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# End Hose Gladhand Dimensions and Separation Forces

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## Summary

End hose gladhand wear does not appear to be a major root cause of air hose separations based on 18 pairs of end hoses tested by Transportation Technology Center, Inc. (TTCI) following their unintended separation in service. New end hoses and typical used end hoses were also tested and showed similar gladhand dimensions and separation forces compared to nearly all of the separated hoses. This work was conducted for the Association of American Railroads (AAR) Strategic Research Initiative on improved brake system performance.

With new wide lip gaskets, all three types of end hoses produced median separation forces between 709 and 741 pounds-force (lbf). When tested with the as-found gaskets, the used and separated end hoses produced median separation forces of 483 lbf and 489 lbf, respectively. One pair of service-separated end hoses showed extreme wear on the gladhand lip beads of both end hoses, and produced median separation forces of just 92 lbf and 63 lbf with new and used gaskets, respectively. Lip bead height appears to have a proportional relationship with separation force, though the lip bead heights did not show substantial wear on 17 out of the 18 pairs of separated hoses. The clearance for the gaskets between mated end hoses did not show a relationship with separation force.

Seven of these 18 pairs of service separated end hoses involved at least one misapplied standard shank end hose on a cushion-equipped car where straight shank end hoses are intended. A query of AAR Car Repair Billing data shows that this situation is not uncommon and may suggest that gladhand peaking is a contributor of unintended air hose separation.



**INTRODUCTION**

Transportation Technology Center, Inc. (TTCI) investigated the effect of gladhand dimensions on the force required to separate end hoses. The height of the lip bead appeared to have a proportional relationship with gladhand separation force, but the gasket clearance dimension did not display any relationship over the range of values tested. In general, gladhand wear does not appear to be a major root cause of air hose separations based on the 18 pairs of end hoses sent to TTCI following their unintended separation in service.

**BACKGROUND**

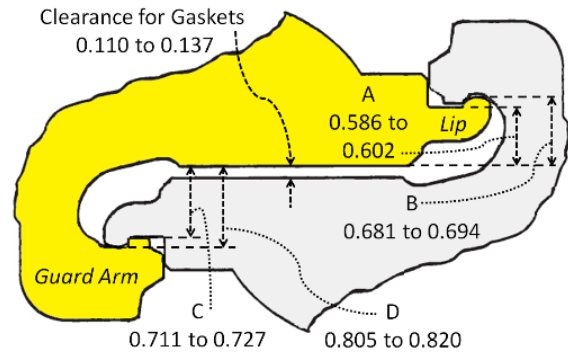
When end hoses separate unexpectedly in service, an emergency brake application ensues and the train comes to a halt. The train crew must then walk the train to identify the separated end hoses, recouple them, and recover the air prior to resuming travel. TTCI has previously shown that the median pull-apart force of relatively new hoses equipped with relatively new gaskets ranges between 273 lbf and 639 lbf.<sup>1</sup>

The current investigation measures standard shank and straight shank end hose gladhand dimensions and separation forces to allow analysis of the relationship between these parameters. The following types of end hoses were investigated:

- New, unused end hoses donated from two suppliers.
- Typical service-worn end hoses.
- Worn end hoses (18 pairs) known to have unexpectedly separated from each other in service.

Figure 1 shows the gladhand dimensions of interest and the associated tolerance range.<sup>2</sup> Although the clearance dimension for the gaskets of coupled gladhands is not specified by AAR, it can be derived from the other dimensions labeled “A” (lip bearing surface), “B” (lip bead), “C” (guard arm bearing surface), and “D” (guard arm groove). Compression of the gaskets and the pressurized air from the train line force the lip bead to press into the guard arm groove of the mate gladhand. A tensile force on the end hoses must overcome the interference of these interlocking components to cause an end hose separation. The lip bead can be subjected not only to wear during normal end hose coupling and uncoupling events, but can also be subjected to wear if it comes into contact with track ballast or other material in the gage of the track while the car is moved in a yard without the end hose coupled.

A relative rotation of the mated gladhands can also result in an end hose separation sometimes called “peaking.” Although the peaking mode of separation is not the focus of this investigation, it is discussed later.

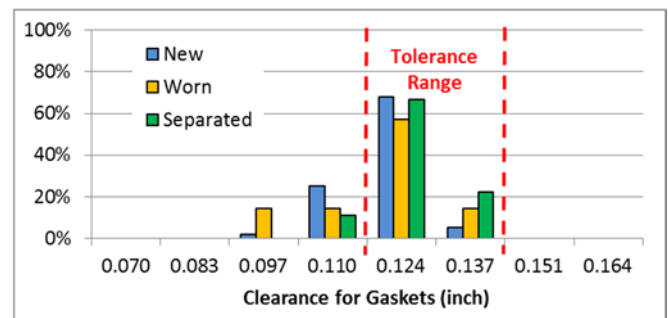


**Figure 1. Side View of Coupled Gladhands Showing the Tolerance Range of Relevant Dimensions in Inches**

**DIMENSIONAL ANALYSIS**

The complex geometry of a gladhand casting does not easily lend itself to dimensional measurement. TTCI used a laser scanning device to generate a three-dimensional point cloud of the gladhand. Surfaces were defined from these points and dimensions between surfaces were compared to the critical dimensions shown in Figure 1.

According to the laser scanning method, some of the measured gladhands were outside the tolerance range on some dimensions. AAR “go/no-go” gauges<sup>2</sup> were then used as a secondary measurement technique. All of the gladhands from new hoses in this investigation met the dimensional criteria of the AAR go/no-go gauges. The apparent discrepancy between measurement methods is thought to be a combination of two factors: 1) difficulty in defining a plane in the three-dimensional digital data that accurately represented the entire surface of one of the dimensions (such as the top of the lip bead), and 2) contact that occurred between the no-go gauges and other parts of the gladhand casting (such as the guard arm groove contacting the gauge at a location other than the extreme depth denoted as dimension D in Figure 1). Figure 2 shows a histogram of the calculated gasket clearance for the pairs of end hoses. Figure 3 shows a histogram of the lip bead height calculated as dimension B minus dimension A.



**Figure 2. Gladhand Dimension Histogram**

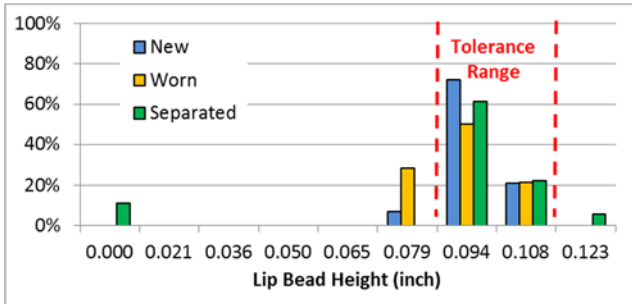


Figure 3. Lip Bead Height Dimension Histogram

One pair of service separated end hoses showed extreme wear on the lip bead of both gladhands. These end hoses had the largest clearance for gaskets (Figure 2) and the smallest lip bead height (Figure 3). Figure 4 shows photos of these gladhands.



Figure 4. The Lip Bead Has Worn Off of Both Gladhands on this Pair of Service Separated End Hoses

**SEPARATION FORCES**

Union Pacific Railroad donated its end hose separation test machine to TTCI for this investigation. After two end hoses are attached to the machine and coupled together, a hydraulic cylinder moves them apart until they separate. TTCI added a source of compressed air for the coupled end hoses and a force measuring load pin to determine the maximum tensile force prior to separation. Figure 5 shows the test machine.

For each combination of end hoses and gaskets that were tested, 30 separation events were recorded. The first 10 events were considered the break-in period for the gaskets and the only the final 20 events were used in generating the median separation force. The hoses were pressurized to 90 psi prior to each separation.



Figure 5. End Hose Separation Force Test Machine

Five pairs of new end hoses were selected for separation force testing based on their dimensional measurements. They represented the midrange and extreme ends of the measurements when considering gasket clearance, lip bead height, and guard arm groove depth. The new end hoses were tested with new wide lip gaskets installed. The service worn end hoses were randomly selected into pairs for separation testing. Each pair was tested in two configurations: with the as-found gaskets that were installed in the end hoses as they were received by TTCI; and again with new wide lip gaskets. Each service separated end hose was tested as a pair with the mate end hose from which it separated while in service with the as-found gaskets and with new wide lip gaskets. Figure 6 shows the results of the testing. There was no practical difference between the hose types when tested with new gaskets. Similarly, there was no practical difference between the worn and service separated hoses when tested with used gaskets. The use of new gaskets increased the median separation force by approximately 250 lbf compared to used gaskets. All hoses produced a median separation force of at least 333 lbf with the exception of the hoses pictured in Figure 4. These hoses coupled together produced a median separation force of 63 lbf with used gaskets and 92 lbf with new gaskets.

Figures 7 and 8 show the median separation force of different configurations of end hoses and gaskets in relation to the gasket clearance and lip bead height, respectively. Separation was not achieved for all end hose pairs on the test machine. In a few cases, the hoses stretched and remained connected at the maximum machine stroke. This data was excluded from Figure 6. In addition to being paired with each other, the two service-separated hoses with extreme wear on the lip bead (Figure 4) were individually paired with a new hose to produce an average lip bead height of approximately half of the minimum tolerance. These combinations are labeled “Mixed Hose” in Figures 7 and 8.

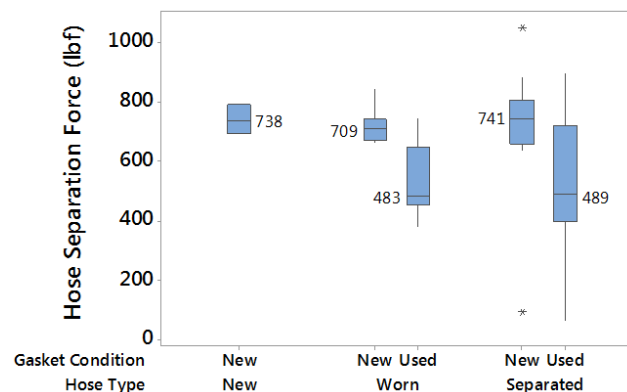


Figure 6. Boxplot of Median Separation Forces

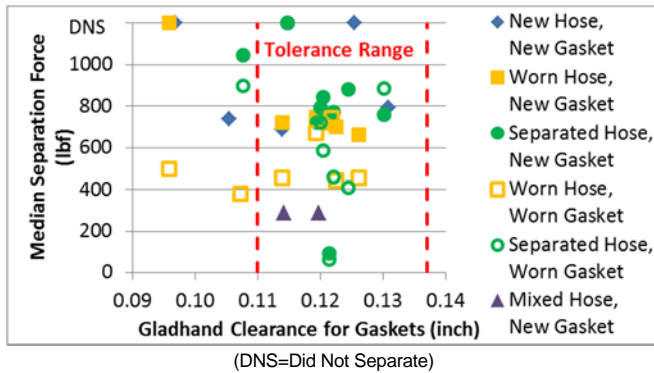


Figure 7. Separation Force and Gasket Clearance

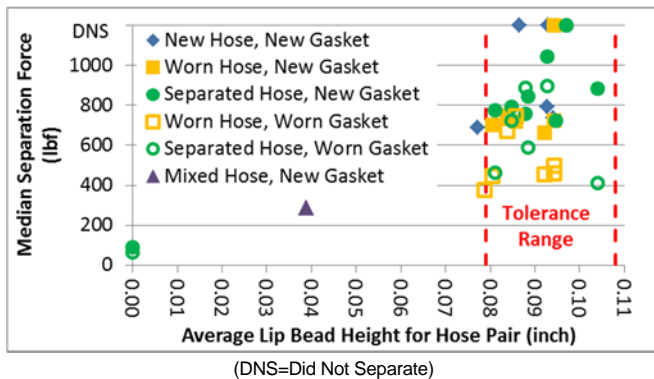


Figure 8. Separation Force and Lip Bead Height

Over the range of values examined, there was no meaningful relationship found between the end hose separation force and the gladhand gasket clearance dimension for new, service-worn, or service-separated end hoses. Nearly all of the service separated hoses showed similar dimensions and similar separation forces compared to new and worn hoses. This suggests that gladhand wear is not a major contributor to end hose separations. Figure 8 shows that lip bead height has a proportional relationship with separation force; although the practical significance of this relationship is limited due to the fact that only 1 out of 18 pairs of service-separated hoses had significant wear on the lip bead.

**SERVICE-SEPARATED HOSES**

For all 18 pairs of service-separated end hoses, at least one car involved in the incident was equipped with end-of-car cushioning or center-of-car cushioning. Cushioned cars represent less than 15 percent of the fleet, but have long been associated with a disproportionate number of air hose separations. The end arrangements on these cars are designed to accommodate more coupler travel compared to a standard draft gear car. Also, because of the lower

height of the end hose attachment to the brake pipe on cushioned cars, they are designed to be equipped with straight shank end hoses as opposed to the 15-degree standard shank end hoses used on standard draft gear cars where the angle cock is mounted at a higher location.

Seven of the 18 pairs of service separated end hoses had at least one of the aforementioned misapplied standard shank end hose. This situation is undesirable from the standpoint of end hose peaking because a misapplied standard shank end hose forces the connection into a peaked position. This suggests that peaking of end hoses could be a significant contributor to air hose separations. A query of the AAR Car Repair Billing database shows that 25.3 percent of the end hoses applied in 2015 to cars with end-of-car cushioning were the standard shank variety.

**CONCLUSION**

TTCI analyzed the gladhand dimensions and separation forces of new, worn, and service separated end hoses.

- Gladhand wear does not appear to be a major root cause of air hose separations. Seventeen of 18 pairs of service separated end hoses displayed gladhand dimensions and separation forces similar to new and typical service worn end hoses.
- Extreme wear on the gladhand lip bead will cause low separation force. The median separation force for a pair of end hoses with both gladhand lip beads worn off was 63 lbf with worn gaskets, and 92 lbf with new wide lip gaskets.
- Gladhand peaking may be a contributor of unintended air hose separation. Seven of 18 pairs of service separated end hoses involved at least one misapplied standard shank end hose on a cushion equipped car.

**FUTURE WORK**

TTCI plans to further investigate gladhand peaking as a root cause of unintended air hose separation.

**References**

1. Sammon, Devin, Scott Cummings, Tony Sultana, Kyle Sheffler. "Study of Force Required to Separate Pressurized Air Hoses." July 2013, *Technology Digest* TD-13-019. Transportation Technology Center, Inc. Pueblo, CO.
2. Association of American Railroads. *Manual of Standards and Recommended Practices*. Section E. Standard S-456 "Hose Coupling Gauges for Gauging New and Used Couplings." Last Revised: 2002.

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