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# Inspection and Maintenance of Poorly Performing Cars Identified by Truck Performance Detectors

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*This Technology Digest (TD) describes inspection and maintenance procedures for cars identified as poor performers by truck performance detectors (TPDs). It complements TD-07-005, which catalogs the inspection and maintenance process for cars identified by hunting detectors (HDs).*

*Inspection and maintenance processes for low warp restraint trucks identified by TPDs mirror those for low warp restraint trucks identified by HDs. These processes, described in TD-07-005, are only referenced here. Three TPD inspection and measurement processes: (1) truck to carbody rotational resistance, (2) carbody twist, and (3) truck warp misalignment are complex and require more detailed description than is possible in one TD. Therefore, they are presented in separately referenced TDs.*

*When maintaining cars identified by TPDs, it is important to refer to the experience gained from inspection of cars identified by HDs. This experience suggests that care be taken not to introduce excessively low truck to carbody rotational resistance that will cause the car to alarm at the latter detector.*

## Summary

TPDs identify cars having poor curving performance. Data collected is used for planning appropriate maintenance actions that reduce inspection and maintenance costs.

In order to prove TPD effectiveness and to develop appropriate inspection and maintenance processes for car owners, poorly performing cars were identified using TPDs, inspected, and partially torn down at local railroad maintenance facilities to establish their physical condition. Two cars were sent to the Transportation Technology Center, Pueblo, CO for detailed inspection, test, and teardown.

Experience gained from these activities enabled the development of procedures to guide inspectors in the identification of car subsystems and components requiring maintenance. Component suppliers' and Association of American Railroads' (AAR) performance limits are used where applicable. Where published limits do not exist, but are desirable, suggestions are made.

Inspection and maintenance experience in response to TPD identification is, to date, limited. In addition, poor performance has been observed to result from a combination of subsystem and component condition and functionality as well as car type. Consequently, recommended condition limits and maintenance actions are often qualitative. It is envisioned that individual car owners will use these recommendations as guidelines for developing inspection and maintenance processes most appropriate for their fleets and operating conditions.

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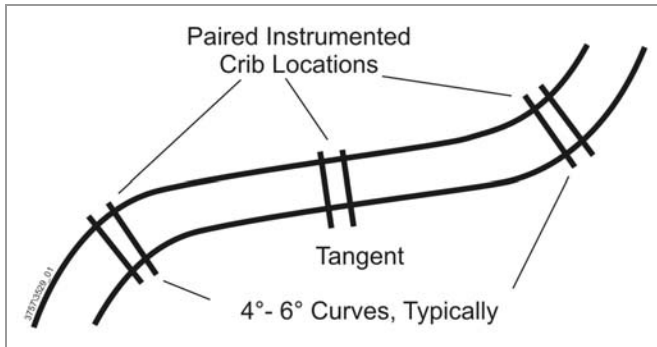
\*Carl Bachhuber, Curt Urban, and Sam Chapman contributed significantly to this work.



**INTRODUCTION**

Transportation Technology Center, Inc. (TTCI) was tasked by the AAR, as part of its Strategic Research Initiatives Program, to develop inspection and maintenance procedures for cars identified as poor performers by TPDs.

TPDs comprise instrumented “cribs” in a section of track with reverse curves in close proximity (Figure 1). A crib is the section of track between adjacent crossties. Each instrumented crib is equipped with strain gages applied to each rail and oriented to measure the vertical and lateral forces of each passing wheel.



**Figure 1. Typical TPD Layout**

Algorithms were developed to identify poorly performing cars from wayside detector data.<sup>1,2</sup> The relationship between these algorithms and the physical condition of the equipment needs to be established for effective car identification and maintenance.

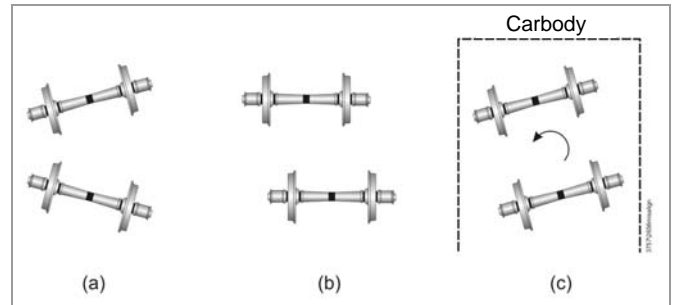
TTCI has conducted 23 inspections and teardowns of identified cars. Of these, 16 cars were initially inspected and partially torn down at railroad maintenance facilities. Two coal cars were brought to the Transportation Technology Center for detailed inspection, test, and teardown.<sup>3,4</sup> Five more coal cars were inspected and partially torn down at another railroad maintenance facility.<sup>5</sup> Experience from these activities has been used to compile this and referenced reports.

This digest documents the inspection and maintenance procedures that were developed from the experience gained from the inspections and teardowns.

**GENERAL CAUSES FOR POOR PERFORMANCE**

General causes for poor curving performance were found to be:

1. Wheelset radial misalignment (Figure 2a)
2. Low truck warp restraint introducing truck warp misalignment (Figure 2b)
3. High truck to carbody rotational resistance, introducing truck to carbody rotational misalignment (Figure 2c)
4. Asymmetric wheel wear



**Figure 2. Modes of Misalignment between Wheelsets in a 2-Axle Truck**

Causes 1 to 3 are considered as prime and maintainable causes for poor performance.

Asymmetric wheel wear has been observed in poorly performing trucks. It is suspected that wheel wear has resulted in a deterioration of curving performance over time.<sup>3</sup> This wear, however, is not considered a prime cause of poor curving performance but a symptom of the first three general causes mentioned above.

This digest is structured to reflect the order of a typical inspection procedure that would be carried out in the field. The order does not necessarily accord with a systematic approach to addressing, individually, causes 1 to 3. Consequently, reference is made to the general causes in the description of each inspection step.

Repairs that reduce truck to carbody rotational resistance should be made with particular reference to TD-07-005 for cars identified as poor performers by HDs.<sup>6</sup> Rotational resistance should not be lowered to the extent that the car alarms at HDs. The use of long travel constant-contact side bearings in conjunction with good center plate geometry, improved center plate liners, and aligned carbody geometry is considered necessary for controlled truck to carbody rotational resistance.<sup>7,8</sup>

**INSPECTION PROCEDURE**

It is assumed that the identified car will generally be inspected in the empty condition since:

- Railroads will not want to delay delivery of the lading
- Lifting of loaded carbodies without proper precautions is undesirable for reasons of safety and lifting equipment capacity

Inspection is made with the carbody on the trucks and with the carbody lifted. These processes are discussed separately. The inspection routine with the carbody on the trucks can obviously be used for inspecting a loaded car.

**Inspection with Carbody in Place on the Trucks**

The identified car should be inspected *before* lifting the carbody. Suspension elements (friction wedges, adapters, etc.) may still be locked, by friction, in a position causal to poor performance. Inspection should be made with the car standing on tangent and level track. Vertically uneven track makes any

assessment of carbody twist difficult.<sup>8</sup> It may be necessary to place the car on a section of especially vertically aligned track to ease this measurement.

Initial inspection should comprise:

- Measuring the wear on all wheel treads to assess the amount of wear relative to specified wear limits (Rule 41<sup>9</sup>) as well as the degree of asymmetric wheel wear. Asymmetric wheel wear may be measured as indicated in Figure 3.

Experience has shown that wheel replacement should be considered if:

- Wheel is at 80 percent of final wear limit
- Differences in flange wear on two wheels on the same axle exceed 0.15 inch
- Differences in hollow worn treads on two wheels on the same axle exceed 0.08 inch

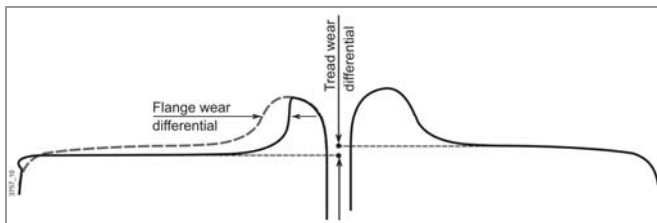


Figure 3. Asymmetric Flange or Tread Wear

- Measuring the wheelbase of each truck on both sides of the truck (Rule 48<sup>9</sup>) for evidence of radial misalignment. This may be done, firstly, by inspecting the buttons cast on each side frame within the truck. The difference between the number of buttons on one side and the number of buttons on the other side must not exceed one, as specified, and is equivalent to a maximum difference in wheelbase from one side of the truck to the other of 0.15 inch.<sup>10</sup> This inspection does not, however, account for misalignment of the axles as a result of:

- Longitudinal free play between pedestal and roller bearing adapter (Figure 4)
- Tilted roller bearing adapter (Figure 5)
- Deformed roller bearing adapter pads (if fitted)

Consequently, the wheelbase on both sides of the truck should be physically measured. This is best done by measuring the distance between a similar point on the outer surface of the bearing cup on each axle on the same side of the truck, (Figure 6), or by using a comparator.

It is suggested that a difference in measured wheelbase between truck sides should not exceed 0.15 inch.

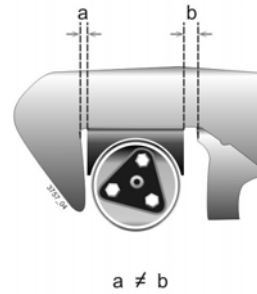


Figure 4. Longitudinal Eccentricity: Adapter Displacement

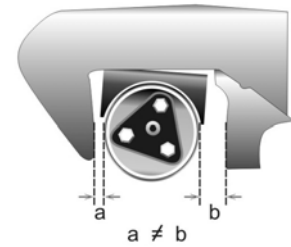


Figure 5. Longitudinal Eccentricity: Adapter Tilt

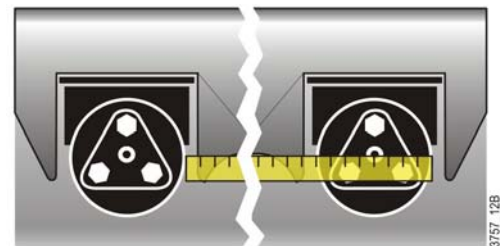


Figure 6. Measurement of Wheelbase on a Truck Side

- Measuring friction wedge rise (Rule 88<sup>9</sup>). High friction wedges are indicative of low truck warp restraint and cause for poor curving performance.
- Inspecting for broken or missing springs in the main spring nests. These may also be indicative of low truck warp restraint and cause for poor curving performance.
- Measuring side bearing clearances or setup heights (Rule 62<sup>9</sup>). Tight or unequal measurements across a truck may be indicative of high rotational resistance and cause for poor curving performance.
- Evaluating truck warp misalignment. This can be a complex procedure and is described in TD-07-008.<sup>11</sup>

**Inspection with Carbody Lifted Off the Trucks**

The carbody should then be slowly and carefully lifted from the trucks. This action may cause the friction wedges to slip relative to side frames and bolsters and may be indicative of truck warp misalignment.<sup>11</sup>

The following inspections or measurements should now be made:

- The condition of each truck center bowl and side bearings should be inspected.<sup>7</sup>
- The condition of the carbody, underframe, body center plates, and body side bearings should be inspected.<sup>7,8</sup>
- The truck bolsters should be lifted from the spring nests, and the inspection of each truck should follow the procedure outlined in TD-07-005,<sup>6</sup> including inspection of the roller bearing adapters, pedestals, and roller bearing adapter pads (if fitted).

**MAINTENANCE PROCEDURES**

Wheelset radial misalignment is corrected by one or a combination of the following:

- Rebuild pedestals and/or install new roller bearing adapters and pads to rectify longitudinal adaptor eccentricity
- Re-match side frames

Low truck warp restraint is corrected by one or a combination of the following:

- Verify that trucks and their components meet AAR *Field Manual* requirements or repair accordingly<sup>9</sup>
- Replace condemnable friction wedges. It is also considered advisable to replace truck side frame column guide wear liners and friction wedge pocket wear plates to enable bedding-in of parallel surfaces for adequate warp restraint.
- Replace broken, deformed or missing truck springs (Rule 50<sup>9</sup>)

High truck to carbody rotational resistance is corrected by one or a combination of the following:

- Correcting carbody twist<sup>8</sup>
- Correcting side bearing clearances or setup heights (Rule 62<sup>9</sup>)
- Use of center plate lubrication (although experience has shown that excessively low center plate friction, associated with lubrication, may cause hunting<sup>6</sup>)
- Improving center plate geometry<sup>7</sup> (eliminating: edge contact, vertical contact, concave contact)

**CONCLUSIONS**

Inspection and maintenance procedures were presented for identifying and rectifying causes of poor curving performance.

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