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REPORT NO. DPS/TW-422/2

ARTILLERY DIVISION

REPORT ON

DEVELOPMENT OF CARTRIDGE, 90-MM, HEAT, T300 FOR 90-MM GUNS, M36 AND M41 (U)

SECOND REPORT ON ORDNANCE PROJECT TW-422

(D. A. PROJECT NO. 504-03-049)

(PICATINNY ARSENAL TPR NO. TM-7(C))

JOSEPH C. SLEEPER, JR.

FEBRUARY 1959

Aberdeen Proving Ground
Maryland

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DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND
MARYLAND

AUTHORITY: OCO - ORDTW

JCSleeperJr/mt/24119
12 February 1959

DEVELOPMENT OF CARTRIDGE, 90-MM, HEAT, T300 FOR 90-MM GUNS, M36 AND M41 (U)

Second Report on Ordnance Project No. TW-422

Dates of Test: 8 and 9 August 1958

(C) ABSTRACT

Firings were conducted for charge establishment with the T300E53 shell in 90-mm gun, M36 to obtain a muzzle velocity of 4000 fps within a pressure limit of 47,000 psi.

The charge was determined to be 9 lb 2.7 oz for an MP, M17 propellant, Lot RAD-38300, having an 0.057-inch web size. The corresponding pressure for the required velocity is 44,500 psi.

The charge was established based on a +70°F temperature; however, some of the rounds were temperature-conditioned at +125, -25, and -40°F and fired. The results obtained in this test and a later test (reference First Report on Project TW-422) indicate erratic velocity and pressure results with this propellant at low temperatures. It is concluded that Propellant Lot RAD-38300 does not perform satisfactorily at low temperatures. It is recommended that this lot not be used under low-temperature conditions.

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CONTENTS

1. (C) INTRODUCTION

In February 1950 the Ordnance Corps formally initiated development of the 90-mm, T108, HEAT shell for the M3 series of tank guns. In May 1951, anticipating the early availability of the new M47 tank and therefore of the T119 (now the M36) tank gun, authorization was given to use the T108 round in the T119 as well as in the T125 and T139 (now the M54 and M41, respectively) guns until such time as ammunition specifically developed for these weapons should become available. Efforts were made to improve the accuracy of this round, but it remained unreliable.

In July 1952 a meeting was held at which it was decided that the T108 was not accurate enough, and that its velocity was too low. Consequently, a new round would have to be developed to provide an antitank projectile superior to anything then available. This development was designated "Cartridge, 90-mm, HEAT, T300." Its primary aim was to provide a HEAT round with a high hit probability. The secondary objective was to improve shaped-charge effectiveness.

A muzzle velocity of 4000 fps and a desired PE of 0.15 mil vertical and horizontal at 1000-yard range were specified for the T300 fired from the M36 and M41 tank guns. In May 1953 development of the 90-mm, T300 round began. The original design was a scaled-down version of the 105-mm, folding-fin round. Considerable difficulties were experienced with this design from the beginning. The conventional ogive was replaced with a spike-nosed, high-drag configuration to increase the cp-cg separation. Also, decreases of fin lengths and fin opening were necessary, due to the high pressures within the chambers of both weapons used, (the rated maximum pressure of the weapon-ammunition system is 47,000 psi). Several other designs were suggested, but because of their exterior configurations they would not withstand the high accelerations to which the components were subjected. It was not until the fixed-fin design specified as the T300E53 was established that consistently successful accuracy was obtained at 1000 yards when firing was conducted at 4000 fps.

In order to maintain a consistent spin rate of 25 rps, a considerable amount of work was performed on band design. Several plastics and other materials were tested; both fixed and slip-type bands were tried. It was found that nylon, when used as a slip-type band, gave a more consistent spin rate of 25 rps and much more satisfactory obturation than any of the other materials tested.

The purpose of the present test was to establish a charge in the 90-mm gun, M36, which will give a velocity of 4000 fps without exceeding a pressure of 47,000 psi, and to secure other ballistic data as indicated by authorizations for test inclosed in Appendix A.

2. (C) DESCRIPTION OF MATERIEL

The 90-mm, T300E53, HEAT cartridge (drawing in Appendix C) is assembled as a complete round and consists of the following major components:

Shell with M509, PIBD fuze (modified); M5A1 tracer; T24B1 cartridge case; M58 modified primer, and propellant.

The body of the shell is cylindrical, with the forward face containing an undercut surface which receives the spike-nosed ogive. There are no threads at this joint; instead, a rubber-base cement holds the assembly together. The base of the body contains threads which permit it to accept an aluminum chamber. The exterior contour of the chamber makes up a portion of the boattail. The interior of the chamber is machined to accommodate the M509 fuze. The forward end of the chamber provides male threads for assembly to the body. Behind the threads is a machined band seat which accepts a slip-type nylon band the purpose of which is to give a more consistent spin rate of 25 rps. When the chamber and body are assembled, the band is confined between the two components.

In order to prevent gas leakage into the charge cavity, rubber "O" rings are placed in the undercut portions of the thread joints between the body and chamber after an aluminum spacer is screwed in place to retain the fuze within the fuze cavity. The fin adapter completes the boattail, and a small cylindrical section of the adapter is considered the boom. At the end of the boom is a male thread which is used for assembly of the aluminum fin.

A shaped-charge liner is assembled directly to the steel spike nose and is secured to the spike adapter with a 360° roll crimp. At the nose end of the spike a potted nose-element assembly is used to initiate the M509 fuze. This element incorporates a piezoelectric crystal (lucky) for initiation. The components are secured and insulated within the cap with a plastic potting compound. The circuit from the nose element to the fuze is completed with nine-strand, nylon-coated, steel wire. Brass terminals are used at both ends to assure a complete circuit. The charge cavity contains 1.25 lb of composition B.

The complete as-fired weight of this shell is approximately 12.68 lb.

A 90-mm, T24B1 steel case with the base end modified by providing a 1.25-inch-diameter hole for base loading is used because the fins intrude too far into the case for front loading. A steel closing plug is provided for resealing the case. The cartridge-case volume with shell and primer intact is 287.72 cubic inches.

A modified M58 primer containing 370 ± 10 grains of black powder is used. The primer is modified to 13.41 inches long so that the fin assembly can be accepted within the case. One liner in lieu of two is used.

3. DETAILS OF TEST

3.1 (U) Procedures

The cartridge case and shell (inert-loaded and with dummy fuze) were shipped to Aberdeen Proving Ground assembled and crimped but without propellant or primer. The weight of the shell was determined by check-weighing six cases, averaging the weights, and subtracting the average weight from the weight of each complete shell and case combination. A used primer was inserted into the primer seat of one complete round and the Special Measurements Section computed the case volume by filling the case with water. The rounds were then sent to the Machine Shop with the gun and tube to be drilled for piezoelectric gauges. The gun and tube were then mounted on a 155-mm gun carriage and moved into position at C barricade. Velocity towers and coils were placed approximately 104 and 159 feet from the muzzle. A piezoelectric gauge was attached to the tube and plugged into the instrument trailer placed behind the barricade. Several conditioning rounds were made up of stock components (see FR P-63411) to condition the tube and seat the weapon system. One test round was loaded with a minimum charge and fired after two conditioning rounds. The data were taken and a propellant curve started. The charge was gradually increased and the data plotted until the desired velocity-pressure ratio was obtained and verified. The remaining rounds were then loaded with this established charge and placed into the temperature-conditioning trailers to be conditioned to the desired temperatures before firing.

3.2 (C) Results

A propellent charge of 9 lb 2.7 oz was established to give the desired velocity of 4000 fps without exceeding 47,000 psi. See Charge Velocity - Charge Pressure Curve, Appendix B.

Table I. (C) Results of Firing

No. of Rounds Considered	Temp of Rds, °F	Avg Shell Wt, lb	Prop. Wt, oz	Velocity			Measured M3 Gauge Pressure			Measured Piezo Gauge Pressure		
				Avg Instrumental fps	Variation fps	Variation %	Avg, psi	Variation psi	Variation %	Avg, psi	Variation psi	Variation %
1	Ambient	12.67	139.0	3751	None	None	38,300	None	None	Lost	None	None
1	Ambient	12.65	147.0	3962	None	None	45,600	None	None	50,700	None	None
1	Ambient	12.86	151.0	4074	None	None	49,000	None	None	54,900	None	None
4	Ambient	12.68	148.5	4006	17	0.42	46,330	300	0.65	52,250	1,200	2.30
4	+125	12.65	148.5	4146	14	0.34	49,680	600	1.21	54,880	4,700	8.56
4	-25	12.66	148.5	3943	26	0.66	46,130	1,900	4.12	56,050	3,000	5.35
5	-40	12.68	148.5	3586	456	12.72	36,900	11,700	31.71	41,540	14,100	33.94

3.3 (C) Observations

Based on the above summary of results it appears this propellant performs satisfactorily up to -25°F but becomes very erratic in velocity and pressure results at -40°F; however, later firings (reference First Report on Project TW-422) indicate erratic results were obtained at temperatures as high as +35°F.

The muzzle flash appeared to be approximately 15 by 10 feet in size and there was no visible difference from round to round. The muzzle smoke appeared to be small and brownish gray.

After the established charge was put into the case there was approximately 1-1/2 inches of remaining space in which to load more propellant if desired.

4. (C) CONCLUSION

Based on results to date Propellant Lot RAD-38300 will not perform satisfactorily at low temperatures using the present ignition system.

5. (C) RECOMMENDATIONS

A charge of 9 lb 2.7 oz is recommended to yield a muzzle velocity of 4000 fps at a corresponding pressure of 44,500 psi.

Propellant Lot RAD-38300 should not be used when firing under low temperature conditions.

SUBMITTED:
Joseph C. Sleeper, Jr.
JOSEPH C. SLEEPER, JR.
Proof Director

REVIEWED:
H B. Anderson
H. B. ANDERSON
Chief, Artillery
Ammunition Branch

M. D. Kaplan
for H. A. BECHTOL
Chief, Artillery Division

APPROVED:
H. G. Noble
H. A. NOBLE
Assistant Deputy Director
for Engineering Testing
Development and Proof Services

REFERENCES

1. Authority for this test is found in Appendix A.

2. Related formal reports, notes, and/or progress reports:

Notes on Development Type Materiel No. 150 (PA-N-150).
Forty Sixth Progress Report of the Firestone Tire and Rubber Co.
Report No. 1 on Project No. 85B - Erie Ordnance Depot.
Summary Progress Report of the Firestone Tire and Rubber Co.
Thirty-Ninth Report on Project TA1-1460.
First Report on Project TW-422.

APPENDICES

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ORDNANCE CORPS
PICATINNY ARSENAL
DOVER, NEW JERSEY

APPENDIX A
Correspondence
Mr. W. Joseph/McC/6174

IN REPLY
REFER TO:
~~SAMUEL FELTMAN AMMUNITION LABORATORIES~~
~~ORDBB~~
FELTMAN RESEARCH AND ENGINEERING LABORATORIES
ORDBB-TM5-470 (TW-422)

SUBJECT: Test Program Request Number TM-7(C), Charge Assessment in Cartridge, HEAT, 90mm, T300E53 (U)

TO: Commanding General
Aberdeen Proving Ground
Aberdeen, Maryland

ATTENTION: ORDBG-DP-TA, Mr. Carothers

1. Inclosed is Test Program Request No. TM-7(C), D/A Priority 1A, covering a charge assessment program with the 90mm T300 round. Since this test will determine the propelling charge necessary for rounds for Final Engineering Tests, it is imperative that the program be scheduled at the earliest possible date.

2. The items listed in paragraph 1a of the inclosed Test Program Request will be shipped to your Proving Ground approximately 21 July 1958. It is assumed that the item listed in paragraph 1b is available at the Proving Ground.

3. Funding Data:

Funds are available under AIF Order No. 87110100-99-60119 and Job Order No. 3026-99-903 (420).

4. Coordination:

a. OCO, ORDTW

b. APG, ORDBG-DP-TA

c. Picatinny Arsenal - Engineer primarily responsible for the test is Mr. W. Joseph, phone: Picatinny Arsenal, Extension 6174.

5774

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SUBJECT: Test Program Request Number TM-7(C), Charge Assessment in Cartridge, HEAT, 90mm, T300E53 (U)

5. Notification of Test Attendance:

Mr. W. Joseph will attend the test and requests notice three days prior to the firing.

FOR THE COMMANDER:

1 Incl
1. TPR No. TM-7(C)
(6 copies)

CC
OCO, ORDTW w/incl 1
APG, Comp Ofc, w/o incl

Mr. W. Joseph/McC/6174
Test Program Request No. TM-7(C)
(Job Order No. 3026-99-903 (420))
Picatinny Arsenal, Dover, N. J.
14 July 1958

1. Material for Test:

a. To be furnished by Picatinny Arsenal:

20 Cartridge, HEAT, 90mm, T300E53 (inert) w/o Propellant

b. To be furnished by Aberdeen Proving Ground:

200 lbs Propellant, M17, Lot RAD 38300

2. Project Authority:

a. Project No. TW-422

b. Funds available under AIF Order No. 87110100-99-60119, Reference Job Order indicated above.

3. Object of Development or Experiment:

To develop Cartridge, HEAT, 90mm, T300 for 90mm Gun, M36 and M41.

4. History Sketch:

In establishing a replacement lot of propellant for expended Lot HEP 35718, Propellant, M17, Lot 60261 was substituted. Recent closed bomb firings with this lot of propellant indicated detonation of the propellant at -40°F conditioning temperature. This condition can result in excessive gun pressures. It is desirable, therefore, to assess another lot of M17 Propellant having approximately the same "quickness", but one that gives satisfactory burning characteristics in closed bomb firings.

5. Description in Detail of Improvements Made Since Last Proving Ground Test:

None

6. Local Tests:

A number of M17 Propellant lots have been evaluated in closed bomb firings. Propellant, M17, Lot RAD 38300 gave normal traces in -40°F temperature firing.

C2 58-2164

7. Object of Test:

To assess Propellant, M17, Lot RAD 38300 in Cartridge, HEAT, 90mm, T300E53.

8. Precautions in Handling and Testing:

Care should be taken not to damage the nylon rotating bands in handling, otherwise the normal precautions in handling live artillery primers and cased propelling charges should be observed.

9. Recommended Test Program:

a. Using Cartridge, HEAT, 90mm, T300E53 (inert) and Propellant, M17, Lot RAD 38300, establish charge in the 90mm Gun, M36 not exceeding a pressure of 47,000 psi (cu). Only one round at each charge, conditioned at 70°F need be fired, but it is desired to obtain at least five points between 38,000 to 47,000 psi for a charge establishment curve.

b. Determine the propelling charge from the curve to give a maximum chamber pressure of 46,000 psi or a velocity of 4000 ft/sec, if this will result in a lower pressure. Fire a three round uniformity series at this charge at 70°F conditioning temperature. Fire five rounds each at the established charge with rounds conditioned at -40° and 140°F temperatures.

c. All rounds shall be crimped with an eight stab crimp one inch wide to give a 4000 lb bullet pull.

d. For all rounds, record instrumental velocity, muzzle velocity, copper pressure, complete description of round, flash, smoke and any unusual occurrences.

10. References:

None

11. Report Distribution:

a. Test Report Security Classification - Confidential

b. 2 copies - OCO, ORDTW
6 copies - Aberdeen Proving Ground
3 copies - Picatinny Arsenal
1 copy - Inspection Division
1 copy - ORDBB-TH8
1 copy - ORDBB-TM5

L. H. ERIKSEN
Chief, Explosives and
Propellants Laboratory

COPY/mt

DATE-----25 Jul 1958
ACTION-----D&PS
INFO-----CONARC LIAISON

1958 JUL 25

NNNN

ETØØ62JAØØ4XEFA273

RR RUETGH

DE RUECJF 273

R 242Ø3ØZ

FM CG ORDAMMCOM JOLIET ILL

TO RUETGH/CG ABERDEEN PROVING GR ABERDEEN MD

INFO: RUEGRP PICATINNY ARSENAL DOVER NJ

DA GRNC

BT

ATTENTION MR JOSEPH FOR MR ANDERSON D&PS FROM ORDLY-ARCC ERWAY/COWAN

TTØ7896

REFERENCE PICATINNY ARSENAL TPR-TM7 (C) REGARDING T3ØØ AMMUNITION.

IT IS REQUESTED THAT IN THE ACCOMPLISHMENT OF THE FIRING OUTLINED IN THE REFERENCE TPR THE FOLLOWING DATA BE SUPPLIED DIRECT TO THIS COMMAND ATTN: ORDLY-ARCC.

1. AS FIRED SHOT WEIGHT.
2. CARTRIDGE CASE VOLUME.
3. LOADING DENSITY OF PROPELLANT USED AT THE ASSESSED CHARGE WEIGHT.

CFN TTØ7896 TPR-TM7 T3ØØ

COPY/mt

PAGE TWO RUECJF 273

4. BRIEF DESCRIPTION OF PRIMER USED.

5. DESIRED MUZZLE VELOCITY.

6. RATED MAXIMUM PRESSURE OF THE WEAPON-AMMUNITON SYSTEM.

7. BALLISTIC RESULTS AT THE TEMPERATURES CONSIDERED INCLUDING:

A. ASSESSED CHARGE WEIGHT AT 7Ø DEGREE F. TO GIVE RATED VELOCITY.

B. RESULTANT AVERAGE PRESSURE AT THIS VELOCITY.

C. PERCENT VELOCITY VARIATION.

D. PERCENT PRESSURE VARIATION.

E. SUMMARY OF BALLISTIC RESULTS AT HOT AND COLD TEMPERATURES.

F. SMOKE AND FLASH CHARACTERISTICS DURING TEST.

8. A TRACING OF THE PIEZO PRESSURE-TIME MEASUREMENTS OF ALL ROUNDS SO TESTED.

IT IS REQUESTED THAT THIS INFORMATION BE FORWARDED AS SOON AS POSSIBLE UPON CONCLUSION OF THE FIRING. THE DATA SHOULD BE TRANSMITTED BY AIR MAIL

BT

CFN 7Ø

24/2Ø55Z

COPY/mt

RR RUETGH

DE RUEGRP 25

R 231915Z

DATE-----28 JULY 58
ACTION-----D & PS
INFO-----CONARC LIAISON

1958 JUL 28

FM CO PICATINNY ARSENAL DOVER NJ

TO CG ABERDEEN PG MD

DA GRNC

BT

FOR ORDBG-DP-TA CAROTHERS FROM ORDBB-TM5 TT7288 JOSEPH SGD ZAUDER

REQ TEST PROGRAM REQ TM-7 BE AMND TO INCLUDE RECORDING OF PRESSURE-TIME DATA FOR RNDS CONDITIONED AT -4Ø DEG AND 14Ø DEG FAHRENHEIT TEMPERATURE. 9ØMM GUN TUBE MOD FOR PIEZO-ELEC GAGE SHOULD BE USED FOR THESE FIRINGS. REQ CARTRIDGE CASE OF T3ØØ RND BE SO MOD TO PERMIT RECORDING OF PRESSURE-TIME TRACE

BT

CFN ORDBG-DP-TA ORDBB-TM5 TT7288 TM-7 -4Ø 14Ø 9ØMM T3ØØ

24/1742Z

UNQUOTE

BT

28/14Ø5Z

OBZ

Z

COPY/mt

NNNN

ETØ75EGAØ56

PP RUETGH

DE RUEGRP 51

P 311430Z

FM CO PICATINNY ARSENAL DOVER NJ

TO CG ABERDEEN PG MD

DA GRNC

BT

DATE-----1 AUG 58
ACTION-----D & PS
INFO-----TRANSP
INFO-----CONARC LIAISON

FOR ORDBG-DP-TA CAROTHERS FROM ORDBB-TM5 T17520 JOSEPH SGD ZAUDER

2Ø EACH CARTRIDGE HEAT 9ØMM T3ØØE53 LESS PROPELLANT AND PRIMER WILL ARR ABERDEEN PG 4 AUG 58 FOR FIRING TEST PROGRAM REQ TM-7. PRIMER DESIGN USED WILL BE DETERMINED AS A RESULT OF FIRING ENGINEERING TEST ON 3 AUG 58. REQ 9ØMM GUN SET UP FOR AUTO CASE EJECTION FOR OBSERVATION OF POSSIBLE FLARE BACK OCCURRING WITH EIMITE PRIMER

BT

CFN ORDBG-DP-TA ORDBB-TM5 TT752Ø 2Ø 9ØMM T3ØØE53 4 58 TM-7 5 58

31/1819Z

APPENDIX B

Firing Record

DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND, MARYLAND
FIRING RECORD

OBJECT OF TEST: Propellant Assessment and Military Characteristics of Cartridge, HEAT, 90-mm, T300E53 for 90-mm Guns, M36 and M41 (U)

DATES OF TEST: 8 and 9 August 1958
FIRING RECORD NO.: P-63411
SHEET 1 OF 4
AUTHORITY: ORDBB-TM5-470 (TW-422); M & R CI 58-2164 and TT07896

DEVELOPMENT
ARMY PROJECT NO. D/A 504-03-049
ORDNANCE PROJECT NO. TW-422, TPR-TM-7 W. O. NO. 332-333-26 mt

(C) AMMUNITION

Test Rounds:

Cartridge, HEAT, 90-mm, T300E53 (Inert), (with Dummy Fuze), Lot PA-E-27651-X; (as fired shot weight averaged 12.68 lb). Data Card No. 88491 is inclosed in Appendix C.
Primer, Percussion, M58 (Mod B), 370 ± 10 grains Grade A1 Black Powder, Lot No. PA-E-26767; Data Card is inclosed in Appendix C.
Propellant, MP, M17, 0.057-inch web, Lot RAD-38300 (loading density is 0.89 at assessed charge weight of 9 lb, 4.5 oz at 70°F). Instrumental velocity is 4006 fps (average of four rounds fired).
Case, Cartridge, 90-mm, T24B1 (Mod), Lot EPO-4-25 (volume 287.72 cubic inches).

(U) Conditioning Rounds:

Projectile, HVAP-T, 90-mm, M332A1, (12.50 lb), Lot CAA-2-87-1952.
Case, Cartridge, 90-mm, T24B1, Lot NOR-11-58.
Primer, Percussion, M58, 400-grain, Lot KOP-50-10.
Propellant, MP, M17, 0.057-inch web, Lot RAD-38300 (charge weight 126 oz loose-loaded).

(U) MATERIEL

Gun: 90-mm, T119E1, No. 6130.
Tube: 90-mm, T119E1, No. 54798 (97% remaining life).
Mount: Proof, Gun - D7138764, No. 3.
Recoil: Mechanism, M3, 155-mm Gun, No. 1676.
Carriage: 155-mm Gun, M1, No. 309.

(U) INSTRUMENTATION

Pressures: Medium Pressure M3 Gauges, Coppers Lot 8C54 X.0 7348-3-11, Annealed 1954, Metal 1954, Comp Curve - Dwg FD-18182 (two gauges per round).

Piezoelectric gauges were used in conjunction with above.

Velocities: Standard 30-inch velocity coils were used and positioned as follows:

Date of Firing	Muzzle to First Coil, feet	First to Second Coil, feet
8 August 1958	103.90	46.44
9 August 1958	104.84	50.12

(C) ROUND-BY-ROUND DATA

Elevation: 1°

Test Round Numbers 1 and 2 are M332A1 (Conditioners)

Test Round Numbers 3 thru 22 are T300E53

Round Number Test	Round Number Tube	Time of Firing	Complete Round Number	Shell Body Number	Spike Nose Retainer Number	Nose Plug Number	Plastic Band Number	Cartridge Case Number	Shell Weight, pounds	Propellant Weight, pounds	Propellant Weight, ounces	Instr Velocity, fps	M3 Gauge Pressure, psi/100	Piezo Gauge Pressure, psi/100
								Date of Firing: 8 August 1958 Temperature of Round: Ambient						
1	52	1119	None	None	None	None	None	None	12.45	7	14.0	3508	NT	NT
2	53	1120	None	None	None	None	None	None	12.47	7	14.0	3581	NT	NT
3	54	1123	40	23	50	F24	45	251	12.67	8	11.0	3751	383	Lost
4	55	1152	120	82	147	F76	52	197	12.65	9	3.0	3962	456	507
5	56	1308	82	80	41	C72	47	199	12.86	9	7.0	4074	490	549
6	57	1314	4	156	32	E93	14	462	12.71	9	4.5	3997	462	517
7	58	1349	118	130	124	F88	19	250	12.67	9	4.5	4014	464	523
8	59	1356	11	3	30	F90	5	463	12.68	9	4.5	4010	465	529
9	60	1359	92	117	91	F29	17	214	12.68	9	4.5	4003	462	521
								Date of Firing: 9 August 1958 Temperature of Round: +125°F						
10	61	0948	136	110	109	F91	37	191	12.65	9	4.5	4142	497	557
11	62	0958	78	60	61	D27	84	461	12.65	9	4.5	4156	500	518
12	63	1007	142	56	129	F84	38	249	12.63	9	4.5	4142	496	555
13	64	1021	13	74	179	C96	15	216	12.67	9	4.5	4142	494	565
								Temperature of Round: -25°F						
14	65	1033	90	151	42	E55	30	213	12.69	9	4.5	3953	458	570
15	66	1041	14	81	23	D20	54	189	12.67	9	4.5	3954	472	560
16	67	1049	110	32	157	F79	44	190	12.64	9	4.5	3928	462	541
17	68	1056	70	114	73	E31	43	464	12.62	9	4.5	3937	453	571
								Temperature of Round: -40°F						
18	69	1103	73	119	69	E77	56	215	12.69	9	4.5	3335	311	342
19	70	1111	35	116	100	F86	16	200	12.70	9	4.5	3683	390	444
20	71	1129	64	107	99	F78	18	198	12.64	9	4.5	3410	314	359
21	72	1138	41	158	114	E79	29	192	12.68	9	4.5	3791	428	483
22	73	1146	121	71	168	E49	39	[a]252	12.66	9	4.5	3710	402	449

(U) Notes: NT - Not Taken.
The piezoelectric gauge was changed for test rounds no. 12 through 22.
[a]This case with projectile and primer intact was used to compute case volume of 257.72 cubic inches.
All plastic rotating bands are larger in diameter than the band seat and revolve around the shell body freely.
Complete round no. 4 was poorly crimped (loose).

CONFIDENTIAL

This firing record forms a part of the Second Report on Ordnance Project No. TW-422.

SUBMITTED:

Joseph C. Sleeper, Jr.
JOSEPH C. SLEEPER, JR.
Proof Director

REVIEWED:

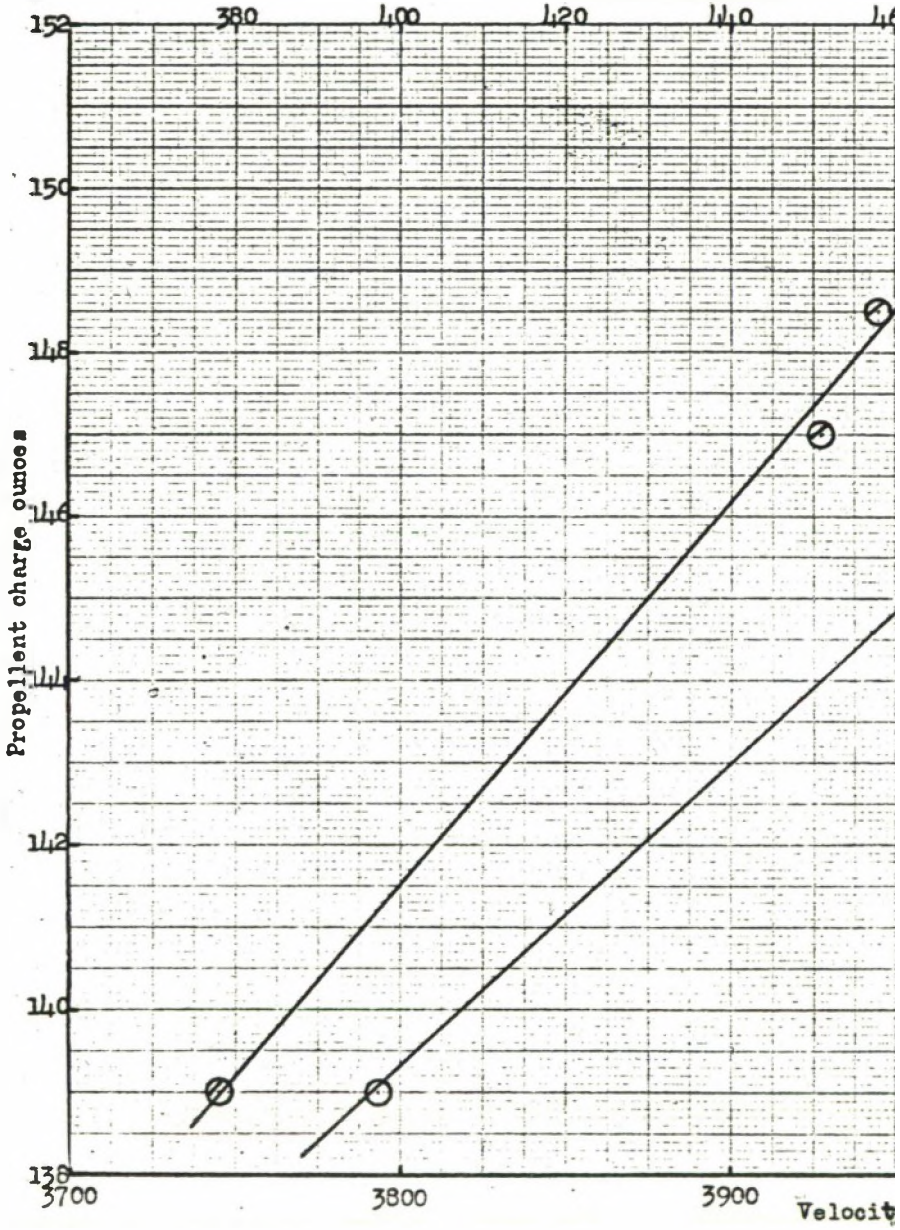
H. B. Anderson
H. B. ANDERSON
Chief, Artillery
Ammunition Branch

APPROVED:

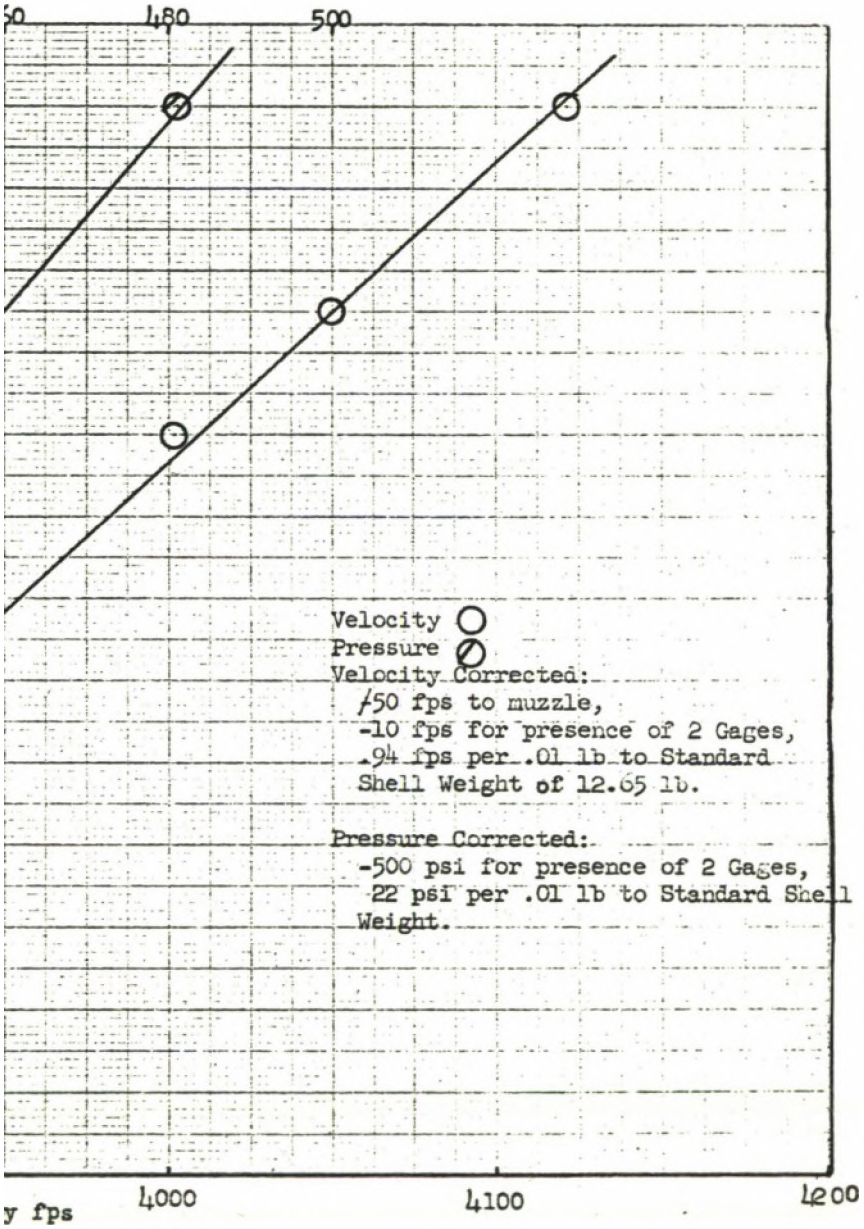
M. D. Kaplan
for H. A. BECHTOL
Chief, Artillery
Division

1 Incl
Charge Velocity - Charge Pressure Curve

Propellent Curve for 90-MM Shell,HEAT,
Propellant, MP, M17, Lot RAD-38300-52 with
Pressure psi/100



T300E5
.0574 inch web



APPENDIX C

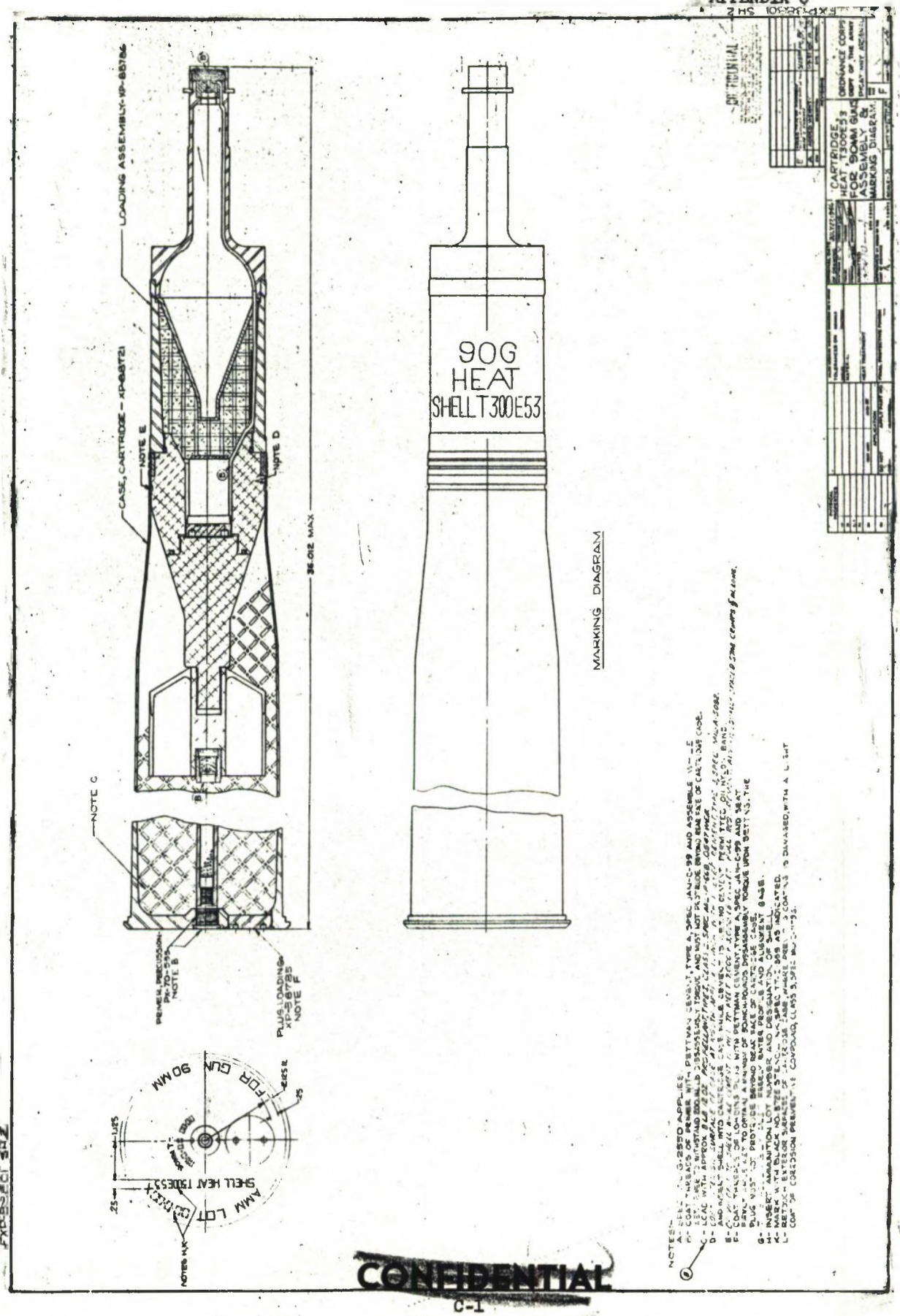


FIGURE I

MULTIPLE STARGAGE MEASUREMENT & INSPECTIO

	NUMBER	MODEL
90 M/M Tube	54798	T119E1
90 M/M GUN	6130	T119E1
DATE OF GAUGING: 12 Aug 1958	FIRING STATUS (Check One): BEFORE / AFTER ✓	NUMBER OF ROUNDS: 72

101	85.15	92	2	2	3	3
97	89.15	88	2	2	3	3
93	93.15	84	2	2	3	3
89	97.15	80	2	2	3	3
85	101.15	76	2	2	3	3
81	105.15	72	2	1	3	3
77	109.15	68	2	1	3	3
73	113.15	64	2	2	3	3
69	117.15	60	2	2	3	3
65	121.15	56	2	2	3	3
61	125.15	52	2	2	3	+
57	129.15	48	2	2	2	3
53	133.15	44	2	2	2	3
49	137.15	40	2	2	2	3
47	139.15	38	2	2	2	3
45	141.15	36	2	2	2	3
44.98	141.37	35.78	2	2	2	3
43	143.15	34	2	2	2	3
41.24	144.91	32.24	2	2	2	3
39	147.15	30	2	2	2	3
37.69	148.46	28.69	2	2	2	3
37.15	149.00	28.15	2	2	1	3
36.15	150.00	27.15	2	1	1	3
35.15	151.00	26.15	2	1	1	2
34.50	151.65	25.50	1	1	1	2
34.25	151.90	25.25	+.00	+.00	+.00	+.07

95% LIFE REM

ORDBG Form 2045-(R) 4 Apr 57 (Part 1)

ON DATA FORM

MANUFACTURER	CASTING NUMBER
OLDS	
W.T.ARS	

PROOF OFFICER

W.O. 332-333-26 PROJ TW-422 TM-7

90 MM TUBE ~~M36~~ (T119E1), ~~M41 (T139)~~, ~~M54 (T125)~~

Main Bore - 25.15" to 177.15"

Distance (Inches) From			Gage Measurements Indicated in 1/1000"			
Rear Face of Breech	Muzzle Face	Rear Face of Tube	LANDS 3.543" Basic Diam.		GROOVES 3.638" Basic Diam.	
Gun	Tube	Tube	Vertical	Horizontal	Vertical	Horizontal
185.60	.55	176.60	+.008	+.007	+.003	+.003
185	1.15	176	3	7	3	3
183	3.15	174	7	2	4	3
181	5.15	172	2	6	4	4
179	7.15	170	2	2	3	4
177	9.15	168	2	2	3	4
173	13.15	164	2	2	3	4
169	17.15	160	3	2	3	4
165	21.15	156	2	1	3	4
161	25.15	152	2	1	3	4
157	29.15	148	1	1	3	4
153	33.15	144	1	1	3	4
149	37.15	140	1	1	3	4
145	41.15	136	1	2	3	4
141	45.15	132	1	2	3	4
137	49.15	128	1	2	3	4
133	53.15	124	1	1	3	4
129	57.15	120	1	1	3	4
125	61.16	116	1	1	3	3
121	65.15	112	1	1	3	3
117	69.15	108	1	1	3	3
113	73.15	104	1	1	3	3
109	77.15	100	2	1	3	3
105	81.15	96	2	2	3	3

90 MM Tube ~~M36~~ (T119E1), ~~M41~~ (~~T139~~), M54 (~~T125~~) — CHAMBER 0" to 24.12" (Basic)

DISTANCE (Inches) FROM

REAR FACE OF BREECH	MUZZLE FACE	REAR FACE OF TUBE	BASIC DIAMETER	ZERO	GAUGE MEASUREMENTS INDICATED IN 1/1000 OF AN INCH — VERTICAL Y: GAUGE READING	VERTICAL Y: ACTUAL DIAMETER	VERTICAL Y: DIFFERENCE	HORIZONTAL X: GAUGE READING	HORIZONTAL X: ACTUAL DIAMETER	HORIZONTAL X: DIFFERENCE
33.00	153.15	24.00	3.677	3.677"	+.005	3.682	+.005	+.005	3.682	+.005
32	154.15	23	3.677		.007	.684	7	.006	.683	6
31	155.15	22	3.677		.007	.684	7	.007	.684	7
30.75	155.40	21.75	3.677		+.007	.684	+.007	+.007	.684	+.007
27.05	159.10	18.05	4.408		+.012	4.412	+.004	+.012	4.412	+.004
26.50	159.65	17.50	4.417		.021	.421	4	21	.421	4
26.	160.15	17	4.426		.030	.430	4	30	.430	4
25	161.15	16	4.442		.046	.446	4	46	.446	4
23	163.15	14	4.475		.078	.478	3	78	.478	3
21	165.15	12	4.508		.111	.511	3	.111	.511	3
19	167.15	10	4.541	4.400"	.144	.544	3	.148	.548	7
17	169.15	8	4.574		.177	.577	3	.179	.577	3
15	171.15	6	4.607		.211	.611	4	.211	.611	4
13	173.15	4	4.640		.244	.644	4	.244	.644	4
12	174.15	3	4.657		.261	.661	4	.261	.661	4
11	175.15	2	4.673		.277	.677	4	.277	.677	4
10	176.15	1	4.690		.294	.694	4	.294	.694	4
9.50	176.65	.50	4.698		.303	.703	5	.303	.703	5
9.10	177.05	.10	4.704		+.309	.709	+.005	+.309	.709	+.005

No diametral taper on some of the first "T" Mod. tubes from 21.75" to 24.00" from the R.F.T. (Basic dia. 3.677").

Pullover Measurements.

Dist. from R.F.T.		
25.25"	3.545"	3.544"
25.40	3.544"	3.544"
25.65	3.544	3.544
26.15	3.545	3.544

Remarks: Borescoped. (Chrome plated) Light rust pitts throughout main powder chamber. Light smooth erosion encircling pressure gauge hole in chamber. Heavy to light flaking on the driving and non driving edges of lands from the origin forward to the commencement. Light pitting and flaking in the grooves in this area. Light smooth erosion with [illegible] light heat checking in the

	BASIC	ACTUAL		BASIC	ACTUAL
TOTAL LENGTH OF GUN	186.15"	186.19"	ROTATION OF TUBE AT BREECH	.00"	—
TOTAL LENGTH OF TUBE	177.15"	—	MOVEMENT OF TUBE AT BREECH	.000"	.001F
DEPTH OF BREECH RECESS	9.00"	9.00"	NUMBER OF LANDS AND GROOVES	32	32

INSPECTION REMARKS: Areas from 18.17" to 21.63", 24.12" to 25.15" and from 176.70" to 177.15" were not measured. [redacted] base metal where the chrome is removed in this area. Moderate to light flaking on the lands throughout remainder of bore. This condition being more pronounced on driving edge of lands and throughout muzzle third of bore. Chrome flaked from forward edge of bore evacuator holes. Light smooth erosion in the base metal where the chrome is removed in this area.

RECEIVED EDD-PA STAMPED	STARGAUGED AND INSPECTED BY EDWARDS	REVIEWED BY Edwards
ROOMAN SHAY	TIME	COMPILATOR
RECORDER BEVINS	PLACE 525	GRAPHED BY

ORDBG Form 2045-(R) 4 Apr 57 (Part 2)

ARMY — ABERDEEN PROVING GROUND, MD.

90 MM TUBE # 54758 AFTER FIRING 72 ROUNDS T119E1

ORDBG- 1170 (22 June 51)

90 mm TUBE, T119

Main Bore - 25.15" to 177.15"

CASTING NUMBER	MANUFACTURER	MODEL	NUMBER	90 mm TUBE
	Olds	T119E1	54798	Mounted in Gun

PROOF OFFICER: MR. HASSELL — W.O. 252 - 11-1

NUMBER OF ROUNDS: 51

FIRING STATUS (Check One): BEFORE ☐ AFTER ☒

DATE OF GAUGING: JUN 18 1956

Distance (Inches) From Rear Face of Breech Gun	Distance (Inches) From Muzzle Face Tube	Distance (Inches) From Rear Face of Tube	Gauge Measurements Indicated in 1/1000" — LANDS 3.543" Basic Diam. Vertical	LANDS 3.543" Basic Diam. Horizontal	GROOVES 3.638 Basic Diam. Vertical	GROOVES 3.638 Basic Diam. Horizontal
	Gun	Tube	Tube				
185.60	.55	176.60	+.001	.000	+.002	+.002
185	1.15	176				
183	3.15	174				
181	5.15	172				
179	7.15	170				
177	9.15	168				
173	13.15	164				
169	17.15	160				
165	21.15	156				
161	25.15	152				
157	29.15	148				
153	33.15	144				
149	37.15	140				
145	41.15	136				
141	45.15	132				
137	49.15	128				
133	53.15	124				
129	57.15	120				
125	61.15	116				
121	65.15	112				
117	69.15	108				
113	73.15	104				
109	77.15	100				
105	81.15	96				
101	85.15	92				
97	89.15	88				
93	93.15	84				
89	97.15	80				
85	101.15	76				
81	105.15	72				
77	109.15	68		+.001		
73	113.15	64				
69	117.15	60				
65	121.15	56				
61	125.15	52				
57	129.15	48				
53	133.15	44	+.001			
49	137.15	40				
47	139.15	38				
45	141.15	36				
44.98	141.37	35.78				
43	143.15	34				
41.24	144.91	32.24				
39	147.15	30				
37.69	148.46	28.69				
37.15	149.00	28.15				
36.15	150.00	27.15				
35.15	151.00	26.15				
34.50	151.65	25.50				
34.25	151.90	25.25	+.001	+.001	+.002	+.002

90 mm TUBE, T119E1										Chamber 0" to 24.12" (Basic)
DISTANCE (Inches) FROM				GAUGE MEASUREMENTS INDICATED IN 1/1000 OF AN INCH						
					VERTICAL X			HORIZONTAL X		
REAR FACE OF BREECH	MUZZLE FACE	REAR FACE OF TUBE	BASIC DIAMETER	ZERO	GAUGE READING	ACTUAL DIAMETER	DIFFERENCE	GAUGE READING	ACTUAL DIAMETER	DIFFERENCE
33.00	153.15	24.00	3.677	3.677	+.005	3.682	+.005	+.005	3.682	+.005
32	154.15	23	3.677		6	.683	6	6	.683	6
31	155.15	22	3.677		6	.683	6	6	.683	6
30.75	155.40	21.75	3.677		7	.684	7	7	.684	7
27.05	159.10	18.05	4.4082	4.400"	+.011	4.411	+.003	+.011	4.411	+.003
26.50	159.65	17.50	4.4172		.021	421	4	021	421	4
26	160.15	17	4.4255		.029	429	3	029	429	3
25	161.15	16	4.4420		.044	.444	2	044	.444	2
23	163.15	14	4.4750		.078	.478	3	078	.478	3
21	165.15	12	4.5080		.110	.510	2	110	.510	2
19	167.15	10	4.5410		.144	.544	3	144	.544	3
17	169.15	8	4.5740		.177	.577	3	177	.577	3
15	171.15	6	4.6070		.211	.611	4	211	.611	4
13	173.15	4	4.6400		.244	.644	4	244	.644	4
12	174.15	3	4.6565		.260	.660	4	260	.660	4
11	175.15	2	4.6730		.277	.677	4	277	.677	4
10	176.15	1	4.6895		.294	.694	4	294	.694	4
9.50	176.65	.50	4.6977		.303	.703	5	303	.703	5
9.10	177.05	.10	4.7043		+.308	.708	+.004	+.308	.708	+.004

SPECIAL MEASUREMENTS

	BASIC	ACTUAL		BASIC	
TOTAL LENGTH OF GUN	186.15"	—	ROTATION OF TUBE AT BREECH	.00"	—
TOTAL LENGTH OF TUBE	177.15"	177.14"	MOVEMENT OF TUBE AT BREECH	.000"	—
DEPTH OF BREECH RECESS	9.00"	—	NUMBER OF LANDS AND GROOVES	32	32
Advance of Rifling (Plug Gauge)					

INSPECTION REMARKS: Areas from 18.17" to 21.63", 24.12" to 25.15" and from 176.70" to 177.15" were not measured. B-scope

Chrome heavily washed away from driving edges of lands encircling origin. Chrome lightly chipped & flaked from lands at various times & distances beginning at mid-bore & extending to muzzle end.

(Prev.)

STAMPED EOD-PA	STARGAUGED AND INSPECTED BY P.B.	REVIEWED BY
RODMAN B.G.	TIME	COMPILATOR
RECORDER R.B.	PLACE 525	GRAPHED BY

ARMY—OO—ABERDEEN PROVING GROUND, MD—1112
2B

90 mm Tube No. 54798 T119E1 A.F. 51 Rds. Mr. Hasson WO 252-110.68

18 June 1956

ORDBG-779
REV. 21 JULY 54

SUPPLEMENTARY FIELD SHEET - EROSION STUDY MEASUREMENTS

DATE 31-July-58

90/7		NUMBER	MODEL	MANUFACTURED BY
	TUBE			
	LINER	55798	T119E1	OLDSMOBILE
	GUN HOWITZER MORTAR			

1. BRITISH PULLOVER MEASUREMENTS FORWARD OF ORIGIN OF RIFLING

DISTANCE FORWARD OF ORIGIN OF RIFLING	INCHES, REAR FACE OF TUBE	VERTICAL	HORIZONTAL
1" .10	25.25	3.544	3.544
2" .25	25.40	3.543	3.543
3" .50	25.65	3.543	3.543
1 CALIBER 1.00	26.15	3.543	3.543
2 CALIBERS	% Remaining Life	97%	
3 CALIBERS	PREV. ECD RDS-UNKNOWN		

2. STARGAUGE MEASUREMENTS FORWARD OF ORIGIN RIFLING

DISTANCE FORWARD OF ORIGIN OF RIFLING	LANDS					GROOVES			
	INCHES R.F.T.	VERTICAL	HORIZONTAL	45° RIGHT	45° LEFT	VERTICAL	HORIZONTAL	45° RIGHT	45° LEFT
1"									
2"									
3"									
1 CALIBER									
2 CALIBERS									
3 CALIBERS									

3. ADVANCE OF RIFLING (*Maximum Only*) - THREE-SHOE GAUGE

DIAMETER OF GAUGE HEAD	*ADVANCE INCHES, REAR FACE OF TUBE	ACTUAL ADVANCE

4. ADVANCE OF RIFLING (*Vertical Only*) - PULLOVER GAUGE, DIAMETER PRE-SET

DIAMETER AT WHICH GAUGE IS SET	BASIC DIAMETER	ADVANCE INCHES, REAR FACE OF TUBE	*ACTUAL ADVANCE

SIGNATURE OF INSPECTOR	TIME	PLACE
BOYD		

*TO BE COMPUTED BY RECORDS UNIT

ARMY-OS-ABERDEEN PROVING GROUND MO. 294

ONDJH FORM 237 A
7 MARCH 1952

STAR GAUGE REPORT

PAGE
BEFORE FIRING
AFTER FIRING ✓

90MM Gun T119E1 [illegible] Tube
Specs. Mil-G-10498 Amend1, 11 July 1951

90MM Gun Mount Comb, M78
Specs. Mil-M-11066, 5 April 1951

Gun No.	Mfr.	Year	Date Fired	Gauged By	Bore Sight Lines
			[illegible] 1-31-53	[illegible]	Yes ✓ No
Tube No.	**Mfr.**	**Year**	**Date Gauged**	**Clerk**	**Stamped**
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mount No.	**Mfr.**	**Year**	**Inspected By**	**Rodman**	**Disposition----- Shipped Held**
			[illegible]	[illegible]	

Type Stargauge
3 Pt. Offset

Y is 7th full land to left of 12:00 o'clock at Muzzle End.

INCHES FROM MUZZLE	LANDS Y VERT.	LANDS λ HOR.	GROOVES Y VERT.	GROOVES λ HOR.	INCHES FROM MUZZLE	LANDS Y VERT.	LANDS λ HOR.	GROOVES Y VERT.	GROOVES λ HOR.	INCHES FROM MUZZLE	LANDS Y VERT.	LANDS λ HOR.	GROOVES Y VERT.	GROOVES λ HOR.
0.1	.00 2	.00 3	.00	.00	95	.00 2	.00 2	.00	.00		.00	.00	.00	.00
1	.00	.00	.00	.00	100	.00	.00	.00	.00		.00	.00	.00	.00
5	.00	.00	.00	.00	105	.00	.00	.00	.00		.00	.00	.00	.00
10	.00	.00 2	.00	.00	110	.00	.00	.00	.00		.00	.00	.00	.00
15	.00	.00	.00	.00	115	.00	.00	.00	.00		.00	.00	.00	.00
20	.00	.00	.00	.00	120	.00	.00	.00	.00		.00	.00	.00	.00
25	.00	.00	.00	.00	125	.00	.00	.00	.00		.00	.00	.00	.00
30	.00	.00	.00	.00	126	.00	.00	.00	.00		.00	.00	.00	.00
35	.00 1	.00	.00	.00	128	.00	.00	.00	.00		.00	.00	.00	.00
40	.00	.00	.00	.00	132	.00	.00	.00	.00		.00	.00	.00	.00
45	.00	.00	.00	.00	134	.00	.00	.00	.00		.00	.00	.00	.00
50	.00	.00	.00	.00	136	.00	.00	.00	.00		.00	.00	.00	.00
55	.00	.00	.00	.00	138	.00	.00	.00	.00		.00	.00	.00	.00
60	.00	.00	.00	.00	140	.00	.00 3	.00	.00		.00	.00	.00	.00
65	.00	.00 1	.00	.00	142	.00	.00	.00	.00		.00	.00	.00	.00
70	.00 2	.00	.00	.00	144	.00	.00	.00	.00		.00	.00	.00	.00
75	.00	.00 2	.00	.00	146	.00	.00	.00	.00		.00	.00	.00	.00
80	.00	.00	.00	.00	148	.00	.00	.00	.00		.00	.00	.00	.00
85	.00	.00	.00	.00	150	.00	.00	.00	.00		.00	.00	.00	.00
90	.00	.00	.00	.00	151	.00 2	.00 3	.00	.00		.00	.00	.00	.00

Boroscope inspection made by [illegible] Bore of gun tube acceptable in accordance with Mil-G-10498 Amend 1, 11 July 1951.

Boroscope inspection report as follows.

~~CONFIDENTIAL~~

ARMY-P.A. DOVER, N.J.
ORDNANCE FORM Guedagno-6179

EXPERIMENTAL AMMUNITION DATA CARD

NO. 88491

T. P. R. NO.	KIND				AMM. LOT NO.
TM-7	Cartridge, HEAT, T300E53, (Shell Inert Loaded) With Dummy Fuze, Without Propellant and Without Primer For 90MM Guns, M36 and M41				PA-E-27651-X
SPEC. NO.					QUANTITY IN LOT 20
DRG. NO.	DRG. DATE OR REV.	ALLOT. ADVICE	PROJECT NO.	RAD OR EPO NO.	QUANTITY IN SHIPMENT
FXP-88801	3-25-57		TW-422 (1460)		20
P. A. X. O.	PROP. CHARGE	EXPECTED M. V.	EXPECTED PRESSURE	ASSEMBLED BY	DATE OF ASSEMBLY
3026-24				PA	July, 1958

REMARKS: Packed: 1 Cartridge/fiber container; 2 containers/wood box. Propellant omitted. Case Cartridge not crimped to shell. Primer Perc., omitted. Cartridges not chamber gaged. Loading Plug assembled to Cartg. Case hand tight. Wire Assembly not required. *Filler Inert consists of 81% PCN, 10% Iron Oxide and 9% Celite. O'Ring CKCX2-546863 omitted between Boom and chamber on Projectile No. 19 and 20. Projectile No. 17 has fin concentricity of .040.

COMPONENT	MPTS Ass'y	Case Cartg	Fuze	Filler	Potted	Tracer	
KIND	Shell	(Mod.)	Dummy	Inert*	Nose	T-	
	T300E53	T24B1			Element		
DRG. NO.	FXP-88634	XP-88721	unk		XP-94425	XP-90142	
DRG. DATE OR REV.	6-21-57	3-25-57	unk		unk	unk	
MFG'D BY	Chamberlain	Ekco Mfg.	PA	PA	PA	PA	
DATE	1957	1956	1958	1958	1958	1958	
LOT NO.	TCC-30-10	EFO-4-25	none	none	none	PA-E-26787	

PREPARED BY A. Mackey — Ars Opers DIVISION

CERTIFIED TO BY: F. Lewis F. Lewis, INSPECTOR — Inspection DIVISION

PICATINNY ARSENAL DOVER, NEW JERSEY

ARMY-P.A. DOVER, N.J.
ORDNANCE FORM 43 7-26 Roberts-2193

EXPERIMENTAL AMMUNITION DATA CARD

NO. 87245

T. P. R. NO.	KIND				AMM. LOT NO.
	Primer Percussion, M58 (Mod. B)				PA-E-26767
SPEC. NO.					QUANTITY IN LOT
DRG. NO.	DRG. DATE OR REV.	ALLOT. ADVICE	PROJECT NO.	RAD OR EPO NO.	QUANTITY IN SHIPMENT
74-2-63	8-19-54				
P. A. X. O.	PROP. CHARGE	EXPECTED M. V.	EXPECTED PRESSURE	ASSEMBLED BY	DATE OF ASSEMBLY
3026-24-005				PA	February, 1958

REMARKS: Packed: 15 Primers/carton; 7 cartons/wood box.
*Overall length of Primer 13.41" max.
Primer charge 370 ± 10 grains Grade A1, Black Powder.
One liner used in lieu of two.

(Over)

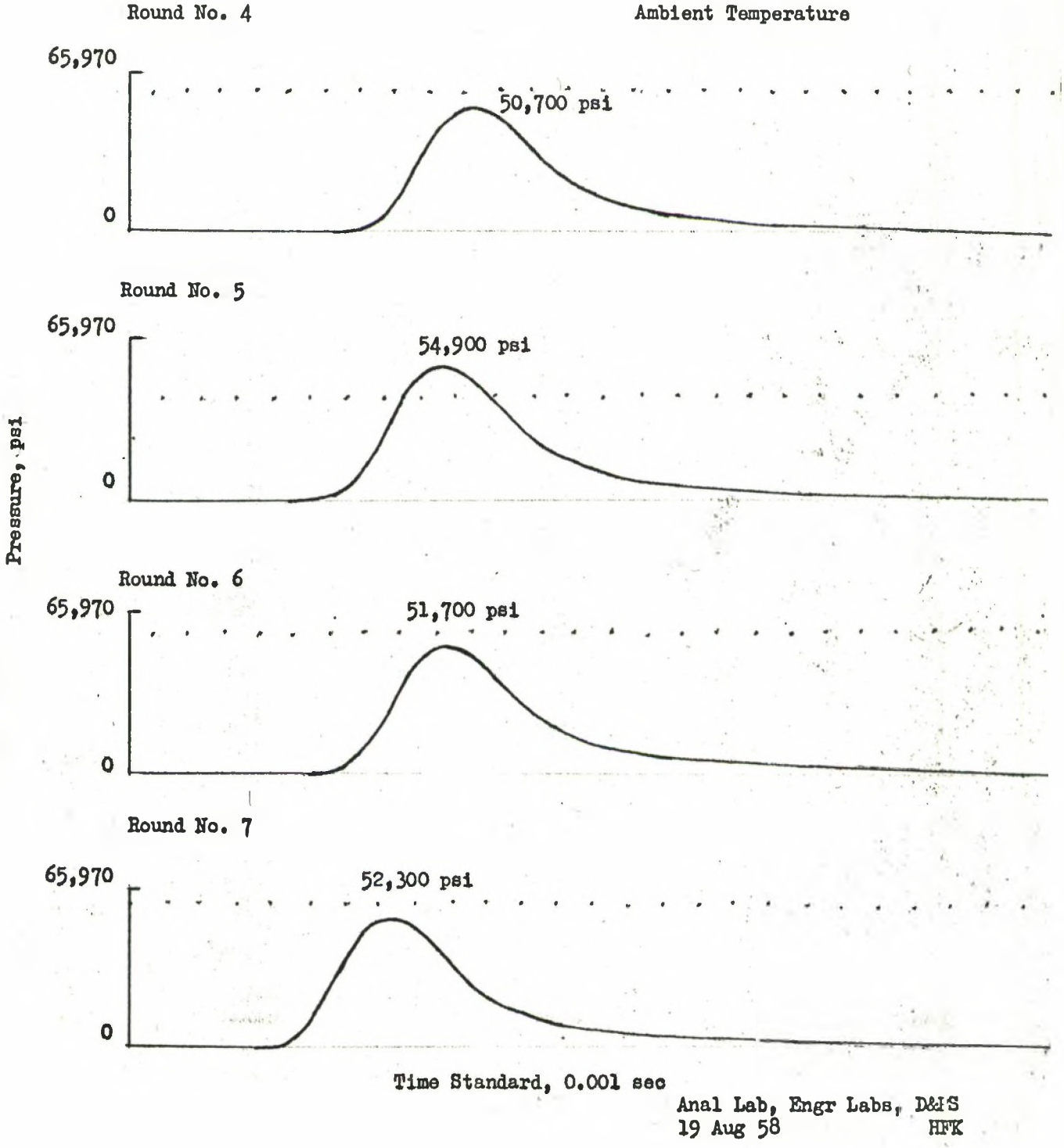
COMPONENT	Body	Head	Plug	Cup	Primer	Charge	Liner
KIND	M58	Primer	Firing	Battery	Perc.	Primer	
	Mod.				M61	Gr. A1	
DRG. NO.		74-2-91E3	74-2-78M	74-2-78L4	74-2-96A		
DRG. DATE OR REV.			12-3-52				
MFG'D BY	PA	ELC	LMC	NSS	PA	DuPont	PA
DATE	1958	unk	unk	unk	1958	unk	1958
LOT NO.	none	ELC-3-1	LMC-21	NSS-3-1	PA-104-38	DUP-37-135	none

PREPARED BY E. Barrett — Ars Opers DIVISION

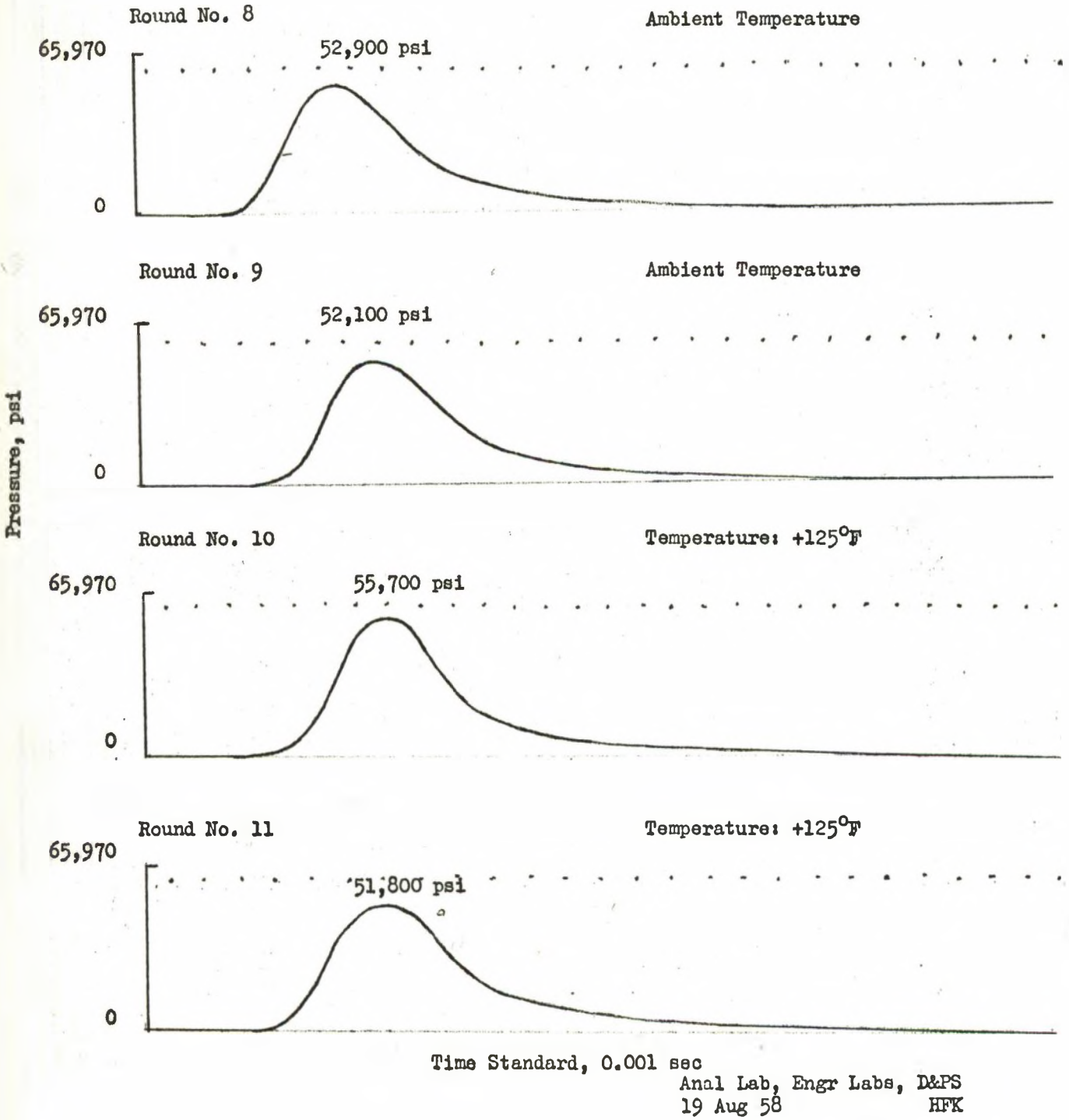
CERTIFIED TO BY: A.A. Babecka AA Babecka, INSPECTOR — Inspection DIVISION

PICATINNY ARSENAL DOVER, NEW JERSEY

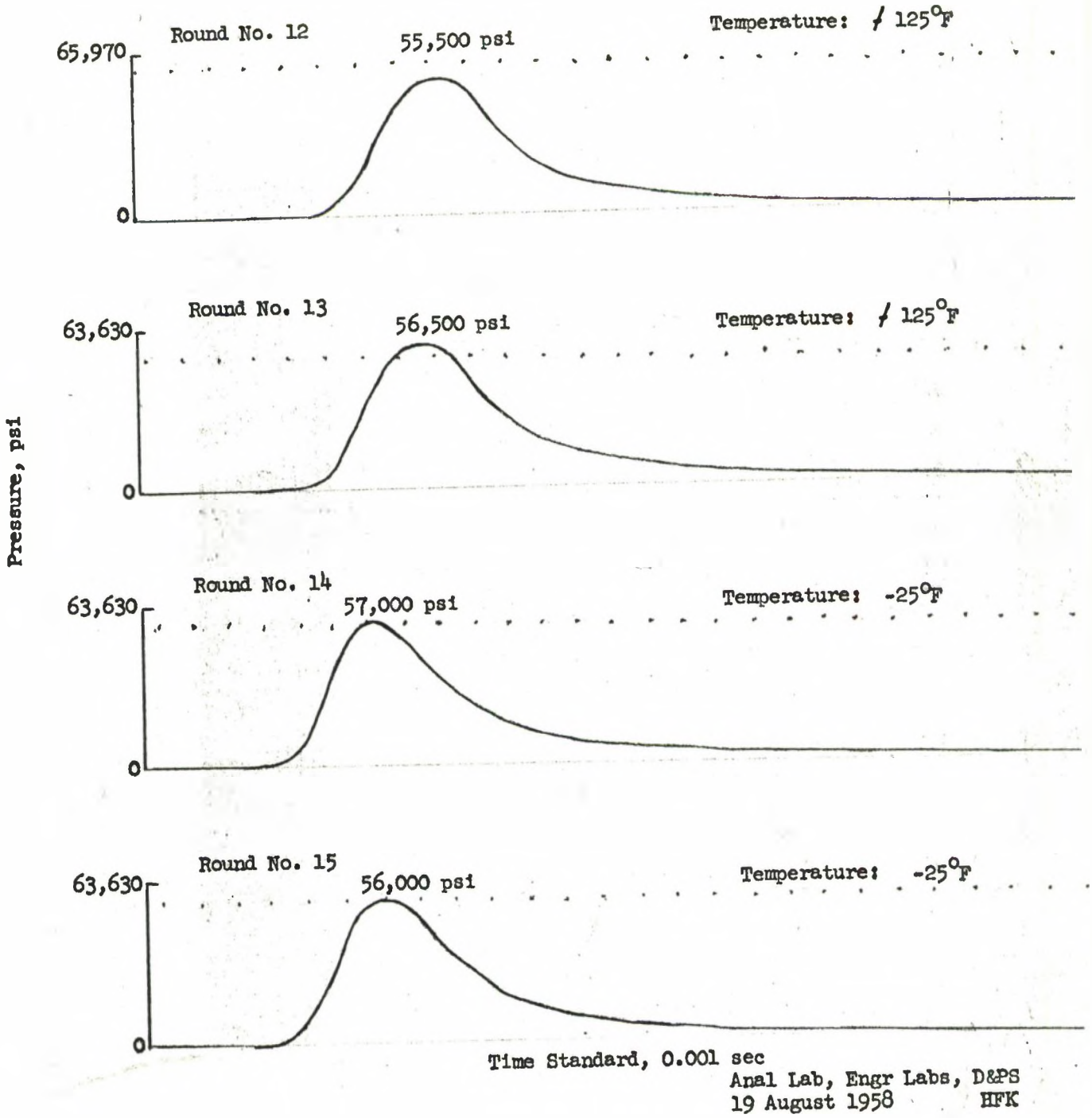
~~CONFIDENTIAL~~

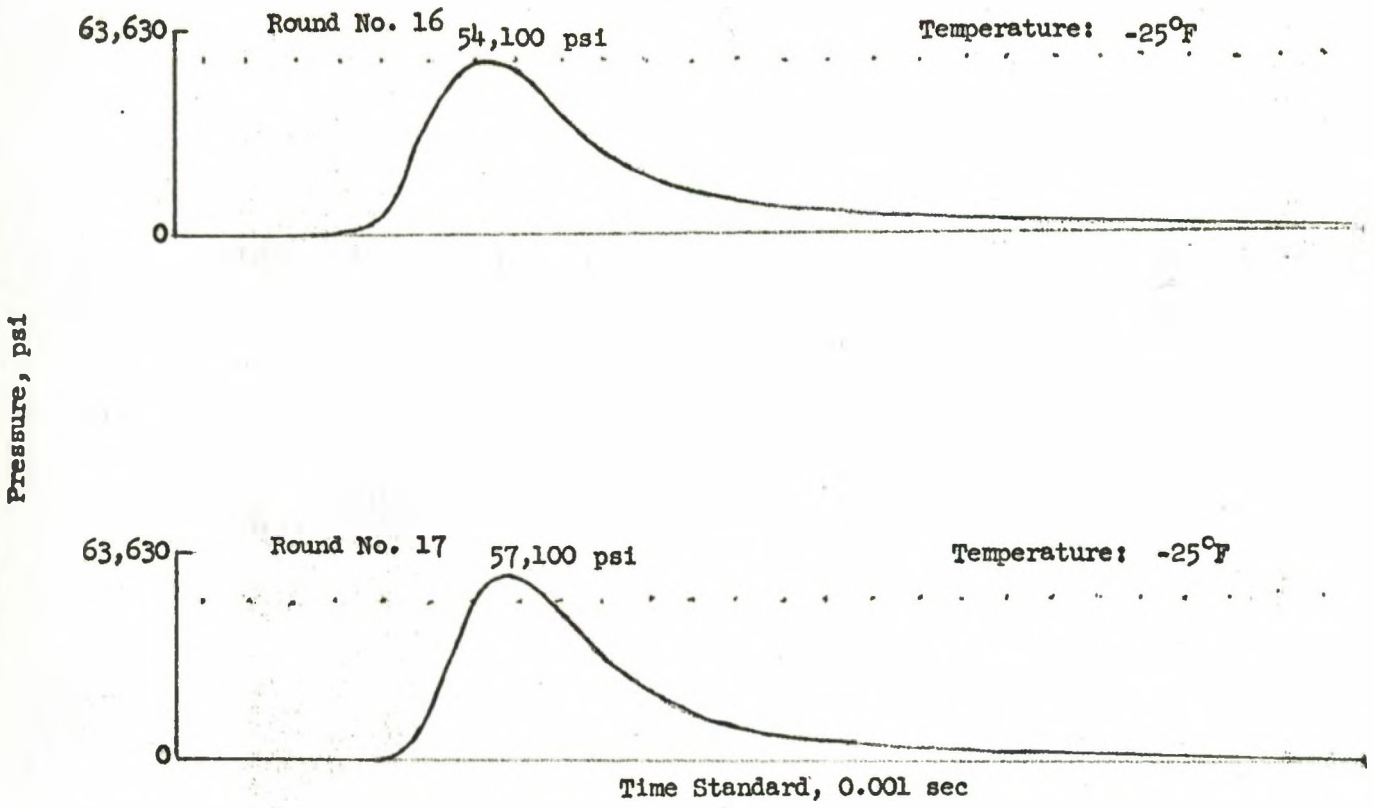


Anal Lab, Engr Labs, D&IS
19 Aug 58 HFK



Anal Lab, Engr Labs, D&PS
19 Aug 58 HFK


Round No. 12
55,500 psi
Temperature: + 125°F
65,970
0
Round No. 13
56,500 psi
Temperature: + 125°F
63,630
0
Round No. 14
57,000 psi
Temperature: -25°F
63,630
0
Round No. 15
56,000 psi
Temperature: -25°F
63,630
0
Pressure, psi
Time Standard, 0.001 sec
Anal Lab, Engr Labs, D&PS
19 August 1958 HFK



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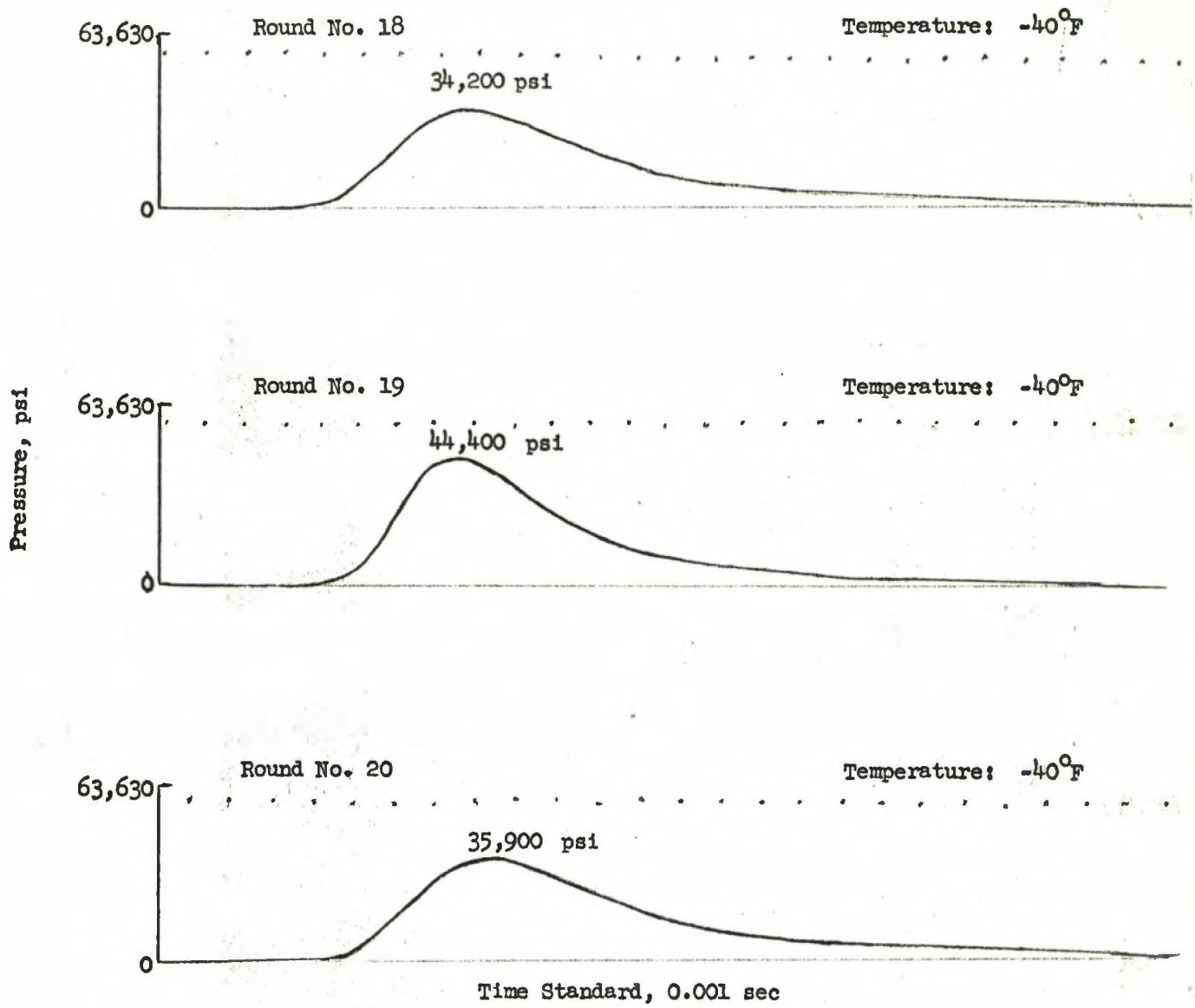
19 August 1958 HFK



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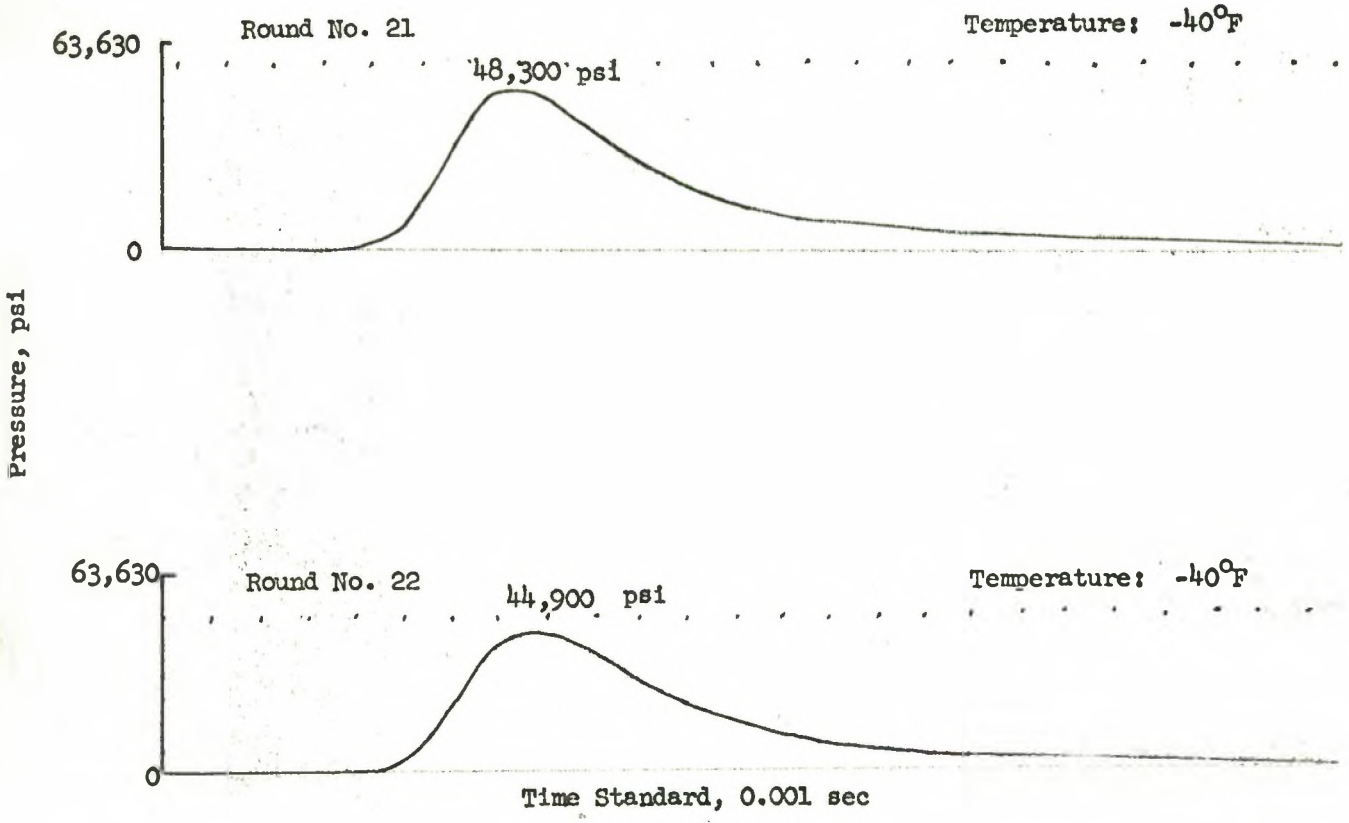
19 August 1958 HFK



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APPENDIX D

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