H.P. WHITE LABORATORY, INC.

-SMALL ARMS SAFETY EXAMINATION AND TEST PROCEDURES-

SECTION I. INTRODUCTION

1. Background

The firearms industry provides configuration controls and minimum performance standards for commercially marketed guns and ammunition but these controls and standards have been limited to controlling those features of the gun and ammunition which will insure their configuration compatibility and safe operating pressures.

Compliance with these controls and standards is voluntary and no legal or industrial sanctions are invoked for non-compliance short of litigation resulting from an accidental firing or pressure related gun failure. As a result of this practice, increasing numbers of manufacturers have found themselves involved in safety related litigations wherein the plaintiff seeks ever increasing settlements. While many of these claims are not morally attributable to the manufacturer, most could be avoided by a comprehensive test and examination of the safety related features of the firearm.

Recognizing their apparently limitless financial exposure to safety related product liability litigations, many gun manufacturers have initiated safety related testing of their own or have asked H.P. White Laboratory, Inc. to develop testing procedures and conduct tests of their products in accordance with those procedures.

2. Objective

The objective of these procedures is to identify the principal design features of a handgun, rifle or shotgun which could contribute to a firearm accident and put forth testing procedures which will confirm or deny the adequacy of the design features of a specific model of gun to resist those factors which result in firearm accidents.

3. Scope

The scope of these procedures is limited to the evaluation of design features relating to firearms safety of conventional configurations of guns and ammunition marketed in the United States and which are in compliance with U.S. regulations controlling commercial sales and use of sporting guns and ammunition. All other factors not relating to safety (performance, reliability, etc.) are beyond the scope of these procedures.

4. Applicable Documents

Unless otherwise specified herein all reference to configuration and performance controls are those promulgated by the latest revisions and additions of the following documents:

a) Performance Standards For Pressure and Velocity of Centerfire Pistol and Revolver Ammunition (SAAMI).

b) Performance Standards For Pressure and Velocity of Rimfire Sporting Ammunition (SAAMI).

c) Performance Standards For Pressure and Velocity of Shotshell Ammunition (SAAMI).

d) Performance Standards For Pressure and Velocity of Centerfire Rifle Ammunition (SAAMI).

5. Disclaimer

Compliance with the testing procedures presented herein will not relieve the manufacturer, distributor or user of all specific and implied liabilities to which they would otherwise be exposed nor does compliance with these procedures imply any transferral of any portion of the manufacturer's or distributor's product liability exposure to H.P. White Laboratory, Inc. whether or not testing, conducted to demonstrate this compliance, is conducted by H.P. White Laboratory, Inc.

The procedures contained herein are offered to the manufacturer (and others with a direct or indirect, legal or moral interest in firearm safety) as a means of evaluating the safe design and performance of a firearms and/or determining the proximate cause of a firearm's accident. Nothing contained herein is to be construed as a guarantee, warranty or endorsement by H.P. White Laboratory, Inc. or its personnel of the design or safety features of any firearm.

SECTION II. DISCUSSION

1. General

Lacking universally acceptable standards for the evaluation of the safety of sporting firearms, H.P. White Laboratory, Inc. has reviewed its files of 40 years of firearms and ammunition testing and has attempted herein to define those features of design and firearms usage which have resulted in unintended personal injury or death excluding those sequences or manipulations - whether conscious or accidental - which were intended by the manufacturer to end in the discharge of the gun.

Within this definition of a firearm accident our review revealed that virtually all firearms accidents will be one of two types -

Catastrophic failure of the gun assembly, or

Inadvertent firings.

2. Catastrophic Failure

This type of accident is characterized by the violent disassembly of the gun assembly (or one or more of its components), is usually accompanied by component breakage and deformation and is always caused by the inability of the gun assembly to contain the internal pressures present at the time of the failure. Catastrophic failures may be the result of a single, extremely high pressure firing or a multiplicity of firing above normal operating pressures but less than that required of a single firing which will produce catastrophic failures. In most instances catastrophic failures caused by multiple excessive pressures will be preceded by minor distortions, breakage and malfunctions which will progressively worsen in extent and frequency and will, unless corrected, culminate in catastrophic failures. Catastrophic failures will usually produce ruptures of the barrel and/or receiver, distortion, breakage and erosion of components within the receiver group or a combination of the two. (Note: receiver, as used herein, refers to the portion of the firearm to which the barrel is mounted and which generally serves as a housing for the hammer, firing pin, trigger, safety, cylinder, feeding and extraction mechanism, etc., and which may otherwise be referred to as a frame, slide assembly, breech assembly, etc.). The level of pressures required to produce these failures will vary and will be determined by any of a variety of factors -

a) Design Deficiencies - Catastrophic failures of the gun assembly as a result of design deficiencies are generally characterized by damage to the barrel, light-to-extensive damage to the receiver and extensive damage to components within the receiver and to the stock and forend. They differ from barrel/receiver failures in that while they may be from high pressures, more often they accompany firings at standard pressures.

(1) Unsupported Cartridge Case - All firearms are configured to completely surround and support the easily deformed brass cartridge case with pressure containing features of steel.

Anything which interrupts this support will permit the cartridge case to blow-out and vent itself with considerable force usually into the receiver. In such instances, the brass of the blown-out case, small components (extractors, ejector, firing pins, etc.) and pieces of the magazine and stock produce a considerable missile hazard along with the thermal hazard from the escaping cases. Unsupported cartridge case failures are generally caused be deficiencies of design, distortion or deformation in the chamber, breech and bolt face.

A special category of Unsupported Cartridge Case accidents has been encountered with increasing frequency which seems to be the result of the increasing popularity of 9mm handguns for both military and sporting purposes and the lack of design coordination between gun and ammunition manufacturers in the rapidly expanding 9mm market place. Some ammunition manufacturers have substituted steel and aluminum for the heretofore brass cartridge cases. The internal configuration of the case, which is not controlled by industrial standards, has also been changed by some manufacturers which has increased the depth of the internal cavity and resulted in a thin case wall further rearward than earlier case configurations. One design includes a two-piece cartridge case - body and head - which are soldered or rolled into a case which, to all but minute inspections, is undetectable as anything other than a one piece construction. In and of itself these case changes are not generally a design deficiency. However, coincidentally, and apparently unrelated to case changes, gun designers have in some instances reduced the chamber depths of their firearms, leaving more of the rear of the case projecting beyond the breech face of the barrel. In some instances while the depth of the chamber was not decreased other design features, such as loading ramps or extractor cut-outs, have created localized, unsupported case areas. In any event the reduction of case support found in some firearms in conjunction with the thinner case walls of the ammunition have produced increasing numbers of cartridge case blowouts many of which produce serious eye, face and hand injuries. While we are unaware of this condition in any other caliber or gun/ammunition system the shooter must be ever critical of any condition which reduces the case support in any caliber of firearm.

(2) Improperly Locked Breech - These failures are closely related to unsupported cartridge case failures in that the missile and thermal hazards are generally similar, however, the unlocked breech firings can blow the breech closure (bolt) rearward with tremendous velocity increasing the level of damage and missile hazard. Unlocked breech firings are more often than not a design deficiency or manufacturing defect (see Para. 2.c, below).

(3) Firing Pin Design - Infrequently the design of the firing pin or its clearance hole in the breech/bolt face is deficient resulting in a punctured or blown primer. The gases venting from this rupture can produce damage similar to that of an unsupported cartridge case firing (II.2.a.1) except that the firing pin and hammer are likely to be driven rearward more violently than in an unsupported cartridge case failure.

(4) Double Feed - Although only infrequently encountered, extensive damage to the receiver area will result from the initiation of a chambered cartridge by attempting to feed a second cartridge into the chamber whose bullet tip impacts and initiates the primer of the chambered cartridge. This type of accident is generally initiated by a failure to extract malfunction and is more often encountered in auto-loading firearms but may occur in a bolt action firearm.

b) Material Deficiencies - Probably the most suspected cause of a catastrophic failure of a gun assembly - but in fact the least encountered - is a flaw in the material itself. Seams, latent cracks, inclusions of impurities and improper hardness are examples of material deficiencies which could result in a catastrophic failure. Material deficiencies of this nature are encountered in the gun assembly and the cartridge case of the ammunition.

In the interest of weight reduction, handgun manufacturers have, in some instances, resorted to the use of alloyed frames in their guns. The reduction in weight in many of these guns was accompanied by a reduction in strength which when subjected to the repeated stress of firing ammunition loaded to the limit of safe pressures may produce minor distortion, breakage and malfunctions which progressively worsen and may culminate in a catastrophic failure of the frame.

c) Manufacturing Defect - Infrequently a catastrophic failure of a gun assembly is encountered which is attributable to the improper execution of an otherwise sound design. Poor threads, incomplete welds and solder joints and out-of-tolerance components are examples of workmanship which may elude detection by quality control inspections and may result in catastrophic failures.

Similar deficiencies in workmanship are sometimes encountered in the ammunition (apart from the gross over or under loads discussed elsewhere) which will produce a catastrophic failure of the gun. Cartridge cases without primer flash holes have caused the violent disassembly of firing pins and cases with inadequate body thickness, often rupture and vent fragments of the cartridge case and high pressure gases into the action causing violent disassembly and breakage.

d) Wear - The most likely mechanism for a catastrophic failure through wear is wear and distortion which causes the headspacing or chamber diameter to increase to the point that the cartridge case is unsupported (II.2.a.1), i.e., wear of breech face, breech locking features, etc. In rare cases worn barrels may continually strip jacketting material from the bullet and, if this is allowed to accumulate, could produce a barrel obstruction (II.2.g).

e) Improper Caliber of Ammunition - In most cases both the cartridge and gun are clearly marked with their respective calibers. Further deterrence in the use of an improper caliber of ammunition is afforded by the differing configuration envelopes of ammunition which in most cases prevent them from being chambered and fired in anything but the proper caliber of gun. Nonetheless, there are several combinations of dissimilar gun/ammunition calibers which can with moderate force and extreme negligence (see Paragraph g, below) be loaded and fired with results similar to those of a single, extremely high pressure firing (Paragraph f,1).

f) Improperly Loaded Cartridge - The most frequently encountered cause of excessive pressure is an improperly loaded cartridge which may be of three types -

(1) One Firing of Extremely High Pressure - produced by excessive propellent, the wrong propellent, excessive bullet or shot weight or an ill-advised combination of propellent and bullet (shot) loads, excessive case length and improper seating depth.

(2) Multiple Firings of Moderately High Pressure - produced by excessive propellent, the wrong propellent, excessive bullet or shot weight or a combination of propellent and bullet (shot) loads, excessive case length and improper seating depth.

(3) Grossly Underloaded - cartridge whose bullet or wadding (shotgun) fails to exit the muzzle creating a barrel obstruction (see Paragraph g, below).

g) Restricted Expansion Volume - Any restriction of the volume into which the manufacturer has intended the expanding gases generated by the propellent should vent or restrictions in the path of the bullet will cause an otherwise properly loaded cartridge or shotshell to generate pressures in excess of normal operating pressures. The effect of such a restriction will be determined by the type and location of the restriction. Examples of conditions which have been known to induce catastrophic failures by restricting the expansion chamber or bullet path are barrel obstructions created by bullets or wadding (shotguns) from the proceeding, improperly loaded cartridge, deformation of the barrel, excessive lubrication, water, sod and the build-up of jacketting material in badly worn barrels. Finally, there is a special case of barrel obstruction which has infrequently been the cause of catastrophic failures - 20 gauge shotshells mistakenly loaded into a 12 gauge shotgun which slide into the forcing cone of the barrel, are forgotten and later detonated by an otherwise properly loaded and fired 12 gauge shotshell.

h) Fatigue - Most firearms of reasonable quality will, with care and maintenance, never fail catastrophically providing none of the foregoing circumstances and deficiencies (a through g, above) are encountered AND ammunition which has been loaded in strict conformity to SAAMI standards for that caliber is used to the exclusion of all others. Factory loads and hand loads intended to increase velocity are normally loaded to the upper limit of acceptable pressures and the continued, long-term use of this ammunition may have a cumulatively weakening effect of the gun assembly which is known as "metal fatigue".

Metal fatigue is the result of working loads on the metal producing stresses within the metal which exceed the YIELD strength causing imperceptible changes. Continued and prolonged working loads of this type will produce a cumulative stress which exceeds the ULTIMATE strength of the metal which will then fail.

Fatigue failures are particularly insidious in that they are usually the cumulative result of repeated, often consistent, and APPARENTLY safe loads whose long term "satisfactory" performance tends to obscure the imperceptible and relentlessly increasing hazard.

The initial manifestations of metal fatigue in small arms is usually annoying non-catastrophic malfunctions and minor breakages - increasing in severity and frequency until one or more of the foregoing conditions prevails producing a catastrophic failure.

One of the most prevalent causes of progressive distortion is the continual use of ammunition which develops pressures which, while not excessive enough to cause catastrophic failures with one shot, are sufficiently in excess of normal pressure to cause progressive distortion and weakening of the gun assembly and its components. This is most often encountered in handloaded ammunition but may be the result of improperly loaded factory ammunition or factory loaded ammunition whose normal pressures exceed the prolonged - usage limits of the firearms. Continued usage usually results in minor breakage and malfunctions - misfires, failures to extract, broken firing pins, broken extractors, etc. - of increasing frequency and eventually in a catastrophic failure.

3. Inadvertent Firings

This type of accident is characterized by the unintended discharge of a firearm by some means other than that intended by the manufacturer. They are not generally attributable to - or accompanied by - breakage or failure of the gun assembly or its components and are usually the result of some combination of abusive handling or manipulation of the mechanism in conjunction with a **Design Deficiency**.

Design Deficiency as used herein is not necessarily descriptive of an identifiable configuration but is H.P. White Laboratory, Inc.'s interpretation of the opinions rendered in inadvertent firing litigations and is intended to describe the absence of design features intended to AUTOMATICALLY prevent inadvertent firings - when the gun assembly is subjected to conditions of normal usage including predictable abusive handling. This (legal) interpretation of "Design Deficiency" has been applied to inadvertent firing litigations wherein the gun itself fails to AUTOMATICALLY prevent inadvertent firings REGARDLESS of the inclusion and/or efficacy of MANUALLY APPLIED safeties which, when applied, will prevent inadvertent firings.

a) Automatic Safeties - The term "automatic safety" as used herein is descriptive of the method by which the safety feature is activated and/or deactivated and is not to be construed as descriptive of the efficacy or reliability of its performance. It is further intended to describe any feature of the design whose only purpose is to prevent the discharge of the firearm by any means other than the pronounced and sustained operation of the trigger and which requires NO manipulation or action by the shooter to perform this function but does require a positive action by the shooter to enable the gun to be fired.

(1) Inertial (Floating) Firing Pin - This design incorporates a firing pin whose length is too short to span the distance between the forward most position of the hammer and the primer of a chambered cartridge and which is usually restrained - with a coil spring - in its rearmost position. When impacted with the hammer the firing pin literally is in free-flight until striking the primer but in so doing compresses the restraining spring which returns the firing pin to its rearmost position AUTOMATICALLY introducing a gap between the firing pin and the primer.

(2) Firing Pin Block - Inasmuch as large inertial firing pins have been known to produce inadvertent firings if the gun is dropped on the muzzle with a chambered cartridge, recent pistol designs have incorporated a feature which introduces an automatic, positive blocking of the firing pin preventing its forward movement and which is only removed by sustained trigger pull.

(3) Rebounding Hammer - The firing pins of rebounding hammer designs may be either fixed to the hammer or floating in the frame or receiver. When the trigger is released after firing, the hammer moves slightly rearward from the fully-forward (fired)

position, AUTOMATICALLY introducing a gap between the firing pin and the primer at which point it is blocked from further forward movement without further manipulation of the trigger.

(4) Transfer Bar - Some firearms designed with a floating firing pin include a design feature intended to automatically prevent the hammer from contacting the firing pin by introducing a "bar" between them which when impacted by the hammer "transfers" the energy to the firing pin. This "Transfer Bar" is automatically out of alignment with the hammer and firing pin when the trigger is released and - if properly designed - is only in alignment with a sustained rearward pull of the trigger.

(5) Hammer Block - The hammer blocking design of automatic safety is similar to the design of the safety-bar in that it is automatic and it requires the sustained rearward pull of the trigger to transfer the energy of the falling hammer to the primer of the cartridge. It differs from the transfer bar in that the falling hammer will impact and come to rest short of the firing position on an otherwise non-functional feature of the assembly unless that feature’s blocking action has been removed through the sustained rearward pull of the trigger.

b) Secondary Automatic Safeties - SECONDARY Automatic safety as used herein is descriptive of a safety feature which requires no action on the part of the shooter to engage the disabling feature and which is intended to disable the firearm until some predetermined condition secondary to shooter intent prevails.

(1) Locked Breech Safeties - Guns designed to fire from a closed and locked breech will normally include a safety device which will block or interrupt - and thereby disable - the trigger to hammer linkage unless the gun is fully closed and locked to prevent Improperly Locked Breech Firings (Paragraph 2.a.2, above).

(2) Magazine Safeties - Some auto-loading firearms incorporate a safety feature which will block or interrupt - and thereby disable - the trigger-to-hammer linkage unless the magazine is locked in position. Magazine safeties are an effective means of intentionally disabling a gun which may be left unattended and will prevent inadvertent firings by mistakenly assuming that without a magazine the gun is unloaded forgetting a round which may have been in the chamber when the magazine was removed.

(3) Grip Safeties - Grip safeties are never provided as the principal safety feature of a gun assembly but as a secondary safety requiring only that the gun be firmly grasped to dis-

engage its disabling effect. It is automatic in that without the firm grasp it will prevent some other feature of the design from functioning - hammer, trigger, sear, etc.

c) Manual Safeties - The term safety as used herein is descriptive of the method by which the safety feature is activated and/or deactivated and is not to be construed as descriptive of the efficacy or reliability of its performance. It is further intended to describe any feature of the design whose only purpose is to prevent the discharge of the firearm by any means other than the pronounced and sustained operation of the trigger and which REQUIRES a positive manipulation or action by the shooter to engage and disengage the disabling feature of the safety.

(1) Half-Cock or Safety Notch - Many firearms - particularly of older designs - include a safety notch in the hammer/sear linkage which is intended to restrain the hammer and firing pin in a position which precludes contact of the primer by the firing pin. When fired, the hammer remains in the fully forward (fire) position with the firing pin bearing on the primer. When manually retracted a short distance, the half-cock or safety notch of the hammer engages the sear which will prevent the forward movement of the hammer and firing pin. The retraction and half-cocking of the hammer are NOT automatic and are normally accomplished by the same MANUAL manipulation required to fully-cock the hammer, i.e., thumbing of the hammer spur.

(2) Trigger Locking Safety - Trigger locking manual safeties are generally "Button" safeties located in or around the trigger guard and when activated prevent the rearward movement of the trigger.

(3) Hammer Locking Safety - Hammer locking manual safeties are usually activated by a "Button", "Slide" or "Lever" located on the frame or receiver, near the hammer, which are intended to lock the hammer in either the forward or fully-cocked positions.

(4) Firing Pin Locking and Blocking Safeties - Manual, firing pin locking and blocking safeties may be "Button". "Slide" or "Lever" safeties located on the frame or receiver which when activated, mechanically lock the forward movement of the firing pin or block the rear of the firing pin from being impacted by the hammer.

(5) Sear Locking safeties - Manual, sear-locking safeties may be "Button", "Slide" or "Lever" safeties located on the frame or receiver which are activated only when the hammer is cocked and then act to prevent the sear from disassociating itself from the hammer.

(6) Locked Breech Safeties - Guns which must be broken-open to load are generally fitted with a lever or slide which locks the assembly closed. To open the gun the lever or slide is moved which unlocks the action and simultaneously interrupts or blocks the trigger to hammer linkage to prevent the gun being fired with an open or unlocked breech.

4. Safety Reliability

It is safe to say that guns incorporating each of these design configurations have been involved in purported inadvertent discharge litigations which highlights the imprudence of complete reliance on any mechanism regardless of the apparent excellence of its design. All of the known safety configurations are susceptible to faulty executions (workmanship) and to functional change from wear or breakage. The product manufacturer and the accident investigator should therefore determine the susceptibility of the mechanism to inadvertent firing from a diversity of causes.

5. Type of Inadvertent Firings

Inadvertent firings are generally one of two types with respect to the shooter’s actions which immediately proceed the firing.

a) Externally Impacted guns - The most often encountered form of an inadvertent firing is one in which an external force is applied to the loaded gun assembly which discharges with the impact. Generally this is from dropping or bumping the gun for which, hereinafter, there will be no differentiation unless otherwise specified.

b) Manipulative Firings - Firearms are frequently discharged inadvertently during loading, unloading, cleaning and other non-abusive forms of handling.

6. Causes of Impact Firings

The cause of such a firing is the transmission of a sufficient portion of an externally applied force to the primer of a chambered cartridge to cause ignition of the primer. If the sensitivity of the primer was in compliance with SAAMI standards these firings can be shown to be the result of design conditions (or conditions of wear and distortion) which permit the firing pin to impact the primer without manipulation of the trigger.

Many single action firearms whose firing pins bear directly on the primers of chambered cartridges are susceptible to this form of inadvertent firing, however, any type of design which does not prevent contact between the firing pin and the primer could be inadvertently fired in this manner. A variety of design features (discussed above) whose sole purpose is to prevent this from occurring are used by manufacturers of firearms currently marketed in the United States.

Despite the designer's efforts to include features that all but preclude impact firings, the manufacturer may fail to faithfully reproduce that design or abusive and extensive usage may introduce extraordinary distortion and wear which result in a malfunction of the design.

7. Causes of Manipulative Firings

Inadvertent manipulative firings are frequently the result of a manipulation (or combination of manipulations) involving the hammer, firing pin, sear, trigger or safety which was not foreseen by the designer. Equally as often, however, distortion, wear or modification of these same components are a contributing (or principal) cause.

8. Miscellaneous

Frequently gun accident litigations are decided on the basis of the manufacturer's printed instructions - particularly warnings related to the use, abuse, maintenance and cleaning. The inclusion of such warnings - in and of itself - will usually not alter the courts' decisions but their absence or deficiencies has often resulted in findings for the Plaintiff despite physical evidence heavily weighted in favor of the defendant.

SECTION III. TEST PROCEDURES - CATASTROPHIC FAILURES

1. General

The test procedures presented herein are general in nature and may have to be varied to suit unique designs and/or unique handling situations. The procedures are those generally and universally recognized by the U.S. Sporting Arms Industry.

The procedures are intended to establish the safety characteristics of non-specific makes and models of guns in new condition but, with some variations, may be used to replicate damage to a gun in conjunction with an accident investigation.

2. Test Sample

In order to establish the truly random nature of the sampling it may be advisable to acquire the test sample(s) through a retail outlet available to the general public.

The number of guns to be tested (sample size) will be determined by two factors - (1) Whether or not only selected tests presented herein are to be performed and (2) the level-of-confidence that the results of the sample are representative of the larger population.

The sample submitted for testing should be thoroughly examined, disassembled and photographically documented. All markings relating to the manufacturer, model, serial number, distributor, caliber and cautionary or warning imprints should be recorded. A brief description of the gun's operation should be prepared including - but not necessarily limited to - the basic design and the type of action, hammer, firing pin and safeties.

3. Documentation

The packaging, operating instructions and any other written or graphic materials provided with the gun should be thoroughly reviewed and incorporated in the final test report.

4. Physical Audit

The critical dimensional characteristics of the gun assembly should be determined and should include - but not necessarily be limited to - headspacing, trigger pull, firing pin protrusion, bore diameter and groove diameter.

5. Proof Pressure Tests

The proof pressure test is intended to demonstrate the gun assembly will withstand a single firing of SAAMI high pressure (Proof) ammunition.

One cartridge (shotshell) of the appropriate caliber (gauge) conforming to

SAAMI specifications, for proof ammunition for that caliber (gauge) is to be fired from each chamber of the gun assembly after which the gun assembly is to be visually examined and inspected (magnetic particle) and its post-test headspacing compared to its pre-test headspacing.

Guns of calibers for which no SAAMI specifications exist will use proof cartridges loaded in accordance with other recognized specifications or cartridges loaded to produce pressures in accordance with Table I - in that order of priority.

TABLE I. PROOF PRESSURES OF CALIBERS NOT SPECIFIED BY SAAMI

Maximum Allowable Average Pressure of Service Loads	Proof Pressures	
	Minimum	Maximum
20,000 and under (a)	1.16 times a	1.7 times a
20,100 to 35,000 (b)	1.16 times b	1.6 times b
35,000 or over (c)	1.16 times c	1.5 times c

6. <u>Excessive Pressure Test</u>

The excessive pressure test is intended to determine the pressure at which the gun assembly is likely to fail catastrophically from the firing of a single cartridge.

Cartridges intentionally loaded to develop incrementally increasing pressures, in excess of PROOF pressures, are to be fired in accordance with the schedule of Table II until the gun assembly catastrophically fails or until the maximum pressure of Table II is fired without catastrophic failure. All firings are to be from the same - but randomly selected - chamber in a multiple chambered gun.

TABLE II. EXCESSIVE PRESSURE TEST PRESSURES

Maximum Proof Pressure	Excessive Pressure Firings		
	Start	Incremental Increases	Maximum
20,000 or less	Maximum proof	5,000	4.5 times maximum proof
20,100 to 30,000	Maximum proof	5,000	3.5 times maximum proof
30,100 to 40,000	Maximum proof	5,000	3.0 times maximum proof
40,100 to 50,000	Maximum proof	5,000	2.5 times maximum proof
50,100 or more	Maximum proof	5,000	2.0 times maximum proof

The failure pressure determined by these tests may be somewhat misleading in that the firings of excessive but less than catastrophic pressures may have severely pre-stressed the gun. In order to confirm the results of this test, another unfired sampling is to be continually fired at the catastrophic failure pressures determined with the first sampling until catastrophic failure is produced or until five such firings (per gun) fail to produce catastrophic failure. All firings are to be from the same - but randomly selected - chamber in a multiple chambered gun.

During both phases of this test only those repairs or component replacements required to enable the gun to be fired will be made. Such repairs and replac-ements will generally be limited to the firing pin, hammer, trigger, etc. No component or assembly whose principal or secondary function is the containment of the internal pressures (bolt, barrel, receiver, etc.) is to be replaced or repaired during these tests.

7. Endurance Test

The endurance test is intended to determine the number of firings (of ammunition complying with SAAMI pressure specifications for service loads) required to induce a catastrophic failure of the gun assembly. In order to insure the ammunition used in these tests includes representations of moderately high pressure firings periodically encountered in service loads, a high pressure test (proof) cartridge will be fired after each 100 firings.

Firings are to proceed in 500 round increments (including 5 proof cartridges) until catastrophic failure is induced or until a total of 10,000 firings without catastrophic failure have been performed. After each 500 round increment the gun is to be thoroughly cleaned and inspected. Repairs and component replacement during this test are limited to non-pressure containing features of the gun (extractor, firing pin, ejector, etc.). Specifically exempted from such repairs and replacement are the receiver (frame), barrel, bolt, components and features of the locking system, etc.

Firings from multi-chambered guns will be conducted in cycles of one firing from each chamber to insure that equal numbers of firings have been conducted from each chamber throughout the test (including PROOF firings).

8. Unlocked Breech Firing Test

The purpose of the unlocked breech firing test is to confirm that the design of the gun will prevent firings from any configuration of the breech other than that intended by the designer. The test is to be conducted on a new sampling and on a sample being tested for ENDURANCE (Paragraph 7, above) at the point in that test wherein the headspacing exceeds the maximum recommended by SAAMI or after 5000 firings and prior to any catastrophic failure.

Repeated attempts (25 minimum) to discharge the gun with the breech unlocked and/or opened are to be made using a new cartridge for each attempt.

9. Double Feed Firing Test

The purpose of the double feed firing test is to confirm that attempts to feed a second cartridge into an already loaded chamber will not cause the chambered cartridge to fire. Repeated attempts (25 minimum) will be made using two new cartridges for each attempt.

10. Recorded Data

The recorded data will thoroughly document the test sample, test ammunition and any special fixturing and will include pre-test photographs of the sample and fixturing.

The recorded data of all testing will include a record of all malfunctions encountered and an analysis (if possible) of the cause.

All component replacement and repairs will be thoroughly documented.

All breakages and wear will be thoroughly documented and recorded photographically (as appropriate).

All catastrophic failures will be thoroughly documented and will include a Photographic record for inclusion in the final report.

All gun components replaced in these tests and all fired cases which were fired at other than SAAMI service load pressures or which are damaged or deformed as a result of firing will be preserved and photographically documented.

SECTION IV. TEST PROCEDURES - INADVERTENT FIRINGS

1. General

The test procedures presented herein are general in nature and may have to be varied to suit unique designs and/or unique situations. Most of the procedures rely heavily on the experience of test personnel to recognize potential weaknesses of the design and to derive a test which will confirm (or deny) that that weakness is not inconsistent with anticipated, reasonable consumer handling and usage.

The procedures are intended to establish the characteristics of non-specific makes and models of guns in new condition but, with some variations, may be used to replicate an inadvertent firing in conjunction with an accident investigation.

The inadvertent firing test procedures are of two general types - impact and manipulation. The former are of two types - those intended to reflect the effects of bumping and low level impacts (Mallet Tests) and the more destructive, Drop Testing.

2. Test Sample

In order to establish the truly random nature of the sampling it may be advisable to acquire the test sample(s) through a retail outlet available to the general public.

The number of guns to be tested (sample size) will be determined by two factors - whether or not only selected tests presented herein are to be performed and the level of confidence that the result of the sample are representative of the larger population.

The sample submitted for testing should be thoroughly examined, disassembled and photographically documented. All markings relating to the manufacturer, model, serial number, distributor, caliber and cautionary or warning imprints should be recorded. A brief description of the gun’s operation should be prepared including - but not necessarily limited to - the basic design and the type of action, hammer, firing pin and safeties.

3. Documentation

The packaging, operating instructions and any other written or graphic materials provided with the gun should be thoroughly reviewed and incorporated in the final test report.

4. Physical Audit

The critical dimensional characteristics of the gun assembly should be determined and should include - but not necessarily be limited to - headspacing, trigger pull, firing pin protrusion, bore diameter and groove diameter.

5. Mallet Test

The purpose of this test is to confirm (or deny) the likelihood of the sample being inadvertently fired through an externally applied impact without destroying or damaging the test sample. This test is intended to be followed by a drop test (Paragraph 6, below) which is destructive and may have to be wavered in instances wherein damage to the sample is intolerable such as evidence in a criminal or civil litigation. While the Mallet Test will not inflict surface damage to the assembly the possibility of distorting components whose design strength is exceeded by the force of the impact exists. Therefore, prior to conducting this test it is imperative that -

a) All interested parties be appraised of the risk of damage or distortion, and

b) The configuration of significant components be determined (photographed) prior to - and upon completion of - the test to document the change (if any) induced by the test, or

c) An alternate, non-evidence sample be provided for this test and the follow-on Drop Test.

Prior to initiation of this test a Primer Sensitivity Test of the ammunition will be conducted to insure the sensitivity of the primer is within acceptable commercial limits.

The proper operation of the assembled gun will be confirmed and a primed cartridge case (shotshell) of the appropriate caliber (gauge) chambered in the test sample. The "loaded" gun is then to be subjected to multiple impacts with a 10 to 15 ounce (avoirdupois) leather or hard rubber mallet. The force of the hand delivered impacts are not necessarily measured but should be initiated with relatively light taps and be incrementally increased to an impact not unlike that used by a professional carpenter to drive a nail. All surfaces of the gun assembly are to be impacted but guns with exposed hammers must be impacted on the exposed portion of the hammer with a blow whose direction is coincidental with the center line of the firing pin. The test is to be conducted with all possible combinations of hammer and safety positions.

The primer of the chambered cartridge case (shotshell) will be inspected after each impact and any imprinted primer which did not fire will immediately be replaced with a fresh casing and the test reconducted until the gun "discharges" or a total of five identical tests have been conducted.

Any "discharge" encountered during the Mallet Test will be recorded and the spent casing (shotshell) retained.

6. Drop Test

The purpose of the Drop Test is to confirm (or deny) the likelihood of the sample being inadvertently fired through being dropped in the loaded configuration. This test is intended to replicate a dropped gun firing, exactly, without regard to physical damage of the test sample and the same risk of damage to the sample and alternate testing procedures discussed in Paragraph 5, above apply.

Prior to initiation of this test a Primer Sensitivity Test of the ammunition will be conducted to insure the sensitivity of the primer is within acceptable commercial limits.

The proper operation of the sample will be confirmed and a primed cartridge case (shotshell) of the appropriate caliber (gauge) without propellent but with a bullet (shotload) in place will be chambered in the test sample. The magazine of the test sample will be fully loaded with ammunition of the appropriate caliber whose bullet weights are - unless otherwise specified - the heaviest available on the commercial market in that caliber.

The gun assembly is then to be subjected to multiple, controlled Drop Tests from a height of 42 inches designed to produce impacts with the centerline of the bore in each of its six cardinal positions. This will require a specially configured drop fixture to control the height of the drop, the orientation of the test sample at impact and the precise area or feature of the sample impacted. The following procedure utilizes one such fixture whose performance has produced acceptable results.

The drop frame of the fixture will be raised to the desired drop height over a rigid, vertically - mounted, one inch diameter - hardened (290-320 BHN) steel rod and restrained at that point with an electromagnet. The test sample will be cradled on the drop frame with the desired impact location directly over the end of the steel rod. When current to the electromagnet is interrupted the drop frame cradling the test sample shall reach drop velocities within 2% of the free fall velocity from that height and will continue unimpeded six inches beyond the point at which the sample impacts the rod and is lifted from its cradle.

One impact test in each of the six cardinal positions of the sample (muzzle up, muzzle down, right side, left side, top and bottom impacts) will be performed noting the condition of the primed case - fired or unfired - after each test. After completion of the sixth impact wherein no firing of the primer was recorded the condition of the primer will be noted and the test sample will be cocked and fired to confirm the suitability of the primed cartridge case. Any test which results in a "firing" will be noted, another primed cartridge case chambered in the sample and the test continued.

The entire sequence of six impacts will be repeated with the hammer and safety in each of their designed positions and combinations thereof, i.e., safety on - hammer cocked, safety on - hammer down, etc.

The precise feature of the gun impacted in each test will be that feature most likely to result in an inadvertent firing. The point of impact on all muzzle up tests will - unless otherwise specified - be the spur of the hammer on all samples with exposed hammers.

On occasions the evidence may bear markings which indicate a specific feature of the gun was impacted in a dropped gun incident (bruises, abrasions, etc.). Samples of this type should be drop tested to provide for this impact orientation prior to conducting other orientations of Drop Testing.

7. Manipulative Testing - Incomplete Searing

The purpose of this test is to determine the extent to which the hammer-sear-trigger linkage can be misoriented to produce "false searing" - best characterized by the sear being tenuously balanced BETWEEN two of its designed positions - from which a slight bump or impact of the gun will result in an inadvertent firing.

The gun is to be loaded by chambering an otherwise empty but primer cartridge case (shotshell). By individual and independent manipulation of the hammer, trigger and all manually and automatically applied safety features (including set triggers, slide hold open features, etc.), every orientation of the assembly is to be tested to determine if a "false searing" is possible.

The test is to be repeated by simultaneous and collective manipulation of the features and components listed above.

All firings and firing pin impacts of the primer of the chambered cartridge (shotshell) are to be recorded and the manipulations producing those results repeatedly conducted to determine the precise nature of the deficiency. Once all testing is completed the gun will be disassembled and the deficiencies (if any) documented by examining, dimensioning and photographing the deficient components.

8. Manipulative Testing - Inadvertent Sear Release

The purpose of this test is closely related to that of the Incomplete Searing Test (Paragraph 7, above) except that the searing mechanism is properly and completely seated at the onset of the test. The components and features described in Paragraph 7, above are then individually and collectively manipulated throughout the full range of their intended orientations and any manipulation which results in a discharge of the gun or indentation of the primer without discharge and which is not the direct result of trigger operation is to be recorded. The manipulation leading to that result are to be repeatedly performed to determine the nature of the component deficiencies.

9. Manipulative Testing - Slam Fire

The purpose of this test is to confirm (or deny) the resistance of the gun assembly to inadvertently firing on closing the breech. This type of inadvertent firing can usually be attributed to one of two causes - an obstruction between the breech face and the primer being crushed into the primer on closing or the linkage designed to restrain the hammer malfunctions allowing the hammer to fall. A third - and almost never encountered - cause of slam fires in rim fired guns is improper headspacing which causes the rim primer to be pinched between the barrel and breech face.

In order to evaluate all of the possible variations of this malfunction the Slam Fire Test procedures have been separated into sub-tests, some of which may be wavered depending on the configuration of the gun assembly and purpose of the test.

a) Bolt Action/Center Fired guns - With the gun rigidly fixtured and loaded with a full compliment of live ammunition, the bolt is to be vigorously slammed from its rearmost position to its forward - most position. The cartridge will be examined for evidence of any indentation of the primer. The test will be repeated in this manner until a total of fifty slam firing attempts have been completed. The above test is to be conducted - when possible - with the safety on and off and the hammer in all of its design positions. One half 25) of each increment of fifty tests will be conducted by vigorously retracting the bolt after each test and the other half by gently retracting the bolt to the forward most position which will enable proper feeding and cocking of the hammer/striker. Every attempt is to be made in these tests to incompletely sear the striker/hammer so that the forward stroke of the bolt - in and of itself - releases the striker/hammer without manipulation of the trigger (see Paragraph 7, above).

The above test is to be repeated in its entirely with only a single round in the magazine/clip of the gun and by hand chambering of each cartridge.

b) Bolt Action/Rim Fired Guns - The slam fire test of rim-fired, bolt action guns will be conducted as in Paragraph 7.a, above after which an additional test will be conducted to determine the likelihood of inducing a slam fire by progressively increasing the force necessary to deflect the claw type of extractor (on rim-fired guns fitted with this type of extractor) until the gun fires or until the gun will not fire because the bolt will not close.

Finally, all bolt action rim-fired guns will be tested to determine the likelihood of inducing a slam fire by progressively shiming the recess intended to accommodate the rim of the cartridge (simulating the presence of foreign material or build-up of firing residues) until the gun fires or until the gun will not fire because the bolt will not close.

c) Automatically Fed Guns - The slam fire testing of automatically fed guns (rim-fired and center-fired) will be conducted as above with appropriate accommodation and consideration extended to the automatic feed features of the gun.

d) Rotary Fed Guns - The slam fire test of revolvers and similarly configured guns shall be conducted with the same objective and intent as that put forth in Paragraphs a and b, above with appropriate consideration for variations in loading, feeding, extraction and manipulation unique to rotary-fed guns.

Rotary-fed guns chambered for rim-fired cartridges whose cylinders swing to the side for loading will be tested to determine the likelihood of an inadvertent firing resulting from closing the cylinder on an incompletely chambered cartridge. An otherwise empty but primed cartridge case will be incompletely loaded into the rotary magazine (cylinder) of the gun and the rotary magazine (cylinder) slammed vigorously into the closed position. The test will be repeated until each position of the rotary magazine (cylinder) has been tested a total of five times. Any discharge encountered in these tests is to be documented as above.

10. Miscellaneous

The favorable performance of a model of gun in all of the tests presented herein should not be construed as evidence of the completely safe design of that model of gun. Favorable results do indicate that the design and the execution of the design exemplified by the test sample are free of PREDICTABLE and FORESEEABLE deficiencies which could result in an inadvertent firing but no procedure regardless of how well conceived will reliably represent all possible circumstances to which each of thousands of guns of a specific model will be exposed during its useful life. Therefore the prudent testing agent should be constantly aware of unpredictable circumstances and unique firearm features and designs which could effect the safe usage of the gun and be quick to augment the procedures herein with procedures intended to evaluate the impact on overall safety of those circumstances and mechanisms.