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315 WEST RING ROAD
ELIZABETHTOWN, KY 42701

Remington Arms Company, Inc.

Test Report – Trial & Pilot Test

M/710 Centerfire

Rifle

.30-06 Springfield

(PART A)

January 2001

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Remington Arms Company, Inc.

Test Report – Trial & Pilot Test

January 2001

M/710 Centerfire Rifle

Caliber: 30-06 Springfield

ABSTRACT:

This Report covers the results of the Trial & Pilot Testing (T&P) procedures performed on the Remington M/710 Centerfire Rifle during November & December 2000 at the Remington Arms Company, Inc., Research & Development Technical Center located at Elizabethtown, KY.

This Testing Program was organized around the goal of determining if this new product met design specifications specified by R&D and produced using production methods and processes at the Remington Arms Mayfield KY plant.

Several "information only" tests were also conducted during the same test program for the purpose of evaluating the products under extreme conditions.

The following general grouping of test procedures were used to determine product and process capability.

1. *Headspace and Proof Checks*
2. *Initial Inspections, Tests and Measurements*
3. *Weights, Lengths and Gun Characteristics*
4. *Firearms Measurements*
5. *- Functional / Endurance Testing*
6. *- Accuracy*
7. *- Environmental Tests*
8. *- Abusive Testing*

It should be noted that although there were a couple of minor areas of concern (primarily pertaining to firing pin head assembly, Magazine Box and Bolt Stop function), the team determined that the product presented no concerns relative to safety. There were also some concerns with the Bushnell optics that still must be addressed by Mayfield. With the understanding that these concerns will be addressed prior to warehousing, the team concluded that production could proceed and product released for shipment to the warehouse.

After reviewing each of the individual tests in the program and taking the entire series of T&P tests as a whole, the Research Test Lab and the Research Design Group have concluded that this product met the acceptance requirements as set forth by the Trial & Pilot Test Plan.

Report Prepared By:

J. R. Snedeker, _____ / January 2001.

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INTRODUCTION

The Model 710, Centerfire Rifle is a new product line for the Remington Arms Company.

This report will review and summarize the results of various Trial & Pilot Tests (T&P) conducted during the time period November 2000 and December 2000 at the Remington Arms Company, Inc., Research & Development Technical Center located in Elizabethtown, KY.

Due to the extensive nature of the testing involving this product this report will consist of two parts. Part A (this document) presents a brief explanation of each of the individual tests that were a part of the overall Trial & Pilot test plan, along with a brief review of the results for that particular test. Part B consists of 1 large binder and contains the raw data for the T&P as well as the individual test reports associated with the test program. It is more extensive in both volume and detail and is intended to give the reader an in-depth look at each of those same tests if desired. Part B also provides additional details such as the flow chart for the T&P test plan, copies of the individual test requests and any supplementary reports or data that was generated during or after the completion of a particular test.

Part B is divided into three parts. B.1 contains the information pertinent to the 1st Trial & Pilot effort (series "A"). B.2 contains the information pertinent to the 2nd Trial & Pilot (series "B") and B.3 the 3rd and final Trial & Pilot series (series "C") of test. Part B also contains copies of supplementary tests that were not scheduled as part of the original test plan.

For reference and consistency, the same section numbering scheme is used in both Part A and in Parts B.1 – B.3.

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1.0 PURPOSE & SCOPE OF TEST PROGRAM

1.1 PURPOSE

The first purpose of this series of tests was to determine if the Model 710 Centerfire Rifle would perform as designed and meet the established function and safety criteria as proposed by the Research & Development Firearms Design Group. The second purpose of this series of tests was to assure that Mayfield production processes were capable of meeting the function, safety and design criteria established for this model by R&D.

1.2 SCOPE

This report covers Trial & Pilot testing of the Remington Model 710 Centerfire in .30-06 caliber only.

2.0 EXECUTIVE SUMMARY

This section of the report is a summary of the test work accomplished through a series of three Trial & Pilot (T&P) Test Programs for Remington's new Model 710 Centerfire Rifle. The testing and associated design development improvements were completed during the time period November through December 2000.

The following is summary letter issued at the end of Trial & Pilot testing (per D. Danner) and is a good summary description of the status of the project and the necessary further steps to be taken prior to shipment of product.

The Test and Measurement organization within the Elizabethtown Research and Development facility formally supports exit from both Design Acceptance and Trial and Pilot testing of the M710 Bolt Action Firearm (configured in .3006 caliber with Bushnell 763942 riflescope) subject to the following issues and conditions:

1. Prior to product shipment from Mayfield a Design Transmittal must occur to formally establish component dimensional parameters. All product must conform to these parameters or a written deviation from design must be obtained from the Design team.
2. Mayfield must address the continuing problem of the Firing Pin Head loosening from the Firing Pin Body. Test recommends a statistically significant audit of product by Mayfield to confirm resolution of the issue.
3. Mayfield must re-examine the process, which allowed two firearms to be swapped between boxes. This issue is driven by BATF serial number tracking requirements.
4. Several issues continue to exist which Test reasonably believes will result in customer dissatisfaction. These issues have no test objective criteria associated with them so Test has no

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basis to withhold ship approval. Consequently, Test supports ship contingent on Marketing approval of these issues:

- Magazine Box Bottom Retention – Latest data from Series C product indicates that 17% of the product will experience this problem within the first 100 rounds of use. During the Series C test the earliest occurrence was at round 49.
- Magazine Box Difficult to Remove - This problem was pervasive on the Series C product and may potentially contribute to the Bottom Retention issue above.
- Bolt Stop Detent Freedom – Latest data from Series C product suggests that 20% of the product will experience a loosening of the detent lever during the first 100 rounds of use.
- Bushnell Scope – Data from Series B product suggests that approximately 8% of the product will experience scope issues early in life. Bushnell has confirmed that an assembly issue exists with the scope.
- Take Down Screw Torque – Data from Series C product indicates that 37% of the product will have some loosening of the takedown screws. Further, data obtained by Mayfield and reported on 20 NOV '00 supports the conclusion that some loss of torque does occur. While this does not constitute a safety issue consumers may potentially notice the phenomena.

Test further recommends that these issues be resolved as quickly as possible via design/process change to limit negative customer exposure.

5. Test recommends that Mayfield re-examine process controls and limits around the Trigger Pull Force via a process capability study. Data obtained in E'town from the Series C product indicated that some product was slightly below the low pull specification of 4.00 pounds. All product however was in excess of the SAAMI specified minimum of 3.00 pounds.

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2.1 TEST SUMMARY TABLE

The following Table lists the individual test procedures that were completed during the T&P series and the Final Status of each by individual category.

1. Note on Final Status: Determination made after final review of all test data was completed by Test management team.

TEST PROCEDURE	A-SERIES	B-SERIES	C-SERIES	Final
TRIAL & PILOT TEST	Status	Status	Status	Status
3.1 INITIAL INSPECTIONS, TESTS & MEASUREMENTS				
3.1.1 Visual Examination, Packaging Audit & Packaging Test				
3.1.1.1 TLW0300A – Visual Examination			Completed	For Information
3.1.1.2 TLW0300B – Packaging Audit	Completed			Passed
3.1.1.3 TLW0300C – Packaging Test	Completed			Passed
3.1.2 Headspace and Proof				
3.1.2.1 TLW0300E – Measure Headspace			Completed by Mayfield	
3.1.2.2 TLW0300F – Proof Test			Completed by Mayfield	
3.1.2.3 TLW0300G – Re-Measure Headspace after Proof			Completed	Passed
3.1.3 Forces				
3.1.3.1 TLW0300H – Measure Firing Pin Indent		Completed		Passed
3.1.3.2 TLW0300I – Measure Sear/Trigger Engagement and Sear Lift			Completed	Passed

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3.1.3.3 TLW0300J – Measure Trigger Pull Forces			Completed	Passed
3.1.3.4 TLW0300K – Measure Safe On/Off Forces		Completed		Passed
3.1.3.5 TLW0300L – Measure Bolt Lift and Closing Forces		Completed		For Information
3.1.3.6 TLW0300M – Measure Magazine Spring Force		Completed		For Information
3.1.3.7 TLW0300N – Measure Firing Pin Head / Scar Engagement			Completed	Passed
3.1.3.8 TLW0300O – Bolt Stop Function Check			Completed	Passed
3.1.3.9 TLW0300P – Function Check of ISS System			Completed	Passed
3.1.3.10 TLW0300Q – Magazine Box Weld Strength Test	Completed			Passed
3.1.3.11 TLW0300AT – Perform Bore Sighting Using Bushnell Scope.		Completed		Passed
3.1.4 Gun Characteristics				
3.1.4.1 TLW0300R – Balance Point – System (Includes Scope and Mount Rails)”			Completed	For Information
3.1.4.2 TLW0300S – Balance Point – Rifle Only (Without Scope, rails and Iron Sights)			Completed	For Information
3.1.5 Firearms Measurements				
3.1.5.1 TLW0300T – Chamber Cast		Completed		Passed
3.1.5.2 TLW0300U – Bore Diameter		Completed		Passed
3.1.5.3 TLW0300V – Groove Diameter		Completed		Passed
3.1.5.4 TLW0300W – Twist Rate (-30-06)		Completed		Passed
3.1.5.5 TLW0300X – Magazine Capacity Test		Completed		Passed

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3.2 FUNCTION & ENDURANCE TESTING	A-SERIES	B-SERIES	C-SERIES	Final
	Status	Status	Status	Status
3.2.1 Function and Endurance Testing				
3.2.1.1 TLW0300Y -- Ten (10) Round Safety Function Test with Lanyard.			Completed	Passed
3.2.1.2 TLW0300Z -- Basic Jack Function Test (100 Rounds with Rem. Ammo.			Completed	Passed
3.2.1.3 TLW0300AA-- Extended Function & Endurance (400 Rounds w/Rem. & Competitive Ammo)			Completed	Passed
3.2.1.4 TLW0300AB -- Clean Rifles and Inspect			Completed	Passed
3.3 ACCURACY AND POI TESTING				
3.3.1 Accuracy and POI Testing				
3.3.1.1 TLW0300AC -- POI & Group Size -- Initial Test with High Quality 36X Scope		Completed		Passed
3.3.1.2 TLW0300AD -- Group Size at 100 yards (System Stability Test, w/Bushnell Scope @ "zero" rounds		Completed		Passed
3.3.1.3 TLW0300AE -- Group Size at 100 yards (System Stability Test, w/Bushnell Scope @ "20" rounds		Completed		Passed
3.3.1.4 TLW0300AF -- Group Size at 100 yards (System Stability Test, w/Bushnell Scope @ "40" rounds		Completed		Passed
3.4 ENVIRONMENTAL TESTING				
3.4.1 Temperature & Humidity Testing				
3.4.1.1 TLW0300AG -- Hot Function Test			Completed	Passed

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3.4.1.2 TLW0300AH – Cold Function Test			Completed	Passed
3.4.1.3 TLW0300AI – Heat & Humidity Test			Completed	Passed
3.5 ABUSIVE TESTING				
3.5.1 Impact Testing				
3.5.1.1 TLW0300AJ – SLAM Testing			Completed	Passed
3.5.1.2 TLW0300AK – SAAMI Drop Test – “System” (Includes Scope and Mounting Rails)			Completed	Passed
3.5.1.3. TLW0300AL – SAAMI Jar-Off Test - “System” (Includes Scope and Mounting Rails)			Completed	Passed
3.5.1.4. TLW0300AM – SAAMI Rotation Test – “System” (Includes Scope and Mounting Rails)			Completed	Passed
3.5.1.5. TLW0300AN – SAAMI Drop Test – (Rifle Only (Without Scope and Mounting Rails and w/ Iron Sights)			Completed	Passed
3.5.1.6. TLW0300AO – SAAMI Jar-Off Test - (Rifle Only (Without Scope and Mounting Rails and w/ Iron Sights)			Completed	Passed
3.5.1.7 TLW0300AP – SAAMI Rotation Test - (Rifle Only (Without Scope and Mounting Rails and w/ Iron Sights)			Completed	Passed
3.5.2 Intentional Abuse				
3.5.2.1 TLW0300AQ – Pierced Primer Test		Completed		Passed
3.5.2.2 TLW0300AR – High Pressure Test		Completed		Passed
3.5.2.3 TLW0300AS – Obstructed Bore Test		Completed		Passed

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3.0 T&P SUMMARY – (DETAILED)

Note: The most recent series of tests is reported on in Part A. See Part B for previous series results.

3.1 INITIAL INSPECTIONS, TESTS & MEASUREMENTS

3.1.1 Visual Examination, Packaging Audit & Packaging Test

3.1.1.1 TLW0300A – (T&P series “C”) Visual Examination – Performed by Elizabethtown Technicians

710 TRAIL & PILOT SERIES - C 12/11/00				RECEIVING INSPECTION - PROOF TEST & MAGNETIC COMPLETED AT MAYFIELD			
TEST LAB TRACKING NUMBER- TLW0300							
NO HANG TAGS WERE ON THE GUNS							
GUN ID #	SERIAL NUMBER	SAFETY POSITION	INTEGRATED SECURITY SYSTEM	INSPECT FOR PROOF STAMP	INSPECT FOR MAGNETIC STAMP	TRIGGER POSITION	NOTES or COMMENTS
				TLW0300A	TLW0300P		
C-1	71002561	ON	LOCKED	YES	YES	OK	DOUBLE PROOF STAMP
C-2	71002558	ON	LOCKED	YES	YES	OK	DOUBLE PROOF STAMP, ONLY 1/2 OF STAMP VISIBLE, WRONG SERIAL NUMBER ON BOX (71001950)
C-3	71002552	ON	LOCKED	YES	YES	TO RIGHT	DOUBLE PROOF STAMP, WHITE PAINT OF BS DOT NOT SOLID
C-4	71002505	ON	LOCKED	YES	YES	OK	
C-5	71001848	ON	LOCKED	YES	YES	OK	ONLY 1/2 OF STAMP MARK VISIBLE
C-6	71001683	ON	LOCKED	YES	YES	TO LEFT	MULTIPLE PROOF STAMPS
C-7	71001834	ON	LOCKED	YES	YES	OK	
C-8	71002501	ON	LOCKED	YES	YES	OK	
C-9	71001429	ON	LOCKED	YES	YES	OK	
C-10	71002551	ON	LOCKED	YES	YES	OK	
C-11	71002555	ON	LOCKED	YES	YES	OK	
C-12	71001850	ON	LOCKED	YES	YES	OK	
C-13	71001686	ON	LOCKED	YES	YES	OK	ONLY 1/2 OF STAMP MARK VISIBLE
C-14	71001787	ON	LOCKED	YES	YES	OK	
C-15	71001948	ON	LOCKED	YES	YES	OK	DOUBLE PROOF STAMP
C-16	71001888	ON	LOCKED	YES	YES	OK	
C-17	71001844	ON	LOCKED	YES	YES	TO LEFT	
C-18	71001950	ON	LOCKED	YES	YES	OK	DOUBLE PROOF STAMP, WRONG SERIAL NUMBER ON BOX (71002558)
C-19	71001911	ON	LOCKED	YES	YES	OK	
C-20	71001157	ON	LOCKED	YES	YES	TO RIGHT	
C-21	71001761	ON	LOCKED	YES	YES	OK	
C-22	71001745	ON	LOCKED	YES	YES	OK	
C-23	71001174	ON	LOCKED	YES	YES	OK	
C-24	71001709	ON	LOCKED	YES	YES	OK	WHITE PAINT OF BS DOT NOT SOLID
C-25	71002583	ON	LOCKED	YES	YES	OK	
C-26	71002580	ON	LOCKED	YES	YES	OK	
C-27	71002557	ON	LOCKED	YES	YES	OK	
C-28	71002565	ON	LOCKED	YES	YES	OK	
C-29	71002569	ON	LOCKED	YES	YES	OK	
C-30	71001534	ON	LOCKED	YES	YES	OK	

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3.1.1.2 **TLW0300B – Packaging Audit –**

(T&P Series "A") - performed by Marketing as specified by the test plan.

The following is from an e-mail message sent to concerned parties by John C. Trull, Product Manager – Firearms. John performed a marketing audit on the first shipment of trial and pilot rifles (T&P, "A") shipped from Mayfield to the Elizabethtown site. This letter describes the results of that audit.

Packaging

Overall, packaging looked good. There were no cartons damaged outside of a few minor tears that did not penetrate through the corrugated container. All guns were secure inside of the package and did not appear to have shifted. With the exception of three guns packaged without ISS keys, all required contents were present.

Stock

Overall appearance of the 710 stock was good. No marring to speak of was noticed. In my opinion, I saw nothing that would inhibit our ability to proceed with the production of the gun, however below are some comments which hopefully can be addressed with the implementation of a new mold at some point next year.

- On approximately half of the guns, a noticeable gap existed along the left-hand side of the barrel. In contrast, the right hand side of the barrel on the same guns showed very little or no gap. In the more extreme cases, when viewed from the muzzle, the barrel appeared off center in it's bedding.
- On the same guns, a more noticeable gap appeared on the right rear corner of the receiver/stock mate (by the safety lever) than was visible on the left. With the both of these gap issues, it was almost as if the barreled action was not mounted straight into the stock.
- On nearly all guns, the safety lever dug slightly into the stock when placed in the "fire" position. Mike Keeney said that the only good way to address this would be to build a shelf into the stock when a new mold was constructed.
- One stock was observed with excessive "sink" on the left-hand side. A "not to exceed" sample was identified which Mayfield will measure in order to obtain maximum acceptance criteria.

Bolt Camming/Bolt Translation

Force required to cam the bolt into battery was noted to be tight but acceptable on essentially all guns. My opinion is that if we can take measures to reduce this on future production, we should do so. The issue raised by all was how to consistently and accurately measure bolt camming force. No consensus was reached on how to do so. I feel strongly that we should explore developing a means to test this criterion on the Model 710.

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Bolt translation varied from gun to gun slightly with one gun being unacceptable with respect to this criterion. The gun in question is going to have both the receiver insert and bolt dimensions measured to determine if they exceeded specification. Again, the issue at hand is how to appropriately measure the forces required to cycle the bolt. As with the camming force, I feel a quantitative test is needed here in order to set acceptance criteria.

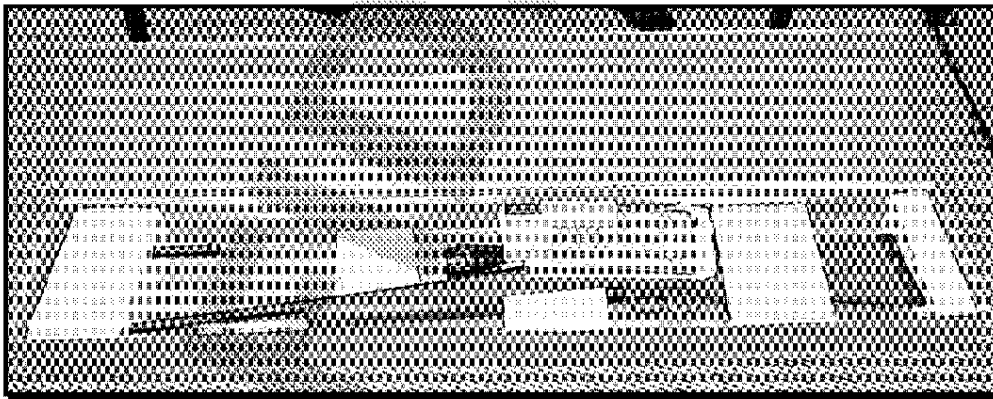
All in all, I felt that the evaluation went well. Although there are areas in which we can improve, the guns were suited to move forward with the test.

3.1.1.3 TLW0300C – Packaging Test

In addition to the above-mentioned Packaging Audit, a Packaging Test was conducted on a small sample of the T&P rifles. This test was designed to expose the product and the shipping carton to real world conditions of shipping to determine the probable effects of normal shipping on the packaging materials and evaluate the protection afforded the product.

Two rifles each were shipped from Elizabethtown by UPS to other Remington locations: Lonoke AR and Findlay OH. Upon arrival at these locations, individuals were assigned to examine the exterior of the packages, note any damage and re-ship the product back to the Elizabethtown site for final evaluation.

The first package design was judged as providing inadequate protection to the product and a redesigned Styrofoam insert was used on later trial and pilot shipments.



Picture #1- Early version of Packaging (after shipment)

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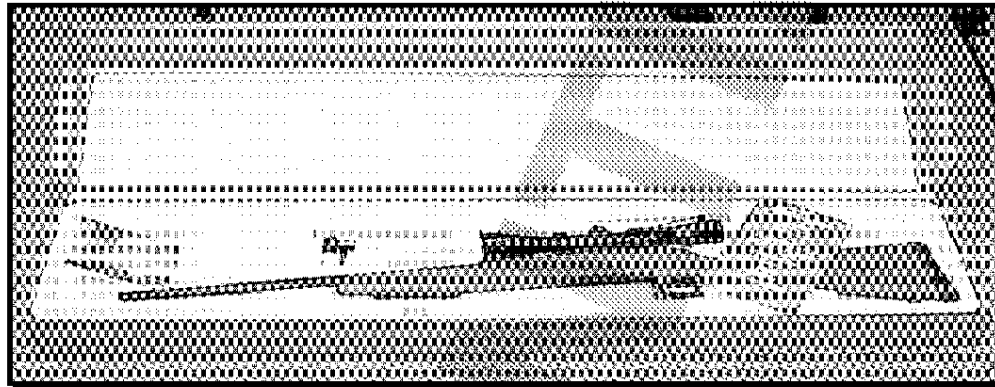
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Picture # 2 - Newest version of Packaging

3.1.2 Headspace and Proof

Note: For Series "C" sample rifles, the proof test and Magnaflux™ inspections were performed at Mayfield prior to shipment to R&D.

3.1.2.1 TLW0300E – Measure Headspace
(Please see Note above)

3.1.2.2 TLW0300F – Proof Test
(Please see Note above)

3.1.2.3 TEW0300G – Re-Measure Headspace after Proof

(T&P, Series "C") – Specification: $\leq \text{Min.} + 0.007"$ after Proof.

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Headspace: (all readings @ min. +)	30	0.0017	0.00064	0.0014; 0.0020

3.1.3 Forces

3.1.3.1 TLW0300H – Measure Firing Pin Indent

(T&P Series "B") - Specification: ≥ 0.017 indent.

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Firing Pin Indent – Preliminary Measurements	29	0.0175 in.	0.00082	0.0172; 0.0178
Firing Pin Indent – After Live Fire Test	24	0.1854	0.00114	0.01806; 0.0190

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3.1.3.2 TLW0300I - Trigger/Sear Engagement

(T&P, Series "C") Specification: 0.020 to 0.025 inches.

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Trigger/Sear Engagement	30	0.028	0.0029	0.027, 0.029

Sear Lift, (T&P, Series "C"); specification: 0.006 to 0.018 inches.

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Sear Lift	30	0.0178 in.	0.0017	0.017, 0.018

3.1.3.3 TLW0300J - Measure Trigger Pull Forces

(T&P, Series "C"); specification: 4.0 to 5.5 lbs., (Note: spring scale used for measurements.)

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Trigger Pull Forces, in Stock	30	3.99 lb.	0.375	3.85 lb., 4.13 lb.
Trigger Pull Forces, out of Stock	30	4.17 lb.	0.334	4.05 lb., 4.30 lb.

3.1.3.4 TLW0300K - Measure Safe On/Off Forces

(T&P, Series "B"); specification: ≥ 1.0 lb.

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Safe Off Force	10	2.37	0.1834	2.24, 2.50
Safe On Force	10	5.87	0.4480	5.55, 6.19

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3.1.3.5 TLW0300L – Measure Bolt Lift and Bolt Closing Force

(T&P, Series "B"); no specification listed – measurements taken for information.

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Bolt Opening Force – Chamber Empty, Cocked	10	2.79	0.0894	2.72, 2.85
Bolt Opening Force – Chamber Empty, Fired	10	10.02	0.5570	9.63, 10.42
Bolt Closing Force – Chamber Empty	10	20.67	3.49	18.17, 23.16
Bolt Opening Force – With Dummy Cartridge in Chamber, Cocked	10	3.21	0.2827	3.01, 3.41
Bolt Opening Force – With Dummy Cartridge in Chamber, Fired	10	10.23	0.486	9.89, 10.58
Bolt Closing Force – With Dummy Cartridge in Chamber	10	27.66	7.43	22.34, 32.97

3.1.3.6 TLW0300M – Measure Magazine Spring Force

(T&P, Series "B"); no specification established – measurements taken for information.

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Magazine Spring Force @ 0.2"	10	2.02	0.1582	1.90, 2.13
Magazine Spring Force @ 1.0"	10	3.38	0.2735	3.18, 3.57

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3.1.3.7 TLW0300N – Measure Firing Pin Head to Scar Engagement

(T&P, Series “C”); Specification: Minimum Vertical Engagement to be $\geq .049$ ”.

Note that the measurement method produces a dimensional range.

Variable	N	Mean (Range)	Std. Dev.	95% Confidence Interval
Firing Pin Head to Scar Engagement - range	30	0.065 – 0.076	0.0029	0.064, 0.077

3.1.3.8 TLW0300O – Bolt Stop Function Check

(T&P, Series “C”)

Variable	Good	Marginal / Loose
Stop Function	10	0
Release Detent	8	2

3.1.3.9 TLW0300P – Function Check of ISS System

(T&P, Series “C”)

All ten samples, C-11 to C-20, passed the ISS Function Test without incident.

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3.1.3.10 TLW0300Q – Magazine box Weld Strength Test

HISTORY: (details and analysis per M. Jiranek)

Thirteen M/710 magazine boxes were delivered to the Remington Arms Company Research and Development Technology Center in Elizabethtown, Kentucky for weld evaluation of the T&P product. The current specification of the welded box is that no box shall fail when loaded as described in this report below 2,000 pounds of applied load. Of the thirteen boxes supplied, 10 were tested and 1 inadvertently was destroyed during set-up. There are two boxes remaining.

SUMMARY:

All 10 of the boxes tested passed the current specification criteria. The average failure load for all 10 tested magazine boxes was 3,037 lbf. The boxes were loaded in the Instron tensile testing machine as depicted in Figure 1. The first two magazine boxes tested did not fail the welds, but rather failed the magazine box material. The test set-up was then altered (for the remaining eight magazine boxes tested) by removing the small block in the bottom of the magazine box. This allowed for the failure of the weld rather than the material in six of the remaining eight magazine boxes tested. The average failure load of the last eight magazine boxes tested was 3,229 lbf.

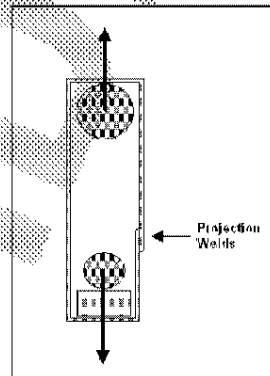


Figure 1. Schematic of the testing set-up for tensile testing the M/710 magazine boxes.

Figure 2 presents an image of one of the magazine boxes which failed the material rather than the welds. Figure 3 presents an image of a magazine box which failed both of the welds during the testing process.

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Figure 2. Image of a magazine box, which did not fail the welds, but did fail the magazine box material during the weld strength testing process.

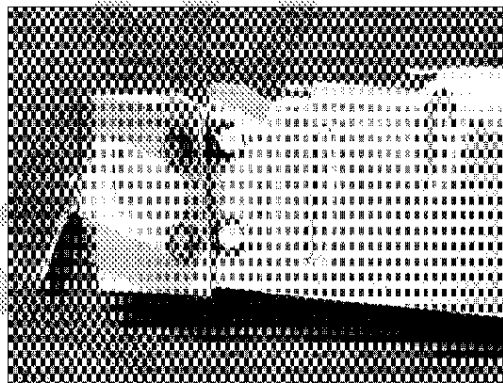


Figure 3. Image of a magazine box, which did fail the welds during the weld strength testing. Note the partial failure of the material at the front of the box as well.

PROCEDURE:

A total sample of ten magazine boxes was tested to failure. As shown in Figure 1, the magazine boxes were loaded into the Instron tensile testing machine using two pins which passed through the ends of the magazine box and a small block which was meant to keep the front of the box square under the loading conditions.

The welds were strong enough, however, to allow the magazine box to deform around the block and tear along the front edge of the magazine box. An example of this type of failure is shown in Figure 2. By removing the block, the magazine box was

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allowed to deform around the two fixture pins. Once the magazine box had conformed to this geometry, the applied load increased with the displacement until the welds ultimately failed.

RESULTS:

Table 1 presents the maximum load obtained prior to failure of each of the magazine boxes as tested. This table also included the average, standard deviation, and the average minus three standard deviations for all ten boxes as well as for the last eight boxes tested (after the set-up change was performed).

M/710 Magazine Box Weld Shear Test			
Maximum Load		Maximum Load	
Box No.	at Failure (lb.)	Box No.	at Failure (lb.)
1	2,354	6	2,820
2	2,184	7	3,285
3	3,029	8	3,393
4	3,486	9	3,321
5	3,624	10	3,197
3,037	10 Box Average	3,229	8 Box Average
459	10 Box St. Dev.	241	8 Box St. Dev.
1,660	10 Box $\mu-3\sigma$	2,506	8 Box $\mu-3\sigma$

Table 1. Individual testing results of each of the ten magazine boxes evaluated for weld strength.

Figure 4 presents a graph of a typical load / displacement curve for the weld strength testing. This graph has the key characteristics of the weld strength testing labeled directly in the regions of interest. These included the magazine box deformation (when the box deforms around the two fixture pins), the failure of the first of the two welds, and the failure of the second weld. This particular curve is of magazine number 8.

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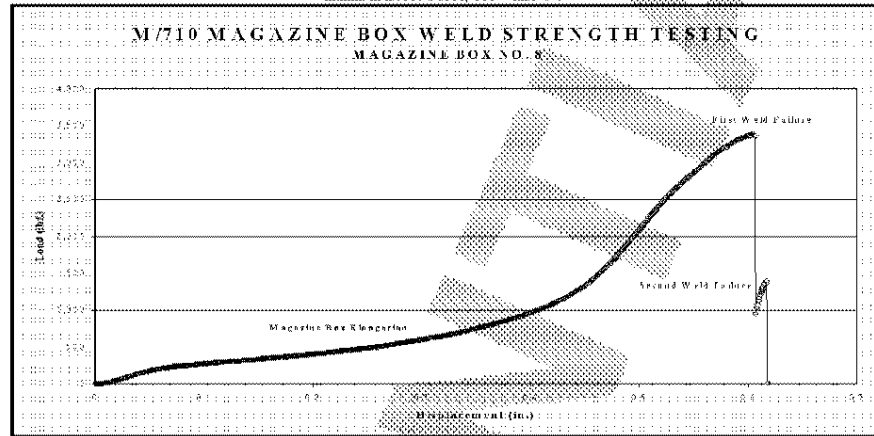


Figure 4. Load / displacement graph of test magazine box number 8.

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3.1.3.11 TLW0300AT - Perform bore sighting Using Bushnell Scope

(T&P, Series "B"), no specification established -- measurements taken for information.

Prior to the start of live fire or accuracy testing a sample of the rifles was tested to determine if production had performed a bore sighting/adjustment after mounting the Bushnell Scopes. The scopes were not adjusted prior to testing. One 5-shot group was shot from each of the test rifles.

From the test data it would appear that the scopes were not adjusted prior to submission to trial & pilot testing. See Pattern Chart next page. The individual points represent the location of each rifles POI (Point of Impact) relative to POA (Point of Aim), (with the POA located at (0,0))

The "Overall Average Position" on the chart represents the average POI relative to POA for the ten rifles tested.

MODEL 710 T&P POI RELATIVE TO POA BORE SIGHTING USING BUSHNELL SCOPE						
GUN	SCOPE	AMMO	GROUP SIZE	POI RELATIVE TO POA		TOTAL DISTANCE (in.)
B-21	BUSHNELL	REM R30064 180GR	2.68	X	-2.49	12.07
				Y	11.81	
B-22	BUSHNELL	REM R30064 180GR	2.37	X	-7.25	11.93
				Y	9.47	
B-23	BUSHNELL	REM R30064 180GR	2.46	X	-8.52	12.63
				Y	9.32	
B-24	BUSHNELL	REM R30064 180GR	3.52	X	-16.11	22.12
				Y	15.15	
B-25	BUSHNELL	REM R30064 180GR	1.05	X	4.45	5.17
				Y	-2.65	
B-26	BUSHNELL	REM R30064 180GR	1.54	X	1.72	17.30
				Y	17.22	
B-27	BUSHNELL	REM R30064 180GR	2.34	X	-13.83	16.78
				Y	9.50	
B-28	BUSHNELL	REM R30064 180GR	2.62	X	-4.47	13.26
				Y	12.49	
B-29	BUSHNELL	REM R30064 180GR	1.89	X	3.50	4.17
				Y	-2.28	
B-30	BUSHNELL	REM R30064 180GR	2.387	X	-9.279	13.63
				Y	9.978	
AVERAGE					12.9	
STD. DEV.					5.4	

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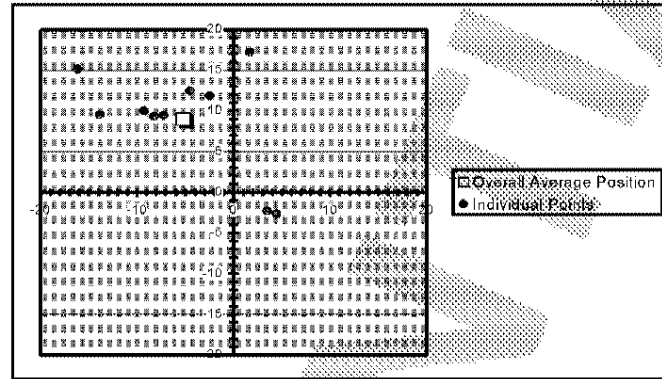
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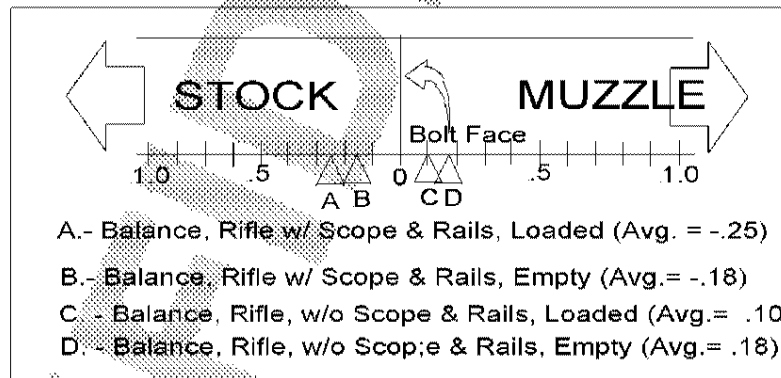


3.1.4 Gun Characteristics

(T&P, Series "C") no specification established – measurements taken for information.

3.1.4.1 TLW0300R – Balance Point – "System" (Includes Scope and Mount Rails)

3.1.4.2 TLW0300S – Balance Point – Rifle Only (Without Scope, Rails and with Iron Sights)



The balance point is measured from the bolt face (to establish a common reference location) and is important in terms of rifle "pointability". In addition, the balance point is used as an indicator of the Center of Gravity of the rifle and is used as the height locator when performing the S.A.A.M.I. Drop test. For this model the balance point is within a 1/4 inch of the bolt face for all 4 test conditions, with and without scope and rails and loaded and unloaded.

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3.1.5 Firearms Measurements

3.1.5.1 TLW0300T – Chamber Cast

(From series "B" – see "Variable" column for specifications)

Variable	N	Mean	Std. Dev.	95% Confidence Interval
.4708-.4728	10	0.4702	0.00087	0.4696, 0.4709
.4425 - .4400	10	0.444	0.00033	0.4437, 0.4445
34.5 Deg.	10	34.5°	0.2550	34.3°, 34.7°
.3404 – 3424	10	0.3437	0.00100	0.3430, 0.3444
.3095 - .3105	10	0.3100	0.00059	0.3096, 0.3105

3.1.5.2 TLW0300U – Bore Diameter

(T&P, Series "B"), specification: 0.300"/0.301"

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Bore Diameter	10	0.3002 - 0.3005	0.00007	0.30014, 0.30054

3.1.5.3 TLW0300V – Groove Diameter

(T&P, Series "B"), specification: 0.308 / 0.309

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Groove Diameter	10	0.309	0.00018	0.3090, 0.3093

3.1.5.4 TLW0300W – Twist Rate (.30-06)

(T&P, Series "B"), specification: 1" in 10", $\pm 0.25"$, RH

Variable	N	Mean	Std. Dev.	95% Confidence Interval
Twist Rate	10	1 in 10.	0.150	9.9, 10.1

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3.1.5.5 TLW0300X – Magazine Capacity Test

(T&P Series "B"), specification : with 4 rounds in magazine box, must be able to load and latch into receiver.

All ten rifles (B11 to B20) passed the Magazine Capacity Test.

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3.2 FUNCTION & ENDURANCE TESTING

3.2.1 Function and Endurance Testing

3.2.1.1 TLW0300Y - Ten (10) Round Safety Function Test with Lanyard

Test completed without incident.

3.2.1.2 LW0300Z - Basic Jack Function Test (100 Rounds with Remington Ammunition.)

Ammo Types	MALFUNCTIONS - BY AMMO TYPE - SERIES "C" - RIFLES C1 - C24,																							
	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
REM, L30062, 150 gr. MC																								
REM, PRT3006B, 165 gr. NBT																								
REM, R30064, 180 gr. SP					3C																			
REM, R30065, 180 gr. PSP			1A		3D																			
REM, R30067, 220 gr. SP				1B	3E															4F				

1A - Rifle C3 - Magazine Box Bottom came off @ 74 rounds into test.

1B - Rifle C4 - Magazine Box Bottom came off @ 90 rounds into test.

3C - Rifle C5 - Magazine Box Bottom came off @ 49, 54 & 58 rounds into test.

3D - Rifle C5 - Magazine Box Bottom came off @ 62, 71 & 78 rounds into test.

3E - Rifle C5 - Magazine Box Bottom came off @ 86, 91 & 97 rounds into test.

4F - Rifle C21 - Magazine Box Bottom came off @ 82, 90, 94 and 98 rounds into test.

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3.2.1.3 TLW0300AA - Extended Function & Endurance (400 Rounds w/Remington & Competitive Ammunition.)

This test procedure is used to determine an estimate of the products expected rate over an extended period of shooting. Not counting the magazine box bottoms that came off during shooting (12 instances in 4000 rounds), there were a total of 13 malfunctions, 12 stem low and 1 Bolt Over-ride, in 4000 rounds for a malfunction rate of 0.3%. The acceptable malfunction rate for Bolt-Action Centerfire rifles is $\leq 2\%$. It was noted that rifles C-6 through C-10 had difficulty removing the magazine box. Rifles C12 through C-15 had additional clearance machined into the magazine well were noted as not having a problem removing the magazine box throughout the test.

400 Round Extended Function Test Rifles C-6 to C-15, TLW0300AA; 12/20/00

This 400 round Extended Function Test was performed in the Function & Casualty Range using std. Remington Test Jacks. An assortment of Ammunition Types was used without specific order or amount.

Note: Rifles C-11 to C-15 had additional clearance machined into the Magazine Well to improve Magazine removal.

RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS FIRED	MALFUNCTIONS
C-6	71001683	Rem.R30064, 180 gr. SP	K29G C4214	100	0
		Rem. L30062, 150 gr. MC	M03G B1	100	0
		Fed. P3006Q, 165 gr.	010614X250	100	0
		Rem. R30064, 180 gr. SP	K29G C4214	100	0
Technician:	J. Arnold				
Comments:	Magazine box became very difficult to remove from gun, straightened magazine box 220 rounds into test & continue.				

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RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS FIRED	MALFUNCTIONS
C-7	71001834	Rem. R30064, 180 gr. SP	K29G C4214	100	0
		Rem. L30062, 150 gr. MC	M03G B1	100	0
		Fed. 3006b, 180 gr.	41033X227	100	0
		Win. S3006XB, 150 gr.	ME61	100	7 Stem Low
Technician:	J. Arnold				
Comments:	Magazine box became very difficult to remove form gun, straightened magazine box 200 rounds & Rounds into test & continue.				
RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS FIRED	MALFUNCTIONS
C-8	71002501	Rem. R30064, 180 gr. SP	K29G C4214	100	0
		Rem. L30062, 150 gr. MC	M03GB1	100	0
		Win. SBST3006XA, 168 gr.	04RK31	100	0
		Rem. R30065, 180 gr. PTD SP	L19D B27	100	0
Technician:	J. Arnold				
Comments:	Magazine box became very difficult to remove form gun, straightened magazine box 200 rounds into test & continue.				

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RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS FIRED	MALFUNCTIONS
C-9	71001429	Rem.R30064, 180 gr. SP	K29G C4214	100	Mag. box bottom came off @ 93 & 100 Rounds.
		Rem. L30062, 150 gr. MC	M03G B1	100	0
		Win. SHV30064, 180 gr.	35PC52	100	0
		Rem. L30062, 150 gr. MC	M02G C1	100	0
Technician:	J. Arnold				
Comments:	Magazine box became very difficult to remove from gun, straightened magazine box 220 rounds into test & continue				
RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS FIRED	MALFUNCTIONS
C-10	71001683	Rem.R30064, 180 gr. SP	K29G C4214	100	Mag. box bottom came off @ 49,53,65,70,84, & 96 Rounds
		Rem. L30062, 150 gr. MC	M03G B1	100	2 Stem Low
		Fed. P3006G, 150 gr.	A146782320	100	0
		Rem. R30067, 220 gr. SP	M24H B14	100	Mag. box bottom came off @ 22 & 32 rounds.
Technician:	J. Arnold				

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<i>Comments:</i>		Magazine box become very difficult to remove form gun, straightened magazine box 200 rounds into test & continue.			
RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS FIRED	MALFUNCTIONS
C-11	71002555	Rem. R30063, 150 gr. BR PT	R26N B97	160	Mag. box bottom came @ 24 rounds
		Win. S3006XB, 150 gr.	ME51	50	3 Stem Low
		Win. SHV30064, 180 gr.	35PC52	50	0
		Fed. P3006G, 150 gr.	A146782320	70	0
		Fed. 3006b, 180 gr.	41047X228	10	0
		Fed. P3006Q, 165 gr.	010614X250	30	0
		Rem. L30062, 150 gr. MC	M03G B1	20	0
		Win. SBST3006XA, 168 gr.	04RK31	10	0
<i>Technician:</i>	<i>J. Arnold</i>				
<i>Comments:</i>	<i>None</i>				
RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS	MALFUNCTIONS

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				FIRE	
C-12	71001680	Rem.R30064, 180 gr. SP	K28 GB3714	100	0
		Rem. L30062, 150 gr. MC	M03G B1	300	0
Technician:	J. Arnold				
Comments:	None				
RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS FIRED	MALFUNCTIONS
C-13	71001686	Rem.PRT3006B, 165 gr. NOL. BAL. TIP	M31A C26	100	1 Bolt Over-ride
		Rem. L30062, 150 gr. MC	M03GB1	300	0
Technician:	J. Arnold				
Comments:	None				
RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS FIRED	MALFUNCTIONS
C-14	71001787	Rem.R30064, 180 gr. SP	K28 GB3714	100	Mag. box bottom came off @ 7 rounds
		Rem. R30065, 180 gr. PTD SP	K04U A7926	60	0

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		Rem. PRT3006B, 165 gr. NOL BAL TIP	M31A C26	40	0
		Rem. L30062, 150 gr. MC	M03G B1	200	0
Technician:	J. Arnold				
Comments:	None				
RIFLE NUMBER	SERIAL NUMBER	AMMUNITION TYPE	LOT NUMBER	ROUNDS FIRED	MALFUNCTIONS
C-15	71001948	Rem. R30062, 150 gr. MC	M03G B1	264	0
		Rem. L30064, 180 gr. SP	K28 GB3714	78	0
		Rem. P30065, 180 gr. PTD SP	K04U A7926	33	0
		Rem. R30063, 150 gr. BR PT	J26N B97	25	0
Technician:	J. Arnold				
Comments:	None				

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3.2.1.4 TLW0300AB – Clean Rifles and Inspect

See “Clean & Inspect Checklist, series C, T&P”, Part B; raw data sheets for details of the results of inspections and measurements.

3.3 ACCURACY AND POI TESTING

3.3.1 Accuracy and POI Testing

3.3.1.1 TLW0300AC – POI & Group Size – Initial Test with High Quality 36X Scope

This point of impact test involves the verification of the firearm's sighting system adjustment and the potential to hit the point of aim. Random variation and/or extreme differences shot to shot point of impact (as well as group size) typically indicate improper barrel processing and is used as a final inspection flag in production. Standard factory ammunition is used for this test and the same code of ammunition is used throughout the test. Three, 5-shot groups were shot in each of the test rifles B-21 to B-30. For this product and this caliber the average group must be $\leq 2.7"$ at 100 yards.

All rifles in the test sample were under the 2.7" group size with the overall average group size calculated to be 1.6", (95% confidence interval = 1.4" to 1.8".)

Rifle	Scope	Ammunition	Group #1	Group #2	Group #3	Average Group
B-21	Swarovski 6-24x50	Rem R30064, 180 gr.	1.482	1.052	1.892	1.475
B-22	Swarovski 6-24x50	Rem R30064, 180 gr.	1.605	2.242	1.085	1.644
B-23	Swarovski 6-24x50	Rem R30064, 180 gr.	1.074	1.509	1.082	1.222
B-24	Swarovski 6-24x50	Rem R30064, 180 gr.	2.282	2.333	1.039	1.885
B-25	Swarovski 6-24x50	Rem R30064, 180 gr.	1.761	0.791	1.361	1.304
B-26	Swarovski 6-24x50	Rem R30064, 180 gr.	1.963	1.219	1.448	1.543
B-27	Swarovski 6-24x50	Rem R30064, 180 gr.	1.451	2.053	0.947	1.484
B-28	Swarovski 6-24x50	Rem R30064, 180 gr.	1.996	1.496	1.032	1.508
B-29	Swarovski 6-24x50	Rem R30064, 180 gr.	1.916	2.120	1.499	1.845
B-30	Swarovski 6-24x50	Rem R30064, 180 gr.	2.498	2.624	1.740	2.287
Group Size - Overall Mean						1.620

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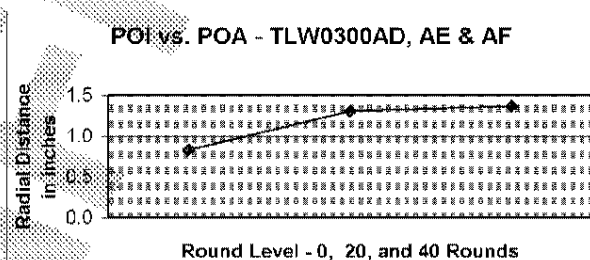
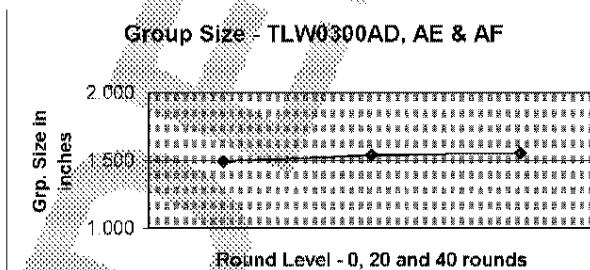
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3.3.1.2 TLW0300AD, AE and AF – Group Size and POI at 100 yards (System Stability Test, w/Bushnell Scope @ “zero” rounds, “20” rounds and at “40” rounds.

(T&P, Series “B”), specification : ≤ 2.7 ” at 100 yards

The purpose of this test is to evaluate the “stability” of the optical scope system over a forty round shooting test. This test was shot at 100 yards using standard factory ammunition (using the same code of ammunition throughout the test.) The test consisted of three, 5-shot groups with the rifles cooled after every group. Each firearm was cleaned and fired with five fouling shots prior to the start of the test. The specification for average group size for this product and caliber was set at ≤ 2.7 ” at 100 yards. The group size change over the 40 rounds was calculated to be 0.063” – an insignificant change.

The change in POI (Point of Impact) vs. POA (Point of Aim) changed approximately 0.5” over the 40 round test. Again, an insignificant change given the test measurement variability.



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3.4 ENVIRONMENTAL TESTING

3.4.1 Temperature & Humidity Testing

3.4.1.1 TLW0300AG – Hot Function Test

This test evaluates the effect(s) of extreme high temperatures on the functioning performance of firearms with special interest in the synthetic parts of the product. For this test Rifle C-21 and 100 rounds of ammunition were placed in the environmental chamber set at a temperature of 120°F for a minimum of six hours. After six hours the rifle and 20 rounds of ammunition were removed from the chamber and shot in the test jack, cycling the safety every five rounds. After shooting the 20 rounds the rifle is returned to the chamber and allowed to return to the chamber temperature for two hours. At that point the rifle is again removed from the chamber with another 20 rounds and the shooting test is continued. This procedure is continued until the entire 100 rounds are fired through the rifle. No malfunctions or other items of note were observed during this test.

3.4.1.2 TLW0300AH – Cold Function Test

This test evaluates the effect(s) of extreme low temperatures on the functioning performance of firearms. Rifle C-22 and 100 rounds of ammunition were put in the freezer set at a -20°F for a minimum of six hours. After six hours the rifle and 20 rounds were removed from the freezer and shot with the safety being cycled every five rounds. The rifle was then replaced in the freezer for a minimum of two hours. This procedure was repeated until the 100 rounds had been shot through the rifle.

There was one misfire noted at round 88, the second round out of the box.

3.4.1.3 TLW0300AI – Heat & Humidity Test

For this test the rifle, C-23 was placed in the environmental chamber with 100 rounds of ammunition for a minimum of six hours. The chamber was set at 100°F and 80-90% Relative Humidity. After the initial six hours of conditioning the rifle and 20 rounds of ammunition were removed and shot in the test jack. The safety was cycled every five rounds. Every 20 rounds the test was repeated. There were no malfunctions noted during this test.

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3.5 ABUSIVE TESTING

3.5.1 Impact Testing

3.5.1.1 TLW0300AJ - SLAM Testing

The purpose of this test is to determine if the firing pin will "follow-down" if the round is rammed home into the chamber as quickly as possible. For each of the four rounds in the magazine the tester closed the bolt "smartly". After each round was loaded into the chamber the round was fired. There were no inadvertent firings in twenty trials (or at least the number of rounds prior to the bolt handle coming off) for each rifle, therefore the test results were deemed to be acceptable for the purpose of the "slam" test. Bolt handles that came off were determined to have poor braze to the bolt body.

Rifles	Serial Number	Round Number	Comments
C1	71002561	15	Bolt handle broke off at end of forward bolt movement Before starting rotation, bolt was left unlocked Stopped test of C1
C2	71002558	2	Bolt handle broke off, same as C1 Stopped Test of C2
C3	71002552	5 6 13	Grip Cap came off Magazine Box bottom came off Bolt Handle Broke off, same as C1 Stopped Test of C3
C4	71002505		No problems

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- 3.5.1.2 TLW0300AK – SAAMI Drop Test – “System” (Includes Scope and Mounting Rails)
- 3.5.1.3 TLW0300AL – SAAMI Jar-Off Test – “System” (Includes Scope and Mounting Rails)
- 3.5.1.4 TLW0300AM – SAAMI Rotation Test – “System” (Includes Scope and Mounting Rails)
- 3.5.1.5 TLW0300AN – SAAMI Drop Test - Rifle Only (Without Scope and Mounting Rails and w/ Iron Sights)
- 3.5.1.6 TLW0300AO – SAAMI Jar-Off Test – Rifle Only (Without Scope and Mounting Rails and w/ Iron Sights)
- 3.5.1.7 TLW0300AP – SAAMI Rotation Test - (Without Scope and Mounting Rails and w/ Iron Sights)

Summary of TLW0300 AK, AL, AM, AN, AO & AP

Rifle	With/Without Scope and Accessories	Jar-Off Test		Drop Test		Rotation Test	
		Pass	Fail	Pass	Fail	Pass	Fail
		All Six Orientations		All Six Orientations		All Six Orientations	
C25	With Scope	√		√		√	
C25	Without Scope	√		√		√	
C26	With Scope	√		√		√	
C26	Without Scope	√		√		√	
C27	With Scope	√		√		√	
C27	Without Scope	√		√		√	
C28	With Scope	√		√		√	
C28	Without Scope	Not available for test – receiver insert broken on previous test – rifle taken out of test. See test log – Gun # C28, “C” series of tests.					
C29	With Scope	√		√		√	
C29	Without Scope	√		√		√	
C30	With Scope	√		√		√	
C30	Without Scope	√		√		√	

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3.5.2 Intentional Abuse

3.5.2.1 TLW0300AQ – Pierced Primer Test

This test involves using a wedge-shaped firing pin point with the intent of piercing the primer thereby allowing high-pressure gases to escape from the shell in the chamber into the bolt, magazine box and receiver areas. The purpose of this test is to evaluate effects on the product due to this release of high-pressure gases into the action. A standard factory round is used for this test.

Three rounds were pierced for this test. There was no indication of damage to the rifle from any of the three test rounds.

3.5.2.2 TLW0300AR – High Pressure Test

The purpose of this test is to determine the probable extent of gun damage that might occur if a customer purposely or accidentally handloads an extremely high pressure load. In the case of the .30-06, a standard load case is loaded with approximately 50.5 grains of IMR4198 powder using a 220-grain bullet. Trial runs are made at lower powder volume levels (generating under 100,000 psi due to transducer limitations) to verify the load at known levels. In this case 47 grains of IMR4198 were used to produce an estimated pressure level of 94,800 psi. For the high pressure load, 50.5 grains of IMR4198 powder was used giving an estimated pressure level of 120,000 psi. (Note: 50.5 grains of powder is the maximum amount that will fit in the case without extensive compression of the powder.)

Damage on the rifle was noted as follows:

- Bolt Plug was set back on bolt body but remained attached to the bolt body.
- The magazine spring, magazine follower and magazine box bottom were thrown clear of the rifle.
- The bolt was firmly seized in the receiver/barrel assembly requiring milling of the parts to free the bolt assembly from the action.
- There was shear and set back noted on the locking lugs of the bolt head. The locking lugs in the barrel were unaffected.

This level of damage is not unusual given the pressure level.

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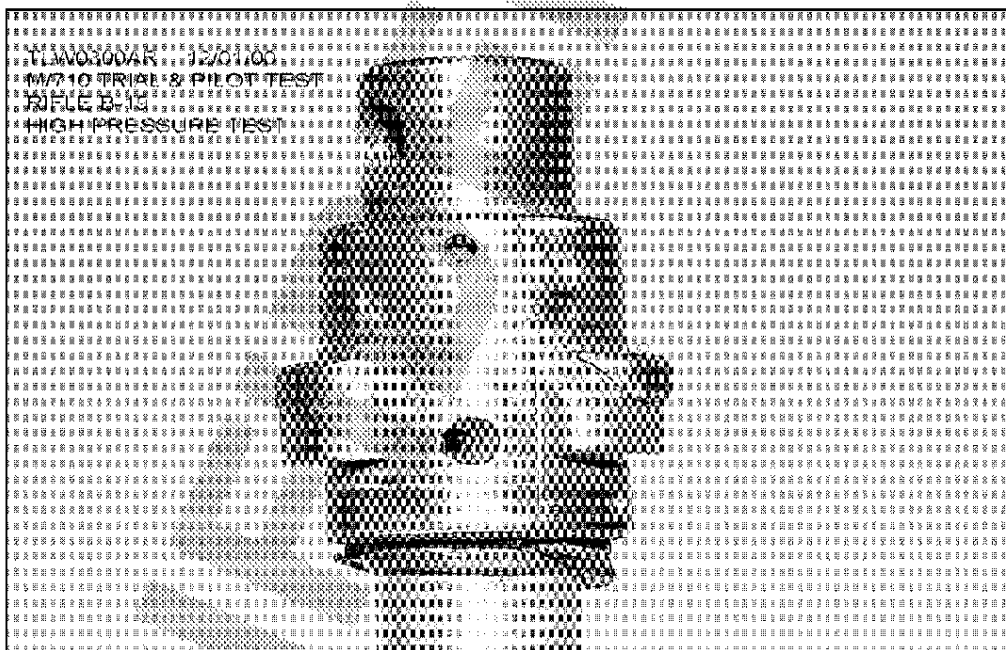
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30-06 Hi Press Load Verification

Barrel:	# 129	# 2130	220g Bullet
Powder:	IMR4198	Lot E99MY20	L3228
Kisler Amp:		1v=20k	
		Scope	
Max Volts	2.46	2.38	4.74
Press:	49200	47600	94800
500us	1v div	1v div	1v div
Time	Warmer 1	Warmer 2	47g



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3.5.2.3 TLW0300AS – Obstructed Bore Test

This test is conducted with an obstruction placed in the bore and a standard factory round is then fired in the rifle to determine what damage, if any, might result. To begin the test a rifle bullet is driven into the bore and is located to a position immediately in front of the chamber. A standard factory projectile, in this case a .30-06, 220 grain bullet, is placed in the chamber and the gun is fired using a lanyard. Witness paper is located directly behind the firearm to determine if debris might cause injury to the shooter.

When this test was conducted it was found that the bolt plug assembly separated from the bolt body when the gas escaping into the bolt head and bolt body traveled the length of the bolt body and impacted the bolt plug. The following is from a report issued on the results of an analysis conducted to determine if this might pose a safety issue for the shooter. The analysis determined that given the mass of the synthetic material bolt plug and the velocity of the part along with the requirement that an obstruction also be present in the bore of the rifle it was unlikely to pose a danger to the shooter.

Test Description: (details & analysis per S. Franz)

Obstruct bore just forward of chamber with a 220-grain bullet

Set-up witness papers and shoot high speed movies to capture event.

Shoot a standard factory load with 220-grain bullet under controlled conditions as per high-pressure test procedures.

Results:

- Gun # B-20 was tested as per the test Plan. The plastic bolt plug separated from the over molded metal insert and was ejected toward the rear of the rifle. A single sheet of witness paper was set-up behind the rifle perpendicular to the axis of the bore at the butt of the stock. The bolt plug penetrated this paper. The ISS tumbler and detent system broke free from the bolt plug and these parts were found in the room. The magazine box bottom, magazine spring and follower along with the grip cap also exited the rifle. The bolt handle was broken away from the bolt body while trying to open the rifle. The high-speed camera malfunctioned and therefore no movie was captured. Pictures were taken of the setup and the condition of the rifle after firing.
- Since no movie was captured and no estimate of part velocity and energy could be determined another gun was tested. Additional layers of witness paper were set-up at various distances behind the gun so as to better estimate part velocity and energy for this retest.
- Gun # B-10 was tested as per above and no failure of the bolt plug area occurred. The box bottom, spring and follower exited the rifle in a downward direction.

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- Another gun, B-9, was tested as per the same procedure. This time the bolt plug cracked and separated slightly from the bolt assembly but it did not detach from the rifle. The grip cap, magazine box bottom, spring and follower also exited the rifle.
- Another gun, B-7, was tested per the above procedure. This time the bolt plug failed as it did in B-20 and was propelled rearward from the rifle. The ISS system components stayed intact with the bolt plug. The box bottom, spring and follower also exited the rifle and the operating handle was separated from the bolt body. The bolt plug penetrated three sheets of paper and hit and bounced off a fourth sheet at which point it fell almost straight downward. A high-speed movie was captured showing failure of the bolt plug and impact and penetration with the first sheet of paper only. The first sheet of paper was placed approximately 20 inches behind the rear surface of the receiver. The second sheet of paper was 39 inches from this reference point, the third 42-½ inches and the fourth 57-½ inches. The paper used was cut from a roll of 36 inch wide by 50-yd. long 20-lb. Hi-Bright computer plotter paper. The paper was taped to wooded frames as depicted in the following picture that shows the room set-up.

Jan. '01 Trial & Pilot Test - Remington M710 Centerfire Rifle;
R & D Technical Center Project No. 241039; TI.W 0300
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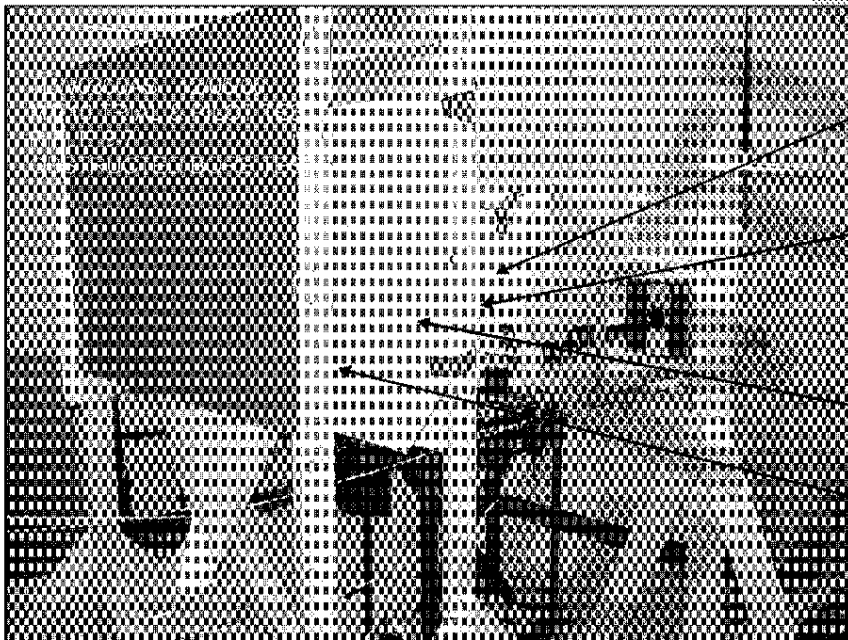
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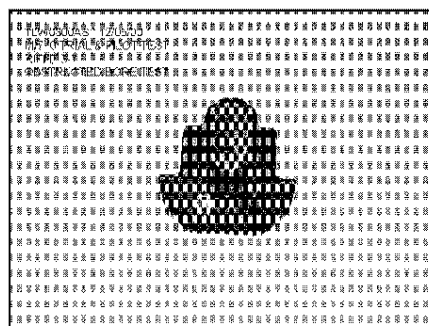
SHEET 1

SHEET 2 - ON FRONT
SIDE OF FRAME

SHEET 3 ON REAR
SIDE OF FRAME

SHEET 4 ON FRONT
SIDE OF FRAME

A close-up of gun B-7, with the bolt plug missing and the bolt plug after test are shown in the following pictures.



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In order to determine the energy in the bolt plug the following information is required:

- Weight/Mass of part
- Velocity of part

The weight was measured on a precision scale as 155.1 Grains. This can be converted to mass units by converting grains to pounds and then using the equation $W = mg$ where W is weight in lbs., m is mass in lbs.-sec.²/ft. and g is acceleration due to gravity in ft./sec.²:

$$155.1 \text{ Grains} * (1 \text{ lb./7000 Grains}) / (32.174 \text{ ft./sec.}^2) = .0006887 \text{ lb.-sec.}^2/\text{ft.}$$

The average velocity is determined from the distance traveled divided by the time required to travel this distance. A string was used to determine the distance from the original location of the part on the rifle to the hole in the first sheet of paper. This distance was measured to be 19.75 inches. The time required to travel this distance was taken from the high speed movie and was determined to be .040 sec.

The calculated average velocity of the bolt plug was:

$$V_{avg.} = \Delta S / \Delta t = 19.75 \text{ in.} / .040 \text{ sec.} = 494 \text{ in./sec. or } 41.15 \text{ ft./sec.}$$

From this data the calculated kinetic energy could be determined by the equation:

$$K.E. = \frac{1}{2} * \text{Mass} * \text{Velocity} * \text{Velocity} = \frac{1}{2} * m * V^2$$

$$K.E. = \frac{1}{2} * (.0006887 \text{ lb.-sec.}^2/\text{ft.}) * (41.15 \text{ ft./sec.}) * (41.15 \text{ ft./sec.}) = .58 \text{ lb.-ft.}$$

For comparison purposes this same kinetic energy level can be obtained by dropping the same bolt plug piece a distance of 26.3 ft. or dropping a 1 lb. weight a distance of .584 ft. (7 inches). This was calculated using the relationship between kinetic energy and potential energy assuming no loss in velocity due to air resistance.

For comparison purposes a table was generated listing kinetic energy levels of other common projectiles.

Description	Kinetic Energy (lb.-ft.)
Bolt Plug from obstructed bore test	.58
BB fired from a Daisy Red Ryder (at the muzzle)	1.00
50-Grain paintball fired at 300 ft./sec.	10.40
150 Grain .30-06 caliber bullet (at the muzzle)	2820.00

In conclusion the calculated bolt plug kinetic energy is approximately 1/2 (50 %) of a BB fired from a BB gun, 1/20th (5 %) of a paintball fired at maximum allowable velocity and 1/4862 (.02 %) of a 150 grain .30-06 caliber bullet at the muzzle.

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