Remington Arms Company, Inc. **CONFIDENTIAL** Research and Development Technology Center
Elizabethtown, Kentucky

September 13, 2000

To: Mike Keeney
From: Marlin Jiranek

Cc: D. Danner, S. Franz, D. Diaz, J. Snedeker, J. Urbon, J. Zajk

RE: M/710 MAGAZINE WELD TESTING

HISTORY:

As a follow-up to the previous work around the documentation and characterization of the weld shear strength of the M/710 magazine boxes, 84 additional "production" magazine boxes were shipped to the Elizabethtown, KY facility for testing and replacement of the current DAT magazine boxes. Ten of the new magazine boxes were tested using the same testing protocol as was used previously.

SUMMARY:

The results indicate that while these boxes have better welds than the original DAT boxes, none of the boxes tested have complete welds. Of the ten magazine boxes tested, the maximum failure load was 1,550 lb. and the minimum was 417 lb. This is a very large spread in the data and is well below the minimum calculated failure load for the magazine box of 2,424 lb. This examination has led to the conclusion that none of the "spot welds" submitted for use on the current production magazine boxes are satisfactory. It is recommended that a plan be devised to address the development of magazine box weld process. This can be done using the current method of two spot welds, or may have to resort to some type of projection, TIG, or MIG setup (all add cost).

PROCEDURE:

A total of ten magazine boxes were presented for testing. All of the magazine boxes were obtained from the current production sample. The samples were labeled as PROD 1 through PROD 10 randomly. As was previously done, the magazine boxes were fixtured into the Instron tensile testing machine using a small block and two pins. Figure 1 presents an illustration of the testing set-up.

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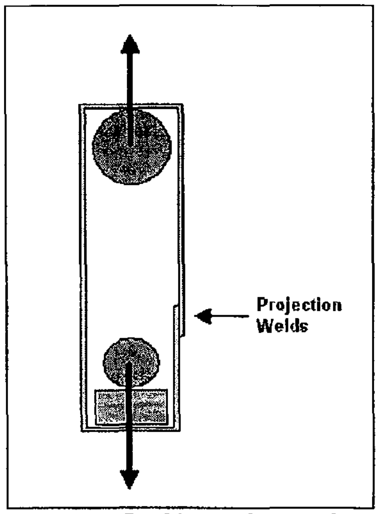

Figure 1. Illustration of the test set-up. Looking at the top of the magazine box cross-section. 83

The block was placed at the front of the magazine box to prevent the box from distorting during the tensile testing. The total force required to fail the box was reported from the Instron load cell. The shear strength per weld at the time of failure was calculated by dividing the total force by 4 (divide by 2 to determine the force per side, then divide by 2 again to determine the force per weld (2 welds on 1 side of the box)).

This shear strength test was used as the geometry of the magazine box does not lend itself to perform a "peel test" of the weldament. In the case of the magazine box being tested, the load imparted to the box during use creates a shear load across the weld as opposed to a tensile load. The test which is currently being used measures the shear load of the box while a peel test would measure the tensile strength of the weld.

RESULTS:

Figure 2 presents a graph of the typical load / displacement curves obtained from the raw data. This graph includes sample 1 (the lowest recorded strength) and sample 4 (the highest recorded strength). All of the curves follow the same path, failing at different load levels based on the strength of the weldament.

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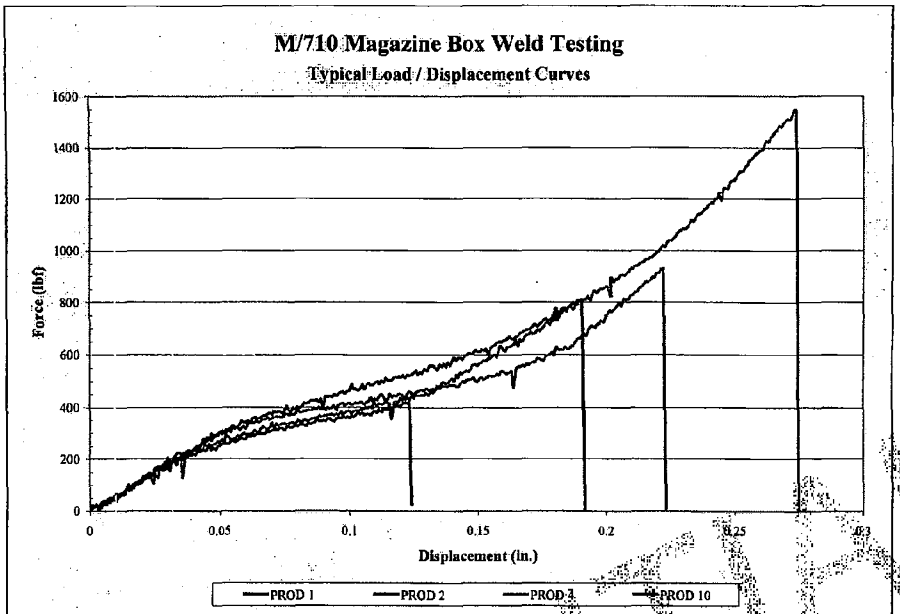

Figure 2. Graph of the typical load / displacement curves obtained from the test set-up.

Additionally, calculations of the expected load at failure, assuming the spot weld is good, were done. The load to fracture for a spot weld exposed to shear stresses (F_s) and tensile stresses (F_t) respectively, can be expressed as follows:

$F_s = k_1 \times t \times d \times \sigma b$
$F_t = k_2 \times F_s$

Where

t = thickness (mm), d = diameter of nugget (mm), σb = UTS of parent metal (N/mm^2)
k_1 and k_2 constants based on carbon equivalent of the base material.

In the case of the current material (AISI 1010 – 1020), assuming the lowest strength case: the material is 1010 by chemistry, having a carbon equivalent of 0.10, giving a k_1 value of 2.9 and a k_2 value of 0.35 respectively. Additionally, assume a UTS of 45 ksi (310 N/mm^2), a part thickness of 0.040" (1 mm) and a nugget diameter of 0.118" (3 mm). This predicts a shear failure at a load of:

$F_s = (2.9) \times (1\text{mm}) \times (3\text{mm}) \times (310 \text{ N/mm}^2) = 2697 \text{ N } (606 \text{ lbf})$ per weld.

Multiply this answer by 4 (multiply by 2 welds and then again by 2 sides of the magazine box) and the expected failure load for this test, given minimum values across the board, is approximately 2,424 lbf.

Figure 3 presents a graph of all of the production box data, along with line indicating the average and the calculated minimum failure load.

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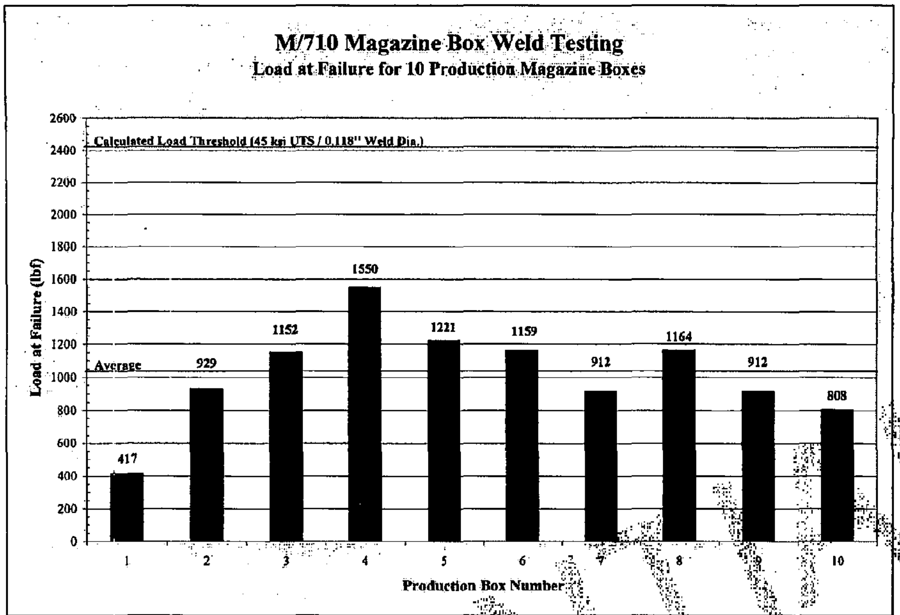

Figure 3. Graph of the production box weld shear strength testing results along with a line to mark the average strength and also the calculated strength of the boxes with a good weld.

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The results were that none of the tested boxes had welds which created an actual metallurgical weld between the two pieces of sheet steel. Figure 4 presents an image of the number 4 production magazine box after testing (highest strength box).

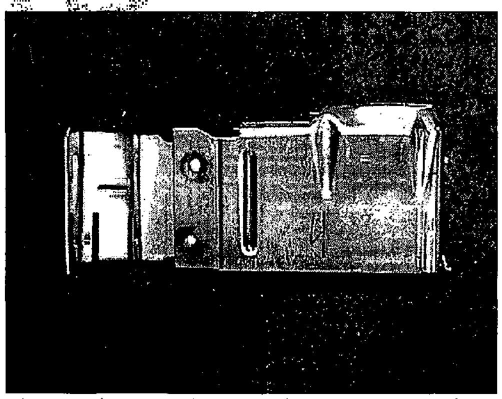

Figure 4. Image of the entire No. 4 production box after testing. The front of the box has been bent out of the way to show the weld regions.

Figures 5 and 6 present close-up images of both the number 4 (highest strength) and the number 1 (lowest strength) magazine box welds after test.

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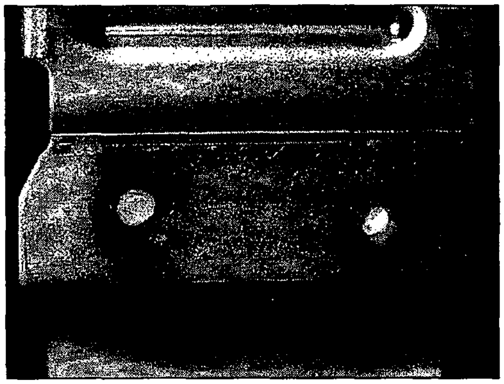

Figure 5. Number 4 magazine box weld close-up.

Figure 6. Number 1 magazine box weld close-up.

It is easy to tell (lack of metal deformation) that there is little or no evidence of actual metal bonding by fusion during the weld process. This could be attributed to many factors including (1) weld current, (2) clamping (electrode) force, (3) electrode shape, and (4) the weld timing (the weld time, squeeze time, and cooling time all being controlled).

This examination has led to the conclusion that none of the "spot welds" submitted for use are satisfactory. It is recommended that a plan be devised to address the development of magazine box weld process. This can be done using the current method of two spot welds, or may have to resort to some type of projection, TIG, or MIG setup (all add cost).