TECHNOLOGY DIGEST

Timely Technology Transfer

CHAPTER XI REFINEMENT AND VALIDATION " STANDARD BOX CAR TESTS "

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Summary

Growing concerns regarding the AAR's freight car certification procedures have accelerated the effort to better define the basis, validity, and benefits of the specification embodied in M-1001, Manual of Standards and Recommended Practices, Chapter XI. The Mechanical Division's Car Engineering Committee has accepted the challenge of establishing the first car certification process which includes dynamic track tests. Tests were selected to duplicate adverse car dynamic behavior experienced in service. The committee requested the AAR to provide a base set of response test results on conventional freight cars. The cars tested under the requirements of Chapter XI were two 100-ton boxcars; one 60 feet in length and one 86 feet in length.

These test results will serve as a basis of comparison with the response experience with the test cars in revenue service. They could also represent a base level of response values to compare a new car design response for certification purposes. The 86-foot boxcar did not meet current Chapter XI criteria in the regimes of roll and spiral negotiation while the 60-foot boxcar failed to meet current criteria for lateral dynamics (hunting and yaw/sway), roll, and spiral negotiation.

The known response history of these cars in revenue service is not available in terms of measured responses e.g. roll angle or wheel unloading, therefore a direct comparison with Chapter XI results is not possible. A qualitative comparison is possible by comparing a cars "bad or poor" performance record in revenue service (in a particular regime) to its performance under a similar test regime in Chapter XI. Several other standard car types have also been tested to increase the data base. Collectively these could represent a range of response values for use as an index in measuring the performance of new car designs in the future.

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INTRODUCTION AND CONCLUSIONS

A set of test and analytical requirements to promote faster and better procedures for the certification of new and untried cars was adopted by the Mechanical Division of the Association of American Railroads (AAR). These new requirements, embodied in the AAR Mechanical Division's Manual of Standards and Recommended Practices, Section C - Part II, Chapter XI, were adopted in 1987.

As with any new process, questions were raised regarding the validity and appropriateness of the test regimes and the associated certification criteria. The Car Engineering Committee decided to resolve some of the questions raised. The proposal involved subjecting **typical** or **conventional** railcar/suspension designs to new test requirements under the "Track-Worthiness" section of Chapter XI. **A conventional car is defined as a car presently approved for unrestricted interchange service having accumulated a significant record of mileage and satisfactory service.**

The intent of this study is to provide a base level data bank of the responses of conventional cars which have a known performance history in service. This data base would then be used to compare the response of new railcar/suspension designs. As part of this effort, two typical 100-ton boxcars, 86 feet and 60 feet in length, were tested under Chapter XI (Track-Worthiness Test) requirements.

The primary task was the conduct of a full complement of the Chapter XI tests under "Track-Worthiness Assessment." Test results were to fulfill two objectives:

1. Establish a confidence level in the test requirements by comparing the response in the various regimes with known response histories for similar regimes in revenue service.

2. Establish a base level of response data by which to gage the response of new designs (inferior, equal or superior performance based on response of conventional cars).

The results from the tests suggest that a conventional car type using a typical three piece truck would have difficulty in meeting all of the criteria under Chapter XI.

The 86-foot boxcar complied with criteria in the regimes of:

- **hunting**
- **constant curving**
- **bounce/pitch**
- **yaw/sway**

It did not comply with criteria in the regimes of:

- **spiral negotiation (complied loaded)**
- **twist/roll (loaded car not tested)**
- **dynamic curving**

The 60-foot boxcar complied with criteria in the regimes of:

- **constant curving (marginal in empty)**
- **bounce/pitch**

It did not comply with criteria in the regimes of:

- **hunting**
- **spiral negotiation**
- **twist/roll**
- **yaw/sway**
- **dynamic curving**

The 60-foot boxcar was tested with roller side bearings in an "as received" condition. Spiral negotiation tests were repeated with constant contact side bearings, however it still failed to meet the criteria.

It should be noted that the **Chapter XI criteria are intended as performance limits to define desirable behavior for new freight cars. These limits are considered conservative and do not represent limits of safe performance, i.e limits where derailments occur.** The test results, along with similar data from tests conducted using other conventional car types, can form a data base to be used as a means of comparing performance of new designs under certification.

STANDARD BOXCAR TESTS

Chapter XI requirements resulted from deliberations of an AAR ad hoc Committee on Advanced Freight Car Testing Technology. This committee included personnel from railroads, industry suppliers, the Federal Railroad Administration (FRA), and the AAR. A FRA funded pilot test program was conducted under the direction of the committee to provide a partial validation of the new test procedures. The results of committee deliberations and the pilot test results were used by the Mechanical Division in their development of the new certification process.

Chapter XI includes the conduct of a series of tests over defined sections of track. Each track section chosen was to test the performance or "track-worthiness" of the candidate railcar/suspension system in a particular regime. The regimes chosen were based on typical response which railcar suspensions exhibit on track geometry conditions encountered in service. As an example, a railcar suspension system is susceptible to lateral instability or hunting, hence a test in the regime of hunting is one of the requirements. On the other hand all cars in service have to negotiate spirals and curves, staggered and parallel joints, etc., and hence there are test sections to expose new car designs to those regimes.

The criteria applied to the results of the Chapter XI test requirements are all based on the phenomenon of wheel climb and rail rollover/gage spreading. This implies the continuous measurement of wheel/rail forces while conducting the tests. The use of instrumented wheelsets enables the measuring of vertical and lateral forces and determination of the ratio of lateral over vertical (L/V) forces. Hence instrumented wheelsets are a requirement for the conduct of the certification tests. Criteria are defined in terms of vertical loads and a combination of L/V (wheel L/V, axle sum L/V, and truck side L/V) ratios.

Tests were conducted for the following regimes, as per Chapter XI requirements :

- hunting (empty)
- constant curving (empty & loaded)
- spiral negotiation (empty & loaded)
- twist/roll (empty & loaded)
- bounce/pitch (loaded)
- yaw/sway (loaded)
- dynamic curving (empty & loaded)

Since the test instrumentation, data acquisition, test conditions/sequence, and test result formats are explicitly detailed in Chapter XI requirements, they are not repeated here. In all cases these were followed as written, and exceptions are noted if any. The following tables show results for the regimes tested.

TEST REGIMES	EMPTY BOXCAR - 86 FOOT			LOADED BOXCAR - 86 FOOT		
	WHEEL L/V	SUM L/V	MIN. VERT%	WHEEL L/V	SUM L/V	MIN. VERT%
HUNTING		1.19				
CONSTANT CURVE 7.5	0.77	1.39	N/A	0.75	1.3	N/A
SPIRAL NEGOTIATION	2.6	3.4	2.2 %	0.86	1.2	19 %
TWIST/ROLL			3.9 %			
BOUNCE/PITCH						64 %
YAW/SWAY*					1.1	
DYNAMIC CURVING	2.8	3.5	0.0 %	2.3	2.9	0.7 %

TEST REGIMES	EMPTY BOXCAR - 60 FOOT			LOADED BOXCAR - 60 FOOT		
	WHEEL L/V	SUM L/V	MIN. VERT%	WHEEL L/V	SUM L/V	MIN. VERT%
HUNTING		1.59				
CONSTANT CURVE 7.5	1.02	1.5	N/A	0.76	1.28	N/A
SPIRAL NEGOTIATION	2.55	3.15	19 %	1.02	1.51	42 %
TWIST/ROLL			0.0 %			2 %
BOUNCE/PITCH						16 %
YAW/SWAY*					1.43	
DYNAMIC CURVING	1.8	4.5	0.2 %	4.0	4.35	2 %

* Maximum truckside L/V during test - 86 foot boxcar = 0.54; 60 foot boxcar = 0.93

Chapter XI criteria limits are:

- Wheel L/V - 1.0
- Truckside L/V - 0.6
- Sum L/V - 1.4
- Minimum Vertical Percent - 10%

The *sum L/V* shown in the tables is the instantaneous sum of the absolute value of the left and right wheel L/V of any axle. The *minimum vertical percent* shown in the tables is the percent of dynamic vertical wheel load with respect to the static vertical wheel load. The *truckside L/V* is the instantaneous sum of the L/V's of the wheels on the same side of a truck.

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