CONFIDENTIAL

[redacted]TIAL

REPORT 2359

INVESTIGATION OF PREMATURES IN 75 MM T165E11 HEP-T SHELL [redacted]

SAMUEL D. STEIN
STANLEY J. LOWELL

JULY 1956

SAMUEL FELTMAN AMMUNITION LABORATORIES
PICATINNY ARSENAL
DOVER, N. J.

ORDNANCE PROJECT TA1-5002H
DEPT. OF THE ARMY PROJECT 5A04-01-001

COPY 41

CONFIDENTIAL

REGRADING DATA CANNOT BE PREDETERMINED

AD- 103508

SECURITY REMARKING REQUIREMENTS

DOD 5200.1-R, DEC 78

REVIEW ON 28 JUL 76

THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

EXCLUDED

FROM GENERAL CLASSIFICATION SCHEDULE
IN ACCORDANCE WITH
INFORMATION SECURITY PROGRAM REGULATION

DATED - JULY 1972

DOD 5200.1R & EXECUTIVE ORDER 11652
(EXECUTIVE ORDER 10501 AMENDED)

BY

Defense Documentation Center
Defense Supply Agency
Cameron Station
Alexandria, Virginia 22314

DEC 1972

UNCLASSIFIED

AD 103508

CLASSIFICATION CHANGED
TO: UNCLASSIFIED
FROM: CONFIDENTIAL
AUTHORITY:
ARRADCOM
ltr, 13 Fe

UNCLASSIFIED

UNCLASSIFIED

DDC REPORT BIBLIOGRAPHY SEARCH CONTROL NO. BFK34D

apr 81

AD- 103 508 19/1

PICATINNY ARSENAL DOVER N J FELTMAN RESEARCH LABS

Investigation of Prematures in 75MM,
T165E11 HEP-T Shell. (U)

JUL 56 17P STEIN,SAMUEL D.;LOWELL,STANLEY J.;
REPT. NO. TR2359
PROJ: TA1 5002H

UNCLASSIFIED REPORT C-3888

DESCRIPTORS: *HIGH EXPLOSIVE AMMUNITION, DETONATIONS,
HAZARDS, PROJECTILES, SEALS (STOPPERS) (U)
IDENTIFIERS: 75-MM ORDNANCE ITEMS, T-165
CARTRIDGES(75-MM) (U)

7/78

CONFIDENTIAL

DDC REPORT BIBLIOGRAPHY SEARCH CONTROL NO. BF035N

AD- 103 508 19/1
PICATINNY ARSENAL DOVER N J FELTMAN RESEARCH LABS

INVESTIGATION OF PREMATURES IN 75MM, T165E11 HEP-T
SHELL (C)

JUL 56 1V STEIN,SAMUEL D.;LOWELL,STANLEY J.;
REPT. NO. TR2359
PROJ: TA1 5002H

EXCL. CONFIDENTIAL REPORT

DESCRIPTORS: *HIGH EXPLOSIVE AMMUNITION, DETONATIONS,
HAZARDS, PROJECTILES, SEALS (STOPPERS) (M)
IDENTIFIERS: 75-MM ORDNANCE ITEMS, T-165
CARTRIDGES(75-MM) (M)

CONFIDENTIAL

INVESTIGATION OF PREMATURES IN 75MM T165E11 HEP-T SHELL (C)

by

Samuel D. Stein
Stanley J. Lowell

July 1956

Picatinny Arsenal
Dover, N. J.

Technical Report 2359

Ordnance Project TA1-5002H

Dept of the Army Project 5A04-01-001

Approved:
Robert Orrye
for D. R. BEEMAN
Acting Director,
Samuel Feltman
Ammunition Laboratories

CONFIDENTIAL

TABLE OF CONTENTS

OBJECT

To determine the cause of prematures in Composition A-3 loaded 75 mm T165E11 HEP-T shell fired at 125°F and chamber pressures above 30,000 psi.

SUMMARY

When 3 prematures occurred out of 32 Composition A-3 loaded 75 mm T165E11 HEP-T shell fired at 125°F and at chamber pressures above 30,000 psi in May 1954, it was theorized that these prematures were caused by the setback of the explosive charge on the fuze. In an investigation conducted in October 1954, to check this theory 100 shell were safely fired at 125°F and service chamber pressure (averaging 29,000 psi). However, since the above 3 prematures had occurred at chamber pressures above 30,000 psi, it was still not known whether this theory was correct. A statistically designed test program was then conducted to determine whether this factor or some other factor was the cause of the prematures at chamber pressures above 30,000 psi.

A total of 34 prematures was obtained out of 574 shell fired at chamber pressures of over 30,000 psi in this program. The lowest incidence of prematures (2 out of 167 rounds fired) occurred with shell having two sealants in the fuze and base plug joints. Three out of 120 rounds prematured when one sealant was applied and 29 out of 287 rounds prematured when no sealant was applied to the joints. Twenty-four prematures occurred with shell containing charges loaded under high pressure (14,800 to 15,000 psi), 4 with shell containing charges loaded under medium pressure (8,500 to 9,000 psi) and 6 with shell containing charges loaded under low pressure (3,800 to 4,000 psi). It is believed that the higher incidence of prematures in shell loaded under high pressure is not due to the fact that the explosive charge had a high density, but to the probability of the joints being spread by the transmission of the pressure during loading.

There was no evidence to substantiate the theory that the setback of the Composition A-3 charge on the fuze was the cause of the prematures. Thirteen prematures occurred with shell assembled with live fuzes and 21 occurred with shell assembled with inert fuzes.

CONCLUSIONS

The lack of an absolutely leakproof seal at the fuze and base plug joints will cause prematures in 75 mm T165E11 HEP-T shell.

HEP-T shell, as presently designed with joints to the rear of the rotating band, will premature more frequently when a high pressure is applied to the charge in the loading operation than when a low pressure is applied.

A joint to the rear of the rotating band of any shell is a potential avenue for the entrance of propellant gases into the shell, and thus a potential source of prematures.

RECOMMENDATIONS

All shell bodies should be designed so as to avoid leaving any avenue by which hot propellant gases can enter the shell body and come into contact with the high explosive.

INTRODUCTION

1. Firing tests were conducted, in May 1954 at Jefferson Proving Ground, to determine whether Type B RDX could be used in Composition A-3 interchangeably with Type A RDX which was prescribed for that explosive (Ref A). The tests were discontinued after 3 prematures occurred out of 32 shell fired at 125°F. Conditions common to all the shell that prematured were: (1) assembled with live fuzes, (2) fired at 125°F and (3) fired at chamber pressures of 30,000 psi or more. Neither cycling the shell nor use of a specific type of RDX in the Composition A-3 charge was exclusive to the shell that prematured. It was theorized that the prematures may have occurred because setback had driven the Composition A-3 charge backward against the fuze with force enough to rupture the booster cup and detonate the tetryl booster (Ref B).

2. In October 1954, when 100 Composition A-3 loaded 75 mm T165E11 HEP-T shell were assembled with live fuzes and fired at 125°F and an average chamber pressure of 29,000 psi, to check whether setback would cause the fuzes to malfunction, no prematures resulted (Ref C). It was not known, however, whether these shell could be fired safely at pressures above 30,000 psi. Moreover, it was not known whether the degree of consolidation of the Composition A-3 charge and the tightness of closure of the fuze and base plug joints in the rear of the shell were factors that could cause prematures.

3. Picatinny Arsenal was authorized in Reference D to continue tests to determine the cause of the prematures experienced at Jefferson Proving Ground. A statistically designed program intended to isolate the factor or factors involved in these prematures was prepared and conducted. This report covers the results obtained.

RESULTS

4. Twelve hundred 75 mm T165E11 HEP-T shell were loaded, assembled, and assigned the lot numbers shown in Table 1. A total of 34 prematures were obtained when 574 of these shell were fired at 125°F and approximate average chamber pressures of 34,000 psi (Ref E). One-half (287) of the 574 shell fired contained Laminac 4116 sealer in the fuze and rear base plug joints. One hundred sixty-seven of these sealed shell contained a coating of Cycleweld C-14 over the fuze and base plug joints in addition to the Laminac 4116. Table 2 shows the influence of each variable on the occurrence of prematures and is a summation of the data contained in Tables 3 and 4. Tables 3 and 4, respectively, show the influence of these variables on the occurrence of prematures

when shell were sealed with Laminac 4116 alone, and when the added seal of Cycleweld C-14 was applied to the fuze and base plug joints. A description of the loading and assembly of each shell which prematured is given in Table 5 together with details pertaining to the premature.

5. A statistical analysis (analysis of variance) of the data obtained in these tests revealed the following:

a. The difference between sealed and unsealed shell and the difference between shell loaded under high pressure and shell loaded under lower pressures was statistically significant at the 99% level with respect to the prematures which occurred.

b. The effect of cycling and the loading pressure depended upon whether or not the shell joints were sealed. The first order interactions[1] of seal and cycling and seal and loading pressure were found to be significant at the 99% level with respect to the prematures which occurred.

c. Second and higher order interactions were found to be non-existent.

DISCUSSION OF RESULTS

6. In the program developed to isolate the factor or factors involved in the prematures of 75 mm T165E11 HEP-T shell, 1200 shell were loaded and assembled as shown in Table 1. There were 60 combinations of variables, each combination being represented by a lot of 20 shell. After assembly, one-half of each lot (10 shell) were subjected to a JAN temperature cycle. Hence, there were then 120 combinations of variables, each combination represented by 10 shell. The shell were fired in groups of 120 consisting of two shell, one cycled and one uncycled, from each of the 60 lots. After 2 groups, 240 shell, had been fired, an analysis of the data showed that a larger number of prematures (11) had occurred with shell having no Laminac 4116 sealer in the fuze and base plug joints than had occurred with shell having the sealer in these joints (3 prematures). The fact that a larger number of prematures had occurred with the unsealed shell substantiated the theory that the prematures were being caused by the leakage of propellant gases into the shell through the fuze and/or base plug joints. It was postulated that the occurrence of prematures in the sealed shell was being caused by the leakage of propellant gases through improperly sealed joints. This was possible because, in the sealing procedure, the Laminac 4116 had been applied only at several places around the circumference of the threads and then spread by the screwing action when the fuze and base plug were assembled to the shell. It is quite possible that, in the sealed shell that prematured, spreading may have been spotty

[1] First order interactions involve data on two variables, second order interactions data on three variables, and so forth.

thereby causing an imcomplete seal. To further substantiate this theory an additional coating of sealer (Cycleweld C-14) was applied to the outside of the fuze and base plug joints of the remaining sealed shell. Cycleweld C-14 was chosen for this additional sealant because it is a highly heat-resistant thermosetting plastic adhesive which forms a strong bond with metals. If this theory were correct, such additional sealing should substantially reduce the frequency of prematures and possibly eliminate them altogether.

7. An additional 334 shell were fired, 167 doubly sealed as described above and 167 unsealed. After the 334th round was fired, a statistical analysis was conducted and it was decided that sufficient data had been obtained to isolate the factor or factors causing the prematures. The tests were therefore discontinued at this stage. The statistical analysis revealed the following:

a. Of the variables investigated (live or inert fuzing, sealed or unsealed fuze and base plug joints, cycled or uncycled shell, variations among batches of explosive from the same lot, and variation of loading pressure), only the differences between sealed and unsealed shell and between shell loaded under high pressure and shell loaded under lower pressures were found to be statistically significant at the 99% level. As previously stated, unsealed shell are hazardous because of leakage of propellant gases through the fuze and base plug joints. The exact reason for the greater incidence of prematures in shell containing charges loaded under high pressure is not known. It is possible, however, that the high loading pressures caused the walls of the shell to spread slightly and when the pressure was released they did not completely return to their normal position. This spreading would increase the inside diameter of the threaded joint portion of the shell body and provide a larger avenue for the entrance of propellant gases through the fuze and base plug joints. The mechanism in all the prematures would thus be essentially the same.

b. It was found that the effect of cycling the shell and the effect of loading pressure depended on whether or not the shell joints were sealed. This is shown by the fact that the first order interactions of unsealed cycled shell and unsealed shell loaded under high pressure were found to be significant at the 99% level. This again shows that the other variables, cycling or loading the shell under high pressure, are only secondary to the fact that the propellant gases could penetrate an unsealed joint.

c. With respect to other variables, no significant difference in number of prematures was found between live and inert fuzed shell, among shell containing different batch charges of Composition A-3, and between cycled and uncycled shell.

8. A comparison of the number of prematures obtained with the shell sealed with Laminac 4116 alone,

and those sealed with both Laminac 4116 and Cycleweld C-14, revealed the following. In the shell sealed with Laminac 4116 alone, the rate of prematures was 1 out of 40. In the shell sealed with both Laminac 4116 and Cycleweld C-14, the rate of prematures was approximately 1 out of 84. It appears that an improvement has been made by applying the additional seal of Cycleweld C-14 to the joints. When the Cycleweld C-14 was applied, there was no assurance that this additional seal would completely prevent the leakage of the propellant gases. The occurrence of prematures in shell containing the double seal indicates that, even with a superior reinforcing seal, there is no certainty that leakage will not occur.

9. An analysis of the details surrounding the prematures showed that all the shell traveled some distance before they prematured. Round No. 207 traveled the shortest distance, prematuring in the gun tube 48 inches from the face of the breech. Round No. 289 traveled the longest distance before prematuring, 150 yards. It is evident, therefore, that the factor causing the prematures requires time to take effect. It should also be noted, that when a premature occurred in the gun tube, in those cases where the time could be recorded, it is shown (Table 5, Figure 2) that the prematures had occurred well past the peak pressure. This supports the theory that propellant gases leaking through the joints may have caused the prematures since a small time factor is necessary for the penetration of the gases.

10. It should be noted (Table 2) that more prematures occurred with shell assembled with inert fuzes than with shell having live fuzes. If the setback of the Composition A-3 charge on the fuze were the cause of prematures, as had been theorized prior to these tests, most of the prematures should have occurred in shell assembled with live fuzes. Also, a premature caused by setback would have occurred almost instantaneously when the shell was fired, and not after the shell had traveled some distance in the gun tube or had left the tube. It is evident, therefore, that the prematures of the 75 mm T165E11 HEP-T shell were not caused by the setback of the Composition A-3 charge on the fuze.

11. Another important characteristic concerning the prematures of 75 mm T165E11 HEP-T shell has been revealed by these tests. When 100 shell were fired at 125°F and average chamber pressures of 29,000 psi, no prematures occurred (Ref B). In this test program, 34 prematures occurred out of 574 rounds fired at 125°F and pressures above 30,000 psi. It is evident, therefore, that a pressure above 30,000 psi is required to cause a premature. That is, the propellant gases require a pressure above 30,000 psi to penetrate the fuze and base plug joints.

12. In summation, it has been found that the lack of a complete seal at the fuze and base plug joints of 75 mm T165E11 HEP-T shell is the cause of prematures in these shell. From this finding, it is obvious that the design of

these shell, with fuze and base plug joints at the rear of the rotating band (Fig 1), creates a potentially hazardous condition. Even the careful application of a thermosetting highly resistant plastic sealant to the outside of these joints did not prevent leakage of propellant gases. Obviously, this shell must be redesigned to insure an absolute closure at the base end. It is clear that all shell (HE, HEP, etc.) must be designed so as to avoid leaving any avenue by which hot propellant gases can enter the shell body and come in contact with the high explosive.

EXPERIMENTAL PROCEDURE

LOADING OF SHELL

High Pressure Loading

13. Before loading, the Composition A-3 charges were preheated to 95 ± 5°F. The shell were then loaded with 8 increments of explosive pressed at 14,800 to 15,000 psi with a 1.87-inch diameter ram. The first increment was approximately 12 ounces and the remaining 7 increments were approximately 5 ounces each. A 10-second dwell was applied on each increment.

Medium Pressure Loading

Before loading, the Composition A-3 charges were preheated to 85 to 90°F. The shell were then loaded with 5 increments of explosive pressed at 8,500 to 9,000 psi, with a 1.87-inch diameter ram. The first increment was approximately 1 pound and the remaining 4 increments were approximately 7½ ounces each. A 5-second dwell was applied on each increment.

Low Pressure Loading

The Composition A-3 charges were loaded at ambient temperature in 3 increments pressed at 3,800 to 4,000 psi with a 1.87-inch diameter ram. The first 2 increments were of such size as would just fill the shell and adapter. The third increment was of the amount required to finish loading the shell. A 3-second dwell was applied on each increment.

ASSEMBLY OF SHELL

14. After loading, the lot numbers shown in Table 1 were assigned to the shell, 20 shell comprising each lot. The fuze cavities were then drilled and faced (Fig 1). The specific gravity of each charge was determined on the Ohmart gage. The base plug, gasket, M91A1 BD fuze, felt disc, and washer were assembled in accordance with Figure 1. The type of fuzing (live or inert) and the use of sealer (Laminac 4116) at the fuze and base plug joints were varied from lot to lot in the pattern shown in Table 1. The Laminac 4116 sealer was applied in accordance with Specification MIL-A-13213, 18 January 1954, "Adhesive and Sealer, Polyester Resin."

APPLICATION OF CYCLEWELD C-14 SEALER TO SHELL

15. The outside extremities of the fuze and base plug joints were thoroughly cleaned with emery cloth and acetone.

The Cycleweld C-14 was then prepared by thoroughly mixing 7 parts by weight of Cycleweld C-14B catalyst with 100 parts by weight of Cycleweld C-14A resin. This mixed adhesive was applied to the cleaned metal surface in a manner which produced a bead-like effect over the joint. The pot-life of the mixed Cycleweld C-14 is approximately 30 minutes. Therefore, only small amounts were prepared as needed.

FIRING OF SHELL

16. The fuzed shell were assembled into complete rounds with M26 cartridge cases and M31A2 primers Lot ROP-5-360 using approximately 35.50 ounces of M1 .0266 web propellant Lot BAJ-15372. Ten rounds from each lot were then cycled, 8 hours at -65°F and 16 hours at 160°F alternately for 5 days. Prior to firing all rounds were conditioned at 125°F for at least 16 hours and this temperature was maintained, insofar as was possible, up to the moment of firing. The shell were fired from a 75 mm M3 gun at approximately 187 mils elevation. Firings were conducted in groups of 120, 2 shell, one cycled and the other uncycled, being taken from each of the 60 lots. All shell were fired through a hole in a screen of Celotex boards, 12 feet by 16 feet by 1 inch thick, placed 80 feet in front of the gun to detect flying fragments of the fuze and shell in the event of a premature. Time-pressure traces were determined by means of strain gages on the gun tube, and chamber pressures by means of copper crusher gages Lot 8C-54. Records of the pressure-time traces were made on both 35 mm moving film and Polaroid film. Sample traces are shown in Figure 2.

REFERENCES

A. Jefferson Proving Ground Firing Record A-8452, *Special Ballistic Test of Shell, HEP-T, 75 mm, T165E11, Composition A-3 Loaded.*

B. Ltr, CO, Picatinny Arsenal to OCO, ORDBB-TE3 471.14/3-46, 21 September 1954, *HEP Shell and HEP Shell Fuzes, Projects TA1-5002H and TA1-2702.*

C. Aberdeen Proving Ground Firing Record P-60048, *Development of Shell, HEP-T, 75 mm, T165E11; 76 mm, T170E3; 90 mm, T142E5; and 105 mm, T81E28, Firings to Determine the Effect of Elevated Temperature on Stability of the Shell.*

D. 1st Ind to Ltr from CO, Picatinny Arsenal to OCO, ORDBB-TE3 471.14/3-46, ORDTA-00/40-19897, 22 October 1954, *HEP Shell and HEP Shell Fuzes, Projects TA1-5002H and TA1-2702.*

E. Jefferson Proving Ground Firing Record A-21723, *Special Ballistic Test of Shell T165E11, HEP-T, Composition A-3 Loaded for 75 mm Gun, M3.*

TABLE 1

Lot Numbers of Shell and Charges Used in Tests

Charge	Loaded at Low Pressure (3800 - 4000 psi)					Loaded at Medium Pressure (8500 - 9000 psi)					Loaded at High Pressure (14,800 - 15,000 psi)				
Composition A-3 Batches[a]	725	727	729	743	744	725	727	729	743	744	725	727	729	743	744
Shell Lot Nos[bc]															
W/Live Fuze and W/Cement	-93A	-93C	-93E	-93G	-93J	-93L	-93N	-93R	-93T	-93V	-93AA	-93CC	-93EE	-93GG	-93JJ
W/Live Fuze and W/O Cement	-93B	-93D	-93F	-93H	-93K	-93M	-93P	-92S	-93U	-93W	-93BB	-93DD	-93FF	-93HH	-93KK
W/Inert Fuze and W/Cement	-94A	-94C	-94E	-94G	-94J	-94L	-94N	-94R	-94T	-94V	-94AA	-94CC	-94EE	-94GG	-94JJ
W/Inert Fuze and W/O Cement	-94B	-94D	-94F	-94K	-94M	-94P	-94S	-94U	-94U	-94W	-94BB	-94DD	-94FF	-94HH	-94KK

a Charges were from Lot WAB-1-56.

b Basic Shell Lot: MA-SR-. Thus, full lot designations are MA-SR-93A, MA-SR-93C, etc.

c Shell bodies from Lot YCC-1-3.

TABLE 2

Effect of Variables on Frequency of Prematures*

	Prematures	Rounds Fired
Loading Pressure		
High (14,800 - 15,000 psi)	24	174
Medium (8,500 - 9,000 psi)	4	200
Low (3,800 - 4,000 psi)	6	200
Type of Fuze (BD, M91A1)		
Live (Lot KOP-32-15)	13	287
Inert (Lot KOP-SR-65)	21	287
Application of Sealer at Fuze and Rear Plug Joints		
With Sealer	5	287
Without Sealer	29	287
Batch Numbers of Composition A-3 Charges (from Lot WAB-1-56)		
725	11	120
727	8	118
729	5	112
743	4	112
744	6	112
Cycling of Shell		
Cycled (JAN Temperature Cycle)	20	287
Uncycled	14	287

---

* In this table, the total number of prematures (34) and the total number of rounds fired (574) are broken down in terms of each variable.

TABLE 3

Results of First 240 Firings*

	Prematures	Rounds Fired
Loading Pressure		
High (14,800 - 15,000 psi)	10	60
Medium (8,500 - 9,000 psi)	2	60
Low (3,800 - 4,000 psi)	2	60
Type of Fuze (BD, M91A1)		
Live (Lot KOP-32-15)	6	120
Inert (Lot KOP-SR-65)	8	120
Application of Sealer at Fuze and Rear Plug Joints		
With One Sealant (Laminac 4116)	3	120
Without Sealant	11	120
Batch Numbers of Composition A-3 Charges (from Lot WAB-1-56)		
725	5	48
727	2	48
729	1	48
743	3	48
744	3	48
Cycling of Shell		
Cycled (JAN Temperature Cycle)	9	120
Uncycled	5	120

* Of these 240 shell, 14 prematured.

TABLE 4

Results of Last 334 Firings*

	Premotures	Rounds Fired
Looding Pressure		
High (14,800 - 15,000 psi)	14	94
Medium (8,500 - 9,000 psi)	2	120
Low (3,800 - 4,000 psi)	4	120
Type of Fuze (BD, M91A1)		
Live (Lot KOP-32-15)	7	167
Inert (Lot KOP-SR-65)	13	167
Applicotion of Seoler ot Fuze ond Reor Plug Joints		
With two Sealants (Laminac 4116 and Cycleweld C-14)	2	167
Without Sealant	18	167
Botch Numbers of Composition A-3 Chorges (from Lot WAB-1-56)		
725	6	72
727	6	70
729	4	64
743	1	64
744	3	64
Cycling of Shell		
Cycled (JAN Temperature Cycle)	11	167
Uncycled	9	167

---

* Of these 334 shell, 20 prematured.

[redacted]

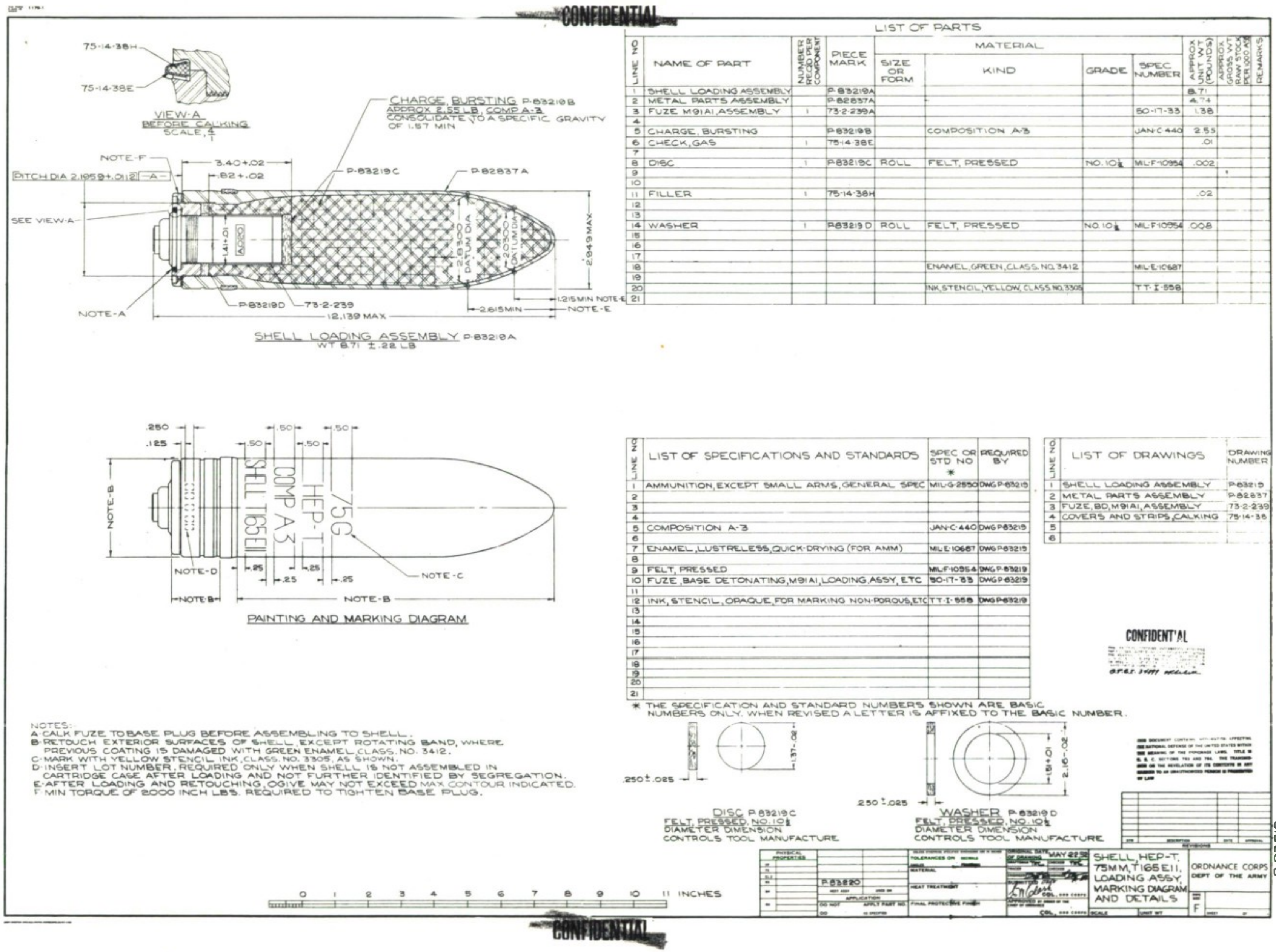
TABLE 5

Detailed Information on T165E11 HEP-T Shell Which Prematured

Round No.	Lot No.	Type of Fuze	Cycling[1]	Sealer[2]	Composition A-3 Charge Number[3]	Specific Gravity of Charge[4]	Projectile Wt, lbs	Chamber Pressure,[5] psi	Time From Zero Pressure To Peak Pressure, milliseconds	Time From Zero Pressure To Premature, milliseconds	Remarks
87	MA-SR-94BB	Inert	Cycled	Without	725	1.62 H	8.71	36,500			Low order outside muzzle of gun.
9[illegible]	MA-SR-93DD	Live	Uncycled	Without	727	1.64 H	8.87	35,600			Low order outside muzzle of gun.
10[illegible]	MA-SR-93GG	Live	Uncycled	With	743	1.63 H	8.87	35,200			High order approximately 100 yards from gun.
117	MA-SR-93KK	Live	Cycled	Without	744	1.64 H	8.84	33,800			High order approximately 100 yards from gun.
127	MA-SR-94B	Inert	Cycled	Without	725	1.44 L	8.39	35,000			Low order in tube of gun 70 inches from face of breech swelling tube approximately 0.013 inch.
167	MA-SR-94M	Inert	Cycled	Without	744	1.59 M	8.67	37,200			Low order outside muzzle of gun.
175	MA-SR-94P	Inert	Cycled	Without	725	1.60 M	8.67	37,100	1.50	3.92	Low order in tube of gun.
188	MA-SR-94T	Inert	Uncycled	With	743	1.59 M	8.68	34,300			Low order outside muzzle of gun.
205	MA-SR-93BB	Live	Cycled	Without	725	1.63 H	8.85	37,700	1.78	4.02	Low order in tube of gun 56-68 inches from face of breech swelling tube 0.010 inch.
207	MA-SR-94BB	Inert	Cycled	Without	725	1.63 H	8.72	36,600	1.86	3.58	Low order in tube of gun 48 inches from face of breech swelling tube 0.183 inch.
214	MA-SR-93DD	Live	Uncycled	Without	727	1.64 H	8.86	38,000			Low order outside muzzle of gun.
221	MA-SR-93FF	Live	Cycled	Without	729	1.63 H	8.85	36,000			Low order outside muzzle of gun.
228	MA-SR-94GG	Inert	Uncycled	With	743	1.64 H	8.72	34,900			Low order approximately 100 feet from gun.
239	MA-SR-94KK	Inert	Cycled	Without	744	1.63 H	8.74	36,000			Low order outside muzzle of gun.
256	MA-SR-94D	Inert	Uncycled	Without	727	1.46 L	8.42	33,700			Low order outside muzzle of gun.
274	MA-SR-93J	Live	Uncycled	With	744	1.46 L	8.55	33,700			High order approximately 100 yards in front of gun.
287	MA-SR-94M	Inert	Cycled	Without	744	1.59 M	8.68	32,200	1.98	4.59	High order in tube of gun approximately 80 inches from face of breech destroying tube.
289	MA-SR-93N	Live	Cycled	With	727	1.59 M	8.77	33,900			High order approximately 150 yards in front of gun.
325	MA-SR-93BB	Live	Cycled	Without	725	1.64 H	8.87	34,100			Low order in tube of gun 92 inches from face of breech swelling tube 0.123 inch.
326	MA-SR-93BB	Live	Uncycled	Without	725	1.63 H	8.86	33,600			Low order outside muzzle of gun.
328	MA-SR-94BB	Inert	Uncycled	Without	725	1.64 H	8.78	33,800			Low order outside muzzle of gun.
335	MA-SR-94DD	Inert	Cycled	Without	727	1.64 H	8.77	34,100			Low order outside muzzle of gun.
343	MA-SR-94FF	Inert	Cycled	Without	729	1.64 H	8.80	34,300			Low order outside muzzle of gun.
344	MA-SR-94FF	Inert	Uncycled	Without	729	1.64 H	8.76	33,700			Low order outside muzzle of gun.
352	MA-SR-94HH	Inert	Uncycled	Without	743	1.63 H	8.76	33,800			Low order outside muzzle of gun.
357	MA-SR-93KK	Live	Cycled	Without	744	1.63 H	8.88	34,400			Low order outside muzzle of gun.
423	MA-SR-94S	Inert	Cycled	Without	727	1.60 M	8.66	34,300			Low order outside muzzle of gun.
447	MA-SR-94BB	Inert	Cycled	Without	725	1.63 H	8.70	33,500	1.95	4.00	Low order in tube of gun.
454	MA-SR-93DD	Live	Uncycled	Without	727	1.64 H	8.81	34,300			Low order outside muzzle of gun.
463	MA-SR-94FF	Inert	Cycled	Without	729	1.64 H	8.71	33,600	1.86	4.22	Low order in tube of gun.
501	MA-SR-93F	Live	Cycled	Without	729	1.45 L	8.53	34,100			Low order outside muzzle of gun.
567	MA-SR-94BB	Inert	Cycled	Without	725	1.64 H	8.73	33,900			Low order outside muzzle of gun.
568	MA-SR-94BB	Inert	Uncycled	Without	725	1.63 H	8.74	34,400			Low order outside muzzle of gun.
574	MA-SR-93DD	Live	Uncycled	Without	727	1.63 H	8.82	35,300	2.08	4.03	High order in tube of gun approximately 60 inches from face of breech destroying the gun.

[1] Rounds noted as cycled were subjected to a JAN temperature cycle.
[2] The sealant was applied to the fuze and base plug joints.
[3] The batches were from Composition A-3 Lot WAB-1-56.
[4] The letters adjacent to the density values represent:
H - High density charge, pressed at 14,800 - 15,000 psi
M - Medium density charge, pressed at 8,500 - 9000 psi
L - Low density charge, pressed at 3,800 - 4,000 psi
[5] Average copper crusher gage readings.

[redacted]



LIST OF PARTS

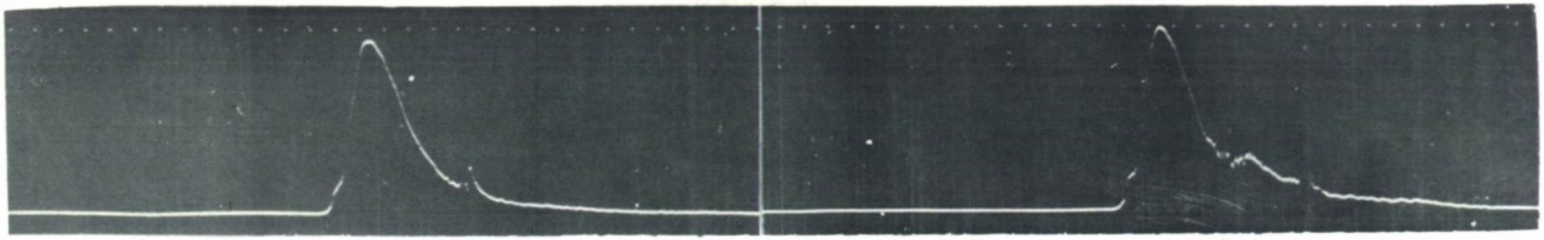
LINE NO	NAME OF PART	NUMBER REQ'D PER COMPONENT	PIECE MARK	MATERIAL: SIZE OR FORM	MATERIAL: KIND	MATERIAL: GRADE	MATERIAL: SPEC NUMBER	APPROX UNIT WT (POUNDS)	APPROX GROSS WT RAW STOCK PER 1000 ASSY	REMARKS
1	SHELL LOADING ASSEMBLY		P-83219A					8.71		
2	METAL PARTS ASSEMBLY		P-82837A					4.74		
3	FUZE M91A1, ASSEMBLY	1	73-2-239A				50-17-33	1.38		
4										
5	CHARGE, BURSTING		P-83219B		COMPOSITION A-3		JAN-C-440	2.55		
6	CHECK, GAS	1	75-14-38E					.01		
7										
8	DISC	1	P-83219C	ROLL	FELT, PRESSED	NO. 10½	MIL-F-10954	.002		
9										
10										
11	FILLER	1	75-14-38H					.02		
12										
13										
14	WASHER	1	P-83219D	ROLL	FELT, PRESSED	NO. 10½	MIL-F-10954	.008		
15										
16										
17										
18					ENAMEL, GREEN, CLASS. NO. 3412		MIL-E-10687			
19										
20					INK, STENCIL, YELLOW, CLASS. NO. 3305		TT-I-558			
21										

LINE NO	LIST OF SPECIFICATIONS AND STANDARDS	SPEC OR STD NO *	REQUIRED BY
1	AMMUNITION, EXCEPT SMALL ARMS, GENERAL SPEC	MIL-G-2550	DWG P-83219
2			
3			
4			
5	COMPOSITION A-3	JAN-C-440	DWG P-83219
6			
7	ENAMEL, LUSTRELESS, QUICK-DRYING (FOR AMM)	MIL-E-10687	DWG P-83219
8			
9	FELT, PRESSED	MIL-F-10954	DWG P-83219
10	FUZE, BASE DETONATING, M91A1, LOADING, ASSY, ETC	50-17-33	DWG P-83219
11			
12	INK, STENCIL, OPAQUE, FOR MARKING NON-POROUS, ETC	TT-I-558	DWG P-83219
13			
14			
15			
16			
17			
18			
19			
20			
21			

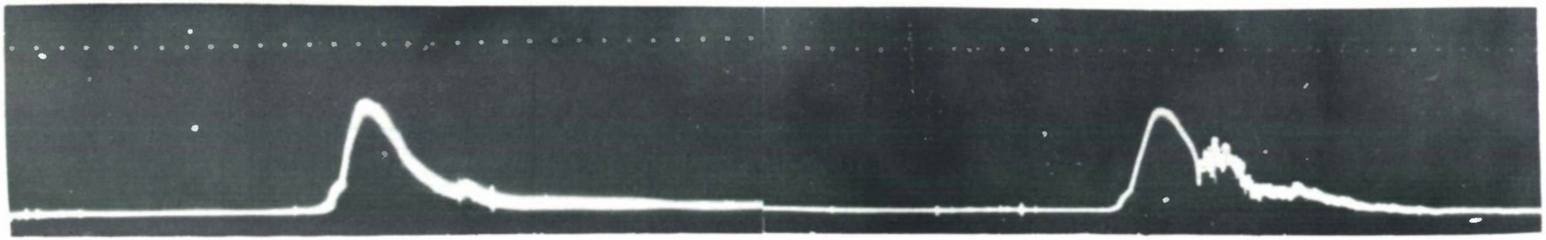
LINE NO	LIST OF DRAWINGS	DRAWING NUMBER
1	SHELL LOADING ASSEMBLY	P-83219
2	METAL PARTS ASSEMBLY	P-82837
3	FUZE, BD, M91A1, ASSEMBLY	73-2-239
4	COVERS AND STRIPS, CALKING	75-14-38
5		
6		

Fig. 1 Loading Assembly, Marking Diagram, and Details of T165E1 Shell

35MM MOVING FILM RECORDS

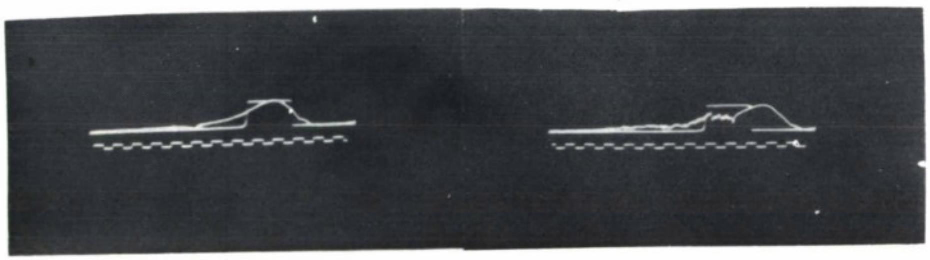


RD # 84, NORMAL　　RD # 85, PREMATURE



RD # 86, NORMAL　　RD # 87, PREMATURE

POLAROID FILM RECORD



RD # 86, NORMAL　　RD # 87, PREMATURE

Fig 2　Sample Pressure-Time Traces From Jefferson Proving Ground Firings.

DISTRIBUTION LIST

	Copy No.
Commanding Officer Picatinny Arsenal Dover, New Jersey ATTN: Technical Information Section	1 - 5
Chief of Ordnance Department of the Army Washington 25, D. C. ATTN: ORDTA Dr. L. R. Littleton	6
ORDIM	7
ORDTU	8
ORDTX-AR	9
ORDFA	10
ORDTR	11
Armed Services Technical Information Agency Document Service Center Knott Building Dayton 2, Ohio ATTN: DSC-SD	12 - 21
Commanding General Ordnance Ammunition Command Joliet, Illinois ATTN: ORDLY-ARAC	22
Commanding General Aberdeen Proving Ground Maryland ATTN: Mr. H. Bechtol	23
Commanding Officer Milan Arsenal Milan, Tennessee	24
Commanding Officer Jefferson Proving Ground Madison, Indiana	25

	Copy No.
Department of the Navy Bureau of Ordnance Washington 25, D. C. ATTN: Section Re2a	26
Re2c	27
Commander Naval Ordnance Laboratory White Oak Silver Spring, Maryland ATTN: Library	28
Commander U. S. Naval Ordnance Test Station Inyokern, P.O. China Lake California	29
Commander U. S. Naval Proving Ground Dahlgren, Virginia ATTN: OMI	30
Los Alamos Scientific Laboratory Los Alamos, New Mexico	31
Commanding General Frankford Arsenal Bridge & Tacony Streets Philadelphia 37, Pa.	32
Commanding General Redstone Arsenal Huntsville, Alabama	33
Air Research & Development Command Hq. P.O. Box 1395 Baltimore, Maryland ATTN: Lt. Col. J. J. Pellegrini, USAF	34

	Copy No.
Commanding Officer Office of Ordnance Research Box CM, Duke Station Durham, North Carolina	35
Chief of the M Division Applied Research Branch Camp Detrick, Maryland	36
British Joint Services Mission Ministry of Supply Staff Washington, D. C. ATTN: Reports Officer	37
Canadian Army Staff 2450 Massachusetts Ave., N. W. Washington 8, D. C.	38