Draft Test Procedures for the Gun Safety Technology Challenge

National Institute of Justice

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Introduction

This document has been developed for the National Institute of Justice (NIJ) Gun Safety Technology Challenge. It describes test methods to provide a basis to determine whether the addition of a smart gun technology does or does not significantly reduce the reliability of the firearm system compared to existing firearms. These firearms or firearms accessories can be understood to use integrated components that exclusively permit an authorized user or set of users to operate or fire the gun and automatically deactivate it under a set of specific circumstances, reducing the chances of accidental or purposeful use by an unauthorized user. The integrated gun safety technology may include different authentication technologies, such as radio frequency identification and fingerprint sensors.

Testing and evaluation is designed to prioritize the collection and use of data that can substantiate conclusions about the relative performance of firearms, so that firearms with and without advanced gun safety technology that are similar with respect to type, form factor, caliber, and other physical characteristics are tested and evaluated using a common methodology and equivalent ammunition. Testing and evaluation is not designed to provide comparison of test results against absolute performance requirements or safety criteria, but rather to provide a meaningful comparison of test results of one firearm against another similar firearm, or a firearm with and without a relevant safety accessory.

Please direct any feedback on this document by email to gunsafetytechnology@usdoj.gov.

1 Scope

1.1 This document describes a testing methodology to provide meaningful comparisons between similar firearms to determine whether the reliability of the tested firearms differs significantly based on performance.

1.2 Test methods are included to determine whether the addition of a smart gun technology does or does not significantly reduce the reliability of the firearm system compared to existing firearms.

1.3 The sample used is designed to detect significant differences between similar firearms with reasonable test economy using a variety of tests.

1.4 The sample used is not designed to be a complete engineering test, or to evaluate a firearm at or close to its expected service life, nor is it designed to detect small differences in statistical parameter(s) of interest, marginal performance, or randomly encountered problems that would require a large sample to measure with a high degree of confidence.

1.5 Firearms such as pistols, revolvers, rifles, and shotguns, as defined at 27 CFR 478.11, are within the scope of this document.

1.6 Semi-automatic pistols, rifles, and shotguns, as defined at 27 CFR 478.11, are within the scope of this document.

1.7 Accessories with integrated components that modify the firearms in 1.5 and 1.6 for the purpose of augmenting safety are also within the scope of this document.

1.8 Fully automatic firearms and machineguns, as defined at 27 CFR 478.11, are not addressed in this document.

1.9 This document shall not be understood as addressing all of the safety risks associated with testing firearms. The user of this document is responsible for following appropriate safety practices when handling or operating firearms.

2 Normative references

Test Operations Procedure (TOP) 3-2-045, *Small Arms - Hand and Shoulder Weapons and Machineguns*, 17 September 2007.

NIJ Standard 0109.00, *38/357 Caliber Revolvers*, July 1983.

NIJ Standard 0112.03 Revision A, *Autoloading Pistols for Police Offi*cers, July 1999.

NIJ Standard 0113.00, *12-Gauge Shotguns for Police Use*, March 1989.

TOP 4-2-500, *Ammunition Characteristics*, 9 November 1981.

TOP 4-2-016, *Ammunition, Small Arms*, 12 June 1978.

TOP 3-2-504, *Safety Evaluation of Hand and Shoulder Weapons*, 1 March 1977.

TOP 3-2-500, *Weapon Characteristics*, 9 November 1981.

TOP 3-2-807, *Nondestructive Testing of Materials*, 5 December 1985.

ITOP 4-2-829, *Vertical Target Accuracy and Dispersion*, 7 September 1999.

AR 70-38, *Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions*, 15 September 1979.

MIL-STD-810G w/ Change 1, *Environmental Engineering Considerations and Laboratory Tests*, 15 April 2014.

ITOP 4-2-602, *Rough Handling Tests*, 19 April 2002.

TOP 1-2-512, *Electromagnetic Compatibility Tests*, 15 May 1995.

MIL-STD-882D, *Standard Practice for System Safety*, 11 May 2012.

ATEC Publication No. 1-8, *Technical Document Style Manual*, 1 March 2005.

ATEC Pamphlet 73-4, *System Test and Evaluation Procedures*, 19 April 2004.

ISO/IEC 27000:2014(E), *Information technology — Security techniques — Information security management systems — Overview and vocabulary*, 15 January 2014.

Siegmund Halpern, *The Assurance Sciences: An Introduction to Quality Control and Reliability* (Englewood Cliffs, NJ: Prentice-Hall), 1978.

3 Terms and definitions

Accuracy
A measure of the ability of the firearm-ammunition system to center projectile impacts on the point of aim.

Authentication
As defined in ISO/IEC 27000:2014(E), provision of assurance that a claimed characteristic of an entity is correct. In practice, it is a process to confirm or verify that a presented value or characteristic, such as a password or biometric, matches a reference value or characteristic.

Cartridge
A unit of ammunition consisting of a projectile, a casing that houses the propellant, and primer.

Chambering
Actuation that inserts a cartridge or round into the chamber.

Dispersion
The extent to which projectile impacts spread about the center of impact because of shot-to-shot variations.

Durability
Resistance to wear, damage, or degradation.

Ejecting
Actuation that jettisons a spent casing from the firearm.

Extracting
Actuation that removes a spent casing from the chamber.

Feeding
Actuation that moves ammunition from a housing device, such as a magazine, toward the chamber.

Firing
Actuation that activates the primer to cause the propellant to ignite and jettision the projectile through the barrel and out the muzzle.

Locking
Actuation that firmly secures a cartridge in the chamber.

Malfunction
Deviation from the normal functioning of a firearm or one of its components.

Pistol
As defined at 27 CFR 478.11, a weapon originally designed, made, and intended to fire a projectile (bullet) from one or more barrels when held in one hand, and having (a) a chamber(s) as an integral part(s) of, or permanently aligned with, the bore(s); and (b) a short stock designed to be gripped by one hand and at an angle to and extending below the line of the bore(s).

Reliability
The probability that a device will perform its intended function for a specified period of time under stated conditions (Halpern).

Revolver
As defined at 27 CFR 478.11, a projectile weapon, of the pistol type, having a breechloading chambered cylinder so arranged that the cocking of the hammer or movement of the trigger rotates it and brings the next cartridge in line with the barrel for firing.

Round
A unit of ammunition when counted.

Rifle
As defined at 27 CFR 478.11, a weapon designed or redesigned, made or remade, and intended to be fired from the shoulder, and designed or redesigned and made or remade to use the energy of the explosive in a fixed metallic cartridge to fire only a single projectile through a rifled bore for each single pull of the trigger.

Semiautomatic pistol
As defined at 27 CFR 478.11, any repeating pistol which utilizes a portion of the energy of a firing cartridge to extract the fired cartridge case and chamber the next round, and which requires a separate pull of the trigger to fire each cartridge.

Semiautomatic rifle
As defined at 27 CFR 478.11, any repeating rifle which utilizes a portion of the energy of a firing cartridge to extract the fired cartridge case and chamber the next round, and which requires a separate pull of the trigger to fire each cartridge.

Semiautomatic shotgun
As defined at 27 CFR 478.11, any repeating shotgun which utilizes a portion of the energy of a firing cartridge to extract the fired cartridge case and chamber the next round, and which requires a separate pull of the trigger to fire each cartridge.

Shotgun
As defined at 27 CFR 478.11, a weapon designed or redesigned, made or remade, and intended to be fired from the shoulder, and designed or redesigned and made or remade to use the energy of the explosive in a fixed shotgun shell to fire through a smooth bore either a number of ball shot or a single projectile for each single pull of the trigger.

Smart gun
Firearms or firearms accessories that can be understood to utilize integrated components that exclusively permit an authorized user or set of users to operate or fire the gun and automatically deactivate it under a set of specific circumstances, reducing the chances of accidental or purposeful use by an unauthorized user.

Stoppage
A malfunction that prevents further firing until corrected.

4 Documentation requirements

4.1 All documentation shall be recorded in either print or electronic format, or a combination of the two, at the discretion of test personnel as test facilities or test conditions may favor one format over the other at different times throughout the duration of testing.

4.2 Firearms chosen for comparative analysis shall be declared and the similarities between them shall be described.

4.3 A firearm chosen for comparative analysis with and without a safety accessory shall be declared and the intended effect of the accessory on the functionality of the firearm shall be described.

4.4 The ammunition selected for use in testing shall be declared and described.

4.5 All inspection activities shall be recorded and reported.

4.6 All test results and observations shall be recorded and reported.

4.7 All maintenance activities of test items, such as cleaning and lubrication, shall be recorded and reported.

4.8 All malfunctions, stoppages, or firearm failures shall be recorded, coded in accordance with 6, and reported.

4.9 Test data shall be recorded in a common tabular or spreadsheet format to facilitate analysis and portability of the data.

4.10 Data from inspections should be recorded in tabular or spreadsheet formats where possible to facilitate data comparisons in subsequent inspections throughout the overall testing.

4.11 Photographs, X-rays, etc. shall be preserved in a digital format to assist data handling and transmission.

4.12 Human factors observations related to operation, maintenance, and usability of test firearms shall be recorded throughout testing.

5 Test requirements

5.1 General considerations

5.1.1 The safety of test personnel shall be the primary consideration in performing any test. Test personnel should perform a thorough safety review before undertaking any firearms testing in accordance with this document.

5.1.2 Test personnel shall observe safe handling of firearms and ammunition at all times and should don appropriate personal protective equipment (PPE) during firing.

5.1.3 Local standard operating procedures (SOPs) regarding safety should be followed.

5.1.4 Prior to conducting any test firings, the initial inspection results in 7.1 shall be reviewed to determine if special warnings, new SOPs, or test revisions are needed to assure safe operations.

5.1.5 Test personnel shall consider whether safety tests should be conducted in accordance with TOP 3-2-504, Safety Evaluation of Hand and Shoulder Weapons, prior to conducting the tests in 7.

5.1.6 For comparative analysis between different firearms, at least two models of firearms should be tested.

— The different models tested should be highly similar to permit a meaningful comparison of performance.

— The similarities between the models shall be documented.

5.1.7 For a comparative analysis of a firearm with and without a safety accessory, at least one model of firearm should be tested with and without the safety accessory.

5.1.8 The test firearms should adequately represent the populations from which the samples have been drawn.

5.1.9 Simple identification numbers should be assigned to the test firearms prior to initial inspection. A list should be maintained of the assigned number versus the firearm serial number or other information that uniquely identifies the firearm.

5.1.10 The operation of firearms is interrelated with ammunition. Care must be taken during testing to assure that the distinction is made between inherent firearm functioning and ammunition induced problems.

5.1.11 Trained and experienced firers should be used. Care must be taken to not fatigue the person firing the firearm.

5.1.12 The arbitrary replacement of critical weapon parts with new parts before the next test is conducted would permit a precise evaluation of the influence of the particular test environment on firearm functioning. However, this practice would negate the accumulation of data on long-term parts durability and firearm life. Care should be taken, therefore, to replace parts only when they are at the end of their serviceable life or present a safety hazard.

5.1.13 All firearms and firearms accessories shall be exposed to adverse conditions as specified in the test methods, except where explicitly excluded. Unless specifically excluded, such as in 7.7.7 and 7.8.16, all devices and artifacts associated with the firearm systems shall be exposed as stated to adverse conditions, such as high or low temperatures, humidity, sand and dust, and water immersion.

5.2 Informational review

5.2.1 All instructional materials that are issued with the test items by the developer or manufacturer, such as manuals, safety assessments, and reports of previous tests conducted on the same model or closely related items, shall be reviewed by test personnel.

5.2.2 Information shall be assembled on the physical characteristics of the test firearm as described in TOP 3-2-500, including its method of operation and maintenance requirements.

5.2.3 All informational materials shall be kept in an organized electronic file or an organized paper file, or both, depending on what is furnished with the test firearms for future reference.

5.3 Facilities and instrumentation

5.3.1 Adequate PPE shall be available for test personnel.

5.3.2 Firing ranges shall safely accommodate firing to the required distances.

5.3.3 Test stands shall safely restrain the firearm, allow remote firing, and assure reproducible results.

5.3.4 Any control firearm used to permit checking test setups, instrumentation, or other aspects of a test protocol should be similar to the test firearm.

5.3.5 Targets shall be physical or electronic with the capability of recording the X and Y coordinates of each projectile passing through the plane of the target.

— Electronic targets are preferred as they allow multiple targets along the line-of-fire so that each shot is recorded at multiple ranges.

— Care must be taken to establish a reproducible aim point.

— Physical targets such as paper, cloth, or plywood require careful manual measurement of each bullet hole.

5.3.6 Velocimeters shall have a maximum permissible error of measurement of 0.1% or 0.5 m/s, whichever is highest.

5.3.7 Antisurge springs shall be long enough to permit gradual load application.

5.3.8 Stargages and airgages shall have a maximum permissible error of measurement of ±0.025 mm.

5.3.9 MIL-STD-810G, *Environmental Engineering Considerations and Laboratory Tests*, shall be used as the default reference regarding environmental conditions for conditioning test items and tests under adverse conditions.

5.3.10 All tests shall be conducted at "standard ambient" as defined in 5.1.a in MIL-STD-810G unless specified otherwise. "Standard ambient" is defined as a temperature of 25° ± 10°C (77 ± 18°F); a relative humidity of 20 to 80 percent; and an atmospheric pressure equal to the site pressure.

5.3.11 Test facilities shall be capable of conducting high temperature conditioning as described in MIL-STD-810G, Method 501.6.

5.3.12 Test facilities shall be capable of conducting low temperature conditioning as described in MIL-STD-810G, Method 502.6.

5.3.13 Test facilities shall be capable of conducting humidity conditioning as described in MIL-STD-810G, Method 507.6.

5.3.14 Test facilities shall be capable of conducting sand and dust conditioning as described in MIL-STD-810G, Method 510.6.

5.3.15 Test facilities shall be capable of conducting water immersion conditioning as described in MIL-STD-810G, Method 512.6.

5.3.16 Climatic chambers shall be capable of providing temperatures between -51°C (-60°F) and 71°C (160°F).

5.3.17 Test items shall be kept within ±2°C (±3.6°F) of the required conditioning temperatures and test temperatures during temperature conditioning.

5.3.18 The air temperature gradient across the test item during temperature conditioning shall not exceed 1°C (2°F) per meter or a maximum of 2.2°C (4°F) total when not operating.

5.3.19 Thermographs and thermocouples shall have a maximum permissible error of measurement of ±0.6°C (±1°F).

5.3.20 Pressure shall be kept at ±5% of the standard ambient value or ±200 Pa (±0.029 psi), whichever is greater.

5.3.21 Climatic chambers shall be capable of providing a relative humidity of at least 95%.

5.3.22 The relative humidity at the chamber control sensor shall be kept within ±5% RH of the specified value.

5.3.23 Sand and dust chamber shall be able to dispense a mixture at a rate of 100±25 g/min·m^2.

5.3.24 The sand and dust compounds that should be used are those identified in TOP 3-2-045 Test Procedure 4.5.4.b(1).

— The compound for the blowing sand and dust test is a mixture, by weight, of the following three products: 50% SIL-CO-SIL 125, 42% No. 1 Dry Unground Silica, and 8% No. 3 Q-ROK Unground Silica. The resulting mixture is approximately 99.5% silicon dioxide and will have the particle distribution as shown in the following table.

Size, Microns	Less than 45	45	53	75	106	150	212	300	425	600	850	1180
Percent, by weight	28.0	10.5	7.5	3.4	2.7	5.5	15.1	17.6	2.1	1.2	6.1	0.3

— The SIL-CO-SIL 125 compound is 99.5% silicon dioxide with the particle size distribution show in the following table.

Size, Microns	Less than 45	45 to 53	53 to 75	75 to 106	106 to 150
Percent, by weight	79	6	9	4.4	1.4

— Supply sources are available from the manufacturer, U.S. Silica, P.O. Box 187, Berkeley Springs, WV 25411-0187, or www.u-s-silica.com.

5.3.25 Firearms subjected to unattended environmental conditioning prior to testing should not be conditioned loaded as there is no continuous hands-on control.

5.3.26 Should a compelling technical reason exist to condition a loaded firearm prior to testing, a safety review shall be conducted prior to environmental conditioning to determine the safety hazards.

5.3.27 Specified lubricants shall be used in each adverse condition test as determined by reference to appropriate manuals or other authority.

5.3.28 Test firearms shall not be cleaned or relubricated prior to the completion of a test procedure unless stated in the test method.

5.4 Ammunition

5.4.1 Ammunition shall be sourced based on need and availability in the following order:

— Option 1: US Government ammunition that has been lot tested to meet relevant U.S. military standards shall be used.

— Option 2: Commercial ammunition from an established manufacturer that meets relevant standards shall be used.

— Option 3: Test item manufacturer or developer shall supply ammunition that meets relevant standards. Documentation shall be provided to demonstrate that the ammunition meets the standards.

5.4.2 Relevant standards may include ANSI/SAAMI standards, U.S. military standards, or other recognized technical standards.

5.4.3 If Option 1 is used, the ammunition shall be fully identified with the full nomenclature, Department of Defense Identification Code (DODIC), condition code (CC), and lot number. Only CC "A" and CC "B" should be used.

5.4.4 The ammunition used should be described in accordance with TOP 4-2-500, Ammunition Characteristics.

5.4.5 If standard ammunition is used, a single lot of ammunition should be used for the entire series of tests.

5.4.6 If a single lot cannot be obtained for the entire series of tests, every effort should be made to complete each separate test procedure with a single lot.

5.4.7 Ammunition that has a small and consistent dispersion should be used. The inherent ammunition dispersion from lot acceptance or test firings should be provided if available.

5.4.8 Candidate ammunition lots can be fired to determine their inherent dispersion, however this process requires special test barrels (Mann type barrels) and rigid test mounts. Dispersion can be demonstrated through prior test results, however test personnel can determine whether inherent dispersion of the ammunition should be measured.

5.4.9 Proprietary, nonstandard, prototype, or experimental ammunition should not be used unless it is an essential component to the gun safety technology and can be demonstrated that it is safe to use.

5.4.10 If other than standard ammunition is used, test personnel shall consider whether should be evaluated for safety in accordance with TOP 4-2-016, Ammunition, Small Arms.

5.4.11 Testing personnel may refuse any ammunition it deems unsafe to use.

5.4.12 Ammunition should be kept in its original shipping and storage containers until use.

5.4.13 A general visual examination of the ammunition should be made after it is removed from its packaging and any discrepancies or irregularities, such as shipping damage or evidence of improper storage, should be recorded.

5.5 Test sequence

5.5.1 Test sequences should generally conduct the most abusive test last for each test item.

5.5.2 For comparative analysis between different firearms, at least two models of firearms selected in accordance with 5.1.6 should complete the test sequence.

5.5.3 For a comparative analysis of a firearm with and without a safety accessory, at least one model of firearm selected in accordance with 5.1.7 should complete the test sequence with and without the safety accessory.

5.5.4 Two predefined test sequences have been designed: "light duty" and "heavy duty."

5.5.5 For "light duty" testing, the test sequence based on a two-firearm sample shall be followed as shown below, with the predefined round count in the test methods indicated in parentheses. The total round count for Test Firearms 1 and 2 is 750 + 750 = 1,500.

Test Firearm No. 1	**Test Firearm No. 2**
Accuracy and dispersion (30)	Accuracy and dispersion (30)
Reliability and durability (600)	Unauthorized user false positive (120)
1.5 m drop (120)	Quick draw scenario (240)
	Electromagnetic interference (120)
	High temperature (120)
	Low temperature (120)

5.5.6 For "heavy duty" testing, the test sequence based on a six-firearm sample shall be followed as shown below, with the predefined round count in the test methods indicated in parentheses. The total round count for Test Firearms 1 through 6 is 6,150 + 6,150 + 6,150 + 3,270 + 2,190 + 270 = 24,180.

Test Firearms No. 1, 2, 3	**Test Firearm No. 4**	**Test Firearm No. 5**	**Test Firearm No. 6**
Accuracy and dispersion (30)	Accuracy and dispersion (30)	Accuracy and dispersion (30)	Accuracy and dispersion (30)
Reliability and durability (6,000)	Unauthorized user false positive (360)	Electromagnetic interference (960)	1.5 m drop (120)
1.5 m drop (120)	Quick draw scenario (720)	Humidity (960)	Mechanical jostling (120)
	High temperature (960)	Water immersion (120)	
	Low temperature (960)	1.5 m drop (120)	
	Sand and dust (120)		
	1.5 m drop (120)		

5.5.7 A unique test sequence may be designed.

5.5.8 The test sequence used shall be documented.

5.6 Firearm maintenance

5.6.1 All maintenance actions shall be recorded.

5.6.2 Firearms shall be maintained in accordance with technical manuals or instructional materials.

5.6.3 Part replacement intervals should be complied with as prescribed in technical publications.

5.6.4 Firearms shall always be cleaned, inspected, and lubricated (CIL) at the end of each test procedure and before the start of another test procedure.

5.6.5 The CIL shall be conducted at the operator level, often referred to as "field strip and clean."

5.6.6 More detailed maintenance shall be performed as needed following completion of each test procedure and only unserviceable components shall be replaced before the test firearm is used in the next test procedure.

5.6.7 Parts that are determined to be in a condition to adversely affect safety should be replaced immediately whenever they are identified, regardless of whether a test procedure has been completed.

5.6.8 The CIL at the end of a test procedure may serve as the CIL for the start of a subsequent test procedure, based on the judgment of test personnel.

5.6.9 The life history of any part that is replaced shall be recorded and the part shall be retained for possible further detailed examination.

6 Data requirements

6.1 General considerations

6.1.1 Firearm functioning data shall be recorded to establish an accurate, complete historic profile of the test firearm under evaluation.

6.1.2 Standardized terminology from TOP 3-2-045 plus additional new codes related to authentication technologies unique to smart guns, such as radio frequency identification and fingerprint sensors, listed shall be used to characterize malfunctions and stoppages to document and analyze these events. These codes describe the condition of the firearm as determined primarily by visual observation.

6.1.3 Malfunctions and stoppages shall be characterized by the terms in organized in standardized groups in the following categories:

— Malfunction and performance codes (6.2)

— Attribution codes (6.3)

— Significance to the operator (6.4)

— Guidance concerning keeping track of incidents by round count (6.5)

— Miscellaneous codes and abbreviations (6.6)

6.1.4 The cycle of operation of firearms within the scope of this document can be broken down into six distinct actions in order: feeding, chambering, locking, firing, extracting, and ejecting.

6.1.5 Malfunctions may occur which can adversely affect firearm performance while still permitting continuation of firing.

6.1.6 Malfunctions may occur which immediately prevent further firing until corrected, referred to as stoppages.

6.1.7 All malfunctions and stoppages may be reviewed by test personnel for safety implications in accordance with MIL-STD-882E.

6.2 Malfunction and performance codes

6.2.1 The following codes shall be used to characterize malfunctions and performance issues:

— BFM: Bolt failed to move. Used for weapons firing from an open bolt to indicate that the bolt made no forward movement when the bolt sear was released by pulling the trigger. Also used for those cases where the bolt is held rearward by a manually operated bolt latch and fails to move forward when the latch is released.

— FSR: Failure to strip round. The bolt properly engaged the cartridge but stalled or failed to push the round out of the magazine.

— FFD: Failure to feed. A cartridge was not fed into the proper position in front of the bolt.

— BFC: Bolt failed to close. The bolt properly stripped the cartridge but stopped short of the forward most position.

— BFL: Bolt failed to lock. The bolt locking surfaces or locking mechanism are not engaged even though the bolt is in the forward most position.

— BCE: Bolt closed on an empty chamber. There is no cartridge in the chamber even though the bolt is forward and locked.

— FFR: Failure to fire. The firearm failed to fire when the trigger was pulled.

— FUL: Failure to unlock. The weapon fired but the bolt is still in the locked position.

— FXT: Failure to extract. The fired cartridge case is still in the chamber or the bolt has not moved back far enough to activate the ejector.

— FEJ: Failure to eject. The bolt moved to, or through, the proper position for ejection but the case did not eject.

— TFN: Trigger false negative. Trigger failed to pull with designated operator handling firearm. Smart gun specific.

— TFP: Trigger false positive. Trigger pulled with undesignated operator handling firearm. Smart gun specific.

6.2.2 These more specific codes may be used to describe a malfunction or performance issue:

— BFM FDS: Failure of safety to disengage.

- BFM FTF: Failure of trigger to function.
- BFC STB: Stubbed round.
- BFC BUR: Bolt under rode cartridge.
- BFC BOR: Bolt overrode cartridge.
- FFD DFD: Double feed.
- FFD FFU: Failure of round to feed up from the magazine.
- FFD FBC: Failure of the bolt to cycle back far enough to pick up the next cartridge.
- FFR FSO: Failure to sear off, firing pin did not strike properly positioned cartridge.
- FFR FCP: Failure of cartridge primer, the primer has a proper indent but did not fire.
- FXT FEX: Failure of extractor to engage or stay engaged with the cartridge.
- FXT FES: Case stuck in chamber such that bolt/extractor cannot extract it.
- FEJ CSB: Case spin back (fired case exited but bounced back into the weapon).

6.3 Attribution codes

6.3.1 The following attributions codes shall be used to designate the source or underlying cause of the malfunction.

— AMO: Ammunition. Problems clearly caused by deficiency of the ammunition.

— GUN: Malfunction that is induced by the weapon itself despite proper maintenance and proper operator performance.

— MAG: Malfunctions identifiable as induced by the magazine.

— PER: Personnel. Problems induced by operator error (repetitive PER may identify a human factors problem or a deficiency in operator training procedures.)

— REP: Repetitive malfunctions. The special category termed "repetitive" is used when repeated stoppages due to a faulty component occur, and corrective action is not immediately determined or incorrect action is taken.

— SYS: System. Problems that cannot be attributable to a single cause, but are caused by the interaction of more than two components.

— TST: Test. Malfunctions induced by the test set up, such as an improper weapon mount, wrong part installed, etc.

— AUT: Authentication system malfunction. Smart gun specific.

6.4 Classification of the significance of a malfunction to the operator

6.4.1 Incidents shall be characterized by one of four classes in accordance with the following definitions:

— Class 1: The operator is able to return the firearm to an operational condition within 10 seconds using only tools and equipment carried in an operational scenario. This class is often referred to as “correctable by immediate action”.

— Class 2: More than 10 seconds are required using only tools and equipment carried in an operational scenario. This class is often referred to as “operator correctable failures”.

— Class 3: A failure not correctable by the operator because it requires a higher level of maintenance or the use of tools and parts that the operator is not authorized to carry on his person. It is correctable, however, at the lowest level organizational maintenance.

— Class 4: A failure that is not correctable in the field. The firearm must be escalated to higher-level maintenance or is unrepairable and must be scrapped.

6.5 Round counts

6.5.1 Round counts shall be the primary method of reporting where an incident occurs.

6.5.2 The round count at each event, such as a malfunction, magazine change, change of firing cycle, or maintenance action, shall be recorded.

6.5.3 The cumulative round count shall be used to correlate firing data throughout testing.

6.5.4 The final record shall be used to identify the exact conditions and sequence of each round fired.

6.6 Miscellaneous codes

6.6.1 The following miscellaneous codes shall be used:

— CIL: Clean, inspect, and lubricate.

— FRA: Failure to remain assembled.

— GFE: Government-furnished equipment.

— NT: No test, data is not reportable as test data.

— SA: Semiautomatic.

— SPM: Shots per minute (do not use rounds per minute as rpm can cause confusion).

— SS: Single shot.

— UNK: Unknown.

6.7 Data presentation

6.7.1 Data shall be presented in formats that are factual, comprehensive, and easy to understand.

6.7.2 U.S. Army Test and Evaluation Command (ATEC) Publication Number 1-8, Technical Document Style Manual may be followed regarding both printed and electronic presentations of data in reports.

6.7.3 ATEC Pamphlet 73-4, System Test and Evaluation Procedures, Chapter 4 may be followed regarding data level definitions.

7 Test methods

The test methods in 7 shall apply to a single test item. For multiple test items, the test method shall be repeated for each test item.

7.1 Initial inspection

This test is adapted from TOP 3-2-045 Test Procedures 4.1 and 4.18 to inspect test firearms for their physical characteristics, safety, and identification to serve as a baseline for subsequent inspections later in the sequence of tests.

7.1.1 Documentation requirements in 4 shall be observed at all times.

7.1.2 The firearm shall be disassembled and all major components shall be visually examined for conformance with specifications and design drawings. Any deviations from specifications shall be recorded.

7.1.3 If a firearm has been chosen for comparative analysis with and without a safety accessory, a visual examination of the safety accessory shall be conducted.

7.1.4 The firearm shall be photographed in various stages of disassembly.

7.1.5 If a firearm has been chosen for comparative analysis with and without a safety accessory, the firearm shall be photographed with and with and without the safety accessory.

7.1.6 Nondestructive testing (NDT) of components subjected to stress during firing shall be conducted in accordance with TOP 3-2-807.

— Magnetic particle inspection shall be the default NDT.

— If different or additional NDT should be required, the rationale shall be documented.

7.1.7 The following for the test item shall be recorded, as applicable:

— Test item nomenclature, serial number(s), manufacturer's name, and the corresponding locally assigned identification;

— Type and adequacy of packaging and preservatives;

— Completeness of logistic support;

— Number and names for all parts;

— Defective parts; and

— Free length or force-displacement curves for all springs, as appropriate, within the designed operating range.

7.1.8 The following firearm characteristics shall be recorded, as applicable:

— Firing pin protrusion;

— Firing pin energy or indent;

— Trigger pull;

— Headspace;

— Barrel length;

— Method of barrel attachment;

— Length of rifled bore;

— Direction and twist of rifling;

— Number of lands and grooves;

— Diameter across lands and grooves;

— Chamber dimensions;

— Charging force;

— Receiver length;

— Magazine capacity;

— Type of feed extraction, ejection, and cocking;

— Fire control selector, type, and method of operation; and

— Type of mechanism (closed or open bolt).

7.1.9 If a firearm has been chosen for comparative analysis with and without a safety accessory, the following characteristics of the safety accessory shall be recorded, as applicable:

— Method of attachment;

— Mode of operation;

— Power requirements;

— Battery type.

7.1.10 The weights of the following shall be recorded:

— Firearm without magazine;

— Empty magazine;

— Single round of ammunition;

— Fully loaded magazine; and

— Firearm with fully loaded magazine.

7.1.11 If a firearm has been chosen for comparative analysis with and without a safety accessory, the weights of the following shall additionally be recorded:

— Safety accessory; and

— Firearm with attached safety accessory and fully loaded magazine.

7.1.12 The dimensions of the firearm shall be recorded.

7.1.13 If a firearm has been chosen for comparative analysis with and without a safety accessory, the dimensions of the firearm with and without a safety accessory shall be recorded.

7.1.14 If a firearm has been chosen for comparative analysis with and without a safety accessory, the accessory shall be:

— Attached to the test firearm and checked to ensure that it remains secure;

— Inspected for possible interference with normal firearm functions, such as loading and fired case ejection; and

— Actuated for its intended purpose and observed whether it operates successfully.

7.1.15 The observations from 7.1.14 shall be recorded.

7.1.16 Sight characteristics shall be recorded as applicable to complete accuracy and dispersion tests in accordance with 7.3.

7.1.17 The time and tools necessary to accomplish complete disassembly and assembly of the test firearm shall be recorded two times by one test personnel.

7.1.18 A characteristics data sheet shall be prepared consisting of a general view photograph of the firearm along with a listing of all principal physical and performance characteristics in accordance with TOP 3-2-500.

7.2 Post-firing inspection

This test is adapted from TOP 3-2-045 Test Procedure 4.20 to inspect test firearms after each test to determine if any damage or degradation has occurred and to verify that they are suitable for the next scheduled test. The complexity of the inspection will depend on the severity of the test just completed.

7.2.1 Documentation requirements in 4 shall be observed at all times.

7.2.2 Test firearms shall be inspected at the completion of each test.

7.2.3 The minimum inspection is the CIL, as follows:

— The CIL is done at the operator's level; and

— Specialized tools and cleaning equipment may be used to expedite the effort.

7.2.4 The test firearm shall be disassembled to the "field strip" level and the following inspections shall be performed:

— Inspect the bore and chamber for residue and deposits, and preserve samples of any unusual deposits for analysis;

— Clean and visually inspect the bore and chamber;

— Inspect sliding and mating surfaces for wear, chipping, galling, etc.;

— Check springs for breakage and manually exercise them as a check on proper function;

— Visually inspect exposed parts of the firing pin, extractor, ejector, etc.;

— Examine load bearing components such as locking lugs and bolts;

— Clean, lubricate, and reassemble the weapon;

— Hand cycle a dummy cartridge to check for proper chambering, sear action, extraction, and ejection;

— Check that safety switches, etc. perform as intended;

— Check the security of safety accessory attachment, if appropriate; and

— Check the function of safety accessories, if appropriate

7.2.5 A comprehensive inspection is done at the conclusion of the test sequence of the test firearm, or at any point in the test program at the determination of test personnel

based on the performance or condition of the test firearm, which includes the CIL and may include the following as determined:

— Bore and chamber measurements;

— Magnetic particle or dye penetrant inspection of components subjected to stress during firing ;

— Free length or force-displacement curves for all springs, as appropriate;

— Firing pin protrusion and indent;

— Trigger pull force; and

— Radiographs.

7.2.6 The following data shall be recorded as obtained above:

— Results of manual and visual inspections, including photographs as required;

— Analysis of unusual residue;

— Bore and chamber measurements;

— Force-displacement spring data;

— Trigger pull force;

— Radiographs; and

— Results of magnetic particle and dye penetrant inspections.

7.3 Accuracy and dispersion

This test is adapted from TOP 3-2-045 Test Procedure 4.4 to determine the accuracy and dispersion characteristics of the test firearm and ammunition at a relevant tactical range when fired handheld from a supported position or fired from a mechanical mount secured to a rigid base.

The results of this test will be used to determine how accuracy and dispersion compare between firearms, as well as if the accuracy and dispersion of a specific test firearm are changing over the course of testing.

7.3.1 Documentation requirements in 4 shall be observed at all times.

7.3.2 Targets shall be positioned perpendicular to the line of fire.

7.3.3 Electronic targets that do not physically interfere with the bullet trajectory should be used.

7.3.4 Physical targets, such as paper, cloth, or plywood may also be used.

7.3.5 Firearms may be fired manually from a supported position and can be accomplished by seating the person firing the firearm in a comfortable position with the firearm supported by sandbags or a height adjustable rest, or a “bench rest” position.

7.3.6 The weapon should be supported such that the firer needs only to adjust the final aim of the weapon.

7.3.7 Gun mounts may be used and shall be compatible with the specific firearm being tested.

7.3.8 If a gun mount is used, the specific procedures for assembling the firearm to the mount and adjusting the aiming of the system shall be documented.

7.3.9 Velocity of the transverse wind shall not exceed 16 km/hr (10 mph) and shall not vary by more than 8 km/hr (5 mph);

7.3.10 Velocity of the wind parallel to the line of fire shall not exceed 24 km/hr (15 mph) and shall not vary by more than 12 km/hr (7.5 mph).

7.3.11 Should a compelling technical reason exist to use lower maximum transverse and parallel wind velocities, records of previous tests of the same or closely related firearm should be consulted before establishing the maximum permitted wind velocities for the test and the rationale shall be documented.

7.3.12 Firing should be done with the firearm and ammunition at standard ambient conditions as specified in 5.3.10.

7.3.13 The ambient air temperature along the trajectory of the bullet may fall outside standard ambient conditions.

7.3.14 Targets for pistols, revolvers, and shotguns shall be positioned at a range of 25 and 50 meters.

7.3.15 Targets for rifles shall be positioned at a range of 50, 100, and 200 meters.

7.3.16 The test firearm shall be disassembled, cleaned, lubricated, and reassembled.

7.3.17 The firearm shall be zeroed in accordance with the product manuals or product information.

7.3.18 The firearm shall be zeroed for 100 meters if product manuals are not available or do not specify the value.

7.3.19 Necessary rounds to assure that the firearm is sighted on target shall be fired, often referred to as "sighting rounds."

7.3.20 If sighting rounds are not required, three rounds shall be fired to condition the barrel, often referred to as "warmer rounds."

7.3.21 Three targets shall be fired.

7.3.22 Ten rounds shall be fired from the test firearm at each target from a bench rest or mechanical mount.

7.3.23 Sight alignment shall be checked before each shot is fired.

7.3.24 An optical or laser boresight may be used as necessary to check alignment to the target aiming point if the firearm is not equipped with sights.

7.3.25 The velocity as corrected to muzzle shall be recorded using appropriate instrumentation for each shot of the accuracy and dispersion test.

7.3.26 The same instrumentation shall be used for the duration of the test.

7.3.27 Accuracy and dispersion measurements shall be calculated in accordance with the methods in ITOP 4-2-829.

7.3.28 The following data shall be measured and recorded:

— X and Y coordinates of each impact relative to the aim point;

— The velocity of each shot;

- Target data reduced in accordance with ITOP 4-2-829;
- Target ranges and type(s) of target(s);
- Photographs of test mounts and bench rest firing facility;
- Procedures used to mount and fire weapons; and
- Meteorological conditions, including transverse and parallel wind velocities.

7.4 Reliability and durability

This test is adapted from TOP 3-2-045 Test Procedure 4.3 to determine the performance of the test firearm and its component parts over a substantial number of rounds fired.

Always be alert for indications of imminent barrel failure!

— These indications may include an increase in muzzle flash, erratic flight of bullets, an increase in the malfunction rate, and any other significant change in firearm performance.

— Since firearms barrels are often fired to, or past, the limits of serviceability, the possibility exists for erratic bullet flight and deviations from the established line-of-fire.

— The nature of this test also requires firing an unusually large number of rounds per day which may also increase toxic fumes to levels above those more typically encountered.

7.4.1 Documentation requirements in 4 shall be observed at all times.

7.4.2 Suitable personal protective equipment shall be donned during firing such as gloves, pads, and other appropriate attire for protection from hot gun barrels and expended cartridge cases.

7.4.3 All firing shall be done with the firearm firmly handheld or held in an appropriate mount.

7.4.4 The firing range shall have adequate ventilation to reduce the exposure to toxic fumes.

7.4.5 The test firearm shall be disassembled, cleaned, inspected, lubricated, and reassembled.

7.4.6 Headspace and barrel bore measurements shall be recorded.

7.4.7 The basic firing cycle shall constitute firing approximately 120 rounds, given in 7.4.8 through 7.4.11 for the particular type of firearm being tested.

7.4.8 Pistols shall have a basic firing cycle that is a multiple of the number of rounds in the magazine totaling approximately 120 rounds.

— Example 1: If the magazine holds 12 rounds, the basic firing cycle would include 10 full magazines for a total of 120 rounds.

— Example 2: If the magazine holds 11 rounds, the basic firing cycle would include 11 full magazines for a total of 121 rounds.

7.4.9 Revolvers shall have a basic firing cycle that is a multiple of the number of rounds in the cylinder totaling approximately 120 rounds.

— Example 1: If the cylinder holds 6 rounds, the basic firing cycle would include 20 full cylinders for a total of 120 rounds.

— Example 2: If the cylinder holds 5 rounds, the basic firing cycle would include 24 full cylinders for a total of 120 rounds.

7.4.10 Shotguns shall have a basic firing cycle of 120 shells.

7.4.11 Rifles shall have a basic firing cycle that is a multiple of the number of rounds in the magazine totaling approximately 120 rounds.

— Example 1: If the magazine holds 17 rounds, the basic firing cycle would include 7 full magazines for a total of 119 rounds.

— Example 2: If the magazine holds 20 rounds, the basic firing cycle would include 6 full magazines for a total of 120 rounds.

7.4.12 The firing procedure for "light-duty" testing shall include 5 basic firing cycles for a total round count of approximately 600 rounds.

— Example: The firing procedure for a pistol with a magazine that holds 12 rounds would include 5 basic firing cycles of 120 rounds per basic firing cycle.

7.4.13 The firing procedure for "heavy-duty" testing shall include 50 basic firing cycles for a total round count of approximately 6,000 rounds.

— Example: The firing procedure for a pistol with a magazine that holds 12 rounds would include 50 basic firing cycles of 120 rounds per basic firing cycle.

7.4.14 If the firing procedure should differ from 7.4.12 or 7.4.13, the firing procedure shall be specified.

7.4.15 Firing shall be done at a regular cadence of approximately one shot per second for semiautomatic or one shot per five seconds for single-shot firearms.

7.4.16 Reloading and magazine changes should be done at a pace that can be comfortably maintained throughout the firings.

7.4.17 Gun safety technology features shall be deactivated and reactivated periodically to ensure for proper functioning in accordance with the following:

— Pistols: Between reloading magazines.

— Revolver: Between reloading the cylinder.

— Shotguns: Ten times per basic firing cycle at regularly spaced intervals.

— Revolvers: Between reloading magazines or ten times per basic firing cycle at regularly spaced intervals if the rifle does not use a magazine.

7.4.18 The firing procedure shall include appropriate breaks for cooling, cleaning, lubrication, and other maintenance activities.

7.4.19 Parts shall be replaced only when they become unserviceable or present a safety hazard.

7.4.20 The first rounds of the first cycle shall include testing accuracy and dispersion in accordance with 7.3.

7.4.21 The firearm shall be allowed to cool for a minimum of 10 minutes after each basic firing cycle, or approximately every 120 rounds.

7.4.22 The firearm shall be cooled to the point that the barrel can be held indefinitely in a bare hand every two basic firing cycles, or approximately every 240 rounds.

7.4.23 The firearm shall be wiped and lubricated without disassembly after every five basic firing cycles, or approximately every 600 rounds.

7.4.24 The firearm shall be disassembled, cleaned, inspected, lubricated, and reassembled every 10 basic firing cycles, or approximately every 1,200 rounds.

7.4.25 Accuracy and dispersion measurements shall be repeated every 10 basic firing cycles, or approximately every 1,200 rounds.

7.4.26 NDT shall be added to the CIL every 20 basic firing cycles, or approximately every 2,400 rounds.

7.4.27 The following data shall be recorded:

— Bore and headspace measurements;

— NDT results;

— Temperature and exposure times;

— Malfunctions in accordance with 6;

— All maintenance actions performed;

— All difficulties in loading or operating the firearms; and

— Meteorological conditions.

7.5 High temperature

This test is adapted from TOP 3-2-045 Test Procedure 4.5.1.a to determine the effect of high temperatures on the performance of firearms.

Personnel are required to load, fire, and service the firearm in a high temperature environment!

— Precautions must be taken to prevent possible heat injuries.

— Local SOPs must be followed to prevent possible heat injuries.

7.5.1 Documentation requirements in 4 shall be observed at all times.

7.5.2 Conditioning test items in a hot test environment shall be done in accordance with MIL-STD-810G, Method 501.6.

7.5.3 Conditioning shall follow the Basic Hot (A2) profile as described in MIL-STD-810G, Method 501.6 based on climatic data found in AR 70-38.

7.5.4 Prior to conditioning, the test firearm shall be cleaned and lubricated with a lubricant specified for high temperatures.

7.5.5 Prior to firing, the test firearm and ammunition shall be conditioned in a climatic chamber for at least 6 hours at 63°C (145°F), which corresponds to the upper bound of the induced air temperature for Basic Hot (A2).

7.5.6 The basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.5.7 The firing procedure for "light-duty" testing shall include one basic firing cycle for a total round count of approximately 120 rounds.

7.5.8 The firing procedure for "heavy-duty" testing shall include eight basic firing cycles for a total round count of approximately 960 rounds.

7.5.8.1 Two basic firing cycles, or approximately 240 rounds~~,~~ shall be fired from the test firearm.

7.5.8.2 The test firearm shall be reconditioned in the climatic chamber for at least two hours at 63°C (145°F).

7.5.8.3 7.5.8.1 and 7.5.8.2 shall be repeated until eight basic firing cycles, or approximately 960 rounds, have been fired.

7.5.9 Firing shall be done in accordance with 7.4.15 through 7.4.17.

7.5.10 Maintenance should not be performed prior to all rounds being fired.

7.5.11 If maintenance is required before the end of the firing procedure, as indicated by increased malfunction rate, difficulty in loading or operating the firearm, etc., the firearm shall be removed from the climatic chamber and maintenance shall be performed as required.

7.5.12 After all rounds have been fired, the test firearm shall be removed from the conditioning chamber and allowed to cool.

7.5.13 The test firearm shall be immediately disassembled, thoroughly inspected, cleaned, and lubricated in accordance with 7.2.

7.5.14 Any changes observed shall be recorded.

7.5.15 The following data shall be recorded:

— Temperature and exposure times;

— Malfunctions in accordance with 6;

— Any damage noted during inspection;

— All maintenance actions performed; and

— All difficulties in loading or operating the firearms.

7.6 Low temperature

This test is adapted from TOP 3-2-045 Test Procedure 4.5.1.b to determine the effect of low temperatures on the performance of firearms.

Personnel are required to load, fire, and service the firearm in a low temperature environment!

— Precautions must be taken to prevent possible injuries due to the cold environment.

— Local SOPs must be followed to prevent possible injuries due to the cold environment.

— Particular attention must be given to avoid the contact of bare skin with the firearm, ammunition, or any cold surface.

7.6.1 Documentation requirements in 4 shall be observed at all times.

7.6.2 Conditioning test items in a hot test environment shall be done in accordance with MIL-STD-810G, Method 502.6.

7.6.3 Conditioning shall follow the Basic Cold (C1) profile as described in MIL-STD-810G, Method 501.6 based on climatic data found in AR 70-38.

7.6.4 Prior to conditioning, the test firearm shall be cleaned and lubricated with a lubricant specified for high temperatures.

7.6.5 Prior to firing, the test firearm and ammunition shall be conditioned in a climatic chamber for at least 6 hours at -33°C (-28°F), which corresponds to the lower bound of the induced air temperature for the Basic Cold (C1) profile.

7.6.6 The basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.6.7 The firing procedure for "light-duty" testing shall include one basic firing cycle for a total round count of approximately 120 rounds.

7.6.8 The firing procedure for "heavy-duty" testing shall include eight basic firing cycles for a total round count of approximately 960 rounds.

7.6.8.1 Two basic firing cycles, or approximately 240 rounds, shall be fired from the test firearm.

7.6.8.2 The test firearm shall be reconditioned in the climatic chamber for at least two hours at -33°C (-28°F).

7.6.8.3 7.6.8.1 and 7.6.8.2 shall be repeated until eight basic firing cycles, or approximately 960 rounds, have been fired.

7.6.9 Firing shall be done in accordance with 7.4.15 through 7.4.17.

7.6.10 Maintenance should not be performed prior to all rounds being fired.

7.6.11 If maintenance is required before the end of the firing procedure, as indicated by increased malfunction rate, difficulty in loading or operating the firearm, etc., the firearm shall be removed from the climatic chamber and maintenance shall be performed as required.

7.6.12 After all rounds have been fired, the test firearm shall be removed from the conditioning chamber and allowed to warm up.

7.6.13 The test firearm shall be immediately disassembled, cleaned, inspected, and lubricated in accordance with 7.2.

7.6.14 Any changes observed shall be recorded.

7.6.15 The following data shall be recorded:

— Temperature and exposure times;

— Malfunctions in accordance with 6;

— Any damage noted during inspection;

— All maintenance actions performed;

— Any difficulties in loading or operating the firearms peculiar to operation at low temperature, including any difficulties when using cold weather gear; and

— Evidence of bullet instability.

7.7 Humidity

This test is adapted from TOP 3-2-045 Test Procedure 4.5.2 to determine the effect of high humidity on the performance of firearms.

7.7.1 Documentation requirements in 4 shall be observed at all times.

7.7.2 Conditioning test items in a humid test environment shall be done in accordance with MIL-STD-810G, Method 507.6.

7.7.3 Conditioning shall follow the Aggravated Cycle outlined in 4.4.2.2 and shown in Table 507.6-7 in MIL-STD-801G.

— Maintain the relative humidity at 95±4% at all times except that during the descending temperature periods the relative humidity may drop to as low as 85%.

— A cycle is 24 hours.

— The temperature profile is as follows:

Time	T (°C)	T (°F)
00:00	30	86
02:00	60	140
08:00	60	140
16:00	30	86
24:00	30	86

7.7.4 Prior to conditioning, the test firearm shall be cleaned and lubricated with a lubricant specified for high temperatures.

7.7.5 Prior to firing, the test firearm and ammunition shall be conditioned in the climatic chamber for at least 24 hours at -27±2°C (73±3.6°F) and 50±5% RH.

7.7.6 The test firearm shall be exposed to the temperatures and humidity in 7.7.3 for ten consecutive 24-hour cycles in the climatic chamber.

7.7.7 The ammunition required for this test shall not be exposed to the environmental conditions.

7.7.8 The test firearm shall be removed from the climatic chamber between hour 20 and hour 24 of the exposure cycle for test firings.

7.7.9 The basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.7.10 Two basic firing cycles, or approximately 240 rounds, shall be fired from the test firearm during the third, fifth, eighth, and tenth cycles.

7.7.11 Firing shall be done in accordance with 7.4.15 through 7.4.17.

7.7.12 The test firearm shall be placed back into the climatic chamber without cleaning, lubrication, or maintenance after each pair of two basic firing cycles.

7.7.13 Maintenance should not be performed prior to all rounds being fired.

7.7.14 If maintenance is required before the end of the firing procedure, as indicated by increased malfunction rate, difficulty in loading or operating the firearm, etc., maintenance shall be performed as required.

7.7.15 If an unscheduled interruption occurs that causes the exposure conditions to fall below allowable limits, the test shall be restarted from the end of the last successfully completed 24-hour cycle.

7.7.16 After 960 rounds have been fired through the test firearm, the test firearm shall be immediately disassembled, cleaned, inspected, and lubricated in accordance with 7.2.

7.7.17 Any changes observed shall be recorded.

7.7.18 The following data shall be recorded:

— Records to substantiate proper exposure chamber operation;

— Malfunctions in accordance with 6;

— Any damage noted during inspection; and

— All maintenance actions performed.

7.8 Sand and dust

This test is adapted from TOP 3-2-045 Test Procedure 4.5.4.b(4) to determine the effects of blowing sand and dust on firearm performance.

Caution should be exercised when handling the sand and dust compounds!

— These compounds are largely composed of silica which is considered hazardous under Occupational Safety and Health Administration standards.

— Obtain the manufacture's Material Safety Data Sheet for additional information.

— Consult local safety specialists with questions on proper handling procedures.

7.8.1 Documentation requirements in 4 shall be observed at all times.

7.8.2 Conditioning test items in a sandy and dusty conditioning environment shall be done in accordance with MIL-STD-810G, Method 510.6.

7.8.3 Sand and dust exposure shall be conducted in a static chamber.

7.8.4 The chamber is a box of any size that allows free circulation of the sand and dust laden air around the test firearm.

7.8.5 A volumetric dry feeder and electric blower should be attached to the back end of the chamber.

7.8.6 The feeder shall deliver a constant but adjustable flow of dust mixture to the air delivery duct of the blower.

7.8.7 Vents should be provided to relieve any buildup of air pressure and aid air circulation.

7.8.8 Access doors, windows, and cable ports may be incorporated as needed, but they shall fit tightly enough to contain the circulating atmosphere.

7.8.9 The chamber may be bottomless so that it can be lowered over the test firearm and mount.

7.8.10 The chamber does not need to accommodate firings, but it should be located as closely as possible to a firing position.

7.8.11 The sand and dust compounds that should be used are those identified in 5.3.24.

7.8.12 Should these compounds not be available, similar compounds can be substituted.

7.8.13 The test firearm shall be cleaned and lubricated prior to conditioning.

7.8.14 One basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.8.15 The test firearm shall be conditioned fully loaded in a "safe" state.

7.8.16 The remaining ammunition to permit one basic firing cycle of rounds shall not be conditioned.

7.8.17 The test firearm shall be positioned vertically in in a normal firing position inside the chamber.

7.8.18 The volumetric feeder and electric blower of the static test chamber shall be adjusted to dispense the mixture at a rate of 100±25 g/min·m^2 as specified in 5.3.23 over the area of concern.

7.8.19 The actual rate can be determined prior to exposure of the test firearm by placing a flat collection plate of known size in the position to be occupied by the test firearm, operating the chamber for one minute, and weighing the mixture that has been deposited on the plate.

7.8.20 The dust dispenser shall be turned on and operated for 5 minutes.

7.8.21 After 5 minutes, the dispenser shall be turned off and the dust shall be allowed to settle before entering the chamber.

7.8.22 The exposed test firearm and ammunition shall be transported to the firing position while disturbing any sand and dust deposits as little as possible.

7.8.23 Firing shall be done in accordance with 7.4.15 through 7.4.17.

7.8.24 Maintenance should not be performed prior to all rounds being fired.

7.8.25 If firearm performance is unsatisfactory, the congested parts shall be cleaned as much as possible by blowing sharply or by jarring the firearm.

7.8.26 If performance is still unsatisfactory, any remaining exposed ammunition shall be replaced with clean ammunition.

7.8.27 If repeated malfunctions make it impossible to fire all of the ammunition, the test firearm shall be cleaned, inspected, and lubricated prior to firing the remaining ammunition.

7.8.28 If repeated malfunctions make it impractical to fire the remaining ammunition, the test firearm shall be completely disassembled to determine the exact source of dust-induced malfunction.

7.8.29 The test firearm shall be reassembled and several rounds shall be fired to verify serviceability.

7.8.30 At the end of the test, the test firearm shall be immediately disassembled, cleaned, inspected, and lubricated in accordance with 7.2.

7.8.31 Any changes observed shall be recorded.

7.8.32 The following data shall be recorded:

— Full specification of the sand and dust compounds used;

— Actual sand and dust dispensing rate;

— Chamber dimensions;

— Position of the test firearm and ammunition while in the chamber;

— Any difficulties encountered during operation of the test firearm;

— Actual number of rounds fired;

— Malfunctions in accordance with 6;

— Any damage noted during inspection; and

— All maintenance actions performed.

7.9 Water immersion

This test is adapted from TOP 3-2-045 Test Procedure 4.5.6 and MIL-STD-810G Method 512.6 to determine firearm performance following water immersion.

7.9.1 Documentation requirements in 4 shall be observed at all times.

7.9.2 Immersing test items in water shall be done in accordance with MIL-STD-810G, Method 512.6.

7.9.3 A water container that can achieve a covering depth of 1 m of water over the uppermost point of the test item and maintain the test item at that depth shall be used.

7.9.4 The temperature of the water shall be 18°C ±10°C (64°F ±18°F).

7.9.5 The immersion water temperature shall be measured and recorded.

7.9.6 The test firearm shall be cleaned and lubricated prior to immersion.

7.9.7 A complete visual examination of the test firearm shall be conducted prior to immersion with special attention to sealed areas, gaskets, seals, and structural integrity, and the results shall be documented.

7.9.8 Additional sealing, taping, caulking, or other means to resist water leakage shall not be used on the test firearm.

7.9.9 One basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.9.10 The test firearm shall be immersed fully loaded in a “safe” state.

7.9.11 The remaining ammunition to permit one basic firing cycle of rounds shall not be immersed.

7.9.12 The fully loaded test firearm shall be weighed prior to immersion.

7.9.13 The test firearm shall be stabilized at standard ambient conditions prior to immersion.

7.9.14 The test firearm shall be positioned vertically in in a normal firing position inside the immersion container.

7.9.15 The test firearm shall be secured in a manner that will allow it to be maintained at the immersion depth in 7.9.3.

7.9.16 The test firearm shall be immersed so that the uppermost point of the test item is 1.0±0.1 m below the surface of the water.

7.9.17 The test firearm shall be immersed for 5 minutes.

7.9.18 After 5 minutes, the test firearm shall be removed from the water and the exterior shall be wiped dry.

7.9.19 The test item shall be weighed immediately after immersion and exterior wiping.

7.9.20 The exposed test firearm shall be transported to the firing position.

7.9.21 Firing shall be done in accordance with 7.4.15 through 7.4.17.

7.9.22 Maintenance should not be performed prior to all rounds being fired.

7.9.23 If firearm performance is unsatisfactory, the test firearm shall be item and examined evidence of water leakage. Any water found and probable points of entry shall be documented and blotted away.

7.9.24 If performance is still unsatisfactory, any remaining exposed ammunition shall be replaced with clean ammunition.

7.9.25 If repeated malfunctions make it impossible to fire all of the ammunition, the test firearm shall be cleaned, inspected, and lubricated prior to firing the remaining ammunition.

7.9.26 If repeated malfunctions make it impractical to fire the remaining ammunition, the test firearm shall be completely disassembled to determine the exact source of water-induced malfunction.

7.9.27 The test firearm shall be reassembled and several rounds shall be fired to verify serviceability.

7.9.28 At the end of the test, the test firearm shall be immediately disassembled, cleaned, inspected, and lubricated in accordance with 7.2.

7.9.29 Any changes observed shall be recorded.

7.9.30 The following data shall be recorded:

— Immersion container dimensions;

— Position of the test firearm and ammunition while in the immersion container;

— Any difficulties encountered during operation of the test firearm;

- Actual number of rounds fired;
- Malfunctions in accordance with 6;
- Any damage noted during inspection; and
- All maintenance actions performed.

7.10 1.5 m drop

This test is adapted from TOP 3-2-045 Test Procedure 4.10, NIJ Standard 0112.03 Revision A Test 5.7, NIJ Standard 0109.00, and NIJ Standard 0113.00 to assess the possibility of accidental firing by dropping the firearm from a height of 1.5 m (approximately 5 ft).

This test may damage the test item and therefore should be done near the end of the overall test sequence!

7.10.1 Documentation requirements in 4 shall be observed at all times.

7.10.2 The test firearm shall be chambered with a primed but otherwise empty cartridge.

7.10.3 The firearm shall be loaded to capacity with dummy ammunition, which shall consist of rounds for the firearm being tested with a projectile in place but no primer and no propellant.

7.10.4 The test firearm shall be dropped onto a clean, level concrete surface.

7.10.5 The test firearm shall be dropped from a height of 1.5 m.

7.10.6 The drop height shall be measured from the surface of the concrete to the lower most point of the firearm.

7.10.7 The test firearm shall be dropped one time in each of the following orientations:

— Normal firing orientation, barrel horizontal;

— Upside down, barrel horizontal;

— On grip or butt, barrel vertical;

— On muzzle, barrel vertical;

— On left side, barrel horizontal;

— On right side, barrel horizontal; and

— On grip or butt, barrel 45° from vertical;

— On muzzle, barrel 45° from vertical;

7.10.8 If the test firearm has an exposed hammer or striker, the firearm shall be dropped on the rearmost point of that device. Otherwise, it shall be dropped on the rearmost point of the test firearm.

7.10.9 A video shall be recorded to verify the proper impact orientation.

7.10.10 The test firearm should be dropped by mechanical means, such as a fixture, but can be manually released in the required orientation.

— For example, a firearm or firearm accessory that uses RFID with a body-worn token can be dropped from a fixture with the token attached to the fixture.

— For example, a firearm or firearm accessory with an integrated fingerprint sensor will likely need a human operator to drop the device.

7.10.11 The firearm shall be dropped in the condition that it would be in if it were dropped when in hand and ready to fire.

7.10.12 Any additional gun safety technology shall be activated to permit firing prior to the drop tests and remain active for all drops.

7.10.13 The test firearm shall be cycled and returned to the specified testing condition after each drop.

7.10.14 The drop tests in 7.10.7 shall be repeated ten times with the manual safety off.

7.10.15 The drop tests in 7.10.7 shall be repeated ten times with the manual safety in the "safe" mode.

7.10.16 The firearm shall be inspected after each drop with following information recorded:

— The position of the manual safety;

— The state of the gun safety technology;

— The condition of the primed cartridge; and

— Any damage to the test firearm.

7.10.17 If the primed cartridge case has fired or if indentations are present, a fresh primed case shall be used for the next drop.

7.10.18 After all drops have been made, one basic firing cycle shall be fired through the test firearm.

7.10.19 The basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.10.20 Firing shall be done in accordance with 7.4.15 through 7.4.17.

7.10.21 Maintenance should not be performed prior to all rounds being fired.

7.10.22 If firearm performance is unsatisfactory, the test firearm shall be item and examined evidence of damage. Any damage found and shall be documented.

7.10.23 If repeated malfunctions make it impractical to fire the remaining ammunition, the test firearm shall be completely disassembled and serviced to bring it to a state of normal operation.

7.10.24 The test firearm shall be reassembled and several rounds shall be fired to verify serviceability.

7.10.25 At the end of the test, the test firearm shall be immediately disassembled, cleaned, inspected, and lubricated in accordance with 7.2.

7.10.26 Any changes observed shall be recorded.

7.10.27 The following data shall be recorded:

— Video recording of each drop;

— The position of the manual safety after each drop;

— The state of the gun safety technology after each drop;

— The condition of the primed cartridge after each drop;

— Any damage to the test firearm.

— Any difficulties encountered during operation of the test firearm;

— Actual number of rounds fired;

— Malfunctions in accordance with 6;

— Any damage noted during inspection; and

— All maintenance actions performed.

7.11 Mechanical jostling

This test is adapted from TOP 3-2-045 Test Procedure 4.10 to assess the possibility of accidental firing and to determine any impact on performance due to mechanical jostling.

This test may damage the test item and therefore should be done near the end of the overall test sequence!

7.11.1 Documentation requirements in 4 shall be observed at all times.

7.11.2 Exposure of test items to mechanical jostling shall be done in accordance with with ITOP 4-2-602 Loose Cargo Test.

7.11.3 The test firearm shall be chambered with a primed but otherwise empty cartridge.

7.11.4 The firearm shall be loaded to capacity with dummy ammunition, which shall consist of rounds for the firearm being tested with a projectile in place but no primer and no propellant.

7.11.5 The firearm shall be exposed to mechanical jostling in the condition that it would be in if it were in hand and ready to fire.

7.11.6 Any additional gun safety technology shall be deactivated to prevent firing prior to mechanical jostling and remain active throughout exposure.

7.11.7 The test machine shall be operated at a 25 mm peak circular motion at a frequency of 5 Hz.

7.11.8 The test firearm shall be placed in the test machine left side down.

7.11.9 The test machine shall be operated for 5 minutes.

7.11.10 The test firearm shall be placed in the test machine right side down.

7.11.11 The test machine shall be operated for 5 minutes.

7.11.12 The test firearm shall be cycled and returned to the specified testing condition after each 5-minute exposure.

7.11.13 The exposure in 7.11.9 shall be repeated ten times with the manual safety in the "safe" mode.

7.11.14 The exposure in 7.11.11 shall be repeated ten times with the manual safety off.

7.11.15 The firearm shall be inspected after each 5-minute exposure with following information recorded:

— The position of the manual safety;

— The condition of the primed cartridge; and

— Any damage to the test firearm.

7.11.16 If the primed cartridge case has fired or if indentations are present, a fresh primed case shall be used for the next drop.

7.11.17 After all exposures have been completed, one basic firing cycle shall be fired through the test firearm.

7.11.18 The basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.11.19 Firing shall be done in accordance with 7.4.15 through 7.4.17.

7.11.20 Maintenance should not be performed prior to all rounds being fired.

7.11.21 If firearm performance is unsatisfactory, the test firearm shall be item and examined evidence of damage. Any damage found and shall be documented.

7.11.22 If repeated malfunctions make it impractical to fire the remaining ammunition, the test firearm shall be completely disassembled and serviced to bring it to a state of normal operation.

7.11.23 The test firearm shall be reassembled and several rounds shall be fired to verify serviceability.

7.11.24 At the end of the test, the test firearm shall be immediately disassembled, cleaned, inspected, and lubricated in accordance with 7.2.

7.11.25 Any changes observed shall be recorded.

7.11.26 The following data shall be recorded:

— The position of the manual safety after each 5-minute exposure;

— The condition of the primed cartridge after each 5-minute exposure;

— Any damage to the test firearm;

— Any difficulties encountered during operation of the test firearm;

- Actual number of rounds fired;
- Malfunctions in accordance with 6;
- Any damage noted during inspection; and
- All maintenance actions performed.

7.12 Electromagnetic interference (EMI)

This test is adapted from TOP 3-2-045 Test Procedure 4.22.2(e) to ensure that the test firearm is able to function in its intended electromagnetic environment without its own performance being degraded. Gun safety technology can contain electronic components that may be susceptible to EMI.

7.12.1 Documentation requirements in 4 shall be observed at all times.

7.12.2 Exposure of test items to EMI shall be done in accordance with TOP 1-2-512 Electromagnetic Compatibility Tests.

7.12.3 The firearm shall be fired in the presence of electromagnetic radiation that could cause interference with the functioning of any integrated gun safety technology. If the test facility cannot accommodate live firing, the weapon may be dry fired to verify proper function of the safety technology.

7.12.4 The specific frequencies that will need to be assessed will depend on the specific test item, however the appropriate tests in TOP 1-2-512 should be followed. If possible, one major frequency at a realistic signal strength should be identified for testing.

7.12.5 Prior to exposure, the test firearm shall be cleaned and lubricated.

7.12.6 The basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.12.7 The firing procedure for "light-duty" testing shall include one basic firing cycle for a total round count of approximately 120 rounds.

7.12.8 The firing procedure for "heavy-duty" testing shall include eight basic firing cycles for a total round count of approximately 960 rounds.

7.12.9 The transmitter shall be turned on five minutes prior to firing.

7.12.10 Firing shall be done in accordance with 7.4.15 through 7.4.17.

7.12.11 Maintenance should not be performed prior to all rounds being fired.

7.12.12 After all rounds have been fired, the transmitter shall be turned off.

7.12.13 If firearm performance is unsatisfactory, the signal strength shall be reduced.

7.12.14 If repeated malfunctions make it impractical to continue firing, the signal strength shall be reduced until the malfunctions are not having a substantial impact on firing.

7.12.15 At the end of the test, the test firearm shall be immediately disassembled, cleaned, inspected, and lubricated in accordance with 7.2.

7.12.16 Any changes observed shall be recorded.

7.12.17 The following data shall be recorded:

— The frequency broadcast;

— The signal strength of the broadcast;

— Any reductions made to the signal strength;

— Any difficulties encountered during operation of the test firearm;

— Actual number of rounds fired;

— Malfunctions in accordance with 6;

— Any damage noted during inspection; and

— All maintenance actions performed.

7.13 Quick draw scenario

This test is designed to determine how a firearm performs when grabbed by the operator from a tabletop and a holster and immediately fired.

7.13.1 Documentation requirements in 4 shall be observed at all times.

7.13.2 Targets shall be positioned perpendicular to the line of fire.

7.13.3 Electronic targets that do not physically interfere with the bullet trajectory should be used.

7.13.4 Physical targets, such as paper, cloth, or plywood may also be used.

7.13.5 Targets for shall be positioned at a range of 10 meters.

7.13.6 Timing devices shall be used to measure the time from a signal to fire to the discharge by the test operator.

7.13.7 One signal shall be audible, such as a beep, chime, or buzz.

7.13.8 One signal shall be visual, such as a light that turns on.

7.13.9 The choice of audible or visual signal in each trial shall be random such that the test operator cannot expect the signal to be the same time each trial.

7.13.10 The time that the signal is activated shall be random such that the test operator cannot expect the signal at the same time each trial.

7.13.11 Timing shall be measured in one of two ways:

— The time from the signal to firearm discharge; or

— The time from the signal to a round hitting or passing the target.

7.13.12 Two setups shall be used, a tabletop setup and a holster setup.

7.13.13 For the tabletop setup, a fully loaded test firearm shall be placed on a table 1.0 meters high in front of the test operator.

7.13.14 If the operator is right-handed, the test firearm shall be placed on its left side. If the operator is left-handed, the test firearm shall be placed on its right side.

7.13.15 Starting from a comfortable standing position, the firing personnel shall pick up the test firearm from the tabletop upon hearing or seeing the signal and fire one shot as quickly as possible at the target.

7.13.16 The firing personnel shall return the test firearm to the table in the same position.

7.13.17 The following data shall be recorded after each trial:

— The type of signal used, either audible or visual;

— Timing in accordance with 7.13.11;

— Malfunctions in accordance with 6; and

— Any difficulties encountered during operation of the test firearm;

7.13.18 For the holster setup, a fully loaded test firearm shall be placed in an appropriate holster on the test operator.

7.13.19 The holster shall be worn on the waist on the same side of the body as the firing hand.

7.13.20 Starting from a comfortable standing position, the firing personnel shall draw the test firearm from the holster upon hearing or seeing the signal and fire one shot as quickly as possible at the target.

7.13.21 The firing personnel shall return the test firearm to the holster.

7.13.22 The following data shall be recorded after each trial:

— The type of signal used, either audible or visual;

— Timing in accordance with 7.13.11;

— Malfunctions in accordance with 6; and

— Any difficulties encountered during operation of the test firearm;

7.13.23 The basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.13.24 For “light-duty” testing, one test operator shall fire one basic firing cycle using the tabletop setup and one basic firing cycle using the holster setup.

7.13.25 For “heavy-duty” testing, three test operators shall each fire one basic firing cycle using the tabletop setup and one basic firing cycle using the holster setup.

7.13.26 At the end of the test, the test firearm shall be immediately disassembled, cleaned, inspected, and lubricated in accordance with 7.2.

7.13.27 Any changes observed shall be recorded.

7.11.28 The following data shall be recorded:

— The type of signal used, either audible or visual;

— Timing in accordance with 7.13.11;

— Any difficulties encountered during operation of the test firearm;

— Actual number of rounds fired;

— Malfunctions in accordance with 6;

— Any damage noted during inspection; and

— All maintenance actions performed.

7.14 Unauthorized user false positive

This test is designed to determine how a gun safety technology performs when an unauthorized operator attempts to fire a smart gun.

7.14.1 Documentation requirements in 4 shall be observed at all times.

7.14.2 The test operator should not be authorized to use the firearm, depending on the modality of the gun safety technology employed.

— For example, if the smart gun uses RFID and a body-worn token, the operator should not wear the token and it should be kept well out of range from the test firearm.

— For example, if the smart gun uses a fingerprint sensor, the operator should not have fingerprint data loaded on the onboard memory.

7.14.3 A fully loaded test firearm shall be placed on a table 1.0 meters high in front of the test operator.

7.14.4 If the operator is right-handed, the test firearm shall be placed on its left side. If the operator is left-handed, the test firearm shall be placed on its right side.

7.14.5 Starting from a comfortable standing position, the firing personnel shall pick up the test firearm and attempt to fire one shot at the target.

7.14.6 The firing personnel shall return the test firearm to the table in the same position.

7.14.7 The following data shall be recorded after each trial:

— The result of each trial;

— Malfunctions in accordance with 6; and

— Any difficulties encountered during operation of the test firearm;

7.14.8 The basic firing cycle for the particular type of firearm being tested described in 7.4.8 through 7.4.11 shall be used.

7.14.9 For “light-duty” testing, one test operator shall attempt to fire one basic firing cycle.

7.14.10 For “heavy-duty” testing, three test operators shall each attempt to fire one basic firing cycle.

7.14.11 At the end of the test, the test firearm shall be immediately disassembled, cleaned, inspected, and lubricated in accordance with 7.2.

7.14.12 Any changes observed shall be recorded.

7.14.13 The following data shall be recorded:

— The result of each trial;

— Any difficulties encountered during operation of the test firearm;

— Actual number of rounds fired;

— Malfunctions in accordance with 6;

— Any damage noted during inspection; and

— All maintenance actions performed.