National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 2, 2009

In reply refer to: R-09-5

To Distribution (See distribution list)

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendation in this letter. The Safety Board is vitally interested in the recommendation because it is designed to prevent accidents and save lives.

The recommendation addresses crew resource management (CRM) training. The recommendation is derived from the Safety Board's investigation of the November 30, 2007, collision of Amtrak train 371 with the rear of Norfolk Southern Railway Company train 23M near Chicago, Illinois, and is consistent with the evidence we found and the analysis we performed. As a result of this investigation,[1] the Safety Board has issued five safety recommendations, one of which is addressed to your organization. Information supporting the recommendation is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendation.

On Friday, November 30, 2007, about 11:23 a.m.,[2] Amtrak passenger train 371, consisting of one locomotive and three passenger cars, struck the rear of standing Norfolk Southern Railway Company freight train 23M near Chicago, Illinois. The forward portion of the Amtrak locomotive came to rest on top of a container on the rear car of the freight train. Sixty-six passengers and five crewmembers were transported to hospitals; two passengers and one crewmember were subsequently admitted. The weather was clear, and the temperature was 30º F. Estimated damage was $1,299,000.

The National Transportation Safety Board determined that the probable cause of the November 30, 2007, collision of Amtrak train 371 with the rear of Norfolk Southern Railway Company train 23M near Chicago, Illinois, was the failure of the Amtrak engineer to correctly

[1] For additional information, see <http://www.ntsb.gov/publictn/2009/RAR0901.pdf>. National Transportation Safety Board, *Collision of Amtrak Train 371 and Norfolk Southern Railway Company Freight Train 23M, Chicago, Illinois, November 30, 2007,* Railroad Accident Report NTSB RAR-09/01 (Washington, DC: NTSB, 2009).

[2] All times are central standard time unless otherwise noted.

interpret the signal at Englewood interlocking and Amtrak's failure to ensure that the engineer had the competency to correctly interpret signals across the different territories over which he operated. Contributing to the accident was the relief engineer's failure to immediately communicate to the engineer that he had miscalled the signal at Englewood and to stop the train when he did not respond to her expressed concern. Also contributing to the accident was an absence of effective crew resource management between the relief engineer and the operating engineer which led to their failure to resolve the miscalled signal prior to the collision. Further contributing to the accident was the absence of a positive train control system that would have stopped the Amtrak train when it exceeded restricted speed.

As the train traveled closer to the first signal at Englewood interlocking, the engineer made a significant error; he misinterpreted the meaning of the red over yellow signal aspect. The red over yellow aspect was a *restricting* indication, requiring the crew to operate the train at a maximum speed of 15 mph and to be prepared to stop for any trains or obstructions ahead. The aspect should have alerted the crew to the possibility of a train on the track ahead of them. However, the engineer misinterpreted the signal as a *slow approach*, which would have allowed him to operate through the interlocking at a maximum speed of 30 mph while being prepared to stop at the next signal. Of even more importance, a *slow approach* signal indication would have meant that there was no train within the next block.

As the westbound Amtrak train approached Englewood, the engineer slowed his train and then crossed over from track 1 to track 2. This action routed his train around the eastbound freight train that was directly ahead of him on track 1. Once the Amtrak train was on track 2, the eastbound freight train was neither a concern nor a source of additional delay. From that point, based on his misinterpretation of the meaning of the signal, the engineer may have had no expectation of operating the train at a reduced speed, at least until the train reached the next signal.

The Amtrak engineer, believing he had just received a *slow approach* indication, operated his train at 25 mph around the curves and at 30 mph on tangent track, which is consistent with the timetable speed for this territory. The crew observed nothing in front of them at that time to suggest that slowing the train below track speed was necessary. Consequently, the engineer likely felt comfortable about increasing the train's speed to the next timetable speed of 40 mph. Moments later, when questioned by the relief engineer about the signal they had passed, he stated that it was a *slow clear* indication, which would have permitted him to operate at the higher speed (40 mph). This second misinterpretation was different from his first misinterpretation and, in fact, was even less restrictive. The engineer and relief engineer continued to discuss the signal while the engineer maintained the train speed at 40 mph. When the engineer saw the stopped Norfolk Southern freight train on the track in front of him, the speed and distance did not allow enough time for him to stop his train short of the Norfolk Southern train.

The relief engineer told investigators that she had immediate concerns about the engineer's misinterpretation of the signal indication at Englewood. However, because of their conflicting interpretations of the signal, she began doubting her own knowledge of that signal and she said that she thought that initially the engineer had understood the signal but misspoke. Consequently, she delayed voicing her concerns until she gave it additional thought and felt more

confident with her position.[3] She communicated her concerns about 3/4 mile before the collision and as the Amtrak train's speed reached 40 mph, which exceeded both the maximum authorized speed (30 mph) of the signal indication that the engineer had erroneously called and the maximum authorized speed (15 mph) that she correctly believed the signal indication allowed. The relief engineer said that she asked the engineer, "You called a *slow approach* at Englewood, right? ... Even if it's a *slow approach*, you have to be down to 30." The discussion about the previous signal between the engineer and the relief engineer lasted for several moments, and the engineer, believing that he was operating the train appropriately, maintained the train's speed.

Although the relief engineer voiced her concerns in time for the engineer to make a brake application and safely stop the train, her actions were not immediate and were not adequate. She asserted herself after the engineer accelerated the train to 40 mph rather than asserting herself immediately after she first believed that the engineer had miscalled the signal, and she never asserted to the engineer that she believed that the Englewood signal was a *restricting* signal that limited their speed to 15 mph. After the relief engineer first voiced her concern, the process by which the two crewmembers attempted to resolve their differences was to discuss the indication of the previous signal: the engineer did not immediately slow the train and the relief engineer, seeing that the engineer did not immediately slow the train, did not herself apply the brakes to stop the train. The engineer applied the brakes only after he saw the stopped Norfolk Southern train in front of them. Therefore, the Safety Board concludes that the engineer misinterpreted and miscalled the signal at Englewood which resulted in the operation of the Amtrak train at a speed greater than authorized, and when challenged by the relief engineer, the engineer failed to slow or stop the train while he and the relief engineer discussed their differences in understanding the signal displayed at Englewood. The Safety Board also concludes that the relief engineer failed to communicate effectively and in a timely manner to the engineer that he had miscalled the restricting signal at Englewood interlocking and failed to then take action herself to stop the train after the engineer did not slow or stop the train when challenged.

The process by which train crews should identify and strategically respond to unsafe situations is addressed in Amtrak's CRM program. Modern railroads emphasize both the application of CRM principles and crewmember proficiency to establish and maintain safe train operations. The purpose of CRM is to help operating crews use all of the available resources (information, personnel, and equipment) at their disposal effectively. The role for crewmembers is to perform their assigned tasks responsibly, to know about or participate in determining the plans for movement of the vehicle, to be alert to departures from plans or from the expected performance of others, and to make those departures known in time to avert an operational error. If properly applied, CRM will increase the likelihood that human operation errors will be detected in time for action to be taken to prevent an accident. Although Amtrak's CRM program emphasizes the importance of crewmembers immediately voicing their concerns after

[3] Lack of confidence is one of several barriers to communication identified in CRM research. Other factors—some of which might have been present in this accident—include gender differences, lack of credibility, lack of rapport, position of authority, experience, rank, and fear of reprisal. R. Baron, "Barriers to Effective Communication: Implications for the Cockpit," 2005, <http://www.airlinesafety.com/editorials/BarriersToCommunication.htm>.

recognizing potentially unsafe situations, this accident clearly demonstrates the importance of crewmembers implementing the principles of CRM to prevent accidents.

As a result of its investigation, the National Transportation Safety Board makes the following recommendation:

> Use the circumstances of the November 30, 2007, accident in Chicago, Illinois, during crew resource management training to reemphasize the necessity of any qualified person on the leading locomotive or car to immediately communicate any disagreement on a called signal and to immediately take action necessary to ensure that the train is operated safely. (R-09-5)

In response to the recommendation in this letter, please refer to Safety Recommendation R-09-05. If you would like to submit your response electronically rather than in hard copy, you may send it to the following e-mail address: correspondence@ntsb.gov. If your response includes attachments that exceed 5 megabytes, please e-mail us asking for instructions on how to use our Tumbleweed secure mailbox procedures. To avoid confusion, please use only one method of submission (that is, do not submit both an electronic copy and a hard copy of the same response letter).

Acting Chairman ROSENKER and Members HERSMAN, HIGGINS, and SUMWALT concurred in this recommendation.

[Original Signed]

By: Mark V. Rosenker
Acting Chairman

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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 2, 2009

In reply refer to: R-09-4 and -5

Mr. Joseph H. Boardman
President and Chief Executive Officer
Amtrak (National Railroad Passenger Corporation)
60 Massachusetts Avenue, N.E.
Washington, D.C. 20002

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The Safety Board is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

The recommendations address Amtrak's (National Railroad Passenger Corporation's) oversight of signal proficiency and its crew resource management (CRM) training. The recommendations are derived from the Safety Board's investigation of the November 30, 2007, collision of Amtrak train 371 with the rear of Norfolk Southern Railway Company train 23M near Chicago, Illinois, and are consistent with the evidence we found and the analysis we performed. As a result of this investigation,[1] the Safety Board has issued five safety recommendations, two of which are addressed to Amtrak. Information supporting the recommendations is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendations.

On Friday, November 30, 2007, about 11:23 a.m.,[2] Amtrak passenger train 371, consisting of one locomotive and three passenger cars, struck the rear of standing Norfolk Southern Railway Company freight train 23M near Chicago, Illinois. The forward portion of the Amtrak locomotive came to rest on top of a container on the rear car of the freight train. Sixty-six passengers and five crewmembers were transported to hospitals; two passengers and one

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crewmember were subsequently admitted. The weather was clear, and the temperature was 30º F. Estimated damage was $1,299,000.

The National Transportation Safety Board determined that the probable cause of the November 30, 2007, collision of Amtrak train 371 with the rear of Norfolk Southern Railway Company train 23M near Chicago, Illinois, was the failure of the Amtrak engineer to correctly interpret the signal at Englewood interlocking and Amtrak's failure to ensure that the engineer had the competency to correctly interpret signals across the different territories over which he operated. Contributing to the accident was the relief engineer's failure to immediately communicate to the engineer that he had miscalled the signal at Englewood and to stop the train when he did not respond to her expressed concern. Also contributing to the accident was an absence of effective crew resource management between the relief engineer and the operating engineer which led to their failure to resolve the miscalled signal prior to the collision. Further contributing to the accident was the absence of a positive train control system that would have stopped the Amtrak train when it exceeded restricted speed.

Amtrak operating crews are often assigned to operate over multiple railroads, sometimes during a single trip, as was the case in this accident. This type of operation requires the crew to be competent in multiple signal systems. Generally, Amtrak has been successful in preparing its crewmembers for these challenges.

However, on the accident trip, the engineer appeared to have misinterpreted the meaning of a signal aspect found on different railroad properties. The signal displayed a red over yellow aspect, yet it had different meanings on different railroads. At Englewood interlocking on Norfolk Southern territory, a red over yellow aspect is a *restricting* indication. During his on-the-job training, the engineer had operated on this territory several times under the supervision of an on-board foreman. It is unknown, however, whether the engineer had been exposed to a *restricting* indication during his training.[3] In contrast, a red over yellow aspect in the Amtrak yard indicates a *slow approach*. Since receiving his certification, the engineer had spent most of his time working yard jobs. His experience with this Amtrak signal aspect and its associated indication would have been more recent and frequent, and as a result, more likely committed to his memory.

In the December 27, 2007, proceedings of Amtrak's internal investigation of this accident, the engineer stated, "I looked at the signal [the Norfolk Southern signal at Englewood], and I saw our signal, Amtrak's signal. And I called that signal a *slow approach*." Certain fallibilities of human memory may have contributed to the engineer misinterpreting or forgetting the meaning of the signal at Englewood. His forgetting may have been related to *retroactive interference*,[4] which happens when new information affects the recall of somewhat similar material that had been previously learned. In this case, the engineer could have easily confused the red over yellow (*slow approach* indication) signal in the train yard, which was a signal indication that currently was more salient to him, with the red over yellow (*restricting* indication)

[3] His certification was 3 months before the accident, and the engineer had operated only twice on the route from Chicago to Grand Rapids.

[4] This type of interference is retroactive in the sense that current tasks are interfering with the retrieval of memories of learning that took place earlier in time.

signal at Englewood, which had been more relevant to him months earlier. Furthermore, the engineer's last experience of the red over yellow *restricting* signal indication may have been during his written examination, which occurred a few months before the accident. He had operated infrequently over the accident territory since then, and this lack of exposure to and rehearsal of the signals in their true context may have made it more difficult for him to accurately retrieve from his memory the meaning of signal aspects while he was operating in this territory.

The Safety Board also is concerned about the Amtrak engineer's proficiency with signal identification when he received his engineer certification. Specifically, after completing several months of training on the accident territory, he nonetheless misinterpreted the meaning of several signals on the examinations just before his certification on the Norfolk Southern territories. During his signal examination, he made the same misinterpretation for a *restricting* signal as he did on the day of the accident. He took this exam only several days before he received his engineer certification.

On the same testing day, he also missed 4 of the 10 questions related to the signals that are found on the Amtrak territories on which he had been qualified to operate. He made a significant mistake when he misinterpreted a *stop* indication for a *stop and proceed* indication. Further, he not only missed this question on his first attempt but also on his second attempt.

Amtrak reported that engineers with limited operating experience may not be exposed to all signal aspects for a significant period, but stated that most of its operating violations are due to factors unrelated to the crew's knowledge of the signal indications.[5] Although the Safety Board understands this, the Board also recognizes that newly certified engineers, whose knowledge and skills related to their craft are still being developed, are most vulnerable to errors that might be attributed to a lack of rehearsal or experience. The Amtrak engineer struggled on his last signal examinations immediately before he received his engineer certification. While engineer trainees occasionally miss some signal exam questions, the accident engineer's multiple mistakes during the latter part of his training demonstrate a lack of mastery of this essential skill. His failure to correctly interpret critical signal indications of territories on which he had been qualified to operate should have raised concerns about his readiness to operate a locomotive independently and may have warranted additional preparation.

Signal interpretation is a skill that should be *overlearned* (that is, practiced beyond the point of mastery). Information that is overlearned is more resistant to disruption and is retained longer in memory. Since his last signal examination, it is unlikely the engineer had engaged in this type of learning for those signals that he had difficulty remembering. Because his work assignments were predominantly yard jobs since his certification, his experience with the signals that he had mistaken would have been extremely limited and would have provided few opportunities to reinforce his signal interpretation memories. The Safety Board concludes that the engineer did not show the signal recognition proficiency level necessary to operate on the territories where the accident occurred. Consequently, the Safety Board believes that Amtrak should identify engineers and engineer trainees who have not consistently demonstrated

[5] A review of Amtrak employee operating violations over the last few years indicates that unfamiliarity with the signal system does not appear to be a common problem.

competency in interpreting signals and provide them with enhanced training, supervision, testing, and evaluation necessary to determine that signal proficiency has been achieved and maintained.

As the train traveled closer to the first signal at Englewood interlocking, the engineer made a significant error; he misinterpreted the meaning of the red over yellow signal aspect. The red over yellow aspect was a *restricting* indication, requiring the crew to operate the train at a maximum speed of 15 mph and to be prepared to stop for any trains or obstructions ahead. The aspect should have alerted the crew to the possibility of a train on the track ahead of them. However, the engineer misinterpreted the signal as a *slow approach*, which would have allowed him to operate through the interlocking at a maximum speed of 30 mph while being prepared to stop at the next signal. Of even more importance, a *slow approach* signal indication would have meant that there was no train within the next block.

The engineer, believing he had just received a *slow approach* indication, operated his train at 25 mph around the curves and at 30 mph on tangent track, which is consistent with the timetable speed for this territory. The crew observed nothing in front of them at that time to suggest that slowing the train below track speed was necessary. Consequently, the engineer likely felt comfortable about increasing the train's speed to the next timetable speed of 40 mph. Moments later, when questioned by the relief engineer about the signal they had passed, he stated that it was a *slow clear* indication, which would have permitted him to operate at the higher speed (40 mph). This second misinterpretation was different from his first misinterpretation and, in fact, was even less restrictive. The engineer and relief engineer continued to discuss the signal while the engineer maintained the train speed at 40 mph. When the engineer saw the stopped Norfolk Southern freight train on the track in front of him, the speed and distance did not allow enough time for him to stop his train short of the Norfolk Southern train.

The relief engineer told investigators that she had immediate concerns about the engineer's misinterpretation of the signal indication at Englewood. However, because of their conflicting interpretations of the signal, she began doubting her own knowledge of that signal and she said that she thought that initially the engineer had understood the signal but misspoke. Consequently, she delayed voicing her concerns until she gave it additional thought and felt more confident with her position.[6] She communicated her concerns about 3/4 mile before the collision and as the Amtrak train's speed reached 40 mph, which exceeded both the maximum authorized speed (30 mph) of the signal indication that the engineer had erroneously called and the maximum authorized speed (15 mph) that she correctly believed the signal indication allowed. The relief engineer said that she asked the engineer, "You called a *slow approach* at Englewood, right? ... Even if it's a *slow approach*, you have to be down to 30." The discussion about the previous signal between the engineer and the relief engineer lasted for several moments, and the engineer, believing that he was operating the train appropriately, maintained the train's speed.

[6] Lack of confidence is one of several barriers to communication identified in CRM research. Other factors—some of which might have been present in this accident—include gender differences, lack of credibility, lack of rapport, position of authority, experience, rank, and fear of reprisal. R. Baron, "Barriers to Effective Communication: Implications for the Cockpit," 2005, <http://www.airlinesafety.com/editorials/BarriersToCommunication.htm>.

Although the relief engineer voiced her concerns in time for the engineer to make a brake application and safely stop the train, her actions were not immediate and were not adequate. She asserted herself after the engineer accelerated the train to 40 mph rather than asserting herself immediately after she first believed that the engineer had miscalled the signal, and she never asserted to the engineer that she believed that the Englewood signal was a *restricting* signal that limited their speed to 15 mph. After the relief engineer first voiced her concern, the process by which the two crewmembers attempted to resolve their differences was to discuss the indication of the previous signal: the engineer did not immediately slow the train and the relief engineer, seeing that the engineer did not immediately slow the train, did not herself apply the brakes to stop the train. The engineer applied the brakes only after he saw the stopped Norfolk Southern train in front of them. Therefore, the Safety Board concludes that the engineer misinterpreted and miscalled the signal at Englewood which resulted in the operation of the Amtrak train at a speed greater than authorized, and when challenged by the relief engineer, the engineer failed to slow or stop the train while he and the relief engineer discussed their differences in understanding the signal displayed at Englewood. The Safety Board also concludes that the relief engineer failed to communicate effectively and in a timely manner to the engineer that he had miscalled the restricting signal at Englewood interlocking and failed to then take action herself to stop the train after the engineer did not slow or stop the train when challenged.

The process by which train crews should identify and strategically respond to unsafe situations is addressed in Amtrak's CRM program. Modern railroads emphasize both the application of CRM principles and crewmember proficiency to establish and maintain safe train operations. The purpose of CRM is to help operating crews use all of the available resources (information, personnel, and equipment) at their disposal effectively. The role for crewmembers is to perform their assigned tasks responsibly, to know about or participate in determining the plans for movement of the vehicle, to be alert to departures from plans or from the expected performance of others, and to make those departures known in time to avert an operational error. If properly applied, CRM will increase the likelihood that human operation errors will be detected in time for action to be taken to prevent an accident. Although Amtrak's CRM program emphasizes the importance of crewmembers immediately voicing their concerns after recognizing potentially unsafe situations, this accident clearly demonstrates the importance of crewmembers implementing the principles of CRM to prevent accidents.

As a result of its investigation, the National Transportation Safety Board makes the following recommendations to Amtrak:

> Identify engineers and engineer trainees who have not consistently demonstrated competency in interpreting signals and provide them with enhanced training, supervision, testing, and evaluation necessary to determine that signal proficiency has been achieved and maintained. (R-09-4)

> Use the circumstances of the November 30, 2007, accident in Chicago, Illinois, during crew resource management training to reemphasize the necessity of any qualified person on the leading locomotive or car to immediately communicate any disagreement on a called signal and to immediately take action necessary to ensure that the train is operated safely. (R-09-5)

The Safety Board also issued safety recommendations to the Federal Railroad Administration, the Association of American Railroads, the American Short Line and Regional Railroad Association, the American Public Transportation Association, the United Transportation Union, and the Brotherhood of Locomotive Engineers and Trainmen.

In response to the recommendations in this letter, please refer to Safety Recommendations R-09-4 and -5. If you would like to submit your response electronically rather than in hard copy, you may send it to the following e-mail address: correspondence@ntsb.gov. If your response includes attachments that exceed 5 megabytes, please e-mail us asking for instructions on how to use our Tumbleweed secure mailbox procedures. To avoid confusion, please use only one method of submission (that is, do not submit both an electronic copy and a hard copy of the same response letter).

Acting Chairman ROSENKER and Members HERSMAN, HIGGINS, and SUMWALT concurred in these recommendations.

[Original Signed]

By: Mark V. Rosenker
Acting Chairman