TECHNOLOGY DIGEST
TD-07-012
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Evaluation of Cars Registering Salient Hunting Indices at or above 0.1

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This Technology Digest (TD) describes the inspection and test results of cars identified with specific performance characteristics when passing across Salient Systems' Hunting Truck Detectors (HTDs). It addresses cars having a hunting index (HI) below 0.25 but at or above 0.1. It complements TD-06-025, which addresses results from cars identified with a HI at or above 0.25. Another TD, TD-07-005, summarizes inspection and maintenance procedures developed for poorly performing cars identified by hunting detectors.

Summary

During 2005, 33 single-unit (two-truck) cars identified by Salient HTDs with a HI at or above 0.25 were brought to Transportation Technology Center (TTC), Pueblo, CO, for inspection, test, teardown, repair, and retest. All were found to hunt between 35 and 50 mph, with obvious causes for degraded performance. This suggested that a poor performance and condition threshold be associated with a HI below 0.25.

Salient HTD data was further analyzed at different HI levels below 0.25 but at or above 0.1. In 2006, 17 single-unit cars from these lower HI levels were brought to TTC for inspection and test. Four of the cars, with HI at or above 0.2, were found to hunt between 35 and 50 mph and were in similar condition to the cars studied in 2005. Thirteen cars with HI typically below 0.2 but at or above 0.1 showed a wider range of performance and condition. Nevertheless, many of the latter cars had either low warp restraint or low truck/carbody rotational resistance. Nine of them were found with condemnable wedge rise; six were fitted with roller side bearings, and four had less than one-third of the prescribed constant-contact side bearing preload.

It is thus concluded that HI ≈ 0.2 can ultimately be utilized as a threshold to identify degraded hunting performance and condition among single-unit cars. This TD documents inspection and test results, in particular, for the single-unit cars with HI typically below 0.2 but at or above 0.1 and suggests that single-unit cars so identified may soon require maintenance attention.

This work was sponsored by the Association of American Railroads as part of its Strategic Research Initiatives Program and was conducted jointly with the Advanced Technology Safety Initiative Program, tasked to improve railroad safety and network efficiency by using innovative trackside technologies to provide freight car owners with advanced warning of degraded car performance.

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INTRODUCTION AND BACKGROUND

As part of Association of American Railroads' (AAR) Strategic Research Initiatives Program, Transportation Technology Center, Inc. was tasked to:

- Analyze hunting detector (HD) data
- Relate this data to car condition through inspections, tests, and teardowns of cars identified at different levels of performance
- Suggest repair procedures to improve condition
- Verify that these repair procedures improve dynamic performance

This work has been conducted jointly with the Advanced Technology Safety Initiative Program, which has been tasked to improve railroad safety and network efficiency by using innovative trackside technologies to provide freight car owners with advanced warning of degraded car performance.

Salient HTD data with absolute valued HI (|HI|) at or above 0.25 was initially collected and analyzed from 36 detector sites over a 1-year period from March 1, 2004, to February 28, 2005.[1] Cars were grouped according to different |HI| levels across these sites. Lists of grouped cars were sent to railroads and car owners. Select single-unit cars from each group were then sent to TTC for inspection, test, teardown, repair, and retest. It was concluded that single-unit cars with |HI| at or above 0.25 behaved poorly and required maintenance; furthermore, it was suggested that single-unit cars registering |HI| below 0.25 might also behave poorly and require maintenance.

Salient HTD data with |HI| at or above 0.1 was subsequently collected and analyzed from 44 detector sites over a 1-year period from January 1, 2005, to December 31, 2005. Cars were again grouped according to different |HI| levels across these sites. Lists of grouped cars were again sent to railroads and car owners. Select single-unit cars from lower |HI| levels were then sent to TTC for inspection and test.

DATA ANALYSIS

Salient HTD data was collected and analyzed, with cars grouped according to:

- Performance level of their worst performing trucks
- Number of passes at that level
- Number of cars identified in each group in a 1-year period (an indication of the maintenance capacity required by the industry if an alarm was set at the indicated criteria given current car and operating conditions)

Table 1 shows the groupings for the year analyzed from January 1, 2005, to December 31, 2005. The estimated numbers of cars alarmed in 1 year at the higher |HI| levels differ from those quoted previously[1] because respective data was collected over the different time periods mentioned.

Seventeen single-unit cars identified from |HI| levels below 0.25 were sent to TTC for inspection and test. Table 2 shows these classifications.

Table 1. Car Groupings According to Performance

Salient |HI| Level	Number of Passes at |HI| Level	Estimated No. of Cars Alarmed in 1 Year
|HI| ≥ 0.65	At least 1	200
|HI| ≥ 0.45	At least 2	1200
|HI| ≥ 0.3	At least 3	3700
|HI| ≥ 0.25	At least 3	3700
|HI| ≥ 0.2	At least 4	1700
|HI| ≥ 0.15	At least 4	6400
|HI| ≥ 0.1	At least 6	11400

Table 2. Single-Unit Car Groupings Sent to TTC

Salient |HI| Level	Number of Passes at |HI| Level	Number of Cars Sent to TTC
|HI| ≥ 0.2	At least 4	4
|HI| ≥ 0.15	At least 4	8
|HI| ≥ 0.1	At least 6	5

INSPECTIONS AT TTC

On arrival at TTC, the single-unit cars were inspected for:

- Car type/truck type
- General indications of hunting: worn uncoupling rods and coupler carriers, worn and/or broken pedestal roof liners, and worn door fittings
- Low warp restraint: high, worn friction wedges, worn truck side frame column guide wear liners, worn bolster pocket wear plates
- Low truck/carbody rotational resistance: roller or block side bearings, low constant-contact side bearing (CCSB) preload (measured by jacking the carbody and inserting a load cell)
- Wheel profiles: Measured using MiniProf™

Inspection and test of the 17 single-unit cars sent to TTC revealed that they could be classified as:

- Four cars with |HI| at or above 0.2, but typically below 0.25, were similar to those cars reported previously[1] because they hunted between 35 and 50 mph and were in similar poor hunting condition
  - Three of the cars had condemnable wedge rise
  - All of the cars had roller side bearings
- Thirteen cars with |HI| typically below 0.2 but at or above 0.1 showed a wider range of performance and condition

This TD focuses on the latter 13 cars just described.

Tables 3 and 4 show the car types identified and their corresponding conditions.

Table 3. Single-Unit Car Types Sent to TTC with |HI| Typically below 0.2 but at or above 0.1

Car Type	Number of Cars
Box Car	1
Flat TOFC/COFC	1
Gondola Car	2
Hopper Car	8
Refrigerator	1

Table 4. Condition of Single-Unit Cars with |HI| Typically below 0.2 but at or above 0.1

General Condition of Car/Truck	Number of Cars with Condition	Total Number of Cars
Condemnable Wedge Rise	9	13
Roller Side Bearings	6	13
Less than One-Third CCSB Preload	4	7

All higher |HI| level cars studied in 2005 and the four cars with |HI| at or above 0.2 studied in 2006 were equipped with old-style variable damped trucks. However, of the 13 cars with |HI| typically below 0.2 but at or above 0.1 studied in 2006, 2 cars were equipped with constant damped trucks.

Many of the 13 cars with |HI| typically below 0.2 but at or above 0.1 were within the age range of all higher |HI| level cars and the 4 cars with |HI| at or above 0.2, although some were newer. Figure 1 shows superimposed age distributions of the two car groups for comparison.

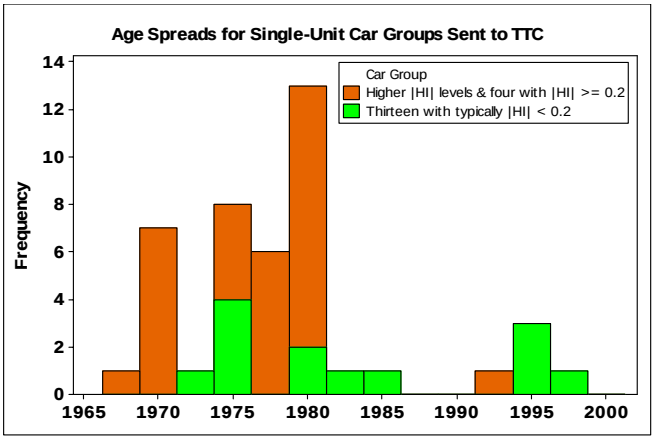

Figure 1. Age Histograms for Single-Unit Car Groups Sent to TTC

Table 4 shows that nine of the thirteen cars with |HI| typically below 0.2 but at or above 0.1 had condemnable friction wedge rise and thus low warp restraint. One of the other cars had high, but not quite condemnable, friction wedges.

Ten of the 13 cars had low truck/carbody rotational resistance through either a lack of CCSBs or degraded or incorrectly adjusted CCSBs.

All wheels were within wear limits and most had less than 2-millimeter (mm) hollow wear. Analysis of the conicities of their profiles when placed on TTC track revealed an average conicity of 0.31 over a range of ± 5-mm lateral deflections from the center position on the track (position where radius differential between the two wheels on a wheelset is zero). Some wheelsets had eccentrically worn wheel treads so that a lateral deflection of 5 mm implied flange contact. Under these conditions, the lateral deflection to flange contact was used to calculate conicity. Figure 2 shows a histogram of the calculated wheel conicities compared with those of all higher |HI| level cars and the four cars with |HI| at or above 0.2, as well as a general sample of wheels in service having an average conicity of 0.24.

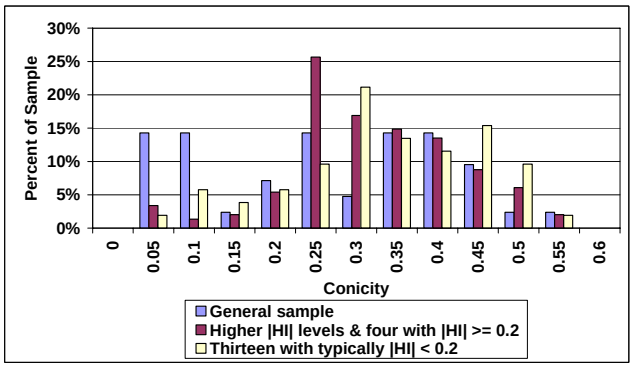

Figure 2. Histograms of Calculated Wheel Conicities

As with all higher |HI| level cars and the four cars with |HI| at or above 0.2, it is interesting to note that the sample of cars identified with |HI| typically below 0.2 but at or above 0.1 shows relatively few wheels with conicities below 0.25. This will account for the difference in average conicities between it and the general sample. This is not surprising because wheelsets with higher conicities will generally be the ones to induce hunting. It must be emphasized, however, that all wheels were within wear limits.

Wheelset replacement to improve hunting stability was not considered. It is regarded as a temporary fix and not cost effective because the wheels will soon wear to similar profiles.

RESULTS OF TESTS IN RECEIVED CONDITION

Each car was tested individually in its received condition and in the direction (A- or B-end lead) in which it most often passed the detectors. The car was equipped with lateral accelerometers on the carbody above each truck and the speed of the car was recorded. The root mean square of the lateral accelerations was determined over sections of the track in accordance with the requirements of AAR Specification M-1001, Chapter XI.[2] The lowest tested speed at which the car met or exceeded Chapter XI hunting criteria was recorded. Figure 3 shows superimposed results of the tests for the two car groups for comparison.

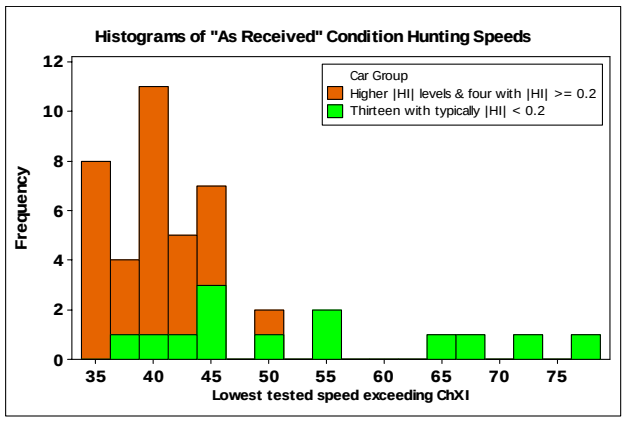

Figure 3. Histograms of Tested Hunting Thresholds

Figure 3 shows that seven of the thirteen cars with |HI| typically below 0.2, but at or above 0.1, had hunting thresholds at or below 50 mph, the designated target speed for acceptable performance. This is consistent with all higher |HI| level cars reported previously and the four cars with |HI| at or above 0.2. However, for the following reasons, six of the thirteen cars had hunting thresholds above 50 mph:

- One car did not have condemnable wedge rise and had adequate rotational resistance
- Two cars had condemnable wedge rise but had adequate rotational resistance.
- One car had reduced rotational resistance but had constant damped trucks without condemnable wedge rise,
- Two cars had condemnable wedge rise and reduced rotational resistance but
  - one had constant damped trucks and only one of them was condemnable; however, the wheelsets for this truck had below average conicities;
  - the other car's wheelsets all had below average conicities.

ADDITIONAL HIGHER |HI| LEVEL CAR

Also in 2006, one car owner sent an additional higher |HI| level single-unit car to TTC for inspection and test. It had been grouped based upon the same Salient HTD data analyzed from January 1, 2005, to December 31, 2005.

Although from a higher |HI| level, it performed slightly differently than the rest of the higher |HI| level cars and the four cars with |HI| at or above 0.2. Specifically, it passed the Chapter XI hunting test between 35 and 50 mph. However, it was on the threshold of hunting at 50 mph, not passing AAR Specification M-976 test[3] at that speed.

It did not have condemnable or nearly condemnable friction wedge rise, but it did have low CCSB preload. All of its wheels were within wear limits and had less than 2-mm hollow wear. Nevertheless, conicities were high, with an average of 0.58, although there are no established limits for conicites.

CONCLUSIONS

- HDs can identify single-unit cars with poor lateral dynamic characteristics.
  - Single-unit cars passing Salient HTDs and registering |HI| at or above 0.2 are very likely to have a hunting stability threshold between 35 and 50 mph and are very likely to show signs of component wear as a result of hunting.
  - Single-unit cars passing Salient HTDs and registering |HI| typically below 0.2 but at or above 0.1 may not have a hunting stability threshold above 50 mph and may shortly require maintenance in order to improve their performance.
- Single-unit cars thus identified with |HI| typically below 0.2 but at or above 0.1 are fairly likely to have at least one of:
  - Low warp restraint (high, worn friction wedges, worn truck side frame column guide wear liners, worn bolster pocket wear plates)
  - Low truck/carbody rotational resistance (roller or block side bearings, degraded CCSBs)
- Poorly performing single-unit cars can be rectified[1,4] by a combination of:
  - Inspection and verification that trucks and their components meet AAR *Field Manual* requirements[5] or repair accordingly and:
    - Fitting of long travel CCSBs preferably with metal caps, or
    - Refurbishing existing CCSBs; i.e., install new elements or components, when necessary

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4. Tournay, Harry, Russell Walker, and Sam Chapman. April 2007. "Inspection and Maintenance of Poorly Performing Cars Identified by Hunting Detectors." *Technology Digest* TD-07-005, AAR, TTCI, Pueblo, CO.
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