# TLW2170
# INTERIM PROGRESS REPORT B
## 40-X X-MARK PRO TRIGGER FAILURE
## 40-X XMP DAT (S/N: TA#17)
## Endurance Dry-Cycle Testing

### DESCRIPTION

A trigger failure occurred during the dry cycle testing portion of the DAT for the 40-X X-Mark Pro (XMP) fire-control conducted on April 10, 2008. Trigger assembly #17 (TA#17) failed by fracture through the adjustment screw boss location on the trigger. The failure was found by Cody Greenwell (co-op student) as the fire-control was being transported to the measurement area to perform sear engagement measurements after 5,000 dry cycles had been completed. The trigger assembly was being transported in a box along with two additional trigger assemblies at the 5,000 cycle level. The trigger assembly was mounted onto a receiver (S/N S7607332) with the bolt in-place. When TA#17 was being removed from the box, C. Greenwell thought he felt some trigger movement on the trigger assembly. Upon inspection, the trigger failed with little-to-no pressure in his hand. Figure 1 presents an image of the failed trigger assembly. This failure location is identical to the failure of TA#12 which occurred by accidental impact during initial testing and measurement by J. Ronkainen on March 28, 2007.

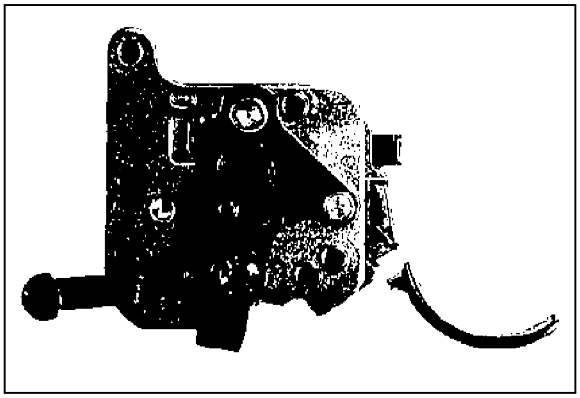

**Figure 1. the failed TA#17 test sample.**

### SUMMARY AND RECOMMENDATIONS

The failure occurred due to a load being applied from the rear of the trigger shoe forward, contrary to the direction of force applied during normal use or dry cycle testing. The most likely cause of the failure is inadvertent impact or loading of the rear of the trigger. Based on the fact that this is the second incident of this type failure, there is an indication that there may be a fragility issue with the prototype trigger adjustment screw boss welded on the trigger. Most likely the fragility issue will be resolved when the production triggers are made available with the integrally molded boss on the trigger. It is recommended that the production part be tested when available to verify the resolution of this issue.

### ACTIONS TAKEN

TA#17 was removed from the DAT dry cycle testing protocol. The DAT was continued with TA#20 substituted for TA#17 for the remainder of the test. All testing previously completed on TA#17 will be repeated on TA#20.

Testing of TA#20 is planned to continue as intended on TA#17. No other changes are planned for the remainder of the DAT. The failed trigger assembly was returned to J. Ronkainen.

## FINDINGS

Figure 2 presents an increased magnification image of the fracture region of the trigger assembly. For clarity, the spring adjustment screw has been removed from the failed trigger assembly. This image presents the specific location of the fracture through the trigger bow and the trigger spring adjustment screw boss. In these prototype parts being used for the DAT test, the trigger boss is welded onto the trigger bow. The actual production trigger will has a molded-in boss which is drilled and tapped rather than a welded boss.

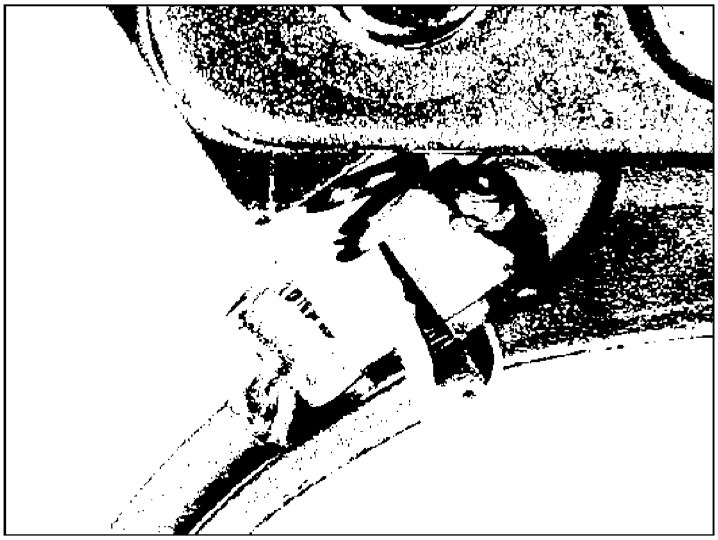

**Figure 2. A close-up view of the fracture area with the trigger spring adjustment screw removed.**

Figure 3 presents a close up image of the trigger bow portion of the fracture as viewed from the side angle. This image shows some fracture morphology characteristics which indicate the direction of fracture propagation. These features include a large area of straight (vertical) fracture and a small region of fracture which occurs at about 45$^{o}$ to the vertical fracture. This region is typically called a shear lip and represents the region of fracture in which the stress state changed from 3-dimensionally constrained to 2-dimensionally constrained – the last portion to fracture. This fracture path geometry indicates that the fracture initiated at the top of the boss or trigger bow and propagated to the bottom.

Figure 4 presents an image of the fracture surfaces as viewed with low-angle incident lighting. This image further confirms the evidence presented in Figure 3. The fracture propagated from the top surface of the boss and the top surface of the trigger bow cross section to the bottom of the trigger bow, ending at the shear lip region. The fracture initiation site is most likely one of two locations. The first probable location is the top of the trigger adjustment screw boss on the left side of the image presented as Figure 4. The second probable location is the top outer corner of the trigger bow cross section on the left side of the image presented as Figure 4.

Based on the direction of the fracture propagation, the load had to be applied to the rear of the trigger bow and applied in a forward direction. This orientation directly opposes the intended direction of force application to the trigger bow. Most likely, this failure occurred as a result of handling or abnormal loading the trigger mechanism.

The repetition of the same type of failure from March 28, 2007 indicates that a fragility issue may exist with the current DAT samples. This issue is most likely due to the nature of the boss assembly and welding process. In the production designed part the boss will be molded into the trigger bow in the production MIM process, thereby eliminating assembly issues relating to the welded trigger adjustment screw boss. The current trigger bow cross section has been reduced by over 60% to make room for the boss insert. The method of attachment of the trigger boss by welding at the front and back regions does not make a good structural connection to effectively transfer load into the trigger bow cross section to the boss cross section. As a result, any load applied to the trigger bow is largely borne by the reduced cross-section trigger bow rather than the combined area of the trigger bow and the trigger adjustment screw boss insert.

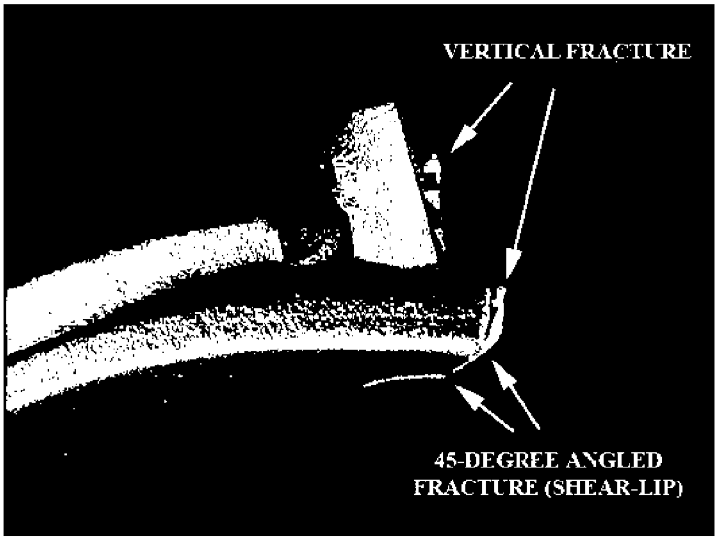


**Figure 3. Side view of the trigger bow fracture. This image shows the change in direction of the fracture path, indicating the location of the shear lip at the final portion of the trigger bow to fracture.**

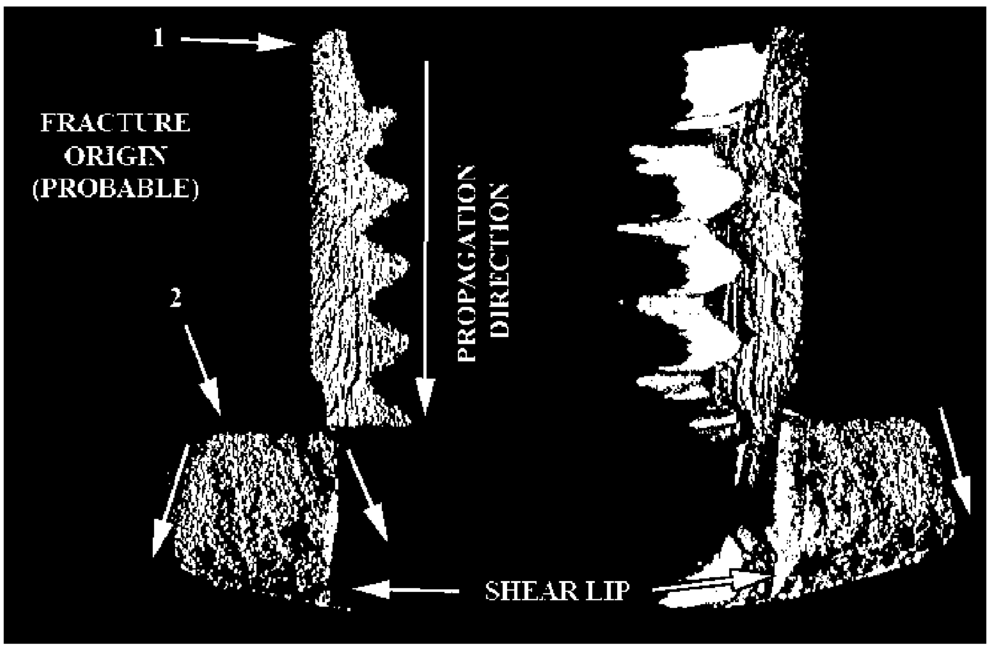


**Figure 4. The fracture surface of the failed trigger showing the fracture morphology of both the trigger bow region (lower edges with the shear lip) and the boss region (threaded portion).**