U.S. Department
of Transportation
Federal Railroad Administration

Operating Practices Research Plan 1993 - 1997

Report to Congress

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

EXHIBITS

FEDERAL RAILROAD ADMINISTRATION
OFFICE OF RESEARCH AND DEVELOPMENT
OPERATING PRACTICES
FIVE YEAR PLAN
1993-1997

REPORT TO CONGRESS

1.0 INTRODUCTION

1.1 Background

The Operating Practices Subprogram directly supports the Equipment, Operations and Hazardous Materials Program and the rail safety responsibility and authority specifically conferred on the Federal Railroad Administration (FRA) in the Federal Railroad Safety Act of 1970, the Occupational Safety and Health Act of 1970, the Rail Safety Improvement Act of 1988, the Rail Safety Enforcement and Review Act of 1992 and related legislation, as amended. This subprogram focuses on that research necessary to: provide for the safe performance of railroad employees in the control, handling, and transport of equipment and lading; provide for the awareness of motorists and the public of the potential hazards associated with railroad operations; and provide for informed responses to emergency situations by response organizations.

1.2 Overview

The Operating Practices Subprogram is primarily concerned with the human factors elements of railroad safety. This focus involves both management and labor in their traditional roles. Examination of traditional ways of operating a railroad can produce new or improved programs, methods, skills or skill mixes, and work environments, which will lead to improved safety performance and efficiency of railroad personnel. Evaluation of new concepts and materials can lead to improved safety environments for motorists at highway-railroad grade crossings and trespassers at other locations along the railroad. Safety, involving the use of new or advanced technologies may also be assured, or improved, through early evaluation of the human function in the operating scenario. For many reasons, these activities and their conclusions may be controversial. However, with the cooperation of management, labor and government, these research efforts can produce significant safety improvements.

Congressional interest in, and support for, this program has been increasing in recent years. The most recent manifestation of this interest is its request for this five-year research plan in the FY 1993 Senate Committee on Appropriations Report. An additional

element of the Congressional request was that the plan be reviewed by the railroad industry, both labor and management, prior to submitting the final version to Congress. This has been done through extensive consultation with the Railway Labor Executives Association and the Association of American Railroads.

Research topics are determined on the basis of: conclusions of accident investigations; practices or conditions identified by field safety inspectors as having potentially high safety risk; practices or conditions identified by railroads or railroad labor as having potentially high safety risk; potential or anticipated risks associated with changes in railroad operations and the use of new technologies; need for legislative or regulatory changes; requests or direction from the Congress; recommendations from the National Transportation Safety Board; or, most often, a combination of these considerations.

Exhibit 1 identifies the Operating Practices research projects that are currently in progress, and those planned for the next five years (by a shorthand title), under applicable topic group headings. All projects benefit the general public in various ways. More specific beneficiaries are identified in the right column of Exhibit 1.

1.3 Related Research

All projects in the Operating Practices Subprogram have at least one common theme--they are intended to contribute to the improved safety of railroad operations, from a broad human factors perspective. Research relating to railroad operations, personnel or equipment often requires the cooperation and participation of some combination of railroad management and labor, as well as suppliers. Where these organizations have conducted related research or have compiled useful data, it is incorporated into the relevant FRA project. For projects focused on highway-railroad grade crossing safety, applicable research, information and assistance are sought from Federal, State and local highway officials.

Summary project descriptions and the timeline charts presented later in this plan are organized in the same way as that presented in Exhibit 1 and, within these groupings, in rough chronological order.

Exhibit 1

FEDERAL RAILROAD ADMINISTRATION
Office of Research and Development

OPERATING PRACTICES RESEARCH PLAN
1993-1997

Topic Area	Safety Issue	Benefitted Group(s)
LOCOMOTIVE ENGINEERS	Selection for Training	Engineers, Engineer Trainees, Train Crews
	Driving Records	Engineers, Engineer Trainees, Train Crews
	Stress and Fatigue: Workshop I Workshop II Phase II Workshop III Seminar	Engineers, Train Crews
LOCOMOTIVE CABS	Advanced Alertor	Train Crews, Other Trains
	Ergonomics	Train Crews
	Advanced Train Control Systems	Engineers, Train Crews, Dispatchers
TRAIN DISPATCHERS	Study Designs	(see below)
	Workload, Stress and Fatigue: Phase I Phase II Phase III	Dispatchers, Train Crews
	Selection for Training	Dispatchers
	Training	Dispatchers
	Dispatch Center Simulator: Engineering Studies	Dispatchers, FRA

Exhibit 1 (continued)

Topic Area	Safety Issue	Benefitted Group(s)
HIGH-SPEED GUIDED GROUND TRANSPORT	Human Factors Issues	Operating Personnel, Passengers
	Stress and Fatigue	Operating Personnel, Passengers
	Training	Operating Personnel, Passengers
	Simulator: Engineering Studies	Operating Personnel, Passengers
GENERAL	Impairment Testing	All Operating Personnel
	Operating Rules	All Operating Personnel
	Train Make-up	All Operating Personnel
GRADE CROSSING SAFETY	Operation Lifesaver	Motorists, Trespassers, Vandals, Train Crews
	Freight Car Reflectorization	Motorists, Train Crews
	Locomotive Conspicuity	Motorists, Train Crews
	Horn Systems	Motorists, Train Crews, Neighborhoods
	Crossing Closings	Motorists, Train Crews, Neighborhoods
	Barriers	Motorists, Train Crews, Neighborhoods
YARD AND TERMINAL SAFETY	Switching, Hazmat Loading/Unloading	Yard and Terminal Workers

2.0 OBJECTIVES

The primary objectives of this subprogram are to: (1) provide information, methodologies, training and/or aids necessary to enhance the safety of railroad operating practices, with special emphasis on human factors; (2) provide guidelines and tools to improve the ability of railroad operating personnel to safely manage complex control demands when operating conventional or advanced technology trains under usual or adverse conditions; and (3) provide information, methodologies and awareness needed to improve safety for motorists at grade crossings, and for other members of the public whose activity may conflict with railroad operations.

3.0 SCOPE

This plan encompasses that research uniquely related to railroad operating practices and human factors. The major emphases are on human factors, including: workload, stress and fatigue; selection for training; training; qualifications; worker-mechanical interface; worker-operating system interface; use of simulators for research and training; and motorist awareness and protection at highway-railroad grade crossings. Each topic is focused on safer and more efficient railroad operations. This subprogram also provides for anticipatory needs, industry coordination and participation, and technology sharing activities to assure maximum application and use of research results.

4.0 INTERFACES

The primary user of the research results from this subprogram will be the railroad industry, including railroad labor, in their efforts to improve employee selection, training, job environment, safety oversight, and operating techniques. FRA's Office of Safety is also likely to be affected in their inspection, safety oversight and rulemaking functions. Offices and organizations most often involved in project coordination activities are:

- Federal Railroad Administration
  - Office of Safety
  - Office of Chief Counsel
- Federal Highway Administration
- National Transportation Safety Board
- Association of American Railroads
- American Short Line Railroad Association
- Brotherhood of Locomotive Engineers

- United Transportation Union
- American Train Dispatchers Association
- Foreign governments, railroads and suppliers

5.0 APPROACH

Exhibit 1 groups the projects described in this plan under seven relational topics. They are: Locomotive Engineers; Locomotive Cab; Train Dispatchers; High-Speed Guided Ground Transport; General; Grade Crossing Safety; and Yard and Terminal Safety. Projects within these topic areas, described in this plan, are expected to produce a project report or to require funding during the five-year period covered by this plan. Activities within the Operating Practices Subprogram which do not meet one or both of these criteria are not included in the plan. One such activity is the oversight of the operation and maintenance of the Research and Locomotive Evaluator/Simulator (RALES).

RALES is used in a variety of research projects. Currently, it is the primary tool for conducting tests of locomotive engineer performance in the Enginemen Stress and Fatigue project. Its computer models also find uses off-line from actual operation of the simulator. One such project involved determining applicable braking curves for use in Automatic Train Control devices required on trains operating in the Northeast Corridor.

Research outcomes are expected to be recommendations relating to the railroad operating environment, equipment use and design. It can also be expected that some of these recommendations will be proposed for inclusion in regulations. Success, in terms of both substantive validity and user acceptance of the techniques and recommendations that evolve from these research efforts, requires close coordination with the railroad industry. This includes drawing upon the experience and insights of many individuals, and effectively disseminating research results.

6.0 WORK PLAN

The current five-year plan for the Operating Practices Subprogram consists of 25 projects grouped in 7 topic areas. Some projects have several phases or subparts. Each project is described in the subparts of this section. Each topic area includes a timeline chart for the projects in its grouping.

6.1 LOCOMOTIVE ENGINEERS (Exhibit 2)

6.1.1 Selection for Training ("Selection of Locomotive Engineer Trainees")

Description: The objectives of this project are to:

(a) Perform job analysis to determine essential knowledge, skills and abilities;

(b) Develop and validate a set of tests to predict applicants who will succeed in locomotive engineer training, and become safe and effective train handlers; and

(c) Document all results and procedures to ensure that tests are fair, valid and in accordance with technical and legal standards.

This project was originally designed in two phases. The first was to develop the appropriate screening tests and perform a concurrent validation, using experienced locomotive engineers. The Phase I report is under review. The second phase was intended to provide a predictive validation, by testing candidates for locomotive engineer training and tracking those selected through training and their first year or two as operating engineers. Based upon the preliminary findings of Phase I, it is unlikely that Phase II will be needed. However, it remains on the timeline chart until that decision becomes final. Nine railroads are participating.

Output: A validated battery of screening tests (currently consisting of three individual tests), with instructions on administering and scoring, will be made available to all railroads. The tests will permit the identification of those applicants most likely to succeed, after appropriate training, in becoming skilled and safe locomotive engineers. Every step of the test development and validation process will be documented to ensure that use of the tests can withstand legal challenge, if necessary.

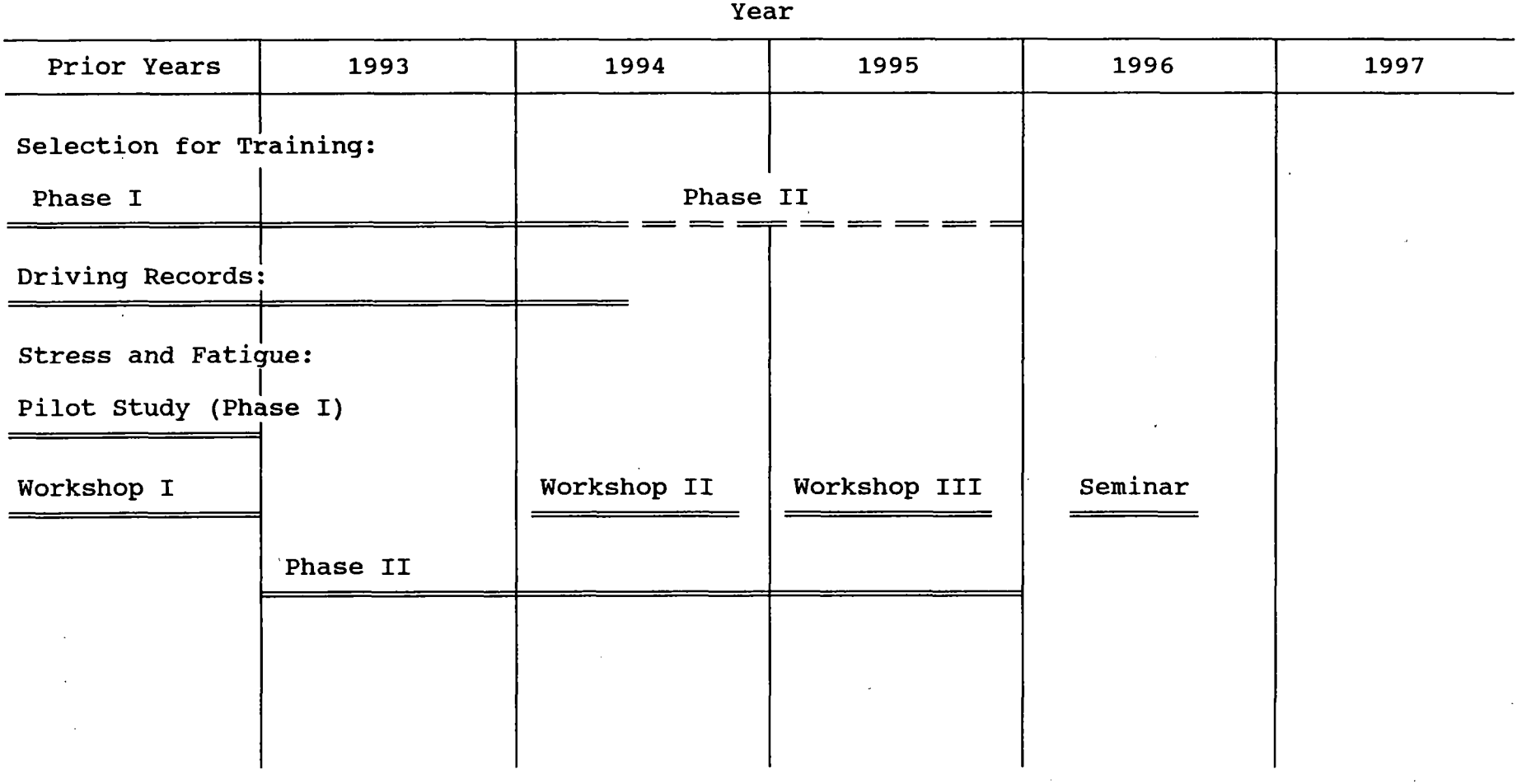
Contractor: University Research Corporation

6.1.2 Driving Records ("Enginemen Driving Records and Train Handling")

Description: The Rail Safety Improvement Act of 1988 directed FRA to consider the motor vehicle driving records of individuals seeking certification as

Exhibit 2

LOCOMOTIVE ENGINEERS



locomotive engineers. The rule establishing the certification process includes consideration of alcohol and drug violations that appear in engineers' motor vehicle driving records. This project was designed to determine if other motor vehicle driving violations are predictive of the train handling, safety-related behavior of locomotive engineers. The project was started in the late summer of 1991 and was expected to take approximately one year. Difficulties in obtaining and processing required railroad source data have slowed the process substantially. The draft final report is currently being revised. Five railroads participated.

Output: The result of this research and analysis will be the determination of whether there is a legally valid and supportable basis for including certain violations recorded in motor vehicle driving records in the certification process for locomotive engineers. If the study concludes that certain motor vehicle violations are strongly related to the safety behavior of locomotive engineers, it is anticipated that the rule on engineer certification will be modified accordingly.

Contractor: IIT Research Institute

6.1.3 Stress and Fatigue ("Enginemen Stress and Fatigue")

Description: The objective of this project is to improve the safety and efficiency performance of locomotive engineers by identifying those stress and fatigue factors most likely to adversely affect performance, and by recommending appropriate actions to counteract these adverse effects.

A variety of often interrelated variables are being given attention, including: biological rhythms; sleep/rest cycles; sleep deprivation; crew calling and scheduling practices; implications of away from home layovers; length of duty period; time of day of duty period; boredom; and locomotive cab working environment.

The project is being executed in several parts. As presently conceived, they are: a pilot study; three workshops; Phase II; and a seminar. Each is described in the following paragraphs.

The pilot study has been completed, and the final report was published in March of 1993. The primary objective of this effort was to evaluate a small number of test procedures with potential for broader application in later phases of the research. Efforts were made to measure differences in locomotive engineer performance

under conditions involving the manipulation of circadian rhythm, sleep deprivation and length of duty period while holding other variables constant. Four locomotive engineers served as test subjects.

Workshop I was held in early October 1992. It was sharply focused to bring together experts with substantial and distinguished experience conducting research, in other industrial settings, involving biological rhythms, sleep disorders, shift work and related topics, with FRA experts in locomotive and railroad operations, and human factors specialists from the Volpe National Transportation Systems Center. The prime objective was to translate the knowledge of stress and fatigue-related research gained in non-railroad settings to application in the railroad operating environment, particularly as it applies to this research effort. A report from this workshop is nearing completion. Workshop II is expected to be held in late 1994, and will build on the work of Workshop I and the information available from early work in Phase II of Enginemen Stress and Fatigue. Workshop III is planned for 1995 to evaluate findings to that point in the research.

Phase II of Enginemen Stress and Fatigue builds on the Pilot Study and Workshop I. Task 1 will produce test protocols based on the knowledge gained from the Pilot Study, Workshop I and another round of testing using a small sample of test subjects. It is currently estimated that at least 60 locomotive engineers will be needed as test subjects during Phase II to provided statistically reliable results. Given the lean duty rosters now maintained by most railroads, obtaining these test subjects in a timely manner may prove to be among the most difficult tasks of this project. The Research and Locomotive Evaluator/Simulator (RALES) is the primary tool for measuring engineer performance under various fatigue conditions.

When the results of Phase II are published (probably 1996), a seminar is planned to disseminate its recommendations as widely as possible throughout the railroad industry.

Output: This research is designed to produce recommendations leading to changes in railroad practices and/or FRA regulation, concerning railroad operating practices, that are intended to improve the safety of operations, as they relate to train crew vigilance.

Contractor: IIT Research Institute (Pilot Study and Phase II, with consultants)

Technical Assistance: Volpe National Transportation Systems Center (technical support to FRA; Workshops I, II and III; and Seminar)

6.2 LOCOMOTIVE CAB (Exhibit 3)

6.2.1 Alertor ("Advanced Alertor")

Description: Accident investigations have concluded that, in some instances, locomotive engineers have unconsciously reset alertors, in a reflex-type response to the light prompt, while dozing or asleep. Accidents involving fatalities have resulted. This project was initiated through the Small Business Innovation Research (SBIR) Program to develop a low-cost retrofit for existing alertors that would preclude such responses to the alertora. Feasibility studies (Phase I) were initiated in September 1992. Development and testing (Phase II) are planned to begin in the spring of 1994.

Output: This research is expected to produce a commercially available, low-cost kit for retrofitting existing alertors that will eliminate the possibility of engineers resetting alertors while dozing or asleep.

Contractor(s):

Phase I: Pulse Electronics, Inc.; Technology International, Inc.

Phase II: Pulse Electronics, Inc.

6.2.2 Ergonomics ("Evaluation of Locomotive Cab Ergonomics")

Description: There are several configurations of locomotive cab interiors being operated by U.S. railroads. Intuitively, some appear to be safer work places for locomotive crews than others. New forms of traditional control equipment (gauges, meters, levers, etc.) are being introduced or planned for introduction into existing and future cabs. Also, additional new equipment (computer terminals, CRT displays, etc.) is being placed in cabs of existing design and is planned for new locomotive cabs when they are ordered from manufacturers. The AAR has created a Locomotive Cab

Committee and a Locomotive Cab Integration Committee to deal with various aspects of standardization, safety and efficiency. The Locomotive Control Compartment Committee, composed of members from the Brotherhood of Locomotive Engineers, the United Transportation Union, the Association of American Railroads, the Federal Railroad Administration, and with alternating railroads and suppliers, is also concerned with these aspects of this changing cab environment, especially those relating to safety.

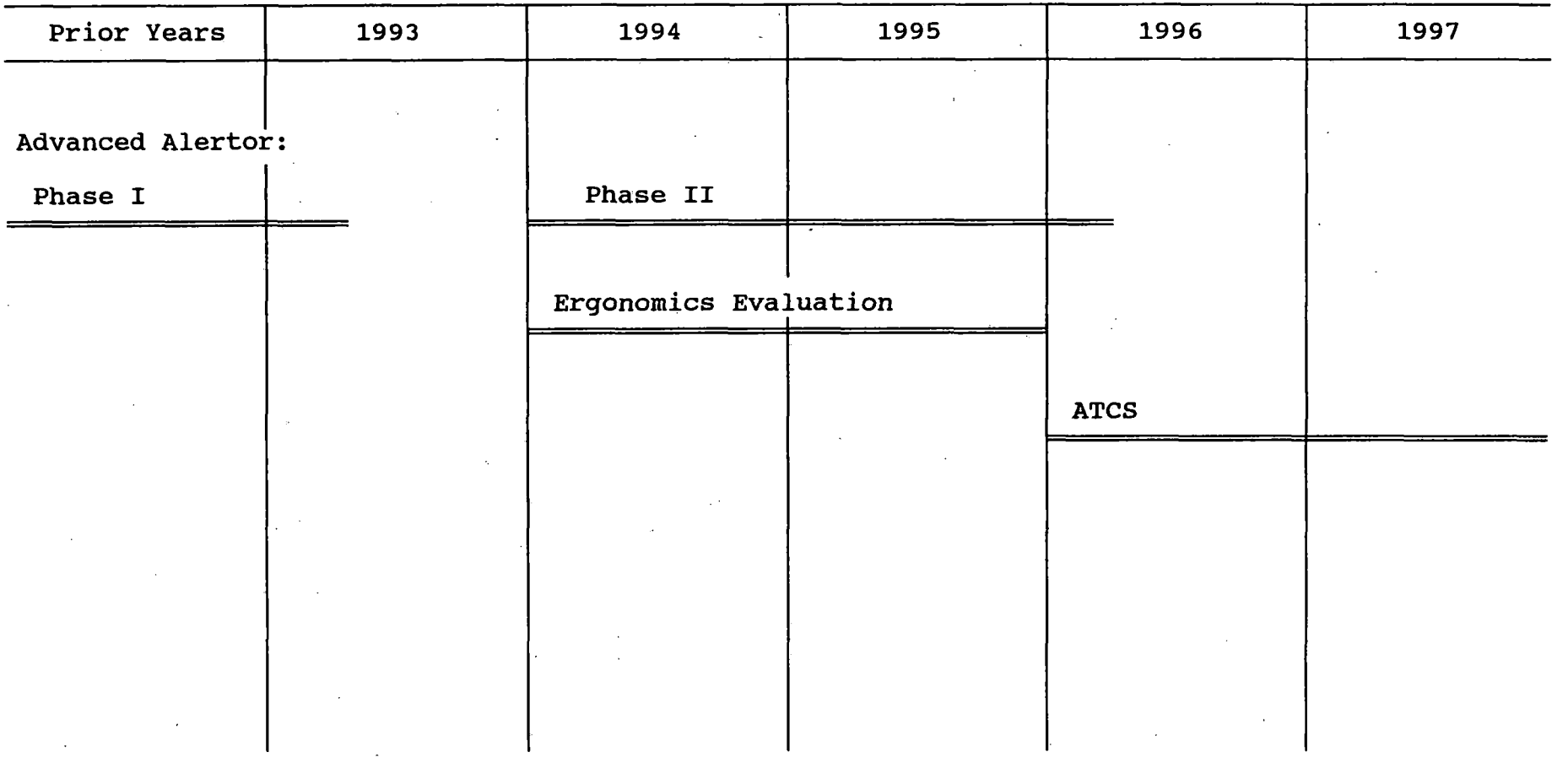
This project is planned to focus on the environment of locomotive cabs, both existing designs and those being designed, from the perspective of safety for the locomotive crew during accidents and their safety performance during train operations. In addition to a focus on new designs and technology, the cab environment will be examined, including air quality, noise, climate control and related conditions. This project was initiated in February 1994. FRA does not intend to duplicate work performed by AAR or others. Crashworthiness studies are being conducted under the Equipment and Components Subprogram.

Output: This project will produce recommendations for the design or retrofit of locomotive cabs, to include: placement and design of instrumentation and controls; securement of equipment and other appurtenances; and padding, corners, lighting and other safety-related environmental elements.

Work By: Volpe National Transportation Systems Center

Exhibit 3

LOCOMOTIVE CABS



6.2.3 ATCS (Advanced Train Control System Evaluation)

Description: This project is intended to evaluate, from a human factors perspective, the safety implications of advanced train control system (ATCS) components upon the performance of locomotive engineers and dispatchers, while acting independently and interactively. An early evaluation of one version of a locomotive cab display was completed in 1992. Additional evaluations of ATCS equipment and equipment designs are planned, as they become available. However, if such evaluations by various segments of the railroad industry are adequately documented, FRA will turn its attention to other safety issues. This equipment is currently expected to be available to begin testing in 1996. Equipment and interfaces likely to be considered include:

- o CRT displays - location, size, format of information, usefulness of information;
- o Keypads - location, shape, size, function, ease of use (several types and configurations are anticipated); and
- o Locomotive Dispatcher interface - voice and data link message accuracy, reliability and usefulness.

Output: This research will either validate the safety, from a human factors perspective, of the design, placement and use of the ATCS equipment provided for locomotive engineers and dispatchers, or it will produce recommendations for necessary changes.

Contractor: TBD

6.3 TRAIN DISPATCHERS (Exhibit 4)

6.3.1 Study Designs ("Dispatcher/Dispatch Center Evaluation")

Description: The report, "National Train Dispatcher Assessment 1987-1988," published by FRA's Office of Safety in July 1990, made several recommendations for the further evaluation of situations and issues related to dispatcher jobs and dispatch centers. This includes concerns resulting from the consolidation of dispatch operations and the introduction of newer technologies. The first step in responding to these recommendations is to develop study designs for: workload, occupational stress, fatigue, selection for training, and training. Drafts of these study designs were received near the end of 1993 and are under review.

Output: Study designs to: evaluate dispatcher workload, stress and fatigue, in a three-phase structure; develop tests for the selection of applicants for dispatcher training; and evaluate current dispatcher training programs.

Contractor(s): TBD

6.3.2 Workload, Stress and Fatigue

Description: Dispatcher workload, occupational stress and fatigue will be evaluated in the same three-phase project because there are data and analysis requirements common to all three topics. Phase I is planned to develop data collection and analysis instruments, establish necessary railroad relationships and scope the following phases; Phase II is planned as a small scale test of the protocols and instruments developed in Phase I; and Phase III is to be the full scale study. Phase I is planned to start in late 1994, Phase II in late 1995 and Phase III in mid-1996.

Output: A model for measuring dispatcher workload will be developed which can be consistently applied by supervisors and FRA inspectors. Sources of adverse stress and fatigue will be identified and measures recommended to offset, reduce or eliminate these influences. Thresholds will be established for maximum safe workload. Attempts will be made to identify similar thresholds for stress and fatigue. Results will be made available to all railroads and have the potential for becoming the basis for FRA rulemaking.

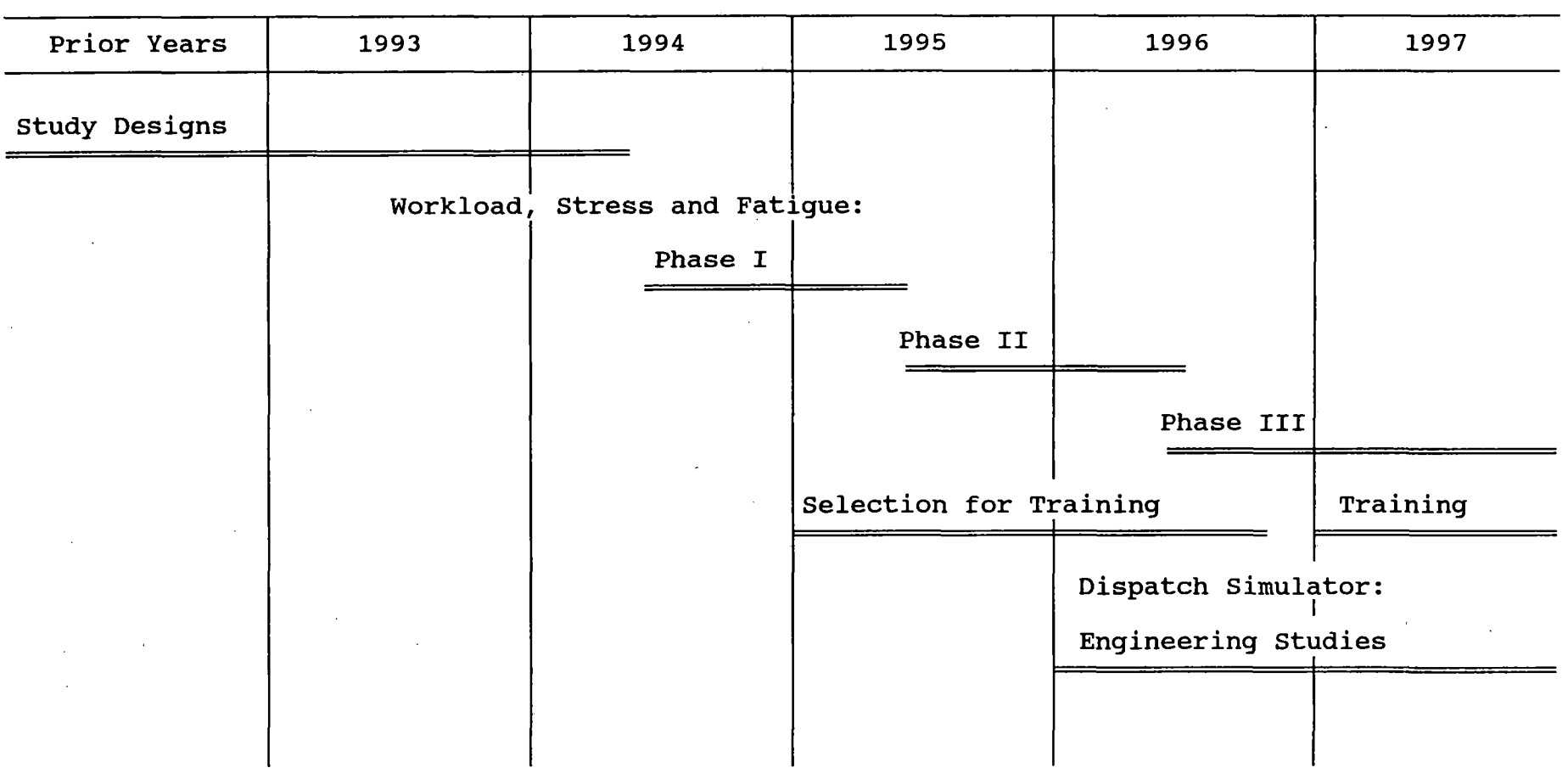
Contractor: TBD

6.3.3 Selection for Training

Description: A detailed job analysis to determine essential knowledge, skills and abilities will be conducted. Based on this analysis, a battery of tests will be developed and validated to predict those applicants for dispatcher training who are most likely to succeed as safe and efficient dispatchers, following appropriate training. Sources of related work, such as that involving air traffic controllers, will be reviewed and evaluated. The project is planned to begin in late 1994 or early 1995 and should be completed in about two years.

Exhibit 4

TRAIN DISPATCHERS



Output: This project is being designed to produce a technically and legally valid group of tests for the selection of applicants for dispatcher training who, after appropriate training, are most likely to succeed as safe and efficient train dispatchers. Instructions for administering and scoring these tests will also be produced. The tests and instructions will be made available to all railroads.

Contractor: TBD

6.3.4 Dispatch Center Simulator

Description: Experience with the Research and Locomotive Evaluator/Simulator (RALES) and spinoff simulators has proven the value of simulators for both training and research. A modular simulator which may be configured in a variety of ways to be representative of most dispatch centers, or work stations within these centers, is envisioned. Such a simulator would be designed for use in both training and research. Desirably, this simulator would be designed and located so it might be used both in conjunction with or independently of RALES. Some railroads currently have dispatcher simulators for training purposes. The first step in this project would be to inventory and assess the capabilities of these existing simulators. Current assumptions are that these simulators: (1) are unlikely to represent the desired range of dispatcher work station types; and (2) are not satisfactorily designed for research. If these assumptions are true, a feasibility and engineering study will be initiated. If feasibility is proven and costs are determined to be reasonable, simulator design will be undertaken. Assessment of existing simulators, and feasibility and engineering studies are planned to start in 1996.

Output: This project is expected to produce performance requirements for a modular, state-of-the-art dispatcher center simulator capable of a variety of configurations representative of dispatch work stations on most railroads. The design would be to support both training and research activities. If feasible and cost effective, design and construction would be expected to occur following the period covered by this plan. If experience with RALES is useful for this application, after the simulator has been built and its value proven, railroads will first use it for training and later build spinoffs appropriate to their own needs.

Contractor: TBD

6.4 HIGH-SPEED GUIDED GROUND TRANSPORTATION (Exhibit 5)

6.4.1 Human Factors Issues ("Evaluation of Human Factors in High-Speed Train Operations")

Description: At speeds exceeding 110 mph, what control functions can an operator be reasonably expected to perform safely and efficiently? Should such an operator be on-board or located in a control center? Or both? How many continuous hours can an operator be reasonably expected to operate while remaining vigilant and efficient? How much rest is desirable between duty periods? Assuming that operating control will or must be computer assisted, what mix, types and configuration of displays, audible signals and printed information are most appropriate for operators to maintain safe train operations? These and other safety-related questions must be answered as higher-speed trains, such as the X-2000 and the ICE trains now being evaluated by Amtrak, are placed in service. Information available from other countries will be fully evaluated. This project is intended to begin addressing these human factors issues. Early work is planned to begin in mid-to-late 1994.

Output: It is anticipated that recommendations for in-depth studies of some topics will be made, as well as recommendations regarding equipment design, operating practices, operating rules, crewing, train control strategies and passenger safety.

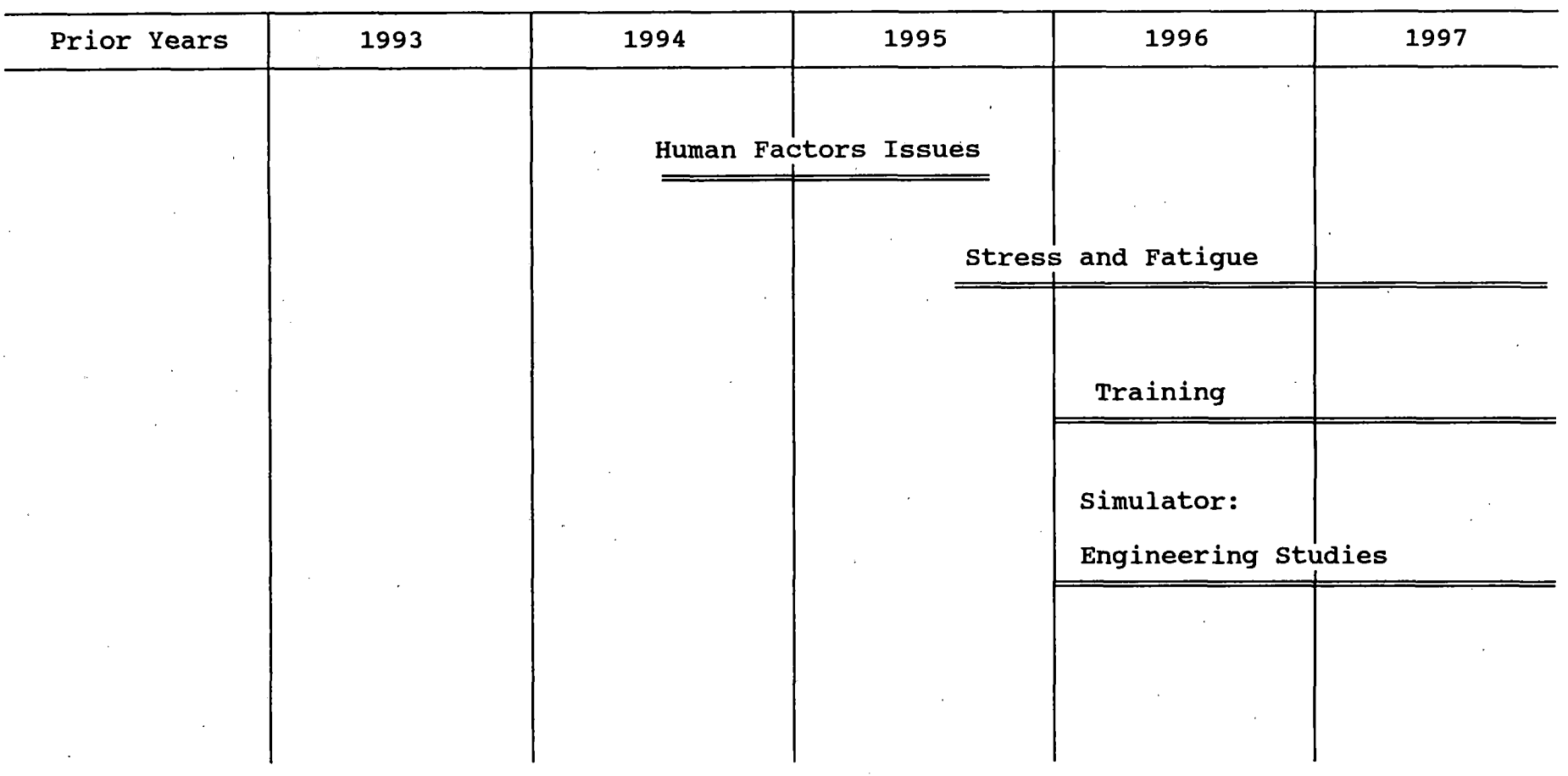
Contractor: TBD

6.4.2 Stress and Fatigue

Description: Based on current work on stress and fatigue involving crews of conventional trains, and that being planned for dispatchers on conventional railroads, it is anticipated that this is one of the topics that will require special attention in the context of high speed operations. Those lessons learned from the research involving conventional railroad operations and information available from foreign high-speed operations will serve as the beginning point for examining the particular implications of the high speed environment on operator stress and fatigue. This project is planned to begin in 1995.

Exhibit 5

HIGH-SPEED GUIDED GROUND TRANSPORT



Output: Recommendations expected to flow from this work will include such topics as: hours of service; operator scheduling; on-duty, off-duty cycles; on-board operator and control center operator teaming; and both on-board and remote control center work environments. Some of these recommendations may be expected to form the basis for FRA rulemaking.

Contractor: TBD

6.4.3 Training

Description: The new technology, operating practices, areas of responsibility and types of service provided, that are unique to various high-speed train operations dictate substantial revisions to conventional training programs for train operators (both on-board and control center). This project is planned to ensure that railroad training programs include the correct subject matter, in the proper mix, to produce safe and skilled operators; that training methods are adequate; that testing frequency and methods are sufficient to assure continuing operator proficiency; and that the training and testing program satisfactorily meets the intent of FRA certification requirements. This project is planned to start in 1996, with the expectation that Amtrak will be operating, or preparing to operate, 125-mph trains in some corridors.

Output: This project will produce recommendations for changes in railroad training programs for high-speed operations and FRA operator certification procedures, as warranted.

Contractor: TBD

6.4.4 Simulator

Description: Experience with the Research and Locomotive Evaluator/Simulator (RALES) and spinoff simulators has proven the value of simulators for both training and research. While state-of-the-art for its purpose, the technology used in RALES is not capable of simulating operations at speeds of 110 mph or greater. This project is planned to conduct feasibility and engineering studies to determine: required performance characteristics for high-speed train and control center simulators, if appropriate technology exists to build such simulators, and whether the availability of such simulators would be cost beneficial for training and research. The first step in the feasibility and engineering study would be to determine what high-speed

simulator technology exists in Europe and Japan, if any, and its capabilities. If such simulators are determined to be both feasible and cost effective, the next step would be the design of the desired simulator(s). Feasibility and engineering studies are planned to begin in 1996. Design would begin after the time horizon of this plan.

Output: The primary product of this project would be the determination of whether high-speed train operations simulator(s), for use in operator training and for research, particularly for human factors research, are feasible and cost effective. If designed and constructed, use of these simulators would be available to railroads, suppliers and government.

Contractor: TBD

6.5 GENERAL (Exhibit 6) (applicable to all railroad operating personnel)

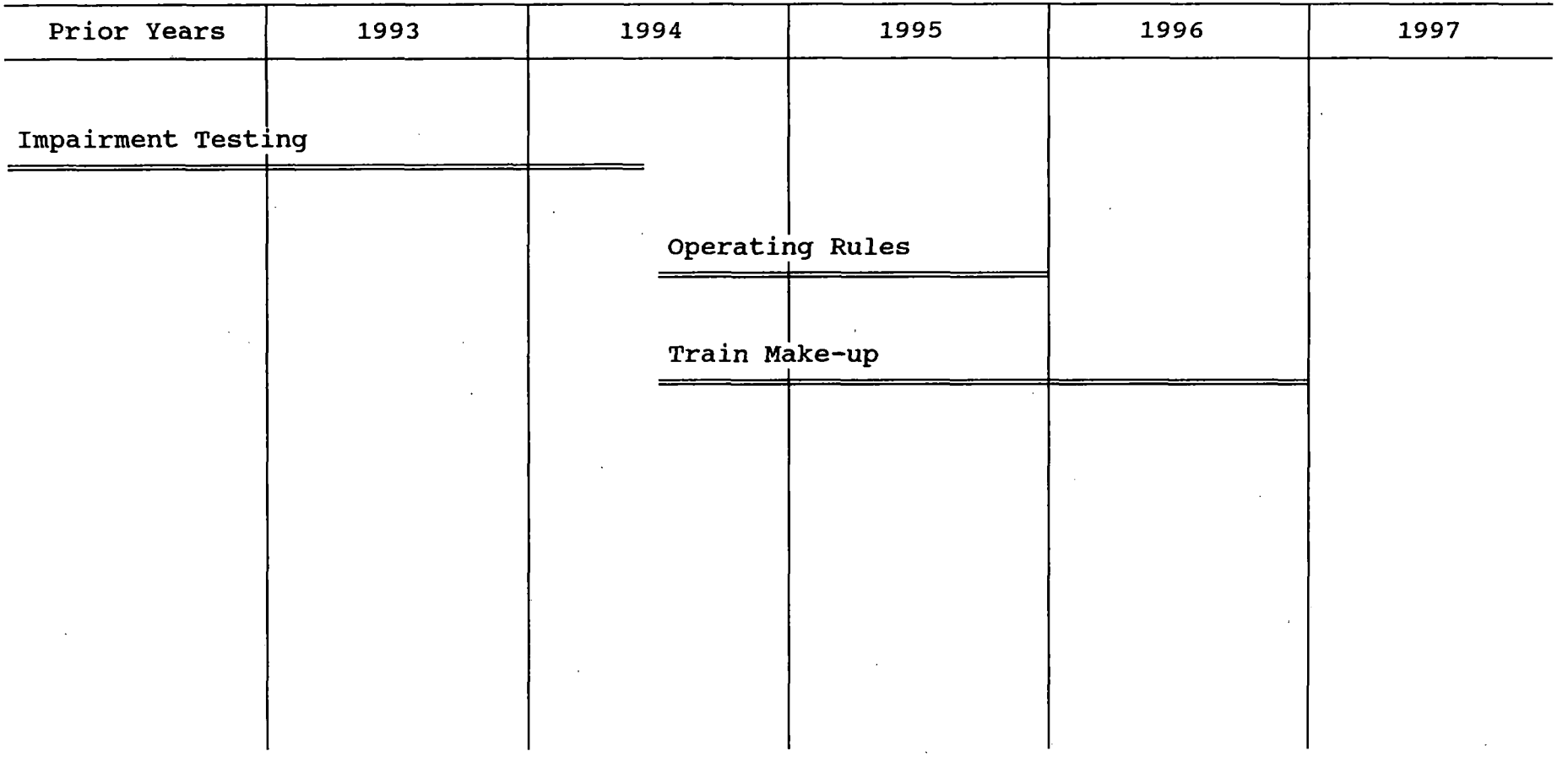
6.5.1 Impairment ("Impairment Testing")

Description: Individuals may be impaired (unable to perform safely or efficiently for part or all of their duty period) for a variety of reasons or for a combination of reasons. The most commonly considered causes in the work place are alcohol, drugs, stress and fatigue. Programs are in place and are being augmented in the railroad operating environment to address issues related to alcohol and drugs. A major research effort addressing stress and fatigue is underway for train crews (described in section 6.1 of this plan), and a research project is proposed to address these issues as they relate to dispatchers (described in section 6.3 of this plan). However, testing is only available currently to determine use of, or impairment by, alcohol and drugs. This project was initiated through the Small Business Innovation Research (SBIR) Program to develop a process or device to determine impairment or "fitness for duty," regardless of cause.

Exhibit 6

GENERAL

Year



The determination would be made when an individual reports for duty. The device or process would be: relatively portable (if a device), low cost, and easily used. Tests using the device or process would: be easy to administer by untrained personnel; produce consistent and reliable results easily interpreted by untrained personnel; be non-intrusive to the test subject (no body fluids or other biological samples, no "wiring up" for physiological measurements, etc.); be capable of being administered quickly (preferably under 5 minutes, no more than 10 minutes); require little or no training of the test subject; and, if possible, be able to determine impairment without the use of baseline data to account for individual differences. Three feasibility studies (Phase I) representing three technological approaches to the challenge of this project were initiated in September 1990. From this work, one approach was selected to advance to development and testing (Phase II). Phase II was initiated in January 1992. While Phase II is permitted to last three years, under the rules of the SBIR Program, results are expected during the summer of 1994.

Output: This project is expected to produce a commercially available device, at affordable cost, to determine the "fitness for duty" of individuals when they report for duty. It is expected to meet all, or nearly all, of the performance parameters described above. Its use is expected to be applicable in a wide variety of transportation and industrial settings.

Contractor: Pulse Medical Instruments, Inc.

6.5.2 Operating Rules

Description: Operating rules are the blueprint for how railroad operating personnel are to do their jobs in a safe and efficient manner. Tests on operating rules are administered periodically by each railroad to all personnel who must know them. Many rule books use jargon that is not universally understood in the same manner by all who must use them and they are, too often, not well structured for easy reference. Many rules tests are not well designed to ensure that the individuals taking them have a working understanding of how they should be applied. This project is intended to produce guidance for writing operating rules and related railroad policy documents that are easily and universally understood by all operating personnel. It is also designed to provide guidance for constructing rules tests that will ensure that employees who take them have a working understanding

of the rules which govern their safety performance. This project is planned to begin in mid-1994, and is expected to be completed in 18 to 24 months.

Output: Guidance to all railroads on the writing of operating rules and the development of rules tests is the intended product of this project.

Contractor: TBD

6.5.3 Train Make-up

Description: The location of loaded cars, empty cars and cars of different design characteristics within a train consist, and their placement with respect to each other, are known to affect within-train and track-train dynamics. Improperly made-up trains have a higher potential accident risk than similar train consists that are properly assembled. Accidents caused by poor train make-up may have catastrophic results. A recent example occurred near Dunsmuir, California. This project will study the practices of the railroad industry in regard to train make-up and operations at locations with high accident records or critical accident potential. It is expected to begin in mid-to-late 1994 and take two to three years to complete.

Output: Guidance to support FRA and industry policy and practice with respect to train make-up.

Contractor: TBD

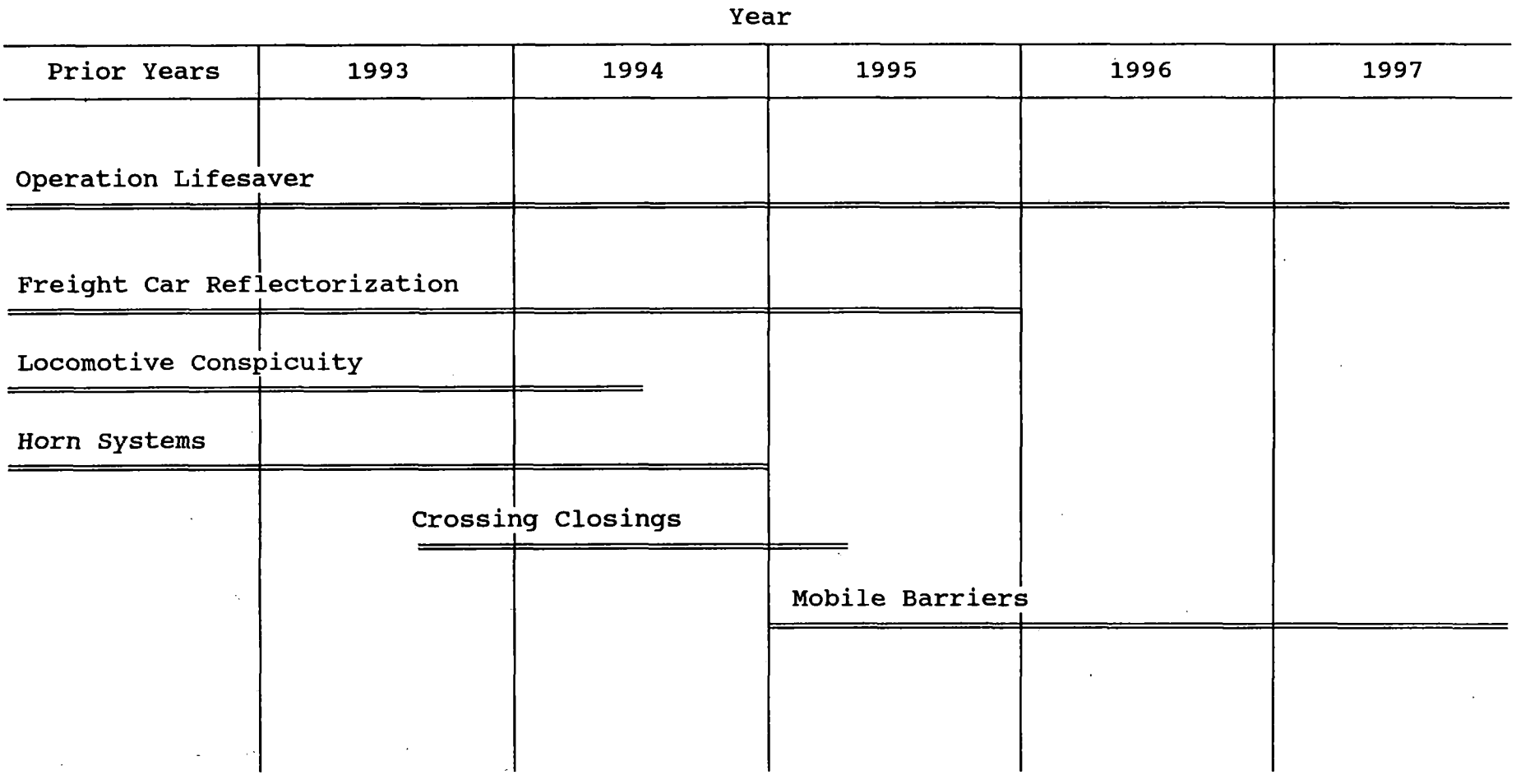
6.6 GRADE CROSSING SAFETY (Exhibit 7)

6.6.1 Operation Lifesaver

Description: This program produces and disseminates educational materials, programs and events to the public through organizations such as schools, civic clubs, fraternal and special interest groups, companies and a wide variety of public agencies; and through the media. The program is designed to increase public awareness of potential hazards at highway-railroad grade crossings and along all segments of railroad track. With funding provided in 1993, and funding requested for 1995, a special emphasis is being placed on issues involving

Exhibit 7

GRADE CROSSING SAFETY



trespassers and vandalism. It is financially supported by the Federal Railroad Administration, Federal Highway Administration, Association of American Railroads, Railway Progress Institute, Amtrak, and other public and private groups. A small professional staff administers the nationwide program. Most of the people who make the program work are volunteers from a wide variety of safety concerned organizations. In its current form, the program began in 1987 and is expected to continue for the foreseeable future.

Output: Printed materials, training and informational videos, public service announcements, presentation guides for volunteers and structured media events are produced under this program.

Grantee: Operation Lifesaver, Inc.

6.6.2 Train Reflectorization ("Freight Car Reflectorization")

Description: Several approaches to making trains more visible and recognizable to motorists at highway-railroad grade crossings are being studied. This project is evaluating the most recently available retroreflective materials, applied to the sides of freight cars, for this purpose. A similar project was completed 12 years ago, with the conclusion that the materials available at that time were not adequate for the purpose. Preparatory work for this project began in late 1991. A pilot test was started in the spring of 1992, and field tests, in a variety of railroad operating environments, were begun in the fall of 1992. The publication of the results of these tests is not easily predictable. Project completion is dependant upon the longevity of the effectiveness of the materials being tested. A report on findings to-date is planned for late 1995.

Output: This project will identify: whether or not available retroreflective materials are useful in improving train visibility at highway-railroad grade crossings; the type of materials, if any, that are useful; and the life cost implications of their use.

Work By: Volpe National Transportation Systems Center

6.6.3 Locomotive Conspicuity

Description: Another approach to making trains more visible to motorists is to make the lead locomotive more visible. This project concentrates on this approach to the problem. Objects of investigation include the use of: extra headlights; higher illumination headlights; ditch lights; lights which illuminate the front of the locomotive, with and without specially designed paint and reflective material schemes; and lights on the locomotive designed to illuminate grade crossings. The final report on this research is planned for the summer of 1994.

Output: The findings and recommendations of this project will form the basis for FRA rulemaking on locomotive illumination, or a report to the Congress as to why such a rulemaking is not appropriate.

Work By: Volpe National Transportation Systems Center

6.6.4 Horn Systems

Description: This project is designed to evaluate: the likelihood of locomotive horn systems to effectively attract the attention of motorists at highway-railroad grade crossings; the likelihood of an experimental horn system, which is mounted at a grade crossing facing highway traffic, to gain motorist's attention; and the potential of these horn systems for disturbing the tranquility of surrounding neighborhoods. This project began in 1992. A report on the acoustic characteristics of the horn systems studied was published during the summer of 1993. A report on the effectiveness of train horns is expected to be available in the summer of 1994. Additional evaluation of a second generation stationary horn is to be initiated in mid-1994 and is expected to require about 10 months to complete.

Output: The recommendations from this research will provide the basis for changes in specifications for locomotive and/or grade crossing horn systems, or for more in-depth research on the subject.

Work By: Volpe National Transportation Systems Center

6.6.5 Crossing Closings

Description: Closing carefully chosen highway-railroad grade crossings, in selected corridors, is believed to be a low-cost and viable approach to significantly reducing accidents at grade crossings without unduly inconveniencing motorists. Such closings might be permanent or

for selected periods of time. The objective of this project is to develop a model for identifying crossings which may be closed, either permanently or part-time. Such closings would have to be justified on the basis of a positive benefit-cost analysis. Work on this project began in late 1993. Its completion date is dependant upon availability of needed data.

Output: The model developed in this project is expected to identify highway-railroad grade crossings which may be closed, either permanently or part-time, to reduce grade crossing accidents. It is also expected that this model will be able to justify its recommendations on the basis of benefit-cost analyses, and that it will be equally useful to Federal, State and local government transportation agencies and to railroads.

Work By: Volpe National Transportation Systems Center

6.6.6 Barriers ("Mobile Barriers")

Description: Two types of moveable barriers are being considered by the Office of Safety for use at highway-railroad grade crossings. The first would be a visible, lightweight gate of as yet undetermined design which would most likely be used to close specified crossings for selected time periods each day. The second would be a barrier designed to keep highway vehicles off of railroad tracks, even if struck at highway speeds. This "crash barrier" would most likely be deployed as a train approaches a crossing and, because of anticipated costs, would be limited to crossings frequented by high-speed passenger trains. Costs of the design and prototype construction of such barriers are expected to be funded under other FRA programs. This project is planned to evaluate the human factors implications of the use of such barriers. Included in this effort will be the evaluation of: motorists' perception, acceptance and compliance; public, local transportation agency and law enforcement perception and acceptance; and, in terms of the "crash barrier", prediction of motor vehicle occupant injury under various crash conditions. This project is expected to start in 1995.

Output: This project may produce recommendations for design changes or community programs to increase acceptance of the barriers as traffic control devices, and compliance with their stop or detour messages. With respect to "crash barriers," recommendations may be made to reduce the likelihood of injury to occupants of motor vehicles that run into them.
Contractor: TBD

6.7 YARD AND TERMINAL SAFETY (Exhibit 8)

Description: In 1991, nearly 20,000 injuries to on-duty railroad employees were reported. Most of these injuries occurred in yard, terminal and maintenance of way operations. Anecdotal evidence indicates that there are four primary reasons for many of the incidents leading to these injuries. They are: (1) employee complacency leading to inattention to safety considerations while performing familiar tasks; (2) inadequate training; (3) inadequate supervision; and (4) inadequate safeguards built into procedures and equipment. The AAR and its member railroads have extensive programs dealing with workplace safety from an ergonomics perspective. FRA does not intend to duplicate these efforts. This project is proposed to analyze accident data and procedures in a sampling of yard and terminal operations to identify improvements which might be made by railroad management to reduce employee injuries. The initial focus is expected to be on switching operations and the loading and unloading of hazardous materials. A decision concerning the inclusion of maintenance of way operations will be made at a later date.

This is expected to be a multiphase project, with Phase I starting in 1995. Phase I will define the scope of the yard and terminal safety problem to be addressed and identify or develop the evaluation techniques to be used in subsequent phases. This work will be done in close cooperation with the Office of Safety, the AAR, and railroad management and labor.

Output: Strategies and procedures for improving safety in the working environment of railroad yard and terminal employees are expected to be developed and recommended to railroad management and labor.

Contractor: TBD

Exhibit 8

ND TERMINAL SAFETY

Year

Pri	1995	1996	1997
	Phase I		
			Phase II

Operating Practices Research Plan, 1993-1997, Report to Congress, US DOT, FRA, Office of Research and Development, 1994 -25-Goverment Policy, Planning & Regulations