

The AAR Sticking Brake Study - Conclusions & Recommendations

by

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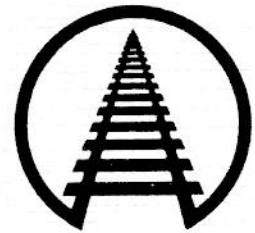
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Summary

Undesired train stops caused by hot wheels due to sticking brakes and other causes have been a worsening problem for the railroad industry. Conservative estimates place the cost of undesired train stops in 1991 at \$48,000,000. The AAR's study found that the primary cause of sticking brakes and other defects leading to hot wheels is defective control valves. New air brake testing procedures inaugurated in 1992 and updated in 1993 are effective in detecting most of the defects leading to sticking brakes and hot wheels. The study also found that while slack action was determined to be a major contributing cause of undesired emergencies, it appears to have little effect on service braking. Therefore, control valve modifications or retrofits are not needed.

The AAR has made recommendations which will greatly diminish the occurrence of sticking brakes. Among these are the full implementation of the new repair track air brake test and the use of 10 psi brake pipe reduction and release during the initial terminal air brake test. Further benefits will come when new diaphragm materials become available and are incorporated into the car fleet when control valves are cleaned.

The dominant cause of a control valve failing to release is a defective service piston diaphragm. A separate air brake rubber component study has shown that control valve rubber parts are prone to attack by ozone and oxygen. Steps are underway to develop a new air brake rubber component performance specification to encourage development of ozone resistant air brake rubber components.



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INTRODUCTION AND CONCLUSIONS

Data from a major western U.S. railroad has shown that sticking brakes account for over half of all undesired train stops. AAR R&T has estimated the cost of these stops during 1991 at \$48,000,000. There are other difficult to quantify costs involving delay to following trains and possible wheel damage.

The cause of a hot wheel may be failure of the brake to release, higher than normal brake cylinder pressure or an applied handbrake. The sticking brake study is concerned with control valve related causes of hot wheels. These causes can be split into two categories; sticking brakes after an intentional or unintentional brake application, and excessive brake cylinder pressure.

The most likely cause of a sticking brake is a small hole in the service piston diaphragm. This could allow a normal service application and yet prevent the release of the brake from a light brake application. A hole in the accelerated service release diaphragm could have the same effect. Leakage of brake pipe or emergency reservoir pressure to the brake cylinder is a possible cause of hot wheels. The former defect is detectable with the repair track air brake test, but leakage of emergency reservoir pressure to brake cylinder requires a gage to measure brake cylinder pressure during the test.

The AAR has shown that severe slack action can result in undesired short duration brake pipe pressure reductions of up to 2-1/2 psi. So there is the possibility that slack run-ins may in effect cause a "feed valve" application, resulting in stuck brakes.

The following conclusions and recommendations can be made as a result of the sticking brake study:

- Slack action does not appear to be a likely cause of sticking brakes, but it is still possible.
- The new repair track air brake test will reliably detect stuck brakes. The test could be improved by measuring brake cylinder pressure during the test.
- An initial terminal air brake test using 10 psi reductions would increase the likelihood of detecting sticking control valves.
- Better control valve diaphragms are needed. This is currently being addressed by R&T and the Brake Systems Subcommittee.
- Cars with multiple wheel change-outs in a short time frame should be tested per S-486 WITH A PRESSURE GAGE INSTALLED IN THE BRAKE CYLINDER PIPING.

FIELD SURVEY

Attempts were made to test control valves identified by hot wheel detectors. The first attempts involved identifying cars which had tripped hot wheel detectors on the Norfolk Southern. These cars were routed to a repair track for extensive air brake tests. However, only three cars were tested. Two of these cars failed the repair track test, and only one of these valves was given an air brake rack test. This valve had a defective service piston diaphragm, yet it passed the old "pump and dump" repair track air brake test.

AAR also worked with Conrail and Santa Fe to identify and shop "stickers". Due to the difficulty of coordinating the efforts of many railroad people in different departments and locations, it was very difficult to find and test any known "stickers".

The AAR also received train stop information from two major member railroads. This data was analyzed in an attempt to identify any patterns involving train operation, weight distribution in the train, or possible slack action. No trends or tendencies could be found which could lead to any theories or conclusions.



EFFECTS OF SLACK ACTION

A major finding of the AAR's Undesired Emergency Study was that severe slack action can cause sharp brake pipe pressure reductions of short duration. These reductions can cause an unstabilized control valve to go into an undesired emergency. This raised the possibility that slack action might also cause a brake pipe reduction, not severe enough to cause a UDE, but still large enough to cause an unintended service brake application. Such an application would have the effect of a very light feed valve application, which is a known cause of sticking brakes.

FTABS COMPUTER SIMULATIONS

Extensive use was made of the Freight Train Air Brake Simulator (FTABS) computer model. This model simulates the effects of slack action on train brake system performance. Exhibit 1 is an example of an FTABS simulation of an undesired service application (UDS). A train with one locomotive and 19 cars was modeled with a slack run-in. No brake applications were made. The brake pipe pressure was slow to recover from the slack induced reduction. The brake cylinders started to fill on car 20 first, followed by cars 19 and 18. The brakes on cars 18 through 20 did not release. While the resulting 5 psi brake cylinder pressure would not cause any significant wheel heating, a defective control valve could result in the brake cylinder pressure increasing to brake pipe pressure in less than one hour.

To verify FTABS results, train tests were run over the Kansas City Southern in 1991. The revenue service trains were equipped with two brake pipe pressure recorders. The test trains operated over extremely undulating territory of the KCS between Shreveport, Louisiana and Greenville, Texas. Tests were made on four mixed freight trains. Dynamic brake was used in virtually every brake application.

Only four slack induced reductions of 1.5 psi or greater occurred. These were all at the rear of a

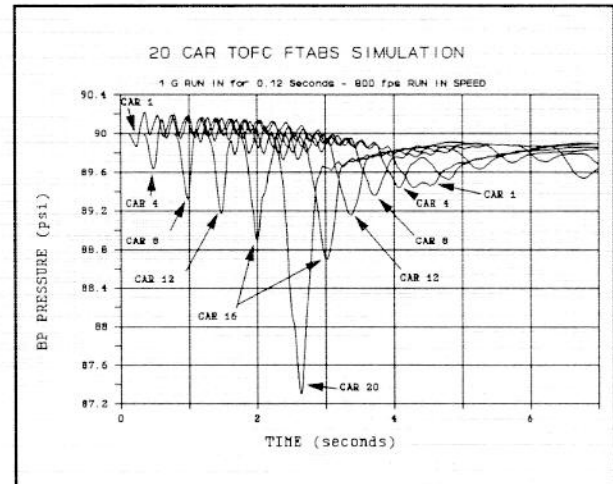


Exhibit 1. FTABS Simulation.

7,100 foot, 4,800 ton train. Exhibit 2 shows the worst of these slack induced reductions. When compared with the FTABS results (Exhibit 1), the degree of reduction might have been enough to cause a UDS, but the duration of the reduction was not.

Another road test was conducted using unit coal trains on the extremely undulating territory of the Burlington Northern south of Trinidad, Colorado. The BN test was conducted in the same manner as the KCS test. The trains consisted of 116 cars weighing 16,000 tons loaded and 4,300 tons empty. The loaded train required significant use of air braking in addition to full dynamic braking to control speed, so no brake pipe pressure reduction data based on slack action alone was obtained on the loaded trip.

The results of these tests showed fewer and much smaller slack induced pressure reductions than those experienced on the KCS tests. The largest of these reductions were significantly below the level of reduction needed to cause a UDS.

Based on these tests, a UDS due to a slack run-in is very unlikely, but it is possible. Because there is only a slight chance of a stuck brake resulting from a slack induced UDS, control valve modifications are not necessary.

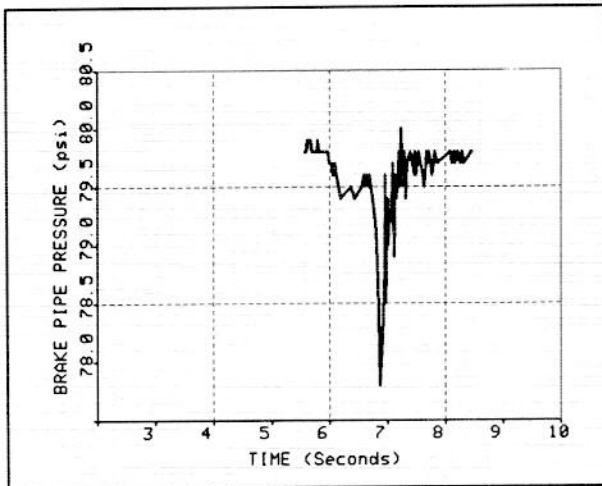


Exhibit 2. Slack Induced Reduction.

CONTROL VALVE DEFECTS LEADING TO HOT WHEELS

The primary cause of sticking brakes is defective control valves. The AAR's Train Braking Research Facility was used to verify the effectiveness of the new repair track air brake testing procedures. A defect simulating a hole in the service piston diaphragm was created on the last car of a 75 car train of 100-foot long cars. The defect was simulated by installing various sized chokes with a hole drilled in the service piston to duplicate the effect of a hole in the service piston diaphragm. Using a 0.0465" diameter choke resulted in a stuck brake 4 out of 7 times when releasing from a minimum service reduction. The control valve was then given the

new repair track air brake test, and it failed 2 out of 2 tests. These tests indicate that the repair track air brake test can reliably detect a slow to release control valve.

INITIAL TERMINAL AIR BRAKE TESTS

The present initial terminal air brake test calls for a 15 psi reduction to check brake pipe leakage followed by a full service reduction to check for piston travel. The brakes are then released, and all cars are checked to assure that all control valves have released.

The problem with this test is that a control valve is more likely to stick in service, when a release from a light brake application is made. If a 10 psi reduction was made instead of the heavier reduction, the probability of detecting a sticking brake increases.

AIR BRAKE RUBBER COMPONENTS

R&T is currently studying the deterioration of air brake rubber components. Some railroad and air brake supply representatives are working with R&T to investigate different materials for use in diaphragms.

This is part of an overall effort to develop a performance specification for air brake rubber components. A draft specification for new air brake diaphragms has been written, and development of new materials by the manufacturers is underway.

Note: Contact F. G. Carlson at (312) 808-5832 with questions or comments about this document.

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