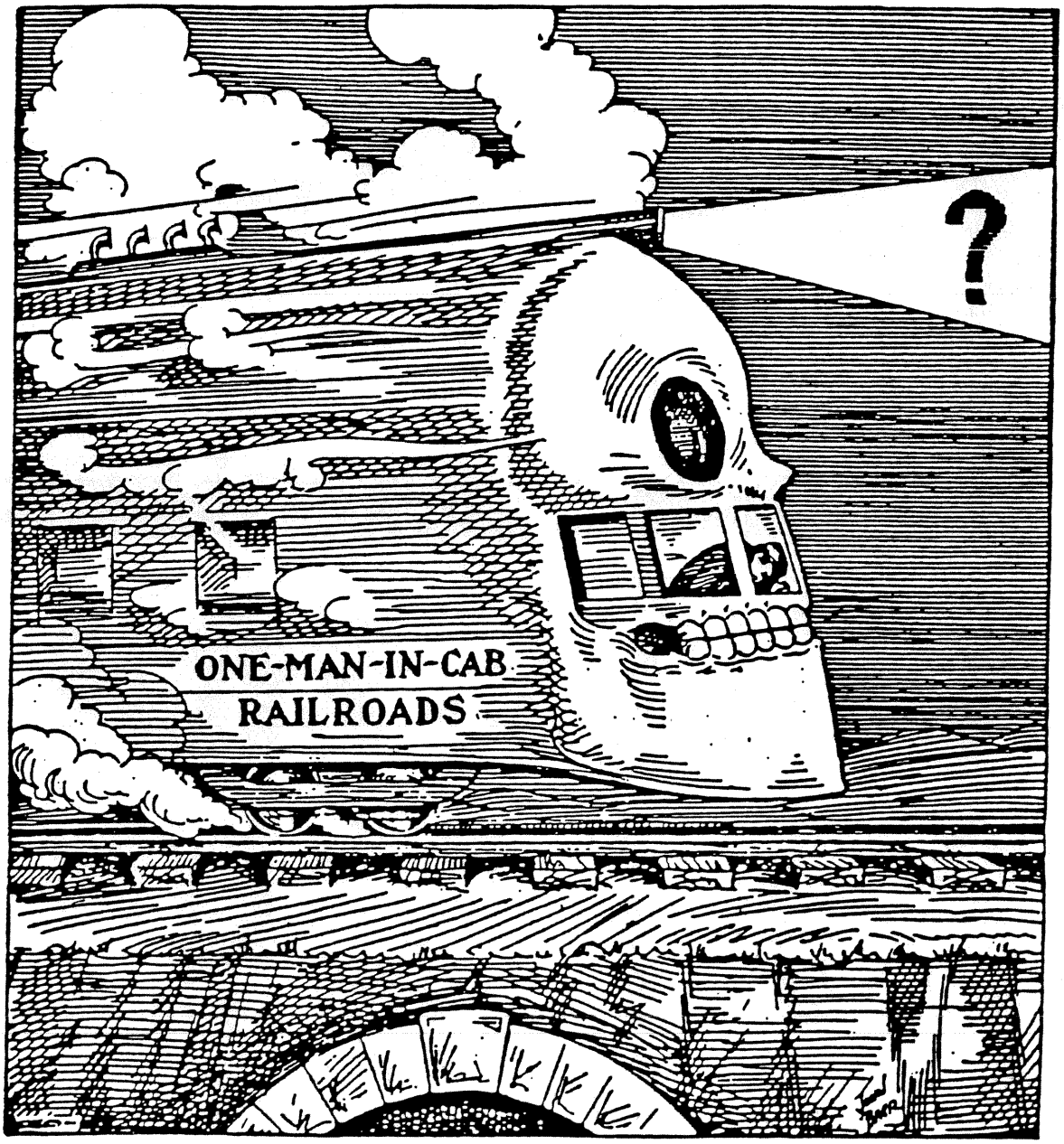
PRESENTATION OF
BROTHERHOOD OF LOCOMOTIVE ENGINEERS
BEFORE THE
FEDERAL RAILROAD ADMINISTRATION

INFORMAL SAFETY INQUIRY
ON
ONE-PERSON CREWS AND
REMOTE-CONTROL LOCOMOTIVE OPERATIONS
December 4-5, 1996



FEDERAL RAILROAD ADMINISTRATION

[Docket Nos. RSSI 96-1A and 1B, Notice No. 1]
Informal Safety Inquiry on
One-Person Crews and
Remote-Control Locomotive Operations

December 4-5, 1996

My name is Leroy Jones. I am the Vice-President and National Legislative Representative for the Brotherhood of Locomotive Engineers (BLE). The BLE has testified in the past in regard to remote control operations in response to FRA's waiver petition docket on the Wheeling and Lake Erie Railway Co. [Petition for Waivers of Compliance, LI-92-6 and RSOP-92-1]. FRA granted waivers from certain provisions of federal railroad safety regulations and § 2 of the Locomotive Inspection Act (45 U.S.C., § 23) and § 229.7 of the Locomotive Safety Standards (49 CFR 229.7) to some railroads seeking to use this new technology.

In FRA's effort to address the needs of railroad employees and the public from undue safety risks, FRA established a testing program which permitted the use of remote control systems subject to appropriate safety conditions. The BLE commented on that testing program in FRA General Docket Number H-94-6. The testing program included conditions for design requirements, training requirements, standard operating procedures, security, inspections and tests, as well as notification of use and protection of workers. Our testimony has made it clear that the BLE has no intention of being an obstructionist in regard to the development of new technology. Our concern with remote control technology remains, first and foremost, that such operation be safe; and secondly, that the

interests of those directly affected are given an open and fair hearing.

We believe, and history affirms, the industry has sought to reduce crew members to the maximum extent possible. We also believe remote control technology is considered as a means to further reduce the number of operating crew persons. We also assert it is their intention to use this new technology in the development of a labor relations strategy. It is therefore in their interest to hasten the regulatory decision making process and, to the extent allowed, cause expansion of remote control operations in spite of the need for careful consideration to safety.

We also believe that there is no need to demonstrate the lack of safety in one person operations by accumulating a mountain of data. FRA should look to the practices of the railroad industry in regard to the role that is played by the various operating employees to see how each fit so that the system is safe. In some ways the need for hard facts and detailed data is like asking if it would be hard to die if one were subjected to a death by stoning. Surely common sense would tell you it would be a difficult death. There is no need to detail the number of stones, their velocity or point of impact to know that to die in such a way would be a hard way to go.

The data on remote control operations is similar to this by the difficulties encountered by the engineer performing the work of two or three others while still operating the locomotive may not reveal a multitude of mishaps, but do still create safety problems. Based on the data we have via the steel industry and the limited events which have been reported through the testing program, coupled with a working knowledge of railroading, our common sense tells us that we have a significant safety issue at hand.

We will now direct our remarks to those issues set forth in the Notice.

This Safety Inquiry, directed at the request of Wisconsin Central Ltd. (WC), was made because of its desire to expand the use of one person crews. As the notice has stated, "the proposed operations pose many complex safety issues." We are to comment on a potpourri of topics. Because of the complexity of the issues, we will address them generally and ask that before any decision is granted to allow implementation or expansion of these operations, FRA conduct a formal rulemaking.

In our approach to this hearing, the BLE testimony will address the issue of one person crews under its own heading, (RSSI-96-1A) and, to the extent meaningful, will follow the topics in the notice. Remote control locomotive operations (RSSI-96-1B) will also be considered in this manner. But, before addressing these single issues we would like to comment on the contemplated use by Wisconsin Central, Ltd. (WC) of engineer-only operating remote control locomotives unassisted by others.

Our statement is brief and based on the sobering thought of a potentially tired individual operating, by remote control, locomotives attached to a string of cars, some of which contain hazardous materials, on a cold snowy night in Wisconsin.

Can it be done technically? Definitely. Can it be done with consistent performance of the technology? Maybe. Can it be done in a safe manner? Perhaps. But, given our experience, it can never be done safely with constancy. Human beings are subject to limitations and error. This contemplated operation seems to overlook that fact. In previous hearings on remote control we have heard the manufacturer's representative

state, "generally, it is the limit of the operator that is reached first." Now comes Wisconsin Central seeking to further challenge human ability with technology, simultaneously confronting rational minds with the foregoing railroad operations scenario. If allowed to institute one person remote operations, the Wisconsin Central would add even more work and potential failure on a single human being. Bear in mind there may be no one present to witness that human failure and no one to assist that person if they are in need.

The potential for accidents increases significantly with just one person. Trains and tracks have two sides, two ends and the possibility of movement in more than one direction. Railroad operating rules, rights-of-way, equipment and the system generally have recognized the need for two or more persons to cope with this reality. We submit that it is asinine for railroad managers to seek such operations. It shows a callous disregard for employee and public safety. That we are required to make this argument is indicative of how far off target some in this industry have come to show a greater profit.

In consideration of these remarks, we ask FRA to deny any use of one person remote control locomotive operations.

RSSI 96-1A One Person Crews

Equipment Standards

Railroad operations in the U.S. are based on some realistic physical assumptions including recognition of the need to keep watch over the equipment and right-of-way on which the railroad operates. The factor of visibility is paramount in any contemplated operation of

the railroad. Any change in operations which allow for one person must consider the need for that person to see both sides of the train and have an unobstructed view of the track in the direction of movement. Equipment standards, their design, training associated with their use, operating procedures, security and the inspection and testing of such equipment must recognize this need for the continuous ability to see the movement.

In the one area where we have one person in the cab operations, the Northeast Corridor, all locomotives are equipped with alertors, overspeed control and cab signals with automatic train stop. The BLE submits that these should be necessary components of any one person operation.

Design Standards

The equipment must be designed to withstand the railroad environment and be fail safe. If it should fail, is unreliable, or as a result of weather conditions, unusable, all movement should stop and additional personnel should assist before movement continues. The equipment should not overburden the engineer with so much information that they are unable to perform their other duties. Audible alarms or warning systems should be obtrusive only to the extent they enhance safety without distracting therefrom.

Employee Training

Employees selected for engineer-only operations should be carefully screened for suitability for this demanding service. Consideration must be given for the physical, psychological and social condition of employees engaged in such service. The additional stress encountered in engineer-only operations, along with the consequences of human failure if failure occurs, requires well trained and the best possible operators. Amtrak has

considerable experience in the area of one person in the cab operations in the Northeast Corridor. In its response to reports on the question of stress as it relates to operating on that busy passenger line, Amtrak states: " Locomotive operation is a demanding profession that requires both physical and mental fitness. It is a serious error to allow anyone to operate a locomotive that is not in a condition of positive global health." The report further states: "The operation of a locomotive is a highly technical job that requires a practiced ability to receive several forms of incoming stimuli. In addition to reception of information, the data must be sorted by priority and a complex decision making process completed before response. At any given moment, the engineer is receiving and processing visual, auditory, tactile, kinesthetic and labyrinthine information. Through experience, the engineer learns to arrange this data according to a hierarchy that includes both safety and operational goals."

If we are to expect one person to do the work of two or more, they must be trained to deal with not only the complex operation of their locomotive and train, but also their personal needs. They must have the tools to deal with their need for rest. They must know of the factors of fatigue and recognize them. They must also be given the opportunity to rest if the need should arise. Recent studies on rail operations and fatigue reveal significant information on the issue. They assert it is not uncommon that irregularity of rail operations, monotony on the job, and the circadian rhythms with which we all function, combine to cause operators to experience micro-sleep. These are periods when response to outside stimuli is significantly impaired if possible at all. This has to be one of the most significant issues of one person operations. According to a study on

"Incidence of Near Accidental Drowsing In Locomotive Driving During A Period of Rotation", by Kazutaku Kogi and Takeo Ohta, conducted on the Japanese National Railroad in 1975, the frequency of drowsiness increases with single person operations, as much as doubling the frequency of such incidents. A statement in the report concludes: "More significant is the monotony which may lead to enhanced fluctuation of attention, often due to lack of interpersonal contact with co-drivers in the single driver system." Awareness of the fatigue issue may serve to put the one person crew member on notice of the potential for disaster but other countermeasures must be required to eliminate the problem, including shorter working assignments and regular and reasonable schedules. All railroad employees need to be identified as to their potential role in one person operations and training developed for them specific to the one person operation. The requirements of engineer certification should , to its highest level, be fully met. Consideration needs to be given to the additional issues and responsibilities that a certified engineer must encounter in regard to operating rules, hazardous material regulations, and any additional changes in regard to the means of operation of the locomotive(s).

Employee Safety

No one person crew member should be without the ability to contact emergency personnel via radio(s) or cellular telephone in the event of radio failure. The emergency notification system as proposed to be used by Wisconsin Central should be required in all operations where one person crews are used. The portable communication systems should be tested and determined suitable for use whenever going off the locomotive and returning to the locomotive if a different radio or device is to be used.

The one person crew member should be afforded the opportunity to deny any work they determine to be too dangerous to perform alone. Such denial should never result in discipline, loss of compensation, or reprisal of any kind.

Derailments or personal injuries occurring during one person operations should immediately be reported by telephone to the Regional FRA Office or, after business hours, to the National Response Center.

Standard Operating Procedures

Careful thought must be given to any and all operation rule changes. To simply modify rules to accommodate a desired end should be looked upon as self serving and without sincere recognition of the needs of safety. All operational scenarios must be addressed and a protocol developed to handle each situation. That protocol should be part of the training. If no conceivable solution exists, the operation should not be allowed. Expediency needs to be seen as the enemy of safety in regard to these type of operations. It is from that premise that the entire operating rule book must be examined. The temptation to move a cut of cars with no one preceding the movement is a significant danger to railroad employees and the public. It should be made clear that it will not be tolerated.

Train Size and Makeup

Wisconsin Central indicates that 1200 feet or approximately 20 cars is the maximum distance that a person can reasonably see their train. Previous testimony has indicated that the working range of radio controlled locomotives is generally reliable at 20 cars. If

engineer-only crews should be allowed it would seem that 10 cars or 600 feet should be the maximum train length permitted for an added safety precaution.

In regard to train makeup, we suggest that all existing regulations be absolutely adhered to which involve hazardous materials. It may be advisable to restrict completely the handling of hazardous materials by one person crews. In the event of derailment or the incapacitation of the engineer, the necessary emergency response information may not be available to the train dispatcher, local authorities, or emergency response personnel. Trains should not be operated with a cut of cars on both ends of a locomotive where they have the potential to proceed over crossings without protection.

Terrain Limitations

One person crews should not be permitted to operate locomotives attached to cars in mountain grade territory.

Communications

All communication systems should be shop tested frequently and each time the crewperson changes their location of operation (moves onto or from the locomotive). Communication devices should not be used if found to be unreliable, there should be a backup system, there should be an emergency response system that is continuously monitored by the dispatching office. There should be no locations where communication signals cannot be transmitted or received.

Inspections and Tests

All electronic devices, including but not limited to; radios, cellular telephones, remote control transmitters and receivers, 2-way rear-end devices, sensors, cameras, motion

detectors, and monitors must be known to operate without interference to each other and to the engineer who would be required to use the equipment. They should be inspected, tested and certified on a regular basis. They must be approved for the use they are intended and meet all measurement requirements conforming to the American Standards Institute Safety Levels with respect to Human Exposure to Electromagnetic Fields, 300 Khz to 100 Ghz (Ansi/IEEEc95.1-1991).

Operations Security

Wisconsin Central, or no other railroad for that matter, can ever make their operations absolutely secure. The recent sabotage in our industry raises our level of concern that there are those who see the vulnerability of railroads. One person operations do nothing to increase security. Vigilance is the only defense. This contemplated operation reduces that vigilance in half, and in some cases, even more. It may very well be inviting vandalism and sabotage. Consideration should be given to requirements for right -of-way fencing or barriers in areas frequented by children or others who might trespass on railroad property.

Other Considerations

The BLE would like to conclude its testimony on one person operations by stating that it is our unqualified opinion that two person crews add to safety and efficiency. The rail operations in the U.S. are far different from operations in other countries. We have long heavy and dangerous trains, long runs, and irregular unpredictable hours of duty. Engineers operate with increasing levels of traffic at high speed. We are moving more freight and passengers with less track and fewer locomotives and far fewer employees than

any time in history. It is time to call a halt to this madness for increased productivity at the expense of safety.

It is also necessary in this discussion on one person crews to mention the National Transportation Safety Board's Safety Recommendation number R-85-52. The recommendation was the result of the Board's investigation of 30 major railroad accidents. That recommendation asked the Brotherhood of Locomotive Engineers to cooperate with the FRA in implementing Safety Recommendation R-85-51, which asked the FRA to require that there be at least two crewmembers on locomotives of through freight trains who are qualified to operate the locomotive, that one of these persons have total responsibility for the train and all employees thereon, and that the second person serve as assistant to the person in charge. That recommendation, in 1995, was classified "Closed-Unacceptable Action", because FRA refused to implement the Safety Recommendation. BLE continues to believe this recommendation is valid and would provide the safest operating environment.

RSSI 96-1B Remote-Control Locomotives

In addition to those comments made earlier in regard to our request that no operation of remote-controlled locomotives be permitted by one person crews, the BLE further asks that there be no operation of remote-control locomotives outside of the confines of dedicated yards or industries.

We also take the position that all employees operating remote-control be fully certified train service engineers.

Equipment Standards and Design Requirements

In its previous testimony, BLE has expressed concern with the limitations of the remote-control device with respect to operating speeds. We continue to advocate that a speed indicator be an integral part of the remote device. If no such device is available we request that the locomotive be restricted by a governor to 10 mph or lower. Air brake pressures are an integral part of the information system needed by engineers to make informed decisions. Air brake data should be available to the engineer of remote-controlled locomotives. Other standards and design requirements should, at a minimum, meet the requirements set forth in the waiver granted under FRA Docket No. LI-92-6.

Employee Training

The BLE asserts that only certified locomotive engineers under CFR Part 240 having successfully completed appropriate classroom and hands-on training regarding safety and operations of remote-controlled locomotives and systems should operate remote-controlled locomotives. We believe that the training programs of all railroads using this technology should be filed with and approved by FRA, prior to being implemented. We request that those training programs be made available to the BLE for review. The training program should be continuously monitored by FRA to assure adequacy. As in engineer only operations, other employees should be considered for training in regard to dangers inherent with remote-control locomotives when they have the potential to work in close proximity with them.

Employee Safety and Standard Operating Procedures

Language needs to be developed to ensure railroads and their employees comply with provisions of the requirements for waiver set forth in LI-92-6, under Section C, Standard Operating Procedures. We request that FRA require, at a minimum, all the published criteria under Section C., subject to recommended changes which have been determined through the testing program and/or the following comments:

f. When operating by remote-control, the operator shall not:

i. ride on a freight car;

ii. ride on the locomotives' walkway or steps when the speed of the locomotive is in excess of 10 mph; or

iii. stand or walk within the gage of the rail while in front of the lead car or locomotive.

BLE Comment:

Part C (1) (f) (iii) It should be required that the movement be stopped whenever the engineer wishes to consult his switching instructions or other written instructions. We were informed that on one occasion, an engineer operating a remote control locomotive was struck by his own movement. In this case, the engineer was referring to written switching instructions and was struck from behind by cars being shoved by his own remote engine. This engineer reported forgetting that the engine was moving and that he did not hear the cars approaching. The engineer suffered no injury, reportable or otherwise, but this incident could have resulted in injury or death. This section should also be modified

to prohibit the engineer from standing or walking within the extreme width of the movement, not merely the gage of the rail.

g. **The maximum authorized speed of a remote-control locomotive being operated from outside the cab is 10 mph.**

BLE Comment:

Part C (1) (g) A locomotive overspeed device should be required which initiates an application of engine and train brakes, power knockdown, and return to idle if the ground speed exceeds 10 mph. The transmitter is not equipped with a speed recorder. This would also eliminate any temptation for an engineer to exceed the legal speed. Every engineer interviewed by BLE officers on one railroad reported that it is impossible to judge the speed of a remote control locomotive if the movement is not adjacent to his/her location. Determination of speed was reported to be particularly difficult at night. Otherwise, an engineer has no reliable means of assuring that he is not operating in excess of 10 mph. The BLE believes it to be fundamentally unfair for an engineer to be subject to discipline derived from carrier use of a radar gun to determine speed if the engineer is denied access to the same information from a speed recorder.

h. **When moving a group of cars for switching or placement purposes, the remote-control operator shall assume a position to observe the leading end of the movement.**

BLE Comment:

Part C (1) (h) Observation of the leading end of a movement is not in itself any real protection. This is an opportunity for the carrier to have it both ways. That is, the engineer is not explicitly required to be at, on, or preceding the movement but will still be held responsible for any incident resulting from a "blind shove". This is one of the greatest single safety hazards regarding remote control locomotives. It was the experience of several engineers in remote control locomotive service to be strongly dissuaded by management one railroad from the practice of placing themselves in position to properly observe the leading end of a shoving movement.

Many engineers reported a temptation to ignore the protection of the leading end of a movement, particularly after having been on duty long hours. The BLE believes this is a natural reaction to the nature of remote control locomotive operation. To burden an engineer with the necessary equipment and require him to walk many miles each day to protect a move that will "probably" be completed without incident and could easily be protected by conventional railroad practices is to invite an accident.

i. **The operator shall operate only one remote-control locomotive consist from the remote-control transmitter, and shall not simultaneously operate any other locomotive consist.**

BLE Comment:

Part C (1) (i) The BLE supports the position stated in (I) with the engineer-only operating one remote-control locomotive at a time.

j. Prior to lining a switch or performing any duty that requires going on, under, or between cars, the operator shall fully apply the brakes on the locomotive and train.

BLE Comment:

Part C (1) (j) The BLE objects to an engineer going on, between, or under cars controlled by a remote control locomotive without the locomotive having been positively disconnected from it's power source by means of a PC switch or some similar device. It has been reported that it is possible to couple air hoses without activating the Tilt Bypass Switch and without a penalty being initiated. The wrong lever or button on a transmitter box accidentally indexed by either the engineer's own body or by brushing against a car could result in unintended movement. The result of unintended movement, even a few feet, with the engineer in a vulnerable position while encumbered by a lantern, switching list, portable radio, helmet, goggles, and a transmitter box strapped to his belly could easily be fatal. Many engineers reported that the amount of equipment worn, particularly in the winter, made coupling air hoses unreasonably difficult to the point of becoming a safety hazard in itself.

k. When operating a remote-control locomotive in the remote mode in road service, the operator shall at all times remain in the cab.

BLE Comment:

Part C (1) (k) Explicit language should be included requiring that any remote control locomotive operated from within the cab must be operated in the conventional manner.

l. A remotely controlled locomotive operated from outside the cab by a one-

person crew shall not operate outside the confines of a geographical yard, an industry, an industrial park, or a lead into such facility when other railroad employees are not in close proximity to the train movement.

BLE Comment:

Part C (1) (l) A remotely controlled locomotive operated from outside the cab shall not operate outside the confines of a geographical yard, an industry, and industrial park, or a lead into such facility.

m. A remote-control locomotive operated by a one-person crew shall be segregated from other locomotives or crews operating in the same yard or facility.

BLE Comment:

A remote-control locomotive shall not be operated by a one-person crew.

n. Movements past any signal, through an interlocking, or over highway-rail crossings shall be made only when the remote-control operator, or another crewmember who can signal or communicate with the operator, has taken a position at the leading end of the movement.

BLE Comment:

Another employee, other than the engineer, should be required to protect an interlocking movement or over a highway rail crossing.

r. Each operator of a remote-control locomotive shall be equipped with an operative holstered hand-held radio equipped with a wired remote microphone which the operator may communicate with another railroad employee.

BLE Comment:

Part C (1) (r) Periodic radio checks to assure continued radio contact with other railroad employees should be required.

Train Size and Makeup

Please refer to our comments on engineer-only crews wherein we request restrictions on train lengths to 10 cars or 600 feet.

Terrain Limitations

Remote-control operations should not be permitted on grades over terrain that could result in in-train-forces which will cause a derailment. With no ability to use the traditional sensing mechanisms associated with on board operations, engineers should not be held accountable for derailment caused by terrain and train makeup.

Communications, Inspection-Tests and Operations Security

Refer to our previous comments addressing these issues in other areas. At minimum, FRA should require railroads to meet the criteria established under LI-92-6.

Additionally, FRA should adopt as requirement for operation of remote-control, Section F. Notification of the Use and Protection of Workers.

Part 1

Introduction

During the 1980s, the National Transportation Safety Board investigated several accidents that involved operator fatigue.[1] Following completion of these accident investigations, the Safety Board in 1989 issued three recommendations to the U.S. Department of Transportation (DOT):[2]

> Expedite a coordinated research program on the effects of fatigue, sleepiness, sleep disorders, and circadian factors on transportation system safety. (I-89-1)
>
> Develop and disseminate educational material for transportation industry personnel and management regarding shift work; work and rest schedules; and proper regimens of health, diet, and rest. (I-89-2)
>
> Review and upgrade regulations governing hours of service for all transportation modes to assure that they are consistent and that they incorporate the results of the latest research on fatigue and sleep issues. (I-89-3)

Ten years have passed since these safety recommendations were issued. In the interim, the Safety Board has issued more than 70 additional recommendations to the DOT, States, and industry to reduce the incidence of fatigue-related accidents.[3] The purpose of this report is to provide an update on the activities and efforts by the DOT and the

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[1] (a) National Transportation Safety Board. 1985. *Collision of Tuba City School District Schoolbus and Bell Creek, Inc., Tractor-Semitrailer, U.S. 160 Near Tuba City, Arizona, April 29, 1985.* Highway Accident Report NTSB/HAR-85/06. Washington, DC. (b) National Transportation Safety Board. 1986. *Grounding of the Panamanian-Flag Passenger Carferry M/V* A. Regina, *Mona Island, Puerto Rico, February 15, 1985.* Marine Accident Report NTSB/MAR-86/02. Washington, DC. (c) National Transportation Safety Board. 1986. *China Airlines, Boeing 747-SP, N4522V, 300 Nautical Miles Northwest of San Francisco, California, February 19, 1985.* Aircraft Accident Report NTSB/AAR-86/03. Washington, DC. (d) National Transportation Safety Board. 1987. *Trailways Lines, Inc., Intercity Bus Collision With Rising Fast Trucking Company, Inc., Interstate Highway 40 Near Brinkley, Arkansas, July 14, 1986.* Highway Accident Report NTSB/HAR-87/05. Washington, DC. (e) National Transportation Safety Board. 1988. *Collision Between the* USS Richard L. Page *(FFG-5) and the U.S. Fishing Vessel* Chickadee, *the Atlantic Ocean, April 21, 1987.* Marine Accident Report NTSB/MAR-88/04. Washington, DC. (f) National Transportation Safety Board. 1988. *Collision Between U.S. Passenger/Car Ferries M/V* North Star *and M/V* Cape Henlopen *on Long Island, Orient Point, New York, July 9, 1987.* Marine Accident Report NTSB/MAR-88/06. Washington, DC. (g) National Transportation Safety Board. 1989. *Head-End Collision of Consolidated Rail Corporation Freight Trains UBT-506 and TV-61 Near Thompsontown, Pennsylvania.* Railroad Accident Report NTSB/RAR-89/02. Washington, DC.

[2] The Safety Board's recommendation letter, issued May 12, 1989, is reproduced in appendix A.

[3] See appendix B for the recommendations issued to the DOT and modal administrations.

modal administrations to address operator fatigue and, consequently, the progress that has been made in the past 10 years to implement the actions called for in the three intermodal recommendations and other fatigue-related recommendations. Before addressing the activities and the progress made regarding these recommendations, the report provides some background information on current hours-of-service regulations, fatigue, and the effects of fatigue on transportation safety.

Current Hours-of-Service Regulations

Hours-of-service regulations specify the length of on-duty and off-duty time for operators in transportation. The current hours-of-service regulations vary from mode to mode. The motor carrier hours-of-service regulations were developed in 1937 and have remained essentially unchanged. The Railroad Hours of Service Act was first enacted in 1907; it was substantially revised in 1969, and amended again in 1976 and 1988. Aviation limits were addressed in the Civil Aeronautics Act of 1938 and the Federal Aviation Act of 1958. In 1985, domestic flight limitations and some commuter limitations were updated; flag and supplemental operations were not. The work-hour regulations for marine are specified in Title 46 *United States Code* (U.S.C.) 8104 and date back to the early part of the 20th century. The Oil Pollution Act of 1990 contained work-hour limitations for tank personnel of 15 hours per 24 hours and 36 hours per 72 hours. In 1997, work-hour regulations from the *Standards for Training, Certification, and Watchkeeping* of the International Maritime Organization became effective, requiring a minimum 10-hour rest period during any 24-hour period. The work and rest provisions for operators in the various modes are summarized in table 1–1.

The regulations for aviation, highway, and some marine vessel types impose weekly work and rest limits. Only the aviation mode has monthly and annual limits as well. The maximum number of hours an employee of each mode is permitted to work in the course of a 30-day period is shown in figure 1–1.[4] A commercial pilot may fly up to 100 hours per month; a truckdriver may be on duty up to about 260 hours per month; licensed individuals on an oceangoing vessel or coastwise vessel of not more than 100 gross tons (GT) may operate up to 360 hours per month when at sea; and locomotive engineers may operate a train up to 432 hours per month.

[4] The time for pilots includes only flying time.

Table 1–1. Summary of the current hours-of-service regulations, all transportation modes.

Aviation (14 CFR Part 121; 14 CFR Part 135)

- Pilots flying domestic Part 121 operations may fly up to 30 hours per week, 100 hours per month, and 1,000 hours per year.
- Pilots flying domestic Part 135 operations may fly up to 34 hours per week, 120 hours per month, and 1,200 hours per year.
- If the scheduled flight time is less than 8 hours, the minimum rest period in the 24 hours preceding the scheduled completion of the flight segment is 9 hours. This time may be reduced to 8 hours if the following rest period, to begin no later than 24 hours after the commencement of the reduced rest period, is increased to 10 hours.
- If the scheduled flight time is 8–9 hours, the minimum rest period in the 24 hours preceding the scheduled completion of the flight segment is 10 hours. This time may be reduced to 8 hours if the following rest period, to begin no later than 24 hours after the commencement of the reduced rest period, is increased to 11 hours.
- If the scheduled flight time is equal to or greater than 9 hours, the minimum rest period in the 24 hours preceding the scheduled completion of the flight segment is 11 hours. This time may be reduced to 9 hours if the following rest period, to begin no later than 24 hours after the commencement of the reduced rest period, is increased to 12 hours.

Motor Carrier (49 CFR Part 395)

- Drivers may drive for 10 hours or be on duty for 15 hours.
- Drivers must have 8 consecutive hours off following a 10/15 hour on-duty period.
- If drivers use a sleeper berth, they may split the 8-hour period into two periods as long as neither period is less than 2 hours.
- Drivers may not exceed 70 hours in 8 days, if the carrier operates 7 days a week.
- Drivers may not exceed 60 hours in 7 days if the carrier does not operate every day of the week.

Marine (46 U.S.C. 8104; 46 CFR Parts 15.705, 15.710, and 15.1111)

- Hours-of-service or watch requirements vary depending on type of vessel.
- An officer must be off duty for at least 6 hours within the 12 hours immediately before leaving port before taking charge of the deck watch on a vessel when leaving port.
- On an oceangoing or coastwise vessel of not more than 100 gross tons (GT), a licensed individual may not work more than 9 of 24 hours when in port or more than 12 of 24 hours at sea, except in an emergency.
- On a towing vessel operating on the Great Lakes, harbors of the Great Lakes, and connecting or tributary waters between Gary, Indiana; Duluth, Minnesota; Niagara Falls, New York; and Ogdensburg, New York, a licensed individual or seaman in the deck or engine department may not work more than 8 hours in one day, except in an emergency.
- On a merchant vessel of more than 100 GT, the licensed individual shall be divided into three watches and shall be kept on duty successively to perform ordinary work incident to the operation and management of the vessel.
- On a towing vessel, an offshore supply vessel, or a barge that is engaged on a voyage of less than 600 miles, the licensed individual and crewmembers may be divided, when at sea, into two watches.
- On a fish processing vessel, the licensed individuals and deck crew shall be divided into three watches. However, if the vessel entered into service before January 1, 1988, and is more than 1,600 GT or entered into service after December 31, 1987, and has more than 16 individuals on board primarily employed in the preparation of fish or fish products, then the licensed individuals and deck crew shall be divided into two watches.

Table 1–1. Summary of the current hours-of-service regulations, all transportation modes (continued).

- On a tanker, a licensed individual or seaman may not work more than 15 hours in any 24-hour period or more than 36 hours in any 72-hour period, except in an emergency or a drill.
- On a fish tender vessel of not more than 500 GT engaged in the Aleutian trade, the licensed individuals and crewmembers shall be divided into at least three watches. However, if the vessel operated in that trade before September 8, 1990, or was purchased to be used in that trade before September 8, 1990, and entered into that trade before June 1, 1992, the licensed individuals and crewmembers may be divided into two watches.
- On a vessel used only to respond to a discharge of oil or a hazardous substance, the licensed individuals and crewmembers may be divided into two watches when the vessel is engaged in operation less than 112 hours.
- On a towing vessel operating in the Great Lakes, harbors, or connecting or tributary waters or a merchant marine vessel of more than 100 GT, a seaman may not work alternately in the deck and engine compartments, or be required to work in the engine department if engaged for deck department duty or required to work in the deck department if engaged for engine department duty. A seaman cannot be required to do unnecessary work on Sundays, New Year's Day, July 4, Labor Day, Thanksgiving day, or Christmas day, when the vessel is in safe harbor. When a vessel is in safe harbor, 8 hours is a day's work.
- Offices in charge of a navigational or engineering watch on board any vessel that operates beyond the boundary line shall receive a minimum of 10 hours rest in any 24-hour period. The hours of rest may be divided into no more than two periods, of which one must be at least 6 hours in length. The hours of rest do not need to be maintained in an emergency. The hours of rest may be reduced to 6 hours if no reduction extends beyond 2 days and not less than 70 hours of rest are provided in each 7-day period.

Pipeline

There are no Federal regulations for operators or controllers of pipeline systems.

Rail (49 U.S.C. 211; 49 CFR Part 228)

- Maximum duty limit of 12 hours.
- Must be off-duty for 10 consecutive hours, after working 12 consecutive hours or off 8 consecutive hours if worked less than 12 consecutive hours.
- Time spent in transportation (deadheading) to duty assignment counts toward on-duty time.
- Time deadheading from duty assignment does not count toward on-duty or off-duty time.

CFR = *Code of Federal Regulations*; U.S.C. = *United States Code*.

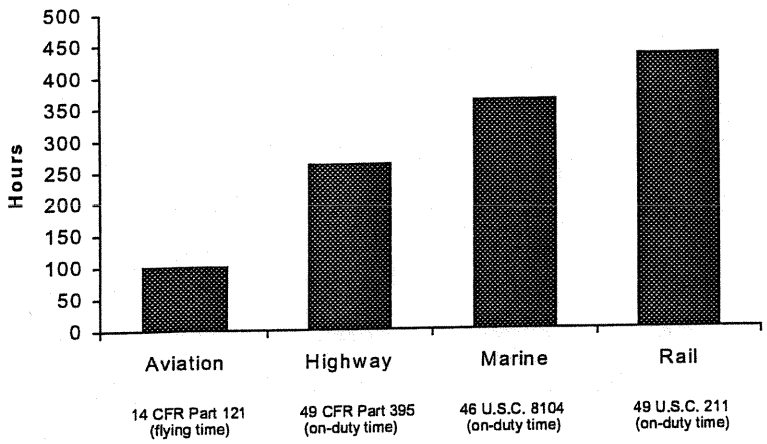

Figure 1–1. Maximum work hours in a 30-day period. For marine, the on-duty and off-duty times are for a licensed individual on an oceangoing vessel or coastwise vessel of not more than 100 gross tons at sea. (CFR = *Code of Federal Regulations;* U.S.C. = *United States Code*)

What is Fatigue?

Traditionally, fatigue was viewed as a simple condition related to the amount of time spent working on a given task.[5] Scientific research, however, has shown that fatigue is related to much more than just the time on a task.[6] Researchers have studied factors that affect fatigue, such as duration and quality of sleep,[7] shiftwork and work schedules,[8] circadian rhythms,[9] and time of day.[10] Others have examined the influence of drugs and alcohol on fatigue and compared performance impaired by alcohol to performance

[5] McDonald, Nicholas. 1984. *Fatigue, Safety and the Truck Driver.* London and Philadelphia: Taylor & Francis. pp. 104-115.

[6] Kryger, M.H.; Roth, T.; Dement; W.C., eds. 1994. *Principles and Practice of Sleep Medicine*. 2nd edition. Philadelphia: W.B. Saunders Company.

[7] (a) Johnson, L.C.; Naitoh, P. 1974. *The Operational Consequences of Sleep Deprivation and Sleep Deficit.* AGARD-AG-193, NATO. London: Technical Editing and Reproduction. (b) Rosekind, M.R.; Gander, P.H.; Connel, L.J.; Co, E.L. 1994. *Crew Factors in Flight Operations. X: Alertness Management in Flight Operations*. NASA/FAA Technical Memorandum DOT/FAA/RD-93/18. Washington, DC: National Aeronautics and Space Administration. (c) National Transportation Safety Board. 1995. *Factors That Affect Fatigue in Heavy Truck Accidents*. Safety Study NTSB/SS-95/01 and NTSB/SS-95/02. Washington, DC.

[8] (a) Folkard, S.; Monk, T.H.; Lobban, M.C. 1979. "Towards a Predictive Test of Adjustment to Shiftwork." *Ergonomics* 21: 785-799. (b) Thomas, G.R.; Raslear, T.G.; Kuehn, G.I. 1997. *The Effects of Work Schedules on Train Handling Performance and Sleep of Locomotive Engineers: A Simulator Study.* DOT/FRA/ORD-97-09. Washington, DC: Federal Railroad Administration.

[9] Kryger, M.H.; Roth, T.; Carskadon, M. 1994. "Circadian Rhythms in Humans: An Overview." In: Kryger, M.H.; Roth, T.; Dement, W.C., eds. *Principles and Practice of Sleep Medicine.* 2nd edition. Philadelphia: W.B. Saunders Company. pp. 301-308.

[10] Wylie, C.D.; Shultz, T.; Miller, J.C.; and others. 1996. *Commercial Motor Vehicle Driver Fatigue and Alertness Study: Project Report*. FHWA-MC-97-002. Washington, DC: Federal Highway Administration.

impaired by fatigue.[11] Sleep disorders and the characteristics of sleep patterns at different ages have also been studied.[12] Cumulative sleep loss and circadian disruption can lead to a physiological state characterized by impaired performance and diminished alertness.[13] Fatigue can impair information processing and reaction time, increasing the probability of errors and ultimately leading to transportation accidents.[14] A summary of sleep and circadian rhythms was originally completed for the Safety Board's investigation of the 1993 American International Airways accident in Guantanamo Bay, Cuba.[15] An update of that summary is provided in appendix C.

Scope of the Fatigue Problem

Fatigue has remained a significant factor in transportation accidents since the Safety Board's 1989 recommendations were issued. Although generally accepted as a factor in transportation accidents, the exact number of accidents due to fatigue is difficult to determine and likely to be underestimated. The difficulty in determining the incidence of fatigue-related accidents is due, at least in part, to the difficulty in identifying fatigue as a causal or contributing factor in accidents. There is no comparable chemical test for identifying the presence of fatigue as there is for identifying the presence of drugs or alcohol; hence, it is often difficult to conclude unequivocally that fatigue was a causal or contributing factor in an accident. In most instances, one or more indirect or circumstantial pieces of evidence are used to make the case that fatigue was a factor in the accidents. This evidence includes witness statements, hours worked and slept in the previous few days, the time at which the accident occurred, the regularity or irregularity of the operator's schedule, or the operator's admission that he fell asleep or was impaired by fatigue.[16]

Despite the difficulty in identifying fatigue as a causal factor, estimates of the number of accidents involving fatigue have been made for the different modes of transportation; the estimates vary from very little involvement to as high as about one-third of all accidents.

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[11] (a) Roehrs, T.; Beare, D.; Zorick, F.; Roth, T. 1994. "Sleepiness and Ethanol Effects on Simulated Driving." *Alcoholism: Clinical and Experimental Research* 18(1): 154-158. (b) Dawson, D.; Reid, K. [In preparation]. "Equating the Performance Impairment Associated With Sustained Wakefulness and Alcohol Intoxication." Woodville, South Australia: Centre for Sleep Research.

[12] (a) Aldrich, M.S. 1994. "Cardinal Manifestations of Sleep Disorders." In: Kryger, M.H.; Roth, T.; Dement, W.C., eds. *Principles and Practice of Sleep Medicine.* 2nd edition. Philadelphia: W.B. Saunders Company. pp. 413-425. (b) Bliwise, D.L. 1994. "Normal Aging." In: Kryger, M.H.; Roth, T.; Dement, W.C., eds. *Principles and Practice of Sleep Medicine.* 2nd edition. Philadelphia: W.B. Saunders Company. pp. 26-39.

[13] Rosekind, M.R.; Graeber, R.C.; Dinges D.F.; and others. 1993. *Crew Factors in Flight Operations. IX: Effects of Planned Cockpit Rest on Crew Performance and Alertness in Long-Haul Operations.* NASA Technical Memorandum 108839; DOT/FAA/92/94. Washington, DC: National Aeronautics and Space Administration.

[14] (a) Dinges, D.F. 1989. "The Nature of Sleepiness: Causes, Context, and Consequences." In: Stunkard, A.; Baum, A., eds. *Perspectives in Behavioral Medicine: Eating, Sleeping, and Sex.* Hillsdale, NJ: Lawrence Erlbaum. pp. 147-179. Chapter 9. (b) Dinges, D.F. 1992. "Probing the Limits of Functional Capability: The Effects of Sleep Loss on Short-Duration Tasks." In: Broughton, R.J.; Oglivie, R., eds. *Sleep, Arousal, and Performance.* Boston: Birkhauser-Boston. pp. 176-188. Chapter 12.

Aviation

The Federal Aviation Administration (FAA) reported that 21 percent of the reports in the Aviation Safety Reporting System (ASRS) were related to general issues of fatigue. This includes reports that mentioned fatigue directly or indirectly. When only reports that directly mention fatigue are included, the percentage drops to 3.8 percent.[17]

Highway

The National Highway Traffic Safety Administration (NHTSA) estimates that each year 100,000 crashes, which result in more than 1,500 fatalities and 71,000 injuries, are caused by drowsy drivers.[18] This amounts to about 1.6 percent of all crashes and about 3.6 percent of fatal crashes. In 1998, the Federal Highway Administration (FHWA) derived estimates of the percentages of large truck crashes involving fatigue: all police-reported crashes (0.53 percent to 1.3 percent); all fatal crashes (2.8 percent to 6.5 percent); crashes fatal to the truck occupant only (12 percent to 29 percent); and crashes fatal to nontruck occupants (1.2 percent to 2.8 percent). The FHWA also concluded that more in-depth investigations yield higher percentages of fatigue-related crashes than indicated in comparable samples of police accident reports.[19] The Safety Board's 1990 study of 182 heavy truck accidents that were fatal to the driver showed that 31 percent of the accidents in this sample involved fatigue.[20] This number is frequently cited as an estimate of the incidence of fatigue in truck accidents that were fatal to the truckdriver. The Safety Board's numbers regarding fatigue-involved accidents are more revealing because the Board's in-depth investigations included such surrogate measures as a 72-hour history of rest and duty times, the amount of sleep in the last 24 hours, and the regularity of the work schedule, to name just a few.

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[15] Rosekind, Mark R. [NASA Ames Research Center]; Gregory, Kevin B. [Sterling Software]; Miller, Donna L. [Sterling Software]; and others. 1994. "Analysis of Crew Fatigue Factors in ATA Guantanamo Bay Aviation Accident." In: *Uncontrolled Collision With Terrain, American International Airways Flight 808, Douglas DC-8-61, N814CK, U.S. Naval Air Station in Guantanamo Bay, Cuba, August 18, 1993.* Aircraft Accident Report NTSB/AAR-94/04. Washington, DC: National Transportation Safety Board. pp. 133-144.

[16] The Safety Board recognizes that people have a limited ability to predict the onset of sleep and to determine their level of sleepiness. (Itoi, A.; Cilveti, R.; Voth, M.; and others. 1993. *Can Drivers Avoid Falling Asleep at the Wheel? Relationship Between Awareness of Sleepiness and Ability To Predict Sleep Onset.* Washington, DC: AAA Foundation for Traffic Safety. p. 25.)

[17] (a) *Federal Register*, Vol. 60, No. 244, dated December 20, 1995. (b) Batelle Memorial Institute. March 1998. *A Review of Issues Concerning Duty Period Limitations, Flight Time Limitations, and Rest Requirements as Stated in the FAA's Notice of Proposed Rulemaking 95-18.* Washington, DC: Federal Aviation Administration.

[18] Knippling, R.R.; Wang, J.S. October 1995. "Revised Estimates of the U.S. Drowsy Driver Crash Problem Size Based on General Estimates System Case Reviews." In: 39th Annual Proceedings, AAAM; October 16–18, 1995; Chicago, IL. Des Plaines, IL: Association for the Advancement of Automotive Medicine.

[19] Federal Highway Administration, Office of Motor Carriers. September 1998. *Crash Problem Size Assessment: Large Truck Crashes Related Primarily to Driver Fatigue.* Washington, DC.

[20] National Transportation Safety Board. 1990. *Fatigue, Alcohol, Other Drugs, and Medical Factors in Fatal-to-the-Driver Heavy Truck Crashes.* Safety Study NTSB/SS-90/01 and NTSB/SS-90/02. Washington, DC.

Marine

A 1996 United States Coast Guard (USCG) analysis of 279 incidents showed that fatigue contributed to 16 percent of critical vessel casualties and 33 percent of personal injuries.[21]

Railroad

According to a Safety Board analysis of Federal Railroad Administration (FRA) data from January 1990 to February 1999, only 18 cases were coded "operator fell asleep" as a causal or contributing factor. The Board believes that 18 cases in more than 9 years underestimates the actual number of cases in which fatigue might have been involved. For example, two Safety Board investigations—Sugar Valley, Georgia (August 9, 1990), and Corona, California (November 7, 1990)—in which fatigue was cited by the Safety Board as a causal factor were not coded in the FRA database as fatigue-related but rather as a failure to comply with signals.

In testimony before the Senate Subcommittee on Surface Transportation and Merchant Marine[22] on September 16, 1998, the Administrator of the FRA stated that "about one-third of train accidents and employee injuries and deaths are caused by human factors. We know fatigue underlies many of them."

In summary, although the data are not available to statistically determine the incidence of fatigue, the transportation industry has recognized that fatigue is a major factor in accidents, as was clearly demonstrated at the Safety Board's 1995 symposium on fatigue.[23] Further, the Safety Board's in-depth investigations have clearly demonstrated that fatigue is a major factor in transportation accidents.

[21] McCallum, Marvin C.; Raby, Mireille; Rothblum, Anita M. 1996. *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. CG-D-09-97. Washington, DC: U.S. Department of Transportation, U.S. Coast Guard, Marine Safety and Environmental Protection.

[22] The subcommittee is an entity of the Senate Committee on Commerce, Science, and Transportation.

[23] The symposium is discussed in further detail in part 2 of this report.

Part 2

Overview of Safety Board Activity Since 1989

Since 1989, the Safety Board has issued more than 70 fatigue-related safety recommendations,[24] which were the result of major accident investigations, special investigations, or safety studies that identified operator fatigue as a factor (see table 2–1). This includes 11 accident reports or studies in aviation regarding air tours and operations conducted under Parts 91, 121, and 135; 7 in highway regarding busdrivers and truckdrivers; 3 in marine regarding passenger vessels and tankships; 4 in railroad regarding freight trains, passenger trains, and rail transit operations; and 1 in pipeline regarding pipeline controllers.

A 1990 safety study that examined the causes of 182 accidents that were fatal to the driver of heavy trucks[25] found that 31 percent of the fatal-to-the-truckdriver accidents in the sample involved fatigue. A 1995 study of 107 accidents (62 of which were fatigue-related) examined the factors that affect fatigue in heavy truck accidents; the Board found that the three most critical factors that predicted a fatigue-related accident were duration of sleep in the last sleep period, the total hours of sleep obtained during the 24 hours prior to the accident, and the presence of split sleep periods.[26]

The Safety Board has also examined operator fatigue in its safety studies on flight crew errors, commuter airlines, and aviation safety in Alaska.[27] In the flight crew study, the Board found that crews comprising captains and first officers whose time since awakening was above the median for their crew position made more errors overall. In the study on commuter airline safety, the Board found that self-reports from commuter airline pilots indicated that most pilots had flown while fatigued. In the study on aviation in Alaska, the Board concluded that the consecutive, long duty days permitted by Title 14 *Code of Federal Regulations* (14 CFR) Part 135.261 for commuter airline and air taxi flight crews in Alaska can contribute to fatigue and are a detriment to safety.

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[24] Thirty-four of these recommendations were issued to the DOT or modal administrations. The remainder of the recommendations were issued to the States, industry, or industry associations.

[25] National Transportation Safety Board. 1990. *Fatigue, Alcohol, Other Drugs, and Medical Factors in Fatal-to-the-Driver Heavy Truck Crashes.* Safety Study NTSB/SS-90/01 and NTSB/SS-90/02. Washington, DC.

[26] National Transportation Safety Board. 1995. *Factors That Affect Fatigue in Heavy Truck Accidents.* Safety Study NTSB/SS-95/01 and NTSB/SS-95/02. Washington, DC.

[27] (a) National Transportation Safety Board. 1994. *A Review of Flightcrew-Involved, Major Accidents of U.S. Air Carriers, 1978 Through 1990.* Safety Study NTSB/SS-94/01. Washington, DC. (b) National Transportation Safety Board. 1994. *Commuter Airline Safety.* Safety Study NTSB/SS-94/02. Washington, DC. (c) National Transportation Safety Board. 1995. *Aviation Safety in Alaska.* Safety Study NTSB/SS-95/03. Washington, DC.

Table 2–1. Fatigue-related investigations and studies conducted by the National Transportation Safety Board since May 1989, by mode.

Location of accident or topic of the study that identified fatigue-related issues[a]	Accident date	NTSB report number
Aviation		
Accident investigation:		
Molokai, Hawaii	10/28/89	AAR-90/05
Brunswick, Georgia	04/05/91	AAR-92/03
Pine Bluff, Arkansas	04/29/93	AAR-94/01/SUM
Guantanamo Bay, Cuba	08/18/93	AAR-94/04
Kansas City, Missouri	02/16/95	AAR-95/06
Cheyenne, Wyoming	04/11/96	AAR-97/02
Everglades, Florida	05/11/96	AAR-97/06
Special investigation:		
Commercial space launch incident, Cape Canaveral, Florida	08/17/93[b]	SIR-93/02
Safety study:		
Flight crew-involved accidents	02/03/94[b]	SS-94/01
Commuter airline safety	11/30/94[b]	SS-94/02
Aviation safety in Alaska	12/01/95[b]	SS-95/03
Highway		
Accident investigation:		
Sutton, West Virginia	07/26/90	HAR-91/01
Donegal, Pennsylvania, and Caroline, New York	06/26/91, 08/03/91	HAR-92/01
Evergreen, Alabama	05/19/93	HAR-94/02
White Plains, New York	07/27/94	HAR-95/02
Special investigation:		
Selective motorcoach issues	02/26/99[b]	SIR-99/01
Safety study:		
Accidents fatal to the truck driver	04/04/90[b]	SS-90/01
Truck driver fatigue	02/07/95[b]	SS-95/01
Marine		
Accident investigation:		
Valdez, Alaska	03/24/89	MAR-90/04
Santa Catalina Island, California	06/14/89	MAR-90/05
Lynn Canal, Alaska	06/23/95	MAR-97/02
Pipeline		
Accident investigation:		
Fork Shoals, South Carolina	06/26/96	PAR-98/01

Table 2–1. Fatigue-related investigations and studies conducted by the National Transportation Safety Board since May 1989, by mode (continued).

Location of accident or topic of the study that identified fatigue-related issues[a]	Accident date	NTSB report number
Railroad		
Accident investigation:		
Corona, California	11/07/90	RAR-91/03
Sugar Valley, Georgia	08/09/90	RAR-91/02
Brooklyn, New York	06/05/95	RAR-96/03
Special investigation:		
Steam locomotives	11/26/96[b]	SIR-96/05

[a] The titles of the published reports are contained in appendix B.

[b] The date the safety recommendations were issued.

Operator fatigue has been on the Safety Board's list of Most Wanted Transportation Safety Improvements since the list's inception in 1990.[28] Had the DOT acted more aggressively on the three intermodal recommendations issued in 1989, the need for the 70-some additional recommendations to the States and industry may have been minimized. (Pertinent recommendations are discussed in more detail in part 3 of this report in connection with the specific issues of Safety Recommendations I-89-1, -2, and -3: research, education, and revisions to hours-of-service regulations, respectively.)

In November 1995, the Safety Board and the National Aeronautics and Space Administration (NASA) cosponsored a symposium to discuss fatigue countermeasures and to demonstrate how they can be applied to prevent accidents in all modes of transportation.[29] The symposium was designed to practically illustrate the intent of one of the Safety Board's 1989 intermodal recommendations (I-89-2): to develop and disseminate educational material. More than 500 people from 16 countries representing all the modes of transportation attended the symposium, which attests to the magnitude and interest in the fatigue problem. As part of the symposium, the participants were divided into modal-specific groups to discuss scheduling, countermeasures, and education. All of the groups indicated that education was needed for the operators as well as for the management of transport companies. While the groups believed there was a need for additional technological countermeasures, they also believed there were some steps that could already be taken or could easily be implemented. For example, both an aviation group and the railroad

[28] In October 1990, the Safety Board adopted a program to identify the "Most Wanted" transportation safety improvements. The purpose of the Board's Most Wanted list, which is drawn up from safety recommendations previously issued, is to bring special emphasis to the transportation safety issues the Board deems most critical.

[29] National Transportation Safety Board; NASA Ames Research Center. 1996. *Fatigue Symposium Proceedings, November 1–2, 1995*. Washington, DC: National Transportation Safety Board.

group discussed the need for quality sleeping areas while away from home, pointing out that many hotels do not have rooms that are adequate for daytime sleeping. There was broad support voiced regarding a need for changes to the hours-of-service regulations. The participants wanted these regulations to be updated and based on scientific research. The summaries of the working groups are provided in appendix D.

Another product from the symposium was the development of the Fatigue Resource Directory, a tool for researchers, industry, and others to use to share information regarding operator fatigue. Following the symposium, the DOT assumed responsibility for maintaining the directory. It is now available on the World Wide Web at <www.hf.faa.gov/dot/fatigue>. The Web site has search capabilities and entries can be edited or new entries can be added.