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POSITIVE TRAIN CONTROL

As Implementation Progresses, Focus Turns to the Complexities of Achieving System Interoperability

Statement of Susan Fleming, Director,
Physical Infrastructure

July 31, 2019

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GAO Highlights

Highlights of GAO-19-693T, a testimony before the Committee on Commerce, Science, and Transportation, U.S. Senate

Why GAO Did This Study

Forty-two railroads are currently subject to the statutory mandate to implement PTC, a communications-based system designed to automatically slow or stop a train that is not being operated safely. Railroads were required to implement PTC by December 31, 2018, but would receive extensions up to December 31, 2020, if specific statutory requirements were met.

GAO was asked to review railroads' PTC implementation progress. This statement discusses (1) railroads' implementation progress and any related implementation challenges and (2) FRA's plans for overseeing railroads' implementation. GAO analyzed railroads' most recent quarterly reports covering activities through March 31, 2019; received responses from all 42 railroads on a brief questionnaire; and interviewed officials from FRA and 8 railroads, selected to include variation in implementation status and type of railroad, among other criteria.

What GAO Recommends

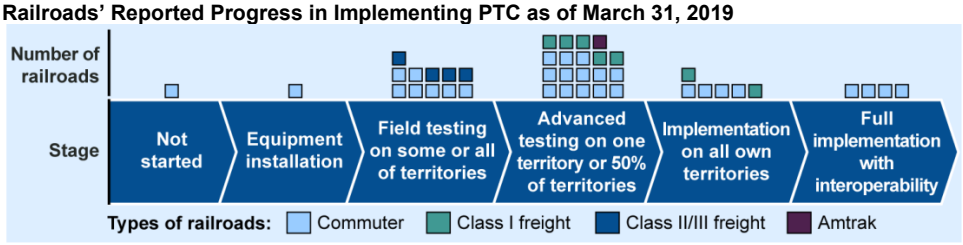
In March 2018, GAO recommended FRA take steps to systematically communicate information to railroads and to use a risk-based approach to prioritize agency resources and workload. FRA concurred with these recommendations. FRA has taken actions to systematically communicate information to railroads. GAO will continue to monitor FRA actions with regard to allocating agency resources to oversee PTC.

View GAO-19-693T. For more information, contact Susan Fleming at (202) 512-2834 or flemings@gao.gov.

What GAO Found

Amtrak, commuter railroads, and freight railroads continue to make progress implementing positive train control (PTC), but significant work remains to achieve interoperability among the railroads' individual PTC systems. Since the end of 2018, many railroads reported making progress on testing and implementation of their own PTC systems. Four railroads reported reaching full implementation as of March 31, 2019, the same number in this stage at the end of 2018. However, many railroads remained in earlier stages of implementation, such as the 11 railroads that reported being in field testing. Nearly all railroads plan to complete full PTC implementation in the last quarter of 2020.

Railroads' Reported Progress in Implementing PTC as of March 31, 2019



Source: GAO analysis of railroads' progress reports to the Federal Railroad Administration. | GAO-19-693T

Full implementation with interoperability is achieved when the PTC system on the locomotive of a "tenant" railroad and the PTC system of a "host" railroad whose track is being used can successfully communicate, allowing uninterrupted movements over property boundaries. As of March 31, 2019, 11 of the 31 host railroads that must have interoperable PTC systems reported that they had achieved interoperability with at least 1 of their tenant railroads. Collectively, 38 of the 227 unique host-tenant relationships that require interoperability have been completed (17 percent), according to the Federal Railroad Administration (FRA). Most railroads reported to GAO that vendor and software issues were currently major or moderate challenges for PTC implementation. Over half of railroads also reported that interoperability was a major or moderate challenge, and can be complicated by software issues and coordinating host and tenant schedules, among other issues. For example, one railroad said that certain software functionality still had to be developed, tested, and implemented to address reliability issues and facilitate interoperability.

FRA continues to provide assistance and support to railroads on PTC interoperabilty and the testing process, but workload challenges for the agency persist. FRA will continue to face a substantial workload through 2020 as it oversees railroads' PTC implementation and reviews documents, including lengthy safety plans required for railroads to obtain PTC system certification. While FRA officials have described supporting interoperability and testing as areas of focus, they have not demonstrated how, within these broad areas, they are monitoring risk and prioritizing resources, as GAO recommended in March 2018. GAO continues to see value in FRA developing a risk-based approach to allocate its resources to oversee PTC.

Chairman Wicker, Ranking Member Cantwell, and Members of the Committee:

Congress mandated the implementation of positive train control (PTC) systems by certain railroads over a decade ago to prevent train-to-train collisions and other types of accidents.[1] PTC is a communications-based system designed to automatically slow or stop a train that is not being operated safely. Forty-two railroads are currently subject to the statutory mandate to implement PTC, including 30 commuter railroads, Amtrak, and several freight railroads. Over the years, we have periodically reported and testified on railroads' progress implementing PTC, which has been a complex and lengthy process, involving nearly all major rail lines and almost every aspect of railroads' operations.[2] Full implementation includes but is not limited to equipment installation, testing, interoperability, and system certification by the Federal Railroad Administration (FRA). According to a 2018 National Transportation Safety Board testimony, since the PTC mandate was enacted, 22 rail accidents it investigated could have been prevented by PTC, including the December 2017 derailment of an Amtrak passenger train near DuPont, Washington, that killed 3 passengers and injured 57 passengers and crewmembers.[3]

While railroads were required to implement PTC by December 31, 2018, FRA was required under the statutory mandate to grant railroads an extension up to December 31, 2020, if they met specific requirements and requested an alternative schedule and sequence (i.e., an extension).[4] Four railroads reported that they had fully implemented PTC for all rail operations on their own track by yearend 2018. FRA approved 36

[1]Certain railroads were required to implement PTC by December 31, 2015. Rail Safety Improvement Act of 2008, Pub. L. No. 110-432, div. A, 122 Stat. 4848 (2008). In 2015, Congress extended this original deadline. Positive Train Control Enforcement and Implementation Act of 2015, Pub. L. No. 114-73, § 1302, 129 Stat. 568, 576-582 (2015), codified at 49 U.S.C. § 20157.

[2]See, for example, GAO, *Positive Train Control: Many Commuter Railroads Still Have Significant Additional Implementation Work and Opportunities Exist to Provide Federal Assistance*, GAO-18-367T (Washington, D.C.: Mar. 1, 2018) and *Positive Train Control: Most Railroads Expect to Request an Extension, and Substantial Work Remains Beyond 2018*, GAO-18-692T (Washington, D.C.: Sept. 13, 2018).

[3]National Transportation Safety Board, *The State of Positive Train Control Implementation in the United States* (Washington, D.C.: Sept. 13, 2018).

[4]49 U.S.C. § 20157.

railroads' requests for an extension.[5] Consequently, while railroads have installed all needed PTC equipment on locomotives and along tracks and met some other statutory requirements, much work—particularly with respect to interoperability—remains to fully implement PTC. Achieving interoperability is critical as U.S. railroads often operate some or all of their trains as "tenants" on the track of another railroad, known as the "host." The individual PTC systems of host and tenant railroads must be interoperable in order for their respective trains to move safely and seamlessly across others' track.

My statement today addresses (1) the progress railroads have made to complete PTC implementation, and any related implementation challenges, and (2) FRA's plans to oversee railroads' PTC implementation to meet the December 2020 deadline.

To describe railroads' progress, we analyzed the most recent available quarterly PTC implementation reports railroads submitted to FRA, that reflected their progress as of March 31, 2019. We analyzed the reports to determine the extent to which each railroad has initiated different stages of testing and different steps to achieve interoperability with other railroads. To identify the implementation status of tenant-only railroads, we categorized them based on the furthest stage of implementation their host(s) railroads have reached. Based on our review of these data for anomalies, outliers, or missing information and our previous assessment of such quarterly reports for our March 2018 and September 2018 testimonies, we determined that these data were sufficiently reliable for our purposes of describing railroads' progress in PTC implementation. In addition, we interviewed representatives from Amtrak, two freight railroads, and five commuter railroads, selected to ensure variation in PTC implementation status and number of tenant railroads. To describe railroads' progress and FRA's plans to oversee PTC implementation, we sent the 42 railroads a questionnaire to obtain information on their implementation progress, including interoperability, as of May 31, 2019;

[5]As of December 31, 2018, 41 railroads were required to implement PTC. In September 2018, FRA approved a temporary main line track exception for one railroad; while this exempted the railroad from the December 31, 2018, deadline, the railroad is still required to implement PTC by December 31, 2020. One new commuter railroad that began service after January 1, 2019, is now also required to implement PTC, bringing the total number required to implement PTC by December 31, 2020, to 42. FRA has reported that it approved 37 railroads' requests for extensions; FRA's count includes one tenant railroad that submitted documentation to demonstrate it met the statutory requirements though it was not required to do so.

challenges to implementing PTC; and any guidance or assistance needed from FRA. We received responses from all 42 railroads. We also interviewed industry associations for commuter (American Public Transportation Association) and freight (Association of American Railroads) railroads. We reviewed applicable laws and FRA regulations, presentations, reports, and guidance, and we interviewed FRA officials in headquarters and three of FRA's nine PTC field specialists who serve as the technical leads for the PTC systems most commonly used by railroads. We also reviewed prior GAO products related to PTC.

We conducted this performance audit from May 2019 to July 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The vast majority of the 42 railroads subject to the statutory mandate to implement PTC—including 30 commuter railroads, Amtrak, seven Class I and four Class II and III freight railroads—are implementing one of three types of PTC systems.[6] These systems include the Interoperable Electronic Train Management System (I-ETMS), the Advanced Civil Speed Enforcement System II (ACSES), and Enhanced Automated Train Control (E-ATC). While these PTC systems are functionally similar, the technologies they use differ. For example, to determine a train's location, ACSES and E-ATC rely on equipment embedded on the track while I-ETMS uses Global Positioning System information. ACSES and E-ATC both supplement existing train control systems to provide all required PTC functionality, while I-ETMS was designed as a new system to provide this functionality.

As noted above, testing is one of the many steps to achieving full implementation. Through multiple stages of testing, which are

[6]Freight railroads are classified by operating revenues. As of 2017, Class I railroads have annual operating revenues of $447.6 million or more. Class II railroads have annual operating revenues of less than $447.6 million but more than $35.8 million, and Class III railroads have annual operating revenues of $35.8 million or less.

summarized below, railroads must demonstrate that the PTC system meets functional requirements.[7]

- **Laboratory testing:** locomotive and wayside equipment testing in a lab environment to verify that individual components function as designed.[8]
- **Field testing:** includes several different tests of individual components and the overall system, such as testing each locomotive type to verify that it meets functional requirements and field integration testing—a key implementation milestone to verify that each PTC component is integrated and functioning safely as designed.
- **Revenue service demonstration (RSD):** an advanced form of field testing in which the railroad operates PTC-equipped trains in regular service under specific conditions. RSD is intended to validate the performance of the PTC system as a whole and to test the system under normal, real-world operations.

Using results from field and RSD testing, combined with other information, host railroads must then submit a safety plan to FRA for system certification and approval. We previously reported that these safety plans have been up to 5,000 pages in length.[9] Once FRA approves a safety plan, the railroad receives system certification, which is required for full implementation, and is then authorized to operate the PTC system in revenue service. According to FRA officials, the FRA may impose conditions to the PTC safety plan approval as necessary to ensure safety, resulting in a conditional certification.

Interoperability is achieved when the locomotives of any host railroad and tenant railroad operating over the same track segment can successfully communicate with and respond to the other railroad's PTC system, allowing uninterrupted movements over property boundaries.[10] For

[7]PTC systems are required to prevent train-to-train collisions, over-speed derailments, incursions into work zone limits, and the movement of a train through a switch left in the wrong position. Pub. L. No. 110-432.

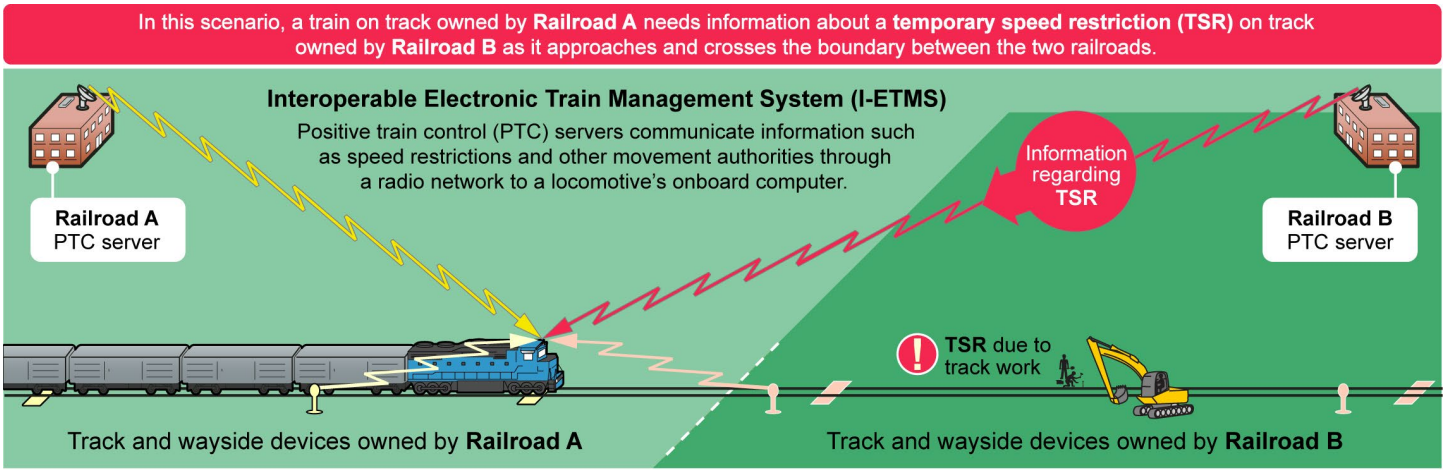
[8]In this statement, we use the term locomotive generally to refer to any of the variety of vehicles, such as cab cars and electric multiple unit trains, that railroads may need to equip. Wayside equipment includes items such as communication towers or poles, switch position monitors, wayside interface units, and base station radios.

[9]GAO-18-367T.

[10]49 U.S.C. § 20157.

example, when a locomotive enters another railroad's territory as a tenant, it immediately needs information about the upcoming track—such as any temporary speed restrictions in place due to track work (see fig. 1).

Figure 1: Examples of Positive Train Control (PTC) Interoperability across Different Railroads' Territories



Source: GAO. | GAO-19-693T

Note: Communications configurations beyond those used in this figure are possible for a host and tenant railroad using I-ETMS or ACSES.

To achieve interoperability, railroads have to complete a series of steps including (1) additional installation work (such as installing equipment on a tenant railroad's locomotives) and scheduling (such as coordinating with the relevant railroad to reach any needed agreements and identify dates for testing), (2) laboratory testing, (3) field testing, and (4) RSD or revenue service operations.[11] Many railroads will complete much of the implementation for their own PTC systems, such as starting RSD on some or most of their track, before they begin to take steps to achieve interoperability with other railroads. However, a railroad can take steps to achieve interoperability with other railroads while simultaneously completing field testing or other stages of testing on its own PTC system.

[11]For certain PTC systems, railroads also have to ensure that their PTC back office servers, which contain information on track features and speed restrictions, are linked and can communicate to achieve interoperability; railroads call this process "federation." However, depending on the PTC system, federation can occur at different points. For I-ETMS, for example, railroads must complete federation before conducting lab or field testing. Because ACSES relies on transponders to communicate certain information to locomotives, railroads can complete federation either before or after lab or field testing.

FRA is responsible for overseeing railroads' implementation of PTC, and the agency monitors progress and provides direct assistance to railroads implementing PTC. For example, each railroad had to develop an FRA-approved PTC implementation plan that includes project schedules and milestones for certain activities, and a railroad is required to report quarterly and annually to FRA on its PTC implementation status relative to its implementation plan.[12] FRA also provides technical assistance to railroads, addresses questions, and reviews and approves railroads' documentation, including test and safety plans. FRA has a national PTC project manager, designated PTC specialists in the eight FRA regions, and approximately a dozen engineers, test monitors, and other staff responsible for overseeing technical aspects of implementation. FRA also has oversight tools, which includes authority to impose civil penalties when a railroad fails to meet certain statutory PTC requirements.[13] Since 2017, FRA reports that it has assessed nearly $400,000 in civil penalties against railroads that failed to comply with their implementation plan milestones or reporting requirements.

[12]To effectively monitor each railroad's progress implementing PTC, FRA requires the submission of quarterly progress reports under its investigative authorities. See e.g., 49 U.S.C. §§ 20107, 20902, 20157(c)(2); 49 C.F.R. § 236.1009(h). In addition, each railroad is required to annually report to FRA on PTC implementation progress in areas such as spectrum acquisition, installation progress, and the total number of route miles where RSD has been initiated or PTC is in operation. See 49 U.S.C. § 20157(c)(1); 49 C.F.R. § 236.1009(a)(5).

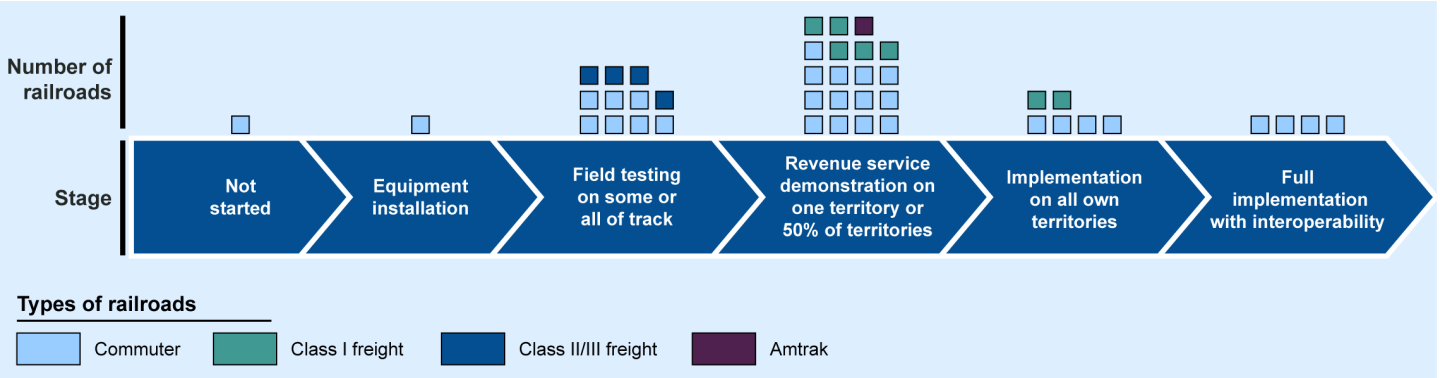
[13]49 U.S.C. § 20157(e)(1)-(4).

Railroads Continue to Make Progress Implementing PTC, but Significant Work Remains to Achieve Interoperability

Railroads' Implementation of Their Own Systems Has Advanced, but Some Commuter and Smaller Freight Railroads Remain in the Early Stages of Testing

Since the end of 2018, some railroads have reported making progress on testing and implementation of their own PTC systems. Figure 2 shows the 42 railroads' reported progress by PTC implementation stage.

Figure 2: Railroads' Reported Progress Implementing Positive Train Control (PTC) as of March 31, 2019



Source: GAO analysis of railroads' progress reports to the Federal Railroad Administration. | GAO-19-693T

Notes:

Full implementation means a railroad has implemented an FRA-certified PTC system on all its own territories and has achieved interoperability with any railroads that operate on its tracks.

Revenue service demonstration on one territory or 50 percent of territories was one of the statutory requirements a railroad had to meet to receive an extension.

The two railroads not yet in field testing are one new commuter railroad and one railroad that received a temporary main line track exception. This allowed the railroad to remain in installation beyond the 2018 deadline. FRA can grant main line exceptions under certain conditions, such as through limited operations. 49 C.F.R. § 236.1019(c).

Six railroads—two Class Is and four commuters—reported to FRA that they had implemented PTC on all of their own territories but had not completed interoperability as of March 31, 2019, and almost all these railroads reported being in this stage at the end of 2018.[14] In addition, as of March 31, 2019, no additional railroads beyond the four that were complete at the end of 2018 reported reaching full implementation. Nearly all railroads still implementing PTC plan to reach full implementation in the last quarter of 2020, based on our analysis of railroads' extension requests.

Few railroads reported moving into RSD during the first quarter of 2019, and the extent of RSD testing being conducted by railroads in this stage varied considerably. Of the 19 railroads that reported RSD testing on some portion of their own track as of March 31, about half (9 of 19) reported RSD testing on more than 75 percent of their total route miles, while about a quarter (5 of 19) reported RSD testing on less than 25 percent of their total route miles. RSD testing also varied between Class I railroads and commuter railroads. On average, the 5 Class I railroads in this stage reported RSD on 86 percent of route miles, while commuter railroads reported an average of 39 percent of route miles in RSD.[15]

Moreover, based on our analysis, 11 railroads—7 commuters and 4 Class II and III railroads—reported that they remained in field testing as of March 31, 2019. Similar to railroads in RSD testing, the extent of field testing reported by railroads varied. Of the 11 railroads in field testing, most (7) reported field testing on the majority or all of their route miles, whereas 4 railroads—all commuters—reported conducting field testing on less than half of their route miles. Based on railroads' responses to our questionnaire, railroads' PTC implementation status did not change significantly as of May 31, 2019; two additional railroads—both commuters—began RSD testing on some portion of their track, and one commuter railroad began field testing.

[14]These railroads continue interoperability efforts with their tenants, and so have not fully implemented PTC. We considered railroads to be in this stage if they reported 100 percent of their route miles or track segments in PTC operation as of March 31, 2019.

[15]All 7 Class I railroads required to implement PTC have received conditional system certification from FRA or provisional authority to operate a PTC system under revenue service. 49 U.S.C. § 20157(h)(2). Therefore, these railroads' PTC operations are considered to be revenue service, rather than RSD testing. For our purposes, we consider these railroads to be in the late stages of PTC testing akin to RSD testing, so we report their activities as RSD rather than revenue service.

Host Railroads Have Achieved Interoperability with Less Than 20 Percent of Tenants, but Nearly All Railroads Have Started Interoperability Planning

As of March 31, 2019, 11 of the 31 host railroads that must have interoperable PTC systems reported to FRA that they had achieved interoperability with at least 1 of their tenant railroads.[16] Collectively, of the 227 unique host-tenant relationships that require interoperability, FRA reported that railroads had achieved interoperability for 38 (17 percent) of these relationships.[17] The number of tenants each railroad must work to achieve interoperability with ranges from 1 to 31 railroads, based on railroad reports to FRA. For example, Class I railroads, as host railroads, average about 18 tenants, while commuter railroads average about 3 tenants. A railroad does not generally start work to achieve interoperability with all the railroads it interoperates with at once, according to FRA; instead a railroad will prioritize its interoperability work. For example, representatives from one Class I railroad we interviewed said it prioritized achieving interoperability in the following sequence: first with commuter-railroad tenants given the need to ensure passenger safety; second with other Class I railroads given the high total miles of track they share; and finally with smaller Class III railroads. In addition, a railroad may be in multiple interoperability steps (e.g., installing, testing) with different tenants at the same time.

FRA counts a relationship as having achieved interoperability if the tenant is operating PTC on all of the host's track miles. This binary measure for interoperability—that is, achieved or not—does not describe the extent to which railroads have started work on interoperability or, according to representatives from two railroads we interviewed, reflect when interoperability has been achieved along most but not all of its host's track.[18] Railroads reported to FRA that they had begun work on interoperability for more than 90 percent of the remaining host-tenant

[16]The 31 railroads exclude six tenant-only railroads that only operate on track of other railroads and 5 railroads that have PTC systems that do not have to be interoperable with other railroads.

[17]As of May 31, 2019, the number of railroads (11) that had achieved interoperability with at least one tenant railroad had not changed, based on responses to our questionnaire. Based on responses, 6 railroads had started field testing with at least one tenant, 12 railroads had started interoperability work but not field testing with at least one tenant, and 2 railroads had not yet started work to achieve interoperability.

[18]In addition to this interoperability measure in FRA's PTC implementation graphics, the FRA PTC website includes links to each railroads' most recent quarterly report and presentations with additional detail on the number of railroads in the installing or testing stage of achieving interoperability.

relationships that need to achieve interoperability. In particular, based on their quarterly reports, railroads were installing for 82 host-tenant relationships and testing for 89 host-tenant relationships as of March 31, 2019. Overall, the status of interoperability work did not vary much among Class I, commuter, and Class II and III railroads.

FRA officials and others we spoke with could not provide an estimate of how long it takes on average for two railroads to complete the individual steps to achieve interoperability. Representatives from industry associations we interviewed said that it can vary. An FRA specialist we interviewed agreed, explaining that interoperability field testing, for example, varies based on track availability. One railroad might complete testing in 4 days while another railroad might need weeks because it can only test at specific times. In its quarterly reports, FRA asks host railroads to provide the scheduled date for completing interoperability testing with each tenant railroad. As of March 31, 2019, seven railroads reported that they did not anticipate completing interoperability testing with at least one tenant until the last quarter of 2020.[19]

Railroads Continue to Report Challenges with Vendors and Software, and Face New Interoperability Challenges

In responding to our May 2019 questionnaire, most railroads reported that vendor and software issues remain major or moderate challenges for PTC implementation.[20] As part of our ongoing work related to PTC, we have reported that railroads have faced challenges associated with the limited number of vendors that design PTC systems, provide the software and hardware, and conduct testing.[21] However, as representatives of half of the railroads we interviewed emphasized, vendor and software issues are more acute now because as the 2020 deadline nears, less time remains to address these issues and associated delays. Software and

[19]Of the 42 railroads, 24 reported scheduled completion dates for their tenants, 14 did not provide these dates because they do not have tenants or because they have completed implementation, and another 4 left the field blank. Railroads' reported dates varied considerably in format, with some only providing a year and others providing a month and year. We only included railroads providing a month and year in our count of 7 railroads.

[20]We only asked railroads that reported they were not fully implemented to identify whether a challenge was a major, moderate, minor, or not at all a challenge. In response, 31 of 37 railroads said software issues were a major or moderate challenge, and 26 of 37 railroads said vendor/contractor issues were a major or moderate challenge.

[21]GAO, *Positive Train Control: Additional Authorities Could Benefit Implementation*, GAO-13-720, (Washington, D.C.: Aug. 16, 2013) and GAO, *Positive Train Control: Additional Oversight Needed As Most Railroads Do Not Expect to Meet 2015 Implementation Deadline*, GAO-15-739, (Washington, D.C.: Sept. 4, 2015).

vendor issues can be interrelated as a small pool of vendors develop and update the software that supports railroads' PTC systems. Representatives from several railroads and FRA specialists we interviewed said that software issues routinely arise in lab testing, field testing, and RSD that require vendor revisions before a railroad's PTC implementation can continue. For example, representatives from one railroad said that existing software defects affecting its PTC system must be addressed and a new version of the software is needed before they can start RSD. They added that they had no control over this process, as they must rely on the vendor to provide reliable software. Representatives from this railroad also noted that resolving software issues is often not entirely within a railroad's control due to the need for vendor support, in contrast to some earlier challenges leading up to the 2018 deadline, where, for example, the railroad itself had more control as it was installing equipment and could more clearly track progress.

Moreover, the limited supply of vendors and high demand for services as railroads work simultaneously to implement PTC by the 2020 deadline continue to pose problems. For example, representatives from one railroad said their vendor has consistently had issues meeting milestones and delivering on its commitments. Representatives from a small railroad said they had limited internal resources to implement PTC, making the railroad's progress heavily reliant on its vendor. Representatives from two other railroads and FRA officials also highlighted implementation delays caused by recalls for some locomotive equipment, which has caused additional work for railroads as well as the vendor. Specifically, the equipment had to be removed, sent in for repair, and then re-installed.

More than half of the railroads implementing PTC also responded to our questionnaire that interoperability was a major or moderate challenge.[22] Railroads said that interoperability can be complicated by software issues and coordinating host and tenant railroad schedules, when asked to describe the biggest challenges to achieving interoperability.[23] Fifteen

[22]As noted above, we asked railroads that had not achieved full implementation to report how much of a challenge—major, moderate, minor, not at all—a list of previously identified challenges currently posed. Twenty-one of 37 railroads said this was a major or moderate challenge. Half or more of the 37 railroads reported major or moderate challenges in only three areas: vendor issues, software issues, and interoperability.

[23]The questionnaire asked railroads that had not achieved full implementation to describe their biggest challenges specific to achieving interoperability. We analyzed the narrative responses received from 31 railroads to report the major themes identified about challenges specific to achieving interoperability.

railroads specifically mentioned software issues, and representatives from several railroads noted that interoperability will require reliable software. For example, one railroad reported that certain software functionality remains to be developed, tested, and implemented to facilitate interoperability and to address software reliability issues that have caused system disruptions. Also, 14 railroads noted that scheduling time with other railroads to begin interoperability testing can be cumbersome and time consuming. For example, several railroads that we interviewed and that responded to our questionnaire said that scheduling can be complicated by whether other railroads have made enough progress on their own PTC implementation to begin work on interoperability.

According to FRA officials, interoperability challenges also differ across PTC systems and geographic areas. Below, we use the Northeast Corridor and the Chicago metropolitan area—where most railroads are implementing ACSES and I-ETMS, respectively—to illustrate the challenges faced in working to achieve interoperability. However, railroads in other areas or implementing other PTC systems may face some of these same challenges or face additional different challenges.

Northeast Corridor and Surrounding Area

Over a dozen railroads operating on the Northeast Corridor and in the surrounding area are required to implement PTC. The Northeast Corridor runs from Washington, D.C., to Boston, Massachusetts, and Amtrak predominantly owns track on the corridor. Eight commuter railroads, Amtrak, and most freight railroads are implementing a form of the ACSES system on at least a portion of their equipment and track. In some cases, railroads in the Northeast will be operating two different PTC systems concurrently on the same track, which will add to the complexity of interoperability, according to FRA.[24] Examples of interoperability challenges faced in the Northeast include:

- **Software issues.** PTC software presents particular challenges in the Northeast because software is being supplied by multiple vendors and has been developed to accommodate railroads' existing systems that have different configurations. Therefore, according to FRA officials, ACSES does not have a common set of requirements or specifications. Also, even if two railroads use the same vendor for

[24]In these cases, railroads plan to either install their locomotives with equipment for both systems or install wayside equipment along the tracks for both systems. Freight railroads, for example, plan to dual-equip the wayside equipment where they operate as a tenant on the Northeast Corridor so their locomotives can use I-ETMS.

their locomotive equipment or software, each railroad may use a different version of software. In addition, representatives from two railroads that operate in the Northeast told us they built different software functionality into their PTC systems to accommodate their own operations, so additional work is needed to resolve such differences to achieve interoperability. In light of these software issues, representatives from one industry association and one railroad we interviewed said that Northeast Corridor railroads are discussing creating a software management process to aid interoperability.

- **Boundary issues.** A train needs to seamlessly operate PTC when it crosses the boundary between two railroads' territories, as previously described. According to a rail industry association, as of June 2019, there are about 20 boundaries on the Northeast Corridor where more work is needed to ensure seamless operation. FRA officials and one industry association said boundary issues are complex and time-consuming to resolve but not insurmountable. For example, FRA officials said a railroad could install its own equipment such as transponders and wayside devices across the boundary to create an overlap between their system and that of the other railroad.
- **Securing PTC wireless communication.** FRA requires that PTC wireless railroad communications be encrypted.[25] However, a solution that aims to encrypt all PTC wireless communication and data transmittal among railroads operating ACSES in the Northeast is currently in lab development. In August 2016, Amtrak received a grant from FRA to create this solution for ACSES. Amtrak originally planned to implement this solution in December 2018, but Amtrak has experienced delays and currently estimates that it will implement the solution by January 2020. However, Amtrak has reported several risks that it will need to overcome to meet this implementation deadline. Further delays could affect railroads' ability to fully implement PTC in the Northeast by the December 2020 deadline. FRA noted it will continue to monitor and support the railroads as they implement security measures in the Northeast.

Chicago Area

Ten I-ETMS railroads that operate in the greater Chicago metropolitan area received extensions to implement PTC. Throughout PTC implementation, FRA, industry associations, and railroads have identified Chicago as a place where interoperability would be challenging due to the dense freight, passenger, and commuter operations in the area. Examples of such challenges include:

[25] 49 C.F.R. § 236.1033.

- **Software issues.** According to FRA and railroads we interviewed, software issues have slowed interoperability work by railroads implementing I-ETMS. The underlying problem is the memory available on the locomotive equipment, which is needed to store its railroad's track data, according to FRA and railroads we interviewed. To be interoperable, the locomotive equipment also needs to store and exchange multiple railroads' track data, causing the memory to fill up very quickly. According to railroad representatives, memory limitations for I-ETMS locomotive equipment prohibited railroads with large track data files—mainly the Class I freight railroads—from being able to interoperate. The vendor for this equipment has been working on a software solution for this problem, and according to a few railroads we interviewed, the vendor delivered an interim software solution in March 2019 that allowed the four largest Class I railroads to achieve interoperability. However, this software was delivered 7 months later than initially planned, and an additional software solution is still needed to allow the locomotive equipment's memory to store the data of all railroads operating I-ETMS, according to representatives from two railroads and an industry association we interviewed.
- **Other technical issues.** Railroads in the Chicago area conducted modeling to help ensure that sufficient communications capacity (e.g., spectrum and radio capacity) would be available to support PTC interoperability in the region.[26] According to one industry association, while actual PTC operations in the area are minimal right now relative to full expected operations, railroads must continue to monitor the communications capacity as more railroads progress with their own PTC implementation and start to interoperate. For example, railroads may have to re-engineer their radio networks, such as re-routing certain communications through different radio towers and other network connections, if issues are subsequently identified.
- **Scheduling interoperability work with other railroads.** Within the Chicago area, the total number of railroads and the number of railroads that have to be interoperable on a single line complicates interoperability. Chicago is the busiest rail hub in North America and

[26]Radio frequency spectrum is the medium for wireless communications and supports a vast array of commercial and governmental services, such as mobile voice and data, broadcast television and radio, and satellite services, among other wireless services. We previously reported that railroads have faced challenges obtaining spectrum to operate PTC. In particular, railroads have raised concerns about the potential for railroads operating in close proximity to cause interference to each other's radios, mostly in congested metropolitan areas where multiple trains are operating with PTC. GAO-15-739.

handles one-fourth of the nation's freight rail traffic. Nearly 500 freight trains and over 700 passenger trains travel through the area on tracks owned by several different railroads every day. For example, one commuter railroad, for one of its lines, operates over track owned by four host railroads that alternates with its own track. Achieving interoperability for this line will involve sequencing and scheduling with multiple railroads to activate PTC along the entire line, including across the numerous boundaries between different railroads' territories, according to representatives from that railroad. According to one FRA specialist, work to achieve interoperability in the Chicago area will ramp up in late 2019 or early 2020. As a result, many railroads will have to coordinate schedules to sequence interoperability work across the dozens of host-tenant relationships in the area.

FRA Is Assisting Railroads with Testing and Interoperability while PTC Workload Challenges Persist

FRA officials told us that the agency continues to provide assistance to railroads on interoperability and to support railroads through the testing process. In summer 2019, FRA began an effort to meet with all freight, non-Class I tenant railroads that have to be interoperable with host railroads required to implement PTC.[27] FRA officials said they will use meetings with these 72 individual tenant railroads to discuss PTC requirements and review the railroads' plans for implementing PTC with their host railroads. FRA officials said they have also continued to meet regularly with railroads still in field testing or starting RSD on their own PTC systems. For example, FRA officials said the agency meets weekly or monthly with each railroad that has not yet initiated RSD to provide targeted technical assistance to resolve any issues. FRA and representatives from one railroad also told us that FRA has met with vendors to discuss specific equipment or software issues and to stress the importance of resolving these issues. FRA also participates in meetings held by the railroad industry's PTC working groups, including those focused on the Northeast Corridor and Chicago area, as needed.

In addition, FRA officials told us that they are working with industry to improve the safety plan review process. Specifically, according to a June FRA presentation, FRA is working with two railroads and an industry

[27]These tenants are largely Class II and III railroads that operate on tracks of the railroads currently required to implement PTC by law. According to FRA, some Class II or III tenant railroads that have four or fewer unequipped movements per day on PTC-required main lines could have until December 31, 2023, to implement PTC, but their host railroads are requiring their tenants to implement PTC by December 31, 2020.

association to create templates for streamlined, more consistent safety plans for two types of PTC systems—I-ETMS and E-ATC. The goal of the template is to reduce the burden on both railroads and FRA by using a shorter format and, where possible, relying on standardized system documents. FRA officials anticipate that the templates will be ready for other railroads to use in fall 2019.[28] In addition, FRA has contracted for help in reviewing safety plans.[29] However, representatives from four railroads and two industry associations we interviewed noted that they remained concerned about the amount of time it has taken FRA to review safety plans. FRA reported in February 2019 that it took on average 331 days to review a safety plan.[30]

While it is too early to determine the effect of FRA's efforts to improve the safety plan review process, much work remains for FRA in the next 18 months. According to FRA, 23 railroads will be submitting safety plans in the next 12 months. While FRA has conditionally certified 13 PTC systems as of March 31, 2019, these railroads, too, are required to continue to work with FRA to provide additional documents to respond to FRA's conditions. Some of these railroads also plan to resubmit safety plans for FRA to review, hoping to receive an unconditional certification before the December 2020 deadline.

In March 2018, we reported that railroads had expressed a need for additional clarification about applying for an extension and that FRA could provide more consistent information to railroads. We recommended that FRA identify and adopt a method for systematically communicating extension-related information to railroads.[31] In 2018, FRA held three

[28]As noted above, there are no common specifications for the ACSES system, so a template or baseline for a safety plan for ACSES would not help speed up FRA's review, according to FRA. Instead, FRA officials said the FRA field specialist for ACSES will work individually with railroads to provide feedback on draft safety plans.

[29]In March 2018, we reported that FRA had 12 technical staff dedicated to the review of railroads' PTC documentation and monitoring of PTC testing. GAO-18-367T. As of February 2019, FRA reported it had 32 staff, including contracted staff, to carry out these duties. The current contract for additional help to review safety plans has ended, and FRA officials said in July 2019 they plan to let a new contract to continue to procure additional support to help review safety plans.

[30]For example, FRA reported that, of safety plans reviewed through February 2019, one E-ATC safety plan took 78 days, the 2 ACSES safety plans took an average of 310 days, and the 10 I-ETMS safety plans took an average of 319 days.

[31]GAO-18-367T.

symposiums for railroads to consistently communicate information to help railroads prepare to qualify for an extension and to understand what was required to have a fully implemented PTC system. FRA held two similar sessions in February and June 2019.[32] Representatives from most of the railroads we interviewed (six of eight) said they have been happy with the communication with FRA, via these sessions as well as regular meetings with FRA's PTC field specialists and other staff. For example, representatives of two railroads said it was helpful to have the FRA Administrator attend the sessions with railroads and talk directly to railroad representatives. In addition, clarity of information from FRA was the lowest rated challenge in response to our questionnaire, with 29 railroads reporting this as a minor challenge or not at all a challenge.

While FRA has made improvements, the extended 2020 deadline for full PTC implementation is less than 18 months away, and FRA and railroads have substantial work to complete and challenges to address before that deadline. Moreover, unlike the 2018 deadline, no additional extensions are available beyond December 2020.[33] In March 2018, we recommended that FRA develop an approach to use the information it gathers on railroads' PTC implementation progress to prioritize the allocation of resources to address the greatest risk.[34] FRA agreed with this recommendation, and while FRA officials have described testing and interoperability as areas of focus in 2018 and 2019, they have not articulated or demonstrated how, within these broad areas, they are monitoring risk and prioritizing resources. For instance, FRA plans to meet with all 72 tenant railroads in over 30 meetings rather than use the data it collects from host railroads to target this outreach. In addition, while FRA will have to review dozens of new and resubmitted safety plans in the coming months, FRA officials have not identified how they will prioritize these reviews relative to other reviews (e.g., other documentation that railroads submit as they continue testing on their own systems and for interoperability).

[32]Based on these collaboration sessions, we closed this recommendation as implemented.

[33]As noted above, FRA has the authority to assess civil penalties against a railroad that fails to implement PTC by its extended deadline, which for most railroads is December 31, 2020.

[34]GAO-18-367T.

According to FRA, it has communicated to railroads in industry-wide meetings that conditional certification for a PTC system is generally sufficient to meet the statutory requirement for full implementation; FRA noted this would only not be sufficient if a railroad's PTC system did not otherwise meet the technical requirements in regulations and one or more of the conditions related to such non-compliance. However, representatives from two railroads we interviewed also said it was unclear whether conditional certification would be enough for a railroad to comply with the 2020 deadline, and uncertainty remains about which conditions must be addressed to meet the statutory requirement for full implementation.

Related to system certification, representatives from three railroads and one industry association we interviewed also said FRA still needed to clarify how it would handle situations where a host or tenant railroad is not fully implemented by the 2020 deadline. Although the FRA Administrator has publicly said he will enforce the implementation deadline (which is December 31, 2020, for most railroads) and recommend assessing the maximum civil penalty against a railroad that did not meet its deadline, FRA has not clarified if this would apply in situations where a host or tenant relationship affects another railroad's implementation. We continue to see value in FRA developing a risk-based approach to allocating its limited resources and will continue to monitor FRA's actions on this recommendation.

Going forward, FRA will also need to transition to overseeing PTC as a routine part of railroad operations after the 2020 deadline. Similarly, railroads will need to transition from implementation—largely done by contractors—to operating and maintaining their own PTC systems. Several railroads, in response to our questionnaire, said that they anticipate difficulties funding ongoing operations and maintenance as well as managing software and other updates. Therefore, December 31, 2020, represents not only the deadline for full PTC implementation but also a point after which railroads and FRA will face a new operational and oversight environment.

Chairman Wicker, Ranking Member Cantwell, and Members of the Committee, this concludes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

GAO Contact and Staff Acknowledgments

If you or your staff have any questions about this testimony, please contact Susan Fleming, Director, Physical Infrastructure at (202) 512-2834 or FlemingS@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. GAO staff who made key contributions to this testimony are Susan Zimmerman (Assistant Director); Katherine Blair Raymond; Delwen Jones; Emily Larson; Joanie Lofgren; Shannin G. O'Neill; Josh Ormond; Madhav Panwar; Marcus Robinson; Maria Wallace; Crystal Wesco; and Elizabeth Wood.

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