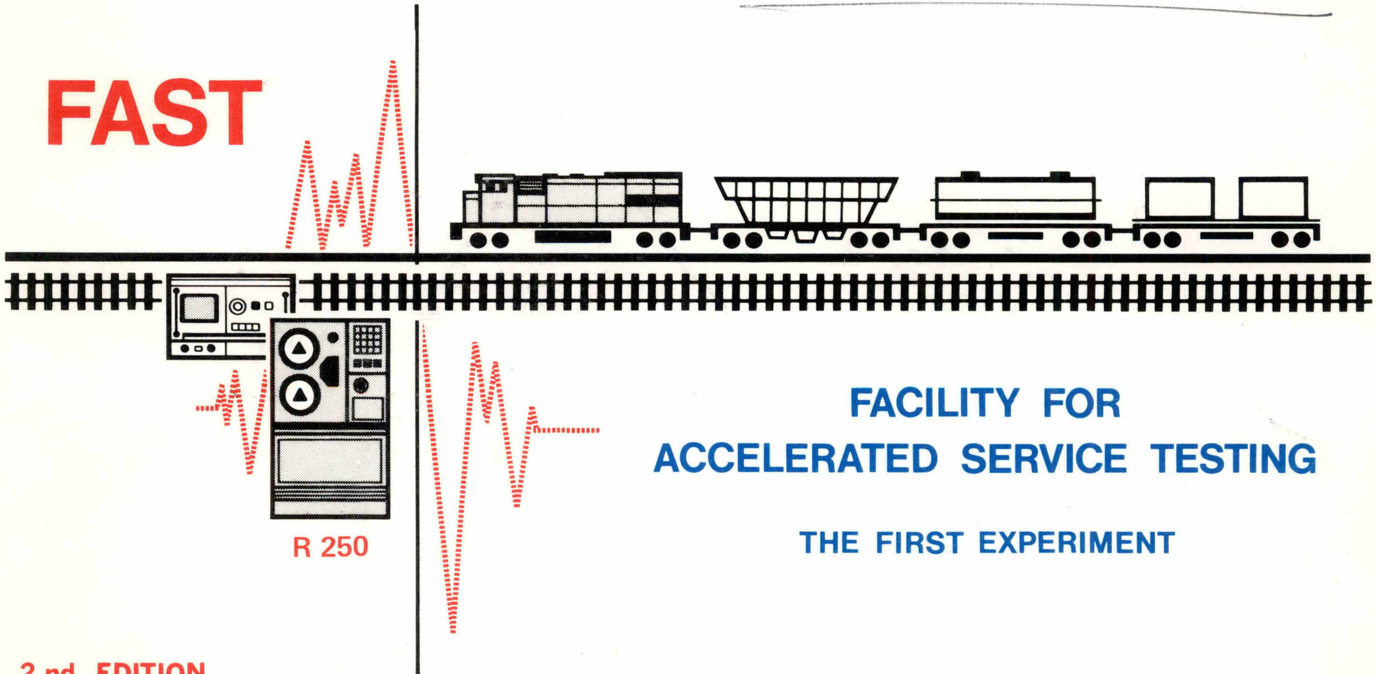
SPANTON'S FILE COPY

FAST



FACILITY FOR ACCELERATED SERVICE TESTING

THE FIRST EXPERIMENT

2 nd EDITION

Transport Canada

AN INTERNATIONAL GOVERNMENT - INDUSTRY RESEARCH PROGRAM ON TRACK-TRAIN DYNAMICS

FOREWORD

The Facility for Accelerated Service Testing(FAST) is a track loop located at the DOT Transportation Test Center at Pueblo, Colorado.

A train operating around the loop for up to 16 hours per day exposes track and equipment components under test to loads approximately ten times as rapidly as in revenue service.

Plans for FAST and its construction and operation were achieved in less than one year because of the enthusiastic support provided by all interested parties, particularly the Federal Railroad Administration, the railroads, the railroad supply industry, the Railway Progress Institute, the Association of American Railroads, and the Transportation Development Agency of Canada.

Date: August 20, 1976
Revised: November 1, 1976
AAR Technical Center
Chicago, Illinois

Note: This second edition includes revisions and additions to the initial text.

INTRODUCTION

Since its inception in the United States, the railroad industry has encouraged the development of improved track and equipment. Laboratory testing has screened out potentially unsatisfactory designs. However, final proof of acceptability has always required extensive testing of new track and equipment in revenue service.

In Czechoslovakia and the USSR, track loops are in use for the testing of track and equipment in high density or high mileage service before evaluation in revenue service. Plans call for construction of a simiIiar loop in the Federal Republic of Germany by 1981.

Studies made between 1972 and 1975 by the AAR under a jointly funded FRA-AAR contract clearly identified the potential for such loops in the USA. In November, 1975, a series of discussions was held between railroad and FRA personnel. It was decided that it would be highly desirable to begin immediate construction of a Facility for Accelerated Service Testing (FAST). On January 5, 1976, a decision was made to coordinate the planning of such a facility as part of the International Government-Industry Track-Train Dynamics Program, a 10-year effort initiated in 1972.

The Transportation Test Center (TTC) of the Department of Transportation at Pueblo, Colorado, already operating test loops for other purposes, was selected as the obvious site. Railroads, through the Association of American Railroads, and railroads and railroad suppliers, largely through the Railway Progress Institute, agreed to furnish many of the track components, including ballast, rail, rail-welding, ties, spikes, turnouts and switches and related components. Railroads agreed to furnish locomotives and cars. Railroads and suppliers agreed to furnish the necessary car components. The FRA provided some rail and ties and agreed to fund construction and maintenance of the track, operation and maintenance of the train, and collection of the required data. The AAR agreed to analyze the data and to coordinate planning of the experiment and facility. In addition, the FRA is analyzing certain data for the Office of Northeast Corridor Development.

This massive, cooperative effort has been successful. The track loop was completed about nine months after the initial decision to proceed. Over 100 individuals from government and industry participated in the planning of the track and equipment experiments and hundreds more made their views known on priorities. The FAST loop was completed on August 20, 1976, and operation began on September 22, 1976.

The FAST program is one more outstanding example of the benefits that can arise from effective government-industry cooperation.

The first experiment is intended to be in place for about one year. In this experiment, measurements are made on 22 specific track sections with various components or design features and on 12 selected car components.

After careful consideration, the first experiment utilizes 4-axle locomotives and a consist of loaded, nearly all 100-ton cars. This experiment will have particular relevance to loaded unit train operations. In subsequent experiments, 6-axle locomotives or combinations of loaded smaller or empty cars will be introduced in the consist. In addition, new track designs or concepts will be tested.

Track and equipment components under study in the first experiment have been evaluated in the laboratory and some have been in limited revenue service but not under the degree of control possible in FAST.

Follow-on experiments are under study. Before components can be selected for these ensuing projects, they must first survive a battery of smaller scale tests. Before the findings of any FAST experiment can be applied to general operating railroad use, some controlled exposure to revenue service is required.

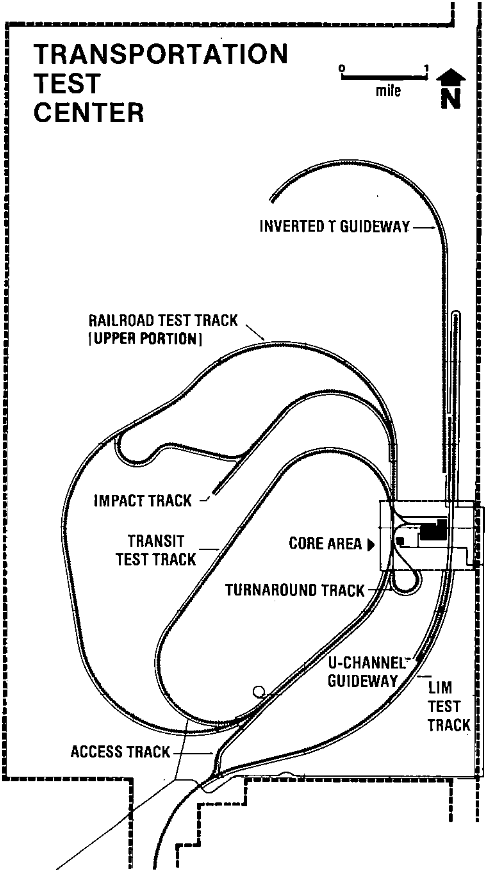
The unique contribution of FAST to the process of acceptance of new technology for railroads arises, in part, from the safe accumulation of service loads at a rate up to 10 times faster than can be achieved in revenue service and, in part, from the uniformity of the test environment and its simultaneous application to a large number of track and equipment experiments. However, experiments on the FAST loop are not identical to revenue service. There is a higher percentage of curved track in FAST than in the United States' array of track and, thus, the potential for more wheel and track wear per unit of exposure. Because of this curvature, safe operating speeds in FAST are below those used in many line haul runs. Phenomena, such as truck hunting, typically encountered at higher speeds, are not effectively simulated. Of course, no yard impacts are introduced.

As the initial experiments are completed on the present FAST loop, the requirements for improved loops and experimental facilities can be generated and built, if warranted by the estimated benefits.

The remainder of this document describes the first experiments involving FAST. Additional documents will be issued as the results become available and as new experiments are established for study of different track or equipment components.

FAST can be expected to be a continuing and permanent part of railroad practice.

An illustration of the layout of test track at the TTC at Pueblo, before construction of the FAST loop, appears on the following page.



TRANSPORTATION
TEST
CENTER
0
1
mile
N
INVERTED T GUIDEWAY
RAILROAD TEST TRACK
(UPPER PORTION)
IMPACT TRACK
TRANSIT
TEST TRACK
CORE AREA
TURNAROUND TRACK
U-CHANNEL
GUIDEWAY
LIM
TEST
TRACK
ACCESS TRACK

PURPOSE

The cost of errors in design of railroad track and equipment is increasing. Delays in the introduction of new technology in track design or rolling stock because of concern with its safety, reliability, and cost effectiveness, are increasingly onerous. The need for facilities to span the gap in testing between the laboratory and experimental revenue service is increasingly evident.

FAST is such a facility.

Operation of a relatively heavy train for up to 16 hours per day on a relatively short loop can introduce 10 times the traffic and density per day observed on most mainline track and even up to 15 times the mileage experienced by rolling stock in average revenue service. Thus, FAST provides for full-scale, accelerated service testing.

As mentioned before, the simulation is not exact. Nevertheless, FAST meet a critically important need for accelerated testing to:

- ☐ determine the fatigue life of track structures and components.
- ☐ provide a more quantitative basis for selecting optimum track structure design and maintenance practices.
- ☐ compare and validate maintenance-of-way methods and equipment.
- ☐ determine the behavior under conditions of high utilization of present and proposed vehicles.

- ☐ determine the fatique life and wear rate of freight car and locomotive components.
- ☐ test the reliability and fatigue endurance of other components such as automatic car identification systems, hot box detectors, on-track or track circuit electro-mechanical testing devices, etc.

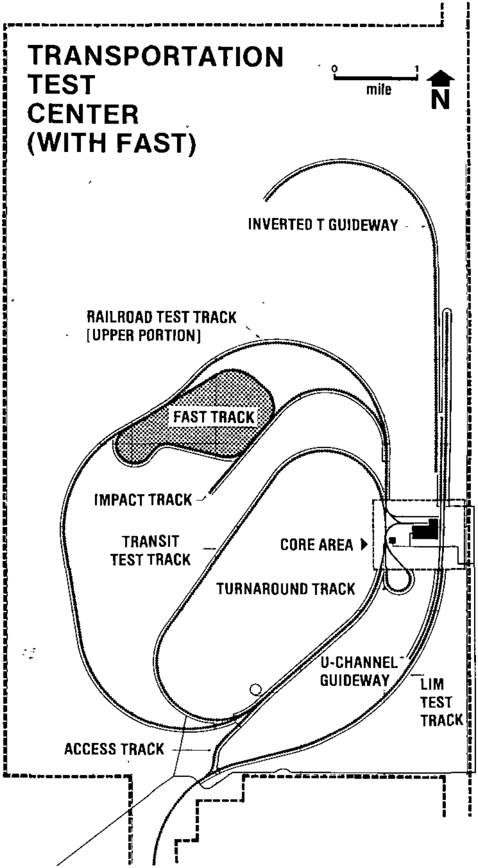
Findings from these experiments can contribute to reductions of track and equipment failure rates and costs, thus improving the capability of the railroads to perform their appropriate role in the transport of the nation's goods.

The illustration at the right shows the relationship of the FAST loop to other facilities at the DOT's Transportation Center.

THE LOOP

The FAST track is a loop, containing 4.8 miles of track. Of this, 1.8 miles of track are on new grading, and 3 miles on grading already in use for other tracks at the Transportation Test Center. In this experiment, the track is maintained to FRA Class 4-track safety standards.

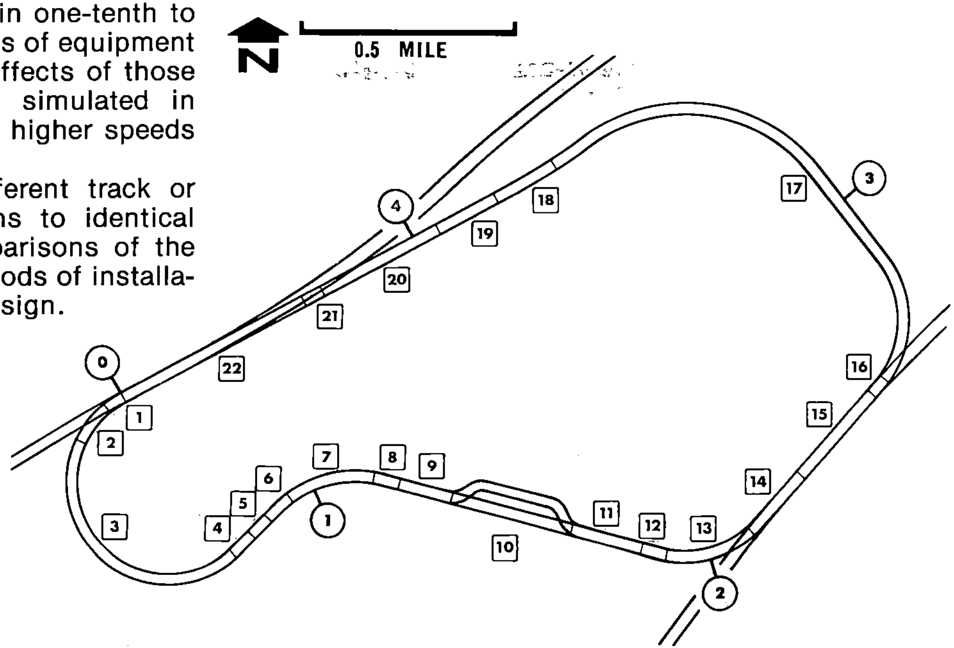
As shown in the illustration on the following page, the track is divided into 22 sections, each of which contains different types of ties, ballast, rail material, joints or spikes - or different combinations of these components. The track profile is shown on page 7.


TRANSPORTATION TEST CENTER (WITH FAST)
0
1
mile
N
INVERTED T GUIDEWAY
RAILROAD TEST TRACK [UPPER PORTION]
FAST TRACK
IMPACT TRACK
TRANSIT TEST TRACK
CORE AREA
TURNAROUND TRACK
U-CHANNEL GUIDEWAY
LIM TEST TRACK
ACCESS TRACK

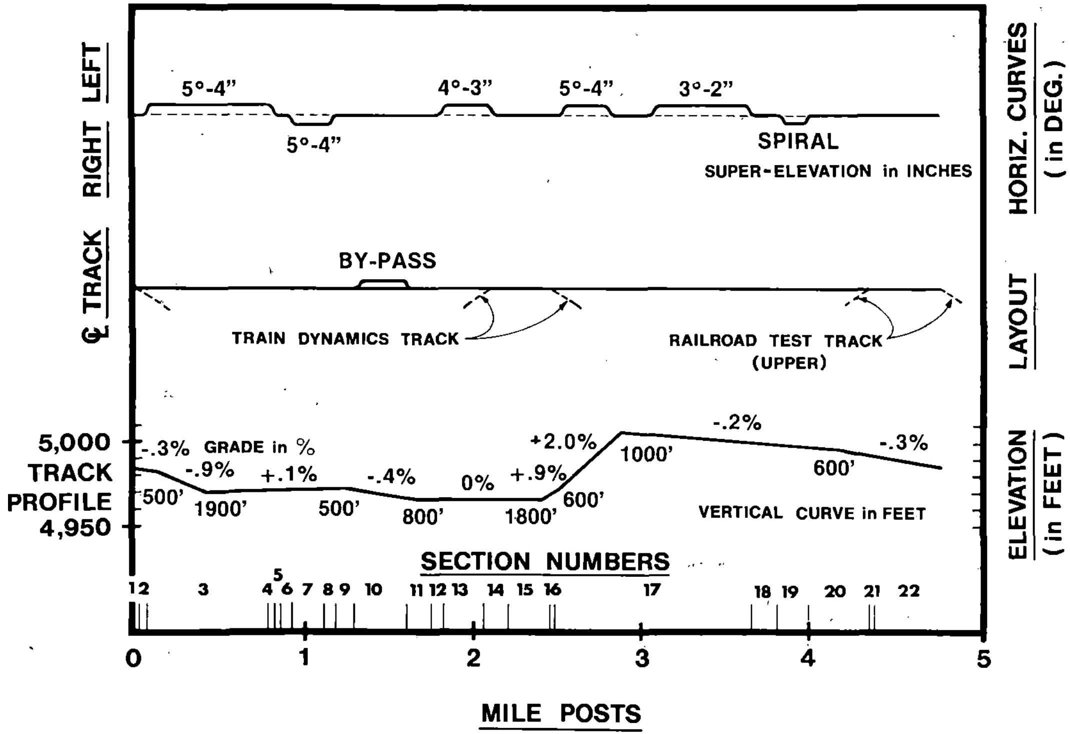
For about 16 hours per day, five days per week, a 9,500 ton, 75-car train will circle the loop at a speed up to 45 miles per hour, subjecting the track to a load equivalent to more than 300 million gross tons (MGT) per year. The locomotive and cars will travel approximately 600 miles per day. As most high-density main lines carry about 30 MGT per year and the average car moves about 50 miles per day, wear or the onset of failure of any of the track or equipment components can be observed in one-tenth to one-fifteenth the time required in tests of equipment in revenue service -- except for the effects of those phenomena that are not correctly simulated in FAST, such as those encountered at higher speeds or in yard impacts.

In addition, the exposure of different track or equipment components and designs to identical service makes possible direct comparisons of the effects of changes in materials, methods of installation, maintenance, fabrication and design.

THE FAST TRACK



FAST TRACK CHART



OPERATION

To simulate high-traffic density in the FAST study, a 75-car train made up of hopper cars filled with expanded shale to duplicate a coal loading; flat cars with loaded trailers, tank cars partially filled with water, and three 2,000 horsepower, four-axle locomotives, equipped with dynamic brakes, is operated for up to 16 hours per day.

The direction of the train movement and the sequence of equipment in the consist are varied in a four-day cycle, to equalize wear at all locations in the track and on the equipment. On the first day, the train moves around the loop in one direction. On the second day, the locomotives are placed at the rear end of the train to allow the cars to move around the loop in the opposite direction. On the third day, the train is turned around so that the wheels which were on the inside of the track are now on the outside. And on the fourth day, the train direction is changed again.

Each day, four cars are removed from the train and routed to the shop for testing and measurement. Every second day, 10% of the consist is rotated from the front to the rear of the train. Each car is cycled into the shop every 22 days for testing and measurement. In addition, the consist is inspected daily to ensure that it complies with all AAR and FRA safety standards. Replacement cars are available for cars removed from service for repair. Each car may remain in operation more than one year, accumulating about 300,000 miles of travel during that period.

All significant test operation parameters are recorded during testing. Measurements of wheel profile, centerplate wear, spring damage and other component changes are monitored and collected on a predetermined schedule, as outlined in more detail in a later section of this report.

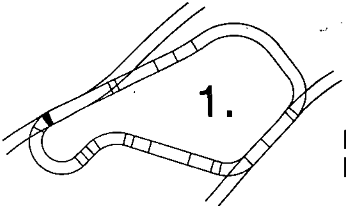
Records of speeds, distances traveled, brake applications, weather conditions, unusual events, fuel consumption and other variables are prepared daily.

Each day a car that measures the track geometry traverses the entire loop.

Measurements of rail-head profile, lateral and vertical loads, and static and dynamic deflections at rail joints are conducted; and ultrasonic inspection is used for flaw detection.

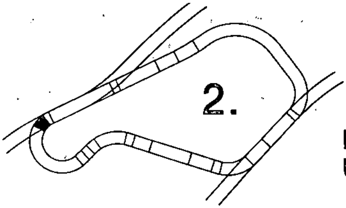
Each test section of track undergoes individual study. These detailed studies and the variables included in them are discussed in greater detail later in this report.

TRACK SECTIONS



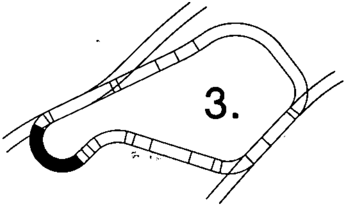
EXISTING NO. 20 TURNOUT

- ☐ No. 20 Left-hand turnout of 136 lb. jointed rail (170 ft.)
- ☐ Wood ties, 7 in. x 9 in. x 9 ft. long, 19½ in. center-to-center.
- ☐ Rail anchors, turnout fully anchored.
- ☐ Standard tie plates, 7-3/4 in. x 14 in., 1:40, with four 6 in. x 5/8 in. reinforced throat cut spikes (five spikes on curves over 2°).
- ☐ Slag ballast: 12 in. lower, 3 in. upper, on tangent and under low rail on curve.
- ☐ Measurements include track survey, rail creep, rail profile, rail hardness, longitudinal rail stress and turnout behavior.



RUBBER PAD UNDER TIE PLATES

- ☐ 329 ft. of track; 29 ft. tangent 300 ft. spiral.
- ☐ Rubber pad under every tie plate.
- ☐ 136 lb. welded rail, used rail anchors box anchored at every tie.
- ☐ Rail respiked in same positions after installation of wood tie plugs.
- ☐ Measurements include tie plate cutting, rail profile, rail hardness, longitudinal rail stress and track survey.



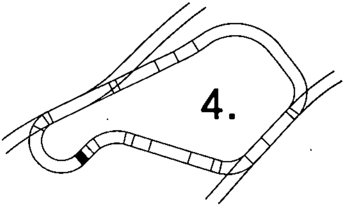
RAIL METALLURGY, TIE PLATE CANT SPIKING PATTERNS, BALLAST SHOULDER WIDTH

- ☐ 3,740 ft. of track 3,672 ft. of 5° curve 67 ft. of 300 ft. spiral in Segment J.
- ☐ Twenty 374 ft. strings of 132 lb. and 136 lb. field welded continuous welded rail.
- ☐ Used rail anchors, box anchored at every second tie.

- ☐ Rails respiked in the original spike holes after installation of wood tie plugs (except Segment G).
- ☐ Measurements include rail hardness, rail profile, track survey, longitudinal rail stress, rail lateral forces, rail/wheel contact zone, tie plate load, rail lateral displacement and tie plate cutting.
- ☐ Rail sequence: head hardened rail, high silicon rail, fully heat-treated rail, chrome molybdenum rail, and standard rail.

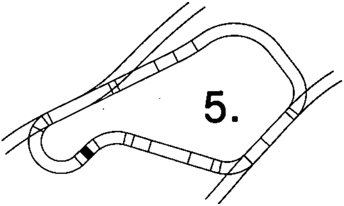
SEGMENT	TIE PLATES	SPIKES PER PLATE	BALLAST SHOULDER
A	Standard*	5	18 in.
B	8-1/2 in. x 16 in. 1:30	5	18 in.
C	7-3/4 in x 14. in. 1:14	5	18 in.
D	7-3/4 in. x 14 in. 1:14	5	6 in.
E	8-1/2 in. x 16 in. 1:30	5	6 in.
F	Standard*	5	6 in.
G	Standard*	3	12 in.
H	7-3/4 in. x 14 in. 1:14	5	12 in.
I	8-1/2 in. x 16 in. 1:30	5	12 in.
J	Standard*	5	12 in.

*7-3/4 in. x 14 in. 1:40



TRANSITION SECTION

- ☐ 210 ft. of 300 ft. spiral.
- ☐ 136 lb. Continuous Welded Rail.
- ☐ Used rail anchors, box anchored every second tie.
- ☐ Measurements include rail hardness, rail profile, track survey, and longitudinal rail stress.



BONDED JOINTS

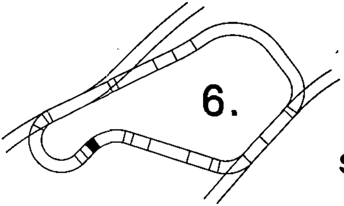
- ☐ 222 ft. of track, 22 ft. of 300 ft. spiral, 200 ft. of tangent.
- ☐ Field-assembled bonded joints with existing 136 lb. rail.
- ☐ Rail moved where necessary, so that bonded joints are unsupported.
- ☐ Used rail anchors, box anchored at every second tie.

- ☐ Twelve pairs of bonded joints staggered 19-1/2 ft. with 39 ft. rail as follows:
  A. Bonded Joint (non-insulated), type 1.
  B. Bonded Insulated Joint, type 2.
  C. Bonded Insulated Joint, type 3.
  D. Bonded Joint (non-insulated), type 4.
  E. Bonded Joint (non-insulated), type 5.
  F. Bonded Joint, type 6.

  Note: On joints B through F two types of fasteners will be used.

  One side of the track assembly will have bolts and the other side will have huck fasteners.

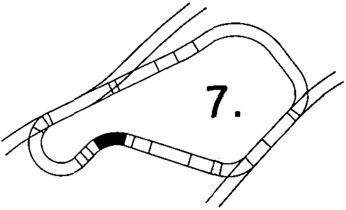
- ☐ Measurements include tie plate load, rail vertical displacement, rail surface profile and joint insulation, joint behavior, rail profile, rail hardness, longitudinal stress and track survey.



STEEL TIES

- ☐ 300 ft. of 300 ft. spiral.
- ☐ 136 lb. continuous welded rail.
- ☐ Steel cross-ties on 21 in. centers.
- ☐ Rail anchors, box anchored every second tie.
- ☐ Measurements include, tie stress rail vertical dis-

placement, rail lateral displacement, pad set, tie insulation, rail hardness, rail profile, rail stress and track survey.

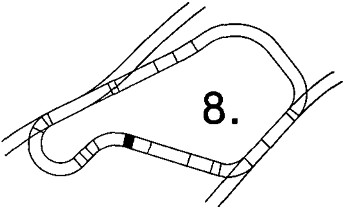


RAIL TIE FASTENERS

- ☐ 1,000 ft. of track on 5° curve.
- ☐ 136 lb. continuous welded rail.
- ☐ Wood tie plugs wherever spikes have been removed and replaced.
- ☐ 200 ft. segments.

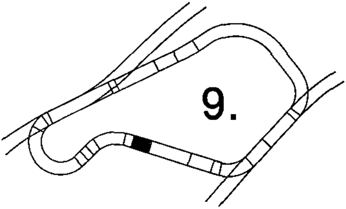
SEGMENT	RAIL/TIE FASTENERS	RAIL ANCHORS	TIE PLATES
A	4 Cut Spikes Per Plate	Every 2nd Tie	Standard
B	2 Cut Spikes at Rail, 2 Lock Spikes on Plate	Every 2nd Tie	Standard
C	2 Cut Spikes on Plate, 2 Compression Clips at Rail	None	Standard
D	Type 1 Clip, 3 lock Spikes on Plate	None	Type 1
E	2 Cut Spikes at Rail, 2 Screw Spikes on Plate (100 ft. with double coil washers)	Every 2nd Tie	Type 1 Screw - type

- ☐ Measurements include tie plate cutting, rail-profile, rail hardness, longitudinal rail stress and track survey.



TRANSITION SECTION

- ☐ 300 ft. of track, 300 ft. spiral
- ☐ 136 lb. continuous welded rail.
- ☐ Wood tie plugs and used rail anchors, box anchored at every tie.
- ☐ Measurements include rail profile, rail hardness, longitudinal rail stress and track survey.

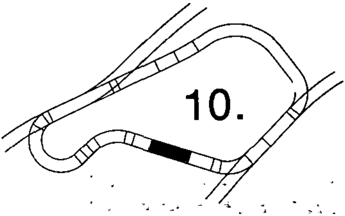


RECONSTITUTED AND LAMINATED TIES

- ☐ 627 ft. of tangent track.
- ☐ 136 lb. jointed rail.
- ☐ Tie installation sequence. Conventional wood ties. 24 monolithic reconstituted ties with steel

reinforcing and rubber tie pads.

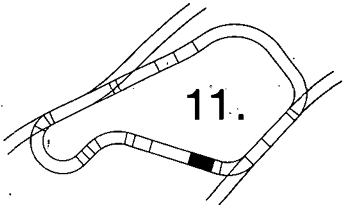
- ☐ 24 monolithic reconstituted ties with steel reinforcing.
- ☐ 36 monolithic reconstituted ties with wood reinforcing.
- ☐ Conventional wood ties.
- ☐ 100 dowel laminated ties.
- ☐ Measurements include tie plate load, tie vertical displacement, tie plate cutting, rail hardness, rail profile, longitudinal rail stress and track survey.



ELASTIC SPIKES, SAFETY EQUIPMENT: TWO #20 TURNOUTS, SPRING FROGS AND GUARD RAILS

- ☐ 1,550 ft. of tangent track and by-pass track.
- ☐ 136 lb. jointed rail.
- ☐ 300 special cross-ties; 275 with tie plates and 25 without tie plates, furnished with double type elastic spikes and no rail anchors.
- ☐ 300 ft. segment for testing safety equipment. At two locations, 133 lb. No. 14 spring frogs with long entrance flare guard rail. (No switches are installed at these locations).
- ☐ Eighteen 12 ft. ties at each frog (not centered under the track).

- ☐ Measurements include elastic spike pullout resistance, rail longitudinal displacement, rail creep, frog wear, frog point hardness, tie plate cutting, rail hardness, rail profile, longitudinal rail stress and track survey.

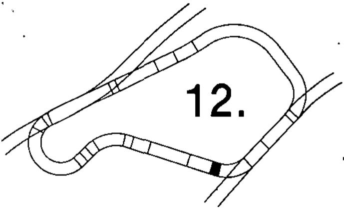


JOINTS: FROGS AND GUARD RAILS

- ☐ 895 ft. of tangent track.
- ☐ 136 lb. jointed rail.
- ☐ First Segment: 8 joints, installed in pairs staggered 19-1/2 ft. unsupported by cross-tie as follows:
  - A. AREA Armored Insulated Joints
  - B. AREA Regular Joints with M-2 Plastic
  - C. Poly Insulated Joints
  - D. Heavy Duty Insulated Joints
- ☐ Second Segment: 3 frogs with guard rails, no switches.
- ☐ Installation as shown in the chart below, with a 132 lb. No. 14 Manganese frogs installed in the track, staggered 70 ft.
- ☐ Eighteen 12 ft. ties at each frog, not centered under the track.

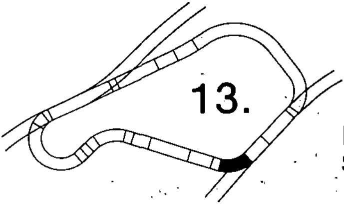
MATERIAL	GUARD RAIL
Hammer Hardened Manganese	Standard
Standard Cast Manganese	Standard
Hammer Hardened Manganese	Long
Standard Cast Manganese	Long

- ☐ Measurements include rail vertical displacement, rail surface profile, insulated joint performance wear characteristics, rail hardness, rail profile, longitudinal rail stress and track survey.



TRANSITION SECTION

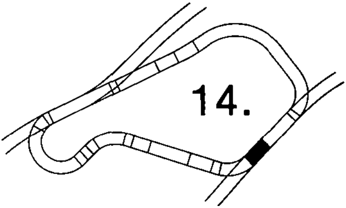
- ☐ 339 ft. of track. 300 ft. of spiral and 39 ft. of 4° curve.
- ☐ 136 lb. jointed rail.



RAIL METALLURGY, SPIKE HOLE FILLER

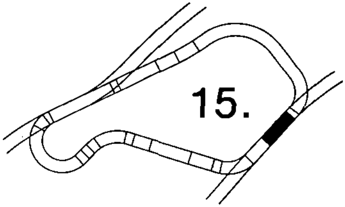
- ☐ 1,248 ft. of 4° curve.

- ☐ Four 312 ft. segments of 115 lb. continuous welded rail, joined by field welds and with compromise joints at both ends of the section. Each segment contains a sequence of 78 ft. head-hardened, 78 ft. high silicon, 78 ft. fully heat treated and 78 ft. standard rail.
- ☐ Box anchored at every second tie.
- ☐ Tie Plugs: First two segments standard wood plug; last two segments granular spike hole filler.
- ☐ Measurements include cut spike pullout resistance, rail surface profile, rail profile, rail hardness, tie plate cutting, longitudinal rail stress and track survey.



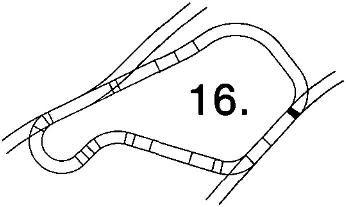
EXISTING NO. 20 TURNOUT

- ☐ 818 ft. of track, 38 ft. of 4° curve 300 ft. of spiral and the remainder tangent track with a standard No. 20 turnout.
- ☐ Jointed 136 lb. rail is used.
- ☐ Measurements include track survey, rail creep, rail profile, rail hardness, longitudinal rail stress, and turnout behavior.



BALLAST SHOULDER WIDTH

- ☐ Section 15 is built on existing track, with the ballast shoulder altered in areas for testing.
- ☐ The ballast shoulder is reduced to 6 in. for 550 ft. and then the ballast shoulder is increased to 18 in. for another 550 ft.
- ☐ Measurements include tie plate cutting, rail profile, rail hardness, longitudinal rail stress and track survey.

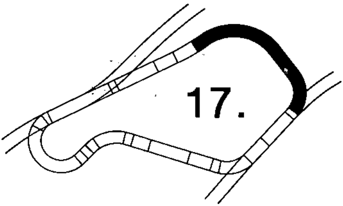


GLUED TURNOUT

- ☐ 170 ft. of track, No. 20 glued turnout on tangent track.
- ☐ Switch point and stock rails 140 lb. heat treated

steel, with standard manganese guard rails.

- ☐ Used rail anchors, box anchored at every tie.
- ☐ Blast furnace slag ballast.
- ☐ Measurements include rail creep, rail profile, rail hardness, longitudinal rail stress and track survey.

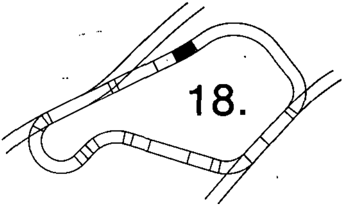


CONCRETE TIES, PADS AND FASTENERS

- ☐ 6,143 ft. of track containing various curves, spirals and tangents.
- ☐ 136 lb. continuous welded rail strings, field welded together.
- ☐ 12 in. of granite ballast under ties; 12 in. on shoulders.
- ☐ Tie Spacing: 24 in. center-to-center.

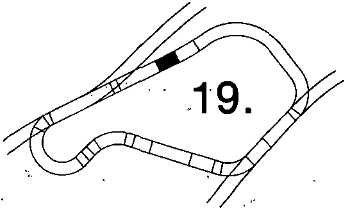
SEGMENT	LENGTH	# OF TIES	TIE TYPE	PAD	FASTENER TYPE
A	526 ft.	263	1	P-1	1
B	324 ft.	162	2	P-1	1
C	324 ft.	162	1	P-2	1
D	526 ft.	263	2	P-2	1
E	400 ft.	200	1	P-3	1
F	202 ft.	101	3	P-4	2
G	500 ft.	250	4	P-2	1
H	700 ft.	350	5	P-5	1&3
I-1	250 ft.	125	4	P-1	1
I-2	250 ft.	125	4	P-6	1
J-1	412 ft.	206	1	P-6	1
J-2	314 ft.	157	1	P-7	1
K-1	136 ft.	68	2	P-7	1
K-2	364 ft.	182	2	P-2	1
L	600 ft.	300	6	P-8	1

- ☐ Several types of pads and ties are tested in the 15 segments into which section 17 is divided, as shown.
- ☐ Measurements include horizontal track stiffness, rail creep, rail profile, rail hardness, longitudinal rail stress and track survey.



BALLAST DEPTH EFFECTS

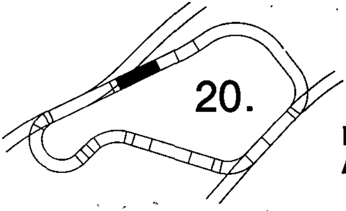
- ☐ 821 ft. of tangent track.
- ☐ 136 lb. jointed rail on 7 in x 9 in. hardwood ties, 8-1/2 ft. long, on 19-1/2 in centers.
- ☐ Standard tie plates with four spikes per plate.
- ☐ 16 anchors per rail length, box anchoring pattern.
- ☐ Segment A, 507 ft. long, granite ballast 21 in. under ties.
- ☐ Segment B, 314 ft. long, 15 in. of granite ballast under the ties.
- ☐ Measurements include tie plate load, horizontal track stiffness, tie vertical displacement, ballast grain size, ballast cross section, rail profile, rail hardness, longitudinal rail stress and track survey.



HARDWOOD vs. SOFTWOOD TIES

- ☐ 600 ft. of two 300 ft. spiral track.

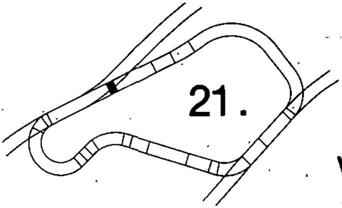
- ☐ 136 lb. jointed rail.
- ☐ Segment A, 300 ft. long, with hardwood ties.
- ☐ Segment B, 300 ft. long, with softwood ties.
- ☐ All ties 7 in. x 9 in., 8-1/2 ft. long, on 19-1/2 in. centers.
- ☐ Standard tie plates with four spikes per plate.
- ☐ 16 anchors per rail length, box anchoring pattern.
- ☐ 12 in. of granite ballast.
- ☐ 6 in. ballast shoulders.
- ☐ Measurements include tie insulation, tie plate cutting, rail profile, rail hardness, longitudinal rail stress and track survey.



BALLAST TYPES, DEPTH AND RAIL ANCHORS

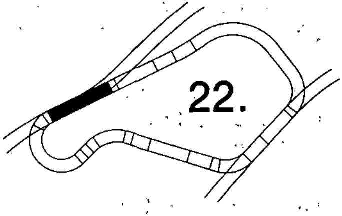
- ☐ 2,278 ft. of tangent track.
- ☐ 136 lb. jointed rail.
- ☐ Standard tie plate, 4 spikes per plate.
- ☐ 7 in. x 9 in. hardwood ties, 8-1/2 ft. long, on 19-1/2 in. centers.
- ☐ Measurements include tie plate load, tie vertical displacement, ballast grain size, ballast cross section, tie plate cutting, rail creep, rail hardness, rail profile, longitudinal rail stress and track survey.

☐ Limestone and traprock slag depth set up to compare to Section 18.



WELDED TURNOUT

☐ 171 ft. of tangent track with a fully welded No. 20 turnout.
☐ Switch point and stock rails, 140 lb. heat treated steel, with standard manganese guard rails.
☐ Used rail anchors, box anchored every tie.
☐ Blast furnace slag ballast.
☐ Measurements include rail creep, rail profile, rail hardness, longitudinal stress and track survey.



SPIKING PATTERNS: RAIL ANCHORS

☐ 1,950 ft. of tangent track common to both the FAST Track and the Transportation Test Center's Railroad Test Track Loop.

- ☐ 136 lb. continuous welded rail.
- ☐ 1,000 ft. segment box anchored at every other tie with five types of anchors.
- ☐ Measurements include tie plate cutting, rail creep, rail hardness, rail profile, longitudinal rail stress and track survey.

TESTING TRACK

Once the FAST task force determined the type of information to be collected on the track just described, it became necessary to devise the means of obtaining that information according to data collection and reduction plans.

For the track alone, 30 separate measurements are needed, often with measuring devices placed along several sections of track.

The experiments and specific methods of data collection for manually collected measurements are as follows:

Rail Head Profile: A profile gage is utilized to measure the rail head profile at 576 sites along Section 3 and 192 sites along Section 13 alone—and at 170 other data points along the rest of the loop.

Rail Hardness: The Transportation Test Center supplied a device which can measure hardness at 3 data points at the top of the railhead. Hardness data are collected at a total of 938 sites along the loop.

Rail/Wheel Contact: A photo jig records the contact pattern at 28 points Section 3, and 4 points in Section 22.

Tie Plate Cutting: A gage is used to take four readings on each plate, at two plates of each tie studied. The readings are taken at 6 ties in Section 2; 108 ties in Section 3; 30 ties in Section 7; 30 ties in Section 9; 6 ties in Section 10; 24 ties in Section 13; 18 ties in Section 15; 12 ties in Section 18; 12 ties in Section 19; 54 ties in Section 20; and 12 ties in Section 22. In all 2,496 readings are taken.

Longitudinal Rail Stress: A mechanical strain gage is used to measure this stress at 100 ft. intervals along the loop, both before and after each frog, a total of 262 sites.

Rail Creep: At the beginning of testing, paint marks are applied to both rail and ties. Rail creep is indicated by the movement of the rail markings with relation to those on the ties. These markings are placed on the inner and outer rails, 6 ties in Section 6; 30 ties in Section 7; 6 ties in Section 10; 114 ties in Section 17; 30 ties in Section 20; 30 ties in Section 22 and at four locations near each turnout.

Pad Set: A dial gage is used to measure pad set at 12 locations in Section 6 and 39 locations in Section 17. At each tie studied, the gage takes 8 separate readings, 4 at each pad.

Pad Performance: A durometer is used to study pad performance and life. Readings are taken from 6 pads in each of Sections 2 and 6; 11 types are taken in Section 17.

Pad and Fastener Movement: Tie pad and fastener movement in the concrete tie section will be studied.

In addition, insulator condition will be monitored.

Tie Insulation: An ohmmeter is used to take 3 readings on each tie studied. Insulation is measured at 6 locations in Section 6; 3 locations in 8 subsections of Section 17; and 6 locations in each subsection of Section 19.

Ballast Grain Size: This test, to be conducted when the track is rebuilt or ties removed, is conducted at 2 sites in Section 18, 9 sites in Section 20 and 10 sites in Section 17.

Ballast Cross Section: The cross section is measured at 4 locations in Section 18 and 18 locations in Section 20.

Frog Wear: Taper gages are used to study wear on all 17 frogs in the loop.

Rail Surface Profile: A manual gage is utilized to study the rail and joint profile at 68 locations, taking 25 readings at each site. Readings are taken at 18 locations in Section 3; 12 locations in Section 4; 12 locations in Section 5; 12 locations in Section 8; 16 locations in Section 11; and 3 switch closure rails in Sections 1, 16 and 21.

Joint Insulation: An ohmmeter is used to study the insulation of 4 joints in Section 5 and 8 joints in Section 11. In addition, insulated joints in Section 16 and 21 will be studied.

Track Inspection: A walking tour of the track is made every day.

Survey to Bench Marks: An electronic survey device is used to measure track alignment every 100 ft. along the loop, taking 4 data points into consideration at each of the 265 locations. The device is referenced to preestablished field bench marks.

Frog Point Hardness: A hardness tester is used to collect data at nine locations at each of the 17 frogs in the loop.

Except for two tests noted, all measurements are taken before train runs begin and at the passage of every 25 MGT over the test sections.

Instrumented track measurements are conducted as follows:

Tie Plate Load: Instrumented tie plates at 174 load measurement sites at 31 locations in Sections 3, 5, 9, 18, 20 and 22 measure loads after the first 5 MGT and every 25 MGT thereafter.

Vertical Track Stiffness: A vertical load is applied to the track and vertical track deflections measured to obtain vertical track stiffness at 32 locations in Sections 1, 2, 3, 6, 7, 9, 10, 13, 15, 16, 17, 18, 19, 20, 21, 22 at the beginning and at 25 MGT intervals.

Horizontal Track Stiffness: A lateral load is applied and lateral deflections measured to determine horizontal stiffness at locations in Sections 6, 15 and 17, every 25 MGT.

Tie Stresses: A total of 9 strain gages, attached to the top of each of two ties in Section 6 and Section 22 measures stresses after the first 5 and at each 25 MGT.

Elastic Spike Pullout Resistance: At every 50 MGT, a special fixture is used to establish the resistance to pullout of 5 spikes in Section 10.

Cut Spike Pullout Resistance: At the passage of every 25 MGT of traffic, a test fixture measures the resistance of 20 spikes in Section 13.

Rail Lateral Displacement: An instrumented system is utilized to study displacement with respect to tie at 18 locations in Section 3 and 6. Readings are taken at the passage of every 25 MGT.

Joint Vertical Displacement: Measurements of vertical displacement with respect ot ties are made at 2 locations in Section 6. Measurements are made at the first 5 MGT and 25 MGT and every 25 MGT thereafter.

Dynamic Track Geometry: Track geometry is measured each day, both before and after any maintenance, by a track measurement car.

Rail Flaw Detection: Every week, the entire loop is inspected for rail flaws through the use of an ultrasonic test car.

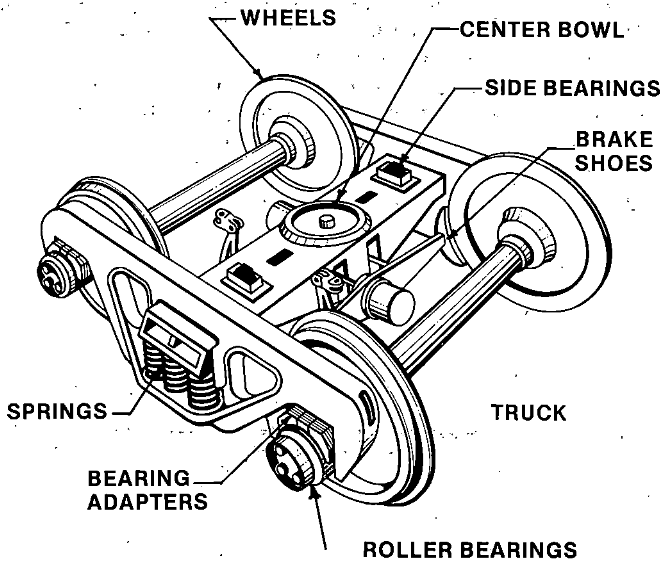
Switch Point Wear: Vertical wear of switch points will be measured on seven sets of switch points.

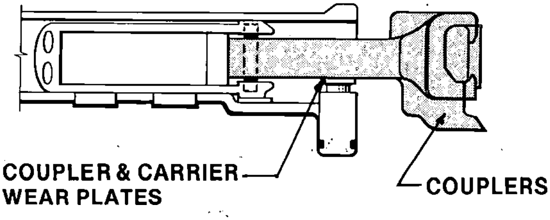
Steel Tie Performance: Detailed geometry measurement of steel and adjacent wood tie track construction will be made to study tie movement, gage and line holding ability.

MECHANICAL TESTING

The objective of car component experiments is to compare the in-service performance of the various

MAJOR EXPERIMENT COMPONENT AREAS





designs being tested.

To ensure an accurate study, detailed test methodologies were developed for the mechanical equipment being tested.

The components tested are applied in accordance with statistically designed experiments. In general, a minimum sample size of three similiar cars is selected. As noted earlier, the cars are moved about within the consist. The direction of movement of the train and its orientation are changed to ensure uniform component wear at all locations of the car.

Mechanical measurements, in general, are made before, three times during, and after the test to evaluate the relative performance of the components. The measurement accuracy and frequency are in each case sufficient to establish wear rates for the components. Automated, instrumented measurements are made during the test to determine the relationship between track quality and car riding characteristics.

The components studied and the methods used are as follows:

Truck Wheels: Seventy-one cars are involved in this experiment of which the first 32 are equipped with equal numbers of new, treated versus untreated, one-wear versus two-wear, cast versus wrought and Canadian test profile versus AAR standard profile wheels. On the remaining cars, wheel measurements are made to evaluate the performance of trucks, side bearing, springs, brake shoe, etc. The "as received" wheels on these cars will be remachined, if necessary, to duplicate a new profile.

Measurements are made every 15,000 miles to determine the rate of change of flange thinning, vertical wall flattening and flange height growth, rim thinning and tread hardness.

The worn two-wear wheels, upon reaching the condemning limit, are remachined and replaced in the consist for additional testing.

Roller Bearings: Thirty cars are involved in this experiment of which equal numbers are equipped with new and reconditioned extended life bearings, as furnished by three different suppliers.

Measurements are made by the suppliers before and after the test to determine grease loss.

Any bearings defective due to excessive grease loss, lateral movement, or loose cap screws are returned to the supplier for inspection and evaluation.

Bearing Adapters: Thirty cars are involved in this experiment of which 6 are equipped with an equal number of new hardened crown adapters versus unhardened crown versus hardened crown and thrust shoulder adapters. On the remaining cars, adapter measurements are made to evaluate the performance of wheels, trucks, etc.

Measurements are made every 15,000 miles to determine the rate of change of wear on the crown, thrust shoulder, machined bore and abutting pedestal surface. Crown and pedestal hardnesses are also determined.

Trucks: Twenty-four cars are involved in this experiment. Equal numbers are equipped with two different types of commonly used new trucks, and four different types of limited usage premium new trucks.

Measurements are made every 30,000 miles to determine the rate of change of wear on the friction castings and abutting surfaces, bolster gibs and side frame column guides. The corresponding surfaces hardness measurements are taken every 60,000 miles.

All components are replaced in the sample position and orientation in the same car.

Truck Springs: Thirty-four cars are involved in this experiment of which 16 cars are equipped with equal number of new D5 alloy versus carbon steel springs. On the remaining cars, spring measurements are made to evaluate the performance of trucks, etc.

Measurements are made every 30,000 miles to determine the rate of change of free height, compressed height at maximum working load and spring rate. (Spring rate measurements are made on only the 16 cars.)

If one or more springs exceed the condemning limit, the entire group in the nest is replaced with new springs.

Center Plates: Thirty cars are involved in this experiment of which 5 are equipped with various configurations, that include flame hardened, work hardening manganese, and standard AAR center plates. On the remaining cars, center plate measurements are made to evaluate the performance of trucks, etc.

Measurements are made every 30,000 miles to determine the rate of change of wear on the vertical and horizontal surfaces of the truck bowls and body center plates. Measurements are also made to determine the hardness of abutting surfaces at these same mileage intervals.

Side Bearings: Thirty-four cars are involved in this experiment of which 16 cars are equipped with equal numbers of double roller versus friction block side bearings and two different types of constant contact side bearings. On the remaining cars, side bearing measurements are made to evaluate the performance of trucks, brake shoes and springs.

Measurements are made every 30,000 miles to determine the rate of change of wear on the rollers, blocks and abutting surfaces, and the hardness of these surfaces. The rate of change of the free height and spring rate for the constant contact side bearings also is determined.

Brake Shoes: Sixty-three cars are involved in this experiment of which 16 cars are equipped with equal numbers of high phosphorous cast iron shoes versus composition high-friction shoes. On the remaining cars, brake shoe measurements are made to evaluate the performance of wheels, trucks, etc.

Measurements are made every 5,000 miles on 16 cars and 15,000 miles on the remaining cars, to determine the rate of change of shoe weight. The braking force at each shoe on the same 16 cars is measured every 60,000 miles.

Both shoes on a beam are replaced if either shoe has exceeded the condemning limit.

Coupler and Carrier Wear Plates: Fifteen cars are involved in this experiment and are equipped with coupler shank wear plate materials of Jalloy AR-360 versus C-1045 versus manganese steel; and coupler carrier materials of Jalloy AR-360 versus C-1045 versus manganese steel.

Measurements are made every 30,000 miles to determine the rate of change of wear and hardness on the abutting surfaces.

Couplers: Eight cars are involved in this experiment. Equal numbers are equipped with coupler materials of grade "C" versus grade "E" steel.

Measurements are made every 30,000 miles to determine the rate of change of wear on head, knuckle and pulling lugs, and changes in surface hardness.

Trailers on Flat Cars: Three cars are involved in this experiment. The truck wheel, bearing adapter, truck, center plates, side bearings, brake shoe and coupler experiments as previously described are duplicated on these 3 cars.

Measurements are made every 60,000 miles to determine the rate of change of wear on trailer king pin, hitch jaw and pins, including surface hardness. The rate of change of permanent set in the center sill also is measured.

"Bathtub" Coal Cars: Three cars are involved in this experiment. The truck wheel, bearing adapter truck, spring and center plate experiments as previously described are duplicated on these 3 cars.

Measurements are made every 60,000 miles to determine the rate of change of permanent set in the side plates and side sills.

Tank Cars: Under the RPI-AAR Tank Car Safety Research Program, in cooperation with the FRA, 18 Tank Cars will join the FAST test. This is for the purpose of accumulating mileage for evaluation of tank head and thermal shields.

DATA COLLECTION AND REDUCTION

With the variety of track and train components, the expectation of accelerated wear, and the dozens of interactions designed into the FAST experiment, a major portion of the planning for the program involved study of data to be collected and development of a system for data processing and analysis.

For the track, one set of data is collected through periodic manual measurements of all sections of the loop. A second set is gathered from additional manual measurements required for individual studies of specific sections. A third set includes all information collected through electronic instruments in the track and instrumented track measuring systems.

For equipment, visual inspections are made daily to ensure that all rolling stock meets minimum safety considerations. Measurements are made on selected components under study to establish the extent of wear or to detect the onset of failure.

The data collection plan calls for recording three sets of factors that influence track and equipment behavior. The first of these is the sequence of cars in the train, the cars that have been switched out of the consist for maintenance, and the fuel consumption of the locomotive. The second is the weather. In Pueblo, the normal high is 92.1°F in July and the normal low is 14.7°F in January. The normal precipitation rate varies from 0.3 inches in December to 1.85 inches in August. This does not represent a climate typical of much of the U.S. Daily temperature, humidity and rainfall are recorded.

The third concerns train movement. Each locomotive is equipped with a device which records speed, braking practice and other elements of train handling.

In the data reduction process, the Transportation Test Center data collection group produces five different types of magnetic tape files each day, as described below.

File 1 contains an inventory of track and vehicle components, maintenance records and measurements made on track and mechanical equipment, locations of cars in the consist and prevailing weather conditions. These data are manually recorded on forms and transferred to keypunch cards for recording in digital form on magnetic tape.

Files 2, 3 and 5 contain analog data as follows: track geometry established by a specially equipped rail car; consist movements obtained from a train operations recording system, and track dynamics measurements obtained by cable linking in-track instruments to a specially equipped highway van. These data are digitized for recording on magnetic tape.

File 4 contains rail and wheel profile data. The measurements are manually produced and recorded in digital form on magnetic tape.

These files are transmitted by mail to the AAR in Chicago where a mini-computer converts the files for subsequent processing on a large-scale computer.

On receipt of a master tape, two sequential tapes are generated by the computer, one containing all measurements of track and equipment and the other containing all the remaining data.

These sequential tapes, updated on a daily basis, are used for analysis through appropriate special computer programs.

SAFETY CONSIDERATIONS

High-volume, high-mileage operation of a train consist can be very informative for railroad researchers, but it is necessary that the program be conducted safely, despite the high mileage and the nearly continuous train operation.

To ensure safety, several visual inspections of consist components are conducted daily. Procedures to be followed comply with the AAR and FRA safety standards as appropriate to the high-mileage being accumulated in a short time.

The safety-oriented measurements are as follows:

Wheel: Every truck wheel is measured for flange thickness, flatness and height, as well as rim thickness. Visual inspections are made to detect cracked or broken flanges; thermal cracks in flange, tread or plate; built up, grooved, shelled or slid-flat treads; cracked, broken, burnt, shattered or spread rims; over-heated wheels; cracked or broken plates or hubs.

Axle Journal Roller Bearings: Each day, the journal roller bearings are checked for grease loss and loose or missing cap screws.

Roller Bearing Adapters: During regular shop maintenance, every 22 days, safety checks are made for adapter crown wear, pedestal roof wear above the adapter, thrust shoulder wear and machined relief wear.

Trucks: Friction castings, side frames, and bolsters are checked for safety.

Air and Hand Brake: Each day, crews check for cracked or bent pipes, leaky fittings and valves; defective or loose hoses; broken shoe keys; proper piston travel and inoperative air brakes; inoperative hand brakes; and worn brake beams, levers, guides and rods.

Truck Springs: All springs are checked during regular maintenance, every 22 days, for permanent set and 50 percent loss of reserve travel. All spring groups are visually checked daily for cracks, breaks or bends.

Miscellaneous Components: Minimum standard examinations of running boards, brake steps, sill steps, handholds, ladders, center sills, body bolsters and structural welds are conducted daily.

Center Plates: During regular maintenance periods, crews check for vertical wall wear on both body and truck plates, horizontal surface wear and vertical linear weld cracks on the truck center plate. In addition the body center plate and weld connections are inspected for cracks daily.

Side Bearings: Daily inspections are conducted for required side bearing clearances, cracks in the truck side bearing cages, wear in the body side bearing wear plates and loose or bent body side bearing bolts. Measurements of constant contact side bearings are made only during regular maintenance.

Brake Shoe: Shoe force is measured before the car is put into use to assure acceptable performance. Daily inspections are made for cracks and breaks in the shoe and excessively worn shoes.

Coupler and Carrier Wear Plates: Coupler shank plates and carriers are checked daily for cracks.

Couplers: During regularly scheduled maintenance, head and knuckles, shank length, butt thickness, knuckle wear and draft key wear are checked to ensure the components meet minimum standards. Coupler body and shank are checked daily for cracks, bends and breaks.

Flat Cars: During regular maintenance periods, trailer hitch jaw, pin and hole; the coupler shank length, butt thickness, pin and pinhole; and the center sill are checked for safety.

"Bathtub" Coal Cars: Safety checks duplicate those for the wheel, roller bearing, adapter, trucks, truck springs and center plates. In addition, fatigue cracks are looked for regularly in the curved bottom sheet of the car.

General: A hot box detector is installed and the train monitored each time around the loop for incidence of hot box. The locomotives also are equipped with communications, as well as a device to shut down the locomotives remotely if necessary.

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Senior Research Engineer

Mr. G. Mui
Computer Support

Mr. J. Smouse
Computer Support

Mr. C. W. Bean
Administrative Assistant

Federal Railroad Administration

Mr. R. E. Parsons
Assoc. Administrator, R. & D.

Dr. D. Spanton
Director - Office of Freight Systems

Mr. L. A. Peterson
Director - Office of Rail Safety Research

Dr. R. M. McCafferty
Program Manager - Improved Track Performance Research

Mr. P. Olekszyk
Chief - Analysis & Evaluation Div.

Mr. D. Gray
Evaluation Program Manager

Transportation Test Center

Mr. E. R. Mathews (DOT/FRA)
Director Transportation Test Center

Mr. E. E. Pazera (DOT/FRA)
Chief Test Control Div.

Mr. R. T. Gill (DOT/FRA)
FAST Test Controller

Mr. G. A. Reiff (DOT/FRA)
Chief Technical Services Div.

Mr. R. J. Begier
FAST Senior Program Engineer
[*Resigning*]

Mr. R. J. Beemler
FAST Safety Engineer

Mr. L. Peck
Contracting Officer

Mr. E. Ekberg (DOT/FRA)
Facility Engineering & Construction Coordinator

Mr. T. Gray (DOT/FRA)
Track Supt.

Mr. M. L. Varnum
FAST Construction Engineer

Mr. P. Kelly
FAST Logistics Coordinator

Mr. L. McIrvin (DOT/FRA)
Instrumentation Engineer

Mr. G. E. Walker
FAST Test Support Engineer

Mr. D. Frankowski
FAST Test Support Engineer

Mr. R. Reiff
FAST Test Support Engineer

Mr. K. Kieres
FAST Test Support Engineer

Mr. S. Benton
FAST Data Acquisition Engineer

Mr. J. Haas (DOT/FRA)
Computer Systems Analyst

Mr. A. Simpson
FAST Data Acquisition Engineer

Mr. S. Roberts, II
FAST Data Processing Engineer

Mr. M. Campanelli
FAST Data Processing Engineer

Mr. J. Venturella
FAST Programming Engineer

Mr. D. Knight
FAST Programming Engineer

Mr. C. E. Trotter
FAST Railroad Equipment Maint. Supervisor

Mr. T. Everly
FAST Railroad Maintenance Foreman

Mr. T. Roberts
Asst. Veh. Operations Suprv.

Mr. Clendenen
Veh. Operations

Mr. F. L. Ferguson
Mgr. Veh. Services

Mr. W. Thompson
Industrial Engineer

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