

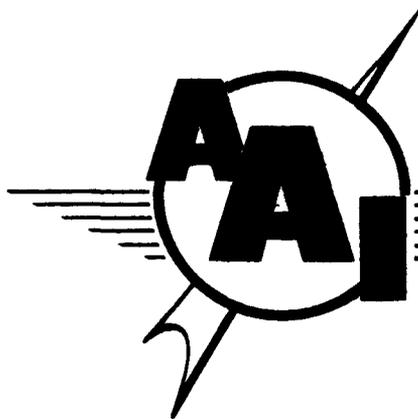
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FINAL REPORT

XM 135

TRAINING WARHEAD SECTION

CONTRACT NO.

DA-28-017-ORD-5060 (A)

ER-27241 (REV. A)
REPORT NO.

APRIL 1963
DATE

Prepared by:

Edmund B. Tyler
E. B. Tyler

Approved by:

F. W. Brown
F. W. Brown

Unclassified

FINAL REPORT

Contractor: Aircraft Armaments, Inc.
Cockeysville, Maryland

Contract No. DA-28-017-ORD-5060 (A)

Covering the Period

6 April 1962
Through
28 February 1963

Title: FINAL SUMMARY REPORT FOR ENGINEERING FABRICATION,
ASSEMBLY AND TESTING OF THE XM 138 TRAINING WARHEAD
SECTION (TYPE X) (U)

Report Number ER-2724I

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Prepared For: Special Weapons Group
Picatinny Arsenal
Dover, New Jersey

Prepared by: Edward B. Tyler

AAI Report No.
ER-2724I

Unclassified



Abstract

This preliminary report is provided for review and approval of the final report for Contract Number DA-28-017-ORD-5060(A). Upon receipt of approval of this report, the final report will be prepared and delivered in accordance with the Scope of Work, Appendix A.

Contract Number DA-28-017-ORD-5060(A) includes engineering, fabrication and testing of eighteen (18) XM 138 Training Warhead Sections (Type X(U)) as well as interface and mono-detail drawings of the device. Most items of the contract were completed according to schedule with no unusual problems or circumstances. Problem areas appeared primarily in the testing phases of the contract. The production electrical test equipment originally requested by Picatinny Arsenal was never constructed due to lack of design, design incompatible with warhead, or lack of contract revision and approval. These events occurred at different times with the result that all warheads were completed and tested, using laboratory equipment, rather than delay the delivery of the completed warheads.

Even though delays were incurred in the shipping of the warheads, they were completed on time for scheduled delivery. These delays were basically containers received late or rejected by RIO;

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was late; or warhead held for shipment with its associated 3052 which had a different delivery schedule.

In conclusion eighteen (18) warheads have been fabricated and accepted as satisfactory items by the Government.



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I. INTRODUCTION

The purpose of this contract was to fabricate, test and deliver eighteen (18) Block IV, XM 138 (Type X) Training Warhead Sections under the direction of Picatinny Arsenal, Dover, New Jersey. Except for minor changes, these warhead airframes were identical to those designed and developed by AAI under Navy Contract N61339-740 for the Naval Training Device Center. The electrical simulation had been modified to be compatible with the Block IV Ground Support Equipment under Contract Number DA-36-034-ORD-3477.

Under Phase I of this program, AAI was required to prepare mono-detail drawings for the warhead and to supply one complete set of reproductions for Picatinny Arsenal. In addition, interface drawings for the Block I, Block II and Block IV designs were to be prepared as were List of Drawings, List of Parts and List of Specifications. These drawings and lists were to be maintained to reflect all changes accomplished during the Phase II portion of the program. As necessary, AAI was required to perform liaison and coordinating services with the Sperry Utah Company of Salt Lake City, Utah (SUCO) to insure electrical and mechanical compatibility of the drawings with the Sergeant Block IV 3G52 Missile Trainer and the Sergeant Block IV Ground Support Equipment.

During Phase II, AAI was required to build the special test equipment, gages (in accordance with PA designs) and any additional tooling necessary to fabricate the eighteen (18) warheads. These warheads were to be fabricated and tested in accordance with Ordnance Drawing 8862-540



developed under Phase I and Purchase Description X-PA-PD-1669 dated 1 August 1962 as amended by Contract Modification Number 4. After final testing and acceptance by the Resident Inspector of Ordnance (RIO), deliveries were required in accordance with the following schedules:

September 1962 - 1 (Preproduction Unit)
October 1962 - 6 Units
November 1962 - 5 Units
December 1962 - 6 Units

During this contract a total of nine (9) modifications were processed. These are as listed below:

Modification No. 1, dated 30 June 1962.- Authorized the preparation of mechanical and electrical interface drawings for the Blocks I, II and IV designs; changed warhead production quantity from seventeen (17) to eighteen (18) units; added the requirements for financial management reports; approved the AAI Quality Control system.

Modification No. 2, dated 5 July 1962.- Changed appropriation date; revised Engineering Parts List delivery schedules; deleted provisional overhead rates and the requirement for prior travel approval.

Modification No. 3, dated 11 October 1962.- Incorporated DCR's - S-X-2, X-2000, X-2001, X-2002, X-2003, X-2004, X-2008, X-2009 and X-2010; incorporated Purchase Description X-PA-PD-1669, dated August 1962.

Modification No. 4, dated 16 October 1962.- Revised resistance tolerance in Paragraphs 3.3.1, 3.3.2.1, and 3.3.2.2 of P.D. 1669.

Modification No. 5, dated 18 October 1962.- Authorized use of the interim test procedure dated 19 September 1962.



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Modification No. 6, dated 26 November 1962.- Added drawings 8862675A, 8862679, 8862586 and 8862541A. Also this modification added DCR's S-X-2012, S-X-2013, S-X-2014 and S-X-2015.

Modification No. 7, dated 27 November 1962.- Changed contract number to DA-28-017-ORD-5060(A) and directed that Preproduction Tests were not to be performed and shipments were to be made without this test.

Modification No. 8, dated 6 December 1962.- Added drawings B-8862552, C-8862546 and DCR's S-X-2005 and S-X-2006.

Modification No. 9, dated 7 December 1962.- Added drawings 8862558, 8862586, 8862540 and 8862570, and DCR's S-X-2007 and S-X-2011.



II. SUMMARY

Included in this section is a summary of the services performed by AAI during the period beginning with the inception of this contract on 6 April 1962 to its conclusion on 31 December 1962.

Immediately upon the receipt of the authorization to proceed, work was begun on the preparation of the Block IV mono-detail drawings for the warhead and on the various lists which were required. By 2 May 1962, work had progressed to such an extent that AAI was authorized by Picatinny Arsenal to commence the fabrication of detailed parts for the Phase II portion of this program. During the course of the Phase II program, these drawings and lists were continuously up-dated to reflect all changes made while fabrication was in progress. Electrical and mechanical interface drawings were also prepared for the Block I, Block II and Block IV designs indicating compatibility between the XM 138 Training Warhead Section and the 3052 Training Missile Guidance Section at Station 139. To complete the requirements of Phase I, AAI maintained liaison with SUCO in the form of telephone conversations and plant visitations to assure that the Block IV Warhead reflected the latest requirements with regards to both the training missiles and its ground support equipment.

During Phase II, the fabricating of eighteen (18) warheads proceeded without major difficulty. Manufacturing was accomplished using standard industrial fabrication and assembly techniques with the only special tooling employed being the Fiberglas forming tool and a jig to locate and position the insert housing assemblies. These tools were utilized from Contract DA-3477 with the Contracting Officer's permission.



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During final acceptance tests, four mechanical tools and gages were utilized. During the weight and center of gravity check, a special tool was used for attachment of the scale to the forward end of the warhead while the insert locating tool served as the means of attachment of the scale to the aft end. The probe retaining block and the aft ring component locations were checked with gages designed by Picatinny Arsenal especially for this purpose.

It was the intent of Picatinny Arsenal that the electrical components be checked using production test equipment. This equipment was designed so that each major component within the simulation box, the cable assemblies and all wire connections could be completely tested after being installed in the warhead. Due to a series of unfortunate circumstances, this equipment was never finally designed by Picatinny Arsenal and consequently never fabricated. Instead, the final acceptance test was performed using an interim test procedure with laboratory type test equipment. This procedure was generated by joint action between Picatinny Arsenal Quality Assurance and AAI personnel and duplicated all tests and checks required by Purchase Description X-PA-PD-1669, dated 1 August 1962. The only difference was in the time required for set up and test and the caliber of person needed to perform this test.

On 21 August 1962, a Block IV Warhead fabricated by AAI under Contract Number DA-36-034-ORD-3477 (Serial No. 4106), was delivered to Picatinny Arsenal for environmental testing. The reason for utilizing this particular warhead was that it was identical to those being fabricated



under the subject program and therefore valid test data could be obtained prior to the performance of test on the Preproduction Item, Serial No. 4009, which at that time was just being assembled.

Table I shows all warheads fabricated under this contract and their respective shipping destinations.



AAI Item No.	Warhead Serial No.	Shipping Destination
1 (Preproduction Unit)	4009	Picatinny Arsenal
2	4010	Redstone Arsenal
3	4011	SUCO
4	4012	SUCO
5	4013	Letterkenny
6	4014	Letterkenny
7	4015	Letterkenny
8	4016	SUCO
9	4017	SUCO
10	CAN BAW	SUCO
11	SIN GON	SUCO
12	LIG DAD	SUCO
13	JIT WOC	SUCO
14	VUG JOV	SUCO
15	HUD TIL	SUCO
16	HIG BED	SUCO
17	DIG LIX	SUCO
18	LAG CON	Letterkenny

TABLE I

Warhead Serial Numbers and
Shipping Destinations



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The remainder of this report is devoted to a detail discussion of the program, including the major difficulties encountered and any appropriate conclusions and recommendations. In order to obtain a clearer understanding of the information presented in subsequent sections, it is suggested that Purchase Description X-PA-FD-1669 be reviewed to familiarize the reader with pertinent warhead details.



III. DETAIL DISCUSSION OF PROGRESS

The discussions in this section include all facets of the program for the engineering, fabrication, assembly and testing of the XM 138 (Type X) Training Warhead Section as well as those environmental tests performed by Picatinny Arsenal and witnessed by AAI personnel. The items discussed herein are presented generally without regard to chronological order between the individual topics but only for the topic under discussion. In all cases it is to be assumed that the Block IV Warhead is under discussion unless specifically indicated otherwise. Further, wherever the term "warhead" is used, it is to be implied as referring to the XM 138 Training Warhead Section.

A. Phase I - Design

1. Warhead Description and Design Approval

In order that a better understanding be obtained from the sections which follow, a brief description of the warhead has been included along with a summary of the design approach.

The end item consists of a welded structural assembly, a Fiberglass skin assembly, a static probe assembly and an electrical simulation box assembly. This design is indicated by drawing 8862540.

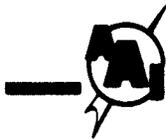
This design was originated under NTDC Contract Number ,N61339-740 during which time one Prototype Block I Warhead was constructed as part of Device 3052 Sergeant Missile Handling and Checkout Trainer.



This was followed by the fabrication of additional quantities under contract number DA-36-034-ORD-3477 for the Army Missile Command. Three (3) Block I, ten (10) Block II and fourteen (14) Block IV Warheads were built during this period with the major difference between the warhead groups being in the ADD package design and corresponding electrical simulation.

The specification (No. 3131-315) included in the original NTDC contract contained only general design parameters with no detail design criteria being included. Such information was obtained by AAI during a major portion of the initial design stages by frequent coordination with the cognizant technical agency. In this program JPL Specification Nos. 14808D and 14827 were received but these were specifications for the tactical ground equipment environmental requirements and were not specifically directed towards the need for training equipment. Subsequently, these were replaced by Missile Purchase Descriptions MPD 9001C and MPD 9700A which did not significantly differ from the JPL specifications and were also written around the environmental requirements for tactical ground support equipment. Both the JPL specifications and the MPD's required an operating temperature range of from -25°F to $+145^{\circ}\text{F}$ and a storage capability of from -80°F to $+100^{\circ}\text{F}$. The peak acceleration specified for vibration tests was 5 g's. The requirements of the above specifications generally paralleled those of PD 1669 but in most cases were not as stringent.

The remaining design consideration was in the area of compatibility with the shipping and storage containers supplied as Government Furnished Equipment (GFE) to AAI. During the NTDC design stages and for a



major portion of the activity under DA-3477, the XM 421 Containers were used. Designs were predicated upon this mounting arrangement. Subsequently, this container was replaced by the XM 481 Container.

All changes made during fabrication of warheads under DA-3477 were nonstructural and at no time was there an alteration made to the design approach followed by AAI. In accordance with the information available to AAI, the entire 3052 Missile Trainer has now been in the hands of field personnel for over a year and has earned a satisfactory evaluation by the Artillery Board. Functionally, the warhead has performed exceptionally well with no serious difficulty having been encountered. Structurally, there have been no failures other than damage to the skin caused by mishandling. From the standpoint of durability during field use, the warhead has been employed in many training exercises, including cross-country transport, without signs of physical deterioration or damage other than normal wear and tear.



2. Drawings

On 7 April 1962 work was begun on the preparation of mono-detail drawings for the Block IV Warhead designs. The drawings were generated from the Block IV equipment already designed and fabricated under previously mentioned programs. This set of drawings has the Bill of Material included on the drawing itself rather than on separate sheets.

On 1 May 1962 approximately fifty percent of the production drawings had been prepared and a representative of Picatinny Arsenal visited AAI to review and approve those drawings already completed. On 3 May 1962 formal release was granted to AAI to proceed with the fabrication phase with the approved drawings. By the end of May all drawings had been completed, approved, and a complete set of reproducibles forwarded to Picatinny Arsenal. In addition, the List of Specifications, List of Parts and List of Drawings had been prepared and reproducibles forwarded to Picatinny Arsenal.

3. Interface Drawings

By Modification No. 1, dated 30 June 1962, AAI was required to generate separate electrical and mechanical interface drawings for the Block I, Block II and Block IV Training Warhead designs. These drawings were prepared to indicate compatibility between the XM 138 Training Warhead Section and the Guidance Section of the 3092 Training Missiles.



The electrical and mechanical interface drawings for the Block I and Block II designs were completed and submitted to Picatinny Arsenal by 31 July 1962; the interface drawings for the Block IV Warhead design were submitted during August 1962. Although AAI was responsible for updating the drawings to reflect any design changes made during the life of the subject contract, no such actions were necessary after these six drawings had been submitted.

4. Changes and Deviations

As drawing changes and deviations were found to be necessary during the course of the Phase II program, either "Drawing Change Request" (DCR) or "Request for Deviation Approval or Technical Actions" (RFD) were prepared by AAI and submitted to Picatinny Arsenal for approval. No formal drawing changes were made when an RFD was approved since its sole purpose on this program was for the salvage of useable parts which, for one reason or another, were not in complete accord with drawings. Such deviations were requested only on the basis of costs and schedule considerations and were not considered if the structural or functional integrity of the item was in any way jeopardized.

DCR's were prepared by AAI and Picatinny Arsenal to correct drawing errors, facilitate manufacturing or to incorporate design improvements. After the DCR's had been approved by either the Technical Officer or the Contracting Officer, drawing changes were prepared and submitted for technical approval before releases were made for manufacturing action. Table II is a tabulation of all deviations and changes made during the course of this contract. Aside from these changes and deviations, plus a



weight and center of gravity change, the only other differences between the warheads fabricated under the subject contract and that designed under the NTDC contract were in the markings, the exterior surface color and the electrical simulation which parallels the Block IV under ORD-3477. By directions received from Picatinny Arsenal on 26 April 1962, the marking arrangement was changed from that previously followed during the fabrication of the Block IV Warhead under DA-3477. This direction was modified on 11 June 1962 along with a change in the exterior color from olive drab to black enamel. Both changes were incorporated without program delay or increase in total contract costs.

5. Center of Gravity and Weight Changes

As the warhead was designed under NTDC Contract No. N61339-740 and fabricated under Contract No. DA-36-034-ORD-3477, its weight was 1490 pounds and its center of gravity was located at Station 103.9. With these required physical characteristics, the warhead assumed a different attitude from the tactical unit when hoisted from the container. No danger to trainees was presented, nor were any differences in training techniques encountered when mating the warhead to the Guidance Section; however, a difference did exist in handling characteristics. The free swing attitude of the training warhead was approximately 13 degrees, 45 min. (nominal) whereas the tactical unit assumed a nose high angle of 5 degrees, 30 min. (nominal) in free swing. Both warheads were positioned to one degree, 15 min. when the yoke was snugged against the bottom of the launcher boom so no adverse effects were experienced in mating the Warhead and Guidance Sections.



DEVIATIONS

Number	Description	Disposition
5060-1	Dust Caps were nicked and burred due to handling	Use as is
5060-2	Forebody Skin Length, 180 inch; below nominal dimension	Use as is
5060-3	Electric PAO Dimension oversize	Use as is
5060-4	Miscellaneous out of tolerance on Aft Ring Cage	Use as is
5060-5	Insert Housing dimension out of tolerance on several items	Use as is

DCR

Number	Description
S-X-1	Skin Salvage
S-X-2	X-PA-PD-1669, 1 August 1962, replaces 3/13/62 Rev
S-X-3	Revises PD Tolerances
S-X-2000	Adds new bracket for F/S Plug, etc.
2001	Add bracket mtg holes for new Fire-Safe Plug
2002	Redesigned Bracket
2003	Redesigned Bracket Plate
2004	Redesigned Bracket Stiffener
2005	Revised incorrect Bolt call-out
2006	Revised incorrect dimension on Aft Supp. Pad
2007	
2008	Added Dust Cap and Cable Clamps
2009	Added Cable Clamp Holes
2010	Added Caps to Probe Assembly
2011	Revised Insert Design
2012	Revised Hardware call-out and quantities
2013	Revised incorrect dimension on Bracket
2014	Revised Skin dimensions
2015	Skin Salvage
2016	Add dimension to Insert Housing
2017	Add Probe Dust Cap to top dwg.
2018	Change Terminal Type on Ledex
2019	Changes 7K Resistor to Spec. Cont. Dwg.

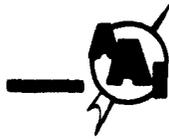
TABLE II

SUMMARY OF WARHEAD CHANGES AND MANUFACTURING DEVIATIONS



Prior to the inception of this contract, this problem had been discussed with AAI and it was agreed that the changes would be made as soon as the information was supplied from Picatinny Arsenal. In response, AAI was advised that the desired weight was 1611 ± 22 pounds with the center of gravity located at Station 100.8 ± 1.0 which was in agreement with Purchase Description X-PA-PD-1669, dated 13 March 1962. Calculations were made from which it was determined that 76 pounds of additional ballast must be added forward of the existing center of gravity to bring the physical characteristics to within acceptable limits. As a final verification, a warhead being fabricated under DA-3477 was modified and checked before the changes were included in the production drawings.

By Picatinny Arsenal letter, dated 7 May 1962, and the revised Purchase Description, dated 20 July 1962, the new requirements specified that the total warhead weight, with the probe attached, be 1581 ± 50 pounds and its center of gravity be 38.6 inches forward of Station 139.0 (or at Station 100.4 ± 1.0). Since the revised configuration fell within these limitations, no further changes were made to adjust either the weight or center of gravity.



B. Phase II - Warhead Fabrication

1. Construction Methods

From the physical description contained in Section III.A.1, it may be seen that no excessively difficult fabrication processes were involved in the production of the eighteen (18) warheads. All manufacturing was accomplished by means of conventional industrial machine shop, sheet metal and assembly practices. The only special tooling utilized during the Phase II program was the forming block to lay up the Fiberglas forebody skin sections and a jig to locate and position the insert housings. The former tool was employed by Atkins and Merrill, Incorporated who used it to form the Fiberglas cloth and mat for each skin half. The latter was used by AAI as a manufacturing aid to assure interchangeability between the warhead and slings. (Also, see Section III.B.3.)

2. Mechanical Gages

On 31 May 1962, AAI received drawings for the fabrication of the gages for Station 139.0 (8868842) and Station 10.0 (8868843). Fabrication of these parts did not proceed as originally planned. Both gages were delayed to the point that they were not available in time to be used during the final acceptance test of the Preproduction Warhead, Serial Number 4009. Unnecessary delays in delivery were prevented however by authorization from the Project Officer who waived the requirement for use of these gages on the Preproduction Warhead. Instead, permission was granted to inspect the critical areas using standard inspection techniques.



A 100 percent final mechanical inspection was performed on this item but all subsequent warheads were inspected and accepted, utilizing these gages. Both the probe and aft ring gages are production test gages suitable for use with the Block I and Block II as well as the Block IV equipment.

3. Weight and Center of Gravity Check

As specified in Purchase Description X-PA-PD-1669, dated 1 August 1962, each warhead was weighed as a part of the final acceptance test conducted by AAI and witnessed by the RIO. The equipment and set-up is as shown in Figure 1. Scales of certified accuracy to 0.2 percent (traceable to the National Bureau of Standards) were attached to either end of the warhead by special adaptors. The forward attachment member was designed specifically for this use, but the aft member served also as the fixture for locating and positioning the insert housings (Section III. B.1.).

The true weight of the warhead section was evaluated by subtracting the weight of the two fixtures from the sum of the two scale readings and the probe weight. The static probe was not weighed as a part of this predelivery test but was considered as a constant in all weight evaluations. This procedure was adopted after a number of static probes fabricated under Contract Number DA-3477 were weighed and it was found that the total weight variation was of such a minor extent as to have no significant influence upon the total warhead weight or its center of gravity location. The mean reading of the probe weighings were accepted for use during this test service to avoid totally unnecessary labor and handling costs.



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To determine the center of gravity for the XM 138 Training Warhead Section, AAI prepared a drawing (SK 4692-000010) of the procedure to be followed in the determination of the weight and c.g. This drawing was approved for use as acceptance inspection equipment on 13 September 1962 by the Picatinny Arsenal Technical Officer. This procedure utilized the two scale readings to determine the actual c.g. location.

4. Electrical Test Equipment

It was specified that AAI would fabricate all test equipment called for in the Purchase Description, provided it was not already available as AAI equipment or Government owned equipment on other contracts. It was further required that this equipment be made available four weeks after designs were furnished by Picatinny Arsenal and be up-dated as changes were developed during the course of the contract. This requirement was complied with to the maximum extent possible by AAI as is illustrated by the utilization of the two mechanical gages fabricated under the subject contract and the use of the two scales which were procured under AMICOM Contract Number DA-3477.

This course of action was planned by AAI for the electrical test fixtures but a series of delays prevented their fabrication. Early in this program several conferences were held at Picatinny Arsenal and AAI to discuss the designs and procedures to be followed in the construction and use of this equipment. The AAI plan was that the test equipment already in use on DA-3477 should be up-dated to the requirements of the current Purchase Description and employed for testing on the subject contract.



FIGURE 1. TYPICAL WARHEAD WEIGHING OPERATION



This proposal approach was as indicated by this contractor in a letter, dated 2 April 1962, where it was stated that the estimated costs were predicted for this procurement on the continued use of equipment and procedures developed under DA-3477. This interpretation was reiterated on frequent occasions followed by a request for final approval of this plan which was submitted to Picatinny Arsenal.

Although AAI was of the opinion that its approach could satisfy the requirements of the Purchase Description in the most economical fashion, it recognized that Picatinny Arsenal also had sound reason for desiring the fabrication of production electrical test equipment. To avoid delays in deliveries due to a lack of acceptable test equipment, AAI advised Picatinny Arsenal on 1 June 1962 that it would proceed with the manufacturing of this equipment upon receipt of reproducible drawings since it appeared that no compromise could be reached on the use of DA-3477 equipment and procedures. This decision was made, since it was specified in the basic contract that the Preproduction unit must be tested with the same tooling, gages and test equipment that was to be used in the fabrication of the remaining seventeen (17) production items. It was therefore necessary that every possible effort be made to expedite this portion of the program which was seriously lagging.

Preliminary drawings of the three test fixtures were finally received from the Technical Officer but no formal direction was received through the Contracting Officer. The preliminary designs were reviewed with Picatinny Arsenal personnel and it was decided that design changes would be necessary before AAI could proceed with procurement and fabrication.



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There followed another period of unexplained delays to the point where it became impossible to build the fixtures in the time remaining before the Preproduction Items were due to be delivered. It was again proposed by AAI on 20 August 1962 to use the procedures and equipment developed for DA-3477 on an interim basis until all problems associated with the test equipment had been resolved and the equipment actually built.

On 30 and 31 August 1962, Picatinny Arsenal personnel met at AAI to discuss the availability of laboratory equipment and methods by which a satisfactory test could be performed. The following is a summary of the items discussed during this conference.

a. Generally, the schematics for the production test fixtures were to be followed in setting up the laboratory type of test equipment.

b. Testing was to be performed in accordance with the requirements of Purchase Description X-PA-FD-1669, dated 1 August 1962, as revised.

(1) Revisions consisted of a relaxation of resistance tolerances in the Rotary Switch Circuit Resistance Test and in the Latching Relay Circuit Resistance Test from 0.0% to 0.2%. This change was formalized by DCR No. S-X-3 and subsequently by Modification No. 4 to the basic contract.

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It is also worthy of mention that at the time of this conference the Purchase Description, dated 13 March 1962, was still in effect, there being no formal action taken to incorporate either the revision, dated 20 July 1962, or the one dated 1 August 1962 into the contract. This problem further compounded the difficulties already discussed above with regard to the fabrication of the production test equipment.

c. A breakout box and connector would be made available as GFE to AAI for the Insulation Resistance Test and a certified Wheatstone Bridge (or Digital Ohmmeter) would be supplied as GFE for the resistance tests.

d. A list of equipment must be submitted for approval before initiating tests and include manufacturer, model and accuracy specifications.

e. A hook-up diagram, including pulsing circuits and connector pins for the unit under test, must be submitted to and approved by Picatinny Arsenal prior to conducting tests.

f. A detail test procedure must be prepared and submitted to Picatinny Arsenal for approval.

An Interim Test Plan (AAI Drawing No. 4692-480050-2) was immediately prepared with the above objectives in mind and submitted for technical approval on 11 September 1962. On 12 September a representative of Picatinny visited AAI to deliver the breakout box and bridge and also to review the procedures in detail. The requested revisions were incorporated and on 18 September the procedures were formally approved for use on the first item only.



Figure 2 shows the equipment used by AAI to perform the Rotary Switch Circuit Resistance Test, the Latching Relay Circuit Resistance Test and Continuity Loop Resistance Tests.

Figure 3 shows the equipment utilized to perform the Diode Characteristics Test while Figure 4 indicates the equipment utilized for the Capacitor Charge Retention Tests. Figure 5 depicts the Insulation Resistance Test Set-up.

Since no formal directions were received from the Contracting Officer for the production equipment, the interim test procedure was used for the entire production lot.

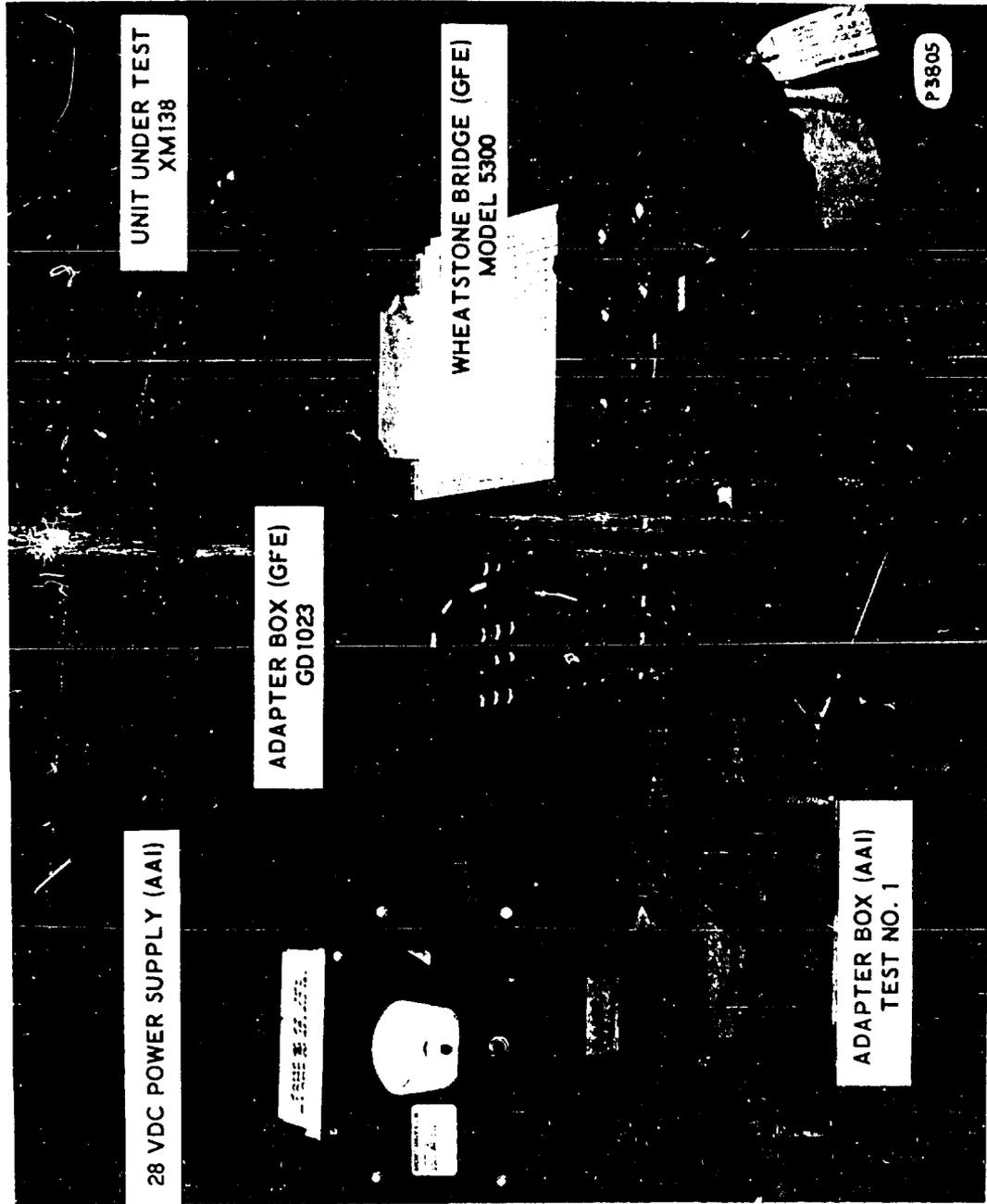


FIGURE 2. INTERIM TEST EQUIPMENT

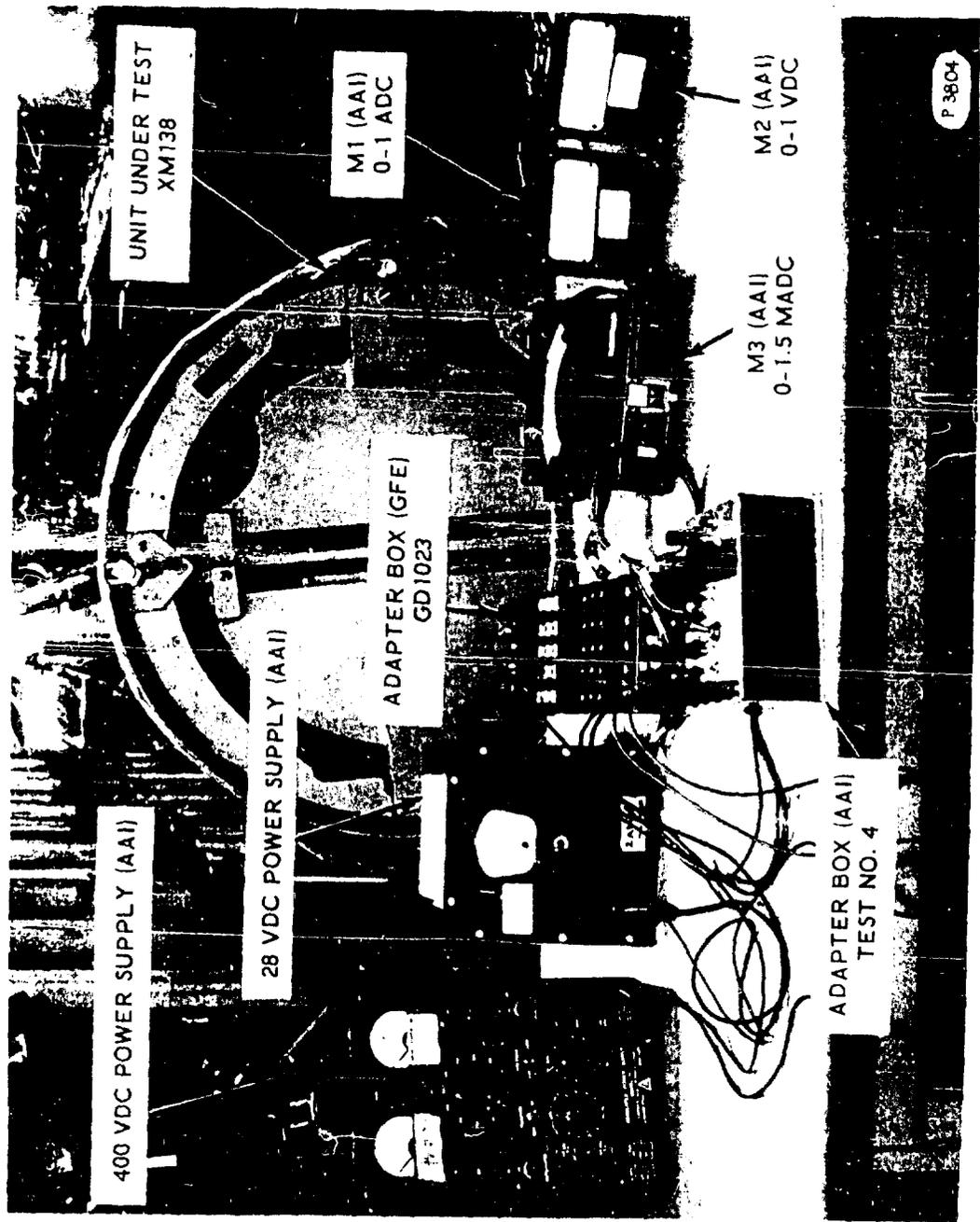


FIGURE 3. DIODE CHARACTERISTICS

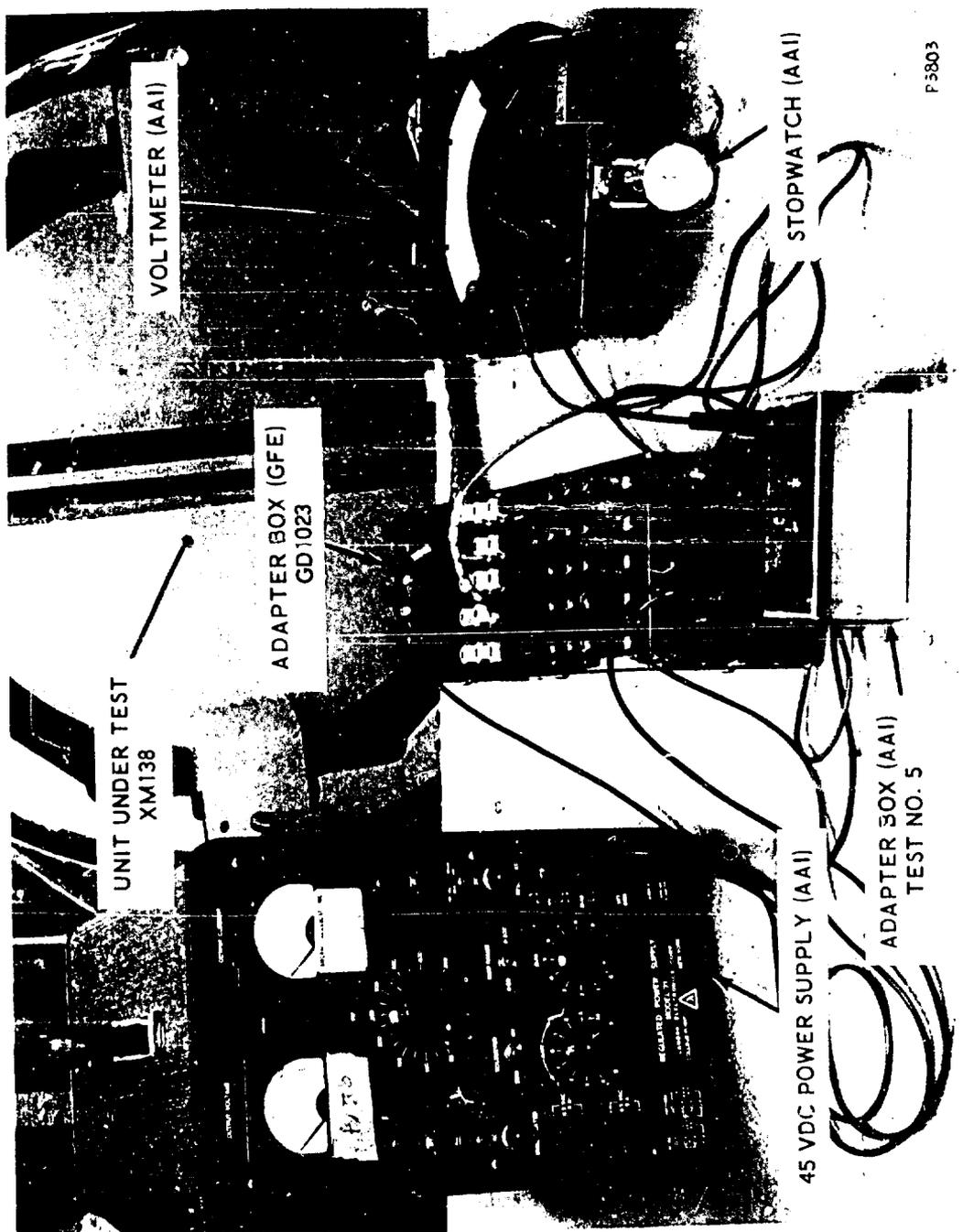


FIGURE 4. CAPACITOR CHARACTERISTICS

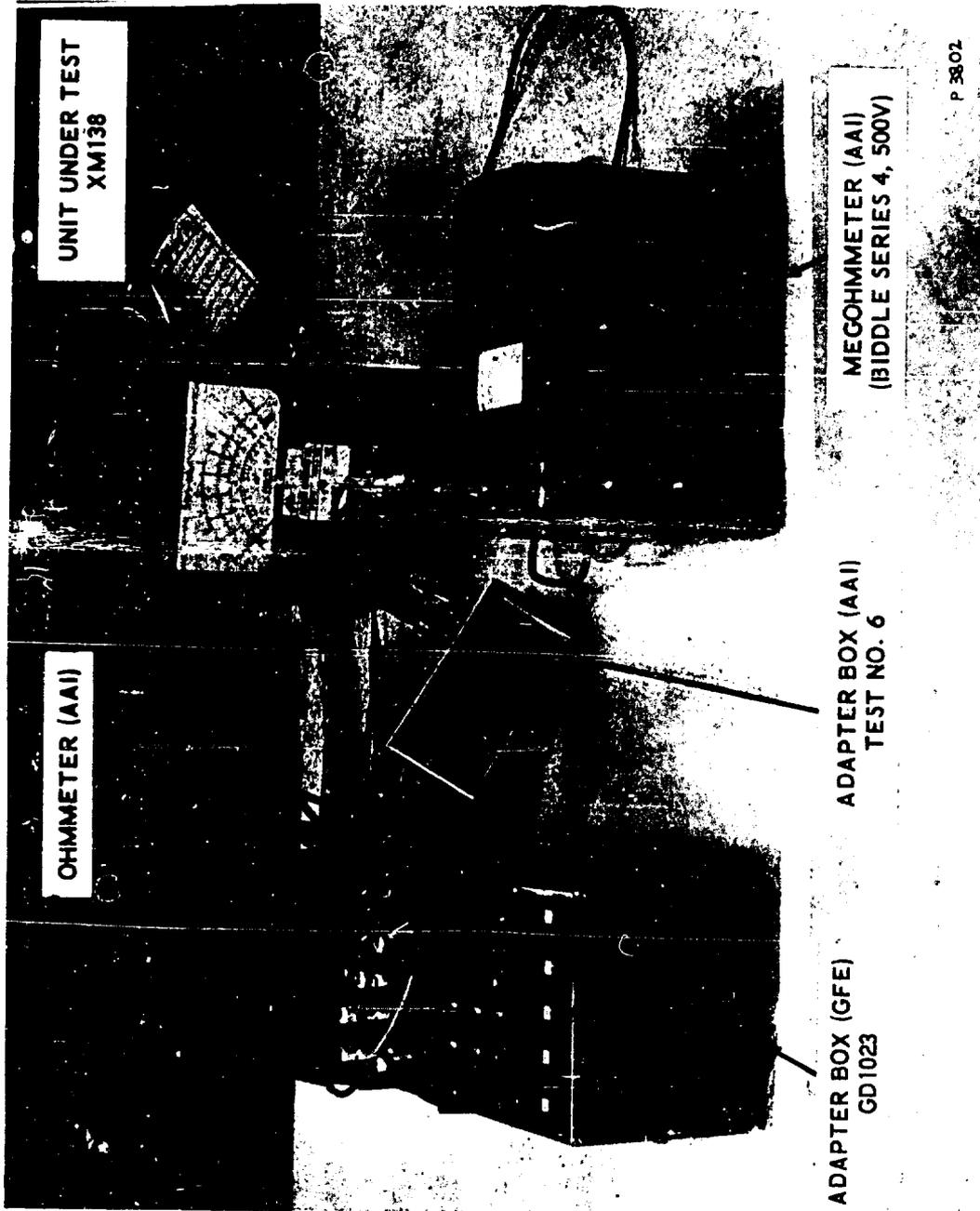


FIGURE 5. INSULATION RESISTANCE



The foregoing discussion is a documentation of a series of events which precluded the fulfillment of a contractual requirement by AAI.

5. Inspection

Throughout the entire fabrication phase of this contract, rigid quality control standards were maintained as required by the Purchase Description. One hundred percent inspection was performed on all purchased parts, after each major manufacturing operation, on each completed detail part, and on all completed subassemblies and assemblies. In addition, a visit was made by an AAI Quality Control representative to Atkins and Merrill, the subcontractors for the Fiberglass skin, to determine the adequacy of their quality control measures and the degree of compliance during their various manufacturing stages. These inspections were performed using standard inspection equipment and procedures as prescribed by the AAI Quality Control Manual which was approved for use by Modification No. 1.

Testing was under the cognizance of the AAI Quality Control Division. The necessary electrical, mechanical, and weight tests were witnessed by the RIO, as was the installation into the shipping containers.

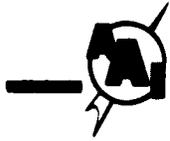
Another area of special interest with regard to inspection concerned the XM 138 Warhead Shipping and Storage Containers. Late in October 1962, AAI was approached about the possibility of performing a complete and detailed inspection of the GFP containers and their components when received and perform any repairs deemed necessary as a result of this inspection. It was further requested that another inspection be performed just prior to shipment and, again, make any necessary repairs.



Several conferences were held with the RIO, Picatinny Arsenal and PPD to discuss the desirability of these requests and methods of implementation. It was the unanimous opinion of the above that these actions were desired and should be implemented as soon as possible. The AAI viewpoint was that first, authorization to perform the complete inspection was not specified in the subject contract and second, AAI was not in possession of a complete technical data package for the warhead containers which were needed in order to perform such a detail inspection.

During conferences regarding this matter, it was agreed that a thorough incoming inspection, to assure the GFP was satisfactory for the use for which it was intended, was the responsibility of AAI but to perform rework on container modifications constituted a change in scope. This is not to imply that AAI had not previously performed the incoming inspection function as heretofore such inspections had been generally limited to a determination of the useability of the containers and not the existence of minor paint scratches, improper stenciling, etc. In every prior instance, the container was judged to be completely useable although there were cases where a container was damaged or its finish marred by scratches or corrosion. It was the opinion of AAI, however, that the containers were absolutely serviceable and that the warheads could be safely shipped or stored with the containers in the existing condition.

Based on the above discussions, it was determined that inspection would be performed by AAI and RIO and all discrepancies recorded. These discrepancies would then be reported to the Contracting Officer along with recommendations to "use as is" or to "rework". Specific rework



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instructions were then to be given to AAI by the Contracting Officer. Three November warheads, Serial Numbers 4016, 4017 and CAN BAW, were delayed in shipping while this matter was being resolved and the containers "touched up".



6. Deliveries

Table I indicates the serial numbers of the warheads fabricated and their respective shipping destinations. As may be seen, a majority were delivered to the Sperry Utah Company, Salt Lake City, Utah. At SUCO, compatibility tests were performed between the XM 138 Training Warhead Section and the remainder of the 3G52 Missile Trainer which in turn was tested in conjunction with the tactical ground support equipment. Because of this test plan, actual shipment was held in abeyance until the balance of the 3G52 was ready for shipment. In every case, however, the production lots were completed as specified in the Scope of Work.

All tests specified in paragraph 4.3 of Purchase Description X-PA-PD-1669 could not be performed until the unit was installed in the container. Serial Numbers 4016, 4017 and CAN BAW were therefore delayed (as well as the 3G52 Missile Trainer) while the inspection problem discussed in Section II.B.5 was being resolved. Extensive delays were also encountered in the delivery of the last eight (8) warheads due to a lack of GFP containers which again delayed delivery of the 3G52 Devices. At the time of the preparation of this report, AAI was still lacking one XM 481 container.

Table III has been prepared to show actual delivery date from AAI and includes the 3G52 Missile Trainer of which the applicable warhead now forms a part. The delays reflected in this table are the result of the container problems discussed above as well as minor delays in the receipt of Government Bill of Ladings.



Item	Serial No.	3G52 Device Serial No.	Shipping Date	Remarks
1	4009		10/2/62	
2	4010	409	10/31	
3	4011	410	11/20	} GBL's Received Late
4	4012	411	11/20	
5	4013		11/9	
6	4014		11/9	
7	4015		11/9	
8	4016	412	12/28	} Held for Shipment with 3G52 for its Scheduled Shipping Date
9	4017	413	12/29	
10	CAN BAW	414	12/29	
11	SIN GON	415	1/10/63	} Containers late and/or in need of repair
12	LIJ DAD	416	1/10	
13	JIT WOC	417	1/10	
14	VUG JOV	418	1/17	
15	HUD TIL	419	2/26	
16	JIG BED	420	2/26	
17	DIG LIX	421	2/26	
18	LAG CON		1/30	

TABLE III
WARHEAD DELIVERIES



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C. Test

1. General

All testing described up to this point has concerned those tests performed by AAI as a part of the final acceptance procedure and as such, has been considered as an integral part of the manufacturing phase. In addition to these tests, which are specified in the Purchase Description for the XM 138 Training Warhead Section, X-PA-PD-1669, dated 1 August 1962, there were two additional categories normally required before this warhead could be formally accepted by the Government. First, tests would have to be performed on a Fiberglas skin as set forth in the Picatinny Arsenal Skin Purchase Description X-PA-PD-2376 and second, environmental tests per paragraphs 3.7, 3.8, 3.9 and 3.10 of PD-1669 would have to be performed. Neither test series was conducted by AAI for the reasons discussed in the following paragraphs.

The PD in effect at the time of contract award was the draft dated 13 March 1962 which, at that time, contained no reference to the Fiberglas skin. It was therefore implied that only normal quality control measures were to be taken to assure that parts were fabricated in accordance with drawing requirements and to specifications listed thereon. In the revision dated 20 July 1962, Purchase Description 2376 was added to the Warhead Purchase Description which, among other items, required a pre-production skin to be subjected to bearing and ultimate tensile strength tests prior to the initiation of production. By the time the Skin PD was incorporated, substantial progress had already been made on the skin fabrication so it was impossible to comply with the new requirements without incurring additional costs and creating considerable scheduling delays.



The new Skin PD was again included in the Warhead Purchase Description Revision dated 1 August 1962 but in neither case was this change acknowledged by formal contract changes or direction from the Contracting Officer. When the revision dated 1 August 1962 was finally incorporated into the contract by Modification No. 3, all Fiberglas skins had been fabricated, so AAI again mentioned the delays described above. Subsequently, this position was substantiated when, by Modification No. 6, Purchase Description X-PA-PL-2376 was deleted as a requirement. With the deletion of this PD, AAI was no longer required to perform any tests on the Fiberglas skin.

Prior to the receipt of an authorization to proceed on the subject contract, a conference was held at Picatinny Arsenal (29 March 1962) to discuss methods of implementing the XM 138 production program on a minimum time and cost basis. One of the points discussed during this meeting concerned environmental testing and it was agreed that Picatinny Arsenal would write the test procedures, perform the environmental test and prepare the final test report. The requirement maintained, however, that the Preproduction Unit would be tested and accepted before the production quantities were delivered. Based on this agreement, no environmental tests were performed by AAI during this program, but instead, its representatives witnessed a major portion of the environmental tests performed at Picatinny Arsenal.

With the exclusion of the Fiberglas skin by formal contractual modification and the environmental testing by prior agreement, AAI therefore fully satisfied all requirements of the governing Purchase Description from



the standpoint of testing. (From preceding discussions, it will be recalled that electrical, mechanical, weight and center of gravity inspection tests were performed for acceptance by the RIO.) There is, however, one additional area of testing required on the production contract which is the Preproduction Test to be performed by the Government. This responsibility was complied with by AAI in that two warheads were delivered to Picatinny Arsenal during the course of this contract for test purposes.

2. Preproduction Test

As a part of the Scope of Work for the Phase II Program, it was required that the first unit be subjected to preproduction tests at Picatinny Arsenal after being subjected to acceptance tests at AAI. The purpose of this preproduction test was to obtain early assurance that the units produced with the tooling, gages, and test equipment were satisfactory for the purpose intended. If any changes were found to be necessary as a result of these tests, they were to be incorporated into the seventeen (17) production items after negotiations between AAI, FPD, and Picatinny Arsenal.

In the early stages of this contract it was agreed that the entire program could be expedited if a spare warhead fabricated under DA-3477 was tested by Picatinny Arsenal before the Preproduction Unit was completed. This decision was based on the fact that the DA-3477 warheads were nearly identical (see Section III.A.1) to those being fabricated under the subject contract and therefore valid test data could be gathered prior to the completion of the Preproduction Unit. Subsequent to this delivery Picatinny Arsenal Preproduction test requirements were deleted.

During September and October 1962 engineering liaison was conducted by AAI for the purpose of witnessing the Picatinny Arsenal testing program.



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3. Insert Test

Each warhead packaged in its shipping container includes the XH 4102 Warhead Section Tactical Sling (8850472) for the purpose of installing or removing the warhead from the container and assembling the section to the missile trainer. The sling is attached to the warhead by a circumferential strap positioned just forward of the center of gravity. This creates a nose-high attitude for the warhead section during handling, so two locking rods are inserted into receptacles in the aft ring to prevent it from sliding rearward and falling free of the sling. A positive locking feature has been incorporated into this mating so that accidental rod disengagement is prevented during handling. To affect the proper sling-warhead mating, the rod is depressed against spring pressure until proper protrusion has been attained to mate with the female insert located on the aft ring of the warhead. The rod is then rotated ninety (90) degrees thereby affecting a coupling which is positively locked in place by constant spring pressure against the rod grooves and the female insert lands.

When drawings for this program were prepared under Phase I, a complete technical data package was supplied for the XH 4201 sling which AAI used in the preparation of the insert drawings. Parts were fabricated and when checked against the sling, it was found that coupling was impossible due to insufficient protrusion of the sling rod. Further checking revealed:

- a. The latest revision to the sling drawings had not been issued to AAI by Picatinny Arsenal.
- b. These drawings were misinterpreted by AAI, thus contributing to this incompatibility of the mating parts.



c. The sling rod housing O D was oversized due to excessive weld fillet.

d. The rod housing mounting face had not been cleaned up after welding, thereby preventing proper seating of the sling on the warhead.

e. The load deflection characteristics of the rod mounted spring washers were grossly out of tolerance.

During May 1962, these problems were discussed with Picatinny Arsenal personnel and the proper design information was promptly supplied to AAI (15 May 1962) but this necessitated a redesign of the insert to achieve compatibility with the warhead sling. New parts were built and again a mating check was performed with unsatisfactory results. While mating could be achieved, it was found that considerable pressure was required for coupling and that after only a few engagements, the insert was distorted to the point where it was no longer useable. In several cases it was found to be impossible to affect an engagement without removing at least one of the spring washers (8850502) contained in the sling rod assembly (8850482). After re-examining the insert and rod, AAI was of the opinion that the sling was defective since it appeared that there was inadequate protrusion provided in the design of the rod.

Picatinny Arsenal was again notified and on 26 and 27 July 1962 their personnel visited AAI to determine if this insert was properly designed or if a defective sling had been supplied. Four slings were examined and found to be in accordance with the Ordnance drawings including



rod protrusion and rod groove locations. Also, the insert was examined and the depth of the insert land and all clearance were found to be satisfactory. Closer inspection of the insert revealed that it had not been designed properly due to an ambiguity associated with the insert land configuration. AAI interpreted the drawing to mean that the radius on the land shown in Figure 7 was to be that which was produced by a radial machine cut about the vertical axis of the insert rather than one made about each land centerline. The parts thus fabricated had a rounded surface only in the central portion of the land rather than over its entire span. When the rod was introduced into the insert under these conditions, mating was extremely difficult since the radial surface on the land was used to cam the rod into the locked position. In the absence of a radius along the entire span of the insert land, it was necessary to fully depress the rod before land and groove alignment was obtained which required a pressure in excess of 300 pounds.

The entire production set of parts had been fabricated (from 304 stainless steel) at this point, so attention was directed towards corrective actions in a minimum time and cost basis. A precision casting would satisfy design requirements but costs and lead time made this approach unattractive. It was finally decided that the existing parts would be reworked by removing the lands and replacing them with a parallel pair of dowel pins pressed into place as shown by the sketch in Figure 7.



Figure 7. Redesigned Insert Assembly

Two inserts were modified in this fashion and installed in a warhead but it was found that mating was still extremely difficult. After several engagements, minor galling on the land was noted but the edge of the rod groove was badly galled. In addition, it was observed that the dowel pins were being worked out of the insert. Re-inspection verified that all parts were within tolerance limitations but on every sling inspected the location of the rod groove in the extended position was at an absolute minimum with respect to the face of the boss on the lower surface of the sling. It was also found that a load of 340 pounds was necessary to com-



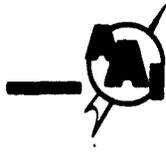
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press the spring washer .030 inch, which was considerably in excess of the 100 pounds rated load. The galling and pin movement were attributed to these factors.

This situation, however, raised some question at AAI as to the ultimate strength of the modified parts under an axial tension load, so two samples were subjected to tensile test. Under design conditions, each rod assembly (8850842) would experience a maximum load of only 200 pounds since most of the weight is carried by the sling strap. The first specimen was installed in a Universal Test machine and loaded to 4000 pounds. After this test, the part was examined, and yielding of the pins was noted along with severe brinelling. The part was again installed in the machine and loaded to failure at 4,260 pounds. The second specimen was then loaded to failure at 4,380 pounds.

Both failures were tensile failures between the holes for the pins. The pins had both bent and rotated but there was no tendency to slide out under load. The ultimate strength of the modified parts was far in excess of the weight of the warhead itself (1581 ± 50 pounds) and exceeded the design load by a factor of over 20:1.

The insert modification was therefore considered to be adequate with a generous margin of safety. All production parts were fabricated in this manner with only one modification; a smaller diameter hole was bored for the dowel pin. This provided an interference fit between the pin and the hole size and prevented the pin from being displaced during normal mating operation between the sling and warhead.



IV. DIFFICULTIES ENCOUNTERED

In the foregoing sections many areas of difficulty have been discussed which have affected the performance of work on this program. These areas included drawings for the mechanical gages and the inserts, delays in the receipt of formal directions concerning final electrical acceptance test procedures and equipment, the rejection of warhead containers by the RIO and the delays in the receipt of directions and approval of DCR's.

In each case the problem was resolved so that production schedules were not seriously impaired. The problem involving the receipt of containers, however, could not be resolved and at the time of preparation of this report, some of the containers had not been received. The result was, of course, that AAI was powerless to adhere to its delivery commitments not only for the subject contract, but the Contract No. DA-3477 as well. All production schedules were maintained within reasonable limits throughout this program but when the above difficulties were encountered, AAI was unable to deliver the XM 138 Training Warhead Sections in accordance with the requirement of the scope of work as outlined in Section I.



V. CONCLUSIONS

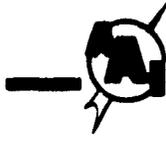
The discussion in the preceding sections may create the impression that undue difficulties were experienced throughout the entire span of this program. This is not the case as evidenced by the fact that the original manufacturing schedule was maintained with the exception of the fabrication of the production test equipment. While many difficulties and inconveniences did exist, it is the opinion of AAI that the main purpose of this contract was performed in a completely satisfactory fashion and at an actual reduction in costs over those originally estimated for this program.



VI. RECOMMENDATIONS

It is the opinion of AAI that the XM 138 Training Warhead Section is a well designed and serviceable item. It is felt that with minimum maintenance, it will have a service life of sufficient duration to last until the tactical Sergeant becomes obsolete. If it is decided that additional design efforts should be directed toward ruggedizing the warhead, AAI recommends the following for consideration:

1. A complete set of detail technical and environmental specifications be established before the inception of such a program.
2. Engineering proof tests be performed in accordance with these specifications.
3. Continue to fabricate the skin of Fiberglas because of its serviceability and overall minimum cost.



VII. REFERENCES

- A. Picatinny Arsenal Contract No. DA-28-017-ORD-5060(A)
- B. "Purchase Description for Warhead Section, Training: XM 138",
Picatinny Arsenal, No. X-PA-PD-1669, dated 1 August 1962.
- C. NTDC Contract Number N61339-740
- D. AMICOM Contract Number DA-36-034-ORD-3477
- E. "Purchase Description Skins", Picatinny Arsenal,
No. X-PA-PD-2376, dated 6 June 1962
- F. "XM 138 Training Warhead Section Qualification Test Program,
Picatinny Arsenal No. 71169, dated 10 August 1962
- G. (Modified Qualification Test)
- H. (Interim Test Procedures)