Rail Dynamics Laboratory
Performance Requirements & Hardware Configurations

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ABSTRACT

This paper describes the Rail Dynamics Laboratory (RDL) facility at the Transportation Test Center (TTC), Pueblo, Colorado. Two unique test machines, the Vibration Test Unit (VTU) and the Roll Dynamics Unit (RDU) are to be housed in this facility to perform dynamic tests of full-scale railroad and transit industry vehicles. Both the VTU and RDU performance requirements and hardware configurations are described.

INTRODUCTION

The objectives of this paper are to acquaint the reader with the Rail Dynamics Laboratory (RDL) facility at the Transportation Test Center (TTC), Pueblo, Colorado; and to review the performance requirements and hardware configurations of two unique test machines that the RDL will house: the Vibration Test Unit (VTU) and the Roll Dynamics Unit (RDU).

The railroad and transit industries have frequently encountered dynamic operating problems with their vehicles leading to: injuries and fatalities, accidents and derailments, lading damage, excessive maintenance costs, and rough train rides for passengers. The Federal Railroad Administration (FRA) since the inception of TTC has long recognized the need for a rail dynamics laboratory as a research tool to conduct fundamental research in a controlled environment on the many dynamic factors affecting vehicle performance and safety. While the RDL facility is not fully operational as of yet, the goals and objectives through the years of development have remained relatively the same.

The RDL goal is to provide a facility to perform dynamic tests of full-scale locomotive, passenger and freight cars, transit vehicles and advanced track systems under controlled conditions. Such a facility will permit the evaluation of various hardware designs in a safe, controlled and reproducible scientific laboratory environment, allowing the performance of a variety of tests with minimal risk to personnel and equipment.

The objectives of the FRA RDL program for the past several years have been to provide an operational facility as soon as possible within reasonable costs that can be utilized by railroad and transit industry researchers in dynamic studies such as: passive and active suspension characteristics; vehicle rock and roll tendencies; component stress analysis; component and vehicle natural frequencies; adhesions; ride comfort; acceleration; braking; lading responses; hunting and analytical model validation as well as supporting causes of derailment. This facility will help to isolate the causes of and aid in the solutions to various dynamic operating problems encountered in the railroad and transit industry. Through study of vehicle dynamics in the RDL, the number of dynamic-related accidents and derailments and their attendant costs should be reduced significantly.

RDL HISTORY

Todays RDL facility is considerably different than what was originally planned at the inception of the program at FRA many years earlier, as will be explained. Prior to the development of DOT's TTC, no test facility was available in the United States to extensively evaluate and determine the solutions to dynamic operation problems. Just before 1970, FRA contractor studies recommended a full-scale roller rig (a rail dynamics simulator) with capability to handle cars and locomotives at full speed and power, with vibrations applied through the wheels to simulate track conditions. Representation of railroads and suppliers assisted FRA in preparing performance specifications for the simulator.

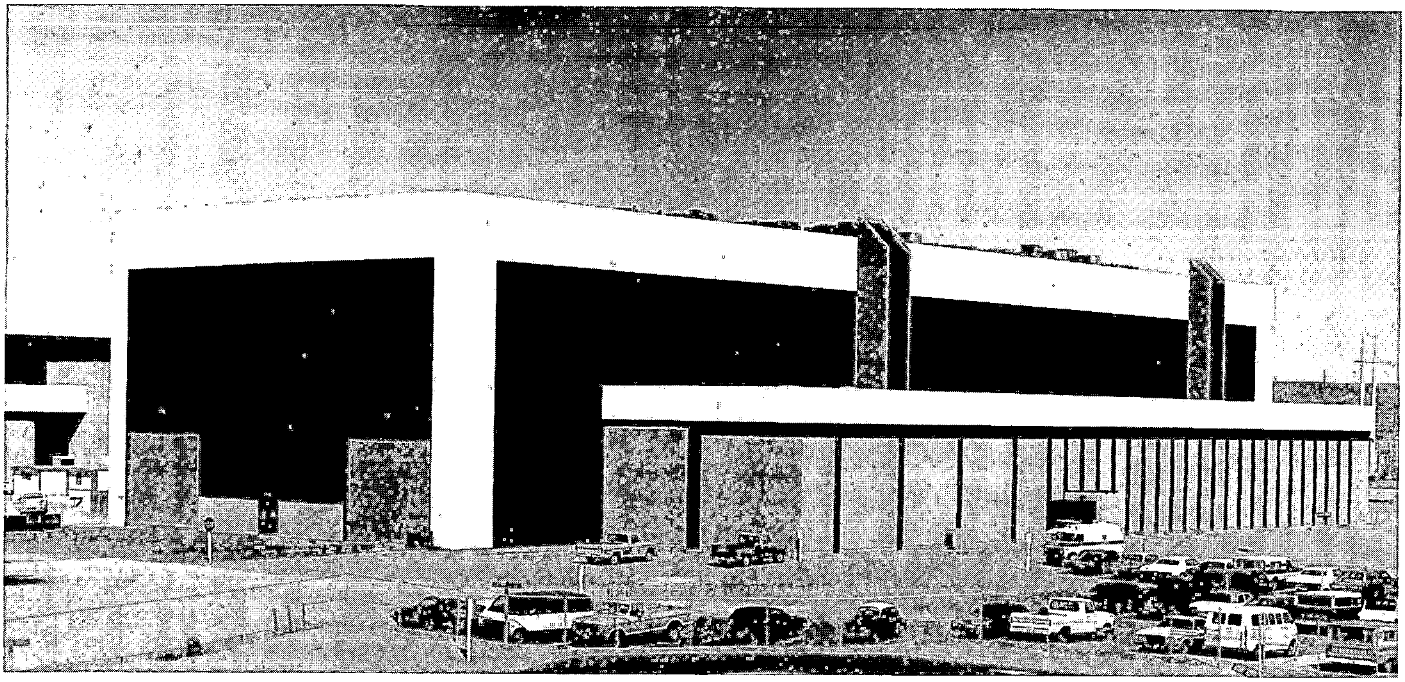

Fig. 1, Rail Dynamics Laboratory Building

FRA engineers opened communications with experts in other countries who had operated similar facilities to use their experience in preparation of the specifications. In order to leave options open for testing advanced high speed systems, such as the tracked air cushion vehicles, the simulator speed capability was designed for approximately 300 mph (483 km/h). The Urban Mass Transportation Administration joined in funding part of the RDL project so that transit vehicles could also be tested in the laboratory and agreed with FRA to locate the rail dynamics simulator (RDS) in a laboratory at TTC.

RDL Building

FRA placed the RDL building construction contract in 1972 for a high bay (the testing area) and a connecting low bay office wing, a two-story structure which contains offices, control room and other facility support areas. The principal dimensions of the high bay is 352' x 108' x 65' (107.3m x 32.9m x 19.8m) while the low bay is 264' x 50' x 30' (80.5m x 15.2m x 9.1m).

This modern steel and reinforced-concrete structure RDL building (Figure 1) was accepted in April 1974. Some notable features of the RDL building include: a) two high bay 100 ton overhead cranes for loading and off loading the test machines, b) calibration laboratory for instrumentation, c) electronic shop for equipment repairs and maintenance, d) clean rooms for disassembly, inspection and cleaning equipment.

Rail Dynamics Simulator (RDS) and Subsystems

The high bay portion of the RDL building was to house the RDS as well as service areas and a vertical shaker. Starting in 1972, FRA let contracts for the following subsystems comprising the RDS:

a. Drive train, which was to provide rotation to the track module rollers;

b. Track module, which was to simulate the tracks on which the test vehicle rests and had the capability to simulate vertical and lateral irregularities;

c. Carriage assembly, which acted as the support and reaction structure for the track module;

d. Instrumentation and control subsystem.

e. Computer subsystem.

f. Communication system.

A separate contractor was involved with each subsystem.

Vertical Shaker System (VSS).

While the RDS subsystem was in the design phase, FRA awarded a contract to Wyle Laboratories to design and construct a Component/Vehicle Preliminary Evaluation System, later named the Vertical Shaker System (VSS), envisioned as a pre-test tool prior to complex testing on the RDS. The VSS was to be used for the determination of rough estimates of response modes and frequencies and for studying the responses of truck assemblies and total vehicles to vertically applied periodic excitation. In 1975, the VSS (Figure 2) was activated, it essentially consists of four independently operated vertical actuators which can be placed under four wheels of a two axle truck on one end of a rail vehicle. Each actuator can accommodate wheel loads of up to 40,000 pounds (18, 144 kg). The acceleration, frequency, and displacement of these actuators can be varied over a wide operating range to simulate operating environments of most test specimens.

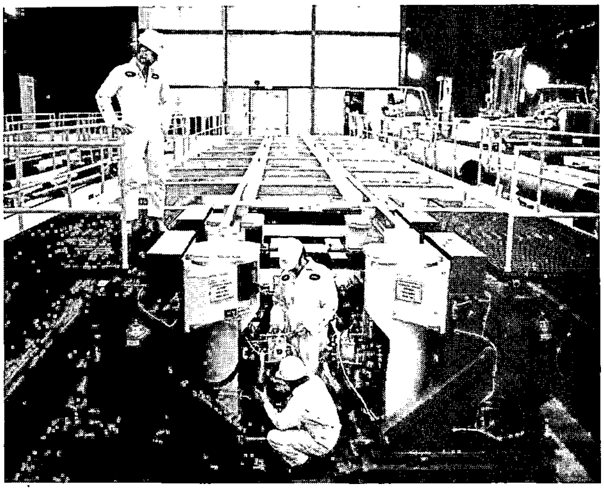

Fig. 2, Vertical Shaker System

Input capabilities for this system include: a) vertical translation of the truck and railcar, b) roll motion of the truck and railcar and c) pitch motion between the forward and aft axle sets. Prior to changes in the RDL program that affected the VSS configuration, two test programs were conducted in the RDL on the VSS:

(a) The Trailer-on-Flatcar (TOFC) Optimization Program (see Figure 3) which was designed primarily to determine the sensitivity of lading response to suspension system component variations and load distribution; and (b) the AAR Structural Dynamics evaluation of the TOFC configuration which was structured to collect data for verification of a mathematical model of the flat car body.

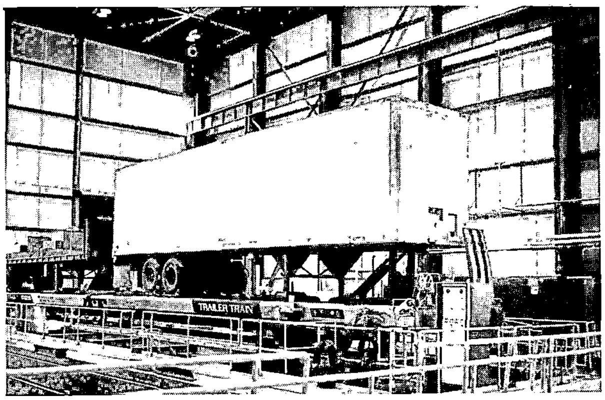

Fig. 3, TOFC on VSS

RDL Program Redirection

During the development of some of the RDS subsystems, unforeseen technical problems arose which resulted in severe schedule delays and associated risks of great concern to DOT.

In mid-1975, after the RDL program had continued to encounter R&D development and management problems, a DOT task force review resulted in the redirection of the RDL program so that it could be completed in a timely manner, relatively free of technical risk, and with minimum cost. The RDS was replaced by the Vibration Test Unit (VTU), on upgraded VSS, which will provide vertical and lateral excitation at both ends of a test vehicle, and the Roll Dynamics Unit (RDU), a basic roller rig. The RDS formerly combined both vibration and roll in one simulator. The redirected RDL program now has one prime contractor, Wyle Laboratories, instead of several major contractors.

The subsystems and systems which formerly supported the RDS, now as Government Furnished Property (GFP), will be modified for VTU and/or RDU operation, wherever possible. These subsystems/systems included the VSS, drive trains, hydraulic subsystem, integrated computer subsystem network, analog acquisition and control subsystem, and communication system, and structures subsystems. The RDL building floor plan including the VTU and RDU test pits is shown in Figure 4.

VTU DEFINITION/BASIC REQUIREMENT

The VTU shall provide the capability for subjecting a 320,000 pound (145,150 kg) rail vehicle equipped with two, two-axle trucks or to one truck of a vehicle having three or four axles per truck, to the vertical and lateral vibrations environments which the vehicle and its components would "see" in traveling over track with representative profile and alignment variations.

RDU DEFINITION/BASIC REQUIREMENT

The RDU will provide the capability for driving, or absorbing power from the wheel sets of a four-axle vehicle or a three or four axle locomotive truck. One roller module shall be provided for each wheel set. Through rotation of the rollers, the RDU will simulate tangent track at various vehicle velocities, and will permit investigation of dynamic phenomena characteristics of "perfect" tangent track such as truck hunting. "Perfect" track is defined as track with no lateral or vertical irregularities.

VTU PERFORMANCE REQUIREMENTS

A brief summary of the major VTU performance requirements are noted here. Table 1 identifies the test vehicle weight and size limitations for VTU. The VSS vertical actuators (as GFP) was the primary factor for the maximum vehicle weight requirements.

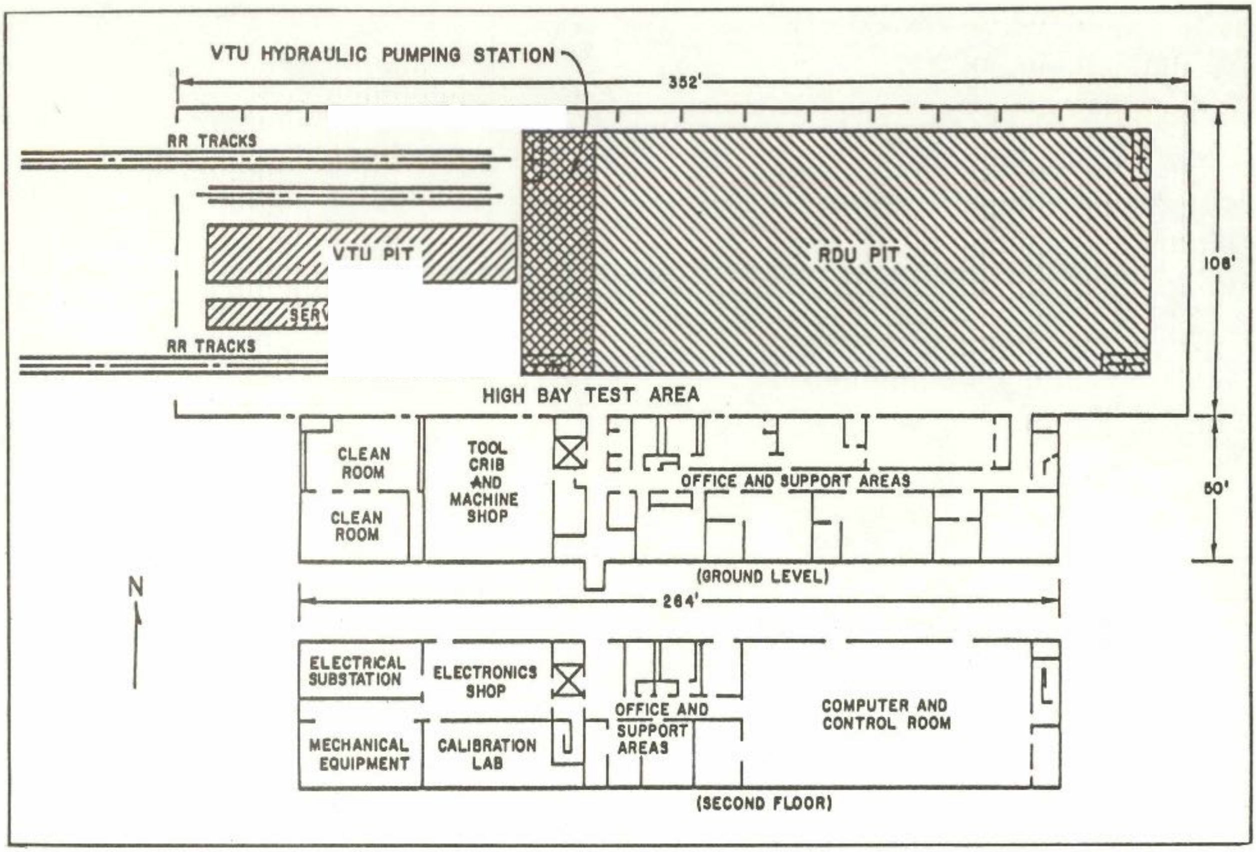

Fig. 4, RDL Building Floor Plan

Table 1. VTU/RDU Vehicle Weight and Size Limitations

Vehicle Length (max)	90.0 ft (27.43m)	108.0 ft (32.92m)
Vehicle Width (max)	12.0 ft (3.66m)	12.0 ft (3.66m)
Vehicle Weight (max)	320,000 lb (145,150 kg)	400,000 lb (181,437 kg)
Axle Load (max)	80,000 lb (36,287 kg)	100,000 lb (45,360 kg)
Truck Center Distance (min)	20.0 ft (6.10m)	20.0 ft (6.10m)
(max)	70.0 ft (21.34m)	80.0 ft (24.38 kg)
Truck Axle Spacing (min)	54.0 in. (1.37m)	54.0 in. (1.37m)
(max)	110.0 in. (2.79m)	110.0 in. (2.79m)
Gauge (min)	56.5 in. (1.44m)	56.5 in. (1.44m)
(max)	66.0 in. (1.68m)	66.0 in. (1.68m)
Coupler Centerline to Railhead		
(min)	17.5 in. (0.44m)	17.5 in. (0.44m)
(max)	34.5 in. (0.88m)	34.5 in. (0.88m)
Center of Gravity to Railroad		
(min)	18.0 in. (0.46m)	18.0 in. (0.46m)
(max)	98.0 in. (2.49m)	98.0 in. (2.49m)

The Table 2 summarizes the vertical and lateral excitation motion requirements.

Table 2. VTU Vertical and Lateral Excitation

	Excitation	
	Vertical	Lateral
Frequency Range	0.2 to 30 Hz	0.2 to 30 Hz
Displacement	± 2"(5.08cm)	±1.5"(3.81cm)
Velocity	25 inch/sec. (63.5 cm/sec)	15 inch/sec. (38.1 cm/sec)
Acceleration	3.5 g's	3.1 g's

The VTU is to provide the following types of vibratory motions to the test vehicle: vertical translation, pitch motions, roll motions, lateral translation, yaw motions, time delayed motions, combined rigid body motions, combined time delay motions and arbitrary wheel vibrations. These modes of vibration are shown in Figure 5.

RIGID BODY MOTIONS

- VERTICAL TRANSLATION
- PITCH
- LATERAL TRANSLATION
- YAW
- COMBINED

TIME DELAYED MOTIONS

- VERTICAL TRANSLATION
- ROLL
- LATERAL TRANSLATION
- COMBINED

ARBITRARY WHEEL VIBRATIONS

- VERTICAL EACH WHEEL
- LATERAL EACH WHEEL SET
- DISPLACEMENT TIME HISTORIES

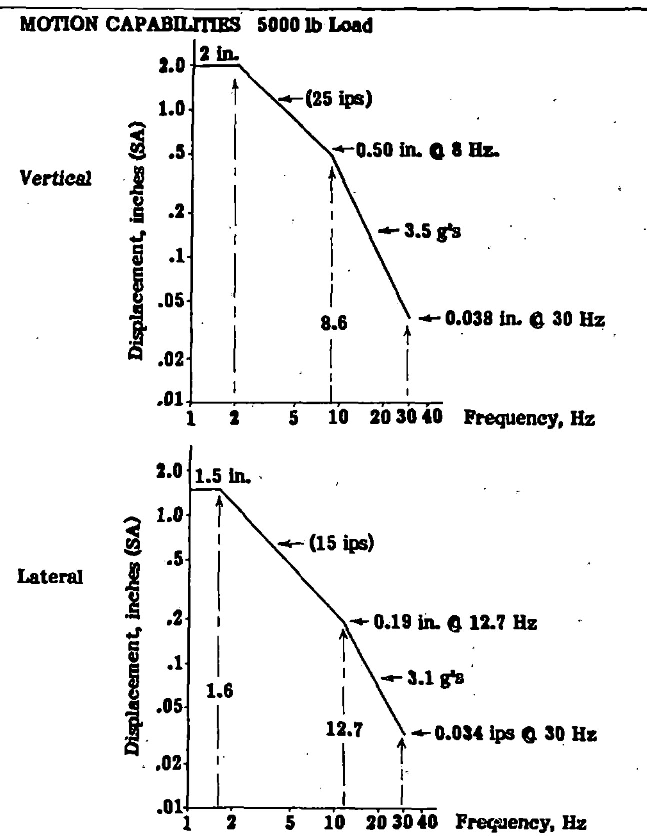

Fig. 5, VTU--Modes of Vibration

Requirements have been specified from (a) continuous VTU operation (periods up to 10 hours), (b) time required to start up/shutdown (four hours or less) and thereby permit a reasonable daily test period and (c) VTU configuration changes per test vehicle requirements (i.e., different truck axle spacings, etc.) in a reasonable time period. In addition, system safety requirements have been specified to prevent the VTU from damaging itself, the test vehicle or causing any hazard to operating/maintenance personnel.

VTU HARDWARE CONFIGURATION

As previously identified the VTU hardware had to be designed to provide the capability to subject a variety of rail vehicles to vertical and lateral vibratory environments similar to that experienced during over-the-road operations.

Owing to the variety of vehicle configurations to be accommodated, each with a unique set of dimensions associated with such elements as axle spacing, truck center distance, overhang, coupler height (in the case of transit vehicle) and inertial properties a modular approach to hardware implementation was required. In addition to modularizing for the purpose of handling the broad spectrum of vehicles, serious consideration had to be given to ease of reconfiguration in order to minimize test program turn around time.

An artist's rendering of one end of the VTU as designed and currently under construction and assembly at the RDL is presented in Figure 6. The VTU hardware as partially shown consists of the following major subsystems:

- Vertical excitation modules (one for each test vehicle wheel)
- Lateral excitation modules (one for each

test vehicle axle).

- Vehicle restraint mechanism (one for each coupler)
- Support elements such as reaction masses and service structures
- Hydraulic pumping and distribution system
- Hybrid control and monitor system

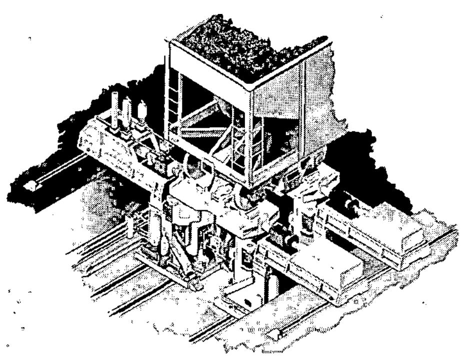

Fig. 6, Vibration Test Unit

The vertical excitation modules (each under independent servo control) are designed around a 60,000 lb (27,216 kg) hydraulic actuator, high performance servo-valve. Part of the actuator assembly is an air/oil biasing system designed to support the particular wheel load being tested such that the degradation of actuator dynamic force capability is minimal. The vertical moving elements are constrained to move in a vertical plane by three hydrostatically lubricated journal bearing designed to carry the attendant transverse forces during operation.

The lateral excitation modules (again each under independent servo control) are the most complicated of the VTU hardware elements in that the following parameters had to be accounted for:

- Lateral translation (per axle basis)
- Lateral translation with a phase shift (per truck basis)
- Allowance for out of phase vertical motion (i.e., roll)
- Provision for longitudinal vehicle expansion and contraction as experienced during excitation of the lower body bending modes
- Minimum impact on truck polar moment of inertia
- Allowance for wheel lift-off

The combination of constraints, high instantaneous loads and overall performance demands resulted in a hardware configuration illustrated in more detail in Figure 7. The lateral excitation modules are centered around a 45,000 lb. (20,412 kg) actuator assembly equipped with a 70 gpm (.0044m^3/s) high performance servo valve. In this case, oil/air biasing is provided on both sides of the primary moving elements in order to "sandwich" or preload the entire assembly. This approach was taken in order to provide minimum moving weight and roll moment of inertial of the moving elements. The motion capabilities of this subsystem as governed by the overall motion requirements previously identified are summarized below:

Δ_A(In): + 1.78/ - 2.04 (+4.52/-5.18)*

Δ_B(In): $\pm$ 2.0 ($\pm$ 5.08)*

Δ_C(In): $\pm$ 3.84 ($\pm$ 9.75)*

Δ_P(In): $\pm$ 0.81 ($\pm$ 2.06)*

θ_P(Deg): $\pm$ 6.78($\pm$ .118)**

θ_R(Deg): $\pm$ 3.85 ($\pm$ .067)**

*( ) Cm
**( ) Rad

The vehicle restraint mechanism is designed to limit the longitudinal rigid body motion of the test car and minimize spurious forces on the excitation modules. The device consists of a universal coupler adaptor, cable and preloading mechanism, with force measuring capabilities.

The support elements such as reaction masses and service structures are designed as permanent or moveable elements as appropriate to react vibratory loads and provide access as required for the variety of test configurations.

The hydraulic flow demands of the various excitation modules and hydrostatic bearing elements at peak excitation levels can be as high as 1,000 gpm (.0631m^3/s) @ 3,000 psi (20,684,271N/m^2) variable volume pumping systems each capable of delivering the rated flow at 3,000 psi (20,684, 271N/m^2). The distribution manifolds provided allow for connection of the excitation modules in the required combinations of axles spacing and truck center distance.

The hybrid control and monitor system will permit the operation of the VTU from the remotely located control room of the RDL. The control consoles provide the approximate devices and displays for operation of the VTU in either a manual or automatic mode. This system consists of two major subsystems. A digital computer subsystem which will provide synthesized signals representing the "track environment" to the analog control and monitor subsystem in the automatic mode.

Portions of this control and monitor system

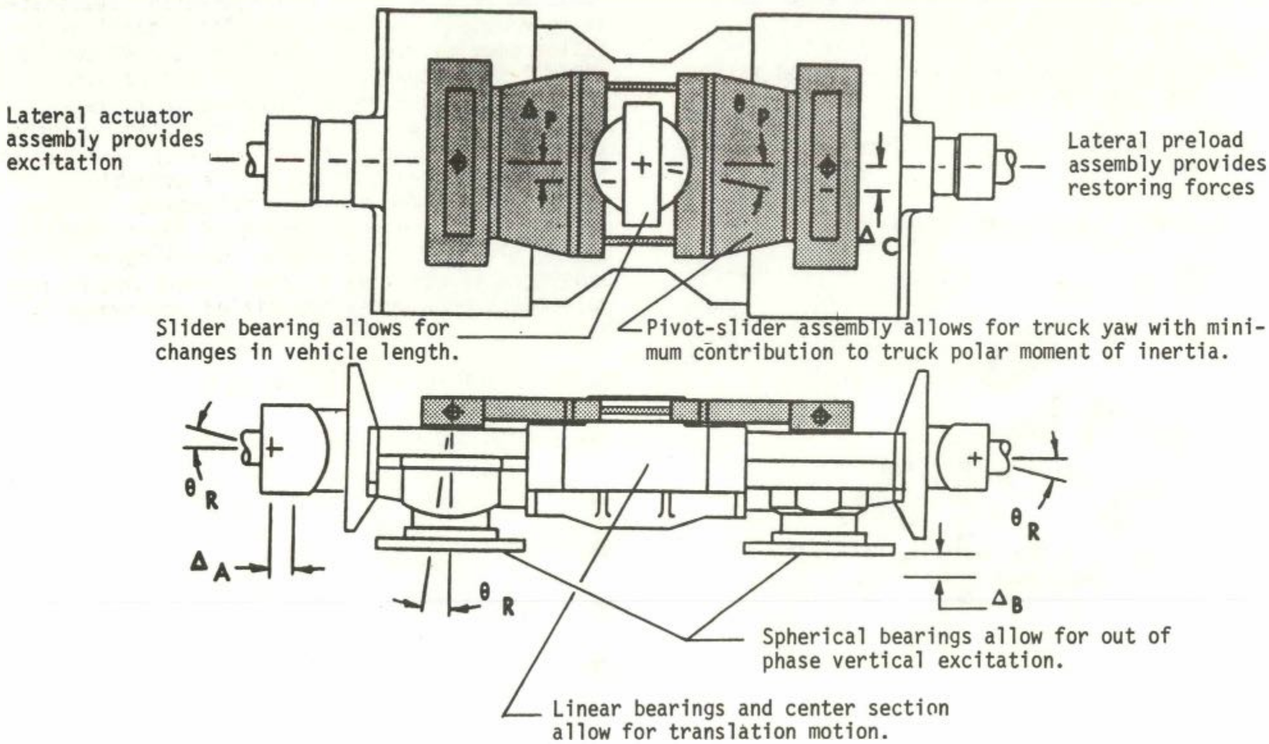

Fig. 7, VTU - Motion Capabilities

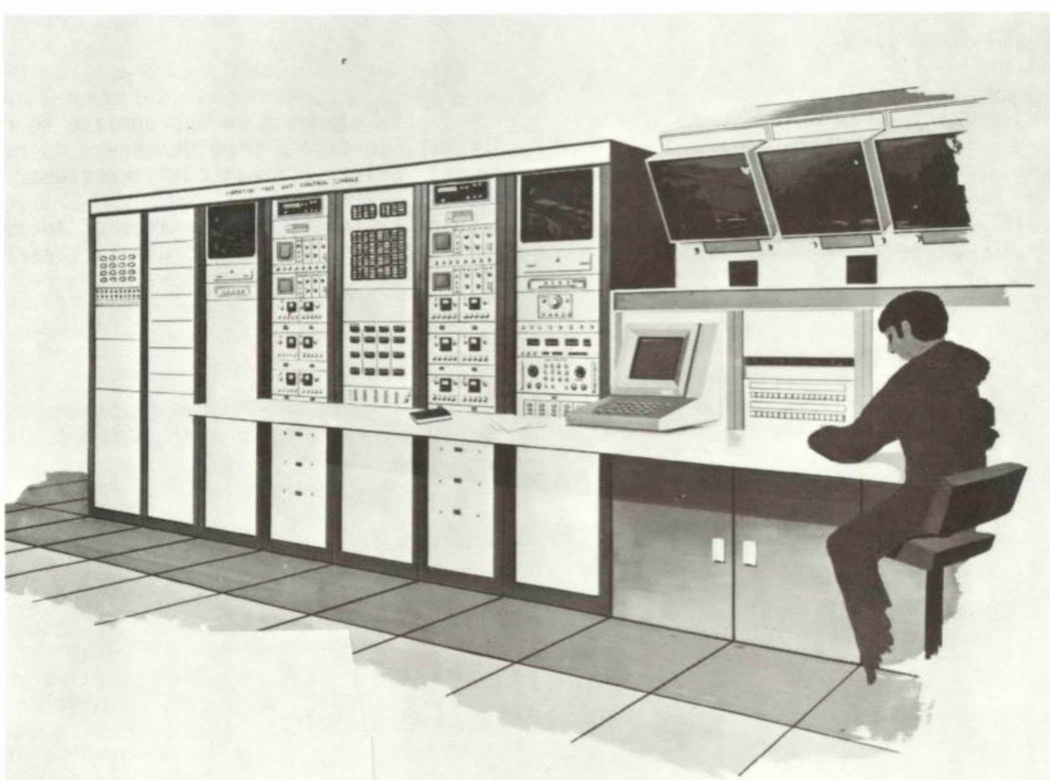

Fig. 8, VTU - Control Console

are shown in Figure 8. The complete analog control and monitor subsystem is illustrated as well as the master computer operations station.

RDU PERFORMANCE REQUIREMENTS

A brief summary of the major RDU performance requirements are noted here. Table 1 identifies the test vehicle weight and size limitations for the RDU, which is essentially the same as the former RDS requirements. Vehicle speed simulations are specified at 3-288 mph (4.8-463km/h) for up to 50,000 lb (22680 kg) axle load and 3-144 mph (4.8-232 km/h) for 50,000 to 100,000 lbs (22680 kg to 45,360 kg) axle loads with special tolerance determined by GFP (drive train) capabilities. Likewise, simulation of wheel/rail traction forces have been specified but will be largely determined by modified GFP (drive train) capabilities.

In addition to driving both ends of the two-axle per truck vehicle, or one end of a three or four axle per truck vehicle, the RDU is required to have the capability to simulate steady state curve track operation (minimum curve radius) as follows:

a). 100 ft. (30.5m) for truck center of 50 ft. (15.2m) or less

b). 150 ft. (45.7m) for truck center between 50 and 80 ft (15.2 and 24.4m).

Requirements have been specified for reasonable times to reconfigure the RDU such as changing gage or axle spacing between rollers, or test vehicles of different length or different curve-radius track. Identical start up/shutdown requirements (four hours or less) have been specified for the RDU as the VTU. During test operation, the RDU operator is only capable of increasing or decreasing the operator speed by manual adjustments. System safety requirements have been specified to prevent the RDU from damaging itself, the test vehicle or causing any hazard to operating/maintenance personnel. The RDU design capabilities have also been specified for the following future installations:

a) Body (lateral and roll) exciters to assess the effect of vehicle dynamic motion and forward speeds, b) installation of equipment for static loading to simulate the effect of super elevation unbalance during steady curve negotiations and c) automatic control of the RDU.

RDU HARDWARE CONFIGURATION

Like the VTU, the RDU hardware had to be designed to provide the capability to subject a variety of rail vehicles to dynamic tests, necessitating a modular hardware approach. The RDU, as shown in Figure 9, will support and drive (or absorb power from) the wheelsets of a four axle rail vehicle or a three or four axle locomotive truck. The rotation of the rollers will simulate vehicle speed on tangent track, and make possible the investigation of those phenomena which are independent of track irregularities, such as hunting modes. The RDU can also be configured to simulate steady state curve negotiations on tangent track.

The RDU consists of the following major subsystems:

- Drive trains
- Roller module units
- RDU support structures, reaction masses and structures
- Vehicle restraint system
- Service structures
- Control and monitor system

Each of the four drive trains is powered by a 600 hp (447.6 kw) variable speed motor. There is a master control station for synchronous operation of selected drive trains.

The roller module units (RMU), each driven by a drive train, will be equipped with two interchangeable sets of rollers, one set with a 42 in. (1.07 m) dia, and a second set with a 60 in. (1.52 m) dia. The smaller set will be used for simulation of vehicle speeds up to 144 mph (231.7 kmph) for axle loads under 100,000 lb (45,360 kg).

Each of the two RDU support structures (RDUSS) supports two drive trains and two RMUs. The RDUSS is equipped with air bearings to permit relocation of the RDUSS for various truck center distances and rotation to provide for simulated curves of up to 100 ft (30.48 m) in radius.

The vehicle restraint system controls the longitudinal position of the test vehicle, with respect to the RDU. This system consists of a cable, a flexibility element, a preloading device and a load measuring device. A reaction mass and structure are provided at each end of the test vehicle to react the loads generated by the vehicle, and transmitted through the vehicle restraint system.

Service structures consist of platforms, stairways and ladders required to provide access to and around the drive trains, roller module units, vehicle restraint systems, and test vehicle.

The control and monitor system will permit operations of the RDU from consoles located in the RDL control room. Speed of drive train rotation is commanded via a thumbwheel switch. Operational parameters are monitored and interlocked to prevent damage to the RDU or the test vehicle. The entire RDU control and monitor console is shown in Figure 10.

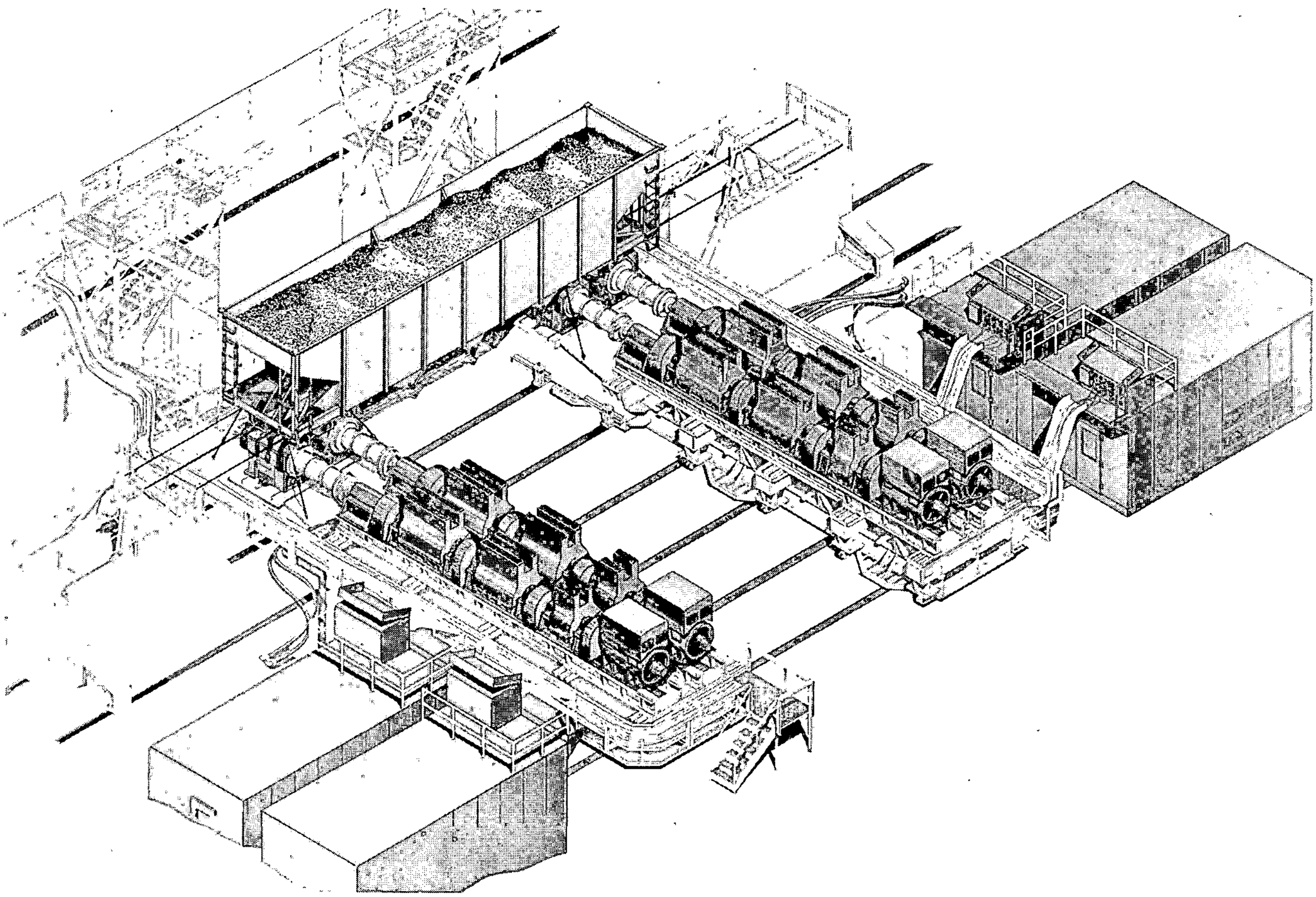

Fig. 9, Roll Dynamics Unit

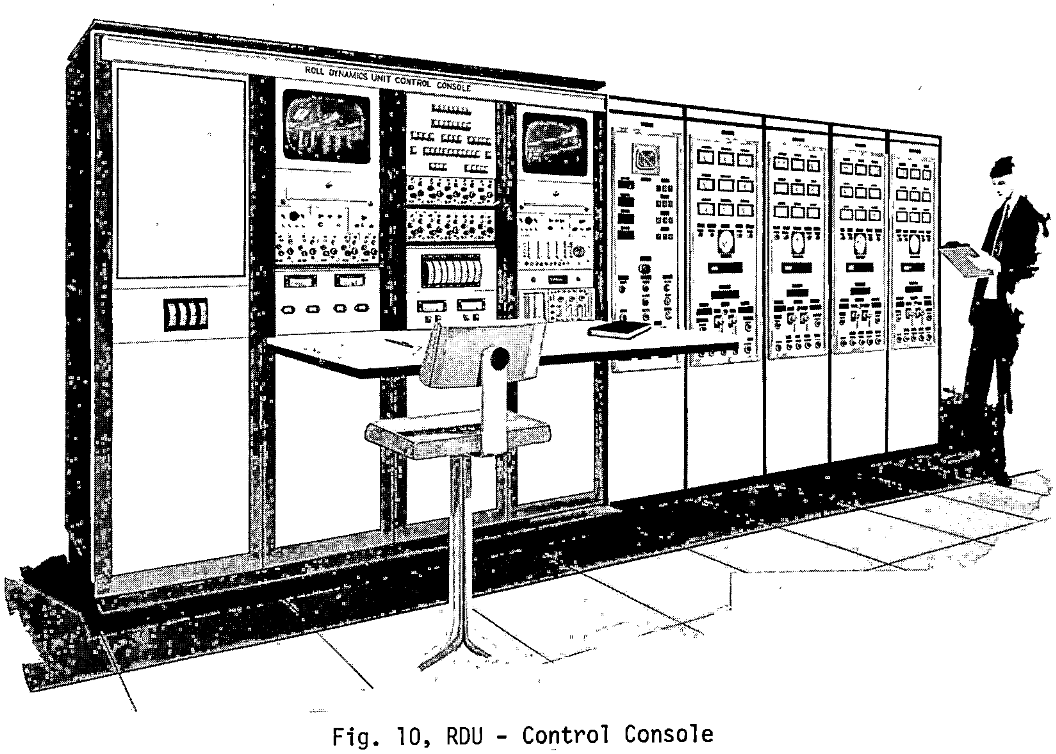

Fig. 10, RDU - Control Console

SPECIMEN DATA ACQUISITION SYSTEM (SDAS)

The VTU and RDU each have requirement for necessary data collection as implemented by SDAS. Figure 11 is a general description schematic of the SDAS. Additional data acquisition equipment as follows are available at TTC: (1) Calibration scanner, (2) photo motion analyzer, (3) closed circuit television, (4) video recording capability and (5) acoustic recording and analyzing capability.

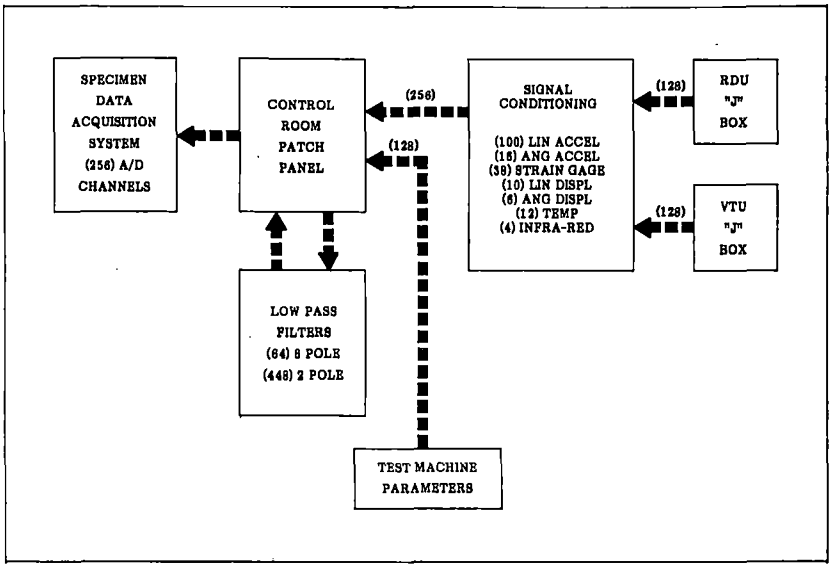

Fig. 11, SDAS General Description

VTU/RDU SYSTEM ACCEPTANCE TESTS

Acceptance tests for both the VTU and RDU are currently scheduled for late spring 1978. During these tests, Wyle Laboratories, the RDL contractor, will demonstrate that the performance requirements per contract statement-of-work have been met. During this same time span training of TTC personnel to operate and maintain the VTU and RDU will be conducted.

SUMMARY

This paper has presented an overview of the RDL's VTU and RDU performance requirements and hardware configuration. At the time of preparing this paper a large percentage of the VTU and RDU designs were complete and fabrication under way. It is also noted, that when the RDL program was redirected via the DOT Task Force a finite budget was also imposed. Depending on the final program costs, the final VTU and RDU systems may be different than described in this paper. FRA is doing all that is fiscally possible to have the RDL facility operational as soon as possible: currently late spring or early summer 1978.

Once operational, the VTU and RDU will permit researchers to perform much needed analytical and experimental tests of full-scale locomotives, passenger and freight cars, transit vehicles and advanced track systems under computer controlled conditions. Lessons learned in the RDL should lead to safer and lower cost equipment before it is built, not after mistakes are demonstrated in the field.

APPENDIX

Abstracts of Recent Reports
and Magnetic Data Tapes
Relating to Freight Systems R&D

1. Report No.	2. Government Accession No. PB 252290	3. Recipient's Catalog No.
4. Title and Subtitle ANALYTICAL AND EXPERIMENTAL DETERMINATION OF WHEEL-RAIL CONSTRAINT RELATIONSHIPS		5. Report Date December 30, 1975 6. Performing Organization Code
7. Authors N. K. Cooperrider, E. H. Law, R. Hull, P. S. Kadala, J. M. Tuten		8. Performing Organization Report No.
9. Performing Organization Name and Address Clemson University Dept. of Mechanical Engineering Clemson, S. C. 29631	Arizona State University Dept. of Mech. Engineering Tempe, Arizona 85281	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DOT-OS-40018
12. Sponsoring Agency Name and Address U. S. Department of Transportation Federal Railroad Administration Washington, D. C.		13. Type of Report and Period Covered Interim 14. Sponsoring Agency Code

15. Supplementary Notes

Prepared in cooperation with Association of American Railroads Research Center, Chicago, Illinois

16. Abstract

Wheel/rail geometric constraint relationships, such as the effective conicity and gravitational stiffness, strongly influence the lateral dynamics of railway vehicles. In general, these geometric constraints are nonlinear functions of the wheelset lateral displacement. This report describes the development and validation of an analytical procedure to determine these nonlinear functions for arbitrary wheel and rail profiles. Data for validation of this analysis was obtained experimentally. Experimental and analytical data for three validation cases is presented. Results of a limited parametric study are also reported. The computer program for the analytical procedure is described and documented.

17. Key Words	18. Distribution Statement
wheel/rail kinematics wheel/rail geometry railroads conicity, gravitational stiffness wheelset wheel profile, rail profile	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this report)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	182	PC$7.50 MF$3.00

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. FRA/ORD-76/249	2. Government Accession No. PB 254810	3. Recipient's Catalog No.
4. Title and Subtitle OPTICAL AUTOMATIC CAR IDENTIFICATION (OACI) Field Test Program		5. Report Date May 1976 6. Performing Organization Code
7. Author(s) Hector C. Ingrao		8. Performing Organization Report No. DOT-TSC-FRA-76-9
9. Performing Organization Name and Address U.S. Department of Transportation Transportation Systems Center Kendall Square Cambridge MA 02142		10. Work Unit No. RR 616/R6335 11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Railroad Administration Office of Research and Development Washington DC 20590		13. Type of Report and Period Covered Final Report June-October 1975 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The results of the Optical Automatic Car Identification (OACI) tests at Chicago conducted from August 18 to September 4, 1975 are presented. The main purpose of this test was to determine the suitability of optics as a principle of operation for an automatic car identification. Readabilities by standard and "modified" scanners were measured. Based on the optical information available in the label-scanner communication channel and the determination of the non-read causes, the label-scanner readability and limit of readability were obtained. Also the same readabilities were obtained using multiplexed data from two scanners, one at each side of the track. The benefits of redundancy in the multiplexed data are based on the analysis of the test results. Conclusions and recommendations are presented. No attempt has been made to evaluate the hardware implementation of the OACI systems used during the Chicago test.

17. Key Words Automatic Car Identification Railroad Information Systems Classification Yard Technology	18. Distribution Statement DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	186	PC$7.50 MF$3.00

Form DOT F 1700.7 (8-69)

Technical Report Documentation Page

1. Report No. FRA/ORD-76/304	2. Government Accession No. PB 264051	3. Recipient's Catalog No.
4. Title and Subtitle RAILROAD CLASSIFICATION YARD TECHNOLOGY A Survey and Assessment		5. Report Date January 1977
		6. Performing Organization Code
7. Author(s) S. J. Petracek, A. E. Moon, R. L. Kiang M. W. Siddiqee		8. Performing Organization Report No. DOT-TSC-FRA-76-35 SRI Project 3983
9. Performing Organization Name and Address Stanford Research Institute 333 Ravenswood Avenue Menlo Park CA 94025		10. Work Unit No. (TRAIS) RR716/R7308
		11. Contract or Grant No. DOT-TSC-968
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Railroad Adminstration Research and Development Washington DC 20590		13. Type of Report and Period Covered Final Report Jan. 1975 - July 1976
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report documents a survey and assessment of the current state of the art in rail freight-car classification yard technology. The major objective was the identification of research and development necessary for technological improvements in railroad classification yards. This involved a projection of future classification yard needs and a comparison of these requirements of existing technology. Separate tasks included a description of the hardware, costs, performance characteristics, and operational practices of existing yards; formulation of general yard-network interaction concepts; collection of in-depth background information concerning the yard population in the United States (categorized by type, technology, and function); estimation of the demands likely to be placed on the nation's network of freight-car terminals during the foreseeable future; and an assessment and prioritization of those areas of terminal operations that warrant further research or development.

17. Key Words Classification Yard Technology, Yard Design, Operational Procedures, Hump Yards, Flat Yards, Train-Terminal Interaction	18. Distribution Statement DOCUMENT IS AVAILABLE TO THE U.S. PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 346	22. Price PC$10.00 MF$3.00

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FRA/ORD-77/44		

4. Title and Subtitle	5. Report Date
RESEARCH PLAN FOR EMC STUDY OF THE COMMUNICATION AND CONTROL SYSTEMS IN A RAILROAD CLASSIFICATION YARD	July 1977
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
P. Speh and S. Storozum of IIT Research Institute	ECAC-CR-77-031
9. Performing Organization Name and Address	10. Work Unit No.
Electromagnetic Compatibility Analysis Center North Severn Annapolis, MD 21402	11. Contract or Grant No. Work Statement AR74311
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
U.S. Department of Transportation Federal Railroad Administration Office of Research and Development Washington, DC 20590	Consultative Report
	14. Sponsoring Agency Code

15. Supplementary Notes

Coordinated with the Inductive Interference Committee, Communication and Signal Section, Association of American Railroads.

16. Abstract

The Federal Railroad Administration (FRA) is planning a study of the electromagnetic interference/electromagnetic compatibility (EMI/EMC) in the railroad classification yard. Classification yards, especially hump yards, are automated to the extent that electromagnetic equipment emits in the range from DC to several thousand megahertz. With the introduction of computers and computer controls, compatible electromagnetic operation in the yards will be more difficult now and in the future.

The FRA has tasked the Electromagnetic Compatibility Analysis Center (ECAC) to investigate the classification yard communication and control systems EMC compatibility situation. An EMC analysis will be conducted to determine the interference impact on yard equipment. Recommendations to improve compatibility within the classification yard will be made in the form of conceptual guidelines.

In partial fulfillment of the investigation are measurements required to determine the EMI/EMC. This research plan addresses the equipments required along with the suggested locations of the measurements. The research plan will be submitted to the Association of American Railroads (AAR) for comment prior to implementation.

17. Key Words	18. Distribution Statement
ELECTROMAGNETIC COMPATIBILITY ELECTROMAGNETIC INTERFERENCE RAILROAD CLASSIFICATION YARD RAILROAD HUMP YARD	THIS DOCUMENT WILL BE INCLUDED AS AN APPENDIX TO THE FINAL REPORT.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	18	

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Technical Report Documentation Page

1. Report No. FRA-OR&D 75-81A	2. Government Accession No. PB 248350	3. Recipient's Catalog No.
4. Title and Subtitle FREIGHT CAR TRUCK DESIGN OPTIMIZATION Literature Search - Volume I		5. Report Date June 1975
		6. Performing Organization Code
7. Author(s) Southern Pacific Transportation Company Technical Research and Development Group		8. Performing Organization Report No. TDOP 75-251
9. Performing Organization Name and Address Southern Pacific Transportation Company One Market Street San Francisco, California 94105		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT FR-40023
12. Sponsoring Agency Name and Address Department of Transportation Federal Railroad Administration Office of Research and Development Washington, D.C. 20590		13. Type of Report and Period Covered Interim Report April 1975 - June 1975
		14. Sponsoring Agency Code

15. Supplementary Notes
This interim report represents the first of a three-volume set. Volumes II and III bear the same report number with B and C suffixes.

16. Abstract
This document serves as an introduction to the literature known to be available and relevant to rail freight car trucks, their components and performance characteristics. In connection with the Federal Railroad Administration sponsored research in Truck Design Optimization a literature search was conducted to review and assemble all relevant publications, papers, and articles. The collected documentation has been organized into five sections:

- The History of the Freight Car Truck
- Truck Design
- Truck Components
- Track-Train Dynamics as Related to Truck Performance
- Truck Performance

Each section contains: an introduction dealing with literature selected for reprinting, reprints of articles judged particularly representative or salient, and a bibliography alphabetized by author. The five sections have been organized into three-volumes. Volume I contains the sections entitled: "The History of the Freight Car Truck" and "Truck Design." Volumes II and III will complete the compilation. It is expected that supplements to the three initial volumes will be published at a later date as additional information becomes available.

17. Key Words Bigliography, history, design principles, freight car trucks, passenger car trucks, locomotive trucks, reprints, literature, truck functions, three-piece truck, bolster, side frames friction snubbers, truck dynamics	18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	124	PC$5.50 MF$3.00

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Technical Report Documentation Pc

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FRA-OR&D-75-81B	PB 248351	

4. Title and Subtitle	5. Report Date
FREIGHT CAR TRUCK DESIGN OPTIMIZATION Literature Search - Volume II	July 1975
	6. Performing Organization Code
7. Author(s) Southern Pacific Transportation Company Technical Research and Development Group	8. Performing Organization Report No. TDOP 75-252
9. Performing Organization Name and Address Southern Pacific Transportation Company One Market Street San Francisco, CA 94105	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DOT FR-40023
12. Sponsoring Agency Name and Address Department of Transportation Federal Railroad Administration Office of Research and Development Washington, D. C. 20590	13. Type of Report and Period Covered Interim Report June-July 1975 14. Sponsoring Agency Code

15. Supplementary Notes

This interim report represents the second of a three-volume set.
Volumes I and III bear the same report number with A and C suffixes respectively.

16. Abstract

Volume II of the TDOP Literature Search contains the sections entitled: "Truck Components" and "Track-Train Dynamics As Related To Truck Performance." Each of the two sections contains:

- An introduction dealing with literature selected for reprinting
- Reprints of articles judged particularly representative or salient
- A bibliography alphabetized by author

The "Bibliography--Truck Components" is further organized into the following subsections:

- Brakes and Brake Rigging
- Centerplates
- Side Frames and Bolsters
- Snubbers and Dampers
- Springs
- Wheels, Axles, and Roller Bearings
- Miscellaneous Component Systems

17. Key Words	18. Distribution Statement
Bibliography, freight car truck, truck components, brakes, brake rigging, centerplates, side frames, bolsters, snubbers, dampers, springs, wheels, axles, roller bearings, track-train dynamics, truck performance	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	198	PC$7.50 MF$3.00

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FRA-OR&D-75-81C	PB 248352	

4. Title and Subtitle	5. Report Date
FREIGHT CAR TRUCK DESIGN OPTIMIZATION Literature Search - Volume III	August 1975
	6. Performing Organization Code
7. Author(s) Southern Pacific Transportation Company Technical Research and Development Group	8. Performing Organization Report No. TDOP 75-253
9. Performing Organization Name and Address Southern Pacific Transportation Company One Market Street San Francisco, CA 94105	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT FR-40023
12. Sponsoring Agency Name and Address Department Of Transportation Federal Railroad Administration Office of Research and Development Washington, D. C. 20590	13. Type of Report and Period Covered Interim Report July - August 1975
	14. Sponsoring Agency Code

15. Supplementary Notes

This interim report represents the third of a three-volume set. Bibliographical additions will be made to these volumes as new articles become available throughout the course of the Truck Design Optimization Project. See also, FRA-OR&D 75-81A & B.

16. Abstract

Volume III of the TDOP Literature Search contains the sections entitled: "Truck Performance" and "Literature Search Title Index." The section dealing with truck performance contains:

- An introduction dealing with literature selected for reprinting
- Reprints of articles judged particularly representative or salient
- A bibliography alphabetized by author

The "Bibliography--Truck Performance" is further organized into the following subsections:

- Computer Analysis of Truck Performance
- Field Analysis of Truck Performance
- Laboratory Analysis of Truck Performance

The index section contains a listing alphabetized by title of all publications included in the three-volume Literature Search.

17. Key Words	18. Distribution Statement
Bibliography, freight car truck, truck performance, computer analysis, field analysis, laboratory analysis, title index	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	215	PC$7.75 MF$3.00

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FRA-OR&D 75-59	PB 248632	

4. Title and Subtitle	5. Report Date
FREIGHT CAR TRUCK DESIGN OPTIMIZATION Introduction and Detailed Tests Plans--Series 1, 2, and 3 Tests--Phase I	June 1975
	6. Performing Organization Code TDOP 75-59
7. Author(s) Southern Pacific Transportation Company Technical Research and Development Group	8. Performing Organization Report No.
9. Performing Organization Name and Address Southern Pacific Transportation Company One Market Street San Francisco, California 94105	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT FR-40023
12. Sponsoring Agency Name and Address Department of Transportation Federal Railroad Administration Office of Research, and Development Washington, D.C. 20590	13. Type of Report and Period Covered Interim Report November 1974-March 1975
	14. Sponsoring Agency Code

15. Supplementary Notes

The information presented herein is a prerequisite to the coming interim report covering the test plan for Test Series 4, FRA Report No. FRA-OR&D 75-60.

16. Abstract

This document serves as an introduction to the Freight Car Truck Design Optimization Project (TDOP) and presents the detailed test plans for Series 1, 2, and 3 Tests of a contemplated group of four series for that project. Some of the background of the project is given, the development of the test method is described, a description of the instrumentation on the test track and test car and of the facilities of Southern Pacific Transportation Co. (SPT Co.) are given, a data collection and processing plan and analytical procedures for comparing test results with predicted values are presented. A description of the Series 1, 2, and 3 Tests, the contemplated test schedule, and the management structure for the project are also given. In the appendix, the tasks required to be performed by the statement of work for Phase I are outlined.

17. Key Words	18. Distribution Statement
Testing, instrumentation, dynamic analysis, data acquisition, wheel wear, spring rate, snubbing level, load, speed, track, side bearing clearance, gib clearance	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	113	PC$5.50 MF$3.00

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FRA-OR&D 75-60	PB 246389	

4. Title and Subtitle	5. Report Date
FREIGHT CAR TRUCK DESIGN OPTIMIZATION PROJECT - Detailed Test Plans For Series 4	August 1975
	6. Performing Organization Code
	8. Performing Organization Report No. TDOP 75-152
7. Author(s) Southern Pacific Transportation Company Technical Research & Development Group	
9. Performing Organization Name and Address: Southern Pacific Transportation Company, One Market Street, San Francisco, Calif. 94105	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-FR-40023
12. Sponsoring Agency Name and Address: Department of Transportation, Federal Railroad Admin., Office of Research & Development, Washington, D.C. 20590	13. Type of Report and Period Covered: Interim Report April-May 1975
	14. Sponsoring Agency Code

15. Supplementary Notes

The report Freight Car Truck Design Optimization, Introduction and Detailed Test Plans -- Series 1, 2, and 3 Tests -- Phase I is a prerequisite to this document.

16. Abstract

This document presents the detailed test plans for Series 4 Tests of Phase I of the Truck Design Optimization Project. It is a continuation of a previous report presenting the introduction and the detailed test plans for Series 1, 2, and 3 Tests, for Phase I of the same project. It describes the modifications to the trucks to be made prior to testing and lists the instrumentation to be used and the sequence of testing. The reader is referred to the previous document for details of the instrumentation and the data analysis.

17. Key Words	18. Distribution Statement
friction-snubbed truck, laboratory testing, mathematical models, center-plate friction, pedestal shims, elastomeric adapter pads, side frame intertie, hydraulic dampers, air bag (constant contact) side bearings, breadboard modifications.	Document is available to the public through the National Technical Information Service, Springfield, Va. 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		PC$4.00 MF$3.00

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FRA-OR&D-75-82	PB 248631	

4. Title and Subtitle	
FREIGHT CAR TRUCK DESIGN OPTIMIZATION Detailed Test Plans For Series 5 Tests-Phase I	5. Report Date November 1975
	6. Performing Organization Code
7. Author(s) Southern Pacific Transportation Company Technical Research & Development Group	8. Performing Organization Report No. TDOP-75-153
9. Performing Organization Name and Address Southern Pacific Transportation Company One Market Street San Francisco, California 94105	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT FR-40023
12. Sponsoring Agency Name and Address Department of Transportation Federal Railroad Administration Office of Research & Development Washington, D.C. 20590	13. Type of Report and Period Covered Interim Report July-August
	14. Sponsoring Agency Code

15. Supplementary Notes

The reports entitled Introduction and Detailed Test Plans For Series 1, 2, and 3 Tests, Phase I, and Detailed Test Plan For Series 4 Tests, Phase I, are prerequisite to this document.

16. Abstract This document presents the detailed test plans for Series 5 Tests of Phase I of the Truck Design Optimization Project. It is a continuation of previous reports for the same project presenting the introduction and detailed test plans for Series 1, 2, and 3 Tests in the first volume and the detailed test plans for Series 4 Tests in the second volume. It includes a description of the trucks and cars to be used in the testing, the basis for selecting them, and a description of the tests themselves. It lists the instrumentation to be used and the sequence of testing. The reader is referred to the previous documents for details of the instrumentation and data analysis.

17. Key Words	18. Distribution Statement
friction snubbed trucks, cylindrical wheels, 1-in-40 tapered wheels, selected wheel profile, spring complements, harmonic roll, 3/4 in. low, half-staggered joints, spring-nest snubbers	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	32	PC$4.00 MF$3.00

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Technical Report Documentation Page

1. Report No. FRA-OR&D 75-58	2. Government Accession No. PB 248832	3. Recipient's Catalog No.
4. Title and Subtitle FREIGHT CAR TRUCK DESIGN OPTIMIZATION METHODOLOGY FOR A COMPREHENSIVE STUDY OF TRUCK ECONOMICS		5. Report Date April , 1975
		6. Performing Organization Code
7. Author(s) David April		8. Performing Organization Report No. TDOP 75-1
9. Performing Organization Name and Address Southern Pacific Transportation Company One Market Street San Francisco, California 94105		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT FR-40023
12. Sponsoring Agency Name and Address U. S. Department of Transportation Federal Railroad Administration Office of Research, Development & Demonstrations Washington, D. C. 20590		13. Type of Report and Period Covered Technical Report August 1974-January 1975
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

As a part of the Federal Railroad Administration's Truck Design Optimization Project (TDOP) a determination of the economics associated with particular freight car truck designs is needed. Although TDOP centers around the development of performance and testing specifications for rail freight car trucks the methodology for evaluating the economic benefits to be derived from efficient truck designs is not at hand. Accordingly, it has been necessary to develop a systematic approach to identifying the cost elements associated with truck ownership. A methodology is proposed for developing the necessary truck economic data first through a pilot study and subsequently through the collection and verification of the data from a wide base of sources. A subsequent report is to outline the findings of this research.

17. Key Words Freight Car Truck Operating Costs, Truck Economic Model, Truck Economic Operating Life, Truck Economic Data Base	18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	27	PC$4.00 MF$3.00

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FRA-OR&D 75-58A	PB 251400	

4. Title and Subtitle	5. Report Date
FREIGHT CAR TRUCK DESIGN OPTIMIZATION: Truck Economic Data Collection and Analysis	March 1976
	6. Performing Organization Code
7. Author(s) David April	8. Performing Organization Report No. TDOP 75-2
9. Performing Organization Name and Address Southern Pacific Transportation Company One Market Street San Francisco, CA 94105	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-FR-40023
12. Sponsoring Agency Name and Address Department of Transportation Federal Railroad Administration Office of Research and Development Washington, D.C. 20590	13. Type of Report and Period Covered Technical Report Feb. 1975 - Feb. 1976
	14. Sponsoring Agency Code

15. Supplementary Notes

See also Freight Car Truck Design Optimization, Methodology for a Comprehensive Study of Truck Economics, April 1975 (NTIS Accession No. PB 248 832/AS) to the extent that this report expands further on the economic analysis of freight car trucks.

16. Abstract

A first interim report covering the development of the TDOP economic methodology was published by the Federal Railroad Administration in April 1975. It contains the truck investment economic evaluation procedures intended for the use of the railroad industry and their suppliers.

The primary objective of the Truck Economic Data Collection and Analysis Program is to test the procedures for establishing the significant actual operating costs of existing Type I general purpose trucks. This second interim report covers the progress of the program. A generalized truck cost information system was designed for the collection and integration of truck economic data. The collection of test data for off-line truck maintenance costs was completed. Test data collection was initiated for on-line truck maintenance and other associated costs and operating conditions. Preparatory work was begun to develop the appropriate data analysis guidelines. A preliminary analysis of some of the test data clearly revealed the truck's reported off-line wear and failure cost performance.

Railroad companies and their suppliers are encouraged to consider adopting the tested procedures of the TDOP economic methodology. A progressive implementation of this methodology will provide them with the timely opportunity to develop a truck economic evaluation capability of their own.

17. Key Words	18. Distribution Statement
Freight Car Truck Operating Costs; Freight Car Economic Model; Freight Car Truck Economic Data Collection; Freight Car Truck Economic Data Base, Freight Car Truck Economic Data Analysis	Document is available to the public through the National Technical Information Service, Springfield, Virginia, 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	86	PC$5.00 MF$3.00

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FRA/ORD-76/287.I	PB 259366	
4. Title and Subtitle FREIGHT CAR TRUCK DESIGN OPTIMIZATION Economic Analysis Report - Phase I		5. Report Date July 1976
		6. Performing Organization Code
7. Author(s) Southern Pacific Transportation Company Technical Research & Development Group		8. Performing Organization Report No. TDOP 76-3
9. Performing Organization Name and Address Southern Pacific Transportation Company One Market Plaza San Francisco, California 94105		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT-FR-40023
12. Sponsoring Agency Name and Address Department of Transportation Federal Railroad Administration Office of Research and Development Washington, D.C. 20590		13. Type of Report and Period Covered Technical Report March 1976 - July 1976
		14. Sponsoring Agency Code

15. Supplementary Notes See also: FRA-OR&D 75-58, April 1975 (NTIS Accession Number PB 248 832) Methodology for a Comprehensive Study of Truck Economics, and FRA OR&D 75-58A, February 1976 (NTIS Accession Number PB 251 400) Truck Economic Data Collection and Analysis

16. Abstract

This report summarizes the truck economic research accomplished during Phase I of the Federal Railroad Administration's three-phase Truck Design Optimization Project (TDOP). In this phase:

- A truck economic methodology was developed with the cooperation of representatives from the railroad industry and their suppliers. The methodology is for industry use to help establish the cost performance of the individual railroads' existing trucks and evaluate investments in proposed truck improvements.
- The economic data elements were identified and procedures were developed at various levels of specification to collect the information. An overall truck cost information system was designed. The system will provide a user with the processing capability to establish the integrated truck economic data base and present the data for evaluation.
- Economic data analysis guidelines were developed to establish and evaluate the cash flows of investments in proposed improvements to existing trucks. The approach to evaluating the operating cost performance of existing trucks through the exploitation of the economic data base was developed.

The report recommends that the railroad industry adapt the TDOP methodology developed thus far to their individual company environments and begin to establish working procedures for the economic selection of existing trucks and proposed improved truck designs. Suggested further economic research is also identified.

17. Key Words		18. Distribution Statement	
Freight Car Truck operating costs, Freight Car Truck operating conditions, Freight Car Truck cost performance evaluation, Improved Freight Car Truck investment evaluation, Freight Car truck cash flow		Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		PC$4.50 MF$3.00

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FRA-OR&D 76-05	PB 648633	

4. Title and Subtitle FREIGHT CAR TRUCK DESIGN OPTIMIZATION Survey and Appraisal of Type II Trucks	5. Report Date December 1975 6. Performing Organization Code
7. Author(s) Southern Pacific Transportation Company Technical Research & Development Group	8. Performing Organization Report No. TDOP 75-201
9. Performing Organization Name and Address Southern Pacific Transportation Company One Market Street San Francisco, California 94105	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DOT-FR-40023
12. Sponsoring Agency Name and Address Department of Transportation Federal Railroad Administration Office of Research and Development Washington, D.C. 20590	13. Type of Report and Period Covered Interim Report Febuary 1975-September 1975 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report serves as an introduction to the family of truck designs known as Type II that will be studied in connection with the Federal Railroad Administration's Truck Design Optimization Project.

An investigation was made of existing trucks and truck designs qualifying as Type II trucks and this investigation considers features which would be of interest in selecting candidates for testing and evaluation of such trucks under Phase II of the Truck Design Optimization Project.

Type II special service designs embody new concepts that utilize current wheel set and journal bearing assemblies and braking arrangements compatible with current air brake systems. Car coupler height is maintained but car body supports other than center plates can be employed. Ride quality and minimum maintenance cost are of major importance to Type II designs.

17. Key Words	18. Distribution Statement
Type II truck, elastomer, parallelogramming, air spring, air brake, car body supports, ride quality, maintenance cost, first cost, unstable hunting	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	133	PC$6.00 MF$3.00

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