National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: NOV 26 1996

In Reply Refer To: R-96-53 through -59

Honorable Jolene M. Molitoris
Administrator
Federal Railroad Administration
Washington, DC 20590

About 7:20 p.m. on June 16, 1995, the firebox crownsheet of Gettysburg Passenger Services, Inc., (Gettysburg Passenger Services) steam locomotive 1278 failed while the locomotive was pulling a six-car excursion train about 15 mph near Gardners, Pennsylvania. The failure resulted in an instantaneous release (explosion) of steam through the firebox door and into the locomotive cab, seriously burning the engineer and the two firemen. The firemen were taken by ambulance to area hospitals. The engineer, who had third-degree burns over 65 percent of his body, was airlifted to a burn center near Philadelphia. None of the 310 passengers or other crewmembers were injured. Locomotive damage was limited to the firebox grates and crownsheet, with some ancillary smoke and debris damage to the locomotive cab.[1]

Investigators found that the crownsheet failed from overheating because the traincrew had allowed the water in the locomotive boiler to drop to a level that was insufficient to cover the crownsheet. When the investigators examined the locomotive components closely, they found that the boiler and its associated equipment had not been maintained well enough to ensure safe operation and that some repairs had been done incorrectly. Investigators determined that the deficiencies were the result of a lack of the specialized knowledge, skills, and training necessary to properly maintain a steam locomotive. It was further determined that those operating the locomotive did not understand the full scope of their duties and did not coordinate their efforts to ensure the highest degree of safety.

[1]For further information, read Railroad Special Investigation Report – *Steam Locomotive Firebox Explosion on the Gettysburg Railroad near Gardners, Pennsylvania, June 16, 1995* (NTSB/SIR-96/05).

The National Transportation Safety Board determines that the probable cause of the firebox explosion on steam locomotive 1278 was the failure of Gettysburg Passenger Services management to ensure that the boiler and its appurtenances were properly maintained and that the crew was properly trained.

Since the water glass was the primary tool that the engineer and firemen had to monitor the level of water in the boiler, the investigators examined the glass and its related valves and spindles to determine their condition at the time of the accident. The passages of the valves had significant deposits. Hard scale plugged about 75 to 85 percent of the spindles. It could not be determined how much if any soft deposit or scale had been blown out during the explosion, but steam-locomotive experts agreed that it is reasonable to believe that soft scale and/or scale flakes further restricted or blocked the spindle passages. The Safety Board concludes that because the water-glass spindles were restricted, the water glass could not accurately represent the water level in the boiler.

Both the first fireman and the engineer acknowledged that their method of washing the boiler was not thorough and that the spindles were not cleaned and reamed out on a monthly basis as, according to the Federal Railroad Administration's (FRA's) regulations, they were supposed to be. The gage cocks were also not cleaned and reamed. The amount of scale and mineral deposit found in the spindles and the gage cocks supported the engineer's admissions that he did not follow the monthly cleaning requirements. The Safety Board concludes that although the engineer had signed the FRA's forms No. 1, certifying that the work had been done, the spindles and gage cocks were not cleaned on a monthly basis.

Investigators also examined the adequacy of the water-monitoring systems (water glass, gage cocks) in this accident since the systems would have been crucial in detecting the level of the water before the crownsheet failed. At the turn of the century, both government and the railroad industry had recognized the shortcomings of gage cocks by requiring the use of a water glass, thus relegating gage cocks to the status of a redundant back-up system.

Government and industry knew that gage cocks were particularly subject to the false-head phenomenon and did not present a readily apparent indication of the level of the boiler water as the water glass did. Government and industry knew that the water column was the optimal solution but did not require the use of a water column. Instead, the *Code of Federal Regulations* (CFR) said, "Every boiler [must] be equipped with at least one water glass and three gage cocks." In 1920, the U.S. Railroad Administration's Committee on Standards recommended the adoption of the water column as a recommended practice. The Safety Board believes that the FRA now should require that, at a minimum, each operating steam locomotive should have in addition to the required water glass and three gage cocks, either another water glass or a water column. While it can be argued that inadequate maintenance, as in this accident, would eventually allow any and all water-monitoring devices to become plugged with scale, the Safety Board believes that the chance that all the devices will be plugged at the same time is remote and that, therefore, two devices provide a degree of redundancy and accuracy that the currently required single water glass and gage cocks do not.

Since scale, particularly as it affected the water-monitoring devices, became a factor in the investigation, Safety Board investigators explored how Gettysburg Passenger Services treated its water in order to control the mineral content. According to experienced steam-locomotive operators and historical railroad documentation, water treatment is critical to the maintenance and safe operation of steam locomotives. Testimony from steam-locomotive experts and investigators, from the owner of Gettysburg Railroad (the accident happened on Gettysburg Railroad track), and from representatives of Gettysburg Passenger Services showed that water treatment for locomotive 1278 was, at best, undocumented and inconsistent.

The attempts at water treatment appeared to be irregular, rather than part of a planned and researched policy. According to his testimony the accident engineer (and co-owner of Gettysburg Passenger Services) sent boiler- and/or supply-water samples to Water Chem for testing. However, Water Chem has no record of doing any testing for Gettysburg Passenger Services. The engineer told Safety Board investigators that he did his own water testing with a kit and that he kept a journal of his testing. There was no documented evidence that this was done on a regular, program-type basis or that anything was done with any test result information. Investigators were unable to determine the effectiveness of such irregular water treatment, since no test results were found or provided. The Safety Board concludes that Gettysburg Passenger Services did not have a comprehensive water-treatment program. The Safety Board believes that the FRA should require steam-locomotive operators to have a documented water-treatment program as a basis for boiler maintenance and operation.

The first fireman's testimony about boiler washing described the manner in which Gettysburg Passenger Services personnel washed the boiler. Contrary to the regulatory requirement that all washout plugs be removed, the fireman removed only 4 of the boiler's 29 washout plugs. With only four plugs removed, it is doubtful that even the most conscientious effort to wash out the boiler would have been very effective in removing a significant amount of sediment.

There was also a discrepancy between the method the fireman said he used to wash out a boiler and the methods described in maintenance literature or described by the Strasburg Railroad chief mechanical officer.[2] The fireman did not use any special nozzles or equipment, which the American Railroad Administration had adopted as recommended practice in 1915. His casual description of the procedure displayed his lack of knowledge and training in this critical procedure. The Safety Board concludes that the boiler washing procedure described by the fireman was inadequate to ensure that the boiler was properly and thoroughly cleaned as required by FRA regulations.

[2]Several steam-locomotive experts were involved in the investigation. Two, the chief mechanical officers of the Strasburg Railroad and The Valley Railroad Company, were brought into the investigation by Gettysburg Passenger Services. Two others, the curator of transportation for the Smithsonian Institution and a representative of Combustion Engineering of Teaneck, New Jersey, are recognized authorities in the field of steam-locomotive boilers and mechanics.

During the testimony, both accident firemen, the helper engineer[3] (who also worked as a steam-locomotive engineer), the helper fireman, another Gettysburg Passenger Services employee (who was qualified as both a steam-locomotive fireman and an engineer), and the owner of Gettysburg Railroad each described and demonstrated how he would blow down and verify the water glass. Only the owner of Gettysburg Railroad, the accident engineer's father, demonstrated the correct method of blowing down. All the Gettysburg Passenger Services employees had been taught by the accident engineer. No one said that he also tested the gage cocks when he blew down the water glass, as required by regulation. The Safety Board therefore concludes that the firemen did not know, because they had not been properly taught, how to blow down the water glass or test the gage cocks. The lack of knowledge about such basic procedures reflects the lack of an effective training program at Gettysburg Passenger Services.

Although the CFR requires boiler washings, it does not describe the procedure. When all railroads depended on steam, the railroad industry had detailed methods and special equipment for boiler washing; however, much of this expertise has disappeared. Despite the recent efforts of the Tourist Railway Association, Inc., (TRAIN) to promote the proper boiler washing methods, it is obvious from this accident that some steam-locomotive operators do not have the initiative or the resources to find and employ proven and accepted boiler washing methods. Therefore the Safety Board believes that the FRA should describe the proper boiler washing methods and techniques in its regulations in order to set some basic safety standard for steam-locomotive operators.

Although fatigue does not appear to have been a factor in this accident, the Safety Board is concerned that the cumulative and consecutive hours worked by employees, particularly part-time employees, of tourist railroads such as Gettysburg Passenger Services, may make such employees susceptible to accidents caused at least in part by fatigue or sleep deprivation. Such an accident exposes the public to danger. The members of the enginecrew of locomotive 1278 had worked a full day, taken a 2- or 3-hour break, and then returned at 5:00 p.m. expecting to work until midnight. Whether part-time or full-time, such a day-to-day pattern can easily cause sleep deprivation and tiredness. This is particularly disturbing in the case of the engineer who, as co-owner of Gettysburg Passenger Services, had duties and responsibilities beyond running and maintaining the entire operation.

While the Safety Board acknowledges that it is up to the FRA to enforce the Hours of Service Act, the work-rest routine of Gettysburg Passenger Services train personnel exceeds the intent of the legislation and might threaten the safety of the public. The Safety Board concludes that Gettysburg Passenger Services management was not aware of the Hours of Service Act. The Safety Board believes that the FRA, in cooperation with TRAIN, should promote awareness of and compliance with the Hours of Service Act.

[3]A Gettysburg Railroad freight-train locomotive had been attached to the accident train as a helper.

Although not a warning or preventative device, the design of the accident locomotive boiler appeared to mitigate the effects of the crownsheet failure. The locomotive had alternating rows of straight-thread and button-head crown stays to help ensure that any crownsheet failure due to low water would occur relatively gradually and in stages, rather than instantaneously and catastrophically.

The design (which appears to have been unique to the company that built locomotive 1278, Canadian Locomotive Company, Ltd.) may well have prevented a more sudden catastrophic failure of the crownsheet, which could have sent the boiler rocketing off the frame, killing or injuring the crew and passengers. The Safety Board believes such a design may be worthy of further study for incorporation in steam locomotives when they are repaired or rebuilt. The Safety Board also believes that the FRA, in cooperation with the National Board of Boiler and Pressure Vessel Inspectors (NBBPVI) and the tourist-railroad industry steam-locomotive operators should explore the feasibility of requiring progressive crown-stay failure features in steam locomotives.

Locomotive 1278 lacked a feed-pump gage. It had an incorrect injector disk and a leaking check valve. Its dynamo was inoperative, and its water-glass light did not function. The Safety Board is concerned that all these problems together reflect a disturbing pattern of poor maintenance and/or improper repair. Such maintenance, in the opinions of the investigation steam-locomotive experts, clearly indicated a lack of knowledge and expertise on the part of the locomotive owners and crew. Steam-locomotive expertise is gone from most modern commercial railroads, and generally only a small number of experts and a limited supply of knowledge and skill remain. Today, many operating steam locomotives are in the hands of a generation that has had to develop steam-locomotive maintenance and operation second- or third-hand, much like the personnel of Gettysburg Passenger Services. One way to establish a minimum level of steam-locomotive expertise and thereby better ensure the safety of operators and the public would be to establish an education and certification program that establishes and enforces basic standards for steam-locomotive operation and maintenance.

The NBBPVI and the tourist-railroad industry steam-locomotive operators have agreed to establish a program for the safe maintenance and operation of boilers. The Safety Board supports such efforts and believes that the FRA, in cooperation with the NBBPVI and the tourist-railroad industry steam-locomotive operators, should develop certification criteria and require steam-locomotive operators and maintenance personnel to be periodically certified to operate and/or maintain a steam locomotive.

The Safety Board believes that the FRA, in cooperation with the NBBPVI and TRAIN, should update 49 CFR Part 230 to take advantage of accepted practical modern boiler-inspection techniques and technologies, to minimize interpretation based on empirical experience, and to maximize the use of objective measurable standards.

Therefore, the National Transportation Safety Board issues the following recommendations to the Federal Railroad Administration:

Require that each operating steam locomotive have either a water column or a water glass in addition to the water glass and three gage cocks that are already required. (R-96-53)

Require steam-locomotive operators to have a documented water-treatment program. (R-96-54)

Describe basic responsibilities and procedures for functions required by regulation, such as blowing down the water glass and washing the boiler. (R-96-55)

In cooperation with the Tourist Railway Association, Inc., promote awareness of and compliance with the Hours of Service Act. (R-96-56)

In cooperation with the National Board of Boiler and Pressure Vessel Inspectors and the Tourist Railway Association, Inc., explore the feasibility of requiring a progressive crown-stay feature in steam locomotives. (R-96-57)

In cooperation with the National Board of Boiler and Pressure Vessel Inspectors and the Tourist Railway Association, Inc., develop certification criteria and require that steam-locomotive operators and maintenance personnel be periodically certified to operate and/or maintain a steam locomotive. (R-96-58)

In cooperation with the National Board of Boiler and Pressure Vessel Inspectors and the Tourist Railway Association, Inc., update 49 *Code of Federal Regulations* Part 230 to take advantage of accepted practical modern boiler-inspection techniques and technologies, to minimize interpretation based on empirical experience, and to maximize the use of objective measurable standards. (R-96-59)

The Safety Board also issued Safety Recommendations R-96-60 through -62 to the National Board of Boiler and Pressure Vessel Inspectors and R-96-63 through -66 to the Tourist Railway Association, Inc.

The Safety Board is interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations R-96-53 through -59. If you need additional information, you may call (202) 314-6438.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman