OFFICE OF RAIL SAFETY RESEARCH

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL RAILROAD ADMINISTRATION
Office of Research and Development

12 - Safety

INTRODUCTION

The Federal Railroad Administration was created pursuant to section 3(e)(1) of the Department of Transportation Act of 1966 and is composed of the Office of the Administrator, the Transportation Test Center, the Alaska Railroad, Regional Offices, and Headquarters Offices. Included in this Act was the transfer of railroad safety activities from the Bureau of Railroad Safety and Service of the Interstate Commerce Commissition. Under the Railroad Safety Act of 1970, the FRA was given the responsibility to conduct and administer a program to assure safe operating and mechanical practices within the railroad industry. After being reorganized, the Office of Research & Development was given the mission to "plan, conduct, promote, and coordinate research, development, and demonstration of all aspects of intercity ground transportation and railroad safety . . . in order to provide national railroad and advanced ground systems technology leadership." As a result, FRA's Research and Development activities were redirected to near-and intermediate-term problems.

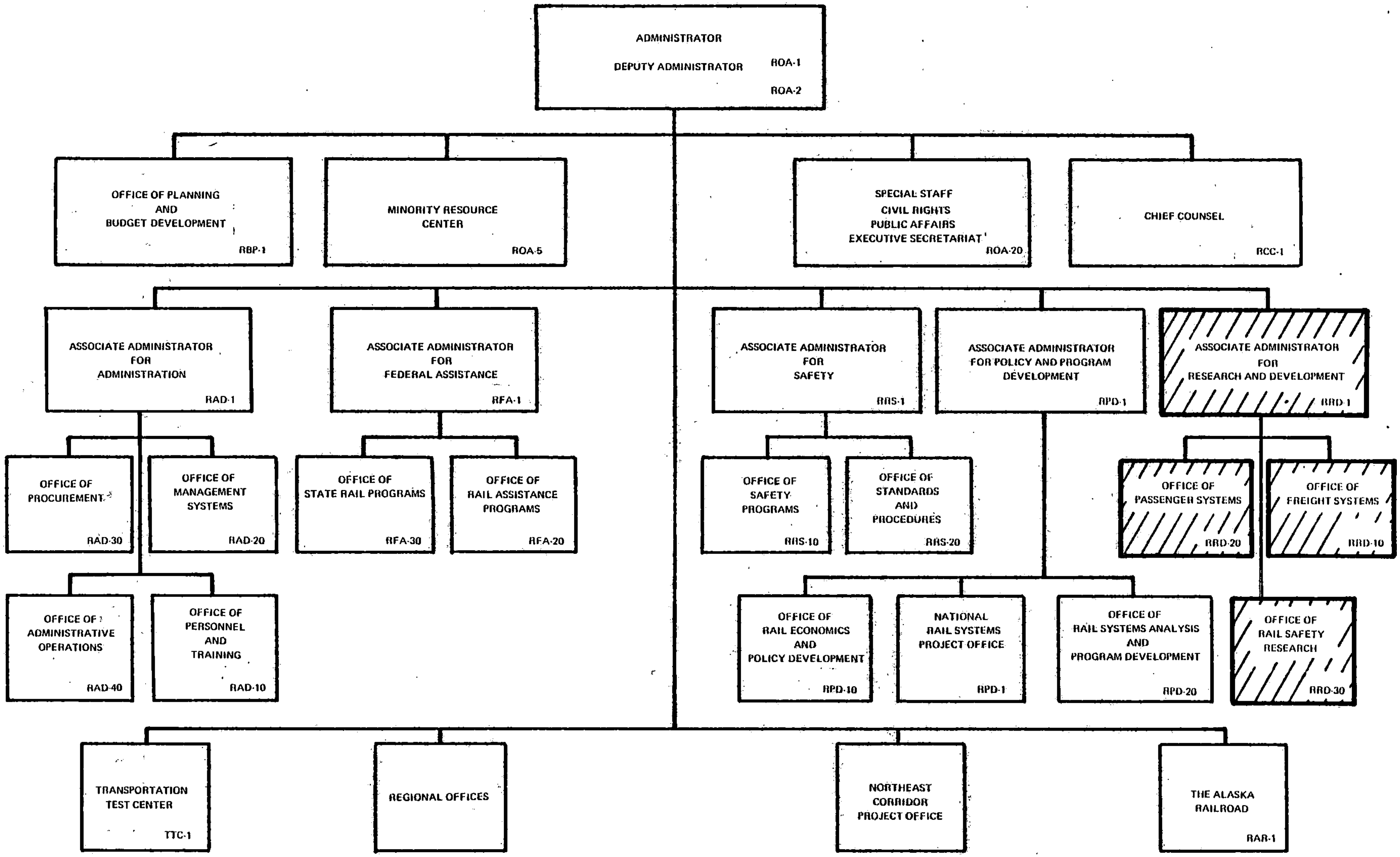
Consistent with this redirection was the structuring of R&D offices to address specific customer needs. In the Office of Passenger Systems, the FRA is concentrating on developing moderate improvements upon existing technology which can be implemented by AMTRAK and other rail passenger systems. These developments will achieve lower operating and maintenance costs. The main areas under investigation include traction and propulsion, suspension and braking equipment, controls, train evaluations, and systems developments.

The Office of Freight Systems was established to respond to the problems confronting the railroad industry in rail freight transportation. The necessity of this R&D activity is highlighted by the fact that government agencies and industry are predicting a doubling of demand for railroad services in the 1980's. This increase of demand for freight transportation will require significant investment in facilities and equipment. Current research programs include those related to classification yards, trailer-on-flatcar (TOFC) evaluations, freight car management systems, freight car components, and the development of the Rail Dynamics Laboratory (RDL).

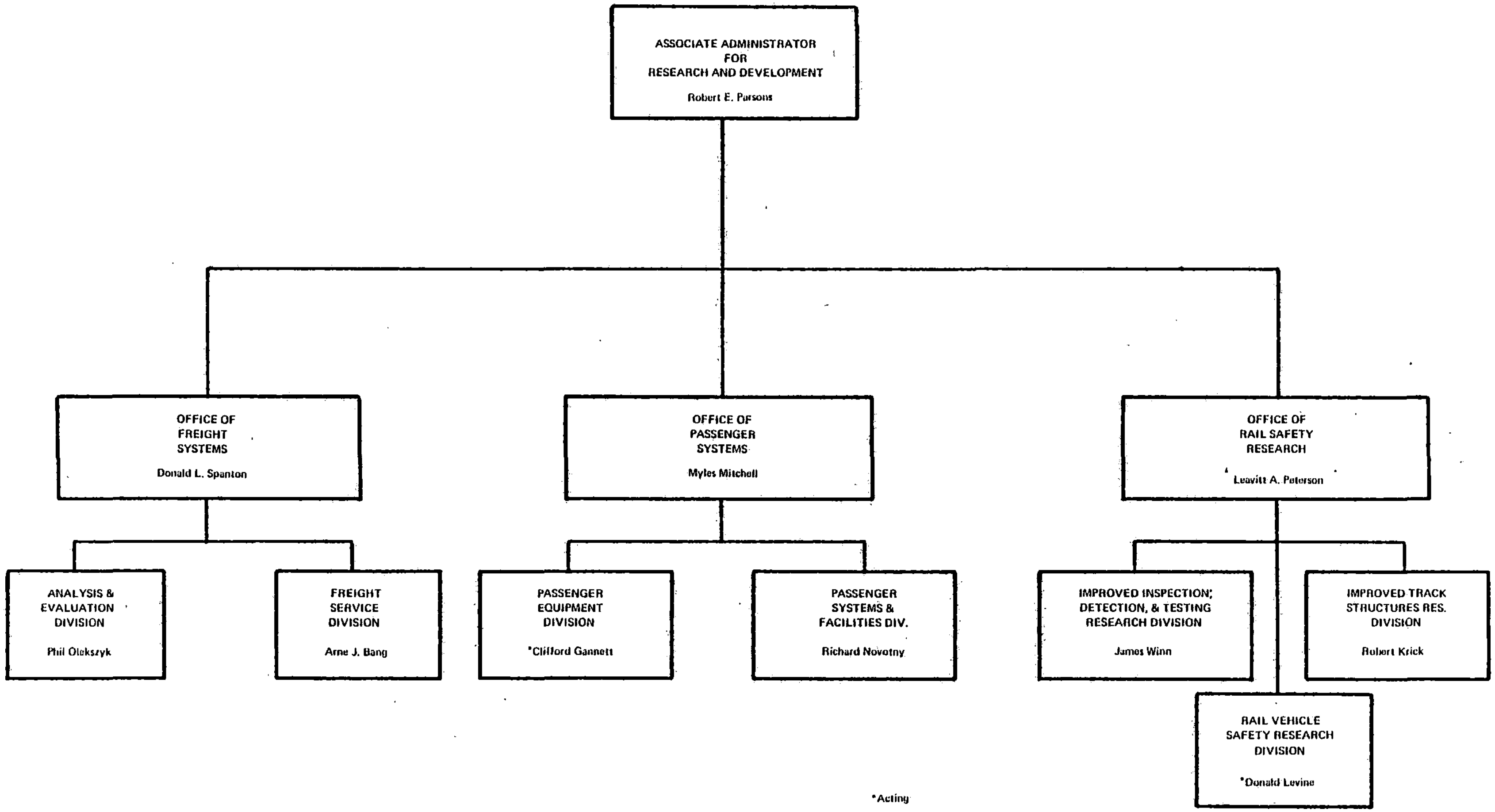
The third R&D office, which was created under the reorganization, is the Office of Rail Safety Research. Its mission is to plan, sponsor, and implement research and development programs designed to improve rail safety. Broadly speaking, the goals of the office are to reduce the number and severity of railroad accidents through the application of research results. To achieve these goals the office is divided into three divisions, each of which conducts research in one of three main areas: (1) Improved Track Structures Research, (2) Rail Vehicle Safety Research, and (3) Improved Inspection, Detection and Testing Research. Research efforts are both planned and coordinated with potential users of the research results, e.g., FRA's Office of Safety, Office of Northeast Corridor Development, AMTRAK, and the railroad industry.

The intent of this booklet is to acquaint the reader with goals and methods employed by the Office of Rail Safety Research to fulfill its mission. The booklet introduces the three divisions within the office and looks at selected projects which are representative of the type of research activities conducted by the Office of Rail Safety Research.

FEDERAL RAILROAD ADMINISTRATION



OFFICE OF RESEARCH AND DEVELOPMENT



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OFFICE OF RAIL SAFETY RESEARCH

- MISSION, OBJECTIVES, APPROACH
- ORGANIZATION
- MAJOR R&D PROGRAM THRUSTS
- SELECTED EXAMPLES OF ACTIVITY

FIGURE 1

Outline of Office of Rail Safety Research Programs

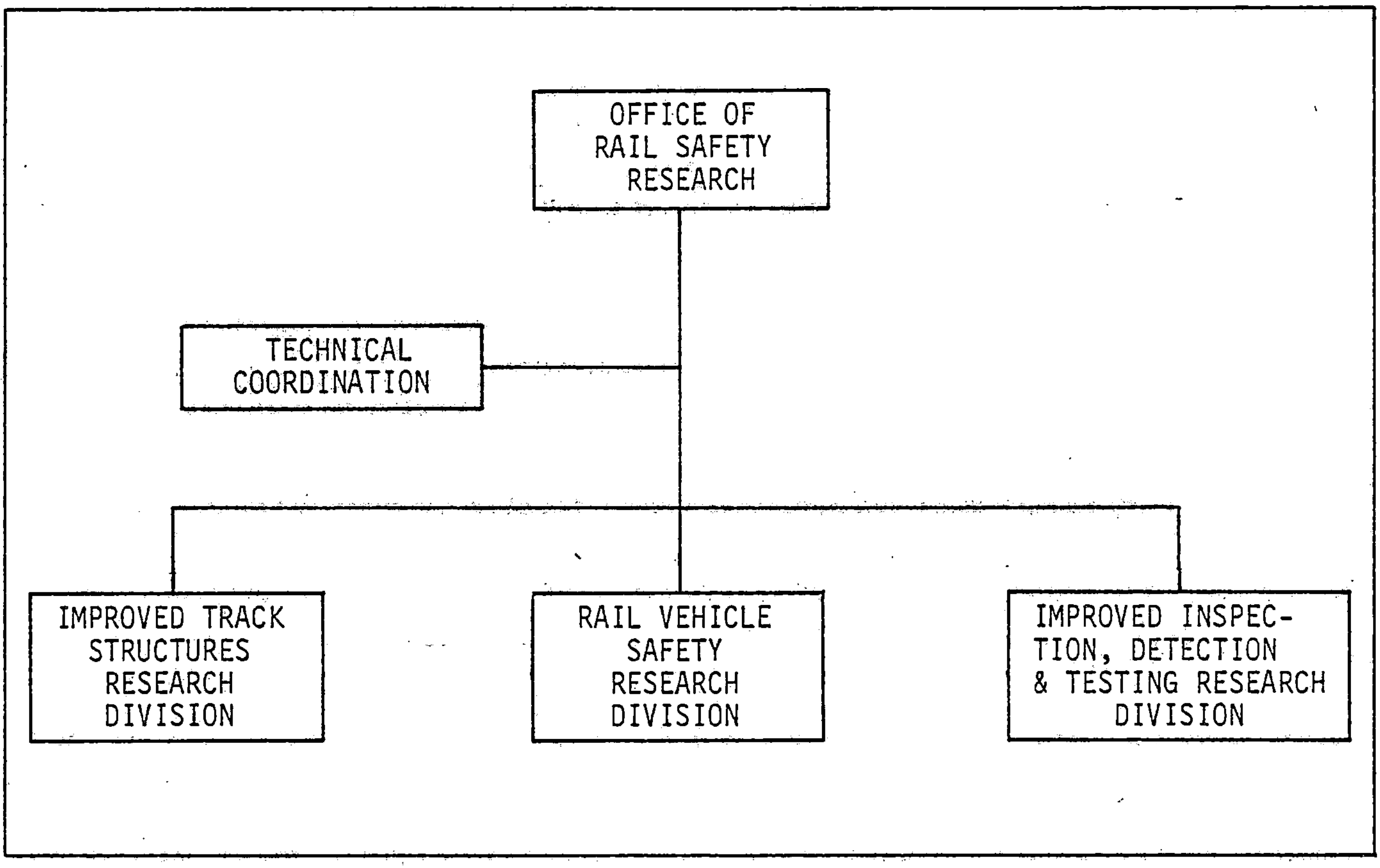


FIGURE 2

In the summer of 1975, the FRA made another positive commitment to give dedicated emphasis to improve railroad safety when the Office of Rail Safety Research (ORSR) was established. Prior to that time, safety research activity was one of the responsibilities of the Rail Systems Division of the Office of Research and Development. ORSR responsibilities are divided into three groups, the Improved Track Structures Research Division, the Rail Vehicle Safety Research Division, and the Improved Inspection Detection and Testing Research Division. Currently the organization consists of 13 professionals and four secretaries with a minimal level of about six engineers for the greater portion of the past periods.

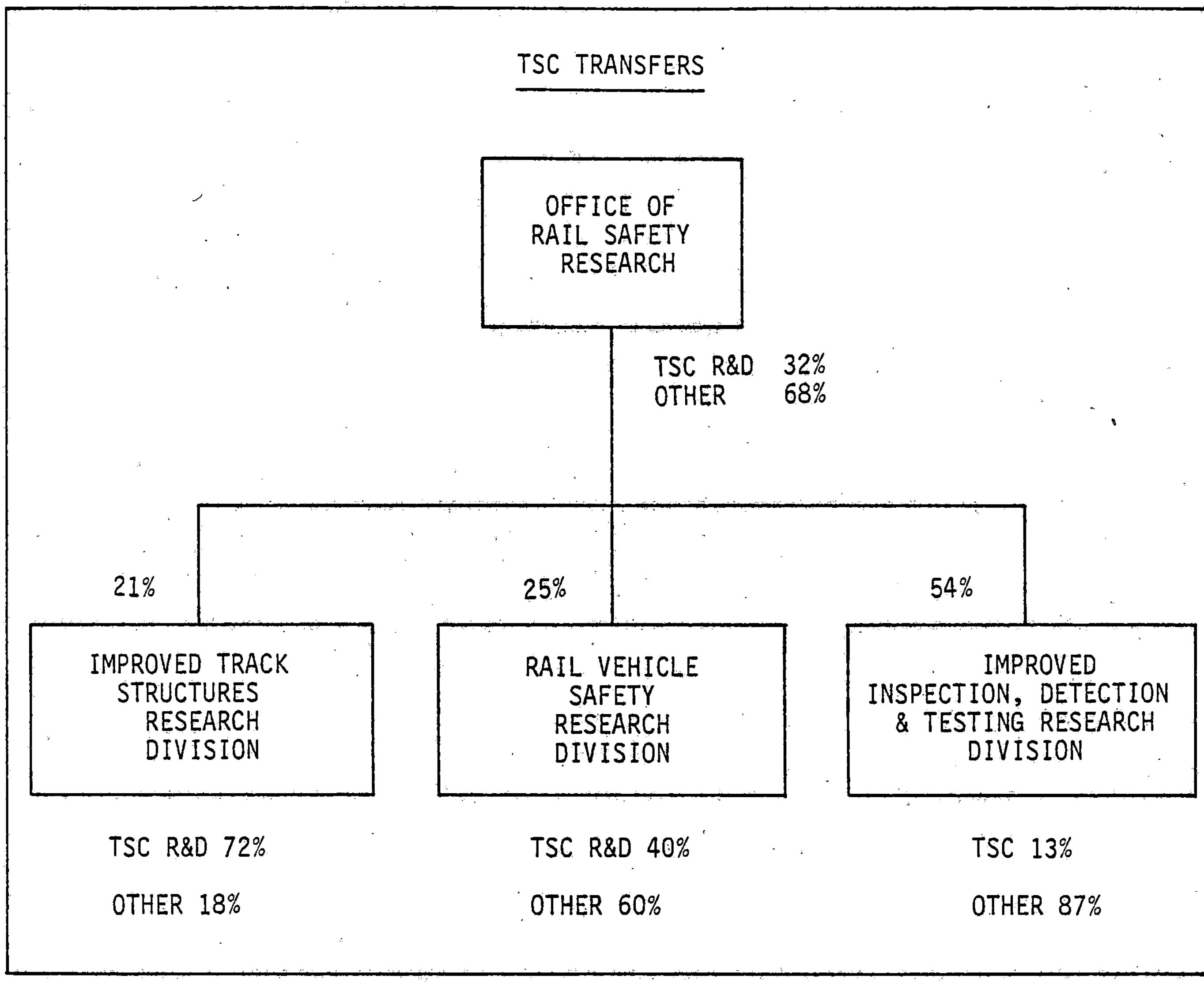


FIGURE 3

The ORSR is not organized to accomplish technical work itself. Its functions include planning, budgeting, program control, and implementation of results. Based on FY 76 operational funds and plans, the distribution of work is 21% in Improved Track Structures Research, 25% in Rail Vehicle Safety Research, and 54% in Improved Inspection, Detection and Testing Research. The Office must rely upon the Transportation Systems Center at Cambridge, Massachusetts and other outside contractors for technical accomplishments. ORSR provides TSC with planning, budgeting, program control and implementation procedures necessary for successful project completion. TSC is our largest single contractor with approximately 32% of the FY 76 office budget obligated to TSC (although the portion in each division's responsibilities varies greatly).

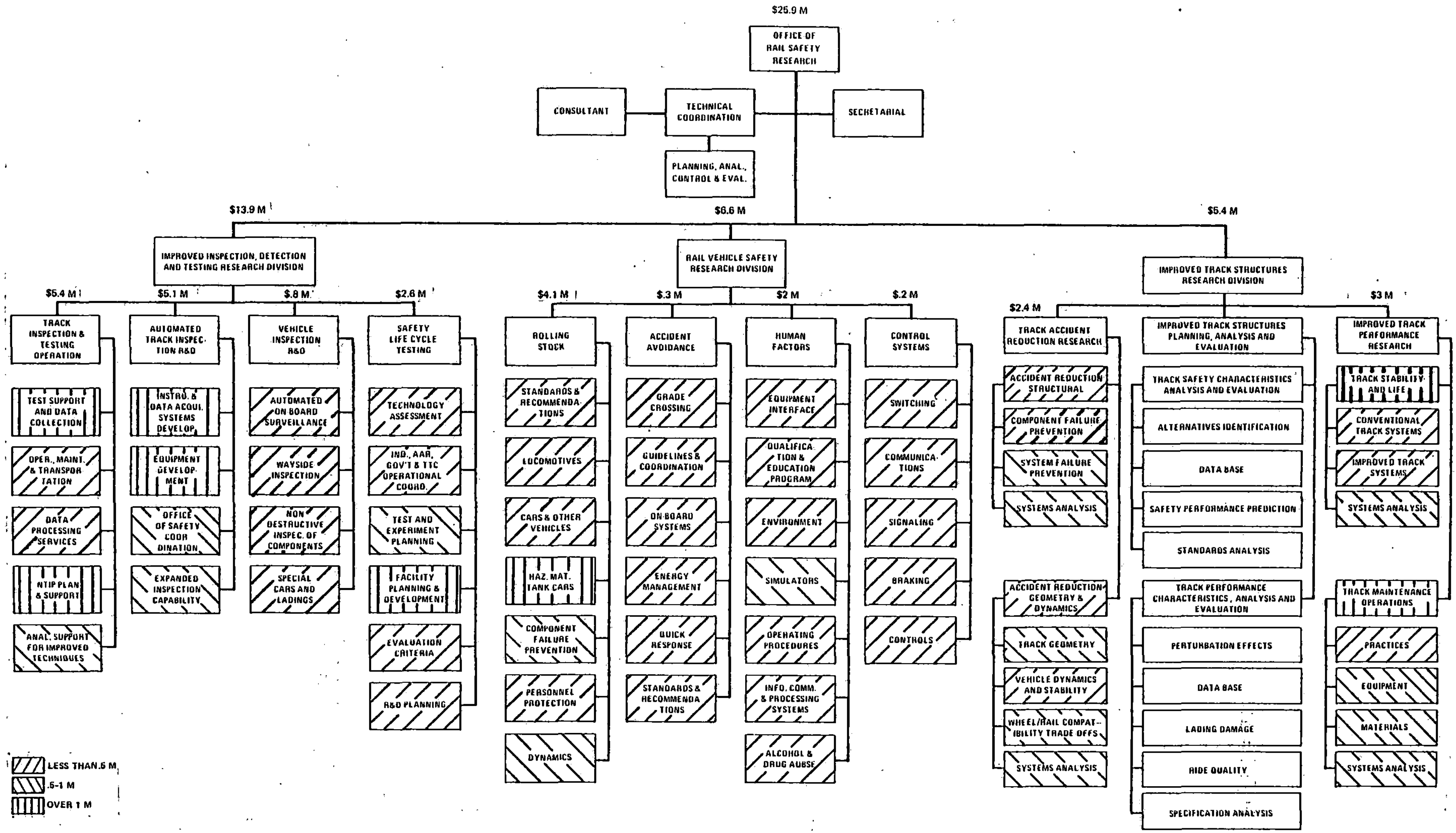


FIGURE 4

The ORSR functions and activities encompasses known needs for railroad safety research. The lined areas express present research priorities in terms of the funding for FY 76 ORSR operations. OVER 1M, indicates areas of heavy research activity, .5 - 1M moderate activity and LESS THAN .5M indicates future projects or areas not receiving much attention.

GOVERNMENT R&D RESOURCES EMPLOYED

- FRA R&D OFFICES
- OTHER DOT AND FRA OFFICES
- TRANSPORTATION CENTER
- TRANSPORTATION TEST CENTER
- NASA, NBS, FHWA, NHTSA & UMTA
- LABS AND TEST SITES

  NSWC (NOL)

  BRL

  AIR FORCE ROCKET PROPULSION LAB. - EAFB

  WHITE SANDS MISSILE RANGE
- SUPPORT CONTRACTORS
- SPONSORED CONFERENCES, INTERNATIONAL AGREEMENTS, UNIVERSITY PROGRAMS, ANALYTICAL AND EVALUATION AGENCIES TECHNICAL MEMBERSHIPS, AND COMPUTER WORKING CAPITAL FUNDS

FIGURE 5

The Office has need for, access to and utilizes other government resources in addition to those available at TSC. Such work may be accomplished through contracts, or interagency agreements.

GOVERNMENT SECTOR

GOVERNMENT SAFETY INTERESTS INCLUDE:

- SAFETY COMMITTEE - FRA
- OFFICE OF SAFETY - FRA
- MATERIAL TRANSPORTATION BUREAU - MTB
- OFFICE OF POLICY & PROGRAM DEVELOPMENT - FRA
- OFFICE OF FEDERAL ASSISTANCE - FRA
- FHWA AND NHTSA
- NATIONAL TRANSPORTATION SAFETY BOARD - NTSB
- INDIVIDUAL STATES
- AMTRAK
- CONRAIL
- U.S. RAILWAY ASSOCIATION
- NORTHEAST CORRIDOR DEVELOPMENT

FIGURE 6

For optimal results, ORSR efforts in Research and Development are dependent on inputs from both government and industry safety and R&D interests. Definition of priorities and resolution of viewpoints have been greatly enhanced by "open" discussions and informal exchanges, especially through interactive industry/government safety interest groups. (See Figures 7 and 8.)

INDUSTRY SECTOR

INDUSTRY SAFETY INTERESTS INCLUDE:

- LABOR ORGANIZATIONS
- AAR
- RPI
- SHIPPERS
- INDIVIDUAL CARRIERS
- OTHER ASSOCIATIONS

INDUSTRY R&D COMMUNITY INCLUDE:

- LABOR ORGANIZATIONS
- AAR
- RPI
- TTD
- INDIVIDUAL CARRIERS
- INDIVIDUAL SHIPPERS, MANUFACTURERS & SUPPLIERS
- OTHER ASSOCIATIONS

FIGURE 7

INDUSTRY/GOVERNMENT GROUPS

INDUSTRY/GOVERNMENT SAFETY INTERESTS GROUPS INCLUDE:

- RAIL SAFETY RESEARCH BOARD
- LOCOMOTIVE CONTROL COMPARTMENT COMMITTEE
- NAS, TRB
- TANK CAR REVIEW COMMITTEE
- TTD
- OTHER JOINT CONFERENCES, ETC.

FIGURE 8

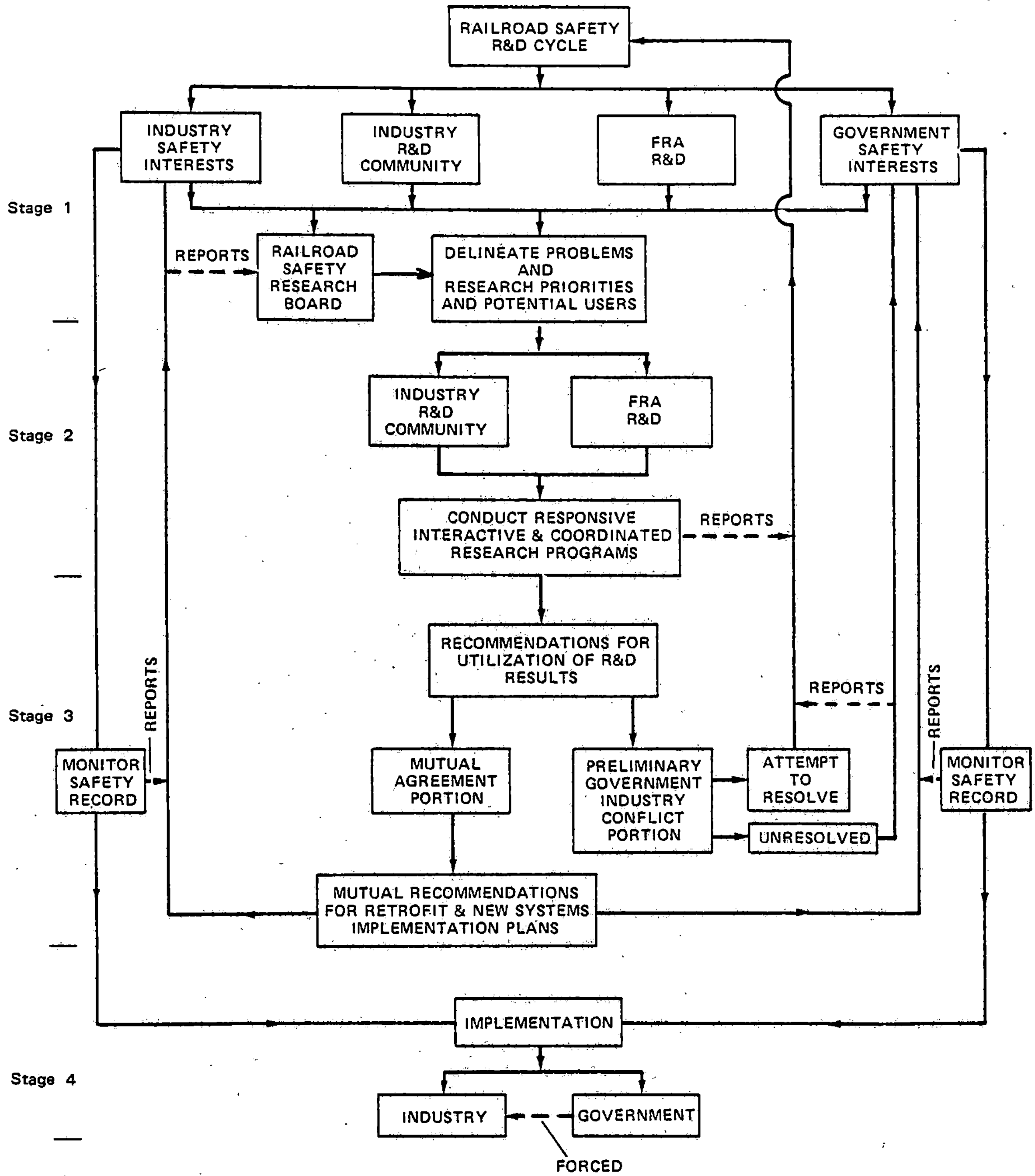


FIGURE 9

ORSR sees its role in terms of total railroad safety objectives. The Railroad Safety R&D cycle, which follows a complicated path, can be divided into four stages. In the first stage, using both industry and government inputs, the research needs are defined. Once the need is defined, the actual research is performed with both the FRA and industry taking coordinated, but many times parallel active roles. In the third stage, recommendations are made and implementation plans developed. Hopefully, this "search for truth" has resulted in a common agreement on implementation needs and methods. In those cases where divergent interpretation on the research results exists or when conditions dictate, government regulations to various degrees may result.

OFFICE OF RAIL SAFETY RESEARCH

MISSION

THRU PARTICIPATIVE INTERACTION TO MAKE A SIGNIFICANT CONTRIBUTION TOWARD:

NEAR TERM SAFETY RECORD IMPROVEMENT

- TREND REDUCTION IN THE RATE (PER APPROPRIATE MEASURE) OF RAIL SYSTEM ACCIDENTS, CASUALITIES, & COST

ESTABLISHMENT OF THE BASIS FOR MORE OPTIMAL FUTURE RAIL SYSTEM DEVELOPMENTS WHICH WILL INCREASE THE RATE OF THE CONTINUING IMPROVEMENT TREND & PRODUCE SUBSTANTIAL INDUSTRY BENEFITS.

FIGURE 10

For guidance in research activities, it is beneficial to reduce implied or "taken for granted" responsibilities to written form. The mission described recognizes the need to deal with the existing system for real near-term improvements in the safety record as measured by a well-defined criteria.

OFFICE OF RAIL SAFETY RESEARCH

OBJECTIVES

FOSTER & PROMOTE ACCOMPLISHMENT OF EFFECTIVE R&D ACTIVITIES BY THE INDUSTRY-ORIENTED RESEARCH COMMUNITY TO:

- SUPPORT SYSTEM PERFORMANCE GUIDELINES & SPECIFICATIONS FOR COMPONENTS OF THE RAIL TRANSPORT SYSTEM
- ACHIEVE NEAR-TERM SAFETY IMPROVEMENTS
  - EXISTING SYSTEM RETROFIT
  - OPERATION CHANGES
- PROVIDE A SOLID BASE FOR THE SAFETY OF NEW EQUIPMENT & SYSTEMS
- ENSURE SAFE & COST-EFFECTIVE RAIL SYSTEMS & GOVERNMENT EVALUATION CAPABILITY
- DEFINE ACCEPTABLE DYNAMIC CHARACTERISTICS OF RAIL SYSTEM FOR BOTH PASSENGER & FREIGHT SERVICE
- DELINEATE THE REQUIREMENT & LIMITATIONS OF PRESENT, MODIFIED, & NEW RAIL SYSTEMS UNDER REASONABLE EXPECTATIONS
  - NEAR- & LONG-TERM OPERATING CONDITIONS
  - DYNAMIC LOADING CONDITIONS

FIGURE 11

In fulfilling the mission, more specific objectives are delineated such as: (1) guidelines and specifications for the rail transport system, (2) near-term (retrofit) safety improvement in the existing rail transport system, (3) a solid technological data base for new equipment and systems, (4) an evaluation capability including adequate facilities, (5) definition of "acceptable" dynamic characteristics of passenger and freight rail systems, and (6) define the requirements and limitations of present and new rail systems.

OFFICE OF RAIL SAFETY RESEARCH

STRATEGY

UTILIZE AN APPROACH OF:

- OPEN AND INTERACTIVE PARTICIPATION

  WITH

- CONTINUING CRITICAL REVIEWS AND ANALYSIS

  - GOVERNMENT R&D AND SAFETY INTERESTS
  - INDUSTRY R&D AND SAFETY INTERESTS

FOR THE PURPOSE OF:

- DETERMINING RESEARCH NEEDS AND PRIORITIES
- CONDUCTING RESEARCH
- RESOLVING CONFLICTS
- MAKING RECOMMENDATIONS
- SUPPORTING COUNTERMEASURES AND IMPROVEMENTS
- MONITORING PROGRESS

FIGURE 12

To satisfy our safety mission, the strategy of the ORSR is to use "open" interactive participation with both government and industry R&D safety interests for the purpose of determining research needs and priorities, conducting research and supporting improvements and monitoring progress.

NATURE OF UTILIZATION OF R&D RESULTS

- OPERATING CHANGES
- RETROFIT AND/OR NEW MODIFICATIONS
  - ROLLING STOCK
  - TRACK
  - COMBINATIONS
- MAINTENANCE REQUIREMENTS AND PRACTICES
- INSPECTION REQUIREMENTS AND PRACTICES
- OTHER
  - TESTING AND EVALUATION METHODS
  - FACILITIES
  - ANALYSIS
  - EDUCATION
  - DATA BASE

FIGURE 13

The utilization of the results of R&D research takes on a variety of forms such as operating changes, retrofit or modifications to rail systems, changes in maintenance and inspection requirements and procedures, and testing and evaluation methods.

MODE OF

UTILIZATION OF R&D RESULTS

- INDIVIDUAL INDUSTRY CARRIERS, SUPPLIERS, LABOR UNIONS
- COLLECTIVE INDUSTRY GROUPS
  - AGREEMENT
  - RULES AND ORDERS
- GOVERNMENTAL GROUPS
  - INFORMATION DISSEMINATION AND RECOMMENDATIONS
  - PROGRAM IMPLEMENTATION OR MODIFICATION
  - GUIDELINES AND STANDARDS
  - REGULATIONS
  - EMERGENCY ORDERS

FIGURE 14

Implementation of safety rules can be brought about by a variety of actions by industry and government groups. Of course, implementation of R&D results can be either voluntarily accepted by the railroad industry or forced by the government. (See Figure 15.)

TYPE OF
UTILIZATION OF R&D RESULTS

- VOLUNTARY
  - BY INDIVIDUAL CARRIERS OR ORGANIZATIONS
  - BECAUSE OF INDEPENDENT GROUP PRESSURES
  - NEGATE NEED FOR LEGISLATIVE ACTION
  - THROUGH AGREEMENT OF KNOWLEDGEABLE AND WELL-INFORMED COMMUNITY
- FORCED
  - INDUSTRY
  - GOVERNMENT

FIGURE 15

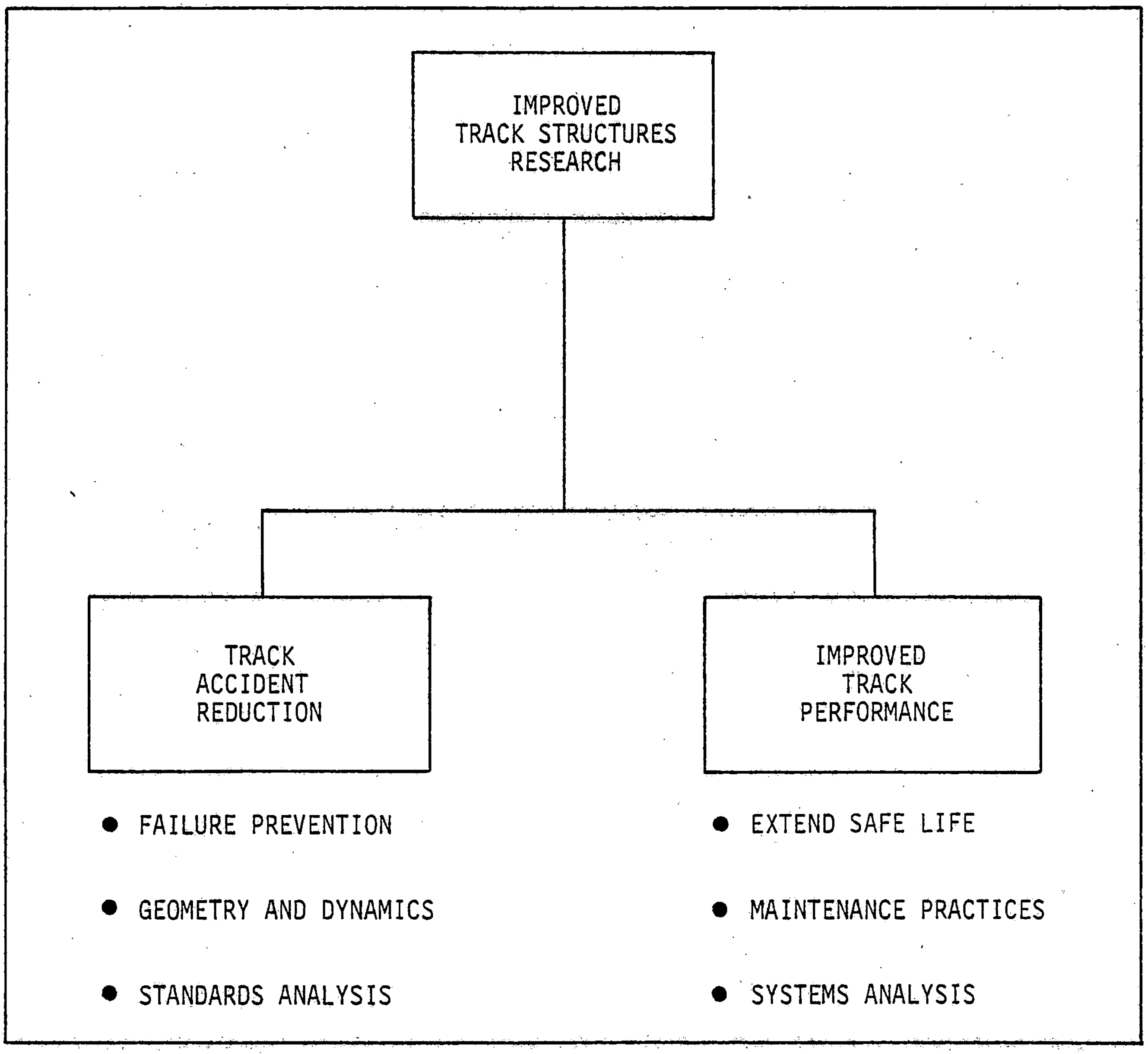


FIGURE 16

The Improved Track Structures Research Division has two separate programs, one is oriented towards reducing track-related accidents on existing structures, while the other aims at improving the performance of track systems by increasing its life and/or developing better maintenance practices. In this respect, on-going work recognizes the existence of 300,000 miles of mainline track and the realization that the U.S.A. cannot depend primarily on the installation of new track to reduce accidents in the next few years.

IMPROVED TRACK STRUCTURES RESEARCH DIVISION

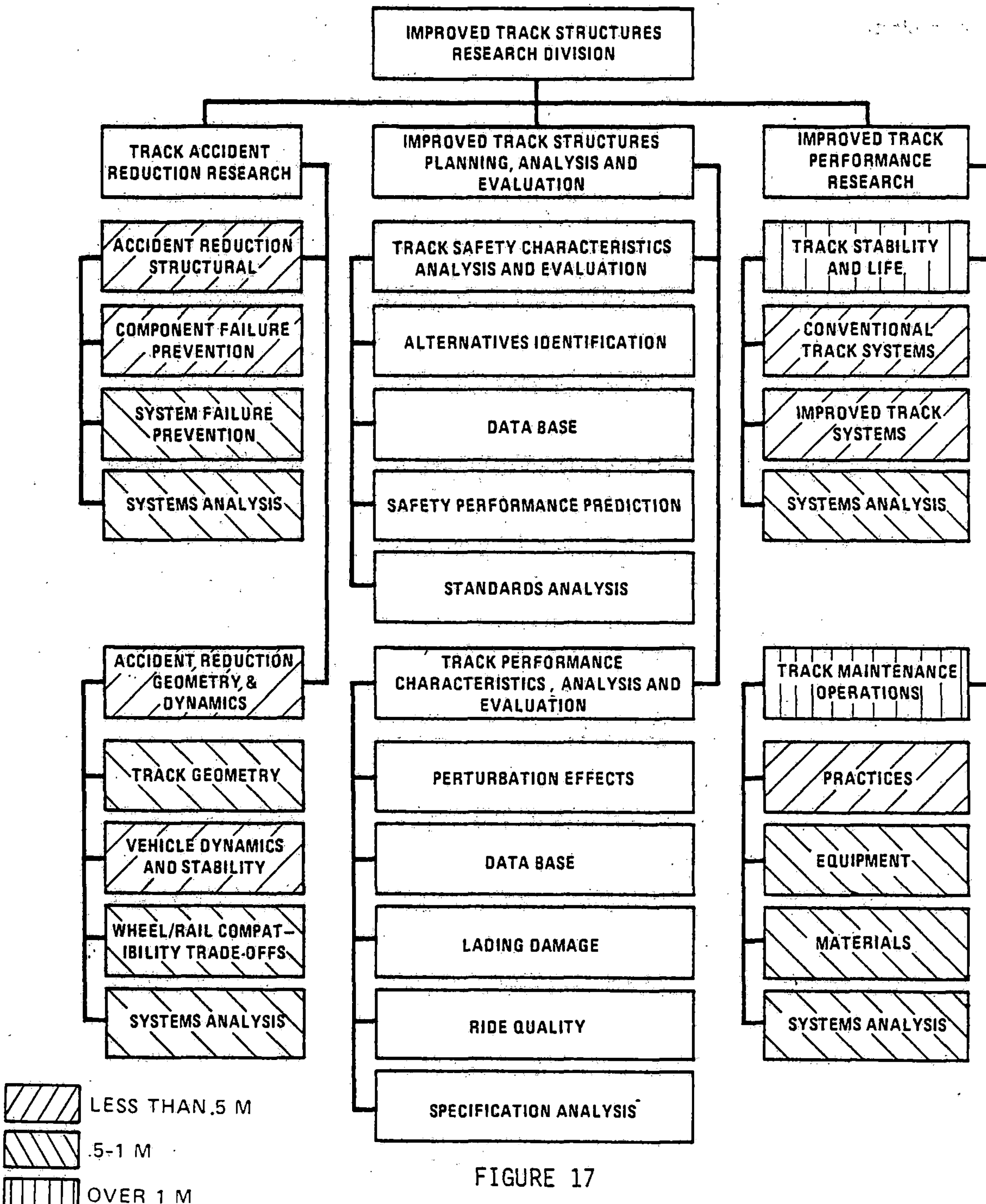


FIGURE 17

This is a detail of the functions assigned to the Improved Track Structures Research Division together with present research priorities. As before, OVER 1M represents high dollar priority areas, .5-1M moderate amount of activity, and LESS THAN .5M reflects future projects on lower activity areas.

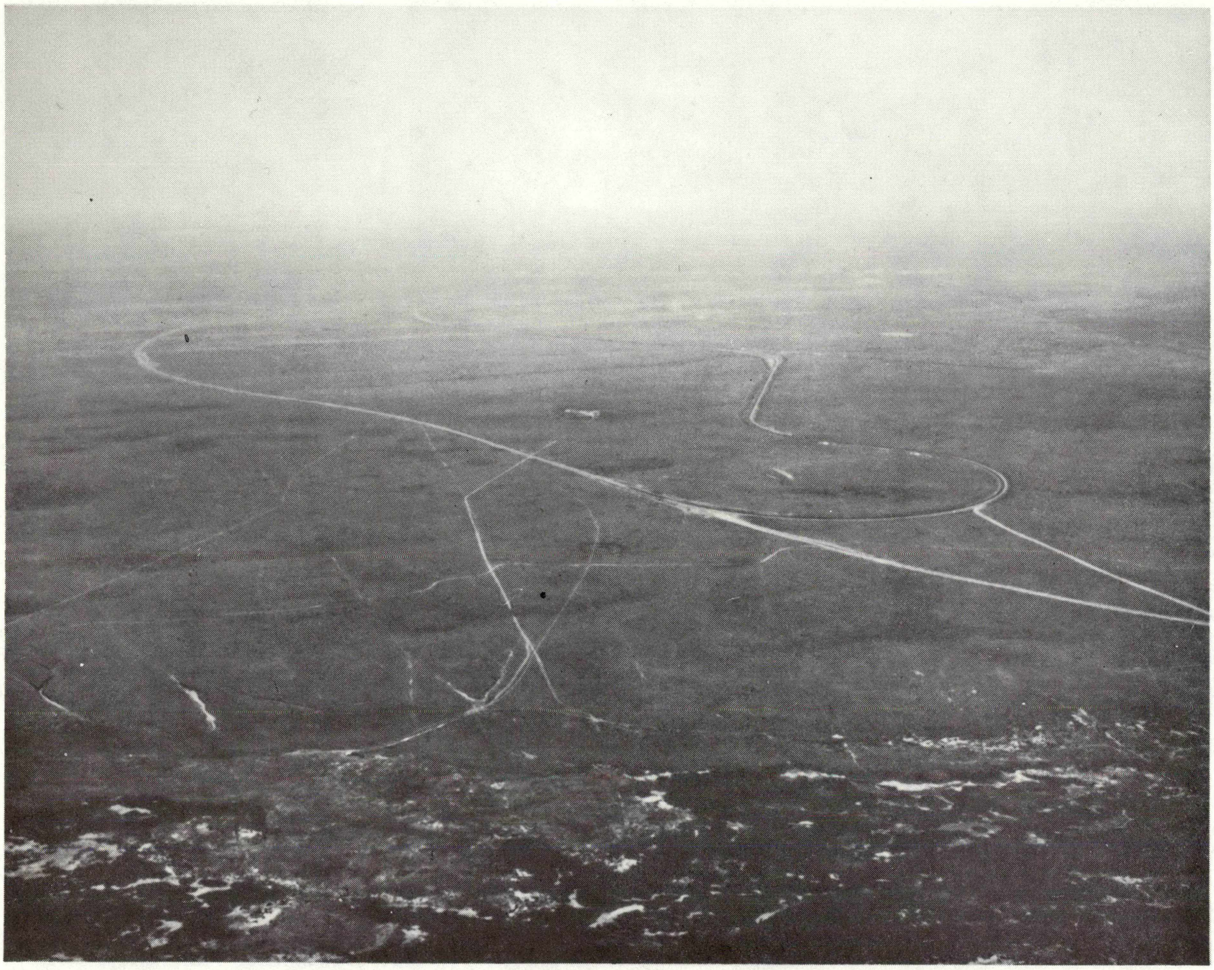


FIGURE 18

Much of the past funding of FRA R&D has been applied to providing test facilities which have been lacking in the industry. Significant track R&D funds have been expended toward the establishing of the Transportation Test Center (TTC) at Pueblo, Colorado. This is an aerial view of TTC in the area of the intended Facility for Accelerated Service Testing (FAST) test loop.

FIGURE 19

Other past activities of this division have included a wide range of results, including obtaining and testing of a ballast consolidator.

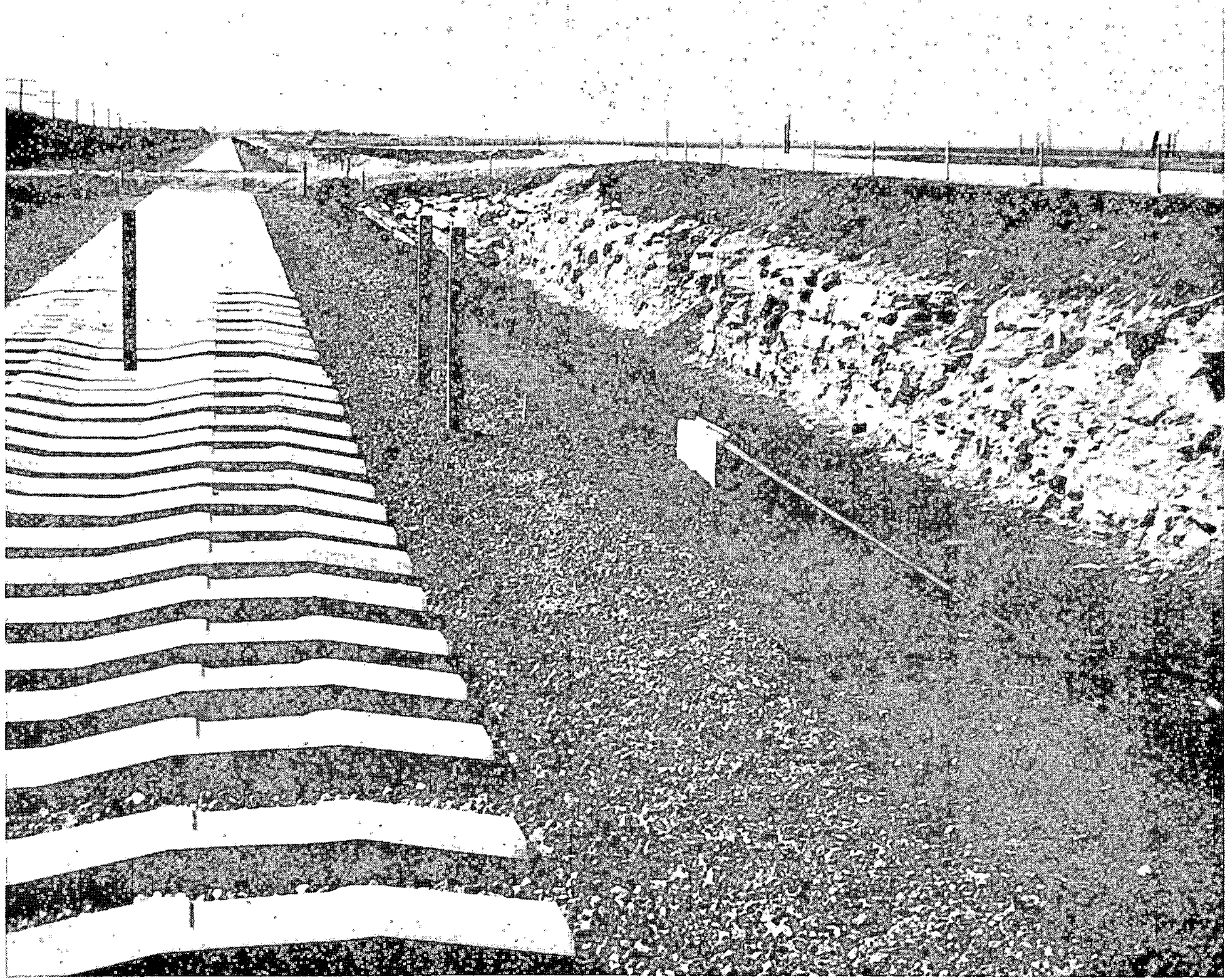


FIGURE 20

Evaluation of various track structure components is a part of this program. This is a view of the Kansas Test Track including concrete ties.

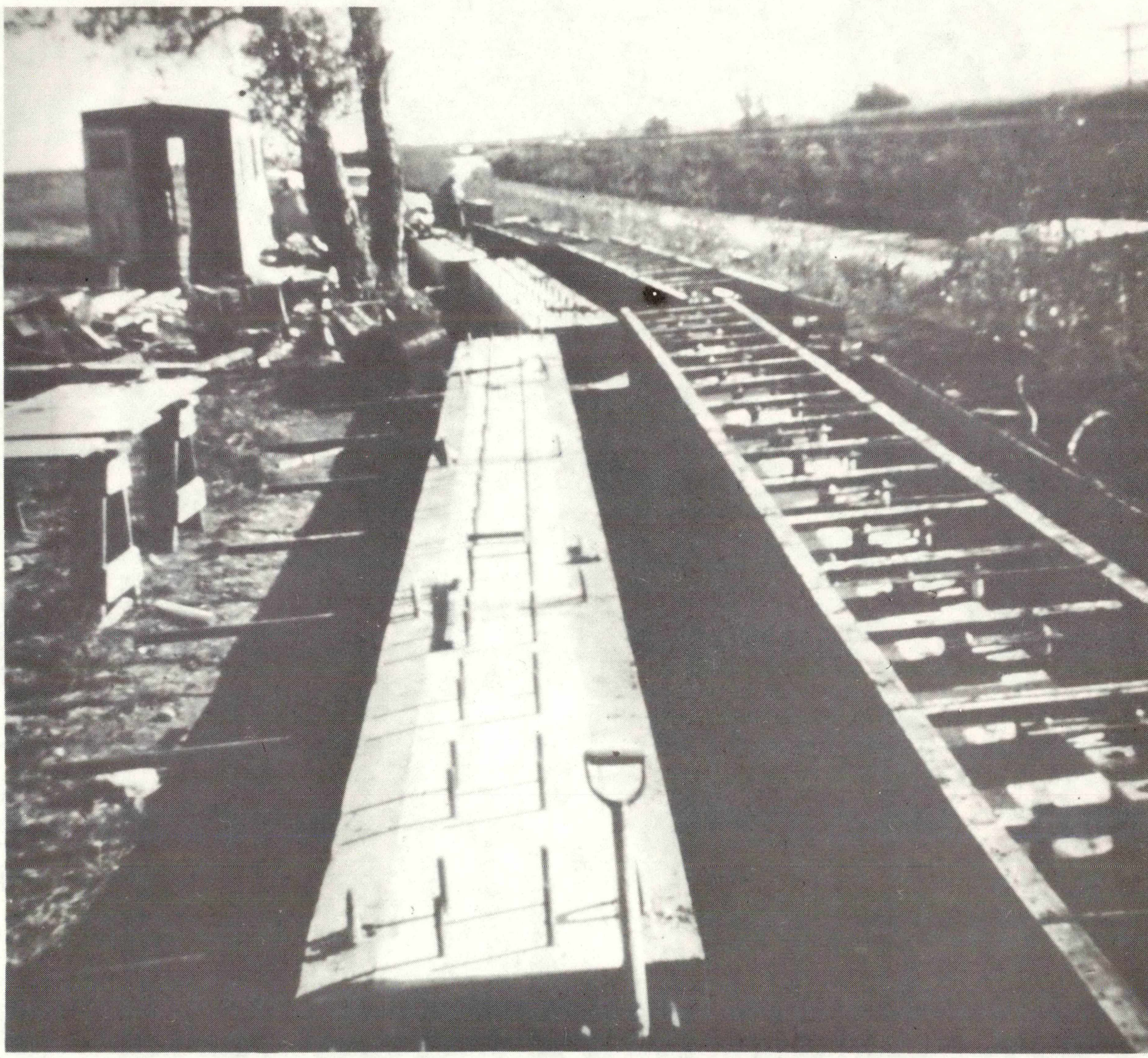


FIGURE 21

Past efforts have looked at more revolutionary concepts. This is another view of the Kansas Test Track showing precast concrete support beams.

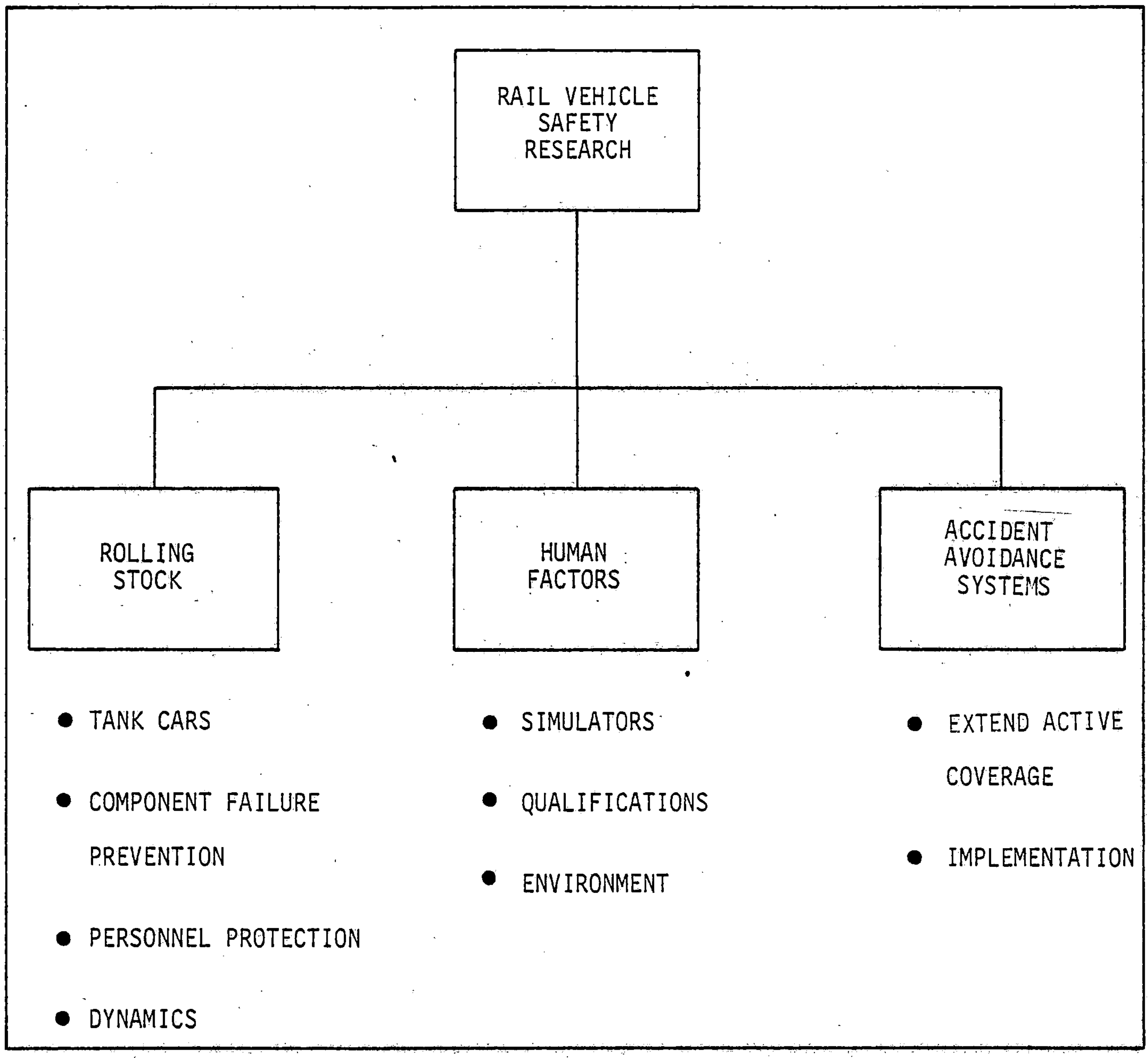


FIGURE 22

The Rail Vehicle Safety Research Division attempts to improve safety by studying and making recommendations in three major program areas: (1) rolling stock including hazardous material cars, (2) human factors, and (3) accident avoidance systems. The Rolling Stock program attempts to increase safety in the approximately 1.7M freight cars and 20,000 tank cars now in service. FRA support for the highly effective Track/Train Dynamics program is provided through this division which also studies vehicle crash-worthiness protection for railroad employees. The area of R&D entitled Human Factors studies the equipment, train and yard environment and its effects on personnel. Provision for a Research Locomotive Cab and Train Handling Evaluator is a major effort now underway. The present thrust of Accident Avoidance System is to achieve implementation of active protection on a greater portion of grade crossings and, at the same time, to improve train conspicuity.

RAIL VEHICLE SAFETY RESEARCH DIVISION

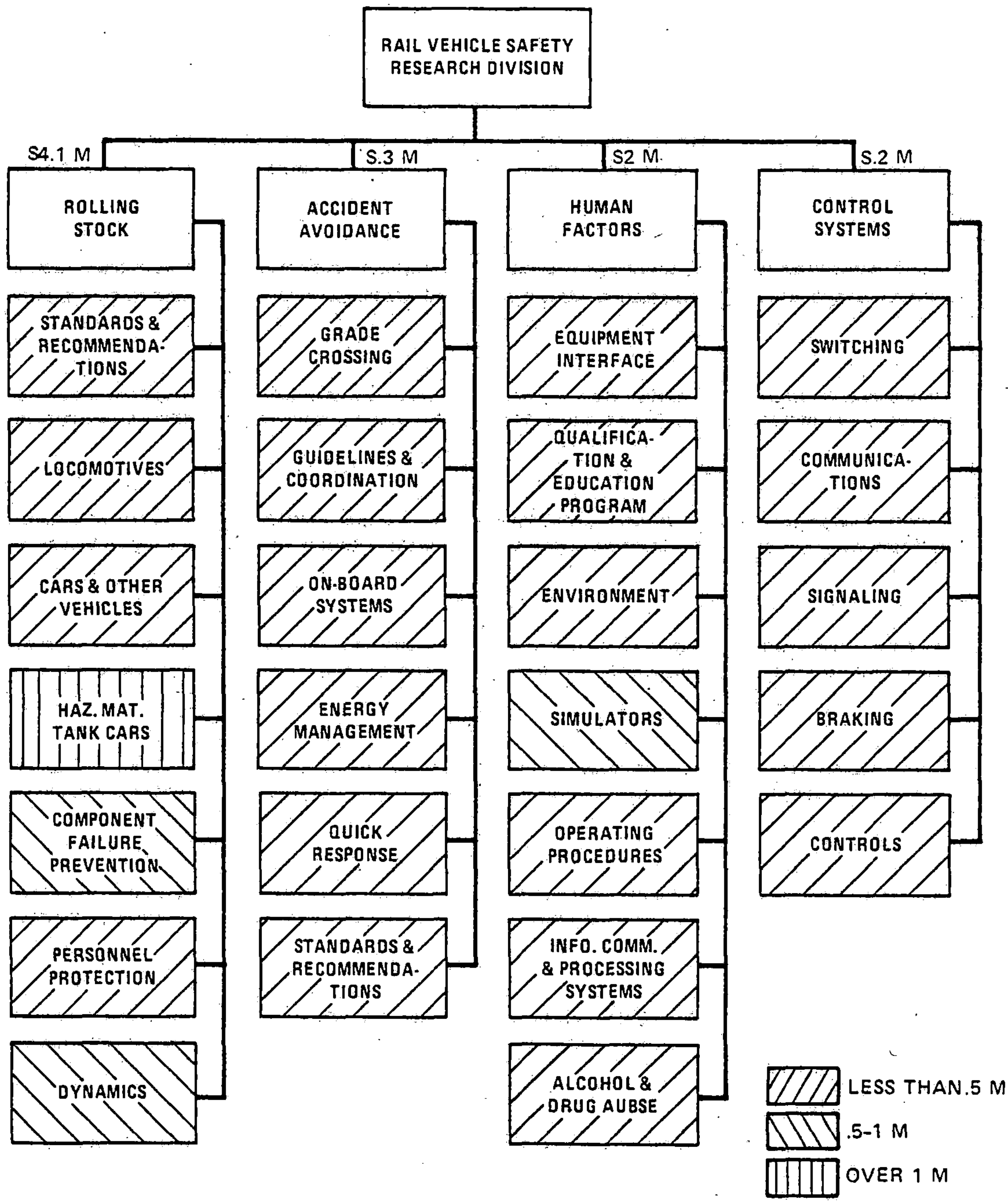


FIGURE 23

This is a detailed package of the intended safety oriented Research and Development activities of the Rail Vehicle Safety Research Division. Present funding is one way to exhibit the existing R&D priorities of this division. OVER 1M, represents high dollar/ priority areas, .5-1M represents a moderate amount of research activity, and the LESS THAN .5M represents future projects or relatively low activity areas.

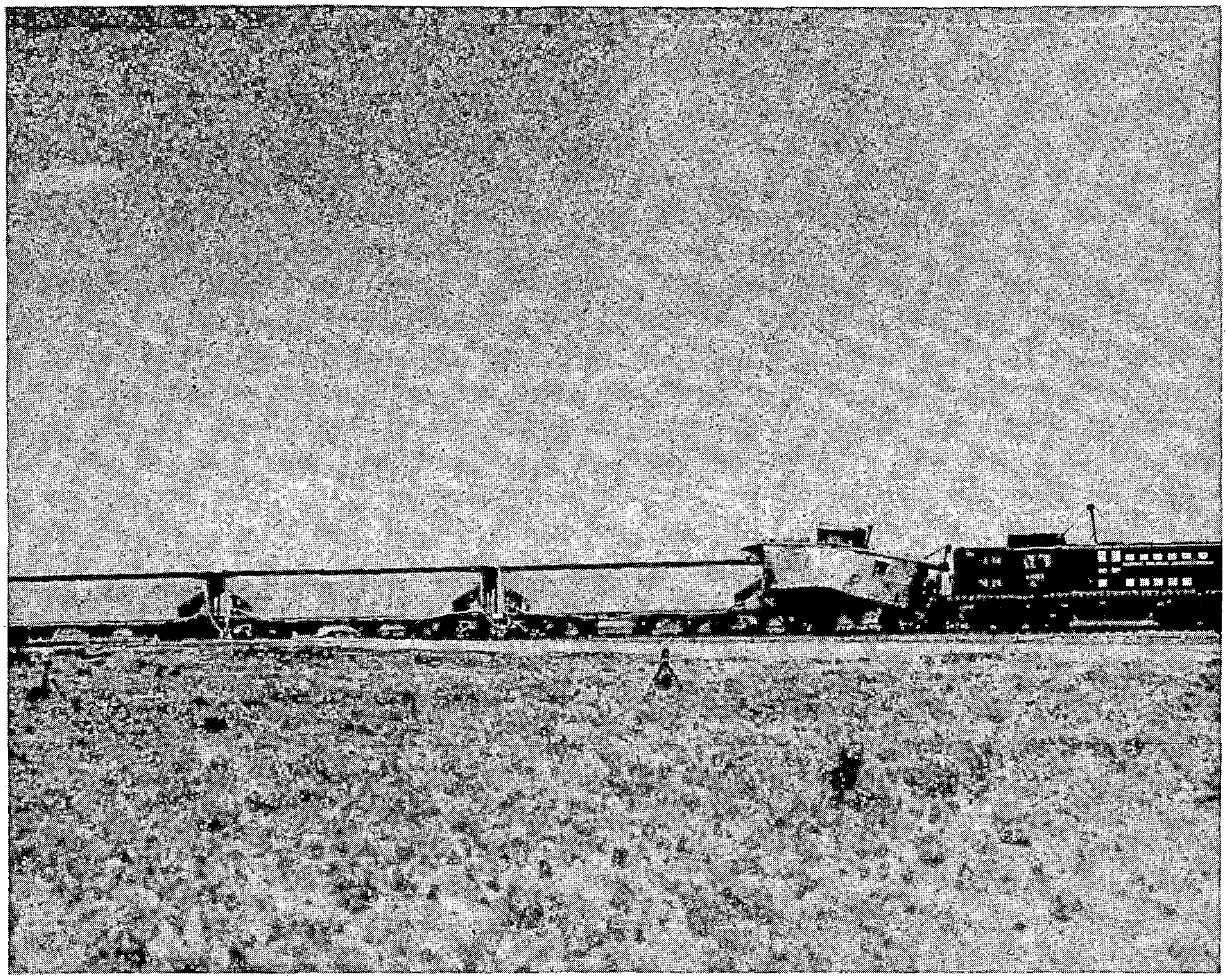


FIGURE 24

The Rail Vehicle Safety Research Division past activities have included coordinated research work with railroad safety interests. This is a view of a full scale rear-end train impact conducted as part of a series of tests at TTC. The impetus was provided by the "Locomotive Control Compartment Committee" with representatives from the FRA, AAR and the Labor Unions. These full-scale tests may be unique in the world and are proving valuable in many areas including the hazardous material tank car program.

RAIL VEHICLE SAFETY RESEARCH DIVISION

HUMAN FACTORS PROGRAM AREA

ACCOMPLISHMENTS TO DATE:

1. HUMAN FACTORS SURVEY OF LOCOMOTIVE CABS - JUNE 1972
2. RAILROAD ENGINEMAN TASK AND SKILL STUDY - AUGUST 1972
3. GUIDELINES FOR WRITING RAILROAD OPERATING RULES - JULY 1973
4. IDENTIFICATION AND CATEGORIZATION OF ACCIDENTS AND INJURIES IN CABS OF LOCOMOTIVES - SEPT. 1973
5. AN ANALYSIS OF THE JOB OF RAILROAD TRAIN DISPATCHER - APR. 1974
6. TASK ANALYSIS FOR THE JOBS OF FREIGHT TRAIN CONDUCTOR AND BRAKEMAN - MAY 1975
7. PROPOSED QUALIFICATION REQUIREMENTS FOR SELECTED RAILROAD JOBS - MAY 1975

FIGURE 25

Past work in the "Human Factors" program has provided a foundation for achieving a better understanding of the safety factors involved in the interface between equipment and human operators. This chart shows some of the reports issued to date. Future actions will include, for example, a more specific assessment of the risks associated with each task of the brakeman along with a weighing of time spent in each activity in order to guide efforts in choosing, evaluating, and recommending safety improvement options.

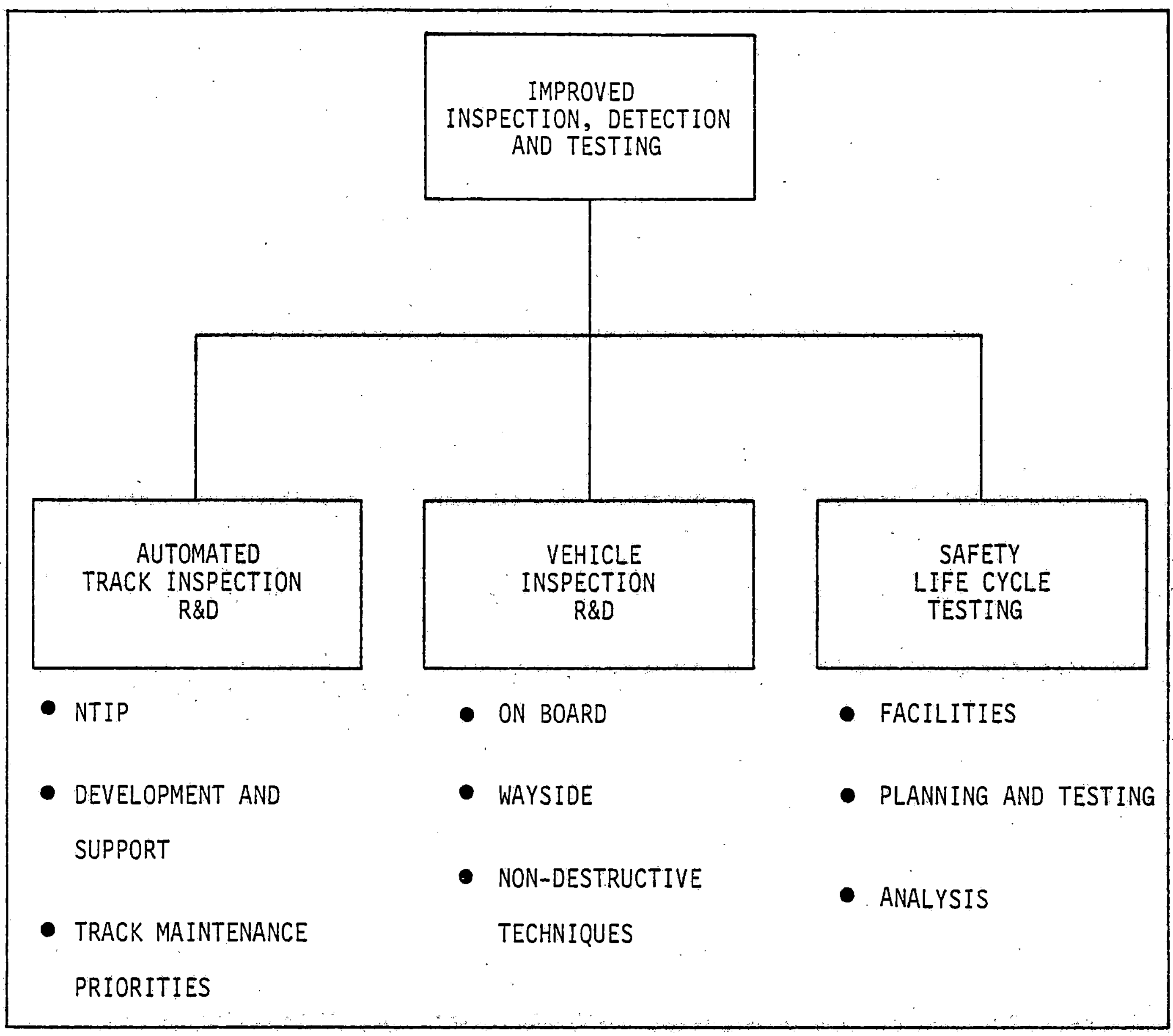


FIGURE 26

The Federal Railroad Administration is giving heavy R&D emphasis in establishing a working and comprehensive inspection capability both within the government and the railroads. The Improved Inspection, Detection and Testing Research Division consists of three major program areas: (1) automated track inspection, (2) vehicle inspection, and (3) safety life cycle testing. Automated Track Inspection through the National Track Inspection Program is providing the Office of Safety with three levels of track monitoring capability in each region.

The program also assists industry in establishing track maintenance priorities and in developing new maintenance procedures. Under the Safety Life-Cycle Program, the methodology to ensure safe performance of rail systems over their entire life-cycle (not just when "new") is being developed. FAST, at Pueblo, by producing equivalent 10-15 year results in one year of accelerated testing is a part of this effort. In the Vehicle Inspection program, methods are being developed for an effective on-board monitoring system for individual cars and for wayside surveillance stations to detect abnormal behavior of cars in trains.

IMPROVED INSPECTION, DETECTION AND TESTING RESEARCH DIVISION

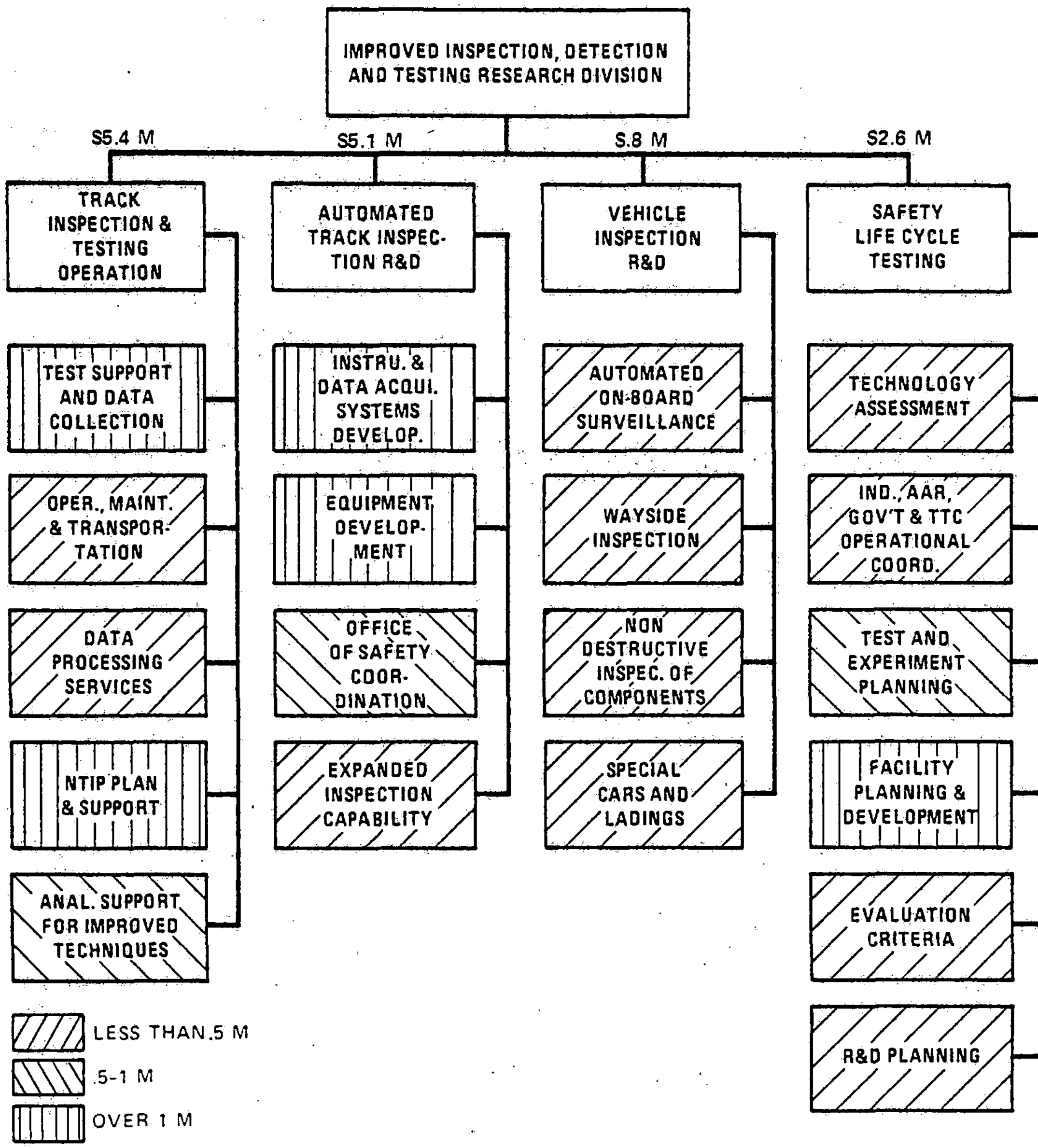


FIGURE 27

Here are the safety concerns of the Improved Inspection, Detection and Testing Research Division expressed in terms of allocation of FY 76 funds to indicated research activities. OVER 1M, represents high dollar/priority areas, .5-1M more moderate expenditures, and the LESS THAN .5M represents future projects or relatively low activity areas.

SELECTED ACTIVITY

EXAMPLE PROJECTS:

- FAST
- TANK CAR SAFETY
- LOCOMOTIVE SAFETY
- ON-BOARD MONITORING SYSTEM
- AUTOMATED TRACK INSPECTION

FIGURE 28

In order to illustrate typical activities, five example projects have been selected. They represent a variety of representative R&D efforts.

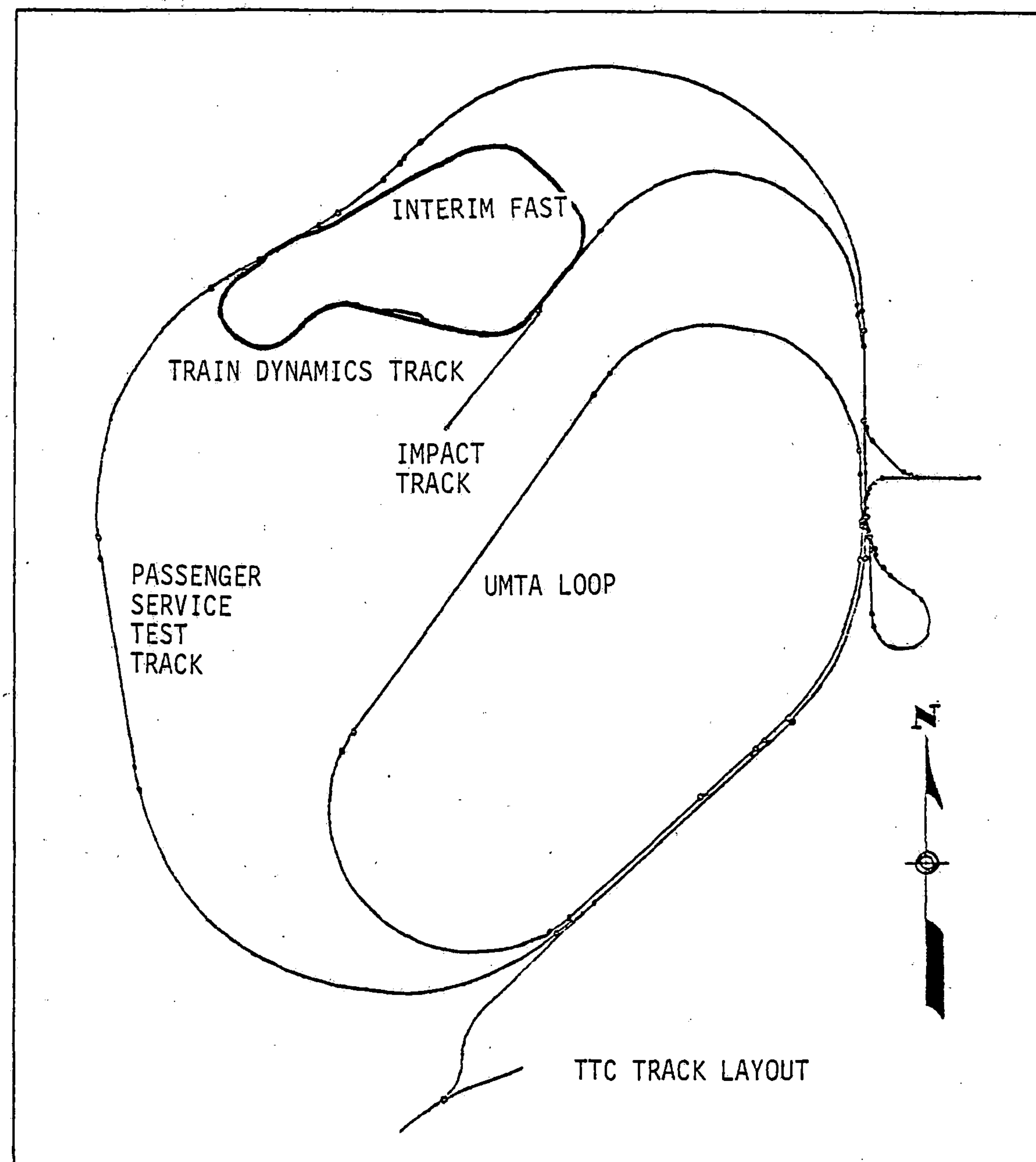


FIGURE 29

FAST is an acronym for Facility for Accelerated Service Testing. The objective is for the FRA to make available to the railroad industry a facility wherein the performance, maintenance and safety expectations of rolling stock, track, operations, etc. during 10-15 years of their life cycles can be reasonably determined in less than 1 year. Although more appropriate layouts may be required in the future, a loop of about 5 miles has been constructed at the Pueblo Transportation Test Center and is scheduled to commence operation in August 1976. The AAR, through the mechanism of Track Train Dynamics, has been instrumental in working with the industry, suppliers, etc. to ensure the success of this effort. The chart shows the location of the FAST trackage.

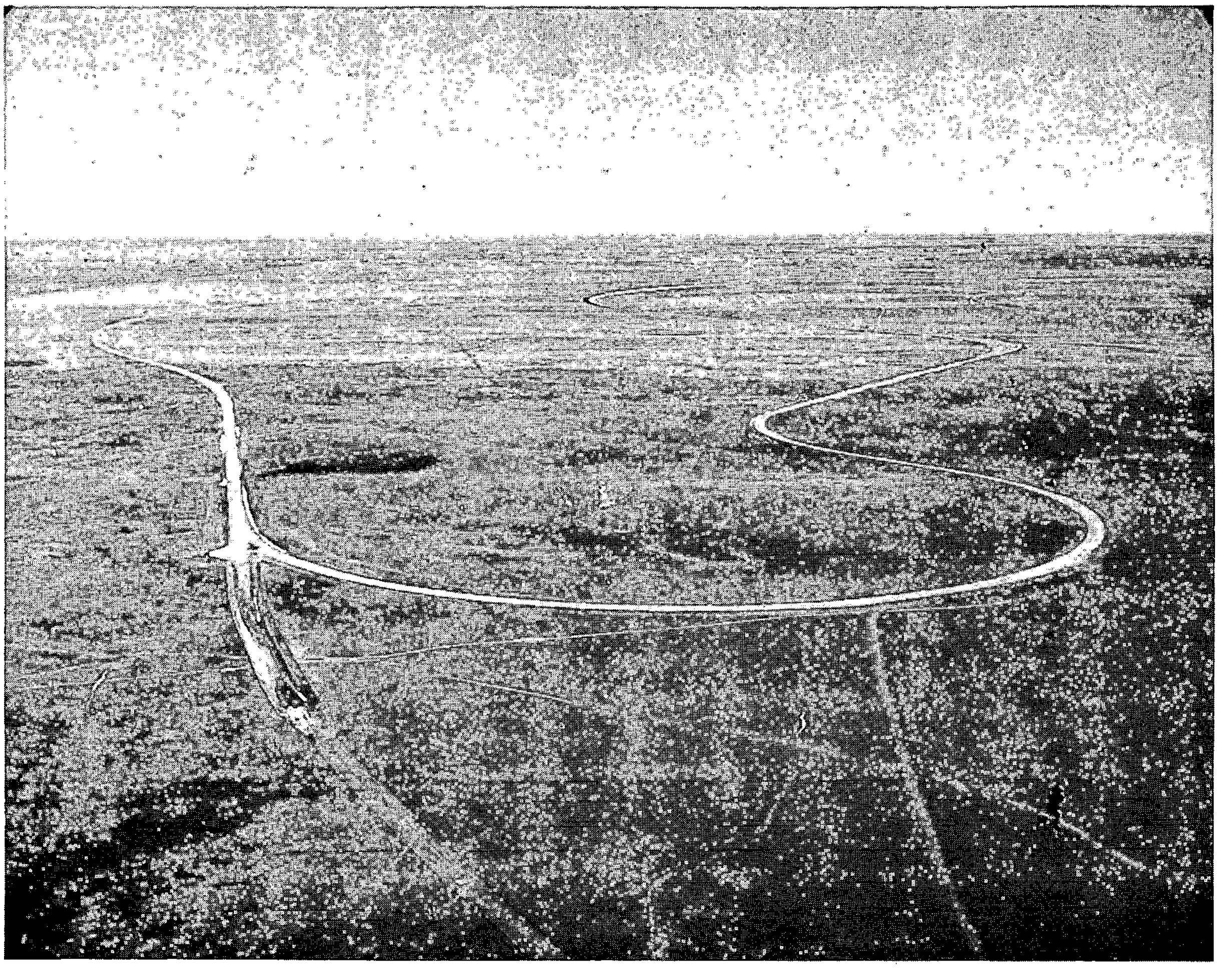


FIGURE 30

This is an aerial view of the Transportation Test Center in the vicinity of the FAST loop and gives some idea of the expanse of the Test Center. As previously mentioned, significant amounts of past FRA R&D funds have been expended to establish this much needed testing facility.

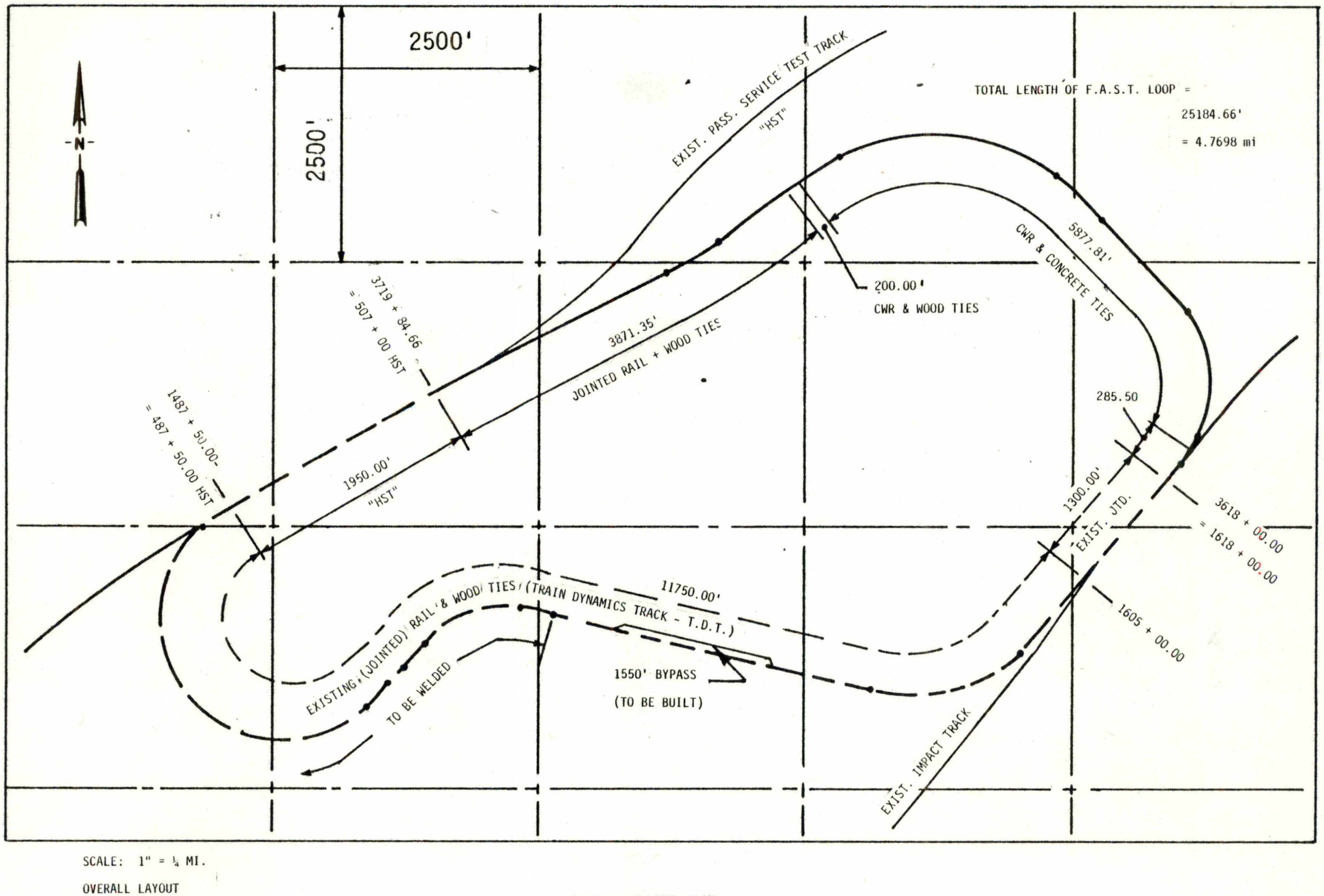


FIGURE 31

A number of variations in track structures and components will be tested in FAST operations. Most of the initial testing will be on combinations of "conventional" components – all of which have been selected by industry track experts under the coordinating guidance of AAR and FRA. This chart locates the various test sections.

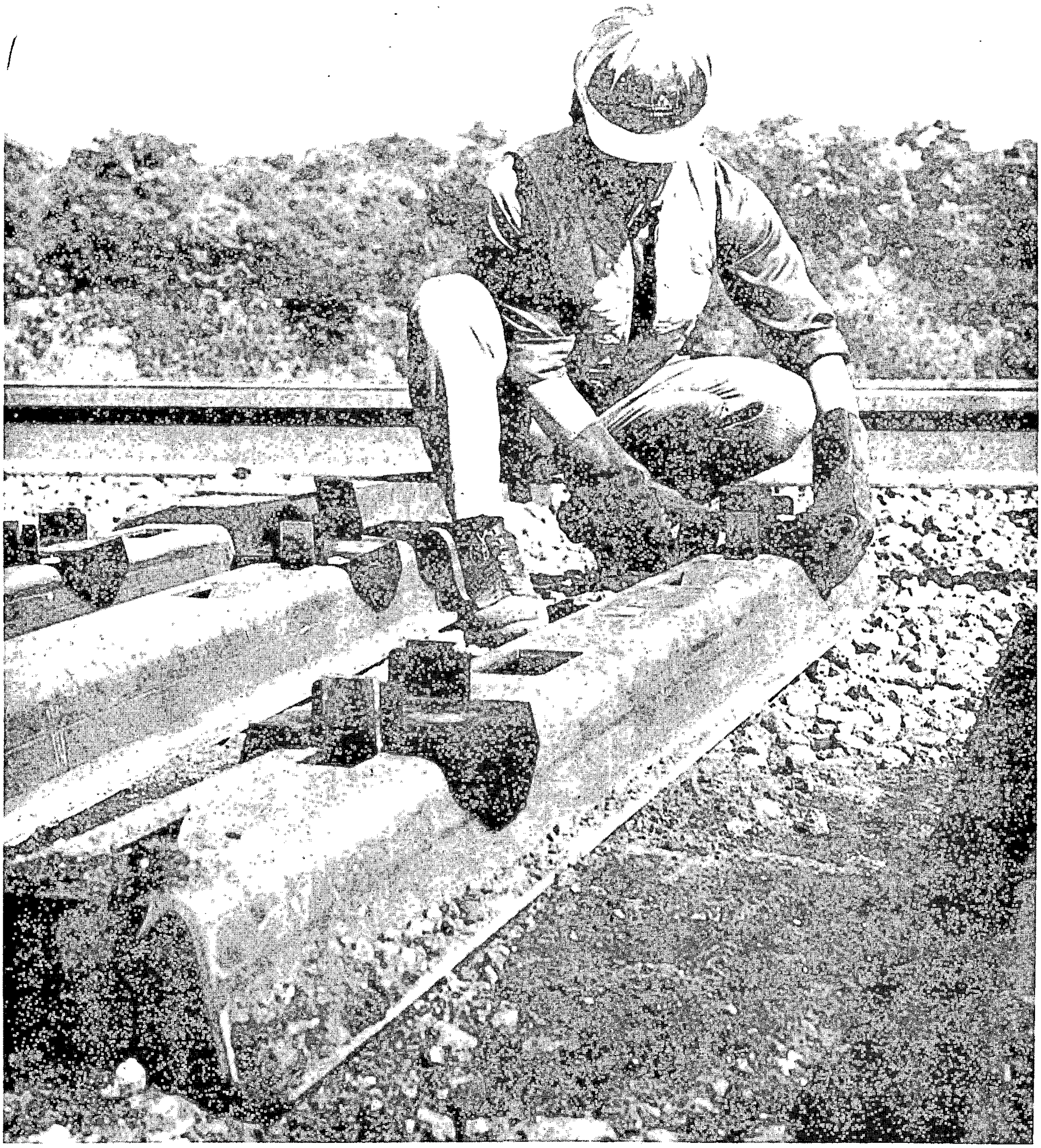


FIGURE 32

FAST will provide an opportunity to evaluate the life cycle effectiveness of some components which currently have not accumulated significant tonnages under heavy axle loading conditions. Variations of concrete tie/fastener configurations and even a steel tie version will be tested in the initial series of tests.

SAMPLES OF EXPECTED RESULTS - FAST PHASE I

TRACK SYSTEM PERFORMANCE

- WEAR CHARACTERISTICS OF VARIOUS TYPES OF RAIL
- EFFECTS OF VARIOUS BALLAST DEPTHS UNDER TIE
- RATE OF DEGRADATION OF SEVERAL TYPES OF BALLAST
- PERFORMANCE OF CONCRETE TIES UNDER HEAVY LOADS

ROLLING STOCK PERFORMANCE

- SERVICE CHARACTERISTICS OF VARIOUS TRUCKS AND COUPLERS
- DIFFERENCES IN WEAR RATES OF COMPONENTS
- LIFE CYCLE PERFORMANCE OF THERMAL COATINGS AND SAFETY EQUIPMENT

TRACK MAINTENANCE ECONOMICS

- CHANGES IN TRACK GEOMETRY AS RELATED TO AMOUNT OF MAINTENANCE
- EFFECTS OF SEVERAL BALLAST SHOULDER WIDTHS
- VARIATIONS IN TRACK DEGRADATION BETWEEN SEVERAL TRACK SYSTEMS
- CHANGES IN TRACK GEOMETRY AS RELATED TO AMOUNT OF MAINTENANCE

SAFETY & INSPECTION METHODOLOGY EVALUATION

- TRACK INSPECTION EFFECTIVENESS
- ON BOARD MONITORING SYSTEMS
- WAYSIDE INSPECTION STATIONS

FIGURE 33

Here are some expected outputs from FAST.

FAST

OBJECTIVE:

OBTAIN LIFE CYCLE PERFORMANCE DATE

SAFETY PERFORMANCE

ECONOMICS

PARTICIPANTS:

TTD, AAR, RPI, INDIV. CARRIERS, SUPPLIERS, & SHIPPERS

REQUIREMENTS:

MEANINGFUL TIME-COMPRESSED COMPARISONS

MAJOR WORK AREAS:

TRACK, ROLLING STOCK, CONTROL & SURVEILLANCE EQUIP.

MAINTENANCE & OPERATING PRACTICES SAFETY & ECONOMICS

FACILITIES:

TTC - IFAST

- FAST

RESULTS TO DATE:

INITIAL STUDIES - AAR

PROJECT RESPON. DEFINITION

TRACK LAYOUT

PROCUREMENT PLANS, TRACK & ROLLING STOCK

IFAST CONSTRUCT. RFP

FUTURE:

OPERATE FAST

CONSTRUCT FAST

FIGURE 34

It is anticipated that FAST will prove to be a vital element in providing timely data for improvment of railroad operations. This chart summarizes the present status. The table gives a brief description of the present status of FAST.

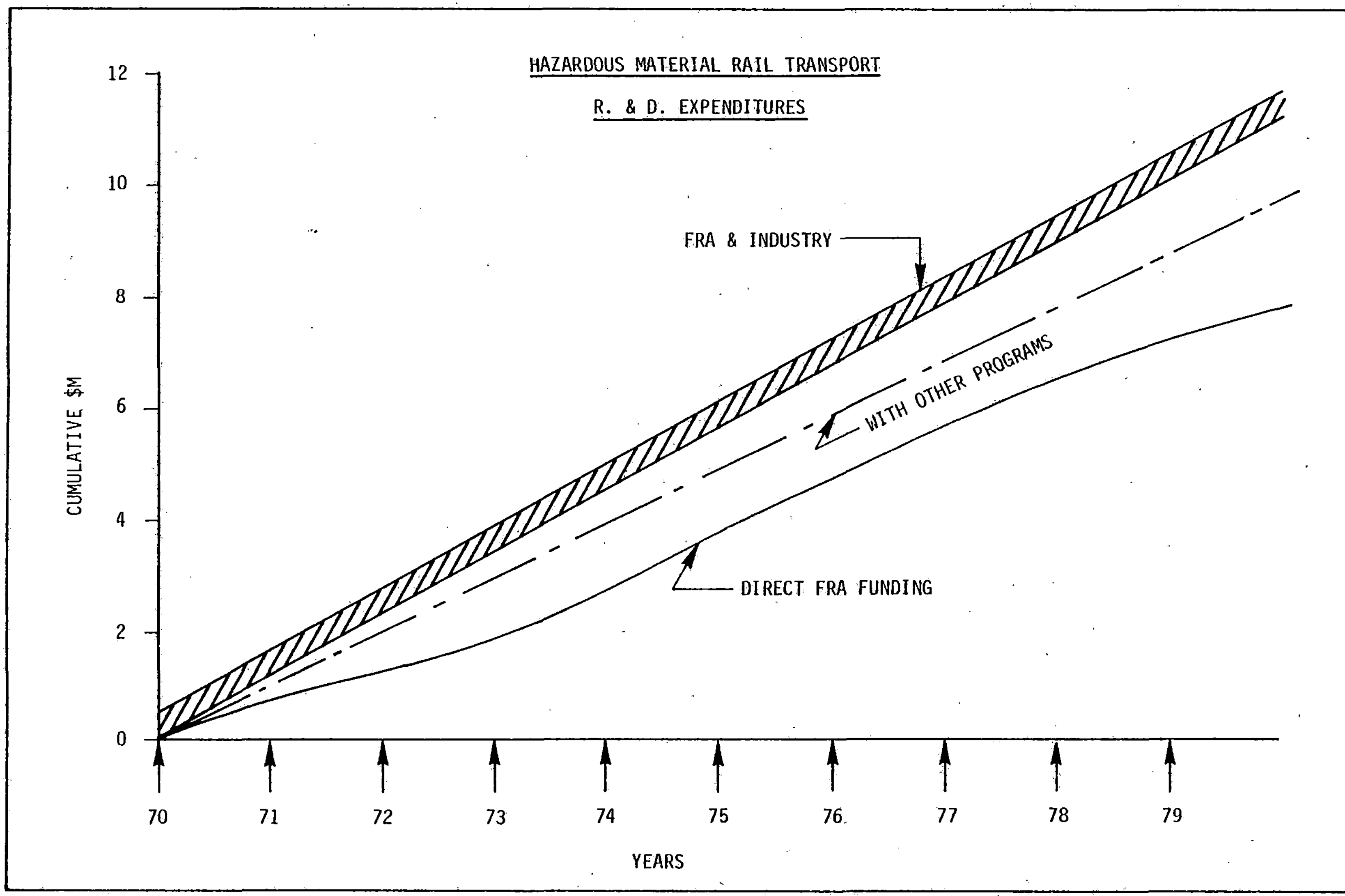
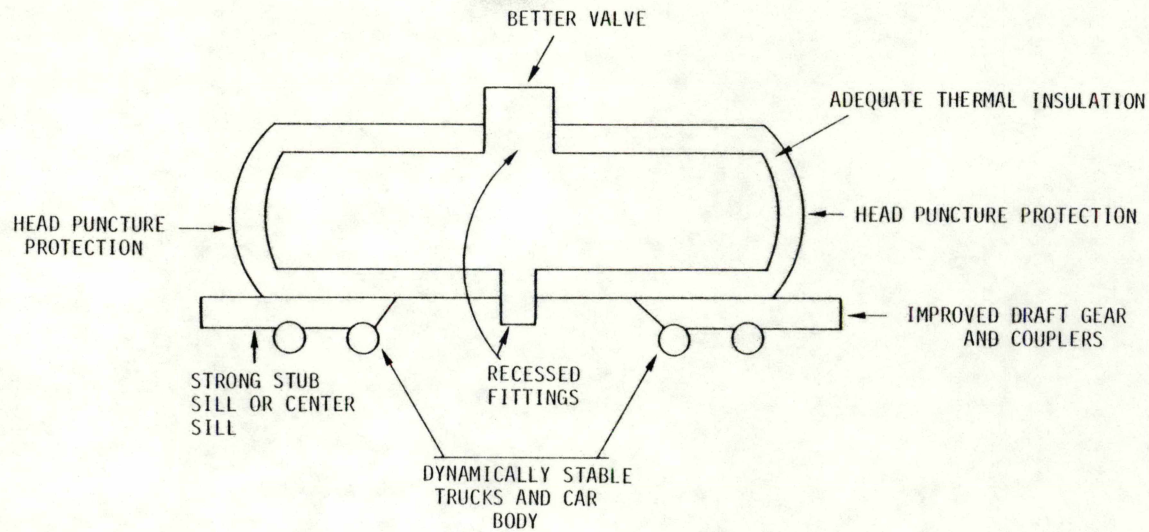


FIGURE 35

Both FRA and the railroad industry have made a substantial commitment toward solving hazardous material rail transport safety problems. The manpower and financial investment toward the end have been large as this chart shows.

RESEARCH CONCERNS TO ACHIEVE
IDEAL HAZARDOUS MATERIAL
TANK CAR



PLUS

- LOWER CENTER OF GRAVITY
- PROPER TRAIN HANDLING, CLASSIFCATION AND OPERATING METHODS (RESTRICTIONS)
- BETTER GAUGING AND LOADING/UNLOADING TECHNIQUES
- IMPROVED CRASH WORTHY STRUCTURE
- EFFECTIVE ABILITY TO WITHSTAND YARD IMPACTS AND ROAD ACCIDENT ENVIRONMENTS
- RESISTANCE TO HIGH TEMPERATURE FAILURES
- FREEDOM FROM FATIGUE FAILURES (OR "FAIL SAFE")
- ADEQUATE MARGINS OF SAFETY TO WITHSTAND TANK PRESSURES IN ACCIDENTS
- CONTINUOUS IN-TRAIN MONITORING AND AUTOMATIC ALERT OR ACTION UPON DETECTION OF DANGEROUS CONDITIONS
- OVERALL COMPATIBILITY IN TRANSPORT SYSTEM

FIGURE 36

In addressing the tank car itself, there are numerous opportunities for R&D to develop improvements. Comprehensive work covering much of the areas has been conducted by RPI/AAR and FRA.

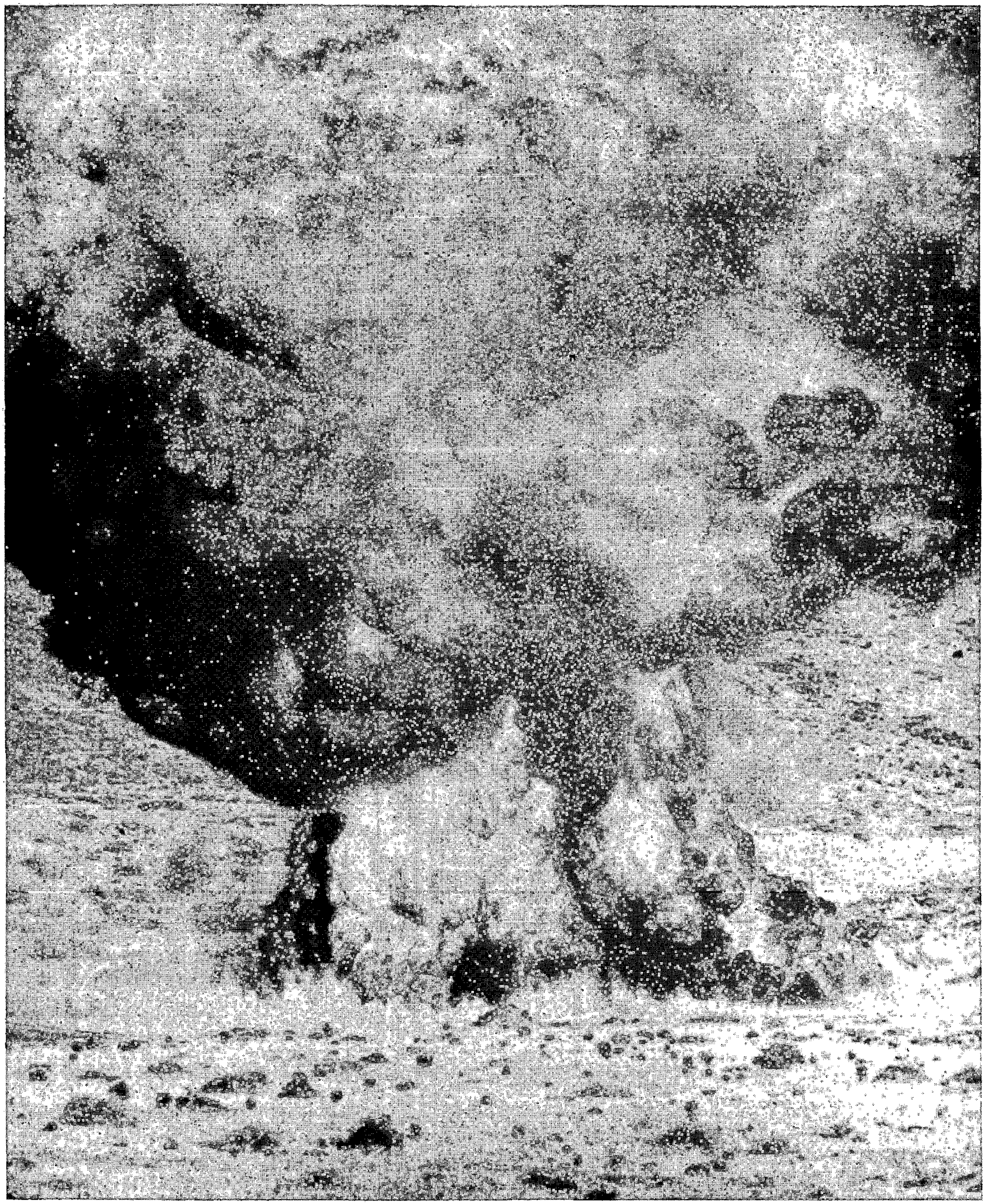


FIGURE 37

Actual full scale pool fire tests at White Sands proved the value of utilizing thermal shielding to prevent "chain reaction" propagation of tank car ruptures.

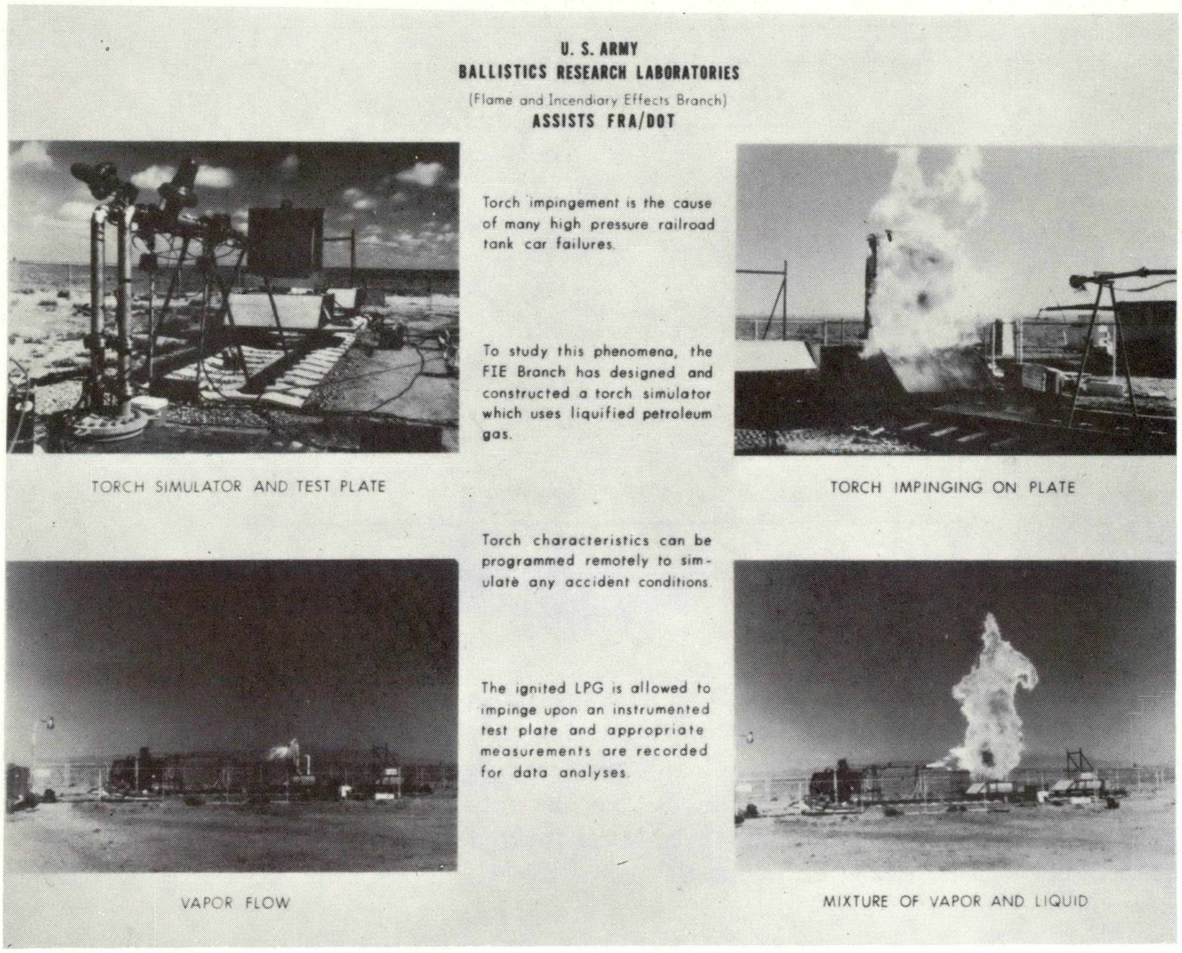


FIGURE 38

In addition, facilities to test the components of the tank car system were constructed at various locations including Edwards Air Force Base and a Torch Facility at the Pueblo Transportation Test Center. The Torch System is run for the FRA by the U. S. Army Ballistics Research Laboratory. It has proved invaluable in assessing the effectiveness of hundreds of thermal shielding systems. The FRA and AAR are striving to validate a smaller scale facility for future performance testing purposes.

TANK CAR RETROFIT PLAN

1. THERMAL PROTECTION

2. PUNCTURE PREVENTION

3. COUPLER SEPARATION AVOIDANCE

FIGURE 39

The measure of success of any R&D effort is the implementation of results. Since new equipment is procured over a comparatively long period of time, improvement in the near-term safety record of railroads must involve application to existing equipment. The government/industry joint R&D effort has been successful in producing a "retrofit" plan which has been advanced in the form of a petition by the industry. The three essential elements are listed.

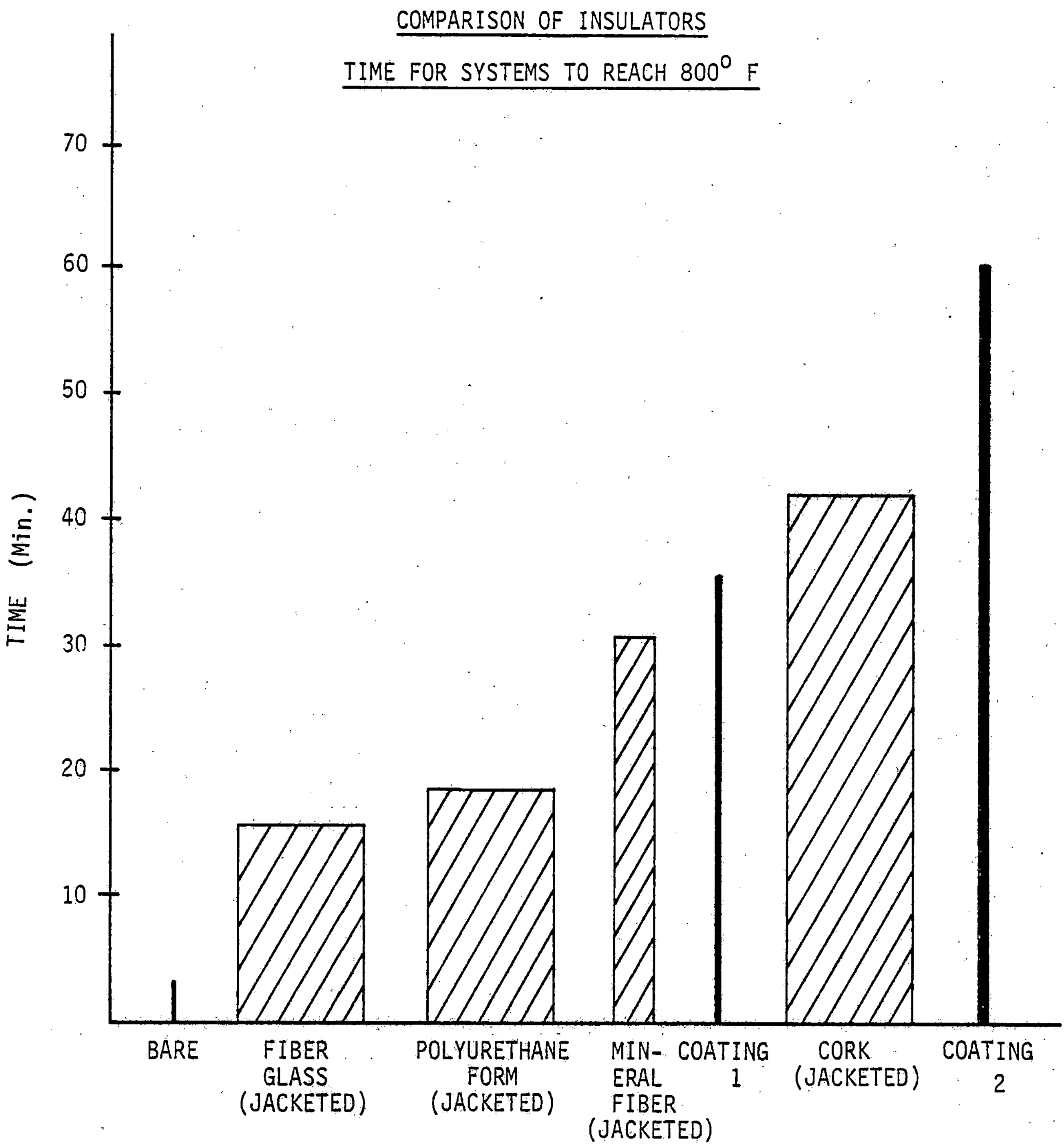


FIGURE 40

As an example of readily understandable results of the R&D conducted to produce thermal shielding for tank cars, an unprotected tank car will reach a dangerous state when subjected to a torching fire in less than 5 minutes, while a highly protected one (with a very thin coating) will not reach the same state for more than 1 hour. About 35 minutes of time is sufficient to prevent the chain reaction effect. The width of the bars above depict the thickness of the various thermal shielding candidates.

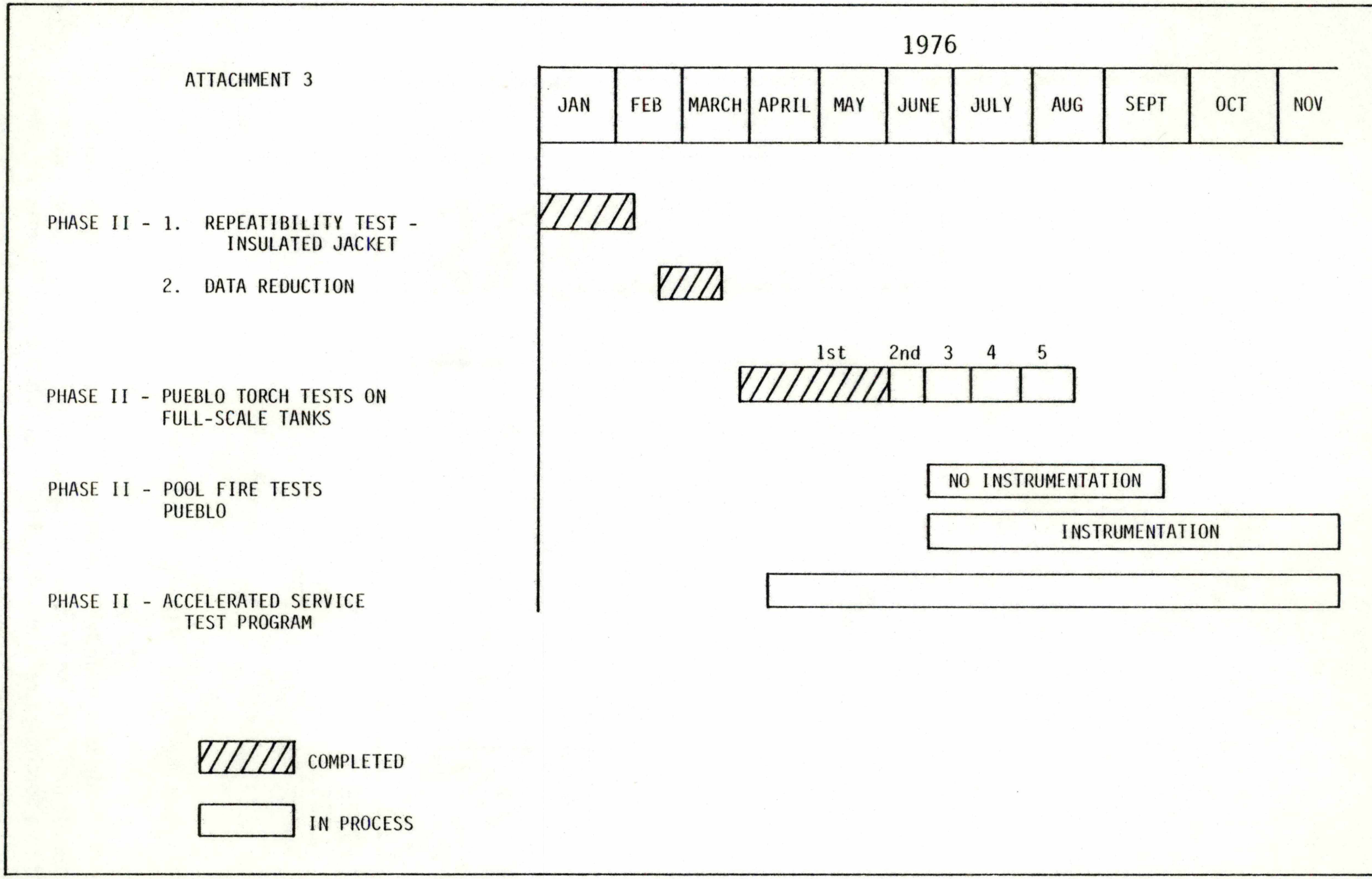


FIGURE 41

Several R&D tasks are still prerequisite to the adoption of a specific retrofit plan. The tasks include Full Scale Torch and Pool Fire Tests, (to be conducted at Pueblo) as well as accelerated service tests to determine maintenance and degradation expectations of candidates.

TANK CAR

OBJECTIVE:

SIGNIFICANT REDUCTION IN TANK CAR ACCIDENTS & CONSEQUENCES

PARTICIPANTS:

RPI/AAR, PROJECT REVIEW COMMITTEE, SHIPPERS

REQUIREMENTS:

RETROFIT PROGRAM FOR EXISTING CARS TO PREVENT CHAIN REACTION ACCIDENTS

PERFORMANCE SPECIFICATION FOR NEW CAR

MAJOR WORK AREAS:

THERMAL SHIELDING

PUNCTURE RESISTORS

COUPLERS

YARD IMPACTS

STRUCTURAL ANALYSIS

RELIEF VALVES

OPERATING FACTORS

SYSTEMS ANALYSIS

METALLURGICAL ANALYSIS

FACILITIES:

WHITE SANDS - FULL SCALE FIRE TESTS

TTC - IMPACT TESTS

RPI/AAR - LAB. FIRE TEST APPAR.

NBS - METALLURGICAL ANALYSIS

TTC - TORCH FACILITY

EAFB - VALVE FACILITY

NASA - LAB. FIRE TEST APPAR.

RESULTS TO DATE:

INDUSTRY RETROFIT PLAN

GUIDELINES FOR NEW CARS

FIGURE 42

This is a summary of the essential components of the Hazardous Material Tank Car R&D program.

LOCOMOTIVE SAFETY

OBJECTIVE:

REDUCTION IN OCCUPANT CASUALITIES & IMPROVED TRAIN HANDLING

PARTICIPANTS:

LOCOMOTIVE CONTROL COMPARTMENT COMMITTEE

AAR, U.T.U., B.L.E., LOCOMOTIVE MANUFACTURERS

REQUIREMENTS:

SAFER INTERIOR & LOCOMOTIVE DESIGN

EVALUATION OF IMPROVED HANDLING AIDS

EVALUATION OF IMPROVED ENVIRONMENT

MAJOR WORK AREAS:

LOCOMOTIVE INTERIOR

HUMAN FACTORS

IMPACT TESTING & ANALYSIS

TRAIN HANDLING AIDS EVALUATION

SIMULATOR DEFINITION

LOCO. ENVIRON. SAMPLING

FACILITIES:

TTC - IMPACT TESTS

LOCOMOTIVE CAB & TRAIN HANDLING EVALUATOR

CAB MOCKUPS

RESULTS TO DATE:

START FACILITY DEVELOPMENT

NEW LOCOMOTIVE - SAFER INTERIOR

IMPACT TESTS COMPLETED

LOCO. ENVIRON. DATA

FUTURE:

NEW FACILITY AT TTC 1979 - LOCOMOTIVE EVALUATOR

FIGURE 43

Past R&D activities to improve Locomotive Safety have been spear headed by the Locomotive Control Compartment Committee - chaired by U.T.U. and B.L.E. with members from AAR, FRA and participation of the locomotive manufacturers.

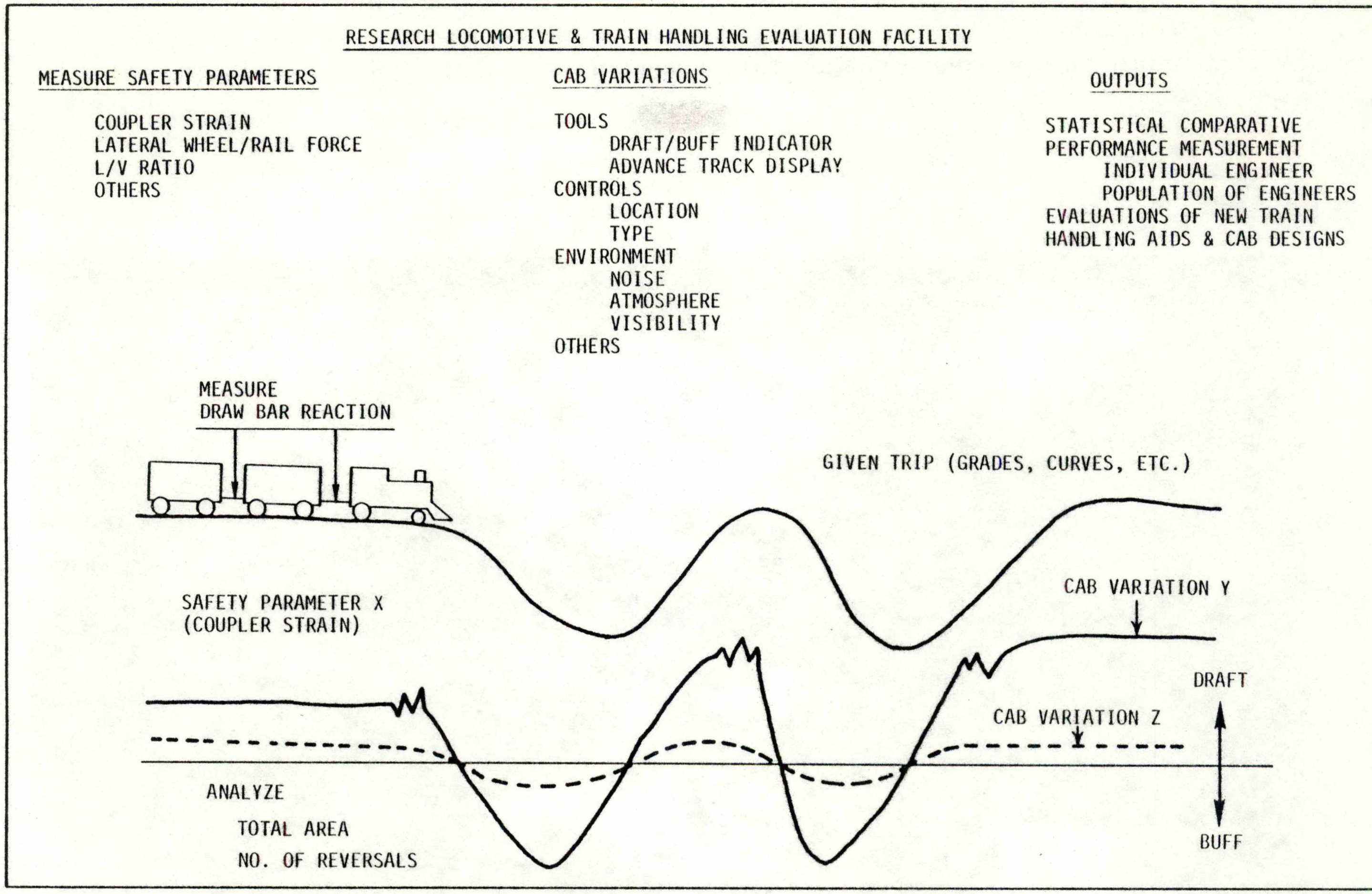


FIGURE 44

One of the future major thrusts of this activity will be the construction of a Research Locomotive and Train Handling evaluator at the Transportation Test Center. Conceptually, the Locomotive and Train Handling Evaluator will provide the means to generate the necessary realism whereby a locomotive engineer can operate the train over a simulated trip. Based on the performance (slack action) of the train, a valid statistical ranking of introduced conditions such as tools, controls, environment, etc. can be established. This facility will not merely be a "trainer" but will be a research tool used to evaluate the effectiveness of suggested changes for improvement in the handling of trains by engineers.

FIGURE 45

Outputs from joint R&D efforts in Locomotive Safety include the development of a safer cab for enginemen. This is a mock up of a "clean" cab design which is aimed at future improvement in locomotive design.

ON-BOARD MONITORING SYSTEM

OBJECTIVE:

PROVIDE ON-BOARD MONITORING ON ROLLING STOCK TO DETECT DANGEROUS CONDITIONS & TAKE AUTO. ACTION IN CASES SUCH AS JOURNAL HEATING OR DERAILMENT.

PARTICIPANTS:

NAVAL SURFACE WEAPONS CENTER — DULUTH, MISSABE & IRON RANGE RR

REQUIREMENTS:

STAND ALONE	COMPATIBLE
SELF POWERED	SAFE
INEXPENSIVE	LOW MAINTENANCE
RELIABLE	

MAJOR WORK AREAS:

ABNORMAL CONDITION DEFINITION	EQUIPMENT
DETECTION METHOD	TESTING

FACILITIES:

NEW SYSTEM

RESULTS TO DATE:

FULL SCALE TESTS - DM&IR

FUTURE:

FAST TESTING

FIGURE 46

For certain extremely hazardous commodities, special on-board monitoring systems to detect unsafe conditons may be justified. Under contract to FRA, the Naval Surface Weapons Center has developed a low-cost reliable system which (1) monitors the temperature of each journal on the car, (2) detects a derailment condition and (3) has the capability of automatically activating a brake application to stop the train. The system is being tested under actual field conditions on the Duluth, Missabe and Iron Range Railroad. The table gives further details.

DOT SYSTEM FOR TRAIN ACCIDENT REDUCTION (STAR)

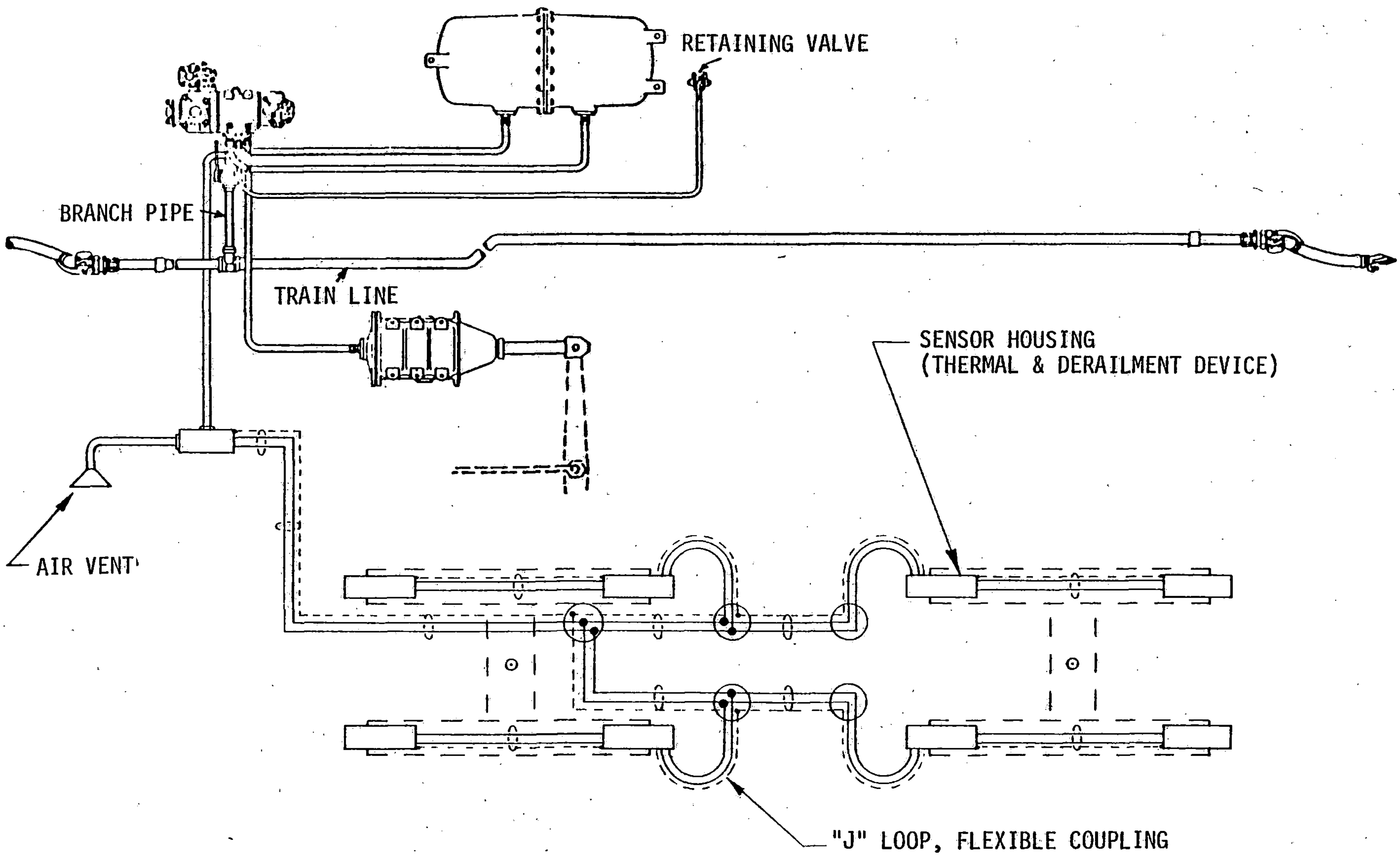


FIGURE 47

This is a sample diagrammatic representation of the system.

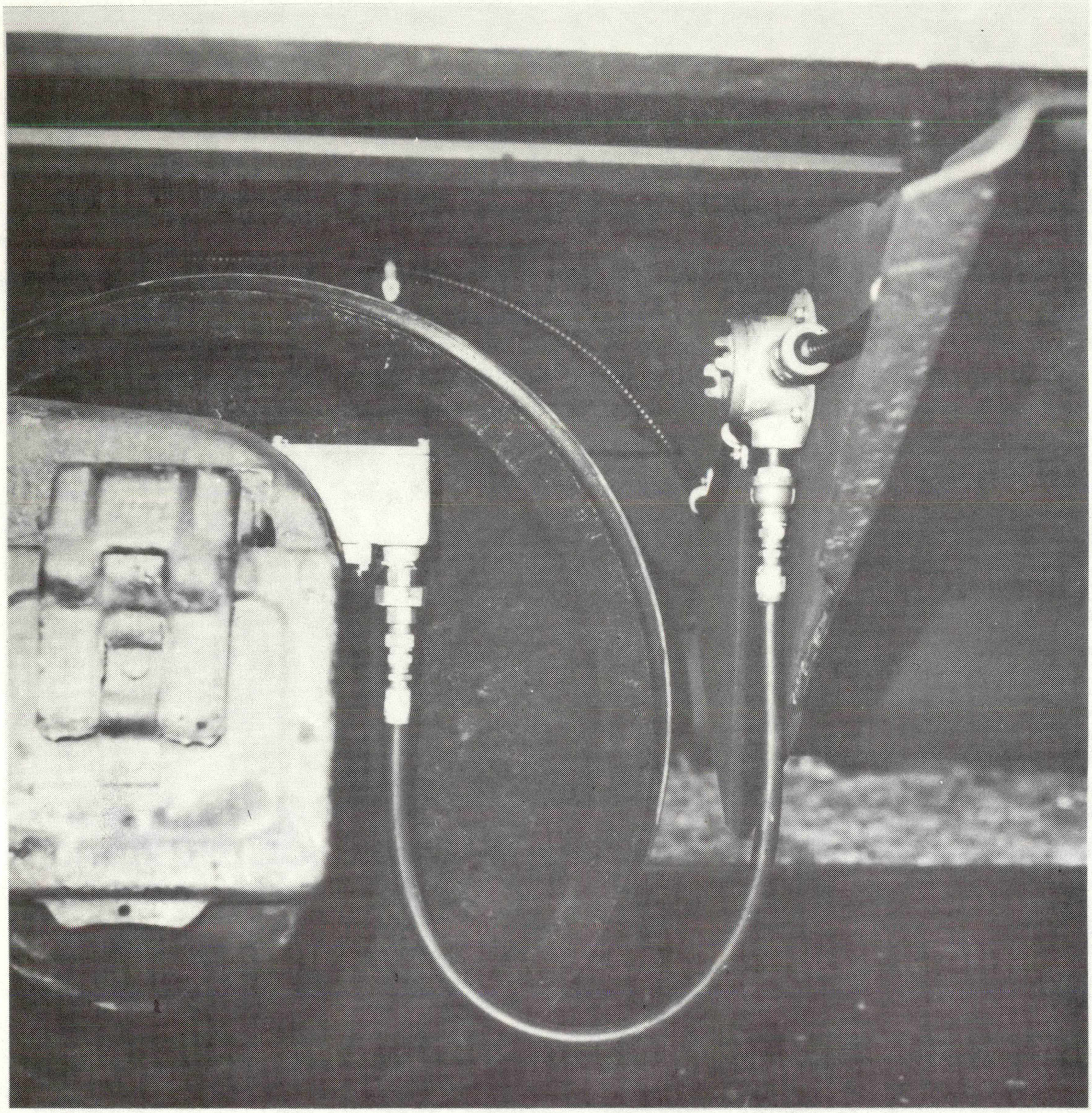


FIGURE 48
Here is an actual installation picture showing the journal sensor connection.

FIGURE 49
This is one of the D.M. & I.R. cars operating with the on-board monitoring system.

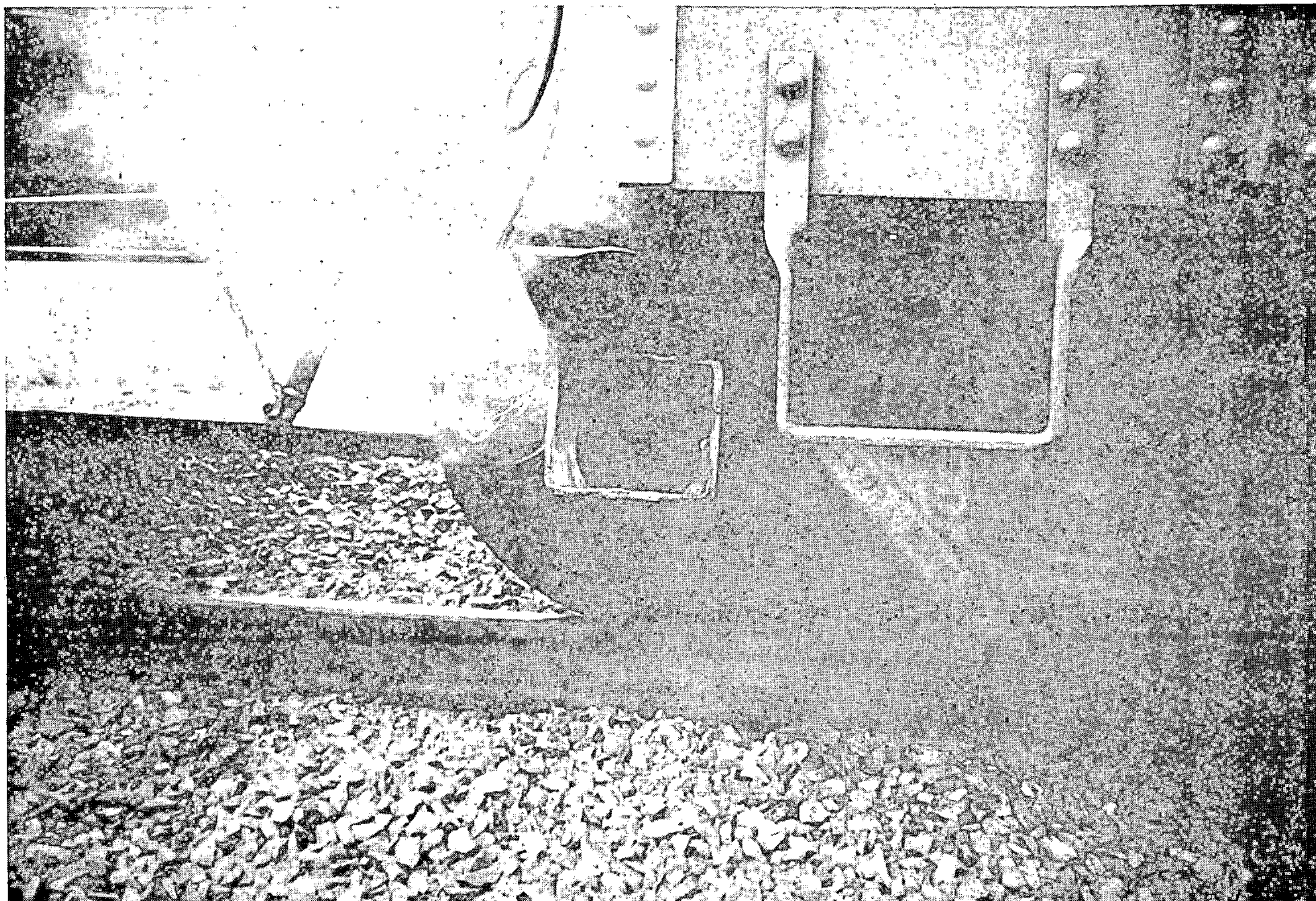


FIGURE 50

Testing on the D.M. & I.R. included creation of intentional hotboxes and derailments to ascertain the equipment needs and effectiveness.

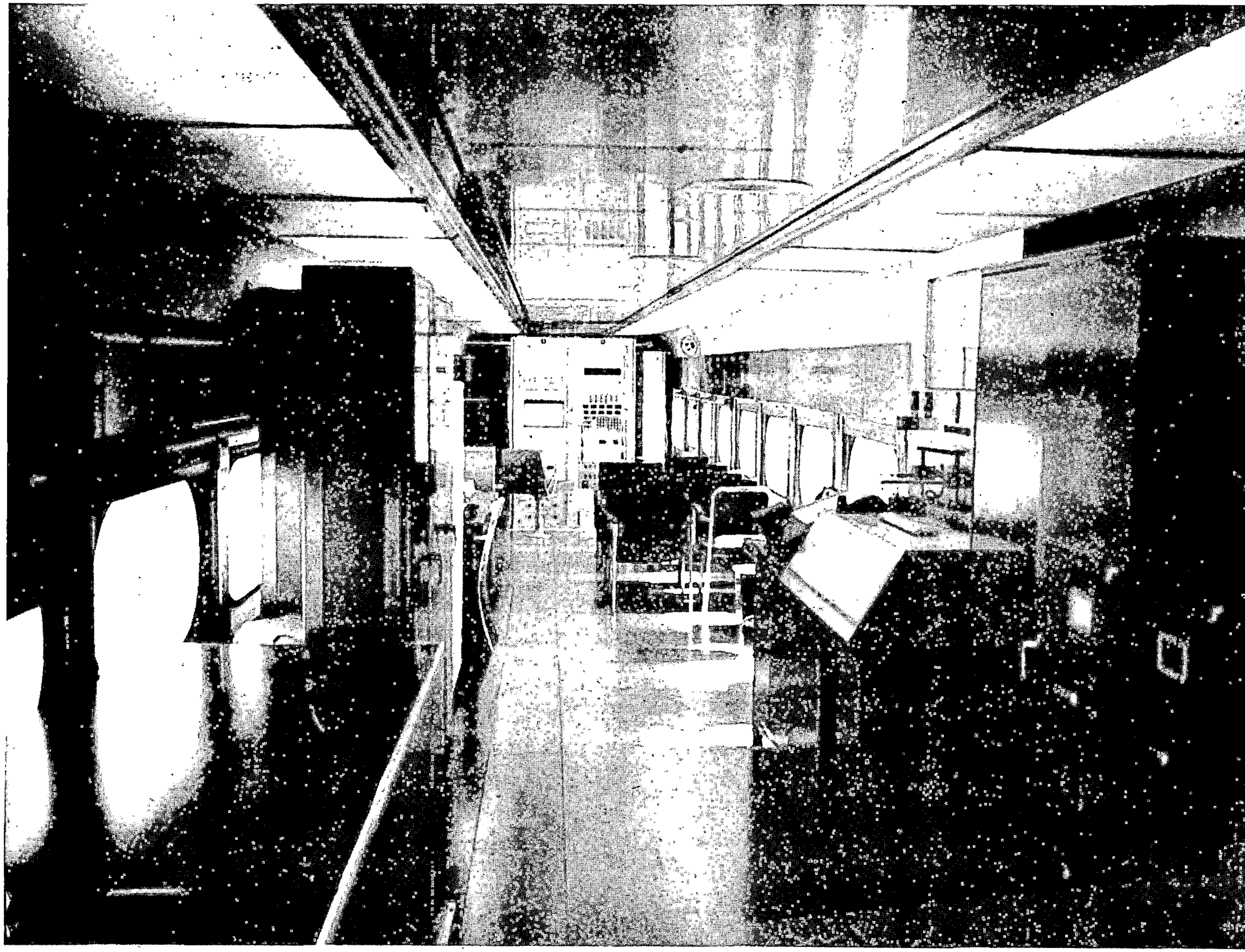


FIGURE 53

The interior of T-3, the track geometry measurement car. It is equipped with various control, computing, analytical, data processing and display devices.

FIGURE 54

The hi-rail type vehicle being developed at the Transportation Systems Center at Cambridge, Massachusetts for FRA is primarily being used to investigate, test, and improve rail flaw detection and analysis techniques.

GLOSSARY OF ABBREVIATIONS

AAR – Association of American Railroads
BLE – Brotherhood of Locomotive Engineers
B&LE – Bessemer and Lake Erie Railroad
BRL – Ballistics Research Laboratory
D.M.&I.R. – Duluth, Missabe and Iron Range Railroad
DOT – Department of Transportation
D&RGW – Denver and Rio Grande Western Railroad
EAFB – Edwards Air Force Base
FAST – Facility for Accelerated Testing
FHWA – Federal Highway Administration
FRA – Federal Railroad Administration
MTB – Materials Transportation Bureau
NAS – National Academy of Sciences
NASA – National Aeronautics & Space Administration
NBS – National Bureau of Standards
NHTSA – National Highway Traffic Safety Administration
NSWC (NOL) – Naval Surface Weapons Center
NTIP – National Track Inspection Program
NTSB – National Transportation Safety Board
O.N.E.C.D. – Office of Northeast Corridor Development
R&D – Research & Development
RPI – Railway Progress Institute
T.G. – Track Geometry
TRB – Transportation Research Board
TSC – Transportation Systems Center
TTC – Transportation Test Center
TTD – Train-Track Dynamics
UMTA – Urban Mass Transportation Administration
UTU – United Transportation Union