a flat ground surface.

#### Blast Effects

Blast parameters which determine human injury and wood-frame house damage are the overpressure, the impulse of the dynamic (blast wind) pressure wave, and to a minor degree explicitly, the wave duration.

These parameters all depend on distance scaled by the cube root of the weight of the equivalent TNT hemisphere. Damage to certain types of buildings such as large, massive structures, which may be a function of the impulse of the overpressure wave, is not treated, nor are close-in (very high pressure) effects or the localized effects of small charges.

In the computer program for casualty and damage prediction, the effective charge weight is obtained by adjusting the total net explosive weight by factors which account for the TNT equivalence of the explosive and for the suppressing effect of metal case material and magazine earth cover, if either or both are present, on explosive blast.<sup>1\*</sup>

The case effect is accounted for by applying a factor F which depends on the metal-to-charge weight ratio M/C in the following way<sup>2</sup>:

$$F = 0.6 + 0.4/(1 + 2M/C)$$

In this expression, C is taken to be the TNT equivalent of the filler explosive weight in the weapon.

The effect of the earth cover of a magazine depends on the cover-to-charge ratio. For simplicity the single numerical value of 0.8, derived from test data for a standard igloo containing 100,000 lb of explosive, is applied to the explosive weight in earth-covered storage. Finally, a factor of 1.2 is applied to account for the enhancement of blast in the directions perpendicular to the faces of rectangular stacks. This value has been found to be a suitable average for nearly cubical stacks.<sup>1</sup>

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\* Superscript numerals designate appended references

With distance  $R$  scaled by the cube root of the weight  $W$  of the effective TNT hemisphere, the peak overpressure  $p$  is calculated from a ninth-order polynomial fit of its logarithm to  $\log(R/W^{1/3})$ , due to Romesberg.<sup>3</sup> Alternatively, a similar eighth-order fit given by Kingery<sup>4</sup> could be used.

The scaled dynamic overpressure impulse per unit area,  $J/W^{1/3}$ , is represented as a one-term power-law function of scaled distance adapted by Fugelso et al.<sup>1</sup> from Richmond and Fletcher.<sup>5</sup> Finally, the scaled positive phase duration,  $t_d/W^{1/3}$ , is also expressed as a one-term power-law function of scaled distance developed by Fugelso et al.<sup>1</sup>

#### Fragment Density

Fragment density (number per unit area) is calculated as a suitable multiple of that from the sidespray of a single weapon. The results of Feinstein<sup>6</sup> for single weapons, obtained as a function of distance by considering the effects of atmospheric drag and gravity on fragment trajectories, using as initial data the velocities and weight distributions determined in weapon effectiveness tests, serve as the basis. The single-weapon density profiles so determined, for all fragments and for fragments of energy exceeding 58 ft-lb at impact, are represented by piecewise linear approximations of the logarithm of fragment density as a function of distance. The approximation for heavy fragments consists of two straight lines, while for some weapons the approximation for all fragments requires three segments. As will be noted later, the junction points in the piecewise linear representations are identified by the distances at which specified levels of fragment density occur from single weapons.

In applications to stacks of weapons, the single-weapon density profiles are multiplied by the number of units on the side or end of the stack considered to be the controlling orientation. No distinction is made between weapons stored aboveground and under earth cover. Empirical rules have, however, recently been suggested which might be incorporated into the code to improve the treatment of fragments from weapon stacks.<sup>7</sup>

#### INJURY AND DAMAGE FUNCTIONS

Personnel injury and building damage are computed from blast pressure and impulse and from fragment density, all as functions of distance from the explosion. Probabilities of injury exceeding each of two levels are considered: severe injury or fatality, and injury of any severity, however slight.

##### Blast Injury

Human injury from blast may be one of three types: primary, due to the overpressure of the blast wave alone; secondary, from impact by debris from damaged structures; and tertiary, by striking the ground surface or a stationary object after acceleration by blast forces.

Damage to the lungs is taken to be indicative of primary blast injury of a serious level. It is a function of blast overpressure alone, except for a weak dependence on wave duration.<sup>8</sup> The probability of severe or fatal injury is calculated from a cumulative lognormal distribution with respect to the pressure (that is, from a standard error function of the logarithm of pressure) centered at 20.5 psi for waves of very long duration, with 1- and 99-percent levels at 14.5 and 29.0 psi, respectively.

Eardrum damage is the farthest-reaching primary effect of blast on personnel. It is a function of overpressure only,<sup>1,5</sup> and is calculated from a lognormal distribution centered at 6.3 psi, with 10- and 90-percent levels at 3.2 and 12.2 psi.

Secondary effects of blast on personnel, from impact by building debris, will depend strongly on the extent of damage to structures. As a result, the risk to occupants can at best only be inferred qualitatively from building damage calculations. On the other hand, displacement (tertiary) effects can be estimated for persons assumed to be without protection from the dynamic pressure impulse.<sup>1</sup> Serious head injury is assumed to occur in 50 percent of cases of impact at 18 ft/sec. This corresponds to an applied impulse of 75.2 psi-msec. The distribution is normal, with 1- and 99-percent levels at 54.3 and 96.1 psi-msec. A marginal level of injury by this same mechanism is assumed to occur in 50 percent of exposures at 2 ft/sec (8.3 psi-msec), with a normal distribution having 1- and 99-percent levels at 1.25 and 15.35 psi-msec, respectively.<sup>5</sup>

#### Fragment Injury

The probability P of a strike by one or more fragments is calculated from formulas of the form

$$P = 1 - \exp(-qA)$$

where q is the fragment density and A is the exposed vulnerable area of the individual. For calculations of severe injury probability, the density of fragments of impact energy exceeding 58 ft-lb is used in the formula,

with area  $A = 6.2 \text{ ft}^2$ , corresponding to the area of a person facing the explosion and taking no evasive action.<sup>5</sup> For calculations of all fragment injury, however slight, the density of all fragments is used with an area of  $8.0 \text{ ft}^2$ , the silhouette area of a standing man.<sup>9</sup> The former value of  $A$  is considered to be the area susceptible to serious injury by heavy fragments, while the latter value includes body extremities as well.

#### Casualty Probabilities

Compound probabilities  $P_c$  are calculated for severe or fatal injury, and for all injury, by combining the probabilities of direct blast injury, displacement injury, and fragment injury in formulas of the type

$$P_c = 1 - (1-P_1)(1-P_2)(1-P_3)$$

where  $P_1$ ,  $P_2$ , and  $P_3$  are the probabilities of injury by the independent mechanisms operating. The result, multiplied by 100, represents the percentage of casualties in a population exposed at a given distance from the explosion.

#### Building Damage

Damage to unstrengthened single-family dwellings in several exposures to test explosions has been assessed quantitatively by Wilton.<sup>10</sup> He found that the level of damage, expressed as a percentage of building value, depends on overpressure alone. The results are well approximated by a cumulative normal distribution centered at 3.8 psi, with 15- and 85-percent levels at 2.1 and 5.5 psi.

## COMPUTER PROGRAM

In an effort to provide, in easily understood tabular form, overall blast and fragment estimates for specific ammunition storage situations, a computer program was prepared in Fortran language incorporating injury and damage functions discussed in the preceding sections of this paper. The program generates tables of numbers of casualties and building damage listed as functions of distance from 100 to 10,000 ft divided into approximately 50 intervals.

The code consists of a main program, two function subprograms, and a block data subprogram. Significant steps in the main program, identified by line numbers in the appended listing, are discussed below.

Line 2: Storage space is allocated for array variables containing descriptive information regarding munition stack shape (SS) and the format of numerical output (FMT).

Lines 3-7: Functions are defined which describe the logarithm of fragment density as piecewise linear with respect to distance from a single munition.

Lines 8-13: Probability units are defined for dynamic overpressure impulse, for the overpressure, and for the logarithm of overpressure, to be used later in calculating injury and damage levels with assumed cumulative normal distributions.

Lines 14-15: A logarithmic increment of distance is defined for later use.

Line 17: Weapon name, gross weight, weight of explosive per unit, TNT equivalence of the filler, and characteristic fragment distances from a single munition are read in.

Line 19: Total explosive weight, earth factor (1.0 or 0.8), number of units on the end of the stack, stack shape, and stack length in unit diameters are read in.

Line 20: If stack length is nonzero in input data, the stack is assumed to be prismatic, and the actual total filler weight is computed. Otherwise the value WE supplied in input data is used.

Lines 21-28: Problem definition and table headings are written.

Lines 29-31: The modified Fano case factor<sup>2</sup> and the effective TNT weight and its cube root are calculated.

Lines 32-33: Distance is initialized at 100 ft.

Lines 34-37: Scaled distance, overpressure, duration and dynamic overpressure impulse are calculated. The function subprogram for overpressure is based on a ninth-degree polynomial fit.<sup>3</sup>

Lines 38-40: Probabilities of serious head and lung injury are calculated from cumulative normal and lognormal distributions. The error function subprogram is based on a rational approximation given in Abramowitz and Stegun's (1964) NBS Handbook of Mathematical Functions.<sup>11</sup>



Line 41: The probability of blowdown with slight injury is computed based on threshold and 50-percent levels suggested by Richmond.<sup>5</sup>

Line 42: The probability of ear injury (considered not a severe lesion) is calculated from a cumulative normal distribution with respect to the logarithm of overpressure.

Line 43: The probability of primary blast injury is obtained by compounding ear and lung injury probabilities.

Lines 44-56: The density (Q) of fragments of impact energy greater than 58 ft-lb, and the density (QA) of all fragments, are calculated unless the fragment distance parameter X3 has not been supplied as input. Q is defined as bilinear in semilogarithmic coordinates, and QA as either bilinear or trilinear, coinciding with Q at distances greater than X3. The piecewise linear approximations for the 155mm projectile with base down, shown in Figure 1, are typical. At the distances X0, X1, ..., X4 supplied in input data, the fragment density from a single weapon has values which are specified to be multiples of  $Q/600 \text{ ft}^{-2}$  by factors of  $10^{1/3}$  in the arithmetic statement function definitions, lines 3-7.

Lines 58-59: The probabilities of impact by heavy fragments and by all fragments on the presented area of an individual facing the explosion are calculated from Poisson statistics. The

former represents severe injury or death, while the latter is an upper bound intended to represent all fragment injury, however slight.

Lines 60-61: Serious injuries per 100 population, and all injuries, are calculated by compounding the appropriate probabilities.

Line 62: Damage in percent of building value is calculated from a cumulative normal distribution with respect to overpressure centered at 3.8 psi. This combines structural and superficial damage, and is an excellent fit of data compiled by Wilton.<sup>10</sup>

Line 63: Results are written in formats specified at program execution time (line 16). The formats (1H0, F8.0, F9.2, 2(3F10.2, F10.0), F10.0) and (1H0, F8.0, 4F10.3, F10.1, 3F10.3, 2F10.1) have been used for 2- and 3-place precision in output.

Lines 64-69: The running distance variable X is increased by a constant logarithmic increment, and R is the next lower integer multiple of 10 ft, not exceeding the table range of 10,000 ft. A coarser table, with values of R being multiples of 100 ft, is obtained if one replaces line 67 with the statement  
$$R = 100 * \text{IFIX}(X/100.)$$

A sample table of output data at 2-place precision is appended with the program listing. Two data cards are required to generate each such table. In addition, the first data card of the deck must specify output format for an entire job.

The tabulated results may be used directly if desired, or they may be plotted and used graphically. Curves of injury and damage for approximately 250,000 lb of tritonal in 750-lb bombs are shown in Figure 2. The results of a number of cases may be cross-plotted to determine the relations between, say, explosive quantity and distance. An example is given in Figure 3, where such curves are shown for two types of weapons at the 10 percent level of serious injury or fatality.

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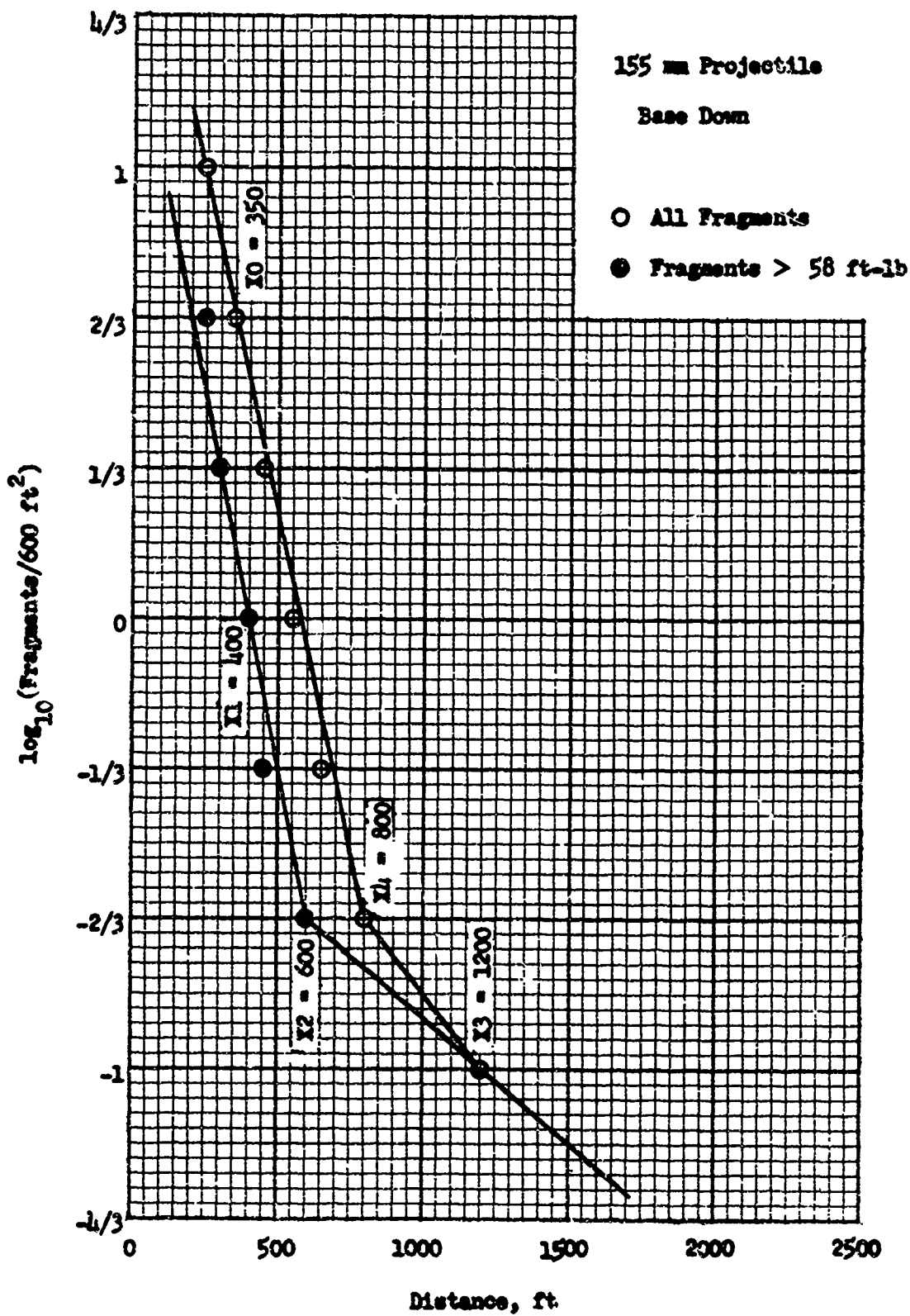


Figure 1 Fragment Density for a Single Weapon

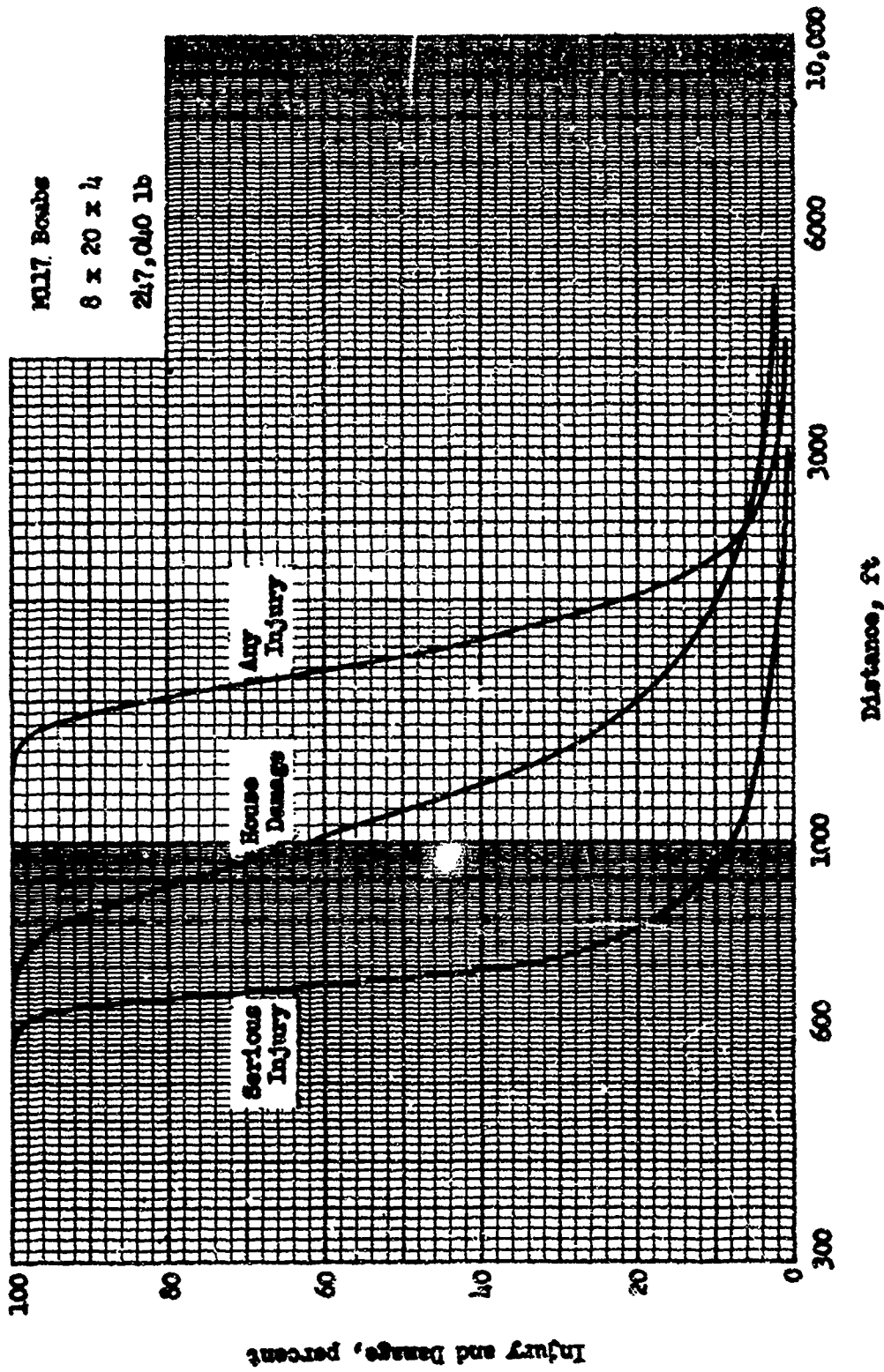


Figure 2 Computed Effects from a Stack of Bombs

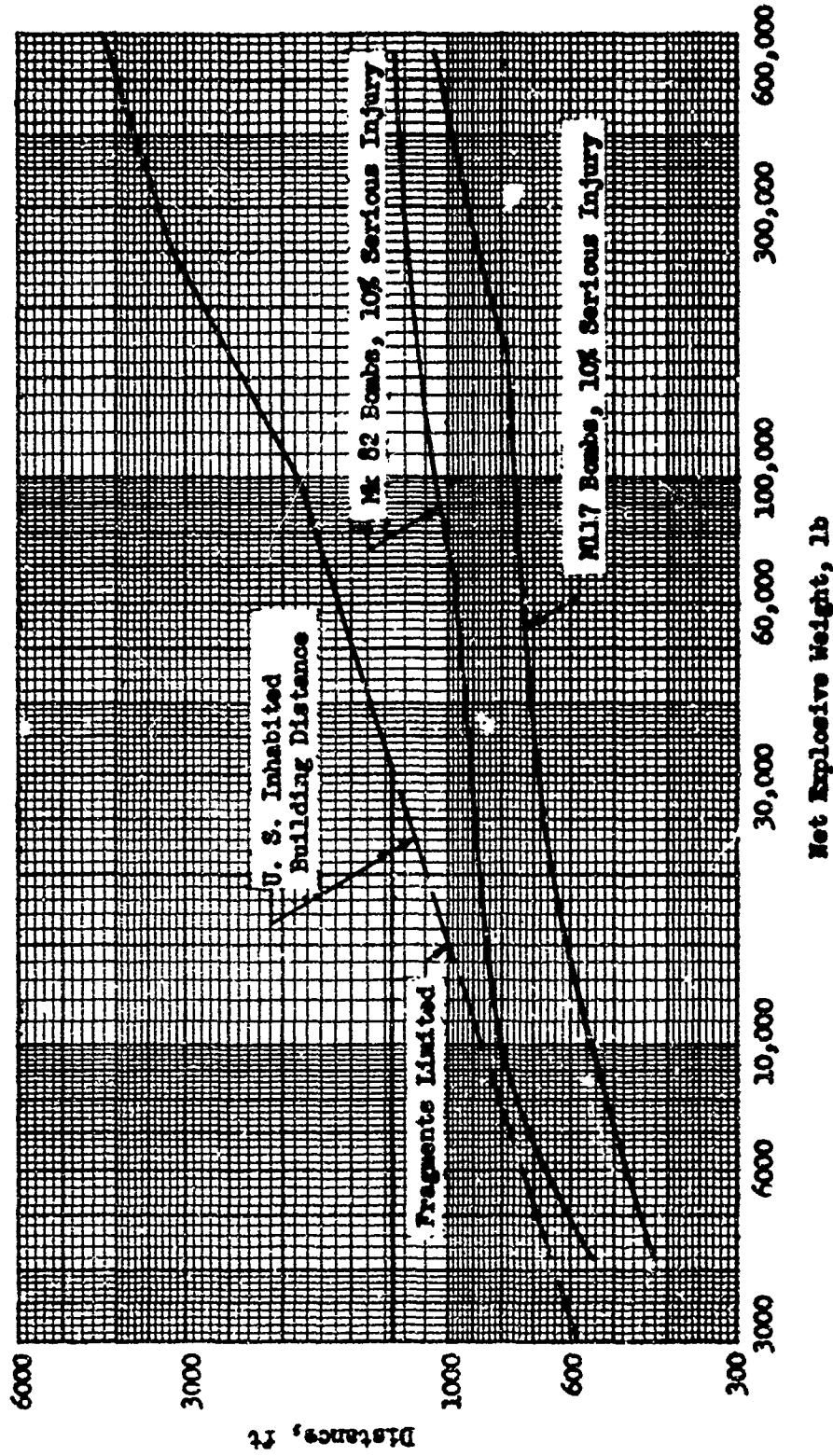


Figure 3 Distances for a Specific Injury Level Compared with Standards

```

PROGRAM CASDAM(INPUT,OUTPUT,TAPE60=INPUT,TAPE61=OUTPUT)
DIMENSION SS(2),FMT(8)
Q12(X) = 10.**((2.*(X=X2)/(3.*(X1=X2))-8./3.)/6.
Q23(X) = 10.**((X=X2)/(3.*(X2=X3))-8./3.)/6.
5
Q03(X) = 10.**((5.*(X=X3)/(3.*(X0=X3))-3.)/6.
Q04(X) = 10.**((4.*(X=X4)/(3.*(X0=X4))-8./3.)/6.
Q43(X) = 10.**((X=X4)/(3.*(X4=X3))-8./3.)/6.
SQRT2 = SQRT(2.)
SDJ2 = SQRT2 *41.8/4.653
10
SDJ2T = SQRT2 *7.05/2.327
SDLP2 = SQRT2 *ALOG(29.0/14.5)/4.653
SDLP2E = SQRT2 *ALOG(12.2/6.3)/1.282
SDP2 = SQRT2 *3.4/2.073
SPC = 25.
15
ULX1 = 10.**((1./SPC)+1.E=7
READ(60,100) FMT
1 READ(60,101) WPN,WGR,WEU,TEQ,X1,X2,X3,X0,X4
IF(EUF(60).NE.0.) STOP
READ(60,102) WE,EF,BS,SS,SW
20
IF(SW.GT.0.) NE = BS*SW*WEU
IW = WE
IB = BS
IE = 5.-4.99*EF
WRITE(61,201) WPN,IW,TEQ,IB,IE,SS
25
WRITE(61,202)
WRITE(61,203)
WRITE(61,204)
WRITE(61,205)
FF = 0.6+0.4/(1.+2.*(WGR=WEU)/(TEQ*WEU))
30
NEF = 1.2*WE*TEQ*FF*EF
CRTW = NEF**((1./3.))
X = 100.
R = X
2 Z = R/CRTW
35
PR = PRF(Z)
TD = 1.188*CRTW*Z**0.5473
XJ = 266.449*CRTW/Z**2.3201
PHD = (1.+ERF((XJ-75.2)/SDJ2))/2.
PMTD = 20.5*(1.+6.76/TD**1.064)
40
PLG = (1.+ERF(ALOG(PR/PMTD)/SDLP2))/2.
PIG = (1.+ERF((XJ-8.3)/SDJ2T))/2.
PER = (1.+ERF(ALOG(PR/6.3)/SDLP2E))/2.
PBI = 1.*(1.-PER)*(1.-PLG)
45
U = 0.
QA = 0.
IF(X3.LE.0.) GO TO 3
IF(R.LT.X2) Q = BS*Q12(R)
IF(R.GE.X2) Q = BS*Q23(R)
QA = Q
50
IF(R.GE.X3) GO TO 3
IF(X4.GT.0.) GO TO 5
QA = BS*Q03(R)
GO TO 3
5 CONTINUE
55
IF(R.LT.X4) QA = BS*Q04(R)
IF(R.GE.X4) QA = BS*Q43(R)
3 CONTINUE

```



```

60      PFR = 1.-EXP(-6.2*Q)
        PAF = 1.-EXP(-8.0*QA)
        PCTC = 100.*(1.-(1.-PHD)*(1.-PLG)*(1.-PFR))
        PCTAC = 100.*(1.-(1.-PIG)*(1.-PBI)*(1.-PAF))
        PCTD = 100.*(1.+ERF((PH-3.8)/SDP2))/2.
        WRITE(61,FMT) R,Z,PHD,PLG,PFR,PCTC,PIG,PBI,PAF,PCTAC,PCTD
65      RU = R
        4 CONTINUE
        X = DLX1*X
        R = 10*IFIX(X/10.)
        IF(R,LE,RU) GO TO 4
        IF(R.GT.1.E4) GO TO 1
70      GO TO 2
        100 FORMAT (8A10)
        101 FORMAT (A8,6F10,0,2F6,0)
        102 FORMAT (3F10,0,2A8,F10,0)
75      201 FORMAT (1M1,A8,I10 ,9H LB HE ATF5,2,8H TNT EQ,I4 ,24H SIDE UNITS
        1, EARTH COVERI2,14H, STACK SHAPE 2A8)
        202 FORMAT (1H0,28X,16HPROBABILITIES OF,8X,7HPERCENT,9X,16HPROBABILITI
        1ES OF,8X,7HPERCENT)
        203 FORMAT (1H ,25X,22HSEVERE OR FATAL INJURY,5X,7HSERIOUS,6X,22HANY I
        1NJURY OR FATALITY,7X,3HANY,5X,7HPERCENT)
80      204 FORMAT (1H ,4X,4HDIST,4X,6HSCALED,5X,4HHEAD,6X,4HLUNG,6X,5HHEAVY,
        13X,6H INJURY,3X,6HGROUND,5X,5HBLAST,6X,3HALL,6X,6HINJURY,2X,8HBUI
        2LDING)
85      205 FORMAT (1H ,4X,4H(FT),5X,4HDIST,5X,6HINJURY,3X,8HCOLLAPSE,2X,9MFRA
        1GMENTS,2X,8HOR DEATH,2X,6HIMPACT,4X,6HINJURY,3X,9HFRAGMENTS,2X,8HO
        2R DEATH,2X,6HDAMAGE)
        END

```

```

FUNCTION PRF(Z)
COMMON/OV/OP(10)
ZL = ALOG(Z)
SUM = OP(10)
5 DO 1 I = 1,4
  IN = -I
1 SUM = SUM*ZL+OP(IN+10)
PRF = EXP(SUM)
10 RETURN
END

```

```

FUNCTION ERF(X)
COMMON/ER/A(5)
AX = X
IF(X.LT.0.) AX = -X
5 SUM = A(5)
DO 1 I = 1,4
  IN = -I
1 SUM = SUM*AX+A(IN+5)
ERF = 1.-1./SUM**4
10 IF(X.LT.0.) ERF = -ERF
RETURN
END

```

```

BLOCK DATA
COMMON/OV/OP(10)
COMMON/ER/A(5)
5 DATA OP/,703681E1,.,1663724E1,.,2516481,.,1137714,.,3618405E-1,
1 .5035198E-1,.,275697E-1,.,5557968E-2,.,5108014E-3,.,1795565E-4,
DATA A/1,.,.278393,.,230389,.,060972,.,078108/
END

```

MARK P2 100000 LB HE AT 1.25 TMT 50, 40 SIDE UNITS, EARTH COVER 0, STACK SHAPE 6 X 12 X 6

DIST (FT)	SCALEG DIST	PROBABILITIES OF			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		SEVERE OR HEAD INJURY	FATAL LUNG COLLAPSE	HEAVY INJURY FRAGMENTS		ANY INJURY OR BLOWN IMPACT	BLAST INJURY	FATALITY ALL FRAGMENTS		
100.	2.11	1.00	1.00	.99	100.	1.00	1.00	1.00	100.	100.
120.	2.53	1.00	1.00	.99	100.	1.00	1.00	1.00	100.	100.
130.	2.74	1.00	1.00	.98	100.	1.00	1.00	1.00	100.	100.
140.	2.95	1.00	1.00	.98	100.	1.00	1.00	1.00	100.	100.
150.	3.16	1.00	1.00	.98	100.	1.00	1.00	1.00	100.	100.
170.	3.58	1.00	1.00	.97	100.	1.00	1.00	1.00	100.	100.
190.	4.00	1.00	1.00	.96	100.	1.00	1.00	1.00	100.	100.
200.	4.22	1.00	1.00	.96	100.	1.00	1.00	1.00	100.	100.
220.	4.64	1.00	1.00	.95	100.	1.00	1.00	1.00	100.	100.
250.	5.27	1.00	1.00	.93	100.	1.00	1.00	1.00	100.	100.
270.	5.69	1.00	.94	.91	100.	1.00	1.00	1.00	100.	100.
300.	6.32	1.00	.76	.88	100.	1.00	1.00	1.00	100.	100.
330.	6.95	1.00	.75	.85	100.	1.00	.99	1.00	100.	100.
360.	7.59	1.00	.63	.81	100.	1.00	.97	1.00	100.	100.
390.	8.22	.99	.60	.78	100.	1.00	.94	1.00	100.	100.
430.	9.06	.54	.60	.72	87.	1.00	.67	1.00	100.	100.
470.	9.91	.67	.60	.66	69.	1.00	.79	.99	100.	100.
520.	10.96	.60	.60	.59	59.	1.00	.67	.94	100.	99.
570.	12.01	.60	.60	.52	52.	1.00	.55	.95	100.	96.
630.	13.28	.60	.60	.44	44.	1.00	.42	.88	100.	88.
690.	14.54	.60	.60	.37	37.	1.00	.31	.78	100.	75.
750.	15.81	.60	.60	.30	30.	1.00	.23	.65	100.	62.
830.	17.49	.60	.60	.23	23.	1.00	.15	.49	100.	37.
910.	19.18	.60	.60	.18	18.	.75	.09	.35	97.	36.
1000.	21.08	.60	.60	.13	13.	.79	.06	.25	85.	27.
1090.	22.97	.60	.60	.09	9.	.56	.03	.18	64.	21.
1200.	25.29	.60	.60	.06	6.	.34	.02	.08	49.	16.
1310.	27.61	.60	.60	.04	4.	.20	.01	.05	24.	13.
1430.	30.35	.60	.60	.02	2.	.11	.01	.03	14.	10.
1580.	33.30	.60	.60	.01	1.	.06	.00	.01	8.	8.
1730.	36.46	.60	.60	.01	1.	.04	.00	.01	5.	7.
1900.	40.04	.60	.60	.00	0.	.03	.00	.00	3.	6.
2080.	43.84	.60	.60	.00	0.	.02	.00	.00	2.	5.
2290.	48.26	.60	.60	.00	0.	.01	.00	.00	1.	4.
2510.	52.90	.60	.60	.00	0.	.01	.00	.00	1.	4.
2750.	57.96	.60	.60	.00	0.	.01	.00	.00	1.	3.
3010.	63.44	.60	.60	.00	0.	.01	.00	.00	1.	3.
3310.	69.76	.60	.60	.00	0.	.01	.00	.00	1.	2.
3630.	76.50	.60	.60	.00	0.	.01	.00	.00	1.	2.
3980.	83.88	.60	.60	.00	0.	.00	.00	.00	0.	2.
4360.	91.89	.60	.60	.00	0.	.00	.00	.00	0.	2.
4760.	100.74	.60	.60	.00	0.	.00	.00	.00	0.	2.
5240.	110.44	.60	.60	.00	0.	.00	.00	.00	0.	2.
5750.	121.18	.60	.60	.00	0.	.00	.00	.00	0.	2.
6300.	132.78	.60	.60	.00	0.	.00	.00	.00	0.	2.
6910.	145.43	.60	.60	.00	0.	.00	.00	.00	0.	1.
7480.	159.75	.60	.60	.00	0.	.00	.00	.00	0.	1.
8110.	175.14	.60	.60	.00	0.	.00	.00	.00	0.	1.
8820.	192.21	.60	.60	.00	0.	.00	.00	.00	0.	1.
10000.	210.76	.60	.60	0.00	0.	.00	.00	0.00	0.	1.

COMPUTER PROGRAM FOR PREDICTING CASUALTIES AND DAMAGE  
FROM ACCIDENTAL EXPLOSIONS

Tables of Results

Technical Paper 11  
Supplement

Department of Defense Explosives Safety Board  
Washington, D. C.

May 1975

COMPUTER PROGRAM FOR PREDICTING CASUALTIES  
AND DAMAGE FROM ACCIDENTAL EXPLOSIONS

Tables of Results

Numerical results tabulated on succeeding pages were calculated by means of a computer program described in Department of Defense Explosives Safety Board Technical Paper 11, of which this is a supplement. The program generates tables of injury probability, percent casualties, and percent damage to residential buildings as functions of distance from block stacks of mass-detonating bombs and projectiles described in the input data.

Results are presented for aboveground stacks of the following four weapons: 500-lb bomb Mark 82, H-6 loaded; 750-lb bomb M117, tritonal loaded; 155-mm projectile M107, TNT loaded; and 175-mm projectile M437A2, Composition B loaded. The stacks considered are assumed to be built up of weapons strapped to their normal shipping pallets, and range from approximately 5,000 to 500,000 lb in net explosive content. In these configurations, the bombs are stored with axes horizontal, while the projectiles are stored with bases down. The scaled distance listed in the second column of each table is in units of feet divided by the cube root of the equivalent weight, in pounds, of uncased TNT.

MARK 82 500000 LB HE AT 1.25 TNT EQ, 102 SIDE UNITS, EARTH COVER 0, STACK SHAPE 17 X 27 X 6

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH		PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH		PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS	OR DEATH	GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS	OR DEATH	OR DEATH		
100.	1.23	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	100.	100.	
200.	2.47	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	100.	100.	
300.	3.70	1.00	1.00	.99	100.	1.00	1.00	1.00	1.00	100.	100.	
400.	4.93	1.00	1.00	.95	100.	1.00	1.00	1.00	1.00	100.	100.	
500.	6.16	1.00	.88	.87	100.	1.00	1.00	1.00	1.00	100.	100.	
600.	7.40	1.00	.88	.75	100.	1.00	1.00	.98	1.00	100.	100.	
800.	9.86	1.00	.80	.47	100.	1.00	1.00	.80	.82	100.	100.	
1000.	12.33	.10	.00	.25	33.	1.00	1.00	.52	.42	100.	93.	
1200.	14.79	.00	.00	.12	12.	1.00	1.00	.29	.16	100.	72.	
1500.	18.49	.00	.00	.03	3.	1.00	1.00	.11	.04	100.	40.	
1800.	22.19	.00	.00	.01	1.	1.00	1.00	.04	.01	100.	33.	
2300.	28.35	.00	.00	.00	0.	.62	.62	.01	.00	62.	12.	
2800.	34.51	.00	.00	.00	0.	.21	.21	.00	.00	21.	0.	
3500.	43.14	.00	.00	.00	0.	.06	.06	.00	.00	6.	3.	
4300.	53.00	.00	.00	.00	0.	.02	.02	.00	.00	2.	3.	
5300.	65.32	.00	.00	.00	0.	.01	.01	.00	.00	1.	3.	
6500.	80.11	.00	.00	.00	0.	.01	.01	.00	.00	1.	2.	
8100.	99.03	.00	.00	.00	0.	.01	.01	.00	.00	1.	2.	
10000.	123.25	.00	.00	.00	0.	.00	.00	.00	.00	0.	2.	

MARK 82 500000 LB HE AT 1.25 TNT EQ, 102 SIDE UNITS, EARTH COVER 0, STACK SHAPE 17 X 27 X 6

MARK 82 250000 LB HE AT 1.25 TNT EQ, 76 SIDE UNITS, EARTH COVER 0, STACK SHAPE 13 X 18 X 6

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY INJURY FRAGMENTS		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	1.55	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
200.	3.11	1.00	1.00	.99	100.	1.00	1.00	1.00	100.	100.
300.	4.66	1.00	1.00	.97	100.	1.00	1.00	1.00	100.	100.
400.	6.21	1.00	.85	.90	100.	1.00	1.00	1.00	100.	100.
500.	7.76	1.00	.02	.79	100.	1.00	.96	1.00	100.	100.
600.	9.32	.94	.00	.65	100.	1.00	.85	.98	100.	100.
800.	12.42	.00	.00	.38	36.	1.00	.51	.73	100.	94.
1000.	15.53	.00	.00	.20	20.	1.00	.24	.34	100.	65.
1200.	18.63	.00	.00	.09	9.	1.00	.11	.12	100.	39.
1500.	25.29	.00	.00	.03	3.	.66	.03	.03	67.	20.
1800.	27.95	.00	.00	.01	1.	.40	.01	.01	42.	12.
2300.	35.72	.00	.00	.00	0.	.09	.00	.00	10.	7.
2800.	43.48	.00	.00	.00	0.	.03	.00	.00	3.	5.
3500.	54.55	.00	.00	.00	0.	.01	.00	.00	1.	3.
4300.	66.77	.00	.00	.00	0.	.01	.00	.00	1.	3.
5300.	82.30	.00	.00	.00	0.	.01	.00	.00	1.	2.
6500.	100.94	.00	.00	.00	0.	.00	.00	.00	0.	2.
8100.	125.78	.00	.00	.00	0.	.00	.00	.00	0.	2.
10000.	155.29	.00	.00	0.00	0.	.00	.00	0.00	0.	1.

MARK 82 100000 LB HE AT 1.25 TNT EQ, 48 SIDE UNITS, EARTH COVER 0, STACK SHAPE 6 X 12 X 6

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY INJURY FRAGMENTS		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	2.11	1.00	1.00	.94	100.	1.00	1.00	1.00	100.	100.
200.	4.22	1.00	1.00	.96	100.	1.00	1.00	1.00	100.	100.
300.	6.32	1.00	.76	.88	100.	1.00	1.00	1.00	100.	100.
400.	6.43	.95	.00	.76	99.	1.00	.92	1.00	100.	100.
500.	10.54	.01	.00	.62	62.	1.00	.72	.99	100.	100.
600.	12.65	.00	.00	.48	48.	1.00	.49	.92	100.	93.
800.	16.86	.00	.00	.26	26.	1.00	.17	.55	100.	52.
1000.	21.08	.00	.00	.13	13.	.79	.06	.22	85.	27.
1200.	25.29	.00	.00	.06	6.	.34	.02	.08	40.	16.
1500.	31.61	.00	.00	.02	2.	.09	.00	.02	11.	9.
1800.	37.94	.00	.00	.00	0.	.03	.00	.01	4.	6.
2300.	48.47	.00	.00	.00	0.	.01	.00	.00	1.	4.
2800.	59.01	.00	.00	.00	0.	.01	.00	.00	1.	3.
3500.	73.76	.00	.00	.00	0.	.01	.00	.00	1.	2.
4300.	90.62	.00	.00	.00	0.	.00	.00	.00	0.	2.
5300.	111.70	.00	.00	.00	0.	.00	.00	.00	0.	2.
6500.	136.99	.00	.00	.00	0.	.00	.00	.00	0.	1.
8100.	170.71	.00	.00	.00	0.	.00	.00	.00	0.	1.
10000.	210.76	.00	.00	0.00	0.	.00	.00	0.00	0.	1.



MARK 82 50000 LB HE AT 1.25 TNT EQ, 30 SIDE UNITS, EARTH COVER 0, STACK SHAPE 5 X 9 X 6

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY INJURY FRAGMENTS		ANY GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	2.66	1.00	1.00	.95	100.	1.00	1.00	1.00	100.	100.
200.	5.31	1.00	1.00	.86	100.	1.00	1.00	1.00	100.	100.
300.	7.97	.75	.00	.74	94.	1.00	1.00	.95	100.	100.
400.	10.62	.00	.00	.59	59.	1.00	1.00	.71	100.	100.
500.	13.26	.00	.00	.45	45.	1.00	1.00	.42	100.	88.
600.	15.93	.00	.00	.34	34.	1.00	1.00	.22	100.	61.
800.	21.24	.00	.00	.17	17.	.51	.05	.05	72.	26.
1000.	26.55	.00	.00	.08	8.	.14	.01	.01	27.	14.
1200.	31.66	.00	.00	.04	4.	.05	.00	.00	10.	9.
1500.	39.63	.00	.00	.01	1.	.02	.00	.00	3.	6.
1800.	47.60	.00	.00	.00	0.	.01	.00	.00	1.	4.
2300.	61.07	.00	.00	.00	0.	.01	.00	.00	1.	3.
2800.	74.35	.00	.00	.00	0.	.00	.00	.00	1.	2.
3500.	92.94	.00	.00	.00	0.	.00	.00	.00	0.	2.
4300.	114.16	.00	.00	.00	0.	.00	.00	.00	0.	2.
5300.	140.73	.00	.00	.00	0.	.00	.00	.00	0.	1.
6500.	172.60	.00	.00	.00	0.	.00	.00	.00	0.	1.
8100.	215.08	.00	.00	.00	0.	.00	.00	.00	0.	1.
10000.	265.54	.00	.00	0.00	0.	.00	.00	0.00	0.	1.

MARK 82 25000 LB HE AT 1.25 TNT EQ, 24 SIDE UNITS, EARTH COVER 0, STACK SHAPE 4 X 6 X 6

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	3.35	1.00	1.00	.90	100.	1.00	1.00	1.00	100.	100.
200.	6.69	.99	.38	.79	100.	1.00	.99	1.00	100.	100.
300.	10.04	.00	.00	.65	65.	1.00	.78	1.00	100.	100.
400.	13.38	.00	.00	.51	51.	1.00	.41	.98	100.	87.
500.	16.73	.00	.00	.38	38.	.66	.16	.89	99.	53.
600.	20.07	.00	.00	.28	28.	.40	.07	.71	84.	31.
800.	26.76	.00	.00	.14	14.	.07	.01	.33	39.	14.
1000.	33.46	.00	.00	.07	7.	.02	.00	.12	14.	8.
1200.	40.15	.00	.00	.03	3.	.01	.00	.04	5.	6.
1500.	50.18	.00	.00	.01	1.	.01	.00	.01	2.	4.
1800.	60.22	.00	.00	.00	0.	.01	.00	.00	1.	3.
2300.	76.95	.00	.00	.00	0.	.00	.00	.00	0.	2.
2800.	93.68	.00	.00	.00	0.	.00	.00	.00	0.	2.
3500.	117.09	.00	.00	.00	0.	.00	.00	.00	0.	2.
4300.	143.86	.00	.00	.00	0.	.00	.00	.00	0.	1.
5300.	177.31	.00	.00	.00	0.	.00	.00	.00	0.	1.
6500.	217.46	.00	.00	.00	0.	.00	.00	.00	0.	1.
8100.	270.99	.00	.00	.00	0.	.00	.00	.00	0.	1.
10000.	354.55	.00	.00	0.00	0.	.00	.00	0.00	0.	1.

MARK 82 10000 LB HE AT 1.25 TNT EQ, 18 SIDE UNITS, EARTH COVER 0, STACK SHAPE 3 X 3 X 6

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	4.54	1.00	1.00	.63	100.	1.00	1.00	1.00	100.	100.
200.	9.08	.00	.00	.69	69.	1.00	.67	1.00	100.	100.
300.	13.62	.00	.00	.55	55.	.96	.39	.99	100.	84.
400.	18.16	.00	.00	.42	42.	.34	.12	.95	97.	42.
500.	22.70	.00	.00	.30	30.	.09	.04	.81	83.	22.
600.	27.24	.00	.00	.22	22.	.03	.01	.61	63.	13.
800.	36.32	.00	.00	.11	11.	.01	.00	.26	27.	7.
1000.	45.41	.00	.00	.05	5.	.01	.00	.09	10.	4.
1200.	54.49	.00	.00	.02	2.	.01	.00	.03	4.	3.
1500.	68.11	.00	.00	.01	1.	.00	.00	.01	1.	3.
1800.	81.73	.00	.00	.00	0.	.00	.00	.00	1.	2.
2300.	104.43	.00	.00	.00	0.	.00	.00	.00	0.	2.
2800.	127.14	.00	.00	.00	0.	.00	.00	.00	0.	2.
3500.	156.92	.00	.00	.00	0.	.00	.00	.00	0.	1.
4300.	195.25	.00	.00	.00	0.	.00	.00	.00	0.	1.
5300.	240.65	.00	.00	.00	0.	.00	.00	.00	0.	1.
6500.	295.14	.00	.00	.00	0.	.00	.00	.00	0.	1.
8100.	367.79	.00	.00	.00	0.	.00	.00	.00	0.	1.
10000.	454.06	.00	.00	0.00	0.	.00	.00	0.00	0.	1.

MARK 82 5000 LB HE AT 1.25 TNT EQ, 8 SIDE UNITS, EARTH COVER 0, STACK SHAPE 2 X 3 X 4

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE (OR FATAL) INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	5.72	.76	.94	.54	99.	1.00	1.00	1.00	100.	100.
200.	11.44	.00	.00	.41	41.	1.00	.62	.98	100.	99.
300.	17.16	.00	.00	.30	30.	.26	.16	.90	94.	49.
400.	22.88	.00	.00	.21	21.	.05	.04	.73	75.	21.
500.	28.60	.00	.00	.15	15.	.02	.01	.52	54.	12.
600.	34.32	.00	.00	.10	10.	.01	.00	.34	35.	6.
800.	45.77	.00	.00	.05	5.	.01	.00	.12	13.	4.
1000.	57.21	.00	.00	.02	2.	.00	.00	.04	5.	3.
1200.	68.65	.00	.00	.01	1.	.00	.00	.01	2.	3.
1500.	85.81	.00	.00	.00	0.	.00	.00	.00	1.	2.
1800.	102.97	.00	.00	.00	0.	.00	.00	.00	0.	2.
2300.	131.58	.00	.00	.00	0.	.00	.00	.00	0.	1.
2800.	160.18	.00	.00	.00	0.	.00	.00	.00	0.	1.
3500.	200.23	.00	.00	.00	0.	.00	.00	.00	0.	1.
4300.	245.99	.00	.00	.00	0.	.00	.00	.00	0.	1.
5300.	303.20	.00	.00	.00	0.	.00	.00	.00	0.	1.
6500.	371.85	.00	.00	.00	0.	.00	.00	.00	0.	1.
8100.	463.38	.00	.00	0.00	0.	.00	.00	.00	0.	1.
10000.	572.08	.00	.00	0.00	0.	.00	.00	0.00	0.	1.

M117 50000 LB HE AT 1.13 TNT EQ, 36 SIDE UNITS, EARTH COVER 0, STACK SHAPE 12 X 36 X 3

DIST (FT)	SCALED DIST	PROBABILITIES OF			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		SEVERE OR FATAL HEAD INJURY	LUNG COLLAPSE	INJURY HEAVY FRAGMENTS		ANY INJURY OR FATALITY BLAST INJURY	GROUND IMPACT	ALL FRAGMENTS		
100.	1.25	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
200.	2.50	1.00	1.00	.99	100.	1.00	1.00	1.00	100.	100.
300.	3.75	1.00	1.00	.95	100.	1.00	1.00	1.00	100.	100.
400.	5.00	1.00	1.00	.83	100.	1.00	1.00	1.00	100.	100.
500.	6.26	1.00	.84	.64	100.	1.00	1.00	1.00	100.	100.
600.	7.51	1.00	.66	.45	100.	1.00	.97	.99	100.	100.
800.	10.01	1.00	.60	.19	100.	1.00	.78	.60	100.	100.
1000.	12.51	.05	.60	.07	12.	1.00	.50	.43	100.	94.
1200.	15.01	.00	.60	.05	6.	1.00	.28	.18	100.	70.
1500.	18.77	.00	.60	.03	3.	1.00	.11	.04	100.	38.
1800.	22.52	.00	.60	.02	2.	.99	.04	.03	99.	22.
2300.	28.77	.00	.60	.01	1.	.56	.01	.01	57.	11.
2800.	35.03	.00	.60	.00	0.	.18	.00	.01	19.	7.
3500.	43.79	.00	.60	.00	0.	.05	.00	.00	3.	5.
4300.	53.79	.00	.60	.00	0.	.02	.00	.00	2.	3.
5300.	66.30	.00	.60	.00	0.	.01	.00	.00	1.	3.
6500.	81.32	.00	.60	.00	0.	.01	.00	.00	1.	2.
8100.	101.33	.00	.60	.00	0.	.01	.00	.00	1.	2.
10000.	125.10	.00	.60	.00	0.	.00	.00	.00	0.	2.

M117 250000 LB HE AT 1.15 TNT EQ, 27 SIDE UNITS, EARTH COVER 0, STACK SHAPE 9 X 24 X 3

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	1.58	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
200.	3.15	1.00	1.00	.98	100.	1.00	1.00	1.00	100.	100.
300.	4.73	1.00	1.00	.90	100.	1.00	1.00	1.00	100.	100.
400.	6.30	1.00	.79	.74	100.	1.00	1.00	1.00	100.	100.
500.	7.88	1.00	.61	.54	100.	1.00	.95	1.00	100.	100.
600.	9.46	.97	.60	.36	98.	1.00	.84	.97	100.	100.
800.	12.61	.60	.60	.14	14.	1.00	.49	.70	100.	93.
1000.	15.76	.60	.60	.06	6.	1.00	.23	.35	100.	62.
1200.	18.91	.60	.60	.04	4.	1.00	.10	.14	100.	37.
1500.	23.64	.60	.60	.03	3.	.61	.03	.03	82.	19.
1600.	24.37	.60	.60	.02	2.	.36	.01	.02	38.	12.
2300.	36.25	.60	.60	.01	1.	.08	.00	.01	9.	7.
2800.	44.13	.60	.60	.00	0.	.03	.00	.00	3.	5.
3500.	55.17	.60	.60	.00	0.	.01	.00	.00	1.	3.
4300.	67.78	.60	.60	.00	0.	.01	.00	.00	1.	3.
5300.	83.54	.60	.60	.00	0.	.01	.00	.00	1.	2.
6500.	102.45	.60	.60	.00	0.	.00	.00	.00	0.	2.
8100.	127.67	.60	.60	.00	0.	.00	.00	.00	0.	2.
10000.	157.62	.60	.60	.00	0.	.00	.00	.00	0.	1.

M117	100000 LB HE AT 1.13 TNT EQ, 15 SIDE UNITS, EARTH COVER 0, STACK SHAPE 5 X 10 X 3										
	DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY	PROBABILITIES OF HEAD INJURY	PROBABILITIES OF LUNG COLLAPSE	PROBABILITIES OF HEAVY INJURY FRAGMENTS	PERCENT SERIOUS INJURY OR DEATH	ANY GROUND IMPACT	PROBABILITIES OF ANY INJURY OR FATALITY	PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
100.	2.14	1.00	1.00	.98	1.00	1.00	1.00	1.00	1.00	1.00	100.
200.	4.28	1.00	1.00	.89	1.00	1.00	1.00	1.00	1.00	1.00	100.
300.	6.42	1.00	.68	.72	1.00	1.00	1.00	1.00	1.00	1.00	100.
400.	8.56	.98	.00	.52	1.00	.94	1.00	.94	1.00	1.00	100.
500.	10.70	.00	.00	.35	1.00	.35	1.00	.71	.96	1.00	100.
600.	12.84	.00	.00	.22	1.00	.22	1.00	.47	.86	1.00	91.
800.	17.11	.00	.00	.08	1.00	.08	1.00	.16	.49	1.00	50.
1000.	21.39	.00	.00	.03	1.00	.03	.74	.05	.21	80.	26.
1200.	25.67	.00	.00	.02	1.00	.02	.30	.02	.08	36.	15.
1500.	32.09	.00	.00	.01	1.00	.01	.08	.00	.02	10.	9.
1800.	38.51	.00	.00	.01	1.00	.01	.03	.00	.01	4.	6.
2300.	49.20	.00	.00	.00	1.00	.00	.01	.00	.01	2.	4.
2800.	59.90	.00	.00	.00	1.00	.00	.01	.00	.00	1.	3.
3500.	74.67	.00	.00	.00	1.00	.00	.01	.00	.00	1.	2.
4300.	91.99	.00	.00	.00	1.00	.00	.00	.00	.00	0.	2.
5300.	113.30	.00	.00	.00	1.00	.00	.00	.00	.00	0.	2.
6500.	139.05	.00	.00	.00	1.00	.00	.00	.00	.00	0.	1.
8100.	173.28	.00	.00	.00	1.00	.00	.00	.00	.00	0.	1.
10000.	213.92	.00	.00	.00	1.00	.00	.00	.00	.00	0.	1.

M317 50000 LB HE AT 1.13 TNT EQ, 12 SIDE UNITS, EARTH COVER 0, STACK SHAPE 4 X 12 X 3

DIST (FT)	SCALED DIST	PROBABILITIES OF		PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF		PERCENT ANY INJURY OR DEATH	PROBABILITIES OF		PERCENT ANY INJURY OR DEATH
		SEVERE OR FATAL HEAD INJURY	OR FATAL LUNG COLLAPSE		INJURY HEAVY FRAGMENTS	ANY GROUND IMPACT		INJURY OR BLAST INJURY	ALL FRAGMENTS	
100.	2.70	1.00	1.00	.95	1.00	1.00	1.00	1.00	1.00	100.
200.	5.39	1.00	1.00	.62	1.00	1.00	1.00	1.00	1.00	100.
300.	8.09	.60	.00	.64	.00	.94	1.00	.94	1.00	100.
400.	10.78	.00	.00	.45	.00	.70	1.00	.70	.99	100.
500.	13.48	.00	.00	.29	.00	.40	1.00	.40	.93	100.
600.	16.17	.00	.00	.18	.00	.21	.99	.21	.79	100.
800.	21.56	.00	.00	.07	.00	.05	.46	.05	.42	70.
1000.	26.95	.00	.00	.03	.00	.01	.12	.01	.17	26.
1200.	32.34	.00	.00	.02	.00	.00	.04	.00	.06	11.
1500.	40.43	.00	.00	.01	.00	.00	.02	.00	.02	3.
1800.	48.51	.00	.00	.01	.00	.00	.01	.00	.01	2.
2300.	61.99	.00	.00	.00	.00	.00	.01	.00	.00	1.
2800.	75.47	.00	.00	.00	.00	.00	.00	.00	.00	1.
3500.	94.33	.00	.00	.00	.00	.00	.00	.00	.00	0.
4300.	115.90	.00	.00	.00	.00	.00	.00	.00	.00	0.
5300.	142.85	.00	.00	.00	.00	.00	.00	.00	.00	0.
6500.	175.19	.00	.00	.00	.00	.00	.00	.00	.00	0.
8100.	218.52	.00	.00	.00	.00	.00	.00	.00	.00	0.
10000.	269.53	.00	.00	.00	.00	.00	.00	.00	.00	0.



M117 25000 LB HE AT 1.15 TNT EQ, 9 SIDE UNITS, EARTH COVER 0, STACK SHAPE 3 X 6 X 3

DIST (FT)	SCALED DIST	PROBABILITIES OF			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		SEVERE OR FATAL HEAD INJURY	SEVERE OR FATAL LUNG COLLAPSE	HEAVY INJURY FRAGMENTS		ANY GROUND IMPACT	ANY BLAST INJURY	ALL FRAGMENTS		
100.	3.40	1.00	1.00	.89	100.	1.00	1.00	1.00	100.	100.
200.	6.79	.97	.30	.73	99.	1.00	.99	1.00	100.	100.
300.	10.19	.90	.00	.53	53.	1.00	.76	1.00	100.	100.
400.	13.58	.80	.00	.36	36.	1.00	.39	.96	100.	85.
500.	16.98	.60	.00	.23	23.	.81	.17	.86	98.	51.
600.	20.37	.40	.00	.14	14.	.36	.07	.67	81.	30.
800.	27.17	.20	.00	.05	5.	.08	.01	.33	30.	13.
1000.	33.96	.10	.00	.02	2.	.02	.00	.13	15.	8.
1200.	40.75	.05	.00	.01	1.	.01	.00	.03	8.	5.
1500.	50.94	.02	.00	.01	1.	.01	.00	.01	3.	4.
1800.	61.12	.01	.00	.01	1.	.01	.00	.01	1.	3.
2300.	78.10	.00	.00	.00	0.	.00	.00	.00	1.	2.
2800.	95.08	.00	.00	.00	0.	.00	.00	.00	1.	2.
3500.	118.05	.00	.00	.00	0.	.00	.00	.00	0.	2.
4300.	146.02	.00	.00	.00	0.	.00	.00	.00	0.	1.
5300.	179.90	.00	.00	.00	0.	.00	.00	.00	0.	1.
6500.	220.73	.00	.00	.00	0.	.00	.00	.00	0.	1.
8100.	275.06	.00	.00	.00	0.	.00	.00	.00	0.	1.
10000.	339.54	.00	.00	.00	0.	.00	.00	.00	0.	1.

M117 10000 LB HE AT 1.13 TNT EG, 4 SIDE UNITS, EARTH COVER 0, STACK SHAPE 2 X 6 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	4.61	1.00	1.00	.63	100.	1.00	1.00	1.00	100.	100.
200.	9.22	.00	.00	.44	44.	1.00	.86	.99	100.	100.
300.	13.83	.00	.00	.29	29.	.94	.37	.92	100.	82.
400.	18.44	.00	.00	.18	18.	.30	.12	.77	86.	40.
500.	23.04	.00	.00	.11	11.	.08	.03	.58	63.	21.
600.	27.65	.00	.00	.06	6.	.05	.01	.40	43.	13.
800.	36.87	.00	.00	.02	2.	.01	.00	.17	18.	7.
1000.	46.09	.00	.00	.01	1.	.01	.00	.06	7.	4.
1200.	55.31	.00	.00	.01	1.	.01	.00	.02	3.	3.
1500.	69.13	.00	.00	.00	0.	.00	.00	.01	1.	2.
1800.	82.96	.00	.00	.00	0.	.00	.00	.00	1.	2.
2300.	106.00	.00	.00	.00	0.	.00	.00	.00	1.	2.
2800.	129.05	.00	.00	.00	0.	.00	.00	.00	0.	2.
3500.	161.51	.00	.00	.00	0.	.00	.00	.00	0.	1.
4300.	198.18	.00	.00	.00	0.	.00	.00	.00	0.	1.
5300.	244.27	.00	.00	.00	0.	.00	.00	.00	0.	1.
6500.	299.58	.00	.00	.00	0.	.00	.00	.00	0.	1.
8100.	375.52	.00	.00	.00	0.	.00	.00	.00	0.	1.
10000.	460.89	.00	.00	.00	0.	.00	.00	.00	0.	1.

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH		PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH		PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY INJURY FRAGMENTS	PERCENT SERIOUS INJURY OR DEATH	ANY GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS	PERCENT ANY INJURY OR DEATH			
100.	5.81	.60	.91	.52	98.	1.00	1.00	1.00	100.	100.	100.	
200.	11.61	.00	.00	.35	35.	.99	.60	.96	100.	98.	98.	
300.	17.42	.00	.00	.22	22.	.23	.13	.85	90.	47.	47.	
400.	23.23	.00	.00	.14	14.	.04	.03	.67	67.	20.	20.	
500.	29.03	.00	.00	.08	6.	.02	.01	.46	49.	11.	11.	
600.	34.64	.00	.00	.05	5.	.01	.00	.32	33.	7.	7.	
800.	46.45	.00	.00	.02	2.	.01	.00	.13	13.	4.	4.	
1000.	58.07	.00	.00	.01	1.	.00	.00	.05	5.	3.	3.	
1200.	69.68	.00	.00	.00	0.	.00	.00	.02	2.	2.	2.	
1500.	87.10	.00	.00	.00	0.	.00	.00	.00	1.	2.	2.	
1800.	104.52	.00	.00	.00	0.	.00	.00	.00	1.	2.	2.	
2300.	153.56	.00	.00	.00	0.	.00	.00	.00	0.	1.	1.	
2800.	162.39	.00	.00	.00	0.	.00	.00	.00	0.	1.	1.	
3500.	203.24	.00	.00	.00	0.	.00	.00	.00	0.	1.	1.	
4300.	249.69	.00	.00	.00	0.	.00	.00	.00	0.	1.	1.	
5300.	307.76	.00	.00	.00	0.	.00	.00	.00	0.	1.	1.	
6500.	377.44	.00	.00	.00	0.	.00	.00	.00	0.	1.	1.	
8100.	470.35	.00	.00	.00	0.	.00	.00	.00	0.	1.	1.	
10000.	580.66	.00	.00	.00	0.	.00	.00	.00	0.	1.	1.	

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY INJURY FRAGMENTS		ANY GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	1.38	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
200.	2.76	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
300.	4.14	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
400.	5.52	1.00	1.00	.93	100.	1.00	1.00	1.00	100.	100.
500.	6.89	1.00	.33	.71	100.	1.00	.99	1.00	100.	100.
600.	8.27	1.00	.00	.43	100.	1.00	.93	.94	100.	100.
800.	11.03	.43	.00	.36	63.	1.00	.67	.52	100.	99.
1000.	13.79	.00	.00	.29	29.	1.00	.37	.39	100.	83.
1200.	16.55	.00	.00	.23	23.	1.00	.19	.29	100.	55.
1500.	20.60	.00	.00	.16	16.	1.00	.06	.21	100.	29.
1800.	24.82	.00	.00	.12	12.	.63	.02	.13	86.	17.
2300.	31.72	.00	.00	.09	6.	.26	.00	.08	32.	9.
2800.	38.61	.00	.00	.03	3.	.08	.00	.04	12.	6.
3500.	48.26	.00	.00	.01	1.	.03	.00	.02	4.	4.
4300.	59.29	.00	.00	.01	1.	.01	.00	.01	2.	3.
5300.	73.08	.00	.00	.00	0.	.01	.00	.00	1.	2.
6500.	89.63	.00	.00	.00	0.	.01	.00	.00	1.	2.
8100.	111.69	.00	.00	.00	0.	.00	.00	.00	0.	2.
10000.	137.89	.00	.00	.00	0.	.00	.00	.00	0.	1.

155 MH 250000 LB HE AT 1.00 TNT EQ, 184 SIDE UNITS, EARTH COVER 0, STACK SHAPE 88 X 92 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	1.74	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
200.	3.47	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
300.	5.21	1.00	1.00	.96	100.	1.00	1.00	1.00	100.	100.
400.	6.95	1.00	.28	.65	100.	1.00	1.00	1.00	100.	100.
500.	8.69	1.00	.00	.59	100.	1.00	1.00	.98	100.	100.
650.	10.42	.17	.00	.34	45.	1.00	1.00	.87	100.	100.
800.	13.90	.00	.00	.27	27.	1.00	1.00	.41	100.	82.
1000.	17.37	.00	.00	.22	22.	1.00	1.00	.30	100.	68.
1200.	20.85	.00	.00	.17	17.	.95	.65	.22	96.	28.
1500.	26.06	.00	.00	.12	12.	.45	.02	.15	55.	15.
1800.	31.27	.00	.00	.08	6.	.15	.00	.11	25.	9.
2300.	39.96	.00	.00	.05	5.	.04	.00	.06	10.	6.
2800.	48.65	.00	.00	.02	2.	.02	.00	.03	5.	4.
3500.	60.81	.00	.00	.01	1.	.01	.00	.01	2.	3.
4300.	74.71	.00	.00	.00	0.	.01	.00	.00	1.	2.
5300.	92.08	.00	.00	.00	0.	.00	.00	.00	1.	2.
6500.	112.93	.00	.00	.00	0.	.00	.00	.00	0.	2.
8100.	140.73	.00	.00	.00	0.	.00	.00	.00	0.	1.
10000.	173.74	.00	.00	.00	0.	.00	.00	.00	0.	1.

155 MM		200000 LB HE AT 1.00 TNT EQ, 160 SIDE UNITS, EARTH COVER 0, STACK SHAPE 60 X 60 X 2									
DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY				PROBABILITIES OF ANY INJURY OR FATALITY				PERCENT ANY INJURY OR DEATH	
		HEAD INJURY	SEVERE OR FATAL INJURY	HEAVY FRAGMENTS	PERCENT SERIOUS INJURY OR DEATH	ANY INJURY OR FATALITY	BLAST INJURY	ALL FRAGMENTS	PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE	
100.	1.87	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	100.	100.
200.	3.74	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	100.	100.
300.	5.61	1.00	.99	.97	100.	1.00	1.00	1.00	1.00	100.	100.
400.	7.49	1.00	.05	.81	100.	1.00	1.00	.97	1.00	100.	100.
500.	9.36	.68	.00	.54	85.	1.00	1.00	.85	.97	100.	100.
600.	11.23	.01	.00	.30	30.	1.00	1.00	.64	.83	100.	99.
800.	14.97	.00	.00	.24	24.	1.00	1.00	.28	.37	100.	70.
1000.	16.72	.00	.00	.19	19.	.99	.99	.11	.27	100.	38.
1200.	22.46	.00	.00	.15	15.	.76	.76	.04	.19	61.	22.
1500.	28.07	.00	.00	.11	11.	.25	.25	.01	.14	35.	12.
1800.	33.69	.00	.00	.07	7.	.08	.08	.00	.09	17.	8.
2300.	43.04	.00	.00	.04	4.	.02	.02	.00	.05	7.	5.
2800.	52.40	.00	.00	.02	2.	.01	.01	.00	.03	4.	4.
3500.	65.50	.00	.00	.01	1.	.01	.01	.00	.01	2.	3.
4300.	80.48	.00	.00	.00	0.	.01	.01	.00	.00	1.	2.
5300.	99.19	.00	.00	.00	0.	.00	.00	.00	.00	1.	2.
6500.	121.65	.00	.00	.00	0.	.00	.00	.00	.00	0.	2.
8100.	151.59	.00	.00	.00	0.	.00	.00	.00	.00	0.	1.
10000.	187.15	.00	.00	.00	0.	.00	.00	.00	.00	0.	1.

155 MM		100000 LB HE AT 1.00 TNT EQ, 116 SIDE UNITS, EARTH COVER 0, STACK SHAPE 56 X 56 X 5									
DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE	
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS		GROUND IMPACT	BLAST INJURY	FRAGMENTS			
100.	2.56	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.	
200.	4.72	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.	
300.	7.07	1.00	.18	.92	100.	1.00	.99	1.00	100.	100.	
400.	9.43	.07	.00	.70	72.	1.00	.84	.99	100.	100.	
500.	11.79	.00	.00	.43	43.	1.00	.58	.92	100.	97.	
600.	14.15	.00	.00	.23	23.	1.00	.34	.73	100.	79.	
800.	18.86	.00	.00	.18	18.	.91	.10	.28	94.	38.	
1000.	23.58	.00	.00	.14	14.	.38	.03	.20	52.	20.	
1200.	28.50	.00	.00	.11	11.	.13	.01	.14	26.	12.	
1500.	35.37	.00	.00	.08	8.	.04	.00	.10	13.	7.	
1800.	42.44	.00	.00	.05	5.	.02	.00	.07	9.	5.	
2300.	54.23	.00	.00	.03	3.	.01	.00	.04	5.	3.	
2800.	66.02	.00	.00	.02	2.	.01	.00	.02	3.	3.	
3500.	82.53	.00	.00	.01	1.	.00	.00	.01	1.	2.	
4300.	101.39	.00	.00	.00	0.	.00	.00	.00	1.	2.	
5300.	124.97	.00	.00	.00	0.	.00	.00	.00	0.	2.	
6500.	153.27	.00	.00	.00	0.	.00	.00	.00	0.	1.	
8100.	190.99	.00	.00	.00	0.	.00	.00	.00	0.	1.	
10100.	235.80	.00	.00	.00	0.	.00	.00	.00	0.	1.	

155 MM 50000 LB HE AT 1.00 TNT EQ, 80 SIDE UNITS, EARTH COVER 0, STACK SHAPE 40 X 40 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY				PERCENT SERIOUS INJURY OR DEATH			PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH		PERCENT BUILDING DAMAGE
		HEAD INJURY	SEVERE OR FATAL INJURY	HEAVY INJURY	FRAGMENTS	HEAD INJURY	HEAVY INJURY	OR DEATH	ANY GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS	OR DEATH	BUILDING DAMAGE	
100.	2,97	1.00	1.00	1.00	1.00	100.	100.	1.00	1.00	1.00	100.	100.		
200.	5,94	1.00	.93	.98	1.00	100.	100.	1.00	1.00	1.00	100.	100.		
300.	8,91	.02	.00	.83	.83	83.	83.	1.00	.89	1.00	100.	100.		
400.	11,88	.00	.00	.56	.56	56.	56.	1.00	.57	.97	100.	97.		
500.	14,85	.00	.00	.32	.32	32.	32.	1.00	.29	.83	100.	72.		
600.	17,82	.00	.00	.16	.16	16.	16.	.83	.14	.59	94.	44.		
800.	25,77	.00	.00	.13	.13	13.	13.	.20	.03	.21	38.	19.		
1000.	29,71	.00	.00	.10	.10	10.	10.	.05	.01	.14	20.	11.		
1200.	35,65	.00	.00	.08	.08	6.	6.	.02	.00	.10	12.	7.		
1500.	44,56	.00	.00	.05	.05	5.	5.	.01	.00	.07	8.	5.		
1800.	53,48	.00	.00	.04	.04	4.	4.	.01	.00	.05	6.	3.		
2300.	68,33	.00	.00	.02	.02	2.	2.	.01	.00	.03	3.	3.		
2600.	83,18	.00	.00	.01	.01	1.	1.	.00	.00	.01	2.	2.		
3500.	103,98	.00	.00	.00	.00	0.	0.	.00	.00	.01	1.	2.		
4300.	127,75	.00	.00	.00	.00	0.	0.	.00	.00	.00	1.	2.		
5300.	157,45	.00	.00	.00	.00	0.	0.	.00	.00	.00	0.	1.		
6500.	193,10	.00	.00	.00	.00	0.	0.	.00	.00	.00	0.	1.		
8100.	240,64	.00	.00	.00	.00	0.	0.	.00	.00	.00	0.	1.		
10000.	297,08	.00	.00	.00	.00	0.	0.	.00	.00	.00	0.	1.		



155 MM 25000 LB HE AT 1.00 TNT EQ, 60 SIDE UNITS, EARTH COVER 0, STACK SHAPE 30 X 28 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY		PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS		ANY INJURY	BLAST INJURY		
100.	5.74	1.00	1.00	1.00	100.	1.00	1.00	100.	100.
200.	7.49	.17	.03	.94	95.	1.00	.97	100.	100.
300.	11.23	.00	.00	.74	74.	1.00	.64	100.	99.
400.	14.97	.00	.00	.46	46.	.95	.28	100.	70.
500.	18.72	.00	.00	.25	25.	.46	.11	87.	38.
600.	22.46	.00	.00	.13	13.	.13	.04	59.	22.
800.	29.94	.00	.00	.10	10.	.03	.01	19.	10.
1000.	37.43	.00	.00	.08	8.	.01	.00	12.	6.
1200.	44.92	.00	.00	.06	6.	.01	.00	8.	5.
1500.	56.15	.00	.00	.04	4.	.01	.00	6.	3.
1800.	67.37	.00	.00	.03	3.	.00	.00	4.	3.
2300.	86.09	.00	.00	.02	2.	.00	.00	2.	2.
2800.	104.80	.00	.00	.01	1.	.00	.00	1.	2.
3500.	131.01	.00	.00	.00	0.	.00	.00	1.	1.
4300.	160.95	.00	.00	.00	0.	.00	.00	0.	1.
5300.	196.38	.00	.00	.00	0.	.00	.00	0.	1.
6500.	245.50	.00	.00	.00	0.	.00	.00	0.	1.
8100.	303.19	.00	.00	.00	0.	.00	.00	0.	1.
10000.	374.50	.00	.00	.00	0.	.00	.00	0.	1.

155 MM		10000 LB HE AT 1.00 TNT EQ, 40 SIDE UNITS, EARTH COVER 0, STACK SHAPE 20 X 16 X 2												
DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY				PERCENT SERIOUS INJURY OR DEATH				PROBABILITIES OF ANY INJURY OR FATALITY		PERCENT ANY INJURY OR DEATH		PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY INJURY FRAGMENTS	ANY INJURY	GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS	ANY INJURY	ANY INJURY	OR DEATH	OR DEATH		
100.	5.08	1.00	1.00	.98	100.	1.00	1.00	1.00	1.00	1.00	1.00	100.	100.	
200.	10.16	.00	.00	.65	85.	1.00	1.00	.77	1.00	1.00	100.	100.	100.	
300.	15.24	.00	.00	.59	59.	.65	.65	.26	.97	.97	99.	99.	99.	
400.	20.32	.00	.00	.54	54.	.13	.13	.07	.83	.83	86.	86.	86.	
500.	25.40	.00	.00	.17	17.	.04	.04	.02	.59	.59	61.	61.	61.	
600.	30.48	.00	.00	.09	9.	.02	.02	.01	.36	.36	38.	38.	38.	
800.	40.64	.00	.00	.07	7.	.01	.01	.00	.11	.11	12.	12.	12.	
1000.	50.80	.00	.00	.05	5.	.01	.01	.00	.08	.08	8.	8.	8.	
1200.	60.96	.00	.00	.04	4.	.00	.00	.00	.05	.05	6.	6.	6.	
1500.	76.20	.00	.00	.03	3.	.00	.00	.00	.04	.04	4.	4.	4.	
1800.	91.44	.00	.00	.02	2.	.00	.00	.00	.02	.02	3.	3.	3.	
2300.	116.88	.00	.00	.01	1.	.00	.00	.00	.01	.01	2.	2.	2.	
2800.	142.24	.00	.00	.01	1.	.00	.00	.00	.01	.01	1.	1.	1.	
3500.	177.80	.00	.00	.00	0.	.00	.00	.00	.00	.00	1.	1.	1.	
4300.	210.44	.00	.00	.00	0.	.00	.00	.00	.00	.00	0.	0.	0.	
5300.	269.24	.00	.00	.00	0.	.00	.00	.00	.00	.00	0.	0.	0.	
6500.	330.20	.00	.00	.00	0.	.00	.00	.00	.00	.00	0.	0.	0.	
8100.	411.49	.00	.00	.00	0.	.00	.00	.00	.00	.00	0.	0.	0.	
10000.	508.01	.00	.00	.00	0.	.00	.00	.00	.00	.00	0.	0.	0.	

155 MM		5000 LB HE AT 1.00 TNT EQ, 20 SIDE UNITS, EARTH COVER 0, STACK SHAPE 14 X 12 X 2										
DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY				PROBABILITIES OF ANY INJURY OR FATALITY				PERCENT ANY INJURY OR DEATH		PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS	PERCENT SERIOUS INJURY OR DEATH	ANY GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS	PERCENT ANY INJURY OR DEATH			
100.	6.80	.02	.45	.94	97.	1.00	1.00	1.00	100.	100.	100.	
200.	12.00	.00	.00	.74	74.	.63	.47	.99	100.	92.	92.	
300.	19.20	.00	.00	.46	46.	.10	.09	.91	93.	36.	36.	
400.	25.60	.00	.00	.25	25.	.02	.02	.71	72.	16.	16.	
500.	32.00	.00	.00	.13	13.	.01	.00	.46	47.	9.	9.	
600.	38.40	.00	.00	.06	6.	.01	.00	.27	28.	6.	6.	
800.	51.20	.00	.00	.05	5.	.00	.00	.08	8.	4.	4.	
1000.	64.00	.00	.00	.04	4.	.00	.00	.05	6.	3.	3.	
1200.	76.80	.00	.00	.03	3.	.00	.00	.04	4.	2.	2.	
1500.	96.00	.00	.00	.02	2.	.00	.00	.03	3.	2.	2.	
1800.	115.20	.00	.00	.01	1.	.00	.00	.02	2.	2.	2.	
2300.	147.20	.00	.00	.01	1.	.00	.00	.01	1.	1.	1.	
2800.	179.20	.00	.00	.00	0.	.00	.00	.00	1.	1.	1.	
3500.	224.00	.00	.00	.00	0.	.00	.00	.00	1.	1.	1.	
4300.	275.20	.00	.00	.00	0.	.00	.00	.00	0.	0.	0.	
5300.	339.20	.00	.00	.00	0.	.00	.00	.00	0.	0.	0.	
6500.	416.00	.00	.00	.00	0.	.00	.00	.00	0.	0.	0.	
8100.	518.40	.00	.00	.00	0.	.00	.00	.00	0.	0.	0.	
10000.	640.00	.00	.00	.00	0	.00	.00	.00	0.	0.	0.	

175 MM 500000 LB HE AT 1.10 TNT EQ, 100 SIDE UNITS, EARTH COVER 0, STACK SHAPE 94 X 07 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	THORAX COLLAPSE	HEAVY FRAGMENTS		BLAST INJURY	FRAGMENTS	GROUND IMPACT		
100.	1.53	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
200.	2.65	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
300.	3.98	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
400.	5.30	1.00	1.00	.98	100.	1.00	1.00	1.00	100.	100.
500.	6.63	1.00	.56	.86	100.	1.00	1.00	1.00	100.	100.
600.	7.95	1.00	.01	.59	100.	1.00	.95	.97	100.	100.
800.	10.60	.84	.00	.30	89.	1.00	.72	.63	100.	100.
1000.	13.25	.00	.00	.23	23.	1.00	.42	.34	100.	86.
1200.	15.90	.00	.00	.18	16.	1.00	.22	.22	100.	61.
1500.	19.88	.30	.00	.12	12.	1.00	.08	.15	100.	32.
1800.	23.85	.00	.00	.07	7.	.93	.03	.09	94.	19.
2300.	30.48	.00	.00	.04	4.	.36	.01	.05	40.	10.
2800.	37.10	.00	.00	.02	2.	.11	.00	.02	13.	6.
3500.	46.38	.00	.00	.01	1.	.03	.00	.01	4.	4.
4300.	56.98	.00	.00	.00	0.	.01	.00	.00	2.	3.
5300.	70.23	.00	.00	.00	0.	.01	.00	.00	1.	2.
6500.	86.13	.00	.00	.00	0.	.01	.00	.00	1.	2.
8100.	107.34	.00	.00	.00	0.	.00	.00	.00	0.	2.
10000.	152.51	.00	.00	.00	0.	.00	.00	.00	0.	1.

175 MM 250000 LB HE AT 1.10 TNT EQ, 132 SIDE UNITS, EARTH COVER 0, STACK SHA .2 X 66 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF			PERCENT SERIOUS INJURY OR DEATH	ANY GROUND IMPACT	PROBABILITIES OF		PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		SEVERE OR FATAL INJURY	HEAD INJURY	SEVERE OR FATAL INJURY OR DEATH			BLAST INJURY	ALL FRAGMENTS		
100.	1.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	100.	100.
200.	3.34	1.00	1.00	1.00	1.00	1.00	1.00	1.00	100.	100.
300.	5.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	100.	100.
400.	6.68	1.00	.95	1.00	1.00	1.00	1.00	1.00	100.	100.
500.	8.35	1.00	.74	1.00	1.00	.93	.99	1.00	100.	100.
600.	10.02	.54	.47	75.	1.00	.76	.91	100.	100.	100.
800.	13.36	.00	.22	22.	1.00	.41	.50	100.	100.	87.
1000.	16.70	.00	.17	17.	1.00	.12	.25	100.	100.	53.
1200.	20.03	.00	.13	13.	.99	.08	.16	99.	99.	31.
1500.	25.04	.00	.08	8.	.60	.02	.11	65.	65.	17.
1800.	30.05	.00	.05	5.	.22	.01	.07	28.	28.	10.
2300.	38.40	.00	.02	2.	.05	.00	.03	6.	6.	6.
2800.	46.75	.00	.01	1.	.02	.00	.01	4.	4.	4.
3500.	58.43	.00	.00	0.	.01	.00	.01	2.	2.	3.
4300.	71.79	.00	.00	0.	.01	.00	.00	1.	1.	2.
5300.	88.49	.00	.00	0.	.01	.00	.00	1.	1.	2.
6500.	108.52	.00	.00	0.	.00	.00	.00	0.	0.	2.
8100.	135.23	.00	.00	0.	.00	.00	.00	0.	0.	1.
10000.	166.96	.00	.00	0.	.00	.00	.00	0.	0.	1.

1/5 MM 200000 LB ME AT 1.10 TNT EQ, 120 SIDE UNITS, EARTH COVER 0, STACK SHAPE 54 X 60 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY				PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS	GROUND IMPACT		BLAST INJURY	ALL FRAGMENTS	ANY INJURY OR DEATH		
100.	1.80	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	100.	100.
200.	5.60	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	100.	100.
300.	5.40	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	100.	100.
400.	7.19	1.00	.14	.95	100.	1.00	.90	1.00	1.00	100.	100.
500.	8.99	.96	.00	.71	99.	1.00	.88	.98	1.00	100.	100.
600.	10.79	.04	.00	.44	46.	1.00	.69	.89	1.00	100.	100.
800.	14.39	.00	.00	.20	20.	1.00	.32	.47	1.00	100.	77.
1000.	17.98	.00	.00	.16	16.	1.00	.13	.23	1.00	100.	43.
1200.	21.58	.00	.00	.12	12.	.68	.05	.15	1.00	90.	25.
1500.	26.98	.00	.00	.08	8.	.34	.01	.10	1.00	42.	14.
1800.	32.37	.00	.00	.05	5.	.11	.00	.06	1.00	17.	9.
2300.	41.37	.00	.00	.02	2.	.03	.00	.03	1.00	6.	5.
2800.	50.36	.00	.00	.01	1.	.01	.00	.01	1.00	3.	4.
3500.	62.95	.00	.00	.00	0.	.01	.00	.00	1.00	1.	3.
4300.	77.33	.00	.00	.00	0.	.01	.00	.00	1.00	1.	2.
5300.	95.32	.00	.00	.00	0.	.00	.00	.00	1.00	0.	2.
6500.	116.90	.00	.00	.00	0.	.00	.00	.00	1.00	0.	2.
8100.	145.68	.00	.00	.00	0.	.00	.00	.00	1.00	0.	1.
10000.	179.85	.00	.00	.00	0.	.00	.00	.00	1.00	0.	1.

11-2200-6-54-1-5-62

1/5 MH 10000 LB HE A/ 1.10 TNT EQ, 84 SIDE UNITS, EARTH COVER 0, STACK SHAPE 40 X 62 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH			PROBABILITIES OF ANY INJURY OR BLAST INJURY			PERCENT ANY INJURY OR DEATH		PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY INJURY FRAGMENTS	OR DEATH	GROUND IMPACT	ANY INJURY OR BLAST INJURY	ALL FRAGMENTS	OR DEATH	OR DEATH	OR DEATH		
100.	2,27	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	1.00	100.	100.	
200.	4,53	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	1.00	100.	100.	
300.	6,80	1.00	.36	.98	100.	1.00	.99	.99	.99	1.00	100.	100.	
400.	9,06	.31	.00	.65	89.	1.00	.87	.87	.99	1.00	100.	100.	
500.	11,33	.00	.00	.58	58.	1.00	.63	.63	.94	1.00	99.	99.	
600.	13,60	.00	.00	.33	33.	1.00	.39	.39	.78	1.00	100.	85.	
800.	18,13	.00	.00	.15	15.	.97	.12	.12	.36	.99	99.	42.	
1000.	22,66	.00	.00	.11	11.	.52	.04	.04	.17	.61	61.	22.	
1200.	27,19	.00	.00	.08	6.	.18	.01	.01	.11	28.	28.	13.	
1500.	33,99	.00	.00	.05	5.	.05	.00	.00	.07	12.	12.	8.	
1800.	40,79	.00	.00	.03	3.	.02	.00	.00	.04	6.	6.	5.	
2300.	52,12	.00	.00	.02	2.	.01	.00	.00	.02	3.	3.	4.	
2800.	63,45	.00	.00	.01	1.	.01	.00	.00	.01	2.	2.	3.	
3500.	79,31	.00	.00	.00	0.	.01	.00	.00	.00	1.	1.	2.	
4300.	97,44	.00	.00	.00	0.	.00	.00	.00	.00	1.	1.	2.	
5300.	120,10	.00	.00	.00	0.	.00	.00	.00	.00	0.	0.	2.	
6500.	147,29	.00	.00	.00	0.	.00	.00	.00	.00	0.	0.	1.	
8100.	183,54	.00	.00	.00	0.	.00	.00	.00	.00	0.	0.	1.	
10000.	226,59	.00	.00	.00	0.	.00	.00	.00	.00	0.	0.	1.	

175 MM 50000 LB HE AT 1.10 TNT EQ, 60 SIDE UNITS, EARTH COVER 0, STACK SHAPE 30 X 27 X 2												
DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH		PERCENT BUILDING DAMAGE	
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS	OR DEATH	OR DEATH		
100.	2.85	1.00	1.00	1.00	100.	1.00	1.00	1.00	1.00	100.	100.	
200.	5.71	1.00	.98	1.00	100.	1.00	1.00	1.00	1.00	100.	100.	
300.	8.56	.11	.00	.94	95.	1.00	1.00	.91	1.00	100.	100.	
400.	11.42	.00	.00	.74	74.	1.00	1.00	.62	.98	100.	99.	
500.	14.27	.00	.00	.46	46.	1.00	1.00	.33	.67	100.	76.	
600.	17.13	.00	.00	.25	25.	.93	.28	.16	.66	98.	50.	
800.	22.84	.00	.00	.11	11.	.07	.04	.04	.27	50.	21.	
1000.	28.55	.00	.00	.06	6.	.01	.01	.01	.12	20.	12.	
1200.	34.26	.00	.00	.06	6.	.03	.03	.00	.06	11.	8.	
1500.	42.82	.00	.00	.04	4.	.01	.01	.00	.03	6.	3.	
1800.	51.39	.00	.00	.02	2.	.01	.01	.00	.03	4.	4.	
2300.	65.66	.00	.00	.01	1.	.01	.01	.00	.01	2.	3.	
2800.	79.94	.00	.00	.01	1.	.00	.00	.00	.01	1.	2.	
3500.	94.42	.00	.00	.00	0.	.00	.00	.00	.00	1.	2.	
4300.	122.76	.00	.00	.00	0.	.00	.00	.00	.00	0.	2.	
5300.	151.31	.00	.00	.00	0.	.00	.00	.00	.00	0.	1.	
6500.	185.57	.00	.00	.00	0.	.00	.00	.00	.00	0.	1.	
8100.	231.25	.00	.00	.00	0.	.00	.00	.00	.00	0.	1.	
10000.	285.49	.00	.00	.00	0.	.00	.00	.00	.00	0.	1.	



175 MM 25000 LB HE AT 1.10 TNT EQ, 42 SIDE UNITS, EARTH COVER 0, STACK SHAPE 20 X 21 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY			PROBABILITIES OF PERCENT SERIOUS INJURY OR DEATH		PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH		PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY FRAGMENTS	ANY GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS	OR DEATH	OR DEATH	OR DEATH		
100.	3.60	1.00	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.	
200.	7.19	.54	.09	.99	1.00	99.	1.00	.98	1.00	100.	100.	
300.	10.79	.00	.00	.07	1.00	07.	1.00	.69	.99	100.	100.	
400.	14.39	.00	.00	.01	.99	61.	.99	.32	.93	100.	77.	
500.	17.98	.00	.00	.35	.60	35.	.60	.13	.76	92.	43.	
600.	21.58	.00	.00	.10	.22	18.	.22	.05	.53	65.	25.	
800.	28.78	.00	.00	.08	.04	8.	.04	.01	.20	24.	11.	
1000.	35.97	.00	.00	.06	.02	6.	.02	.00	.09	11.	7.	
1200.	43.16	.00	.00	.04	.01	4.	.01	.00	.05	6.	5.	
1500.	53.95	.00	.00	.03	.01	3.	.01	.00	.03	4.	3.	
1800.	64.75	.00	.00	.02	.01	2.	.01	.00	.02	3.	3.	
2300.	82.73	.00	.00	.01	.00	1.	.00	.00	.01	1.	2.	
2800.	109.72	.00	.00	.00	.00	0.	.00	.00	.00	1.	2.	
3500.	125.89	.00	.00	.00	.00	0.	.00	.00	.00	1.	2.	
4300.	154.07	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.	
5300.	190.64	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.	
6500.	233.60	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.	
8100.	291.35	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.	
10000.	359.70	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.	

175 MM 10000 LH HE AT 1.10 TNT EQ, 28 SIDE UNITS, EARTH COVER 0, STACK SHAPE 14 X 12 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF			PERCENT		PROBABILITIES OF			PERCENT	
		SEVERE OR HEAD INJURY	LUNG COLLAPSE	FATAL INJURY	HEAVY FRAGMENTS	ON DEATH	SEVERIOUS INJURY	ANY GROUND IMPACT	ANY INJURY OR BLAST INJURY	OR FATALITY ALL FRAGMENTS	ANY INJURY OR DEATH
100.	4.88	1.00	1.00	1.00	1.00	100.	1.00	1.00	1.00	100.	100.
200.	9.76	.00	.00	.94	.94	94.	1.00	.81	1.00	100.	100.
300.	14.65	.00	.00	.74	.74	74.	.74	.30	.96	99.	74.
400.	19.55	.00	.00	.46	.46	46.	.18	.09	.82	87.	34.
500.	24.41	.00	.00	.25	.25	25.	.05	.02	.61	64.	18.
600.	29.29	.00	.00	.13	.13	13.	.02	.01	.40	42.	11.
800.	39.05	.00	.00	.05	.05	5.	.01	.00	.14	15.	6.
1000.	48.82	.00	.00	.04	.04	4.	.01	.00	.06	7.	4.
1200.	58.58	.00	.00	.03	.03	3.	.00	.00	.04	4.	3.
1500.	73.21	.00	.00	.02	.02	2.	.00	.00	.02	3.	2.
1800.	87.87	.00	.00	.01	.01	1.	.00	.00	.01	2.	2.
2300.	112.28	.00	.00	.01	.01	1.	.00	.00	.01	1.	2.
2800.	136.69	.00	.00	.00	.00	0.	.00	.00	.00	1.	1.
3500.	170.86	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.
4300.	209.92	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.
5300.	258.74	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.
6500.	317.52	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.
8100.	395.43	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.
10000.	488.18	.00	.00	.00	.00	0.	.00	.00	.00	0.	1.

5000 LB HE AT 1.10 TNT EQ, 20 SIDE FEET, EARTH COVER 0, STACK SHAPE 10 X 9 X 2

DIST (FT)	SCALED DIST	PROBABILITIES OF SEVERE OR FATAL INJURY				PERCENT SERIOUS INJURY OR DEATH	PROBABILITIES OF ANY INJURY OR FATALITY			PERCENT ANY INJURY OR DEATH	PERCENT BUILDING DAMAGE
		HEAD INJURY	LUNG COLLAPSE	HEAVY INJURY FRAGMENTS	ANY INJURY		GROUND IMPACT	BLAST INJURY	ALL FRAGMENTS		
100.	6.15	.11	.66	.99	100.	1.00	1.00	1.00	100.	100.	
200.	12.30	.00	.00	.87	87.	.95	.52	.99	100.	95.	
300.	18.45	.00	.00	.62	62.	.14	.11	.90	92.	40.	
400.	24.60	.00	.00	.36	36.	.03	.02	.71	72.	17.	
500.	30.75	.00	.00	.19	19.	.01	.01	.49	50.	10.	
600.	36.90	.00	.00	.09	9.	.01	.00	.30	31.	7.	
800.	49.21	.00	.00	.04	4.	.01	.00	.10	11.	4.	
1000.	61.51	.00	.00	.03	3.	.00	.00	.04	5.	3.	
1200.	73.81	.00	.00	.02	2.	.00	.00	.03	3.	2.	
1500.	92.26	.00	.00	.01	1.	.00	.00	.02	2.	2.	
1800.	110.71	.00	.00	.01	1.	.00	.00	.01	1.	2.	
2300.	141.47	.00	.00	.00	0.	.00	.00	.00	1.	1.	
2800.	172.22	.00	.00	.00	0.	.00	.00	.00	1.	1.	
3500.	215.28	.00	.00	.00	0.	.00	.00	.00	0.	1.	
4300.	264.48	.00	.00	.00	0.	.00	.00	.00	0.	1.	
5300.	325.99	.00	.00	.00	0.	.00	.00	.00	0.	1.	
6500.	399.60	.00	.00	.00	0.	.00	.00	.00	0.	1.	
8100.	498.21	.00	.00	.00	0.	.00	.00	.00	0.	1.	
10000.	615.07	.00	.00	.00	0.	.00	.00	.00	0.	1.	