IRON HIGHWAY--PHASE II EVALUATION

TECHNOLOGY DIGEST

Timely Technology Transfer

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Summary

Evaluation tests of Iron Highway Phase II prototype show that the technical benefits predicted from the integral train design are attainable. The tests have proven that the control and braking, loading and unloading, split ramp and platform suspension systems are ready to be engineered into production equipment. The power system requires further development. The acceleration measurements during the dynamic tests show that the load bearing platforms provide a comparable or better ride than existing intermodal equipment with the exception of vertical bounce response. Further analysis will be made by the proponent to tune the suspension for a better vertical ride. Based on wayside strain gage measurements taken in a 12 degree curve and a spiral leading to a 10 degree curve, wheel/rail forces showed improved curving compared to any existing intermodal equipment. Response measurements of the power and control unit and its suspension show no derailment tendencies, but do suggest improvements can be made for better human ride performance.

The control system tests indicate that the central traction computer software is functional and provides accurate and repeatable commands for proper control and monitoring of the system. Modifications were identified to improve the response time of the control software. Power system tests were not conducted due to failures in the differential gear box sub-systems. Brake system tests demonstrated successful operation in blended, full service and emergency braking modes. The blended mode results show that the hydro-dynamic retarders functioned as intended. Tests of the split ramp car successfully demonstrated its function. It allows loading and unloading of fully loaded non-railroad trailers, up to 53 feet in length. They can be loaded or unloaded at the middle of a consist, at any level gravel surface. Yard facilities are not required.

The test results proved that a drive on - drive off type intermodal system using a custom hostler and hitch design is practical. The economic benefits realized by being able to handle non-railroad trailers of any length should prove to be substantial.

The tests were carried out at the Transportation Test Center and were funded jointly by the Federal Railroad Administration and by the AAR as part of the High Productivity Integral Train (HPIT) Program. Only certain portions of the test program are documented here. A full detailed report will be published later.

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INTRODUCTION AND CONCLUSIONS

To evaluate the New York Air Brake Company (NYAB) and CSX Intermodal (CSXI) sponsored Iron Highway Phase II prototype equipment, a series of tests were conducted. These tests were performed under AAR's High Productivity Integral Train (HPIT) program. They included dynamic response tests, and control, loading/ unloading and brake system performance tests.

The HPIT concept design was developed by NYAB. It consists of a 1000 foot continuous platform, supported by single axle trucks every 28 feet at an articulated joint. Power units, with two 750 horsepower diesel powered generators are connected at each 1000 foot platform. They supply AC three-phase power to traction motors on the first five single-axle trucks. The truck suspension is unique, in that, at each articulated joint, rubber springs connect the truck to the carbody. The non-powered wheels at each truck are supported on stub axles and rotate independently of each other. Each of the wheel/axle assemblies has a pair of steering links, one above and one below the axle.

The Phase II prototype, as shown in Exhibit 1, consists of a partial train element. Seven pieces of equipment are joined to form an articulated train. The first piece is a Power and Control Unit (PCU) frame. The PCU is equipped with a temporary cab, two power pods and fuel tanks. This unit pulls three load carrying platforms which are followed by the articulated split ramp car. A fourth load carrying platform is next. The last unit in the consist is a second ballasted power and control unit frame with no cab or engine. It serves as an end of train buffer with on-board electronics to complete the train line functions.

Analyses of the test data supports the following observations and conclusions:

- The load or trailer bearing platforms exhibit better than average performance in hunting, twist/roll, yaw/sway and curving. The carbody lateral acceleration and roll degree are lower in twist/roll, dynamic curving and yaw/sway when compared to an intermodal 40 foot spine car or autorack. Response in the bounce/pitch mode is comparable or slightly higher, in terms of accelerations, than those for a loaded autorack. No indications of unsafe or derailment tendencies were observed from the wayside rail forces during the curving and spiral negotiation tests.
- The PCU dynamic response tests indicated that the suspension is adequate from a safety or derailment aspect, but may need to be tuned to offer a better ride for the human occupants.
- The control system tests demonstrated that the software/hardware that controls and monitors the equipment under traction and braking functioned as designed. During the tests, successful software modifications were made to meet the design goals. Deliberately induced sticking brakes and excess bearing temperatures were successfully identified on the cab console.

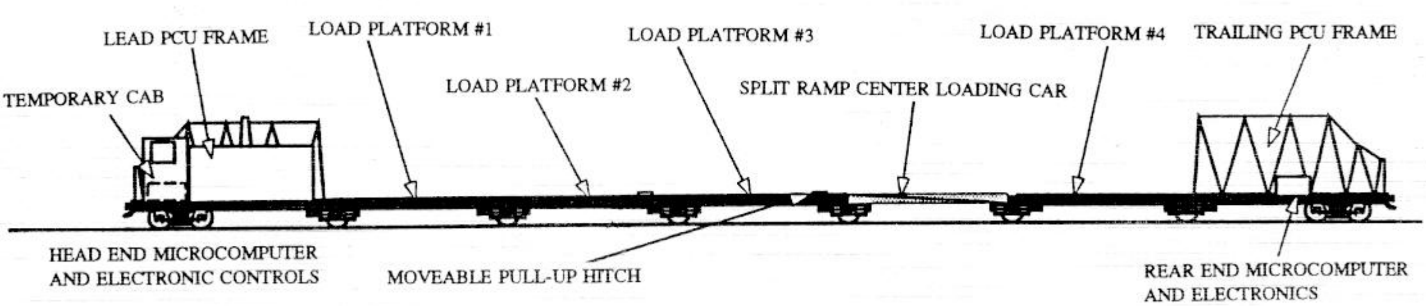

Exhibit 1. Iron Highway Phase II Prototype

• The power system tests were not undertaken due to mechanical failures to the differential gear box components. But the following observations were made during related tests: Train speed with the unloaded consist powered at 4.8 HP per ton seemed to balance at 63 mph on straight and level track. This horsepower is lower than NYAB's estimate of 5.18 HP per ton for an empty 20 platform element. For a 20 platform element loaded with trailers weighing 65,000 lbs. each, NYAB estimates 3.0 HP per ton. Balance speed for the final element design is predicted by NYAB to be between 60 and 70 mph.

• The braking system performed as designed, including the hydro-dynamic retarder during blended braking. For the empty consist stop distance test from 60 mph, the blended full service produced a shorter stopping distance than emergency and full service. Stop distances from 48 mph for the consist loaded with 20 foot containers and 40 foot trailers were the same for blended full service and full service. The stop distance for emergency required 42 feet more.

• Longitudinal squeeze loads up to the design buff load of 200 kips, applied to the empty consist, showed no high stress areas in the platforms, split ramp or PCU.

• The split ramp car and the custom hostler/hitch systems functioned as designed.

DATA ANALYSIS

The tests were conducted in three configurations:

1. all platforms empty

2. a 53 foot trailer weighing 60 kips, using hitch #2 on platform #2, trailer wheels towards PCU end of platform #1.

3. a 20 foot container on chassis weighing 67 kips, using hitch #1 on platform #2, trailer wheels towards PCU end of platform #1 and a 40 foot trailer weighing 65 kips using movable hitch on platform #3, trailer wheels over articulation between platforms #2 and #3.

The control and braking system tests were conducted with the consist powered by the PCU. The problems with the differential gear box components prevented the operation of high speed runs under PCU power. The dynamic response tests were conducted by towing the test equipment with a conventional locomotive. This was done in order to evaluate the ride performance up to 70 mph.

To summarize the dynamic performance, Table 1 presents values from the speeds at which maximum peak to peak values were measured. Comparable acceleration data from previous tests conducted on an 89 foot autorack and a 5-platform (40 feet each) articulated all purpose spine car is also presented. Both were equipped with conventional 3-piece trucks. Data from a conventional locomotive is presented to provide a means to evaluate the PCU.

As can be seen the Iron Highway load platform equipment is generally superior. The PCU response needs to be improved to provide comparable human ride comfort. The lower center roll response was better than the conventional locomotive (see Table 1). The PCU has an upper center roll which generates high accelerations. Maximum peak to peak for the PCU was measured as 1.17 G at 54 mph. This compares to a conventional locomotive which measured a maximum of 0.26 G at 55 mph.

The braking system test data consists of stop distances and brake pipe and cylinder pressures for three different braking modes. Tests were performed at various speeds. The brake pipe and cylinder pressures indicated that the blended full service, emergency and full service braking modes functioned as designed. The stop distances for the platforms in the empty condition for the three brake modes are presented in Table 2.

EQUIPMENT	HUNTING Peak-Peak/ Std. Dev. (G) EMPTY	BOUN/PITCH Peak-Peak (G) 30/5 HZ LOADED	YAW/SWAY Peak-Peak (G) 30/5 HZ LOADED	TWST/ROL Peak-Peak (Degree) LOADED	DYNMC CURVING Peak-Peak (Degree) LOADED
PCU	0.95/0.06 @ 75 mph	0.78/0.53 @ 60 mph	0.29/0.2 @ 70 mph	1.7 @ 20 mph	1.05 @ 20 mph
Platform # 1	0.49/0.1 @ 75 mph	1.88/0.69 @ 60 mph	1.49/1.0 @ 70 mph		
Platform # 2	0.47/0.07 @ 75 mph	22.37/0.5 @ 60 mph	0.97/0.5 @ 70 mph		
Platform # 3	0.76/0.11 @ 75 mph	1.69/0.76 @ 60 mph	0.88/0.5 @ 70 mph		
53 Foot Trailer		0.47/0.11 @ 72 mph	0.48/0.3 @ 75 mph	1.33 @ 20 mph	0.79 @ 20 mph
20 Foot Container		2.84/1.6 @ 60 mph	1.12/0.6 @ 70 mph	1.53 @ 15 mph	2.09 @ 15 mph
40 Foot Spine			2.38 @ 15 HZ & 70 mph	1.98 @ 18 mph	1.56 @ 21 mph
Autorack Car	1.6/0.2 @ 75 mph LOADED	0.9@15 HZ @60 mph	1.55 @ 15 HZ & 50 mph		
Conventional Locomotive			0.26 @ 15 HZ & 64 mph	2.2 @ 10 mph	1.4 @ 12 mph

Table 1. Maximum Peak to Peak Values Measured During Dynamic Response Test Series

SPEED (MPH)	BLENDED FULL SERV	FULL SERV AIR ONLY	EMERGENCY AIR ONLY	LOADED (L) EMPTY (E)
30	791	807	737	E
60	2994	3285	3175	E
30	935	1004	899	L
48	2658	2657	2702	L

Table 2. Stop Distance For Various Brake Applications

Note: Contact F. D. Irani at (312) 808-5830 with questions or comments about this document.