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FRAGMENT HAZARD INVESTIGATION PROGRAM:
NATURAL COMMUNICATION DETONATION OF
155-MM PROJECTILES

by
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prepared for
Department of Defense
Explosives Safety Board

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20. ABSTRACT (Continued)

→ In order to simplify the problem, various projectile stacks based on the standard storage pallet were detonated by means of natural communication in a series of small-scale (one pallet) fragmentation arena tests and large-scale (multiple pallet) tests designed for far-field fragment collection. A description of each test is discussed, and an analysis of the data is presented. A fragmentation model characterizing the detonation by means of natural communication of a pallet of 155-mm projectiles is presented and verified. From this model, a methodology was developed for the determination of far-field fragment hazards produced from the detonation by means of natural communication of open storage stacks of 155-mm projectiles. The significance of the methodology indicates that the quantity-distance standards for large stacks of ammunition can be determined from less expensive, less complex small-scale fragmentation arena tests.

FOREWORD

This report presents the efforts expended by the Naval Surface Weapons Center (NSWC) to generate data to improve quantity-distance standards for handling and storage of stacked munitions. The hazard classification under investigation is the mass-detonating hazard materials (Class 1, Division 1).

The work was accomplished for the Department of Defense Explosives Safety Board (DDESB) under Military Interdepartmental Purchase Requests CE-NSWC-78-1 of 30 June 1978 and CE-NSWC-79-1 of 22 August 1978. The technical monitor of the program for DDESB is Dr. T. A. Zaker.

This report has been reviewed and approved by J. J. Walsh, Head, Terminal Effects Branch, and R. Shank, Head, Environments Division.

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SI CONVERSION

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
feet	30.48	centimeters
inches	2.54	centimeters
grains	0.0648	grams
ft/sec	0.3048	meters/sec

INTRODUCTION

The Department of Defense Explosives Safety Board (DDESB) is conducting a continuing program to evaluate the fragment hazards produced by the accidental detonation of stored munitions. In support of this effort, the Naval Surface Weapons Center (NSWC) was funded in July 1975 to conduct the Fragment Hazard Investigation Program. The purpose of the program is to provide the DDESB with the necessary fragmentation data to improve or to substantiate the quantity-distance (QD) standards of Reference 1. Reference 1 specifies the safe and efficient storage of stacked munitions according to specific hazard classifications. The hazard class under investigation is the mass-detonating hazard materials (Class 1, Division 1). Mass-detonating items are those for which instantaneous explosion or detonation of the entire quantity may be expected in the event of an accident. Munitions of this type consist of bulk explosives and certain propellants, mines, bombs, demolition charges, torpedo and missile warheads, rockets, palletized projectiles loaded with TNT or Composition B, 8-in. and larger high-capacity projectiles loaded with explosive "D", and other munitions listed in Reference 2.

NSWC was directed by the DDESB to conduct tests with the ARMY M107 155-mm projectile (TNT-loaded), in order to permit comparison of the results with those of previous tests of large stacks of the same projectile.³ In addition, NSWC was authorized to conduct concurrent analytical efforts in support of the test activities. The analytical studies were to be viewed as a program of continual review of experimental data and design of new tests. This combined effort was divided into three phases. Phases I and II were designed to provide the necessary fragment characterization data to develop a fragmentation model that describes the fragment hazards produced by projectile clusters that simultaneously detonate. The largest cluster of projectiles tested during Phases I and II was a single pallet of eight projectiles banded in a two-by-four matrix (standard storage configuration). These efforts have been completed, and the results are documented in an NSWC technical report.⁴ Phase III was designed to investigate the fragment hazards produced from projectile clusters that detonate by means of natural communication (only one projectile primed). The data were gathered from small-scale (single pallet) detonation tests similar to those of Reference 4 and from the conduct of large-scale detonation tests (multiple pallets) designed for far-field fragment collection. These data were combined with the experimental findings from Phases I and II to validate equations previously developed⁴ for the prediction of far-field fragment density.

This technical report addresses the Phase III efforts of the testing and analytical studies group. A description of the small and large-scale tests and an analysis of the far-field collection data are presented. The implications of the test results upon existing QD criteria are discussed.

TEST AND ANALYSIS PROGRAM

BACKGROUND

The test program was designed to be a follow-on effort of Phases I and II⁴ that dealt with 155-mm projectile clusters that were simultaneously detonated. Utilizing these experimental findings, a series of tests were designed to characterize the fragment hazards produced from a projectile cluster that is detonated by means of natural communication (only one projectile is primed).

The characterization was based on close-in fragmentation data and far-field fragment collection data. The data included polar and azimuthal spatial references, and range where applicable, for fragment weights (W), numbers, velocities (V), and presented areas ($\bar{A}$).

APPROACH

The fragmentation data required to characterize projectile clusters that detonate by means of natural communication were accumulated by conducting a series of small-scale tests followed by a series of large-scale tests. The test methods utilized throughout the test series reflect the basic test designs and definitions of Reference 5. A description of the fragment collection methods and data handling techniques are presented in Appendix A.

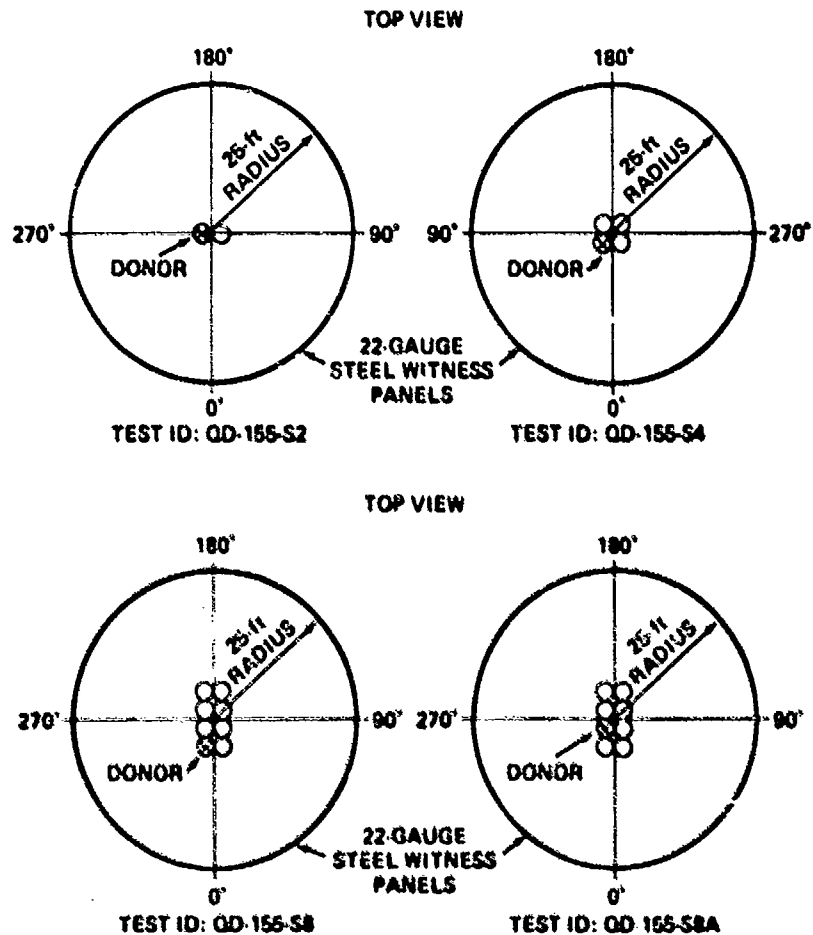
The small-scale tests were conducted at NSWC and consisted of gathering fragmentation data on projectile clusters of two, four, and eight projectiles. These projectile configurations were identical to the scenarios used in the azimuthal tests⁴ and were indicative of the standard pallet design (projectile spacing 7 in. center-to-center). The detonation by means of natural communication was achieved in each projectile configuration by priming only one projectile. A Hercules Engineer's Special Blasting Cap assembled in a modified US Army M564 point-detonating (PD) nose fuze was used for the detonation. The fragmentation data were collected as a function of polar angle measured from the direction of the nose of the projectiles in a cluster with their longitudinal axis vertical.

The large-scale tests consisted of gathering far-field fragment collection data on stacks of standard shipping pallets of 155-mm projectiles that were detonated by means of natural communication. Each pallet consists of eight vertical projectiles banded in a two-by-four matrix. These tests were conducted at the White Sands Missile Range (WSMR), New Mexico, and consisted of detonating (natural communication) 1, 8, 16, and 36 pallets of projectiles.

SMALL-SCALE TESTS

The small-scale test series began with the detonation by means of natural communication of two, four, and eight projectiles configured in the arena designs of Figure 1. Two firings of the two- and four-projectile configurations

and four firings of the eight-projectile configurations were conducted between 12 and 28 July 1977. Each configuration consisted of one donor projectile. The tests were setup to characterize the fragment patterns observed⁴ in earlier tests for each of the configurations. Fragment velocities and hole count data were gathered 360° azimuthally over a polar region of 90 to 105°. High-speed motion picture cameras were used to record the fragment penetrations through 22-gauge steel witness panels. This information was used to calculate the fragment velocities. The fragment hole count data were taken from the witness panels after each test, in order to map the fragment concentrations. A list of the fragment hole count data and velocity information is presented in Appendix



NOTES

1. ALL PROJECTILES ARE VERTICAL (NOSE UP)
2. PROJECTILE SPACING 7.0 in. CENTER-TO-CENTER
3. POLAR COVERAGE 90 TO 105°
4. DRAWING NOT TO SCALE

Figure 1. Witness Panel Arena Layouts for Two-, Four-, and Eight-Projectile Configurations

FRAGMENT CONCENTRATIONS

An analysis of the hole count data, presented in Appendix B, and the fragment velocity information (Figures 2 through 5) revealed that high-density fragment concentrations with velocities higher than a single round are forming. A close inspection of the velocity data indicates that these concentrations are similar to the ones formed from the area between adjacent projectiles (projectile interaction area) that are simultaneously detonated.¹ However, the high-velocity fragment concentrations were found to have an appreciable angular shift in the azimuthal impact points, as compared to simultaneous detonation. At the completion of the test series shown in Figure 1, the fragment hole count data showed that the azimuthal shifts were completely predictable and depended upon the primed projectile location. The angular shifts fall into three categories.

1. A shift of approximately 11° that occurs when two adjacent projectiles are nonsimultaneously detonated by a third projectile.
2. A 28° shift that results when a projectile detonates a single adjacent projectile.
3. No shift in the concentration occurs when two adjacent projectiles are simultaneously detonated by another source.

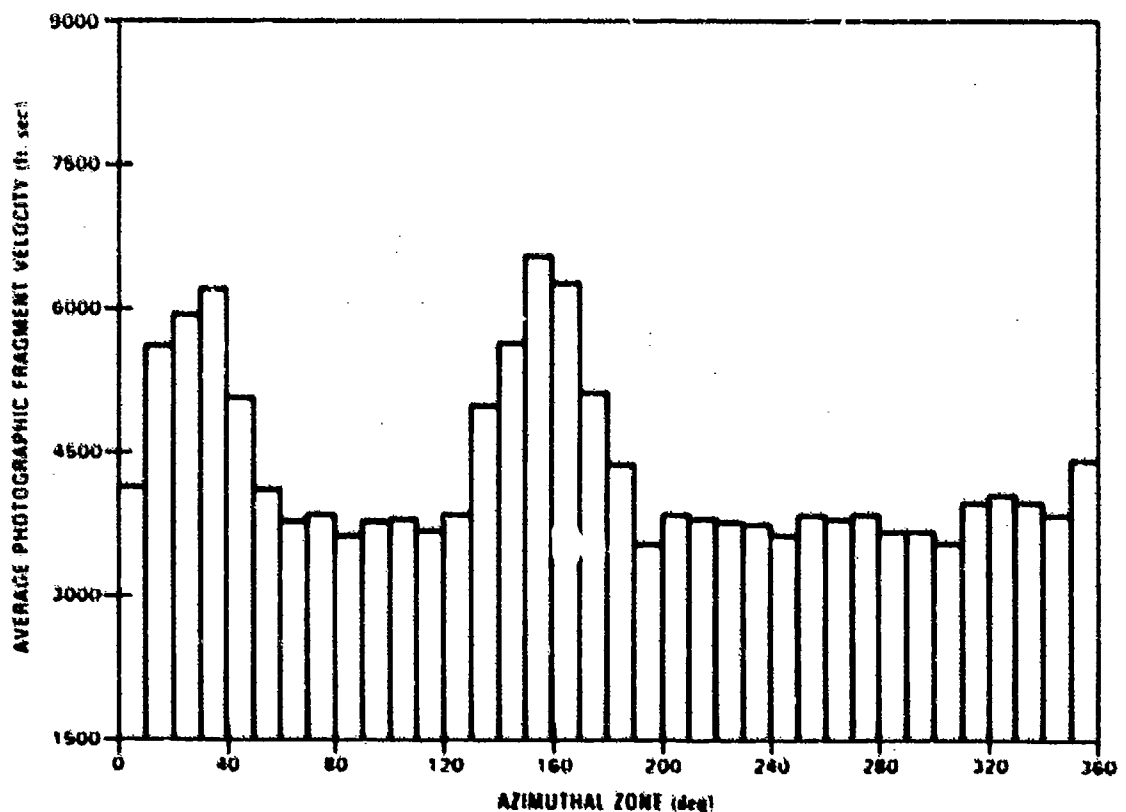


Figure 2. Average Fragment Velocities for Polar Zone 90 to 105°
for Test No. Q-155-52

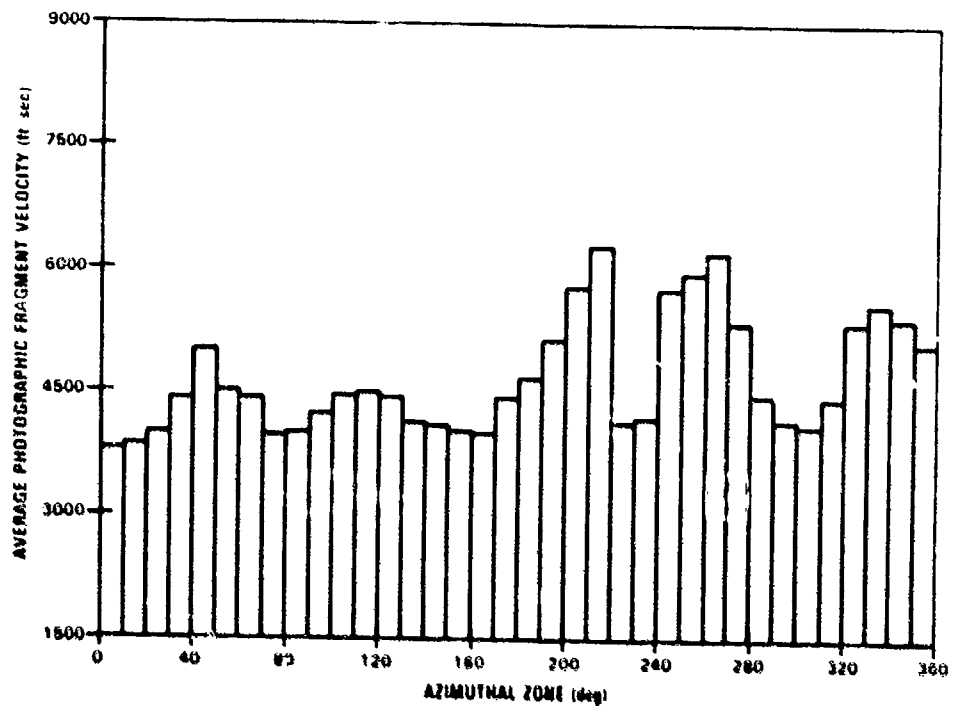


Figure 3. Average Fragment Velocities for Polar Zone 90 to 105° for Test No. QD-155-S4

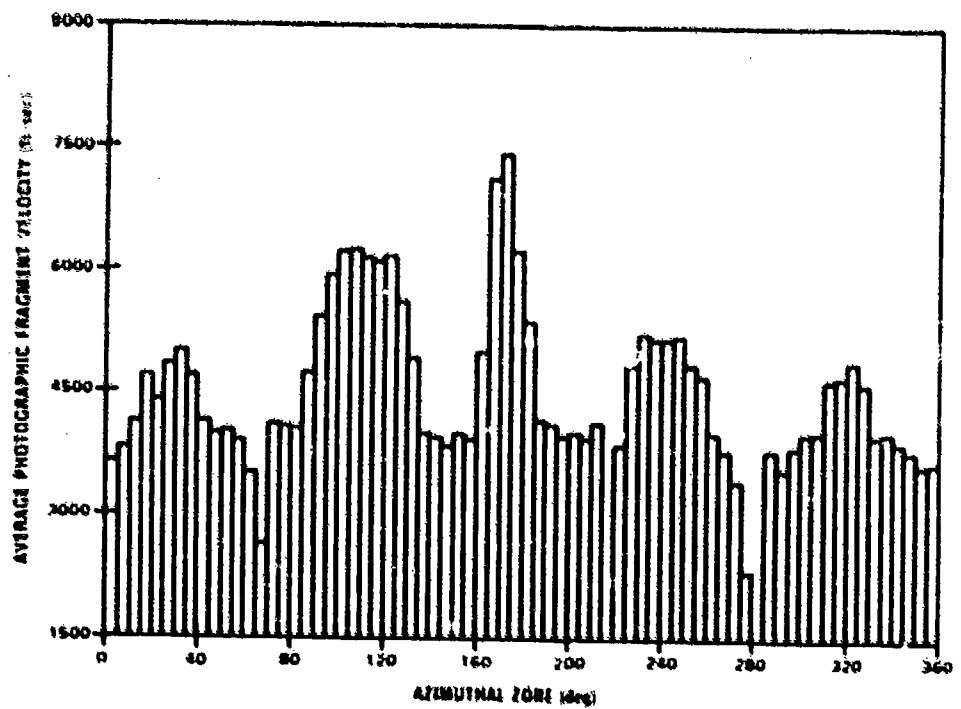


Figure 4. Average Fragment Velocities for Polar Zone 90 to 95° for Test No. QD-155-S8

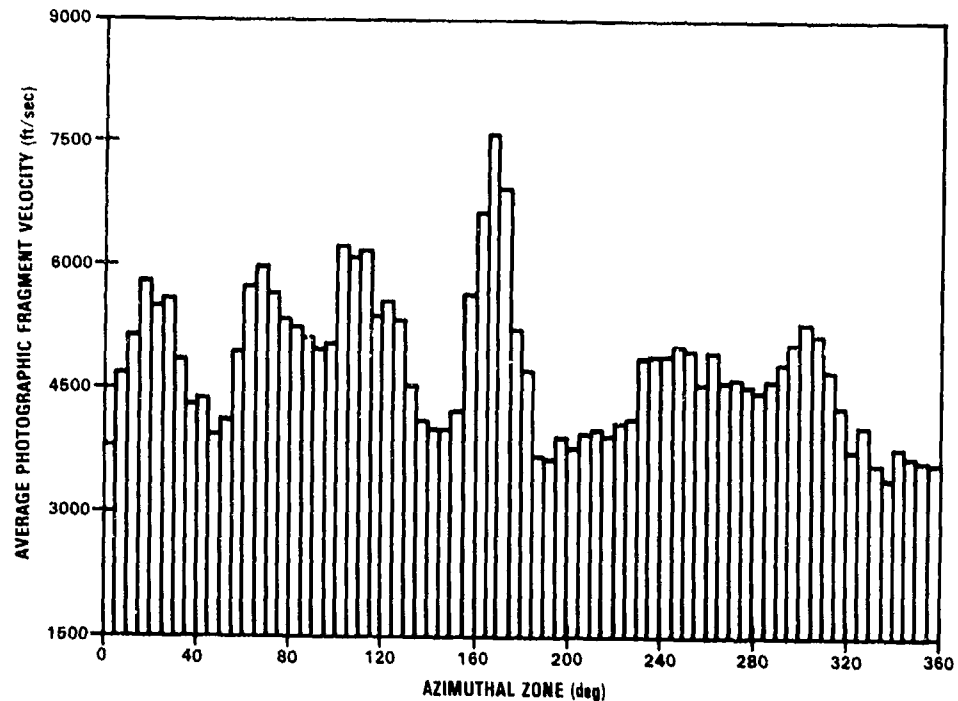


Figure 5. Average Fragment Velocities for Polar Zone 90 to 105° for Test No. QD-155-S8A

Figure 6 illustrates the concentration locations for a full-pallet detonation. The main concentration appears to come from the long side of the pallet away from the detonation source (azimuthal zone 70 to 120°). Smaller concentrations are evident at 169, 242, and 315°. Fragments from the interior of the pallet may be escaping from the 315° concentration, which is formed by the simultaneous detonation of projectile nos. 2 and 8. In order to properly characterize the fragmentation phenomena associated with the high-velocity fragment concentrations, two follow-on, small-scale fragment collection tests were conducted.

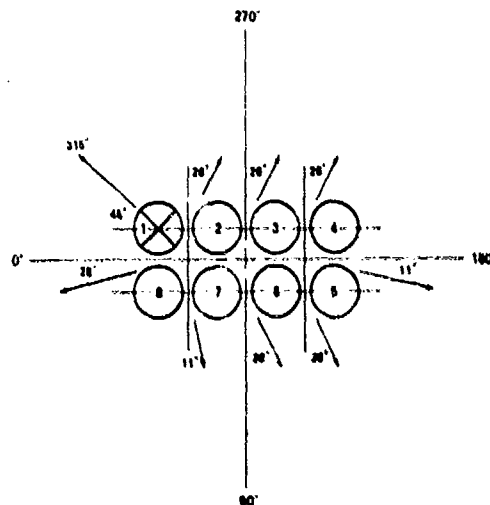
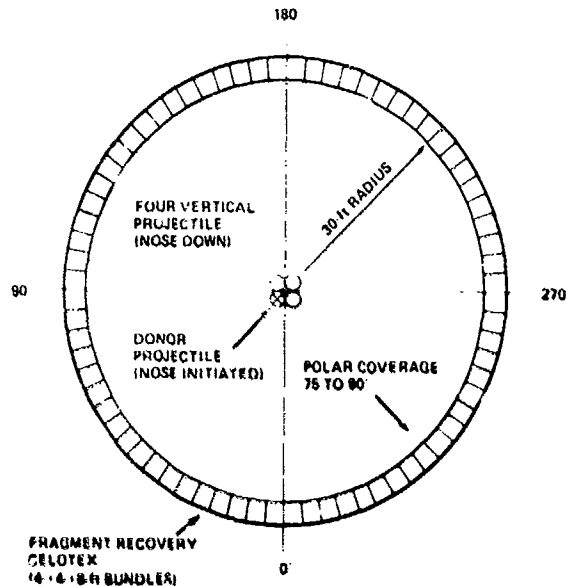


Figure 6. Fragment Concentration Locations for the Detonation of Projectile No. 1

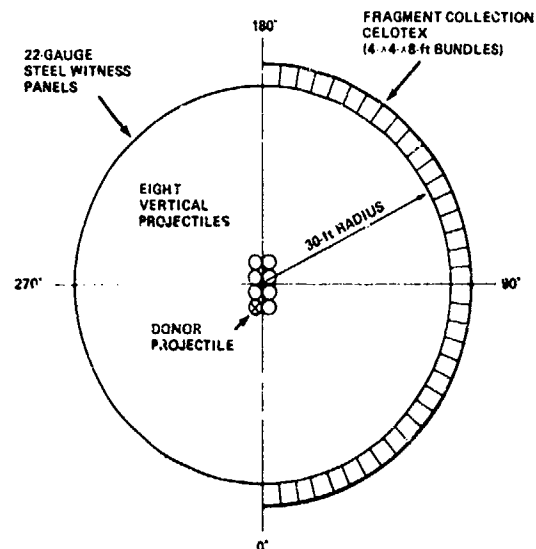
The first fragment collection test was conducted 7 November 1977. The test consisted of the detonation by means of natural communication of four projectiles in a cube configuration. The test identification number is QD-155-SC4 and was designed to characterize the fragment-weight number distributions of the high-velocity fragment concentrations observed in the previous tests. Fragments were collected for 360° azimuthally for polar region 75 to 90°. Figure 7 is a sketch of the projectile cluster configuration positioned in the arena layout. A copy of the fragment weight-number data and average presented area data ($\bar{A}$) is presented in Appendix B.



NOTES
 1. AZIMUTHAL ZONES ARE IN 5° INCREMENTS
 2. PROJECTILE SPACING 7.0 IN CENTER TO CENTER
 3. POLAR ZONES ARE IN 5° INCREMENTS
 4. DRAWING NOT TO SCALE

Figure 7. Arena Layout for Test No. QD-155-SC4

A full pallet of eight projectiles banded in a two-by-four vertical configuration was used for the final, small-scale fragment collection test. The test identification number is QD-155-SC12 and consists of the combined fragmentation data from three separate pallet detonations conducted 20 June 1978, 5 June 1980, and 23 July 1980. The combined data included fragment collection for 180° azimuthally for polar region 90 to 105° and 50° azimuthally for polar regions 75 to 90° and 100 to 120°. Fragment hole count data were combined to include a polar region of 85 to 120° for 180° of azimuth. Figure 8 is a sketch of the typical arena layout utilized for the three single-pallet detonations. A copy of the fragment weight-number and average presented area ($\bar{A}$) data is presented in Appendix B.



NOTES

1. WITNESS PANELS - TOTAL POLAR COVERAGE 75 TO 120° AT 5° INCREMENTS (INCLUDES 3-PALLET DETONATION)
2. PROJECTILE SPACING 7.0 IN. CENTER-TO-CENTER
3. FRAGMENT COLLECTION - TOTAL POLAR COVERAGE 75 TO 120° AT 5° INCREMENTS (INCLUDES 3-PALLET DETONATION)
4. DRAWING NOT TO SCALE

Figure 8. Arena Layout for Test No. QD-155-SC12

COMPARISON WITH SIMULTANEOUS DETONATION

The fragmentation data from the full-pallet natural-communication detonation test (QD-155-SC12) were analyzed and compared with the results of the full-pallet simultaneous detonation test (QD-155-12).⁴ The analysis showed:

1. The metal in the shaded area of Figure 9 (interior casing) does not enter into the fragment distribution but is instead trapped within the interior area. This was proven for the simultaneous detonation of a pallet⁴ and can be shown for natural communication detonation by comparing the total fragment weights recovered for both types of detonation. For example, the total metal weight recovered from polar zone 90 to 95° (0 to 180° azimuth) for the natural communication detonation test was 99105.2 grains. The total fragment weight recovered from the same polar zone and azimuthal angles for the simultaneous detonation of a pallet was 99246.4 grains. Similarly, the total metal weight from polar zone 95 to 100° (0 to 180° azimuthal) was 213197.6 grains for QD-155-SC12 and 229743.8 grains for QD-155-12. Therefore, there is no indication of a contribution to the interaction area on the long side of the pallet from the interior of the pallet as a result of natural communication detonation.

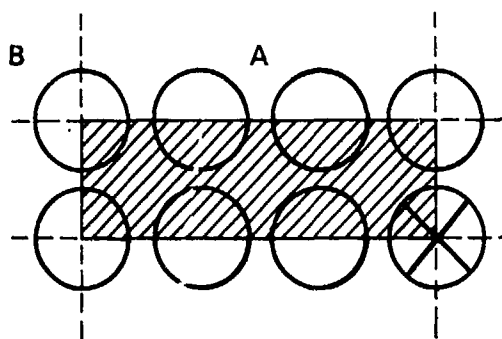


Figure 9. Fragments are Trapped within the Shaded Area

2. Fragments from the interaction area on the long side away from the primed projectile will be concentrated in a beam approximately 45° wide azimuthally as compared to 20° wide azimuthally for simultaneous detonation. A comparison of these data is presented in Figure 10. Furthermore, the total fragment weight recovered from the interaction area for simultaneous detonation (polar zone 90 to 100°) and natural communication detonation (polar zone 90 to 105°) is 170315.0 and 163745.5 grains, respectively. This indicates that the polar spread of the fragment concentration is 5° wider than simultaneous detonation.

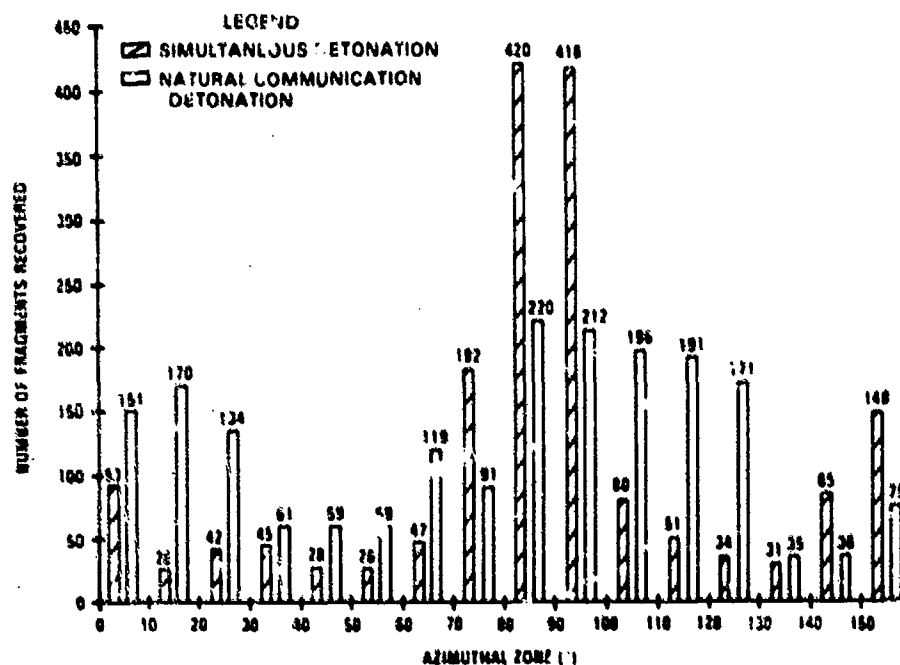


Figure 10. Fragment Distribution

3. The slope of the weight-number distribution (Mott Plot) for the interaction area fragments approximates the slope of the Mott Plot for interaction area fragments from the simultaneous detonation of a pallet. Figure 11 presents a comparison of the Mott Plot for interaction area fragments from each detonation scheme. The similarity of the slopes of a first-order, least-squares fit to the data is apparent.

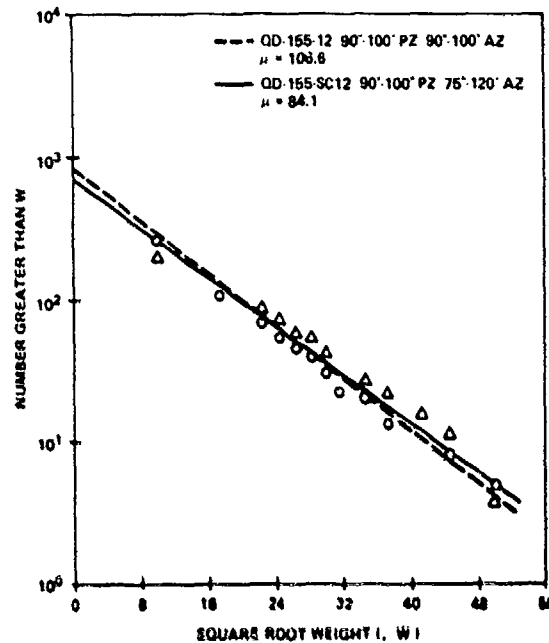


Figure 11. Fragment Weight-Number Distribution for Natural Communication Detonation of a Pallet of 155-mm Projectile (QD-155-SC12)

4. The ballistic efficiency of fragments from the interaction area is similar to the ballistic efficiency of fragments from the interaction area for the simultaneous detonation of a pallet. Reference 4 shows that a measure of fragment ballistic efficiency is provided by analyzing the distribution of the number of fragments as a function of gamma (A/W). Figure 12 presents a comparison of this distribution for interaction area fragments from the detonation of a pallet by both detonation schemes. The slopes of a least-squares fit to the data are quite similar, which indicates that the distribution of gamma is equivalent for both types of detonation.

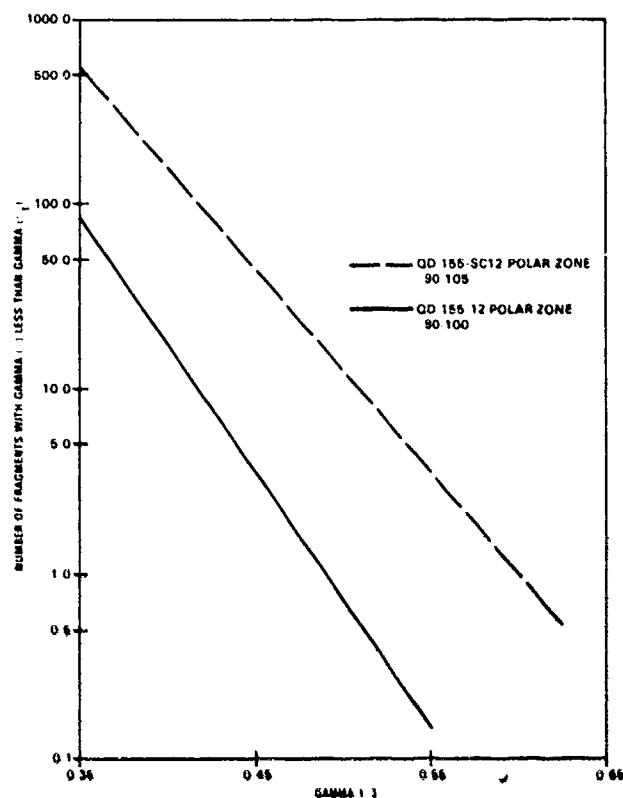


Figure 12. Gamma Distribution for Simultaneous Detonation (QD-155-12) and Natural Communication Detonation (QD-155-SC12) of a Pallet

SUMMARY

To summarize, the significant difference between natural communication and simultaneous detonations of a pallet of 155-mm projectiles is in the angular width and velocity of the fragment concentrations produced from the pallet interaction areas. The natural communication detonation produces a wider concentration that is less densely packed with fragments traveling at a lower velocity than those produced by simultaneous detonation. The Mott Plot and gamma distribution parameters characterizing the fragment concentrations are equivalent for both types of detonation.

These data imply that the fragment concentrations from the pallet interaction area possess the greatest potential to produce far-field fragments. However, empirical data were not available to indicate that similar fragment concentrations would occur as the result of the detonation of a multiple-pallet stack. Therefore, the detonation of multiple-pallet stacks was necessary to obtain the far-field fragment data necessary to evaluate empirical relations previously developed⁴ using small-scale test data.

LARGE-SCALE MULTIPLE-PALLET TESTS

The large-scale, multiple-pallet detonation tests were designed based upon the fragment patterns characterized in the small-scale fragmentation arena tests. These tests were conducted at WSMR on the Dice Throw test site from August 1979 to March 1980. Approximately 255 acres of high-elevation desert were bladed clear of foliage and surveyed according to range and azimuthal location for far-field fragment collection. Blast overpressure data were also measured for each test. Blast gages were located on two perpendicular lines at distances corresponding to peak overpressures of 40, 10, 4, and 1 psi from a TNT hemisphere of the same weight as the net explosive content of the projectiles. Figure 13 shows the far-field fragment collection area, the blast gauge locations, the stack configuration, and the donor projectile location for the single-pallet configuration.

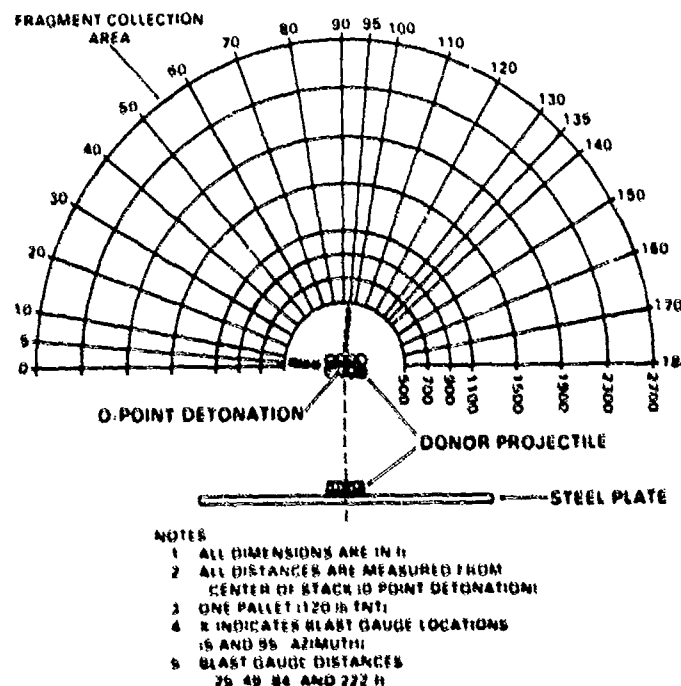


Figure 13. Test Configuration for the Natural Communication Detonation of a Pallet of 155-mm Projectiles

The single-pallet configuration was the first configuration detonated in the large-scale series. The test consisted of eight separate pallet detonations. At the completion of the last firing, the far-field fragments were collected by hand pickup.

The follow-on sequence of tests consisted of an 8-pallet detonation, two 16-pallet detonations, and a 36-pallet detonation. Figures 14 through 16 are sketches of the test layout and donor projectiles' locations for each of the stack configurations.

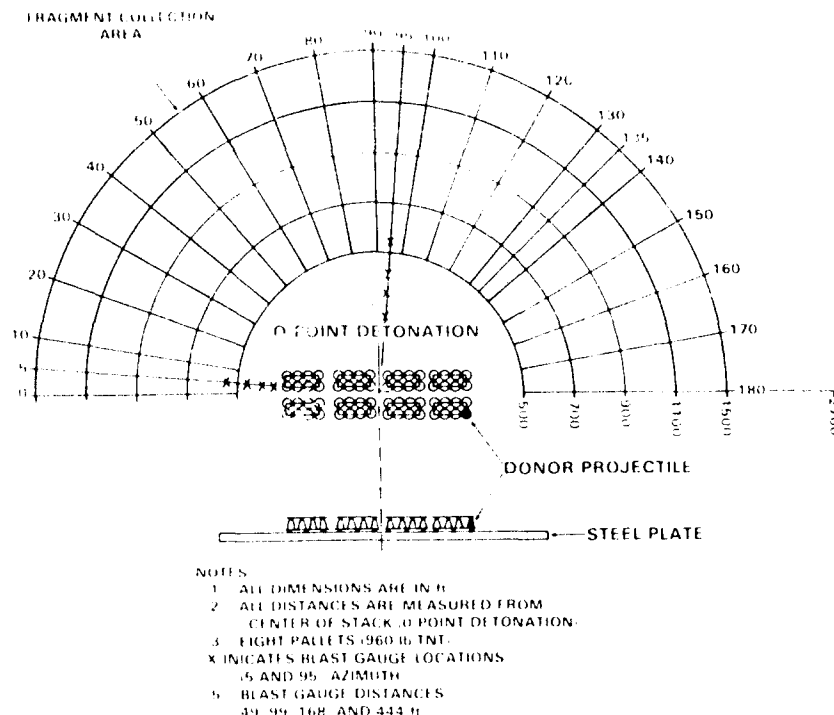


Figure 14. Fragment Collection Area for the Detonation of Eight Pallets of 155-mm Projectiles

FRAGMENT CONCENTRATIONS

The first step in the analysis of the large-scale, multiple-pallet test data was to count the number of the fragments recovered from each angular recovery sector between the ranges of 500 and 2700 ft. The detailed data are presented in Appendix B. The data plotted in Figures 17 through 19 show that the fragment concentrations are forming at the positions (70 to 120° azimuth) observed for the single-pallet test (QD-155-SC12). Furthermore, from the data presented in Table 1, the number of fragments in the fragment concentration is directly related to the number of interaction areas (N_{IA}) in the stack, since the calculated number of fragments per interaction area is essentially constant for each stack size.

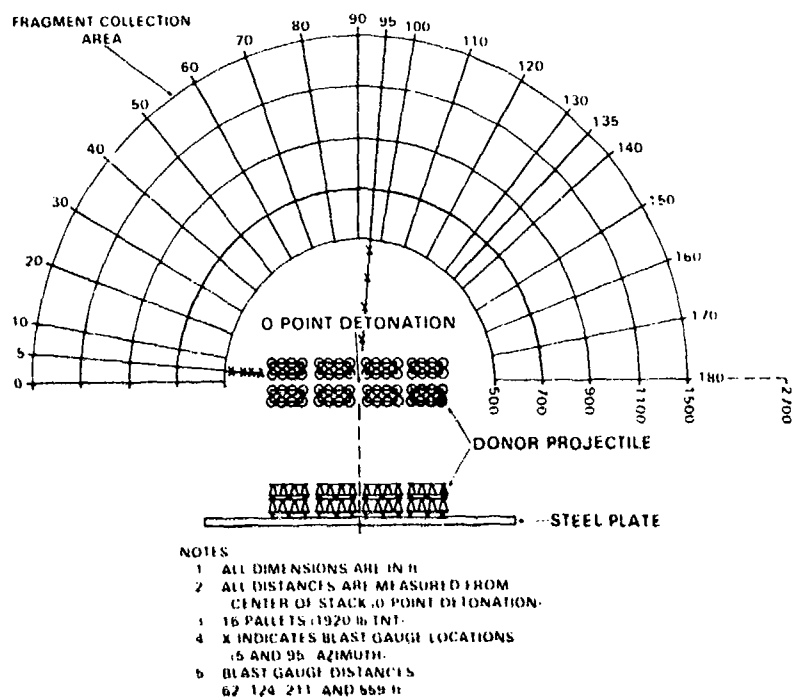


Figure 15. Fragment Collection Area for the Detonation of 16 Pallets of 155-mm Projectiles

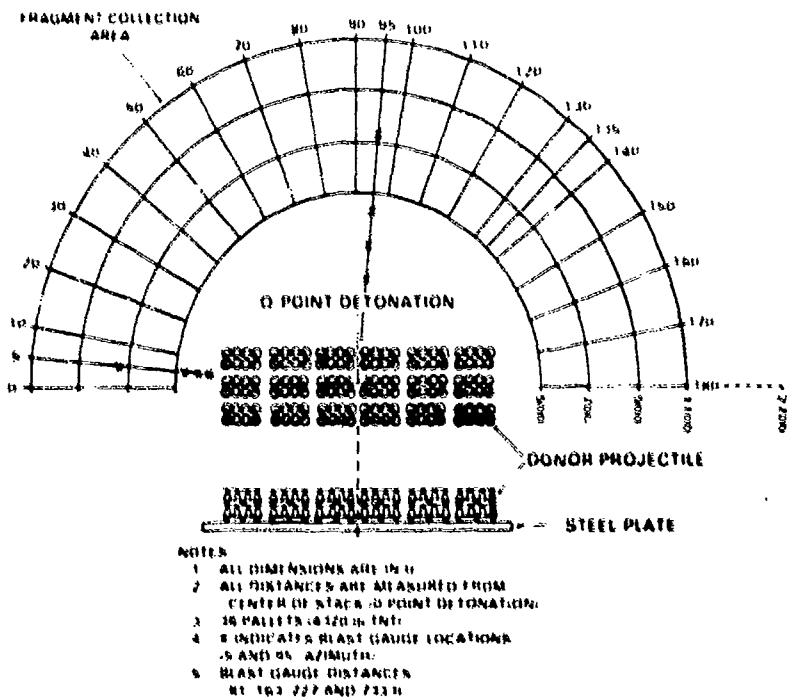


Figure 16. Fragment Collection Area for the Detonation of 36 Pallets of 155-mm Projectiles

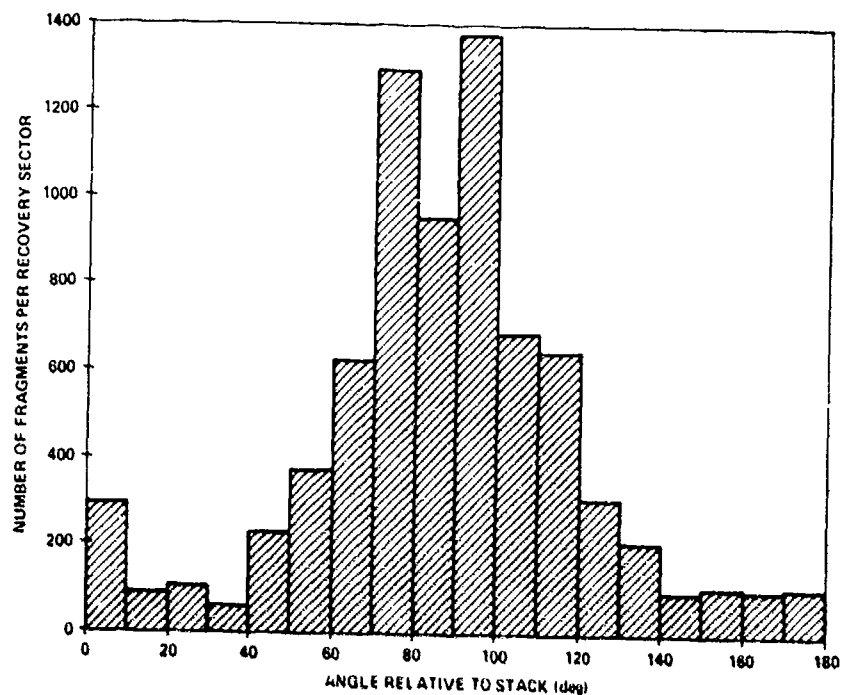


Figure 17. Total Number of Fragments Recovered per Recovery Sector for 8-Pallet Detonation Test

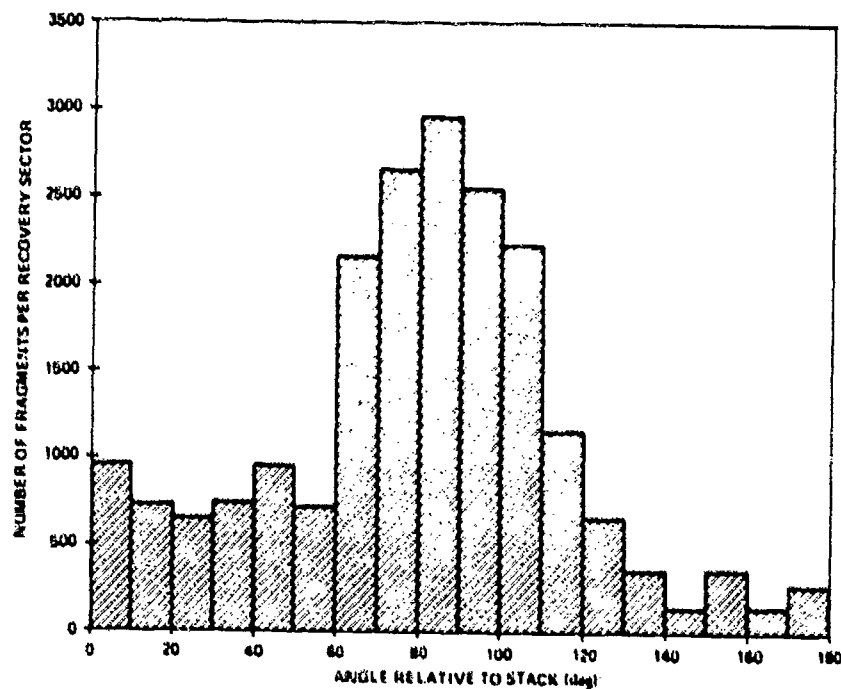


Figure 18. Total Number of Fragments Recovered per Recovery Sector for 16-Pallet Detonation Test

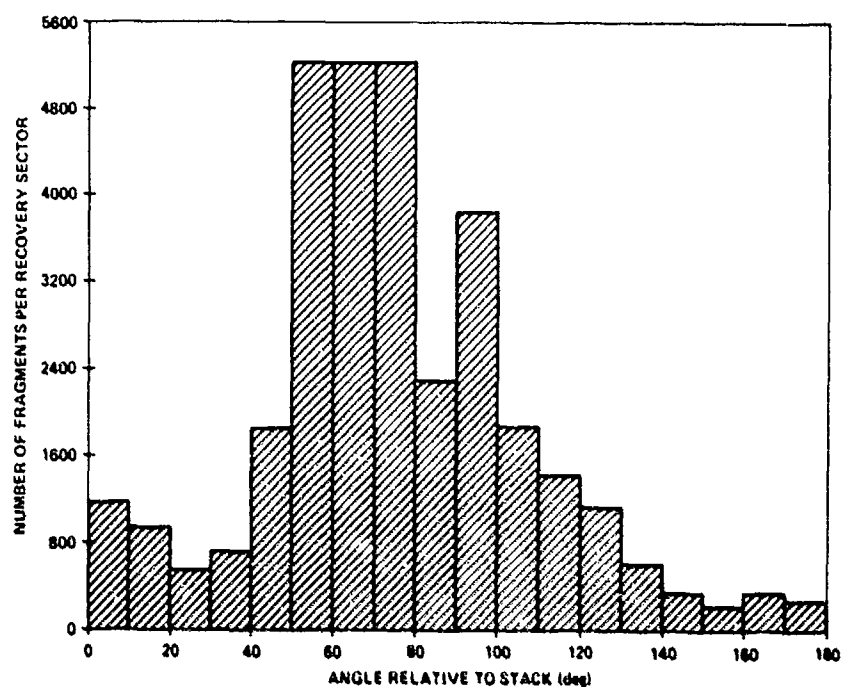


Figure 19. Total Number of Fragments Recovered per Recovery Sector for 36-Pallet Detonation Test

Table 1. Number of Fragments in Fragment Concentrations Related to Number of Interaction Areas (N_{IA}) in Stack

Stack Size (Pallets)	N_{IA}	Recovery Sector (%)	Total No. Fragments	No. Fragments per Interaction Area
8	15	90 to 100	1390	92.7
16	30	90 to 100	2545	84.8
36	46	90 to 100	3850	83.7

FRAGMENT WEIGHT-NUMBER DISTRIBUTION (MOTT PLOT)

The second step in the analysis of the multiple-pallet test data was to weigh and sort the recovered fragments, in order to produce the weight-number distribution (Mott Plot). The tremendous quantity (numbers and weight) of fragments recovered from the multiple-pallet detonation test made it impractical to weigh and sort each and every fragment. It was decided to process just the fragments recovered from azimuthal zones that correspond to the fragment concentrations. The detailed data for these zones for each test are contained in Appendix B.

Figure 20 presents the Mott Plot for the azimuthal sector of 90 to 95° and the range of 500 to 2700 ft for the three multiple-pallet detonations (8, 16, and 36 pallets). The slopes of a first-order, least-squares fit to the data for each test are quite similar. The data and a least-squares fit for the single-pallet natural communication detonation test (azimuthal zone 90 to 95°, polar zone 90 to 120°) are presented for comparative purposes. As can be seen, the slope of the fit to these data are also similar to those of the multiple-pallet detonation. This is further confirmation that the fragments from the multiple-pallet detonation tests are similar in weight and number to the fragments from the single-pallet natural communication detonation.

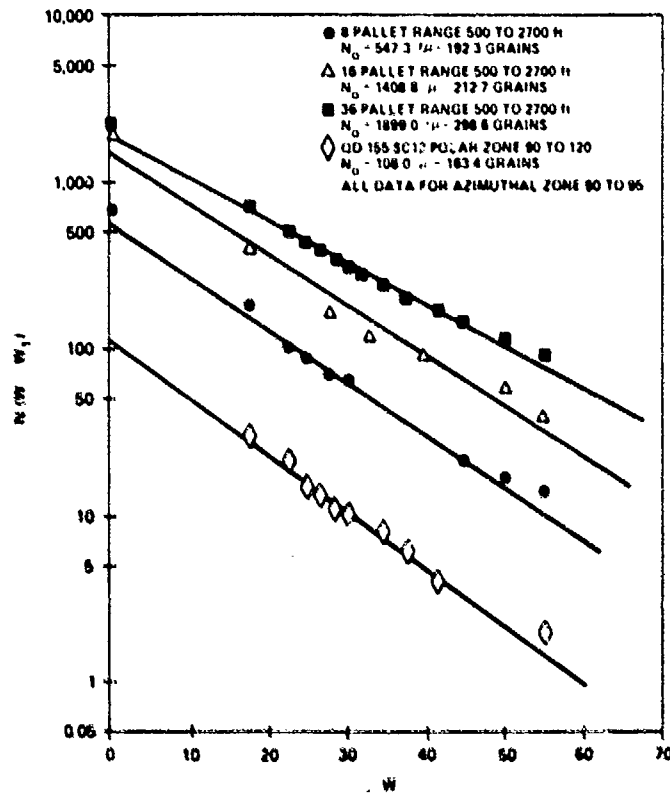


Figure 20. Mott Plot Comparison for Multiple-Pallet Detonation Tests and Single-Pallet Arena Test

FRAGMENT BALLISTIC EFFICIENCY

The fragments that were processed to produce the Mott Plots had their presented areas measured, in order to evaluate their ballistic efficiency. As previously mentioned, a good measure of fragment ballistic efficiency is provided by the distribution of the number of fragments as a function of gamma (A/W). Figure 21 presents these data for the three multiple-pallet detonation tests (azimuthal zone 90 to 95°, range 500 to 2700 ft) and the single-pallet natural communication detonation test (QD-155-SC12). The slopes of a first-order, least-squares fit to the data for each test are similar and is a further confirmation that the fragments from the multiple-pallet detonations are identical to the fragments from the single-pallet natural communication detonation.

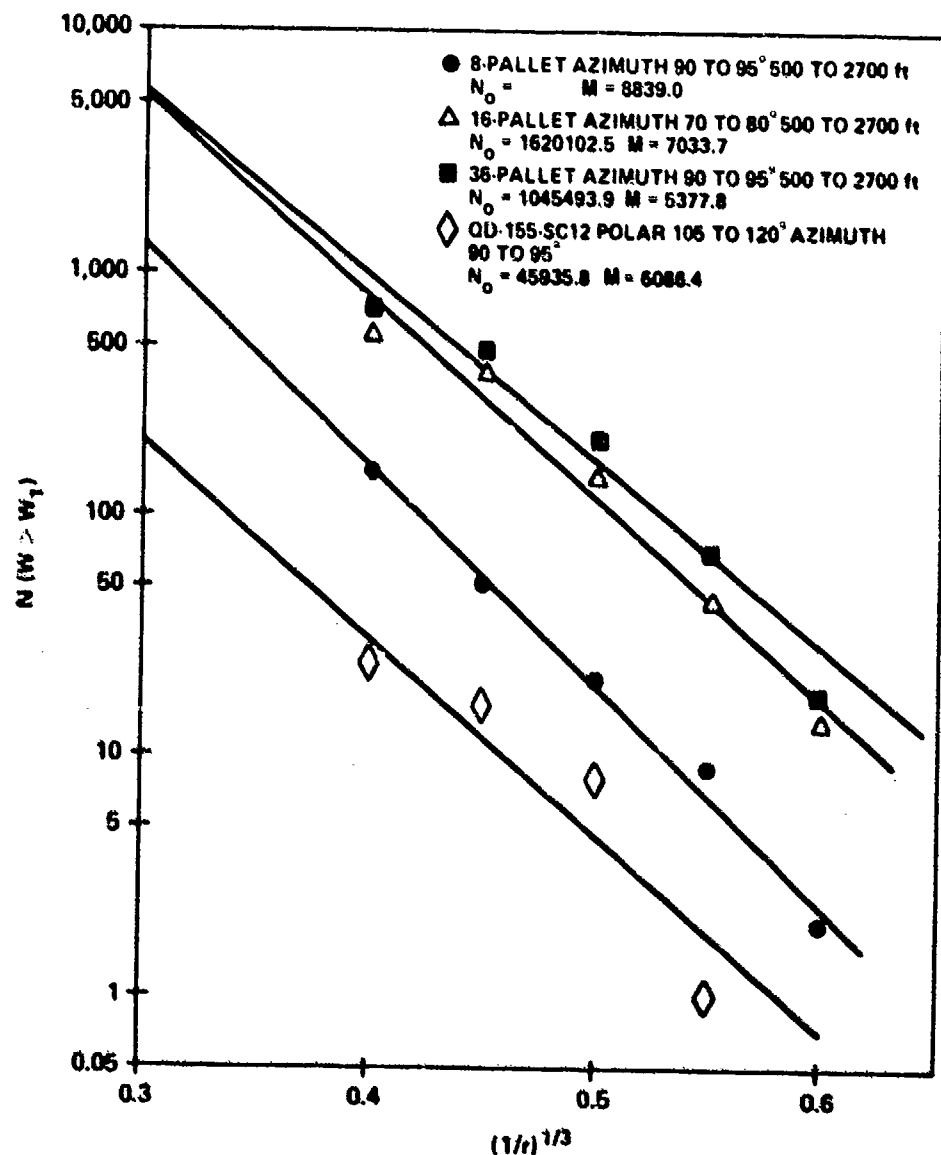


Figure 21. Gamma Distribution

AIR BLAST OVERPRESSURE

The peak air blast overpressure data contained in Appendix B are presented graphically in Figure 22 as a function of range. Also shown for comparative purposes are the existing blast criteria ($40 W^{1/3}$) that corresponds to a peak overpressure of approximately 1.2 psi.⁶ Table 2 compares the range at which 1.2 psi occurs for each stack configuration to the $40 W^{1/3}$ range. The existing criteria overestimate the actual 1.2-psi range.

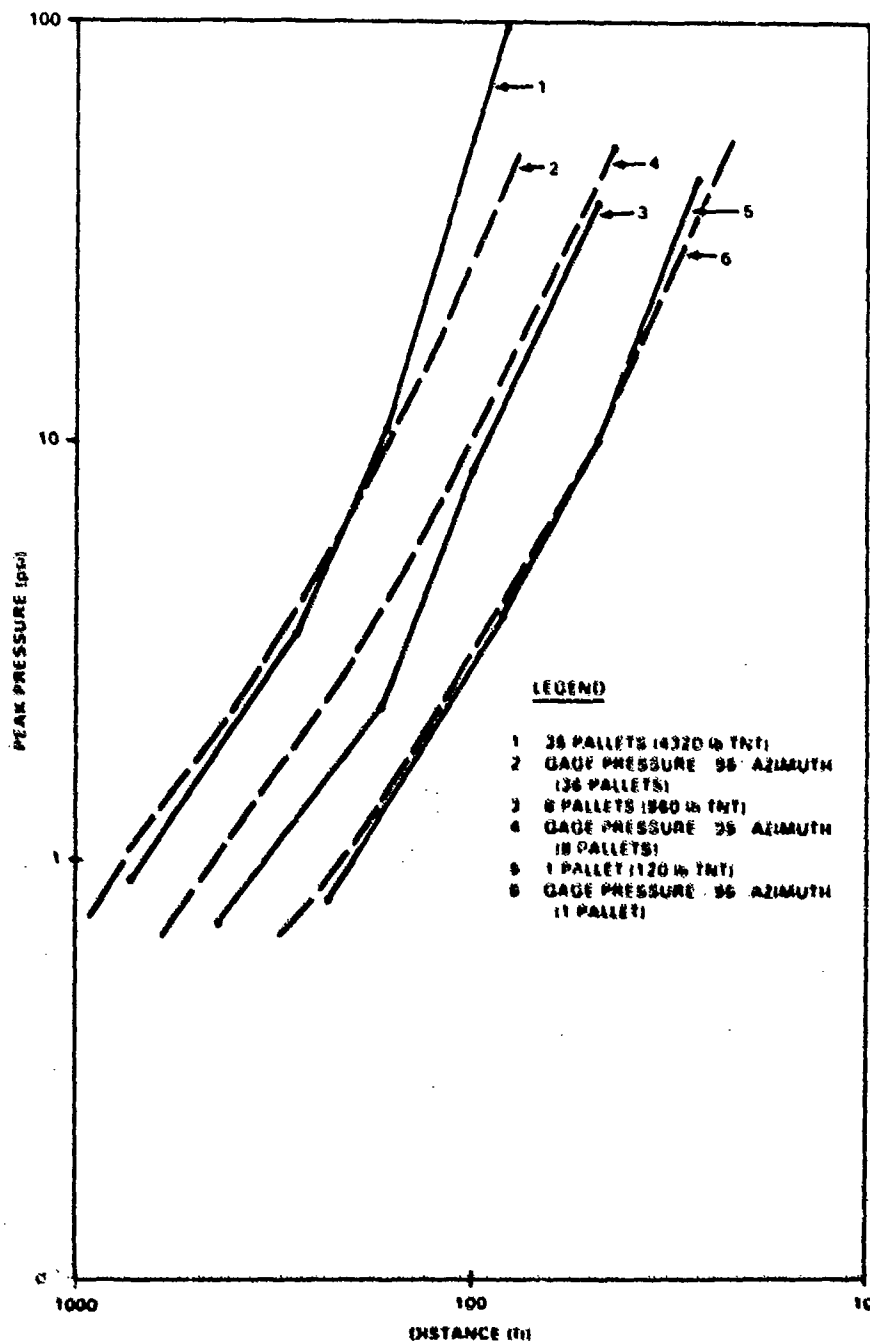


Figure 22. Peak Air Blast Overpressure Data

Table 2. Estimated 1.2-psi Ranges and Existing QD Criteria
($40 W^{1/3}$) for Stack Configuration

Stack Size (Pallets)	Multiple-Pallet Detonation Net Explosive (Wt/lb)	Range (ft)	
		95° Array	$40 W^{1/3}$
1	120	170	197
8	960	275	395
36	4320	620	651

SUMMARY

The multiple-pallet detonation tests showed that the pallet interaction areas produce significant quantities of far-field fragments. The number of fragments recovered as a function of range for the 8-, 16-, and 36-pallet (90 to 95° azimuth) tests is presented in Figures 23 through 25. Also shown is the existing fragment criteria ($1/600 \text{ ft}^2$). The range at which the fragment density falls below the existing criteria is compared to the QD criteria ($40 W^{1/3}$) in Table 3. It is apparent that the existing QD criteria underestimates the fragment hazard for the stack configuration tested.

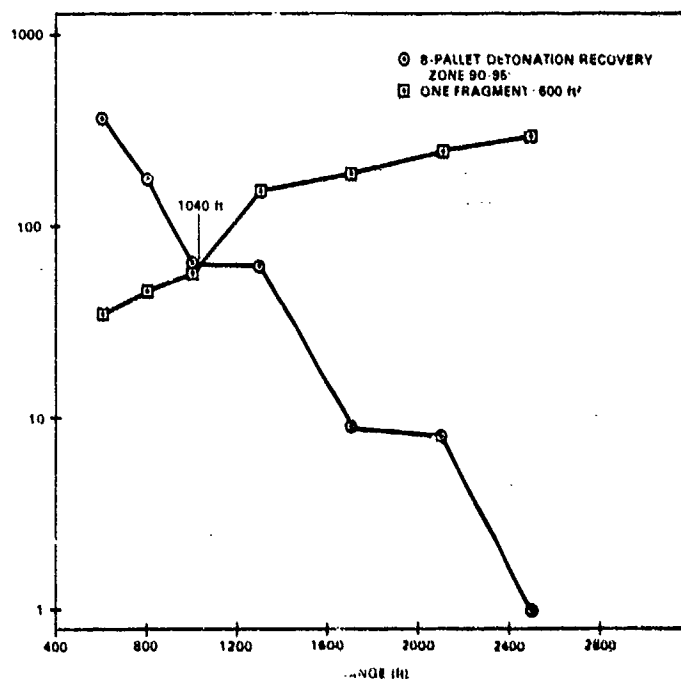


Figure 23. Comparison of Recovery Data to Hazardous Fragment Criteria for 8-Pallet Detonation

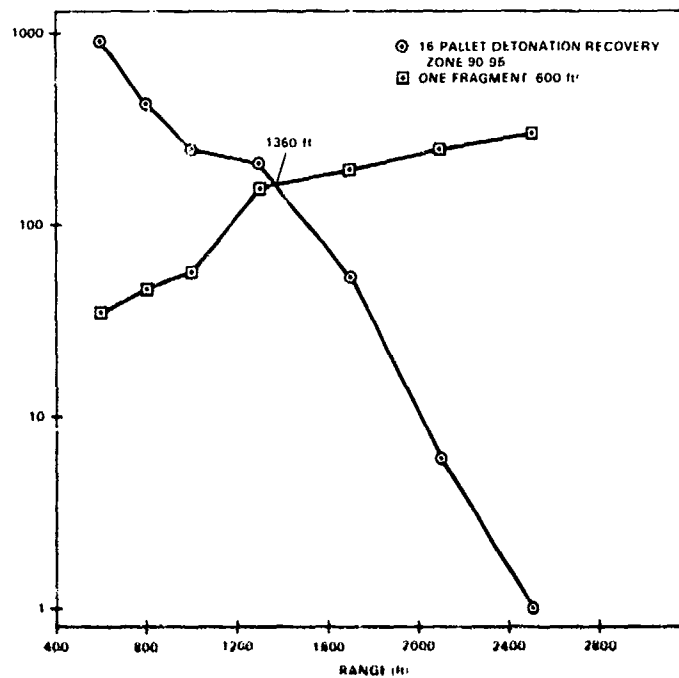


Figure 24. Comparison of Recovery Data to Hazardous Fragment Criteria for 16-Pallet Detonation

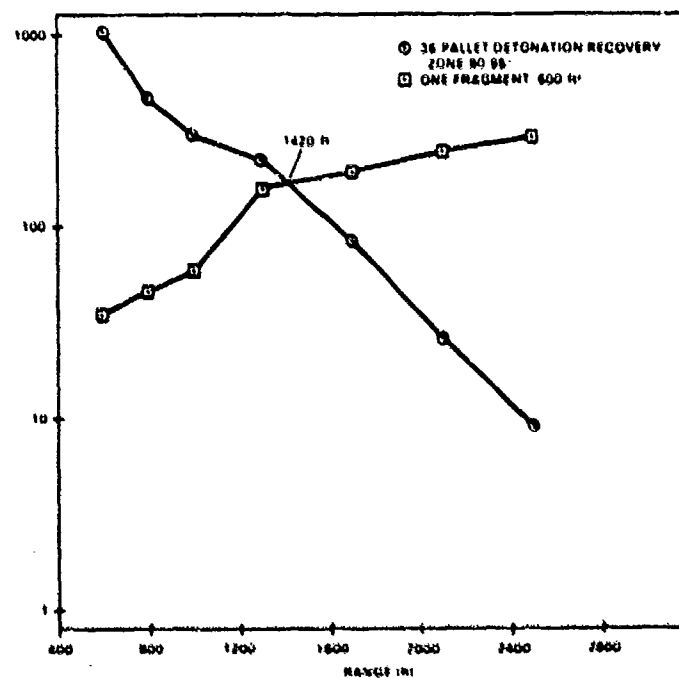


Figure 25. Comparison of Recovery Data to Hazardous Fragment Criteria for 36-Pallet Detonation

Table 3. Range at Which Fragment Density Falls Below
1/600 ft² Compared to QD Criteria (40 W^{1/3})

Stack Size	1/600 ft ²	Range (ft) 40 W ^{1/3}
8	1040	197
16	1360	395
36	1420	651

ANALYTICAL STUDIES

The far-field fragment data collected from the multiple-pallet detonation tests indicate that the QD criteria may not be adequate for the specific stack configurations tested. However, the goal of the program is to develop a capability to predict fragment density as a function of stack configuration and size. This section describes the results of recent studies in the area of fragment trajectory and the refinement of the empirical relations developed during Phases I and II⁴ using the small- and large-scale test data.

FRAGMENT RANGE INVESTIGATION

The following section presents a discussion of the implications upon fragment range of recent research conducted to further define the subsonic and supersonic drag coefficients of typical fragments.

FRAGMENT DRAG COEFFICIENT (C_D)

Two experimental fragment drag programs have been conducted. The first program discussed in Reference 7 was conducted in the vertical wind tunnel at the Edgewood Area of the Aberdeen Proving Ground to determine the drag coefficient of 58 fragments collected from the simultaneous detonation of 155-mm projectiles. The fragments were divided into five characteristic shapes and, as expected, there was a subsonic C_D to shape correlation. Figure 26 presents a summary of the results. The maximum to minimum variations (dispersions) in C_D for all five shapes (±0.24) compare favorably with the ±0.2 dispersion obtained for 105-mm projectile and 120-mm mortar projectile fragments reported in Reference 8. The only surprise was the large difference in mean values for the five shapes. Previous results⁸ had shown that the mean values were equivalent for the two projectiles.

The second fragment drag program was conducted with MARK 81 bomb fragments in the Aeroballistic Research Facility at Eglin AFB, Florida. Approximately 100 fragments were tested at mach numbers ranging from 0.67 to 3.66.* The fragments were divided into nine different shapes, and again there was an

* James W. McDonald, "Bomb Fragments," Eglin Air Force Base, 23 September 1980.

evident correlation between C_D and shape. Only 11 fragments were tested at subsonic conditions, and the C_D varied from 0.68 to 1.61. Supersonic C_D varied from 0.76 to 2.98.



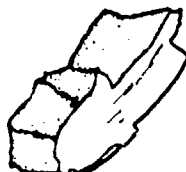
COPPER BAND

CHARACTERISTICS : SMOOTH, ROUNDED SURFACE
DENSE
FLAT BOTTOM
RANGE OF C_D : 1.44 TO 1.11
STANDARD DEVIATION: 0.108
MEAN VALUE : 1.288



BOX PLATEAU

CHARACTERISTICS : LARGE PORTION OF BOTH SIDES
OF FRAGMENT IS FLAT
FLAT SECTIONS ARE SMOOTH
NO GENERAL OVERALL SHAPE
RANGE OF C_D : 1.59 TO 1.211
STANDARD DEVIATION: 0.149
MEAN VALUE : 1.433



PARALLEL PIPED

CHARACTERISTICS : LARGE PORTIONS OF BOTH SIDES
ARE FLAT AND SMOOTH
OVERALL RECTANGULAR SHAPE
RANGE OF C_D : 2.07 TO 1.34
STANDARD DEVIATION: 0.2829
MEAN VALUE : 1.707



MOUNTAIN RIDGE

CHARACTERISTICS : FLAT BOTTOM
FORMS A RIDGE AT TOP
RANGE OF C_D : 1.39 TO 0.85
STANDARD DEVIATION: 0.184
MEAN VALUE : 1.132



WEDGES

CHARACTERISTICS : TRIANGULAR SHAPE
TWO OF THE THREE SURFACES
ARE GENERALLY SMOOTH
RANGE OF C_D : 0.618 TO 1.01
STANDARD DEVIATION: 0.185
MEAN VALUE : 0.812

Figure 26. Fragment Types

These new data were combined to produce the minimum, average, and maximum C_D curves for bomb and projectile fragments (Figure 27). For comparison, the average C_D curves contained in References 4 and 9 are shown as dashed lines. It is assumed that at least 95% of all bomb and projectile fragments will have a C_D between the minimum and maximum limits shown.

A fragment that travels to the far-field spends the majority of its flight time at subsonic velocity. Consequently, the accuracy of the value used for the subsonic drag coefficient is critical to the accuracy of a range calculation. Also significantly affected by the subsonic C_D is the impact velocity (V_f) of the fragment and, therefore, its terminal kinetic energy (KE). Table 4 presents the results of a particle trajectory calculation for a "typical" 155-mm₂ fragment; for example, ($W = 1350$ grains, $V_0 = 6500$ ft/sec, $\alpha = 20^\circ$, $\gamma = 8 \frac{\text{in.}^2}{\text{lb}}$) using the minimum, average, and maximum C_D curves presented in Figure 26.

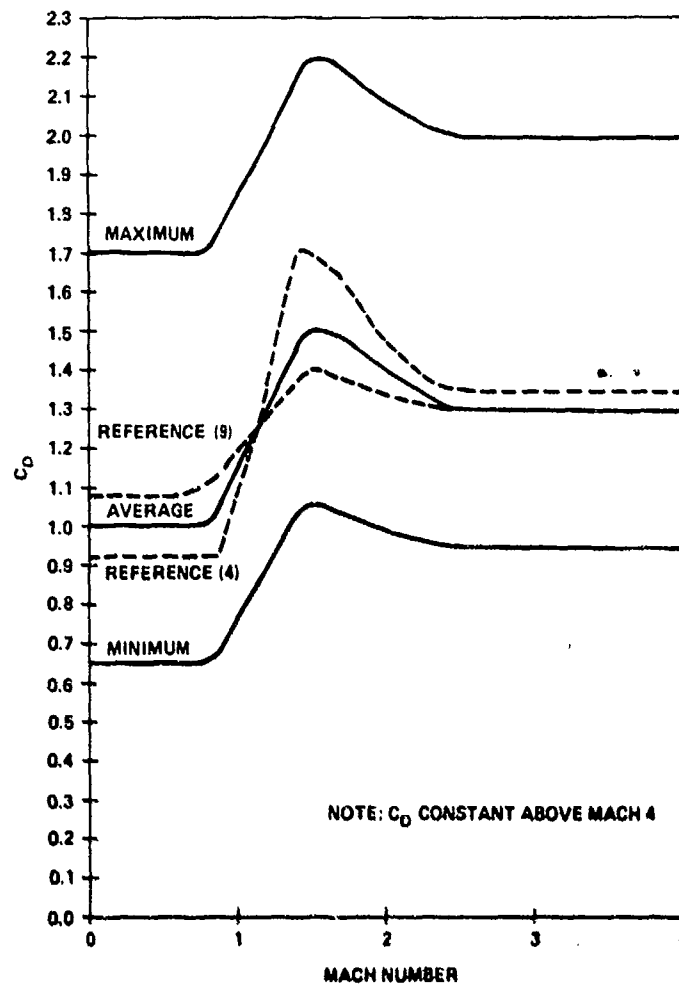


Figure 27. Coefficient of Drag Versus Mach Number

Table 4. Results of a Particle Trajectory Calculation Using C_D Curves

C_D Curve	Range (ft)	V_F (ft/sec)	Final (Impact) KE (ft/lb)
Minimum	2790	141	60
Average	1980	115	40
Maximum	1285	90	24

The C_D uncertainty for any one fragment shape will only be about one-half the minimum to maximum C_D difference. Assuming that the fragment used above has mean C_D equal to the average C_D and a variation around the average $\pm 0.25 C_D$, the following effects are obtained in Table 5.

Table 5. Results of a Particle Trajectory Calculation
Using Average C_D Curve ± 0.25

C_D Curve	Range (ft)	V_F (ft/sec)	Final (Impact) KE (ft/lb)
$C_{DAvg} - 0.25 C_{DAvg}$	2470	132	52
C_{DAvg}	1980	115	40
$C_{DAvg} + 0.25 C_{DAvg}$	1650	104	32

The effect upon range and KE is still significant. The gamma data from the large-scale, multiple-pallet detonation tests were analyzed to determine which C_D curve should be used for range calculations. The data indicated that the mean C_D is most representative of the "typical" 155-mm, far-field fragment.

DEVELOPMENT OF EMPIRICAL RELATION

The development of an empirical relation to predict fragment density in the far-field for a general weapon stack configuration is discussed in this section. The relation is developed from the following equations.

NUMBER OF FRAGMENTS

It was shown in Reference 4 that a good representation for 155-mm projectile fragments is provided by

$$N(\gamma < \gamma_1) = N_0 e^{-\left(\frac{\gamma}{\gamma_1}\right)^{1/3}} \quad (1)$$

where

$N(\gamma < \gamma_1)$ = number of fragments with γ less than a specified gamma (γ_1)

N_0 = constant that is equal to the number of fragments with γ less than infinity, or equally, the number of fragments with weight greater than zero. It is the theoretical total number of fragments including predicted fragments that are the size of dust particles. N_0 is not the number of fragments collected.

$-M^{1/3}$ = slope of the straight line relationship when plotted on semilogarithmic paper against $\left(\frac{1}{\gamma_1}\right)^{1/3}$

γ = average presented area to weight ratio of the fragments (in.²/lb)

γ_1 = represents any specified value of γ

Since N_0 in Equation (1) is developed from arena test data, it is based on more than a 1° azimuthal zone and more than one fragment interaction area (N_{IA}) and will have to be corrected and a new variable redefined as,

$$N_{OA} = \frac{N_0}{(\text{Deg}_{AZ})(N_{IA})} \quad (1a)$$

where

N_{OA} = the theoretical total number of fragments for 1° azimuthal zone and for one interaction area

Deg_{AZ} = the number of degrees in the azimuthal zone used to calculate N_0

N_{IA} = number of interaction areas in the small-scale arena test used to compute N_0

Equation (1) reduces to

$$N(\gamma < \gamma_1) = N_{OA} e^{-\left(\frac{M}{\gamma_1}\right)^{1/3}} \quad (1b)$$

for 1° of azimuth and one interaction area.

To be useful for density calculations, Equation (1b) must be expressed in terms of range. Using a particle trajectory program, the following relation can be established:

$$\gamma = aR^b \quad (2)$$

or

$$R = \left(\frac{\gamma}{a}\right)^{\frac{1}{b}} \quad (2a)$$

where

R = range (ft)

a, b = constants developed based upon fragment velocity, drag coefficient and ejection angle (b is always negative)

Substituting Equation (2) into Equation (1b) yields

$$N(R > R_1) = N_{0A} e^{-\left(\frac{MR_1^{-b}}{a}\right)^{1/3}} \quad (1c)$$

where

$N(R > R_1)$ = number of fragments with range greater than R_1 .

In order to consider more than one interaction area, N_{IA} is introduced into Equation (1c) to yield

$$N(R > R_1) = N_{0A} N_{IA} e^{-\left(\frac{MR_1^{-b}}{a}\right)^{1/3}} \quad (3)$$

where N_{IA} is equal to the number of projectiles in the side of the stack facing the target area (one tier) -1 , multiplied by the number of tiers.

The desired relation is for the number of fragments between ranges R_1 and $R_1 + dR$. Referring to Figure 28, the required number of fragments (dN) is the difference between $N(R > R_1)$ and $N(R > R_1 + dR)$. It may also be written

$$dN = \tan \theta (dR) \quad (4)$$

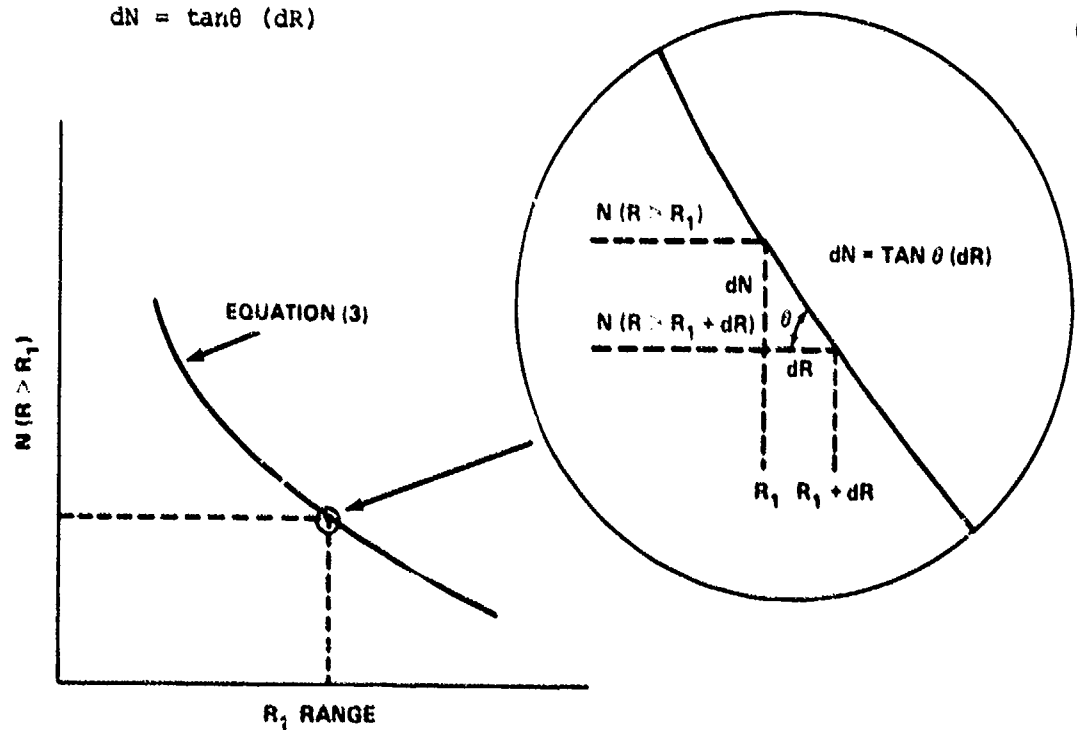


Figure 28. Calculation of dN

By definition, the derivative of Equation (3) is equal to the slope ($\tan\theta$) of the function at any range R_1 . Taking the derivative of Equation (3) and substituting it for $\tan\theta$ in Equation (4) yields

$$dN = \left[\left(\frac{-b}{3} \right) \left(\frac{M}{a} \right)^{1/3} R^{-\left(\frac{a}{3}+1\right)} \right] N_{OA} N_{IA} e^{-\left(\frac{MR^{-b}}{a}\right)^{1/3}} dR \quad (4a)$$

where

dN = number of fragments between ranges R and $R + dR$

R = range (subscript no longer needed)

a, b, M, N_{OA}, N_{IA} = constants previously described

FAR-FIELD AREA

The far-field area into which the fragments fall is based upon a 1° azimuthal sector shown in Figure 29. It can be shown for this area that

$$dA = 0.01745 R (dR) \quad (5)$$

dA and dR are the infinitesimal increments of the differential calculus. For illustrative purposes, dR can be thought of as a very small number, much less than 1 ft.

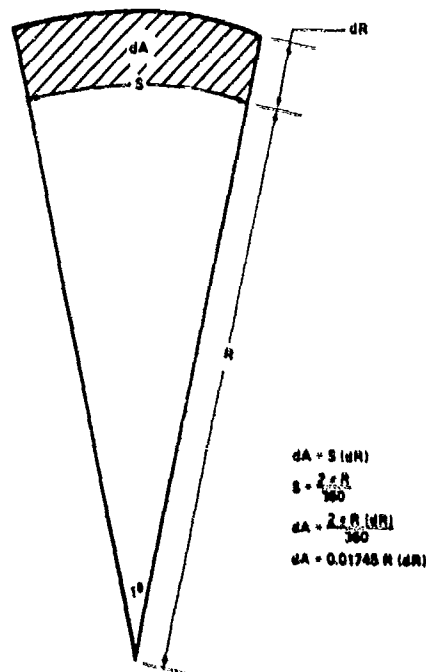


Figure 29. Incremental Area at Range R for a 1° Azimuthal Zone in the Ground Plane

DENSITY RELATION

Finally the density of fragments at range R is obtained by dividing the number of fragments between R and R + dR by the area between R and R + dR for a 1° azimuthal zone; that is, divide Equation (4a) by Equation (5).

$$\frac{dN}{dA} = \left[57.3 \left(\frac{-b}{3} \right) \left(\frac{M}{a} \right)^{1/3} R - \left(\frac{b}{3} + 2 \right) N_{OA} N_{IA} e^{-\left(\frac{MR^{-b}}{a} \right)^{1/3}} \right] \quad (6)$$

where

$$dN/dA = \text{fragment density (fragments/ft}^2\text{)}$$

VALIDATION OF EMPIRICAL RELATION

The accuracy of Equation (6) can be evaluated by comparing the density predicted for the large-scale, multiple-pallet detonation test configurations to actual recovery data for these tests. For this purpose, a modified version of Equation (3) can be used more efficiently. The relation is

$$N_{R_1 R_2} = N_{AZ} N_{IA} [N(R > R_1) - N(R > R_2)] \quad (3a)$$

where

$$N_{R_1 R_2} = \text{number of fragments in a particular recovery zone between ranges } R_1 \text{ and } R_2$$

$$N_{AZ} = \text{number of degrees of azimuth encompassed by the chosen recovery zone}$$

$$N_{IA} = \text{number of interaction areas in stack wall adjacent to recovery zone}$$

The values of the constants required are calculated from the natural communication arena test data (QD-155-SC12). The data from polar zone 90 to 105° and azimuthal zone 90 to 105° were used to calculate these values

$$N_{OA} = 3062.4$$

$$M = 6086.4$$

$$a = 44491.4$$

$$b = -1.1369$$

The results of using these values and the multiple-pallet detonation configuration (i.e., number of interaction areas) are plotted in Figures 30

through 32. Also shown is the actual number of recovered fragments. The accuracy of the prediction is excellent. It is apparent that the empirical relation is a valid and conservative estimate of the far-field fragment density resulting from the detonation of 155-mm projectiles.

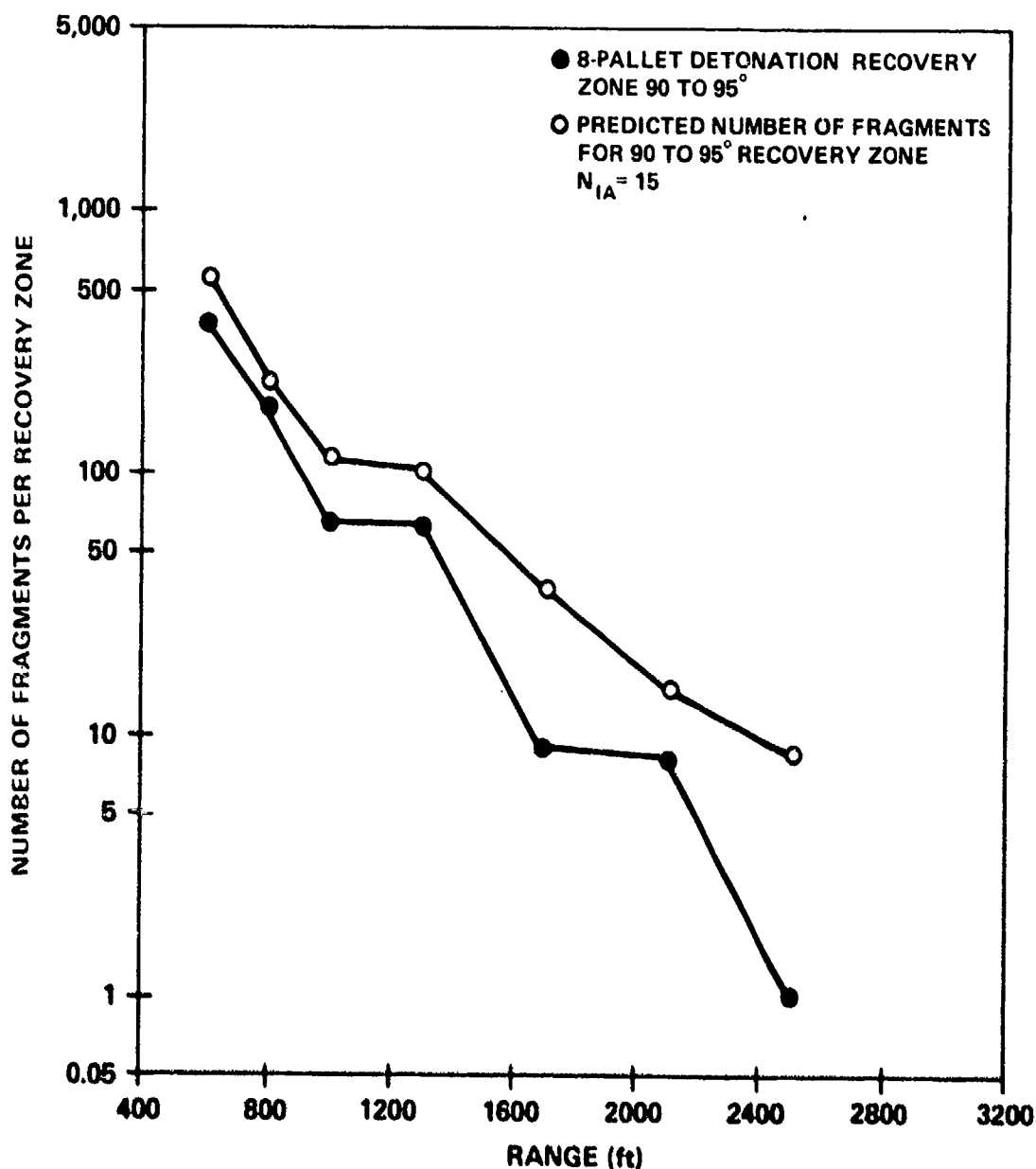


Figure 30. Predicted and Actual Number of Fragments for 8-Pallet Detonation

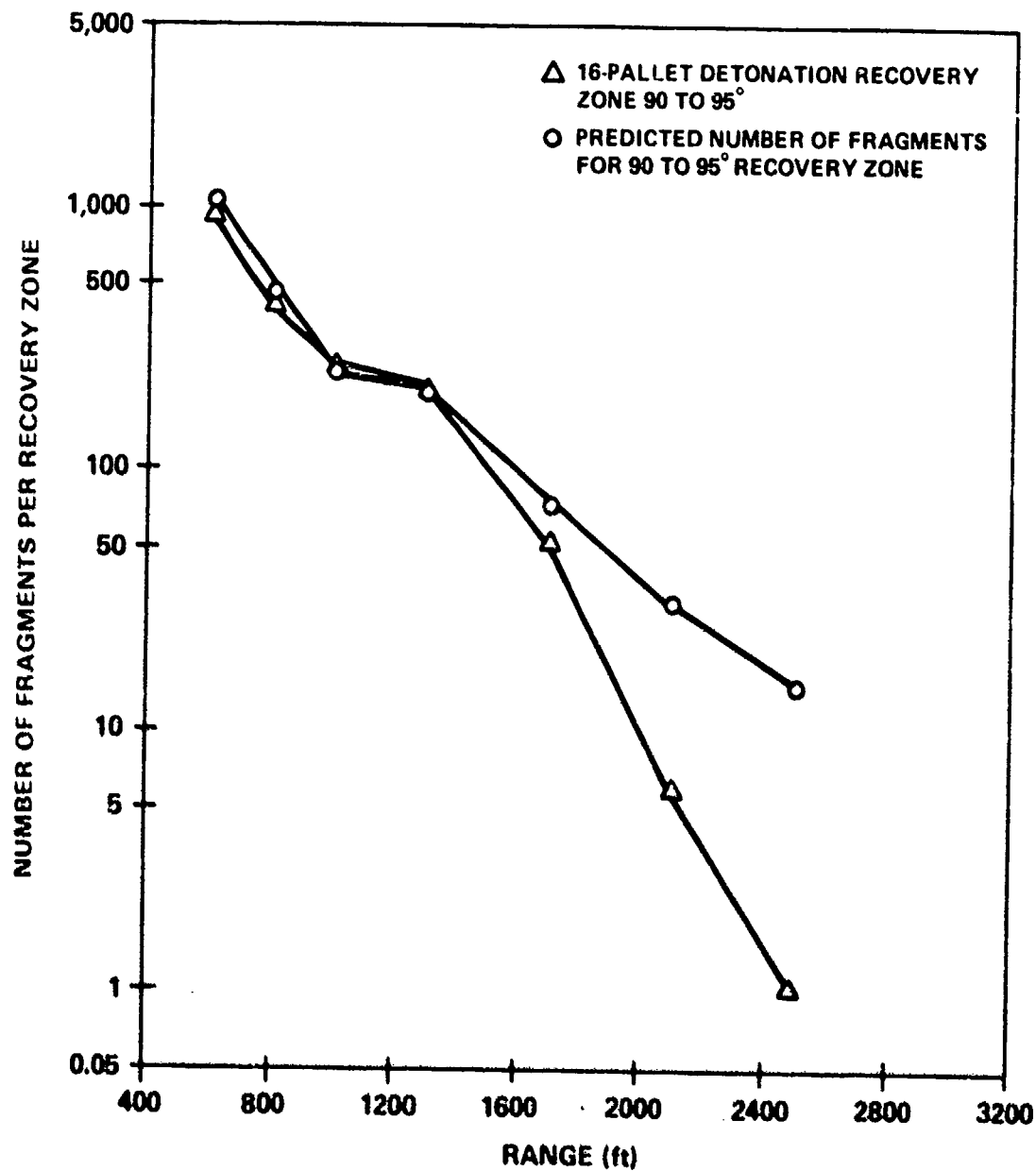


Figure 31. Predicted and Actual Number of Fragments for 16-Pallet Detonation

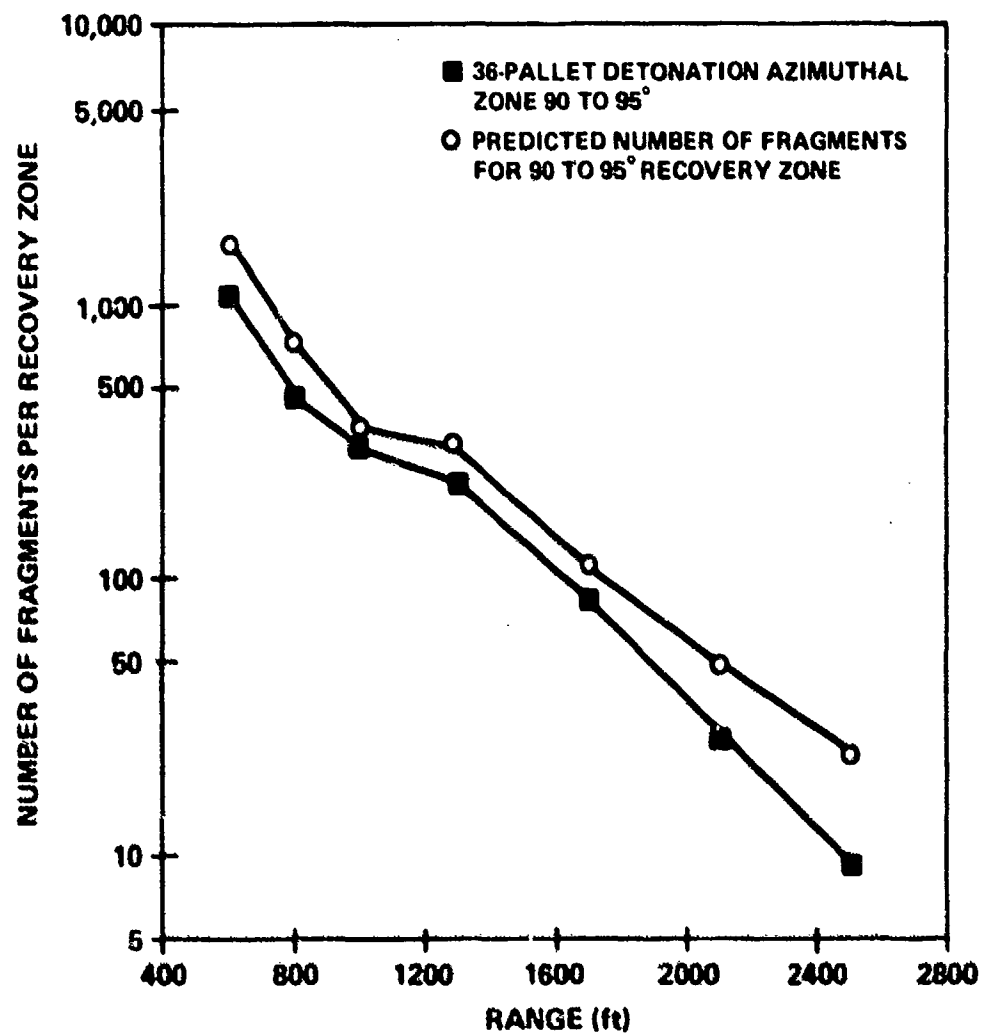


Figure 32. Predicted and Actual Number of Fragments for 36-Pallet Detonation

IMPLICATIONS FOR QD REQUIREMENTS

QD requirements for fragments are based upon both fragment density (1/600 ft²) and terminal KE (58 ft/lb). Equation (6) can be used to calculate the range at which a density of 1/600 ft² occurs. However, the calculation of the hazardous fragment density is somewhat more complex and will be discussed in detail. Fragment KE at impact is defined as

$$KE = \frac{WV_F^2}{2g} \quad (7)$$

where

KE = kinetic energy (ft/lb)

W = fragment weight (lb)

V_F = impact velocity (ft/sec)

g = acceleration of gravity (ft/sec²)

Two more relations are required. The first relation is obtained from a particle trajectory program. It can be shown that

$$V_F = c\gamma^d \quad (8)$$

V_F = final (impact) velocity (ft/sec)

γ = fragment average presented area to weight ratio (in.²/lb)

c, d = constants developed from data fit, d is always negative

The second relation developed from the relation of fragment weight and gamma is

$$\gamma = fw^h \quad (9)$$

or

$$W = \left(\frac{\gamma}{f}\right)^{\frac{1}{h}}$$

where

W = fragment weight (grains)

γ = fragment average presented area to weight ratio (in.²/lb)

f, h = constants developed from least-squares fit to the data, h is always negative

Substituting Equations (8) and (9) into Equation (7) yields

$$KE = \frac{\left(\frac{Y}{F}\right)^{\frac{1}{h}} c^2 \gamma^{2d}}{4.508 \times 10^5} \quad (7a)$$

Finally, Equation (2a) is substituted into Equation (7a), and the expression solved to yield

$$R_H = \left[\frac{4.508 \times 10^5 (KE)_f^{\frac{1}{h}}}{c^2 \left(a^{\frac{1}{h} + 2d} \right)} \right]^{\frac{1}{\frac{b}{h} + 2bd}} \quad (2b)$$

where

R_H = the range at and beyond which all fragments will possess a specified KE level (ft)

The equation can be used with parameters developed from the single-pallet arena test (QD-155-SC12) to determine the range at which all fragments will be hazardous ($KE > 58$ ft/lb). The parameters used are

$$a = 79405$$

$$b = -1.1603$$

$$c = 375.0$$

$$d = -0.4712$$

$$f = 107.6$$

$$h = -0.3507$$

$$V_O = 6500 \text{ ft/sec}$$

$$\alpha = 20^\circ$$

$$C_D = \text{minimum from Figure 27}$$

$$KE = 58 \text{ ft/lb}$$

Using these values in Equation (2b) results in a value of 2770 ft for R_H . The accuracy of this equation can be evaluated by analyzing the fragment recovered from the 36-pallet detonation test (recovery zone 90 to 95°). Figure 33 presents the results of estimating the percentage of hazardous fragments at each range using Equations (7), (8), and (9). The plot shows that the percent-

age of hazardous fragments approaches 90% at 2500 ft. This is a good indication that Equation (2b) is correct. However, Equation (2b) does not provide the percentage of hazardous fragments as a function of range. What is required is a relation that calculates the percentage of hazardous fragments as a function of range.

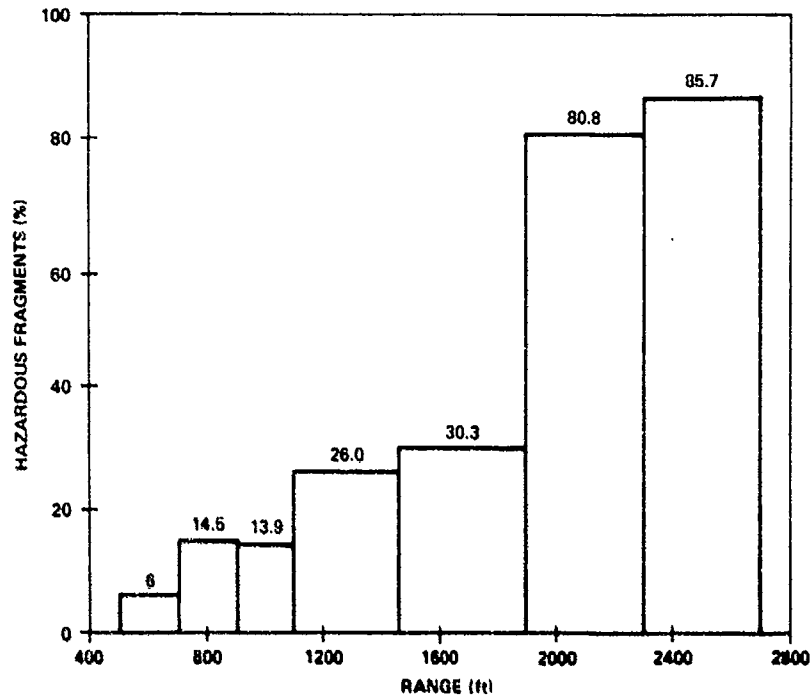


Figure 33. Estimated Percentage of Hazardous Fragments as a Function Range

The excellent agreement between the predicted and actual number of fragments per recovery zone in the multiple-pallet detonation tests (Figures 30 through 32) strongly implies that the majority of the recovered fragments are ejected from the stack at the optimum ejection angle (5 to 45°). Therefore, the fragments will impact at the velocity calculated by Equation (8) and possess the KE calculated by Equation (7). Consequently, the data presented in Figure 33 for the 36-pallet detonation test should be an accurate representation of the percentage of hazardous fragments as a function of range. A good fit to these data is provided by

$$P_H = N_1 e^{K R_1} \quad (10)$$

where

P_H = fraction of fragments that are hazardous

R_i = range of interest (ft)

N_i, K = constants derived from a least-squares fit to the data in Figure 33

Values calculated for the 36-pallet detonation test are

$$N_i = 0.099$$

$$K = 8.53 \times 10^{-4}$$

Applying Equation (10) to the density relation, Equation (6),

$$\left(\frac{dN}{dA}\right)_{HAZ} = 57.3 \left(\frac{-b}{3}\right) \left(\frac{M}{a}\right)^{1/3} R_i^{-\left(\frac{b}{3}+2\right)} N_{0A} N_{IA} F_{He} - \left(\frac{MR_i^{-b}}{a}\right)^{1/3} \quad (6a)$$

where

$$\left(\frac{dN}{dA}\right)_{HAZ} = \text{hazardous fragment density (fragments/ft}^2\text{)}$$

This equation can be solved for the range at which a density of one hazardous fragment/600 ft² occurs. Figure 34 presents a plot of this range as a function of stack size and configuration (N_{IA}). Also plotted is the currently used blast criteria ($40 W^{1/3}$) for each stack. The plot shows that the existing $40 W^{1/3}$ criteria significantly underestimates the fragment hazard from the detonation, in the open, of a stack of 155-mm projectiles.

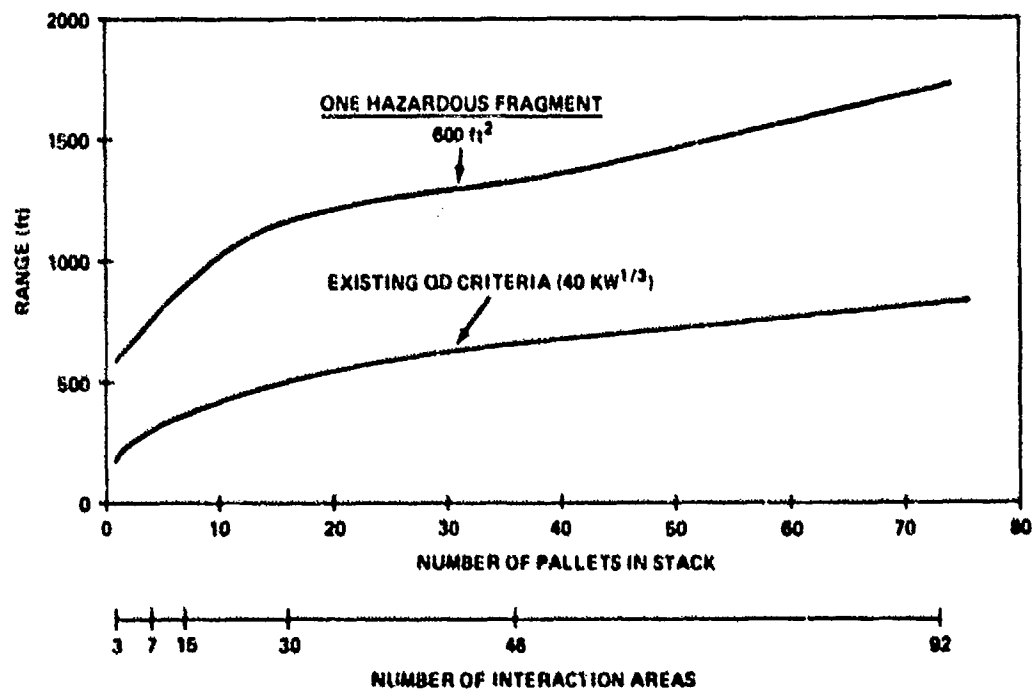


Figure 34. Fragment Hazard Range

LIMITATIONS OF METHODOLOGY

There are a number of limiting assumptions for the previously discussed methodology that need to be addressed in greater detail. These assumptions and their effects upon the validity of the methodology are discussed in this section.

DENSITY RELATION

The development of the density relation (Equation (6a)) is based upon the assumption that the fragments are ejected from the stack at optimum angles (5 to 45°). However, the multiple-pallet detonation tests clearly show that the fragments recovered from the far-field are similar in weight-number distribution to fragments from polar zone 90 to 105° of a single pallet. These fragments should be ejected at a negative angle (toward the ground) and impact well before 500 ft. Obviously, the detonation of a multiple-pallet stack is not absolutely identical to the detonation of a single pallet. The mechanism by which these fragments are ejected from a multiple-pallet stack needs further investigation.

HAZARDOUS FRAGMENT

The calculation of the KE of fragments recovered from the multiple-pallet detonation tests is also based upon assuming optimum ejection angles, a single value for initial velocity and the average C_D curve. These assumptions ignore fragments that do not meet these criteria. A potentially significant number of fragments could be ejected at lower angles (1 to 5°) and somewhat lower velocity (up to 50% less). These fragments can travel to distances that would overlap the far-field fragments by approximately 80% based upon particle trajectory calculations. The low-angle fragments will also possess a much higher impact velocity than the optimum angle fragments. These fragments will impact with greater KE than similar fragments from optimum angles. The existing test data are insufficient to determine the relationship between the proportion of low and optimum ejection angle fragments. The potential increase in the percentage of hazardous fragments at each range cannot be evaluated at this time.

SENSITIVITY OF PARAMETERS

The entire methodology is based upon variables that are calculated from analytic fits to test data. No attempt has been made to determine the sensitivity of the density calculation to variations in these variables.

SIZE OF STACK

The methodology assumes there is no limit to the number of interaction areas in the stack. However, for very long stacks a point will be reached where the first and last fragment concentrations will no longer overlap. This limit has not been identified.

FRAGMENT HAZARD CRITERIA

A modification of the existing fragment criteria ($KE > 58$ ft/lb, $1/600$ ft²) would significantly affect the hazardous range calculation. For example, if it is assumed that

$$P_H = 1 - e^{-\rho A}$$

where

P_H = probability of one or more hits on a target (Poisson Distribution)

ρ = fragment density (fragments/ft²)

A = presented area of the target (ft²)

Structures would normally have presented areas greater than 100 ft². An average size man has a presented area of 5.6 ft² and a very large man 7 ft². The probability of hit by one or more fragments for various presented areas is shown in Table 6.

Table 6. Probability of Hit for Target Area (ft²)

Density (fragments/ ft ²)	Man (ft ²)		Structure (ft ²)			
	5.6	7	100	600	2000	5000
1/300	0.018	0.023	0.283	0.865	0.999	1.000
1/600	0.009	0.012	0.154	0.632	0.964	1.000
1/1200	0.005	0.006	0.080	0.393	0.811	0.984
1/2400	0.002	0.003	0.041	0.221	0.565	0.875

Changing the allowed fragment density can affect the probability of hitting a target and, therefore, will affect the hazardous fragment density calculation (Equation (6a)). Furthermore, the 58-ft/lb criteria is based on a personnel casualty criteria used prior to the advent of the more definitive wound ballistic equations developed in the 1950's. The rule defines the KE for severe wounding. A 1-in.-diameter steel sphere (0.15 lb) traveling at 108 mi per hr has a KE of about 58 ft/lb. Reducing this criteria would also affect the hazardous fragment density calculation.

CONCLUSIONS AND RECOMMENDATIONS

The present study provides a methodology for using small-scale single pallet arena data to determine the fragment hazards produced by the detonation of large stacks (up to 36 pallets of 155-mm projectiles in open storage). However, the methodology has limitations and cannot presently be applied to other mass-detonating munitions. The following is a summary of conclusions and recommendations necessary to improve the emerging methodology.

1. It is recommended that a detonation test be conducted with a stack representative of that found in a "typical" magazine. The far-field fragments from this detonation will be collected and analyzed to determine the validity of the methodology. A follow-on detonation of an identical stack inside a simulated magazine should be conducted to determine the effect of magazine structures on far-field fragment density.
2. The ejection angle of fragments from a multiple-pallet detonation needs to be determined. Arena tests of multiple-pallet detonations should be conducted to evaluate the fragment ejection angle. These data are necessary to improve the evaluation of fragment KE criteria.
3. The sensitivity of the density equation to variations in input variables should be evaluated. The methodology should be modified as necessary to minimize adverse effects.
4. An entirely different type of mass-detonating ammunition should be tested to evaluate the applicability of the methodology. Arena tests and large-scale, multiple-pallet detonation tests should be conducted.

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APPENDIX A

FRAGMENTATION TEST METHODS

A-1/A-2

INTRODUCTION

The fragmentation tests conducted throughout the Fragment Hazard Investigation Program were designed to gather fragment mass, velocity, and spatial distribution data. The basic test procedures reflect the ones agreed upon by the services.* The purpose of this discussion is to provide a general description of the techniques, definitions, and methods utilized throughout the testing portions of the program.**

GEOMETRIC CONSIDERATIONS

In conducting a fragmentation test, certain basic principles must be considered. One of these is munition geometry. Most frequently, munitions have an axis of symmetry (e.g., the longitudinal axis of a gun-fired projectile). Defining the longitudinal axis as the polar axis, we can see from Figure A-1 that fragmentation characteristics would be functions of the polar angle, θ , but for a given polar angle, should be independent of the azimuth angle, α .

*Joint Munitions Effectiveness Manual, Test Procedures for High Explosives Munitions, NAVAIR 00-130-ASR-2-1 (Washington, D.C., 8 December 1970).

**D. J. Ammerman and M. R. Jamison, Fragmentation Test Facilities Methods and Data Processing Used at NSWC, NSWC MP 81-16 (Dahlgren, Virginia, June 1981).

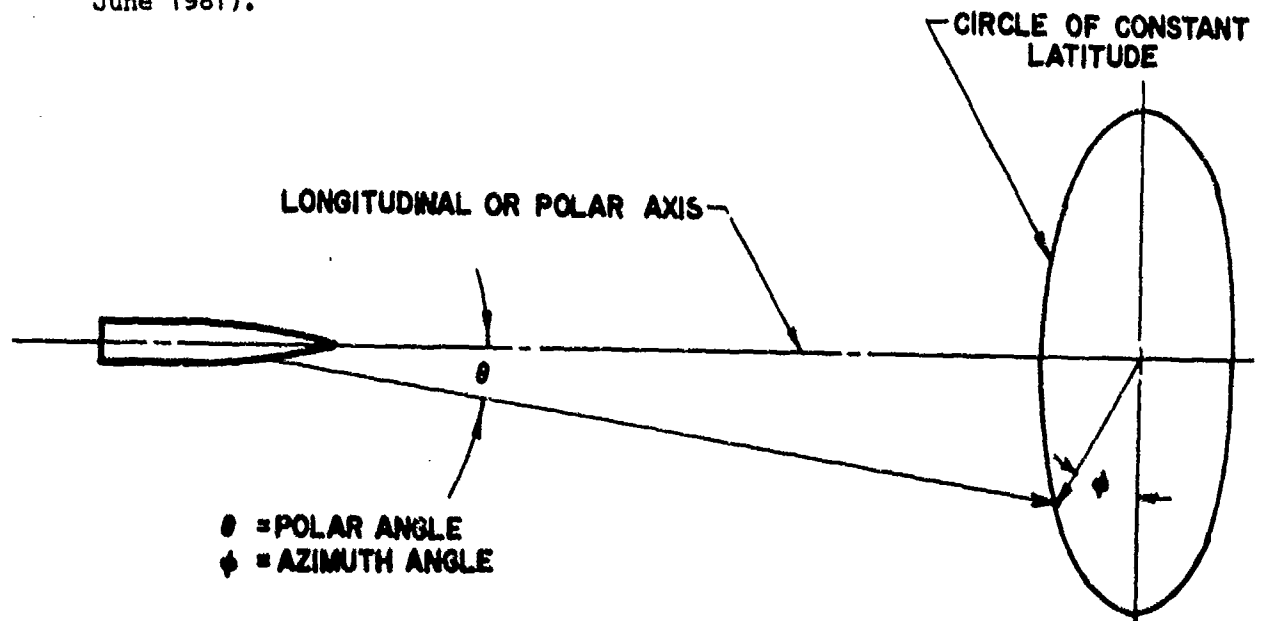


Figure A-1. Polar and Azimuth Angles

With the independence of α , it is unnecessary to sample all fragments when characterizing a single item. A portion of the fragments can be sampled, and the results can be extended to predict the characteristics of the entire munition. However, when characterizing a multiple-munition detonation, as in a pallet of 155-mm projectiles, it is important that as much emphasis as necessary be placed on sampling fragments from the azimuth angles, as well as, from the polar angles.

The fragmentation characteristics are generally sampled in various θ intervals between $\theta = 0^\circ$ at the munition nose and $\theta = 180^\circ$ at the munition base. At NSWC, θ is generally divided into 5° increments called polar zones, although for smaller munitions, it may be divided into 10 or 15° intervals. Figure A-2 illustrates the surface area of one such zone, and Figure A-3 shows how a portion of that zone is sampled. The area of the portion of a polar zone covered by the recovery media, as projected on a sphere equal to the radius of the recovery media, is divided into the total surface area of the polar zone. This ratio yields a zone factor or zone multiplier (usually shortened to multiplier). Theoretically, if one takes the number-mass product of recovered metal fragments from each polar zone times its multiplier and sums this over all polar zones, the resultant mass should equal the original mass of metal in the tested munition.

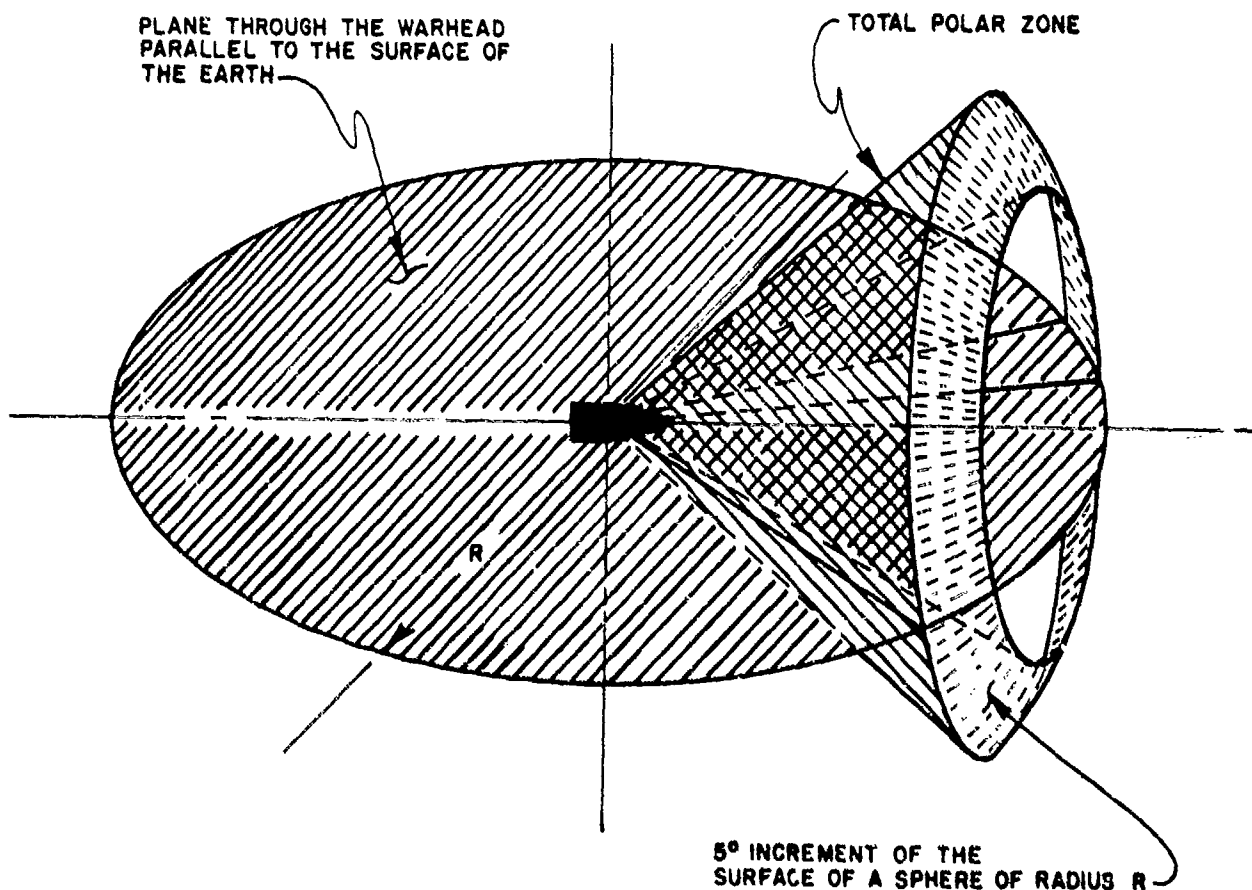


Figure A-2. Surface Area of a Polar Zone

POLAR ZONE EDGE MARKINGS
PAINTED ON THE FACE OF THE RECOVERY MEDIA

RECOVERY MEDIA

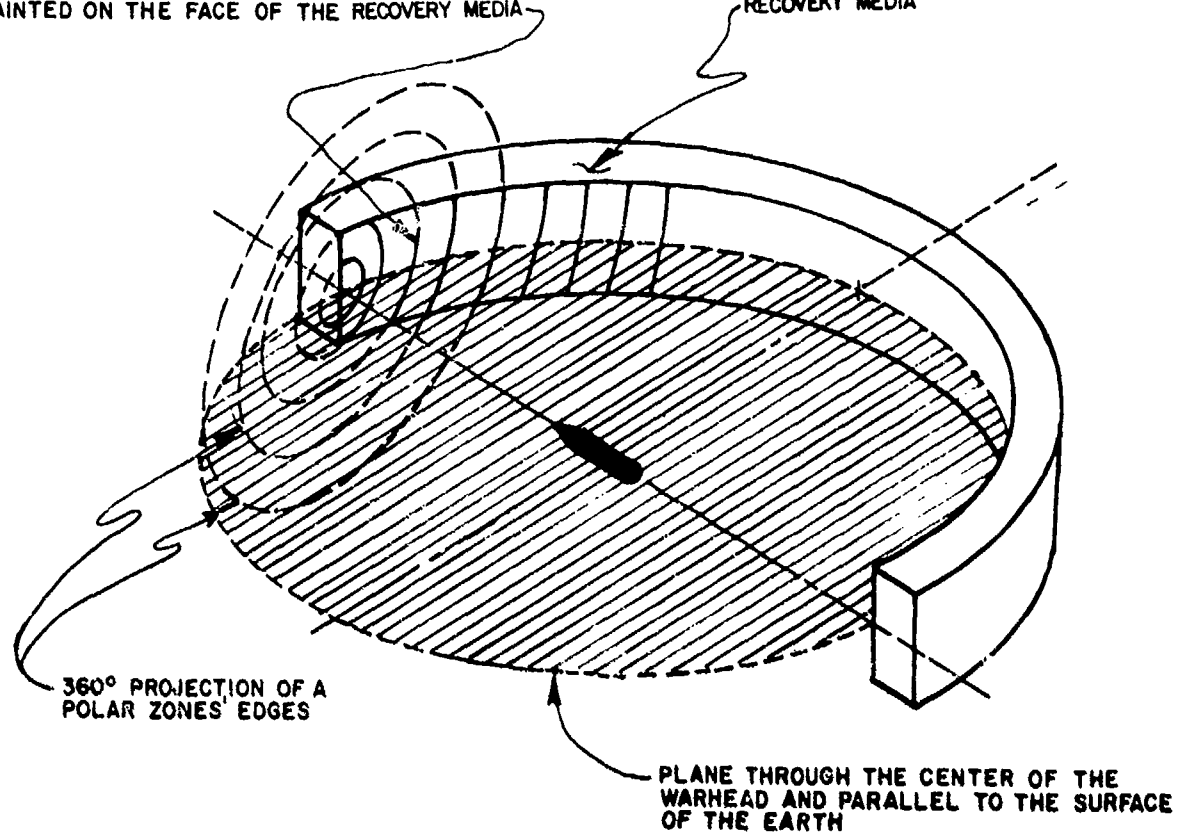


Figure A-3. Sampling of a Polar Zone

In some cases, munitions possess only partial symmetry about the longitudinal axis. Examples are bombs with lifting lugs or voids caused by explosive shrinkage following casting, or fins, bomblets with aerodynamic flutes, etc. When this occurs, it is necessary to sample fragments from each portion of the casing in which azimuthal symmetry does not exist as well as from symmetrical portions. When doing this, one must carefully sort out fragments resulting from asymmetry prior to applying multipliers.

Fragments from most munitions travel at supersonic speed over the distances at which their velocities are measured. Little error is introduced by assuming they travel in a straight line during the supersonic portion of their trajectory. Consequently, the number of fragments per unit area can be assumed to decrease inversely with the square of the distance from the munition. By analogy with radiation geometry, a target area can be expressed by the non-dimensional solid angle that it subtends; thus, the density of fragments in this area can be identified as the number of fragments per steradian.

FRAGMENTATION ARENA

Figures A-4 and A-5 illustrate the manner of constructing a typical fragmentation arena. The recovery media is made up of cane fiberboard panels. Each panel is 4 by 8 ft by 1/2-in. thick, and 96 panels are bundled together to make a 4-ft-thick bundle commonly called a celotex pack. These packs are arrayed over all polar angles at a prescribed radius for the test item. As a rule of thumb, this radius is approximately $10 W^{1/3}$ ft where W is the explosive weight (lb) of the test item. The results of this figure are generally rounded off to the next higher 5- or 10-ft interval. The bundles are set tightly against each other. In the beam spray and at the polar extremities, extra backup recovery packs are placed so that no energetic fragments pass completely through. In addition, an extra recovery pack is usually placed at both $\theta = 0$ and 180° to ensure that all fragments from the polar zones at the nose and base of the test item are caught.

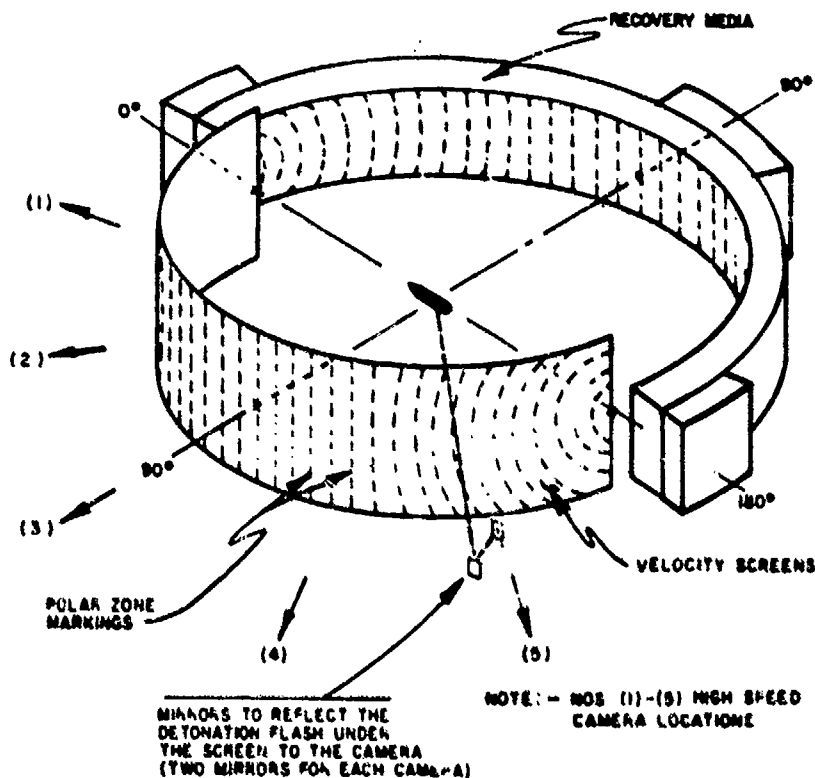


Figure A-4. Sketch of Typical Fragmentation Arena

Velocity data in these arenas are usually acquired by using high-speed framing cameras and witness panels. The usual material for witness panels is 22-gauge-mild-steel plate that is sold in 4- by 12-ft sheets. These sheets are positioned on the opposite side of the arena from the recovery packs and cover all polar angles from $\theta = 0$ to 180° . They are generally positioned at a radius above 75% as large as the recovery pack radius. High-speed framing cameras are positioned outside the witness panels, and they photograph the flash of each

fragment as it impacts and perforates the witness panel. A mirror arrangement is used so that the test item is in the camera field of view prior to detonation. The initial flash of the detonating test item provides a zero point, and the 1-kHz timing marks on the film edge provide a time reference on the film. For a witness panel radii of 40 ft and less, the cameras should have a minimum frame rate of 10,000 frames per second. At larger radii, frame rates on the order of 5,000 to 6,000 frames per second are sufficient. Sufficient cameras should be used that an individual camera is photographing only 15 to 20 ft of witness plate, and the curvature of the plate will not be enough to cause parts of the plate to be out of focus.

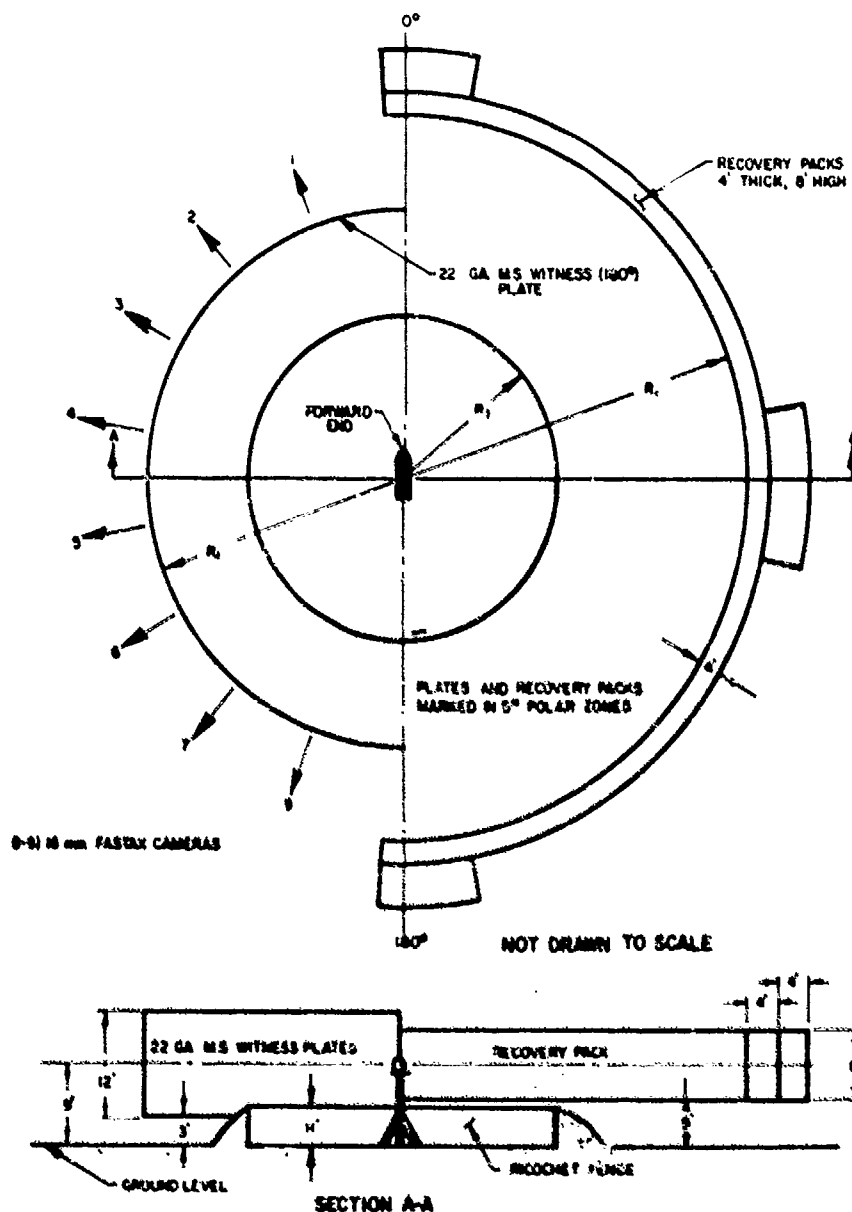


Figure A-5. Plan and Profile of Typical Fragmentation Arena

The test items should be positioned horizontally, with the forward end oriented toward $\theta = 0^\circ$ and the base end at $\theta = 180^\circ$, on a custom-built wooden stand to hold it. This stand is placed on a thick steel base plate at the arena center. This base plate serves (1) to prevent localized cratering at the arena center as a result of the detonation and (2) as a reference point from which all elevations in the arena are measured. The recovery media should be soaked with water just prior to initiation and again after the test, and a fire watch should be maintained for several hours after the test.

Inside the witness panels and recovery packs, a ricochet fence is constructed. This can be earthen or steel backed up by earth. Its function is to prevent fragments from ricocheting off the ground, inside the arena, into the witness panels or recovery packs. In determining the height of a ricochet fence, it is assumed that the path angle of a fragment bouncing from the ground is equal to the angle of its path in striking the ground. An analogy can be made here with the law of geometrical optics--the angle of incidence a light beam makes with a reflecting surface is equal to the angle of reflection.

Prior to constructing the arena, the face sheets of the recovery packs and the outside faces of the witness panels should be marked with the polar zone markings. The panels are laid out on the ground, and arcs are struck on them using the results of a computer program that calculates the radius of curvature for each polar zone arc and determines the location of the center of curvature with respect to the point $\theta = 0$ or 180° . The computer program also calculates the polar zone multipliers to be used with that size arena. In order to obtain all these quantities, the number of polar zones in the arena, the interval between polar zone boundaries, the arena radius, and the height of the recovery packs must be provided as program input.

A sample of from two to five (usually three) test items is fired in a test arena. The same recovery packs are used for all detonations; however, new witness panels are erected for each test item. There is some hazard in this procedure, if the second or a subsequent test item does not detonate properly, the entire set must be repeated. There is little probability of this, and the economics of fragment recovery after a single round make such a procedure prohibitive.

Immediately following each test, the following data should be recorded.

1. Date
2. Time of firing
3. Ambient temperature, pressure, and relative humidity
4. Number of perforations in each zone of each witness panel

Following the detonation of the last test item, fragment recovery from the recovery packs commences. Fragment recovery is a lengthy procedure that requires a crew of men several days. Each pack is inspected panel by panel for fragments. In some cases, it is evident that a fragment has passed completely

through a panel; in others, it is not evident. Hand-held magnets and electronic metal locators are used to aid in locating fragments. The type of electronic metal locator used is a surgical metal detector. It is extremely sensitive to ferrous metal and reasonably sensitive to nonferrous metals. When fragments are found, they are catalogued according to polar and azimuth zones. The face sheet of the pack can be used as a template for this purpose. The apparent path of a fragment in a recovery pack should be followed so that the fragment can be catalogued by the polar zone of entry into the recovery pack. Recovered fragments are then cleaned and weighed.

DATA REDUCTION

The data reduction is divided into two main parts. The first has to do with fragment-mass distributions; the other is the velocity distribution.

FRAGMENT-MASS DISTRIBUTION

Most work concerned with fragment mass distribution is done at the fragment weighing house. As fragments from a given test are brought to the weighing house, they are catalogued with an identifying number that stays with that particular test from then on.

The first process, following the assignment of an identifying number, is cleaning the fragments. During testing, fragments impact the recovery media with such force that minute quantities of the recovery media adhere to the fragments and become embedded in the irregular fragment surface. Individually, this could affect the weight distribution by causing a fragment to be listed in a higher weight group than it belongs in. Cumulatively, the total mass recovered would be affected; thus, distorting the total percentage recovery. In most cases, it is relatively easy to clean the recovery media from fragments having a low-impact velocity (less than 1500 ft/sec). Cleaning fragments with higher impact velocities is much more difficult. The cane fiberboard of the recovery media adheres to the fragment almost as though it were glued on. A sandblaster type device with micron-sized aluminum-oxide granules is used for the cleaning process.

Following cleaning, the fragments are sorted into weight groups. The test engineer must preselect the desired weight groups. As a part of the sorting and cleaning process, the fragments are inspected to ensure that they are valid fragments. Ricochet fragments are removed. Metal filings, rusted paint flakes, and residue from welding repairs in the arena, etc., are also removed at this time. This requires a keen eye, in some cases, to decide whether or not a fragment is valid. After all fragments (or all fragments from a particular spatial zone) are weighed and sorted, the final data processing is handled by an assortment of computer programs. Computer programs are available to perform Mott Plot or ballistic density comparisons, to calculate range and trajectory data, to provide statistical fits to fragment area-to-weight

relationships, and, finally, to provide a list of the fragment weight-number distributions according to polar and azimuthal zones.

MEAN PRESENTED AREA DETERMINATION

The mean presented ($\bar{A}$) area is used in determining retardation of a fragment during flight due to air resistance. Thus, it is important to the test activity so that initial velocity may be determined as accurately as possible from the average velocity measurements made during a test. It is important to the user of fragmentation data in that the velocity decay of a fragment plays a large part in determining the lethal area of a round of ammunition.

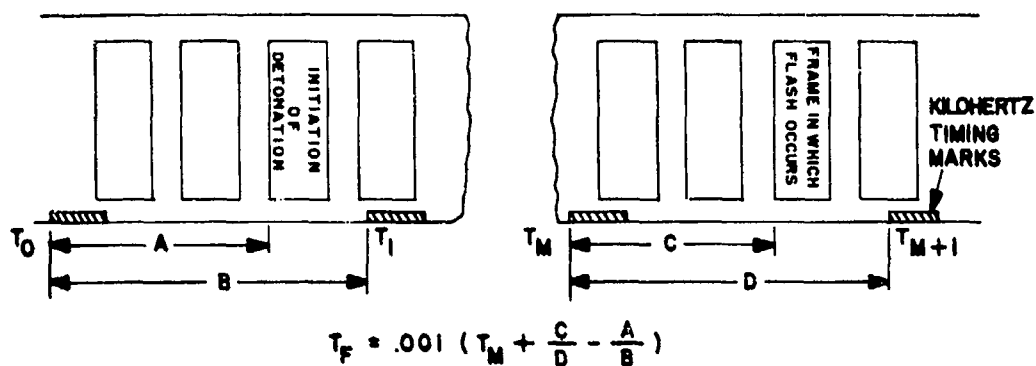
Mean presented area is determined by use of an icosahedron gauge. An icosahedron is the regular solid with the largest number of faces of all regular solids. For this reason, its shape was chosen as the basis for selecting angular positions for measuring presented area of fragments. *Ammunition and Explosives Ashore** explains the theory behind the gauge and the selection of the 16 angular positions used. The gauge itself consists of a point light source collimating lens, gimbal system for supporting fragments, condensing lens, light detector, and indicating device. Fragments are mounted in the gimbal system so that they are in the path of the collimated light beam. The gimbal system is stepped through each of the 16 positions, and the presented area is recorded. The average of these 16 areas is taken as the mean presented area of that particular fragment.

In practice, a minimum of 100 fragments from the particular area under investigation are chosen for gauge measurements. A plot of mean presented area versus mass (M) on log-log paper is approximately a straight line, with the slope equal to the constant $c + 1$ in the equation $A = bM^{c+1}$ where the vertical axis intercept is equal to $c + 1$. To get the ratio $A/M = bM^c$, the data are processed through a computer program. The program takes the values of mass and mean presented area for each fragment as input data and goes through a least-squares fitting procedure to determine the value of the equation.

FRAGMENT-VELOCITY DISTRIBUTION

Fragment-velocity distribution is determined by measuring the time of flight of fragments into the witness panels of Figure A-4. As shown in Figure A-6, the distance over which the measurement is taken is divided by the measured time-of-flight to obtain an average velocity for a particular strike. The first few velocities in a given polar zone are summed and divided by the number of readings made. This mean value is used as the average velocity for a polar zone. It is also used in calculating an initial velocity to be used for fragments from that polar zone.

* Naval Sea Systems Command, *Storage Data, Ammunition and Explosives Ashore*, OP 5 Volume II Third Revision (Washington, D.C., 15 September 1970).



T_F = TIME OF FLIGHT IN SECONDS

T_M = NUMBER OF TIMING MARKS FROM ORIGIN

A = LINEAR DISTANCE FROM T_0 TO INITIATION

B,D = LINEAR DISTANCE BETWEEN TIMING MARKS BRACKETING FRAMES OF INTEREST.

C = LINEAR DISTANCE FROM T_M TO FRAME OF FLASH

Figure A-6. Diagram and Equation for Obtaining Time-of-Flight from Film

APPENDIX B

INDIVIDUAL STATIC ARENA TEST SHEETS

B-1/B-2

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-S2

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Two projectiles vertically positioned, side-by-side, with the projectile centerlines parallel and 7 in. apart

Number of Firings/Date: 2/12 July 1977

Location: NSWC/Experimental Explosive Area

Zone Information: Fragment hole count: 90 to 105° Polar
360° Azimuth

Meteorology: 27 July 1977

Barometric Pressure: 31.05 in Hg

Temperature: 98°F

Instrumentation: Fragment velocity--five high-speed motion picture cameras,
black and white film

Fragment Velocities

Firing No. 1

Test QD-155-S2

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
0 - 10	3880.0	4006.7	4000.3
10 - 20	5102.0	5525.0	4166.7
20 - 30	5747.9	6024.1	5000.0
30 - 40	6330.1	6135.2	6578.9
40 - 50	4902.0	4902.0	5235.7
50 - 60	4065.0	4098.4	4545.5
60 - 70	3893.9	4004.6	3429.8
70 - 80	3973.9	4052.5	3464.6
80 - 90	4016.6	4032.6	3290.9
90 - 100	4085.8	4445.2	3472.3
100 - 110	4476.5	4077.6	3149.5
110 - 120	3970.6	3758.6	3498.3
120 - 130	4375.9	3866.9	3314.9
130 - 140	5082.6	4854.8	5227.0
140 - 150	6253.9	5128.3	5239.2
150 - 160	6379.6	6369.7	6666.7
160 - 170	6187.9	6098.5	6371.8
170 - 180	6172.8	4504.9	5618.0
180 - 190	3703.1	5495.2	4587.5
190 - 200	3459.9	3531.1	3367.8
200 - 210	3773.6	3787.9	3759.4
210 - 220	3922.1	3846.2	3731.3
220 - 230	3787.9	3676.5	3787.9
230 - 240	4032.3	3787.9	3333.3
240 - 250	3984.1	3379.0	3205.1
250 - 260	3807.8	4234.5	3538.2
260 - 270	4098.4	3918.9	3432.8
270 - 280	4143.2	4199.9	3436.3
280 - 290	3809.7	3700.9	3529.1
290 - 300	4000.0	4037.0	3035.7
300 - 310	3777.9	3648.7	3157.2
310 - 320	4207.4	3623.2	4000.3
320 - 330	4228.6	4226.5	3455.8
330 - 340	4009.2	4016.9	3504.0
340 - 350	3885.3	3871.0	3638.5
350 - 360	4065.0	3916.4	4033.3

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities

Firing No. 2

Test QD-155-S2

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
0 - 10	4141.3	4854.8	4525.0
10 - 20	6172.8	6097.6	6135.2
20 - 30	6329.1	6596.3	6313.1
30 - 40	6476.7	6172.8	5434.8
40 - 50	5465.9	4739.4	5208.3
50 - 60	3968.3	3952.6	4166.7
60 - 70	3906.3	3906.3	3676.5
70 - 80	3993.1	4032.3	3571.4
80 - 90	3936.7	3230.7	3271.5
90 - 100	3906.3	3537.9	3370.4
100 - 110	4009.9	3635.6	3787.9
110 - 120	3769.8	3667.4	3937.0
120 - 130	4166.7	3297.2	4065.0
130 - 140	4739.4	5000.0	5000.0
140 - 150	5133.6	6297.4	6329.1
150 - 160	6854.5	6580.1	6666.7
160 - 170	6411.3	6251.0	6493.5
170 - 180	5076.3	4951.0	5025.3
180 - 190	4062.5	3816.8	3921.6
190 - 200	4166.7	3623.2	3312.5
200 - 210	4262.4	3268.0	3862.9
210 - 220	4016.6	3676.5	3703.7
220 - 230	3906.3	3906.3	3649.6
240 - 250	4000.3	3676.5	3676.5
250 - 260	3968.3	3846.2	3759.4
260 - 270	3876.2	3424.7	3868.0
270 - 280	3787.9	3571.4	3846.2
280 - 290	3968.3	3787.9	3521.1
290 - 300	3906.3	3649.6	3676.5
300 - 310	3921.6	3937.0	3623.2
310 - 320	3846.2	3906.3	4065.0
320 - 330	4166.7	4166.7	4245.4
330 - 340	4069.9	4167.7	3971.6
340 - 350	4066.7	4169.3	3699.0
350 - 360	5093.9	4984.5	3937.0

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S2

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
0 - 10	3996.1	4249.0	4262.6
10 - 20	5637.4	5715.9	5479.0
20 - 30	5941.6	6310.2	5656.6
30 - 40	6379.0	6147.7	6006.9
40 - 50	5278.0	4793.6	5222.0
50 - 60	4016.6	4001.2	4356.1
60 - 70	3898.0	3976.5	3479.1
70 - 80	3981.1	4044.4	3486.0
80 - 90	3954.4	3631.6	3281.2
90 - 100	4034.5	3797.1	3456.6
100 - 110	4243.2	3823.1	3362.3
110 - 120	3870.2	3701.6	3586.0
120 - 130	4323.6	3704.1	3564.9
130 - 140	4911.0	4879.0	5189.2
140 - 150	5693.7	5712.9	5602.5
150 - 160	6617.0	6474.9	6666.7
160 - 170	6299.6	6174.7	6412.3
170 - 180	5441.8	4727.9	5222.8
180 - 190	3902.7	4935.7	4254.6
190 - 200	3813.3	3546.5	3334.6
200 - 210	4122.8	3527.9	3845.6
210 - 220	3969.4	3761.3	3717.5
220 - 230	3847.1	3791.4	3718.8
230 - 240	4088.0	3787.9	3452.4
240 - 250	3992.2	3478.2	3440.8
250 - 260	3834.5	4169.8	3593.5
260 - 270	3950.3	3836.5	3606.9
270 - 280	4024.8	4074.2	3538.8
280 - 290	3862.6	3729.9	3527.8
290 - 300	3953.1	3959.6	3195.9
300 - 310	3835.4	3696.7	3250.4
310 - 320	4147.2	3764.7	4021.9
320 - 330	4147.2	4216.5	3751.9
330 - 340	4080.6	4092.3	3759.0
340 - 350	3953.3	3956.2	3661.2
350 - 360	4888.2	4391.1	4001.2

* Velocities recorded photographically
at 25-ft standoff

Fragment Hole Count Data
Firing No. 1
Test QD-155-S2

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	12	11	14
5 - 10	15	21	20
10 - 15	11	33	32
15 - 20	22	33	30
20 - 25	28	26	32
25 - 30	30	23	18
30 - 35	31	25	23
35 - 40	20	24	29
40 - 45	15	17	18
45 - 50	10	9	11
50 - 55	8	7	5
55 - 60	5	6	5
60 - 65	4	5	5
65 - 70	5	6	4
70 - 75	3	5	5
75 - 80	4	4	4
80 - 85	5	3	3
85 - 90	5	6	7
90 - 95	4	4	6
95 - 100	5	5	5
100 - 105	6	7	5
105 - 110	6	4	4
110 - 115	5	7	7
115 - 120	4	8	7
120 - 125	5	5	6
125 - 130	12	13	14
130 - 135	16	17	14
135 - 140	19	18	20
140 - 145	30	28	32
145 - 150	37	16	23
150 - 155	32	19	24
155 - 160	15	20	26
160 - 165	10	31	17
165 - 170	8	24	34
170 - 175	10	16	21
175 - 180	11	19	16
180 - 185	12	29	16
185 - 190	11	12	13
190 - 195	9	8	12
195 - 200	6	7	9

Fragment Hole Count Data
 Firing No. 1
 Test QD-155-S2
 (Continued)

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
200 - 205	8	9	9
205 - 210	6	8	7
210 - 215	5	5	9
215 - 220	6	5	6
220 - 225	6	6	5
225 - 230	7	7	7
230 - 235	8	5	6
235 - 240	9	6	6
240 - 245	7	7	5
245 - 250	7	4	5
250 - 255	8	4	3
255 - 260	8	4	4
260 - 265	8	5	2
265 - 270	6	6	3
270 - 275	5	3	4
275 - 280	4	5	5
280 - 285	4	4	6
285 - 290	5	7	7
290 - 295	6	6	8
295 - 300	5	6	7
300 - 305	3	4	5
305 - 310	2	8	6
310 - 315	4	7	8
315 - 320	3	4	5
320 - 325	2	5	6
325 - 330	1	4	5
330 - 335	4	1	3
335 - 340	5	2	3
340 - 345	5	3	4
345 - 350	6	4	5
350 - 355	1	6	5
355 - 360	12	13	12

Fragment Hole Count Data
Firing No. 2
Test QD-155-S2

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	6	24	15
5 - 10	7	20	16
10 - 15	11	21	19
15 - 20	9	29	17
20 - 25	17	28	33
25 - 30	20	29	39
30 - 35	25	13	36
35 - 40	35	23	21
40 - 45	21	25	20
45 - 50	17	27	45
50 - 55	10	11	9
55 - 60	13	12	10
60 - 65	5	4	6
65 - 70	6	6	7
70 - 75	4	4	7
75 - 80	5	5	6
80 - 85	4	10	9
85 - 90	5	11	12
90 - 95	4	12	11
95 - 100	6	8	8
100 - 105	5	10	9
105 - 110	8	7	8
110 - 115	7	6	9
115 - 120	8	7	6
120 - 125	4	4	5
125 - 130	3	4	5
130 - 135	4	5	4
135 - 140	5	6	6
140 - 145	6	6	10
145 - 150	24	26	27
150 - 155	26	32	18
155 - 160	23	24	18
160 - 165	34	25	24
165 - 170	28	15	24
170 - 175	22	24	32
175 - 180	22	23	23
180 - 185	12	21	17
185 - 190	8	31	28
190 - 195	16	21	15
195 - 200	12	11	9

Fragment Hole Count Data

Firing No. 2

Test QD-155-S2

(Continued)

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
200 - 205	6	17	10
205 - 210	4	4	3
210 - 215	5	3	4
215 - 220	5	5	4
220 - 225	6	6	4
225 - 230	5	8	4
230 - 235	4	7	5
235 - 240	3	5	3
240 - 245	4	5	8
245 - 250	5	5	7
250 - 255	5	6	5
255 - 260	5	3	4
260 - 265	6	4	4
265 - 270	5	2	3
270 - 275	4	5	5
275 - 280	5	4	7
280 - 285	4	4	5
285 - 290	5	8	5
290 - 295	7	6	4
295 - 300	8	7	5
300 - 305	6	8	6
305 - 310	6	7	10
310 - 315	7	8	8
315 - 320	8	9	7
320 - 325	9	11	6
325 - 330	8	9	8
330 - 335	7	8	9
335 - 340	5	7	10
340 - 345	6	4	11
345 - 350	7	7	12
350 - 355	8	8	8
355 - 360	10	9	7

FRAGMENT HAZARD INVESTIGATION

Test Number: QU-155-S4

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Four projectiles vertically positioned, cube configuration, side-by-side, with the projectile centerline parallel and 7 in. apart

Number of Firings/Date: 2/14 July 1977

Location: NSWC/Experimental Explosive Area

Zone Information: Fragment hole count: 90 to 105° Polar
360° Azimuth

Meteorology: 14 July 1977
Barometric Pressure:
Temperature:

Instrumentation: Fragment velocity--five high-speed motion picture cameras, black and white film

Fragment Velocities
Averaged for Both Firings
Test QD-155-S4

Azimuthal Zone (°)	Fragment Velocity* Averaged for Polar Zone 90-105° (ft/sec)
0 - 10	3779
10 - 20	3885
20 - 30	4028
30 - 40	4478
40 - 50	5095
50 - 60	4556
60 - 70	4375
70 - 80	4010
80 - 90	4023
90 - 100	4288
100 - 110	4465
110 - 120	4480
120 - 130	4395
130 - 140	4185
140 - 150	4150
150 - 160	4075
160 - 170	4025
170 - 180	4400
180 - 190	4730
190 - 200	5190
200 - 210	5895
210 - 220	6300
220 - 230	4175
230 - 240	4200
240 - 250	5875
250 - 260	5950
260 - 270	6275
270 - 280	5392
280 - 290	4490
290 - 300	4180
300 - 310	4090
310 - 320	4430
320 - 330	5300
330 - 340	5510
340 - 350	5375
350 - 360	5120

* Velocities recorded photographically
at 25-ft standoff

Fragment Hole Count Data
for Firing No. 1
Test QJ-155-S4

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	7	11	12
5 - 10	3	8	11
10 - 15	6	7	12
15 - 20	5	3	4
20 - 25	5	8	6
25 - 30	6	10	6
30 - 35	9	7	15
35 - 40	14	9	12
40 - 45	20	21	13
45 - 50	17	27	23
50 - 55	15	16	18
55 - 60	12	9	14
60 - 65	9	10	10
65 - 70	9	6	11
70 - 75	5	8	6
75 - 80	5	7	7
80 - 85	7	15	8
85 - 90	13	15	11
90 - 95	4	14	16
95 - 100	11	21	20
100 - 105	6	22	23
105 - 110	12	20	29
110 - 115	20	22	25
115 - 120	22	18	19
120 - 125	16	9	25
125 - 130	17	32	24
130 - 135	9	10	22
135 - 140	3	6	4
140 - 145	3	4	7
145 - 150	2	3	6
150 - 155	9	8	6
155 - 160	8	9	7
160 - 165	9	10	17
165 - 170	10	15	16
170 - 175	20	10	16
175 - 180	9	16	23
180 - 185	12	38	75
185 - 190	25	35	69
190 - 195	36	38	60
195 - 200	37	27	28

Fragment Hole Count Data
for Firing No. 1
Test QD-155-S4
(Continued)

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
200 - 205	13	20	30
205 - 210	13	23	40
210 - 215	12	7	11
215 - 220	13	6	10
220 - 225	6	9	8
225 - 230	3	10	9
230 - 235	6	5	7
235 - 240	6	6	5
240 - 245	12	15	20
245 - 250	22	23	19
250 - 255	42	44	51
255 - 260	47	32	59
260 - 265	41	34	46
265 - 270	21	31	50
270 - 275	22	21	47
275 - 280	11	14	25
280 - 285	14	8	9
285 - 290	10	7	19
290 - 295	6	5	9
295 - 300	3	7	7
300 - 305	9	5	8
305 - 310	1	4	1
310 - 315	0	3	7
315 - 320	3	1	7
320 - 325	14	8	7
325 - 330	21	12	26
330 - 335	17	17	32
335 - 340	9	16	21
340 - 345	7	20	30
345 - 350	11	17	17
350 - 355	4	15	28
355 - 360	5	8	11

Fragment Hole Count Data
for Firing No. 2
Test QD-155-S4

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	8	11	20
5 - 10	8	12	19
10 - 15	6	11	10
15 - 20	7	11	11
20 - 25	11	7	8
25 - 30	12	6	7
30 - 35	20	15	15
35 - 40	21	16	17
40 - 45	35	32	39
45 - 50	15	18	25
50 - 55	16	17	35
55 - 60	19	13	18
60 - 65	9	10	8
65 - 70	10	11	9
70 - 75	9	10	11
75 - 80	9	11	11
80 - 85	12	18	21
85 - 90	13	22	18
90 - 95	12	10	21
95 - 100	12	19	29
100 - 105	15	21	16
105 - 110	16	20	18
110 - 115	22	26	25
115 - 120	35	29	28
120 - 125	28	13	28
125 - 130	36	19	29
130 - 135	7	8	9
135 - 140	7	9	8
140 - 145	5	3	9
145 - 150	5	3	8
150 - 155	7	8	12
155 - 160	8	8	13
160 - 165	5	7	12
165 - 170	6	6	12
170 - 175	12	15	16
175 - 180	18	27	22
180 - 185	7	16	30
185 - 190	13	21	47
190 - 195	29	25	52
195 - 200	32	24	50

Fragment Hole Count Data
for Firing No. 2
Test QD-155-S4
(Continued)

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
200 - 205	22	20	15
205 - 210	29	19	25
210 - 215	20	22	28
215 - 220	10	5	11
220 - 225	5	4	7
225 - 230	1	2	7
230 - 235	6	11	11
235 - 240	7	13	10
240 - 245	19	28	25
245 - 250	26	43	37
250 - 255	56	63	79
255 - 260	59	64	55
260 - 265	46	50	60
265 - 270	32	27	45
270 - 275	13	24	32
275 - 280	17	12	13
280 - 285	11	7	5
285 - 290	6	6	4
290 - 295	6	8	10
295 - 300	4	8	9
300 - 305	4	3	7
305 - 310	3	3	7
310 - 315	9	10	8
315 - 320	10	13	6
320 - 325	19	15	12
325 - 330	20	17	11
330 - 335	15	19	23
335 - 340	10	16	21
340 - 345	8	15	25
345 - 350	9	16	27
350 - 355	6	26	36
355 - 360	12	22	22

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-S8

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Eight projectiles vertically positioned in a two-by-four matrix side-by-side, with the projectile centerline parallel and 7 in. apart.

Number of Firings/Date: 1/19 July 1977
1/21 July 1977

Location: NSWC/Explosive Experimental Area

Zone Information: Fragment hole count: 90 to 105° Polar
360° azimuth

Meteorology: 19 July 1977
Barometric Pressure: 29.70 in Hg
Temperature: 99°F
21 July 1977
Barometric Pressure: 28.75 in Hg
Temperature: 98°F

Instrumentation: Fragment velocity--five high-speed motion picture cameras, black and white film

Fragment Velocities

Firing No. 1

Test QD-155-S8

Azimuthal Zone (°)		Velocity* (ft/sec) per Polar Zone (°)		
		90-95	95-100	100-105
0 - 5		3046.3	4132.2	4027.1
5 - 10		4015.6	4137.0	3934.7
10 - 15		4545.8	4025.7	4401.6
15 - 20		4587.2	3775.1	4407.5
20 - 25		4326.1	4468.0	4350.8
25 - 30		4993.4	4433.4	4927.7
30 - 35		4907.8	4882.7	5344.2
35 - 40		4738.0	4852.8	5061.2
40 - 45		0.0	3984.3	3876.0
45 - 50		3506.2	3787.9	4389.0
50 - 55		0.0	4273.5	4273.5
55 - 60		3572.0	3545.6	0.0
60 - 65		3345.3	3981.8	3261.6
65 - 70		0.0	0.0	3261.6
70 - 75		3787.9	4038.8	3968.3
75 - 80		3877.6	3922.5	0.0
80 - 85		3679.7	3961.6	4920.6
85 - 90		4761.9	4733.0	5104.2
90 - 95		4977.5	5100.0	5420.3
95 - 100		5750.4	6137.7	5420.3
100 - 105		6146.1	6567.9	6172.8
105 - 110		6464.1	6267.7	6041.6
110 - 115		6410.3	6144.6	6393.6
115 - 120		5839.4	6085.1	6361.6
120 - 125		6085.1	6085.1	6554.1
125 - 130		4587.2	5187.7	5000.0
130 - 135		4424.8	4098.4	4587.2
135 - 140		3760.0	4237.3	4303.4
140 - 145		4386.0	4143.7	4098.4
145 - 150		4132.2	3789.2	4006.4
150 - 155		0.0	0.0	4166.7
155 - 160		0.0	0.0	0.0
160 - 165		0.0	3846.2	4858.5
165 - 170		5741.3	6725.0	7213.2
170 - 175		6687.5	7518.1	7050.5
175 - 180		6173.8	6137.9	6499.0
180 - 185		5651.7	4936.9	6131.8
185 - 190		0.0	0.0	4065.0
190 - 195		4166.7	4065.3	3906.3

* Velocities recorded photographically
25-ft standoff

Fragment Velocities

Firing No. 1

Test QD-155-S8

(Continued)

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
195 - 200	4006.3	3919.8	3787.9
200 - 205	3968.3	3908.2	4132.2
205 - 210	3731.3	3943.1	3787.9
210 - 215	3731.3	4202.0	0.0
215 - 220	0.0	4347.8	0.0
220 - 225	3546.1	4056.6	4098.4
225 - 230	3378.4	4671.9	4237.3
230 - 235	0.0	4725.9	0.0
235 - 240	4902.0	5263.2	4854.4
240 - 245	5434.8	5662.2	5434.8
245 - 250	5421.9	5377.6	5681.8
250 - 255	4902.0	5050.5	5434.8
255 - 260	0.0	4761.9	5655.7
260 - 265	0.0	4578.8	0.0
265 - 270	0.0	0.0	0.0
270 - 275	0.0	0.0	0.0
275 - 280	0.0	0.0	0.0
280 - 285	0.0	0.0	0.0
285 - 290	0.0	4016.6	3787.9
290 - 295	0.0	3787.9	4240.0
295 - 300	0.0	4132.2	4132.2
300 - 305	0.0	3968.3	0.0
305 - 310	3571.4	4202.3	4132.2
310 - 315	0.0	3731.3	4237.3
315 - 320	4903.8	4587.2	4545.5
320 - 325	4903.2	5000.0	5104.2
325 - 330	4807.7	4479.1	4618.6
330 - 335	3968.3	3731.3	3976.2
335 - 340	3571.4	4065.0	4065.0
340 - 345	3571.4	4015.9	4056.6
345 - 350	3496.5	4083.1	4184.8
350 - 355	3247.4	3400.2	4237.3
355 - 360	3564.2	3514.4	4111.9

* Velocities recorded photographically
25-ft standoff

Fragment Velocities

Firing No. 2

Test QD-155-S8

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	0.0	3546.1	4098.4
5 - 10	3012.0	3242.1	4367.6
10 - 15	3787.9	3994.8	4251.9
15 - 20	5077.3	5376.3	5202.4
20 - 25	4424.8	4424.8	4545.5
25 - 30	5159.6	5319.1	4951.0
30 - 35	5106.4	4750.0	5000.0
35 - 40	4762.3	4276.0	3978.7
40 - 45	4489.4	4374.1	3846.2
45 - 50	4098.4	0.0	4570.9
50 - 55	3571.4	4201.7	4237.3
55 - 60	3713.7	4335.6	4201.7
60 - 65	3500.4	0.0	3154.1
65 - 70	0.0	4137.7	4193.4
70 - 75	4201.7	4238.1	4411.5
75 - 80	3857.3	0.0	4473.2
80 - 85	3649.6	4118.4	4008.5
85 - 90	4587.2	4858.5	4757.4
90 - 95	4918.5	4950.5	5058.8
95 - 100	4950.5	4950.5	5302.4
100 - 105	5895.4	5747.1	6142.3
105 - 110	6014.1	6410.3	6050.7
110 - 115	5889.0	6078.7	5747.1
115 - 120	5682.6	6538.5	6331.1
120 - 125	5682.6	5747.1	6410.3
125 - 130	5618.0	6337.4	6362.8
130 - 135	5050.5	4979.3	5283.8
135 - 140	4166.7	3832.5	4166.7
140 - 145	3780.5	4082.3	3877.1
145 - 150	3668.4	3665.5	4237.3
150 - 155	3521.1	4272.9	4166.7
155 - 160	3223.5	4138.3	4386.0
160 - 165	4950.5	4717.0	7352.9
165 - 170	6899.5	7721.6	7815.7
170 - 175	7882.6	7745.9	7367.4
175 - 180	6651.5	5611.2	6095.8
180 - 185	5142.2	4807.7	5440.6
185 - 190	4065.0	4331.0	0.0
190 - 195	3571.6	4420.3	4545.5

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities

Firing No. 2

Test QD-155-S8

(Continued)

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
195 - 200	0.0	3981.3	4166.7
200 - 205	0.0	0.0	0.0
205 - 210	4237.3	4159.7	0.0
210 - 215	4386.0	4244.5	4201.7
215 - 220	0.0	0.0	0.0
220 - 225	0.0	4032.3	0.0
225 - 230	5434.8	4246.7	5400.5
230 - 235	5438.6	5529.3	4854.4
235 - 240	5618.0	5050.5	5050.5
240 - 245	4761.9	4587.2	4797.0
245 - 250	4347.8	4902.0	4693.4
250 - 255	4321.9	4347.8	4902.9
255 - 260	4386.0	4239.1	4347.8
260 - 265	3530.6	4281.3	4154.8
265 - 270	3766.0	3624.9	3958.8
270 - 275	3257.7	3274.2	3911.2
275 - 280	0.0	3227.0	3827.8
280 - 285	0.0	0.0	0.0
285 - 290	3276.9	3999.6	4322.8
290 - 295	3076.2	3646.5	3941.8
295 - 300	3787.9	3135.1	4329.1
300 - 305	3760.6	4033.3	4201.7
305 - 310	3760.6	3521.1	4201.7
310 - 315	4761.9	4313.2	4201.7
315 - 320	4587.2	4717.0	4587.2
320 - 325	4587.5	4854.4	4629.6
325 - 330	4464.3	4761.9	4545.5
330 - 335	0.0	4201.7	3993.4
335 - 340	4201.7	4049.1	3848.7
340 - 345	3472.2	4100.8	4310.3
345 - 350	3125.0	3720.3	4256.0
350 - 355	3246.8	3550.5	3787.9
355 - 360	3414.2	3659.0	3715.4

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S8

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	3046.3	3839.2	4039.0
5 - 10	3681.8	3881.3	4107.9
10 - 15	4166.9	4017.5	4345.5
15 - 20	4913.9	4461.3	4748.2
20 - 25	4375.4	4455.7	4415.7
25 - 30	5040.9	4581.0	4934.4
30 - 35	4982.3	4823.7	5286.8
35 - 40	4744.9	4605.6	4655.2
40 - 45	4489.4	4211.7	3861.1
45 - 50	3703.6	3787.9	4479.9
50 - 55	3571.4	4237.6	4255.4
55 - 60	3642.9	3861.6	4201.7
60 - 65	3438.4	3981.8	3154.1
65 - 70	0.0	4143.7	3927.2
70 - 75	3994.8	4181.2	4337.6
75 - 80	3849.5	3922.5	4473.2
80 - 85	3669.6	4040.0	4464.6
85 - 90	4674.5	4768.9	4896.1
90 - 95	4955.4	5025.2	5364.4
95 - 100	5617.1	5939.8	5376.1
100 - 105	6074.5	6431.1	6164.1
105 - 110	6335.6	6333.9	6044.2
110 - 115	6019.3	6125.8	6285.8
115 - 120	5776.7	6214.6	6350.2
120 - 125	5970.1	5988.5	6496.6
125 - 130	5102.6	5680.5	5973.4
130 - 135	4894.1	4853.5	5005.2
135 - 140	3861.7	3933.7	4269.2
140 - 145	3901.6	4102.7	3921.4
145 - 150	3745.7	3727.3	4083.4
150 - 155	3521.1	4272.9	4166.7
155 - 160	3223.5	4138.3	4386.0
160 - 165	4950.5	4281.6	5690.0
165 - 170	6320.4	7306.3	7614.9
170 - 175	7139.3	7654.8	7209.0
175 - 180	6412.6	5850.6	6319.8
180 - 185	5397.0	4904.6	5786.2
185 - 190	4065.0	5331.0	4065.0
190 - 195	3770.0	4278.3	4225.9

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S8
(Continued)

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
195 - 200	4006.3	3942.9	3977.3
200 - 205	3968.3	3908.2	4132.2
205 - 210	3984.3	4015.3	3787.9
210 - 215	4058.7	4216.1	4201.7
215 - 220	0.0	4347.8	0.0
220 - 225	3546.1	4048.5	4098.4
225 - 230	4063.8	5165.9	5206.6
230 - 235	5438.6	5368.6	4854.4
235 - 240	5260.0	5192.3	5001.5
240 - 245	5098.3	5303.9	5052.1
245 - 250	5153.4	5258.7	5117.0
250 - 255	4515.3	4816.3	5168.8
255 - 260	4386.0	4413.4	5328.7
260 - 265	3530.6	4380.5	4154.8
265 - 270	3766.0	3624.9	3958.8
270 - 275	3257.7	3234.2	3811.2
275 - 280	0.0	3227.0	3827.8
280 - 285	0.0	0.0	0.0
285 - 290	3276.9	4004.5	4108.9
290 - 295	3076.2	3674.8	4008.0
295 - 300	3787.9	3467.5	4263.5
300 - 305	3760.6	4011.6	4201.7
305 - 310	3666.0	3929.8	4167.0
310 - 315	4761.9	4119.3	4219.5
315 - 320	4798.3	4652.1	4566.3
320 - 325	4776.9	4927.2	4946.0
325 - 330	4636.0	4549.8	4594.2
330 - 335	3968.3	3966.5	3983.1
335 - 340	3991.6	4054.4	3935.2
340 - 345	3521.8	4040.1	4141.2
345 - 350	3248.8	3901.7	4220.4
350 - 355	3247.2	3486.1	4087.5
355 - 360	3489.2	3576.4	3874.0

* Velocities recorded photographically
at 25-ft standoff

Fragment Hole Count Data

Firing No. 1

Test QD-155-S8

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	11	13	19
5 - 10	18	23	16
10 - 15	9	21	25
15 - 20	22	20	44
20 - 25	18	19	29
25 - 30	32	16	22
30 - 35	10	12	39
35 - 40	24	14	15
40 - 45	5	4	5
45 - 50	5	4	5
50 - 55	7	5	4
55 - 60	3	6	6
60 - 65	11	7	12
65 - 70	10	8	17
70 - 75	11	13	20
75 - 80	18	20	19
80 - 85	24	19	25
85 - 90	33	36	50
90 - 95	47	43	56+
95 - 100	76	49	99+
100 - 105	56	51	83+
105 - 110	69	41	80
110 - 115	55	38	46
115 - 120	63	35	106
120 - 125	106	110	160
125 - 130	103	126	138
130 - 135	23	19	24
135 - 140	3	4	9
140 - 145	4	5	10
145 - 150	2	5	5
150 - 155	4	7	7
155 - 160	3	2	2
160 - 165	6	14	6
165 - 170	63	73	49
170 - 175	93	203	205
175 - 180	77	125	113
180 - 185	28	33	65
185 - 190	15	14	24
190 - 195	7	5	12
195 - 200	7	8	8
200 - 205	8	8	8

Fragment Hole Count Data

Firing No. 1

Test QD-155-S8

(Continued)

Number of Fragment

Holes in 22-Gauge

Witness Panels

Azimuthal Zone (°)	per Polar Zone (°)		
	90-95	95-100	100-105
205 - 210	13	21	5
210 - 215	6	6	7
215 - 220	2	7	8
220 - 225	3	7	4
225 - 230	8	4	11
230 - 235	35	37	22
235 - 240	63	34	53
240 - 245	66	43	99
245 - 250	74	47	74
250 - 255	60	39	97
255 - 260	25	37	64+
260 - 265	32	43	62
265 - 270	43	44	46
270 - 275	38	44	30
275 - 280	26	29	33
280 - 285	20	26	12
285 - 290	19	23	13
290 - 295	15	13	11
295 - 300	12	14	7
300 - 305	15	11	7
305 - 310	17	17	9
310 - 315	21	23	16
315 - 320	29	37	25
320 - 325	39	36	28
325 - 330	30	36	23
330 - 335	16	17	13
335 - 340	21	9	5
340 - 345	14	12	10
345 - 350	6	8	5
350 - 355	6	8	5
355 - 360	7	13	8

Fragment Hole Count Data
Firing No. 2
Test QD-155-S8

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	7	11	19
5 - 10	12	24	19
10 - 15	12	19	26
15 - 20	8	16	42
20 - 25	9	14	27
25 - 30	20	14	26
30 - 35	11	21	40
35 - 40	10	16	17
40 - 45	1	7	9
45 - 50	6	4	6
50 - 55	6	3	8
55 - 60	5	11	10
60 - 65	7	6	10
65 - 70	14	15	24
70 - 75	7	14	21
75 - 80	14	15	20
80 - 85	33	22	33
85 - 90	36	54	50+
90 - 95	53	53	95
95 - 100	42	70	96
100 - 105	86	46	78
105 - 110	39	38	112
110 - 115	34	49	94
115 - 120	52	76	143
120 - 125	76	73	115
125 - 130	113	82	105
130 - 135	68	71	33
135 - 140	10	15	6
140 - 145	15	14	8
145 - 150	9	8	16
150 - 155	2	11	11
155 - 160	5	15	5
160 - 165	12	23	23
165 - 170	72	113	89
170 - 175	122	155	195
175 - 180	64	81	166
180 - 185	23	31	65
185 - 190	11	12	19
190 - 195	6	15	16
195 - 200	3	9	4
200 - 205	6	12	5

Fragment Hole Count Data

Firing No. 2

Test QD-155-S8

(Continued)

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
205 - 210	3	4	4
210 - 215	6	5	7
215 - 220	4	5	9
220 - 225	3	5	6
225 - 230	31	28	10
230 - 235	44	53	36
235 - 240	42	52	108
240 - 245	62	43	59
245 - 250	29	24	61
250 - 255	33	47	55
255 - 260	40	64	62
260 - 265	28	61	46
265 - 270	29	60	31
270 - 275	15	35	35
275 - 280	19	23	27
280 - 285	12	8	12
285 - 290	16	13	13
290 - 295	20	21	9
295 - 300	20	11	7
300 - 305	17	13	16
305 - 310	17	11	15
310 - 315	30	17	17
315 - 320	41	46	28
320 - 325	44	52	29
325 - 330	25	22	26
330 - 335	11	8	14
335 - 340	15	13	15
340 - 345	6	8	5
345 - 350	8	9	9
350 - 355	5	15	13
355 - 360	10	17	22

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-S8A

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Eight projectiles vertically positioned, two-by-four matrix,
side-by-side, with the projectile centerline parallel and 7 in.
apart

Numbr of Firings/Date: 1/28 July 1977
1/4 August 1977

Location: NSWC/Explosive Experimental Area

Zone Information: Fragment hole count: 90 to 105° Polar
360° Azimuth

Meteorology: 28 July 1977
Barometric Pressure: 28.45 in Hg
Temperature: 88°F
4 August 1977
Barometric Pressure: 29.95 in Hg
Temperature: 98°F

Instrumentation: Fragment velocity--five high-speed motion picture cameras,
black and white film

Fragment Velocities

Firing No. 1

Test QD-155-S8A

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	3816.8	4347.8	3114.3
5 - 10	4464.3	3728.1	5146.6
10 - 15	5046.1	4317.3	5436.1
15 - 20	5423.9	5073.4	5497.6
20 - 25	5292.3	5056.2	5103.7
25 - 30	6172.8	6410.3	5580.4
30 - 35	5849.8	5815.5	5465.9
35 - 40	5555.6	5376.3	4902.0
40 - 45	5347.1	5555.6	4525.0
45 - 50	3846.2	4357.4	3869.0
50 - 55	3589.2	4260.6	3460.6
55 - 60	5121.7	4854.4	4098.4
60 - 65	5814.0	4816.0	6538.5
65 - 70	6805.6	6672.0	4583.5
70 - 75	6550.2	6079.2	6607.7
75 - 80	5434.8	5915.3	5906.8
80 - 85	4939.3	6396.2	4951.5
85 - 90	6454.0	4902.0	4723.7
90 - 95	5428.8	4629.6	4784.4
95 - 100	4850.4	4902.0	4812.8
100 - 105	6559.9	5618.0	5167.5
105 - 110	5306.7	5618.0	5977.4
110 - 115	6097.6	5681.8	5618.0
115 - 120	4950.5	5263.2	4541.4
120 - 125	5452.6	4809.4	5263.2
125 - 130	5452.6	5102.0	4717.0
130 - 135	4954.9	4905.8	4545.8
135 - 140	4099.5	4807.7	3834.2
140 - 145	4000.0	4251.7	4386.0
145 - 150	4006.4	4214.6	4386.0
150 - 155	3968.3	4166.7	4223.1
155 - 160	5924.0	6222.9	6087.7
160 - 165	6493.5	6583.7	6719.0
165 - 170	7462.7	6944.4	7375.8
170 - 175	5681.8	6493.5	6944.4
175 - 180	4902.0	5246.1	5398.1
180 - 185	4742.9	4262.6	4583.8
185 - 190	4629.6	3693.4	3246.8
190 - 195	0.0	3844.1	3401.4

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities

Firing No. 1

Test QD-155-S8A

(Continued)

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
195 - 200	4131.9	4069.4	3734.3
200 - 205	4280.5	4406.1	0.0
205 - 210	4350.8	4219.6	0.0
210 - 215	4098.4	3703.7	4132.2
215 - 220	4347.8	0.0	3937.0
220 - 225	4311.0	3937.0	3703.7
225 - 230	3811.0	4000.0	3434.4
230 - 235	3918.5	3906.3	4386.0
235 - 240	4467.1	4902.0	4347.8
240 - 245	4609.2	4761.9	4587.2
245 - 250	5102.0	4717.0	4672.9
250 - 255	5618.0	4950.5	4593.3
255 - 260	5102.0	4545.5	4310.3
260 - 265	6666.7	4310.3	5000.0
265 - 270	4761.9	4391.4	4464.3
270 - 275	4672.9	4464.3	4237.3
275 - 280	4629.6	4545.5	4746.9
280 - 285	5102.0	4237.3	4525.0
285 - 290	4807.7	4587.2	4717.0
290 - 295	4960.9	5102.0	5000.0
295 - 300	5376.3	5376.3	5376.3
300 - 305	5376.3	5182.6	5263.2
305 - 310	4854.4	5376.3	5263.2
310 - 315	4527.2	4004.1	0.0
315 - 320	4310.3	3745.8	4237.3
320 - 325	3623.2	3968.3	3098.4
325 - 330	4097.8	4006.6	0.0
330 - 335	3701.4	3270.5	0.0
335 - 340	3048.3	3632.7	3273.8
340 - 345	4098.4	2873.6	0.0
345 - 350	4098.4	3564.3	3355.7
350 - 355	3954.0	3423.5	3424.7
355 - 360	4098.4	3418.2	3227.5

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities

Firing No. 2

Test QD-155-S8A

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	3559.9	3985.5	4212.9
5 - 10	5102.0	4629.6	5349.0
10 - 15	5263.2	6189.6	5671.8
15 - 20	6593.0	6187.8	6258.0
20 - 25	6466.5	6097.6	5263.2
25 - 30	5690.7	4984.2	4950.5
30 - 35	3597.1	4274.4	3763.0
35 - 40	3597.1	3849.8	3164.6
40 - 45	4166.7	4020.2	2977.9
45 - 50	3164.6	4191.8	4587.2
50 - 55	5035.9	4231.8	3648.4
55 - 60	5884.5	5237.1	4168.4
60 - 65	6178.6	5982.1	5620.5
65 - 70	5741.0	5868.3	5927.8
70 - 75	4807.7	4525.7	4711.8
75 - 80	4790.1	4505.2	4347.8
80 - 85	4807.7	4717.0	4792.4
85 - 90	4950.5	4761.9	4464.3
90 - 95	5210.6	5102.0	4563.5
95 - 100	5437.4	5555.6	5001.0
100 - 105	6744.5	6671.4	6223.2
105 - 110	6588.2	6434.7	6260.2
110 - 115	6498.8	6396.1	5952.4
115 - 120	6490.5	5064.5	4950.5
120 - 125	5960.6	5811.3	5588.7
125 - 130	6493.5	5479.4	5151.1
130 - 135	4464.3	4275.5	3496.5
135 - 140	4081.7	4193.5	4237.3
140 - 145	3878.1	4237.3	3653.2
145 - 150	3731.3	4386.0	3825.7
150 - 155	4717.0	4605.8	3355.7
155 - 160	5154.6	5017.0	4504.5
160 - 165	7091.5	6849.3	6172.8
165 - 170	8007.4	8151.7	7885.8
170 - 175	7129.7	7424.7	7110.3
175 - 180	5134.8	5573.8	5102.0
180 - 185	5406.8	4970.9	4347.8
185 - 190	3745.4	3556.9	3216.7
190 - 195	3705.0	3784.6	3546.1

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities

Firing No. 2

Test QD-155-S8A

(Continued)

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
195 - 200	4187.2	3877.4	3462.4
200 - 205	4175.3	4206.4	2857.1
205 - 210	0.0	3787.9	3414.7
210 - 215	4387.3	4310.3	3246.8
215 - 220	4387.3	3355.7	4152.8
220 - 225	4505.2	4201.7	3846.2
225 - 230	4696.8	4375.2	4098.4
230 - 235	5500.5	5154.6	5082.0
235 - 240	5197.2	5236.9	5077.3
240 - 245	5330.4	5000.0	5025.3
245 - 250	5236.9	5274.6	4985.5
250 - 255	4974.4	5025.3	5102.0
255 - 260	4601.8	4310.6	4902.0
260 - 265	4717.0	4513.7	5208.3
265 - 270	4720.8	4494.9	4717.0
270 - 275	4717.0	4632.7	4940.7
275 - 280	4227.0	4587.2	4807.7
280 - 285	4294.5	4285.7	4717.0
285 - 290	4587.2	4687.4	4386.0
290 - 295	4006.0	4927.2	4882.8
295 - 300	4949.5	4831.0	4761.9
300 - 305	5319.1	5434.8	5376.3
305 - 310	5154.6	5263.2	5154.6
310 - 315	4950.5	4954.9	5050.5
315 - 320	4132.2	4761.9	4950.5
320 - 325	3846.2	4545.5	4201.7
325 - 330	0.0	4386.0	4098.4
330 - 335	0.0	4132.2	3816.8
335 - 340	4573.9	3379.0	3333.3
340 - 345	3816.8	3978.7	4000.0
345 - 350	4386.0	3906.3	3184.7
350 - 355	4237.3	3710.9	3407.4
355 - 360	5000.0	3778.3	3864.5

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S8A

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	3688.3	4130.4	3585.1
5 - 10	4889.5	3908.4	5214.0
10 - 15	5082.3	4852.3	5553.9
15 - 20	6073.4	5551.0	5877.8
20 - 25	5996.8	5403.3	5167.5
25 - 30	5828.4	5554.6	5370.4
30 - 35	5399.2	4934.9	4330.6
35 - 40	4576.3	4358.6	4033.3
40 - 45	5111.0	4327.2	3751.4
45 - 50	3505.4	4274.6	4108.4
50 - 55	4553.7	4243.3	3585.8
55 - 60	5598.5	5127.7	4133.4
60 - 65	6117.8	5399.0	5882.8
65 - 70	6045.1	6327.5	5543.7
70 - 75	6052.3	5302.4	5659.7
75 - 80	5219.9	5210.2	5595.0
80 - 85	4906.4	5836.5	4872.0
85 - 90	5952.9	4831.9	4568.1
90 - 95	5341.5	4944.6	4646.3
95 - 100	5018.1	5228.8	4893.5
100 - 105	6639.0	6144.7	5871.3
105 - 110	6107.6	6108.0	6154.2
110 - 115	6431.9	6277.1	5868.8
115 - 120	6233.9	5104.2	4745.9
120 - 125	5734.8	5525.1	5507.3
125 - 130	5660.8	5403.9	5006.4
130 - 135	4791.3	4590.6	4196.1
135 - 140	4090.6	4347.0	3968.5
140 - 145	3918.7	4246.9	3836.4
145 - 150	3914.7	4257.4	3965.8
150 - 155	4342.6	4496.0	3934.0
155 - 160	5731.7	5620.0	5559.9
160 - 165	6749.8	6628.0	6609.7
165 - 170	7765.3	7548.1	7567.0
170 - 175	6550.5	7238.5	7068.8
175 - 180	5057.2	5433.3	5250.1
180 - 185	5008.5	4687.6	4489.4
185 - 190	4187.5	3615.4	3226.7
190 - 195	3705.0	3801.6	3473.7

* Velocities recorded photographically
at 25-ft standoff

Fragment Velocities
Averaged for Both Firings
Test QD-155-S8A

(Continued)

Azimuthal Zone (°)	Velocity* (ft/sec) per Polar Zone (°)		
	90-95	95-100	100-105
195 - 200	4163.5	3973.4	3625.5
200 - 205	4214.7	4306.2	2857.1
205 - 210	4350.8	4111.6	3414.7
210 - 215	4291.0	4007.0	3689.5
215 - 220	4374.2	3355.7	4044.9
220 - 225	4408.1	4069.3	3774.9
225 - 230	4549.2	4281.4	3600.4
230 - 235	4973.2	4738.5	4942.8
235 - 240	4832.2	5125.2	4834.2
240 - 245	5041.9	4881.0	4879.2
245 - 250	5169.5	5088.8	4907.3
250 - 255	5296.2	5000.3	4762.9
255 - 260	4701.8	4369.3	4606.2
260 - 265	5366.9	4412.0	5104.2
265 - 270	4734.5	4453.5	4590.6
270 - 275	4694.9	4590.6	4589.0
275 - 280	4327.6	4566.3	4762.1
280 - 285	4456.0	4261.5	4589.0
285 - 290	4660.7	4667.3	4551.5
290 - 295	4483.5	4985.5	4960.9
295 - 300	5091.8	5103.7	5069.1
300 - 305	5362.0	5266.7	5319.8
305 - 310	4954.5	5319.8	5227.0
310 - 315	4668.3	4479.5	5050.5
315 - 320	4221.3	4084.5	4593.9
320 - 325	3734.7	4160.7	3466.1
325 - 330	4097.8	4082.5	4098.4
330 - 335	3701.4	3414.1	3816.8
335 - 340	3484.2	3560.2	3293.7
340 - 345	4004.5	3426.1	4000.0
345 - 350	4242.2	3632.7	3270.2
350 - 355	4024.8	3628.8	3410.9
355 - 360	4323.8	3598.3	3682.5

* Velocities recorded photographically
at 25-ft standoff

Fragment Hole Count Data

Firing No. 1

Test QD-155-S8A

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	17	19	26
5 - 10	29	37	50
10 - 15	58	28	41
15 - 20	65	39	41
20 - 25	22	32	39
25 - 30	25	24	63
30 - 35	17	30	65
35 - 40	44	20	27
40 - 45	11	9	8
45 - 50	4	12	8
50 - 55	6	11	7
55 - 60	7	10	6
60 - 65	18	14	18
65 - 70	43	32	44
70 - 75	82	59	102
75 - 80	60	96	97
80 - 85	65	52	74
85 - 90	40	47	43
90 - 95	58	54	66
95 - 100	60	91	73
100 - 105	102	86	138
105 - 110	49	61	77
110 - 115	33	42	38
115 - 120	39	40	45
120 - 125	16	29	46
125 - 130	23	48	50
130 - 135	20	27	16
135 - 140	9	16	12
140 - 145	8	15	4
145 - 150	4	9	8
150 - 155	8	5	8
155 - 160	23	29	28
160 - 165	63	66	91
165 - 170	135	134	167
170 - 175	96	103	140
175 - 180	32	40	79
180 - 185	27	42	31
185 - 190	16	10	14
190 - 195	5	8	8
195 - 200	7	8	10
200 - 205	6	15	8

Fragment Hole Count Data

Firing No. 1

Test QD-155-S8A

(Continued)

Number of Fragment

Holes in 22-Gauge

Witness Panels

Azimuthal Zone (°)	per Polar Zone (°)		
	90-95	95-100	100-105
205 - 210	15	4	7
210 - 215	6	10	10
215 - 220	9	9	8
220 - 225	7	7	6
225 - 230	5	13	12
230 - 235	33	33	24
235 - 240	40	29	56
240 - 245	32	36	62
245 - 250	48	33	53
250 - 255	17	40	57
255 - 260	29	40	52
260 - 265	31	59	72
265 - 270	33	57	54
270 - 275	49	46	45
275 - 280	37	48	29
280 - 285	33	30	19
285 - 290	34	24	52
290 - 295	33	24	41
295 - 300	44	31	35
300 - 305	38	33	53
305 - 310	24	16	16
310 - 315	3	14	6
315 - 320	3	4	7
320 - 325	5	3	4
325 - 330	5	5	3
330 - 335	4	12	2
335 - 340	5	9	10
340 - 345	12	7	9
345 - 350	22	14	12
350 - 355	31	21	16
355 - 360	19	22	30

Fragment Hole Count Data

Firing No. 2

Test QD-155-S8A

Azimuthal Zone (°)	Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)		
	90-95	95-100	100-105
0 - 5	23	31	55
5 - 10	39	55	56
10 - 15	35	56	38
15 - 20	36	35	46
20 - 25	18	32	41
25 - 30	31	36	9
30 - 35	9	13	4
35 - 40	4	3	4
40 - 45	4	5	6
45 - 50	4	6	6
50 - 55	11	10	10
55 - 60	64	51	13
60 - 65	53	54	67
65 - 70	47	54	105
70 - 75	46	39	68
75 - 80	41	68	69
80 - 85	28	45	45
85 - 90	39	29	47
90 - 95	84	74	99
95 - 100	93	62	116
100 - 105	78	54	73
105 - 110	47	41	76
110 - 115	54	39	73
115 - 120	29	50	54
120 - 125	50	94	77
125 - 130	27	22	27
130 - 135	5	6	6
135 - 140	3	5	11
140 - 145	3	4	8
145 - 150	4	7	9
150 - 155	7	2	6
155 - 160	12	27	17
160 - 165	83	72	63
165 - 170	120	83	166
170 - 175	67	62	114
175 - 180	37	30	46
180 - 185	7	15	11
185 - 190	4	12	13
190 - 195	8	19	8
195 - 200	10	5	6
200 - 205	7	11	6

Fragment Hole Count Data

Firing No. 2

Test QD-155-S8A

(Continued)

Number of Fragment

Holes in 22-Gauge

Witness Panels

Azimuthal
Zone (°) per Polar Zone (°)

	90-95	95-100	100-105
205 - 210	3	10	8
210 - 215	5	10	11
215 - 220	4	4	6
220 - 225	8	6	7
225 - 230	15	20	25
230 - 235	51	47	63
235 - 240	31	36	54
240 - 245	50	43	83
245 - 250	43	57	95
250 - 255	40	45	66
255 - 260	36	46	32
260 - 265	27	49	29
265 - 270	32	29	21
270 - 275	33	22	26
275 - 280	24	36	37
280 - 285	30	30	20
285 - 290	30	30	20
290 - 295	26	21	40
295 - 300	79	34	54
300 - 305	76	52	42
305 - 310	10	17	12
310 - 315	13	8	3
315 - 320	7	4	6
320 - 325	8	9	4
325 - 330	4	10	10
330 - 335	8	8	3
335 - 340	3	5	8
340 - 345	13	23	6
345 - 350	11	7	10
350 - 355	11	20	18
355 - 360	14	24	29

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-SC4

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Four projectiles vertically positioned, cube configuration,
side-by-side, with the projectile centerline parallel and
7 in. apart

Number of Firings/Date: 1/7 November 1977

Location: NSWC/Explosive Experimental Area

Zone Information: Fragment recovery: 75 to 90° Polar
360° Azimuth

Meteorology: 7 November 1977
Barometric Pressure: 29.95 in Hg
Temperature: 72°F

Instrumentation: None

FRAGMENT HAZARD INVESTIGATION

Test Number: QD-155-SC12

Item Tested: M107 155-mm projectile, 15-lb TNT

Configuration: Eight projectiles vertically positioned, two-by-four matrix,
side-by-side, with the projectile centerline parallel and
7 in. apart

Number of Firings/Date: 1/20 June 1978

Location: NSWC/Explosive Experimental Area

Zone Information: Fragment recovery: 90 to 105° Polar
180° Azimuth
Fragment hole count: 85 to 105° Polar
180° Azimuth

Meteorology: 20 June 1978

Barometric Pressure: 28.75 in Hg

Temperature: 85°F

Instrumentation: None

Fragment Recovery Data for Azimuthal Zone 90-95°
Test No. QD-155-SC12

Fragment Wt. (gr)	Polar Zone (°)					
	60 - 65		65 - 70		70 - 75	
	No. Fragment	Total Fragment Wt. (gr)	No. Fragment	Total Fragment Wt. (gr)	No. Fragment	Total Fragment Wt. (gr)
0 - 108	17	352.7	12	391.2	15	485.1
108 - 308	1	298.8	2	358.8	2	420.4
308 - 500	0	0.0	1	357.3	0	0.0
500 - 600	0	0.0	0	0.0	0	0.0
600 - 700	0	0.0	0	0.0	0	0.0
700 - 800	0	0.0	0	0.0	1	746.9
800 - 900	0	0.0	0	0.0	1	868.6
900 - 1000	0	0.0	0	0.0	0	0.0
1000 - 1200	0	0.0	0	0.0	0	0.0
1200 - 1400	0	0.0	0	0.0	0	0.0
1400 - 1700	0	0.0	0	0.0	0	0.0
1700 - 2000	0	0.0	0	0.0	0	0.0
2000 - 2500	0	0.0	0	0.0	0	0.0
2500 - 3000	0	0.0	0	0.0	0	0.0
3000 +	0	0.0	0	0.0	0	0.0
Totals	18	651.4	15	1107.3	19	2521.0

Fragment Recovery Data for Azimuthal Zone 90-95°

Test No. QD-155-SC12

(Continued)

Fragment Wt. (gr)	Polar Zone (°)					
	75 - 90		90 - 95		95 - 100	
	No. Fragment	Total Fragment Wt. (gr)	No. Fragment	Total Fragment Wt. (gr)	No. Fragment	Total Fragment Wt. (gr)
0 - 108	4	110.9	44	685.3	41	865.5
108 - 308	1	127.8	4	920.9	4	639.1
308 - 500	1	332.6	0	0.0	1	345.0
500 - 600	0	0.0	0	0.0	2	1084.2
600 - 700	0	0.0	0	0.0	0	0.0
700 - 800	0	0.0	0	0.0	1	774.6
800 - 900	0	0.0	0	0.0	1	845.5
900 - 1000	0	0.0	0	0.0	0	0.0
1000 - 1200	0	0.0	1	1033.3	0	0.0
1200 - 1400	0	0.0	0	0.0	0	0.0
1400 - 1700	0	0.0	0	0.0	0	0.0
1700 - 2000	0	0.0	0	0.0	0	0.0
2000 - 2500	0	0.0	0	0.0	0	0.0
2500 - 3000	0	0.0	0	0.0	0	0.0
3000 +	0	0.0	0	0.0	0	0.0
Totals	6	571.3	49	2639.6	50	4553.8

Fragment Recovery Data for Azimuthal Zone 90-95°

Test No. QD-155-SC12

(Continued)

Fragment Wt. (gr)	Polar Zone (°)					
	100 - 105		105 - 110		110 - 115	
	No. Fragment	Total Fragment Wt. (gr)	No. Fragment	Total Fragment Wt. (gr)	No. Fragment	Total Fragment Wt. (gr)
0 - 108	51	1050.3	15	274.1	11	448.1
108 - 308	10	1715.6	10	1837.2	3	611.4
308 - 500	3	1341.3	4	1606.2	0	0.0
500 - 600	2	1110.3	0	0.0	2	1125.7
600 - 700	0	0.0	1	651.4	0	0.0
700 - 800	0	0.0	1	791.6	0	0.0
800 - 900	0	0.0	0	0.0	0	0.0
900 - 1000	0	0.0	0	0.0	0	0.0
1000 - 1200	0	0.0	1	1185.8	0	0.0
1200 - 1400	0	0.0	0	0.0	2	2541.0
1400 - 1700	0	0.0	2	3115.4	0	0.0
1700 - 2000	0	0.0	0	0.0	0	0.0
2000 - 2500	1	2105.2	0	0.0	0	0.0
2500 - 3000	0	0.0	0	0.0	0	0.0
3000 +	1	7760.1	0	0.0	1	6361.7
Totals	68	15082.8	34	9461.8	19	11088.0

Fragment Recovery Data for Azimuthal Zone 90-95°
 Test No. QD-155-SC12
 (Continued)

Fragment Wt. (gr)	Polar Zone (°)	
	115 - 120	
	No.	Total
	Fragment	Fragment
		Wt. (gr)
0 - 108	3	
0 - 108	3	83.2
108 - 308	1	194.0
308 - 500	1	341.9
500 - 600	0	0.0
600 - 700	1	617.5
700 - 800	0	0.0
800 - 900	0	0.0
900 - 1000	0	0.0
1000 - 1200	0	0.0
1200 - 1400	0	0.0
1400 - 1700	1	1515.8
1700 - 2000	0	0.0
2000 - 2500	0	0.0
2500 - 3000	0	0.0
3000 +	0	0.0
Totals	7	2787.4

Fragment Weight and Number Totals Combined for
Polar Zone 60-120° and Azimuthal Zone 90-95°
Test No. QD-155-SC12

<u>Fragment Wt.</u> <u>(gr)</u>	<u>No. of</u> <u>Fragment</u>	<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Wt. (gr)</u>
0 - 108	213	4746.3	22.3
108 - 308	38	7124.0	187.5
308 - 500	11	4324.3	393.1
500 - 600	6	3320.2	553.4
600 - 700	2	1269.0	634.5
700 - 800	3	2313.1	771.0
800 - 900	2	1714.0	857.0
900 - 1000	0	0.0	0.0
1000 - 1200	2	2219.1	1109.6
1200 - 1400	2	2541.0	1270.5
1400 - 1700	3	4666.2	1555.4
1700 - 2000	0	0.0	0.0
2000 - 2500	1	2105.2	2105.2
2500 - 3000	0	0.0	0.0
3000 +	2	14121.8	7060.9

Fragment Number Totals for Azimuthal Zone 75-120°
Test No. QD-155-SC12

Weight Group (gr)	60-65 No. Frag.	65-70 No. Frag.	70-75 No. Frag.	90-95 No. Frag.	95-100 No. Frag.	100-105 No. Frag.	105-110 No. Frag.	110-115 No. Frag.	115-120 No. Frag.
0 - 100	180	201	257	374	499	644	261	184	70
100 - 300	30	53	81	38	77	143	117	57	20
300 - 500	9	25	37	13	35	64	51	25	11
500 - 600	3	12	18	11	24	40	29	17	9
600 - 700	3	8	12	8	19	33	25	11	6
700 - 800	2	7	9	7	16	29	20	10	3
800 - 900	1	3	8	5	14	27	17	9	3
900 - 1000	1	3	3	5	9	23	15	9	3
1000 - 1200	1	3	3	4	8	18	14	8	2
1200 - 1400	1	2	3	3	6	13	8	7	2
1400 - 1700	1	2	2	3	5	12	7	4	2
1700 - 2000	1	2	2	3	3	7	4	2	-*
2000 - 2500	1	2	2	2	3	6	4	2	-*
3000+	-	-	1	1	1	3	2	2	-*

* No fragments in this weight group

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 90-95°

Polar Zone 60-120°

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
868.60	1.00	8.1	868.6	22.4
746.90	.80	7.5	1043.8	20.7
357.30	.60	11.8	768.8	6.3
332.60	.60	12.6	715.6	5.5
1033.30	1.20	8.1	786.1	26.4
7760.10	5.30	4.8	636.0	337.6
2105.20	1.80	6.0	871.7	73.2
580.60	1.20	14.5	441.7	8.3
529.80	.90	11.9	620.5	9.3
489.70	1.00	14.3	489.7	7.1
443.50	.80	12.6	619.8	7.3
408.10	.70	12.0	696.8	7.1
774.60	1.20	10.8	589.3	14.9
559.00	.90	11.3	654.7	10.3
345.00	.70	14.2	589.1	5.1
845.60	1.00	8.3	845.6	21.2
525.10	.90	12.0	615.0	9.1
1235.10	1.40	7.9	745.6	32.4
1305.90	1.30	7.0	881.0	39.0
6361.70	3.80	4.2	858.8	316.5
526.70	.90	12.0	616.9	9.2
599.10	.90	10.5	701.7	11.9
318.80	.70	15.4	544.3	4.3
677.60	1.00	10.3	677.6	13.6
779.20	1.30	11.7	525.7	13.9
1185.80	1.30	7.7	800.0	32.1
1464.50	1.80	8.6	606.4	35.4
1650.90	1.90	8.1	630.4	42.6
2152.90	2.30	7.5	617.2	59.9
3175.50	3.00	6.6	611.1	99.9
391.10	.60	10.7	841.5	7.6
394.20	.60	10.7	848.2	7.7
434.30	.70	11.3	741.6	8.0
651.40	1.20	12.9	495.5	10.5
791.60	1.00	8.8	791.6	18.6
386.50	.80	14.5	540.2	5.5
632.90	1.20	13.3	481.5	9.9
695.10	1.00	10.1	695.1	14.4
1550.80	1.40	6.3	936.2	51.0

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 90-95°

Polar Zone 60-120°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
341.90	.60	12.3	735.7	5.8
617.50	.70	7.9	1054.4	16.2

Total number of fragments = 41

Average ballistic density for all fragments = 703.2

Average gamma for all fragments = 10.167

Number of hazardous fragments in zone = 5

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 80-100°

Polar Zone 90-100°

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
527.2	.79	10.5	746.7	10.4
620.6	1.06	11.9	571.1	10.8
597.3	1.02	11.9	580.7	10.4
1865.5	3.48	13.0	288.0	29.8
821.9	1.54	13.1	429.3	13.0
1027.3	1.93	13.1	383.4	16.3
706.1	1.51	15.0	379.0	9.8
2266.7	2.36	7.3	625.2	74.7
1691.1	1.82	7.5	688.5	46.7
1783.7	1.96	7.7	649.3	48.2
1533.0	1.82	8.3	625.6	38.4
1885.5	2.27	8.4	550.0	46.5
1323.6	1.60	8.5	651.9	32.5
1910.2	2.45	9.0	498.6	44.3
773.4	1.12	10.2	648.6	15.8
521.4	.79	10.6	745.1	10.2
511.2	.80	10.9	718.9	9.7
2036.8	3.31	11.4	337.8	37.2
913.1	1.69	12.9	417.4	14.7
726.4	1.35	13.0	464.1	11.6
686.2	1.30	13.3	463.5	10.8
963.5	1.68	13.6	395.5	13.2
925.4	1.94	14.7	341.8	13.1
1135.2	1.35	8.3	722.9	28.3
2325.3	2.84	8.6	484.9	56.5
440.0	.82	8.8	877.0	15.3
1367.6	1.78	9.1	574.4	31.2
689.9	.95	9.6	746.1	14.9
1242.2	1.74	9.8	539.3	26.3
616.8	.88	10.0	744.6	12.8
1160.0	1.84	11.1	464.0	21.7
501.1	.80	11.1	703.5	9.4
811.3	1.31	11.3	543.6	15.0
1596.4	2.59	11.4	383.3	29.3
2570.6	4.19	11.4	300.0	46.9
565.6	.98	12.1	582.6	9.7
578.5	1.09	13.1	511.3	9.2
680.8	1.33	13.7	444.4	10.4
1617.1	3.77	16.3	221.2	20.6
3430.1	3.13	6.4	620.9	111.9

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 80-100°

Polar Zone 90-100°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
3450.1	3.21	6.5	599.2	110.1
2356.2	2.40	7.1	634.9	68.8
1277.0	1.35	7.4	812.0	35.8
1007.3	1.09	7.6	886.4	27.7
942.6	1.11	8.2	808.9	23.8
703.7	.86	8.6	881.4	17.1
1533.6	1.90	8.7	584.7	36.7
1119.8	1.49	9.3	615.1	25.0
712.0	.95	9.3	769.7	15.9
589.2	.79	9.4	842.0	13.1
579.2	.79	9.6	822.7	12.6
769.3	1.07	9.8	691.1	16.4
815.5	1.15	9.9	663.3	17.2
981.2	1.42	10.1	578.6	20.1
609.0	.91	10.5	699.9	12.1
3106.1	4.65	10.5	309.8	61.7
638.8	.97	10.6	671.9	12.5
672.0	1.02	10.7	649.2	13.1
669.1	1.04	10.9	630.8	12.8
525.6	.82	11.0	703.3	10.0
766.6	1.24	11.3	555.8	14.1
598.5	.98	11.4	619.3	10.9
1179.1	1.96	11.6	429.9	21.1
636.2	1.11	12.2	546.2	10.9
590.2	1.06	12.6	540.9	9.8
889.3	1.60	12.6	439.0	14.7
799.5	1.44	12.6	462.6	13.2
747.7	1.35	12.6	478.2	12.3
802.8	1.52	13.3	428.1	12.6
1485.1	3.15	14.8	265.6	20.8
1485.1	3.15	14.8	265.6	20.8

Total number of fragments = 71

Average ballistic density for all fragments = 571.1

Average gamma for all fragments = 10.75°

Number of hazardous fragments in zone = 5

Fragment Weight Presented Area Data
 Test No. QD-155-SC12
 Azimuthal Zone 75-120°
 Polar Zone 90-105°

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
3906.98	3.73	5.7	542.1	121.6
3802.28	2.28	4.2	1108.1	188.8
2450.14	2.64	7.5	572.4	67.7
7279.58	5.47	5.3	569.2	287.9
2638.02	3.56	9.5	392.3	58.0
2758.14	3.35	8.5	450.6	67.6
7760.06	5.34	4.8	628.1	334.8
3243.24	3.98	8.6	407.9	78.5
879.34	1.13	9.0	728.3	20.3
1820.28	1.85	7.1	722.2	53.2
1695.54	1.69	7.0	771.0	50.5
1643.18	1.54	6.6	859.7	52.1
997.92	1.06	7.4	917.8	28.0
1213.52	1.44	8.3	698.9	30.3
563.64	.94	11.7	615.6	10.0
512.82	1.07	14.6	461.7	7.3
497.42	.85	12.0	630.5	8.6
1074.92	1.22	8.0	794.5	28.1
2105.18	1.84	6.1	842.3	71.5
580.58	1.16	14.0	462.1	8.6
529.76	.87	11.5	651.1	9.6
489.72	.97	13.9	510.3	7.3
443.52	.83	13.0	590.7	7.1
774.62	1.22	11.0	573.5	14.6
559.02	.89	11.1	665.4	10.4
344.96	.69	14.0	600.1	5.1
1033.34	1.16	7.8	831.5	27.4
651.42	.85	9.1	831.4	14.8
539.00	.87	11.3	662.5	9.9
478.94	.76	11.1	720.2	8.9
397.32	.63	11.0	803.3	7.5
386.54	.62	11.2	798.1	7.2
346.50	.66	13.4	639.7	5.4
1093.40	1.11	7.1	934.3	32.0
418.88	.81	13.5	579.1	6.5
392.70	.80	15.0	509.6	5.5
311.08	.68	15.4	549.2	4.2
882.42	1.05	8.4	816.2	22.0
594.44	.94	11.1	648.4	11.1
563.64	.78	9.7	821.9	12.1

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 75-120°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
314.16	.62	13.8	641.4	4.7
434.28	.80	12.9	607.5	7.0
423.50	.74	12.3	659.3	7.2
392.70	.73	13.0	631.8	6.3
620.62	.92	10.4	701.1	12.4
383.46	.66	12.1	712.9	6.6
2220.68	2.32	7.3	627.8	63.1
1501.50	1.84	8.6	602.9	36.5
1449.14	1.74	8.4	629.0	35.8
851.62	1.41	11.6	507.4	15.3
1002.54	1.28	8.9	696.3	23.4
777.70	1.29	11.6	531.5	13.9
426.58	.79	13.0	604.5	6.8
973.28	1.17	8.4	764.7	24.0
888.58	1.27	10.0	618.0	18.4
568.26	1.02	12.5	553.2	9.4
426.58	.76	12.5	639.1	7.1
988.68	1.17	8.3	702.1	24.8
380.38	.66	12.1	712.7	6.5
355.74	.60	11.9	757.9	6.2
308.00	.57	12.9	716.4	4.9
321.86	.60	13.1	692.4	5.1
408.10	.74	12.7	641.2	6.7
845.46	1.00	8.2	850.1	21.3
525.14	.87	11.6	647.6	9.4
699.16	1.11	11.1	595.4	13.0
623.70	.89	10.0	736.7	12.9
520.52	.89	11.9	621.9	9.1
509.74	.74	10.2	798.7	10.4
405.02	.74	12.7	641.3	6.6
355.74	.62	12.3	723.2	6.0
569.80	.82	10.1	762.9	11.7
472.78	.89	13.2	561.8	7.5
495.88	.79	11.2	702.8	9.2
669.90	.89	9.3	792.5	14.9
642.18	.85	9.3	821.5	14.4
446.60	.76	11.9	675.1	7.8
311.08	.66	14.9	577.7	4.3
589.82	.82	9.7	798.1	12.6

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 75-120°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
636.02	.95	10.5	682.0	12.6
518.98	.83	11.2	682.1	9.6
914.76	1.50	11.5	496.6	16.5
971.74	1.24	8.9	707.6	22.7
793.10	1.09	9.6	694.4	17.1
355.74	.69	13.5	626.1	5.5
318.78	.85	18.6	407.5	3.6
780.78	1.14	10.2	641.2	15.9
1110.34	1.32	8.3	735.3	27.8
494.34	.98	13.9	510.6	7.4
1353.66	1.73	9.0	594.2	31.4
463.54	.91	13.8	532.4	7.0
1107.26	1.79	11.3	463.3	20.4
709.94	1.32	13.0	467.7	11.3
1021.02	1.29	8.9	695.3	24.0
930.16	1.41	10.6	553.2	18.2
885.50	1.29	10.2	60.12	18.0
876.26	1.70	13.6	396.4	13.4
1646.26	2.47	10.5	423.2	32.6
1096.48	1.56	10.0	563.2	22.9
694.54	1.29	13.0	475.3	11.1
896.28	1.42	11.1	527.5	16.8
900.90	1.43	11.1	528.4	16.9
2927.54	2.69	6.4	664.1	94.7
1466.08	2.01	9.6	516.4	31.9
2758.14	2.62	6.7	649.5	86.2
1570.80	2.13	9.5	505.5	34.4
1966.58	2.19	7.8	607.9	52.5
859.32	1.31	10.7	572.2	16.7
372.68	.56	10.4	900.7	7.4
358.82	.57	11.2	828.8	6.7
343.42	.57	11.7	789.8	6.1
352.66	.57	11.4	812.7	6.4

Total number of fragments = 112

Average ballistic density for all fragments = 652.7

Average gamma for all fragments = 10.630

Number of hazardous fragments in zone = 12

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 90-105°

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
2602.6	2.1	5.7	851.2	95.5
3049.2	2.1	4.8	1005.6	131.9
2413.2	2.3	6.7	685.4	74.8
3907.0	3.7	6.7	542.1	121.6
3555.9	3.0	5.9	684.3	125.2
3024.6	2.0	4.7	1043.2	133.7
3802.3	2.3	4.2	1108.1	188.8
3200.1	3.0	6.5	618.1	101.7
2450.1	2.6	7.5	572.4	67.7
2126.7	2.3	7.7	593.6	57.4
7279.6	5.5	5.3	569.2	287.9
2638.0	3.6	9.5	392.3	58.0
2758.1	3.3	8.5	450.6	67.6
7760.1	5.3	4.8	628.1	334.8
3243.2	4.0	8.6	407.9	78.5
20745.3	14.4	4.9	378.8	886.7
17911.7	11.5	4.5	459.3	829.0
6588.1	12.1	12.8	156.9	106.8
13974.0	7.8	3.9	637.8	741.0
6435.7	6.8	7.4	365.9	182.0
42088.2	24.5	4.1	347.1	2148.4
7336.6	5.4	5.1	590.5	298.2
3793.0	6.1	11.3	250.9	69.9
44321.2	23.1	3.6	400.3	2531.4
19042.1	11.0	4.0	525.4	983.9
13293.3	9.5	5.0	451.8	551.0
2442.4	2.6	7.4	591.4	68.9
3040.0	2.9	6.6	628.2	96.0
879.3	1.1	9.0	728.3	20.3
1820.3	1.9	7.1	722.2	53.2
1695.5	1.7	7.0	771.0	50.5
1643.2	1.5	6.6	859.7	52.1
997.9	1.1	7.4	917.8	28.0
1213.5	1.4	8.3	698.9	30.3
563.6	.9	11.7	615.6	10.0
512.8	1.1	14.6	461.7	7.3
497.4	.9	12.0	630.5	8.6
1074.9	1.2	8.0	794.5	28.1
2105.2	1.8	6.1	842.3	71.5
580.6	1.2	14.0	462.1	8.6

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
529.8	.9	11.5	651.1	9.6
489.7	1.0	13.9	510.3	7.3
443.5	.8	13.0	590.7	7.1
774.6	1.2	11.0	573.5	14.6
559.0	.9	11.1	665.4	10.4
345.0	.7	14.0	600.1	5.1
1033.3	1.2	7.8	831.5	27.4
572.9	.9	11.2	655.1	10.7
309.5	.6	14.2	621.7	4.5
651.4	.8	9.1	831.4	14.8
539.0	.9	11.3	662.5	9.9
478.9	.8	11.1	720.2	8.9
397.3	.6	11.0	803.3	7.5
386.5	.6	11.2	798.1	7.2
346.5	.7	13.4	639.7	5.4
1093.4	1.1	7.1	934.3	32.0
418.9	.3	13.5	579.1	6.5
392.7	.8	15.0	509.6	5.5
311.1	.7	15.4	549.2	4.2
882.4	1.1	8.4	816.2	22.0
594.4	.9	11.1	648.4	11.1
563.6	.8	9.7	821.9	12.1
314.2	.6	13.8	641.4	4.7
434.3	.8	12.9	607.5	7.0
423.5	.7	12.3	659.3	7.2
392.7	.7	13.0	631.8	6.3
620.6	.9	10.4	701.1	12.4
383.5	.7	12.1	712.9	6.6
2220.7	2.3	7.3	627.8	63.1
1501.5	1.8	8.6	602.9	36.5
1449.1	1.7	8.4	629.0	35.8
851.6	1.4	11.6	507.4	15.3
742.3	1.1	10.3	652.3	15.0
1047.2	1.3	8.4	746.8	26.0
1233.5	1.2	6.5	996.7	39.2
890.1	1.1	9.0	724.8	20.5
542.1	1.0	13.3	520.3	8.5
494.3	1.0	13.9	509.3	7.4
366.5	.9	16.7	448.8	4.6
11.1	.7	16.7	486.9	3.9

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1002.5	1.3	8.9	696.3	23.4
777.7	1.3	11.6	531.5	13.9
426.6	.8	13.0	604.5	6.8
973.3	1.2	8.4	764.7	24.0
888.6	1.3	10.0	618.0	18.4
568.3	1.0	12.5	553.2	9.4
426.6	.8	12.5	639.1	7.1
988.7	1.2	8.3	782.1	24.8
380.4	.7	12.1	712.7	6.5
355.7	.6	11.9	757.9	6.2
308.0	.6	12.9	716.4	4.9
321.9	.6	13.1	692.4	5.1
408.1	.7	12.7	641.2	6.7
845.5	1.0	8.2	850.1	21.3
525.1	.9	11.6	647.6	9.4
474.3	.8	11.4	696.2	8.6
471.7	.8	12.5	612.3	7.9
363.4	.9	16.4	461.3	4.6
622.2	1.0	10.9	649.9	11.8
820.8	.9	7.6	983.5	22.6
341.9	.8	16.8	460.7	4.2
583.7	1.0	12.0	582.8	10.1
388.1	.8	13.8	582.5	5.9
537.5	1.1	14.6	451.2	7.6
375.8	.8	14.1	571.9	5.3
446.6	.8	14.0	527.5	5.6
335.7	.8	16.3	485.9	4.3
525.1	1.1	15.2	432.5	7.2
360.4	.7	12.7	683.4	5.9
340.3	.7	15.3	531.9	4.3
318.8	.6	13.8	642.8	4.8
392.7	.8	14.9	515.4	5.5
602.1	.9	10.2	732.3	12.3
331.1	.7	13.9	620.3	5.0
329.6	.6	12.4	739.7	5.3
768.5	1.3	8.9	798.5	18.7
525.1	.9	12.3	593.1	8.9
429.7	.8	12.5	636.3	7.1
409.6	.7	12.5	651.6	6.8
369.6	.6	11.7	758.6	6.6

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
377.3	.7	13.1	635.9	6.0
311.1	.6	14.2	619.7	4.6
539.0	.8	9.8	827.4	11.5
614.5	1.1	12.1	562.2	10.6
1538.5	1.7	7.6	708.3	41.9
696.1	1.1	11.3	582.0	12.8
893.2	1.6	12.6	437.8	14.7
616.0	1.0	11.2	633.4	11.5
580.6	1.0	12.3	561.3	9.8
352.7	.9	17.7	419.3	4.1
623.7	1.4	15.7	375.9	8.2
705.3	1.3	12.5	496.0	11.7
632.9	1.0	11.0	638.8	12.0
976.4	1.4	10.3	563.3	19.6
974.8	1.4	10.1	580.6	20.0
871.6	1.1	8.7	773.2	20.8
314.2	.8	17.8	440.2	3.7
591.4	1.0	11.4	626.6	10.8
843.9	1.2	10.2	621.8	17.3
1110.3	1.3	7.9	789.9	29.2
592.9	1.1	12.9	521.7	9.6
417.3	1.0	16.5	429.6	5.3
785.4	1.3	11.2	560.8	14.6
366.5	.9	16.3	465.7	4.7
751.5	1.3	12.0	515.7	13.1
529.8	1.0	12.8	558.7	8.6
702.2	1.2	11.6	556.1	12.5
699.2	1.1	11.1	595.4	13.0
623.7	.9	10.0	736.7	12.9
520.5	.9	11.9	621.9	9.1
509.7	.7	10.2	798.7	10.4
405.0	.7	12.7	641.3	6.6
355.7	.6	12.3	723.2	6.0
569.8	.8	10.1	762.9	11.7
472.8	.9	13.2	561.8	7.5
495.9	.8	11.2	702.8	9.2
669.9	.9	9.3	792.5	14.9
642.2	.8	9.3	821.5	14.4
446.6	.8	11.9	675.1	7.8
311.1	.7	14.9	577.7	4.3

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
589.8	.8	9.7	798.1	12.6
636.0	1.0	10.5	682.0	12.6
519.0	.8	11.2	682.1	9.6
914.8	1.5	11.5	496.6	16.5
1852.6	2.1	8.1	595.3	47.8
1720.2	2.0	8.3	595.8	43.4
2148.3	2.5	8.0	555.5	55.7
557.5	1.4	17.2	347.7	6.7
1278.2	1.8	9.9	524.4	26.8
823.9	1.5	12.8	446.0	13.4
1751.0	2.3	9.1	507.1	39.9
1025.6	1.9	12.7	404.6	16.8
2097.5	1.9	6.5	779.5	67.6
971.7	1.2	8.9	707.6	22.7
793.1	1.1	9.6	694.4	17.1
355.7	.7	13.5	626.1	5.5
318.8	.8	18.6	407.5	3.6
780.8	1.1	10.2	641.2	15.9
1110.3	1.3	8.3	735.3	27.8
494.3	1.0	13.9	510.6	7.4
1353.7	1.7	9.0	594.2	31.4
463.5	.9	13.8	532.4	7.0
1107.3	1.8	11.3	463.3	20.4
709.9	1.3	13.0	467.7	11.3
1021.0	1.3	8.9	695.3	24.0
463.5	.9	13.4	557.3	7.2
309.5	.8	19.2	396.9	3.4
1054.9	1.3	8.7	705.2	25.3
1208.9	1.7	9.6	566.7	26.2
1044.1	1.6	10.9	505.2	20.0
611.4	1.2	13.2	492.3	9.6
817.7	1.2	10.4	612.0	16.4
486.6	.9	13.3	545.7	7.6
1587.7	1.8	7.9	662.5	41.8
1061.1	1.6	10.5	528.4	21.0
328.0	.8	16.7	472.6	4.1
569.8	1.1	13.5	495.8	8.8
771.5	1.2	11.0	574.1	14.5
825.4	1.2	10.2	628.4	16.9
625.2	1.0	11.5	603.4	11.3

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
494.3	1.0	13.7	518.3	7.5
381.9	.8	13.9	575.2	5.7
967.1	1.3	9.3	659.7	21.5
1208.9	1.4	8.1	728.8	31.0
1264.3	1.5	8.4	676.4	31.3
1090.3	1.4	9.1	648.7	25.0
1252.0	1.5	8.7	649.9	30.1
673.0	1.0	10.6	655.3	13.2
1971.2	2.6	9.1	477.2	44.8
2453.2	3.1	8.8	452.5	57.9
1690.9	2.5	10.3	428.1	34.0
1878.8	2.7	10.0	425.9	39.0
930.2	1.4	10.6	553.2	18.2
885.5	1.3	10.2	601.2	18.0
876.3	1.7	13.6	396.4	13.4
1646.3	2.5	10.5	423.2	32.6
1096.5	1.6	10.0	563.2	22.9
457.4	1.4	21.0	285.2	4.5
1960.4	1.9	6.9	733.0	59.3
694.5	1.3	13.0	475.3	11.1
896.3	1.4	11.1	527.5	16.8
900.9	1.4	11.1	528.4	16.9
608.3	1.2	13.3	487.7	9.5
557.5	1.3	16.1	384.3	7.2
1252.0	1.5	8.2	703.3	31.7
1093.4	1.4	9.3	627.4	24.5
1552.3	2.0	9.1	542.8	35.5
1566.2	2.3	10.2	455.1	32.0
1570.8	2.2	9.9	474.4	33.0
1165.8	2.0	12.3	397.7	19.7
777.7	1.1	9.5	722.7	17.1
1004.1	1.8	12.9	399.7	16.2
1663.2	2.2	9.2	515.4	37.6
2927.5	2.7	6.4	664.1	94.7
1466.1	2.0	9.6	516.4	31.9
2071.3	2.4	8.2	548.8	52.6
1062.6	1.7	11.3	471.5	19.5
2758.1	2.6	6.7	649.5	86.2
1570.8	2.1	9.5	505.5	34.4
1966.6	2.2	7.8	607.9	52.5

Fragment Weight Presented Area Data
 Test No. QD-155-SC12
 Azimuthal Zone 0-180°
 Polar Zone 90-105°
 (Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
908.6	1.4	10.4	576.6	18.1
859.3	1.3	10.7	572.2	16.7
432.7	.6	10.3	850.7	8.7
401.9	.8	13.1	617.3	6.4
616.0	.8	8.6	928.8	14.8
506.7	.8	11.5	670.1	9.2
381.9	.8	14.2	559.9	5.6
374.2	.7	12.4	697.2	6.3
320.3	.7	15.9	518.1	4.2
511.3	.9	12.9	557.2	8.2
349.6	.6	12.5	708.8	5.8
509.7	.9	12.3	601.7	8.6
438.9	.9	14.5	508.5	6.3
337.3	.6	13.1	672.2	5.4
329.6	.5	10.5	942.1	6.5
372.7	.6	10.4	900.7	7.4
358.8	.6	11.2	828.8	6.7
343.4	.6	11.7	789.8	6.1
352.7	.6	11.4	812.7	6.4
378.8	.6	11.4	784.1	6.9
317.2	.5	11.7	821.4	5.6
311.1	.5	10.8	931.0	6.0
1897.3	2.2	8.1	587.2	48.9
947.1	1.8	13.5	384.4	14.6
1014.9	1.5	10.1	575.2	21.0
699.2	1.3	12.7	486.8	11.4
1526.1	1.9	8.7	581.0	36.4
1609.3	1.9	8.2	619.4	40.7
850.1	1.2	9.8	650.7	18.0
696.1	1.0	10.2	676.6	14.1
1131.9	1.3	7.9	783.1	29.8
862.4	1.1	9.1	727.4	19.7
629.9	1.1	11.9	567.8	11.0
612.9	1.0	11.6	595.0	10.9
442.0	.8	12.8	609.0	7.2
452.8	1.0	14.8	485.3	6.4
847.0	1.1	9.2	725.8	19.2
1068.8	1.4	9.0	665.5	24.8
352.7	.8	16.1	482.6	4.6
332.6	.7	15.0	551.2	4.6

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1054.9	1.3	8.4	742.6	26.2
495.9	.9	12.2	617.3	8.5
1162.7	1.3	8.1	749.5	30.0
1586.2	1.8	7.8	678.8	42.5
1553.9	2.5	11.1	400.1	29.0
1980.4	2.1	7.3	670.5	56.6
1350.6	1.7	8.9	596.1	31.4
1957.3	2.2	7.8	612.4	52.5
619.1	.9	9.9	757.0	13.0
546.7	.9	12.1	597.7	9.4
369.6	.7	13.2	634.5	5.8
800.8	1.0	8.9	780.1	18.7
332.6	.6	12.5	726.2	5.5
813.1	1.0	8.9	776.1	19.0
555.9	1.0	12.3	576.7	9.4
392.7	.8	13.4	602.9	6.1
502.0	.7	10.0	823.0	10.4
397.3	.7	11.6	739.1	7.1
871.6	1.0	8.3	830.5	21.9
405.0	.7	12.0	696.1	7.0
354.2	.6	12.6	698.9	5.9
526.7	1.0	12.8	556.2	8.5
366.5	.7	13.2	637.3	5.8
463.5	.7	10.6	791.7	9.1
408.1	.8	13.3	595.0	6.4
314.2	.7	14.6	595.2	4.5
361.9	.6	12.4	705.7	6.1
317.2	.7	15.1	561.2	4.4
651.4	.9	9.2	823.3	14.7
711.5	.9	9.3	772.9	15.9
381.9	.7	11.9	726.2	6.7
803.9	1.1	9.6	699.0	17.5
360.4	.7	13.1	654.0	5.7
811.6	1.0	8.7	800.3	19.4
780.8	1.0	9.1	765.3	17.9
328.0	.5	11.7	811.3	5.8

Total number of fragments = 316

Average ballistic density for all fragments = 623.0

Average gamma for all fragments = 10.909

Number of hazardous fragments in zone = 33

Fragment Weight Presented Area Data
 Test No. QD-155-SC12
 Azimuthal Zone 0-180°
 Polar Zone 105-120°

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
369.6	.7	13.8	595.1	5.6
465.1	.7	10.2	835.0	9.5
569.8	.7	8.5	989.2	13.9
699.2	1.0	10.5	653.3	13.9
448.1	.6	10.1	865.2	9.3
614.5	.9	9.7	778.7	13.1
318.8	.5	11.1	892.0	6.0
324.9	.5	11.6	826.5	5.8
452.8	.7	11.0	755.2	8.6
458.9	.7	11.3	715.6	8.4
489.7	.8	10.9	737.9	9.4
345.0	.6	12.0	756.5	6.0
383.5	.7	12.9	649.1	6.2
526.7	.8	10.3	776.1	10.7
653.0	.9	9.2	822.3	14.8
454.3	.7	10.9	758.8	8.6
522.1	.7	9.9	818.0	10.9
974.8	1.0	7.4	931.7	27.4
309.5	.6	13.0	710.1	5.0
323.4	.6	12.1	778.3	5.6
371.1	.7	12.7	667.9	6.1
440.4	.8	12.3	647.3	7.5
617.5	.9	9.9	760.3	13.0
1044.1	1.3	8.9	681.4	24.4
531.3	.7	9.9	821.4	11.2
548.2	.8	9.8	812.5	11.6
318.8	.6	14.1	620.5	4.7
358.8	.5	10.6	902.0	7.1
519.0	.7	10.0	813.4	10.8
754.4	1.0	9.8	694.5	15.7
617.5	.9	10.3	710.2	12.4
391.2	.6	11.2	791.4	7.3
394.2	.6	10.7	846.5	7.7
434.3	.7	11.7	703.7	7.7
651.4	1.2	12.4	522.4	10.9
791.6	1.0	9.2	750.4	18.0
526.7	.9	12.5	576.3	8.8
599.1	.9	10.1	750.1	12.4
341.9	.6	11.7	795.8	6.1
617.5	.7	8.3	980.8	15.4

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 105-120°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
318.8	.6	12.4	751.1	5.3
443.5	.7	10.5	812.9	8.8
372.7	.8	14.6	543.7	5.3
338.8	.5	10.5	940.9	6.7
563.6	.8	9.5	845.7	12.4
1041.0	1.3	8.5	738.9	25.6
237.2	.5	14.5	687.5	3.4
537.5	.8	11.0	689.1	10.1
385.0	.6	11.1	803.3	7.2
420.4	.7	11.8	703.7	7.4
475.9	.8	11.9	655.4	8.3
485.1	.9	13.2	557.3	7.7
512.8	.8	11.2	687.7	9.5
323.4	.5	11.6	820.6	5.8
338.8	.6	12.9	688.6	5.5
455.8	.8	11.7	688.7	8.1
783.9	1.0	9.1	766.5	18.0
317.2	.5	10.8	931.6	6.1
440.4	.7	10.9	774.2	8.4
465.1	.7	10.7	773.6	9.0
352.7	.7	13.3	642.6	5.5
365.0	.7	13.5	621.0	5.6
389.6	.6	11.4	774.4	7.1
400.4	.7	11.5	746.0	7.2
405.0	.7	12.9	628.2	6.5
438.9	.8	12.6	627.8	7.3
443.5	.6	9.4	967.1	9.8
591.4	.9	10.1	750.9	12.2
597.5	.8	9.9	765.4	12.5
318.8	.7	14.8	577.7	4.5
677.6	1.0	10.6	654.7	13.3
309.5	.7	15.2	562.1	4.2
349.6	.7	14.8	552.2	4.9
372.7	.7	12.7	668.0	6.1
392.7	.7	13.3	606.5	6.1
397.3	.7	11.8	723.8	7.0
432.7	.7	10.7	805.6	8.4
505.1	.9	12.4	596.8	8.5
514.4	.9	12.9	559.9	8.3
582.1	.7	8.4	990.4	14.4

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 105-120°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
312.6	.7	16.4	497.3	4.0
338.8	.7	13.5	644.4	5.2
343.4	.7	14.3	582.3	5.0
514.4	.7	10.0	811.0	10.6
489.7	1.0	14.0	503.9	7.3
522.1	1.0	13.0	548.4	8.4
528.2	1.0	12.9	549.4	8.5
489.7	.9	12.8	580.5	8.0
991.8	1.3	9.2	664.8	22.4
687.9	1.1	10.0	657.1	16.3
386.5	.8	14.5	537.7	5.5
676.1	1.1	11.0	616.6	12.8
1054.9	1.3	8.6	720.7	25.6
1033.3	1.2	8.3	762.0	25.9
1008.7	1.3	9.1	667.6	23.0
189.4	1.4	52.2	112.8	.8
813.1	1.3	11.4	533.9	14.8
956.3	1.3	9.5	647.1	20.9
415.8	.7	12.5	649.3	6.9
417.3	.7	11.2	761.4	7.7
805.5	1.0	9.0	760.8	18.7
392.7	.9	15.6	479.4	5.2
962.5	1.2	9.1	690.2	22.1
1001.0	1.2	8.6	731.4	24.2
632.9	1.2	13.3	482.1	9.9
696.1	1.0	10.3	669.4	14.0
779.2	1.3	11.9	513.2	13.7
559.0	1.0	12.5	561.3	9.3
592.9	1.0	11.6	607.5	10.6
928.6	1.2	9.1	699.1	21.2
1064.1	1.4	9.3	631.7	23.8
705.3	1.2	11.5	564.6	12.7
930.2	1.3	10.0	603.2	19.3
480.5	1.0	14.1	504.4	7.1
743.8	1.1	10.0	675.4	15.4
1252.0	1.5	8.2	710.9	31.9
1635.5	1.4	6.0	978.6	56.4
1523.1	1.9	8.7	585.4	36.4
2601.1	2.0	5.4	919.6	100.5
6976.2	4.3	4.3	796.2	340.3

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 0-180°

Polar Zone 105-120°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
7007.0	3.8	3.8	933.6	380.6
5106.6	3.4	4.6	832.9	231.3
1185.8	1.3	7.7	800.0	32.1
1464.5	1.8	8.5	619.3	35.9
1650.9	1.9	7.8	656.1	43.8
1235.1	1.4	7.7	773.0	33.2
1305.9	1.3	6.9	898.3	39.5
6361.7	3.8	4.1	870.2	319.3
1550.8	1.4	6.5	895.9	49.6
1341.3	1.6	8.2	678.6	33.9
1464.5	1.8	8.4	632.6	36.4
1524.6	1.9	8.8	578.3	36.2
1734.0	2.1	8.5	569.8	42.5
2216.1	2.0	6.3	783.5	73.0
2899.8	2.2	5.3	893.7	114.0
3124.7	2.5	5.5	802.5	117.2
1538.5	1.8	8.0	655.2	39.8
2189.9	2.1	6.7	723.9	68.1
3635.9	2.6	5.0	875.7	152.1
2328.5	2.1	6.4	751.7	75.8
2152.9	2.3	7.5	610.6	59.5
3175.5	3.0	6.7	603.6	99.1
6292.4	3.4	3.8	985.5	341.8
1087.2	1.5	9.6	596.8	23.5
1307.5	1.7	9.2	581.3	29.6
1447.6	1.7	8.3	643.6	36.3

Total number of fragments = 146

Average ballistic density for all fragments = 709.8

Average gamma for all fragments = 10.655

Number of hazardous fragments in zone = 14

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 75-120°

Polar Zone 100-105°

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
3802.26	2.28	4.2	1108.1	188.8
2638.02	3.56	9.5	892.3	58.0
2758.14	3.35	8.5	450.6	67.6
7760.06	5.34	4.8	628.1	334.8
3243.24	3.98	8.6	407.9	78.5
1820.28	1.85	7.1	722.2	53.2
1695.54	1.69	7.0	771.0	50.5
1643.18	1.54	6.6	859.7	52.1
997.92	1.06	7.4	917.8	28.0
497.42	.85	12.0	630.5	8.6
2105.18	1.84	6.1	842.3	71.5
580.58	1.16	14.0	462.1	8.6
529.76	.87	11.5	651.1	9.6
489.72	.97	13.9	510.3	7.3
443.52	.83	13.0	590.7	7.1
651.42	.85	9.1	831.4	14.8
539.00	.87	11.3	662.5	9.9
478.94	.76	11.1	720.2	8.9
397.32	.63	11.0	803.3	7.5
386.54	.62	11.2	798.1	7.2
346.50	.66	13.4	639.7	5.4
1093.40	1.11	7.1	934.3	32.0
418.88	.81	13.5	579.1	6.5
392.78	.84	15.0	509.6	5.5
311.08	.68	15.4	549.2	4.2
882.42	1.05	8.4	816.2	22.0
434.28	.80	12.9	607.5	7.0
423.50	.74	12.3	659.3	7.2
392.70	.73	13.0	631.8	6.3
1449.14	1.74	8.4	629.0	35.8
1002.54	1.28	8.9	696.3	23.4
777.70	1.29	11.6	531.5	13.9
426.58	.79	13.0	604.5	6.8
973.28	1.17	8.4	764.7	24.0
888.58	1.27	10.0	618.0	18.4
568.26	1.02	12.5	553.2	9.4
408.10	.74	12.7	641.2	6.7
699.16	1.11	11.1	595.4	13.0
623.70	.89	10.0	736.7	12.9
520.52	.89	11.9	621.9	9.1

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 75-120°

Polar Zone 100-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
509.74	.74	10.2	798.7	10.4
405.02	.74	12.7	641.3	6.6
355.74	.62	12.3	723.2	6.0
495.88	.79	11.2	702.8	9.2
589.82	.82	9.7	798.1	12.6
914.76	1.50	11.5	496.6	16.5
971.74	1.24	8.9	707.6	22.7
793.10	1.09	9.6	694.4	17.1
1110.34	1.32	8.3	735.3	27.8
494.34	.98	13.9	510.6	7.4
1353.66	1.73	9.0	594.2	31.4
473.54	.91	13.8	532.4	7.0
1021.02	1.29	8.9	695.3	24.0
1096.48	1.56	10.0	563.2	22.9
894.54	1.29	13.0	475.3	11.1
896.28	1.42	11.1	527.5	16.8
900.90	1.43	11.1	528.4	16.9
1466.08	2.01	9.6	516.4	31.9
2758.14	2.62	6.7	649.5	86.2
859.32	1.31	10.7	572.2	16.7
372.68	.56	10.4	900.7	7.4
358.82	.57	11.2	628.8	6.7
343.42	.57	11.7	789.8	6.1
352.66	.57	11.4	812.7	6.4

Total number of fragments = 64

Average ballistic density for all fragments = 663.7

Average gamma for all fragments = 10.536

Number of hazardous fragments in zone = 7

Fragment Weight Presented Area Data

Test No. QD-155-SC12
(Interaction Fragment)
Azimuthal Zone 75-120°
Polar Zone 90-105°

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
3907.0	3.7	6.7	542.1	121.6
3802.3	2.3	4.2	1108.1	188.8
2450.1	2.6	7.5	572.4	67.7
7279.6	5.5	5.3	569.2	287.9
2638.0	3.6	9.5	392.3	58.0
2758.1	3.3	8.5	450.6	67.6
7760.1	5.3	4.8	628.1	334.8
3243.2	4.0	8.6	407.9	78.5
879.3	1.1	9.0	728.3	20.3
1820.3	1.9	7.1	722.2	53.2
1695.5	1.7	7.0	771.0	50.5
1643.2	1.5	6.6	859.7	52.1
997.9	1.1	7.4	917.8	28.0
1213.5	1.4	8.3	698.9	30.3
563.6	.9	11.7	615.6	10.0
512.8	1.1	14.6	461.7	7.3
497.4	.9	12.0	630.5	8.6
1074.9	1.2	8.0	794.5	28.1
2105.2	1.8	6.1	842.3	71.5
580.6	1.2	14.0	462.1	8.6
529.8	.9	11.5	651.1	9.6
489.7	1.0	13.9	510.3	7.3
443.5	.8	13.0	590.7	7.1
774.6	1.2	11.0	573.5	14.6
559.0	.9	11.1	665.4	10.4
345.0	.7	14.0	600.1	5.1
1033.3	1.2	7.8	831.5	27.4
651.4	.8	9.1	831.4	14.8
539.0	.9	11.3	662.5	9.9
476.9	.8	11.1	720.2	8.9
397.3	.6	11.0	803.3	7.5
386.5	.6	11.2	798.1	7.2
346.5	.7	13.4	639.7	5.4
1093.4	1.1	7.1	934.3	32.0
418.9	.8	13.5	579.1	6.5
392.7	.8	15.0	509.6	5.5
311.1	.7	15.4	549.2	4.2
882.4	1.1	8.4	816.2	22.0
594.4	.9	11.1	648.4	11.1

Fragment Weight Presented Area Data

Test No. QD-155-SC12

(Interaction Fragment)

Azimuthal Zone 75-120°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
563.6	.8	9.7	821.9	12.1
314.2	.6	13.8	641.4	4.7
434.3	.8	12.9	607.5	7.8
423.5	.7	12.3	659.3	7.2
392.7	.7	13.0	631.8	6.3
620.6	.9	10.4	701.1	12.4
383.5	.7	12.1	712.9	6.6
2220.7	2.3	7.3	627.8	63.1
1501.5	1.8	8.6	602.9	36.5
1449.1	1.7	8.4	629.0	35.8
851.6	1.4	11.6	507.4	15.3
1002.5	1.3	8.9	696.3	23.4
777.7	1.3	11.6	531.5	13.9
426.6	.8	13.0	604.5	6.8
973.3	1.2	8.4	764.7	24.0
888.6	1.3	10.0	618.0	18.4
568.3	1.0	12.5	553.2	9.4
426.6	.8	12.5	639.1	7.1
986.7	1.2	8.3	782.1	24.8
380.4	.7	12.1	712.7	6.5
355.7	.6	11.9	757.9	6.2
308.0	.6	12.9	716.4	4.9
321.9	.6	13.1	692.4	5.1
408.1	.7	12.7	641.2	6.7
845.5	1.0	8.2	850.1	21.3
525.1	.9	11.6	647.6	9.4
699.2	1.1	11.1	595.4	13.0
623.7	.9	10.0	736.7	12.9
520.5	.9	11.9	621.9	9.1
509.7	.7	10.2	798.7	10.4
405.0	.7	12.7	641.3	6.6
355.7	.6	12.3	723.2	6.0
569.8	.8	10.1	762.9	11.7
472.8	.9	13.2	561.8	7.5
495.9	.8	11.2	702.8	9.2
669.9	.9	9.3	792.5	14.9
642.2	.8	9.3	821.5	14.4
446.6	.8	11.9	675.1	7.8
311.1	.7	14.9	577.7	4.3

Fragment Weight Presented Area Data

Test No. QD-155-SC12

(Interaction Fragment)

Azimuthal Zone 75-120°

Polar Zone 90-105°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
589.8	.8	9.7	798.1	12.6
636.0	1.0	10.5	682.0	12.6
519.0	.8	11.2	682.1	9.6
914.8	1.5	11.5	496.6	16.5
971.7	1.2	8.9	707.6	22.7
793.1	1.1	9.6	694.4	17.1
355.7	.7	13.5	626.1	5.5
318.8	.8	18.6	407.5	3.6
780.8	1.1	10.2	641.2	15.9
1110.3	1.3	8.3	735.3	27.8
494.3	1.0	13.9	510.6	7.4
1353.7	1.7	9.0	594.2	31.4
463.5	.9	13.8	532.4	7.0
1107.3	1.8	11.3	463.3	20.4
709.9	1.3	13.0	467.7	11.3
1021.0	1.3	8.9	695.3	24.0
930.2	1.4	10.6	553.2	18.2
885.5	1.3	10.2	601.2	18.0
876.3	1.7	13.6	396.4	13.4
1646.3	2.5	10.5	423.2	32.6
1096.5	1.6	10.0	563.2	22.9
694.5	1.3	13.0	475.3	11.1
896.3	1.4	11.1	527.5	16.8
900.9	1.4	11.1	528.4	16.9
2927.5	2.7	6.4	664.1	94.7
1466.1	2.0	9.6	516.4	31.9
2758.1	2.6	6.7	649.5	86.2
1570.8	2.1	9.5	505.5	34.4
1966.6	2.2	7.8	607.9	52.5
859.3	1.3	10.7	572.2	16.7
372.7	.6	10.4	900.7	7.4
358.8	.6	11.2	828.8	6.7
343.4	.6	11.7	789.8	6.1
352.7	.6	11.4	812.7	6.4

Total number of fragments = 112

Average ballistic density for all fragments = 652.7

Average gamma for all fragments = 10.630

Number of hazardous fragments in zone = 12

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 75-120°

Polar Zone 60-120°

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
591.36	.88	10.5	712.7	11.8
338.80	.51	10.5	941.3	6.7
348.04	.63	12.7	697.7	5.7
435.82	.77	12.4	645.0	7.3
790.02	1.14	10.1	649.1	16.3
797.72	1.06	9.3	731.0	17.8
344.96	.66	13.5	637.6	5.3
845.46	1.10	9.1	732.8	19.3
968.66	1.24	9.0	701.5	22.5
364.98	.56	10.6	882.7	7.1
388.08	.61	11.1	806.6	7.3
408.10	.75	12.8	632.1	6.6
465.08	.75	11.2	720.4	8.6
522.06	.72	9.7	854.5	11.2
526.68	.90	12.0	616.9	9.2
563.64	.85	10.5	723.1	11.1
321.86	.54	11.7	815.6	5.7
328.02	.52	11.2	867.3	6.1
371.14	.66	12.4	696.9	6.2
357.28	.60	11.7	776.5	6.4
746.90	.83	7.8	984.2	19.9
868.56	.96	7.7	922.0	23.3
332.64	.62	13.0	683.0	5.3
406.56	.69	11.8	715.5	7.2
448.14	.77	12.0	664.5	7.8
482.02	.78	11.3	698.4	8.8
492.80	.78	11.1	718.1	9.3
366.52	.66	12.7	677.4	6.0
867.02	1.13	9.1	721.8	19.8
620.62	.89	10.1	736.7	12.8
867.02	1.13	9.1	721.8	19.8
375.76	.68	12.7	670.1	6.2
311.08	.47	10.5	981.1	6.2
383.46	.55	10.0	942.7	8.0
526.68	.72	9.6	863.9	11.5
311.08	.69	15.5	541.6	4.2
320.32	.59	12.9	705.0	5.2
368.86	.62	11.8	753.9	6.5
309.54	.55	12.4	763.0	5.2
334.18	.67	14.1	603.9	4.9

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 75-120°

Polar Zone 60-120°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
371.14	.67	12.6	682.9	6.1
412.72	.85	14.3	530.4	6.0
374.22	.54	10.0	953.6	7.8
344.96	.63	12.8	686.6	5.6
315.70	.52	11.5	846.8	5.7
348.04	.66	13.2	652.1	5.5
363.44	.57	11.0	840.1	6.9
383.46	.79	14.5	542.0	5.5
417.34	.69	11.6	723.4	7.5
426.58	.68	11.2	757.4	7.9
441.98	.65	10.3	839.5	8.9
552.86	.95	12.0	601.8	8.6
585.20	.88	10.6	706.5	11.5
600.60	.78	9.0	878.6	13.8
691.46	.99	10.0	699.8	14.3
311.08	.57	12.8	721.0	5.0
617.54	1.02	11.6	599.5	11.1
321.86	.50	11.0	899.5	6.1
389.62	.62	11.1	798.1	7.3
417.34	.78	13.0	608.2	6.7
483.56	.70	10.2	822.1	9.9
488.18	.81	11.6	670.9	8.8
888.58	1.21	9.5	667.6	19.4
457.38	.89	13.5	549.4	7.0
702.24	1.10	11.0	608.7	13.3
688.38	.96	9.7	737.6	14.7
830.06	1.26	10.6	586.9	16.2
733.04	1.13	10.8	610.3	14.1
739.20	1.05	9.9	687.0	15.5
993.30	1.31	9.2	662.5	22.4
545.16	.90	11.6	638.5	9.8
539.00	.95	12.3	584.0	9.1
562.10	1.01	12.6	553.8	9.3
2018.94	1.90	6.6	778.9	63.7
2025.10	1.87	6.5	791.9	65.2
2057.44	1.83	6.2	831.1	68.7
1347.50	1.50	7.8	733.5	36.0
2266.88	2.28	7.0	658.5	67.0
1361.36	1.20	6.2	1035.6	45.9
3269.42	2.18	4.7	1015.7	145.7

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 75-120°

Polar Zone 60-120°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1101.10	1.45	9.2	630.6	24.8
2810.50	4.64	11.6	281.2	50.6
1252.02	1.46	8.2	710.9	31.9
1635.48	1.41	6.0	978.6	56.4
1523.06	1.89	8.7	585.4	36.4
2601.06	2.00	5.4	919.6	100.5
6976.20	4.25	4.3	796.2	340.3
7007.00	3.83	3.8	933.6	380.6
5106.64	3.35	4.6	832.9	231.3
1185.80	1.30	7.7	800.0	32.1
1464.54	1.78	8.5	619.3	35.9
1650.88	1.85	7.8	656.1	43.8
1235.08	1.37	7.7	773.0	33.2
1305.92	1.28	6.9	898.3	39.5
6361.74	3.77	4.1	870.2	319.3
1550.78	1.44	6.5	895.9	49.6
1341.34	1.58	8.2	678.6	33.9
1464.54	1.75	8.4	632.6	36.4
1524.60	1.91	8.8	578.3	36.2
1734.04	2.10	8.5	569.8	42.5
2216.06	2.00	6.3	783.5	73.0
2899.82	2.19	5.3	893.7	114.0
3124.66	2.48	5.5	902.5	117.2
1538.46	1.77	8.0	655.2	39.8
2189.88	2.09	6.7	723.9	68.1
3635.94	2.58	5.0	875.7	152.1
2328.48	2.13	6.4	751.7	75.8
2152.92	2.32	7.5	610.6	59.5
3175.48	3.03	6.7	603.6	99.1
6292.44	3.44	3.8	985.5	341.8
1087.24	1.49	9.6	596.8	23.5
1307.46	1.72	9.2	581.3	29.6
1447.60	1.72	8.3	643.6	36.3
369.60	.73	13.8	595.1	5.6
465.08	.68	10.2	835.0	9.5
569.80	.69	8.5	989.2	13.9
699.16	1.05	10.5	653.3	13.9
448.14	.64	10.1	865.2	9.3
614.46	.85	9.7	778.7	13.1
318.78	.50	11.1	892.0	6.0

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 75-120°

Polar Zone 60-120°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
324.94	.54	11.6	826.5	5.8
452.76	.71	11.0	755.2	8.6
458.92	.74	11.3	715.6	8.4
489.72	.76	10.9	737.9	9.4
344.96	.59	12.0	756.5	6.0
383.46	.70	12.9	649.1	6.2
526.68	.77	10.3	776.1	10.7
652.96	.86	9.2	822.3	14.8
454.30	.71	10.9	758.8	8.6
522.06	.74	9.9	818.0	10.9
974.82	1.03	7.4	931.7	27.4
309.54	.57	13.0	710.1	5.0
323.40	.56	12.1	778.3	5.6
371.14	.68	12.7	667.9	6.1
440.44	.77	12.3	647.3	7.5
617.54	.87	9.9	760.3	13.0
1044.12	1.33	8.9	681.4	24.4
531.30	.75	9.9	821.4	11.2
548.24	.77	9.8	812.5	11.6
318.78	.64	14.1	620.5	4.7
358.82	.54	10.6	902.0	7.1
518.98	.74	10.0	813.4	10.8
745.36	1.05	9.8	694.5	15.7
617.54	.91	10.3	710.2	12.4
391.16	.63	11.2	791.4	7.3
394.24	.60	10.7	846.5	7.7
434.28	.72	11.7	703.7	7.7
651.42	1.16	12.4	522.4	10.9
791.56	1.04	9.2	750.4	18.0
526.68	.94	12.5	576.3	8.8
599.06	.86	10.1	750.1	12.4
341.88	.57	11.7	795.8	6.1
617.54	.73	8.3	980.8	15.4
318.78	.56	12.4	751.1	5.3
443.52	.67	10.5	812.9	8.8
372.68	.78	14.6	543.7	5.3
338.80	.51	10.5	940.9	6.7
563.64	.76	9.5	845.7	12.4
1041.04	1.26	8.5	738.9	25.6
237.16	.49	14.5	687.5	3.4

Fragment Weight Presented Area Data

Test No. QD-155-SC12

Azimuthal Zone 75-120°

Polar Zone 60-120°

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
537.46	.85	11.0	689.1	10.1
385.00	.61	11.1	803.3	7.2
420.42	.71	11.8	703.7	7.4
475.86	.81	11.9	655.4	8.3
485.10	.91	13.2	557.3	7.7
512.82	.82	11.2	687.7	9.5
323.40	.54	11.6	820.6	5.8
338.80	.62	12.9	688.6	5.5
455.84	.76	11.7	688.7	8.1
783.86	1.01	9.1	766.5	18.0
317.24	.49	10.8	931.6	6.1
440.44	.69	10.9	774.2	8.4
465.08	.71	10.7	773.6	9.0
352.66	.67	13.3	642.6	5.5
364.98	.70	13.5	621.0	5.6
389.62	.63	11.4	774.4	7.1
400.40	.66	11.5	746.0	7.2
405.02	.75	12.9	628.2	6.5
438.90	.79	12.6	627.8	7.3
443.52	.59	9.4	967.1	9.8
591.36	.85	10.1	750.9	12.2
597.52	.85	9.9	765.4	12.5
318.78	.67	14.8	577.7	4.5
677.60	1.02	10.6	654.7	13.3
309.54	.67	15.2	562.1	4.2
349.58	.74	14.8	552.2	4.9
372.68	.68	12.7	668.0	6.1
392.70	.75	13.3	606.5	6.1
397.32	.67	11.8	723.8	7.0
432.74	.66	10.7	805.6	8.4
505.12	.89	12.4	596.8	8.5
514.36	.95	12.9	559.9	8.3
582.12	.70	8.4	990.4	14.4
312.62	.73	16.4	497.3	4.0
338.80	.65	13.5	644.4	5.2
343.42	.70	14.3	582.3	5.0
514.36	.74	10.0	811.0	10.6
489.72	.98	14.0	503.9	7.3
522.06	.97	13.0	548.4	8.4
528.22	.97	12.9	549.4	8.5

Fragment Weight Presented Area Data
 Test No. QD-155-SC12
 Azimuthal Zone 75-120°
 Polar Zone 60-120°
 (Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
489.72	.89	12.8	580.4	8.0
991.76	1.31	9.2	664.8	22.4
786.94	1.13	10.0	657.1	16.3
386.54	.80	14.5	537.7	5.5
676.06	1.06	11.0	616.6	12.8
1054.90	1.29	8.6	720.7	25.6
1033.34	1.23	8.3	762.0	25.9
1008.70	1.32	9.1	667.6	23.0
189.42	1.41	52.2	112.8	.8
813.12	1.32	11.4	533.9	14.8
956.34	1.30	9.5	647.1	20.9
415.80	.74	12.5	649.3	6.9
417.34	.67	11.2	761.4	7.7
808.50	1.04	9.0	760.8	18.7
392.70	.88	15.6	479.4	5.2
962.50	1.25	9.1	690.2	22.1
1001.00	1.23	8.6	731.4	24.2
632.94	1.20	13.3	482.1	9.9
696.08	1.03	10.3	669.4	14.0
779.24	1.32	11.9	513.2	13.7
559.02	1.00	12.5	561.3	9.3
928.62	1.21	9.1	699.1	21.2
1064.14	1.42	9.3	631.7	23.8
705.32	1.16	11.5	564.6	12.7
930.16	1.33	10.0	603.2	19.3
480.48	.97	14.1	504.4	7.1
743.82	1.07	10.0	675.4	15.4

Total number of fragments = 228

Average ballistic density for all fragments = 716.0

Average gamma for all fragments = 10.725

Number of hazardous fragments in zone = 19

Fragment Hole Count Data
Test No. QD-155-SC12

<u>Azimuthal Zone (°)</u>	<u>Number of Fragment Holes in 22-Gauge Witness Panels per Polar Zone (°)</u>
180 - 190	342
190 - 200	61
200 - 210	31
210 - 220	28
220 - 230	155
230 - 240	369
240 - 250	392
250 - 260	377
260 - 270	269
270 - 280	135
280 - 290	108
290 - 300	85
300 - 310	144
310 - 320	194
320 - 330	178
330 - 340	126
340 - 350	53
350 - 360	55

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS

Location: White Sands Missile Range, NM

Date: 8 August 1979

Collection Zone: Azimuth: 360°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
4524.52	2.85	4.4	940.4	213.4
1047.20	1.47	9.8	589.6	22.2
27750.80	11.58	2.9	704.7	1976.9
3538.92	3.35	6.6	577.2	111.1
1607.76	2.00	8.7	568.4	38.4
3870.02	4.18	7.6	452.8	106.5
7002.38	6.25	6.2	448.2	233.1
44.66	.15	24.0	746.2	.4
2140.60	2.56	8.4	522.6	53.2
3629.78	3.10	6.0	665.0	126.3
3894.66	3.80	6.8	525.8	118.6
4938.78	4.54	6.4	510.5	159.6
5202.12	5.03	6.8	461.1	159.9
5562.48	5.00	6.3	497.5	183.9
10197.88	7.40	5.1	506.6	417.6
23352.56	13.35	4.0	478.8	1213.8
999.46	1.39	9.7	612.1	21.4
1041.04	1.36	9.2	654.7	23.6
2460.92	2.63	7.5	478.6	68.6
280.28	.54	13.5	702.5	4.3
364.98	.58	11.0	835.9	6.9
372.68	.65	12.2	711.0	6.3
411.18	.74	12.5	650.6	6.8
420.42	.64	10.7	816.6	8.2
497.42	.91	12.8	571.9	8.1
523.60	1.00	13.4	521.1	8.1
602.14	1.10	12.8	522.5	9.8
740.74	.91	8.6	857.9	18.0
891.66	1.31	10.3	592.9	18.0
1784.86	1.92	7.5	672.6	49.4
150.92	.34	15.8	756.5	2.0
246.40	.46	12.9	801.3	4.0
255.64	.49	13.4	744.4	4.0
260.26	.54	14.4	661.7	3.7
280.28	.61	15.2	593.1	3.8
292.60	.48	11.4	888.3	5.3

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS
(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
360.36	.59	11.4	804.1	6.6
372.68	.84	15.7	487.8	4.9
432.74	.74	12.0	675.9	7.5
435.82	.74	12.0	677.8	7.6
466.62	.89	13.3	559.9	7.3
512.82	.80	10.9	721.6	9.8
565.18	1.08	13.3	506.7	8.8
697.62	1.05	10.6	644.4	13.7
709.94	1.02	10.0	690.3	14.7
716.10	.85	8.3	912.7	17.9
811.58	1.46	12.6	459.0	13.4
868.56	1.19	9.6	671.1	18.9
903.98	1.31	10.2	601.1	18.5
1036.42	1.18	7.9	811.6	27.1
1316.70	2.03	10.8	454.1	25.3
1795.64	1.85	7.2	713.6	51.8
1855.70	1.47	5.5	1044.7	69.8
2356.20	1.81	5.4	968.9	91.2
2457.84	1.77	5.0	1046.7	101.6
101.64	.28	19.2	689.9	1.1
161.70	.38	16.3	702.1	2.1
163.24	.34	14.7	814.8	2.3
212.52	.47	15.4	663.1	2.9
224.84	.56	17.4	537.1	2.7
260.26	.59	15.8	578.4	3.4
267.96	.64	16.6	526.9	3.3
287.98	.63	15.3	574.0	3.9
303.38	.60	13.9	648.0	4.5
351.12	.64	12.8	679.8	5.7
358.82	.71	13.9	596.1	5.4
368.06	.74	14.0	582.9	5.5
377.30	.73	13.5	608.9	5.8
431.20	.90	14.7	500.9	6.1
446.60	.87	13.7	545.6	6.8
514.36	.98	13.4	529.3	8.0
629.86	1.21	13.4	475.5	9.8
632.94	1.18	13.0	496.8	10.1
897.82	1.46	11.3	511.5	16.5
922.46	1.48	11.2	511.2	17.1
1062.60	1.40	9.2	643.3	24.0
1239.70	1.67	9.4	576.1	27.4
1321.32	1.45	7.7	756.8	35.8

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
2605.68	1.87	5.0	1021.7	108.1
1433.74	1.18	5.8	1113.8	51.6
2037.42	2.05	7.0	694.1	60.2
3985.52	2.65	4.7	923.9	178.1
679.14	1.05	10.8	633.6	13.1
702.24	1.05	10.5	649.6	13.9
984.06	2.08	14.8	326.9	13.8
2120.58	1.95	6.4	778.8	68.5
2427.04	2.23	6.4	727.2	78.4
5299.14	4.23	5.6	608.4	197.1
9681.98	5.40	3.9	771.6	515.8
3481.94	2.23	4.5	1043.3	161.3
4082.54	5.30	9.1	334.6	93.4
2225.30	1.96	6.2	812.0	75.1
731.50	.92	8.8	826.8	17.3
4820.20	2.65	3.8	1117.4	260.5
645.26	1.05	11.4	602.1	11.8
922.46	1.58	12.0	466.2	16.0
1507.66	1.67	7.7	700.7	40.5
6474.16	2.45	2.6	1688.2	508.4
1461.46	1.73	8.3	640.4	36.6
426.58	.87	14.3	523.4	6.2
2530.22	2.82	7.8	535.2	67.5
2551.78	1.84	5.0	1022.4	105.2
662.20	1.24	13.1	480.4	10.5
883.96	1.40	11.1	531.3	16.5
4458.30	6.15	9.7	292.3	96.0
1530.76	1.83	8.4	618.3	38.0
1958.88	3.13	11.2	353.7	36.4
8624.00	8.09	6.6	374.8	273.2
23911.58	15.17	4.4	404.7	1119.9
1290.52	2.03	11.0	446.2	24.4
4826.36	2.69	3.9	1093.9	257.3
11371.36	5.67	3.5	842.2	677.7
21673.96	11.21	3.6	577.5	1245.2
586.74	1.83	21.8	237.1	5.6
1321.32	1.55	8.2	684.7	33.5
1650.92	1.12	4.6	1433.0	76.1
542.08	.88	11.4	653.8	9.9
776.16	1.26	11.4	547.7	14.2
782.32	1.15	10.3	637.8	15.9
947.10	1.47	10.9	530.7	18.1

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS
(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
950.18	1.21	8.9	711.7	22.1
1004.08	1.51	10.5	540.6	19.8
1178.10	1.68	10.0	539.9	24.5
1409.10	1.77	8.8	600.1	33.4
1424.50	1.73	8.5	624.2	34.8
1456.84	1.20	5.8	1108.3	52.6
1613.92	1.42	6.1	957.2	54.6
2251.48	2.50	7.8	569.6	60.3
1315.16	1.66	8.8	614.9	31.0
1479.94	1.74	8.2	644.8	37.4
1652.42	2.08	8.8	550.8	39.0
1667.82	1.80	7.6	690.6	45.9
3144.68	2.07	4.6	1058.5	142.2
3304.84	2.86	6.1	683.3	113.5
6962.34	6.30	6.3	440.3	228.6
1262.80	2.34	13.0	352.8	20.2
940.94	1.11	8.3	801.8	23.6
1041.04	1.57	10.5	531.1	20.6
1084.16	1.59	10.3	540.0	21.9
1325.94	1.47	7.8	744.0	35.5
1798.72	1.60	6.2	887.1	60.0
1829.52	2.07	7.9	613.4	48.0
1888.04	1.95	7.2	693.4	54.3
4442.90	4.54	7.1	459.6	129.3
5117.42	3.83	5.2	683.3	203.3
25302.20	11.79	3.3	624.9	1613.2
28665.56	11.70	2.9	716.3	2086.9
606.76	.97	11.2	632.9	11.3
850.08	1.24	10.2	615.6	17.3
970.20	1.27	9.1	680.3	22.1
1105.72	1.54	9.7	580.4	23.6
1256.64	1.71	9.5	562.0	27.4
2282.28	1.24	3.8	1652.9	124.8
5134.36	5.45	7.4	403.5	143.7
7465.92	6.24	5.9	479.0	265.4
13353.34	12.83	6.7	290.5	412.9
28596.26	12.51	3.1	646.3	1942.3
39782.82	21.58	3.8	397.0	2179.7
585.20	.80	9.5	825.5	12.8
1402.94	1.35	6.7	894.4	43.3
1492.26	2.28	10.7	433.5	29.0
645.26	1.08	11.7	578.6	11.5

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS
(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1121.12	1.96	12.3	407.3	19.0
2168.32	4.78	15.4	207.5	29.2
2382.38	2.68	7.9	543.0	62.9
2835.14	3.23	8.0	488.4	73.9
8463.86	7.50	6.2	413.0	285.2
10291.82	8.24	5.6	435.1	382.0
4070.22	2.86	4.9	841.5	172.1
2003.54	2.28	8.0	582.0	52.3
5021.94	2.90	4.0	1016.9	258.4
623.70	1.32	14.8	411.6	8.8
805.42	1.67	14.5	373.0	11.5
714.56	1.25	12.2	513.9	12.2
1287.44	1.42	7.7	763.5	34.8
3820.74	4.30	7.9	428.5	100.9
9309.30	5.56	4.2	710.4	463.3
762.30	1.17	10.8	601.2	14.7
924.00	1.64	12.4	440.8	15.5
1801.80	3.67	14.2	256.6	26.3
20066.20	8.47	3.0	814.5	1413.1
21604.66	10.03	3.3	679.8	1382.3
799.26	1.20	10.5	609.9	15.9
1638.56	1.83	7.8	660.1	43.5
2608.76	2.48	6.6	670.0	81.7
2109.80	2.65	8.8	489.1	49.9
3817.66	4.87	8.9	355.6	89.0
300.30	.75	17.6	459.4	3.6
451.22	.68	10.6	799.2	8.9
643.72	1.14	12.4	529.0	10.8
994.84	1.23	8.6	731.8	24.0
2713.48	1.99	5.1	964.5	109.8
693.00	1.23	12.5	505.7	11.6
887.04	1.68	13.2	408.6	13.9
1298.22	1.62	8.7	631.6	31.0
790.02	1.39	12.3	481.4	13.3
292.60	.80	19.1	409.2	3.2
535.92	1.16	15.2	428.5	7.4
686.84	.76	7.8	1030.3	18.4
768.46	1.89	17.2	295.2	9.3
1338.26	2.43	12.7	354.4	21.9
5419.26	4.98	6.4	488.4	175.4
571.34	.81	9.9	789.4	12.0
1051.82	1.23	8.2	774.9	26.8

FAR-FIELD FRAGMENT COLLECTION DATA
FOR DETONATION OF EIGHT SINGLE PALLETS

(Continued)

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1062.60	1.44	9.5	615.1	23.3
774.62	1.40	12.6	468.2	12.7
984.06	1.91	13.6	372.3	15.1
4190.34	3.68	6.1	594.8	142.0
753.06	1.29	12.0	515.0	13.1
796.18	1.36	11.9	504.2	13.9
1208.90	1.50	8.7	659.7	29.0
1467.62	2.14	10.2	468.8	29.9
2363.90	4.50	13.3	247.6	36.9
2596.44	2.58	7.0	625.3	77.5
25872.00	13.68	3.7	511.6	1454.4
13679.82	6.73	3.4	783.5	826.2
9021.32	6.31	4.9	569.1	383.2
1635.48	2.41	10.3	437.1	33.0
47193.30	20.28	3.0	516.7	3263.3
354.20	.62	12.3	724.4	6.0
902.44	1.70	13.2	408.1	14.3
1618.54	2.14	9.3	517.0	36.4
16570.40	12.28	5.2	385.1	664.4
23281.72	14.63	4.4	416.1	1100.9

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-20°
Range: 500 to 2700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>	<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Wt. (gr)</u>
0 - 300	229	25637.9	112.0
300 - 500	27	10935.5	405.0
500 - 600	10	5382.3	538.2
600 - 700	10	6460.3	646.0
700 - 800	11	8183.6	744.0
800 - 900	4	3494.3	873.6
900 - 1000	3	2853.6	951.2
1000 - 1200	14	15369.2	1097.8
1200 - 1400	7	9130.7	1304.4
1400 - 1700	9	13421.1	1491.2
1700 - 2000	4	7447.4	1861.9
2000 - 2500	5	10490.5	2098.1
2500 - 3000	1	2752.0	2752.0
3000+	16	110355.4	6928.5

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

<u>Fragment Wt. (gr)</u>	<u>No. Fragment</u>	<u>Fragment Wt. (gr)</u>	<u>Average Wt. (gr)</u>
0 - 300	1080	90419.6	83.7
300 - 500	88	34212.6	388.8
500 - 600	25	13652.1	546.1
600 - 700	16	10234.8	639.7
700 - 800	15	11161.9	744.1
800 - 900	16	13496.6	843.5
900 - 1000	9	8428.4	936.5
1000 - 1200	4	4570.7	1142.7
1200 - 1400	11	14269.6	1297.2
1400 - 1700	7	10673.7	1524.8
1700 - 2000	4	7327.3	
2000 - 2500	11	24944.9	2267.7
2500 - 3000	4	10732.3	2683.1
3000+	12	63095.3	5257.9

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 90-95°
Range: 500 to 2700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>	<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Wt. (gr)</u>
0 - 308	514	47941.8	93.3
308 - 500	69	27060.9	392.2
500 - 600	15	8356.0	557.1
600 - 700	17	11112.6	653.7
700 - 800	5	3888.5	777.7
800 - 900	9	7797.0	866.3
900 - 1000	4	3839.2	959.8
1000 - 1200	10	11057.2	1105.7
1200 - 1400	6	7522.9	1253.8
1400 - 1700	14	21567.7	1540.6
1700 - 2000	2	3739.1	1869.6
2000 - 2500	4	8987.4	2246.9
2500 - 3000	3	8463.8	2821.3
3000+	14	87926.3	6280.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 90-100°
Range: 500 to 2700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>	<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Wt. (gr)</u>
0 - 308	919	88642.5	96.5
308 - 500	111	43716.0	393.8
500 - 600	24	13276.3	553.2
600 - 700	22	14322.0	651.0
700 - 800	11	8451.5	768.3
800 - 900	10	8593.2	859.3
900 - 1000	6	5770.4	961.7
1000 - 1200	19	21130.3	1112.1
1200 - 1400	11	13892.3	1262.9
1400 - 1700	21	31970.4	1522.4
1700 - 2000	5	9110.6	1822.1
2000 - 2500	8	18614.0	2326.7
2500 - 3000	7	19059.0	2722.7
3000+	28	180686.7	6453.1

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 700 to 900 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>	<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Wt. (gr)</u>
0 - 300	1331	150479.6	113.1
300 - 500	150	60494.3	403.3
500 - 600	50	27302.7	546.1
600 - 700	37	24013.2	649.0
700 - 800	16	11902.7	743.9
800 - 900	19	16190.0	852.1
900 - 1000	15	14463.7	964.2
1000 - 1200	23	25633.3	1114.5
1200 - 1400	12	15715.7	1309.6
1400 - 1700	24	36568.8	1523.7
1700 - 2000	9	16738.3	1859.8
2000 - 2500	16	35433.9	2214.6
2500 - 3000	11	30051.6	2732.0
3000+	40		

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 900 to 1100 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>	<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Wt. (gr)</u>
0 - 300	558	75828.1	135.9
300 - 500	143	55418.4	387.5
500 - 600	45	24672.3	548.3
600 - 700	22	14277.3	649.0
700 - 800	20	14996.5	749.8
800 - 900	18	15393.8	855.2
900 - 1000	19	18184.3	957.1
1000 - 1200	22	24301.2	1104.6
1200 - 1400	15	19276.2	1285.1
1400 - 1700	11	16923.1	1538.5
1700 - 2000	6	10900.1	1816.7
2000 - 2500	12	27174.8	2264.6
2500 - 3000	7	19171.5	2738.8
3000+	32	255473.7	7983.6

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 1100 to 1500 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>	<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Wt. (gr)</u>
0 - 300	283	48180.4	170.2
300 - 500	149	58749.5	394.3
500 - 600	30	16515.0	550.5
600 - 700	33	21191.9	642.2
700 - 800	29	21778.7	751.0
800 - 900	14	11918.1	851.3
900 - 1000	23	21901.9	952.3
1000 - 1200	24	26756.0	1114.8
1200 - 1400	24	31311.3	1304.6
1400 - 1700	33	50321.0	1524.0
1700 - 2000	9	16270.1	1807.8
2000 - 2500	17	38704.8	2276.8
2500 - 3000	10	27093.2	2709.3
3000+	47	313299.1	6665.9

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 1500 to 1900 ft

<u>Fragment Wt. (gr)</u>	<u>No. Fragment</u>	<u>Fragment Wt. (gr)</u>	<u>Average Wt. (gr)</u>
0 - 300	55	8350.0	151.8
300 - 500	28	12061.3	430.8
500 - 600	12	6558.9	546.6
600 - 700	7	4496.8	642.4
700 - 800	7	5322.2	760.3
800 - 900	4	3341.8	835.4
900 - 1000	4	3759.1	939.8
1000 - 1200	10	10912.4	1091.2
1200 - 1400	11	14067.9	1278.9
1400 - 1700	8	12087.5	1510.9
1700 - 2000	6	11200.4	1866.7
2000 - 2500	8	18441.5	2305.2
2500 - 3000	4	11363.7	2840.9
3000+	20	173725.9	8686.3

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

Location: White Sands Missile Range, NM

Date: 26 September 1979

Collection Zone: Azimuth: 0-180°
Range: 1900 to 2300 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>	<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Wt. (gr)</u>
0 - 300	13	1911.1	147.0
300 - 500	6	2310.0	385.0
500 - 600	0	0.0	0.0
600 - 700	1	640.6	640.6
700 - 800	1	782.3	782.3
800 - 900	1	882.4	882.4
900 - 1000	1	959.4	959.4
1000 - 1200	3	3275.6	1091.9
1200 - 1400	3	4084.1	1361.4
1400 - 1700	4	6451.1	1612.8
1700 - 2000	1	1958.9	1958.9
2000 - 2500	6	13197.8	2199.6
2500 - 3000	1	2662.7	2662.7
3000+	10	70687.5	7068.8

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
311.1	.511	11.499	851.6	5.6
321.9	.663	14.419	596.2	4.6
331.1	.603	12.748	707.1	5.4
365.0	.667	12.792	670.0	5.9
445.1	.718	11.293	731.5	8.2
477.4	.788	11.554	682.5	8.6
517.4	.864	11.688	644.3	9.2
606.8	1.310	15.113	404.7	8.4
722.3	.914	8.858	826.6	17.0
845.5	.988	8.180	860.9	21.5
1225.8	1.660	9.479	573.2	26.9
1697.1	1.430	5.898	992.4	59.8
2256.1	1.870	5.802	882.3	80.9
4258.1	2.220	3.650	1287.3	242.7
6905.4	4.700	4.764	677.7	301.5
317.2	.571	12.599	735.2	5.2
354.2	.718	14.190	582.2	5.2
388.1	.682	12.302	689.0	6.6
425.0	.648	10.672	814.8	8.3
489.7	.711	10.163	816.9	10.0
517.4	.800	10.823	723.1	9.9
597.5	.831	9.735	788.8	12.8
834.7	.947	7.942	905.7	21.9
890.1	1.160	9.122	712.5	20.3
1406.0	1.270	6.323	982.4	46.3
2651.9	2.300	6.071	760.3	90.9
315.7	.714	15.831	523.3	4.1
355.7	.601	11.826	763.5	6.3
358.8	.715	13.948	593.5	5.4
435.8	.564	9.059	1028.9	10.0
532.8	.660	8.671	993.8	12.8
579.0	.699	8.450	990.8	14.3
639.1	1.050	11.501	594.0	11.6
736.1	.869	8.264	908.7	18.5
830.1	1.490	12.565	456.4	13.7
1145.8	1.380	8.431	706.8	28.3

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
2114.4	1.900	6.290	807.3	69.9
406.6	.578	9.956	924.6	8.5
417.3	.704	11.809	706.5	7.4
423.5	.620	10.242	868.2	8.6
426.6	.795	13.045	601.8	6.8
428.1	.843	13.781	553.3	6.5
429.7	.609	9.918	904.6	9.0
398.9	.741	13.009	625.0	6.4
445.1	.661	10.390	828.9	8.9
460.5	.837	12.718	601.8	7.5
469.7	.858	12.782	591.3	7.6
472.8	.982	14.547	485.5	6.8
483.6	.661	9.565	900.3	10.5
358.8	.608	11.862	756.7	6.3
357.3	.639	12.512	700.1	5.9
360.4	.802	15.579	501.7	4.8
360.4	.544	10.571	897.7	7.1
361.9	.804	15.544	502.3	4.8
368.1	.761	14.469	554.6	5.3
378.8	.713	13.178	629.0	6.0
386.5	.770	13.948	571.9	5.8
386.5	.667	12.071	710.2	6.7
392.7	.729	12.988	631.4	6.3
392.7	.753	13.430	600.5	6.1
405.0	.706	12.203	682.7	6.9
311.1	.646	14.526	599.8	4.5
314.2	.576	12.828	719.2	5.1
323.4	.558	12.074	776.3	5.6
324.9	.688	14.823	569.3	4.6
324.9	.616	13.276	671.6	5.3
326.5	.593	12.707	715.6	5.3
329.6	.492	10.448	955.3	6.6
334.2	.723	15.145	543.6	4.6
346.5	.524	10.590	913.0	6.8
346.5	.654	13.220	654.5	5.5
351.1	.441	8.790	1199.4	8.3

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
351.1	.591	11.783	772.7	6.2
485.1	.789	11.392	691.5	8.9
497.4	.971	13.868	519.7	7.6
499.0	.779	10.933	725.3	9.5
502.0	.833	11.608	660.9	9.0
503.6	.911	12.658	579.5	8.3
505.1	.771	10.691	745.4	9.8
523.6	.954	12.751	562.1	8.5
542.1	.822	10.615	727.3	10.6
568.3	1.062	13.086	519.0	9.0
571.3	1.009	12.363	563.7	9.6
582.1	.900	10.825	681.6	11.2
592.9	.932	11.008	658.5	11.2
600.6	.780	9.096	871.2	13.7
608.3	1.001	11.515	607.7	11.0
609.8	1.145	13.144	497.7	9.7
637.6	1.209	13.274	479.6	10.0
637.6	.884	9.711	766.4	13.7
702.2	.761	7.587	1057.5	19.3
648.3	1.063	11.478	591.5	11.7
673.0	1.229	12.782	494.0	11.0
703.8	.807	8.030	970.1	18.2
705.3	1.681	16.685	323.6	8.8
720.7	1.150	11.174	584.1	13.4
740.7	.979	9.252	764.6	16.7
751.5	1.229	11.444	551.9	13.7
777.7	1.087	9.788	685.8	16.5
817.7	1.060	9.076	749.0	18.7
822.4	1.313	11.179	546.4	15.3
857.8	1.377	11.234	531.1	15.9
896.3	.994	7.767	903.7	24.0
910.1	1.454	11.182	519.2	16.9
927.1	1.134	8.561	767.8	22.5
956.3	1.224	8.963	705.8	22.2
994.8	1.297	9.124	673.8	22.7
751.5	1.229	11.444	551.9	13.7

FAR-FIELD FRAGMENT COLLECTION DATA FOR EIGHT-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
308.0	.663	15.059	571.0	4.3
777.7	1.087	9.788	685.8	16.5
817.7	1.060	9.076	749.0	18.7
822.4	1.313	11.179	546.4	15.3
857.8	1.377	11.234	531.1	15.9
896.3	.994	7.767	903.7	24.0
910.1	1.454	11.182	519.2	16.9
927.1	1.134	8.561	767.8	22.5
956.3	1.224	8.963	705.8	22.2
994.8	1.297	9.124	673.8	22.7
922.5	1.687	12.798	421.2	15.0
317.2	.553	12.201	771.5	5.4
378.8	.654	12.078	716.9	6.5
477.4	.693	10.163	827.3	9.8
509.7	.663	9.104	944.3	11.6
580.6	.859	10.360	728.9	11.7
671.4	.952	9.921	723.3	14.1
768.5	1.239	11.286	557.2	14.2
782.3	.887	7.933	937.2	20.5
807.0	1.247	10.814	579.8	15.5
833.1	.911	7.654	958.2	22.6
959.4	1.088	7.939	845.3	25.1
1104.2	1.203	7.628	836.6	30.1
401.9	.680	11.834	717.6	7.1

Total number of fragments = 132

Average ballistic density for all fragments = 710.1

Average gamma for all fragments = 10.997

Number of hazardous fragments in zone = 6

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION

Location: White Sands Missile Range, NM

Date: 23 January 1980

Collection Zone: Azimuth: 0-20°
Range: 500 to 2700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>
0 - 300	1694
300 - 770	400
770 - 1080	182
1080 - 1540	141
1540 - 2310	94
2310 - 3080	63
3080+	50

Collection Zone: Azimuth: 70-80°
Range: 500 to 700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>
0 - 300	2654
300 - 770	437
770 - 1080	154
1080 - 1540	91
1540 - 2310	63
2310 - 3080	33
3080+	18

Collection Zone: Azimuth: 80-90°
Range: 500 to 2700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>
0 - 300	2944
300 - 770	475
770 - 1080	184
1080 - 1540	120
1540 - 2310	84
2310 - 3080	50
3080+	40

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

Collection Zone: Azimuth: 90-100°
Range: 500 to 2700 ft

<u>Fragment Wt. (gr)</u>	<u>No. Fragment</u>
0 - 300	2620
300 - 770	552
770 - 1080	238
1080 - 1540	163
1540 - 2310	113
2310 - 3080	66
3080+	40

Collection Zone: Azimuth: 100-110°
Range: 500 to 2700 ft

<u>Fragment Wt. (gr)</u>	<u>No. Fragment</u>
0 - 300	2220
300 - 770	382
770 - 1080	173
1080 - 1540	117
1540 - 2310	89
2310 - 3080	52
3080+	40

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

.BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
797.72	1.20	10.5	605.6	15.7
1151.92	1.86	11.3	453.3	21.2
1047.20	1.71	11.4	469.3	19.1
816.20	1.00	8.6	815.6	19.8
834.68	1.12	9.4	705.1	18.5
845.46	1.21	10.0	632.9	17.5
870.10	1.22	9.8	643.0	18.4
887.04	1.21	9.6	662.5	19.2
897.82	1.12	8.7	761.6	21.5
900.90	1.01	7.9	882.8	23.8
922.46	.95	7.2	1003.0	26.7
982.52	1.03	7.3	946.0	28.0
1033.34	1.48	10.0	573.3	21.4
1050.28	1.70	11.4	472.1	19.2
1147.30	1.39	8.5	703.2	28.2
1171.94	1.43	8.6	683.3	28.5
1188.88	1.75	10.3	514.1	24.0
1211.98	1.62	9.4	586.6	26.9
1284.36	1.68	9.1	592.5	29.3
1333.64	2.06	10.8	451.6	25.7
1338.26	1.61	8.4	652.5	33.0
1569.26	1.64	7.3	746.0	44.6
1649.34	1.87	7.9	646.7	43.3
1684.76	2.23	9.3	504.8	37.8
1695.54	2.25	9.3	502.4	38.0
1703.24	1.73	7.1	746.4	49.7
1801.80	2.08	8.1	602.8	46.5
1815.66	1.77	6.8	773.2	55.4
1895.74	2.29	8.5	546.5	46.6
1903.44	2.13	7.8	610.9	50.5
2102.10	2.48	8.2	539.9	53.1
2169.86	2.25	7.3	642.9	62.2
2373.14	2.59	7.6	568.8	64.6
2376.22	2.52	7.4	595.2	66.7
2427.04	2.48	7.1	623.3	70.7
2670.36	3.28	8.6	450.6	64.7
3163.16	2.48	5.5	808.3	119.7

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
3224.76	3.68	8.0	456.2	83.9
3226.30	3.32	7.2	534.1	93.3
3538.92	3.40	6.7	564.5	109.5
3854.62	3.60	6.5	564.3	122.6
3916.22	3.68	6.6	554.0	123.7
4053.28	4.26	7.4	461.3	114.6
5243.70	3.63	4.8	759.8	225.4
6432.58	3.68	4.0	913.1	334.6
8180.48	4.58	3.9	833.7	433.9
8808.80	6.73	5.4	504.2	342.4
11745.58	8.68	5.2	459.7	472.5
803.88	1.05	9.2	742.4	18.2
834.68	1.01	8.4	827.3	20.6
1071.84	2.04	13.3	366.8	16.7
848.54	.97	8.0	889.5	22.1
902.44	1.28	10.0	620.9	18.9
964.04	1.20	8.7	733.9	23.0
1185.80	1.25	7.4	852.2	33.5
1273.58	1.47	8.1	717.0	32.9
1296.68	1.73	9.3	572.3	29.0
1569.26	1.87	8.3	615.3	39.2
1720.18	2.19	8.9	530.2	40.1
1932.70	2.33	8.4	545.2	47.7
2095.94	2.08	6.9	701.2	62.9
2169.86	2.37	7.6	596.0	59.1
2249.94	2.65	8.2	521.6	56.8
2427.04	2.80	8.1	518.0	52.5
2448.60	2.25	6.4	725.5	9.2
2616.46	2.43	6.5	692.9	83.9
3012.24	2.62	6.1	711.7	103.0
3075.38	3.26	7.4	522.9	86.3
3398.78	3.49	7.2	520.9	98.3
3788.40	2.96	5.5	744.5	144.2
3883.88	3.54	6.4	582.7	126.6
5383.84	3.33	4.3	884.7	258.4
5453.14	4.44	5.7	582.5	198.9
6432.58	3.99	4.3	806.6	308.0

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
7760.06	4.33	3.9	862.8	413.7
11745.58	7.64	4.6	556.0	536.4
14192.64	10.07	5.0	444.4	594.6
1039.50	1.31	8.8	693.3	24.5
1288.98	1.53	8.3	678.9	32.2
2279.20	2.28	7.0	660.6	67.6
4781.70	2.91	4.3	964.1	233.6
9369.36	6.95	5.2	511.4	375.3

Total number of fragments = 82

Average ballistic density for all fragments = 644.1

Average gamma for all fragments = 7.726

Number of hazardous fragments in zone = 36

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Presented</u> <u>Area (in.²)</u>	<u>Gamma</u> <u>(in.²/lb)</u>	<u>Ballistic</u> <u>Density</u> <u>(gr/in.³)</u>	<u>Impact</u> <u>Kinetic</u> <u>Energy</u> <u>(ft/lb)</u>
309.5	.538	12.166	784.4	5.3
317.2	.529	11.673	824.5	5.7
328.0	.519	11.076	877.3	6.2
334.2	.734	15.375	531.4	4.5
335.7	.501	10.446	946.7	6.7
337.3	.749	15.546	520.3	4.5
340.3	.604	12.423	725.0	5.7
346.5	.797	16.101	487.0	4.5
354.2	.622	12.292	722.0	6.0
361.9	.638	12.340	710.2	6.1
369.6	.567	10.739	865.7	7.2
375.8	.864	16.095	467.9	4.9
378.8	.602	11.123	811.1	7.1
383.5	.535	9.766	979.9	8.2
386.5	.623	11.282	786.1	7.1
389.6	.622	11.175	794.2	7.3
391.2	.610	10.916	821.0	7.5
401.9	.838	14.594	524.0	5.7
415.8	.996	16.768	418.3	5.2
420.4	.706	11.755	708.7	7.4
420.4	.675	11.239	758.1	7.8
438.9	1.180	18.820	342.4	4.9
460.5	.783	11.903	664.6	8.0
462.0	.657	9.955	867.5	9.7
482.0	.739	10.732	758.7	9.3
482.0	.707	10.267	810.8	9.8
483.6	.827	11.072	643.0	8.4
483.6	.765	10.074	722.7	9.1
519.0	.754	10.170	792.7	10.6
525.1	.740	9.637	854.2	11.3
531.3	.881	9.750	834.6	11.3
537.5	.731	11.474	650.0	9.7
537.5	1.200	9.521	859.9	11.7
540.5	.779	15.540	411.2	7.2
551.3	.779	9.891	801.9	11.6
592.9	.946	9.197	862.3	13.4
599.1	.854	11.054	651.1	11.3

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
619.1	.854	9.656	784.4	13.3
636.0	1.300	14.308	429.1	9.2
677.6	1.130	11.674	564.1	12.1
679.1	1.470	15.152	381.1	9.3
714.6	.898	8.797	839.7	16.9
717.6	.987	9.627	731.9	15.5
750.0	1.060	9.894	687.2	15.8
753.1	1.240	11.526	545.4	15.6
794.6	1.010	8.897	782.9	18.6
820.8	1.450	12.366	470.1	13.8
830.1	1.170	9.867	655.9	17.5
856.2	1.160	9.483	685.3	18.8
860.9	1.170	9.514	608.2	18.8
900.9	1.150	8.936	730.5	21.0
2005.1	2.140	7.471	640.5	55.8
1181.2	1.270	7.526	825.3	32.6
1290.5	1.260	6.834	912.4	39.3
1647.8	1.380	5.862	1016.4	58.5
2875.2	1.950	4.748	1055.9	126.0
6012.2	4.910	5.717	552.6	218.7
6851.5	4.840	4.945	643.5	288.2
309.5	.480	10.855	930.8	5.9
317.2	.477	10.525	963.0	6.3
318.8	.584	12.824	714.3	5.2
323.4	.506	10.952	898.5	6.1
324.9	.539	11.611	821.1	5.8
335.7	.715	14.908	555.3	4.7
340.3	.756	15.549	517.8	4.6
341.9	.604	12.367	728.3	5.8
343.4	.675	13.759	619.3	5.2
345.0	.801	16.254	481.2	4.4
354.2	.592	11.700	777.6	6.3
357.3	.554	10.854	866.5	6.8
363.4	.748	14.407	561.8	5.2
369.6	.563	10.663	874.9	7.2
389.6	.645	11.588	752.1	7.0
418.9	.691	11.547	729.2	7.5

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
420.4	.621	10.340	859.1	8.5
435.8	.735	11.805	691.6	7.7
438.9	1.160	18.501	351.3	4.9
457.4	.923	14.126	515.8	6.7
465.1	.809	12.176	639.2	7.9
466.6	.707	10.606	784.9	9.2
477.4	1.060	15.543	437.4	6.4
478.9	.716	10.465	790.5	9.5
483.6	.828	11.986	641.8	8.4
485.1	.745	10.750	754.4	9.4
486.6	.748	10.759	752.2	9.4
488.2	.730	10.467	782.7	9.7
489.7	.814	11.635	666.8	8.8
495.9	.827	11.674	659.4	8.8
497.4	.667	9.386	913.1	11.0
506.7	.626	8.649	1023.0	12.2
526.7	.797	10.593	740.2	10.3
535.9	.798	10.423	751.8	10.7
535.9	.777	10.149	782.5	11.0
546.7	1.410	18.054	326.5	6.3
548.2	.722	9.219	893.6	12.4
551.3	.769	9.764	817.5	11.7
566.7	1.190	14.699	436.6	8.0
586.7	1.460	17.418	332.6	7.0
597.5	.845	9.899	769.2	12.6
611.4	.735	8.415	970.2	15.1
622.2	.893	10.047	737.3	12.9
626.8	.911	10.174	720.8	12.8
626.8	1.400	15.635	378.4	8.3
639.1	.804	8.806	886.5	15.1
651.4	.928	9.972	728.7	13.6
656.0	1.180	12.591	511.8	10.8
665.3	.953	10.027	715.1	13.8
686.8	1.100	11.211	595.3	12.7
731.5	1.340	12.823	471.6	11.9
734.6	1.100	10.482	636.7	14.6
745.4	.901	8.462	871.5	18.3

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
745.4	.839	7.879	969.9	19.7
760.8	.943	8.677	830.8	18.2
782.3	.952	8.518	842.2	19.1
820.8	1.010	8.613	808.7	19.8
842.4	1.670	13.877	390.3	12.6
848.5	1.010	8.332	836.0	21.2
874.7	1.280	10.243	604.0	17.8
922.5	1.220	9.258	684.6	20.7
922.5	1.090	8.271	810.6	23.2
961.0	1.260	9.178	679.4	21.8
987.1	1.790	12.693	412.2	16.2
1025.6	2.090	14.264	339.4	15.0
1054.9	1.240	8.228	764.0	26.7
1070.3	1.010	6.606	1054.4	33.7
1084.2	1.390	8.975	661.6	25.1
1284.4	1.330	7.249	837.4	36.9
1406.0	1.480	7.368	780.9	39.7
1660.1	1.720	7.252	735.9	47.6
1638.2	2.030	8.442	582.0	41.5
1758.7	2.110	8.398	573.8	43.6
1960.4	2.080	7.427	653.5	54.9
2108.3	1.950	6.475	774.2	67.7
2462.5	2.360	6.709	679.2	76.3
7760.1	5.830	5.259	551.3	306.9
10696.8	5.200	3.403	902.1	653.8
1279.7	1.620	8.861	620.7	30.0
1436.8	1.570	7.649	730.4	39.1
1466.1	2.210	10.552	446.2	28.9
1546.2	1.330	6.021	1008.0	53.4
1553.9	1.490	6.712	854.3	48.2
1607.8	1.910	8.316	609.1	40.2
1674.0	1.830	7.652	676.2	45.4
1726.3	1.490	6.042	949.2	59.4
1732.5	1.990	8.040	617.2	44.8
2565.6	2.470	6.739	660.9	79.2
312.6	.597	13.368	677.7	4.9
315.7	.507	11.242	874.5	5.8

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
315.7	.582	12.905	711.0	5.1
317.2	.507	11.187	878.8	5.9
321.9	.678	14.746	576.5	4.5
323.4	.703	15.216	548.7	4.4
323.4	.603	13.052	690.7	5.2
329.6	.537	11.406	837.5	6.0
334.2	.562	11.772	793.2	5.9
334.2	.636	13.322	658.9	5.2
338.8	.720	14.876	554.6	4.7
341.9	.646	13.227	658.5	5.4
341.9	.577	11.814	780.0	6.0
343.4	.631	12.862	685.1	5.6
351.1	.608	12.121	740.6	6.0
354.2	.563	11.126	838.5	6.6
354.2	.778	15.375	516.2	4.8
358.8	.627	12.232	722.7	6.1
375.8	.578	10.768	855.1	7.3
380.4	.528	9.717	991.4	8.1
381.9	.562	10.301	906.5	7.7
386.5	.790	14.306	550.5	5.6
388.1	.666	12.013	714.0	6.7
405.0	.696	12.029	697.5	7.0
417.3	.470	7.883	1295.2	11.0
423.5	.747	12.347	656.0	7.1
429.7	.847	13.799	551.2	6.5
434.3	.839	13.524	565.1	6.7
454.3	.698	10.755	779.0	8.8
471.2	.671	9.967	857.4	9.8
523.6	.858	11.471	658.8	9.5
532.8	.728	9.564	857.8	11.6
534.4	.889	11.645	637.5	9.5
551.3	.560	7.110	1315.6	16.1
562.1	.735	9.153	892.0	12.8
592.9	.819	9.669	799.9	12.8
594.4	.888	10.457	710.4	11.8
612.9	.748	8.543	947.4	14.9
631.4	.585	6.486	1411.1	20.2

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
631.4	.768	8.514	938.1	15.4
637.6	1.050	11.528	592.6	11.5
685.3	1.010	10.317	675.1	13.8
694.5	1.120	11.288	586.0	12.8
706.9	1.080	10.695	629.8	13.7
730.0	.971	9.311	762.9	16.3
739.2	1.110	10.511	632.1	14.6
766.9	.931	8.498	853.7	18.8
783.9	1.270	11.341	547.7	14.4
786.9	1.160	10.318	629.9	15.9
790.0	1.090	9.658	694.2	17.0
797.7	.975	8.556	828.6	19.4
810.0	.714	6.170	1342.6	27.3
811.6	1.130	9.746	675.6	17.3
816.2	.928	7.959	913.0	21.3
820.8	.704	6.004	1389.6	28.4
880.9	.644	5.118	1704.5	35.8
880.9	1.080	8.582	784.8	21.3
882.4	1.180	9.361	688.4	19.6
286.4	.646	15.787	551.7	3.8
301.8	.506	11.735	838.6	5.4
309.5	.486	10.991	913.6	5.9
311.1	.529	11.904	808.5	5.4
314.2	.504	11.230	878.0	5.8
315.7	.533	11.818	811.3	5.6
321.9	.575	12.505	738.2	5.4
321.9	.675	14.680	580.4	4.6
326.5	.545	11.685	811.5	5.8
334.2	.643	13.469	648.1	5.2
343.4	.674	13.738	620.6	5.2
346.5	.698	14.101	594.2	5.1
346.5	.630	12.727	692.9	5.7
348.0	.596	11.987	756.4	6.0
354.2	.622	12.292	722.0	6.0
357.3	.583	11.422	802.6	6.5
363.4	.600	11.556	782.0	6.5
363.4	.730	14.060	582.7	5.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
368.1	.531	10.099	951.2	7.6
372.7	.533	10.011	957.7	7.7
375.8	.773	14.400	552.9	5.4
375.8	.590	10.991	829.1	7.1
375.8	.565	10.525	884.8	7.4
378.8	.560	10.347	904.0	7.6
378.8	.650	12.010	722.9	6.6
380.4	.509	9.367	1047.5	8.4
381.9	.681	12.482	679.6	6.4
383.5	.703	12.833	650.6	6.2
389.6	.575	10.331	893.6	7.8
397.3	.815	14.359	540.0	5.8
401.9	.773	13.462	591.4	6.2
405.0	.726	12.548	654.7	6.7
408.1	.749	12.847	629.6	6.6
412.7	.650	11.024	787.6	7.8
412.7	.817	13.857	558.9	6.2
412.7	.653	11.075	782.1	7.8
414.3	.656	11.085	779.7	7.8
417.3	.706	11.842	703.5	7.3
422.0	.808	13.404	531.0	6.5
422.0	.720	11.944	90.7	7.3
422.0	.701	11.629	718.9	7.5
429.7	.844	13.750	554.1	6.5
434.3	.889	14.329	518.1	6.3
437.4	.760	12.164	660.1	7.5
438.9	.685	10.925	774.2	8.4
438.9	.744	11.866	683.9	7.7
440.4	.730	11.602	706.2	7.9
443.5	.684	10.795	784.0	8.5
446.6	.698	10.940	765.8	8.5
457.4	.915	14.004	522.6	6.8
466.6	.779	11.586	678.7	8.3
469.7	.908	13.532	542.9	7.2
469.7	.688	10.253	823.1	9.5
472.8	.713	10.552	785.3	9.3
485.1	.723	10.433	789.1	9.7

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
485.1	.759	10.952	733.6	9.2
488.2	.869	12.461	602.6	8.1
492.8	.667	9.474	904.7	10.8
514.4	.908	12.357	594.5	8.7
515.9	.910	12.347	594.3	8.7
515.9	.868	11.777	637.9	9.1
520.5	.750	10.086	801.4	10.7
522.1	.671	8.997	949.8	12.1
543.6	.984	12.671	556.9	8.9
554.4	.771	9.735	818.9	11.8
576.0	.883	10.732	694.1	11.2
579.0	.859	10.384	727.3	11.6
580.6	.988	11.912	591.2	10.1
582.1	.928	11.159	651.2	10.9
583.7	.916	10.986	665.8	11.1
589.8	.893	10.598	698.9	11.6
596.0	.799	9.385	834.5	13.2
597.5	1.060	12.418	547.5	10.0
600.6	.910	10.606	691.9	11.8
603.7	.955	11.074	646.8	11.3
609.8	.978	11.226	630.5	11.3
622.2	1.460	16.427	352.7	7.9
625.2	.813	9.102	852.9	14.3
625.2	.966	10.815	658.5	12.0
632.9	.880	9.732	766.7	13.5
634.5	.855	9.433	802.5	14.0
653.0	.939	10.066	717.6	13.5
662.2	.873	9.228	811.8	14.9
679.1	1.110	11.441	580.7	12.3
686.8	1.470	14.982	385.4	9.5
697.6	.869	8.720	861.2	16.6
702.2	.926	9.230	788.1	15.8
709.9	1.200	11.832	540.1	12.5
709.9	.939	9.259	780.2	15.9
717.6	1.090	10.632	630.6	14.0
720.7	.868	8.430	891.2	17.8
737.7	1.110	10.533	630.8	14.6

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
737.7	1.040	9.869	695.5	15.5
768.5	.894	8.144	909.1	19.6
770.0	1.340	12.182	496.4	13.1
776.2	1.025	9.247	747.6	17.5
951.7	1.580	11.623	479.1	17.0
783.9	1.008	9.005	774.2	18.1
785.4	1.134	10.109	650.1	16.2
785.4	1.390	12.387	479.3	13.2
796.2	1.061	9.330	728.3	17.7
803.9	1.013	8.821	788.5	19.0
803.9	1.043	9.083	754.6	18.4
816.2	1.039	8.912	770.5	19.0
825.4	1.063	9.019	752.6	19.0
836.2	1.043	8.732	784.9	19.9
847.0	1.521	12.574	451.3	14.0
882.4	1.128	8.952	736.1	20.5
884.0	1.229	9.731	648.9	18.9
890.1	1.110	8.730	761.0	21.2
919.4	1.431	10.894	537.2	17.6
928.6	1.544	11.638	484.1	16.6
931.7	1.257	9.441	661.5	20.5
953.3	1.179	8.656	744.9	22.9
954.8	1.318	9.660	631.3	20.6
1027.2	1.520	10.360	548.0	20.6
1045.7	1.147	7.679	851.1	28.3
1058.0	1.318	8.717	699.6	25.2
1125.7	1.606	9.984	553.3	23.5
1127.3	1.246	7.734	811.0	30.3
1199.7	1.528	8.916	635.1	28.0
1247.4	1.417	7.950	739.8	32.6
1250.5	2.058	11.522	423.5	22.6
1281.3	1.533	8.377	674.8	31.8
1301.3	1.675	9.010	600.3	30.0
1304.4	1.633	8.765	624.9	31.0
1353.7	1.667	8.619	629.1	32.7
1424.5	1.633	8.026	682.4	36.9
1527.7	1.817	8.324	623.9	38.2

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1564.6	1.958	8.761	570.9	37.1
1629.3	2.150	9.237	516.8	36.7
1649.3	1.867	7.922	646.7	43.3
1672.4	1.867	7.813	655.8	44.5
1700.2	1.950	8.029	624.4	44.0
1703.2	1.883	7.740	659.0	45.8
1863.4	1.892	7.106	716.2	54.5
1885.0	2.050	7.613	642.2	51.5
2031.3	2.067	7.122	683.7	59.3
2189.9	2.850	9.110	455.1	50.0
2240.7	2.467	7.706	578.4	60.5
2334.6	2.425	7.271	618.2	66.8
2559.5	2.508	6.860	644.3	77.6
2667.3	2.808	7.370	566.8	75.3
2762.8	2.167	5.490	866.3	104.7
2902.9	2.275	5.486	846.0	110.1
2938.3	2.992	7.127	567.8	85.8
2958.3	2.703	6.397	665.6	96.2
3394.2	4.025	8.301	420.3	85.0
3554.3	3.725	7.336	494.4	100.8
4210.4	3.783	6.290	572.1	139.2
4304.3	4.508	7.332	449.7	122.1
7621.5	5.450	5.006	599.0	316.7
9229.2	4.942	3.748	840.1	512.2
10487.4	5.092	3.399	912.8	641.9
29215.3	12.208	2.925	684.9	2077.5
1453.8	1.500	7.223	791.3	41.9
1672.4	1.800	7.534	692.5	46.2
1746.4	1.990	7.977	622.1	45.5
2083.6	2.620	8.802	491.3	49.2
2092.9	1.940	6.489	774.5	67.1
2209.9	2.980	9.439	429.6	48.7
2331.6	2.480	7.446	597.0	65.1
2465.5	2.560	7.268	601.9	70.6
3013.8	3.340	7.758	493.7	80.8
3152.4	2.920	6.484	631.8	101.1
4133.4	4.180	7.079	483.7	121.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
4667.7	4.440	6.658	498.9	145.8
1275.1	1.800	9.881	528.0	26.8
1367.5	1.800	9.214	566.3	30.9
1443.0	1.360	6.597	909.8	45.5
1239.7	1.140	6.437	1018.5	40.1
1247.4	1.320	7.407	822.5	35.0
1275.1	1.660	9.113	596.2	29.1
1401.4	2.000	9.990	495.5	29.2
1974.3	2.180	7.729	613.4	53.1
2216.1	2.040	6.444	760.6	71.5
2628.8	2.840	7.562	549.3	72.3
1355.2	1.620	8.368	657.3	33.7
771.5	1.212	10.998	578.1	14.6
1332.1	2.135	11.217	427.1	24.7
1336.7	2.285	11.967	387.0	23.2
1307.5	2.147	11.496	415.5	23.7
810.0	1.529	13.209	428.6	12.8
867.0	1.428	11.532	507.9	15.6
885.5	1.551	12.264	458.2	15.0
893.2	1.515	11.873	479.0	15.6
997.9	1.563	10.964	510.7	18.9
1098.0	1.732	11.041	461.8	20.7
1171.9	1.586	9.471	586.9	25.7
1253.6	1.701	9.497	565.1	27.5
773.1	1.069	9.681	699.2	16.6
777.7	1.132	10.191	645.5	15.9
799.3	1.335	11.696	517.9	14.2
803.9	.832	7.241	1060.2	23.1
808.5	1.027	8.896	776.3	18.9
814.7	1.386	11.910	499.2	14.2
816.2	1.066	9.144	741.4	18.6
825.4	1.119	9.489	697.4	18.1
828.5	1.043	8.814	777.6	19.6
830.1	1.263	10.655	584.5	16.2
833.1	1.277	10.727	577.6	16.2
834.7	.958	8.038	889.6	21.5
834.7	1.364	11.441	523.8	15.2

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
857.8	1.169	9.541	678.5	18.7
862.4	.923	7.495	971.9	23.9
882.4	1.343	10.654	567.0	17.2
888.6	.996	7.846	894.0	23.6
899.4	1.168	9.088	712.8	20.6
924.0	1.082	8.198	820.8	23.4
925.5	1.193	9.025	710.0	21.3
934.8	1.045	7.825	875.2	24.8
945.6	1.004	7.435	939.5	26.5
951.7	1.152	8.474	769.6	23.4
956.3	.950	6.951	1033.5	28.6
979.4	1.035	7.398	930.1	27.5
991.8	1.381	9.747	611.2	21.2
999.5	1.167	8.176	792.3	25.4
1122.7	1.145	7.140	916.2	32.7
1201.2	1.321	7.697	791.3	32.5
1242.8	1.417	7.980	736.9	32.4
1364.4	2.120	10.876	442.0	26.1
1381.4	1.960	9.932	503.4	28.9
1481.5	1.540	7.277	775.2	42.3
1532.3	2.210	10.096	466.4	31.6
1589.3	1.790	7.884	663.6	41.9
1607.8	1.420	6.183	950.1	54.1
1654.0	2.150	9.099	524.6	37.8
1680.1	1.300	5.416	1133.5	64.5
2075.9	2.020	6.811	723.1	63.4
2092.9	1.817	6.076	854.7	71.6
2136.0	1.920	6.292	802.9	70.6
2217.6	3.140	9.912	398.6	46.5
2545.6	2.370	6.517	697.7	81.2
2667.3	2.980	7.821	518.5	70.9
3899.8	1.992	4.808	1031.7	125.5
3007.6	2.670	6.214	689.4	100.7
3180.1	2.400	5.283	855.3	125.2
3289.4	2.517	5.356	823.9	127.8
3395.7	1.800	3.711	1406.1	190.3
3520.4	3.730	7.417	488.7	98.7

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
3799.2	3.158	5.819	676.9	135.8
3996.3	3.200	5.605	698.1	148.3
4124.1	3.217	5.460	714.9	157.1
4715.5	2.983	4.429	915.1	221.5
4895.7	3.217	4.599	848.6	221.4
5733.4	4.180	5.103	670.9	233.7
6083.0	4.242	4.881	696.3	259.2
774.6	1.265	11.428	544.7	14.1
1036.4	1.688	11.398	472.7	18.9
1104.2	1.584	10.040	554.0	22.9
1118.0	1.586	9.931	559.7	23.4
1199.7	1.585	9.248	601.2	27.0
774.6	1.818	10.677	603.2	15.1
793.1	1.085	9.577	701.7	17.2
810.0	.958	8.279	863.8	20.4
814.7	1.032	8.869	776.9	19.1
817.7	1.029	8.807	783.6	19.3
831.6	1.344	11.315	533.6	15.3
847.0	1.197	9.894	646.6	17.8
865.5	1.212	9.806	648.3	18.4
1007.2	1.285	8.933	691.2	23.5
1102.6	1.333	8.464	716.2	27.1
1248.9	1.350	7.566	796.2	34.3
1290.5	1.658	8.995	604.3	29.8
1538.5	1.492	6.787	844.5	47.1
1703.2	1.783	7.329	715.2	48.3
1727.9	1.850	7.495	686.7	48.0
1869.6	1.733	6.490	819.2	59.9
2365.4	2.208	6.535	720.8	75.3
2671.9	2.533	6.637	662.6	83.7
3056.9	3.042	6.965	576.3	91.3
4610.8	4.208	6.389	534.1	150.1
6571.2	4.700	5.007	644.9	273.0
7410.5	5.458	5.156	581.1	298.9
9578.8	6.142	4.488	629.3	443.9
332.6	.491	10.332	966.8	6.7
334.2	.567	11.877	782.7	5.9

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
349.6	.623	12.475	710.9	5.8
351.1	.660	13.158	654.8	5.6
371.1	.655	12.354	700.1	6.2
374.2	.556	10.400	902.6	7.5
374.2	.613	11.467	779.7	6.8
392.7	.626	11.159	792.9	7.3
400.4	.706	12.343	675.0	6.7
417.3	.783	13.133	602.3	6.6
418.9	.707	11.815	704.6	7.4
422.0	.699	11.596	722.0	7.6
426.6	.718	11.782	701.2	7.5
429.7	.711	11.584	716.7	7.7
474.3	.710	10.478	792.8	9.4
474.3	.759	11.201	717.3	8.8
478.9	.770	11.254	708.8	8.9
497.4	.774	10.892	730.5	9.5
512.8	.729	9.951	823.9	10.7
514.4	.742	10.098	804.8	10.6
514.4	.833	11.336	676.5	9.4
519.0	.726	9.792	839.0	11.0
529.8	1.020	13.478	514.3	8.2
979.4	.709	5.067	1640.6	40.2
576.0	.754	9.164	879.7	13.1
579.0	.938	11.339	637.4	10.6
606.8	1.090	12.575	533.2	10.0
614.5	.940	10.709	674.2	11.9
642.2	.803	8.753	892.4	15.3
659.1	.974	10.344	685.7	13.3
660.7	.894	9.472	781.6	14.5
662.2	.968	10.233	695.3	13.5
686.8	.904	9.213	799.1	15.5
697.6	.878	8.810	848.0	16.5
723.8	.995	9.623	729.3	15.6
731.5	1.100	10.526	634.1	14.5
739.2	1.020	9.659	717.6	15.9
740.7	1.160	10.962	592.9	14.1
742.3	1.140	10.751	609.8	14.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1192.0	1.756	10.310	512.5	24.0
822.4	1.325	11.276	539.4	15.2
827.0	1.032	8.737	788.6	19.7
940.9	1.164	8.656	749.7	22.6
945.6	1.149	8.505	767.9	23.1
979.4	1.497	10.700	534.7	19.0
984.1	1.240	8.821	712.7	23.2
1059.5	1.177	7.773	830.2	28.4
1074.9	1.271	8.279	749.9	27.0
1155.0	1.432	8.680	673.9	27.7
1156.5	1.441	8.724	668.3	27.6
1178.1	1.360	8.084	742.4	30.3
1213.5	1.312	7.568	807.5	33.4
1247.4	1.505	8.448	675.3	30.7
1392.2	1.940	9.755	515.2	29.7
1399.9	1.060	5.301	1282.7	54.9
1510.7	1.810	8.387	620.4	37.5
1567.7	1.430	6.385	916.8	51.1
1908.1	1.208	4.433	1436.5	89.5
1958.9	2.320	8.290	554.3	49.1
2394.7	1.960	5.729	872.7	86.9
2918.3	3.180	7.628	514.6	79.6
3137.0	3.000	6.694	603.7	97.5
4119.5	3.080	5.234	762.1	163.7
4750.9	3.480	5.127	731.8	192.7
7971.0	2.190	1.923	2459.5	862.1
930.2	1.106	8.322	799.9	23.2
1042.6	1.260	8.459	737.3	25.6
2111.3	1.283	4.255	1452.3	103.2
2972.2	2.720	6.406	662.6	96.5
1435.3	1.850	9.023	570.4	33.1
1726.3	1.617	6.555	839.8	54.8
2254.6	1.742	5.408	980.9	86.7
2254.6	2.200	6.831	690.9	68.7
2314.6	2.092	6.326	765.1	76.1
3073.8	2.942	6.699	609.2	95.4
8599.4	3.817	3.107	1153.3	575.7

FAR-FIELD FRAGMENT COLLECTION DATA FOR SIXTEEN-PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 70-80°
Range: 500 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
482.0	.642	9.323	937.0	10.8
502.0	.698	9.732	860.9	10.7
954.8	1.148	8.416	776.3	23.6
8741.0	4.567	3.657	895.7	497.2
925.5	1.118	8.452	783.4	22.8
1236.6	1.257	7.114	877.7	36.2
1577.0	1.808	8.027	648.5	40.9
1871.1	2.217	8.293	567.0	46.9
1954.3	2.217	7.940	592.2	51.2
2778.2	2.917	7.349	557.7	78.6
4903.4	2.992	4.271	947.6	238.8
6432.6	5.533	6.021	494.2	222.2
8165.1	5.500	4.715	633.0	360.2
2462.5	1.942	5.520	910.1	92.8
1079.5	1.472	9.545	604.4	23.5
1723.3	1.633	6.635	825.5	54.0
3140.1	2.767	6.168	682.3	105.9
2912.1	3.100	7.452	533.5	81.3
8248.2	7.083	6.011	437.5	285.4

Total number of fragments = 574

Average ballistic density for all fragments = 715.9

Average gamma for all fragments = 9.756

Number of hazardous fragments in zone = 86

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION

Location: White Sands Missile Range, NM

Date: 19 March 1980

Collection Zone: Azimuth: 90-95°
Range: 500 to 2700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>
0 - 308	2222
308 - 500	724
500 - 600	504
600 - 700	448
700 - 800	395
800 - 900	348
900 - 1000	310
1000 - 1200	274
1200 - 1400	242
1400 - 1700	208
1700 - 2000	171
2000 - 2500	145
2500 - 3000	116
3000+	94

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

<u>Fragment Wt. (gr)</u>	<u>No. Fragment</u>
0 - 308	461
308 - 770	131
770 - 1078	64
1078 - 1540	38
1540 - 2310	27
2310 - 3080	16
3080+	10

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

<u>Fragment Wt. (gr)</u>	<u>No. Fragment</u>
0 - 308	305
308 - 770	137
770 - 1078	63
1078 - 1540	43
1540 - 2310	29
2310 - 3080	18
3080+	15

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

<u>Fragment Wt. (gr)</u>	<u>No. Fragment</u>
0 - 308	272
308 - 770	212
770 - 1078	109
1078 - 1540	87
1540 - 2310	68
2310 - 3080	47
3080+	34

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

Collection Zone: Azimuth: 90-95°
Range: 1500 to 1900 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>
0 - 308	73
308 - 770	69
770 - 1078	50
1078 - 1540	41
1540 - 2310	28
2310 - 3080	22
3080+	15

Collection Zone: Azimuth: 90-95°
Range: 1900 to 2300 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>No.</u> <u>Fragment</u>
0 - 308	27
308 - 770	26
770 - 1078	25
1078 - 1540	23
1540 - 2310	22
2310 - 3080	18
3080+	17

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION

BALLISTIC DATA

Collection Zone: azimuth: 60-70°

Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
311.08	.72	16.2	511.7	4.0
312.62	.64	14.3	610.6	4.5
312.62	.61	13.7	649.8	4.7
312.62	.56	12.4	754.1	5.2
314.16	.74	16.4	496.5	4.0
318.78	.66	14.4	598.6	4.6
324.94	.57	12.3	753.1	5.5
326.48	.48	10.4	972.6	6.6
332.64	.82	17.3	446.3	4.0
332.64	.51	10.6	926.9	6.5
332.64	.58	12.2	755.0	5.7
341.88	.89	18.3	404.5	3.9
343.42	.57	11.7	789.7	6.1
344.96	.50	10.1	978.6	7.1
344.96	.75	15.2	532.2	4.7
348.02	.60	12.1	743.1	6.0
355.74	.57	11.3	818.0	6.6
358.82	.54	10.6	899.2	7.1
368.06	.77	14.7	542.6	5.2
368.06	.69	13.0	649.2	5.9
381.92	.59	10.9	818.5	7.3
386.54	.66	12.0	714.4	6.7
389.62	.59	10.7	851.1	7.6
397.32	1.07	18.9	359.0	4.4
398.86	.74	13.1	621.5	6.4
401.94	.77	13.4	597.2	6.3
401.94	.78	13.6	564.6	6.2
405.02	.65	11.3	778.3	7.5
411.18	.65	11.1	784.6	7.7
417.34	.87	14.6	513.4	5.9
418.88	.77	12.9	618.7	6.8
421.96	.80	13.3	587.5	6.6
425.04	.75	12.3	655.7	7.2
432.74	.75	12.1	664.9	7.4
432.74	.59	9.5	967.1	9.5
483.90	.71	11.3	738.3	8.1
449.68	.88	13.7	545.7	6.8
455.84	.70	10.7	700.0	8.8
460.46	.84	12.7	600.2	7.5

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
468.16	1.01	15.1	461.2	6.4
468.16	.91	13.7	536.6	7.1
475.86	.79	11.7	672.6	8.5
475.86	1.09	16.0	418.2	6.2
488.18	1.02	14.6	473.9	6.9
489.72	.74	10.6	767.8	9.6
489.72	.72	10.3	795.0	9.8
491.26	.78	11.2	709.0	9.2
495.88	1.12	15.8	418.4	6.5
495.88	.99	13.9	504.9	7.4
506.66	.76	10.4	770.8	10.1
518.98	.69	9.3	899.6	11.5
520.52	.78	10.5	751.3	10.3
523.60	1.05	14.0	486.6	7.8
539.00	.84	10.9	696.4	10.2
551.32	.97	12.4	573.5	9.3
551.32	.78	9.9	800.3	11.6
557.48	.87	11.0	682.3	10.6
602.14	.82	9.5	813.9	13.2
662.20	1.14	12.1	544.0	11.4
663.74	.77	8.1	966.2	17.0
676.06	1.41	14.6	401.8	9.6
756.14	.92	8.5	856.9	18.5
776.16	.90	8.1	909.0	19.9
780.78	1.12	10.0	658.7	16.2
854.70	1.50	12.3	465.2	14.5
871.64	1.29	10.4	594.9	17.5
882.42	1.15	9.1	715.5	20.1
894.74	1.45	11.3	512.4	16.4
897.82	1.10	8.6	778.2	21.8
951.72	1.16	8.5	761.8	23.2
1044.12	1.46	9.8	591.9	22.2
1156.54	1.25	7.6	827.6	31.8
1235.08	1.71	9.7	552.3	26.5
1250.48	1.67	10.5	489.0	24.8
1252.02	1.64	9.2	596.1	28.4
1279.74	1.58	8.6	644.4	30.8
1395.24	1.63	8.2	670.5	35.5

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1402.94	1.25	6.2	1003.9	46.8
1646.26	1.62	6.9	798.4	49.7
1660.12	1.46	6.2	941.0	56.1
1683.22	1.63	6.8	808.8	51.6
1743.28	2.34	9.4	487.0	38.6
1803.34	1.62	10.2	425.2	36.9
1894.20	1.66	6.1	885.7	64.2
1925.00	2.35	8.5	534.4	46.9
2077.46	1.91	6.4	787.0	67.1
2177.56	2.05	6.6	741.9	68.7
2915.22	1.88	4.5	1130.9	134.3
2990.68	1.99	4.7	1065.3	133.6
3374.14	3.55	7.4	504.5	95.3
5733.42	3.57	4.4	850.0	273.6
7056.28	4.28	4.2	796.9	345.7
13493.48	5.35	2.8	1090.4	1011.3
14891.80	6.07	2.9	995.8	1085.6
15800.40	9.09	4.0	576.5	816.1
2277.66	11.00	33.8	62.4	14.0
326.48	.70	15.0	556.3	4.5
334.18	.62	12.9	687.9	5.4
335.72	.68	14.1	601.4	4.9
340.34	.64	13.2	663.2	5.4
343.42	.62	12.6	708.6	5.7
344.96	.83	16.8	457.9	4.3
348.04	.66	13.2	655.0	5.5
348.04	.53	10.7	891.9	6.7
352.66	.72	14.3	576.0	5.1
360.36	.59	11.4	797.2	6.6
361.90	.65	12.6	690.6	6.0
364.98	.62	11.8	753.1	6.4
377.30	.61	11.3	790.0	6.9
380.38	.68	12.6	673.9	6.3
394.24	.74	13.2	615.6	6.2
397.32	.60	10.6	848.5	7.8
400.40	.74	13.0	625.2	6.4
400.40	1.11	19.4	342.4	4.3

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 50-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
405.02	.70	12.0	697.5	7.0
412.72	.79	13.3	593.4	6.4
426.58	.67	10.9	784.9	8.1
438.90	.90	14.3	515.8	6.4
440.44	.66	10.5	815.9	8.7
452.76	.88	13.6	546.6	6.9
474.32	1.47	21.7	266.1	4.5
474.32	.90	13.2	560.2	7.5
486.64	.65	9.3	937.3	10.9
506.66	.74	10.3	792.7	10.3
518.98	1.10	14.8	449.8	7.3
574.42	1.02	12.4	557.6	9.6
640.64	1.10	12.0	555.3	11.1
648.34	1.50	16.2	352.9	8.3
652.96	1.49	16.0	359.0	8.5
660.66	1.06	11.2	605.4	12.2
696.08	.87	8.8	856.3	16.5
697.62	1.11	11.1	596.5	13.0
699.16	1.08	10.8	622.9	13.4
709.94	1.00	9.8	714.2	15.0
728.42	1.27	12.2	509.0	12.4
757.68	1.15	10.6	614.4	14.8
763.84	.99	9.1	774.3	17.5
763.84	1.10	10.1	662.1	15.8
831.60	1.08	9.1	740.9	19.0
887.04	1.54	12.2	464.2	15.2
897.82	1.35	10.5	572.4	17.7
953.26	1.84	13.5	381.9	14.7
974.82	1.08	7.8	868.5	26.1
993.30	1.73	12.2	436.5	16.9
996.38	1.18	8.3	777.3	25.0
1007.16	1.44	10.0	582.8	20.9
1096.48	1.02	6.5	1064.4	35.0
1124.20	1.40	8.7	678.7	26.8
1124.20	1.31	8.2	678.7	26.8
1162.70	1.98	11.9	417.3	20.3
1211.98	1.36	7.9	764.2	32.1
1224.30	1.48	8.5	680.0	30.1

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Presented</u> <u>Area (in.²)</u>	<u>Gamma</u> <u>(in.²/lb)</u>	<u>Ballistic</u> <u>Density</u> <u>(gr/in.³)</u>	<u>Impact</u> <u>Kinetic</u> <u>Energy</u> <u>(ft/lb)</u>
1352.12	1.79	9.3	564.6	30.3
1389.08	1.95	9.8	510.1	29.4
1479.94	1.71	8.1	661.8	38.1
1686.30	1.39	5.8	1029.0	60.8
2360.82	2.44	7.2	619.4	67.9
2753.52	2.04	5.2	945.0	110.4
3948.56	3.41	6.0	627.1	135.9
6221.60	3.18	3.6	1097.1	361.7
8109.64	4.81	4.2	768.7	406.3
12235.30	7.10	4.1	646.7	626.5
308.00	.53	12.1	793.7	5.3
309.54	.93	21.0	346.8	3.1
315.70	.84	18.7	407.9	3.5
317.24	.52	11.4	855.9	5.8
317.24	.53	11.7	822.2	5.6
318.78	.57	12.4	750.6	5.3
318.78	.63	13.8	637.5	4.8
320.32	.74	16.1	505.2	4.1
328.02	.74	15.7	517.4	4.3
337.26	.50	10.3	968.4	6.8
346.50	.84	16.9	450.9	4.3
348.04	.61	12.2	734.1	5.9
351.12	.75	15.0	538.4	4.9
360.36	.59	11.5	787.1	6.5
368.06	.75	14.2	571.2	5.4
369.60	.53	10.1	947.2	7.6
375.76	.56	10.4	903.9	7.5
375.76	.73	13.7	597.5	5.7
377.30	.93	17.2	423.4	4.6
378.84	.70	13.0	641.4	6.1
388.08	1.08	19.5	345.8	4.1
401.94	.80	14.0	559.6	6.0
405.02	.60	10.3	880.3	8.2
408.10	.60	10.2	889.2	8.3
411.18	.66	11.3	765.1	7.6
411.18	.69	11.7	719.0	7.3
415.80	.60	10.1	894.7	8.6
418.88	.60	10.0	910.4	8.7

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
421.96	.86	14.2	533.7	6.2
423.50	.69	11.3	747.0	7.8
432.74	.93	15.0	484.9	6.0
435.82	.83	13.4	573.2	6.8
440.44	.78	12.3	644.3	7.4
458.92	.75	11.4	713.7	8.4
468.16	.81	12.1	644.6	8.1
469.70	.77	11.5	691.1	8.5
498.96	.66	9.3	928.5	11.2
498.96	.79	11.1	709.3	9.4
526.68	1.04	13.8	496.6	7.9
551.32	.82	10.4	747.9	11.1
555.94	.74	9.3	876.9	12.4
563.64	.70	8.6	970.7	13.6
585.20	.75	8.9	910.1	13.7
617.54	.90	10.2	726.9	12.6
620.62	1.13	12.7	516.7	10.1
645.26	.94	10.2	704.6	13.1
654.50	.93	10.0	726.3	13.6
719.18	1.29	12.6	490.9	11.9
731.50	1.10	10.5	634.1	14.5
771.54	1.60	14.5	381.2	11.1
799.26	1.50	13.1	435.1	12.7
803.88	1.29	11.2	548.7	14.9
874.72	1.63	13.0	420.3	13.9
944.02	1.28	9.5	651.9	20.7
980.98	1.09	7.8	862.0	26.2
1021.02	1.93	13.2	380.8	16.1
1033.34	1.70	11.5	466.2	18.7
1116.50	1.28	8.0	771.0	28.9
1182.72	1.99	11.8	421.3	20.9
1199.66	1.71	10.0	536.5	25.0
1210.44	1.38	8.0	746.7	31.5
1230.46	1.65	9.4	580.6	27.3
1253.56	1.39	7.8	764.9	33.6
1272.04	1.81	10.0	522.4	26.6
1299.76	2.34	12.6	363.1	21.5

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1302.84	1.57	8.4	662.3	32.1
1401.40	1.43	7.1	819.5	40.8
1572.34	2.11	9.4	513.0	34.8
1652.42	1.90	8.0	630.9	42.7
1675.52	1.75	7.3	723.8	47.7
1730.96	1.63	6.6	831.8	54.6
2068.22	1.67	5.7	958.3	76.1
2702.70	2.38	6.2	736.1	91.2
3529.68	3.12	6.2	640.5	118.7
3873.10	2.18	3.9	1203.3	204.5
15731.10	8.23	3.7	666.3	893.5
311.08	.40	9.0	1229.7	7.2
314.16	.48	10.7	944.7	6.1
315.70	.49	10.9	920.4	6.0
315.70	.35	7.8	1524.7	8.5
317.24	.48	10.6	954.0	6.2
317.24	.38	8.4	1354.3	7.9
317.24	.42	9.3	1165.5	7.1
317.24	.54	11.9	799.5	5.5
318.78	.59	13.0	703.4	5.1
321.86	.48	10.4	967.8	6.4
321.86	.63	13.7	643.7	4.9
323.40	.36	7.8	1497.2	8.6
323.40	.38	8.2	1380.6	8.2
326.48	.49	10.5	951.8	6.5
326.48	.44	9.4	1118.6	7.2
328.02	.38	8.1	1400.3	8.4
328.02	.44	9.4	1123.9	7.3
328.02	.71	15.2	548.3	4.5
329.56	.60	12.7	709.1	5.4
331.10	.37	7.8	1471.1	8.8
334.18	.54	11.3	842.2	6.1
334.18	.42	8.8	1227.7	7.9
334.18	.55	11.5	819.3	6.0
335.72	.57	11.9	780.1	5.9
335.72	.66	13.8	626.1	5.1
337.26	.53	11.0	874.1	6.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
338.80	.42	8.7	1244.7	8.1
341.88	.50	10.2	967.0	6.9
341.88	.49	10.0	996.7	7.1
344.96	.50	10.1	975.7	7.1
346.50	.69	13.9	604.5	5.2
349.58	.47	9.4	1084.9	7.7
351.12	.64	12.8	685.8	5.7
352.66	.46	9.1	1130.4	8.0
354.20	.81	16.0	485.9	4.6
354.20	.40	7.9	1400.1	9.3
357.28	.48	9.4	1074.4	7.9
358.82	.38	7.4	1531.8	10.1
361.90	.45	8.7	1198.9	8.6
372.68	.50	9.4	1054.1	8.3
372.68	.44	8.3	1276.9	9.4
372.68	.66	12.4	695.1	6.3
378.84	.63	11.6	757.6	6.8
385.00	.48	8.7	1157.7	9.2
386.54	.47	8.5	1199.6	9.4
386.54	.79	14.3	550.5	5.6
388.08	.71	12.8	648.7	6.3
389.62	.52	9.3	1039.0	8.7
391.16	.62	11.1	801.2	7.3
395.78	.67	11.9	721.7	6.9
395.78	.57	10.1	919.7	8.2
395.78	.46	8.1	1268.6	10.1
398.86	.42	7.4	1465.4	11.3
400.40	.58	10.1	906.5	8.2
401.94	.69	12.0	701.3	7.0
408.10	.70	12.0	696.8	7.1
409.64	.43	7.3	1452.8	11.6
412.72	.91	15.4	475.4	5.6
412.72	.55	9.3	1011.8	9.2
414.26	.83	14.0	547.8	6.1
420.42	.45	7.5	1392.7	11.7
421.96	.65	10.8	805.2	8.1
423.50	.59	9.8	934.5	9.0

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
425.04	.46	7.6	1362.4	11.7
426.58	.48	7.9	1282.7	11.3
429.66	.43	7.0	1523.8	12.8
432.74	.62	10.0	886.4	9.0
432.74	.78	12.6	628.2	7.1
440.44	.48	7.6	1324.4	12.0
448.14	.53	8.3	1161.4	11.3
457.38	.51	7.8	1255.8	12.2
462.00	.55	8.3	1132.7	11.5
465.08	.63	9.5	930.1	10.2
465.08	.74	11.1	730.6	8.7
466.62	.54	8.1	1175.9	12.0
469.70	.60	8.9	1010.6	10.9
477.40	.89	13.0	568.6	7.6
480.48	.57	8.3	1116.5	12.0
492.80	.87	12.4	607.3	8.3
494.34	.77	10.9	731.6	9.4
498.86	.91	12.8	574.8	8.1
503.58	.83	11.5	666.0	9.1
511.28	.93	12.7	570.1	8.4
532.84	.82	10.8	717.6	10.3
534.38	1.01	13.2	526.5	8.4
535.92	.87	11.4	660.4	9.8
535.92	.63	8.2	1071.7	13.5
537.46	.87	8.7	980.0	12.8
537.46	.77	10.0	795.4	11.1
563.64	.75	9.3	867.8	12.6
571.34	.85	10.4	729.1	11.4
571.34	.95	11.6	617.0	10.2
589.82	.65	7.7	1125.5	15.9
595.98	.80	9.4	832.9	13.2
600.60	.98	11.4	619.1	10.9
603.68	.73	8.5	967.9	14.8
603.68	.82	9.5	813.0	13.2
605.22	.92	10.6	685.9	11.8
611.38	1.00	11.4	611.4	11.1
611.38	1.13	12.9	509.0	9.8

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Presented</u> <u>Area (in.²)</u>	<u>Gamma</u> <u>(in.²/lb)</u>	<u>Ballistic</u> <u>Density</u> <u>(gr/in.³)</u>	<u>Impact</u> <u>Kinetic</u> <u>Energy</u> <u>(ft/lb)</u>
614.46	.85	9.7	784.1	13.2
637.56	1.00	11.0	637.6	12.1
639.10	.80	8.8	893.2	15.2
665.28	.63	6.6	1330.4	20.9
668.36	.97	10.2	699.6	13.7
682.22	.95	9.7	736.8	14.6
682.22	.77	7.9	1009.7	18.0
686.84	1.05	10.7	638.4	13.4
688.38	1.15	11.7	558.2	12.2
689.92	.80	8.1	964.2	17.7
696.08	1.07	10.8	628.9	13.5
709.94	.85	8.4	905.9	17.6
743.82	1.27	12.0	519.7	12.9
748.44	.82	7.7	1007.9	20.3
751.52	.75	7.0	1157.0	22.4
757.68	.90	8.3	887.4	19.0
759.22	1.08	10.0	676.4	15.9
793.10	1.17	10.3	626.7	16.0
810.04	.75	6.5	1247.1	26.0
813.12	.88	7.6	985.0	22.3
845.46	.90	7.5	990.2	23.6
910.14	1.28	9.8	628.5	19.2
967.12	1.68	12.2	444.1	16.5
1010.24	.99	6.9	1025.6	30.6
1013.32	1.73	12.0	445.3	17.6
1057.98	1.08	7.1	942.6	30.8
1067.22	.92	6.0	1209.4	36.8
1087.24	1.16	7.5	870.2	30.3
1161.16	1.09	6.6	1020.4	36.8
1173.48	.96	5.7	1247.6	42.6
1187.34	1.68	9.9	545.3	24.9
1213.52	.94	5.4	1331.5	46.6
1221.22	1.30	7.5	823.9	34.1
1242.78	.99	5.6	1261.7	46.4
1248.94	1.58	8.9	628.9	29.3
1250.48	1.35	7.6	797.2	34.4
1270.50	1.43	7.9	743.0	33.5

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1278.20	1.30	7.1	862.4	37.3
1312.08	1.23	6.6	961.8	41.6
1350.58	1.55	8.0	699.9	35.0
1365.98	1.83	9.4	551.8	30.3
1540.00	1.68	7.6	707.2	41.9
1669.36	1.73	7.3	733.6	47.9
1683.22	1.85	7.7	668.9	45.5
1721.72	1.59	6.5	858.8	55.4
1757.14	1.87	7.4	687.1	49.1
1760.22	2.77	11.0	381.8	33.2
1834.14	1.88	7.2	711.5	53.2
1901.90	2.03	7.5	657.6	52.9
1903.44	2.88	10.6	389.4	37.4
2051.28	2.07	7.1	688.8	60.4
2339.26	2.00	6.0	827.1	81.3
2491.72	3.02	8.5	474.8	61.1
2713.48	2.68	6.9	618.5	81.6
2832.06	3.52	8.7	428.8	67.7
2841.30	3.78	9.3	386.6	63.5
3010.70	2.29	5.3	868.8	117.6
3426.50	2.32	4.7	969.7	150.4
4341.26	3.71	6.0	607.5	150.9
4931.08	4.08	5.8	598.3	177.1
5228.30	4.06	5.4	639.1	200.1
5283.74	4.01	5.3	658.0	206.9
8739.50	5.22	4.2	732.8	434.8
11676.28	5.58	3.3	885.8	726.0
12304.60	7.41	4.2	610.0	607.1
14402.08	6.83	3.3	806.9	902.4
309.54	.65	14.6	593.7	4.4
314.16	.63	14.1	627.3	4.7
314.16	.61	13.7	652.8	4.8
318.78	.49	10.9	917.3	6.1
323.40	.56	12.2	762.4	5.5
323.40	.53	11.6	826.8	5.8
326.48	.61	13.1	680.6	5.2
326.48	.53	11.5	835.1	5.9

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
337.26	.50	10.3	960.9	6.8
338.80	.56	11.5	313.2	6.1
341.88	.73	14.9	551.9	4.8
343.42	.56	11.4	825.4	6.3
346.50	.53	10.7	897.5	6.7
354.20	.58	11.4	807.4	6.5
360.36	.60	11.6	779.8	6.5
361.90	.61	11.8	762.6	6.4
361.90	.62	12.0	744.9	6.3
366.52	.57	10.9	851.6	7.0
369.60	.56	10.6	886.0	7.3
371.14	.68	12.8	666.0	6.0
374.22	.67	12.5	686.2	6.2
375.76	.68	12.7	664.7	6.1
375.76	.65	12.2	708.9	6.4
378.84	.72	13.3	623.2	5.9
381.92	.66	12.1	715.9	6.6
386.54	.61	11.0	818.3	7.3
392.70	.69	12.2	690.6	6.7
409.64	.60	10.3	876.0	8.3
415.80	.61	10.2	877.5	8.5
420.42	.59	9.9	922.3	8.9
441.98	.57	9.0	1024.6	10.2
451.22	.63	9.8	893.5	9.5
452.76	.66	10.2	844.7	9.2
466.62	.68	10.2	828.5	9.5
475.86	.65	9.5	918.2	10.4
483.56	.63	9.1	976.8	11.1
485.10	.74	10.7	764.8	9.5
486.64	.63	9.1	964.5	11.1
494.34	.76	10.7	748.8	9.6
514.36	.74	10.0	813.7	10.7
537.46	.74	9.7	840.4	11.6
548.24	.77	9.9	807.8	11.6
565.18	.81	10.0	777.2	11.7
572.88	.78	9.6	827.8	12.5
574.42	.79	9.7	814.6	12.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
586.74	.78	9.3	846.1	13.1
602.14	.78	9.1	876.5	13.8
603.68	.79	9.2	861.0	13.7
612.92	.81	9.3	839.1	13.8
637.56	.74	8.2	995.5	16.3
643.72	.81	8.8	879.7	15.2
663.74	.89	9.4	785.2	14.6
700.70	.90	9.0	825.5	16.3
726.88	.84	8.1	938.4	18.6
776.16	.86	7.7	976.0	20.9
796.18	.90	7.9	930.1	20.9
894.74	1.03	8.0	858.8	23.1
329.56	.70	14.9	563.1	4.6
334.18	.59	12.4	729.6	5.6
334.18	.78	16.4	484.5	4.3
337.26	.69	14.3	587.4	4.9
340.34	.62	12.7	699.1	5.6
341.88	.59	12.1	752.4	5.9
343.42	.66	13.5	639.7	5.3
354.20	.69	13.7	612.8	5.4
355.74	.71	14.0	592.2	5.3
358.82	.66	12.9	668.0	5.8
363.44	.63	12.2	718.7	6.2
364.98	.71	13.6	610.0	5.6
369.60	.78	14.7	541.6	5.2
371.14	.72	13.6	605.1	5.7
372.68	.66	12.4	694.6	6.3
372.68	.74	13.9	587.4	5.6
375.76	.80	14.8	528.4	5.3
378.84	.67	12.4	691.5	6.4
385.00	.73	13.3	613.1	6.0
394.24	.67	11.9	719.4	6.9
426.58	.80	13.2	591.1	6.7
408.10	.80	13.8	566.5	6.2
411.18	.74	12.6	643.2	6.8
417.34	.73	12.2	670.0	7.1
428.12	.79	12.9	612.7	6.9

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
429.66	.81	13.2	590.7	6.8
432.74	.83	13.4	572.9	6.7
434.28	.82	13.2	584.3	6.8
451.22	.89	13.8	539.9	6.8
452.76	.84	13.1	583.1	7.2
457.38	.77	11.8	678.6	8.1
460.46	.85	12.9	589.3	7.4
462.00	.85	12.9	585.2	7.4
462.00	.80	12.1	648.4	8.0
463.54	.79	11.9	666.4	8.1
468.16	.82	12.3	630.4	7.9
480.48	.78	11.4	697.9	8.8
506.66	.95	13.1	550.2	8.1
515.90	.80	10.8	724.3	9.9
515.90	.99	13.4	523.7	8.0
526.68	.90	11.9	620.2	9.2
534.38	.83	10.9	701.9	10.2
543.62	.92	11.9	612.1	9.5
545.16	.96	12.3	582.2	9.2
560.56	1.00	12.5	562.4	9.4
572.88	.85	10.4	733.1	11.5
574.42	.87	10.6	703.6	11.2
612.92	1.02	11.7	594.5	10.9
617.54	.92	10.4	701.2	12.3
617.54	.95	10.7	669.9	12.0
626.78	.94	10.4	693.2	12.5
632.94	1.00	11.1	631.7	11.9
640.64	.95	10.4	687.6	12.8
663.74	1.08	11.4	590.5	12.1
672.98	1.09	11.3	591.0	12.3
677.60	1.15	11.9	547.2	11.8
682.22	1.09	11.2	599.5	12.7
693.00	.91	9.2	803.2	15.7
722.26	1.06	10.2	664.6	14.7
780.78	1.01	9.0	773.6	18.0
797.72	1.10	9.6	695.7	17.3
803.88	.92	8.0	909.4	20.8

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
848.54	1.05	8.7	786.9	20.3
857.78	.98	8.0	890.9	22.4
907.06	1.07	8.3	818.1	22.8
924.00	1.12	8.5	781.2	22.7
942.48	1.03	7.7	898.5	25.6
979.44	1.17	8.3	777.2	24.4
990.22	1.16	8.2	795.1	25.2
397.32	.85	15.0	503.5	5.5
443.52	.90	14.2	518.0	6.5
460.46	.89	13.5	548.3	7.1
463.54	.94	14.2	509.3	6.8
503.58	.95	13.2	545.8	8.0
506.66	.89	12.3	603.8	8.6
526.68	.98	13.1	541.0	8.4
562.10	1.05	13.0	526.1	9.0
572.88	1.01	12.4	563.2	9.6
589.82	1.04	12.3	556.4	9.9
603.68	1.10	12.8	520.0	9.8
605.22	1.11	12.8	516.9	9.8
628.32	1.07	11.9	570.1	11.0
642.18	1.17	12.7	508.3	10.5
643.72	1.15	12.5	520.1	10.7
660.66	1.19	12.6	512.0	10.9
683.76	1.04	10.7	642.4	13.3
694.54	1.30	13.1	470.8	11.1
773.08	1.21	11.0	577.7	14.5
862.40	1.28	10.4	597.9	17.3
865.48	1.27	10.3	606.3	17.6
928.62	1.30	9.8	627.2	19.7
956.34	1.36	9.9	603.7	20.0
976.36	1.35	9.7	623.4	21.0
987.14	1.38	9.8	606.0	20.9
1022.56	1.18	8.1	799.7	26.4
1131.90	1.04	6.4	1064.7	36.5
2653.42	1.41	3.7	1589.6	148.7
1155.00	1.73	10.5	506.1	22.9
1199.66	1.44	8.4	693.0	29.7

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1256.64	1.37	7.6	786.5	34.3
1261.26	1.41	7.8	754.7	33.6
1276.64	1.83	10.0	517.8	26.5
1292.06	1.28	7.0	888.7	38.7
1309.80	1.17	6.3	1034.3	43.5
1389.98	1.49	7.5	762.5	38.4
1413.72	1.37	6.8	884.8	43.5
1455.30	1.55	7.5	754.1	40.6
1476.86	1.38	6.6	907.7	46.9
1578.50	1.27	5.6	1107.3	58.5
1692.46	1.65	6.8	798.5	51.6
1697.08	1.75	7.2	733.1	48.9
1741.74	1.34	5.4	1122.9	67.3
1791.02	1.45	5.7	1025.8	65.7
1814.12	1.38	5.3	1115.0	70.7
1824.90	2.04	7.8	626.3	48.5
1832.60	1.65	6.3	864.7	60.5
1858.78	1.82	6.8	759.1	56.5
1995.84	2.07	7.2	671.8	57.3
1998.92	3.40	11.9	318.8	34.9
2176.02	1.68	5.4	999.3	83.7
2251.48	1.92	6.0	848.5	78.6
2269.96	2.47	7.6	585.9	62.1
2302.30	2.00	6.1	814.6	78.8
2601.06	2.10	5.7	854.7	95.7
2722.72	1.83	4.7	1096.8	120.2
2761.22	2.60	6.6	658.6	87.1
3435.74	2.55	5.2	843.7	137.6
3501.96	2.96	5.9	687.7	123.1
3769.92	2.37	4.4	1035.4	178.4
4532.22	2.60	4.0	1081.1	234.8
4955.72	2.77	3.9	1076.9	263.8
6083.00	4.30	4.9	682.2	255.7
7830.90	3.99	3.6	981.9	456.5
8249.78	4.30	3.6	925.2	470.3
8599.36	4.84	3.9	807.2	453.8
8670.20	3.43	2.8	1362.9	650.6

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
8808.80	4.98	4.0	791.8	462.7
9089.08	3.56	2.7	1354.1	689.9
12375.44	5.70	3.2	909.4	798.4
17060.12	5.58	2.3	1296.0	1551.3
30763.04	12.51	2.8	695.3	2247.8
37405.06	12.90	2.4	807.3	3222.8
1087.24	1.63	10.5	524.9	21.6
1127.28	1.15	7.1	914.1	32.8
1178.10	1.44	8.6	680.6	28.6
1182.72	1.65	9.8	558.0	25.2
1201.20	1.62	9.4	584.4	26.5
1210.44	1.48	8.5	675.7	29.5
1225.84	1.57	7.9	625.1	28.5
1238.16	1.76	9.9	531.0	25.9
1242.78	1.83	10.3	504.1	25.1
1248.94	1.43	8.0	727.8	32.3
1256.64	1.15	6.4	1019.0	40.8
1262.80	1.42	7.9	748.9	33.4
1301.30	1.67	9.0	604.8	30.2
1358.28	1.72	8.8	603.9	31.9
1416.60	1.83	9.1	570.8	32.5
1504.58	1.93	9.0	559.7	34.8
1524.60	2.40	11.0	410.1	28.8
1640.10	1.02	6.9	797.9	49.4
1660.12	1.62	6.8	807.6	50.7
1709.40	2.17	8.9	536.0	40.1
1720.18	1.68	6.9	787.6	52.2
1787.94	1.63	6.4	856.5	58.2
1846.46	1.50	5.7	1005.1	67.5
1849.54	1.30	6.8	765.9	56.5
1861.86	1.47	5.5	1048.2	70.2
1864.94	1.82	6.8	761.6	56.9
1897.28	2.13	7.9	608.9	50.1
2014.32	1.97	6.8	730.4	61.3
2263.80	2.57	7.9	550.5	59.3
2360.82	3.05	9.0	443.2	54.3
2450.14	2.10	6.0	805.1	84.9

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
2459.38	2.68	7.6	559.5	67.0
2467.08	2.27	6.4	722.9	79.8
2511.74	1.73	4.8	1100.7	108.2
2588.74	1.95	5.3	950.7	102.1
2687.30	1.86	4.8	1060.8	115.5
2711.94	3.18	8.2	477.5	68.7
3120.04	2.05	4.6	1063.0	141.1
3150.84	2.68	6.0	716.8	109.9
3238.62	2.03	4.4	1117.0	153.3
3465.00	2.72	5.5	773.8	131.3
4255.02	2.19	3.6	1311.4	245.5
4495.26	3.23	5.0	773.2	185.7
4641.56	2.16	3.3	1463.8	295.6
4797.10	4.08	6.0	581.4	167.5
5091.24	4.37	6.0	558.0	176.4
5249.86	4.37	5.8	575.3	187.5
5453.14	2.75	3.5	1195.8	321.3
5453.14	3.23	4.2	937.9	273.3
6223.14	3.00	3.4	1197.6	383.6
7060.90	3.35	3.3	1151.6	442.2
7481.32	5.47	5.1	505.3	304.2
7550.62	5.40	5.0	601.7	313.7
10207.12	4.78	3.3	975.7	647.2
11396.00	4.83	3.0	1072.5	798.4
14192.64	4.68	2.3	1400.3	1278.0
16360.96	5.47	2.3	1280.0	1455.0
25659.48	10.00	2.7	811.4	1956.4
28665.56	6.83	1.7	1604.8	3573.2
33419.54	11.07	2.3	907.8	2998.8
311.08	.68	15.3	554.1	4.2
329.56	.60	12.7	713.2	5.4
341.88	.65	13.4	645.5	5.3
361.90	.55	10.7	875.5	7.0
371.14	.67	12.6	676.8	6.1
385.00	.60	10.9	834.4	7.4
395.78	.72	12.8	641.8	6.4
398.86	.54	9.5	1001.1	8.7

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
408.10	.60	10.3	883.0	8.3
414.26	.68	11.4	744.8	7.5
460.46	.63	9.5	925.1	10.0
469.70	.65	9.7	895.2	10.1
491.26	.72	10.3	802.4	9.9
514.36	.69	9.4	891.0	11.3
552.86	.69	8.8	954.2	13.1
583.66	.80	9.6	817.5	12.7
588.28	.72	8.6	955.5	14.2
606.76	.78	9.0	879.8	14.0
609.84	.77	8.8	906.9	14.4
622.16	.74	8.3	976.2	15.5
622.16	.82	9.2	842.7	14.1
403.48	.79	13.6	578.3	6.1
417.34	.74	12.4	660.0	7.0
426.58	.81	13.3	587.1	6.7
437.36	.75	12.0	675.1	7.6
443.52	.70	11.1	756.2	8.3
469.70	.73	10.9	750.8	9.0
472.78	.82	12.1	637.2	8.1
472.78	.85	12.5	607.0	7.8
478.94	.73	10.7	764.2	9.3
491.26	.75	10.6	763.2	9.6
491.26	.86	12.2	619.4	8.4
492.80	.87	12.3	608.6	8.3
494.34	.76	10.8	742.7	9.5
503.58	.77	10.7	750.1	9.8
543.62	.90	11.6	634.3	9.7
557.48	.96	12.1	591.1	9.6
568.26	.85	10.5	723.5	11.3
579.04	.92	11.1	660.8	10.9
591.36	.84	9.9	768.0	12.4
620.62	.92	10.4	705.9	12.5
625.24	.91	10.2	716.6	12.7
669.90	.95	10.0	720.1	14.0
716.10	1.02	10.0	694.6	14.9
725.34	1.03	10.0	689.5	15.1

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 60-70°
Range: 500 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
729.96	1.01	9.6	724.3	15.8
729.96	1.27	12.2	509.9	12.5
751.52	1.17	10.9	594.4	14.4
759.22	.99	9.1	776.5	17.4
820.82	1.04	8.8	777.1	19.3
833.14	1.18	9.9	653.3	17.5
839.30	1.08	9.0	752.7	19.5
865.48	1.16	9.3	697.0	19.3
928.62	1.15	8.6	756.6	22.4
1007.16	1.35	9.4	643.3	22.4
1067.22	1.18	7.7	836.2	28.8
462.00	.84	12.8	596.3	7.5
545.16	1.02	13.0	533.0	8.7
592.90	1.03	12.2	567.3	10.1
617.54	.95	10.8	666.9	11.9
654.50	1.34	14.4	419.8	9.5
654.50	1.15	12.3	530.7	11.1
722.26	1.14	11.0	594.8	13.6
811.58	1.26	10.8	576.1	15.6
848.54	1.21	9.9	641.5	17.8
868.56	1.14	9.2	710.5	19.6
939.40	1.21	9.0	706.3	21.7
957.88	1.27	9.3	665.8	21.4
960.96	1.25	9.1	687.0	21.9
984.06	1.17	8.3	773.9	24.5
1017.94	1.30	9.0	683.7	23.6

Total number of fragments = 734

Average ballistic density for all fragments = 755.0

Average gamma for all fragments = 10.010

Number of hazardous fragments in zone = 103

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

<u>Fragment Wt. (gr)</u>	<u>Average Presented Area (in.²)</u>	<u>Gamma (in.²/lb)</u>	<u>Ballistic Density (gr/in.³)</u>	<u>Impact Kinetic Energy (ft/lb)</u>
309.54	.60	13.6	661.1	4.7
311.08	.56	12.7	734.4	5.1
312.62	.66	14.7	587.0	4.4
317.24	.55	12.2	771.4	5.4
320.32	.55	12.0	787.5	5.6
320.32	.66	14.5	594.7	4.6
321.86	.58	12.6	728.7	5.3
328.02	.56	11.9	787.0	5.7
328.02	.59	12.7	718.3	5.4
329.56	.85	18.0	421.3	3.8
331.10	.52	10.9	893.3	6.3
331.10	.64	13.4	654.3	5.1
332.64	.66	13.8	626.1	5.0
334.18	.67	14.1	605.3	4.9
335.72	.62	12.9	691.0	5.4
335.72	.57	11.8	786.3	5.9
337.26	.57	11.8	783.7	5.9
337.26	.65	13.4	649.6	5.2
340.34	.79	16.2	487.5	4.4
340.34	.56	11.5	818.7	6.2
341.88	.55	11.3	838.2	6.3
344.96	.58	11.8	774.9	6.1
352.66	.64	12.8	684.0	5.7
354.20	.71	14.0	592.1	5.3
354.20	.78	15.4	513.2	4.8
355.74	.75	14.7	548.8	5.0
357.28	.91	17.0	412.3	4.2
357.28	.49	9.5	1057.8	7.8
363.44	.60	11.5	785.9	6.6
369.60	.89	16.8	441.7	4.6
372.68	.65	12.1	719.4	6.4
377.30	.67	12.4	691.1	6.3
377.30	.64	11.9	736.9	6.6
377.30	.55	10.2	920.0	7.7
380.38	.38	7.0	1604.8	11.2
383.46	.64	11.6	754.2	6.9
383.46	.50	9.1	1087.9	8.8

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Presented</u> <u>Area (in.²)</u>	<u>Gamma</u> <u>(in.²/lb)</u>	<u>Ballistic</u> <u>Density</u> <u>(gr/in.³)</u>	<u>Impact</u> <u>Kinetic</u> <u>Energy</u> <u>(ft/lb)</u>
385.00	.60	11.0	820.2	7.3
385.00	.78	14.2	556.7	5.6
385.00	.71	12.9	644.9	6.2
389.62	.76	13.6	590.4	6.0
391.16	.89	15.9	465.1	5.1
398.86	.97	17.0	417.5	4.9
400.40	1.09	19.0	353.3	4.4
400.40	.69	12.1	694.1	6.9
400.40	.79	13.7	575.7	6.1
401.94	.81	14.1	554.4	5.9
406.56	.87	14.9	503.6	5.7
406.56	.74	12.7	640.0	6.6
408.10	1.06	18.2	373.9	4.7
408.10	.93	15.9	464.5	5.3
409.64	1.02	17.4	397.7	4.9
411.18	.68	11.5	739.8	7.4
417.34	.57	9.6	969.8	9.1
420.42	.62	10.3	869.6	8.5
421.96	.78	12.9	614.9	6.8
435.82	.72	11.5	716.3	7.9
438.90	.66	10.5	824.2	8.7
446.60	.77	12.0	666.2	7.7
425.76	.77	11.8	675.3	8.0
457.38	.71	10.9	766.1	8.8
466.62	.81	12.8	589.2	7.6
469.70	.92	13.6	536.6	7.2
477.40	.69	10.1	836.6	9.8
480.48	.74	10.7	762.5	9.3
489.72	.83	11.8	651.2	8.6
500.50	.87	12.2	615.7	8.5
505.12	.92	12.7	577.1	8.3
509.74	.68	9.3	915.1	11.4
514.36	1.00	13.6	512.8	7.8
515.90	.83	11.3	677.4	9.5
522.06	.80	10.7	732.3	10.1
523.60	.77	10.3	774.9	10.6
528.22	.70	9.3	901.9	11.8

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
542.08	.74	9.6	844.7	11.7
549.78	.95	12.1	593.7	9.5
551.32	1.01	12.8	543.2	8.9
554.40	.98	12.4	572.3	9.3
568.26	1.32	16.3	374.7	7.3
571.34	.82	10.1	768.0	11.8
574.42	.91	11.1	658.5	10.7
580.58	1.06	12.7	535.8	9.5
599.06	1.00	11.7	600.0	10.7
608.30	.78	9.0	878.0	14.0
614.46	.94	10.7	672.1	11.9
623.70	.87	9.8	764.6	13.2
637.56	.83	9.1	844.7	14.6
645.26	.79	8.6	913.7	15.6
657.58	1.00	10.7	655.6	12.8
662.20	.82	8.6	895.1	15.9
666.82	.71	7.4	1119.3	18.7
668.36	1.74	18.2	291.4	7.6
693.00	.86	8.6	876.6	16.7
694.54	1.03	10.4	666.4	13.9
702.24	1.26	12.5	499.5	11.7
716.10	.98	9.6	734.8	15.5
728.42	1.01	9.7	723.0	15.7
742.28	.99	9.3	755.8	16.6
783.86	1.06	9.5	716.2	17.2
796.18	1.28	11.2	551.1	14.7
797.72	1.21	10.6	598.6	15.6
797.72	.96	8.4	850.8	19.7
839.30	1.08	9.0	752.0	19.5
843.92	1.34	11.1	545.9	15.8
846.54	1.05	8.7	785.3	20.3
867.02	1.21	9.7	654.6	18.5
867.02	1.08	8.7	773.6	20.7
876.26	1.02	8.1	853.1	22.4
877.80	1.16	9.2	705.3	19.8
894.74	1.01	7.9	886.7	23.6
897.82	1.14	8.9	734.7	21.0

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
908.60	1.22	9.4	671.0	20.0
916.30	1.20	9.2	695.3	20.8
922.46	1.54	11.7	483.2	16.4
942.48	1.35	10.0	600.9	19.6
951.72	1.30	9.6	642.1	20.7
960.96	1.29	9.4	656.6	21.3
997.92	1.53	10.7	527.3	19.3
1016.40	1.03	7.1	978.0	29.9
1081.08	1.65	10.7	509.1	21.0
1127.28	1.10	6.8	975.8	34.3
1173.48	1.09	6.5	1034.0	37.6
1210.44	1.40	8.1	729.9	31.1
1227.38	2.58	14.7	296.9	17.4
1281.28	2.07	11.3	429.6	23.5
1292.06	2.48	13.4	330.8	20.0
1349.04	2.04	10.6	461.6	26.5
1376.76	1.33	6.7	901.7	42.5
1378.30	1.62	8.2	668.5	34.8
1455.30	1.73	8.3	639.6	36.4
1478.40	1.93	9.1	551.4	33.7
1546.16	2.08	9.4	515.4	34.2
1569.26	1.71	7.6	701.8	42.8
1581.58	1.79	7.9	660.4	41.5
1609.30	2.13	9.3	517.7	36.1
1670.90	1.74	7.3	728.0	47.7
1673.98	1.92	8.0	629.2	43.4
1744.82	1.52	6.1	931.1	59.5
1794.00	2.03	7.9	620.3	47.1
1875.72	1.79	6.7	783.2	58.4
1891.88	2.26	8.4	553.9	46.6
1932.70	1.98	7.2	693.7	56.1
2119.04	2.08	6.9	706.9	64.2
2380.84	2.49	7.3	607.4	67.8
2711.94	4.81	12.4	257.5	45.5
2909.06	2.99	7.2	561.8	84.0
2910.60	2.75	6.6	636.8	91.4
3290.98	6.06	12.9	220.6	53.1

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 500 to 700 ft

<u>Fragment</u> <u>Wt. (gr)</u>	<u>Average</u> <u>Presented</u> <u>Area (in.²)</u>	<u>Gamma</u> <u>(in.²/lb)</u>	<u>Ballistic</u> <u>Density</u> <u>(gr/in.³)</u>	<u>Impact</u> <u>Kinetic</u> <u>Energy</u> <u>(ft/lb)</u>
5523.98	4.88	6.2	512.4	185.8
2665.74	5.60	14.7	201.2	37.7
3716.02	4.42	8.3	399.9	92.8
13564.32	10.01	5.2	428.3	546.2

Total number of fragments = 152

Average ballistic density for all fragments = 669.5

Average gamma for all fragments = 11.147

Number of hazardous fragments in zone = 9

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
312.62	.58	12.9	711.4	5.0
318.78	.62	13.5	659.4	4.9
323.40	.58	12.6	726.5	5.3
331.10	.53	11.3	850.9	6.1
331.10	.77	16.2	494.8	4.3
340.34	.87	7.9	419.4	4.0
343.42	.51	10.4	942.9	6.9
349.58	.72	14.3	578.2	5.1
349.58	.72	14.3	578.2	5.1
351.12	.83	16.6	461.0	4.4
361.90	.68	13.1	648.3	5.7
366.52	.98	18.7	377.8	4.1
368.06	.75	14.2	568.9	5.4
377.30	.79	14.6	540.4	5.4
378.84	.75	13.9	582.1	5.7
391.16	.46	8.3	1241.6	9.8
392.70	.64	11.4	770.6	7.2
392.70	1.01	18.1	384.6	4.5
397.32	.78	13.7	579.0	6.0
397.32	.81	14.3	543.0	5.9
398.86	.65	11.4	757.6	7.3
400.40	.99	17.3	405.9	4.8
401.94	.78	13.6	581.2	6.1
411.18	.63	10.6	812.2	8.0
411.18	.56	9.5	983.8	9.0
411.18	.98	16.6	425.8	5.1
412.72	.96	16.4	436.1	5.3
415.80	.75	12.5	646.6	6.9
417.34	.61	10.2	880.3	8.5
428.12	.83	13.5	569.3	6.6
431.20	.65	10.5	832.4	8.6
440.44	.78	12.4	638.1	7.4
440.44	.56	8.9	1051.0	10.3
445.06	1.09	17.1	392.7	5.4
466.62	.69	10.3	823.1	9.4
477.40	.76	11.2	716.3	8.9
482.02	.87	12.7	592.0	7.9

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
491.26	.75	10.6	760.9	9.6
500.50	.74	10.3	791.0	10.1
503.58	.89	12.3	602.8	8.5
508.20	.88	12.1	620.9	8.8
535.92	.86	11.3	667.3	9.9
546.70	1.10	14.1	473.9	8.1
566.72	.88	10.9	685.3	10.8
572.88	.82	10.1	767.3	11.8
574.42	.86	10.5	719.0	11.4
588.28	.02	12.1	571.1	10.1
592.90	.94	11.0	655.8	11.2
600.60	1.24	14.4	437.1	8.7
609.84	.80	9.2	852.3	13.8
619.08	1.03	11.6	595.7	11.1
620.62	1.11	12.5	530.0	10.3
623.70	.75	8.4	958.9	15.4
629.86	.95	10.5	685.2	12.5
632.94	.70	7.8	1076.1	17.0
637.56	1.14	12.5	526.6	10.6
639.10	.86	9.4	799.8	14.1
652.96	.92	9.9	740.4	13.8
662.20	1.02	10.8	642.8	12.8
680.68	1.36	13.9	431.1	10.2
682.22	1.17	12.0	539.1	11.8
696.08	1.00	10.0	699.2	14.4
703.78	1.00	9.9	704.8	14.7
717.64	1.07	10.4	648.4	14.3
745.36	1.00	9.4	747.6	16.5
748.44	1.36	12.7	470.3	12.2
762.30	1.08	9.9	683.9	16.1
770.00	.95	8.7	827.7	18.5
773.08	1.35	12	492.9	13.2
788.48	.87	7.7	976.7	21.3
791.56	1.44	12.8	456.2	12.9
793.10	1.21	10.7	598.1	15.5
797.72	1.26	11.1	562.0	15.0
806.96	1.30	11.3	546.3	14.9

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
823.90	1.29	10.9	563.6	15.7
856.24	1.37	11.2	536.9	16.0
871.64	1.02	8.2	844.9	22.1
883.96	1.06	8.4	806.6	21.8
885.50	1.26	10.0	626.1	18.5
890.12	1.43	11.3	519.4	16.4
893.20	1.18	9.3	695.9	20.1
902.44	1.07	8.3	818.8	22.7
914.76	1.15	8.8	746.6	21.7
920.92	1.16	8.8	733.3	21.6
931.70	1.21	9.1	702.6	21.4
953.26	1.12	8.2	800.7	24.2
956.34	1.56	11.4	489.9	17.4
977.90	1.14	8.2	801.3	24.9
987.14	1.28	9.1	684.1	22.7
1037.96	1.14	7.7	848.3	28.0
1048.74	1.49	9.9	577.8	22.0
1057.99	1.09	7.2	927.1	30.5
1071.84	1.27	8.3	748.9	26.9
1167.32	1.45	8.7	668.6	27.9
1198.12	1.44	8.4	697.0	29.7
1199.66	1.37	8.0	748.1	31.2
1213.52	2.32	13.4	343.9	18.9
1304.38	2.43	13.0	344.1	20.8
1361.36	1.67	8.6	630.8	33.0
1369.06	1.24	6.3	590.3	44.9
1395.24	1.91	9.6	528.6	30.3
1478.70	1.69	8.0	647.7	38.5
1515.36	1.99	9.2	539.8	34.3
1555.40	1.67	7.5	720.1	43.0
1580.04	1.85	8.2	628.9	40.1
1781.78	1.55	6.1	926.9	61.0
1806.42	1.84	7.1	723.8	52.7
1820.28	2.36	9.1	502.1	41.7
1875.72	2.00	7.4	665.2	52.4
1888.04	3.85	14.3	249.9	27.5
1966.58	2.37	8.4	530.0	48.5
2163.70	2.83	9.2	454.5	49.5

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 700 to 900 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
2251.48	2.07	6.4	756.5	72.8
2256.10	1.92	6.0	846.0	78.7
2356.20	2.20	6.5	724.0	75.1
2374.68	2.56	7.5	579.8	65.5
2427.04	2.13	6.1	780.2	82.1
2579.50	2.59	7.0	619.2	76.4
2718.10	3.25	8.4	463.9	67.5
2735.04	2.97	7.6	534.4	74.8
4164.16	2.81	4.7	885.4	183.6
6152.30	4.60	5.2	623.6	244.5
1920.38	3.15	11.5	343.5	34.8
5383.84	5.80	7.5	385.4	148.5
6851.46	6.46	6.6	417.3	215.9
8530.06	6.17	5.1	556.6	350.4
19716.62	15.08	5.4	336.7	766.0
27057.80	14.74	3.8	478.1	1475.9
27476.68	12.84	3.3	597.2	1747.1
34118.70	14.92	3.1	592.0	2318.4
58170.42	21.18	2.5	596.8	4747.3

Total number of fragments = 131

Average ballistic density for all fragments = 648.4

Average gamma for all fragments = 10.375

Number of hazardous fragments in zone = 19

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
309.54	.80	18.1	433.4	3.6
311.08	.69	15.5	543.9	4.2
317.24	.55	12.0	786.3	5.5
321.86	.53	11.5	841.3	5.8
323.40	.59	12.8	711.8	5.3
324.94	.69	14.8	568.2	4.6
329.56	.86	18.2	416.1	3.8
334.18	.57	11.9	780.7	5.8
341.88	.82	16.7	462.1	4.2
343.42	.81	16.4	473.7	4.3
344.96	.86	17.5	431.8	4.1
346.50	.62	12.6	704.6	5.7
349.58	.58	11.6	793.5	6.3
352.66	.88	17.4	429.4	4.2
355.74	.56	11.1	839.9	6.7
358.82	.62	12.1	738.5	6.2
360.36	.74	14.3	570.7	5.2
360.36	.69	13.4	630.1	5.6
363.44	.88	16.9	441.8	4.5
364.98	.64	12.2	719.6	6.2
364.98	.73	13.9	591.2	5.5
368.06	.75	14.3	566.7	5.4
369.60	.70	13.2	635.2	5.8
378.84	.82	15.2	507.4	5.2
380.38	.89	16.3	455.3	4.8
381.92	.69	12.6	673.7	6.3
383.46	.64	11.7	745.4	6.8
392.70	.75	13.4	605.8	6.1
406.56	.67	11.5	744.7	7.4
408.10	.71	12.2	682.1	7.0
408.10	.63	10.8	816.1	7.9
408.10	.84	14.3	533.9	5.9
420.42	.81	13.5	574.6	6.5
440.44	1.58	25.0	222.8	3.7
441.98	.70	11.1	754.7	8.3
441.98	.33	13.1	587.7	7.0
443.52	.69	11.0	767.1	8.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
446.60	.72	11.3	725.0	8.2
446.60	.64	10.1	868.2	9.2
448.14	.90	14.1	522.3	6.6
452.76	.91	14.0	523.3	6.7
465.08	.76	11.4	707.5	8.5
472.78	.86	12.7	598.0	7.8
475.86	.87	12.8	589.5	7.8
480.48	.92	13.4	543.6	7.4
485.10	.94	13.5	533.1	7.4
488.18	.63	9.0	988.0	11.3
494.34	.79	11.1	710.8	9.3
495.88	.86	12.2	619.6	8.5
498.96	.87	12.2	618.1	8.5
502.04	.97	13.5	526.3	7.7
511.28	1.07	14.6	461.9	7.3
512.82	1.00	13.6	516.7	7.9
520.52	.67	9.1	940.7	11.9
523.60	.86	11.6	652.0	9.4
526.68	.76	10.2	788.7	10.8
532.84	1.13	14.8	443.6	7.5
562.10	1.10	13.7	487.2	8.5
575.96	.91	11.1	661.3	10.8
585.20	.83	10.0	771.1	12.2
600.60	1.05	12.2	558.2	10.2
609.84	.80	9.2	850.7	13.8
628.32	.85	9.5	796.1	13.7
649.88	.81	8.8	884.9	15.4
662.20	.94	9.9	726.6	13.9
662.20	.89	9.4	787.4	14.6
665.28	1.21	12.7	499.2	10.9
671.44	.95	9.9	726.3	14.1
722.26	1.06	10.3	663.7	14.7
733.04	.99	9.4	747.6	16.2
742.28	1.02	9.6	718.4	16.0
742.28	1.02	9.6	719.5	16.0
749.98	.99	9.3	756.8	16.8
759.22	.95	8.7	826.5	18.1

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
793.10	1.23	10.8	582.8	15.2
805.42	1.20	10.5	609.7	16.0
817.74	1.18	10.1	641.2	16.9
823.90	1.12	9.5	699.8	18.1
868.56	1.28	10.3	602.6	17.6
873.18	1.35	10.9	554.2	16.7
882.42	1.25	9.9	628.4	18.5
883.96	1.19	9.4	680.9	19.5
890.12	1.24	9.8	644.6	19.0
911.68	1.38	10.6	562.4	17.9
914.76	1.23	9.4	670.6	20.2
914.76	1.42	10.9	541.7	17.5
944.02	1.39	10.3	576.0	19.1
950.18	1.21	8.9	713.9	22.2
967.12	1.50	10.9	526.4	18.5
968.66	1.33	9.6	631.5	21.0
996.38	1.34	9.4	642.3	22.0
1001.00	1.36	9.5	631.1	21.9
1019.48	1.09	7.5	895.9	28.3
1070.30	2.16	14.1	337.2	15.8
1124.20	1.51	9.4	605.9	24.9
1164.24	1.30	7.8	785.5	31.0
1182.72	1.22	7.2	877.7	34.1
1216.60	1.30	7.5	820.8	33.8
1265.88	1.76	9.7	542.2	27.1
1299.76	2.04	11.0	446.1	24.6
1301.30	1.45	7.8	745.3	34.7
1336.72	1.51	7.9	720.4	35.2
1355.20	2.66	15.7	312.4	20.5
1378.30	1.76	8.9	590.3	32.1
1402.94	1.53	7.6	741.3	38.2
1483.02	1.71	8.1	663.2	38.2
1503.04	1.69	7.9	681.1	39.7
1540.00	1.81	8.2	632.4	33.9
1583.12	1.81	8.0	670.1	41.1
1618.54	2.08	9.0	539.5	37.4
1635.48	1.92	8.2	614.7	41.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 900 to 1100 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1638.56	1.63	7.0	787.4	35.2
1694.00	1.92	7.9	636.7	44.4
1795.64	3.39	13.2	287.7	28.3
1848.00	3.91	14.8	239.0	26.0
1971.20	1.65	5.9	930.0	70.0
2139.06	2.33	7.6	601.4	58.4
2283.82	2.30	7.0	654.7	67.4
2721.18	2.89	7.4	553.9	76.1
2955.26	4.56	10.8	303.5	56.9
3213.98	3.22	7.0	556.2	95.3
3592.82	3.56	6.9	534.9	107.7
4181.10	4.14	6.9	496.4	125.5
5453.14	3.59	4.6	801.7	246.1
5523.98	4.29	5.4	621.7	211.4
5593.28	4.64	5.8	559.6	200.3
1931.16	3.36	12.2	313.6	33.0
2343.88	3.46	10.3	364.2	47.2
4154.92	4.72	8.0	405.2	108.7
8320.62	6.26	5.3	531.2	328.6
8389.92	7.54	6.3	405.2	277.4
8670.20	6.36	5.1	540.6	351.2
9019.78	7.07	5.5	479.8	341.9
12654.18	8.83	4.9	482.3	538.9
13214.74	7.96	4.2	588.4	651.9
19017.46	10.33	3.8	572.8	1040.3
23771.44	13.14	3.9	499.1	1277.9

Total number of fragments = 137

Average ballistic density for all fragments = 619.9

Average for all fragments = 10.778

Number of hazardous fragments in zone = 19

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
304.92	.54	12.4	770.6	5.1
308.00	.50	11.4	863.4	5.6
314.16	.62	13.8	642.0	4.7
318.78	.49	10.7	938.0	6.2
318.78	.50	10.9	907.1	6.1
321.86	.48	10.4	977.0	6.5
324.94	.48	10.2	992.6	6.6
329.56	.60	12.8	707.3	5.4
337.26	.50	10.4	948.2	6.7
337.26	.51	10.7	915.2	6.6
341.88	.72	14.6	565.5	4.9
344.96	.65	13.2	659.8	5.4
346.50	.70	14.1	596.7	5.1
348.04	.54	10.8	889.4	6.7
348.04	.56	11.2	832.7	6.4
348.04	.61	12.3	723.4	5.9
349.58	.51	10.2	965.5	7.1
351.12	.71	14.1	590.6	5.2
352.66	.52	10.3	943.2	7.1
358.82	.57	11.0	842.7	6.8
368.06	.61	11.6	768.8	6.6
374.22	.75	14.1	573.9	5.5
375.76	.59	11.0	825.0	7.1
377.30	.56	10.4	895.5	7.5
381.92	.61	11.1	805.6	7.1
385.00	.59	10.7	847.4	7.5
386.54	.65	11.7	744.5	6.9
395.78	.59	10.4	882.3	7.9
398.86	.70	12.3	682.5	6.8
398.86	.68	12.0	705.1	6.9
400.40	.74	13.0	625.2	6.4
405.02	.58	10.1	912.2	8.4
411.18	.72	12.2	677.3	7.0
411.18	.56	9.4	994.5	9.1
412.72	.63	10.7	825.4	8.0
414.26	.74	12.5	652.1	6.9
423.50	.63	10.4	842.9	8.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
425.04	.76	12.5	645.3	7.1
426.58	.68	11.2	755.7	7.9
431.20	.65	10.6	817.2	8.5
435.82	.66	10.7	805.5	8.5
438.90	.74	11.8	688.1	7.7
438.90	.77	12.3	645.8	7.4
440.44	.75	11.9	680.8	7.7
441.98	.67	10.7	798.8	8.6
445.06	.61	9.6	929.6	9.6
449.68	.84	13.1	585.1	7.2
451.22	.71	11.0	754.2	8.5
455.84	.87	13.3	562.7	7.1
460.46	.76	11.6	695.0	8.3
465.08	.89	13.4	551.1	7.2
469.70	.77	11.5	692.5	8.5
469.70	.98	14.6	485.6	6.7
469.70	.68	10.1	845.1	9.7
475.86	.72	10.6	777.3	9.3
488.18	.71	10.2	810.9	9.9
492.80	.94	13.4	539.9	7.7
505.12	.91	12.7	578.1	8.3
509.74	.76	10.4	769.4	10.2
511.28	.80	11.0	713.2	9.7
512.82	.96	13.0	548.6	8.2
517.44	.63	8.5	1032.3	12.6
525.14	.67	9.0	951.2	12.2
526.68	.96	12.8	557.3	8.6
534.38	.76	10.0	806.5	11.2
535.92	.79	10.3	761.8	10.8
551.32	.75	9.6	843.7	12.0
554.40	.76	9.6	836.8	12.0
569.80	.71	8.7	948.4	13.5
574.42	.78	9.5	835.5	12.6
575.96	.98	11.9	596.4	10.1
585.20	.95	11.4	629.0	10.7
595.98	.96	11.3	634.6	11.0
600.60	.90	10.4	709.3	12.0

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
609.84	.98	11.2	632.5	11.3
619.08	.88	10.0	746.1	12.9
634.48	1.14	12.6	522.0	10.5
636.02	.99	10.9	644.7	12.1
639.10	.83	9.1	848.2	14.7
640.64	.97	10.6	674.8	12.6
642.18	.78	8.5	935.8	15.8
648.34	.97	10.5	680.8	12.9
657.58	.95	10.1	713.5	13.6
663.74	1.07	11.3	597.2	12.2
669.90	1.01	10.5	661.0	13.2
671.44	.96	10.0	718.3	14.0
682.22	.80	8.2	960.6	17.4
683.76	.85	8.7	878.7	16.4
686.84	1.00	10.2	688.9	14.0
688.38	.96	9.7	735.3	14.7
693.00	.94	9.5	761.6	15.2
708.40	.92	9.1	805.4	16.2
711.48	.92	9.0	808.9	16.4
711.48	1.18	11.6	552.9	12.7
725.34	.99	9.6	733.0	15.7
725.34	1.07	10.3	654.4	14.6
740.74	1.09	10.3	647.4	14.9
742.28	1.24	11.7	540.2	13.2
746.90	1.06	10.0	682.5	15.6
748.44	.96	9.0	799.4	17.4
756.14	1.33	12.3	494.1	12.8
765.38	.86	7.9	954.7	20.2
766.92	1.06	9.7	698.8	16.4
776.16	.91	8.2	892.6	19.6
780.78	.99	8.9	787.9	18.2
799.26	.96	8.4	848.4	19.8
820.82	1.18	10.1	638.7	16.9
823.90	1.30	11.3	535.9	15.1
825.44	1.12	9.5	697.3	18.1
845.46	1.12	9.3	710.4	18.9
860.86	1.12	9.1	728.2	19.7

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
862.40	.99	8.1	870.2	22.2
879.34	1.16	9.3	701.1	19.8
880.88	1.08	8.6	783.8	21.3
885.50	1.26	10.0	625.3	18.5
908.60	1.28	9.9	626.0	19.1
930.16	1.23	9.2	686.0	21.0
940.94	1.19	8.8	726.7	22.1
954.80	1.38	10.1	590.3	19.7
971.74	1.38	9.9	598.8	20.3
973.28	1.49	10.7	534.6	18.9
976.36	1.29	9.2	666.4	22.0
976.36	1.28	9.2	671.8	22.1
991.76	1.43	10.1	580.6	20.5
1044.12	1.26	8.4	740.0	25.8
1124.20	1.37	8.5	701.1	27.4
1125.74	1.38	8.6	694.4	27.3
1127.28	1.24	7.7	816.4	30.5
1179.64	1.61	9.6	577.4	25.7
1258.18	1.24	6.9	911.2	37.9
1272.04	1.58	8.7	640.5	30.4
1292.06	1.24	6.7	935.7	40.0
1302.84	1.45	7.8	746.2	34.8
1312.08	1.37	7.3	818.2	37.3
1316.70	1.68	8.9	604.7	30.7
1376.76	1.83	9.3	556.1	30.8
1378.30	1.74	8.8	600.5	32.4
1381.38	1.77	9.0	586.6	32.0
1392.16	1.68	8.4	639.3	34.3
1439.90	1.59	7.7	718.2	38.7
1496.88	1.34	6.3	965.0	49.7
1498.42	1.75	8.2	647.3	38.1
1512.28	1.70	7.9	682.3	40.0
1519.98	1.52	7.0	811.1	45.2
1550.78	2.28	10.3	450.5	31.3
1555.40	1.42	6.4	919.2	50.6
1580.04	1.42	6.3	933.8	52.2
1603.14	1.36	5.9	1010.8	56.2

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

<u>Fragment Wt. (gr)</u>	<u>Average Presented Area (in.²)</u>	<u>Gamma (in.²/lb)</u>	<u>Ballistic Density (gr/in.³)</u>	<u>Impact Kinetic Energy (ft/lb)</u>
1617.00	1.81	7.8	664.0	42.9
1617.00	2.01	8.7	567.4	38.7
1687.84	1.41	5.8	1008.1	60.0
1687.84	2.08	8.6	562.6	40.7
1710.94	2.06	8.4	578.7	42.2
1794.10	1.86	7.3	707.3	51.4
1798.72	1.64	6.4	856.4	58.6
1826.44	1.53	5.9	965.1	64.8
1875.72	1.87	7.0	733.5	55.9
2014.32	2.21	7.7	613.1	54.6
2111.34	2.33	7.7	593.6	56.8
2192.96	2.04	6.5	752.6	70.0
2202.20	2.19	7.0	679.5	65.8
2212.98	2.37	7.5	606.5	61.4
2274.58	2.90	8.9	460.6	53.0
2282.28	2.71	8.3	511.6	57.1
2289.98	2.54	7.8	565.7	61.3
2336.18	2.24	6.7	696.8	72.4
2337.72	2.42	7.2	621.0	67.1
2370.06	2.49	7.4	603.2	67.0
2585.66	2.86	7.7	534.6	69.5
2594.90	2.44	6.6	680.8	82.0
2704.24	2.12	5.5	876.1	102.5
2708.86	2.93	7.6	540.1	74.4
2711.94	2.39	6.2	734.0	91.4
2742.74	3.12	8.0	497.7	71.6
2778.16	2.68	6.8	633.2	85.6
2825.90	2.99	7.4	546.6	79.4
2861.32	2.45	6.0	746.1	99.3
2895.20	2.27	5.5	846.5	109.7
3218.60	3.47	7.5	497.9	88.7
3255.56	2.91	6.3	655.8	108.2
3317.16	2.87	6.1	682.3	113.9
3354.12	2.93	6.1	668.8	114.1
3411.10	3.16	6.5	607.2	109.4
3497.34	2.50	5.0	884.8	145.4
3808.42	2.43	4.5	1005.4	177.4

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1100 to 1500 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
3967.04	3.57	6.3	588.1	131.0
3968.58	2.98	5.3	771.5	157.0
3999.38	3.82	6.7	535.7	124.4
4096.40	2.88	4.9	838.1	173.1
4185.72	3.91	6.5	541.4	133.1
4231.92	4.22	7.0	488.2	126.1
4797.10	3.66	5.3	685.1	186.8
5383.84	4.38	5.7	587.3	196.6
5523.98	3.82	4.8	739.9	237.4
9578.80	6.73	4.9	548.6	405.1
7410.48	5.28	5.0	610.8	309.0
11745.58	7.03	4.2	630.1	583.1
27868.12	10.17	2.6	853.7	2239.6
6501.88	5.63	6.1	486.7	223.1
12725.02	6.83	3.8	712.9	704.5
6223.14	5.50	6.2	482.5	209.2
7760.06	5.80	5.2	555.5	308.5
9857.54	7.67	5.4	464.1	376.4
24261.16	12.83	3.7	527.9	1363.2
7621.46	5.56	5.1	581.3	310.4
6292.44	5.38	6.0	504.2	218.7
7690.76	6.01	5.5	522.0	292.4
	35.79	2.3	504.5	9687.5
3404.94	3.95	8.1	433.7	87.2
6223.14	5.23	5.9	520.3	220.0
7341.18	6.08	5.8	489.7	263.4
6292.44	5.56	6.2	480.0	211.6
7690.76	6.01	5.5	522.0	292.4
22862.84	15.42	4.7	377.6	1007.3

Total number of fragments = 215

Average ballistic density for all fragments = 705.5

Average gamma for all fragments = 9.047

Number of hazardous fragments in zone = 56

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1500 to 1900 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
329.56	.53	11.2	863.9	6.1
331.10	.55	11.6	816.2	5.9
355.74	.57	11.2	828.8	6.6
420.42	.61	10.2	876.0	8.6
423.50	.66	10.9	788.0	8.1
428.12	.87	14.3	525.8	6.2
438.90	.77	12.3	648.3	7.4
478.94	.66	9.6	893.2	10.3
480.48	.66	9.6	892.0	10.4
515.90	.77	10.4	771.0	10.3
532.84	.71	9.3	892.5	11.9
568.26	.80	9.8	801.7	12.1
611.38	.81	9.3	840.7	13.7
614.46	.83	9.4	818.5	13.6
700.70	.94	9.4	772.5	15.6
705.32	1.17	11.6	557.3	12.6
714.56	1.00	9.8	715.6	15.2
722.26	.97	9.4	757.2	16.0
739.20	1.21	11.5	555.4	13.4
806.96	1.15	9.9	656.9	16.9
825.44	.95	8.1	888.6	21.3
860.86	1.06	8.6	785.5	20.7
867.02	1.06	8.5	796.7	21.1
914.76	1.19	9.1	703.8	20.9
951.72	1.13	8.3	792.3	23.8
976.36	1.14	8.1	806.4	24.9
1067.22	1.17	7.7	840.1	28.9
1070.30	1.33	8.7	699.4	25.6
1088.78	1.24	8.0	784.7	28.3
1118.04	1.36	8.5	704.9	27.3
1127.28	1.26	7.8	794.2	29.9
1153.46	1.27	7.7	805.9	31.1
1156.54	1.48	9.0	642.3	26.9
1164.24	1.36	8.1	738.1	29.7
1168.86	1.67	10.0	541.6	24.3
1235.08	1.49	8.4	679.1	30.4
1241.24	1.59	9.5	565.0	27.1

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1500 to 1900 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1321.32	1.50	7.9	719.2	34.6
1372.14	1.57	8.0	698.2	35.7
1398.32	1.56	7.8	718.4	37.3
1466.08	1.42	6.8	866.4	45.0
1686.30	1.90	7.9	643.9	44.5
1743.28	1.63	7.4	702.5	49.3
1749.44	1.77	6.9	775.5	52.9
1778.70	1.89	7.4	684.6	49.7
1877.26	2.18	8.1	583.2	48.0
2160.62	2.09	6.8	715.1	66.4
2172.94	1.80	5.8	902.0	78.1
2376.22	1.86	5.5	936.7	90.2
2385.46	2.44	7.2	625.9	69.3
2591.82	2.80	7.6	553.2	71.3
2601.06	2.53	6.8	646.4	79.5
2644.18	2.21	5.9	804.8	94.0
2949.10	2.61	6.2	699.4	99.0
3061.52	2.58	5.9	738.8	107.9
3138.52	3.98	8.9	395.3	73.5
4150.30	5.09	8.6	361.4	100.6
4299.68	4.86	7.9	401.3	113.0
4700.08	5.41	8.1	373.5	121.3
8459.22	5.81	4.8	604.0	366.0
21604.66	16.02	5.2	336.9	865.8
22373.12	10.26	3.2	608.8	1449.7
22722.70	13.07	4.0	480.9	1173.8
27267.24	15.22	3.9	459.2	1451.6
29923.74	16.11	3.8	462.8	1651.6
49989.94	24.23	3.4	419.1	3064.6

Total number of fragments = 694.4

Average ballistic density for all fragments = 694.4

Average gamma for all fragments = 8.219

Number of hazardous fragments in zone = 20

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 1900 to 2300 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
346.50	.66	13.3	650.7	5.4
934.78	1.35	10.1	595.9	19.2
1039.50	1.11	7.5	888.9	28.9
1410.64	1.66	8.2	659.6	35.6
1895.74	2.17	8.0	593.0	49.2
2125.20	1.94	6.4	786.5	69.2
2159.08	2.23	7.2	648.4	62.1
2177.56	2.25	7.2	645.2	62.6
2919.84	2.56	6.1	712.9	99.0
4305.84	2.75	4.5	944.2	200.3
4874.10	5.35	7.7	393.9	131.9
4883.34	3.84	5.2	703.2	194.7
4935.70	4.83	6.9	465.0	149.9
5021.94	5.11	7.1	434.8	146.7
5802.72	4.43	5.3	622.3	225.9
7830.90	6.93	6.2	429.3	262.9
8080.34	7.27	6.3	410.2	264.2
8739.50	7.93	6.4	391.4	286.2
9928.38	6.91	4.9	546.6	423.9
10627.54	10.44	6.9	315.1	321.5
18178.16	15.06	5.8	311.0	652.0
20275.65	15.17	5.2	343.2	805.2
21184.24	12.48	4.1	480.5	1068.5
22442.42	11.06	3.4	610.2	1353.2
24330.46	16.40	4.7	366.3	1072.6
25659.48	13.39	3.7	521.7	1461.1

Total number of fragments = 26

Average ballistic density for all fragments = 556.6

Average gamma for all fragments = 6.477

Number of hazardous fragments in zone = 21

FAR-FIELD FRAGMENT COLLECTION DATA FOR THIRTY-SIX PALLET DETONATION
(Continued)

BALLISTIC DATA

Collection Zone: Azimuth: 90-95°
Range: 2300 to 2700 ft

Fragment Wt. (gr)	Average Presented Area (in. ²)	Gamma (in. ² /lb)	Ballistic Density (gr/in. ³)	Impact Kinetic Energy (ft/lb)
1626.24	1.77	7.6	690.6	44.4
2864.40	2.64	6.5	667.8	92.3
3557.40	2.50	4.9	900.0	150.4
5028.10	3.84	5.3	668.2	195.6
5266.80	5.24	7.0	439.1	157.3
5313.00	5.62	7.4	398.8	149.2
4733.42	5.77	7.0	413.7	169.3

Total number of fragments = 8

Average ballistic density for all fragments = 617.6

Average gamma for all fragments = 6.984

Number of hazardous fragments in zone = 6

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