log# R-584A

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

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In reply refer to: R-87-39 through -45

Mr. Frank Wilson
General Manager
Southeastern Pennsylvania
Transportation Authority
130 South Ninth Street
Philadelphia, Pennsylvania 19107

On August 23, 1986, Southeastern Pennsylvania Transportation Authority (SEPTA) single-car train 167 was en route to Upper Darby, Pennsylvania, on the Norristown High Speed Line (NHSL) when a passenger requested to be let off at the Beechwood/Brookline Station. The operator was unable to stop the 60-series car using normal braking. Subsequently, he applied the airbrakes in emergency, released the deadman pedal, and applied the mechanical handbrake on each end of the car. The car continued forward and began to accelerate as it descended the grade into the 69th Street Terminal at Upper Darby. The car overrode the bumping block at the end of the track, derailed, penetrated a terminal wall, and came to rest about 6 feet inside the terminal building. Of the 55 passengers on board, 44 were injured; 11 of the 44 injured passengers were hospitalized. In addition, one person inside the terminal building was injured. The operator received minor injuries. Damage to the equipment and building was estimated to be $225,000. 1/

The operator of car 167 said that when he departed the Bryn Mawr Station en route to Upper Darby he advanced the controller handle to enable the car to move up and over the crest of a slight upgrade and then he manually returned the controller handle to the power off position. The operator did not attempt to stop the car at the Wynnewood Road Station because there were no passengers who wanted to get on or off. When he attempted to stop the car at the Beechwood/Brookline Station by making a normal service application of the train brakes, the operator said he did not experience a retarding effect and thus made an emergency application of the brakes. When this failed, he attempted to recharge the airbrakes (although he did not allow the system sufficient time to recharge) and made another emergency application. He then released the deadman pedal and applied the handbrakes on both car ends. None of these efforts retarded the forward movement of the car as it passed the Penfield and Parkview Stations and then struck the 69th Street Terminal building. There is no evidence that he manipulated the controller handle at any time while trying to stop the car.

Between August 25-27, 1986, a series of running tests using the same type of equipment as car 167 were conducted on the NHSL. Running tests 1-3 were unsuccessful in recreating the sequence of events leading to the collision by having the controller handle in the power off position and by using the braking techniques the operator of car

1/ For more detailed information, read Railroad Accident Report—"Collision and Derailment of Southeastern Pennsylvania Transportation Authority Single-Car Train 167, 69th Street Terminal, Upper Darby, Pennsylvania, August 23, 1986" (NTSB/RAR-87/04).

167 said he used. However, examination of the controller from car 167 indicated that the controller handle could stick in the third point of power when returned manually. Had the controller handle never returned to the power off position from a full power position, as the operator said it had, the car would have remained under full power, even though the handle was partially returned. In subsequent running tests, 5 and 6, with the controller from car 167 installed on the test car, the controller did stick in the third point of power after having been returned from the full power position. The tests showed that a similar 60-series car with the controller in the third point of power and with the brakes applied in emergency could negotiate the grade past the Penfield Station and continue forward to the point of collision. The Safety Board was unable to determine any way in which the test car could negotiate the grade with its brakes applied unless the car was under full power. The brake tests conducted after the accident, the comparison of the brakeshoes on car 167 with the shoes from the test car on which the brakes were applied while the car was under power, and the statements by the operator of car 167 that he had no problems with the brakes on car 167 until the time of the accident indicate that the brakes on car 167 were working well enough to stop the car if it had not been under power. Therefore, the Safety Board concludes that the controller handle on car 167 was not in the power off position during the accident sequence, as the operator believed, and that the car was operating under power up to the collision.

A controller handle was reported stuck on another 60-series car on July 2, 1986, 52 days before this accident. Since the accident, SEPTA has retrofitted the 60-series cars with a "power knock-out" feature that prevents simultaneous application of power and braking. Given the potential consequences of a controller handle sticking in the power mode, the Safety Board believes that SEPTA should have conducted a thorough investigation into the July 2 report; instead, it expended only 15 minutes to inspect the vehicle and determine that no repair was necessary. Further, the Safety Board believes that the power/brake interlock should have been installed on the 60-series cars long before the accident.

The deadman feature on the 60-series cars was not a fail-safe device. Most deadman features in the rail and transit industry apply the brakes when the pedal is released regardless of other factors, unless the brakes are already being applied. The deadman feature on the 60-series cars only applied when the car was stopped or the controller handle was in the lower half of the power range (series). The deadman pedal was designed in the 1920's to work in conjunction with the spring-loaded controller handle. If the controller handle was in the parallel range or stuck before returning to the power off position, the deadman feature was nullified. After the accident, SEPTA modified the deadman control to operate in all power control handle positions. The Safety Board believes that SEPTA should have corrected this deficiency long before the accident.

Car 167 traveled about 3 miles under power with full braking applied while carrying a full passenger load. Part of the 3 miles was up a steep grade. Cars in the 60-series fleet are equipped with an overload relay for electrical circuit protection. During the first few days of the on-scene investigation, SEPTA representatives dismissed the "power on/brake applied" theory because it was held that under such stress, the traction motors would have been creating so much electrical resistance that the overload relay would have operated and cut power. It became apparent from repeated tests that this was not occurring. Not once did an overload relay open from an excess of current while overcoming the brakes. Had an overload relay opened, power to the traction motors would have been interrupted, car 167 would have stopped, and the accident would not have occurred. The Safety Board believes that SEPTA should establish realistic standards for the sensitivity of the electrical circuit protection on the 60-series cars.

In a letter dated March 6, 1987, the SEPTA general manager notified the Safety Board that SEPTA had arranged to "Modify controller plates on the 60 series cars so as

not to allow any controller handles to mechanically 'hang up' in series or parallel circuit. This was complete as of August, 1986." In reviewing the maintenance records of the NHSL equipment for April 29, 1987, the Safety Board noted that car 161 was reported defective for "A-end controller sticks." The defect was diagnosed as a "stuck finger"; repairs made were reported as "filed finger." Apparently, SEPTA's modification of the controller plates to eliminate controller handle sticking was not successful in all cases, and the Safety Board urges SEPTA to review its modification program to ensure that the problem will be eliminated.

Due to the relatively small pool of equipment being operated on the NHSL at the time of the accident, the operators would become very familiar with the operational characteristics of that equipment. The Safety Board's investigation established that the 60-series cars were being routinely reported by the operators for weak brakes, as well as broken and maladjusted brakeshoes. Often the defect reports were on days subsequent to brake attention and adjustments made by SEPTA mechanical forces, resulting in brake attention about 3 out of every 4 days in the month before the accident.

SEPTA terms much of the repair work it does on the NHSL equipment as "preventive maintenance." If a component is broken or if it malfunctions during an inspection, it is generally immediately repaired or replaced. In the rapid transit industry, this manner of inspection and repair is generally termed "running repair" rather than preventive maintenance where components are replaced at predetermined limits of time or wear. At the time of the accident, there were no rudimentary scheduled maintenance requirements, nor periodic attention to the airbrake system. There also were no condemning wear limits for wheels or other components. The Safety Board does not consider the repair methods on the NHSL to have been a preventive maintenance program.

Brake attention appeared to be extensive during the 2-month period preceding the accident. However, brake attention appeared to be appreciably less following the accident. The significantly higher maintenance levels and failure rate suggests that there may have been a deterioration of the braking effectiveness of the 60-series fleet preceding this accident. Further, it appears that this deterioration may have been brought under control following this accident.

The investigation of this accident revealed deficiencies in SEPTA operational procedures in several areas. Several passengers stated that a person was sitting on the operator's stool in the operating compartment sketching the operator before the accident. The operator and the person sketching him reportedly were talking and laughing while the train was en route. The activity on the operating platform may have distracted the operator in performing his duties. This distraction in the moments preceding the operator's initial recognition that the train was not slowing after he applied the brakes, may have contributed to his failure to recognize that the controller handle was not in the power off position. SEPTA's operational rules prohibit passengers from being in the operating compartment while a train is en route and a sign is posted to that effect in the operating compartment. However, SEPTA supervisors and train operators repeatedly stated that passengers do ride in the operating compartments daily, generally during rush hours. The Safety Board believes that for a system of operational rules to be effective, they must be uniformly and consistently enforced. Supervisors ignoring or condoning violations of rules cast doubt in the minds of the employees as to the credibility and/or applicability of the entire rules system.

SEPTA's operating rules required its train operators to operate trains in accordance with speed restrictions on portions of the NHSL. However, at the time of this accident, none of the 60-series cars were equipped with speed indicators or speedometers, and only one of the 200-series cars was so equipped. As early as 1976, the Board had recommended

that SEPTA equip its trains with reasonably accurate speed indicators. While SEPTA subsequently equipped some of its cars with speedometers, it did not so equip cars operating on the NHSL. SEPTA's method of using radar guns and flash cards could only provide an operator information about his train speed at a given instant. Further, SEPTA's belief that a train operator can judge train speed based on experience gained driving an automobile (SEPTA required its train operators to be licensed automobile drivers), is not supported by any empirical data of which the Safety Board is aware. Consequently, although SEPTA required its train operators to operate their trains in accordance with speed restrictions, there was no consistent and accurate means provided to the operators which would enable them to determine their speeds at any given time. Rather, operators were required to estimate the speed of their trains to comply with the various speed restrictions.

Two earlier speeding violations by the train operator involved in this accident were not listed on his disciplinary record in the proper chronological sequence. This suggests to the Safety Board that speed restrictions may not have been consistently enforced on the NHSL and that SEPTA's actual practice was inconsistent with its written policy.

The Safety Board is aware that subsequent to this accident, SEPTA installed speed indicators on the NHSL equipment; however, the Safety Board has also been informed that the digital speed indicators have such a proclivity toward erratic display that they are repeatedly reported as being defective by the operators. This unreliable information is of little use to a train operator in attempting to maintain the appropriate speed of his train. The Safety Board believes that SEPTA should take immediate action to correct the erratic display of the in-cab speed indicators.

The Safety Board's investigation of this accident also revealed shortcomings in other aspects of SEPTA's operating methods which, although not factors in this accident, could compromise safety if the practices were to continue. SEPTA's failure to require switch lock track protection for workers on the NHSL who are regularly on, under, or between rolling equipment is inexcusable. The Safety Board finds no valid reason why each manually operated switch providing access to the track on which work is being performed should not be lined against movement and locked with an effective locking device, as is done on SEPTA's other rail operations. The Safety Board does not believe it should be necessary for an accident to occur before SEPTA institutes corrective procedures.

Also, SEPTA's "flag" system for identifying defective equipment on the NHSL does not differentiate between equipment that has been repaired and equipment that is being routed to the NHSL repair facility for repairs. In both cases, there is an absence of a flag. In some instances, there may be an on-board defect report from the operator; however, if the controller routes a car to the repair facility, it probably will not have on-board documentation. The Safety Board believes that SEPTA should establish a positive method with on-board documentation of identifying defective equipment.

SEPTA has failed to establish guidelines concerning the amount of time an NHSL operator must be off duty between shifts. SEPTA does have "hours of service" standards on other portions of its rail operations. The Safety Board does not understand why SEPTA fails to operate the NHSL in the same manner as its Regional Rail Division (RRD). There are more areas where the RRD and the NHSL are similar than there are areas where the NHSL is unique. The RRD's detailed instructions concerning operational, mechanical, and maintenance-of-way systems could certainly aid the NHSL to function more safely.

Given the nature of the failure of the ordinary plate glass in the side windows and end bulkheads, and the fact that some of the passengers exited car 167 through the window openings, it is reasonable to assume that the broken glass caused some injuries and

further contributed to the severity of other injuries. With the repeated failure of the glass experienced by SEPTA through vandalism and other accidents on the NHSL, it should have been apparent to SEPTA that superior glazing material was desirable. Further, since SEPTA uses modern safety glazing on its RRD, it is apparent that SEPTA knew of the availability of such materials. Since SEPTA's RRD operates through virtually the same type of territory as the NHSL, it seems the only difference regarding glazing standards is that there are no State or Federal glazing requirements on the NHSL equipment. The Safety Board recognizes that SEPTA is currently planning to replace the plate glass side-facing windows on the NHSL equipment with glazing equivalent to that required on its RRD equipment. The Safety Board believes that all glazing, including the interior bulkheads, should be the same standard as that installed on SEPTA's other rail equipment.

Initial training of railcar operators consisted of classroom instruction coupled with extensive over-the-road evaluations by both SEPTA supervisors and qualified train operators. However, previously qualified railcar operators who had rotated between bus and rail service were only required to pass a written and field examination in a recertification program that generally lasted a single day.

The operator of car 167 was qualified by SEPTA in the characteristics of the equipment and territory of the NHSL. He had passed his recertification examination when he returned to rail service from bus service about 2 months before the accident. However, he was not given any refresher training about railcar operations at that time, and this may partially account for his failure to exercise all of the options available to stop the car before the accident. Had the operator turned off the overhead power or reversed the traction motors, the latter of which was taught during his initial railcar training in 1984, car 167 would have stopped before colliding with the terminal building.

The operator had missed test questions on the recertification examination about emergency procedures, including that of reversing the traction motors as an emergency means of stopping a railcar, and although his service supervisor had filled in the words "jack the motors" in the blank spot on the examination, there is no evidence that the operator was ever provided with an explanation of, or training on, this procedure. There is little doubt that the operator was making considerable effort to stop the train. It also is apparent that sufficient time was available to the operator to attempt different methods of stopping. Since the operator made these efforts and had the necessary time to stop the train, the fact that he was unable to do so indicates that he was not adequately trained to deal with emergency situations.

Based on SEPTA's system of requalification, an operator could qualify with a score as low as 73 percent on the written portion of the examination. The Safety Board is concerned that SEPTA's recertification program would permit operators to return to rail service even if they did not correctly understand 27 percent of the questions on a written examination.

In this accident, the operator's failure to use all available means to stop the train and his lack of knowledge about jacking the motors underscore the insufficiency of SEPTA's recertification of him for train operation. The evidence shows SEPTA to have a training deficiency that needs prompt attention and correction for safe rail operations. The service supervisor testified at the public hearing that, as a result of the accident, they were "reviewing, re-evaluating, and reformulating aspects of the training program." When asked to provide details, he said they were considering increasing the amount of training and improving the test program as a way to increase operator knowledge of equipment. He also stated that more emphasis would be given to the procedure of jacking the motors as well. The Safety Board believes that SEPTA should evaluate and restructure its recertification program to provide more effective training. This could

include, for example, an additional day of "hands-on" training and demonstrations in emergency procedures, and the development and review of an emergency procedures checklist.

Therefore, the National Transportation Safety Board recommends that the Southeastern Pennsylvania Transportation Authority:

> Evaluate and restructure the railcar operator recertification program to include effective retraining of emergency procedures. (Class II, Priority Action) (R-87-39)
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> Revise the existing maintenance standards program to include comprehensive and specific standards for the inspection, repair, and replacement of all parts and components used on the Norristown High Speed Line. (Class II, Priority Action) (R-87-40)
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> Retrofit the ordinary plate glass glazing on the Norristown High Speed Line equipment with glazing material that meets the safety standards for the equipment used on the Regional Rail Division. (Class II, Priority Action) (R-87-41)
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> Establish a positive method, through on-board documentation, to identify defective equipment that is being routed into a repair facility on the Norristown High Speed Line. (Class II, Priority Action) (R-87-42)
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> Establish detailed procedures for switch lock protection for workers who are on, under, and between equipment on the Norristown High Speed Line. (Class II, Priority Action) (R-87-43)
>
> Establish hours of service requirements for operators on the Norristown High Speed Line. (Class II, Priority Action) (R-87-44)
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> Take the necessary corrective action so that the in-cab speed indicators display accurate and reliable train speeds. (Class II, Priority Action) (R-87-45)

Also, the Safety Board issued Safety Recommendation R-87-38 to the State of Pennsylvania.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER, NALL, and KOLSTAD, Members, concurred in these recommendations.

By: Jim Burnett
Chairman