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DEVELOPMENT OF XM5E2 AND XM10 GUIDED MISSILE WARHEADS (U)

BRIAN D. WALTERS

JANUARY 1959

FELTMAN RESEARCH AND ENGINEERING LABORATORIES
PICATINNY ARSENAL
DOVER, N. J.

ORDNANCE PROJECT TU1-3050
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by

Brian D. Walters

January 1959

Feltman Research and Engineering Laboratories
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Dept of the Army Project 516-04-006

Approved

V. LINDNER
Chief, Missile Warhead
and Special Projects
Laboratory

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OBJECT

To design and develop blast-fragmentation and training warheads for use with the Hawk missile.

SUMMARY

The XM5E2 warhead is a 110-pound blast-fragmentation warhead designed and developed by Picatinny Arsenal for use in the Hawk missile against aircraft. The warhead, which is barrel shaped, contains approximately 73 pounds of H–6 explosive. It is initiated by the XM32E2 safety and arming device.

Development tests of the warhead gave satisfactory results. These tests included static functioning, drop, and storage tests at Aberdeen Proving Ground, centrifuge and vibration tests at Picatinny Arsenal, and missile flight tests at White Sands Missile Range.

The XM10 warhead is essentially an inert training version of the XM5E2 warhead. Because it is inert, no special tests of the XM10 were conducted.

Packing crate designs were prepared, and crates manufactured and tested at Picatinny Arsenal. The warhead designs were then released by Army Rocket and Guided Missile Agency for production engineering, and manufacture of user test quantities.

CONCLUSIONS

a. The XM5E2 and XM10 warheads and packing designs as developed meet military requirements established by OCM 34681, dated 9 April 1953.

b. The XM5E2 warhead is suitable for use in the Hawk missile system.

RECOMMENDATION

It is recommended that production engineering work on the XM5E2 and XM10 warheads continue.

INTRODUCTION

1. Studies were conducted by the Ballistic Research Laboratories, at the direction of the Ordnance Office, to determine design parameters for the XM5-type warhead. The parameters selected were:

Charge-to-metal ratio	3
Fragment size, grains	120
Fragment beam angle	±30°
Explosive	H–6

The warhead was to be primarily a blast type, with fragmentation secondary, in order to cause structural kills of any type aircraft.

2. In February 1955, Redstone Arsenal (now Army Rocket and Guided Missile Agency) requested Picatinny Arsenal to

design and develop the XM5-type warhead based on results of the Ballistic Research Laboratories studies (Ref 1). Because of the high charge-to-metal ratio, the weight of purely structural parts had to be held to a minimum. Plastic materials were therefore used for as many of the warhead components as possible. Following completion of initial designs, a series of development tests were conducted which included static functioning, drop, storage, centrifuge, vibration, and missile flight tests.

3. In April 1957, Picatinny Arsenal was assigned responsibility for design and development of the XM10 warhead (Ref 2). The XM10 was to simulate the XM5E2 warhead for use in training of personnel.

DESCRIPTION OF THE WARHEADS

4. The XM5E2 and XM10 warheads are barrel shaped, 13 inches long, and 13.38 inches in diameter. Their inert parts assemblies weigh approximately 37 pounds and are identical, with one exception. The plug in the XM5E2 warhead is drilled to accept two RDX leads which form a part of the explosive train of that design (Figs 3, 4, & 6, pp 9, 10, and 12). The various components of the assemblies are bonded with polyester or epoxy resin mixtures.

5. The inner body assembly consists of an aluminum fore plate and locator pin well and a glass-reinforced-plastic inner body and aft plate (Figs 7, 8, and 10, pp 13, 14, and 16). To this assembly is bonded a molded phenolic S & A liner assembly (Figs 5 and 7, pp 11 and 13) containing a molded phenolic plug for the XM10 (Fig 4) or booster extension for the XM5E2 (Fig 3). Fragments are bonded to the outer surface of the inner body and are covered by a glass-reinforced-plastic outer body (Fig 2, p 8).

6. The S & A liner assembly contains threaded inserts which are used to secure an XM32E2 safety and arming device. This device initiates two RDX leads in the booster assembly (Fig 6) which in turn initiate a centrally located RDX booster. The booster initiates the 73-pound bursting charge of H–6 explosive (Fig 1, p 7). The XM10 warhead contains an inert filler in lieu of these explosive components (Fig 11, p 17). After loading, a glass-reinforced-plastic closing plug (Fig 7) is bonded over the loading hole in the fore plate.

TEST RESULTS

7. A series of fragmentation tests were conducted using approximately 120-grain configurations. The following size fragments were tested (dimensions given in inches):

- .50 × .50 × .25
- .522 × .522 × .221
- .668 × .668 × .135
- .674 × .674 × .133
- .528 × .528 × .218

For each test, nine fragments were sandwiched between two .06-inch-thick glass-reinforced-plastic sheets. The fragment sandwich was positioned in front of a 4.2-inch-high by 1.5-inch-diameter cylinder of H–6 explosive. After the charge was initiated by an RDX booster and blasting cap, fragments were recovered from a stack of 4 × 8 foot cardboard sheets and weighed. It was concluded from these tests that .50 × .50 × .25 inch fragments should be used in the warhead since these exhibited the least breakup and weight loss (Ref 3).

8. An investigation was made to determine whether or not RDX leads in the booster extension would initiate the bursting charge before initiating the centrally located booster cup assembly. The leads were initiated and the resultant detonation photographed using a camera running at 25 frames in 20 microseconds. It was concluded from these tests that the leads would initiate the booster, as intended, before their detonation waves propagated through the sides of the booster extension.

9. Following the above tests of components, 28 warheads were fabricated and used for development tests as follows:

Static functioning tests	6
MIL–STD tests	15
Packing tests	2
Missile flight tests	5

Static Functioning Tests

10. Each warhead was positioned on top of a 10-foot-high pedestal located in the center of an arena of 15 feet radius. The arena consisted of mild steel plates and blast gages as shown in Figures 15, 16, and 17 (pp 21, 22, and 23). The centers of the plates and blast gages were also positioned 10 feet above the ground. Measurements were made of the free-air blast and the mass, spatial, and velocity distribution of warhead fragments (Figs 18 and 19, pp 24 and 25).

11. Two XM5 warheads were tested in the as-received condition. The remainder (2 XM5, 2 XM5E1) were positioned inside a missile compartment. A water tank simulating the mass of the missile guidance package was positioned at the forward end of the compartment.

12. From these tests, it was concluded that the missile skin causes a 350 fps, or 5%, loss in average fragment velocity through the missile skin and that the warhead produces an average side-on free-air peak blast pressure of approximately 42.3 psi at a distance of 20 feet (Ref 4).

MIL-STD Tests

13. Safety drop tests from a 40-foot height were conducted at Aberdeen Proving Ground. One warhead impacted on its forward end, the second impacted on the S & A cavity, and the third impacted on a mounting lug on its fore plate. Since there was no evidence of detonation on or after impact of each warhead, it was concluded from these tests that the warhead is drop safe (Ref 5).

14. A total of 6 storage tests were conducted at Aberdeen Proving Ground.

In the first series of tests two XM5E1 warheads were subjected to 30-day storage tests at 180°F. That temperature was used instead of 160°F at the direction of Army Rocket and Guided Missile Agency, based on temperatures expected at that time to be encountered during the missile-ready period on the launcher. Both tests were stopped after 140 hours because 2.88 and 3.8 pounds of explosive had exuded from the respective warheads. One of these warheads was then dropped from a height of 40 feet with no resultant detonation. The second was statically detonated to provide more blast and fragmentation data (Ref 6).

15. Two additional XM5E1 warheads were subjected to two 14-day JAN cyclic temperature and humidity tests except that the upper temperature limit was increased from 160°F to 180°F for reasons stated above. One test was stopped after 143 hours due to the exudation of 1.8 pounds of explosive. When dropped from a height of 40 feet this warhead did not detonate. The second test was stopped after 189 hours due to the exudation of 3.31 pounds of explosive. This warhead was statically tested to obtain additional blast and fragmentation data (Ref 6).

16. Based on further missile tests conducted by Raytheon Manufacturing Company, the prime missile contractor, it was concluded that the warhead would not be subjected to temperatures in excess of 160°F. Subsequently, one XM5E2 warhead was subjected to two 14-day JAN cyclic temperature and humidity tests, and a second XM5E2 was stored for 30 days at 160°F. The warhead subjected to the cyclic storage test successfully passed the test since no exudation of explosive was observed and the components were not damaged. However, a small amount of explosive exuded from the warhead stored for 30 days at 160°F (Ref 7). On the basis of a subsequent investigation conducted at Picatinny Arsenal, it was decided to add 0.5% of Micro-Cel E to the H–6 explosive to prevent further exudation.

17. One XM5 warhead was centrifuge-tested at Picatinny Arsenal. During the test, two lugs of the fore plate delaminated when 30 "g's" was applied in the aft direction. To strengthen the lugs, the plastic laminate was sandwiched between steel plates, which were held together by cap screws. Warheads with these metal-reinforced lugs were designated XM5E1.

18. An inert-loaded XM5E1 warhead successfully passed additional centrifuge tests in which 50 "g" loads were applied in aft and lateral directions (Ref 8). Subsequently, however, the fore plate material was changed from a glass-reinforced-plastic laminate to aluminum to eliminate tolerance difficulties and to make the warhead stronger. Warheads with this aluminum fore plate were designated XM5E2. The change necessitated repeating the 50 "g" centrifuge test. One XM10 warhead (an inert-loaded XM5E2) successfully withstood the 50 "g" loads applied aft and laterally (Ref 9).

19. One XM5E1 warhead successfully withstood vibration tests. During these tests a 30-minute resonant search was conducted using vibrations of 30 to 2000 cps at ±6 "g" accelerations. The warhead was then vibrated for 10 minutes at each resonant frequency detected (Ref 10). Because of the change to an aluminum fore plate described in the previous paragraph, the vibration tests were repeated with an XM10 warhead. The vibration schedule was revised in accordance with later information received from Raytheon Manufacturing Company as follows:

a. 10 to 150 cps at ±4 "g" accelerations

b. 150 to 400 cps at ±6 "g" accelerations

c. 400 to 2000 cps at ±8 "g" accelerations

As before, the warhead was vibrated for 10 minutes at each resonant frequency detected. It was not damaged (Ref 11).

20. An internal pressure test was made to determine the failure point of an XM5 warhead inert parts assembly. It was found that the S & A liner fractured under an air pressure of 15 to 20 psi gage (Ref 12).

Packing Tests

21. Satisfactory results were obtained from rough handling tests of the warhead packing crate. A crate containing 2 inert-loaded XM5 warheads was subjected to 1 drop from a height of 2 feet onto each of 2 diagonally opposite corners of the base and 1 horizontal drop from 2 feet onto the 2-inch edge of a 2 × 4 timber. Neither warhead was damaged.

Missile Flight Tests

22. Three XM5E1 and two XM5E2 warheads were successfully flown in Hawk missiles. In each of the three cases where the missile functioned properly, there resulted "K" kills of QF–80 or QB–17 drones. Because of missile malfunctions, two of the warheads did not reach their target. However, one of these latter two was successfully initiated by the missile destruct system. No destruct command reached the other, and it did not detonate, even after impacting the ground. These tests demonstrated the compatibility of the warhead and fuze system and the ability of the warhead to be safely flown in the Hawk missile.

23. Additional flight tests using industrially furnished XM5E2 warheads are continuing. Out of 4 such additional tests, all have resulted in "K" kills of target drones.

24. On the basis of satisfactory performance during static functioning, MIL–STD, packing, and missile flight tests, the XM5E2 and XM10 warheads were released for production engineering and manufacture of user test quantities (Ref 13).

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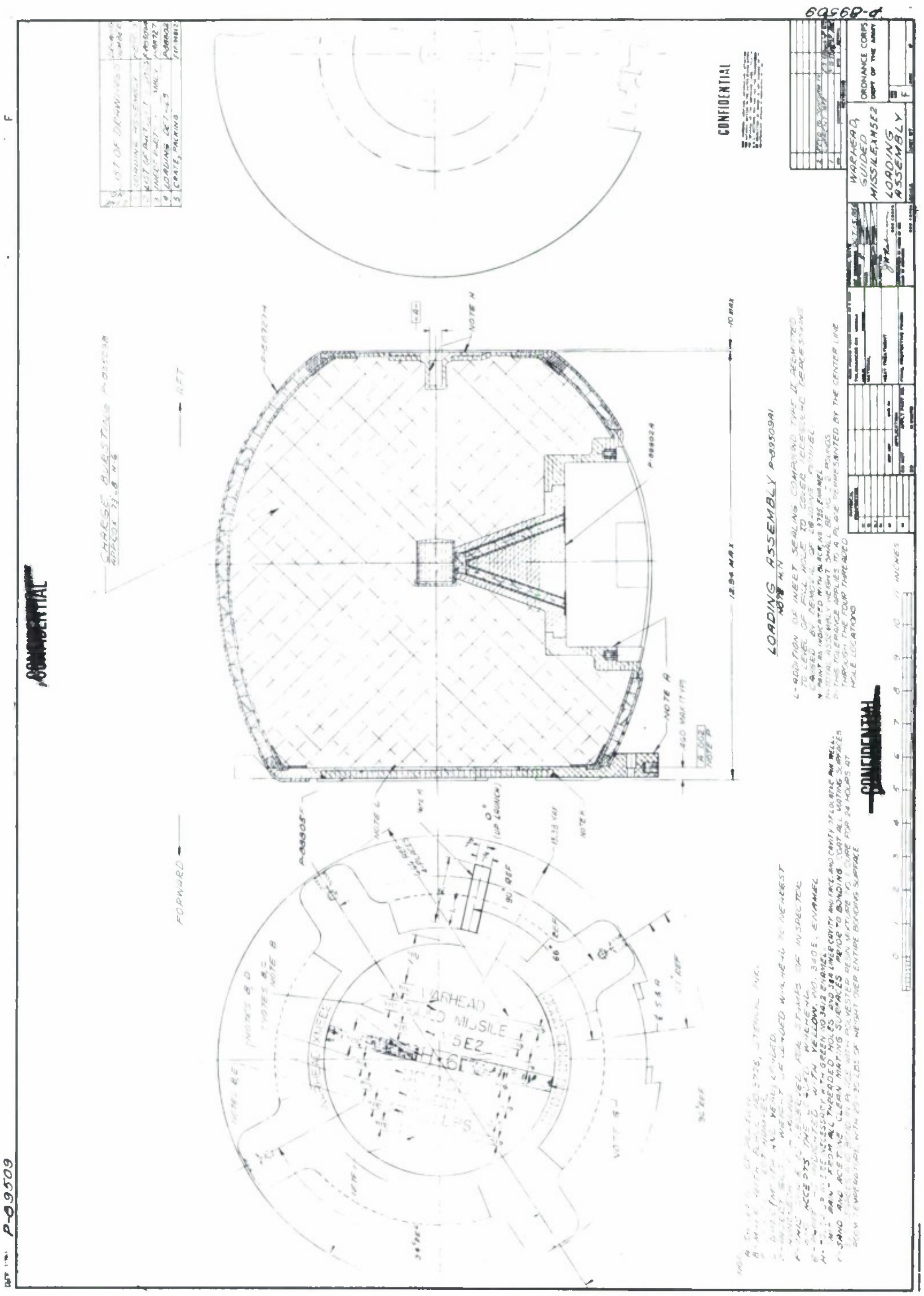

Fig 1 Loading Assembly of XM5E2 Guided Missile Warhead

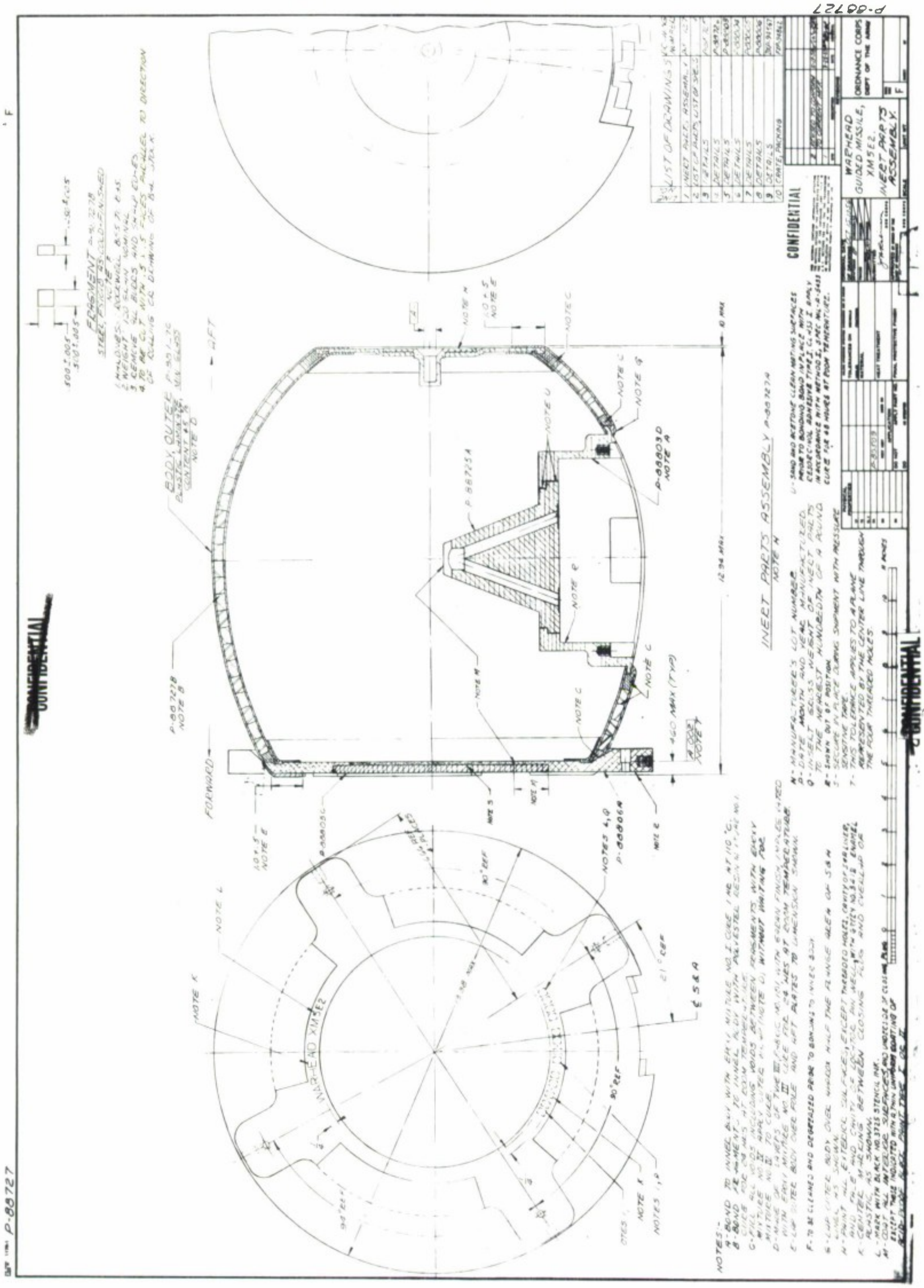

Fig 2 Inert Parts Assembly of XM5E2 Guided Missile Warhead

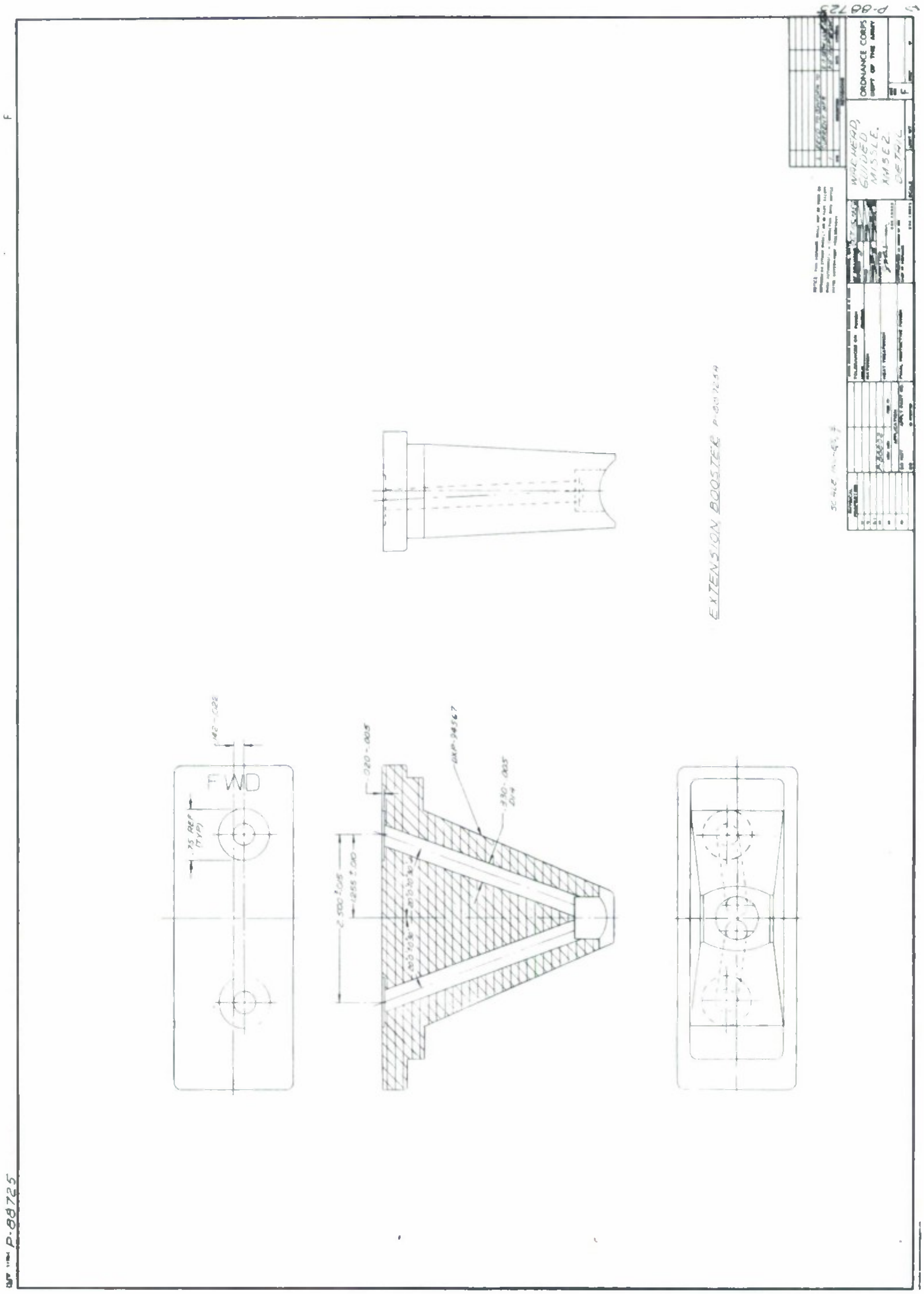

Fig 3 Detail of XM5E2 Guided Missile Warhead

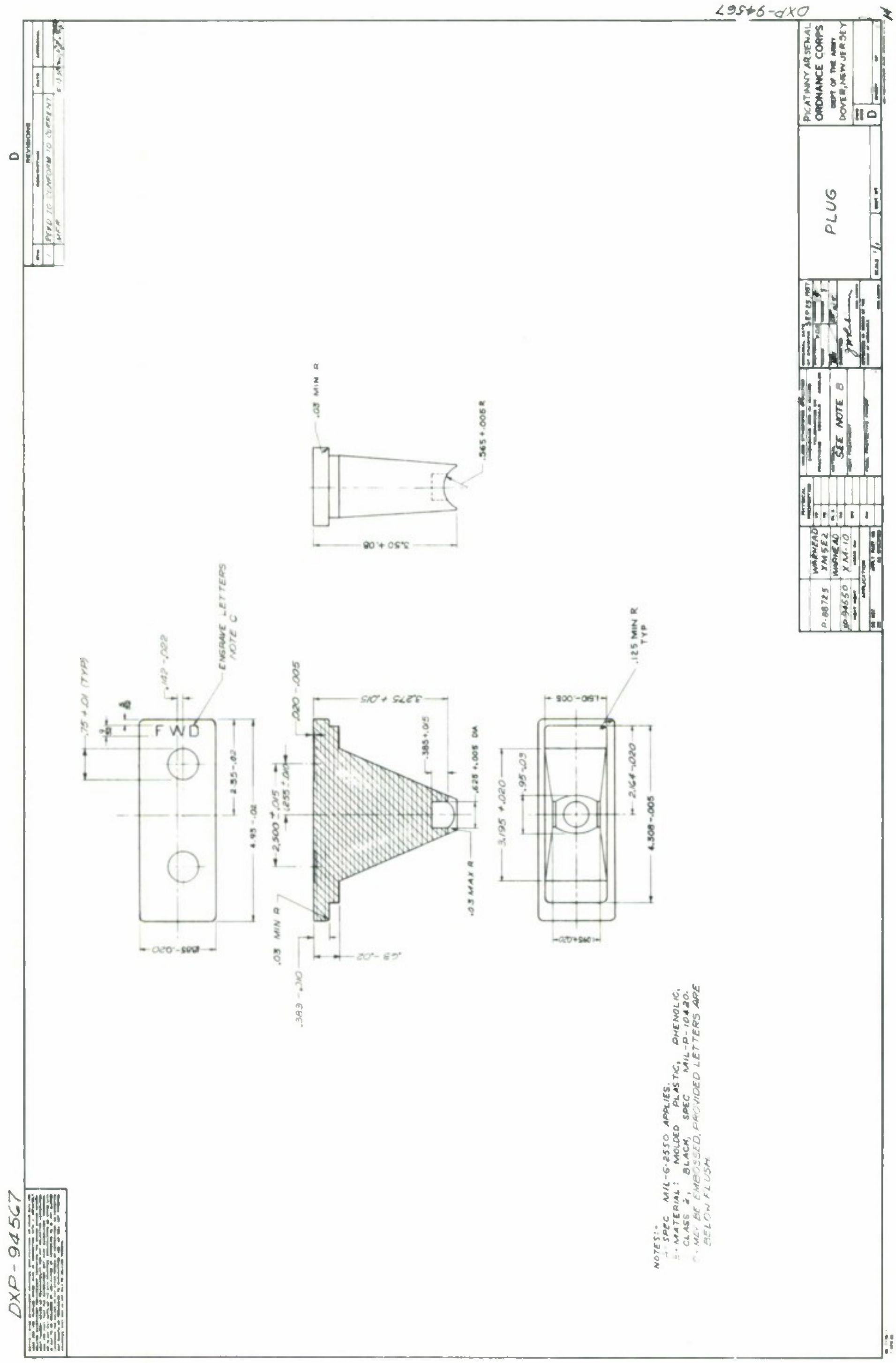

Fig 4 Molded Phenolic Plug for the XM10 Warhead

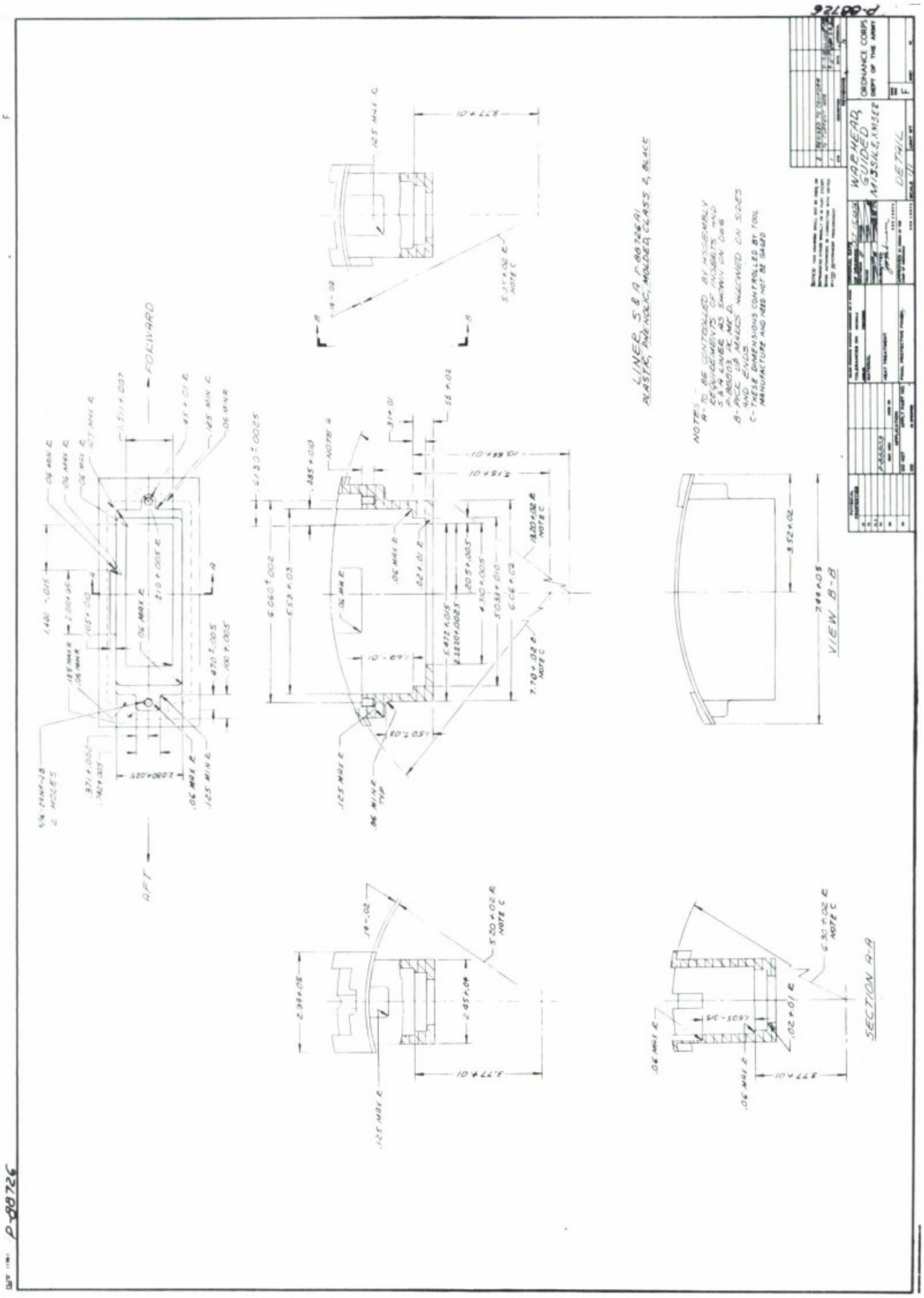

Fig 5 Detail of XM5E2 Guided Missile Warhead

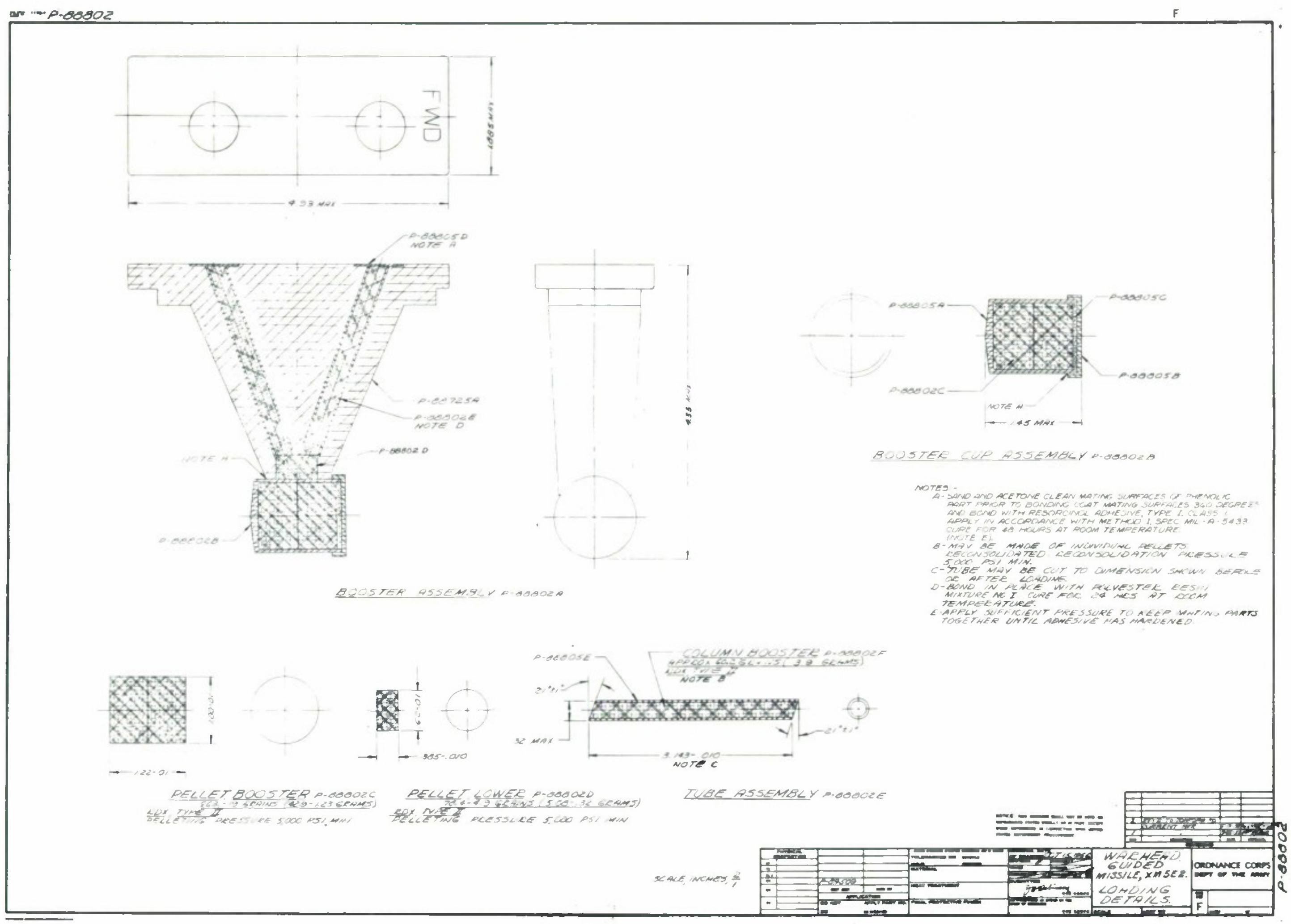

Fig 6 Loading Details of XM5E2 Guided Missile Warhead

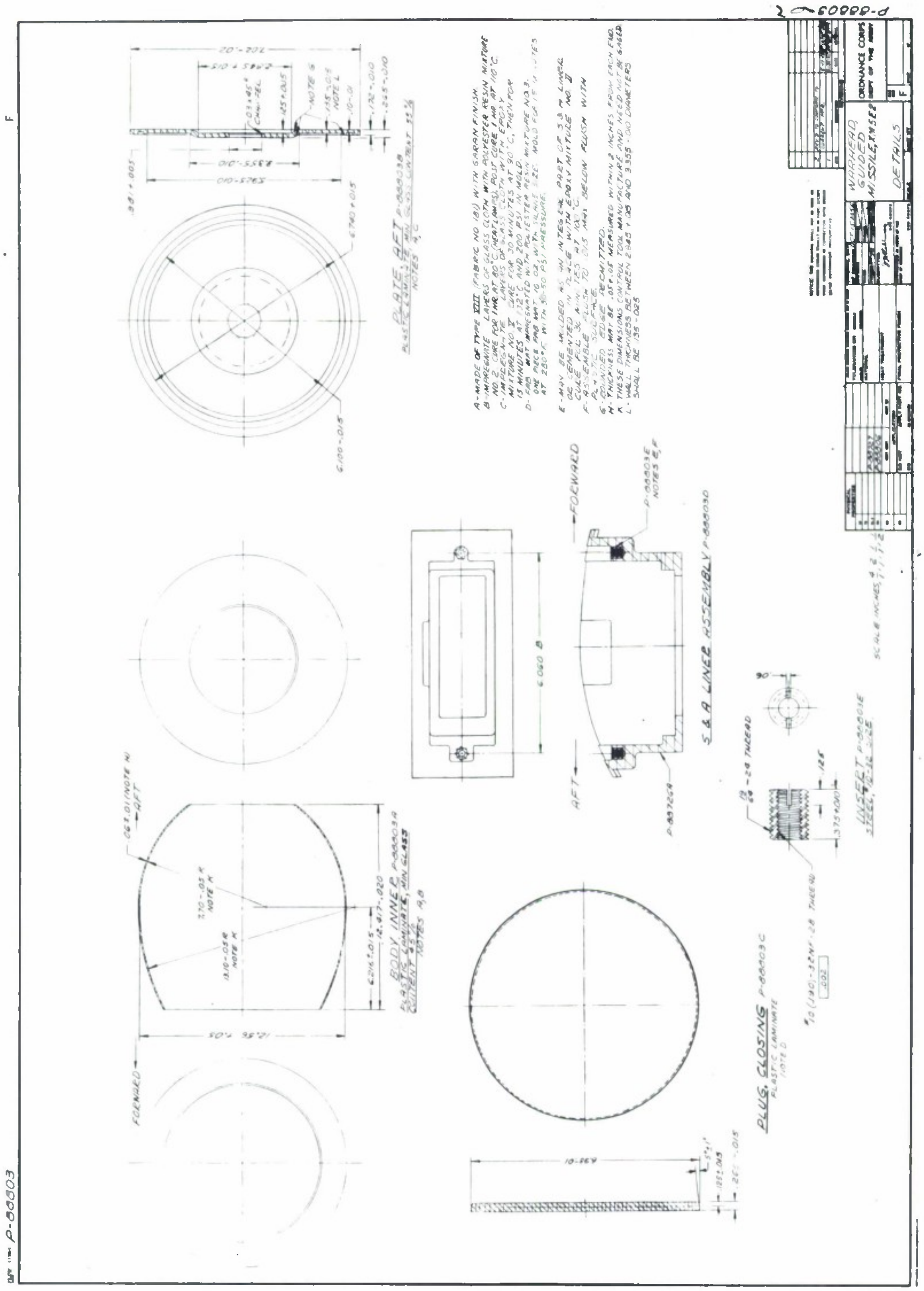

Fig 7 Details of XM5E2 Guided Missile Warhead

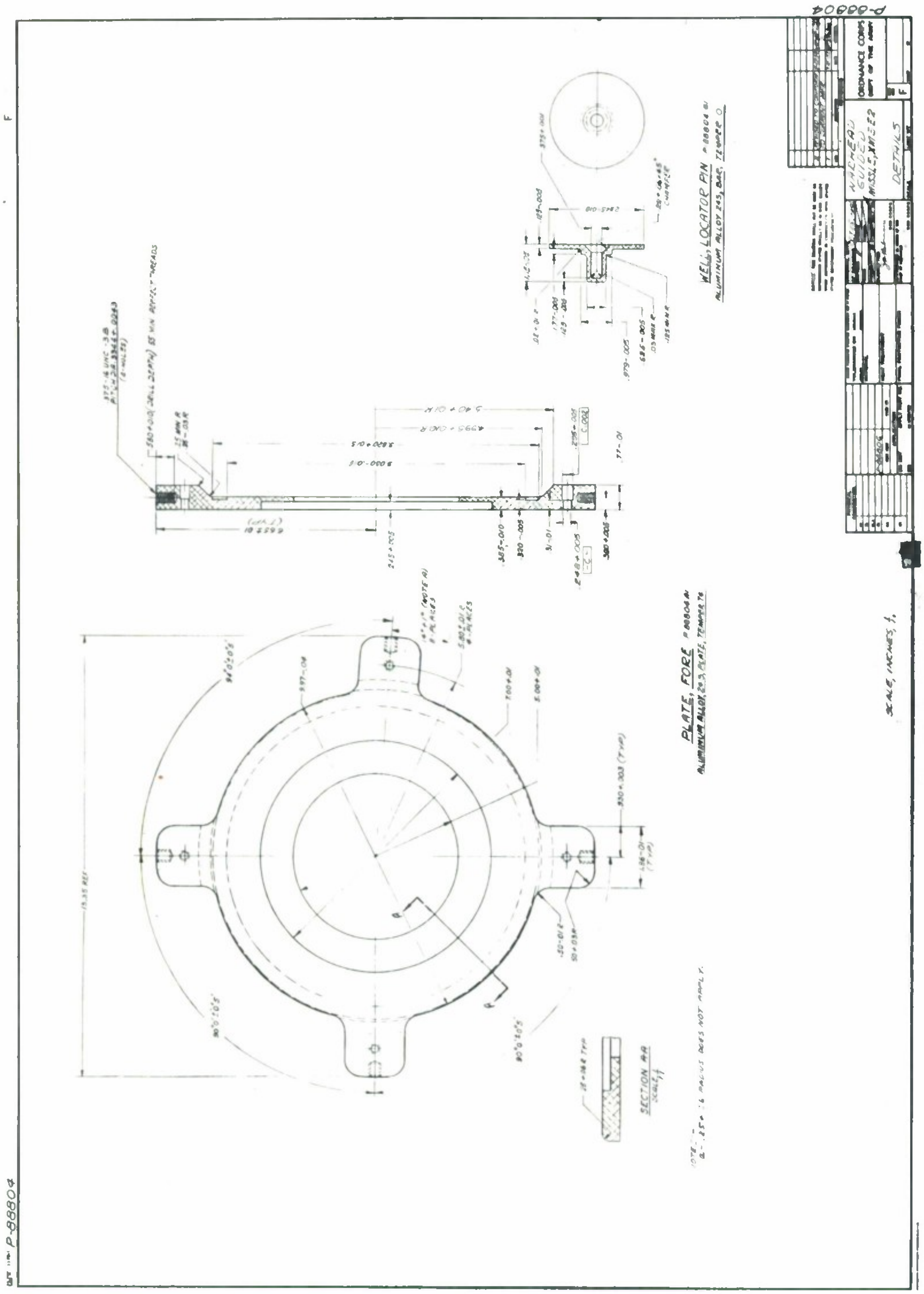

Fig 8   Details of XM5E2 Guided Missile Warhead

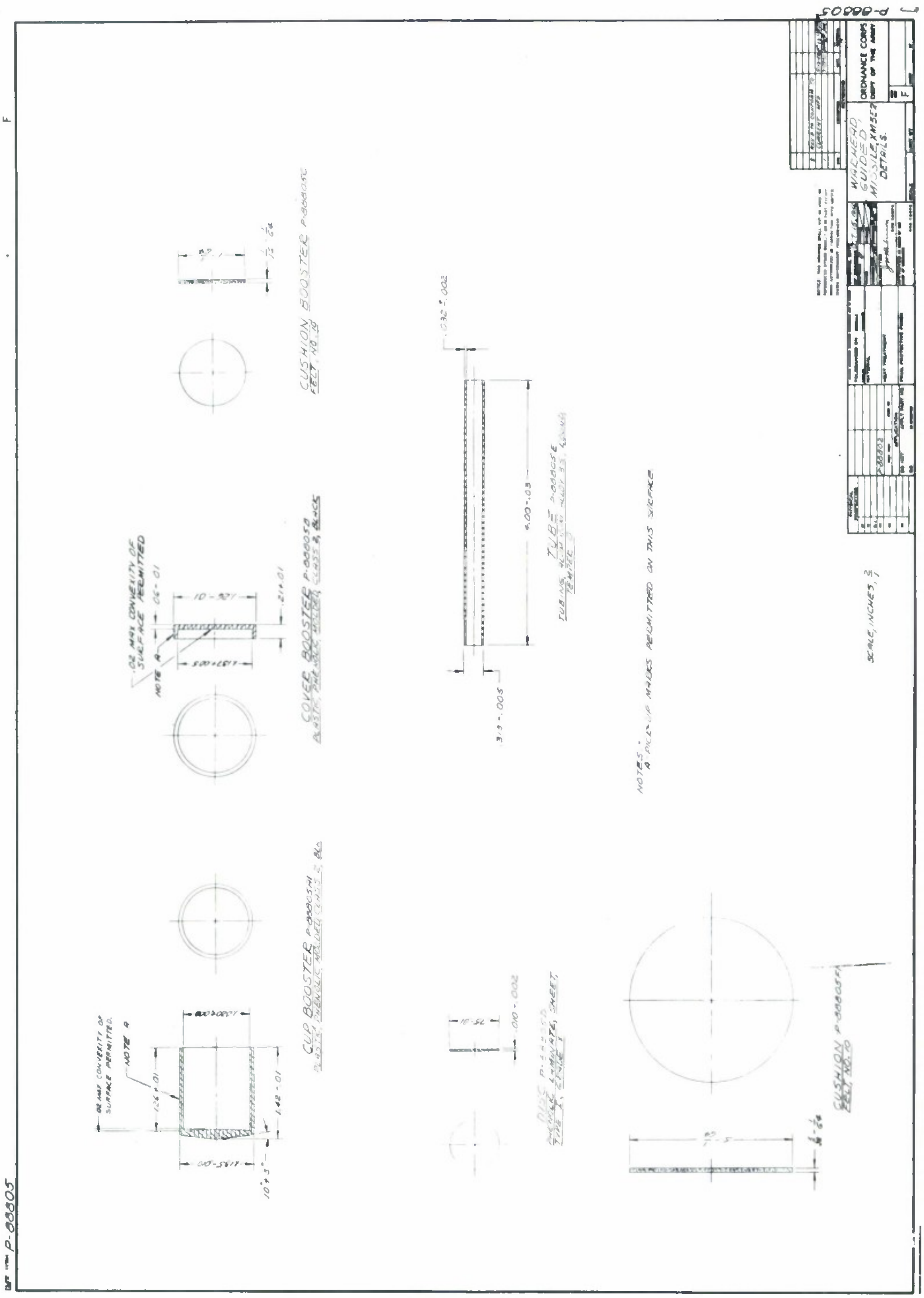

Fig 9 Details of XM5E2 Guided Missile Warhead

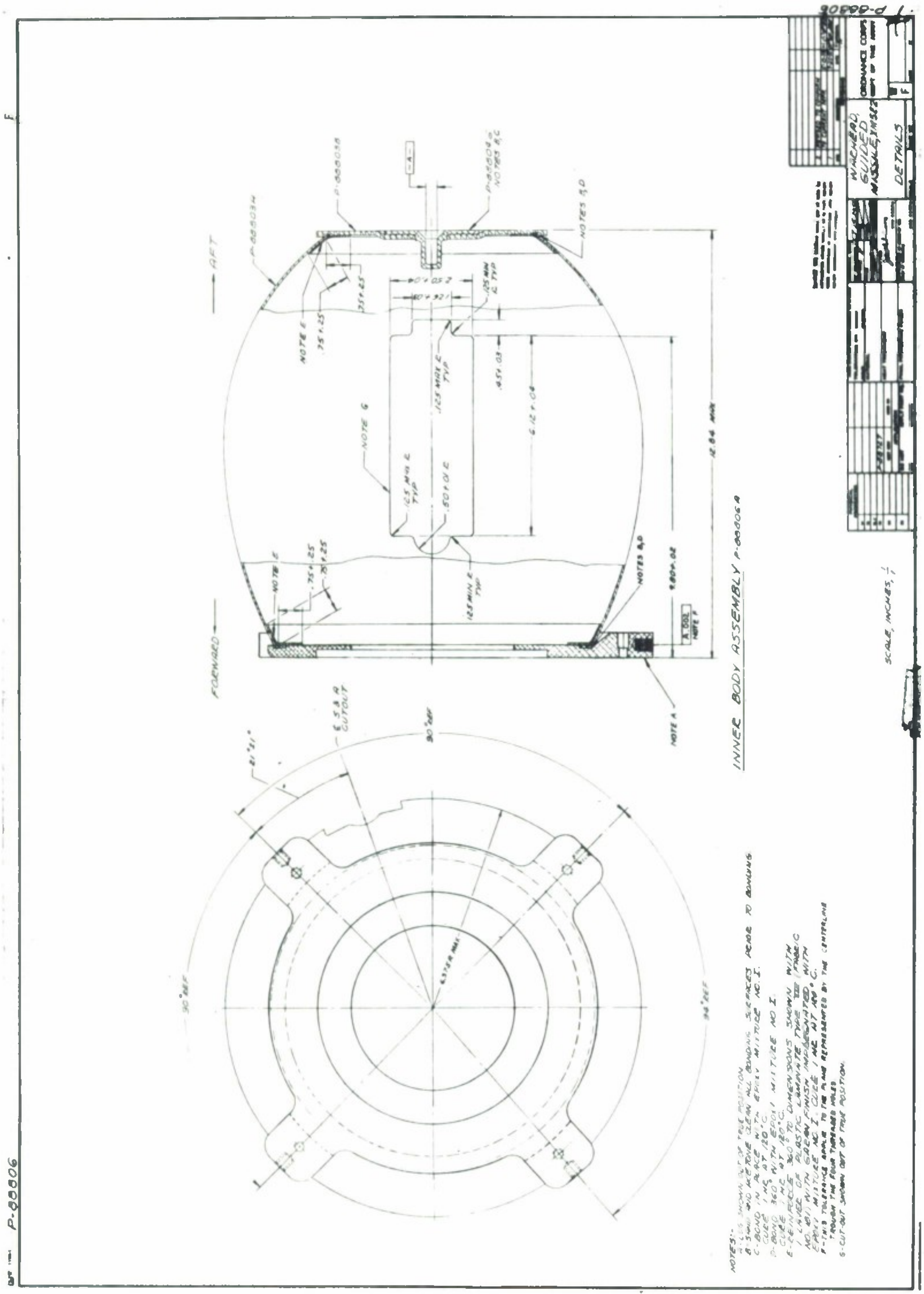

Fig 10   Details of XM5E2 Guided Missile Warhead

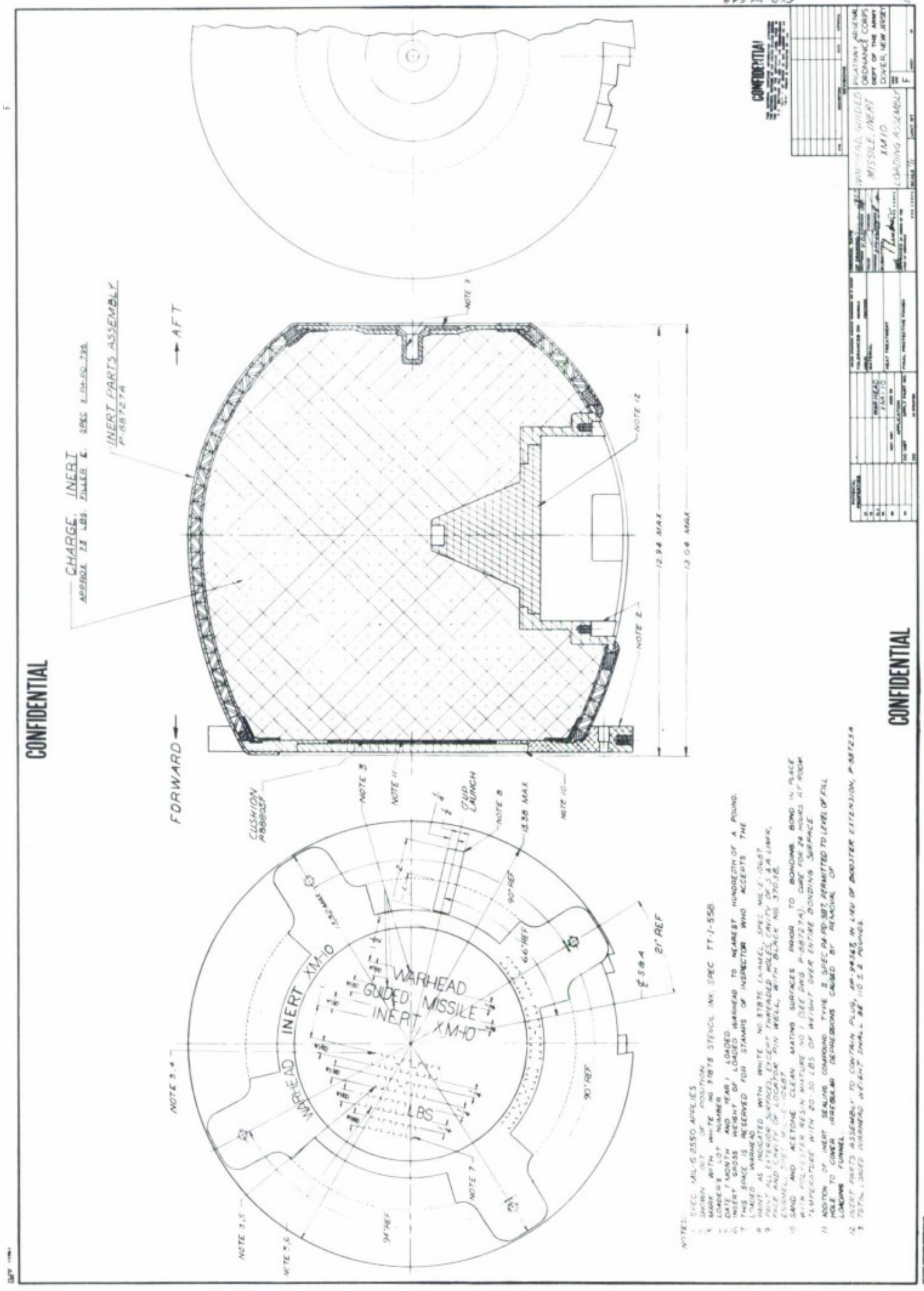

Fig 11 Loading Assembly of XM10 Inert Guided Missile Warhead

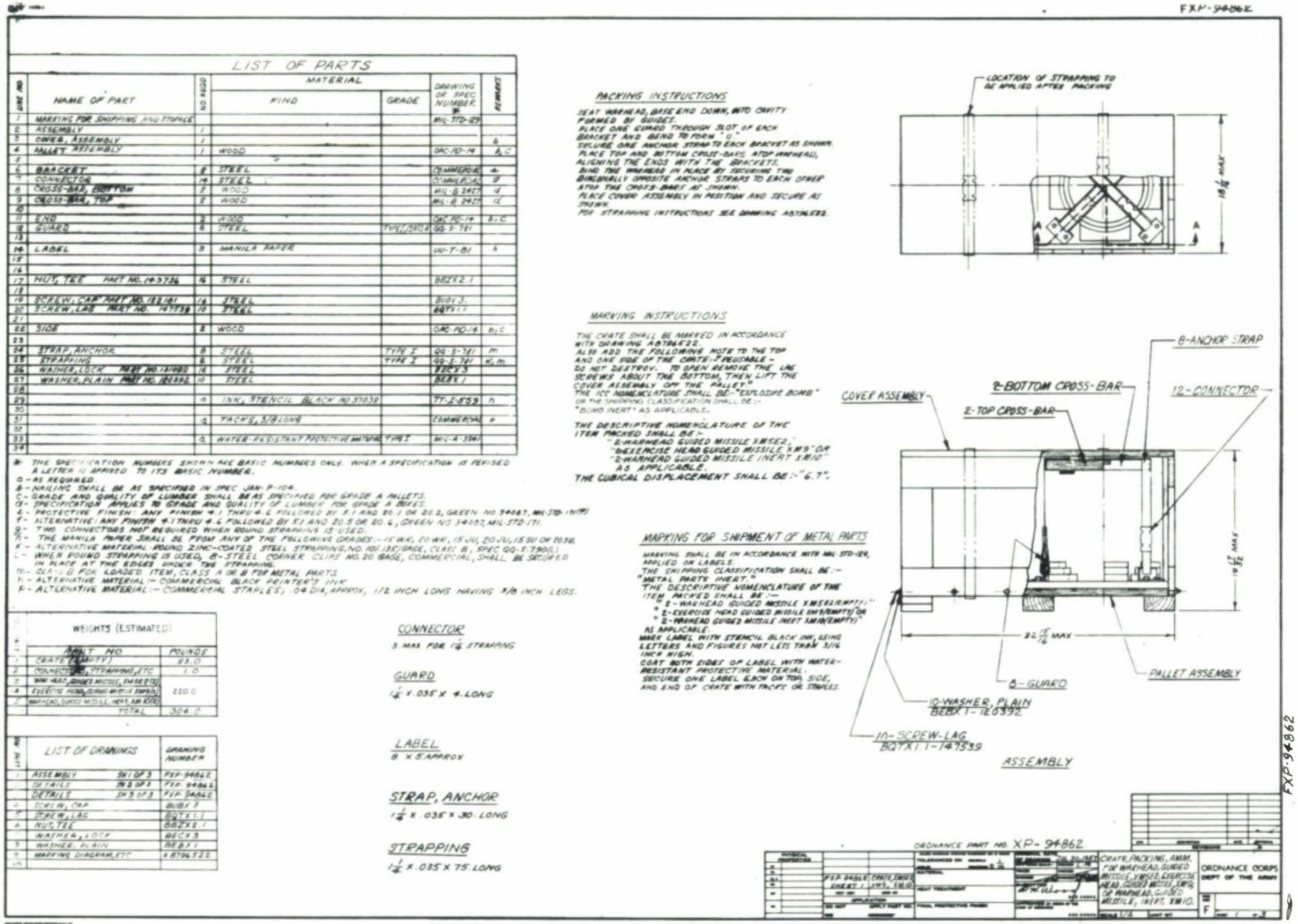

Fig 12 Ammunition Packing Crate for XM5E2, XM9, and XM10 Guided Missile Warheads (Sheet 1)

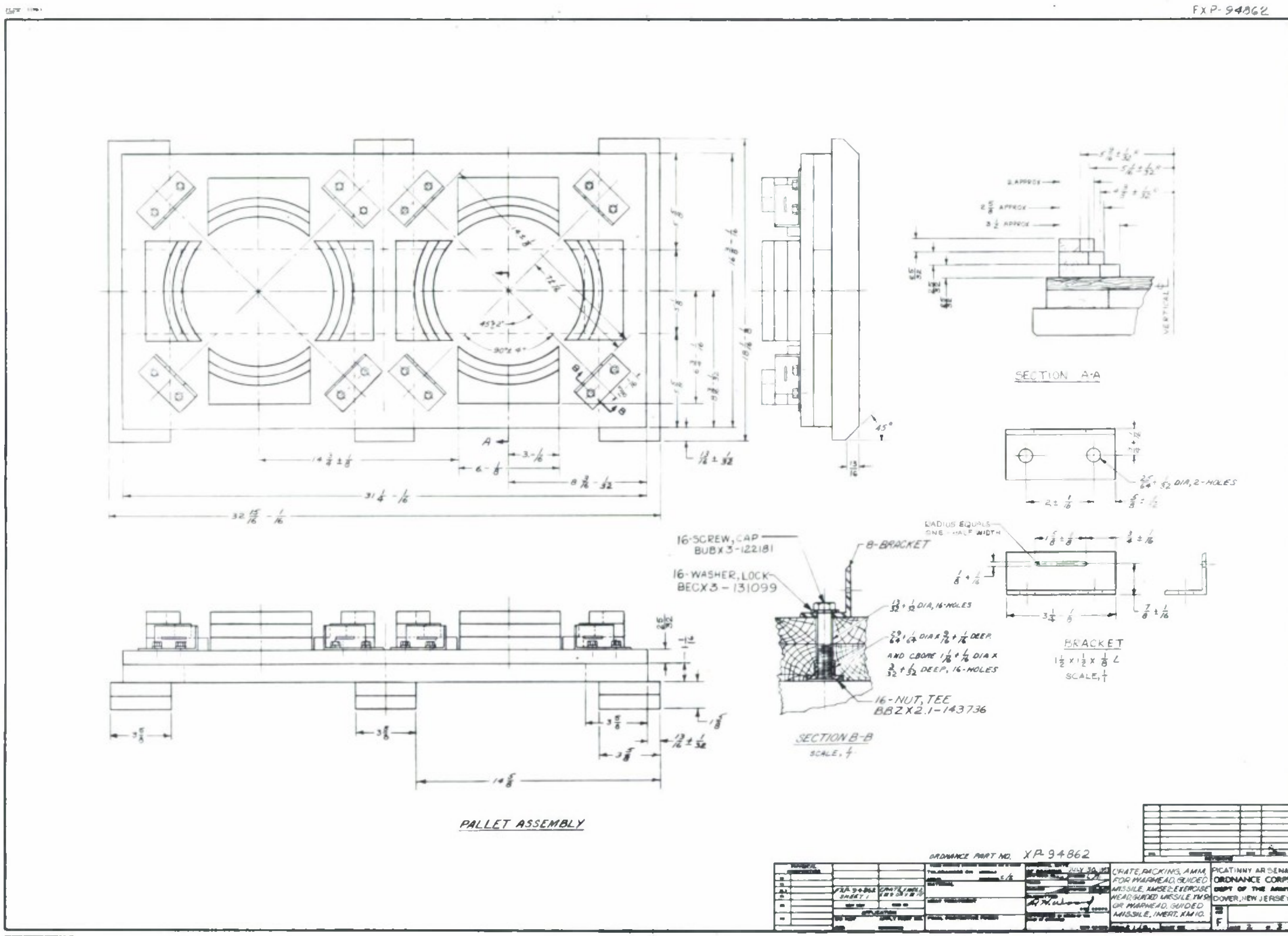

Fig 13 Ammunition Packing Crate for XM5E2, XM9, and XM10 Guided Missile Warheads (Sheet 2)

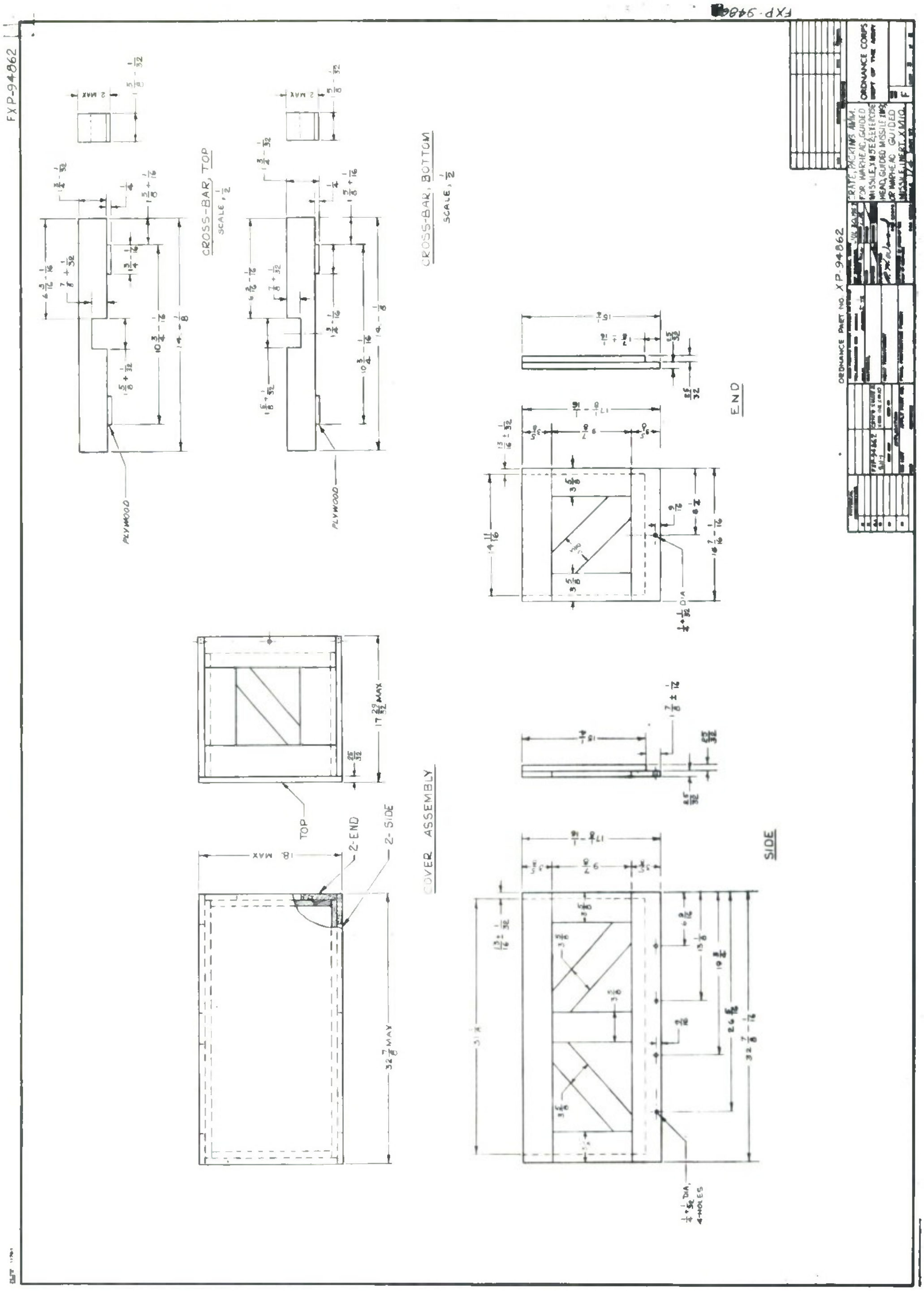

Fig 14 Ammunition Packing Crate for XM5E2, XM9, and XM10 Guided Missile Warheads (Sheet 3)

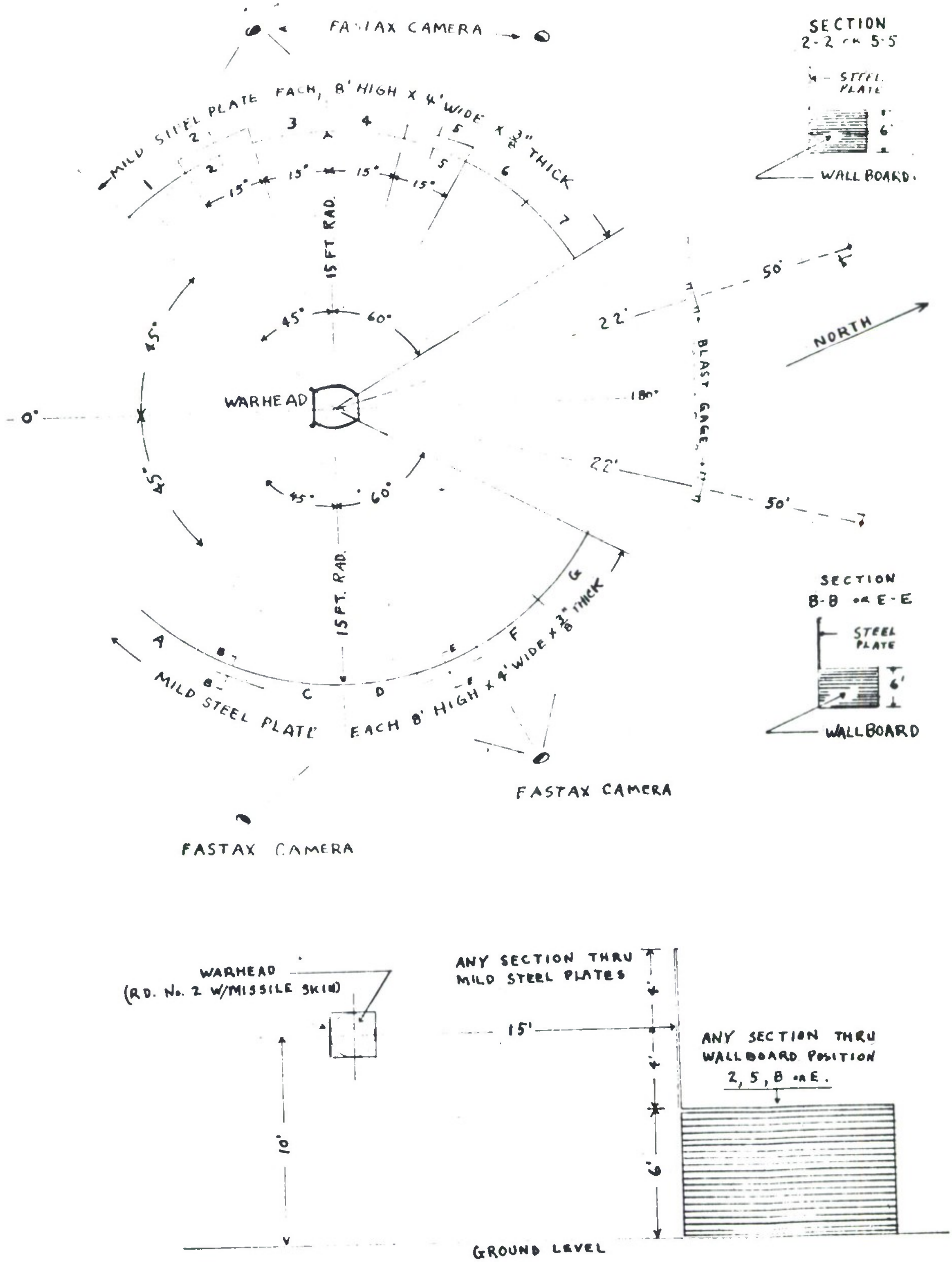

Fig 15 Field Setup for Static Functioning Tests

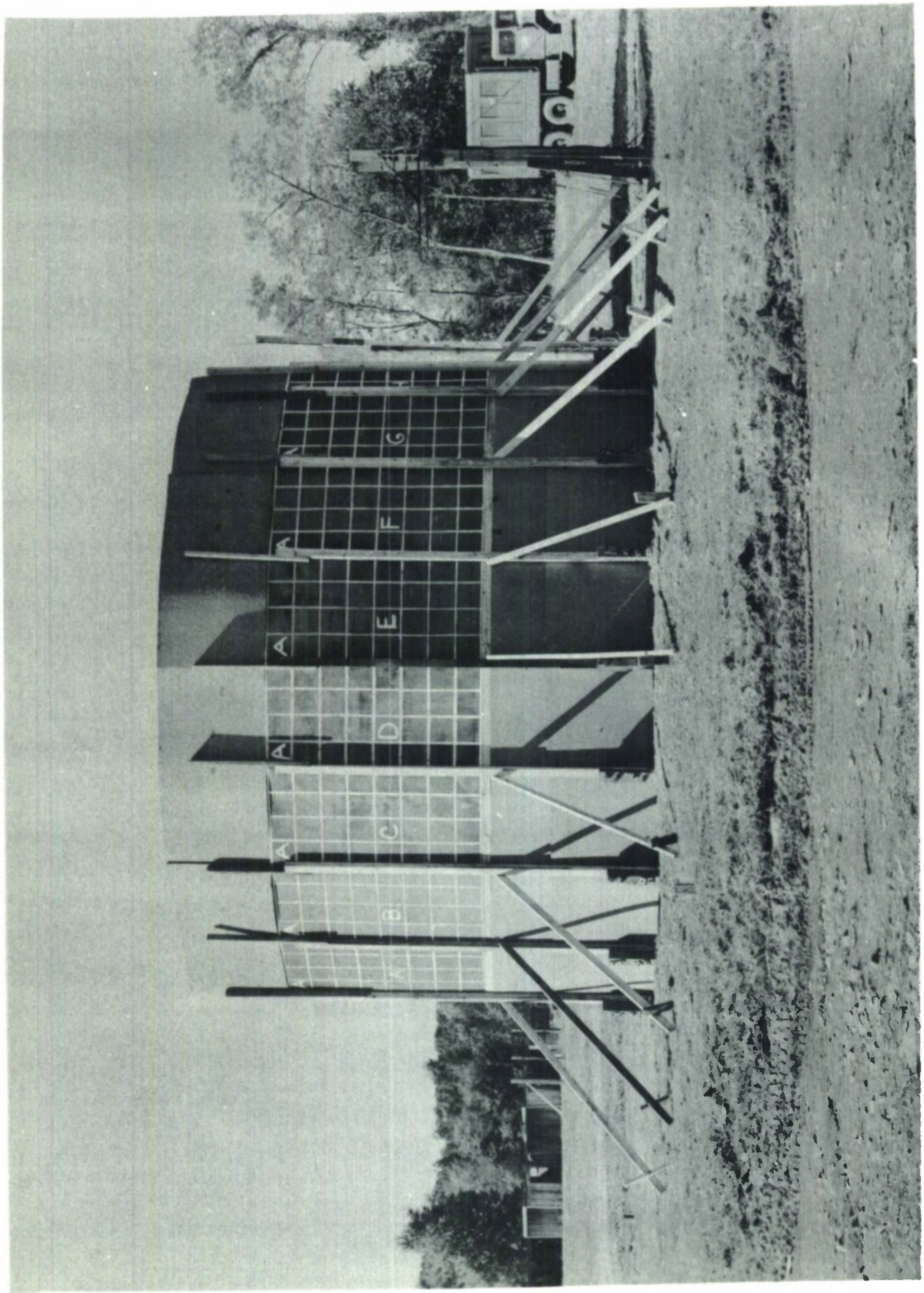

Fig 16 External View of Field Setup

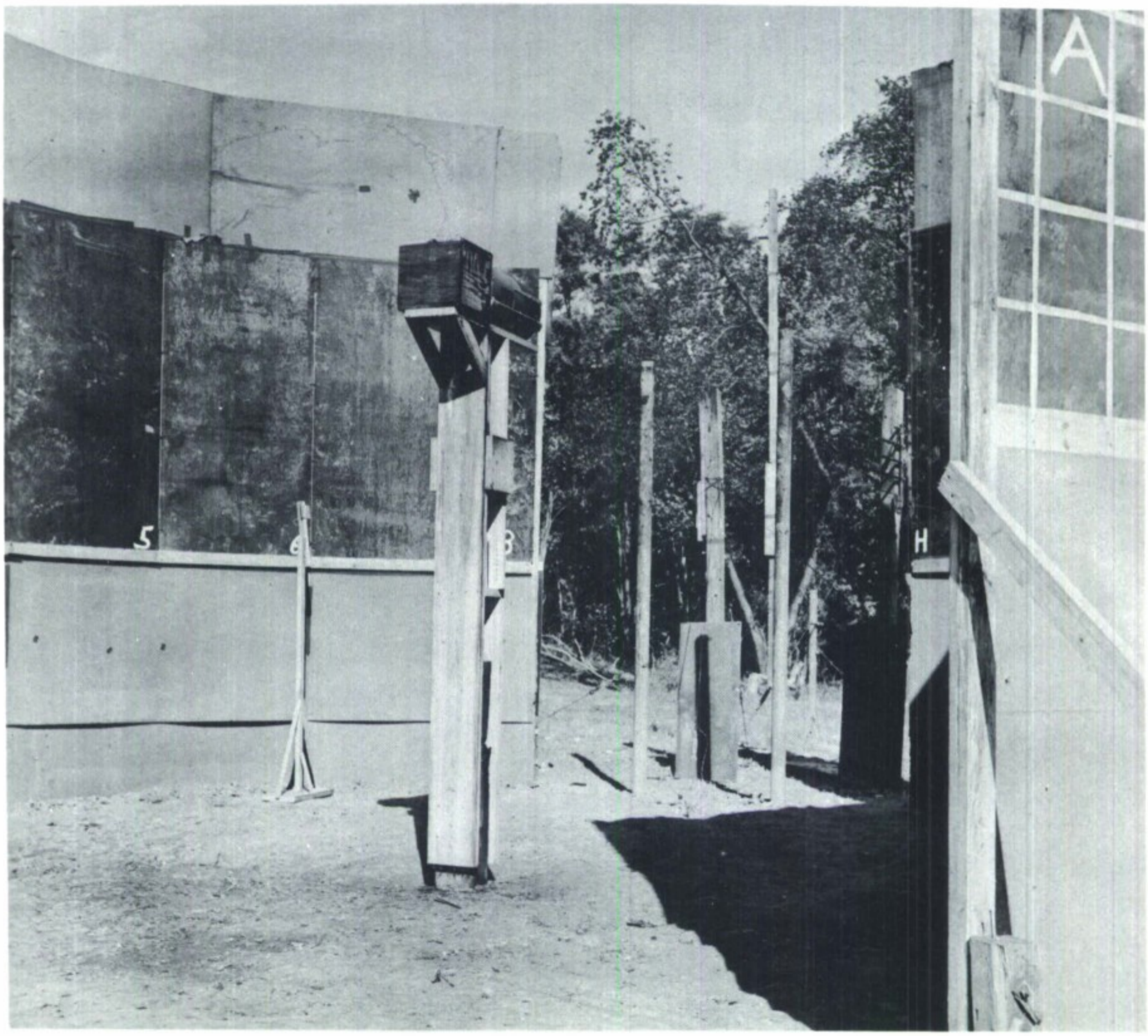

Fig 17   Internal View of Field Setup Showing Warhead Positioned in Missile Compartment

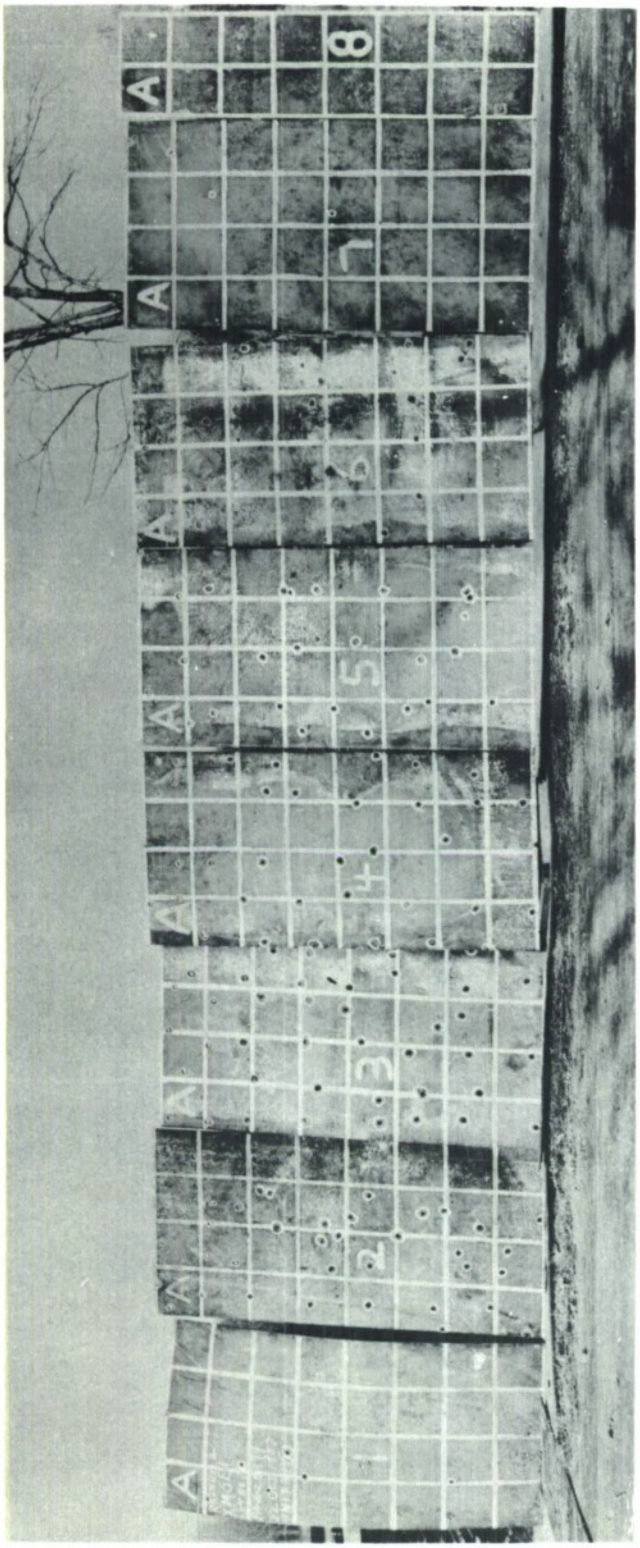

Fig 18 Typical Fragment Pattern on Mild Steel Plates Located at 15 Feet

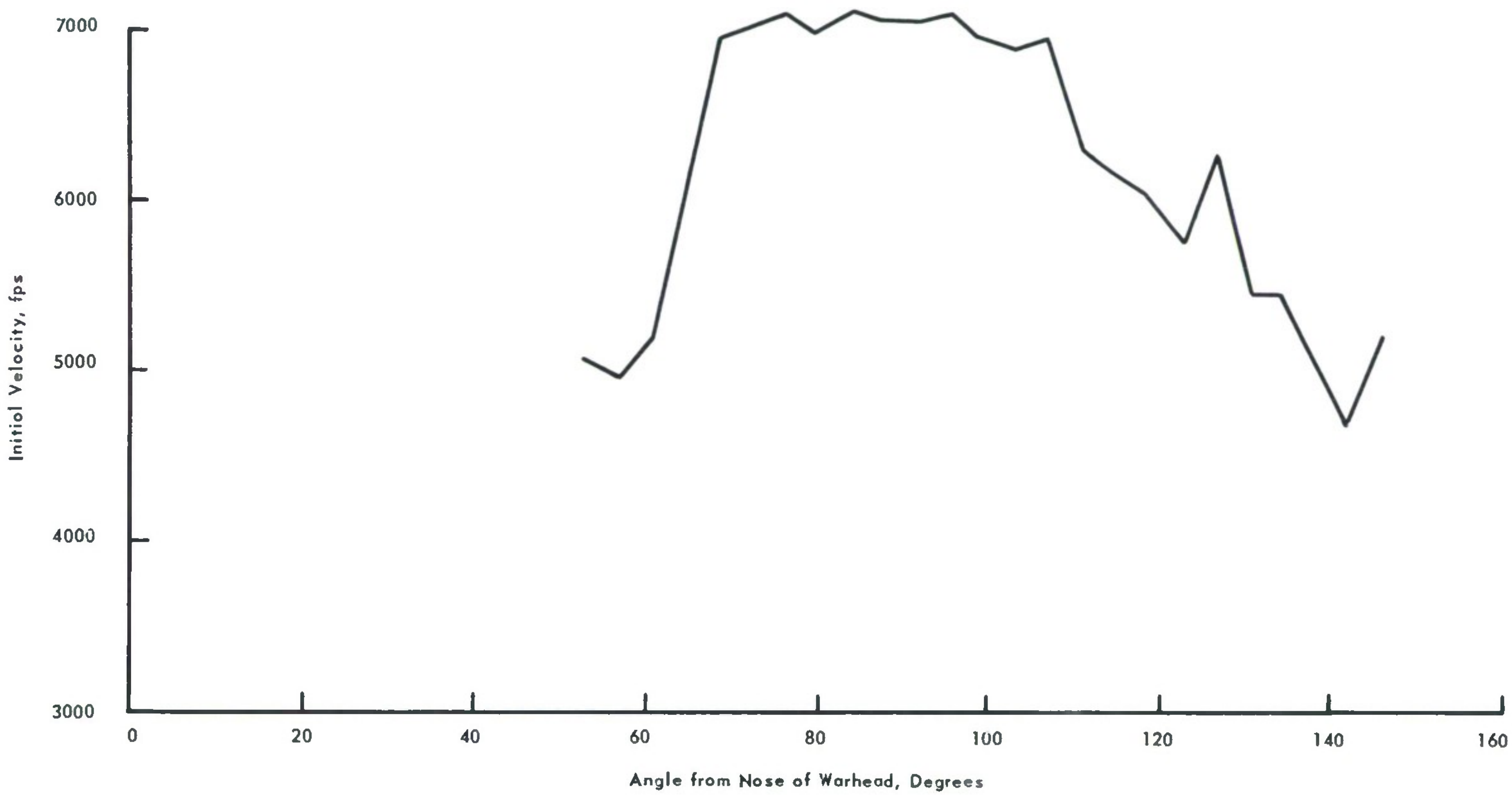

Fig 19 Initial Fragment Velocity for XM5 Warhead with Missile Components

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