U.S. Department
of Transportation

**Federal Railroad
Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

August 4, 2023

The Honorable Patty Murray
Chair
Committee on Appropriations
United States Senate
Washington, DC 20510

Dear Chair Murray:

Enclosed is the Report to Congress, Automated Track Inspection Technologies, prepared by the Federal Railroad Administration (FRA) in response to the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2023 (Joint Explanatory Statement), which requested FRA to report to Congress on FRA's activities in evaluating the ability of automated track inspection technology to detect all defects outlined in 49 CFR 213 track safety standards. The Joint Explanatory Statement further requested FRA to describe any next steps the FRA is considering, including any potential regulatory actions, to incorporate automated track inspections into the inspection process upon completion of the Railroad Safety Advisory Committee (RSAC) Task 19-05.

A similar response has been sent to the Vice Chair of the Senate Committee on Appropriations, and the Chairwoman and Ranking Member of the House Committee on Appropriations.

Sincerely,

Amit Bose
Administrator

Enclosure

U.S. Department of Transportation
Federal Railroad Administration

Report to Congress:

Automated Track Inspection Technologies

Joint Explanatory Statement Accompanying the Consolidated Appropriations Act, 2023 (P.L. 117-328)

Division L – Departments of Transportation and Housing and Urban Development, and Related Agencies Appropriations Act, 2023

Automated Track Inspection Technologies

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Abbreviations and Phrases in this Report

AAR	Association of American Railroads
ATGMS	Autonomous Track Geometry Measurement System
BMWED	Brotherhood of Maintenance of Way Employes Division
BNSF	BNSF Railway Company
CN	Canadian National Railway Company
CP	Canadian Pacific Railway
CSX	CSX Transportation, Inc.
FRA	Federal Railroad Administration
NS	Norfolk Southern Railway Company
RSAC	Railroad Safety Advisory Committee
TGMS	Track Geometry Measurement System
TSWG	Track Standards Working Group
UP	Union Pacific Railroad Company

Automated Track Inspection Technologies

Legislative Direction

Source: Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2023 Pub. L. 117-328, 168 Cong. Rec. S9333 (2022)

Automated track inspection technologies.—Instead of the direction in House Report 117-402, the agreement directs the Department to continue to evaluate the performance of automated track inspection technology and determine whether any additional data is needed. In evaluating these technologies, the Department shall evaluate the ability of automated track inspection technology to detect all defects outlined in 49 CFR 213 track safety standards. The Department shall report to the House and Senate Committees on Appropriations on such evaluation and any next steps the FRA is considering, including any potential regulatory actions, to incorporate automated track inspections into the inspection process within 90 days of enactment of this act. The Department is further directed to only consider regulatory action following the completion with recommendations of railroad safety advisory committee task 19-05.

I. Introduction

Federal Railroad Administration (FRA) regulations require qualified railroad track inspectors to perform visual inspections to ensure the railroad's roadbed, track geometry, track structure, and track appliances and track-related devices meet FRA-minimum track safety standards. The use of automated track inspection technology, specifically Track Geometry Measurement Systems (TGMS) or Automated Track Geometry Measurement Systems (ATGMS), in addition to visual inspections, has helped drive down the number of track-caused derailments. Today, every Class I railroad uses automated track inspection technology without waivers from FRA. BNSF has a waiver on its Powder River Territory route and BNSF's Southern Transcon route that allows BNSF to reduce the number of visual inspections.

Class I railroads have conducted test programs as an initial step in gathering data to evaluate whether increasing the use of automated track inspection technology under Federal regulations, specifically autonomous or unmanned technology that measures track geometry, and decreasing the frequency of visual inspections would improve railroad safety. As of January 20, 2023, six Class I railroads have conducted FRA-approved track inspection test programs. Each program was designed to test whether using ATGMS to supplement visual inspections could justify decreasing the frequency of those visual inspections.

This document responds to Congress's request that FRA report on automated track inspection technologies. Section II provides an overview of available automated track inspection technologies. Section III provides an update on FRA-approved Track Inspection Test Programs. Section IV discusses the Railroad Safety Advisory Committee's (RSAC) progress on Task 19-05. Section V provides conclusions.

II. Automated Track Inspection Technologies

Federal track safety regulations require railroads to conduct various track safety inspections, which include visual inspections at specified minimum intervals.[1] The regulations require qualified inspectors, either on foot or by vehicle, to conduct routine visual track inspections at specified minimum frequencies according to the class and type of track.[2] The regulations also require railroads to conduct automated internal rail inspections at specified minimum intervals.[3] While FRA regulations do not generally require freight railroads to utilize other automated systems to inspect track, today, all Class I railroads utilize TGMS as well as other inspection technologies.[4]

TGMS is a method to evaluate track geometry conditions (i.e., gage, cross-level, warp, alignment, and profile) and identify defects—geometry conditions that do not comply with Federal regulations—or geometry conditions that could lead to defects. Traditional TGMS requires dedicated crews to operate the testing equipment. However, TGMS can be autonomous; these systems can perform track geometry inspections without direct human involvement (i.e., uncrewed operations) with equipment mounted to a car or locomotive in the train operating in revenue service. These systems are referred to as ATGMS. Attaching ATGMS to trains in operation enables geometry measurement inspection of all track the trains cover, compared to the time- and distance-limited traditional use of TGMS. FRA regulations do not prohibit a railroad from utilizing ATGMS.

In addition to TGMS or ATGMS, many railroads supplement the required regulatory inspections with additional inspections made with novel instrumentation systems to better plan maintenance and allocate resources. While these novel instrumentation systems may also identify track safety issues, they have not yet been proven to be as accurate or reliable as the required visual track inspections. Their use also varies widely by railroad. Ground penetrating radar is used to identify issues with ballast and sub-ballast. Light detection and ranging (Lidar)/3-D imaging systems can map grade crossings and other physical characteristics of the right-of-way. Machine vision systems image the track structure, including optical-based systems utilizing high-speed cameras to capture the images, and more sophisticated systems combining lasers and cameras to produce images or 3-D renderings of the right-of-way. Vertical deflection measurement systems help railroads evaluate the stiffness of the track and identify soft spots in the roadbed. As with TGMS or ATGMS FRA, does not restrict the use of novel instrumentation systems.

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[1] Code of Federal Regulations, title 49, sections 213.231 to 213.241 (49 CFR §§ 213.231–213.241).

[2] 49 CFR § 213.233(c) requires, for example, weekly visual inspections of Class 1, 2, and 3 main tracks used once a week or more, and twice weekly visual inspections of Class 4 and 5 tracks.

[3] *See* 49 CFR § 213.237 (*Inspection of rail*).

[4] Track geometry measurement system inspections are required for track Classes 6–9 and, under certain circumstances, in track Classes 1–5. 49 CFR § 213.333(a).

Many of these technologies rely on machine learning or artificial intelligence to identify track components, diagnose safety or maintenance issues, flag changes to the track conditions between two inspection runs, or interpret the results. Due to issues that can occur during the development and refinement of machine learning and artificial intelligence algorithms, research is ongoing for better ways to evaluate and improve the accuracy and consistency of these algorithms and also to determine how to effectively utilize the data they produce. FRA sponsors research to advance track inspection with projects that bring together academic and industry researchers to develop new sensor technologies and inspection platforms such as drones, machine learning, and artificial intelligence algorithms. While no combination of current technologies can detect all defects outlined in FRA's track safety regulations, ATGMS was chosen as the focus of the Track Inspection Test Programs due to its potential to decrease derailments caused by track geometry.

III. FRA-Approved Track Inspection Test Programs

Starting in 2018, six Class I railroads sought FRA approval to conduct Track Inspection Test Programs. FRA approved requests from BNSF Railway Company (BNSF), Norfolk Southern Railway Company (NS), Canadian National Railway Company (CN), CSX Transportation, Inc. (CSX), Union Pacific Railroad Company (UP), and Canadian Pacific Railway (CP).[5] The test programs were each designed to evaluate the effectiveness of ATGMS on each railroad and different combinations of visual and automated inspections at different frequencies.[6] FRA found that suspension of certain requirements was necessary for conducting each test program, with conditions added to ensure safety. Therefore, FRA suspended the applicability of certain visual inspection requirements[7] so that each program could gradually decrease visual inspections according to its phased approach. The details varied among test programs including phasing schedules, inspection frequencies, and equipment specifics, but all programs used non-contact, optical, and inertial sensors to measure track geometry. The test programs did not change the railroads' responsibility to comply with any Federal track inspection regulations other than certain aspects of the 49 CFR § 213.233(c) visual inspection frequency requirements.

Each program included a phased methodology and specific safety metrics for the railroad to meet before transitioning to its next phase. The phased methodology required railroads to conduct more track geometry testing with ATGMS while reducing the frequency of visual inspections. The incremental phases were structured to collect data to help find the combination of visual and automated inspections that produces the greatest level of safety. Each railroad initially requested between 12-18 months to complete its program. During the programs, no railroads met their

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[5] FRA approved the Test Programs under 49 CFR § 211.51.

[6] BNSF, https://www.regulations.gov/docket/FRA-2018-0091; NS, https://www.regulations.gov/docket/FRA-2019-0099; CSX, https://www.regulations.gov/docket/FRA-2020-0013; CN, https://www.regulations.gov/docket/FRA-2020-0014; UP, https://www.regulations.gov/docket/FRA-2020-0031; CP, https://www.regulations.gov/docket/FRA-2020-0056.

[7] 49 CFR § 213.233(c).

proposed timelines, so each railroad requested and was granted at least one extension allowing further testing, including:

- After receiving approval for several extensions, BNSF's Test Program ran for a total of 28 months. BNSF completed its five-phase test program on January 31, 2021, and transitioned to an FRA-approved waiver that applies to BNSF's Test Program route (Powder River Territory) and BNSF's Southern Transcon route.[8] The waiver includes two performance-based inspection frequencies similar to BNSF's Test Program phases 4 and 5. The previous month's track geometry defect metric is used to determine the next month's ATGMS inspection frequency. BNSF submits monthly reports to FRA and annual reports to the public docket.
- During NS's Test Program, it requested two extensions. FRA granted one of those requests, effectively lengthening NS's program to 18 months from an initial plan of 12 months. NS's three-phase Test Program concluded in phase three on September 30, 2021.
- CN requested two extensions during its program. FRA granted both, allowing CN's Test Program to run for 31 months. CN's four-phase program ended in phase three on November 23, 2022.
- UP requested one extension of its two-phase Test Program. FRA granted the request, allowing the program to run for 29 months. UP's Test Program ended in phase two on November 23, 2022.
- CSX requested one extension of its three-phase Test Program. FRA granted the request, allowing the program to run for 32 months. CSX's Test Program ended in phase two on November 23, 2022; however, CSX did not attempt to reduce visual inspections below the regulatory required level of twice weekly inspections.
- CP requested one extension of its Test Program, and also modified its initial three-phase program to remove the third phase. FRA granted CP's request allowing CP's program to run for 27 months. CP's Test Program ended in phase two on November 23, 2022.

Upon their conclusion, the monthly reports from each test program were collected and combined into a complete data set. As of November 24, 2022, there were no ongoing track inspection test programs, but BNSF's waiver remains in place. While the last phase of each Test Program was noted above, that does not necessarily indicate that the railroad fully reduced visual inspections to the minimum frequency of that phase. As of April 11, 2023, FRA continues to analyze the data produced by the test programs and BNSF's waiver, and, as discussed below, FRA will share this analysis with the RSAC Track Standards Working Group (TSWG).

[8] BNSF, https://www.regulations.gov/docket/FRA-2020-0064.

IV. Railroad Safety Advisory Committee Task 19-05

In 2019, FRA tasked the RSAC to consider specific improvements to the Federal Track Safety Standards to enhance rail safety by improving track inspection methods, frequency, and documentation.[9] As part of this task, the TSWG is examining "the feasibility to fulfill certain inspection requirements using automated track inspection technologies while maximizing the effectiveness of visual inspections." The data from the test programs will be critical to RSAC's evaluation of the issue. In addition, this RSAC task provides a platform for industry representatives, labor organizations, and other stakeholders to collaborate and provide input on the feasibility of improving railroad safety by identifying current and future technologies to supplement visual inspections.

The TSWG has met regularly to discuss this task and the data produced by the test programs and waiver. The most recent meeting was held virtually on January 18, 2023. The six Class I railroads presented the results of their test programs. The Association of American Railroads (AAR) and MxV Rail (the research arm of AAR) also made presentations. During the next TSWG meeting, FRA plans to provide analysis of all test program data. FRA's analysis will focus on determining to what extent each railroad achieved its desired combination track inspection frequency, what challenges led to each railroad requesting an extension of its initially-proposed timelines, and a review of best practices and lessons learned from each Test Program. After that presentation, participants will discuss a path forward to reach consensus. Under the RSAC charter, if a working group does not reach consensus, the RSAC will be unable to make a recommendation to FRA on the matter. In that scenario, FRA will consider possible options to incorporate automated track inspection technology in FRA's Track Safety Standards.

V. Conclusions

In combination with visual inspections, technological advancement has become essential to railroads' track asset management and safety assurance programs. While maintaining visual inspections, FRA encourages railroads to continue to develop and test new track inspection technologies. Visual inspections are necessary since no combination of available track inspection technologies can detect all defects outlined in 49 CFR part 213. The Track Inspection Test Programs have concluded, and FRA is continuing to monitor BNSF's waiver. FRA and RSAC are currently examining the results of the Test Programs and waiver with the goal of reaching a consensus recommendation. Regardless of the outcome of the RSAC task, FRA will continue to evaluate additional track inspection technologies to improve the safety and efficiency of the rail network.

[9] RSAC Task Number 2019-05, https://rsac.fra.dot.gov/tasks.