

The M4/M16 platform is capable of great precision and accuracy, however, that ability has come at the cost of reliability in harsh environments. The M4/M16 bolt and barrel extension design, has been copied in many designs since its introduction. This is a tribute to the benefits of the design, so rather than a complete redesign of the bolt, carrier, and barrel extension, an attempt to provide increased tolerance to environmental conditions, without any loss of critical tolerances and accuracy was undertaken.

After thorough analysis of the bolt, carrier and barrel extension was completed it was determined that the easiest and most economical approach to focus attention on was the breech bolt. A complete review of the critical features and surfaces of the bolt revealed that the rear of the locking lugs and the face of the bolt itself were the most critical, particularly when isolating it to dimensions ahead of the carrier to maintain "drop-in" capability with current carriers. Once the critical dimensions were identified, it was time to isolate what aspects of the design could be modified to obtain the desired result.

Two main areas identified in the review of the likely causes of reliability issues were the interaction between the bolt lugs and raceways in the barrel extension and the clearance of the bolt barrel extension. The first area would cause a failure due to a lack of any significant tolerance to the bolt being even slightly out of time with the barrel extension. The second area indicated a lack of any tolerance to any debris that would make it into the barrel extension. While many possible means of addressing this were reviewed, staying with the "drop-in" replacement bolt concept the conical breech bolt was found to be the most effective cure with the least possible burden to either the M4/M16 platform or the supply system.

The conical bolt's two main innovations are that the lugs that are not the two used for stripping rounds out of magazines are tapered and rounded. The two lugs that strip rounds from the magazine, were first tired in conical format and worked fine in most tests, unless the magazine didn't get the round to full height before the action cycled. To resolve this issue and maintain the design benefits sought by the modified bolt a wedge-shaped lug was employed. This allowed for full lug height, but the narrowing of the lug assure that if there was a timing issue, the conical shape of the other lugs would engage the barrel extension first and prevent the front of the ledge from causing a jam. The conical lugs work by providing a camming action to put the bolt back into the lug raceways and permit the firearm to go into battery.

A firearm malfunction during extended testing illustrates just how well this design works. During testing the nut securing the barrel and extension to the upper came loose. Due to how the firearm was secured in its test fixture, the barrel began to move forward and tension cause the barrel to arc up. This caused the barrel extension to be tilted down and in at the top of the receiver and up and out at the bottom. It was also of angle from roughly an 11 o'clock position was the furthest in and the 5 o'clock position being the furthest out. The test firearm was still able to cycle and fire in this condition until the bolt was reaching well beyond a calculated 70 thousandths too far forward and out of time, at a minimum. The bolt provides functionality long after any standard bolt would have failed to go into battery, indicating increased reliability not only due to normal usage developed timing issues, but also significant damaged due to other part failure or damage sustained in combat.

The conical design also leaves a gap breech end of the barrel extension. This provides space for any dirt or debris to accumulate without causing a failure to go into battery. The individual conical and wedge lugs further have a profile that allows them push through and auger away any accumulated debris. While this ability hasn't been fully quantified, the amount of material found in different initial severe condition tests that could accumulate in the barrel extension was best termed as significant. In short, if the firearm was clean enough or the bolt carrier to cycle, the test firearm would continue to go into battery and fire.

The conical bolt warrants further review and consideration as it is a 100% "drop-in" replacement, fully compatible with all M4/M16 models ever manufactured and 100% compatible with all current parts for the standard M4/M16 bolt. Moderately to minimally higher manufacturing costs due to longer manufacturing time attributed to contouring and profiling the lugs is well justified for this significant increase in reliability of this platform.