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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: AUG 11 1998

In reply refer to: H-98-40

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More than 4,000 accidents have occurred at the Nation's active and passive grade crossings each year from 1991 through 1996. Many of the accidents at active crossings have involved highway vehicle drivers who did not comply with train-activated warning devices installed at the crossings. This failure to comply often includes driver actions resulting from a deliberate decision, such as driving around a lowered crossing gate arm or ignoring flashing lights. Drivers at passive crossings are not provided warnings from train-activated devices; consequently, they must rely on a system of grade crossing signs and pavement markings, passive devices, that are designed to warn drivers only of the presence of a crossing. No element of this passive system changes to alert drivers to an oncoming train. Further, the effectiveness of the passive system is influenced by characteristics of the physical layout of the crossing, such as an adequate view of the area surrounding the crossing (sight distance) and roadway alignment, that affect the information given to an approaching motorist regarding an upcoming hazard.

According to the Federal Railroad Administration (FRA), there were 4,054 accidents in 1996 that involved highway vehicles at grade crossings, 54 percent (2,208) of those accidents occurred at passive grade crossings. About 60 percent of the fatalities from all grade crossing accidents in 1996 (247 of 415 fatalities) were at passive grade crossings.

The cost to eliminate or upgrade passive grade crossings is very high. According to the General Accounting Office, the average cost of adding lights and gates in 1995 was $150,000 per grade crossing. The total cost to upgrade the 96,759 passive crossings on public roadways would be about $14 billion. Gates and lights do not completely eliminate the hazards present at crossings, and, therefore, sole reliance on them would reduce but not eliminate all the fatalities. The ultimate solution from a safety standpoint would be a standard grade separation, which usually involves construction of bridges or overpasses and costs an estimated $3 million per crossing. The large number of passive grade crossings, the high percentage of fatalities that occur at passive grade crossings, and the cost to eliminate or upgrade passive grade crossings prompted the Safety Board to conduct a study to identify some of the common causes for accidents at

passive grade crossings, and to identify less costly remedies to improve safety at passive crossings not scheduled for closure or upgrade.[1]

For this study, the Safety Board investigated 60 grade crossing accidents that occurred between December 1995 and August 1996. The Safety Board selected for study accidents involving a collision between a train and a highway vehicle occurring at a passive grade crossing, wherein the highway vehicle was sufficiently damaged to require towing. The sample of accidents is not intended to be statistically representative of the entire population of accidents at passive grade crossings during the study period, but rather to illustrate a range of passive grade crossing accidents.

In May 1997, the Safety Board convened a 2-day public forum in Jacksonville, Florida, to gather information about issues affecting safety at passive grade crossings. Witnesses included experts from the railroad industry; law enforcement; research groups; Operation Lifesaver; and Federal, State, and local government agencies. Those involved in grade crossing accidents, both highway vehicle occupants and traincrews, testified about their personal experiences. In addition, representatives from Canada and Italy discussed passive grade crossing issues and experiences in their countries.

Detecting a train at a passive crossing and making the correct decisions about whether a highway vehicle should stop at the crossing or can cross the tracks safely before the train arrives is a complex task that has confronted the Nation's motoring public for decades. The task is affected by the driver's ability to (1) detect the presence of the crossing, (2) detect the presence of a train, and (3) accurately gauge the train's speed and arrival time at the crossing. The task is further complicated by the driver's attention at a crossing, which as shown in the Safety Board's study, can be affected by what that individual expects to see. The Safety Board concludes that a driver's decision to look for a train may be adversely affected by the driver's familiarity with and expectations at a specific passive grade crossing and the driver's experience with passive crossings in general. Also, as shown in the Board's study, the train horn—one of only two active signals given to a driver to alert the driver that a train is present—is effective as a warning only if the driver recognizes it as a train horn. The Safety Board, therefore, concludes that in some circumstances, audible warning devices on trains fail to meet their objective of alerting motorists to an oncoming train because of highway vehicle design and environmental factors.

Despite the complexity of the task, the approach to passive grade crossing safety has remained relatively unchanged over the years. The current approach includes providing a sight distance triangle for an approaching motorist to see a train and installing a railroad crossing advance warning sign, pavement markings, and a crossbuck sign, where appropriate. The accident sample in the Safety Board's study illustrates that this approach has been inadequate in many instances.

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[1] National Transportation Safety Board. 1998. Safety at passive grade crossings. Volume 1: Analysis. Safety Study NTSB/SS-98/02. Washington, DC.

To eliminate the continuing problems encountered by the motoring public at passive crossings, the Safety Board concludes that a systematic and hierarchic approach to improving passive grade crossing safety is needed, an approach that does not depend primarily on the ability of the driver approaching the crossing to see an oncoming train. The hierarchic approach includes grade separation and closure, installation of active warning devices, improved signage, and intelligent transportation systems technology. The approach includes immediate and long-term measures. This letter addresses the role that the Advertising Council can play in the approach to improving safety at passive crossings.

Improved Signage

The Safety Board's study suggests the need for a system-wide approach that provides for uniformity of signage at passive crossings and instructs the driver what action is needed while providing the driver adequate time to react accordingly.

The issue of installing stop signs at highway–rail crossings has been debated for many decades. A 1929 report by the National Association of Railroad and Utilities Commissioners noted the following:

> In many States, experience with the "Stop" law, that is, the law requiring all vehicles on the highway to come to a full stop before passing over any railroad crossing at grade, indicates that enforcement of this requirement is not practical . . . [However,] . . . in some States, where the stopping of highway traffic is required at certain crossings which are designated "stop crossings" or "extra hazardous crossings," . . . better results are being secured.[2]

A report on rail–highway grade crossing accidents from 1935 to 1954 stated that "unrealistic regulations, such as the requirement that vehicles stop or slow down to 5 mph at the approach to a crossing, are so generally disregarded that they are not effective and create disrespect for warnings generally."[3] In 1985, however, the Federal Highway Administration (FHWA) indicated that upgrading from no stop signs to stop signs at crossings resulted in an overall reduction in the expected number of accidents of 35 percent.[4]

In response to requests for guidance on the selection of highway–rail grade crossings for the installation of stop and yield signs, the FHWA and the FRA in 1993 jointly developed recommended guidance.[5] The document developed by the FHWA and FRA stated "it is

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[2] National Association of Railroad and Utilities Commissioners. 1929. Report of committee on railroad grade crossings, elimination and protection. [Publisher's location not indicated.] 72 p.

[3] Interstate Commerce Commission, Bureau of Transport Economics and Statistics. 1955. Rail-highway grade-crossing accidents 1935-1954. Statement 5521; File 4-B-1. Washington, DC. 123 p. (page 60).

[4] U.S. Department of Transportation, Federal Highway Administration. 1985. Effectiveness of motorist warning devices at rail-highway crossings. FHWA/RD-85/015; DOT-TSC-FHWA-85-1. Washington, DC. Variously paged (page 3-16). [Prepared by the Transportation Systems Center, Research and Special Programs Administration.]

[5] U.S. Department of Transportation; Federal Highway Administration; Federal Railroad Administration. 1993. Recommended guidance for stop and yield sign installation at highway-rail grade crossings. Washington,

recommended that the following considerations be met in every case where a STOP sign is installed:"

1. Local and/or State police and judicial officials will commit to a program of enforcement no less vigorous than would apply at a highway intersection equipped with STOP signs.

2. Installation of a STOP sign would not occasion a more dangerous situation (taking into consideration both the likelihood and severity of highway–rail collisions and other highway traffic risks) than would exist with a YIELD sign.

The document further stated that "any one of the following conditions indicate that use of STOP signs would tend to reduce risk of a highway–rail collision. It is recommended that the following considerations be weighed against the [factors in opposition to STOP signs]:"

1. Maximum train speeds equal or exceed 30 mph (a factor highly correlated with highway–rail accident severity).

2. Highway traffic mix includes buses, hazardous materials carriers and/or large (trash or earth moving) equipment.

3. Train movements are 10 or more per day, 5 or more days per week.

4. The rail line is used by passenger trains.

5. The rail line is regularly used to transport a significant quantity of hazardous materials.

6. The highway crosses two or more tracks, particularly where both tracks are main tracks or one track is a passing siding that is frequently used.

7. The angle of approach to the crossing is skewed.

8. The line of sight from an approaching highway vehicle to an approaching train is restricted such that approaching traffic is required to substantially reduce speed.

According to the document, "factors to be weighed in opposition to STOP signs," or "contra-indications," include the following:

DC. 3 p. [Attachment 2 to a memorandum from the Associate Administrator for Safety and Systems Applications, FHWA, and the Associate Administrator for Safety, FRA, issued on July 8, 1993, to the FHWA Regional Administrators and the FRA Regional Directors of Railroad Safety.]

1. The highway is other than secondary in character. Recommended maximum of 400 ADT [average daily traffic] in rural areas, and 1,500 ADT in urban areas.

2. The roadway is a steep ascending grade to or through the crossing, sight distance in both directions is unrestricted in relation to maximum closing speed, and the crossing is used by heavy vehicles.

The Safety Board acknowledges that there has been some concern expressed about the use of stop signs at passive crossings. According to one witness at the Board's public forum, "stop signs don't seem to make a difference because people recognize it is a stop sign at a railway crossing, not a stop sign at a road crossing."[6] Twenty-two accident crossings in the Safety Board's study were protected by stop signs, but 11 highway vehicle drivers made no effort to stop. The results of the Safety Board study are consistent with previous findings on stop sign compliance at passive crossings. A study funded by the FHWA found that 60 percent of drivers stopped at crossing stop signs compared with 80 percent who stopped at highway intersection stop signs where there was no grade crossing.[7] Another study reported that for familiar crossings, stopping compliance can be as low as 29 percent.[8] A third study indicated that as few as 18 percent of all motorists come to a full stop, even at crossings with no available sight distance.[9] This is particularly disconcerting because most of the highway vehicle drivers in the Safety Board's study cases had their accidents at familiar crossings, and many of the crossings had less sight distance for approaching motorists than is recommended in the American Association of State Highway and Transportation Officials' *A Policy on Geometric Design of Highways and Streets*.

Another concern raised about stop signs is that drivers have difficulty judging the speed of an approaching train, even when there is some apparent movement across the visual field, as occurs when a driver some distance away from the crossing sees an approaching train. The cues provided by the lateral movement of the train are not available to the driver who is stopped at the crossing; the only information available to this driver comes from the rate of apparent change in the train's size, which varies according to the distance between the driver and the approaching train. Drivers tend to be effective at estimating the speed of the train when it is closest because the change in visual angle is rapid. However, drivers tend to decide on the safety of proceeding

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[6] Statement by an official of the Canadian National Railway. In: Transcript of the NTSB public forum on safety at passive grade crossings (page 114)

[7] U.S. Department of Transportation, Federal Highway Administration. 1978. Safety features of stop signs at rail-highway grade crossings. Vol. 1: Executive summary. FHWA-RE-78-40. Washington, DC. 17 p. [Prepared by BioTechnology; Falls Church, VA.]

[8] Parsonson, P.S.; Rinalducci, E.J. 1982. Positive guidance demonstration project at a railroad-highway grade crossing. In: Automotive technology, information needs of highway users, and promotion of safety belt usage. Transportation Research Record 844. Washington DC: Transportation Research Board, National Research Council: 29-34.

[9] Burnham, A. 1995. Stop sign effectiveness at railroad grade crossings (abuse without excuse). In: Proceedings, 3rd international symposium on railroad-highway grade crossing research and safety; 1994 October 24-26; Knoxville, TN. Knoxville: University of Tennessee: 91-113 (page 105)

across the tracks when the train is at greater distances, when the change in visual angle is slow and they are more likely to underestimate the train's speed.

In addition, drivers of large trucks point out that if they are forced to come to a full stop, it takes several seconds longer to clear a crossing than it does if the truck merely drops down to a slow roll.[10] Federal regulations in 49 CFR 392.10, however, require certain commercial vehicles transporting hazardous materials to stop at all grade crossings, whether or not there is a stop sign present. Further, in its investigations of two collisions involving trains and tank trucks transporting hazardous materials, the Safety Board found that the collisions could have been avoided had the truckdrivers stopped at the crossings.[11]

Despite concerns about the use of stop signs at passive crossings, the Safety Board believes that the benefits of stop signs at passive crossings outweigh the concerns. Foremost, in the Safety Board's opinion, is the need for a system-wide approach that provides consistent information and instruction to the driver. Installation of stop signs at passive crossings accomplishes this objective. Specifically, (1) the action required by a stop sign is well understood by drivers, (2) a driver stopped at a crossing has more time in which to detect an approaching train, and (3) sight distance along the tracks when viewed from a stop line is generally adequate, according to study accident data. In the Board's 60 cases, sight obstructions existed for a driver stopped at the crossing in only 10 cases; in comparison, there were 33 cases in which the visibility was limited on the approach to the crossing. By placing a stop sign at a passive crossing, a clear, unambiguous message is sent to the driver so that the driver knows both where the crossing is and what action must be taken. Further, the presence of a stop ahead sign, required by the FHWA's *Manual on Uniform Traffic Control Devices* (MUTCD) before a stop sign at a grade crossing, warns the driver in advance of what action is needed. Requiring the driver to stop at passive crossings can eliminate some of the problems created by limited sight distance or other physical characteristics such as skewed angle of intersection along the roadway approach.

In the Safety Board's study sample, several conditions existed that were consistent with conditions that would prompt installation of stop signs according to the FHWA and FRA joint guidance, including inadequate sight distance, skewed angle of approach, train traffic exceeding 10 trains per day, and/or maximum train speeds equal to or exceeding 30 mph. Although many of the crossings in the Board's sample met the conditions of the FHWA and FRA guidance that warranted installation of a stop sign, none were installed. For example, in 36 of the study cases, the maximum authorized train speed was greater than 30 mph, but stop signs were not present; and in 20 of the study cases, the average daily train traffic was greater than 10, but stop signs

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[10] Remarks by a private-sector investigator of railroad crossing accidents. In: Transcript of the NTSB public forum on safety at passive grade crossings (page 102).

[11] (a) National Transportation Safety Board. 1971. Illinois Central Railroad Company, train No. 1 collision with gasoline tank truck at South Second Street grade crossing; Loda, Illinois; January 24, 1970. Railroad/Highway Accident Report NTSB/RHR-71/1. Washington, DC. 28 p. (b) National Transportation Safety Board. 1989. Consolidated Rail Corporation train collision with Island Transportation Corporation truck; Roosevelt Avenue grade crossing near Lafayette Street; Carteret, New Jersey; December 6, 1988. Railroad/Highway Accident Report NTSB/RHR-89/1. Washington, DC.

were not present. The Safety Board is concerned that the use of stop signs is underutilized by the States.

The decision to install a stop sign, according to the 1993 guidance document developed by the FHWA and the FRA, is based on a determination of risk and is reasonable from a systems planning approach. The Board's study data, however, suggest that, given the level of risk present at all passive grade crossings, wider use of stop signs would increase safety. Rather than using engineering studies to determine that a stop sign is needed at a crossing, the Board believes that a more reasonable approach is for the States to use traffic engineering studies to determine why a stop sign **should not** be placed at a crossing. Thus, the Board questions the need to limit the use of stop signs based on the 1993 guidance provided by the FHWA and the FRA, but concurs with the guidance regarding the need for enforcement. The Safety Board concludes that installation and enforcement of stop signs at passive grade crossings would provide consistent information, instruction, and regulation to the motoring public and would improve the safety of the Nation's passive grade crossings. The Board recognizes that the FHWA and the FRA believe that the use of stop signs at certain crossings may increase the risk to the traveling public; for example, crossings where there is a steep ascending grade on the approach to or through the crossing. However, the Safety Board is recommending that the States install, within 2 years of receiving Federal funding, stop signs at all passive grade crossings unless a traffic engineering analysis determines that installation of a stop sign would reduce the level of safety at a crossing. Crossings where conditions are such that the installation of stop signs would reduce the level of safety should be upgraded with active warning devices or should be eliminated.

In 1996, there were 198,985 public and private passive crossings; installation of stop signs, and the associated stop ahead signs, is estimated to cost between $1,200 and $2,000 per crossing. The Safety Board is recommending that the U.S. Department of Transportation (DOT) provide full funding within 3 years for the installation of stop and stop ahead signs at passive grade crossings.

Enforcement Activities at Crossings

According to the Association of American Railroads (AAR) Railroad Industry Grade Crossing Policy Agenda, "the violation of traffic laws relating to highway–rail grade crossings is the single most significant factor in grade crossing incidents . . . Incidents annually occur at grade crossings at which traditional highway 'stop' signs have been installed."[12]

The Safety Board acknowledges that a considerable proportion of passive crossings lie in rural regions on roads with fairly low traffic volume. In addition, casualties at grade crossings represent a very small percentage of overall highway casualties and, concurrently, a small part of law enforcement resources. Nevertheless, over 2,000 accidents occur each year at passive crossings. The Safety Board is aware that Operation Lifesaver (OL) organizations in several States have completed some innovative law enforcement programs that address enforcement of

[12] The AAR Policy Agenda, developed in 1994 and revised in 1998, summarizes the Association's recommendations for improving the safety at highway-rail grade crossings.

grade crossing warning devices.[13] These efforts are primarily targeted at locations with active warning devices, but some of the programs have addressed enforcement of stop signs at passive crossings. These programs, some entitled "Trooper on the Train," "Officer on the Train," or "Operation Stopgate," are often run sporadically; Ohio, however, runs about 11 or 12 trains per year because of strong coordination between the full-time OL coordinator and the law enforcement community and because of the interest of law enforcement in this initiative. Generally, the rail corridors targeted for these enforcement trains are selected because of high accident rates and the number of highway vehicle drivers who do not comply with active and passive warning devices. For the most part, these programs follow the same basic format: law enforcement officers are placed on the train and at stationary locations on either side of the grade crossings that are targeted for the program. Highway vehicle operators who do not comply with the lowered arm of a crossing gate and/or a flashing light or stop sign, and to a much lesser degree the crossbuck sign, are stopped by law enforcement officers and are ticketed. These programs also include video cameras that record the actions of the highway vehicle driver crossing in front of the train. The Safety Board emphasizes that one of the fundamental considerations that must be met for stop signs to be effective is that law enforcement officials must commit to a vigorous program of enforcement equal to the enforcement of stop signs at highway intersections

Concurrent with the installation of stop signs at all passive crossings is the need to inform the Nation's motorists of the need to stop at passive crossings. The Safety Board believes that a national media campaign is warranted to inform motorists of newly installed stop signs at passive crossings. The Advertising Council, Inc., has experience in developing messages to the public in an understandable manner and has worked with the modal administrations of the DOT on prior highway safety public service announcements. Therefore, the Safety Board believes that the DOT, in conjunction with the Advertising Council, should develop a media campaign to inform motorists that stops signs will be installed at many of the Nation's passive grade crossings, and to inform motorists of the importance of obeying stop signs at passive grade crossings.

Therefore, the National Transportation Safety Board recommends that the Advertising Council, Inc.:

> Develop, in conjunction with the U. S. Department of Transportation, a media campaign to inform motorists that stop signs will be installed at many of the Nation's passive grade crossings, and to inform motorists of the importance of obeying stop signs at passive grade crossings. (H-98-40)

Also as a result of this study, the Safety Board issued recommendations to the U.S. Department of Transportation, the Federal Railroad Administration, the National Highway Traffic Safety Administration, the Federal Highway Administration, the States, Operation Lifesaver, Inc., the American Association of Motor Vehicle Administrators, the American Automobile Association, the Professional Truck Drivers Institute of America, the American Association of

[13] Telephone conversations of Safety Board staff with the OL coordinators in selected States (North Carolina, Ohio, Alabama, Georgia, and Florida) that have enforcement programs.

State Highway and Transportation Officials, the Association of American Railroads, the American Short Line and Regional Railroad Association, and the American Public Transit Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility ". . . to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation H-98-40 in your reply.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman