CSX Transportation Railway Maintenance Machine Operator Fatality Wartrace, Tennessee March 12, 2018



## **Accident Report**

NTSB/RAR-20/02 PB2020-101005



National Transportation Safety Board

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National Transportation Safety Board

490 L'Enfant Plaza, S.W. Washington, D.C. 20594

## National Transportation Safety Board. 2020. CSX Transportation Railway Maintenance Machine Operator Fatality, Wartrace, Tennessee, March 12, 2018. NTSB/RAR-20/02. Washington, DC: NTSB.

Abstract: On March 12, 2018, about 2:15 p.m. local time, a CSX Transportation (CSX) equipment operator was fatally injured while working with a CSX model BR-201202 ballast regulator (roadway maintenance machine) on the main track near Wartrace, Tennessee, on the CSX Chattanooga Subdivision. The CSX manager of work equipment was traveling on the highway in the area when he saw the ballast regulator operator climb into the ballast regulator cab. Shortly thereafter, he heard a radio transmission from the operator reporting a problem with a proximity switch on the ballast regulator. The manager drove toward the ballast regulator to assist the operator and saw him under the east ballast regulator wing. The operator died at the scene. Investigators determined that the probable cause of the accident was the ballast regulator operator's attempt to repair the machine without powering it off and using lockout/tagout procedures. The investigators focused on the safety issues of rules compliance and operator present controls. As a result of the investigation, the National Transportation Safety Board makes one safety recommendation to the Federal Railroad Administration, two recommendations to CSX, and one recommendation to the American Railway Engineering and Maintenance-of-Way Association.

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## **Executive Summary**

## **Accident Summary**

On March 12, 2018, about 2:15 p.m. local time, a CSX Transportation (CSX) equipment operator was fatally injured while working with a CSX model BR-201202 ballast regulator (roadway maintenance machine) on the main track near Wartrace, Tennessee, on the CSX Chattanooga Subdivision. The CSX manager of work equipment was traveling on the highway in the area when he saw the ballast regulator operator climb into the ballast regulator cab. Shortly thereafter, he heard a radio transmission from the operator reporting a problem with a proximity switch on the ballast regulator. The manager drove toward the ballast regulator to assist the operator and saw him under the east ballast regulator wing. The operator died at the scene.<sup>1</sup>

## **Probable Cause**

The National Transportation Safety Board determines that the probable cause of this accident was the ballast regulator operator's attempt to repair the machine without powering it off and using lockout/tagout procedures, which re-established the electrical connection to the proximity sensor, allowing the machine to move and strike the operator while he was out of the cab, resulting in his death.

## Safety Issues

- **Rules Compliance.** CSX developed a 99-page operation manual, dated 2017, for its ballast regulator. The manual provides instructions and information on properly operating and performing preventative maintenance on the machine. The manual also provides safety instructions and lists several safety warnings and safety precautions when operating, troubleshooting, and performing preventative maintenance on the machine. On the day of the accident, the ballast regulator operator made at least two attempts to implement a repair of the proximity sensor on the BR-201202 ballast regulator. The position of the controls of the machine suggests that when the ballast regulator operator exited the cab the second time to address the issue with the proximity switch, he did not follow proper lockout/tagout procedures.
- **Operator Presence Controls.** Operator presence controls are an essential safety feature designed to prevent unintended and uncontrolled machine movements, which often result from human error, as observed in this accident. If the BR-201202 ballast regulator had been equipped with an operator presence control, the machine would not have moved once the regulator operator left the cab.

<sup>&</sup>lt;sup>1</sup> For more information, see the <u>factual information</u> and <u>analysis sections</u> of this report. Additional information can be found in the public docket for this National Transportation Safety Board (NTSB) accident investigation (case number RRD18FR004) by accessing the <u>Accident Dockets</u> at <u>www.ntsb.gov</u>. For information about our safety recommendations, see the <u>Safety Recommendation Database</u> at the same website.

## Findings

- 1. None of the following were factors in the accident: the weather; the condition of the track; cell phone use; or physical or mental impairment of the ballast regulator operator due to alcohol, other impairing drugs, medical condition, or fatigue.
- 2. Operator presence controls are a critical safety feature (not currently required in selfpropelled track equipment) needed to mitigate the hazard of unintended movement.
- 3. Had the BR-201202 ballast regulator been equipped with an operator presence control, the machine would not have moved once the operator left the cab, and the accident would have been prevented.
- 4. Safety would be improved by the development of an industry standard for operator presence controls on self-propelled track equipment.
- 5. Safety would be improved with the implementation of federal regulations requiring operator presence controls throughout the rail industry for self-propelled track equipment.

### Recommendations

#### To the Federal Railroad Administration:

Require new roadway maintenance machines to be equipped with operator presence controls to prevent unintended movement and protect workers on and around the machines. (R-20-11)

#### **To CSX Transportation:**

Include operator presence controls as a mandatory safety feature for all newly purchased or manufactured self-propelled roadway maintenance machines. (R-20-12)

Inspect your existing self-propelled roadway maintenance machines and install operator presence controls on any machines without such controls. (R-20-13)

#### To the American Railway Engineering and Maintenance-of-Way Association:

Develop a recommended practice for operator presence controls in self-propelled roadway maintenance machines to protect workers from unintended equipment movement. (R-20-14)

## 1 Factual

#### **1.1 Accident Description**

On March 12, 2018, about 2:15 p.m. local time, a CSX Transportation (CSX) equipment operator was fatally injured while working with a CSX model BR-201202 ballast regulator (a type of roadway maintenance machine), shown in figure 1.<sup>2</sup> The accident occurred near Wartrace, Tennessee, on the main track near milepost (MP) OOJ-57.50 of the CSX Chattanooga Subdivision. The CSX manager of work equipment was traveling on the highway in the area when he saw the operator climbing into the ballast regulator cab. Shortly thereafter, he heard a radio transmission from the operator reporting a problem with a "proximity switch" on the ballast regulator.<sup>3</sup> The manager drove toward the ballast regulator to assist the operator. When the manager arrived at the ballast regulator, he saw the operator under the east ballast regulator wing. The operator died at the scene.<sup>4</sup>

<sup>&</sup>lt;sup>2</sup> (a) All times in this document are local time unless otherwise noted. (b) According to Title 49 *Code of Federal Regulations* (*CFR*) 214.7, a *roadway maintenance machine* is a "device powered by any means of energy other than hand power that is being used on or near railroad track for maintenance, repair, construction or inspection of track, bridges, roadway, signal, communications, or electric traction systems. Roadway maintenance machines may have road or rail wheels or may be stationary."

<sup>&</sup>lt;sup>3</sup> The proper name for the subject machine component is *proximity sensor*. A *proximity sensor* is an electronic sensor that can detect the presence of objects within its vicinity without any actual physical contact. During interviews, it was referred to as a "proximity switch." Aside from interview references, in the remainder of this report it will be referred to as a "proximity sensor."

<sup>&</sup>lt;sup>4</sup> For more detailed information about this accident investigation, see the public docket at <u>https://www.ntsb.gov/investigations/dms.html</u> and search for accident number RRD18FR004.



Figure 1. Raised east wing and mold board (red circle) of BR-201202 ballast regulator at accident location.

The ballast regulator was a part of the CSX 5XS3 (S3) Surfacing Team, which is a systemproduction work group that typically consists of 8 roadway maintenance machines and 20 employees, including machine operators, vehicle operators, and laborers. The task assigned to the team on the day of the accident was to surface track between MP OOJ-55.0 and MP OOJ-58.0.<sup>5</sup> The S3 Surfacing Team went on duty near their lodging location in Monteagle, Tennessee, about 8:00 a.m. on the day of the accident. The employees interviewed described a normal workday leading up to the accident.

<sup>&</sup>lt;sup>5</sup> *Track surfacing* refers to a railroad maintenance operation to raise the track structure and obtain desired track geometry. This work is primarily accomplished using specialized railroad work equipment.



Figure 2. Accident site at MP OOJ-57.5 just off Bugscuffle Road.

The CSX manager of work equipment, who was assigned to the S3 Surfacing Team, was traveling north on Bugscuffle Road in his personal truck when he saw the operator climb into the ballast regulator cab. Shortly thereafter, about 2:10 p.m., the manager of work equipment heard a radio transmission from the ballast regulator operator reporting a problem with a wire on the ballast regulator's "proximity switch." He asked the ballast regulator operator what assistance he needed to address the issue. According to the manager of work equipment, the ballast regulator operator said he went down and moved the wire and got the machine running, indicating to the manager that the equipment operator exited his machine, made some type of repair, and reboarded his machine, but when he returned, they would need to put on a new proximity sensor.

The manager of work equipment returned to the ballast regulator location to aid the ballast regulator operator. He arrived at the location of the ballast regulator about 2:15 p.m. (5 minutes after he spoke with the operator) and saw the operator under the east wing of the ballast regulator. The ballast regulator was running at the time. He approached the employee, checked for vital signs, and determined that the ballast regulator operator had died. The manager indicated that the wings were down and that the ballast regulator operator had been impacted by the mold board on the ballast regulator wing.<sup>6</sup> The ballast regulator's east mold board and wing, which are raised to the

<sup>&</sup>lt;sup>6</sup> The *mold board* is a portion affixed to the bottom of the regulator wing. The mold board is designed to properly engage the railroad ballast without damaging the track structure.

nonwork position, are circled in figure 1. The manager of work equipment stated that it appeared as if the ballast regulator operator had been dragged in a northward direction, near the proximity sensor, a position consistent with the ballast regulator operator troubleshooting the sensor.

The manager of work equipment radioed the assistant foreman for help, and one of the employees phoned 911 about 2:19 p.m. When the assistant foreman arrived, the manager of work equipment instructed him to turn off the ballast regulator. The assistant foreman told NTSB investigators that the ballast regulator was stopped and at a low idle as he approached the equipment. He said he observed the parking brake was not engaged, but the service brake was, as illustrated in figure 2. At that point, the assistant foreman turned off the ballast regulator and engaged the parking brake.



Figure 2. Control stand in BR-201202 ballast regulator as found at the time of the accident. (Source: CSX.)

### 1.2 Site Description

The CSX Chattanooga Subdivision consists of about 140 miles of single and double track between Nashville and Chattanooga, Tennessee, with multiple sections of double main track and about 10 passing sidings. The accident occurred on the single main track at MP OOJ-57.5 (See figure 2.); at this location, the track grade is 1.0 percent.

At the accident location, the track was constructed with concrete crossties. The rails were fastened to the concrete crossties using elastic clips. The rails were 141-pound continuous welded rail.<sup>7</sup> The track was supported by granite rock ballast with a standard ballast section.

#### 1.3 Ballast Regulator

The BR-201202 ballast regulator, also called the "Rhino," is used to move ballast to elevate and stabilize the track structure. The ballast regulator weighs about 47,000 pounds and is powered by a six-cylinder diesel engine. The ballast regulator is propelled by a hydraulic drive system, and its friction braking system consists of a combination of mechanical and pneumatic systems. The ballast regulator is equipped with a front plow, a rear broom, and two side wings to perform standard track maintenance operations. These attachments are positioned hydraulically. Operational joysticks are located on both sides of the operator's seat. CSX built the BR-201202 ballast regulator at the CSX Bryan Park Roadway Shop in Richmond, Virginia.

CSX developed a 99-page operation manual, dated 2017, for this ballast regulator. The operation manual provides instructions and information on operating and performing preventative maintenance on the machine. The operation manual shows various pictograms indicating warning, caution, and danger signs as well as illustrations indicating how to safely operate and maintain the machine. One warning directs the operator to "shutdown engine and secure machine before doing maintenance inspections and work. Run engine ONLY when a specified check requires engine operation. Maintenance inspection and work should be performed by qualified personnel only. Failure to observe this warning may result in serious injury." A caution pictogram on page 5 reads, "before doing any maintenance or check on machine, lockout and tagout the main power source. This will disable the propel [propulsion], electrical locks, electrical wing templates, and broom deflector. After operator is safely in cab, remove LOTO [lockout/tagout] protection." Furthermore, page 6 in the operation manual provides a detailed listing of how to perform specific LOTO functions.<sup>8</sup> A copy of this operation manual was found inside the cab of the ballast regulator.

CSX also developed a presentation and a video titled "CSX Lockout & Tagout Procedures." The presentation and video provide step-by-step processes and illustrations on how to safely perform and carryout various LOTO functions on roadway maintenance machines when performing troubleshooting and maintenance activities.

#### 1.3.1 Postaccident Inspection of Ballast Regulator

Investigators observed the mechanical testing and inspection of the ballast regulator. A component of the ballast regulator, referred to as the "turntable," is center mounted under the

<sup>&</sup>lt;sup>7</sup> Continuous welded rail is rail that has been welded together into lengths exceeding 400 feet.

<sup>&</sup>lt;sup>8</sup> Lockout/tagout (LOTO) refers specifically to procedures used to ensure that equipment or machinery is shut down and inoperable until maintenance or repair work is completed. These procedures are used to keep employees safe from equipment or machinery that could injure or kill them if not managed correctly. The OSHA standard for The Control of Hazardous Energy (Lockout/Tagout), codified at 29 *CFR* 1910.147, addresses the practices and procedures necessary to disable machinery or equipment, thus preventing the release of hazardous energy while employees perform servicing and/or maintenance activities. The standard outlines measures for controlling hazardous energies—electrical, mechanical, hydraulic, pneumatic, chemical, thermal, and other energy sources. LOTO is found everywhere across the manufacturing and construction industries.

equipment and is lowered to lift the ballast regulator off of the tracks enough to rotate the machine 180 degrees and change the direction of the equipment on the tracks. The proximity sensor is a safety feature used to ensure that the turntable base is raised and in a safe position for travel of the machine. If the turntable base drops, the proximity sensor circuitry will disable the propulsion of the ballast regulator. The inspection revealed a damaged control wire connected to the proximity sensor, the electrical circuit could be intermittently broken, which disables the ballast regulator's propulsion, keeping it from moving while still running. Investigators also determined that if the ballast regulator had been under power (idling) and the electrical circuit was remade, the machine would then move.



Figure 3. Control wire damage at the proximity sensor.

#### 1.3.2 CSX Inspection

In a written statement, the CSX director of work equipment reported that he inspected ballast regulator BR-201202 on March 14, 2018, 2 days after the accident. It was built by CSX in 2012 and the second ballast regulator built that year. This machine had been on a service production team since its in-service date and had neither been rebuilt nor altered in any way. The machine's overall condition was reported as "good." The director noted several items needing

repair, including a cracked window, a moderate but inconsequential air leak under the cab, and a transmission charge pump that required extra time to build charge pressure when first starting the cold engine, but he did not consider these, "in his professional experience," to be the cause of the accident. He stated that he observed all safety items to be in "good working order." No visible oil leaks were found, and all brake functions were working.

The director of work equipment further stated that, during this postaccident inspection, he could duplicate the problem with the turntable proximity sensor not making proper connection to allow the transmission to engage in forward or reverse. He stated that in his professional opinion, the unit was in good working condition after the repair of the turntable proximity sensor.

#### 1.3.3 Federal Railroad Administration Standards

Federal Railroad Administration (FRA) inspectors also conducted an inspection of the ballast regulator on March 14, 2018, 2 days after the accident, to determine compliance with Title 49 *Code of Federal Regulations (CFR)* Part 214 Subpart D, Roadway Maintenance Machines and Hi-Rail Vehicles. The machine met all the requirements of Subpart D, which does not contain any requirements for operator presence controls. The FRA found no issues with the condition of the ballast regulator.<sup>9</sup>

## 1.4 Ballast Regulator Operator

CSX records show that the ballast regulator operator who was operating CSX BR-201202 ballast operator on the day of the accident was hired on May 24, 1978. He held the position of system production gang ballast regulator operator from January 2011 until the accident. However, CSX records showed that he also served as a machine operator, a vehicle operator, and a system production gang spike puller intermittently during that time. The ballast regulator operator had 39 years of railroad experience, and he had operated a ballast regulator for more than 7 years.

During an interview with the investigative team, the manager of work equipment stated that the ballast regulator operator's responsibilities regarding equipment maintenance included replacing hoses, broom elements, wear blades, plows, and skirts. He also adjusted brakes, inspected equipment, and changed oil, which the manager of work equipment said he "was very good at." He further noted that the mechanics were there for heavy maintenance, such as breakdowns, but were always willing to help the equipment operators with anything they asked.

The manager of work equipment further noted that the ballast regulator operator had been running a ballast regulator for at least 20 years and "probably knew more about the machine than a lot of the mechanics, which is why he knew how to repair his machine." He had been used in several safety videos pertaining to equipment operation and maintenance and training operations.

<sup>&</sup>lt;sup>9</sup> A copy of the FRA inspection report can be found in the public docket.

#### 1.4.1 Training and Testing

Since 1997, the ballast regulator operator had successfully completed over 400 CSX training courses covering a broad range of topics. Many of the courses consisted of safety-related extinguisher training, such as fire safety, fall protection, mounting/dismounting vehicles/equipment, and LOTO. Certain areas were covered more than once. For instance, the ballast regulator operator's record showed coursework pertaining to LOTO annually from 2002 to 2018, with the only exceptions in 2003 and 2009. The training records show that the operator completed a course titled Regulator Safety Procedures and Operation Training in 2018, 2017, and 2016. Additionally, the regulator operator completed a course titled On Track Equipment Brake Inspection/Adjustment Training in 2017 and 2015. The CSX operational testing records indicate that the ballast regulator operator had been tested 128 times in the prior 2 years, primarily on CSX operating rules pertaining to equipment operation and roadway worker protection, and that he was compliant 100 percent of the time. Much testing of railroad employees is proficiency-based and observational during inspections and similar opportunities. A record of all such training can be found in the public docket.

#### 1.4.2 Work/Rest Cycle

Investigators examined the work/rest cycle for the ballast regulator operator. The ballast regulator operator started work about 8:00 a.m. the day of the accident and was on duty for about 6 hours 15 minutes at the time of the accident. During the previous 7 days (March 6–11, 2018), he had reported for work at 8:00 a.m. and stopped work at either 5:30 or 6:30 p.m. He did not work during the prior 5 days (March 1–5, 2018).

#### 1.4.3 Medical Factors

Effective November 14, 2017, the CSX chief medical officer found the ballast regulator operator to be "medically qualified" but required that he wear corrective lenses while on duty.

#### 1.4.4 Toxicology

The FRA postaccident forensic urine toxicology testing conducted by Quest Laboratories was negative for the substances tested.<sup>10</sup> Although the blood level of ethanol was 0.011 gm/dL, the vitreous was negative for ethanol, indicating the blood ethanol was likely due to postmortem production. The Federal Aviation Administration's Forensic Sciences Laboratory toxicology testing was negative for all substances tested, including ethanol.<sup>11</sup>

<sup>&</sup>lt;sup>10</sup> Department of Transportation urine drug testing is limited to identifying urinary metabolites of amphetamine, methamphetamine, cocaine, codeine, morphine, heroin, phencyclidine (PCP), methylenedioxymethamphetamine (MDAA), methylenedioxyamphetamine (MDA), methylenedioxyethylamphetamine (MDEA), tetrahydrocannabinol (THC), oxycodone, oxymorphone, hydrocodone, and hydromorphone.

<sup>&</sup>lt;sup>11</sup> The Federal Aviation Administration Forensic (FAA) Sciences Laboratory has the capability to test for more than 1,300 substances including toxins, common prescription, and over-the-counter medications, as well as illicit drugs. See the FAA Forensic Toxicology's WebDrugs Page.

### **1.5 Postaccident Actions**

In response to the accident, on March 13, 2018, CSX conducted a safety stand-down with its engineering department employees, including maintenance of way, bridge and building, and signal and communications employees. The instructions in a CSX Safety Alert, dated March 12, 2018, were distributed. These instructions included noting the purpose and applicability of LOTO procedures and defining affected employees. CSX emphasized that LOTO is required whenever a person is performing service or maintenance around equipment or machinery. (See appendix B.)

CSX also implemented an upgrade procedure for ballast regulator proximity sensors. The upgrade made the control wiring attached to the proximity sensor more robust by adding a cord grip and wire loom to protect the wire connection.<sup>12</sup> CSX intends to retrofit all existing ballast regulators and incorporate the upgrade in all equipment obtained in the future, which is documented in the CSX Ballast Regulator Proximity Switch Upgrade Procedure that can be found in the public docket.

<sup>&</sup>lt;sup>12</sup> See the <u>public docket</u> for additional information on this upgrade.

## 2 Analysis

### 2.1 Exclusions

On the day of the accident, which occurred on a main CSX train track near Wartrace, Tennessee, a CSX equipment operator was fatally injured when he got off his ballast regulator (roadway maintenance machine) to investigate a problem with a proximity sensor on the machine. He had 39 years with the railroad and 7 years as a ballast regulator operator.

During the investigation of this accident, NTSB investigators examined the track; the BR-201202 ballast regulator; CSX and FRA inspection reports; and ballast regulator operator training, qualifications, and medical and toxicology reports. As a result of its investigation, the NTSB concludes that none of the following were factors in the accident: the weather; the condition of the track; cell phone use; or physical or mental impairment of the ballast regulator operator due to alcohol, other impairing drugs, medical condition, or fatigue.

### 2.2 Operator Qualifications

The ballast regulator operator was experienced and qualified to operate and repair the regulator as noted in <u>section 1.4</u> of this report. Regarding the inspection and maintenance of the machine, the CSX manager of work equipment said that the ballast regulator operator had extensive experience with the machine and probably knew more about it than a lot of mechanics did. The NTSB determined that CSX management expected the ballast regulator operator to routinely conduct inspection and maintenance activities of the ballast regulator.

CSX indicated that the ballast regulator operator was not expected to perform the work that he was engaged in when he sustained fatal injuries and that such work should be performed by a roadway mechanic. However, considering that the ballast regulator operator had been previously trained on this type of work and routinely conducted some inspection and maintenance activities, he likely felt capable of examining the machine when it shut off abruptly on the day of the accident. Moreover, the evidence suggests that the ballast regulator operator had accurately diagnosed the problem and was able to implement a solution to get the machine running. He knew that a mechanic would need to perform a permanent repair on the machine.

## 2.3 Operator Presence Controls

Self-propelled track equipment may cause serious injury or death if its movement is not controlled. Operator presence controls are a specific type of safety interlock that can address this issue.<sup>13</sup> Operator presence controls are designed to prevent unintended and uncontrolled machine movement when the operating cab is not occupied. For decades, these controls have been recognized in the field of human factors engineering as an essential safety feature of various

<sup>&</sup>lt;sup>13</sup>Safety interlocks, which are key safety features, are switches or sensors used to monitor the position of guards, gates, working attachments, or personnel to control access or to prevent a machine from starting or moving when an unsafe condition is detected.

equipment. For instance, a guide for equipment design issued by the American Institutes for Research in 1972 discusses elastic (spring loaded) resistance operator presence controls.<sup>14</sup> As another example, human factors design guidance from a National Aeronautics and Space Administration (NASA) overhead crane guide states:

Dead-Man Controls: Wherever operator incapacity can produce a critical system condition, the crane shall incorporate dead-man controls that will result in system shutdown to a noncritical operating state when force or input is removed.<sup>15</sup>

"Dead-man controls" are a type of operator presence control. U.S. regulations mandate operator presence controls in many forms of industrial and consumer equipment. For instance, every walk-behind lawn mower sold in the United States since 1982 has an operator presence control, which by law must stop the blades within 3 seconds after the user lets go of the controls.<sup>16</sup>

Historical accounts suggest that various forms of operator presence controls have been used successfully in the rail industry for decades.<sup>17</sup> Some locomotives were equipped with elastic resistance-based controls that typically required the operator to maintain continuous foot pressure on a pedal because releasing that pressure would stop the equipment.

Title 49 *CFR* Parts 229.140 and 238.237 mandate that trains be equipped with an alerter, a type of operator presence control. An alerter is a buzzer or bell that sounds about every minute to prompt a response from the motorman or engineer. If they do not respond, the system will automatically initiate a penalty brake application.<sup>18</sup> Thus, the system is put into a safe state in the absence of input from an operator, and the mechanism is not easily circumvented because the alerter requires input from the operator. These mechanisms and regulations are based on a recognition that there are situations in which humans may be incapacitated or make errors while operating the machine. The NTSB concludes that operator presence controls are a critical safety feature (not currently required in self-propelled track equipment), needed to mitigate the hazard of unintended movement.

Despite the importance of operator presence controls, there are no federal regulations requiring these safety devices for self-propelled track equipment. This contrasts with U.S. regulations for many forms of industrial and consumer equipment that do mandate operator presence controls. No analogous heavy freight rail equipment regulations exist. This is concerning to the NTSB, as ballast regulators are large, heavy pieces of equipment requiring humans to operate, maintain, and repair them, without this critical safety equipment in place to mitigate hazards encountered. The risk of uncontrolled movement from a ballast regulator to the operator.

<sup>&</sup>lt;sup>14</sup> H.P. Van Cott and R.G. Kinkade, eds. *Human Engineering Guide to Equipment Design*, Rev ed. (Washington, DC: American Institutes of Research, 1972), 350.

<sup>&</sup>lt;sup>15</sup> Human Factors Engineering Guidelines for Overhead Cranes. (John F. Kennedy Space Center: National Aeronautics and Space Administration, September 28, 2001), 2-15.

<sup>&</sup>lt;sup>16</sup> Title 16 CFR Part 1205, Safety Standards for Walk-Behind Power Lawn Mowers.

<sup>&</sup>lt;sup>17</sup>Andy Newman. <u>"Not the First Time the 'Dead-Man' Switch Did Its Job,"</u> *The New York Times*, May 7, 2010 Retrieved May 7, 2010 (last accessed April 6, 2020).

<sup>&</sup>lt;sup>18</sup> A *penalty brake application* is an automated brake application that is initiated due to lack of engineer response.

is significant. The FRA has already recognized the hazard as evidenced by the alerter requirement for trains. It is unclear why self-propelled track equipment is omitted from existing regulation.

On the day of the accident, the ballast regulator operator had made at least two attempts to repair the proximity sensor on the ballast regulator. The manager of work equipment learned about the first attempt when the ballast regulator operator said over the radio that he had exited the cab, moved a wire, and got the machine running. It was the ballast regulator operator's second attempt, after the machine stopped a second time, that resulted in his fatal injury.

When the manager of work equipment arrived to assist the ballast regulator operator, the accident had already occurred. The position of the controls of the machine suggests that when the ballast regulator operator exited the cab the second time to address the issue with the proximity sensor, he left the hydrostatic travel level in the full "reverse" position, and he left the ignition control in the "on" position. When using mechanized equipment, operators and mechanics are required to perform various maintenance and repair operations. LOTO procedures are implemented to provide those workers protection when working on and around equipment. These procedures require all sources of energy to be isolated before a worker is exposed to the risks associated with the movement of the equipment or components of the equipment.

After the ballast regulator operator exited the machine a second time, he attempted the same repair that he had performed the first time by moving a wire. Again, he was likely able to reestablish the electrical connection, allowing the machine to move under power. With the controls in the full "reverse" position and because the ballast regulator was not equipped with an operator presence control, the machine unexpectedly moved, causing the fatal injury. This scenario is precisely the type of accident that LOTO procedures are designed to prevent. However, even when operators are knowledgeable and experienced, as in this accident, they sometimes fail to adhere to safety-critical rules and procedures. Often, such procedural deviations are not intentional but the result of distraction or memory failure. Thus, to maximize safety, stronger engineering controls (for example, operator presence controls) should be used in conjunction with administrative controls (for example, LOTO procedures). Like LOTO procedures, operator presence controls are designed to prevent the accident sequence that occurred in this accident. However, operator presence controls, unlike LOTO procedures, do not require human interaction for them to perform their safety function. The NTSB concludes that had the BR-201202 ballast regulator been equipped with an operator presence control, the machine would not have moved once the operator left the cab, and the accident would have been prevented.

Safety would be improved with the addition of operator presence controls into CSX's equipment. CSX should install such controls as they acquire new equipment. Therefore, the NTSB recommends that CSX include operator presence controls as a mandatory safety feature for all newly purchased or manufactured self-propelled roadway maintenance machines.

The current investigation did not include an inspection of CSX's existing equipment, but such an inspection should be performed to identify where operator presence controls are not installed. Upon identifying equipment lacking such controls, they should be installed. The NTSB recommends that CSX inspect its existing self-propelled roadway maintenance machines and install operator presence controls on any machines without such controls.

The issue of operator presence controls does not apply only to CSX. Such controls are applicable to the entire railroad industry. The NTSB reached out to multiple organizations within the industry, including railroads and equipment manufactures, and determined that operator presence controls appeared to be implemented in a piecemeal manner. There are no industry standards for operator presence controls in self-propelled track equipment. Existing federal regulations do not address the issue. The NTSB concludes that safety would be improved by the development of an industry standard for operator presence controls on self-propelled track equipment.

Action is needed from organizations that have the scope and capacity to develop guidelines for safety devices such as operator presence controls on roadway maintenance machines. The American Railway Engineering and Maintenance of Way Association (AREMA) can contribute to such an effort. AREMA focuses its efforts on the heavy freight railroad industry. It is an engineering association focusing on freight railroad infrastructure. Although AREMArecommended practices are primarily meant for the freight industry, they are also used in the passenger railroad industry. AREMA's stated mission is "the development and advancement of both technical and practical knowledge and recommended practices pertaining to the design, construction and maintenance of railway infrastructure." AREMA has a technical committee devoted to maintenance of way work equipment. The NTSB recommended practice for operator presence controls in roadway maintenance machines to protect workers from unintended equipment movement.

To maximize safety, federal regulations should also address the issue. Current FRA regulations mandate that alerters be installed in locomotives, which prevents trains from moving without an operator actively engaged in the control of the train. However, the FRA does not require operator presence controls in self-propelled track equipment. The NTSB concludes that safety would be improved with the implementation of federal regulations requiring operator presence controls throughout the rail industry for self-propelled track equipment. The NTSB therefore recommends that the Federal Railroad Administration require new roadway maintenance machines to be equipped with operator presence controls to prevent unintended movement and protect workers on and around the machines.

## **3 Conclusions**

### 3.1 Findings

- 1. None of the following were factors in the accident: the weather; the condition of the track; cell phone use; or physical or mental impairment of the ballast regulator operator due to alcohol, other impairing drugs, medical condition, or fatigue.
- 2. Operator presence controls are a critical safety feature (not currently required in selfpropelled track equipment) needed to mitigate the hazard of unintended movement.
- 3. Had the BR-201202 ballast regulator been equipped with an operator presence control, the machine would not have moved because the operator left the cab, and the accident would have been prevented.
- 4. Safety would be improved by the development of an industry standard for operator presence controls on self-propelled track equipment.
- 5. Safety would be improved with the implementation of federal regulations requiring operator presence controls throughout the rail industry for self-propelled track equipment.

## 3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the ballast regulator operator's attempt to repair the machine without powering it off and using lockout/tagout procedures, which re-established the electrical connection to the proximity sensor, allowing the machine to move and strike the operator while he was out of the cab, resulting in his death.

## **4** Recommendations

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

#### To the Federal Railroad Administration:

Require new roadway maintenance machines to be equipped with operator presence controls to prevent unintended movement and protect workers on and around the machines. (R-20-11)

#### **To CSX Transportation:**

Include operator presence controls as a mandatory safety feature for all newly purchased or manufactured self-propelled roadway maintenance machines. (R-20-12)

Inspect your existing self-propelled roadway maintenance machines and install operator presence controls on any machines without such controls. (R-20-13)

#### To the American Railway Engineering and Maintenance-of-Way Association:

Develop a recommended practice for operator presence controls in roadway maintenance machines to protect workers from unintended equipment movement. (R-20-14)

### BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III Chairman JENNIFER HOMENDY Member

**BRUCE LANDSBERG** Vice Chairman

MICHAEL E. GRAHAM Member

THOMAS B. CHAPMAN Member

Adopted: July 24, 2020

## **Appendix A: Investigation**

The National Transportation Safety Board (NTSB) was notified on March 12, 2018, of the accident in which a CSX equipment operator was killed while performing railroad track maintenance in Wartrace, Tennessee. The NTSB launched an investigator-in-charge, who was the on-scene spokesperson, and a system safety investigator to investigate track, railroad operations, mechanical functions, human performance, and medical issues.

NTSB investigators from Washington, DC, and Virginia assisted in the investigation.

The parties to the investigation include the Federal Railroad Administration, CSX Transportation, and the Brotherhood of Maintenance of Way Employes Division of the International Brotherhood of Teamsters.<sup>19</sup>

<sup>&</sup>lt;sup>19</sup> The Brotherhood of Maintenance of Way Employes Division of the International Brotherhood of Teamsters officially spells "Employes" with one "e."

## Appendix B: CSX Safety Alert

	March 12, 2018 CSX Engineering Team Safety Advisory Training Code: ESSD201
Subject	On March 12, 2018 the engineering department suffered an unfortunate incident when an employee was struck by equipment and fatally injured
All Engineering Employees	<ul> <li>The purpose of Lock-out/Tag-out procedure is to ensure that equipment and machinery is properly secured during servicing or maintenance. The procedure is applicable to all authorized and affected personnel, both outside contractors and CSX employees. Lock-out/Tag-out is required whenever a person is performing service or maintenance around equipment/machinery creating the potential for injury by: <ul> <li>The unexpected start-up of the equipment/machinery.</li> <li>The release of stored energy.</li> </ul> </li> <li>Affected employee- <ul> <li>An employee whose job requires him or her to work in area or to operate or use a machine or equipment upon which servicing or maintenance may be performed under conditions requiring Lock-out/Tag-out</li> <li>Lock-out/Tag-out is required whenever a person is performing service or maintenance around equipment or machinery.</li> </ul> </li> </ul>
Points of Emphasis	<ul> <li>Engineering has sustained 14 reportable injuries this year including 2 serious broken bone fractures and 6 lacerations</li> <li>There have been 6 human factor incidents resulting in 5 equipment -to-equipment collisions</li> <li>Engineering has seen an escalation in incidents this quarter which coincides with the Accident Pyramid</li> </ul>
	CSX Briefing Rules Review

<ul> <li>Refer to operator's manual for machine or equipment specific Lock-out/Tag-out procedures.</li> <li>Shut down the machine or equipment by using its operating controls, then deactivatin the main power source.</li> <li>Operate valves, switches, or other isolating device(s) to dissipate or relieve potential (stored) energy in equipment. (Examples include springs, gravitation, rotating fitywheels, hydraulic systems, gas, pneumatic, water pressure, etc.)</li> <li>Return the operating controls to the neutral or off position after the dissipation test described above.</li> <li>Visually inspect to ensure that all equipment, switches, valves, etc. are in the shutdow mode as prescribed by the operator's manual</li> <li>The state of a machine or system in which residual energy in any form has been dissipated to its lowest practical value, and in which lock outs have been installed and verified on every power source that can produce a machine movement.</li> <li>Avoid doing anything that could re-activate the equipment.</li> <li>Do not bypass the lock-out/Tag-out when installing parts or components.</li> <li>Once the equipment has been isolated and locked out from its energy sources, complete the following steps to verify that all energy has been dissipated.</li> <li>Refers to operator's manual for machine specific energy dissipation procedures</li> <li>Ensure all components have stopped moving.</li> <li>Release tension on springs, or block the movement of spring driven parts.</li> <li>Block or brace components that could move due to gravity such as workheads spike guns, booms, clamps, dump bodies, etc.</li> <li>Steps for Lock-out/Tag-out</li> <li>Preparation for Equipment</li> <li>Apply Lock-out/Tag-out</li> <li>Preparation for Equipment Sutdown</li> <li>Apply Lock-out/Tag-out</li> <li>Renoving Lock-out/Tag-out</li> <li>Notify all affected personnel before the application of Lock-out/Tag-out devices.</li> <li>Identify the types (pot</li></ul>

2503 - Operating Mechanized Equipment 2503.1 Employees operating mechanized equipment must:         1. Use equipment only to its rated capacity:         2. Inspect to see that the equipment you are operating has a properly maintained back up alarm, top mounted flashing amber light, fire, extinguisher and a first aik kinavaliable;         3. Ride and operate equipment only in the manner in which it was designed;         4. Sound a warning and reduce speed when view is restricted;         5. Stop equipment when the operator's attention cannot be directed exclusively to controlling the movement;         8. Transport passengers only in designated, permanently installed seats;         7. Never leave running mechanized equipment unattended;         8. Maintain contact between fuel pipe and tank while fueling; and         9. See that tock-out/Tag-out Procedures         Steps For Lock-out/Tag-out Procedures         1. Precaration for Equipment Shutdown The authorized employees must:         a. Notify all affected personnel before the application of lock-out/tag-out devices.         b. Identify the types (potential, residual), the sources (electrical, hydraulic, mechanical, etc.), and the amount of energy that powers the equipment.         Procedures       0. Establish the required Safety Zone near mobile equipment.         Procedures       0. Better to operator's manual for machine or equipment specific lock-out/tag-out procedures, on other isolating device(s) to dispate or relieve potential (stored) energy in equipment. (Examples include springs, gravitation, rota	2503 - Operating Mechanized Equipment Z503.1 Employees operating mechanized equipment must:         1. Use equipment only to its rated capacity:         2. Inspect to see that the equipment for you are operating has a properly maintained back up alarm, top mounted flashing amber light, fire, extinguisher and a first aid kit available:         3. Ride and operate equipment only in the manner in which it was designed:         4. Sound a warning and reduce speed when view is restricted:         5. Stop equipment when the operator's attention cannot be directed exclusively to controlling the movement:         6. Transport passengers only in designated, permanently installed seats:         7. Never leave running mechanized equipment unattended:         8. Maintain contact between fulle pipe and tank while tweling: and         9. See that look-out/Tag-out Procedures         Steps For Lock-out/Tag-out Procedures         Interation for Equipment Shutdown         The authorized employees must:         a. Notify all affected personnel before the application of lock-out/tag-out devices.         b. Identify the types (potential, residual), the sources (electrical, hydraulic, mechanical, etc.), and the amount of energy that powers the equipment.         Procedures       1. Establish the required Safety Zone near mobile equipment.         B. Identify how the energy sources (i.e. motors, pumps, gravity, electrical power, etc.) can be controlled (i.e. energy-isolating device(i) to dissipate or relieve potential (stored) energy in equipment, fis		
<ul> <li>Engineering Department Rules and Procedures</li> <li>Refer to operator's manual for machine or equipment specific lock-out/tag-out devices.</li> <li>Shut down the machine or equipment by using its operating controls, then deactivating the main power source.</li> <li>Operate valves, switches, or other isolating device(s) to dissipate or relieve potential (stored) energy in equipment. (Examples include springs, gravitation, rotating flywheels, hydraulic systems, gas, pneumatic, water pressure, etc.)</li> <li>Return the operating controls to the neutral or off position after the dissipation test described above.</li> <li>Visually inspect to ensure that all equipment, switches, valves, etc. are in the shutdown mode as prescribed by the operator's manual.</li> </ul>	<ul> <li>Ine authorized employees must:         <ul> <li>Notify all affected personnel before the application of lock-out/tag-out devices.</li> <li>Identify the types (potential, residual), the sources (electrical, hydraulic, mechanical, etc.), and the amount of energy that powers the equipment.</li> <li>Identify how the energy sources (i.e. motors, pumps, gravity, electrical power, etc.) can be controlled (i.e. energy-isolating device).</li> <li>Equipment Shutdown</li></ul></li></ul>		<ol> <li>2503 - Operating Mechanized Equipment         2503.1 Employees operating mechanized equipment must:         <ol> <li>Use equipment only to its rated capacity;</li> <li>Inspect to see that the equipment you are operating has a properly maintained back up alarm, top mounted flashing amber light, fire, extinguisher and a first aid kit available;</li> <li>Ride and operate equipment only in the manner in which it was designed;</li> <li>Sound a warning and reduce speed when view is restricted;</li> <li>Stop equipment when the operator's attention cannot be directed exclusively to controlling the movement;</li> <li>Transport passengers only in designated, permanently installed seats;</li> <li>Never leave running mechanized equipment unattended;</li> <li>Maintain contact between fuel pipe and tank while fueling; and</li> <li>See that lock-out/Tag-out Procedures</li> </ol> </li> <li>Preparation for Equipment Shutdown         Theorethering the procedure sectors         The probability of the procedures         </li> </ol>
	ISSUED BY THE CSX SAFETY DEPARTMENT	Engineering Department Rules and Procedures	<ul> <li>The authorized employees must: <ul> <li>Notify all affected personnel before the application of lock-out/tag-out devices.</li> <li>Identify the types (potential, residual), the sources (electrical, hydraulic, mechanical, etc.), and the amount of energy that powers the equipment.</li> <li>Identify how the energy sources (i.e. motors, pumps, gravity, electrical power, etc.) can be controlled (i.e. energy-isolating device).</li> <li>Equipment Shutdown</li> <li>Refer to operator's manual for machine or equipment specific lock-out/tag-out procedures.</li> <li>Shut down the machine or equipment by using its operating controls, then deactivating the main power source.</li> <li>Operate valves, switches, or other isolating device(s) to dissipate or relieve potential (stored) energy in equipment. (Examples include springs, gravitation, rotating flywheels, hydraulic systems, gas, pneumatic, water pressure, etc.)</li> <li>Return the operating controls to the neutral or off position after the dissipation test described above.</li> </ul> </li> <li>Visually inspect to ensure that all equipment, switches, valves, etc. are in the shutdown mode as prescribed by the operator's manual.</li> </ul>
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