



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: December 22, 2011

In reply refer to: R-11-5

Mr. Stephen A. Roell
Chairman, President, and Chief Executive Officer
Johnson Controls, Inc.
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The National Transportation Safety Board (NTSB) 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 NTSB is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

The recommendation is derived from the NTSB's investigation of a November 28, 2008, accident in which a three-car "automated people mover" (APM) train operating at Miami International Airport failed to stop at the passenger platform and struck a terminal wall. As a result of this investigation, the NTSB has issued five safety recommendations, one of which is addressed to Johnson Controls, Inc. (JCI). The NTSB would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendation.

About 4:44 p.m., eastern standard time, on November 28, 2008, a three-car APM train (referred to in the report as the south train) operating along a fixed guideway¹ on E Concourse at Miami International Airport near Miami, Florida, failed to stop at the passenger platform and struck a wall at the end of the guideway. Although a maintenance technician was monitoring train operations from the lead car of the train when the accident occurred, the train was operating in fully automatic mode without a human operator. The maintenance technician and

¹ A rail fixed guideway system is defined by Title 49 Code of Federal Regulations Part 659 as any light, heavy, or rapid rail system, monorail, inclined plane, funicular, trolley, or automated guideway.

five passengers on board the train were injured in the accident. One person on the passenger platform also required medical attention.²

The National Transportation Safety Board determined that the probable cause of this accident was the installation by Johnson Controls, Inc., maintenance technicians of a jumper wire that prevented the overspeed/overshoot system from activating to stop the train when the crystal within the primary program stop module failed. Contributing to the accident were (1) the failure of Johnson Controls, Inc., to provide its maintenance technicians with specific procedures regarding the potential disabling of vital train control systems during passenger operations, (2) ineffective safety oversight by the Miami-Dade Aviation Department, (3) lack of adequate safety oversight of such systems by the state of Florida, and (4) lack of authority by the U.S. Department of Transportation to provide adequate safety oversight of such systems.

At the time of the accident, the APM south train was operating, as designed, in fully automatic mode. Although a JCI maintenance technician was on board who could have operated the train manually if it had stopped unexpectedly, the maintenance technician was essentially a passenger so long as the train continued to function normally.

In automatic mode, the train depended for its safe operation on the proper functioning of the various automatic train control (ATC) components and subsystems. For example, as the train neared its berthing point at either end of the guideway, onboard receivers would detect a signal induced from the wayside program stop antenna. The program stop module on board the train was designed to count the phase changes in the loops of the wayside antenna to determine the train's location with regard to the stopping point. The ATC system would then decelerate and apply necessary braking to ensure a safe stop. If a component of the program stop system failed, the overspeed/overshoot system was designed to intervene to stop the train.

Postaccident testing of the wayside program stop antenna indicated that the antenna was properly transmitting the stop signal to the south train. Testing of the program stop module from the south train, however, revealed a failed crystal in the program stop module oscillator, which rendered the oscillator inoperative. The oscillator was the component within the stop module that was responsible for counting the phase changes in the wayside loop antenna to determine the train's proximity to its berthing point. Without a properly functioning oscillator, the train control system had no means of effecting a normal deceleration and stop. The fact that the train had made normal stops during previous trips indicates that failure occurred without warning after its most recent station stop. The NTSB concluded that the south train failed to make a normal deceleration and stop at its station platform berthing point because of the failure of a crystal within the program stop system module.

In the event of a failure of the type evidenced by the south train program stop module on the day of the accident, the overspeed/overshoot system should have functioned as a backup system to prevent the accident. Postaccident testing showed the wayside overshoot flags were

² See *Miami International Airport, Automated People Mover Train Collision with Passenger Terminal Wall, Miami, Florida, November 28, 2008*, Railroad Accident Report NTSB/RAR-11/01 (Washington, DC: National Transportation Safety Board, 2011) on the NTSB website at <http://www.nts.gov>.

working normally. Additionally, the electro-mechanical overspeed/overshoot relay mounted on the south train was tested and found to be performing within the manufacturer's specifications.

The investigation revealed, however, that JCI maintenance technicians, while troubleshooting ongoing problems with the ATC system and in order to keep the trains in service, had installed a jumper wire in the train control compartment of the south train. The NTSB reviewed the system schematics and determined that this jumper wire bypassed the overspeed/overshoot system relay. Bypassing the relay took the fail-safe component of the system "out of the loop" and placed sole responsibility for safely stopping the train on the nonvital program stop system—with no backup system in place if that system failed. Postaccident examination of train control and train braking system components revealed no evidence to suggest that the overspeed/overshoot system would not have worked as designed on the day of the accident. The NTSB concluded that, had it not been bypassed by placement of a jumper wire as part of a troubleshooting process, the overspeed/overshoot relay on board the south train would have functioned as designed when the program stop module failed and the overspeed/overshoot system would have intervened to safely stop the train and prevent the accident.

JCI had contractual responsibility for maintaining the Miami airport APM system, having taken over that role from Bombardier—Automated People Movers in 2008. A JCI maintenance technician was the individual who installed the jumper wire on the south train control panel about 1 week before the accident. Based on a review of log entries, such jumper wires had been used before by maintenance technicians working to keep the trains running.

The NTSB is concerned about the lack of agreement, or even understanding, about the use of such jumper wires that was demonstrated by JCI maintenance technicians and managers. The maintenance technician who had installed the jumper wire stated that he was not sure what the jumper wire was for but acknowledged that it had been used before to keep trains running. The JCI site manager said the jumper wire was used to provide voltage to the auxiliary control, or "hostler," panel for manual operation. One maintenance technician was aware that the jumper wire, placed as it was, bypassed the vital braking system. He said he brought this to the attention of his superiors, but the significance of this finding was never acknowledged or acted upon. The JCI site manager told the NTSB that he had directed that the jumper wire not be used when the trains were in passenger service, but none of the maintenance technicians said they were aware of this directive, and all were apparently aware that the jumper wire was left in place during regular train operations. All of the information regarding the use of jumper wires was conveyed either orally or through logbook entries because no written policies or procedures were in place that addressed jumper wires or that delineated their use. The NTSB therefore concluded that JCI had no formalized procedures with regard to train maintenance and operations, with the result that the south train was allowed to operate without a vital backup safety system that could have prevented the accident.

The NTSB believes that JCI should implement procedures to prohibit the deactivation of safety-critical systems on fixed guideway transportation systems in passenger service on all properties maintained by the company. The NTSB recognizes that during the normal course of operation, unique conditions may arise that expose passengers to an unacceptable level of risk and that under those conditions it may be necessary to temporarily bypass a safety-critical system

on a train in passenger service. However, such an action should be taken only when no other means is available to allow the train to be moved to a location where passengers can safely disembark and the train can be taken out of service. The NTSB trusts that JCI will address those unique circumstances in its procedures and that a hazard analysis and risk assessment will be performed before a train is allowed to continue in passenger service, even temporarily, with a disabled safety-critical device or component.

Therefore, the National Transportation Safety Board makes the following safety recommendation to Johnson Controls, Inc.:

Implement procedures to prohibit the deactivation of safety-critical systems on fixed guideway transportation systems in passenger service on all properties maintained by Johnson Controls, Inc. (R-11-5)

The NTSB also issued safety recommendations to the U.S. Department of Transportation, to the 50 states and the District of Columbia, and to Miami-Dade County. Additionally, the report reiterated a previously issued recommendation to the U.S. Department of Transportation.

In response to the recommendation in this letter, please refer to Safety Recommendation R-11-5. 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 secure mailbox. 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).

Chairman HERSMAN, Vice Chairman HART, and Members SUMWALT, ROSEKIND, and WEENER concurred in this recommendation. Vice Chairman HART filed a concurring statement, which is attached to the railroad accident report for this accident.

[Original Signed]

By: Deborah A.P. Hersman
Chairman