REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for information on Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
08-12-2014	Final	

4. TITLE AND SUBTITLE
Test Operations Procedure (TOP)
04-2-607A Check Firing of Master and Reference Propellants

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHORS

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Commander
Munitions and Weapons Division
U.S. Army Yuma Proving Ground
Yuma, AZ 85365

8. PERFORMING ORGANIZATION REPORT NUMBER
TOP 04-2-607A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Test and Evaluation Command
CSTE-TM (Range Infrastructure Division)
2202 Aberdeen Boulevard
Aberdeen Proving Ground, MD 21005-5001

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Same as item 8

12. DISTRIBUTION/AVAILABILITY STATEMENT

Distribution Statement A. Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Defense Technical Information Center (DTIC), AD No.:

This TOP supersedes TOP 04-2-607, Check Firing of Master and Reference Propellants, dated 22 July 1970.

Marginal notations are not used in this revision to identify changes, with respect to the previous issue, due to the extent of the changes.

14. ABSTRACT
This Test Operations Procedure (TOP) describes test methods and techniques for check firing of artillery ammunition propellants to determine whether their continued use as calibration lots is satisfactory. Master or reference propellants lots are considered. Artillery ammunition includes field artillery, tank, mortar, and recoilless rifle ammunition.

15. SUBJECT TERMS
Engineering Test, Check Firing, Reference Propellant Lot, Artillery Ammunition, Field Artillery, Tank, Mortar, Recoilless Rifle Ammunition

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**B. ABSTRACT**	**C. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified	SAR	26	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

(This page is intentionally blank.)

U.S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure 04-2-607A 8 December 2014
DTIC AD No.

CHECK FIRING OF MASTER AND REFERENCE PROPELLANTS

			Page
Paragraph	1.	SCOPE	2
	1.1	Objective	2
	1.2	Limitations	2
	2.	BACKGROUND	2
	3.	REQUIRED EQUIPMENT	2
	4.	TEST PROCEDURES	3
	4.1	Preparation for Test	3
	4.2	Test Conduct	5
	5.	DATA REQUIRED	8
	5.1	General Test Data	8
	5.2	Meteorological Data	8
	5.3	Test Round Data	8
	6.	PRESENTATION OF DATA	10
	6.1	General	10
	6.2	Criteria	12
APPENDIX	A.	ABBREVIATIONS	A-1
	B.	DEFINITIONS	B-1
	C.	REFERENCES	C-1
	D.	APPROVAL AUTHORITY	D-1

* This TOP supersedes TOP 04-2-607, Check Firing of Master and Reference Propellants, dated 22 July 1970.

Approved for public release; distribution is unlimited.

1. SCOPE.

This Test Operations Procedure (TOP) describes the procedures for check firing artillery ammunition propellants and the techniques to be followed in ammunition and weapon inspection and preparation before, during, and after the firings. As discussed in this TOP, artillery ammunition includes field artillery, tank, mortar, and recoilless rifle ammunition.

1.1 Objective.

The objective of this TOP is to instruct personnel in the techniques of conducting and evaluating check firing of artillery, tank, mortar, and recoilless rifle ammunition master and reference propellants.

1.2 Limitations.

None.

2. BACKGROUND.

a. Check firing is employed to determine whether or not a master or reference propellant is functioning satisfactorily and whether its continued use as a calibration lot should be permitted. Check firings will be conducted every two years for calibration lots that have not been used for that period, or whenever a change in performance occurs. These firings are performed on all master and reference lots to ensure that no significant physical or chemical changes affecting ballistic performance have occurred in the propellant since the previous firing check or calibration test. The same care must be exercised in the check firing as in the calibration test to ensure proper evaluation of propellant functioning. For check firings of matching or reference calibration lots, only the subject matching calibration propellant lot or the reference propellant lot will be fired. The calibration lot for the original matching test will not be fired.

b. While firings are being conducted at the proving grounds, the Armament Research and Development Center (ARDEC) at Picatinny Arsenal performs surveillance tests on the identical lots for additional verification of their satisfactory condition.

3. REQUIRED EQUIPMENT.

The following equipment is required for testing:

a. Video camera with time stamp (optional).

b. Appropriate meteorological equipment to measure surface and upper air data.

c. "Check" tube.

d. Stargauge.

e. Pressure gauge (piezoelectric preferred, and/or crusher).

f. Muzzle velocity radar unit.

g. Scales for propellant loading.

h. Constant-temperature chamber 70 ± 2 degrees Fahrenheit (°F).

i. Chamber temperature indicating equipment.

4. TEST PROCEDURES.

4.1 Preparation for Test.

4.1.1 General.

The test officer shall review records of previous firings of the propellant lot. If two years have not elapsed from when the lot was last fired, or a change in performance has not occurred, the reason for the check firing requirement shall be determined.

4.1.2 Weapon.

Preparations relating to the weapon shall be as follows:

a. Obtain the appropriate “Check” tube; the word "CHECK" shall be stenciled on the tube end. Verify that the “Check” tube is a dedicated tube that will only be used for calibration purposes. If a “Check” tube is not available, a first quarter tube is acceptable. If a first quarter tube will be used, examine previous firing data for uniformity and proper level of ballistic performance. Any tube displaying abnormal performance should be replaced by a satisfactory tube.

b. Review the report of the tube that will be used to verify that the tube is serviceable. If a stargauge was not performed following the last firing event, the tube shall be stargauged as described in International Test Operations Procedure (ITOP) 03-2-802A**[1].

c. Verify the tube round number to ensure that additional rounds have not been fired since the last test. If the round number is not in agreement with the last gauge report, the discrepancy shall be resolved before firing.

d. The tube shall be assembled in the same type of mount as was used for the original calibration test.

e. Record caliber, model, and serial number of recoil mechanism, gun, tube, and carriage.

** Superscript numbers correspond to Appendix C, References.

f. For recoilless weapons, check vent life and compensator setting as applicable.

4.1.3 Ammunition.

Preparation of ammunition and ammunition components shall be as follows:

a. Take all ammunition components from the same lots used in the previous calibration firing.

b. Ensure each type of pressure gauge for a given pressure range are all from the same lot.

c. Check the propellant loading scales for zero reading with the correct counterbalance. The weight of the propellant shall be the same as that determined in the calibration test (TOP 04-2-606[2]).

d. Unless otherwise specified, prepare a one-pound sample of propellant for shipment to ARDEC at Picatinny Arsenal for closed bomb testing and moisture analysis.

e. Specify lot number of test propellant, web size, manufacturer, and year manufactured.

f. Record projectile model, lot numbers, and filler type.

g. Weigh all projectiles and record all in-flight weights.

h. Number each projectile for future correlation with the round number in the firing record.

i. Measure and record diameters, in two planes, of all projectiles at the bourrelet, the rotating band, and on the body above and below the band (optional).

j. Record propellant charge weight as well as total bagged charge weight for separate-loading ammunition.

k. If bag type charge is used, record composition of bag.

l. If combustible case type charge is used, record composition of case.

m. Record dimensions of bagged charges: length and diameter at three positions along the charge (optional) when used.

n. Record primer model and lot number when used.

o. Record igniter, type, grade, and weight when used.

p. Record fuze model and lot numbers when used.

q. Record cartridge case model and lot numbers when used.

r. Weigh and record the weight of the cartridge case when used.

s. For any ammunition item or ammunition component, including the propellant, which is determined not to be in compliance with drawing requirements:

(1) Appropriately label the item.

(2) Segregate and hold it for disposition instructions.

NOTE: Under no circumstances shall such materiel be used in check firing without written approval from the technical authority.

4.1.4 Final Inspection.

The following final inspections shall be made during the last stage of preparation for assembly:

a. When firing fixed ammunition, check crimping machine pressure for obtaining the required bullet pull.

b. Check all ammunition visually for any defects, such as dents or other abnormalities that would prevent satisfactory functioning.

4.2 Test Conduct.

4.2.1 Pre-Firing.

The following shall be accomplished on the day of firing:

a. Provide electronics personnel with the weapon caliber and type, the weight and model of projectile, and expected muzzle velocities.

b. Check the constant-temperature chamber to ensure that the rounds have been conditioned as required (70 ± 2 °F for 24 hours).

4.2.2 Firing.

a. The following restrictions to this test shall be observed:

(1) A check firing test must be completed on the same day it is begun.

(2) Use a uniform rate-of-fire: approximately one round every 2 to 5 minutes.

(3) Do not allow the elapsed time between removal of the round or propelling charge from its conditioning chamber and firing to exceed 5 minutes. Minimize the time that the ammunition remains in the weapon before firing.

(4) Any interruption of firing exceeding 15 minutes will require the firing of conditioning rounds. At a minimum, three conditioning rounds should be fired.

(5) Any delay exceeding 60 minutes will require initial conditions stated in paragraph 4.2.2.1 to be repeated.

b. Just before firing the first conditioning round, and on a 15 minute basis thereafter until the completion of firing, record meteorological data.

c. Record all applicable test data in paragraph 5.1.

4.2.2.1 Conditioning Rounds.

Fire three conditioning rounds for fast burning propellant and seven for slow burning propellant and record the tube round number and projectile muzzle velocity (ITOP 04-2-805[3]). This relatively large number of conditioning rounds for slow burning propellant is required to ensure proper tube conditioning to stabilize the velocities and pressures at low zones. If data still shows velocities have not stabilized, additional conditioning rounds should be fired.

NOTE: Conditioning round velocities shall be used to provide a check on the muzzle velocity radar prior to the firing of check rounds.

4.2.2.2 Check Rounds.

Fire check rounds as indicated under the appropriate heading of Table 1.

NOTE: Check rounds shall be fired for the highest velocity prescribed for the weapon propellant under test.

TABLE 1. NUMBER OF ROUNDS TO BE FIRED IN UNIFORMITY SERIES

ZONES		FOR ZONED AMMUNITION							
Total	Arrangement	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Single Granulation Charges									
*1	NA	--	--	--	--	--	--	--	--
2	NA	7	7	--	--	--	--	--	--
3	NA	7	4	7	--	--	--	--	--
4	NA	7	4	4	7	--	--	--	--
5	NA	7	4	4	4	7	--	--	--
6	NA	7	4	4	4	4	7	--	--
7	NA	7	4	4	4	4	4	7	--
8	NA	7	4	4	4	4	4	4	7
Dual Granulation Charges									
3	Zone 1 FP, Zones 2 & 3 SP	7	7	7	--	--	--	--	--
4	Zone 1 FP, Zones 2 to 4 SP	7	7	4	7	--	--	--	--
4	Zones 1 & 2 FP, Zones 3 & 4 SP	7	7	7	7	--	--	--	--
5	Zone 1 FP, Zones 2 to 5 SP	7	7	4	4	7	--	--	--
5	Zones 1 & 2 FP, Zones 3 to 5 SP	7	7	7	4	7	--	--	--
6	Zone 1 FP, Zones 2 to 6 SP	7	7	4	4	4	7	--	--
6	Zones 1 & 2 FP, Zones 3 to 6	7	7	7	4	4	7	--	--
6	Zones 1 to 3 FP, Zones 4 to 6 SP	7	4	7	7	4	7	--	--
7	Zone 1 FP, Zones 2 to 7 SP	7	7	4	4	4	4	7	--
7	Zones 1 & 2 FP, Zones 3 to 7 SP	7	7	7	4	4	4	7	--
7	Zones 1 to 3 FP, Zones 4 to 7 SP	7	4	7	7	4	4	7	--
8	Zone 1 FP, Zones 2 to 8 SP	7	7	4	4	4	4	4	7
8	Zones 1 & 2 FP, Zones 3 to 8 SP	7	7	7	4	4	4	4	7
8	Zones 1 to 3 FP, Zones 4 to 8 SP	7	4	7	7	4	4	4	7

*For single zone or fixed type round - 10 rounds.

LEGEND:
FP – Fast propellant
SP – Slow propellant

5. DATA REQUIRED.

5.1 General Test Data.

Record/obtain the following, as applicable:

a. Propellant description sheet and whether propellant is a master, reference, or matching calibration lot.

b. Propellant moisture-analysis results.

c. Data records and identification of all ammunition components.

d. Tube caliber, model, and serial number.

e. Tube stargauge data (ITOP 03-2-802A[1]), to include pre-firing and post-firing inspections.

f. Model of weapon mount and serial number.

g. Chamber temperature for a minimum of 24 hours and time of day.

h. Malfunction of weapon, recoil mechanism, or component parts.

i. Visible evidence of breakdown of tube, breech, recoil mechanism, carriage, etc.

j. Crimp machine pressure, force in inch-pounds.

k. Location of test site.

l. Test weapon elevation.

m. Line-of-fire.

5.2 Meteorological Data.

a. Surface, on a 15 minute basis.

b. Upper air, if impact dispersion is required.

5.3 Test Round Data.

Record as applicable for each test round fired:

a. Tube round number.

b. Test sample number.

c. Propellant – lot number.

d. Propellant – charge weight per increment/zone.

e. Container model and lot number.

f. Bag model and lot number.

g. Cartridge case weight.

h. Projectile model and lot number.

i. Individual projectile weight and all in-flight weights.

j. Projectile seating measurement, as described in ITOP 04-2-802[4], for separate-loading rounds.

k. Noticeable defects.

l. Primer model and lot number.

m. Igniter type, grade, and weight (in ounces).

n. Fuze model and lot number.

o. Time of firing.

p. Muzzle velocity as described in ITOP 04-2-805[3] and corrected for presence of crusher gauges when used and/or nonstandard projectile weight.

NOTE: If the recorded velocity differs from the expected velocity by more than 2 percent; cease firing and determine the cause.

q. Chamber pressure.

(1) Chamber pressure as described in ITOP 03-2-810(1)[5] and corrected for nonstandard projectile weight.

(2) Chamber gauge pressure, as described in ITOP 03-2-810(2)[6], and corrected for presence of crusher gauges and nonstandard projectile weight.

r. Visually estimate amount and color of smoke generated.

s. Visually estimate amount and color of muzzle flash generated.

t. Residue, if any, in cartridge, case, chamber, or bore.

u. Malfunction of weapon, recoil mechanism, or component parts.

6. PRESENTATION OF DATA.

6.1 General.

a. All data required in Section 5 will be included in the final test report. If applicable, muzzle velocity and crusher gauge pressure for all test rounds shall be corrected to standard conditions. The corrected values for muzzle velocity and chamber pressure means and standard deviations shall be calculated for all rounds. Maximum dispersion shall be substituted for standard deviation in the case of 4-round groups.

b. The following equations should be used for calculations:

Correction to velocity and pressures due to nonstandard projectile weight:

Velocity Correction (ΔV):

$$\Delta \mathrm{V} = \frac{\eta(V)(\Delta w)}{w_{std}}$$

Pressure Correction (ΔP):

$$\Delta \mathrm{P} = \frac{\eta_1(P)(\Delta w)}{w_{std}}$$

Correction to velocity and pressure due to nonstandard projectile weight for recoilless rifles only:

Velocity Correction (ΔV):

$$\Delta \mathrm{V} = V\sqrt{\frac{w_{measured}}{w_{std}}}$$

Pressure Correction (ΔP):

$$\Delta \mathrm{P} = P\sqrt{\frac{w_{measured}}{w_{std}}}$$

Correction to velocity and pressure due to presence of crusher gauges:

Velocity Correction (ΔV):

$$\Delta \mathrm{V} = \frac{B(V)(\Delta c)}{C}$$

Pressure Correction (ΔP):

$$\Delta \mathrm{P} = \frac{B_1(V)(\Delta c)}{C}$$

Mean (μ):

$$\mu = \frac{\sum x}{N}$$

Standard Deviation (σ):

$$\sigma = \sqrt{\frac{1}{N}\sum (x-\mu)^2}$$

Maximum Dispersion or Variance (σ^2):

$$\sigma^2 = \frac{\sum (x-\mu)^2}{N}$$

Where:

η = velocity coefficient for projectile-weight variation
η_1 = pressure coefficient to account for projectile-weight variation
B = velocity coefficient for presence of crusher gauges
B_1 = pressure coefficient to account for presence of crusher gauges

NOTE: In determining the velocity and pressure coefficients/corrections, a computer program for interior ballistic solution is required. Consult your technical agency or local Calibration Coordinator.

V = average measured velocity
P = average measured pressure
Δw = change in projectile weight ($\Delta w = w_{measured} - w_{std}$)
$w_{measured}$ = measured projectile weight
w_{std} = standard projectile weight
C = chamber volume
Δc = change in chamber volume due to presence of crusher gauges
x = each value in the sample
N = number of values (sample size)

6.2 Criteria.

a. The calibration values shall be considered valid if the check firing results are not statistically different from the calibration firings at the 95-percent confidence level. If the mean of the velocity or pressure or the standard deviation of these parameters is significantly different at the 95-percent confidence level, the proving ground shall determine the cause of such difference prior to acceptance of the calibration values or requiring a new calibration. Additionally, applicable specification requirements shall be met.

b. To determine if the mean of the velocity or pressure is significantly different at the 95-percent confidence level use the following method:

(1) Two-Sample T-test for Comparing Two Means:

(a) Requirements**:** Two normally distributed but independent samples are obtained.

(b) Calculate Degrees of Freedom:

$$df = \frac{\left(\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}\right)^2}{\frac{\left(\frac{\sigma_1^2}{N_1}\right)^2}{N_1 + 1} + \frac{\left(\frac{\sigma_2^2}{N_2}\right)^2}{N_2 + 1}} - 2$$

(2) Look for two-tailed t-critical value corresponding to the degree of freedom from the t-distribution table (Table 2).

(3) Calculate T Distribution:

$$\mathrm{T} = \frac{\mu_1 - \mu_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}}$$

(4) Interpolate known values:

$$-t \le T \le t$$

(5) If statement is true the data gives a high degree of confidence that the calibration lot is still reliable.

Where:
μ_1 = mean of sample one
μ_2 = mean of sample two

σ_1 = standard deviation of sample one
σ_2 = standard deviation of sample two
N_1 = size of sample one
N_2 = size of sample two
df = degrees of freedom

TABLE 2. t-DISTRIBUTION TABLE

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	**0.50**	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**	**0.0005**
two-tails	**1.00**	**0.50**	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.002**	**0.001**
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

c. To determine if the variance or standard deviation of the velocity is significantly different at the 95-percent confidence level use the following method:

(1) Testing the Difference Between Two Variances or Standard Deviations:

(a) Requirements: Two normally distributed but independent samples are obtained.

(b) Calculate Degrees of Freedom:

$$df_1 = N_1 - 1$$

$$df_2 = N_2 - 1$$

(c) Find the upper critical values corresponding to the degree of freedom from the f-distribution table (Table 3).

$$F_{upper, df_1, df_2}$$

(d) Calculate Lower Critical Value:

$$F_{lower, df_1, df_2} = \frac{1}{F_{upper, df_2, df_1}}$$

(e) Calculate F distribution:

$$F = \frac{\sigma_1^2}{\sigma_2^2}$$

(f) Interpolate known values:

$$F_{lower} \leq F \leq F_{upper}$$

(2) If statement is true there is not enough evidence to say that the standard deviation or variances from sample one difference from sample two.

Where:
σ_1 = standard deviation of sample one
σ_2 = standard deviation of sample two
N_1 = size of sample one
N_2 = size of sample two
df_1 = degrees of freedom of sample one
df_2 = degrees of freedom of sample two

TABLE 3. F DISTRIBUTION TABLE: CRITICAL VALUES OF F (5% SIGNIFICANCE LEVEL) (α/2 TWO-SIDED TEST)

F Distribution for alpha = 0.025

df2	Degrees of Freedom of the numerator df1									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	647.7931	799.4822	864.1509	899.5994	921.8347	937.1142	948.2028	956.6429	963.2786	968.6337
2	38.50619	39.00004	39.16557	39.24833	39.29836	39.3311	39.35565	39.37294	39.38658	39.3984
3	17.44343	16.04417	15.43913	15.10102	14.88479	14.73472	14.62445	14.53986	14.47302	14.4189
4	12.21792	10.64905	9.979203	9.604491	9.364499	9.197265	9.074142	8.979555	8.904635	8.843926
5	10.00694	8.433631	7.76356	7.387882	7.146355	6.9777	6.853043	6.757205	6.681034	6.619189
6	8.813117	7.259871	6.598782	6.22714	5.987545	5.819743	5.695483	5.599645	5.523418	5.461345
7	8.072675	6.541541	5.889831	5.522594	5.285244	5.118579	4.994888	4.899334	4.823221	4.761119
8	7.570861	6.059452	5.415984	5.052641	4.817281	4.651696	4.528545	4.433275	4.357219	4.295117
9	7.20928	5.714696	5.078107	4.718061	4.484406	4.31973	4.197034	4.101963	4.025992	3.963862
10	6.936716	5.4564	4.825608	4.468347	4.236085	4.07212	3.949822	3.854893	3.77895	3.716792
11	6.724122	5.255885	4.63001	4.27508	4.044011	3.880643	3.758629	3.663814	3.5879	3.52567
12	6.553762	5.09587	4.474202	4.121205	3.891131	3.728303	3.606516	3.511786	3.435844	3.373543
13	6.414268	4.965273	4.347186	3.995893	3.766672	3.604256	3.482668	3.387981	3.312039	3.249667
14	6.29791	4.856702	4.241713	3.891927	3.663416	3.501356	3.379938	3.285294	3.209294	3.146852
15	6.199514	4.765042	4.15281	3.804274	3.576417	3.414669	3.293366	3.198735	3.122707	3.060194
16	6.115101	4.686683	4.07681	3.729411	3.502123	3.340631	3.219441	3.124825	3.048754	2.986155
17	6.042001	4.618869	4.011156	3.664752	3.437947	3.276682	3.155577	3.060975	2.984862	2.922192
18	5.978052	4.559666	3.953858	3.608335	3.38197	3.220919	3.099871	3.005269	2.929113	2.866372
19	5.921606	4.507513	3.903438	3.558711	3.332715	3.171849	3.050872	2.956256	2.880057	2.817245
20	5.87147	4.461242	3.858702	3.514685	3.28906	3.128349	3.007415	2.912799	2.836543	2.773675

F Distribution for alpha = 0.025

df2	Degrees of Freedom of the numerator df1									
	11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1	973.0284	976.7246	979.8387	982.5453	984.8736	986.9109	988.7153	990.3451	991.8003	993.0809
2	39.40659	39.41477	39.42114	39.4266	39.43114	39.43569	39.43933	39.44206	39.44569	39.44751
3	14.37411	14.33659	14.30453	14.27679	14.25269	14.23155	14.21267	14.19608	14.18084	14.16743
4	8.793563	8.751158	8.715006	8.683742	8.656571	8.632583	8.611323	8.592338	8.575284	8.559937
5	6.567802	6.524544	6.487596	6.455593	6.42774	6.403184	6.381356	6.361915	6.344408	6.328548
6	5.40976	5.366246	5.329014	5.296812	5.268646	5.243862	5.221807	5.202139	5.184404	5.168403
7	4.709477	4.665822	4.628475	4.596075	4.567795	4.542812	4.520643	4.500777	4.482899	4.466756
8	4.243418	4.199677	4.16216	4.129674	4.101224	4.076099	4.05376	4.033751	4.01576	3.999446
9	3.912078	3.868223	3.830593	3.797965	3.769344	3.744105	3.721624	3.701473	3.68334	3.666912
10	3.664923	3.620954	3.583182	3.550412	3.521677	3.496268	3.473644	3.45338	3.435105	3.418535
11	3.473701	3.429619	3.391733	3.358821	3.329944	3.304393	3.281642	3.261235	3.242832	3.226148
12	3.321475	3.277279	3.239265	3.20621	3.177206	3.151527	3.128633	3.108113	3.089582	3.07277
13	3.197499	3.153175	3.115034	3.081851	3.052719	3.026912	3.00389	2.983242	2.964583	2.947672
14	3.094584	3.050161	3.011891	2.978595	2.949321	2.9234	2.900265	2.879489	2.860716	2.843692
15	3.007827	2.963276	2.924907	2.891483	2.862095	2.836046	2.812797	2.791907	2.773035	2.755897
16	2.933703	2.889053	2.850555	2.817018	2.787516	2.761354	2.738005	2.717002	2.69803	2.680792
17	2.869641	2.824891	2.786294	2.752643	2.723027	2.696765	2.673303	2.6522	2.633129	2.615799
18	2.813735	2.768886	2.730189	2.696424	2.666724	2.640348	2.616787	2.595598	2.576428	2.559005
19	2.764523	2.719574	2.680778	2.646928	2.617114	2.590653	2.566992	2.545704	2.526448	2.508941
20	2.720867	2.675833	2.636938	2.603002	2.573103	2.546543	2.522789	2.501416	2.482075	2.464489

(This page is intentionally blank.)

APPENDIX A. ABBREVIATIONS.

ARDEC	Armament Research and Development Center
F	Fahrenheit
FP	Fast Propellant
ITOP	International Test Operations Procedure
TOP	Test Operations Procedure
SP	Slow Propellant

(This page is intentionally blank.)

APPENDIX B. DEFENITIONS.

a. Master calibration lots. Propellant and other ammunition components used to establish a standard performance level for interior and exterior ballistics. A master lot is established by an extensive statistically designed test. The values established provide sufficient information on the master lot to correct accurately the influences of day to day, weapon to weapon, and temperature variations. Procedures described in TOP 04-2-606.

b. Reference calibration lots. Propellant and other ammunition components used for the purpose of providing calibration factors while conserving the master lot. A reference lot is established by comparison testing with the master lot. Procedures described in TOP 04-2-606.

c. Check tube. A dedicated tube that will only be used for calibration purposes.

d. First quarter tube. A tube having more than 75 percent remaining life.

e. Check rounds. Check rounds are identified as the rounds having the candidate set of ammunition components as the master calibration or reference calibration lot.

f. Conditioning rounds. Service charge ammunition fired to provide final input to acquire the proper state of equilibrium of tube temperature differential and bore resistance as manifested by velocity and pressures at or near the expected levels. The ammunition should be of the same type or similar to the item undergoing check testing. These conditioners are fired at the same temperature as the test rounds and also provide an opportunity to check out instrumentation and weapon performance.

g. Single granulation. Charges containing an individual lot of propellant such as the 155mm M232A1 charge.

h. Dual granulation. Charges containing two individual lots of propellant such as the 105mm M67 charge.

i. Fast propellant. Propellant burns out at an instant when pressure is still rising.

j. Slow propellant. Propellant burnout occurs after the instant of maximum pressure.

(This page is intentionally blank.)

APPENDIX C. REFERENCES.

1. ITOP 03-2-802A, Measurement and Inspection of Gun Tubes.

2. TOP 04-2-606, Establishment of Master and Reference Calibration Rounds.

3. ITOP 04-2-805, Projectile Velocity and Time-Of-Flight Measurements.

4. ITOP 04-2-802, Projectile Seating and Fallback.

5. ITOP 03-2-810(1), Electrical Measurement of Weapon Chamber Pressure.

6. ITOP 03-2-810(2), Copper Crusher Measurement of Weapon Chamber Pressure.

For information only (related publications).

a. ITOP 03-2-506(2), Tank Cannon and Recoil Mechanism.

b. ITOP 03-2-815, Recoil Motion Measurement.

NOTE: The latest version of the reference documents will be used.

(This page is intentionally blank.)

APPENDIX D. APPROVAL AUTHORITY.

CSTE-TM 8 December 2014

MEMORANDUM FOR

Commanders, All Test Centers
Technical Directors, All Test Centers
Directors, U.S. Army Evaluation Center
Commander, U.S. Army Operational Test Command

SUBJECT: Test Operations Procedure (TOP) 04-2-607A, Check Firing of Master and Reference Propellants, Approved for Publication

1. TOP 04-2-607A, Check Firing of Master and Reference Propellants, has been reviewed by the U.S. Army Test and Evaluation Command (ATEC) Test Centers, the U.S. Army Operational Test Command, and the U.S. Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency. The scope of the document is as follows:

This TOP describes the procedures for check firing artillery ammunition propellants and the techniques to be followed in ammunition and weapon inspection and preparation before, during, and after the firings. As discussed in this TOP, artillery ammunition includes field artillery, tank, mortar, and recoilless rifle ammunition.

2. This document is approved for publication and has been posted to the Reference Library of the ATEC Vision Digital Library System (VDLS). The VDLS website can be accessed at https://vdls.atc.army.mil/.

3. Comments, suggestions, or questions on this document should be addressed to U.S. Army Test and Evaluation Command (CSTE-TM), 2202 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atec.mbx.atec-standards@mail.mil.

FONTAINE.RAYMOND.G.1228612770

RAYMOND G. FONTAINE
Associate Director, Test Management Directorate (G9)

FOR

MICHAEL J. ZWIEBEL
Director, Test Management Directorate (G9)

(This page is intentionally blank.)

Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Range Infrastructure Division (CSTE-TM), U.S. Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5001. Technical information may be obtained from the preparing activity: Munitions and Weapons Division, U.S. Army Yuma Proving Ground, Yuma, Arizona 85365. Additional copies can be requested through the following website: http://www.atec.army.mil/publications/topsindex.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.