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FRAGMENT HAZARD INVESTIGATION PROGRAM

QD CRITERIA FOR 155MM PROJECTILES

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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 was funded to conduct the Fragment Hazard Investigation Program. The purpose of the program is to provide the DDESB with fragmentation data to improve or to substantiate the quantity-distance (QD) standards for the safe and efficient storage of stacked munitions. The current program uses near-field fragment characterization data in conjunction with far-field collection data to predict far-field fragment density. The ultimate goal is to provide a methodology for the determination of QD standards for all hazard classifications. The hazard classification under investigation in this paper is the Mass-Detonating Hazard Materials (Class 1, Division 1).

The major effort of this program to date has been focused on the mass-detonating Army M107 155mm (TNT loaded) projectile. Close-in arena and far-field collection tests of various projectile and pallet stacking configurations have been conducted concurrent with supporting analytical studies. Fragmentation data were generated on projectile clusters which simultaneously detonate^{1,2} and on those which detonate by means of natural communication.³ Far-field collection tests were conducted on large stacks (up to 36 pallets) of projectiles at the White Sands Missile Range.⁴ A methodology was developed based on the entire set of test data which accurately predicted the total far-field fragment density. However, the assumptions used to develop the methodology were found to limit its usefulness in calculating the hazardous portion

¹Ramsey, R. T., et al, "Fragment Hazard Investigation Program", Minutes of 18th DOD explosives Safety Board Seminar, September 1978.

²Ramsey, R. T., et al, "Fragment Hazard Investigation Program", NSWC Technical Report, TR-3664, October 1978.

³Powell, J. G., et al, "Fragment Hazard Investigation Program (Large-Scale Detonation Tests)", Minutes of 19th DOD Explosives Safety Board Seminar, September 1980.

⁴Powell, J. G., et al, "Fragment Hazard Investigation Program Natural Communication Detonation of 155mm Projectiles", NSWC Technical Report TR 81-54, July 1981.

of the far-field distribution. This limitation was overcome by the development of a fragmentation computer model⁵ which uses the fragmentation characteristics obtained from arena tests to predict far-field fragment hazards.

This paper presents the results of the test and analysis effort accomplished to validate the computer model for pallets of 155mm projectiles.

MODEL VALIDATION

Test Program

Review of the fragmentation data developed on single pallets of projectiles and the large-scale multiple pallet detonation tests conducted at WSMR indicated that additional small-scale fragmentation arenas were required. These tests consisted of the detonation by means of natural communication of two pallets of projectiles. The projectiles were positioned horizontally as shown in Figure 1. The velocity and presented area of all fragments weighing more than 300 grains were obtained between polar angles 0°-110°.

Prediction of Far-Field Fragment Density

The computer model and the two pallet tests data were used to generate predictions of the total far-field fragment density for the 16 pallet and 36 pallet stack configurations tested at WSMR. Figures 2 and 3 present a comparison of the minimum and maximum fragment density predicted by the model (20 replications) and the test data for three 10° collection zones. The plots show that the model adequately bounds the test data for both stack configurations. This indicates that the model and the small-scale arena data can be used to generate QD criteria for stacks of 155mm projectiles.

QD CRITERIA

The computer model calculates the QD curve based upon hazard criteria provided as input.⁵ The curve is presented as the number of projectiles required in the stack face to just exceed the established criteria. Figure 4 presents the QD curve for 155mm projectiles using the current DDESB definition of one hazardous fragment (kinetic energy = 58 ft lb) per 600 sq ft. Shown for comparison is the current Class 1 Division 1 QD criteria ($40 W_{EX}^{1/3}$) for the 16 pallet and 36 pallet tests at WSMR. It can be seen that the computer model indicates that the current criteria underestimates the fragment hazard for munitions stored in the open.

⁵McCleskey, F. R., "Fragmentation Hazard Computer Model", Minutes of 21st DOD Explosives Safety Board Seminar, August 1984.

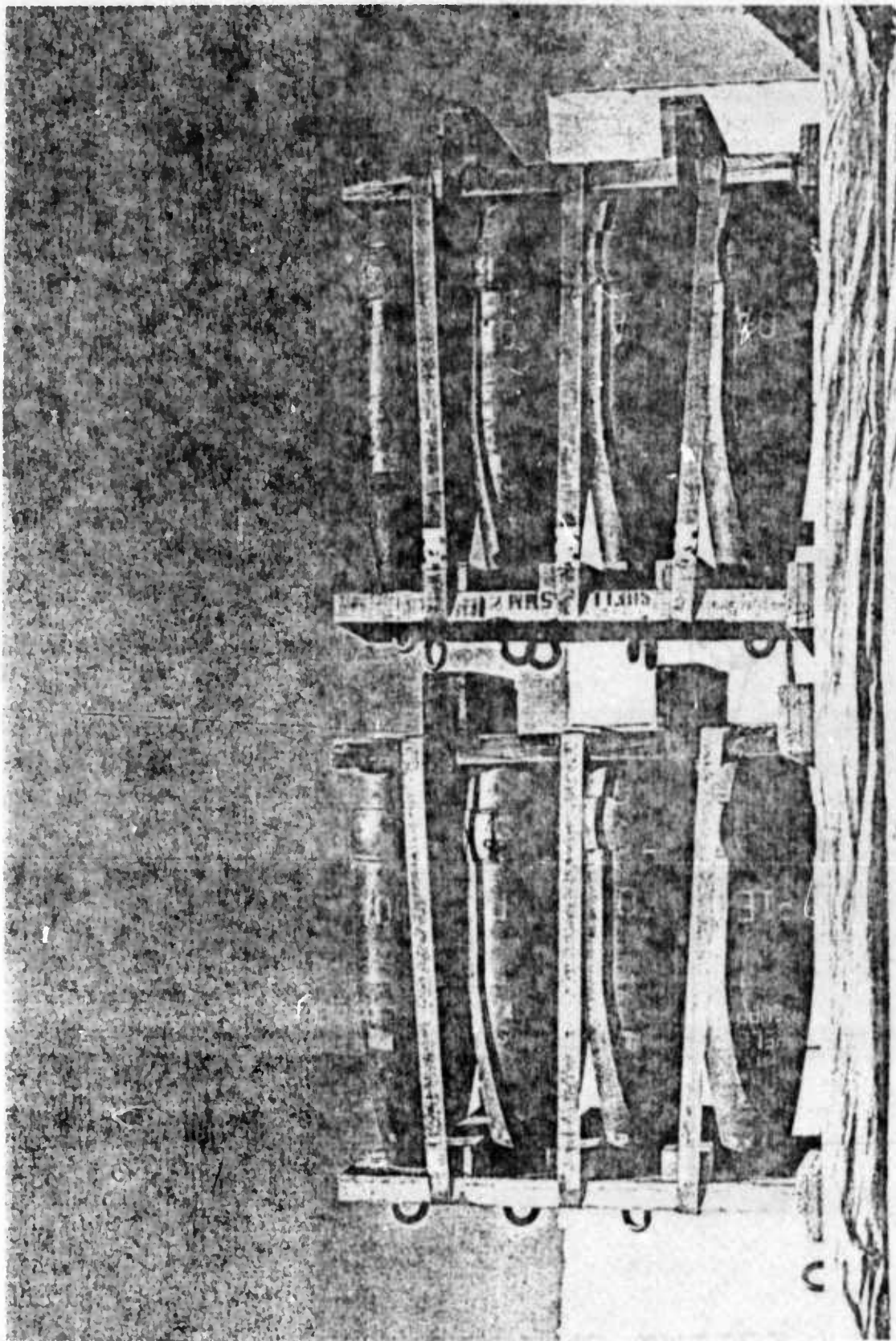


Figure 1

Two Pallet Test Configuration For Small-Scale Fragmentation Arenas

NUMBER OF FRAGS PER TEN DEGREE RECOVERY ZONE
16 PALLET CONFIGURATION 20 REPS

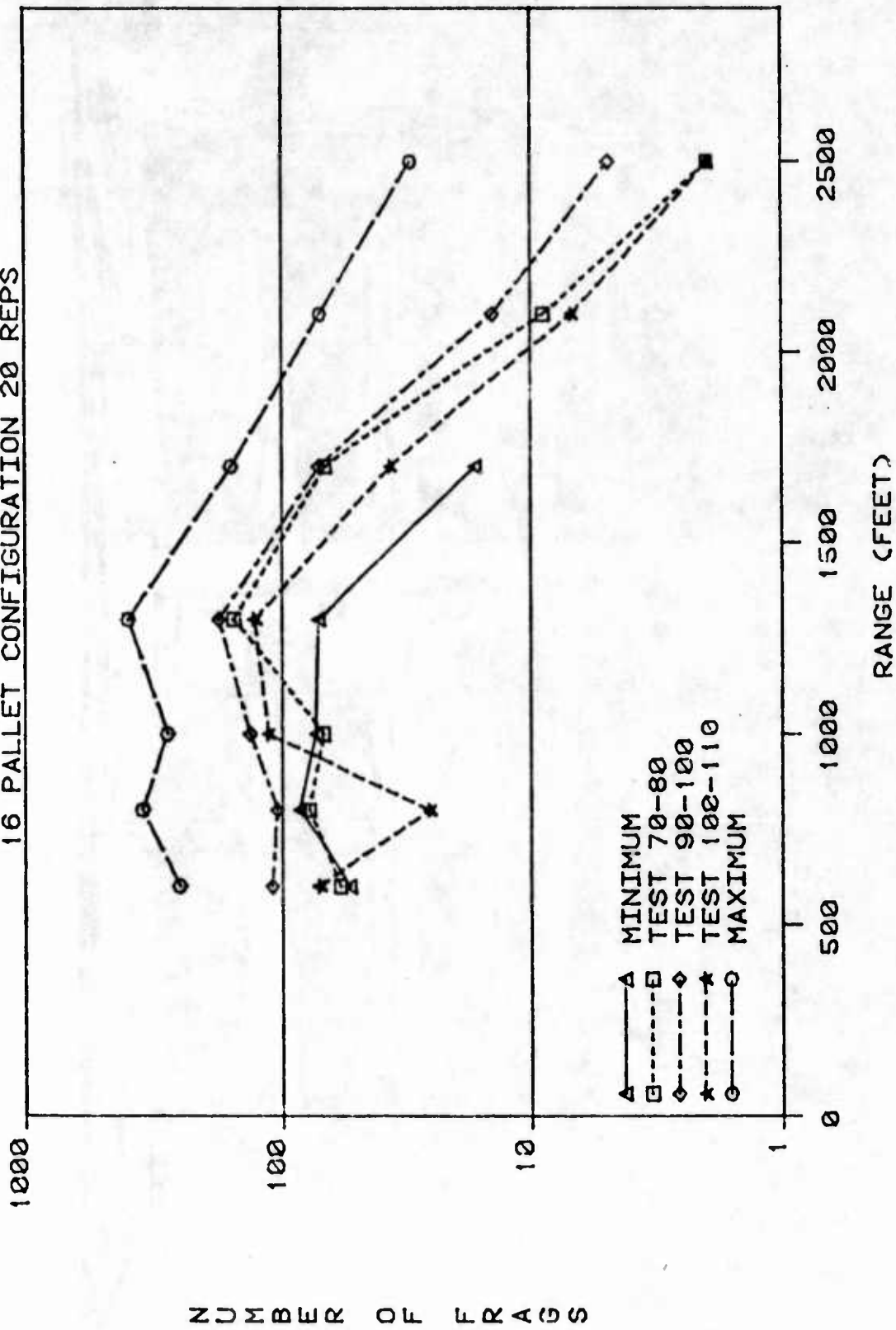


Figure 2

NUMBER OF FRAGS PER 1LN DEGREE RECOVERY ZONE
36 PALLET CONFIGURATION 20 REPS

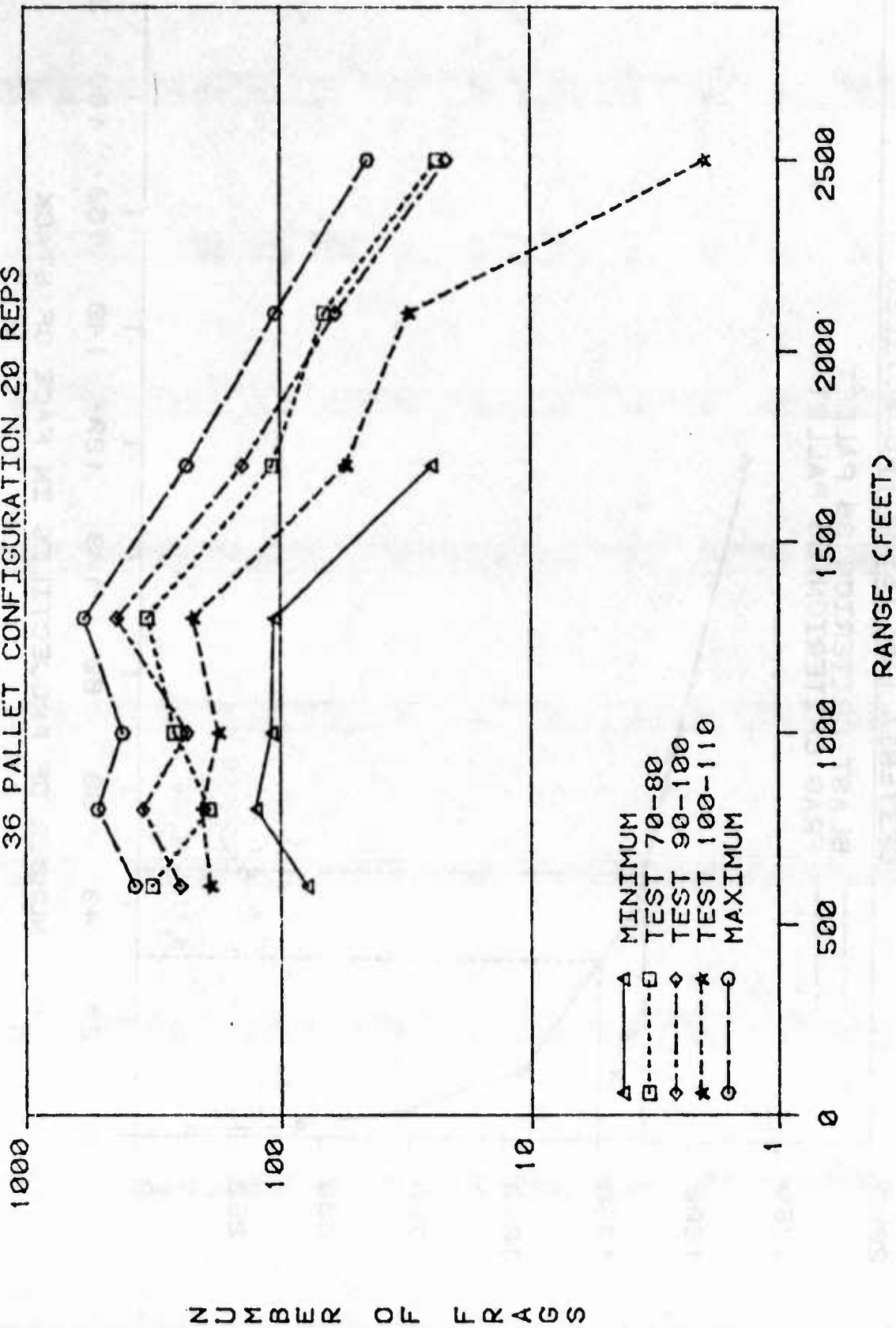
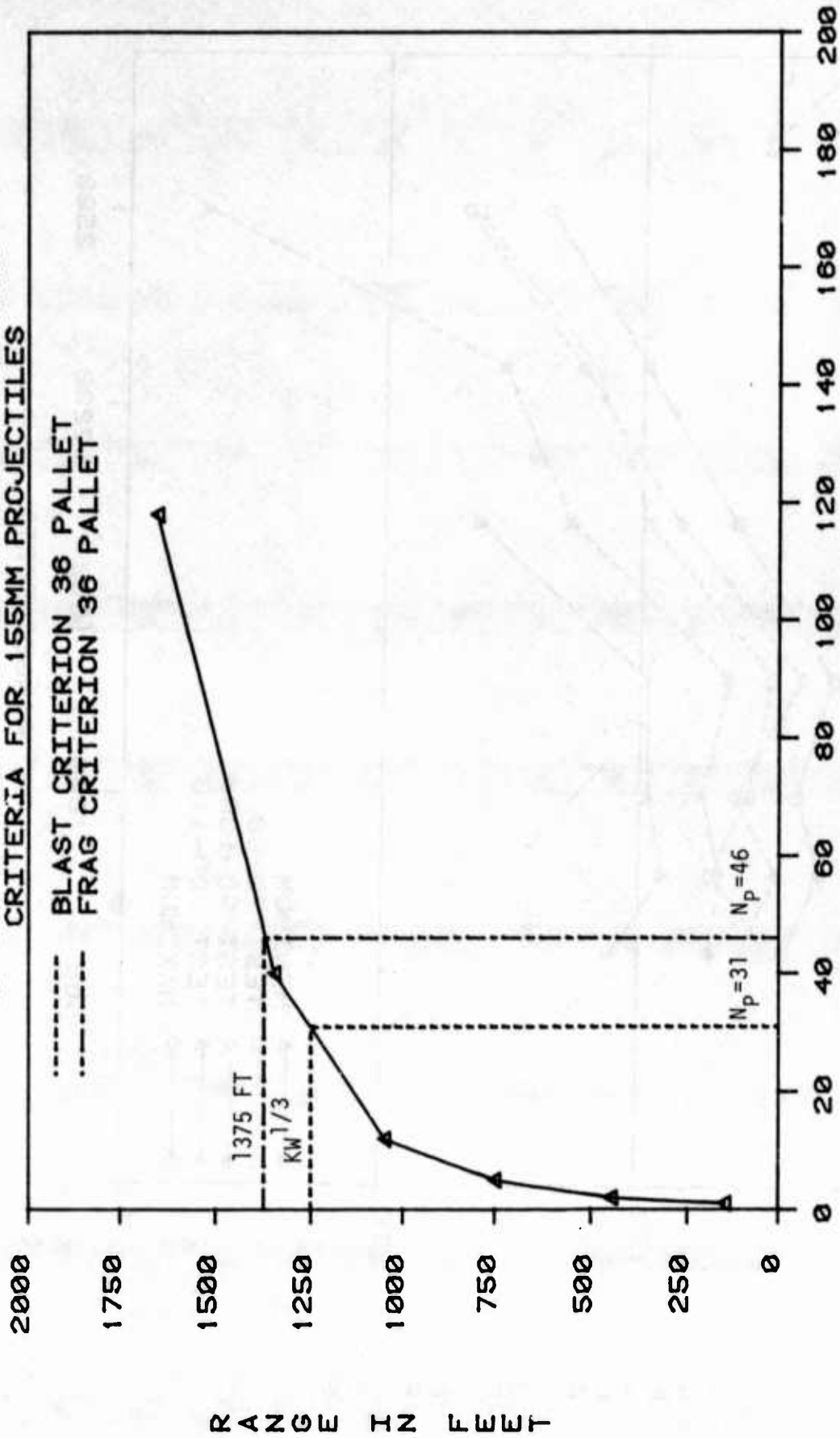


Figure 3

NUMBER OF FRAGS

OD CURVE COMPARISON FOR BLAST AND FRAG
CRITERIA FOR 155MM PROJECTILES



NUMBER OF PROJECTILES IN FACE OF STACK

FIGURE 4

RANGE IN FEET

CONCLUSIONS

The results of this study indicate that the computer model is an accurate, flexible method of determining the fragment hazards for stacks of 155mm projectiles. The model will be validated for another mass-detonating munitions (general purpose bombs) and will be modified to allow the computation of fragment hazards for non-mass detonating ammunition (Class 1, Division 2) during FY 85.

