



MASSACHUSETTS WATER RESOURCES AUTHORITY

Charlestown Navy Yard
100 First Avenue, Building 39 302929
Boston, MA 02129

Frederick A. Laskey
Executive Director

August 27, 2021

ENTERED
Office of Proceedings Telephone: (617) 242-6000
August 27, 2021 Fax: (617) 788-4899
Part of TTY: (617) 788-4971
Public Record

VIA E-FILING

Cynthia T. Brown
Chief, Section of Administration
Surface Transportation Board
Office of Proceedings
395 E. Street, SW
Washington, DC 20423

Re: **STB Docket No. FD 36472, CSX Corporation and CSX Transportation, Inc., et al.—Control and Merger—Pan Am Systems, Inc., Pan Am Railways, Inc., Boston and Maine Corporation, Maine Central Railroad Company, Northern Railroad, Pan Am Southern LLC, Portland Terminal Company, Springfield Terminal Railway Company, Stony Brook Railroad Company, and Vermont & Massachusetts Railroad Company**

Dear Ms. Brown:

I am General Counsel for the Massachusetts Water Resources Authority. Attached for filing please find:

- (X) **COMMENTS AND REQUEST FOR CONDITIONS OF THE MASSACHUSETTS WATER RESOURCES AUTHORITY;**
- (X) **VERIFIED STATEMENT OF MATTHEW HORAN (WITH ATTACHED WACHUSETT RESERVOIR WATERSHED RAIL SAFETY & RISK MITIGATION MEMORANDUM); and**
- (X) **VERIFIED STATEMENT OF ELIZABETH REILLEY.**

Kindly add my contact information, in addition to that of Frederick A. Laskey, on behalf of the Massachusetts Water Resources Authority on the service list. Thank you.

Respectfully Submitted,

/s/ Carolyn M. Francisco Murphy
Carolyn M. Francisco Murphy
Attorney for the Massachusetts Water
Resources Authority
100 First Avenue
Boston, Massachusetts 02129
(617) 788-2011
carolyn.francisco-murphy@mwra.com

cc: All parties of record

BEFORE THE
SURFACE TRANSPORTATION BOARD

FD 36472¹

CSX CORPORATION AND CSX TRANSPORTATION, INC., ET AL.

—CONTROL AND MERGER—

PAN AM SYSTEMS, INC., PAN AM RAILWAYS, INC., BOSTON AND MAINE
CORPORATION, MAINE CENTRAL RAILROAD COMPANY, NORTHERN RAILROAD,
PAN AM SOUTHERN LLC, PORTLAND TERMINAL COMPANY, SPRINGFIELD
TERMINAL RAILWAY COMPANY, STONY BROOK RAILROAD COMPANY, AND
VERMONT & MASSACHUSETTS RAILROAD COMPANY

**COMMENTS AND REQUEST FOR CONDITIONS OF THE
MASSACHUSETTS WATER RESOURCES AUTHORITY**

INTRODUCTION

The Massachusetts Water Resources Authority (“MWRA”), in keeping with the procedural schedule set forth by the Surface Transportation Board (the “Board”) in Decision No. 4 in the FD 36472 proceeding, hereby responds to the primary application and to related notices of exemption and petition for exemption (respectively) presented in the main docket and the five related “sub-no.” proceedings (collectively, the “Inter-related Filings”). As explained below, MWRA does not at this time object to, or oppose, the transactions proposed in the Inter-related Filings (the “Transactions”), nor does it support authorization or approval of the Inter-Related Filings.

¹ The present filing also embraces the following dockets: *Norfolk Southern Railway—Trackage Rights Exemption—CSX Transportation, Inc.*, Docket No. FD 36472 (Sub-No. 1); *Norfolk Southern Railway—Trackage Rights Exemption—Providence & Worcester Railroad*, Docket No. FD 36472 (Sub-No. 2); *Norfolk Southern Railway—Trackage Rights Exemption—Boston & Maine Corp.*, Docket No. FD 36472 (Sub-No. 3); *Norfolk Southern Railway—Trackage Rights Exemption—Pan Am Southern LLC*, Docket No. FD 36472 (Sub-No. 4); *Pittsburg & Shawmut Railroad—Operation Exemption—Pan Am Southern LLC*, Docket No. FD 36472 (Sub-No. 5); *SMS Rail Lines of New York, LLC—Discontinuance Exemption—in Albany County, N.Y.*, Docket No. AB 1312X.

Consistent with its comments filed in this proceeding on March 17, 2021, there are significant public health and safety concerns stemming from the Transactions that the Board can and should address by way of specific conditions on approval. While MWRA has had productive discussions with the applicants (primarily CSX Transportation, Inc. – “CSXT”) to address its concerns, a written accord has not been reached. The conditions MWRA seeks are presented below, and evidence in support of them is offered where pertinent. The legal case for the conditions MWRA requests will not be (and need not be) presented at this time, but will be offered, if necessary (barring an intervening settlement adequately addressing MWRA’s concerns), by or before the deadline for final briefs (currently set for January 3, 2022).

BACKGROUND

Dedicated to ensuring the protection of the health, safety and welfare of Commonwealth residents, MWRA is a public authority established by an act of the Massachusetts Legislature in 1984 to provide wholesale water and sewer services to 3.1 million people and more than 5,500 large industrial users in 61 communities primarily in eastern Massachusetts, including the City of Boston. MWRA’s Waterworks System draws its drinking water from the Quabbin Reservoir (412 billion gallons), which is transferred to the Wachusett Reservoir (65 billion gallons) prior to treatment. A railroad line owned by Boston and Maine Corporation extending generally from Barbers Station (near Worcester), Massachusetts, to Harvard, Massachusetts (the “Worcester Main Line”) – currently operated by Springfield Terminal Railway Company – crosses directly over the reservoir via a causeway and also over numerous streams within the watershed that flow quickly and directly into the reservoir. Approximately 7.6 miles (Milepost 6 to Milepost 13.58) of the Worcester Main Line (the “Reservoir Segment”) is located within the Wachusett Watershed. The location of these tracks within the watershed causes concern that a train derailment could result in

railcars rupturing and their contents entering the water supply for over 3.0 million people. The potential damage to the public health of over 3.0 million people living and working in Eastern Massachusetts, as well as the potential economic impact to Massachusetts and potentially much of New England as a result of a derailment and spill impacting the water supply would have a regional, if not national, impact. Potential impacts of changes of operations on this line should also be closely reviewed.

MWRA, along with the Massachusetts Department of Transportation (“MassDOT”) and the Massachusetts Bay Transportation Authority (“MBTA”) (collectively the “Commonwealth”), have been (and remain) actively engaged in discussions with the applicants and allied parties – but primarily with CSXT – to reach a written accord whereby MWRA may (as it hopes to be able to do) rescind some or all of its current reservations about the Transactions, and lend its support for the Inter-related Filings. The parties have discussed rail infrastructure improvements and other necessary measures to, among other things, protect against, and mitigate the potential impacts of, a derailment or other accident that could result in the release of harmful or toxic materials into the Wachusett Watershed. Indeed, CSXT’s recent Supplemental Verified Statement of Mark Wallace, which forecasts increased traffic growth through 2027, heightens the need for conditions concerning infrastructure improvements and other mitigation provisions. While discussions between the MWRA, Commonwealth and CSXT have been positive and amicable, MWRA has requested specific written protective arrangements and protocols, detailed below, particularly as relates to mechanisms to address, mitigate and protect against potential accident-related harm to the watershed. The following are the items that MWRA requests that the Board impose as conditions to approval of the subject Transactions (again, the legal bases for these requests for relief will be presented at the briefs phase of the proceedings).

REQUESTED CONDITIONS

1. Track Upgrade: The Worcester Main Line is currently classified as a Federal Railroad Administration Class 1 track, which is the second-lowest standard for track condition and maintenance allowed for an active freight railroad behind “excepted track.” Given the critical importance of protecting the health and safety of the citizens of Massachusetts that rely on this water supply, MWRA contracted with a firm familiar with railroad construction and maintenance to make recommendations for improvements to the Worcester Main Line. Those recommendations were formalized in the Wachusett Reservoir Rail Safety & Risk Mitigation Memorandum dated January 22, 2016 (“Wachusett Memorandum”) and have informed MWRA in its requests and the discussion related to track improvements necessary to facilitate anticipated traffic increases and track speeds, and to protect against increased risk to the watershed presented by such changes. See, Verified Statement of Matthew Horan and Memorandum attached as Exhibit A. MWRA requests the following conditions relating to track upgrades.²

CSXT shall provide all labor, materials, design and other services and everything else necessary to upgrade, and shall upgrade, the Worcester Main Line tracks and track structures located within the Reservoir Segment to no less than Federal Railroad Administration Class 3 (“FRA Class 3”). Such upgrade work shall also include, without limitation: i) furnishing and installing new continuous welded rail of 136RE or greater section sufficiently ballasted and anchored to prevent buckling; (ii) replacing necessary ties and surfacing all track to bring track to FRA Class 3 condition; (iii) furnishing and installing car integrity scanner, wheel impact detector, dragging equipment and hot bearing detectors (“defect detectors”) at locations on the Worcester Main Line sufficient to detect irregularities and allow a train to stop prior to entering the Reservoir Segment; and (iv) furnishing and installing new guard rails over, and 200 feet on either side of, the causeway, all bridges within the Reservoir Segment, all culverts within the Reservoir Segment and those portions of the track that is within 50 feet of the Wachusett Reservoir or its tributaries. (All requirements under this subparagraph shall collectively be referred to as the “Upgrade Work”.) The Upgrade Work shall be performed in a good and workmanlike manner, in accordance with all applicable laws, regulations, and industry standards. Upon the Board’s approval of the Transactions, and

² Negotiations took place among CSXT, MWRA, MassDOT and MBTA. MassDOT and MBTA have an interest in several of the measures requested by MWRA, and have been included in certain requests of CSXT.

CSXT's final inspection of the Worcester Main Line track which will be completed no more than two months after such approval, CSXT shall provide MWRA, MassDOT and MBTA with a detailed schedule for the Upgrade Work. The Upgrade Work shall be fully completed within one (1) year of the Board's approval of the Transactions.

CSXT has indicated that it plans to upgrade the entire Reservoir Segment to FRA Class 3 track standards (Revised Appl., Ex. 4, Envtl. Matters 6.), but MWRA and CSX have not reached an agreement on the specifics of the upgrade work (e.g., 136RE rail proposed by MWRA vs. 115 RE proposed by CSXT; locations of guardrails, etc.).

2. Maintenance of Track & Inspections: Consistent with the recommendation to upgrade the Worcester Main Line to FRA Class 3 condition, the continued maintenance of those tracks at that level will improve rail safety and mitigate the risk of potential derailments due to track conditions within the Reservoir Segment. The Wachusett Memorandum recommends that the track be maintained at FRA Class 3, once it has been upgraded. See, Verified Statement of Matthew Horan and Memorandum attached as Exhibit A. In addition, MWRA seeks the right to periodically inspect the tracks to ensure compliance with these conditions, as well as after certain events to ensure the track condition remains at FRA Class 3 to mitigate the risk of derailment. Therefore, MWRA requests the following conditions.

CSXT shall, in compliance with federal requirements, maintain the tracks, track structures and all other components of the Upgrade Work to a not less than FRA Class 3 track safety standard. Maintenance shall include, but shall not be limited to, all necessary inspections, repairs and replacement work. All maintenance work shall be performed in a good and workmanlike manner, in accordance with all applicable laws, regulations, and industry standards and at CSXT's sole cost and expense. CSXT shall, promptly upon request (but no more frequently than once per quarter), provide MWRA, MassDOT and MBTA with all relevant information and documentation necessary to confirm the condition and maintenance of the tracks, track structures and all other components of the Upgrade Work.

CSXT shall, upon thirty (30) days advance notice and at a mutually agreeable time (but no more frequently than once per quarter), allow MWRA, MassDOT and

MBTA, and their respective agents, to conduct inspections of the tracks, track structures and all other components of the Upgrade Work. Provided, however, that in the event of a derailment, spill or release, or weather event, emergency or exigent circumstance which, in MWRA's sole opinion, may result in increased risk to the Reservoir Segment and/or reservoir, CSXT shall allow MWRA, MassDOT and MBTA, and their respective agents, to conduct inspections of the tracks, track structures and all other components of the Upgrade Work immediately upon request. The inspector will be accompanied by CSXT personnel. Neither MWRA, MassDOT nor MBTA shall have any obligation to perform any inspections. Any inspections by MWRA, MassDOT and/or MBTA, or any election by MWRA, MassDOT and/or MBTA not to inspect shall not relieve CSXT of its obligations and responsibilities hereunder, and neither MWRA, MassDOT nor MBTA shall have any liability for any such inspection or elections not to inspect. CSXT shall remain liable for its acts, errors and omissions, and those of its agents, employees and contractors and anyone else for whom CSXT is responsible.

It is MWRA's understanding that CSXT is in general agreement regarding the maintenance terms, although the parties are still discussing the specifics of such as well as MWRA's proposed inspection provisions.

3. Speed: The Wachusett Memorandum recommends that trains operating over the Reservoir Segment of the Worcester Main Line, after it has been upgraded to FRA Class 3, be limited to a maximum of 25 miles per hour. The 25 miles per hour cap, which is lower than that allowed based on the proposed FRA track standard, will help to mitigate the risk of a derailment within the Reservoir Segment. See, Verified Statement of Matthew Horan and Memorandum attached as Exhibit A. Therefore, MWRA requests the following conditions, which should apply once the track is upgraded to FRA Class 3.

Trains, locomotives and hi-rail vehicles shall operate at a speeds at or below 25 miles per hour (Class 2 track speed) within the Reservoir Segment. CSXT shall ensure compliance with this requirement.

MWRA understands that CSXT is in general agreement with a 25 miles per hour restriction for the Reservoir Segment.

4. Idling: In many areas within the Reservoir Segment, the tracks are located immediately adjacent to or over the Wachusett Reservoir or its tributaries. MWRA is concerned that a train idling within the Reservoir Segment for an extended period of time increases the risk of accidental or nefarious release of locomotive fuel or harmful materials within the railcars within the train. Therefore, MWRA requests the following conditions.

At no time shall any trains, locomotives or hi-rail vehicles park or otherwise idle within the Reservoir Segment, except only in the event of emergency or in such instance where continued operation would result in a risk of derailment or violation of law. CSXT shall ensure compliance with this requirement. In addition, CSXT shall schedule all trains and locomotives in such a manner that crews will not reach the maximum hours of service allowable for operation while within the Reservoir Segment.

MWRA understands that CSXT is in general agreement with the “no idling” measure, although an accord as to the specific language of a potential agreement has not been reached.

5. Transport of Hazardous Materials: Emergency response planning, including detailed information regarding the materials that are handled via the Reservoir Segment, are critical components of MWRA’s work in planning for, and quickly responding to, any potential incidents. See, Verified Statement of Elizabeth Reilley attached as Exhibit B. Therefore, MWRA requests the following conditions.

CSXT shall, by the third day of each month, provide MWRA, MassDOT and MBTA with sufficient documentation and information necessary to disclose and describe the type and quantity of all items, materials and commodities, including but not limited to pollutants and hazardous materials that were transported through the Reservoir Segment during the previous month. Such documentation and information shall include, without limitation: (i) a description of the items/materials/commodities, the maximum volume transported on a single train and the total volume transported during the month; (ii) the Standard Transportation Commodity Code; (iii) the United Nations/North American Code; (iv) the Department of Transportation (“DOT”) shipping name and technical name; (v) the DOT hazardous class; (vi) the physical state of all transported chemicals (e.g., liquid, gas, compressed gas, refrigerated liquid, solid); and (vii) whether a transported chemical is subject to a federal or state reportable quantity if there is a

spill or release. Such documentation and information shall be considered security sensitive, relating to security measures and emergency preparedness. In addition, CSXT, when possible, will make reasonable efforts to provide advance notice of the transport through the Reservoir Segment of any new pollutants, new hazardous materials, or new items/materials/commodities that might impact water quality if released or spilled for emergency planning purposes. (As used herein, “pollutants” and “hazardous materials” shall include, without limitation, those as defined under the Clean Water Act.) See, e.g., 33 USC §§1319(c)(7), 1321(b)(2)(A) and 1362(6). A pollutant or hazardous material need not be discharged into water to be considered a pollutant under 33 USC §1362(6).

CSXT has expressed a willingness to disclose certain information regarding the transport of materials through the Reservoir Segment. The parties have discussed, but have not yet reached agreement, on the level of detail and frequency of the disclosure.

6. Notice of Derailment & Emergency Planning: To ensure the public health and safety MWRA requires prompt notification of a derailment or emergency within the Reservoir Segment. This notice will allow MWRA to deploy its reservoir emergency response assets, or make other operational changes to minimize the impact of an incident. See, Verified Statement of Elizabeth Reilley attached as Exhibit B. Therefore, MWRA requests the following conditions.

Within one (1) hour of any derailment, spill, or release within the Reservoir Segment CSXT shall notify, by phone and email, parties identified on an emergency notification list provided by MWRA, MassDOT and MBTA. Such notice shall include the information provided in the monthly reports as required above. CSXT shall cooperate with, and provide any further requested information and documentation to MWRA, MassDOT and MBTA following such derailment, spill or release. CSXT shall work with MWRA, MassDOT and MBTA and other emergency response agencies, as necessary, to develop appropriate response plans to ensure compliance with all applicable laws and regulations and conduct training specific to the potential risk associated within the Reservoir Segment.

MWRA understands that CSXT is amenable to providing notice of a derailment, spill or release; however, no agreement has been reached as to the timing or details of any such notice (e.g., a specific deadline of 1 hour vs. “timely notice”). In addition, MWRA understands that CSXT does not object to working with the parties on emergency planning and response.

7. Other Responsibilities: MWRA proposed language for inclusion in a potential agreement regarding CSXT's responsibility for costs and expenses arising out its obligations and requirements, as well as indemnity provisions. CSXT offered revisions to MWRA's proposed language. MWRA anticipates further discussion with CSXT regarding this provision. MWRA requests the following condition.

CSXT shall be solely responsible for all costs and expenses arising out of its requirements and obligations herein. CSXT shall indemnify and hold harmless MWRA, MassDOT and MBTA, and their respective officers, agents, employees and directors, from and against any and all suits, claims and liabilities arising out of: (i) the Upgrade Work; (ii) CSXT's failure to comply with its obligations and requirements herein; (iii) any derailment, release or spill that is caused, in whole or in part, by CSXT; (iv) CSXT's operation and maintenance of the tracks, track structures and all other components of the Upgrade Work; and/or (v) any acts, errors or omissions of CSXT, its agents, employees, contractors, carriers, customers, invitees, and anyone else for whom CSXT is responsible.

Given the statute-imposed limitation on the timeframe for comments and requests for conditions, MWRA reserves its right to present its legal case in support of its request for conditions at the final briefing phase on January 3, 2022. In addition, MWRA will respond in October to other interested parties' comments and requests for conditions as MWRA's interests may appear, and it will participate at any other juncture in this proceeding where it is entitled to do so under the terms of the governing procedural schedule.

CONCLUSION

The importance of the Wachusett Reservoir Watershed to the health, safety and well-being of millions of residents of the Commonwealth of Massachusetts cannot be understated. MWRA remains hopeful the parties will reach an accord on the above measures and provisions that are designed to ensure the continued protection of those interests.

Respectfully Submitted,

/s/ Carolyn M. Francisco Murphy

Carolyn M. Francisco Murphy
Attorney for the Massachusetts Water
Resources Authority
100 First Avenue
Boston, Massachusetts 02129
(617) 788-2011
carolyn.francisco-murphy@mwra.com

Dated: August 27, 2021

CERTIFICATE OF SERVICE

I hereby certify that I have this 27th day of August arranged to serve the foregoing Comments and Request for Conditions upon all parties of record by electronic service or where such service is not available, by U.S. Mail, postage prepaid.

/s/ Carolyn M. Francisco Murphy

Carolyn M. Francisco Murphy

Exhibit A

**VERIFIED STATEMENT OF MATTHEW HORAN (WITH ATTACHED WACHUSETT
RESERVOIR WATERSHED RAIL SAFETY & RISK MITIGATION MEMORANDUM)**

BEFORE THE
SURFACE TRANSPORTATION BOARD

FD 36472

CSX CORPORATION AND CSX TRANSPORTATION, INC., ET AL.

—CONTROL AND MERGER—

PAN AM SYSTEMS, INC., PAN AM RAILWAYS, INC., BOSTON AND MAINE
CORPORATION, MAINE CENTRAL RAILROAD COMPANY, NORTHERN RAILROAD,
PAN AM SOUTHERN LLC, PORTLAND TERMINAL COMPANY, SPRINGFIELD
TERMINAL RAILWAY COMPANY, STONY BROOK RAILROAD COMPANY, AND
VERMONT & MASSACHUSETTS RAILROAD COMPANY

Exhibit A

Verified Statement of Mr. Matthew Horan

I am Matthew Horan, Deputy Director of Finance/Treasurer of the Massachusetts Water Resources Authority (“MWRA”). Since approximately 2000 I have worked on behalf of MWRA on various railroad matters; and since 2015 on issues relating specifically to the Worcester Main Line. In connection with this matter, I participated in discussions among MWRA, the Massachusetts Department of Transportation, the Massachusetts Bay Transportation Authority and CSX Transportation, Inc. (“CSXT”) relating to, among other things, the environmental and public health concerns associated with the Worcester Main Line and items (requests of CSXT) which MWRA believes are critical to minimizing the risk of derailment within the Wachusett watershed. Such requests (detailed in MWRA’s Comments and Requests for Conditions) include, without limitation, provisions concerning track upgrades, maintenance and inspections, speed and idling of trains, transport of hazardous materials and emergency planning. MWRA’s requests to CSXT, and the conditions MWRA has sought in this proceeding by way of the filing to which my verified statement is appended, have been informed by the attached, redacted Wachusett Reservoir

Watershed Rail Safety & Risk Mitigation Memorandum (the “Memorandum”) dated January 22, 2016, prepared for MWRA by STV Incorporated (“STV”).¹ STV evaluated existing conditions of the Worcester Main Line at MWRA’s behest, and recommended measures that would minimize the potential for train derailments within the Wachusett watershed resulting in the release of hazardous substances that could pollute the Wachusett Reservoir, its tributaries, and surrounding ground water. At the time of STV’s review, the Worcester Main Line was classified an FRA Class 2 track. It is currently classified an FRA Class 1 track. While the Memorandum was not prepared specifically for this proceeding, it was previously prepared to review similar concerns that MWRA has raised in these proceedings and it is thus highly informative of its requests and the basis therefor.

VERIFICATIONS

I, Matthew Horan, verify under penalty of perjury that I have read the foregoing Verified Statement offered on behalf of the the Massachusetts Water Resources Authority (“MWRA”), that I know the contents thereof, and that the same are true and correct, and that the attached Wachusett Reservoir Watershed Rail Safety & Risk Mitigation Memorandum is a true and correct copy of the original document, except as for the redactions made for the reasons supplied above. Further, I certify that I am qualified and authorized to file this statement on behalf of MWRA.

/s/ Matthew Horan
Matthew Horan

Executed on August 26, 2021

¹ Removal of Appendix B from the appended Memorandum has been made to protect against the disclosure of information that is security-sensitive. Specifically, Appendix B deals with measures to protect a critical Massachusetts resources from threats, and/or identifies related (and specific) security risks to fresh water supplies and distribution in Massachusetts. In the interest of security, MWRA considers it inadvisable to disclose such redacted terms of the Memorandum, even under seal pursuant to the terms of the protective order governing these proceedings. Other Appendixes (C and H) have also been removed as they do not contribute to the issues presented to the Board in MWRA’s Comments and Request.

Wachusett Reservoir Watershed Rail Safety & Risk Mitigation Memorandum Final

**Pan Am Railway Worcester Mainline
Worcester County, MA**

January 22, 2016

Prepared for:
Massachusetts Water Resources Authority
Prepared by:
STV Incorporated

Table of Contents

Executive Summary	2
1 Introduction	3
2 Train Derailment Causes and Prevention	4
3 Study Area Characteristics	8
4 Railway Characteristics	9
4.1 Operations	9
4.2 Track Infrastructure	9
4.3 Mainline Track Condition	9
4.4 Grade Crossings	11
4.5 Vehicle Inspection Equipment	12
4.6 Rail Lubricators	12
4.7 Bridges and Culverts	12
5 Recommendation	13
5.1 Recommended Maintenance Standards	13
5.1.1 Roadbed	13
5.1.2 Track Geometry	13
5.1.3 Track Surface	14
5.1.4 Track Geometry	14
5.2 Best Practices	17
5.3 Final Recommendation	21
Summary of Appendices	22

Executive Summary

STV conducted a review of existing conditions reports obtained from Massachusetts Department of Transportation (MassDOT), on behalf of the Massachusetts Water Resources Authority (MWRA), of the Pan Am Railways Worcester Mainline traversing through the Wachusett Reservoir Watershed in Worcester County, MA. This review was intended to be used in the development of recommendations to increase rail safety and reduce risk within the watershed. Upon review of information provided, it was determined that only general observations of the track conditions were documented and no detailed track inspection data was provided. Based on the available data, it is recommended that the track through the watershed be maintained at Federal Railroad Administration (FRA) Class 3 standards, one classification above existing operating classification, while maintaining maximum operating speed of 25 mph. Maintaining track above the minimum Class 2 safety requirements will improve rail safety and mitigate risk of potential derailments due to poor track conditions within the watershed.

In addition to increasing maintenance to Class 3 standards, it also recommended that best practices are considered for spike patterns, ballast, and use of inner guardrails, rail lubricators, and defect detectors along the track within the watershed.

Data reviewed in preparation of this memorandum included Track Carts, Timetables, Watershed hazardous materials report and MassDOT 5/29/15 field observation notes and very limited 5/8/15 STV field observations of the Prescott grade crossing. The field visit within the study area was limited to basic visual inspection of the track and did not include geometric measurements. This data has been included in the Appendix of this memorandum. No geometry car or Sperry car data was provided.

The professional opinions and recommendations presented in this document are based only on evaluation of data made available.

1 Introduction

The Wachusett reservoir is located near West Boylston in Worcester County, MA and provides the main drinking water source for the MWRA. The service area for the MWRA includes much of eastern Massachusetts, including the City of Boston. In order to maintain high standards of water quality, the MWRA mitigates runoff and potential sources of contamination within the watershed surrounding the reservoir. The Pan Am Railways' Worcester Mainline, which traverses approximately eight miles through the watershed, has been identified as a potential source of contamination due to spills and/or derailment.

A specific concern of the MWRA is potential contamination caused by rail car cargo release onto the ground and/or water within the watershed due to train derailment.

This memorandum evaluated observed existing conditions of the Worcester Mainline to determine recommendations to minimize potential of train derailment through the watershed. Main causes of train derailment are attributed to either deficiencies in track infrastructure, rolling stock equipment, or operating error (Human Factors). This memorandum focuses on the use of track maintenance to reduce the potential of train derailment through the watershed. Although this memorandum only analyzes track infrastructure along the study corridor, it is recommended that Pan Am Railways be consulted regarding best practices of maintaining rolling stock to further reduce derailment potential.

2 Train Derailment Causes and Prevention

Train derailments are the most common type of accident occurring on United States railways. Severity and frequency of derailments vary depending on track infrastructure, operating, and rolling stock characteristics.

According to a 2012 article, “Analysis of Causes of Major Train Derailment and Their Effect on Accident Rates”, published in Journal of the Transportation Research Board (TRB) (see Appendix A), the leading track related causes of derailment (in terms of total train derailments) on mainlines are:

- Broken rails or welds
- Track geometry (excluding wide gauge)
- Wide gauge
- Obstructions
- Buckled track

Below are the top ten accident causes of freight train derailments from Table 3 of the study, which analyzed data from 4,352 FRA reportable accidents:

Top 10 Accident Causes of Freight Train Derailments by Track Type: Number of Derailments

Rank	Mainline Track		Siding Track		Yard Track	
	Cause	Percentage	Cause	Percentage	Cause	Percentage
1	Borken rails or welds	15.3	Borken rails or welds	16.5	Borken rails or welds	16.4
2	Track geometry (excluding wide gauge)	7.3	Wide gauge	14.2	Use of Switches	13.5
3	Bearing failure (car)	5.9	Turnout defects-switches	9.7	Wide gauge	13.5
4	Broken wheel (car)	5.2	Switching rules	7.7	Turnout defects-switches	11.1
5	Train handling (excluding brakes)	4.6	Track geometry (excluding wide gauge)	7.2	Train handling (excluding brakes)	6.7
6	Wide gauge	3.9	Use of Switches	5.8	Switching rules	6.2
7	Obstructions	3.5	Train handling (excluding brakes)	3.5	Track geometry (excluding wide gauge)	3.6
8	Buckled track	3.4	Lading problems	2.3	Miscellaneous track and structure defects	3.4
9	Track-train interaction	3.4	Roadbed defects	2.1	Track-train interaction	3.1
10	Other axle of journal defects (car)	3.3	Miscellaneous track and structure defects	2.1	Other miscellaneous	3.0

Derailment top 10 list from Analysis of Causes of Major Train Derailments and their Effect on Accident Rates. Journal of the Transportation Research Board No. 2289.

The report further analyzes causes of derailment based on FRA track class speed range of the mainline in Figure 2:

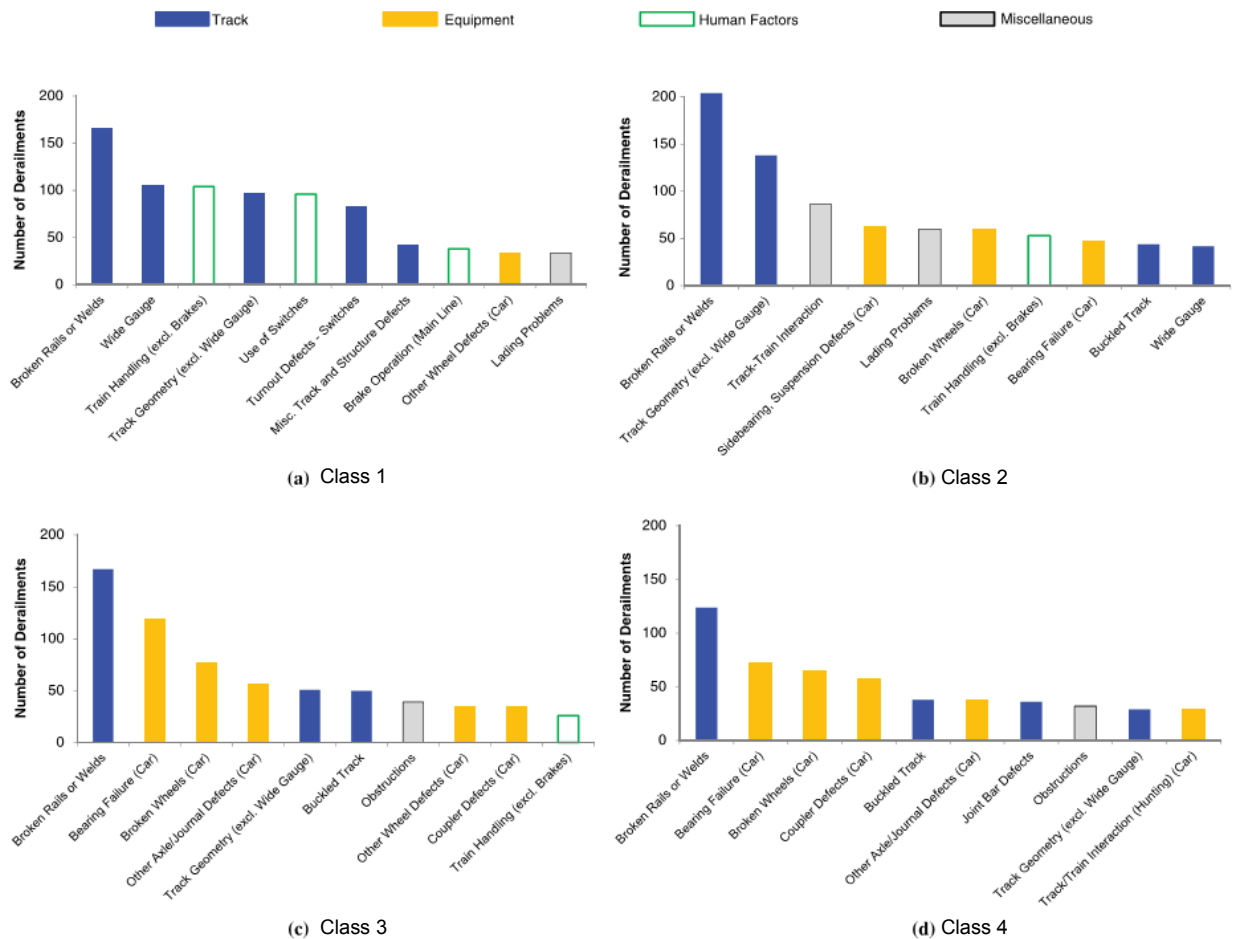


FIGURE 2 Number of freight train derailments by speed and accident cause on Class I main lines: (a) derailment speed 0–10 mph, (b) derailment speed 10–25 mph, (c) derailment speed 25–40 mph, and (d) derailment speed 40–80 mph.

Track infrastructure related derailment causes on mainline operating at 10-25 mph, similar to the Pan Am Worcester mainline, include:

- Broken rails or welds
- Track geometry (excluding wide gauge)
- Buckled track
- Wide gauge

Broken rails and welds, which is also the leading cause of derailments for mainlines operating between 25-40 mph, can be minimized with proper maintenance of the track.

Due to the high number of derailments caused by track related conditions, preventative maintenance of track infrastructure is a widely used strategy to reduce risk and improve safety. In addition to maintenance, railroads in the industry typically institute derailment prevention programs which focus on close monitoring and frequent inspection of the track as well as specialized on-track equipment to detect defects and deficiencies

A typical track section, which includes steel rails fastened to wooden ties with steel plates and spikes, is supported by a compacted subgrade and impervious subballast, with pervious ballast providing lateral stability to the wooden ties. The ballast also provides drainage away from the track preventing water from ponding on the track and deteriorating wood ties. Proper drainage provided by ditch channels along the section edges is also typical of track in a cut section carrying water away from roadbed. All these elements work together to make up the infrastructure for trains to travel safely. Degradation to any one or multiple elements will increase risk of an occurrence.

Leading causes of derailment, such as broken rail or welds, wide gauge, or poor track geometry are likely to occur where there is a loss of strength in track infrastructure and no longer provides proper support to the guiding steel rails. Examples of conditions where these causes may occur include:

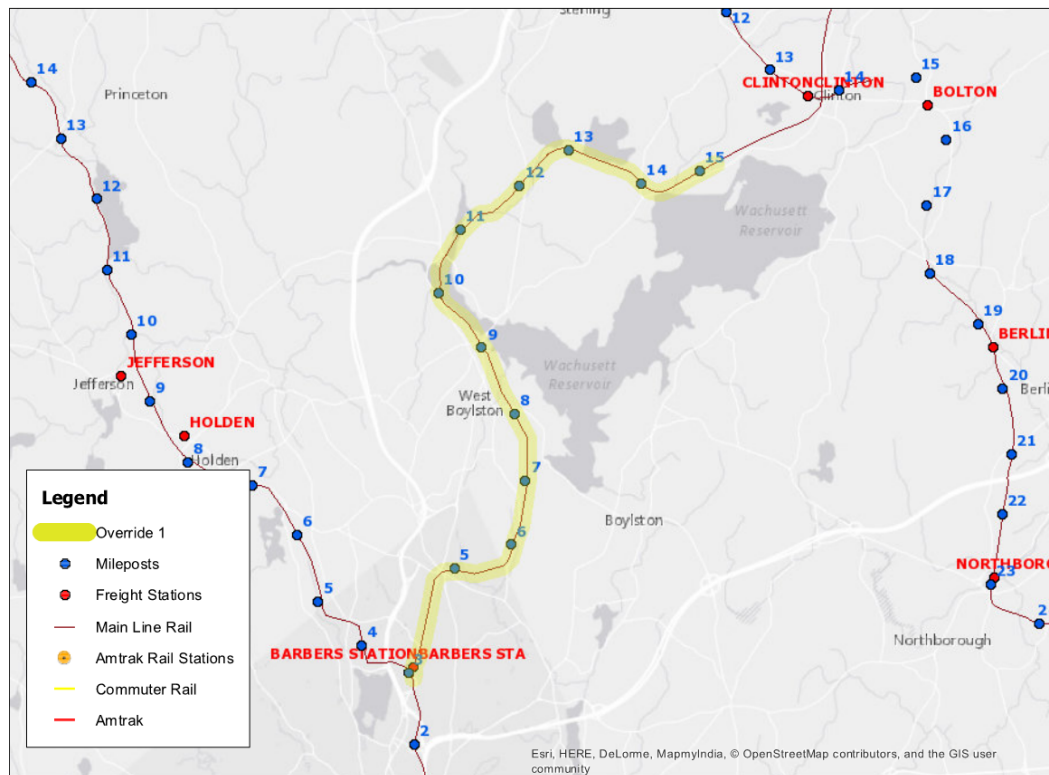
- Subgrade stability loss due to poor drainage and standing water
- Fouled ballast from subgrade pumped up during traffic
- Insufficient ballast between ties (cribs) and shoulders (especially curves)
- Tie deterioration (rot) due to water ponding on track
- Rail stress due to seasonal temperature fluctuation
- Rail deterioration (loss of section from oxidation) due to water ponding on track

Many of these conditions can be prevented or corrected through frequent track inspection and maintenance programs. These programs would help avoid the need for major capital replacements by planning to renew select components of the track infrastructure such as rail, ties, or ballast, over the course of several years.

3 Study Area Characteristics

The study area consists of a single track mainline traversing through residential, park land, and over water in close proximity to the Wachusett Reservoir Worcester County, MA. Features along the study area include seven at-grade roadway/railway crossings, two railway structures over roadways, and two railway structures over waterways. In addition to the structures, there is approximately 0.44 miles of earthen embankment within the Reservoir the railway traverses.

Two segments of the Worcester Main Line, 7.4 miles in total, traverse through the Wachusett Reservoir Watershed: the first segment from Milepost 6.06 to Milepost 12.84 and the second from Milepost 13.59 to Milepost (MP) 14.21. These limits were derived from the Hazardous Materials Transportation Release Control Project Final Report from 1998 (see Appendix B). For the purpose of this memorandum, the study area will extend from MP 6.06 to MP 14.21 plus 1,000 feet of approach track into the watershed from east and west. See Map 1 below:



Map 1: Study Area – Pan Am Worcester Mainline MP 6.06 to MP 14.21

4 Railway Characteristics

4.1 Operations

The Pan-Am Railway Timetable indicates the Worcester Main is operated under a Form D Control System (DCS) (see Appendix C). Under DCS, trains are given Form D Authority by dispatcher to occupy the designated segment of track and do not require the use of wayside signals. The mainline maximum operating speed is listed within the timetable as 25 mph, FRA Class 2, effective June 2014.

4.2 Track Infrastructure

A detailed track inspection was not performed within the study area, though, field observations of existing track conditions were performed by MassDOT on May 29, 2015 (See Appendix D & E). Data from the field observations as well as, track charts and timetables provided to the project team were used to develop the following existing conditions.

4.3 Mainline Track Condition

The mainline through the watershed consists of a single track with grade variation of 0.02% - 0.90% and 21 horizontal curves with varying degrees of curvature from 0° -42' to 5° -30' (see Appendix F). Several of the curves are compound and reverse geometry. No specific measurements were available to determine the track gauge or cross level at the time of the observations.

There were observed drainage issues along portions of the mainline. In addition to drainage issues, several segments appeared to need ditch remediation according to the field observation. Vegetation and over grown brush also appeared to be encroaching the train envelope the length of the study area.

Summary of 5/29/15 field observation notes:***Rail***

The track charts indicates track from MP 6.06 to MP 11.60 is made up of 112R continuously welded rail (CWR) manufactured in 1994. At MP 11.60, 100R jointed rail is shown to extend beyond the study limits. The field observation report supports the rail type from the track charts.

Cross Ties

Specific type of existing ties along mainline were not identified but photographs from the field observation indicate grade 5 wood ties, 7" x9" x 8'-6", are present. Visual inspection showed debris covering ties along the study area suggesting a tie renewal program could be warranted.

Inner guard rails

Photographs from the 5/8/15 site visit indicate inner guard rail is present along track at MP 10.88 over the Waushacum Brook Bridge. Guard rail appears to be fastened every other tie with spikes and unfastened at joints (see Appendix G – photo P5080353).

Turnouts

One turnout is shown within the watershed limits located at MP 6.10. Conditions of the existing turnout not available from data provided.

Ballast

In general, ballast was observed to be deficient or fouled throughout the study area.

Drainage

Drainage along the mainline appears to be in poor condition according to field observations.

Vegetation

Brush along track was observed to be encroaching train envelope and scraping hi rail equipment. In addition to overgrown brush, vegetation was observed within the ballast section and appear to require weed spray.

4.4 Grade Crossings

Public grade crossing conditions were derived from the most current FRA crossing inventory data retrieved on 10/21/2015 from the national database. Crossing inventory reports summarize highway configuration, crossing surface, and safety equipment at crossing location (see Appendix H). Below are summaries of the crossings within the study area.

Shrewsbury Street – DOT# 053842U – Revision Date 07/21/03

The crossing is located at MP 6.06 (note, DOT inventory form lists incorrect MP) and consists of asphalt crossing surface. There are an estimated 4 thru and 1 switching trains a day. Shrewsbury Street is classified as an Urban Local with an AADT of 3300 with 4% truck traffic as of 2003. Signs or signals are present along with 2 roadway gate arms, 1 mast mounted flashing lights, and 1 bell.

Temple Street (RT140) – DOT# 053838E– Revision Date 06/24/2002

The crossing is located at MP 7.78 and consists of asphalt crossing surface. There are an estimated 4 thru trains and 1 switching train per day. Temple Street is classified as a Major Collector with an AADT of 7900 as of 2002. Signs or signals are present along with 2 roadway gate arms, 3 mast mounted flashing lights, and 1 bell. A W10-1 advanced warning sign is used at this crossing.

Prescott Street - DOT# 053837X– Revision Date 06/24/2002

The crossing is located at MP 11.19 and consists of asphalt crossing surface. There are an estimated 4 thru trains and 2 switching trains per day. Prescott Street is classified as an Urban road with an AADT of 290 as of 2002. Signs or signals are present along with a W10-1 advanced warning sign.

Gates Road – DOT# 053834C- Revision Date 06/28/2002

The crossing is located at MP 12.31 and consists of rubber crossing surface. There are an estimated 4 thru trains a day. Gates Road is classified as a Minor Collector with an AADT of 1400 as of 2002. Sign or signals are present.

New Hill Road – DOT# 053833V- Revision Date 06/28/2002

The crossing is located at MP 12.85 and consists of asphalt crossing surface. There are an estimated 4 thru trains and 1 switching train per day. New Hill Road is classified as a Rural Local road with an AADT of 210 as of 2002 with 4% truck traffic. Signs or signals are present along with 2 roadway gate arms, 3 mast mounted flashing lights, and 1 bell.

4.5 Vehicle Inspection Equipment

There is one Dragging Equipment Detector located at MP 7.8 at the southern segment of the study area. The Track Charts also depict a Train Defect Detector at MP 15.4, at the north approach to the watershed.

4.6 Rail Lubricators

No Rail Lubricators are shown on the Track Charts. This equipment located at the approaches to curves within the watershed would mitigate rail wheel friction and reduce wear to the rail head wear in the sharp curves.

4.7 Bridges and Culverts

There is a through girder bridge that carries the track over Route 12 at MP 8.70. There is one large stone arch bridge that carries the track over the Thomas Basin at MP 9.81 and one large stone arch bridge that carries the track over the Stillwater River at MP 9.81. There is one small concrete slab bridge that carries the track over Gates Brook at MP 8.00 and one small stone arch bridge that carries the track over West Boylston Brook at MP 8.05. There are approximately 15 box culverts and pipes below the tracks. Conditions of these structures were not evaluated as part of this memorandum.

5 Recommendation

Upon evaluation of the existing conditions discerned from the data made available to the study team, it is recommended that the track be maintained at FRA Class 3 standards while maintaining current operating speeds of 25 mph. This is one classification higher than FRA Class 2 track classification the existing mainline operates at through the watershed.

Additionally, it is recommended that the structures along the corridor be studied as part of a separate report.

5.1 Recommended Maintenance Standards

Below are the minimum maintenance tolerances recommended for the track structure within the MWRA water shed.

5.1.1 Roadbed

Drainage and other water carrying facilities under or adjacent to the roadbed must be maintained and kept free of obstruction to accommodate water flow.

Vegetation on the railroad property immediately adjacent to the roadbed shall be controlled so that it does not become a fire hazard to structures, obstruct visibility of railroad signs and signals along rights-of way or highway-rail crossings, interfere with railroad employees, prevent proper functioning of signal and communication lines, or prevent railroad employees from visually inspecting moving equipment.

5.1.2 Track Geometry

Gauge, measured between the heads of the rails at right angles to the rails in a plane five-eighths of an inch below the top of rail head. True gauge is 56 ½" (4' 8 ½") and shall be at least 4' 8" but not more than 4' 9 ¾".

Horizontal track alignment deviations shall:

- For mid-offset from the 62-foot line, may not be more than 1¾ inches for tangent track;
- For mid-ordinate from the 31-foot chord, may not be more than 1 inch for curved track; and

- Mid- ordinate from the 62-foot line may not be more than $1\frac{1}{2}$ inches for tangent track.

5.1.3 Track Surface

- The runoff in any 31 feet of rail at the end of a raise may not be more than 2 inches
- The deviation from uniform profile on either rail at the mid-ordinate of a 62-foot chord may not be more than $2\frac{1}{4}$ inches
- The deviation from zero crosslevel at any point on tangent or reverse crosslevel elevation on curves may not be more than $1\frac{3}{4}$ inches
- The difference in crosslevel between any two points less than 62 feet apart may not be more than 2 inches

5.1.4 Track Geometry

Crossties:

- Crossties shall be made of a material to which rail can be securely fastened.
- Each 39-foot segment of track shall have –
 - A sufficient number of crossties, which in combination provide effective support, will -
 - (i) Hold gauge within the limits described in 5.1.2;
 - (ii) Maintain surface within the limits described in 5.1.3; and
 - (iii) Maintain horizontal alignment within the limits prescribed in 5.1.2.
 - The minimum number and type of crossties specified shall be effectively distributed to support the entire segment with 8 minimum number of crossties for tangent track and curves up to 2 degrees and 10 minimum number of crossties for turnouts and curved track over 2 degrees per 39 feet of track.

Rail end mismatch: Any mismatch of rails at joints may not be more than $\frac{3}{16}$ inches on the tread of the rail ends and gauge side of the rail ends.

CWR, rail lengths welded together that exceed 400 feet, shall be maintained according to FRA approved plan provided established by Pan Am Railways. This plan should include procedures for the installation, adjustment, maintenance and inspection of CWR. It is recommended that the plan executed specify the following:

- CWR installation procedures which includes desired rail neutral temperature and temperature differential
- Rail anchoring requirements for:
 - o standard Box pattern
 - o Bridge pattern
 - o Solid Box pattern
 - At turnouts, rail crossings, and joints where CWR abuts jointed rail: minimum anchor every tie for 195' in each direction
 - At bolted joint installed during CWR installation using heater, rail stretcher or ambient temperature:
 - Weld joint within 60 days or,
 - Install joint with 6 bolts or,
 - Anchor every tie for 195' in each direction
- Preventative Maintenance on existing CWR track procedures which includes de-stressing rail
- Monitoring curve movement following track surfacing and lining
- Placing temporary speed restrictions due to work
- Rail joint inspections at a minimum of 1 inspection per calendar year of all CWR joints
- Extreme weather inspection procedures which includes inspections, at minimum of above 100° F for buckling inspection and minimum below 0° F for pull-a-part inspection

Tie plates: tie plates must be under the running rails on at least 8 of any 10 consecutive ties. No metal object which causes a concentrated load by solely supporting a rail shall be allowed between the base of the rail and the bearing surface of the tie plate.

Turnouts shall be equipped with rail anchoring through and on each side to retrain movement affecting the position of switch points and frogs. Each flangeway at turnouts and track crossings must be at least 1½ inches wide.

Frogs: flangeway depth measured from a plane across the wheel-bearing area of a frog may not be less than 1½ inches.

Frog guard rails and guard faces; gauge:

- The guard check gauge, distance between the gauge line of a frog to the guard line of its guard rail or guarding face, measured across the track at right angles to the gauge line, may not be less than 4' 6³/₈".
- The guard face check, the distance between guard lines measured across the track at right angles to the gauge line, may not be more than 4' 5¹/₈".

Track Inspections: All mainline track shall be inspected weekly with at least 3 calendar day interval between inspections, or before use, if the track is used less than once a week, or twice weekly with at least 1 calendar day interval between inspections, if the track carries 10 million gross tons of traffic during the preceding calendar year.

Inspection of Rail: In addition to track inspections, a continuous search for internal defects shall be made of all rail at least once every 30 million-gross-tons (mgt) or once a year, whichever interval is longer.

Inspection of Bridges: Bridges should be inspected following the railroad's FRA Bridge management program.

5.2 Best Practices

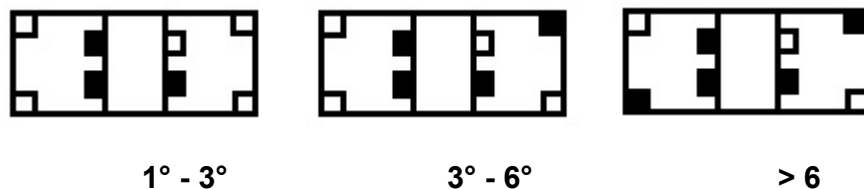
Spikes

Standard spiking criteria are as follows for curves of varying degrees:

Curves 1° - 3° require: **3 spikes**

Curves 3° - 6° require: **4 spikes**

Curves $> 6^{\circ}$ require: **5 spikes**



Any additional spikes should be installed gauge side first and then followed by the field side of rail.

Ballast

In general, ballast should be free of fines or vegetation to ensure proper drainage. Along the track, a minimum of a 12" shoulder should be maintained especially along curves which may require additional ballast. The ballast is to be of sufficient quantity to restrain the track from moving laterally under dynamic loads imposed by railroad equipment

Inner guardrail

Per the AREMA Practical Guide to Railway Engineering, Section 8.2.3 Bridge Deck, inner guardrails help straighten and guide a derailed truck, which supports axles and wheels of rolling stock, into the space between the running rail and the guardrail (seen Figure 8-10 from AREMA PGRE Section 8.2.3). Though inner guardrails do not prevent train derailments, it minimizes



Figure 8-10 Inside Tee Guard Rails - Courtesy of BNSF

potential damage of derailed rolling stock by attempting to contain train within bridge deck.

Scrap rail can be used for guardrails inside the running rail and may be installed without tie plates. Guardrails should be fastened to every tie with spikes and spliced at every joint. Placement of guardrails should extend beyond the bridge ends a minimum of 200 feet in direction of traffic.

Rail Lubricators

Per the AREMA Practical Guide to Railway Engineering, Section 3.8.3, Lubrication in curves will result in reduction of wheel abrasion and extend the useful life of rail. Wayside lubricators properly located to ensure lubricant is carried throughout the

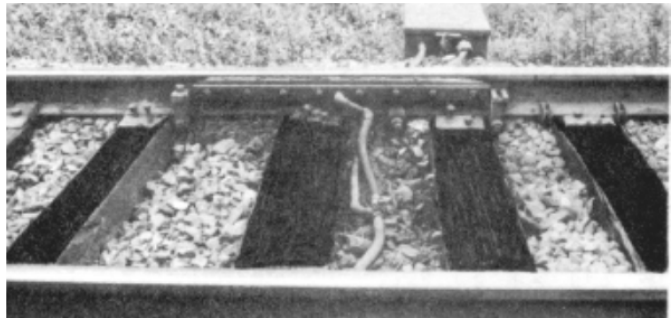


Figure 3-80 Wiper Bars of a Rail Lubricator – Conrail

curve will help prevent alignment and gauge related problems created by wheel hunting (seen Figure 3-80 from AREMA PGRE Section 3.8.3). It is recommended that wayside lubricators be installed strategically before and within the watershed to reduce rail wear related problems.

Defect Detectors

Per the AREMA Practical Guide to Railway Engineering - Section 7.7, Defect Detectors help prevent derailments by inspecting rolling stock for issues while train passes. There are many types of Defect Detectors such as, Dragging Equipment Detectors, Flat Wheel Detectors, Car Integrity Scanners, and others. For example, Dragging Equipment Detectors would improve safety through the watershed by alarming the railway office or train by radio when it is struck as train passes (see Figure

7-37 from AREMA PGRE Section 7.7). All detectors function similarly, if a train exhibits signs of rolling stock malfunction, such as a hot axle or wheel, or dragging component, the engineer or office will be notified via radio and the train stopped and inspected. It is recommended that Defect Detectors be installed at the northern and southwestern approaches into the watershed at sufficient distance to allow for safe stop before entering into area. In addition, detectors can also be installed within the watershed to alert trains of any potential equipment issues while traversing area.

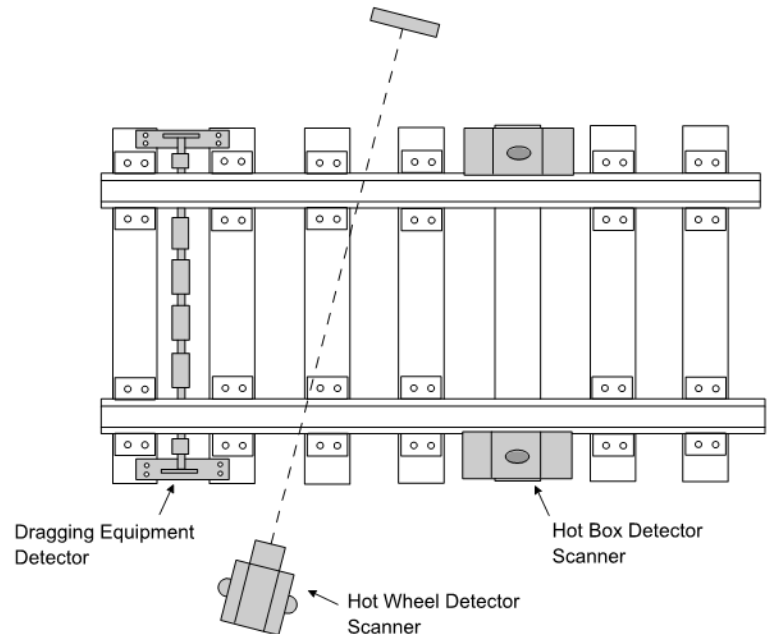


Figure 7-37 A Site with Three Defect Detectors

Grade Crossings

Prescott Street At Grade Crossing

This crossing is of a north-south roadway in the Town of West Boylston. It is located at MP 11.19. The roadway is at a skew to the track. The northbound roadway approach to the crossing is on a tangent with good sight lines. The southbound roadway approach to the crossing is on a curve and restricts some sight lines. On the south side of the crossing, there are post mounted flashers. On the north side, there are cantilever mounted flashers to mitigate the restricted sight lines. The crossing has rubber rail seals that appear to have been installed recently and are in good condition. Approximately 100' to the south of the crossing is the bridge that spans over the Waushacum Brook.

The rail at the crossing is on a 0.5% grade. The eastbound approach is up grade and on a 4°-10' degree curve that ends approximately 800 feet from the crossing then is

on tangent track to just before the crossing. The westbound approach is down grade and on a 5°-15' degree curve with the curve ending just to the west of the crossing.

The crossing would benefit from installing gates. This would provide added assurance that vehicles would stop at the crossing when a train is approaching thus mitigating the risk of rail to automobile collisions.

Signs should be posted at the crossing to provide an emergency call number in case the signals are malfunctioning or a vehicle is stuck on the tracks.

The cabinet should have the street name, mile post and Federal Department of Transportation number stenciled on the outside.

5.3 Final Recommendation

After reviewing the limited available visual observations, it is recommended that the track through the watershed be maintained to FRA Class 3 standards, one classification higher than existing operating speed of 25 mph, and implement best practices (detailed in section 5.2) to improve safety and mitigate risk through the Wachusett Reservoir.

Further, it is recommended that the MWRA partner with Pan Am Railways to develop a Capital Maintenance Program and funding to provide the additional maintenance above the minimum standard. This program could consist of several track component replacement and renewal programs such as:

- Rail Renewal Program – to replace old or deteriorating rail that show signs of internal or external signs of wear
- Tie Renewal Program
- Rail Grinding Program – to extend life of rail by reducing irregular rail head surfaces
- Production Undercutting Program – to improve drainage and ballast conditions along track

The cost estimate table below was developed from historical data from railroad contracts performed on similar Class 3 track and includes only capital cost, exclusive of soft costs such as engineering, legal etc. Note, actual costs may vary or may be significantly influenced by material market costs at the time of Request for Proposals, number of bidders, and availability of track time to perform work.

Capital Improvements	Cost Estimate	
	Cost	Unit
Inner Guardrail	\$ 45	per track foot
Rail Lubricators	\$ 20,000	each
Defect Detectors	\$ 260,000	each
Signalize Grade Crossing	\$ 350,000	per single track roadway crossing
Maintenance Activities		
Rail Renewal	\$ 900,000	per mile
Tie Renewal	\$ 220,000	per 1,000 ties per mile
Rail Grinding	\$ 250,000	per mile
Production Undercutting	\$ 360,000	per mile

Summary of Appendices

Appendix A – Liu, Xiang, M. Rapik Saat, and Christopher P. L. Barkan. "Analysis of Causes of Major Train Derailment and Their Effect on Accident Rates." TRR: Journal of the Transportation Research Board 2289 (2012): 154-63. Web. 10 Oct. 2015.

Appendix B – Hazardous Materials Transportation Release Control Project #WM95-054-SIA -1998 – Rail Sections

Appendix C – Pan AM Railways Timetable No. 3 Effective June 15, 2014

Appendix D – Pan AM Worcester Team notes by mile

Appendix E – Worcester to Harvard field notes

Appendix F – Pan Am Railways Track Charts - Worcester to Harvard

Appendix G – Site Photos

Appendix H – FRA Crossing Inventory Log

Appendix I – FRA Track Safety Standards - CFR-2011-title49-vol4-part213

Appendix I – AREMA Practical Guide to Railway Engineering - 2003

Appendix A

Liu, Xiang, M. Rapik Saat, and Christopher P. L. Barkan. "Analysis of Causes of Major Train Derailment and Their Effect on Accident Rates." TRR: Journal of the Transportation Research Board 2289 (2012): 154-63. Web. 10 Oct. 2015.

Analysis of Causes of Major Train Derailment and Their Effect on Accident Rates

Xiang Liu, M. Rapik Saat, and Christopher P. L. Barkan

Analysis of the causes of train accidents is critical for rational allocation of resources to reduce accident occurrence in the most cost-effective manner possible. Train derailment data from the FRA rail equipment accident database for the interval 2001 to 2010 were analyzed for each track type, with accounting for frequency of occurrence by cause and number of cars derailed. Statistical analyses were conducted to examine the effects of accident cause, type of track, and derailment speed. The analysis showed that broken rails or welds were the leading derailment cause on main, yard, and siding tracks. By contrast to accident causes on main tracks, bearing failures and broken wheels were not among the top accident causes on yard or siding tracks. Instead, human factor-related causes such as improper use of switches and violation of switching rules were more prevalent. In all speed ranges, broken rails or welds were the leading cause of derailments; however, the relative frequency of the next most common accident types differed substantially for lower-versus higher-speed derailments. In general, at derailment speeds below 10 mph, certain track and human factor causes—such as improper train handling, braking operations, and improper use of switches—dominated. At derailment speeds above 25 mph, those causes were nearly absent and were replaced by equipment causes, such as bearing failure, broken wheel, and axle and journal defects. These results represent the first step in a systematic process of quantitative risk analysis of railroad freight train safety, with an ultimate objective of optimizing safety improvement and more cost-effective risk management.

Train accidents cause damage to infrastructure and rolling stock as well as service disruptions, and may cause casualties and harm the environment. Accordingly, improving train operating safety has long been a high priority of the rail industry and the government. Train accidents occur as a result of many different causes; however, some are much more prevalent than others. Furthermore, the frequency and severity of accidents also varies widely, depending on the particular accident cause (1–3). Efficient allocation of resources to prevent accidents in the most cost-effective manner possible requires understanding which factors account for the greatest risk, and under which circumstances. Assessment of the benefits and costs of strategies to mitigate each accident cause can then be evaluated and resources allocated so that the greatest safety improvement can be

achieved for the level of investment available. This paper presents statistical results representing the first step in a systematic process of quantitative risk analysis and risk management for railroad freight train safety.

APPROACH

The approach taken in this research is to conduct detailed analysis of the train accident data supplied by the railroads to FRA of the U.S. Department of Transportation. FRA regularly publishes statistical summaries of these data; however, the results are generally presented at a highly aggregated level. Further insights are possible by analyzing the results in more detail and considering other statistical approaches. In addition, there are various metrics that can be used to assess train safety. The effectiveness of specific risk reduction strategies needs to be understood when the cost-effectiveness of research, development, and implementation of new strategies is considered. Consequently, in the final section of this paper a preliminary sensitivity analysis of several groups of accident causes is conducted to understand how changes in practice or failure prevention technology might affect the overall accident rate. The results enable objective comparison of different approaches that could be used to inform decision making by industry and government concerning which research, development, or implementation strategies to invest in.

DATA SOURCES AND ANALYSIS

FRA requires railroads to submit detailed reports of all significant accidents or incidents associated with railroad train operation. It is useful to review briefly the FRA databases in the larger context of railroad safety and analysis, including how the databases relate to one another and the hierarchical organization of the train accident database, which is the subject of the research described in this paper. These databases can be considered at increasing levels of detail as follows: type of incident (corresponding to particular FRA databases) and, within the database on train accidents, by track type, accident type, and accident cause.

FRA DATABASES

FRA maintains three major databases, each related to a different aspect of train operating safety: train accidents, employee casualties, and railroad and highway grade crossing incidents. A particular

Rail Transportation and Engineering Center, Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, 205 North Mathews Avenue, Urbana, IL 61801. Corresponding author: X. Liu, liu94@illinois.edu.

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DOI: 10.3141/2289-20

reportable event may require that reports be submitted to any or all of these, alone or in combination, depending on the circumstances. Of principal interest for the research described in this study is the first database describing the circumstances, physical characteristics, and other information related to damage to rolling stock and infrastructure. Within this database the interest lies in the type of track—main, siding, yard, or industry—that an accident occurred on. At the next level down, interest is focused on the type of accident, that is, derailment, collision, or various other types. Finally, within each of these track and accident types the particular cause of the accident and other circumstances, notably derailment speed, are the focus of interest.

Event Category and Corresponding FRA Database

The Rail Equipment Accident/Incident Report (REAIR) form (FRA F 6180.54) is used by railroads to report all accidents that exceed a monetary threshold of damages to infrastructure and rolling stock. [The form accounts for damage to on-track equipment, signals, track, track structures, and roadbed. The reporting threshold is periodically adjusted for inflation and increased from \$7,700 in 2006 to \$9,400 in 2011 (4).] FRA compiles these reports into the rail equipment accident (REA) database, which records rail equipment accident data dating back to 1975. In addition to the REAIR, the Highway–Rail Grade Crossing Accident/Incident Report (FRA F 6180.57) and Death, Injury, or Occupational Illness Summary (FRA F 6180.55a) are the other two principal eponymous railroad accident and incident reporting forms. A single accident may require more than one report, depending on its circumstances. For example, if a train accident occurs that results in damages to track and equipment exceeding the threshold, an FRA F 6180.54 report must be submitted, and if the accident involved a highway user at a highway–rail crossing, regardless of impact, a Form FRA F 6180.57 must also be completed. All casualties resulting from a reportable rail equipment accident, in addition to being recorded on Form FRA F 6180.54, must also be reported individually on Form FRA F 6180.55a (4). This study used data exclusively from the FRA REA database. Depending on the nature of one's interest in train accident analysis, additional useful information may be found in the other databases and these databases can be linked to pursue additional questions not possible with a particular database alone (5).

FRA Rail Equipment Accident Database

The FRA REA database records railroad, accident type, location, accident cause, severity, and other information important for accident analysis and prevention. This paper focuses on Class I freight railroads (operating revenue exceeding \$378.8 million in 2009), which account for approximately 68% of U.S. railroad route miles, 97% of total ton-miles transported, and 94% of the total rail freight revenue (6). In addition to analysis of the number of freight trains derailed due to various causes, consideration of statistics on the number of cars derailed and the circumstances of their derailment is necessary because accident severity varies among different accident causes. To understand the effect of various derailment prevention strategies, first there is a need to quantify how much different accident causes contribute to derailment risk and also how accident characteristics affect the risk.

ACCIDENT BY TRACK TYPE

Four types of tracks are recorded in the FRA REA database—main, siding, yard, and industry tracks. These track types are used for different operational functions and consequently have different associated accident types, causes, and consequences. Train accidents are categorized into derailment, collision, highway–rail grade crossing accident, and several other less frequent types. When there is more than one type of accident, the type of accident that occurred first would be designated for all reports related to it. For example, a derailment caused by a collision would be classified as a “collision.” Highway–rail grade crossing accidents in the REA database include only those that occur at the highway–rail interface and involve at least one highway user (4).

FRA-reportable freight train accident data for Class I railroads for the period 2001 to 2010 were compiled to show the number of FRA-reportable accidents, the average number of cars derailed per accident, and the total number of cars derailed by accident type and track type (Table 1). Train derailment was the most common type of accident on each track type, and train collision was the least frequent (excluding highway–rail grade crossing accidents on siding, yard, and industry tracks). Ninety-eight percent of highway–rail grade crossing accidents occurred on main track and accounted for 20% of all types of Class I main-line train accidents. By definition, these accidents exceeded the FRA reporting threshold for damages, but often did not result in a derailment (5). Accident severity is defined in this study as the number of cars derailed per accident and varies by track type and accident type. Train derailments on main and siding tracks had a greater average accident severity than did other types of accidents and tracks. Highway–rail grade crossing accidents had fewer cars derailed per accident because many reportable highway–rail grade crossing accidents resulted in no derailment (5).

Total number of cars derailed accounts for accident frequency and severity. The majority of cars derailed on Class I freight railroads were derailed as a result of train derailments. Derailments on main and siding tracks accounted for 65% of freight train accidents and correspondingly 87% of the cars derailed on all types of track.

It is evident that the distribution of accident types varied by track type. For example, 98% of highway–rail grade crossing accidents occurred on main tracks, whereas far fewer occurred on yard tracks. A chi-square test was used to examine the association between track type (main, siding, yard, and industry) and accident type (derailment, collision, highway–rail grade crossing accident, and other) by accident frequency. The chi-squared test showed that the accident frequency distributions of different accident types varied by track type ($\chi^2 = 1,054$, $df = 9$, $P < .01$). This result was significant even when only derailment and collision were included in the analysis ($\chi^2 = 68$, $df = 3$, $P < .01$). The association between accident type and track type implies that different track types have different accident cause distributions, which will be discussed in the following sections. Train collisions and highway–rail grade crossing accidents have been analyzed in other recent studies, so this research focused on train derailments (5, 7, 8).

TRAIN ACCIDENT CAUSE

FRA train accident cause codes are hierarchically organized and categorized into major cause groups—track, equipment, human factors, signal, and miscellaneous. Within each of these major cause groups, FRA organizes individual cause codes into subgroups of

TABLE 1 Accident Frequency, Accident Severity, and Car Derailment by Accident Type and Track Type, Class I Freight Railroads, 2001–2010

	Accident Type				
Track Type	Derailment	Collision	Highway–Rail	Other	All Accident Types
Number of Freight Train Accidents					
Main	4,439	302	1,343	590	6,674
Yard	2,848	355	12	378	3,593
Siding	436	23	4	40	503
Industry	369	21	6	49	445
All	8,092	701	1,365	1,057	11,215
Average Number of Cars Derailed per Accident					
Main	8.4	3.3	0.5	1.0	5.9
Yard	4.7	1.5	0.8	1.4	4.0
Siding	5.7	3.7	0.0	1.2	5.2
Industry	4.3	1.0	1.3	0.5	3.7
All	6.8	2.3	0.5	1.1	5.2
Total Number of Cars Derailed					
Main	37,456	989	609	580	39,634
Yard	13,363	527	9	511	14,410
Siding	2,477	85	0	47	2,609
Industry	1,593	22	8	23	1,646
All	54,889	1,623	626	1,161	58,299

related causes, such as roadbed and track geometry, within the track group and similar subgroups within the other major cause groups. A variation on the FRA subgroups developed by Arthur D. Little, in which similar cause codes were combined into groups on the basis of expert opinion, was used (9, 10). The Arthur D. Little groupings are similar to FRA's subgroups but are more fine-grained, thereby allowing greater resolution for certain causes. For example, FRA combines broken rails, joint bars, and rail anchors in the same subgroup, whereas the Arthur D. Little grouping distinguishes between broken rail and joint bar defects. These groups were used to analyze cause-specific derailment frequency and severity. The cause groups are ranked in descending order by number of derailments and total number of cars derailed, respectively. The former metric pertains to derailment frequency, whereas the latter accounts for derailment frequency and severity. Different ranking methods may lead to different safety improvement prioritization decisions.

TRAIN DERAILMENTS

Derailments are the most common type of train accident in the United States, and preventing them has long been a focus of the rail industry and the government (1–3, 9–25). Most previous studies have focused on main-line derailments, with less research published on yard and siding derailments. The derailment-cause distribution on main lines differs from distributions on yard or siding tracks, in part because of the different nature of operations in these two settings. Understanding the top causes affecting train derailment occurrence and number of cars derailed on different tracks provides additional insight into the development, evaluation, prioritization, and implementation of accident prevention strategies given a specific set of operating conditions.

Derailments on Main Tracks

Although serious incidents can and do occur on yard and siding tracks, the focus of this research is on main-line derailments because of the higher speeds and longer consists typical of main-line operation. The greater mass and speed mean that the force and potential impact in regard to property damage, casualties, and environmental effects are all correspondingly greater. An analysis of derailment causes was conducted to compare the relationship between frequency and severity by derailment cause. Accounting for severity is important because derailments in which more cars are involved are likely to be more damaging and more costly, have a greater likelihood of involving a hazardous materials car if any are in the consist, and if derailed they are more likely to suffer a release (1). In addition to type of track, accident severity, as measured by number of cars derailed per accident, also varies by accident cause (Table 2). Accident severity is affected by a variety of factors, including train length (2, 16, 20), derailment speed (1–3, 13, 16, 17, 20, 25), point of derailment (POD) (the position of the first car in the train that is derailed) (2, 16), and other factors (11, 12). A number of studies have investigated the parametric relationships between accident cause and certain contributing factors affecting train derailment severity (2, 13, 16). The number of derailments and total number of cars derailed are directly related to train derailment rate and car derailment rate, respectively. The former represents the likelihood that a train is involved in a derailment and the latter the likelihood of an individual car derailed. Both rates are useful in risk assessment depending on the question being addressed (2, 3, 9, 13, 17, 19–25). The importance of either statistic can be used to rank the importance of a particular accident cause, and these were used to investigate the association between the two ranking methods (Table 2). A Spearman's rank correlation test showed that the two ranking methods were significantly related

TABLE 2 Derailment Frequency and Severity by Accident Cause on Class I Main Lines, Sorted by Frequency

Cause Group	Description	Derailments		Cars Derailed		Average Number of Cars Derailed per Derailment
		Number	Percentage	Number	Percentage	
08T	Broken rails or welds	665	15.3	8,512	22.7	12.8
04T	Track geometry (excluding wide gauge)	317	7.3	2,057	5.5	6.5
10E	Bearing failure (car)	257	5.9	1,739	4.6	6.8
12E	Broken wheels (car)	226	5.2	1,457	3.9	6.4
09H	Train handling (excluding brakes)	201	4.6	1,553	4.1	7.7
03T	Wide gauge	169	3.9	1,729	4.6	10.2
01M	Obstructions	153	3.5	1,822	4.9	11.9
05T	Buckled track	149	3.4	1,891	5.0	12.7
04M	Track–train interaction	149	3.4	1,110	3.0	7.4
11E	Other axle or journal defects (car)	144	3.3	1,157	3.1	8.0
03M	Lading problems	134	3.1	791	2.1	5.9
07E	Coupler defects (car)	133	3.1	771	2.1	5.8
13E	Other wheel defects (car)	129	3.0	668	1.8	5.2
09E	Sidebearing, suspension defects (car)	126	2.9	816	2.2	6.5
10T	Turnout defects: switches	118	2.7	601	1.6	5.1
11H	Use of switches	104	2.4	407	1.1	3.9
06E	Centerplate or carbody defects (car)	98	2.3	507	1.4	5.2
01H	Brake operation (main line)	95	2.2	881	2.4	9.3
12T	Miscellaneous track and structure defects	80	1.8	687	1.8	8.6
01T	Roadbed defects	67	1.5	665	1.8	9.9
07T	Joint bar defects	66	1.5	1,040	2.8	15.8
10H	Train speed	61	1.4	403	1.1	6.6
09T	Other rail and joint defects	56	1.3	1,132	3.0	20.2
19E	Stiff truck (car)	55	1.3	365	1.0	6.6
05M	Other miscellaneous	54	1.2	422	1.1	7.8
15E	Locomotive trucks, bearings, wheels	50	1.1	177	0.5	3.5
18E	All other car defects	47	1.1	248	0.7	5.3
06T	Rail defects at bolted joint	46	1.1	927	2.5	20.2
12H	Miscellaneous human factors	44	1.0	377	1.0	8.6
02T	Nontraffic, weather causes	43	1.0	331	0.9	7.7
02H	Handbrake operations	41	0.9	177	0.5	4.3
20E	Track–train interaction (hunting) (car)	40	0.9	419	1.1	10.5
05E	Other brake defect (car)	37	0.9	187	0.5	5.1
08E	Truck structure defects (car)	35	0.8	265	0.7	7.6
07H	Switching rules	30	0.7	198	0.5	6.6
02E	Brake rigging defect (car)	27	0.6	148	0.4	5.5
01E	Air hose defect (car)	19	0.4	148	0.4	7.8
01S	Signal failures	17	0.4	121	0.3	7.1
17E	All other locomotive defects	13	0.3	155	0.4	11.9
11T	Turnout defects: frogs	11	0.3	97	0.3	8.8
08H	Mainline rules	11	0.3	56	0.1	5.1
16E	Locomotive electrical and fires	10	0.2	28	0.1	2.8
04E	UDE (car or locomotive)	8	0.2	86	0.2	10.8
03H	Brake operations (other)	4	0.1	47	0.1	11.8
05H	Failure to obey or display signals	4	0.1	23	0.1	5.8
04H	Employee physical condition	3	0.1	41	0.1	13.7
06H	Radio communications error	3	0.1	13	0.0	4.3
14E	TOFC–COFC defects	2	0.0	2	0.0	1.0
03E	Handbrake defects (car)	1	0.0	2	0.0	2.0
	Total	4,352	100	37,456	100	8.6

NOTE: UDE = undesired emergency (brake application); TOFC = trailer on flat car; COFC = container on flat car.

(Spearman rho = 0.95, $P < .01$). Certain derailment causes, notably broken rails or welds, are the most frequent when using either metric; consequently, efforts to prevent these high-frequency, high-severity accidents receive considerable attention.

Derailment frequency and severity (average number of cars derailed) were plotted against one another, with frequency on the abscissa and severity on the ordinate (Figure 1). The graph is divided into four quadrants on the basis of the average derailment frequency and severity along each axis. The graph enables easy comparison of the relative frequency and severity of different causes. Those causes in the upper right quadrant are most likely to pose the greatest risk because they are both more frequent and more severe than the average. The five cause groups are

- Broken rails or welds,
- Wide gauge,
- Buckled track,
- Obstructions, and
- Main-line brake operation.

Four other cause groups that are notable because of their high frequency of occurrence are

- Track geometry (excluding wide gauge),
- Bearing failure (car),

- Broken wheels (car), and
- Train handling (excluding brakes).

Three other cause groups are notable because of the high average severity of the resultant derailments and because they all have related causes:

- Rail defects at bolted joints,
- Other rail and joint defects, and
- Joint bar defects.

These three causes, along with the related cause group, broken rails or welds, are of particular interest, because when combined they accounted for almost 20% of all derailments and more than 30% of all derailed cars on Class I main lines (Table 2).

Derailments on Siding and Yard Tracks

As discussed above, main track derailments are likely to be the most serious, but understanding the causes of derailments on siding and yard tracks is worthwhile because certain causes and solutions may apply to both. A chi-square test was conducted to compare the distributions of derailment frequency by the top 20 main-line derailment causes on main, yard, and siding tracks. The distribution of

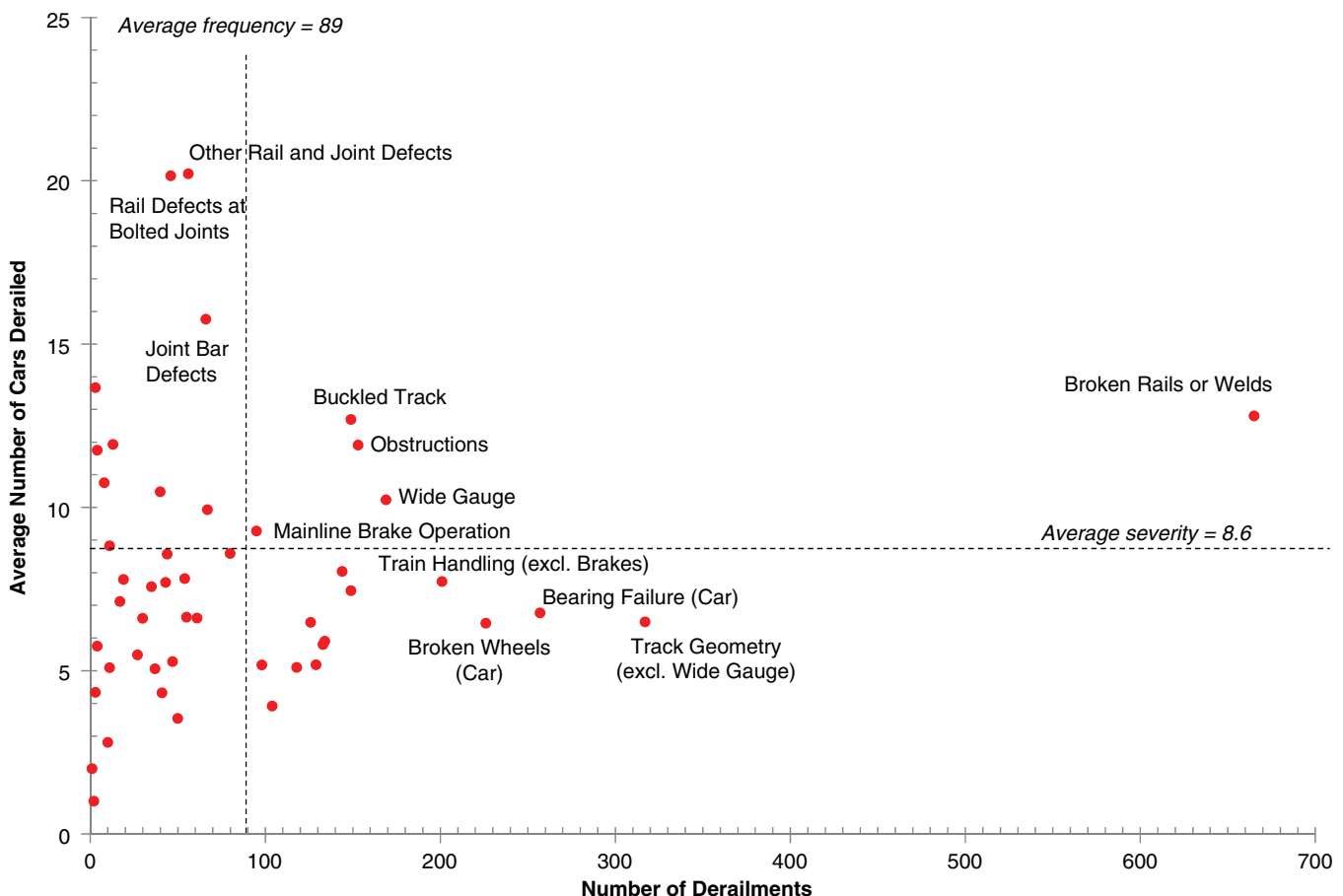


FIGURE 1 Frequency and severity graph of Class I main-line freight train derailments, 2001–2010.

TABLE 3 Top 10 Accident Causes of Freight Train Derailments by Track Type: Number of Derailments

Freight Train Derailments						
Rank	Main		Siding		Yard	
	Cause Group	Percentage	Cause Group	Percentage	Cause Group	Percentage
1	Broken rails or welds	15.3	Broken rails or welds	16.5	Broken rails or welds	16.4
2	Track geometry (excluding wide gauge)	7.3	Wide gauge	14.2	Use of switches	13.5
3	Bearing failure (car)	5.9	Turnout defects—switches	9.7	Wide gauge	13.5
4	Broken wheels (car)	5.2	Switching rules	7.7	Turnout defects—switches	11.1
5	Train handling (excluding brakes)	4.6	Track geometry (excluding wide gauge)	7.2	Train handling (excluding brakes)	6.7
6	Wide gauge	3.9	Use of switches	5.8	Switching rules	6.2
7	Obstructions	3.5	Train handling (excluding brakes)	3.5	Track geometry (excluding wide gauge)	3.6
8	Buckled track	3.4	Lading problems	2.3	Miscellaneous track and structure defects	3.4
9	Track–train interaction	3.4	Roadbed defects	2.1	Track–train interaction	3.1
10	Other axle or journal defects (car)	3.3	Miscellaneous track and structure defects	2.1	Other miscellaneous	3.0

derailment causes varied significantly by track type ($\chi^2 = 1,780$, $df = 38$, $P < .01$). Tables 3 and 4 show the top 10 accident causes by derailment frequency and total number of cars derailed, respectively, on different track types.

Comparison of main tracks with yard and siding tracks using either metric, derailment frequency or number of cars derailed, reveals that broken rails or welds were the leading derailment cause on all

three track types. However, by contrast to main tracks, bearing failures and broken wheels were not among the top accident causes on yard and siding tracks, probably because of lower operating speeds. Instead, human factor–related causes such as improper use of switches and violation of switching rules were more prevalent. Misaligned switches caused 14% of yard derailments, and this cause has received particular attention in recent years. The higher incidence

TABLE 4 Top 10 Accident Causes of Freight Train Derailments by Track Type: Number of Cars Derailed

Freight Cars Derailed Because of Train Derailments						
Rank	Main		Siding		Yard	
	Cause Group	Percentage	Cause Group	Percentage	Cause Group	Percentage
1	Broken rails or welds	22.7	Broken rails or welds	23.2	Broken rails or welds	19.3
2	Track geometry (excluding wide gauge)	5.5	Wide gauge	13.8	Wide gauge	18.2
3	Buckled track	5.0	Turnout defects—switches	10.4	Use of switches	10.0
4	Obstructions	4.9	Track geometry (excluding wide gauge)	6.2	Turnout defects—switches	9.8
5	Bearing failure (car)	4.6	Use of switches	4.8	Train handling (excluding brakes)	7.7
6	Wide gauge	4.6	Switching rules	4.0	Miscellaneous track and structure defects	4.2
7	Train handling (excluding brakes)	4.1	Train handling (excluding brakes)	3.5	Switching rules	3.9
8	Broken wheels (car)	3.9	Obstructions	3.0	Track geometry (excluding wide gauge)	3.3
9	Other axle or journal defects (car)	3.1	Buckled track	2.8	Track–train interaction	3.2
10	Other rail and joint defects	3.0	Brake operation (main line)	2.7	Brake operation (main line)	2.7

of switch-related derailments in yards and sidings compared with main lines is probably due to the greater number and more frequent use of turnouts on these tracks and thus the greater likelihood of error. Another consequence of the more frequent use of switches is the greater prevalence of switch defects. Switch defects caused approximately 10% of derailments on yard and siding tracks, but only 3% on main lines. The reason for this is probably twofold: the more frequent use of switches on these types of tracks subjects them to greater exposure and thus more opportunity to cause a derailment, and because of their heavy use, the switches are subject to more wear and tear and consequently faster deterioration. The switch points are typically the most vulnerable parts of switches, so their protection and lubrication, along with improved wheel profile and truck steering performance, may offer means to prevent switch-defect derailments (26–28). Another difference between main tracks compared with yard and siding tracks is that wide gauge accounted for 14% of derailments on siding and yard tracks but for only 4% on main lines. Again, this difference is probably due to the lower speed characteristic of yard and siding tracks but with a different explanation; the lower operating speed permits greater tolerances in the

track gauge standards, and therefore these tracks may be more prone to this type of derailment (29).

EFFECT OF DERAILMENT SPEED

So far this paper has considered accident and track type as factors affecting the likelihood that a train or rail car will derail, but another important parameter affecting derailments is train speed at the time of derailment. Indeed, speed may be a contributing factor to some of the differences cited above. Common sense demands that speed is a factor affecting derailment severity, and previous research has established several qualitative and quantitative relationships between derailments and speed (1). The top 10 accident causes of main-line train derailments were sorted into different groups, corresponding to the FRA track class speed ranges, and compared, again by derailment frequency and number of cars derailed (Figure 2) (29).

In all speed ranges, broken rails or welds were the leading cause of derailments; however, the relative frequency of the next most common accident types differed substantially for lower versus

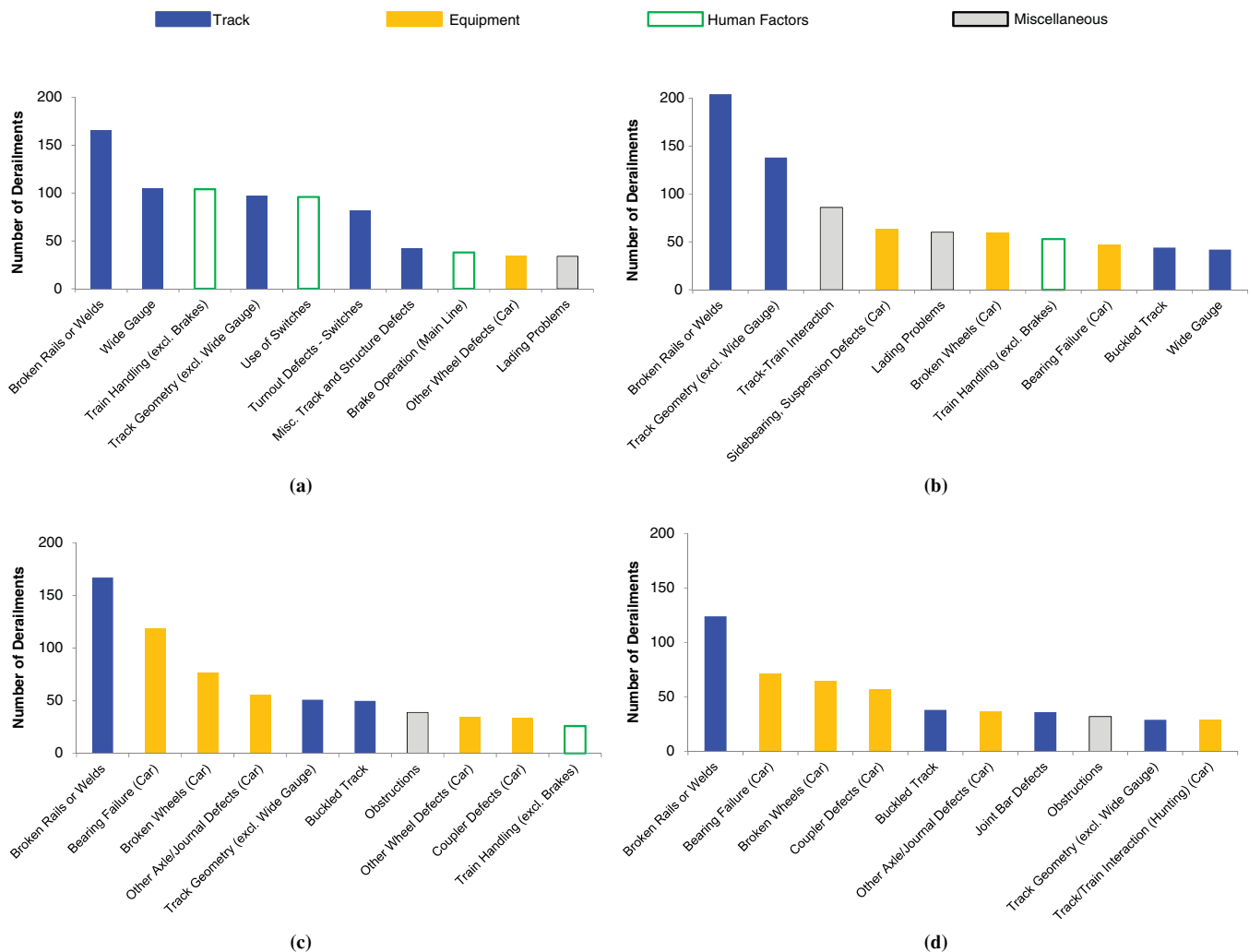


FIGURE 2 Number of freight train derailments by speed and accident cause on Class I main lines: (a) derailment speed 0–10 mph, (b) derailment speed 10–25 mph, (c) derailment speed 25–40 mph, and (d) derailment speed 40–80 mph.

higher speed derailments. At speeds below 10 mph, certain track-related and human factor-related causes occurred more frequently than equipment-related causes. But at derailment speeds greater than 25 mph, human factors accidents such as improper train handling, braking operations, and improper use of switches were almost completely absent, replaced by equipment causes, such as bearing failure, broken wheel, and axle and journal defects. The derailment frequency distribution for 49 main-line accident causes and three derailment-speed groups (<10 mph, 11–25 mph, and >25 mph) were compared in a chi-square analysis, and the results were significant ($\chi^2 = 1,192$, $df = 96$, $P < .01$), indicating an association between accident cause and derailment speed.

ACCIDENT PREVENTION STRATEGY

To gain insights into the potential safety benefits of strategies to reduce various types of derailments, a sensitivity analysis was conducted (Figure 3, *a* and *b*). An estimation was done to determine by what percentage main track train and car derailment rates would be reduced in the event that certain accident causes were reduced or eliminated. Four of the leading main-line accident causes were considered: broken rails or welds (08T), track geometry defects (04T), bearing failure (10E), and broken wheels (12E). There are a number of approaches in practice or being developed that may address these. Broken rail preventive measures include rail inspection, rail grinding, rail repair,

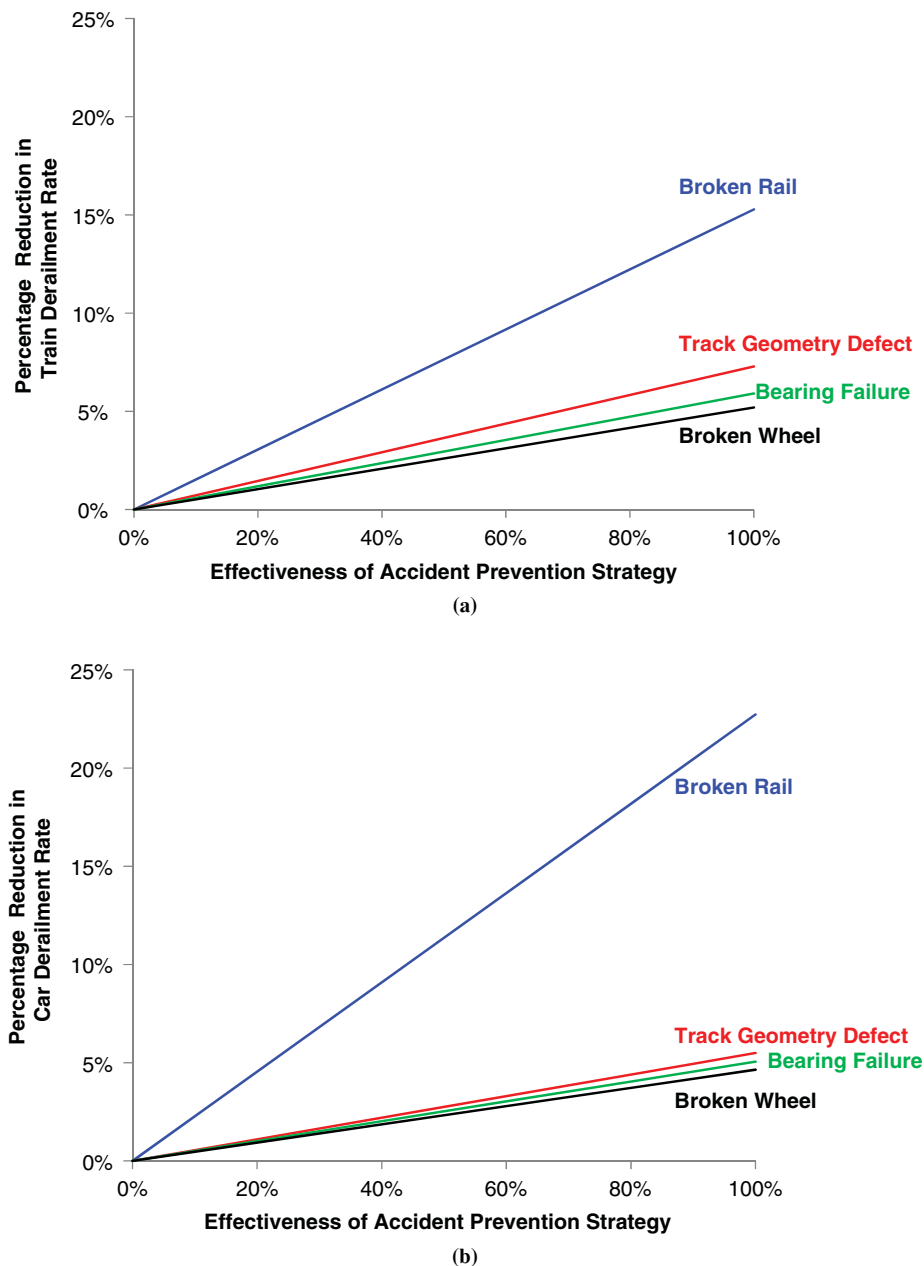


FIGURE 3 Percentage reduction in derailment rates by derailment prevention strategy: (a) train derailment rate reduction and (b) car derailment rate reduction.

and renewal (30). Track geometry inspection and maintenance are often based on some measurable indices, such as the track quality index (31, 32). Wayside and onboard detection systems aim to identify and inform railroads and car owners about the need to remove or repair rolling stock defects before they cause an accident. Hot bearing detectors and wheel impact load detectors are commonly used to detect problems with those components (33, 34). Nevertheless, these techniques and technologies are not 100% effective in eliminating all the accident causes they are intended to prevent, and research and development are ongoing to further develop their capability. The effectiveness of an accident prevention strategy is defined here as the percentage of the maximum safety benefit it might potentially realize. The sensitivity analysis helps illustrate the relevant potential safety benefit that might be realized if technologies or techniques were implemented with varying degrees of effectiveness. For example, broken rails or welds caused 15.3% of train derailments and 22.7% of cars derailed (Table 2); thus, if all broken-rail-related causes were eliminated, train and car derailment rates would decline by a corresponding amount. Even if only 50% of broken rails or welds could be prevented, the prevention would result in a larger percentage reduction in train and car derailment rates than would any of the other accident prevention strategies at 100% effectiveness.

The effects of different accident prevention strategies may not necessarily be independent of one another. For example, improved wheel condition can reduce dynamic loading of track, thereby reducing track defect rates, and vice versa. The interactive damage forces between track and equipment have been discussed in previous studies (35, 36). Resor and Zarembski proposed an engineering model to estimate the change in relative damage to track and equipment given the change in impact load (35). With the use of their model, it was estimated that a 1% reduction in impact load would result in a 1.3% reduction in damage to track and a 0.6% reduction in damage to wheels and axles. Nevertheless, the authors are unaware of any research that quantifies the reduction in track and equipment damages, with the corresponding reduction in accident probability. Further research is needed to understand better what the possible interactive effects are, how to quantify them where they exist, and what their effects are on accident rate estimation and safety policy evaluation. For purposes of illustration, independence of individual derailment prevention strategies was assumed in the sensitivity analyses presented here. To the extent that interactive effects among different accident prevention strategies reduce the safety benefits due to another, the analyses here may slightly overstate the benefit of a particular derailment cause prevention measure if other related measures were implemented.

This paper focuses on developing an analytical framework to understand the relative importance of different accident causes under various operating conditions. The analyses presented here are just the first step in a risk-based approach to derailment prevention. The implementation costs of different risk reduction measures may be affected by the effectiveness of technology, extent of implementation, installation and maintenance practices, and many other factors. Schafer and Barkan estimated \$900 per track mile as the annual cost for ultrasonic and geometric track inspection and \$1,900 per track mile for rail grinding on one Class I railroad (30). Robert et al. reported a total cost of \$86 million for implementing wayside detectors in the United States from 1994 to 2008 (37). However, the proportion of the costs directly related to safety improvement is not well understood and further study is required. An additional complexity is that safety improvement activities may affect operational efficiency differently in different time periods. For example, track maintenance may cause

train delay in the short term but improve efficiency in the long term by reducing the potential service disruptions due to accidents.

Further research is needed to understand the relationship between accident rates and occurrence in regard to accident frequency and corresponding traffic exposure. This research will enable a better comparison of the accident risk under different operating conditions, such as main lines versus yard tracks. The next step is to quantify the benefits and costs of specific risk reduction measures, thereby allowing integration of the multiple trade-offs involving safety, efficiency, and cost. In that way, interactive effects between strategies can be accounted for, and the optimal combination of investment strategies selected for any given level of financial resources.

CONCLUSIONS

Accident cause distribution varies by accident type, track type, and speed. Derailments are the most common type of train accident on each track type, and the majority of cars derailed are due to train derailments. Track and equipment failures are the primary causes of train derailments on main tracks, whereas the use of switches and switching rules has a substantial effect on derailment frequency on siding and yard tracks. Some accident causes tend to occur more frequently at higher speeds, whereas others are more likely at lower speeds. The interactive effects of derailment speed and accident cause affect train accident frequency and severity.

The safety benefits of accident prevention strategies were evaluated according to the percentage reduction in train and car derailment rates. Prevention of broken rails or welds is expected to yield a larger percentage reduction in train and car derailment rates than other accident prevention strategies. However, the cost-effectiveness of this and other accident prevention strategies must be properly compared to select the most efficient means of improving railroad train operating safety. Ultimately these strategies should be considered as part of an integrated framework to optimize investment that maximizes safety benefits and minimizes risk.

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The Railroad Operational Safety Committee peer-reviewed this paper.

Appendix B –Hazardous Materials Transportation Release Control
Project #WM95-054-SIA-1998 –Rail Sections

Removed Contains Security Sensitive Information

Appendix C –Pan AM Railways Timetable No.3 Effective June 15, 2014

Removed

Appendix D

Pan AM Worcester Team notes by mile

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
2.9	3.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
0.8%	100%	2.9	1° - 30'		
	Condition	Type	Comments		
Rail		100R 1945	107 NH Worn out. Replace with 115RE. Gage track.		
Ties			Need 1000-1200 ties/mile.		
Ballast			Needs additional ballast in curves		
Joint Bars/OTM					
Gage			Curves needs to be regaged		
Surface/Line					
Drainage			Needs spot ditching to restore proper drainage.		
Vegetation			Needs brush cutting and spraying.		
	# Locations	Description		Comments	
Sidings	N/A				
Turnouts	1	MP 2.92	P & WRR	Need to replace if the rail is changed out	
Grade Crossings	N/A				
Other Structures					

Appendix B:
Summary of Conditions (MP 3.0 - MP 4.0)

Page 1 of 2

Redacted Version 8-26-2021

Worcester Main Line Summary of Conditions						
Mile Post	to Mile Post	FRA Class		Operation	Speed	
3.0	4.0			Freight	30 MPH	
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments		
0.8%	30%	2.9	1° - 30'	Curve starts in previous mile (MP 2.9)		
		3.1	2° - 00'			
		3.3	1° - 00'			
				Begins 112 CWR - 1941		
	Condition	Type	Comments			
Rail		100 R 1945	100 NH - 39' Pieces			
Ties			Need 1000-1200 ties/mile, 1500 bad ties, Anchors/ Fair			
Ballast			Needs additional ballast on mud spots and in curves.			
Joint: Bars/OTM						
Gage			Curves needs to be regaged.			
Surface/Line						
Drainage			Washout Northside MP 3.6			
Vegetation			Needs brush cutting.			
	# Locations	Description		Comments		
Sidings	1	MP 3.9				
Turnouts						
Grade Crossings	1	MP 3.1	New Bond St.	Needs replacing - crossing debris on rubber		
Bridges	1	MP 3.35	Brook St. (UG)	Timber deck, needs 20 of 48 timber - needs to be hooked		
Other Structures						

5/29/15

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**Appendix B:
Summary of Conditions (MP 4.0 - MP 5.0)**

Page 1 of 2

Redacted Version 8-26-2021

Worcester Main Line Summary of Conditions						
Mile Post	to Mile Post	FRA Class		Operation	Speed	
4.0	5.0			Freight	30 MPH	
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments		
0.1%	20%	4.4	5° - 20'			
Condition		Type	Comments			
Rail		100R 1945	End at MP 4.3, 112 Relay Welded begins at PS MP 4.2			
		112R CWR 1994	Begin at MP 4.3			
Ties			Need 1500+/- / mile			
Joint Bars/OTM			Head of web separation, Low rail at MP 4.4.			
Gage			Curves needs to be regaged.			
Surface/Line			Needs more ballast east of Burcoat St. - ditch curves 5° - 20' (high & low rails)			
Drainage			Dirty Ballast			
Vegetation			Needs brush cutting - Gage rods through curve			
	# Locations	Description		Comments		
Sidings	1 MP 4.0	Greendale				
Turnouts	2 MP 4.3	Greendale		#15 TO Fair condition (CWR start at PS)		
				(Endsof YL)		
Grade Crossings	1 MP 4.6	Burncoat Street		Fair condition - Change Epxflex		
	2 MP 4.9	Private - Golf Course		Replace Asphalt		
Bridges	1 MP 4.51	West Boylston Street (OH)				
Other Structures						

5/29/15

MP

Recommendations

5/29/15

Appendix B:
Summary of Conditions (MP 5.0 - MP 6.0)

Redacted Version 8-26-2021

Page 1 of 2

Worcester Main Line Summary of Conditions						
Mile Post	to	Mile Post	FRA Class		Operation	Speed
5.0		6.0			Freight	30 MPH
Ave. Grade	% Curve/MI	MP	Curve > 5°	Comments		
-0.6%	40%	5.1	4° - 10'	Curve ends in next mile		
		5.5	5° - 10'			
		5.8	1° - 00'			
Condition		Type	Comments			
Rail		112R CWR 1994	112 CWR - Replace all CWR in curves.			
Ties			Need 1000-1500 ties/mile			
Ballast			Needs additional ballast in curves			
Joint Bars/OTM						
Gage			Curves needs to be regaged.			
Surface/Line						
Drainage						
Vegetation			Needs brush cutting at MP 5.5.			
	#	Locations	Description	Comments		
Sidings		N/A	Lubricator MP 5.8			
Turnouts		N/A				
Grade Crossings	1	MP 5.1	Private Golf Course	Cobra fair		
Bridges		N/A				
Other Structures		N/A				

5/29/15

Appendix B:
Summary of Conditions (MP 5.0 - MP 6.0)
Page 2 of 2

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Appendix B:
Summary of Conditions (MP 6.0 - MP 7.0)

Redacted Version 8-26-2021

Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
6.0	7.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
-0.9%	60%	5.8	1° - 00'	Curve starts in previous mile (MP 5.8)	
		6.2	2° - 40'		
		6.3	1° - 20'		
		6.7	4° - 00'		
		6.9	5° - 30'	Need to replace both rails	
	Condition	Type	Comments		
Rail		112R CWR 1994	Scrap rail on ROW.		
Ties			Tie debris		
Ballast			Needs ballast at 5° - 30' curve, dirty ballast water table at bottom of tie		
Joint Bars/OTM					
Gage			Curves needs to be regaged.		
Surface/Line			Needs under cutter MP 6.4 to MP 7.0		
Drainage			Needs ditching MP 6.4 to MP 7.0		
Vegetation			Needs brush cuttingMP 6.2 east (Northside hitting equipment), Grass in track MP 6.3		
	#	Locations	Description	Comments	
Sidings		N/A			
Turnouts	1	MP 6.1	Ziff Paper	Retired	
	2	MP 6.2	New England Envelope	Fair / Replace 50% Timber (38 pieces)	
Grade Crossings	1	MP 6.1	Shrewbury St.	Epflex - replace	
	2	MP 6.4	Private	Gone	
Bridges	1	MP 6.60	Hartwell Street (OH)	Chpt 634	
Other Structures	1	MP 6.9		Culvert MP 6.9	
				Well at MP 6.3 to MP 6.5 corner of fence	

5/29/15

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
7.0	8.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
-0.9%	20%	7.1	4° - 00'		
		7.3	4° - 00'		
Condition		Type	Comments		
Rail		112R CWR 1994	Tangent CWR fair/ Curves poor.		
Ties			Need 1000+/- ties/mile		
Ballast			Need additional ballast in curves		
Joint Bars/OTM					
Gage			Curves needs to be regaged.		
Surface/Line					
Drainage			Need spreader, Clear ditch on both sides		
Vegetation			Need clippers, cut canopy, MP 7 to MP 8 striking equipment		
# Locations		Description		Comments	
Sidings					
Turnouts					
Grade Crossings		Asphalt & Epflex.	Replace bad rail		
	MP 7.9	Temple St. OH	Route 140		
Bridges					
Other Structures	1	MP 7.9	Dragging Equipment Detector (Temple Street - Route 140)	East side	
				MCI - South side	
				Sprint - North side	

Appendix B:
Summary of Conditions (MP 7.0 - MP 8.0)
Page 2 of 2

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Appendix B:
Summary of Conditions (MP 8.0 - MP 9.0)

Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
8.0	9.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
-0.9%	45%	8.1	2° - 20'		
		8.5	2° - 00'		
		8.6	1° - 30'		
Condition		Type	Comments		
Rail		112R CWR 1994	Welded Relay - tangent CWR fair, Curves poor		
Ties			Need 1300+/- ties/mile (10 per rail)		
Ballast			Need additional ballast in curves		
Joint Bars/OTM					
Gage			Curves needs to be regaged.		
Surface/Line					
Drainage					
Vegetation			West Rail / striking equipment, North Rail Jordan Spreader		
# Locations		Description		Comments	
Sidings	N/A				
Turnouts	N/A				
Grade Crossings					
Bridges	1	MP 8.00	Burnt (UG)		
	2	MP 8.70	Route 12 (UG)	1/2 thru plategirder ballast check	
Other Structures					

5/29/15

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Appendix B:
Summary of Conditions (MP 9.0 - MP 10.0)

Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
9.0	10.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
-0.5%	50%	9.1	2° - 20'		
		9.5	3° - 40'		
		9.9	0° - 42'	Curve ends in next mile	
	Condition	Type	Comments		
Rail		112R CWR 1994	Target CWR fair / Curves poor, MP 9.6 - 3°40' -corrugation low rail, gage face high rail		
Ties			Need 1000 ties/mile (6 per rail)		
Ballast			Need additional ballast in curves (8-9 cars/mile)		
Joint Bars/OTM					
Gage			Curves needs to be rearranged.		
Surface/Line					
Drainage			Needs spot ditching to restore drainage - MP 9-10 North rail		
Vegetation			Needs weed spray - North rail striking equipment		
	# Locations	Description		Comments	
Slidings	N/A				
Turnouts	N/A				
Grade Crossings					
Bridges	1 MP 9.81	Quinapoxet (UG)		Stone Arch (Quabbin Feed)	
Other Structures	N/A				

5/29/15

Appendix C:
Summary of Conditions (MP 9.0 - MP 10.0)
Page 2 of 2

[illegible]

Appendix B:
Summary of Conditions (MP 10.0 - MP 11.0)

Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
10.0	11.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
0.5%	60%	9.9	0° - 42'	Curve starts in previous mile (MP 9.9)	
		10.1	2° - 00'		
		10.5	2° - 00'		
		10.8	3° - 00'		
		10.9	4° - 10'	Curve ends in next mile	
	Condition	Type	Comments		
Rail		112R CWR 1994	Worn out. Replace 112 RE on vladuct as guard rail/ add new rail		
Ties			Need 1100-1300 ties/mile - (5 ties / rail length)		
Ballast			Need additional ballast in curves		
Joint Bars/OTM					
Gage			Curves needs to be regaged.		
Surface/Line					
Drainage			Needs spot ditching to restore drainage.		
Vegetation			Needs brush cutting and Spraying: both side of track striking equipment		
	# Locations	Description		Comments	
Sidings	N/A				
Turnouts	N/A				
Grade Crossings					
Bridges	1 MP 10.21	Beaman Street (OH)			
	2 MP 10.57	Quinapoxet (UG)		8-10 bad ties/rail=1100-1300 ties/mile	
				Add guardrail between arches due to existing guardrail no joint spikes on every other ties	
Other Structures	3 MP 10.98	Waushacum Brook (UG)			
				Sprint - North, MCI - South	
	MP 10.8			BEM Low Rail 4°-11 Head Web separation Low Rail poor / Several rails cut in.	

5/29/15

5/29/15
MWRA Document 71

Appendix B:
Summary of Conditions (MP 11.0 - MP 12.0)

Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
11.0	12.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5'	Comments	
0.4%	25%	10.8	4° - 10'	Curve starts in previous mile (MP 10.8)	
		11.2	5° - 15'		
Condition		Type	Comments		
Rail		112R CWR 1994	Ends at MP 11.6, MP 11.3, 5° - 15' corrugation low rail		
		100R 1945	Begins at MP 11.6, MP 11.6 back to 107 NH JTD		
Ties			Need 1100-1200 ties/mile (CWR) (10 MPH), 1300 ties/mile (JTD rail) (10 MPH)		
Ballast			Need additional ballast in curves		
Joint Bars/OTM					
Gage					
Surface/Line					
Drainage			Needs spot ditching with a Jordan Spreader on both sides of track in curves to restore drainage		
Vegetation			Needs brush cutting and spraying both sides of track, striking equipment at MP 11.7.		
# Locations		Description		Comments	
Sidings					
Turnouts					
Grade Crossings	1	MP 11.3	Prescott Street	Cut brush quadout - Epflex good	
Bridges	1	MP 11.87	Route 12 (OH)		
Other		MP 11.1		Old lubricator just west of Prescott St.	

5/29/15

Appendix C:
Summary of Conditions (MP 11.0 - MP 12.0)
Page 2 of 2

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Appendix B:
Summary of Conditions (MP 12.0 - MP 13.0)

Redacted Version 8-26-2021

Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
12.0	13.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
0.2%	40%	12.3	3° - 20'		
Condition		Type	Comments		
Rail		100R 1945			
Ties			Need 1300-1500 ties/mile (100 NH) JTD rail (bad joint ties cluster)		
Ballast			Needs additional ballast in curves		
Joint Bars/OTM					
Gage					
Surface/Line					
Orainage			Needs spot ditching with a Jordan Spreader in North Rail		
Vegetation			Needs brush cutting and spraying (Brush North Rail striking the equipment)		
# Locations		Description		Comments	
Sidings					
Turnouts					
Grade Crossings	1	MP 12.3	Gates	107 NH Epflex - fair, sperry in low rail CWR	
	2	MP 12.8	Newell Hill Road	107 NH Epflex - fair	
Bridges		N/A			
Other Structures		N/A			

5/29/15

Appendix C:
Summary of Conditions (MP 12.0 - MP 13.0)
Page 2 of 2

[illegible]

Appendix B:
Summary of Conditions (MP 13.0 - MP 14.0)

Page 1 of 2

Worcester Main Line Summary of Conditions						
Mile Post	to	Mile Post	FRA Class		Operation	Speed
13.0		14.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments		
-0.6%	50%	13.4	3° - 15'			
		13.7	3° - 40'	Curve ends in next mile		
	Condition	Type	Comments			
Rail		100R 1945	Worn out and bent. Replace with 100 NH JTD rail (39')			
Ties			Need 1300+ ties/mile			
Ballast			Needs additional ballast in spots (JTD track), in curves (dirt bikes)			
Joint Bars/OTM						
Gage						
Surface/Line						
Drainage			Needs spot ditching under OH Hastings			
Vegetation			North rail			
	# Locations	Description			Comments	
Sidings		N/A				
Turnouts		N/A				
Grade Crossings						
Bridges	1	MP 13.51	Hastings (Squareshire Rd) (OH)	3° - 15' curve- Epflex - Good		
				107 NH Welded in curve - sperry		
	2	MP 13.75	Howes (Chase Hill Rd) (OH)	Low rail 107 CWR		
Other Structures						

5/29/15

Appendix C:
Summary of Conditions (MP 13.0 - MP 14.0)
Page 2 of 2

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5/29/15
MWRA Document 78

Appendix C:
Summary of Conditions (MP 14.0 - MP 15.0)
Page 2 of 2

[illegible]

Worcester Main Line Summary of Conditions						
Mile Post	to	Mile Post	FRA Class		Operation	Speed
15.0		16.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments		
-0.8%	10%	15.4	1° - 20'			
Condition		Type	Comments			
Rail		100R 1945	Some 107 NH Welded Rail			
Ties			Need 1300-1500 ties/mile (100 NH JTD)			
Ballast			Needs additional ballast, dirt bike			
Joint Bars/OTM						
Gage						
Surface/Line						
Drainage			Not too bad			
Vegetation						
	#	Locations	Description		Comments	
Sidings						
Turnouts						
Grade Crossings						
Other Structures	1	MP 15.5	Train Defect Detector (Sheehan)		Epflex - Good (Sect 130)	

5/29/15

Appendix C:
Summary of Conditions (MP 15.0 - MP 16.0)
Page 2 of 2

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Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
16.0	17.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
-0.5%	50%	16.2	3° - 30'		
		16.5	4° - 00'		
Condition		Type	Comments		
Rail		100R 1945	100 NH JTD Rail		
Ties			Need 1300-1500 ties/mile		
Ballast			Needs additional ballast in curves MP 16.1-16.4, MP 13.34, dirt bikes		
Joint Bars/OTM					
Gage					
Surface/Line					
Drainage					
Vegetation			Needs brush cutting. (North and South rails) Brush striking equipment		
# Locations		Description		Comments	
Sidings	1 MP 16.8				
Turnouts					
Grade Crossings	1 MP 16.8	Sterling Street		Epflex - Good (Sect 130 Add gates)	
Bridges	1 MP 16.34	New Harbor Road (OH)		107 CWR under bridges (both rails)	
	2 MP 16.74	Conrail (OH)		100 CWR (low side) - Mixture of 100 and 107	
	3 MP 16.95	Brook Street (UG)		Timber deck - (fair, no bolts, no spacer bars, 1/2 thru plate girder)	
Other Structures					

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Appendix B:
Summary of Conditions (MP 17.0 - MP 18.0)

Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
17.0	18.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
-0.6%	40%	17.2	1° - 10'		
		17.8	1° - 50'		
Condition		Type	Comments		
Rail		100R 1945	100 NH JTD		
Ties			Need 1300 ties/mile.		
Ballast			Needs additional ballast in curves		
Joint Bars/OTM					
Gage					
Surface/Line					
Drainage					
Vegetation			Brush not bad		
	# Locations	Description		Comments	
Sidings	1	MP 17.2			
Turnouts	1	MP 17.4	Quantum Plastics		
Grade Crossings					
Bridges	1	MP 17.91	Main Street (UG)	1/2 thru plate girder - 107 CWR	
				Timber - no hook bolts, no spacer bar	
Other Structures			Culvert		
		MP 17.8+			

Appendix C:
Summary of Conditions (MP 17.0 - MP 18.0)
Page 2 of 2

[illegible]

Appendix B:
Summary of Conditions (MP 18.0 - MP 19.0)
 Page 1 of 2

Worcester Main Line Summary of Conditions						
Mile Post	to	Mile Post	FRA Class		Operation	Speed
18.0		19.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments		
-0.4%	20%	18.0	3° - 10°			
Condition		Type	Comments			
Rail		100R 1946	100 NH JTD			
Ties			Need 1300-1500 ties/mile			
Ballast			Needs additional ballast in curves			
Joint Bars/OTM						
Gage						
Surface/Line						
Drainage						
Vegetation			Needs brush cutting - vegetation spots			
# Locations		Description		Comments		
Sidings						
Turnouts						
Grade Crossings	1	MP 18.2	Mill Street	Epflex - fair		
	2	MP 18.4	Private	Cobra No Signage		
Bridges	1	MP 18.54	Thayer's (UG)	In profile hole / 1/2 thru plate girder		
				Need 30 timbers, no hook bolts, blocks, spacers		
Other Structures		MP 18.8		Rail bunching going down hill at MP 18.8		

Appendix C:
Summary of Conditions (MP 18.0 - MP 19.0)
Page 2 of 2

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Appendix B:
Summary of Conditions (MP 19.0 - MP 20.0)
 Page 1 of 2

Worcester Main Line Summary of Conditions						
Mile Post	to	Mile Post	FRA Class		Operation	Speed
19.0		20.0			Freight	25 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments		
0.5%	40%	19.0	1° - 40'			
		19.5	4° - 20'			
Condition		Type	Comments			
Rail		100R 1946	107 CWR with corrugation on curves			
Ties			Need 1300-1500 ties/mile, Pick up tie debris			
Ballast			Needs additional ballast in curves			
Joint Bars/OTM						
Gage						
Surface/Line			East end Nashua River due to bridge seat settlement			
Drainage						
Vegetation			Some Spots			
	#	Locations	Description		Comments	
Sidings						
Turnouts						
Grade Crossings	1	MP 19.2	Center Bridge Road		Epflex - fair	
	2	MP 19.4	Neck Road		Epflex - fair	
	3	MP 19.7	Packard Road		Epflex - fair	
Bridges	1	MP 19.05	Nashua River (UG)		Deck plate girder - no hook bolts, no blocks, no spacer bars	
Other Structures		N/A			East abutment seat settled	
					South corner - track out of line. Realign	

Appendix C:
Summary of Conditions (MP 19.0 - MP 20.0)
Page 2 of 2

[illegible]

Appendix B:
Summary of Conditions (MP 20.0 - MP 21.0)
Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
20.0	21.0			Freight	25 MPH (up to MP20.5), 30 MPH (past MP20.5)
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
-0.3%	50%	20.0	2° - 10'		
		20.1	2° - 00'		
		20.4	2° - 30'		
		20.9	2° - 20'	Curve ends in next mile	
		Condition	Type	Comments	
Rail			100R 1930/1945	Needs rail on curves	
Ties				Need 1300+ ties/mile	
Ballast				Needs additional ballast on curves and some on tangents.	
Joint Bars/OTM					
Gage					
Surface/Line					
Drainage				Needs ditching west of Neck Road (MP 20+/-)	
Vegetation					
		#	Locations	Description	Comments
Slidings					
Turnouts					
Grade Crossings	1	MP 20.1	Neck Road		Needs ditching, Epflex - good
	2	MP 20.3	Route 117		Epflex - fair, 107 NH welded in curve
	3	MP 20.5	Farm Crossing		Gravel - poor
	4	MP 20.8	Private - Pine Hill Road		Epflex - fair (Sect 130)
Bridges					
Other Structures		MP 20.9+	Culvert		Check culvert / water at MP 20.9+
				MCI - North side	
				Sprint - South side	

MWRA Document 91 5/29/15

**Appendix B:
Summary of Conditions (MP 21.0 - MP 22.0)**

Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
21.0	22.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
0.1%	10%	20.9	2° - 20'	Curve starts in previous mile (MP 20.9)	
Condition		Type	Comments		
Rail		100R 1930			
Ties			Need 1300-1500 ties/mile , Pick up scrap ties		
Ballast			Needs additional ballast on tangent		
Joint Bars/OTM					
Gage					
Surface/Line					
Drainage			No issues		
Vegetation			No issues		
# Locations		Description	Comments		
Sidings					
Turnouts					
Grade Crossings					
Bridges					
Other Structures	N/A				

MWRA Document 93

MWRA Document 94 5/29/15

Appendix C:
Summary of Conditions (MP 22.0 - MP 23.0)
Page 2 of 2

[illegible]

Appendix B:
Summary of Conditions (MP 23.0 - MP 24.0)

Page 1 of 2

Worcester Main Line Summary of Conditions						
Mile Post		to Mile Post		FRA Class	Operation	Speed
23.0		24.0			Freight	30 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments		
0.2%	10%	23.0	1° - 30'			
		Condition	Type	Comments		
Rail			100R 1930/1945			
Ties				Need 1300+ ties/mile, pick up tie debris along ROW.		
Ballast				Needs additional ballast on all shoulders		
Joint Bars/OTM						
Gage						
Surface/Line						
Drainage				No problem		
Vegetation				No problem		
# Locations		Description		Comments		
Sidings						
Turnouts						
Grade Crossings	1	MP 23.2	Still River Xing	Plant crossing with Epflex (gage)		
Bridges						
Other Structures				Sprint - South Rail		
				MCI - North Rail		

Appendix C:
Summary of Conditions (MP 23.0 - MP 24.0)
Page 2 of 2

[illegible]

Appendix B:
Summary of Conditions (MP 24.0 - MP 25.0)

Page 1 of 2

Worcester Main Line Summary of Conditions				
Mile Post	to Mile Post	FRA Class		Operation
24.0	25.0			Freight
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments
0.4%	10%	24.6	1° - 20'	
		24.9	2° - 30'	Curve ends in next mile
Condition		Type	Comments	
Rail		100R 1942/1945	100 NH JTD	
Ties			Need 1000 ties/mile (7-8 bad rail length). Pick up tie debris.	
Ballast			Needs additional ballast on shoulders.	
Joint Bars/OTM				
Gage				
Surface/Line				
Drainage			No problems	
Vegetation			No problems	
# Locations		Description	Comments	
Sidings				
Turnouts				
Grade Crossings				
Bridges	1 MP 24.97	Route 2 (OH)		
Other Structures	N/A			

Appendix C:
Summary of Conditions (MP 24.0 - MP 25.0)
Page 2 of 2

[illegible]

Appendix B:
Summary of Conditions (MP 25.0 - MP 26.0)

Page 1 of 2

Worcester Main Line Summary of Conditions					
Mile Post	to Mile Post	FRA Class		Operation	Speed
25.0	26.0			Freight	30 MPH (up to MP25.7), >10 MPH (past MP25.7)
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments	
-0.1%	55%	24.9	2° - 30'	Curve starts in previous mile (MP 24.9)	
		25.3	1° - 50'		
		25.4	3° - 00'		
		25.5	2° - 10'		
Condition		Type	Comments		
Rail		100R 1930/1942	100 NH JTD		
Ties			Need 1300 ties/mile, Pick up ties debris		
Ballast			No high shoulders on curves		
Joint Bars/OTM					
Gage					
Surface/Line					
Drainage			No problems		
Vegetation			No problems		
# Locations		Description		Comments	
Sidings					
Turnouts					
Grade Crossings	1	MP 25.5	Private - MCI	Epflex - poor	
Bridges					
Other Structures		N/A			

Appendix B:
Summary of Conditions (MP 26.0 - MP 27.0)

Page 1 of 2

Worcester Main Line Summary of Conditions						
Mile Post	to	Mile Post	FRA Class		Operation	Speed
26.0		27.0			Freight	>10 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments		
-0.4%	20%	26.1	1° - 00'			
		26.2	1° - 10'			
		26.6	1° - 00'			
		26.9	2° - 30'	Curve ends in next mile		
		Condition	Type	Comments		
Rail		100R 1930	100 NH JTD - Worn badly and bent ends			
Ties			Need 1300 ties/mile. Pick up tie debris			
Ballast			Needs additional ballast on shoulders			
Joint Bars/OTM						
Gage						
Surface/Line						
Drainage			No problems			
Vegetation			No problems			
		# Locations	Description	Comments		
Sidings						
Turnouts	1	MP 26.4	Hill Yard			
	2	MP 26.8	GMX Warehouse			
Grade Crossings	1	MP 26.6	Private			
Bridges	1	MP 26.08	Dry Bridge (UG)			
	2	MP 26.50	Davis Gate (UG)			
Other Structures		N/A				

Appendix C:
Summary of Conditions (MP 26.0 - MP 27.0)
Page 2 of 2

[illegible]

Appendix B:
Summary of Conditions (MP 27.0 - MP 28.0)

Redacted Version 8-26-2021

Page 1 of 2

Worcester Main Line Summary of Conditions						
Mile Post	to	Mile Post	FRA Class		Operation	Speed
27.0		28.0			Freight	>10 MPH
Ave. Grade	% Curve/Mi	MP	Curve > 5°	Comments		
-0.4%	35%	26.9	2° - 30'	Curve starts in previous mile (MP 26.9)		
		27.2	3° - 30'			
		27.4	3° - 30'			
		27.7	3° - 10'			
Condition		Type	Comments			
Rail		100R 1930				
Ties						
Ballast						
Joint Bara/OTM						
Gage						
Surface/Line						
Drainage						
Vegetation						
# Locations		Description		Comments		
Sidings	1	MP 27.8	Hill Yard Track			
	2	MP 27.8	Hill Yard Track			
	3	MP 27.9	Hill Yard Track			
Turnouts						
Grade Crossings						
Bridges	1	MP 27.81	Over Pond (UG)			
Other Structures		N/A				

5/29/15

Appendix C:
Summary of Conditions (MP 27.0 - MP 28.0)
Page 2 of 2

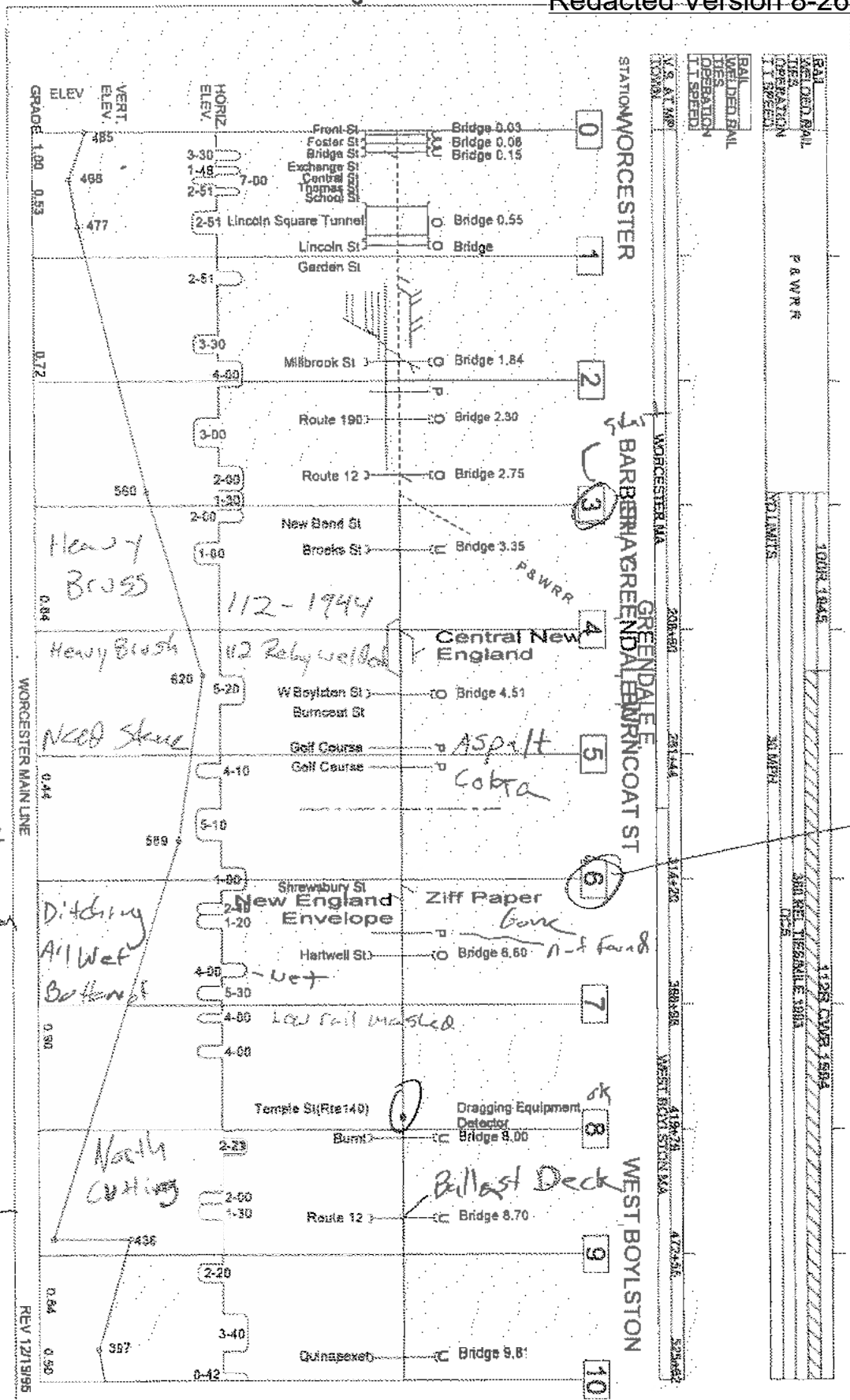
[illegible]

Appendix E

Worcester to Harvard field notes

Barber 2.9 Stach

29-3



Water
shed

50k

1000 mile

1000
cycle

100Δ
rule

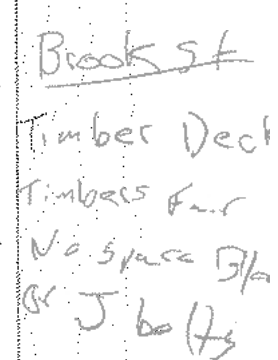
Vaght - 2017

950
mile

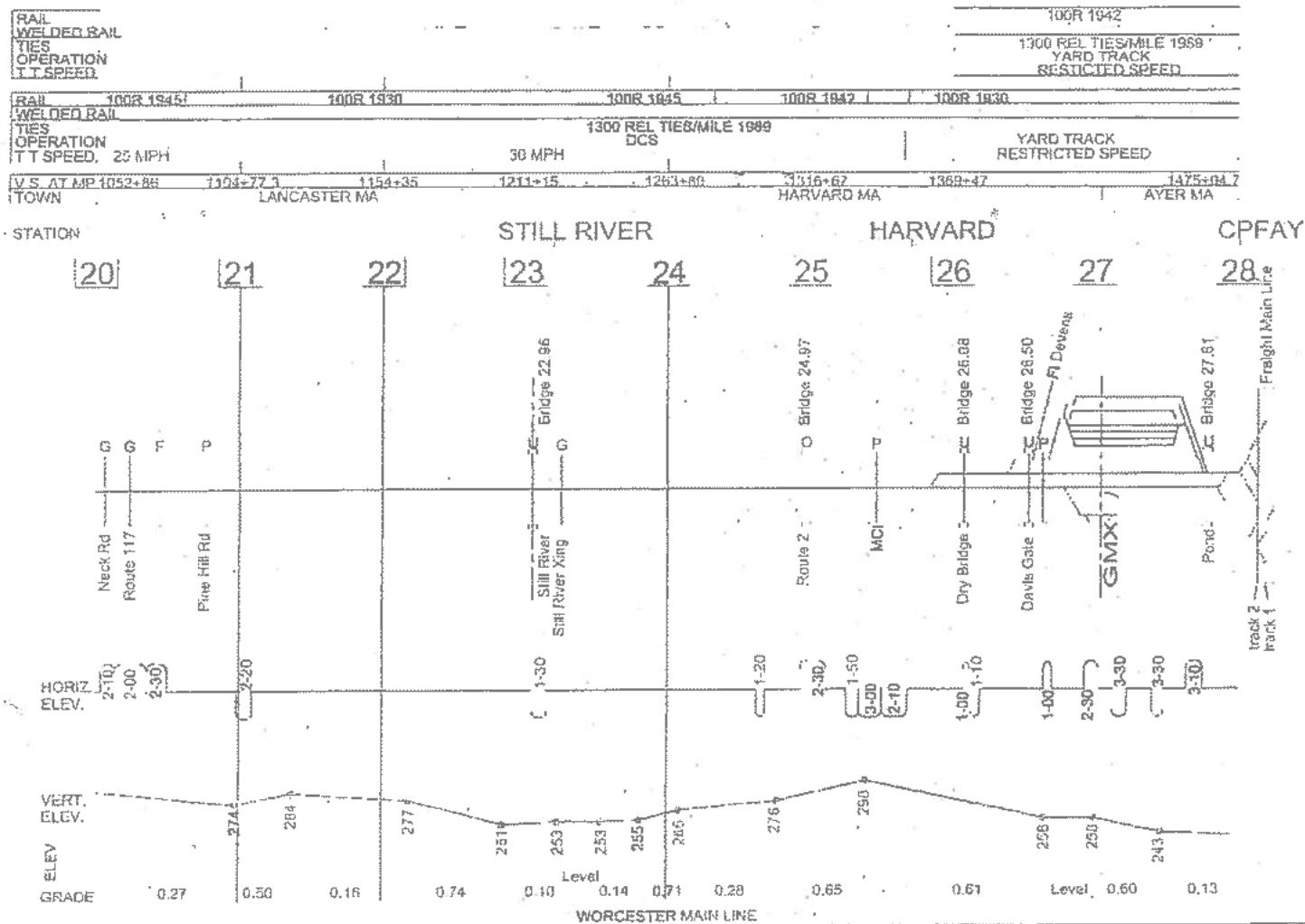
full col¹
C₂₅

miles - per hour per rail

mile 9 - 6 Bad per mile (1000 per mile)



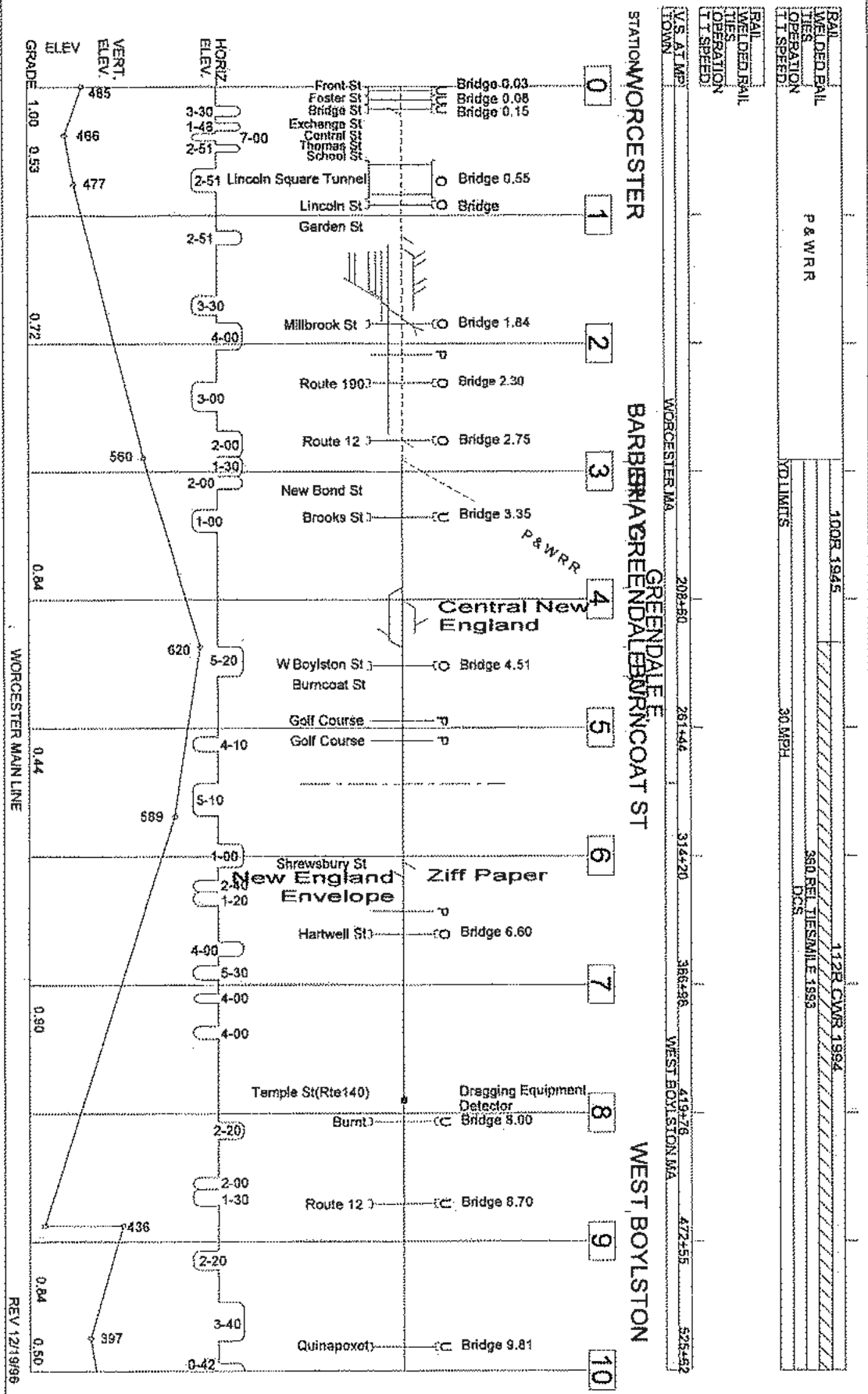
MWRA Document 109

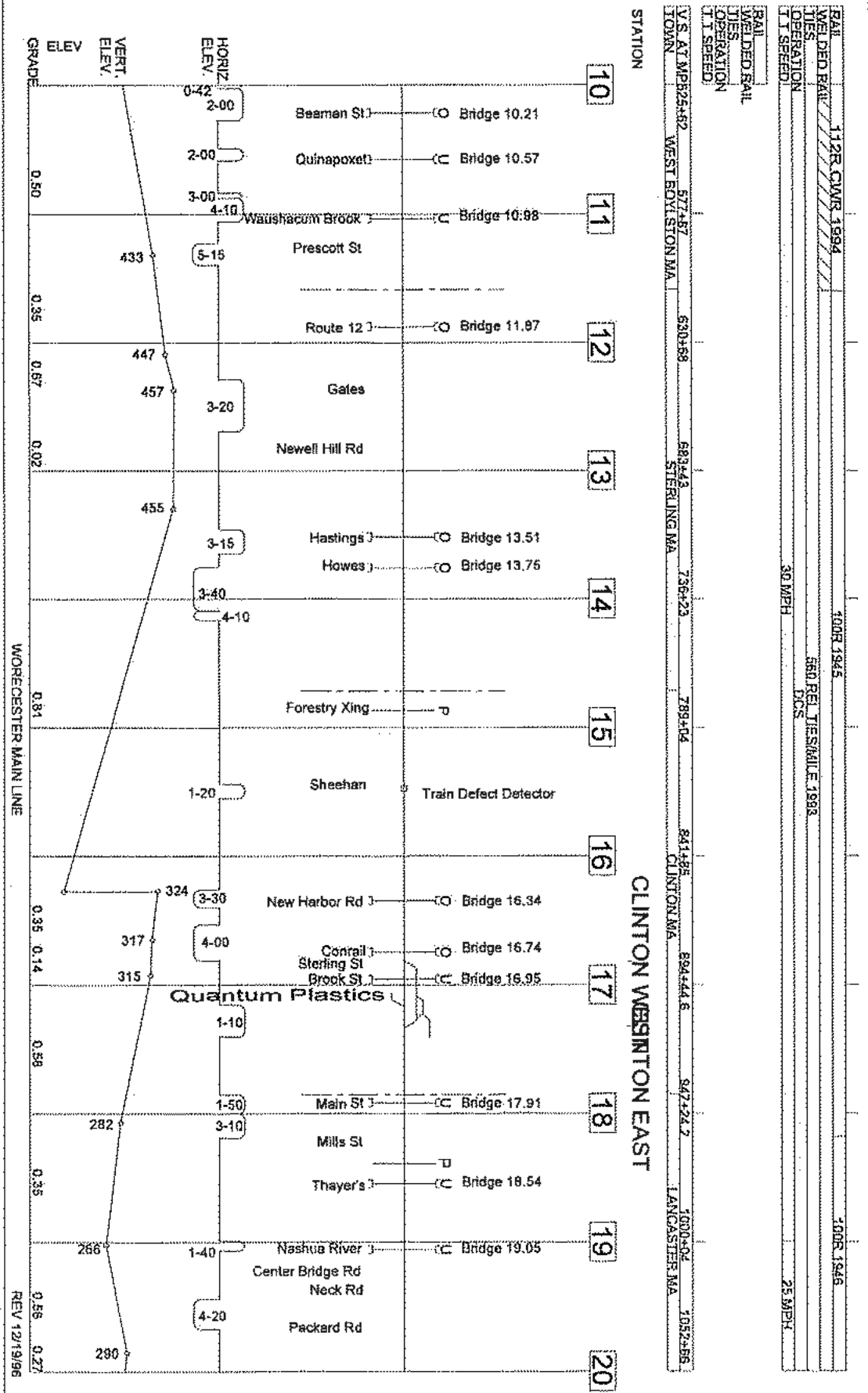


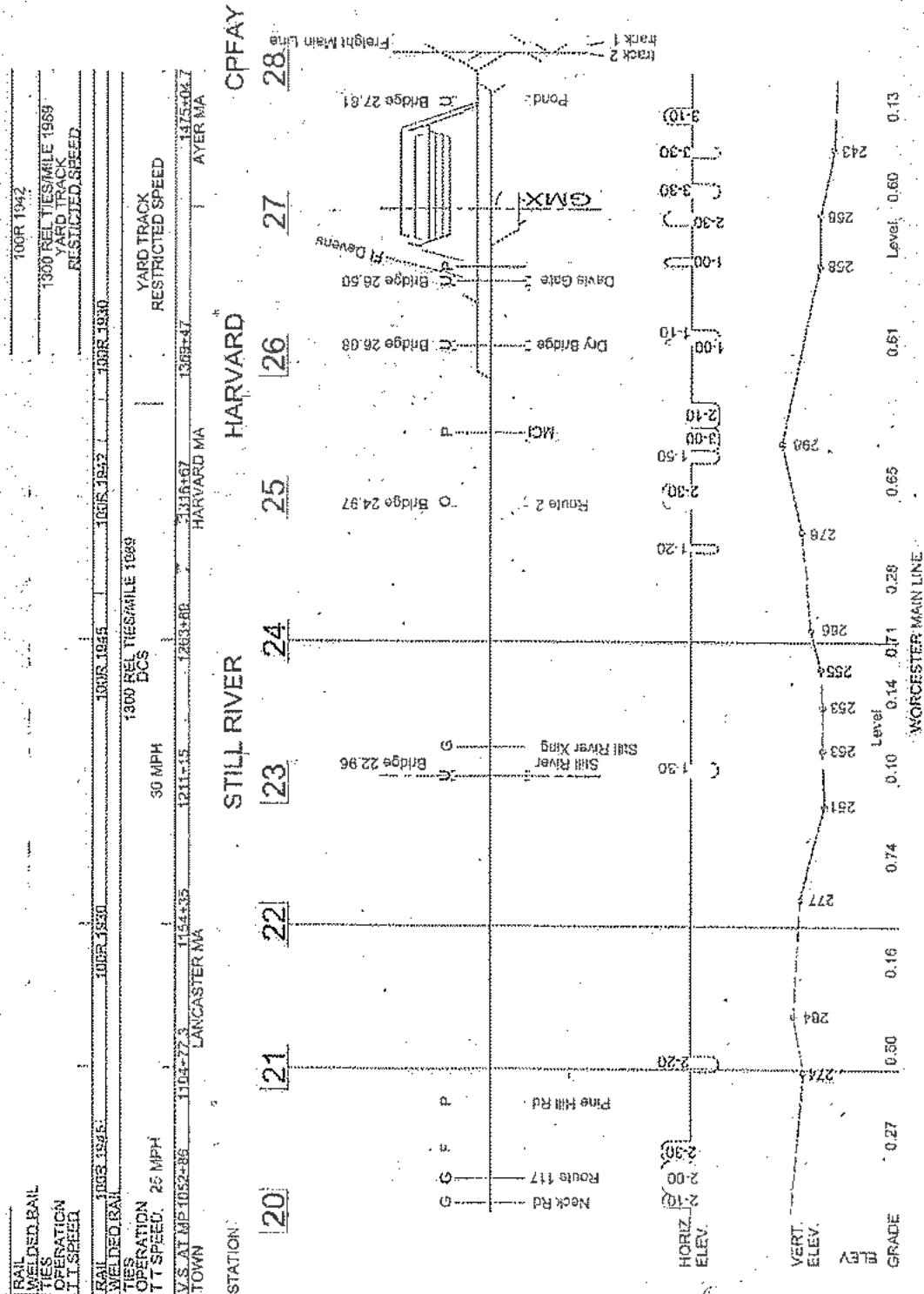
REV 12/18/98

Appendix F

Pan Am Railways Track Charts - Worcester to Harvard







REV 12/19/96

Appendix G

Site Photos

SITE PHOTOS Redacted Version 8-26-2021
WORCESTER MAINLINE
5/8/15



MILEPOST MARKER BY ARCH BRIDGE OVER STILLWATER RIVER



TRACK SECTION BY MP 10.25 +/-



STONE ARCH BRIDGE OVER THE STILLWATER RIVER



STONE ARCH BRIDGE OVER THE STILLWATER RIVER



TRACK AT STONE ARCH BRIDGE OVER THE STILLWATER RIVER



TRACK AT STONE ARCH BRIDGE OVER THE STILLWATER RIVER

PRESCOTT STREET CROSSING



PRESCOTT STREET GRADE CROSSING- NORTHBOUND ROADWAY
APPROACH



PRESCOTT STREET GRADE CROSSING- NORTHBOUND ROADWAY
APPROACH



PRESCOTT STREET GRADE CROSSING- THE WESTBOUND APPROACH



PRESCOTT STREET GRADE CROSSING- THE EASTBOUND APPROACH



PRESCOTT STREET GRADE CROSSING- CMP ARCH OVER THE WAUSHACUM BROOK



PRESCOTT STREET GRADE CROSSING- LOOKING WEST FROM EASTBOUNDBND APPROACH



PRESCOTT STREET GRADE CROSSING-SOUTHBOUND ROADWAY
APPROACH



TRACK SECTION BY MP 10.25 +/-

Appendix H –FRA Crossing Inventory

Removed

Appendix I

FRA Track Safety Standards - CFR-2011-title49-vol4-part213

§ 212.233

deemed to meet all requirements of this section and is qualified to conduct independent inspections of all types of highway-rail grade crossing warning systems for the purpose of determining compliance with Grade Crossing Signal System Safety Rules (49 CFR part 234), to make reports of those inspections, and to recommend institution of enforcement actions when appropriate to promote compliance.

[59 FR 50104, Sept. 30, 1994]

§ 212.233 Apprentice highway-rail grade crossing inspector.

(a) An apprentice highway-rail grade crossing inspector shall be enrolled in a program of training prescribed by the Associate Administrator for Safety leading to qualification as a highway-rail grade crossing inspector. The apprentice inspector may not participate in investigative and surveillance activities, except as an assistant to a qualified State or FRA inspector while accompanying that qualified inspector.

(b) Prior to being enrolled in the program the apprentice inspector shall demonstrate:

(1) Working basic knowledge of electricity;

(2) The ability to use electrical test equipment in direct current and alternating current circuits; and

(3) A basic knowledge of highway-rail grade crossing inspection and maintenance methods and procedures.

[59 FR 50104, Sept. 30, 1994]

§ 212.235 Inapplicable qualification requirements.

The Associate Administrator may determine that a specific requirement of this subpart is inapplicable to an identified position created by a State agency if it is not relevant to the actual duties of the position. The determination is made in writing.

[47 FR 41051, Sept. 16, 1982. Redesignated at 57 FR 28115, June 24, 1992. Further redesignated at 59 FR 50104, Sept. 30, 1994]

49 CFR Ch. II (10–1–11 Edition)**PART 213—TRACK SAFETY STANDARDS****Subpart A—General****Sec.**

- 213.1 Scope of part.
- 213.3 Application.
- 213.4 Excepted track.
- 213.5 Responsibility for compliance.
- 213.7 Designation of qualified persons to supervise certain renewals and inspect track.
- 213.9 Classes of track: operating speed limits.
- 213.11 Restoration or renewal of track under traffic conditions.
- 213.13 Measuring track not under load.
- 213.15 Penalties.
- 213.17 Waivers.
- 213.19 Information collection.

Subpart B—Roadbed

- 213.31 Scope.
- 213.33 Drainage.
- 213.37 Vegetation.

Subpart C—Track Geometry

- 213.51 Scope.
- 213.53 Gage.
- 213.55 Alinement.
- 213.57 Curves; elevation and speed limitations.
- 213.59 Elevation of curved track; runoff.
- 213.63 Track surface.

Subpart D—Track Structure

- 213.101 Scope.
- 213.103 Ballast; general.
- 213.109 Crossties.
- 213.110 Gage restraint measurement systems.
- 213.113 Defective rails.
- 213.115 Rail end mismatch.
- 213.118 Continuous welded rail (CWR); plan review and approval.
- 213.119 Continuous welded rail (CWR); plan contents.
- 213.121 Rail joints.
- 213.122 Torch cut rail.
- 213.123 Tie plates.
- 213.127 Rail fastening systems.
- 213.133 Turnouts and track crossings generally.
- 213.135 Switches.
- 213.137 Frogs.
- 213.139 Spring rail frogs.
- 213.141 Self-guarded frogs.
- 213.143 Frog guard rails and guard faces; gage.

Federal Railroad Administration, DOT**§ 213.4****Subpart E—Track Appliances and Track-Related Devices**

- 213.201 Scope.
- 213.205 Derails.

Subpart F—Inspection

- 213.231 Scope.
- 213.233 Track inspections.
- 213.234 Automated inspection of track constructed with concrete crossties.
- 213.235 Inspection of switches, track crossings, and lift rail assemblies or other transition devices on moveable bridges.
- 213.237 Inspection of rail.
- 213.239 Special inspections.
- 213.241 Inspection records.

Subpart G—Train Operations at Track Classes 6 and Higher

- 213.301 Scope of subpart.
- 213.303 Responsibility for compliance.
- 213.305 Designation of qualified individuals; general qualifications.
- 213.307 Class of track: operating speed limits.
- 213.309 Restoration or renewal of track under traffic conditions.
- 213.311 Measuring track not under load.
- 213.317 Waivers.
- 213.319 Drainage.
- 213.321 Vegetation.
- 213.323 Track gage.
- 213.327 Alinement.
- 213.329 Curves, elevation and speed limitations.
- 213.331 Track surface.
- 213.333 Automated vehicle inspection systems.
- 213.334 Ballast; general.
- 213.335 Crossties.
- 213.337 Defective rails.
- 213.339 Inspection of rail in service.
- 213.341 Initial inspection of new rail and welds.
- 213.343 Continuous welded rail (CWR).
- 213.345 Vehicle qualification testing.
- 213.347 Automotive or railroad crossings at grade.
- 213.349 Rail end mismatch.
- 213.351 Rail joints.
- 213.352 Torch cut rail.
- 213.353 Turnouts, crossovers, and lift rail assemblies or other transition devices on moveable bridges.
- 213.355 Frog guard rails and guard faces; gage.
- 213.357 Derails.
- 213.359 Track stiffness.
- 213.361 Right of way.
- 213.365 Visual inspections.
- 213.367 Special inspections.
- 213.369 Inspection records.

APPENDIX A TO PART 213—MAXIMUM ALLOWABLE CURVING SPEEDS

APPENDIX B TO PART 213—SCHEDULE OF CIVIL PENALTIES

AUTHORITY: 49 U.S.C. 20102-20114 and 20142; Sec. 403, Div. A. Pub. L. 110-432, 122 Stat. 4885; 28 U.S.C. 2461, note; and 49 CFR 1.49.

SOURCE: 63 FR 34029, June 22, 1998, unless otherwise noted.

Subpart A—General**§ 213.1 Scope of part.**

(a) This part prescribes minimum safety requirements for railroad track that is part of the general railroad system of transportation. The requirements prescribed in this part apply to specific track conditions existing in isolation. Therefore, a combination of track conditions, none of which individually amounts to a deviation from the requirements in this part, may require remedial action to provide for safe operations over that track. This part does not restrict a railroad from adopting and enforcing additional or more stringent requirements not inconsistent with this part.

(b) Subparts A through F apply to track Classes 1 through 5. Subpart G and 213.2, 213.3, and 213.15 apply to track over which trains are operated at speeds in excess of those permitted over Class 5 track.

§ 213.3 Application.

(a) Except as provided in paragraph (b) of this section, this part applies to all standard gage track in the general railroad system of transportation.

(b) This part does not apply to track—

(1) Located inside an installation which is not part of the general railroad system of transportation; or

(2) Used exclusively for rapid transit operations in an urban area that are not connected with the general railroad system of transportation.

§ 213.4 Excepted track.

A track owner may designate a segment of track as excepted track provided that—

(a) The segment is identified in the timetable, special instructions, general order, or other appropriate records which are available for inspection during regular business hours;

§213.5

(b) The identified segment is not located within 30 feet of an adjacent track which can be subjected to simultaneous use at speeds in excess of 10 miles per hour;

(c) The identified segment is inspected in accordance with 213.233(c) and 213.235 at the frequency specified for Class 1 track;

(d) The identified segment of track is not located on a bridge including the track approaching the bridge for 100 feet on either side, or located on a public street or highway, if railroad cars containing commodities required to be placarded by the Hazardous Materials Regulations (49 CFR part 172), are moved over the track; and

(e) The railroad conducts operations on the identified segment under the following conditions:

(1) No train shall be operated at speeds in excess of 10 miles per hour;

(2) No occupied passenger train shall be operated;

(3) No freight train shall be operated that contains more than five cars required to be placarded by the Hazardous Materials Regulations (49 CFR part 172); and

(4) The gage on excepted track shall not be more than 4 feet 10¼ inches. This paragraph (e)(4) is applicable September 21, 1999.

(f) A track owner shall advise the appropriate FRA Regional Office at least 10 days prior to removal of a segment of track from excepted status.

[63 FR 34029, June 22, 1998]

§213.5 Responsibility for compliance.

(a) Except as provided in paragraph (b) of this section, any owner of track to which this part applies who knows or has notice that the track does not comply with the requirements of this part, shall—

(1) Bring the track into compliance;

(2) Halt operations over that track; or

(3) Operate under authority of a person designated under §213.7(a), who has at least one year of supervisory experience in railroad track maintenance, subject to conditions set forth in this part.

(b) If an owner of track to which this part applies designates a segment of track as “excepted track” under the

49 CFR Ch. II (10–1–11 Edition)

provisions of §213.4, operations may continue over that track without complying with the provisions of subparts B, C, D, and E of this part, unless otherwise expressly stated.

(c) If an owner of track to which this part applies assigns responsibility for the track to another person (by lease or otherwise), written notification of the assignment shall be provided to the appropriate FRA Regional Office at least 30 days in advance of the assignment. The notification may be made by any party to that assignment, but shall be in writing and include the following—

(1) The name and address of the track owner;

(2) The name and address of the person to whom responsibility is assigned (assignee);

(3) A statement of the exact relationship between the track owner and the assignee;

(4) A precise identification of the track;

(5) A statement as to the competence and ability of the assignee to carry out the duties of the track owner under this part; and

(6) A statement signed by the assignee acknowledging the assignment to him of responsibility for purposes of compliance with this part.

(d) The Administrator may hold the track owner or the assignee or both responsible for compliance with this part and subject to penalties under §213.15.

(e) A common carrier by railroad which is directed by the Surface Transportation Board to provide service over the track of another railroad under 49 U.S.C. 11123 is considered the owner of that track for the purposes of the application of this part during the period the directed service order remains in effect.

(f) When any person, including a contractor for a railroad or track owner, performs any function required by this part, that person is required to perform that function in accordance with this part.

§213.7 Designation of qualified persons to supervise certain renewals and inspect track.

(a) Each track owner to which this part applies shall designate qualified

Federal Railroad Administration, DOT**§213.7**

persons to supervise restorations and renewals of track under traffic conditions. Each person designated shall have—

(1) At least—
(i) 1 year of supervisory experience in railroad track maintenance; or

(ii) A combination of supervisory experience in track maintenance and training from a course in track maintenance or from a college level educational program related to track maintenance;

(2) Demonstrated to the owner that he or she—

(i) Knows and understands the requirements of this part;

(ii) Can detect deviations from those requirements; and

(iii) Can prescribe appropriate remedial action to correct or safely compensate for those deviations; and

(3) Written authorization from the track owner to prescribe remedial actions to correct or safely compensate for deviations from the requirements in this part.

(b) Each track owner to which this part applies shall designate qualified persons to inspect track for defects. Each person designated shall have—

(1) At least—

(i) 1 year of experience in railroad track inspection; or

(ii) A combination of experience in track inspection and training from a course in track inspection or from a college level educational program related to track inspection;

(2) Demonstrated to the owner that he or she—

(i) Knows and understands the requirements of this part;

(ii) Can detect deviations from those requirements; and

(iii) Can prescribe appropriate remedial action to correct or safely compensate for those deviations; and

(3) Written authorization from the track owner to prescribe remedial actions to correct or safely compensate for deviations from the requirements of this part, pending review by a qualified person designated under paragraph (a) of this section.

(c) Individuals designated under paragraphs (a) or (b) of this section that inspect continuous welded rail (CWR) track or supervise the installa-

tion, adjustment, and maintenance of CWR track in accordance with the written procedures of the track owner shall have:

(1) Current qualifications under either paragraph (a) or (b) of this section;

(2) Successfully completed a comprehensive training course specifically developed for the application of written CWR procedures issued by the track owner;

(3) Demonstrated to the track owner that the individual:

(i) Knows and understands the requirements of those written CWR procedures;

(ii) Can detect deviations from those requirements; and

(iii) Can prescribe appropriate remedial action to correct or safely compensate for those deviations; and

(4) Written authorization from the track owner to prescribe remedial actions to correct or safely compensate for deviations from the requirements in those procedures and successfully completed a recorded examination on those procedures as part of the qualification process.

(d) Persons not fully qualified to supervise certain renewals and inspect track as required in paragraphs (a) through (c) of this section, but with at least one year of maintenance-of-way or signal experience, may pass trains over broken rails and pull apart provided that—

(1) The track owner determines the person to be qualified and, as part of doing so, trains, examines, and re-examines the person periodically within two years after each prior examination on the following topics as they relate to the safe passage of trains over broken rails or pull apart: rail defect identification, crosstie condition, track surface and alignment, gage restraint, rail end mismatch, joint bars, and maximum distance between rail ends over which trains may be allowed to pass. The sole purpose of the examination is to ascertain the person's ability to effectively apply these requirements and the examination may not be used to disqualify the person from other duties. A minimum of four hours training is required for initial training;

§213.9

(2) The person deems it safe and train speeds are limited to a maximum of 10 m.p.h. over the broken rail or pull apart;

(3) The person shall watch all movements over the broken rail or pull apart and be prepared to stop the train if necessary; and

(4) Person(s) fully qualified under §213.7 are notified and dispatched to the location promptly for the purpose of authorizing movements and effecting temporary or permanent repairs.

(e) With respect to designations under paragraphs (a) through (d) of this section, each track owner shall maintain written records of—

(1) Each designation in effect;

(2) The basis for each designation; and

(3) Track inspections made by each designated qualified person as required by §213.241. These records shall be kept available for inspection or copying by the Federal Railroad Administration during regular business hours.

[63 FR 34029, June 22, 1998, as amended at 74 FR 43002, Aug. 25, 2009]

§213.9 Classes of track: operating speed limits.

(a) Except as provided in paragraph (b) of this section and §§213.57(b), 213.59(a), 213.113(a), and 213.137(b) and (c), the following maximum allowable operating speeds apply—

[In miles per hour]

Over track that meets all of the requirements prescribed in this part for—	The maximum allowable operating speed for freight trains is—	The maximum allowable operating speed for passenger trains is—
Excepted track	10	N/A
Class 1 track	10	15
Class 2 track	25	30
Class 3 track	40	60
Class 4 track	60	80
Class 5 track	80	90

(b) If a segment of track does not meet all of the requirements for its intended class, it is reclassified to the next lowest class of track for which it does meet all of the requirements of this part. However, if the segment of track does not at least meet the requirements for Class 1 track, operations may continue at Class 1 speeds for a period of not more than 30 days without bringing the track into com-

49 CFR Ch. II (10–1–11 Edition)

pliance, under the authority of a person designated under §213.7(a), who has at least one year of supervisory experience in railroad track maintenance, after that person determines that operations may safely continue and subject to any limiting conditions specified by such person.

§213.11 Restoration or renewal of track under traffic conditions.

If during a period of restoration or renewal, track is under traffic conditions and does not meet all of the requirements prescribed in this part, the work on the track shall be under the continuous supervision of a person designated under §213.7(a) who has at least one year of supervisory experience in railroad track maintenance, and subject to any limiting conditions specified by such person. The term “continuous supervision” as used in this section means the physical presence of that person at a job site. However, since the work may be performed over a large area, it is not necessary that each phase of the work be done under the visual supervision of that person.

§213.13 Measuring track not under load.

When unloaded track is measured to determine compliance with requirements of this part, the amount of rail movement, if any, that occurs while the track is loaded must be added to the measurements of the unloaded track.

§213.15 Penalties.

(a) Any person who violates any requirement of this part or causes the violation of any such requirement is subject to a civil penalty of at least \$650 and not more than \$25,000 per violation, except that: Penalties may be assessed against individuals only for willful violations, and, where a grossly negligent violation or a pattern of repeated violations has created an imminent hazard of death or injury to persons, or has caused death or injury, a penalty not to exceed \$100,000 per violation may be assessed. “Person” means an entity of any type covered under 1 U.S.C. 1, including but not limited to the following: a railroad; a manager, supervisor, official, or other employee

Federal Railroad Administration, DOT**§ 213.53**

or agent of a railroad; any owner, manufacturer, lessor, or lessee of railroad equipment, track, or facilities; any independent contractor providing goods or services to a railroad; any employee of such owner, manufacturer, lessor, lessee, or independent contractor; and anyone held by the Federal Railroad Administrator to be responsible under § 213.5(d) or § 213.303(c). Each day a violation continues shall constitute a separate offense. See appendix B to this part for a statement of agency civil penalty policy.

(b) Any person who knowingly and willfully falsifies a record or report required by this part may be subject to criminal penalties under 49 U.S.C. 21311.

[63 FR 34029, June 22, 1998, as amended at 69 FR 30593, May 28, 2004; 72 FR 51196, Sept. 6, 2007; 73 FR 79701, Dec. 30, 2008]

§ 213.17 Waivers.

(a) Any owner of track to which this part applies, or other person subject to this part, may petition the Federal Railroad Administrator for a waiver from any or all requirements prescribed in this part. The filing of such a petition does not affect that person's responsibility for compliance with that requirement while the petition is being considered.

(b) Each petition for a waiver under this section shall be filed in the manner and contain the information required by part 211 of this chapter.

(c) If the Administrator finds that a waiver is in the public interest and is consistent with railroad safety, the Administrator may grant the exemption subject to any conditions the Administrator deems necessary. Where a waiver is granted, the Administrator publishes a notice containing the reasons for granting the waiver.

§ 213.19 Information collection.

(a) The information collection requirements of this part were reviewed by the Office of Management and Budget pursuant to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.) and are assigned OMB control number 2130-0010.

(b) The information collection requirements are found in the following

sections: §§ 213.4, 213.5, 213.7, 213.17, 213.57, 213.119, 213.122, 213.233, 213.237, 213.241, 213.303, 213.305, 213.317, 213.329, 213.333, 213.339, 213.341, 213.343, 213.345, 213.353, 213.361, 213.369.

Subpart B—Roadbed**§ 213.31 Scope.**

This subpart prescribes minimum requirements for roadbed and areas immediately adjacent to roadbed.

§ 213.33 Drainage.

Each drainage or other water carrying facility under or immediately adjacent to the roadbed shall be maintained and kept free of obstruction, to accommodate expected water flow for the area concerned.

§ 213.37 Vegetation.

Vegetation on railroad property which is on or immediately adjacent to roadbed shall be controlled so that it does not—

(a) Become a fire hazard to track-carrying structures;

(b) Obstruct visibility of railroad signs and signals:

(1) Along the right-of-way, and

(2) At highway-rail crossings; (This paragraph (b)(2) is applicable September 21, 1999.)

(c) Interfere with railroad employees performing normal trackside duties;

(d) Prevent proper functioning of signal and communication lines; or

(e) Prevent railroad employees from visually inspecting moving equipment from their normal duty stations.

Subpart C—Track Geometry**§ 213.51 Scope.**

This subpart prescribes requirements for the gage, alignment, and surface of track, and the elevation of outer rails and speed limitations for curved track.

§ 213.53 Gage.

(a) Gage is measured between the heads of the rails at right-angles to the rails in a plane five-eighths of an inch below the top of the rail head.

(b) Gage shall be within the limits prescribed in the following table—

§ 213.55**49 CFR Ch. II (10–1–11 Edition)**

Class of track	The gage must be at least—	But not more than—
Excepted track	N/A	4'10¼".
Class 1 track	4'8"	4'10".
Class 2 and 3 track	4'8"	4'9¾".
Class 4 and 5 track	4'8"	4'9½".

§ 213.55 Alinement.

Alinement may not deviate from uniformity more than the amount prescribed in the following table:

Class of track	Tangent track	Curved track	
	The deviation of the mid-offset from a 62-foot line ¹ may not be more than— (inches)	The deviation of the mid-ordinate from a 31-foot chord ² may not be more than— (inches)	The deviation of the mid-ordinate from a 62-foot chord ² may not be more than— (inches)
Class 1 track	5	³ N/A	5
Class 2 track	3	³ N/A	3
Class 3 track	1¾	1¼	1¾
Class 4 track	1½	1	1½
Class 5 track	¾	½	¾

¹ The ends of the line shall be at points on the gage side of the line rail, five-eighths of an inch below the top of the railhead. Either rail may be used as the line rail, however, the same rail shall be used for the full length of that tangential segment of track.

² The ends of the chord shall be at points on the gage side of the outer rail, five-eighths of an inch below the top of the railhead.

³ N/A—Not Applicable.

§ 213.57 Curves; elevation and speed limitations.

(a) The maximum crosslevel on the outside rail of a curve may not be more than 8 inches on track Classes 1 and 2 and 7 inches on Classes 3 through 5. Except as provided in § 213.63, the outside rail of a curve may not be lower than the inside rail. (The first sentence of paragraph (a) is applicable September 21, 1999.)

(b)(1) The maximum allowable operating speed for each curve is determined by the following formula—

$$V_{\max} = \sqrt{\frac{E_a + 3}{0.0007D}}$$

Where—

$V_{\max}$ = Maximum allowable operating speed (miles per hour).

E_a = Actual elevation of the outside rail (inches).¹

¹ Actual elevation for each 155 foot track segment in the body of the curve is determined by averaging the elevation for 10 points through the segment at 15.5 foot spacing. If the curve length is less than 155 feet,

D = Degree of curvature (degrees).²

(2) Table 1 of appendix A is a table of maximum allowable operating speed computed in accordance with this formula for various elevations and degrees of curvature.

(c)(1) For rolling stock meeting the requirements specified in paragraph (d) of this section, the maximum operating speed for each curve may be determined by the following formula—

$$V_{\max} = \sqrt{\frac{E_a + 4}{0.0007D}}$$

Where—

$V_{\max}$ = Maximum allowable operating speed (miles per hour).

E_a = Actual elevation of the outside rail (inches).¹

D = Degree of curvature (degrees).²

(2) Table 2 of appendix A is a table of maximum allowable operating speed

average the points through the full length of the body of the curve.

² Degree of curvature is determined by averaging the degree of curvature over the same track segment as the elevation.

Federal Railroad Administration, DOT**§ 213.57**

computed in accordance with this formula for various elevations and degrees of curvature.

(d) Qualified equipment may be operated at curving speeds determined by the formula in paragraph (c) of this section, provided each specific class of equipment is approved for operation by the Federal Railroad Administration and the railroad demonstrates that:

(1) When positioned on a track with a uniform 4-inch superelevation, the roll angle between the floor of the equipment and the horizontal does not exceed 5.7 degrees; and

(2) When positioned on a track with a uniform 6 inch superelevation, no wheel of the equipment unloads to a value of 60 percent of its static value on perfectly level track, and the roll angle between the floor of the equipment and the horizontal does not exceed 8.6 degrees.

(3) The track owner shall notify the Federal Railroad Administrator no less than 30 calendar days prior to the proposed implementation of the higher curving speeds allowed under the formula in paragraph (c) of this section. The notification shall be in writing and shall contain, at a minimum, the following information—

(i) A complete description of the class of equipment involved, including schematic diagrams of the suspension systems and the location of the center of gravity above top of rail;

(ii) A complete description of the test procedure³ and instrumentation used to qualify the equipment and the maximum values for wheel unloading and roll angles which were observed during testing;

(iii) Procedures or standards in effect which relate to the maintenance of the suspension system for the particular class of equipment; and

(iv) Identification of line segment on which the higher curving speeds are proposed to be implemented.

³The test procedure may be conducted in a test facility whereby all the wheels on one side (right or left) of the equipment are alternately raised and lowered by 4 and 6 inches and the vertical wheel loads under each wheel are measured and a level is used to record the angle through which the floor of the equipment has been rotated.

(e) A track owner, or an operator of a passenger or commuter service, who provides passenger or commuter service over trackage of more than one track owner with the same class of equipment may provide written notification to the Federal Railroad Administrator with the written consent of the other affected track owners.

(f) Equipment presently operating at curving speeds allowed under the formula in paragraph (c) of this section, by reason of conditional waivers granted by the Federal Railroad Administration, shall be considered to have successfully complied with the requirements of paragraph (d) of this section.

(g) A track owner or a railroad operating above Class 5 speeds, may request approval from the Federal Railroad Administrator to operate specified equipment at a level of cant deficiency greater than four inches in accordance with §213.329(c) and (d) on curves in Class 1 through 5 track which are contiguous to the high speed track provided that—

(1) The track owner or railroad submits a test plan to the Federal Railroad Administrator for approval no less than thirty calendar days prior to any proposed implementation of the higher curving speeds. The test plan shall include an analysis and determination of carbody acceleration safety limits for each vehicle type which indicate wheel unloading of 60 percent in a steady state condition and 80 percent in a transient (point by point) condition. Accelerometers shall be laterally-oriented and floor-mounted near the end of a representative vehicle of each type;

(2) Upon FRA approval of a test plan, the track owner or railroad conducts incrementally increasing train speed test runs over the curves in the identified track segment(s) to demonstrate that wheel unloading is within the limits prescribed in paragraph (g)(1) of this section;

(3) Upon FRA approval of a cant deficiency level, the track owner or railroad inspects the curves in the identified track segment with a Track Geometry Measurement System (TGMS) qualified in accordance with §213.333 (b) through (g) at an inspection frequency of at least twice annually with not less

§ 213.59

than 120 days interval between inspections; and

(4) The track owner or railroad operates an instrumented car having dynamic response characteristics that are representative of other equipment assigned to service or a portable device that monitors on-board instrumentation on trains over the curves in the identified track segment at the revenue speed profile at a frequency of at least once every 90-day period with not less than 30 days interval between inspections. The instrumented car or the portable device shall monitor a laterally-oriented accelerometer placed near the end of the vehicle at the floor level. If the carbody lateral acceleration measurement exceeds the safety limits prescribed in paragraph (g)(1), the railroad shall operate trains at curving speeds in accordance with paragraph (b) or (c) of this section; and

(5) The track owner or railroad shall maintain a copy of the most recent exception printouts for the inspections required under paragraphs (g)(3) and (4) of this section.

[63 FR 34029, June 22, 1998; 63 FR 54078, Oct. 8, 1998]

49 CFR Ch. II (10–1–11 Edition)**§ 213.59 Elevation of curved track; runoff.**

(a) If a curve is elevated, the full elevation shall be provided throughout the curve, unless physical conditions do not permit. If elevation runoff occurs in a curve, the actual minimum elevation shall be used in computing the maximum allowable operating speed for that curve under § 213.57(b).

(b) Elevation runoff shall be at a uniform rate, within the limits of track surface deviation prescribed in § 213.63, and it shall extend at least the full length of the spirals. If physical conditions do not permit a spiral long enough to accommodate the minimum length of runoff, part of the runoff may be on tangent track.

§ 213.63 Track surface.

Each owner of the track to which this part applies shall maintain the surface of its track within the limits prescribed in the following table:

Track surface	Class of track				
	1 (inches)	2 (inches)	3 (inches)	4 (inches)	5 (inches)
The runoff in any 31 feet of rail at the end of a raise may not be more than	3½	3	2	1½	1
The deviation from uniform profile on either rail at the mid-ordinate of a 62-foot chord may not be more than	3	2¾	2¼	2	1½
The deviation from zero crosslevel at any point on tangent or reverse crosslevel elevation on curves may not be more than	3	2	1¾	1¼	1
The difference in crosslevel between any two points less than 62 feet apart may not be more than* 1,2	3	2¼	2	1¾	1½
* Where determined by engineering decision prior to the promulgation of this rule, due to physical restrictions on spiral length and operating practices and experience, the variation in crosslevel on spirals per 31 feet may not be more than	2	1¾	1¼	1	¾

¹ Except as limited by § 213.57(a), where the elevation at any point in a curve equals or exceeds 6 inches, the difference in crosslevel within 62 feet between that point and a point with greater elevation may not be more than 1½ inches. (Footnote 1 is applicable September 21, 1999.)

² However, to control harmonics on Class 2 through 5 jointed track with staggered joints, the crosslevel differences shall not exceed 1¼ inches in all of six consecutive pairs of joints, as created by 7 low joints. Track with joints staggered less than 10 feet shall not be considered as having staggered joints. Joints within the 7 low joints outside of the regular joint spacing shall not be considered as joints for purposes of this footnote. (Footnote 2 is applicable September 21, 1999.)

[63 FR 34029, June 22, 1998; 63 FR 45959, Aug. 28, 1998]

Subpart D—Track Structure

assembly fittings, and the physical conditions of rails.

§ 213.101 Scope.

This subpart prescribes minimum requirements for ballast, crossties, track

Federal Railroad Administration, DOT

§ 213.109

§ 213.103 Ballast; general.

Unless it is otherwise structurally supported, all track shall be supported by material which will—

(a) Transmit and distribute the load of the track and railroad rolling equipment to the subgrade;

(b) Restrain the track laterally, longitudinally, and vertically under dynamic loads imposed by railroad rolling equipment and thermal stress exerted by the rails;

(c) Provide adequate drainage for the track; and

(d) Maintain proper track crosslevel, surface, and alignment.

§ 213.109 Crossties.

(a) Crossties shall be made of a material to which rail can be securely fastened.

(b) Each 39-foot segment of track shall have at a minimum—

(1) A sufficient number of crossties that in combination provide effective support that will—

(i) Hold gage within the limits prescribed in § 213.53(b);

(ii) Maintain surface within the limits prescribed in § 213.63; and

(iii) Maintain alignment within the limits prescribed in § 213.55;

(2) The minimum number and type of crossties specified in paragraph (b)(4) of this section and described in paragraph (c) or (d), as applicable, of this section effectively distributed to support the entire segment;

(3) At least one non-defective crosstie of the type specified in paragraphs (c) and (d) of this section that is located at a joint location as specified in paragraph (e) of this section; and

(4) The minimum number of crossties as indicated in the following table.

FRA track class	Tangent track, turnouts, and curves	
	Tangent track and curved track less than or equal to 2 degrees	Turnouts and curved track greater than 2 degrees
Class 1	5	6
Class 2	8	9
Class 3	8	10
Class 4 and 5	12	14

(c) Crossties, other than concrete, counted to satisfy the requirements set

forth in paragraph (b)(4) of this section shall not be—

(1) Broken through;

(2) Split or otherwise impaired to the extent the crosstie will allow the ballast to work through, or will not hold spikes or rail fasteners;

(3) So deteriorated that the crosstie plate or base of rail can move laterally ½ inch relative to the crosstie; or

(4) Cut by the crosstie plate through more than 40 percent of a crosstie's thickness.

(d) Concrete crossties counted to satisfy the requirements set forth in paragraph (b)(4) of this section shall not be—

(1) Broken through or deteriorated to the extent that prestressing material is visible;

(2) Deteriorated or broken off in the vicinity of the shoulder or insert so that the fastener assembly can either pull out or move laterally more than ¾ inch relative to the crosstie;

(3) Deteriorated such that the base of either rail can move laterally more than ¾ inch relative to the crosstie on curves of 2 degrees or greater; or can move laterally more than ½ inch relative to the crosstie on tangent track or curves of less than 2 degrees;

(4) Deteriorated or abraded at any point under the rail seat to a depth of ½ inch or more;

(5) Deteriorated such that the crosstie's fastening or anchoring system, including rail anchors (see § 213.127(b)), is unable to maintain longitudinal rail restraint, or maintain rail hold down, or maintain gage due to insufficient fastener toeload; or

(6) Configured with less than two fasteners on the same rail except as provided in § 213.127(c).

(e) Class 1 and 2 track shall have one crosstie whose centerline is within 24 inches of each rail joint (end) location. Class 3, 4, and 5 track shall have either one crosstie whose centerline is within 18 inches of each rail joint location or two crossties whose centerlines are within 24 inches either side of each rail joint location. The relative position of these crossties is described in the following three diagrams:

(1) Each rail joint in Class 1 and 2 track shall be supported by at least one crosstie specified in paragraphs (c) and

§213.109

49 CFR Ch. II (10-1-11 Edition)

(d) of this section whose centerline is within 48 inches as shown in Figure 1.

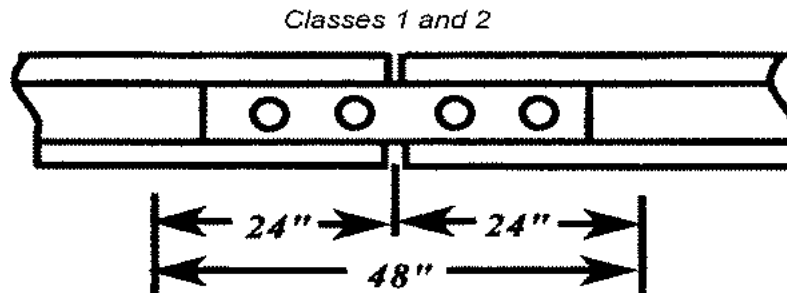


Figure 1

(2) Each rail joint in Class 3, 4, and 5 track shall be supported by either at least one crosstie specified in paragraphs (c) and (d) of this section whose centerline is within 36 inches as shown in Figure 2, or:

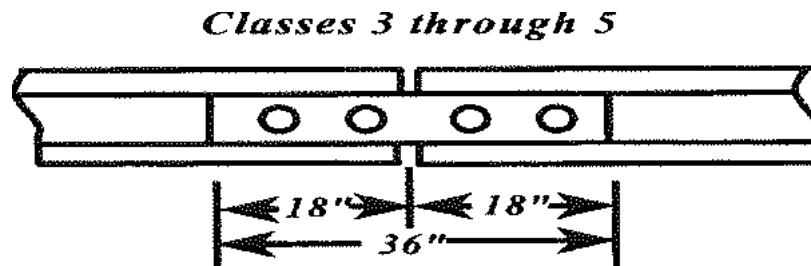


Figure 2

(3) Two crossties, one on each side of the rail joint, whose centerlines are within 24 inches of the rail joint location as shown in Figure 3.

Federal Railroad Administration, DOT

§213.110

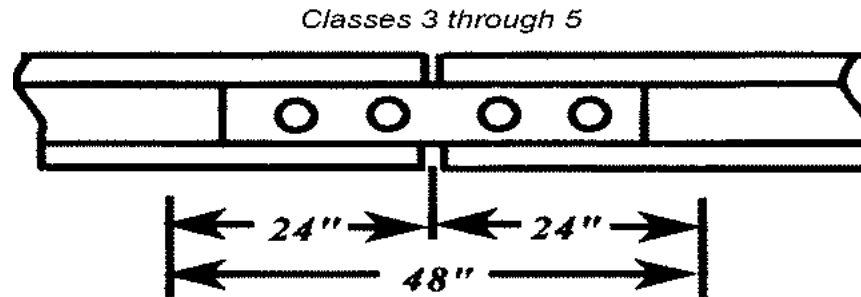


Figure 3

(f) For track constructed without crossties, such as slab track, track connected directly to bridge structural components, track over servicing pits, etc., the track structure shall meet the requirements of paragraph (b)(1) of this section.

[76 FR 18084, Apr. 1, 2011]

§213.110 Gage restraint measurement systems.

(a) A track owner may elect to implement a Gage Restraint Measurement System (GRMS), supplemented by the use of a Portable Track Loading Fixture (PTLF), to determine compliance with the crosstie and fastener requirements specified in §§213.109 and 213.127 provided that—

(1) The track owner notifies the appropriate FRA Regional office at least 30 days prior to the designation of any line segment on which GRMS technology will be implemented; and

(2) The track owner notifies the appropriate FRA Regional office at least 10 days prior to the removal of any line segment from GRMS designation.

(b) Initial notification under paragraph (a)(1) of this section shall include—

(1) Identification of the line segment(s) by timetable designation,

milepost limits, class of track, or other identifying criteria; and

(2) The most recent record of million gross tons of traffic per year over the identified segment(s).

(c) The track owner shall also provide to FRA sufficient technical data to establish compliance with the minimum design requirements of a GRMS vehicle which specify that—

(1) Gage restraint shall be measured between the heads of rail—

(A) At an interval not exceeding 16 inches;

(B) Under an applied vertical load of no less than 10,000 pounds per rail; and

(C) Under an applied lateral load which provides for a lateral/vertical load ratio between 0.5 and 1.25, and a load severity greater than 3,000 pounds but less than 8,000 pounds.

(d) Load severity is defined by the formula— $S=L-cV$

Where—

S =Load severity, defined as the lateral load applied to the fastener system (pounds).

L =Actual lateral load applied (pounds).

c =Coefficient of friction between rail/tie which is assigned a nominal value of (0.4).

V =Actual vertical load applied (pounds).

(e) The measured gage values shall be converted to a Projected Loaded Gage 24 (PLG 24) as follows—

$$PLG\ 24 = UTG + A \times (LTG - UTG)$$

§213.110

49 CFR Ch. II (10–1–11 Edition)

Where—

UTG=Unloaded track gage measured by the GRMS vehicle at a point no less than 10 feet from any lateral or vertical load application.

LTG=Loaded track gage measured by the GRMS vehicle at a point no more than 12

inches from the lateral load application point.

A=The extrapolation factor used to convert the measured loaded gage to expected loaded gage under a 24,000 pound lateral load and a 33,000 pound vertical load.

For all track—

$$A = \frac{13.153}{(.001 \times L - .000258 \times V) - .009 \times (.001 \times L - .000258 \times V)^2}$$

NOTE: The A factor shall not exceed (3.184) under any valid loading configuration.

where—

L=Actual lateral load applied (pounds).

V=Actual vertical load applied (pounds).

(f) The measured gage value shall be converted to a Gage Widening Ratio (GWR) as follows—

$$GWR = \frac{(LTG - UTG)}{L} \times 16,000$$

(g) The GRMS vehicle shall be capable of producing output reports that provide a trace, on a constant-distance scale, of all parameters specified in paragraph (l) of this section.

(h) The GRMS vehicle shall be capable of providing an exception report containing a systematic listing of all exceptions, by magnitude and location, to all the parameters specified in paragraph (l) of this section.

(i) The exception reports required by this section shall be provided to the appropriate person designated as fully qualified under §213.7 prior to the next inspection required under §213.233.

(j) The track owner shall institute the necessary procedures for maintaining the integrity of the data collected by the GRMS and PTLF systems. At a minimum, the track owner shall—

(1) Maintain and make available to the Federal Railroad Administration documented calibration procedures on each GRMS vehicle which, at a minimum, shall specify a daily instrument verification procedure that will ensure correlation between measurements made on the ground and those recorded by the instrumentation with respect to loaded and unloaded gage parameters; and

(2) Maintain each PTLF used for determining compliance with the requirements of this section such that the 4,000-pound reading is accurate to within five percent of that reading.

(k) The track owner shall provide training in GRMS technology to all persons designated as fully qualified under §213.7 and whose territories are subject to the requirements of this section. The training program shall be made available to the Federal Railroad Administration upon request. At a minimum, the training program shall address—

(1) Basic GRMS procedures;

(2) Interpretation and handling of exception reports generated by the GRMS vehicle;

(3) Locating and verifying defects in the field;

(4) Remedial action requirements;

(5) Use and calibration of the PTLF; and

(6) Recordkeeping requirements.

(l) The GRMS record of lateral restraint shall identify two exception levels. At a minimum, the track owner shall initiate the required remedial action at each exception level as defined in the following table—

Federal Railroad Administration, DOT

§213.110

GRMS parameter ¹	If measurement value exceeds	Remedial action required
First Level Exception		
UTG	58 inches	(1) Immediately protect the exception location with a 10 mph speed restriction; then verify location; and (2) Restore lateral restraint and maintain in compliance with PTLF criteria as described in paragraph (m) of this section; and (3) Maintain compliance with §213.53(b) of this part as measured with the PTLF.
LTG	58 inches.	Second Level Exception
PLG24	59 inches.	
GWR	1.0 inches.	
LTG	57¾ inches on Class 4 and 5 track ² .	² Limit operating speed to no more than the maximum allowable under §213.9 for Class 3 track; then verify location; and (1) Maintain in compliance with PTLF criteria as described in paragraph (m) of this section; and (2) Maintain compliance with §213.53(b) of this part as measured with the PTLF.
PLG24	58 inches.	
GWR	0.75 inches.	

¹ Definitions for the GRMS parameters referenced in this table are found in paragraph (p) of this section.

² This note recognizes that typical good track will increase in total gage by as much as ¼ inch due to outward rail rotation under GRMS loading conditions. For Class 2 & 3 track, the GRMS LTG values are also increased by ¼ inch to a maximum of 58 inches. However, for any Class of track, GRMS LTG values in excess of 58 inches are considered First Level exceptions and the appropriate remedial actions must be taken by the track owner. This ¼-inch increase in allowable gage applies only to GRMS LTG. For gage measured by traditional methods, or with the use of the PTLF, the table in §213.53(b) will apply.

(m) Between GRMS inspections, the PTLF may be used as an additional analytical tool to assist fully qualified §213.7 individuals in determining compliance with the crosstie and fastener requirements of §§213.109 and 213.127. When the PTLF is used, whether as an additional analytical tool or to fulfill the requirements of paragraph (l), it shall be used subject to the following criteria—

(1) At any location along the track that the PTLF is applied, that location will be deemed in compliance with the crosstie and fastener requirements specified in §§213.109 and 213.127 provided that—

(i) The total gage widening at that location does not exceed ⅝ inch when increasing the applied force from 0 to 4,000 pounds; and

(ii) The gage of the track under 4,000 pounds of applied force does not exceed the allowable gage prescribed in §213.53(b) for the class of track.

(2) Gage widening in excess of ⅝ inch shall constitute a deviation from Class 1 standards.

(3) A person designated as fully qualified under §213.7 retains the discretionary authority to prescribe additional remedial actions for those locations which comply with the require-

ments of paragraph (m)(1)(i) and (ii) of this section.

(4) When a functional PTLF is not available to a fully qualified person designated under §213.7, the criteria for determining crosstie and fastener compliance shall be based solely on the requirements specified in §§213.109 and 213.127.

(5) If the PTLF becomes non-functional or is missing, the track owner will replace or repair it before the next inspection required under §213.233.

(6) Where vertical loading of the track is necessary for contact with the lateral rail restraint components, a PTLF test will not be considered valid until contact with these components is restored under static loading conditions.

(n) The track owner shall maintain a record of the two most recent GRMS inspections at locations which meet the requirements specified in §213.241(b). At a minimum, records shall indicate the following—

(1) Location and nature of each First Level exception; and

(2) Nature and date of remedial action, if any, for each exception identified in paragraph (n)(1) of this section.

(o) The inspection interval for designated GRMS line segments shall be such that—

§213.113**49 CFR Ch. II (10–1–11 Edition)**

(1) On line segments where the annual tonnage exceeds two million gross tons, or where the maximum operating speeds for passenger trains exceeds 30 mph, GRMS inspections must be performed annually at an interval not to exceed 14 months; or

(2) On line segments where the annual tonnage is two million gross tons or less and the maximum operating speed for passenger trains does not exceed 30 mph, the interval between GRMS inspections must not exceed 24 months.

(p) As used in this section—

(1) *Gage Restraint Measurement System (GRMS)* means a track loading vehicle meeting the minimum design requirements specified in this section.

(2) *Gage Widening Ratio (GWR)* means the measured difference between loaded and unloaded gage measurements, linearly normalized to 16,000 pounds of applied lateral load.

(3) *L/V ratio* means the numerical ratio of lateral load applied at a point on the rail to the vertical load applied at that same point. GRMS design requirements specify an L/V ratio of between 0.5 and 1.25. GRMS vehicles using load combinations developing L/V ratios which exceed 0.8 must be operated with caution to protect against the risk of wheel climb by the test wheelset.

(4) *Load severity* means the amount of lateral load applied to the fastener system after friction between rail and tie is overcome by any applied gage-widening lateral load.

(5) *Loaded Track Gage (LTG)* means the gage measured by the GRMS vehicle at a point no more than 12 inches from the lateral load application point.

(6) *Portable Track Loading Fixture (PTLF)* means a portable track loading device capable of applying an increasing lateral force from 0 to 4,000 pounds on the web/base fillet of each rail simultaneously.

(7) *Projected Loaded Gage (PLG)* means an extrapolated value for loaded gage calculated from actual measured loads and deflections. PLG 24 means the extrapolated value for loaded gage under a 24,000 pound lateral load and a 33,000 pound vertical load.

(8) *Unloaded Track Gage (UTG)* means the gage measured by the GRMS vehicle at a point no less than 10 feet from any lateral or vertical load.

[66 FR 1899, Jan. 10, 2001; 66 FR 8372, Jan. 31, 2001]

§213.113 Defective rails.

(a) When an owner of track to which this part applies learns, through inspection or otherwise, that a rail in that track contains any of the defects listed in the following table, a person designated under §213.7 shall determine whether or not the track may continue in use. If he determines that the track may continue in use, operation over the defective rail is not permitted until—

(1) The rail is replaced; or

(2) The remedial action prescribed in the table is initiated.

Federal Railroad Administration, DOT

§ 213.113

183

REMEDIAL ACTION

Defect	Length of defect (inch)		Percent of rail head cross-sectional area weakened by defect		If defective rail is not replaced, take the remedial action prescribed in note
	More than	But not more than	Less than	But not less than	
Transverse fissure			70	5	B, A2, A.
			100	70	
				100	
Compound fissure			70	5	B, A2, A.
			100	70	
				100	
Detail fracture Engine burn fracture Defective weld			25	5	C, D, [A2] or [E and H], [A] or [E and H].
			89	25	
			100	80	
				100	
Horizontal split head Vertical split head Split web Piped rail Head web separation	1	2 .....	.....	.....	If and F, I and G, B, A.
	2	4 .....	.....	.....	
	4	(1)	(1) .....	.....	
	(1)	(1)	(1) .....	.....	
Hot hole crack	3/4	1 .....	.....	.....	H and F, H and G, B, A.
	1	1 1/4 .....	.....	.....	
	(1)	(1)	(1) .....	.....	
	(1)	(1)	(1) .....	.....	
Broken base	1	6 .....	.....	.....	D, [A] or [E and I].
	6 .....	.....	.....	.....	
Ordinary break	.....	.....	.....	.....	A or E.
Damaged rail	.....	.....	.....	.....	D.
Flattened rail	Depth > 1/8 and Length > 8	.....	.....	.....	H.

(1) Break out in rail head.

Notes: A. Assign person designated under § 213.7 to visually supervise each operation over defective rail.

A2. Assign person designated under § 213.7 to make visual inspection. After a visual inspection, that person may authorize operation to continue without continuous visual

§213.113

49 CFR Ch. II (10–1–11 Edition)

supervision at a maximum of 10 m.p.h. for up to 24 hours prior to another such visual inspection or replacement or repair of the rail.

B. Limit operating speed over defective rail to that as authorized by a person designated under §213.7(a), who has at least one year of supervisory experience in railroad track maintenance. The operating speed cannot be over 30 m.p.h. or the maximum allowable speed under §213.9 for the class of track concerned, whichever is lower.

C. Apply joint bars bolted only through the outermost holes to defect within 20 days after it is determined to continue the track in use. In the case of Classes 3 through 5 track, limit operating speed over defective rail to 30 m.p.h. until joint bars are applied; thereafter, limit speed to 50 m.p.h. or the maximum allowable speed under §213.9 for the class of track concerned, whichever is lower. When a search for internal rail defects is conducted under §213.237, and defects are discovered in Classes 3 through 5 which require remedial action C, the operating speed shall be limited to 50 m.p.h., or the maximum allowable speed under §213.9 for the class of track concerned, whichever is lower, for a period not to exceed 4 days. If the defective rail has not been removed from the track or a permanent repair made within 4 days of the discovery, limit operating speed over the defective rail to 30 m.p.h. until joint bars are applied; thereafter, limit speed to 50 m.p.h. or the maximum allowable speed under §213.9 for the class of track concerned, whichever is lower.

D. Apply joint bars bolted only through the outermost holes to defect within 10 days after it is determined to continue the track in use. In the case of Classes 3 through 5 track, limit operating speed over the defective rail to 30 m.p.h. or less as authorized by a person designated under §213.7(a), who has at least one year of supervisory experience in railroad track maintenance, until joint bars are applied; thereafter, limit speed to 50 m.p.h. or the maximum allowable speed under §213.9 for the class of track concerned, whichever is lower.

E. Apply joint bars to defect and bolt in accordance with §213.121(d) and (e).

F. Inspect rail 90 days after it is determined to continue the track in use.

G. Inspect rail 30 days after it is determined to continue the track in use.

H. Limit operating speed over defective rail to 50 m.p.h. or the maximum allowable speed under §213.9 for the class of track concerned, whichever is lower.

I. Limit operating speed over defective rail to 30 m.p.h. or the maximum allowable speed under §213.9 for the class of track concerned, whichever is lower.

(b) As used in this section—

(1) *Transverse fissure* means a progressive crosswise fracture starting from a

crystalline center or nucleus inside the head from which it spreads outward as a smooth, bright, or dark, round or oval surface substantially at a right angle to the length of the rail. The distinguishing features of a transverse fissure from other types of fractures or defects are the crystalline center or nucleus and the nearly smooth surface of the development which surrounds it.

(2) *Compound fissure* means a progressive fracture originating in a horizontal split head which turns up or down in the head of the rail as a smooth, bright, or dark surface progressing until substantially at a right angle to the length of the rail. Compound fissures require examination of both faces of the fracture to locate the horizontal split head from which they originate.

(3) *Horizontal split head* means a horizontal progressive defect originating inside of the rail head, usually one-quarter inch or more below the running surface and progressing horizontally in all directions, and generally accompanied by a flat spot on the running surface. The defect appears as a crack lengthwise of the rail when it reaches the side of the rail head.

(4) *Vertical split head* means a vertical split through or near the middle of the head, and extending into or through it. A crack or rust streak may show under the head close to the web or pieces may be split off the side of the head.

(5) *Split web* means a lengthwise crack along the side of the web and extending into or through it.

(6) *Piped rail* means a vertical split in a rail, usually in the web, due to failure of the shrinkage cavity in the ingot to unite in rolling.

(7) *Broken base* means any break in the base of the rail.

(8) *Detail fracture* means a progressive fracture originating at or near the surface of the rail head. These fractures should not be confused with transverse fissures, compound fissures, or other defects which have internal origins. Detail fractures may arise from shelly spots, head checks, or flaking.

(9) *Engine burn fracture* means a progressive fracture originating in spots where driving wheels have slipped on top of the rail head. In developing downward they frequently resemble the

Federal Railroad Administration, DOT**§213.118**

compound or even transverse fissures with which they should not be confused or classified.

(10) *Ordinary break* means a partial or complete break in which there is no sign of a fissure, and in which none of the other defects described in this paragraph (b) are found.

(11) *Damaged rail* means any rail broken or injured by wrecks, broken, flat, or unbalanced wheels, slipping, or similar causes.

(12) *Flattened rail* means a short length of rail, not at a joint, which has flattened out across the width of the rail head to a depth of $\frac{3}{8}$ inch or more below the rest of the rail. Flattened rail occurrences have no repetitive regularity and thus do not include corrugations, and have no apparent localized cause such as a weld or engine burn. Their individual length is relatively short, as compared to a condition such as head flow on the low rail of curves.

(13) *Bolt hole crack* means a crack across the web, originating from a bolt hole, and progressing on a path either inclined upward toward the rail head or inclined downward toward the base. Fully developed bolt hole cracks may continue horizontally along the head/web or base/web fillet, or they may progress into and through the head or base to separate a piece of the rail end from the rail. Multiple cracks occurring in one rail end are considered to be a single defect. However, bolt hole cracks occurring in adjacent rail ends within the same joint must be reported as separate defects.

(14) *Defective weld* means a field or plant weld containing any discontinuities or pockets, exceeding 5 percent of the rail head area individually or 10 percent in the aggregate, oriented in or near the transverse plane, due to incomplete penetration of the weld metal between the rail ends, lack of fusion between weld and rail end metal, entrapment of slag or sand, under-bead or other shrinkage cracking, or fatigue cracking. Weld defects may originate in the rail head, web, or base, and in some cases, cracks may progress from the defect into either or both adjoining rail ends.

(15) *Head and web separation* means a progressive fracture, longitudinally

separating the head from the web of the rail at the head fillet area.

[63 FR 34029, June 22, 1998; 63 FR 51639, Sept. 28, 1998]

§213.115 Rail end mismatch.

Any mismatch of rails at joints may not be more than that prescribed by the following table—

Class of track	Any mismatch of rails at joints may not be more than the following—	
	On the tread of the rail ends (inch)	On the gage side of the rail ends (inch)
Class 1 track	$\frac{1}{4}$	$\frac{1}{4}$
Class 2 track	$\frac{1}{4}$	$\frac{3}{16}$
Class 3 track	$\frac{3}{16}$	$\frac{3}{16}$
Class 4 and 5 track	$\frac{1}{8}$	$\frac{1}{8}$

§213.118 Continuous welded rail (CWR); plan review and approval.

(a) Each track owner with track constructed of CWR shall have in effect and comply with a plan that contains written procedures which address: the installation, adjustment, maintenance, and inspection of CWR; inspection of CWR joints; and a training program for the application of those procedures.

(b) The track owner shall file its CWR plan with the FRA Associate Administrator for Railroad Safety/Chief Safety Officer (Associate Administrator). Within 30 days of receipt of the submission, FRA will review the plan for compliance with this subpart. FRA will approve, disapprove or conditionally approve the submitted plan, and will provide written notice of its determination.

(c) The track owner's existing plan shall remain in effect until the track owner's new plan is approved or conditionally approved and is effective pursuant to paragraph (d) of this section.

(d) The track owner shall, upon receipt of FRA's approval or conditional approval, establish the plan's effective date. The track owner shall advise in writing FRA and all affected employees of the effective date.

(e) FRA, for cause stated, may, subsequent to plan approval or conditional approval, require revisions to the plan to bring the plan into conformity with this subpart. Notice of a revision requirement shall be made in writing and specify the basis of FRA's requirement. The track owner may, within 30 days of

§213.119

the revision requirement, respond and provide written submissions in support of the original plan. FRA renders a final decision in writing. Not more than 30 days following any final decision requiring revisions to a CWR plan, the track owner shall amend the plan in accordance with FRA's decision and resubmit the conforming plan. The conforming plan becomes effective upon its submission to FRA.

[74 FR 43002, Aug. 25, 2009]

§213.119 Continuous welded rail (CWR); plan contents.

The track owner shall comply with the contents of the CWR plan approved or conditionally approved under §213.118. The plan shall contain the following elements—

(a) Procedures for the installation and adjustment of CWR which include—

(1) Designation of a desired rail installation temperature range for the geographic area in which the CWR is located; and

(2) De-stressing procedures/methods which address proper attainment of the desired rail installation temperature range when adjusting CWR.

(b) Rail anchoring or fastening requirements that will provide sufficient restraint to limit longitudinal rail and crosstie movement to the extent practical, and specifically addressing CWR rail anchoring or fastening patterns on bridges, bridge approaches, and at other locations where possible longitudinal rail and crosstie movement associated with normally expected train-induced forces, is restricted.

(c) CWR joint installation and maintenance procedures which require that—

(1) Each rail shall be bolted with at least two bolts at each CWR joint;

(2) In the case of a bolted joint installed during CWR installation after October 21, 2009, the track owner shall either, within 60 days—

(i) Weld the joint;

(ii) Install a joint with six bolts; or

(iii) Anchor every tie 195 feet in both directions from the joint; and

(3) In the case of a bolted joint in CWR experiencing service failure or a failed bar with a rail gap present, the track owner shall either—

49 CFR Ch. II (10–1–11 Edition)

(i) Weld the joint;

(ii) Replace the broken bar(s), replace the broken bolts, adjust the anchors and, within 30 days, weld the joint;

(iii) Replace the broken bar(s), replace the broken bolts, install one additional bolt per rail end, and adjust anchors;

(iv) Replace the broken bar(s), replace the broken bolts, and anchor every tie 195 feet in both directions from the CWR joint; or

(v) Replace the broken bar(s), replace the broken bolts, add rail with provisions for later adjustment pursuant to paragraph (d)(2) of this section, and re-apply the anchors.

(d) Procedures which specifically address maintaining a desired rail installation temperature range when cutting CWR, including rail repairs, in-track welding, and in conjunction with adjustments made in the area of tight track, a track buckle, or a pull-apart. Rail repair practices shall take into consideration existing rail temperature so that—

(1) When rail is removed, the length installed shall be determined by taking into consideration the existing rail temperature and the desired rail installation temperature range; and

(2) Under no circumstances should rail be added when the rail temperature is below that designated by paragraph (a)(1) of this section, without provisions for later adjustment.

(e) Procedures which address the monitoring of CWR in curved track for inward shifts of alignment toward the center of the curve as a result of disturbed track.

(f) Procedures which govern train speed on CWR track when—

(1) Maintenance work, track rehabilitation, track construction, or any other event occurs which disturbs the roadbed or ballast section and reduces the lateral or longitudinal resistance of the track; and

(2) The difference between the average rail temperature and the average rail neutral temperature is in a range that causes buckling-prone conditions to be present at a specific location; and

(3) In formulating the procedures under paragraphs (f)(1) and (f)(2) of this section, the track owner shall—

Federal Railroad Administration, DOT

§213.119

(i) Determine the speed required, and the duration and subsequent removal of any speed restriction based on the restoration of the ballast, along with sufficient ballast re-consolidation to stabilize the track to a level that can accommodate expected train-induced forces. Ballast re-consolidation can be achieved through either the passage of train tonnage or mechanical stabilization procedures, or both; and

(ii) Take into consideration the type of crossties used.

(g) Procedures which prescribe when physical track inspections are to be performed.

(1) At a minimum, these procedures shall address inspecting track to identify—

(i) Buckling-prone conditions in CWR track, including—

(A) Locations where tight or kinky rail conditions are likely to occur; and

(B) Locations where track work of the nature described in paragraph (f)(1)(i) of this section has recently been performed; and

(ii) Pull-apart prone conditions in CWR track, including locations where pull-apart or stripped-joint rail conditions are likely to occur; and

(2) In formulating the procedures under paragraph (g)(1) of this section, the track owner shall—

(i) Specify when the inspections will be conducted; and

(ii) Specify the appropriate remedial actions to be taken when either buckling-prone or pull-apart prone conditions are found.

(h) Procedures which prescribe the scheduling and conduct of inspections to detect cracks and other indications of potential failures in CWR joints. In formulating the procedures under this paragraph, the track owner shall—

(1) Address the inspection of joints and the track structure at joints, in-

cluding, at a minimum, periodic on-foot inspections;

(2) Identify joint bars with visible or otherwise detectable cracks and conduct remedial action pursuant to §213.121;

(3) Specify the conditions of actual or potential joint failure for which personnel must inspect, including, at a minimum, the following items:

(i) Loose, bent, or missing joint bolts;

(ii) Rail end batter or mismatch that contributes to instability of the joint; and

(iii) Evidence of excessive longitudinal rail movement in or near the joint, including, but not limited to; wide rail gap, defective joint bolts, disturbed ballast, surface deviations, gap between tie plates and rail, or displaced rail anchors;

(4) Specify the procedures for the inspection of CWR joints that are imbedded in highway-rail crossings or in other structures that prevent a complete inspection of the joint, including procedures for the removal from the joint of loose material or other temporary material;

(5) Specify the appropriate corrective actions to be taken when personnel find conditions of actual or potential joint failure, including on-foot follow-up inspections to monitor conditions of potential joint failure in any period prior to completion of repairs;

(6) Specify the timing of periodic inspections, which shall be based on the configuration and condition of the joint:

(i) Except as provided in paragraphs (h)(6)(ii) through (h)(6)(iv) of this section, track owners must specify that all CWR joints are inspected, at a minimum, in accordance with the intervals identified in the following table:

MINIMUM NUMBER OF INSPECTIONS PER CALENDAR YEAR ¹

	Freight trains operating over track with an annual tonnage of:			Passenger trains operating over track with an annual tonnage of:	
	Less than 40 mgt	40 to 60 mgt	Greater than 60 mgt	Less than 20 mgt	Greater than or equal to 20 mgt
Class 5 & above	2	3 ²	4 ²	3 ²	3 ²
Class 4	2	3 ²	4 ²	2	3 ²
Class 3	1	2	2	2	2
Class 2	0	0	0	1	1

§213.119

49 CFR Ch. II (10–1–11 Edition)

MINIMUM NUMBER OF INSPECTIONS PER CALENDAR YEAR¹—Continued

	Freight trains operating over track with an annual tonnage of:			Passenger trains operating over track with an annual tonnage of:	
	Less than 40 mgt	40 to 60 mgt	Greater than 60 mgt	Less than 20 mgt	Greater than or equal to 20 mgt
Class 1	0	0	0	0	0
Excepted Track	0	0	0	n/a	n/a

4 = Four times per calendar year, with one inspection in each of the following periods: January to March, April to June, July to September, and October to December; and with consecutive inspections separated by at least 60 calendar days.

3 = Three times per calendar year, with one inspection in each of the following periods: January to April, May to August, and September to December; and with consecutive inspections separated by at least 90 calendar days.

2 = Twice per calendar year, with one inspection in each of the following periods: January to June and July to December; and with consecutive inspections separated by at least 120 calendar days.

1 = Once per calendar year, with consecutive inspections separated by at least 180 calendar days.

¹ Where a track owner operates both freight and passenger trains over a given segment of track, and there are two different possible inspection interval requirements, the more frequent inspection interval applies.

² When extreme weather conditions prevent a track owner from conducting an inspection of a particular territory within the required interval, the track owner may extend the interval by up to 30 calendar days from the last day that the extreme weather condition prevented the required inspection.

(ii) Consistent with any limitations applied by the track owner, a passenger train conducting an unscheduled detour operation may proceed over track not normally used for passenger operations at a speed not to exceed the maximum authorized speed otherwise allowed, even though CWR joints have not been inspected in accordance with the frequency identified in paragraph (h)(6)(i) of this section, provided that:

(A) All CWR joints have been inspected consistent with requirements for freight service; and

(B) The unscheduled detour operation lasts no more than 14 consecutive calendar days. In order to continue operations beyond the 14-day period, the track owner must inspect the CWR joints in accordance with the requirements of paragraph (h)(6)(i) of this section.

(iii) Tourist, scenic, historic, or excursion operations, if limited to the maximum authorized speed for passenger trains over the next lower class of track, need not be considered in determining the frequency of inspections under paragraph (h)(6)(i) of this section.

(iv) All CWR joints that are located in switches, turnouts, track crossings, lift rail assemblies or other transition devices on moveable bridges must be inspected on foot at least monthly, consistent with the requirements in §213.235; and all records of those inspections must be kept in accordance with

the requirements in §213.241. A track owner may include in its §213.235 inspections, in lieu of the joint inspections required by paragraph (h)(6)(i) of this section, CWR joints that are located in track structure that is adjacent to switches and turnouts, provided that the track owner precisely defines the parameters of that arrangement in the CWR plans.

(7) Specify the recordkeeping requirements related to joint bars in CWR, including the following:

(i) The track owner shall keep a record of each periodic and follow-up inspection required to be performed by the track owner's CWR plan, except for those inspections conducted pursuant to §213.235 for which track owners must maintain records pursuant to §213.241. The record shall be prepared on the day the inspection is made and signed by the person making the inspection. The record shall include, at a minimum, the following items: the boundaries of the territory inspected; the nature and location of any deviations at the joint from the requirements of this part or of the track owner's CWR plan, with the location identified with sufficient precision that personnel could return to the joint and identify it without ambiguity; the date of the inspection; the remedial action, corrective action, or both, that has been taken or will be taken; and the name or identification number of the person who made the inspection.

Federal Railroad Administration, DOT

§213.119

(ii) The track owner shall generate a Fracture Report for every cracked or broken CWR joint bar that the track owner discovers during the course of an inspection conducted pursuant to §213.119(g), §213.233, or §213.235 on track that is required under §213.119(h)(6)(i) to be inspected.

(A) The Fracture Report shall be prepared on the day the cracked or broken joint bar is discovered. The Report shall include, at a minimum: the railroad name; the location of the joint bar as identified by milepost and subdivision; the class of track; annual million gross tons for the previous calendar year; the date of discovery of the crack or break; the rail section; the type of bar (standard, insulated, or compromise); the number of holes in the joint bar; a general description of the location of the crack or break in bar; the visible length of the crack in inches; the gap measurement between rail ends; the amount and length of rail end batter or ramp on each rail end; the amount of tread mismatch; the vertical movement of joint; and in curves or spirals, the amount of gage mismatch and the lateral movement of the joint.

(B) The track owner shall submit the information contained in the Fracture Reports to the FRA Associate Administrator twice annually, by July 31 for the preceding six-month period from January 1 through June 30 and by January 31 for the preceding six-month period from July 1 through December 31.

(C) After February 1, 2010, any track owner may petition FRA to conduct a technical conference to review the Fracture Report data submitted through December of 2009 and assess whether there is a continued need for the collection of Fracture Report data. The track owner shall submit a written request to the Associate Administrator, requesting the technical conference and explaining the reasons for proposing to discontinue the collection of the data.

(8) In lieu of the requirements for the inspection of rail joints contained in paragraphs (h)(1) through (h)(7) of this section, a track owner may seek approval from FRA to use alternate procedures.

(i) The track owner shall submit the proposed alternate procedures and a supporting statement of justification to the Associate Administrator.

(ii) If the Associate Administrator finds that the proposed alternate procedures provide an equivalent or higher level of safety than the requirements in paragraphs (h)(1) through (h)(7) of this section, the Associate Administrator will approve the alternate procedures by notifying the track owner in writing. The Associate Administrator will specify in the written notification the date on which the procedures will become effective, and after that date, the track owner shall comply with the procedures. If the Associate Administrator determines that the alternate procedures do not provide an equivalent level of safety, the Associate Administrator will disapprove the alternate procedures in writing, and the track owner shall continue to comply with the requirements in paragraphs (h)(1) through (h)(7) of this section.

(iii) While a determination is pending with the Associate Administrator on a request submitted pursuant to paragraph (h)(8) of this section, the track owner shall continue to comply with the requirements contained in paragraphs (h)(1) through (h)(7) of this section.

(i) The track owner shall have in effect a comprehensive training program for the application of these written CWR procedures, with provisions for annual re-training, for those individuals designated under §213.7(c) as qualified to supervise the installation, adjustment, and maintenance of CWR track and to perform inspections of CWR track. The track owner shall make the training program available for review by FRA upon request.

(j) The track owner shall prescribe and comply with recordkeeping requirements necessary to provide an adequate history of track constructed with CWR. At a minimum, these records must include:

(1) Rail temperature, location, and date of CWR installations. Each record shall be retained for at least one year;

(2) A record of any CWR installation or maintenance work that does not conform to the written procedures. Such record shall include the location

§213.119

49 CFR Ch. II (10–1–11 Edition)

of the rail and be maintained until the CWR is brought into conformance with such procedures; and

(3) Information on inspection of rail joints as specified in paragraph (h)(7) of this section.

(k) The track owner shall make readily available, at every job site where personnel are assigned to install, inspect or maintain CWR, a copy of the track owner's CWR procedures and all revisions, appendices, updates, and referenced materials related thereto prior to their effective date. Such CWR procedures shall be issued and maintained in one CWR standards and procedures manual.

(l) As used in this section—

Adjusting/de-stressing means a procedure by which a rail's neutral temperature is re-adjusted to the desired value. It typically consists of cutting the rail and removing rail anchoring devices, which provides for the necessary expansion and contraction, and then re-assembling the track.

Annual re-training means training every calendar year.

Buckling incident means the formation of a lateral misalignment sufficient in magnitude to constitute a deviation from the Class 1 requirements specified in §213.55. These normally occur when rail temperatures are relatively high and are caused by high longitudinal compressive forces.

Buckling-prone condition means a track condition that can result in the track being laterally displaced due to high compression forces caused by critical rail temperature combined with insufficient track strength and/or train dynamics.

Continuous welded rail (CWR) means rail that has been welded together into lengths exceeding 400 feet. Rail installed as CWR remains CWR, regardless of whether a joint or plug is installed into the rail at a later time.

Corrective actions mean those actions which track owners specify in their CWR plans to address conditions of actual or potential joint failure, including, as applicable, repair, restrictions on operations, and additional on-foot inspections.

CWR joint means any joint directly connected to CWR.

Desired rail installation temperature range means the rail temperature range, within a specific geographical area, at which forces in CWR should not cause a buckling incident in extreme heat, or a pull apart during extreme cold weather.

Disturbed track means the disturbance of the roadbed or ballast section, as a result of track maintenance or any other event, which reduces the lateral or longitudinal resistance of the track, or both.

Mechanical stabilization means a type of procedure used to restore track resistance to disturbed track following certain maintenance operations. This procedure may incorporate dynamic track stabilizers or ballast consolidators, which are units of work equipment that are used as a substitute for the stabilization action provided by the passage of tonnage trains.

Pull apart or stripped joint means a condition when no bolts are mounted through a joint on the rail end, rendering the joint bar ineffective due to excessive expansive or contractive forces.

Pull-apart prone condition means a condition when the actual rail temperature is below the rail neutral temperature at or near a joint where longitudinal tensile forces may affect the fastenings at the joint.

Rail anchors mean those devices which are attached to the rail and bear against the side of the crosstie to control longitudinal rail movement. Certain types of rail fasteners also act as rail anchors and control longitudinal rail movement by exerting a downward clamping force on the upper surface of the rail base.

Rail neutral temperature is the temperature at which the rail is neither in compression nor tension.

Rail temperature means the temperature of the rail, measured with a rail thermometer.

Remedial actions mean those actions which track owners are required to take as a result of requirements of this part to address a non-compliant condition.

Tight/kinky rail means CWR which exhibits minute alignment irregularities which indicate that the rail is in a considerable amount of compression.

Federal Railroad Administration, DOT**§ 213.123**

Tourist, scenic, historic, or excursion operations mean railroad operations that carry passengers with the conveyance of the passengers to a particular destination not being the principal purpose.

Track lateral resistance means the resistance provided by the rail/crosstie structure against lateral displacement.

Track longitudinal resistance means the resistance provided by the rail anchors/rail fasteners and the ballast section to the rail/crosstie structure against longitudinal displacement.

Train-induced forces means the vertical, longitudinal, and lateral dynamic forces which are generated during train movement and which can contribute to the buckling potential of the rail.

Unscheduled detour operation means a short-term, unscheduled operation where a track owner has no more than 14 calendar days' notice that the operation is going to occur.

[74 FR 43002, Aug. 25, 2009, as amended at 74 FR 53889, Oct. 21, 2009; 75 FR 4705, Jan. 29, 2010]

§ 213.121 Rail joints.

(a) Each rail joint, insulated joint, and compromise joint shall be of a structurally sound design and dimensions for the rail on which it is applied.

(b) If a joint bar on Classes 3 through 5 track is cracked, broken, or because of wear allows excessive vertical movement of either rail when all bolts are tight, it shall be replaced.

(c) If a joint bar is cracked or broken between the middle two bolt holes it shall be replaced.

(d) In the case of conventional jointed track, each rail shall be bolted with at least two bolts at each joint in Classes 2 through 5 track, and with at least one bolt in Class 1 track.

(e) In the case of continuous welded rail track, each rail shall be bolted with at least two bolts at each joint.

(f) Each joint bar shall be held in position by track bolts tightened to allow the joint bar to firmly support the abutting rail ends and to allow longitudinal movement of the rail in the joint to accommodate expansion and contraction due to temperature variations. When no-slip, joint-to-rail contact exists by design, the requirements of this

paragraph do not apply. Those locations when over 400 feet in length, are considered to be continuous welded rail track and shall meet all the requirements for continuous welded rail track prescribed in this part.

(g) No rail shall have a bolt hole which is torch cut or burned in Classes 2 through 5 track. For Class 2 track, this paragraph (g) is applicable September 21, 1999.

(h) No joint bar shall be reconfigured by torch cutting in Classes 3 through 5 track.

§ 213.122 Torch cut rail.

(a) Except as a temporary repair in emergency situations no rail having a torch cut end shall be used in Classes 3 through 5 track. When a rail end is torch cut in emergency situations, train speed over that rail end shall not exceed the maximum allowable for Class 2 track. For existing torch cut rail ends in Classes 3 through 5 track the following shall apply—

(1) Within one year of September 21, 1998, all torch cut rail ends in Class 5 track shall be removed;

(2) Within two years of September 21, 1998, all torch cut rail ends in Class 4 track shall be removed; and

(3) Within one year of September 21, 1998, all torch cut rail ends in Class 3 track over which regularly scheduled passenger trains operate, shall be inventoried by the track owner.

(b) Following the expiration of the time limits specified in paragraphs (a)(1), (2), and (3) of this section, any torch cut rail end not removed from Classes 4 and 5 track, or any torch cut rail end not inventoried in Class 3 track over which regularly scheduled passenger trains operate, shall be removed within 30 days of discovery. Train speed over that rail end shall not exceed the maximum allowable for Class 2 track until removed.

§ 213.123 Tie plates.

(a) In Classes 3 through 5 track where timber crossties are in use there shall be tie plates under the running rails on at least eight of any 10 consecutive ties.

(b) In Classes 3 through 5 track no metal object which causes a concentrated load by solely supporting a

§ 213.127

rail shall be allowed between the base of the rail and the bearing surface of the tie plate. This paragraph (b) is applicable September 21, 1999.)

§ 213.127 Rail fastening systems.

(a) Track shall be fastened by a system of components that effectively maintains gage within the limits prescribed in § 213.53(b). Each component of each such system shall be evaluated to determine whether gage is effectively being maintained.

(b) If rail anchors are applied to concrete crossties, the combination of the crossties, fasteners, and rail anchors must provide effective longitudinal restraint.

(c) Where fastener placement impedes insulated joints from performing as intended, the fastener may be modified or removed, provided that the crosstie supports the rail.

[76 FR 18086, Apr. 1, 2011]

§ 213.133 Turnouts and track crossings generally.

(a) In turnouts and track crossings, the fastenings shall be intact and maintained so as to keep the components securely in place. Also, each switch, frog, and guard rail shall be kept free of obstructions that may interfere with the passage of wheels.

(b) Classes 3 through 5 track shall be equipped with rail anchoring through and on each side of track crossings and turnouts, to restrain rail movement affecting the position of switch points and frogs. For Class 3 track, this paragraph (b) is applicable September 21, 1999.)

(c) Each flangeway at turnouts and track crossings shall be at least 1½ inches wide.

§ 213.135 Switches.

(a) Each stock rail must be securely seated in switch plates, but care shall be used to avoid canting the rail by overtightening the rail braces.

(b) Each switch point shall fit its stock rail properly, with the switch stand in either of its closed positions to allow wheels to pass the switch point. Lateral and vertical movement of a stock rail in the switch plates or of a switch plate on a tie shall not adversely affect the fit of the switch

49 CFR Ch. II (10–1–11 Edition)

point to the stock rail. Broken or cracked switch point rails will be subject to the requirements of § 213.113, except that where remedial actions C, D, or E require the use of joint bars, and joint bars cannot be placed due to the physical configuration of the switch, remedial action B will govern, taking into account any added safety provided by the presence of reinforcing bars on the switch points.

(c) Each switch shall be maintained so that the outer edge of the wheel tread cannot contact the gage side of the stock rail.

(d) The heel of each switch rail shall be secure and the bolts in each heel shall be kept tight.

(e) Each switch stand and connecting rod shall be securely fastened and operable without excessive lost motion.

(f) Each throw lever shall be maintained so that it cannot be operated with the lock or keeper in place.

(g) Each switch position indicator shall be clearly visible at all times.

(h) Unusually chipped or worn switch points shall be repaired or replaced. Metal flow shall be removed to insure proper closure.

(i) Tongue & Plain Mate switches, which by design exceed Class 1 and excepted track maximum gage limits, are permitted in Class 1 and excepted track.

§ 213.137 Frogs.

(a) The flangeway depth measured from a plane across the wheel-bearing area of a frog on Class 1 track shall not be less than 1¾ inches, or less than 1½ inches on Classes 2 through 5 track.

(b) If a frog point is chipped, broken, or worn more than five-eighths inch down and 6 inches back, operating speed over the frog shall not be more than 10 m.p.h.

(c) If the tread portion of a frog casting is worn down more than three-eighths inch below the original contour, operating speed over that frog shall not be more than 10 m.p.h.

(d) Where frogs are designed as flange-bearing, flangeway depth may be less than that shown for Class 1 if operated at Class 1 speeds.

Federal Railroad Administration, DOT

§ 213.143

§ 213.139 Spring rail frogs.

(a) The outer edge of a wheel tread shall not contact the gage side of a spring wing rail.

(b) The toe of each wing rail shall be solidly tamped and fully and tightly bolted.

(c) Each frog with a bolt hole defect or head-web separation shall be replaced.

(d) Each spring shall have compression sufficient to hold the wing rail against the point rail.

(e) The clearance between the holddown housing and the horn shall not be more than one-fourth of an inch.

§ 213.141 Self-guarded frogs.

(a) The raised guard on a self-guarded frog shall not be worn more than three-eighths of an inch.

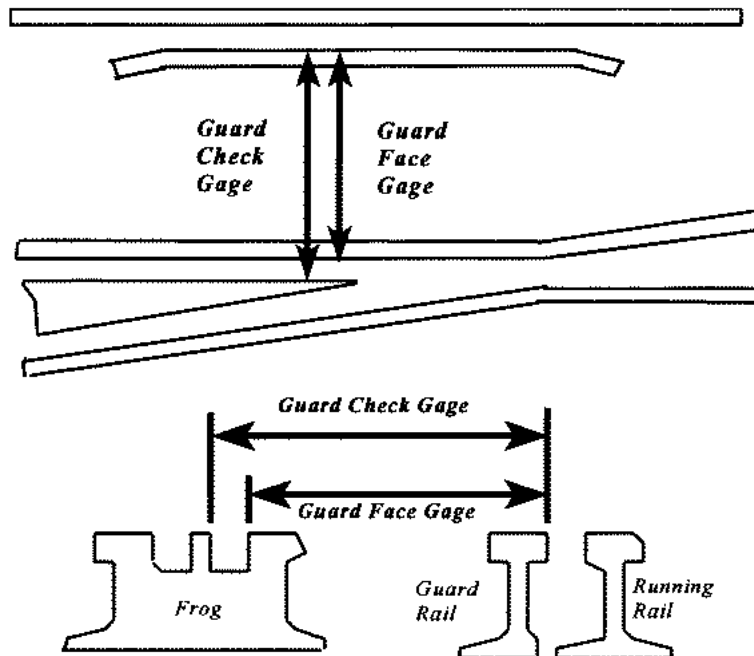
(b) If repairs are made to a self-guarded frog without removing it from service, the guarding face shall be restored before rebuilding the point.

§ 213.143 Frog guard rails and guard faces; gage.

The guard check and guard face gages in frogs shall be within the limits prescribed in the following table—

Class of track	Guard check gage The distance between the gage line of a frog to the guard line ¹ of its guard rail or guarding face, measured across the track at right angles to the gage line ² , may not be less than—	Guard face gage The distance between guard lines ¹ , measured across the track at right angles to the gage line ² , may not be more than—
Class 1 track	4' 6 1/8"	4' 5 1/4"
Class 2 track	4' 6 1/4"	4' 5 1/8"
Class 3 and 4 track	4' 6 3/8"	4' 5 1/8"
Class 5 track	4' 6 1/2"	4' 5"

¹ A line along that side of the flangeway which is nearer to the center of the track and at the same elevation as the gage line.
² A line 5/8 inch below the top of the center line of the head of the running rail, or corresponding location of the tread portion of the track structure.



§ 213.201**49 CFR Ch. II (10–1–11 Edition)****Subpart E—Track Appliances and Track-Related Devices****§ 213.201 Scope.**

This subpart prescribes minimum requirements for certain track appliances and track-related devices.

§ 213.205 Derails.

(a) Each derail shall be clearly visible.

(b) When in a locked position, a derail shall be free of lost motion which would prevent it from performing its intended function.

(c) Each derail shall be maintained to function as intended.

(d) Each derail shall be properly installed for the rail to which it is applied. (This paragraph (d) is applicable September 21, 1999.)

Subpart F—Inspection**§ 213.231 Scope.**

This subpart prescribes requirements for the frequency and manner of inspecting track to detect deviations from the standards prescribed in this part.

§ 213.233 Track inspections.

(a) All track shall be inspected in accordance with the schedule prescribed in paragraph (c) of this section by a person designated under § 213.7.

(b) Each inspection shall be made on foot or by riding over the track in a vehicle at a speed that allows the person making the inspection to visually inspect the track structure for compliance with this part. However, mechanical, electrical, and other track inspection devices may be used to supplement

visual inspection. If a vehicle is used for visual inspection, the speed of the vehicle may not be more than 5 miles per hour when passing over track crossings and turnouts, otherwise, the inspection vehicle speed shall be at the sole discretion of the inspector, based on track conditions and inspection requirements. When riding over the track in a vehicle, the inspection will be subject to the following conditions—

(1) One inspector in a vehicle may inspect up to two tracks at one time provided that the inspector's visibility remains unobstructed by any cause and that the second track is not centered more than 30 feet from the track upon which the inspector is riding;

(2) Two inspectors in one vehicle may inspect up to four tracks at a time provided that the inspectors' visibility remains unobstructed by any cause and that each track being inspected is centered within 39 feet from the track upon which the inspectors are riding;

(3) Each main track is actually traversed by the vehicle or inspected on foot at least once every two weeks, and each siding is actually traversed by the vehicle or inspected on foot at least once every month. On high density commuter railroad lines where track time does not permit an on track vehicle inspection, and where track centers are 15 foot or less, the requirements of this paragraph (b)(3) will not apply; and

(4) Track inspection records shall indicate which track(s) are traversed by the vehicle or inspected on foot as outlined in paragraph (b)(3) of this section.

(c) Each track inspection shall be made in accordance with the following schedule—

Class of track	Type of track	Required frequency
Excepted track and Class 1, 2, and 3 track.	Main track and sidings	Weekly with at least 3 calendar days interval between inspections, or before use, if the track is used less than once a week, or twice weekly with at least 1 calendar day interval between inspections, if the track carries passenger trains or more than 10 million gross tons of traffic during the preceding calendar year.
Excepted track and Class 1, 2, and 3 track.	Other than main track and sidings	Monthly with at least 20 calendar days interval between inspections.
Class 4 and 5 track .....	.....	Twice weekly with at least 1 calendar day interval between inspections.

Federal Railroad Administration, DOT

§ 213.234

(d) If the person making the inspection finds a deviation from the requirements of this part, the inspector shall immediately initiate remedial action.

NOTE TO § 213.233: Except as provided in paragraph (b) of this section, no part of this section will in any way be construed to limit the inspector's discretion as it involves inspection speed and sight distance.

§ 213.234 Automated inspection of track constructed with concrete crossties.

(a) *General.* Except for track described in paragraph (c) of this section, the provisions in this section are applicable on and after January 1, 2012. In addition to the track inspection required under § 213.233, for Class 3 main track constructed with concrete crossties over which regularly scheduled passenger service trains operate, and for Class 4 and 5 main track constructed with concrete crossties, automated inspection technology shall be used as indicated in paragraph (b) of this section, as a supplement to visual inspection, by Class I railroads (including Amtrak), Class II railroads, other intercity passenger railroads, and commuter railroads or small governmental jurisdictions that serve populations greater than 50,000. Automated inspection shall identify and report exceptions to conditions described in § 213.109(d)(4).

(b) *Frequency of automated inspections.* Automated inspections shall be conducted at the following frequencies:

(1) If annual tonnage on Class 4 and 5 main track and Class 3 main track with regularly scheduled passenger service, exceeds 40 million gross tons (mgt) annually, at least twice each calendar year, with no less than 160 days between inspections.

(2) If annual tonnage on Class 4 and 5 main track and Class 3 main track with regularly scheduled passenger service is equal to or less than 40 mgt annually, at least once each calendar year.

(3) On Class 3, 4, and 5 main track with exclusively passenger service, either an automated inspection or walking inspection must be conducted once per calendar year.

(4) Track not inspected in accordance with paragraph (b)(1) or (b)(2) of this

section because of train operation interruption shall be reinspected within 45 days of the resumption of train operations by a walking or automated inspection. If this inspection is conducted as a walking inspection, the next inspection shall be an automated inspection as prescribed in this paragraph.

(c) *Nonapplication.* Sections of tangent track 600 feet or less constructed of concrete crossties, including, but not limited to, isolated track segments, experimental or test track segments, highway-rail crossings, and wayside detectors, are excluded from the requirements of this section.

(d) *Performance standard for automated inspection measurement system.* The automated inspection measurement system must be capable of measuring and processing rail seat deterioration requirements that specify the following:

(1) An accuracy, to within $\frac{1}{8}$ of an inch;

(2) A distance-based sampling interval, which shall not exceed five feet; and

(3) Calibration procedures and parameters assigned to the system, which assure that measured and recorded values accurately represent rail seat deterioration.

(e) *Exception reports to be produced by system; duty to field-verify exceptions.* The automated inspection measurement system shall produce an exception report containing a systematic listing of all exceptions to § 213.109(d)(4), identified so that an appropriate person(s) designated as fully qualified under § 213.7 can field-verify each exception.

(1) Each exception must be located and field-verified no later than 48 hours after the automated inspection.

(2) All field-verified exceptions are subject to all the requirements of this part.

(f) *Recordkeeping requirements.* The track owner shall maintain and make available to FRA a record of the inspection data and the exception record for the track inspected in accordance with this paragraph for a minimum of two years. The exception reports must include the following:

§ 213.235

49 CFR Ch. II (10–1–11 Edition)

(1) Date and location of limits of the inspection;

(2) Type and location of each exception;

(3) Results of field verification; and

(4) Remedial action if required.

(g) *Procedures for integrity of data.* The track owner shall institute the necessary procedures for maintaining the integrity of the data collected by the measurement system. At a minimum, the track owner shall do the following:

(1) Maintain and make available to FRA documented calibration procedures of the measurement system that, at a minimum, specify an instrument verification procedure that ensures correlation between measurements made on the ground and those recorded by the instrumentation; and

(2) Maintain each instrument used for determining compliance with this section such that it accurately measures the depth of rail seat deterioration in accordance with paragraph (d)(1) of this section.

(h) *Training.* The track owner shall provide annual training in handling rail seat deterioration exceptions to all persons designated as fully qualified under § 213.7 and whose territories are subject to the requirements of § 213.234. At a minimum, the training shall address the following:

(1) Interpretation and handling of the exception reports generated by the automated inspection measurement system;

(2) Locating and verifying exceptions in the field and required remedial action; and

(3) Recordkeeping requirements.

[76 FR 18086, Apr. 1, 2011]

EFFECTIVE DATE NOTE: At 76 FR 55825, Sept. 19, 2011, § 213.234 was amended by revising the first sentence of paragraph (a) and paragraphs (d), (e) and (g), effective November 8, 2011. For the convenience of the user, the revised text is set forth as follows:

§ 213.234 Automated inspection of track constructed with concrete cross-ties.

(a) *General.* Except for track described in paragraph (c) of this section, the provisions in this section are applicable on and after July 1, 2012. * * *

* * * * *

(d) *Performance standard for automated inspection measurement system.* The automated

inspection measurement system must be capable of indicating and processing rail seat deterioration requirements that specify the following:

(1) An accuracy, to within $\frac{1}{8}$ of an inch;

(2) A distance-based sampling interval, which shall not exceed five feet; and

(3) Calibration procedures and parameters assigned to the system, which assure that indicated and recorded values accurately represent rail seat deterioration.

(e) *Exception reports to be produced by system; duty to field-verify exceptions.* The automated inspection measurement system shall produce an exception report containing a systematic listing of all exceptions to § 213.109(d)(4), identified so that an appropriate person(s) designated as fully qualified under § 213.7 can field-verify each exception.

(1) Exception reports must be provided to or be made available to all persons designated as fully qualified under § 213.7 and whose territories are subject to the requirements of § 213.234.

(2) Each exception must be located and field-verified no later than 48 hours after the automated inspection.

(3) All field-verified exceptions are subject to all the requirements of this part.

(4) Exception reports must note areas identified between $\frac{3}{8}$ of an inch and $\frac{1}{2}$ of an inch as an “alert.”

* * * * *

(g) *Procedures for integrity of data.* The track owner shall institute the necessary procedures for maintaining the integrity of the data collected by the measurement system. At a minimum, the track owner shall do the following:

(1) Maintain and make available to FRA documented calibration procedures of the measurement system that, at a minimum, specify an instrument verification procedure that ensures correlation between measurements made on the ground and those recorded by the instrumentation; and

(2) Maintain each instrument used for determining compliance with this section such that it accurately provides an indication of the depth of rail seat deterioration in accordance with paragraph (d)(1) of this section.

* * * * *

§ 213.235 Inspection of switches, track crossings, and lift rail assemblies or other transition devices on moveable bridges.

(a) Except as provided in paragraph (c) of this section, each switch, turnout, track crossing, and moveable

Federal Railroad Administration, DOT**§ 213.241**

bridge lift rail assembly or other transition device shall be inspected on foot at least monthly.

(b) Each switch in Classes 3 through 5 track that is held in position only by the operating mechanism and one connecting rod shall be operated to all of its positions during one inspection in every 3 month period.

(c) In the case of track that is used less than once a month, each switch, turnout, track crossing, and moveable bridge lift rail assembly or other transition device shall be inspected on foot before it is used.

§ 213.237 Inspection of rail.

(a) In addition to the track inspections required by § 213.233, a continuous search for internal defects shall be made of all rail in Classes 4 through 5 track, and Class 3 track over which passenger trains operate, at least once every 40 million gross tons (mgt) or once a year, whichever interval is shorter. On Class 3 track over which passenger trains do not operate such a search shall be made at least once every 30 mgt or once a year, whichever interval is longer. (This paragraph (a) is applicable January 1, 1999.

(b) Inspection equipment shall be capable of detecting defects between joint bars, in the area enclosed by joint bars.

(c) Each defective rail shall be marked with a highly visible marking on both sides of the web and base.

(d) If the person assigned to operate the rail defect detection equipment being used determines that, due to rail surface conditions, a valid search for internal defects could not be made over a particular length of track, the test on that particular length of track cannot be considered as a search for internal defects under paragraph (a) of this section. (This paragraph (d) is not retroactive to tests performed prior to September 21, 1998.

(e) If a valid search for internal defects cannot be conducted for reasons described in paragraph (d) of this section, the track owner shall, before the expiration of time or tonnage limits—

(1) Conduct a valid search for internal defects;

(2) Reduce operating speed to a maximum of 25 miles per hour until such

time as a valid search for internal defects can be made; or

(3) Remove the rail from service.

§ 213.239 Special inspections.

In the event of fire, flood, severe storm, or other occurrence which might have damaged track structure, a special inspection shall be made of the track involved as soon as possible after the occurrence and, if possible, before the operation of any train over that track.

§ 213.241 Inspection records.

(a) Each owner of track to which this part applies shall keep a record of each inspection required to be performed on that track under this subpart.

(b) Each record of an inspection under §§ 213.4, 213.119, 213.233, and 213.235 shall be prepared on the day the inspection is made and signed by the person making the inspection. Records shall specify the track inspected, date of inspection, location and nature of any deviation from the requirements of this part, and the remedial action taken by the person making the inspection. The owner shall designate the location(s) where each original record shall be maintained for at least one year after the inspection covered by the record. The owner shall also designate one location, within 100 miles of each state in which they conduct operations, where copies of records which apply to those operations are either maintained or can be viewed following 10 days notice by the Federal Railroad Administration.

(c) Rail inspection records shall specify the date of inspection, the location and nature of any internal defects found, the remedial action taken and the date thereof, and the location of any intervals of track not tested per § 213.237(d). The owner shall retain a rail inspection record for at least two years after the inspection and for one year after remedial action is taken.

(d) Each owner required to keep inspection records under this section shall make those records available for inspection and copying by the Federal Railroad Administration.

(e) For purposes of compliance with the requirements of this section, an owner of track may maintain and

§ 213.301

transfer records through electronic transmission, storage, and retrieval provided that—

(1) The electronic system be designed so that the integrity of each record is maintained through appropriate levels of security such as recognition of an electronic signature, or other means, which uniquely identify the initiating person as the author of that record. No two persons shall have the same electronic identity;

(2) The electronic storage of each record shall be initiated by the person making the inspection within 24 hours following the completion of that inspection;

(3) The electronic system shall ensure that each record cannot be modified in any way, or replaced, once the record is transmitted and stored;

(4) Any amendment to a record shall be electronically stored apart from the record which it amends. Each amendment to a record shall be uniquely identified as to the person making the amendment;

(5) The electronic system shall provide for the maintenance of inspection records as originally submitted without corruption or loss of data;

(6) Paper copies of electronic records and amendments to those records, that may be necessary to document compliance with this part shall be made available for inspection and copying by the Federal Railroad Administration at the locations specified in paragraph (b) of this section; and

(7) Track inspection records shall be kept available to persons who performed the inspections and to persons performing subsequent inspections.

[63 FR 34029, June 22, 1998, as amended at 70 FR 66298, Nov. 2, 2005]

Subpart G—Train Operations at Track Classes 6 and Higher

§ 213.301 Scope of subpart.

This subpart applies to all track used for the operation of trains at a speed greater than 90 m.p.h. for passenger equipment and greater than 80 m.p.h. for freight equipment.

49 CFR Ch. II (10–1–11 Edition)**§ 213.303 Responsibility for compliance.**

(a) Any owner of track to which this subpart applies who knows or has notice that the track does not comply with the requirements of this subpart, shall—

(1) Bring the track into compliance; or

(2) Halt operations over that track.

(b) If an owner of track to which this subpart applies assigns responsibility for the track to another person (by lease or otherwise), notification of the assignment shall be provided to the appropriate FRA Regional Office at least 30 days in advance of the assignment. The notification may be made by any party to that assignment, but shall be in writing and include the following—

(1) The name and address of the track owner;

(2) The name and address of the person to whom responsibility is assigned (assignee);

(3) A statement of the exact relationship between the track owner and the assignee;

(4) A precise identification of the track;

(5) A statement as to the competence and ability of the assignee to carry out the duties of the track owner under this subpart;

(6) A statement signed by the assignee acknowledging the assignment to that person of responsibility for purposes of compliance with this subpart.

(c) The Administrator may hold the track owner or the assignee or both responsible for compliance with this subpart and subject to the penalties under § 213.15.

(d) When any person, including a contractor for a railroad or track owner, performs any function required by this part, that person is required to perform that function in accordance with this part.

§ 213.305 Designation of qualified individuals; general qualifications.

Each track owner to which this subpart applies shall designate qualified individuals responsible for the maintenance and inspection of track in compliance with the safety requirements prescribed in this subpart. Each individual, including a contractor or an

Federal Railroad Administration, DOT**§ 213.305**

employee of a contractor who is not a railroad employee, designated to:

(a) Supervise restorations and renewals of track shall meet the following minimum requirements:

(1) At least;

(i) Five years of responsible supervisory experience in railroad track maintenance in track Class 4 or higher and the successful completion of a course offered by the employer or by a college level engineering program, supplemented by special on the job training emphasizing the techniques to be employed in the supervision, restoration, and renewal of high speed track; or

(ii) A combination of at least one year of responsible supervisory experience in track maintenance in Class 4 or higher and the successful completion of a minimum of 80 hours of specialized training in the maintenance of high speed track provided by the employer or by a college level engineering program, supplemented by special on the job training provided by the employer with emphasis on the maintenance of high speed track; or

(iii) A combination of at least two years of experience in track maintenance in track Class 4 or higher and the successful completion of a minimum of 120 hours of specialized training in the maintenance of high speed track provided by the employer or by a college level engineering program supplemented by special on the job training provided by the employer with emphasis on the maintenance of high speed track.

(2) Demonstrate to the track owner that the individual:

(i) Knows and understands the requirements of this subpart;

(ii) Can detect deviations from those requirements; and

(iii) Can prescribe appropriate remedial action to correct or safely compensate for those deviations; and

(3) Be authorized in writing by the track owner to prescribe remedial actions to correct or safely compensate for deviations from the requirements of this subpart and successful completion of a recorded examination on this subpart as part of the qualification process.

(b) Inspect track for defects shall meet the following minimum qualifications:

(1) At least:

(i) Five years of responsible experience inspecting track in Class 4 or above and the successful completion of a course offered by the employer or by a college level engineering program, supplemented by special on the job training emphasizing the techniques to be employed in the inspection of high speed track; or

(ii) A combination of at least one year of responsible experience in track inspection in Class 4 or above and the successful completion of a minimum of 80 hours of specialized training in the inspection of high speed track provided by the employer or by a college level engineering program, supplemented by special on the job training provided by the employer with emphasis on the inspection of high speed track; or

(iii) A combination of at least two years of experience in track maintenance in Class 4 or above and the successful completion of a minimum of 120 hours of specialized training in the inspection of high speed track provided by the employer or from a college level engineering program, supplemented by special on the job training provided by the employer with emphasis on the inspection of high speed track.

(2) Demonstrate to the track owner that the individual:

(i) Knows and understands the requirements of this subpart;

(ii) Can detect deviations from those requirements; and

(iii) Can prescribe appropriate remedial action to correct or safely compensate for those deviations; and

(3) Be authorized in writing by the track owner to prescribe remedial actions to correct or safely compensate for deviations from the requirements in this subpart and successful completion of a recorded examination on this subpart as part of the qualification process.

(c) Individuals designated under paragraphs (a) or (b) of this section that inspect continuous welded rail (CWR) track or supervise the installation, adjustment, and maintenance of CWR in accordance with the written

§ 213.307

49 CFR Ch. II (10–1–11 Edition)

procedures established by the track owner shall have:

(1) Current qualifications under either paragraph (a) or (b) of this section;

(2) Successfully completed a training course of at least eight hours duration specifically developed for the application of written CWR procedures issued by the track owner; and

(3) Demonstrated to the track owner that the individual:

(i) Knows and understands the requirements of those written CWR procedures;

(ii) Can detect deviations from those requirements; and

(iii) Can prescribe appropriate remedial action to correct or safely compensate for those deviations; and

(4) Written authorization from the track owner to prescribe remedial actions to correct or safely compensate for deviations from the requirements in those procedures and successful completion of a recorded examination on those procedures as part of the qualification process. The recorded examination may be written, or it may be a computer file with the results of an interactive training course.

(d) Persons not fully qualified to supervise certain renewals and inspect track as outlined in paragraphs (a), (b) and (c) of this section, but with at least one year of maintenance of way or signal experience, may pass trains over broken rails and pull aparts provided that—

(1) The track owner determines the person to be qualified and, as part of doing so, trains, examines, and re-examines the person periodically within two years after each prior examination on the following topics as they relate to the safe passage of trains over broken rails or pull aparts: rail defect identification, crosstie condition, track surface and alinement, gage restraint, rail end mismatch, joint bars, and maximum distance between rail ends over which trains may be allowed to pass. The sole purpose of the examination is to ascertain the person's ability to effectively apply these requirements and the examination may not be used to disqualify the person from other duties. A minimum of four

hours training is adequate for initial training;

(2) The person deems it safe, and train speeds are limited to a maximum of 10 m.p.h. over the broken rail or pull apart;

(3) The person shall watch all movements over the broken rail or pull apart and be prepared to stop the train if necessary; and

(4) Person(s) fully qualified under § 213.305 of this subpart are notified and dispatched to the location as soon as practicable for the purpose of authorizing movements and effectuating temporary or permanent repairs.

(e) With respect to designations under paragraphs (a), (b), (c) and (d) of this section, each track owner shall maintain written records of:

(1) Each designation in effect;

(2) The basis for each designation, including but not limited to:

(i) The exact nature of any training courses attended and the dates thereof;

(ii) The manner in which the track owner has determined a successful completion of that training course, including test scores or other qualifying results;

(3) Track inspections made by each individual as required by § 213.369. These records shall be made available for inspection and copying by the Federal Railroad Administration during regular business hours.

[63 FR 34029, June 22, 1998; 63 FR 45959, Aug. 28, 1998]

§ 213.307 Class of track: operating speed limits.

(a) Except as provided in paragraph (b) of this section and §§ 213.329, 213.337(a) and 213.345(c), the following maximum allowable operating speeds apply:

Over track that meets all of the requirements prescribed in this subpart for—	The maximum allowable operating speed for trains ¹ is—
Class 6 track	110 m.p.h.
Class 7 track	125 m.p.h.
Class 8 track	160 m.p.h. ²
Class 9 track	200 m.p.h.

¹ Freight may be transported at passenger train speeds if the following conditions are met:

(1) The vehicles utilized to carry such freight are of equal dynamic performance and have been qualified in accordance with Sections 213.345 and 213.329(d) of this subpart.

Federal Railroad Administration, DOT**§ 213.323**

(2) The load distribution and securement in the freight vehicle will not adversely affect the dynamic performance of the vehicle. The axle loading pattern is uniform and does not exceed the passenger locomotive axle loadings utilized in passenger service operating at the same maximum speed.

(3) No carrier may accept or transport a hazardous material, as defined at 49 CFR 171.8, except as provided in Column 9A of the Hazardous Materials Table (49 CFR 172.101) for movement in the same train as a passenger-carrying vehicle or in Column 9B of the Table for movement in a train with no passenger-carrying vehicles.

²Operating speeds in excess of 150 m.p.h. are authorized by this part only in conjunction with a rule of particular applicability addressing other safety issues presented by the system.

(b) If a segment of track does not meet all of the requirements for its intended class, it is to be reclassified to the next lower class of track for which it does meet all of the requirements of this subpart. If a segment does not meet all of the requirements for Class 6, the requirements for Classes 1 through 5 apply.

§ 213.309 Restoration or renewal of track under traffic conditions.

(a) Restoration or renewal of track under traffic conditions is limited to the replacement of worn, broken, or missing components or fastenings that do not affect the safe passage of trains.

(b) The following activities are expressly prohibited under traffic conditions:

(1) Any work that interrupts rail continuity, e.g., as in joint bar replacement or rail replacement;

(2) Any work that adversely affects the lateral or vertical stability of the track with the exception of spot tamping an isolated condition where not more than 15 lineal feet of track are involved at any one time and the ambient air temperature is not above 95 degrees Fahrenheit; and

(3) Removal and replacement of the rail fastenings on more than one tie at a time within 15 feet.

§ 213.311 Measuring track not under load.

When unloaded track is measured to determine compliance with requirements of this subpart, evidence of rail movement, if any, that occurs while the track is loaded shall be added to the measurements of the unloaded track.

§ 213.317 Waivers.

(a) Any owner of track to which this subpart applies may petition the Federal Railroad Administrator for a waiver

from any or all requirements prescribed in this subpart.

(b) Each petition for a waiver under this section shall be filed in the manner and contain the information required by §§ 211.7 and 211.9 of this chapter.

(c) If the Administrator finds that a waiver is in the public interest and is consistent with railroad safety, the Administrator may grant the waiver subject to any conditions the Administrator deems necessary. Where a waiver is granted, the Administrator publishes a notice containing the reasons for granting the waiver.

§ 213.319 Drainage.

Each drainage or other water carrying facility under or immediately adjacent to the roadbed shall be maintained and kept free of obstruction, to accommodate expected water flow for the area concerned.

§ 213.321 Vegetation.

Vegetation on railroad property which is on or immediately adjacent to roadbed shall be controlled so that it does not—

(a) Become a fire hazard to track-carrying structures;

(b) Obstruct visibility of railroad signs and signals:

(1) Along the right of way, and

(2) At highway-rail crossings;

(c) Interfere with railroad employees performing normal trackside duties;

(d) Prevent proper functioning of signal and communication lines; or

(e) Prevent railroad employees from visually inspecting moving equipment from their normal duty stations.

§ 213.323 Track gage.

(a) Gage is measured between the heads of the rails at right-angles to the rails in a plane five-eighths of an inch below the top of the rail head.

(b) Gage shall be within the limits prescribed in the following table:

Class of track	The gage must be at least—	But not more than—	The change of gage within 31 feet must not be greater than—
6	'8"	4'9¼"	½"

§ 213.327

Class of track	The gage must be at least—	But not more than—	The change of gage within 31 feet must not be greater than—
7	4'8"	4'9¼"	½"
8	4'8"	4'9¼"	½"
9	4'8¼"	4'9¼"	½"

§ 213.327 Alinement.

(a) Uniformity at any point along the track is established by averaging the

49 CFR Ch. II (10–1–11 Edition)

measured mid-chord offset values for nine consecutive points centered around that point and which are spaced according to the following table:

Chord length	Spacing
31'	7'9"
62'	15'6"
124'	31'0"

(b) For a single deviation, alinement may not deviate from uniformity more than the amount prescribed in the following table:

Class of track	The deviation from uniformity of the mid-chord offset for a 31-foot chord may not be more than— (inches)	The deviation from uniformity of the mid-chord offset for a 62-foot chord may not be more than— (inches)	The deviation from uniformity of the mid-chord offset for a 124-foot chord may not be more than— (inches)
6	½	¾	1½
7	½	½	1¼
8	½	½	¾
9	½	½	¾

(c) For three or more non-overlapping deviations from uniformity in track alinement occurring within a distance equal to five times the specified chord length, each of which exceeds the

limits in the following table, each owner of the track to which this subpart applies shall maintain the alinement of the track within the limits prescribed for each deviation:

Class of track	The deviation from uniformity of the mid-chord offset for a 31-foot chord may not be more than— (inches)	The deviation from uniformity of the mid-chord offset for a 62-foot chord may not be more than— (inches)	The deviation from uniformity of the mid-chord offset for a 124-foot chord may not be more than— (inches)
6	¾	½	1
7	¾	¾	7/8
8	¾	¾	½
9	¾	¾	½

§ 213.329 Curves, elevation and speed limitations.

(a) The maximum crosslevel on the outside rail of a curve may not be more than 7 inches. The outside rail of a curve may not be more than ½ inch lower than the inside rail.

(b) (1) The maximum allowable operating speed for each curve is determined by the following formula:

$$V_{\max} = \sqrt{\frac{E_a + 3}{0.0007D}}$$

Where—

$V_{\max}$ = Maximum allowable operating speed (miles per hour).

E_a = Actual elevation of the outside rail (inches)⁴.

⁴Actual elevation for each 155 foot track segment in the body of the curve is determined by averaging the elevation for 10

Federal Railroad Administration, DOT**§213.331**

D = Degree of curvature (degrees)⁵.
 3 = 3 inches of unbalance.

(2) Appendix A includes tables showing maximum allowable operating speeds computed in accordance with this formula for various elevations and degrees of curvature for track speeds greater than 90 m.p.h.

(c) For rolling stock meeting the requirements specified in paragraph (d) of this section, the maximum operating speed for each curve may be determined by the following formula:

$$V_{\max} = \sqrt{\frac{E_a + E_u}{0.0007D}}$$

Where—

$V_{\max}$ = Maximum allowable operating speed (miles per hour).

E_a = Actual elevation of the outside rail (inches)⁴.

D = Degree of curvature (degrees)⁵.

E_u = Unbalanced elevation (inches).

(d) Qualified equipment may be operated at curving speeds determined by the formula in paragraph (c) of this section, provided each specific class of equipment is approved for operation by the Federal Railroad Administration and the railroad demonstrates that—

(1) When positioned on a track with uniform superelevation, E_a , reflecting the intended target cant deficiency, E_u , no wheel of the equipment unloads to a value of 60 percent or less of its static value on perfectly level track and, for passenger-carrying equipment, the roll angle between the floor of the vehicle and the horizontal does not exceed 5.7 degrees.

(2) When positioned on a track with a uniform 7-inch superelevation, no wheel unloads to a value less than 60% of its static value on perfectly level track and, for passenger-carrying equipment, the angle, measured about the roll axis, between the floor of the

vehicle and the horizontal does not exceed 8.6 degrees.

(e) The track owner shall notify the Federal Railroad Administrator no less than thirty calendar days prior to any proposed implementation of the higher curving speeds allowed when the “ E_u ” term, above, will exceed three inches. This notification shall be in writing and shall contain, at a minimum, the following information:

(1) A complete description of the class of equipment involved, including schematic diagrams of the suspension system and the location of the center of gravity above top of rail;

(2) A complete description of the test procedure⁶ and instrumentation used to qualify the equipment and the maximum values for wheel unloading and roll angles which were observed during testing;

(3) Procedures or standards in effect which relate to the maintenance of the suspension system for the particular class of equipment;

(4) Identification of line segment on which the higher curving speeds are proposed to be implemented.

(f) A track owner, or an operator of a passenger or commuter service, who provides passenger or commuter service over trackage of more than one track owner with the same class of equipment, may provide written notification to the Federal Railroad Administrator with the written consent of the other affected track owners.

[63 FR 34029, June 22, 1998; 63 FR 46102, Aug. 28, 1998]

§213.331 Track surface.

(a) For a single deviation in track surface, each owner of the track to which this subpart applies shall maintain the surface of its track within the limits prescribed in the following table:

points through the segment at 15.5 foot spacing. If the curve length is less than 155 feet, average the points through the full length of the body of the curve. If E_u exceeds 4 inches, the $V_{\max}$ formula applies to the spirals on both ends of the curve.

⁵Degree of curvature is determined by averaging the degree of curvature over the same track segment as the elevation.

⁶The test procedure may be conducted in a test facility whereby all wheels on one side (right or left) of the equipment are raised or lowered by six and then seven inches, the vertical wheel loads under each wheel are measured and a level is used to record the angle through which the floor of the vehicle has been rotated.

§ 213.333

49 CFR Ch. II (10–1–11 Edition)

Track surface	Class of track			
	6 (inches)	7 (inches)	8 (inches)	9 (inches)
The deviation from uniform ¹ profile on either rail at the midordinate of a 31-foot chord may not be more than	1	1	¾	½
The deviation from uniform profile on either rail at the midordinate of a 62-foot chord may not be more than	1	1	1	¾
The deviation from uniform profile on either rail at the midordinate of a 124-foot chord may not be more than	1¾	1½	1¼	1¼
The difference in crosslevel between any two points less than 62 feet apart may not be more than ²	1½	1½	1½	1½

¹ Uniformity for profile is established by placing the midpoint of the specified chord at the point of maximum measurement.

² However, to control harmonics on jointed track with staggered joints, the crosslevel differences shall not exceed 1¼ inches in all of six consecutive pairs of joints, as created by 7 joints. Track with joints staggered less than 10 feet shall not be considered as having staggered joints. Joints within the 7 low joints outside of the regular joint spacing shall not be considered as joints for purposes of this footnote.

(b) For three or more non-overlapping deviations in track surface occurring within a distance equal to five times the specified chord length, each of which exceeds the limits in the fol-

lowing table, each owner of the track to which this subpart applies shall maintain the surface of the track within the limits prescribed for each deviation:

Track surface	Class of track			
	6 (inches)	7 (inches)	8 (inches)	9 (inches)
The deviation from uniform profile on either rail at the midordinate of a 31-foot chord may not be more than	¾	¾	½	¾
The deviation from uniform profile on either rail at the midordinate of a 62-foot chord may not be more than	¾	¾	¾	½
The deviation from uniform profile on either rail at the midordinate of a 124-foot chord may not be more than	1¼	1	7/8	7/8

§ 213.333 Automated vehicle inspection systems.

(a) For track Class 7, a qualifying Track Geometry Measurement System (TGMS) vehicle shall be operated at least twice within 120 calendar days with not less than 30 days between inspections. For track Classes 8 and 9, it shall be operated at least twice within 60 days with not less than 15 days between inspections.

(b) A qualifying TGMS shall meet or exceed minimum design requirements which specify that—

(1) Track geometry measurements shall be taken no more than 3 feet away from the contact point of wheels carrying a vertical load of no less than 10,000 pounds per wheel;

(2) Track geometry measurements shall be taken and recorded on a distance-based sampling interval which shall not exceed 2 feet; and

(3) Calibration procedures and parameters are assigned to the system which assure that measured and recorded values accurately represent track conditions. Track geometry measurements

recorded by the system shall not differ on repeated runs at the same site at the same speed more than 1/8 inch.

(c) A qualifying TGMS shall be capable of measuring and processing the necessary track geometry parameters, at an interval of no more than every 2 feet, which enables the system to determine compliance with: § 213.323, Track gage; § 213.327, Alinement; § 213.329, Curves; elevation and speed limitations; and § 213.331, Track surface.

(d) A qualifying TGMS shall be capable of producing, within 24 hours of the inspection, output reports that—

(1) Provide a continuous plot, on a constant-distance axis, of all measured track geometry parameters required in paragraph (c) of this section;

(2) Provide an exception report containing a systematic listing of all track geometry conditions which constitute an exception to the class of track over the segment surveyed.

(e) The output reports required under paragraph (c) of this section shall contain sufficient location identification

Federal Railroad Administration, DOT

§ 213.333

information which enable field forces to easily locate indicated exceptions.

(f) Following a track inspection performed by a qualifying TGMS, the track owner shall, within two days after the inspection, field verify and institute remedial action for all exceptions to the class of track.

(g) The track owner shall maintain for a period of one year following an inspection performed by a qualifying TGMS, copy of the plot and the exception printout for the track segment involved, and additional records which:

(1) Specify the date the inspection was made and the track segment involved; and

(2) Specify the location, remedial action taken, and the date thereof, for all listed exceptions to the class.

(h) For track Classes 8 and 9, a qualifying Gage Restraint Measurement System (GRMS) shall be operated at least once annually with at least 180 days between inspections to continuously compare loaded track gage to unloaded gage under a known loading condition. The lateral capacity of the track structure shall not permit a gage widening ratio (GWR) greater than 0.5 inches.

(i) A GRMS shall meet or exceed minimum design requirements which specify that—

(1) Gage restraint shall be measured between the heads of the rail—

(i) At an interval not exceeding 16 inches;

(ii) Under an applied vertical load of no less than 10,000 pounds per rail;

(iii) Under an applied lateral load which provides for lateral/vertical load ratio of between 0.5 and 1.25⁷, and a load severity greater than 3,000 pounds but less than 8,000 pounds per rail. Load severity is defined by the formula—

$$S = L - cV$$

where:

S = Load severity, defined as the lateral load applied to the fastener system (pounds).

L = Actual lateral load applied (pounds).

⁷GRMS equipment using load combinations developing L/V ratios which exceed 0.8 shall be operated with caution to protect against the risk of wheel climb by the test wheelset.

c = Coefficient of friction between rail/tie which is assigned a nominal value of (0.4).
V = Actual vertical load applied (pounds).

(2) The measured gage value shall be converted to a gage widening ratio (GWR) as follows:

$$GWR = \frac{(LTG - UTG)}{L} \times 16,000$$

Where:

UTG=Unloaded track gage measured by the GRMS vehicle at a point no less than 10 feet from any lateral or vertical load application.

LTG=Loaded track gage measured by the GRMS vehicle at the point of application of the lateral load.

L=Actual lateral load applied (pounds).

(j) At least one vehicle in one train per day operating in Classes 8 and 9 shall be equipped with functioning on-board truck frame and carbody accelerometers. Each track owner shall have in effect written procedures for the notification of track personnel when on-board accelerometers on trains in Classes 8 and 9 indicate a possible track-related condition.

(k) For track Classes 7, 8 and 9, an instrumented car having dynamic response characteristics that are representative of other equipment assigned to service or a portable device that monitors on-board instrumentation on trains shall be operated over the track at the revenue speed profile at a frequency of at least twice within 60 days with not less than 15 days between inspections. The instrumented car or the portable device shall monitor vertically and laterally oriented accelerometers placed near the end of the vehicle at the floor level. In addition, accelerometers shall be mounted on the truck frame. If the carbody lateral, carbody vertical, or truck frame lateral safety limits in the following table of vehicle/track interaction safety limits are exceeded, speeds will be reduced until these safety limits are not exceeded.

(l) For track Classes 8 and 9, an instrumented car having dynamic response characteristics that are representative of other equipment assigned to service shall be operated over the track at the revenue speed profile annually with not less than 180 days between inspections. The instrumented

§ 213.333

49 CFR Ch. II (10–1–11 Edition)

car shall be equipped with functioning instrumented wheelsets to measure wheel/rail forces. If the wheel/rail force limits in the following table of vehicle/track interaction safety limits are exceeded, speeds will be reduced until these safety limits are not exceeded.

(m) The track owner shall maintain a copy of the most recent exception printouts for the inspections required under paragraphs (k) and (l) of this section.

Vehicle/Track Interaction Safety Limits

Parameter	Safety Limit	Filter/Window	Requirements
Wheel/Rail Forces¹			
Single Wheel Vertical Load Ratio	≥ 0.1	5 ft	No wheel of the equipment shall be permitted to unload to less than 10% of the static vertical wheel load. The static vertical wheel load is defined as the load that the wheel would carry when stationary on level track. The vertical wheel load limit shall be increased by the amount of measurement error.
Single Wheel L/V Ratio	$\leq \frac{\tan \delta + .5}{1 + .5 \tan \delta}$	5 ft	The ratio of the lateral force that any wheel exerts on an individual rail to the vertical force exerted by the same wheel on the rail shall be less than the safety limit calculated for the wheel's flange angle (δ).
Net Axle L/V Ratio	≤ 0.5	5 ft	The net lateral force exerted by any axle on the track shall not exceed 50% of the static vertical load that the axle exerts on the track.
Truck Side L/V Ratio	≤ 0.6	5 ft	The ratio of the lateral forces that the wheels on one side of any truck exert on an individual rail to the vertical forces exerted by the same wheels on that rail shall be less than 0.6.
Accelerations			
Carbody Lateral ²	≤ 0.5 g peak-to-peak	10 Hz 1 sec window	The peak-to-peak accelerations, measured as the algebraic difference between the two extreme values of measured acceleration in a one second time period, shall not exceed 0.5 g.
Carbody Vertical ²	≤ 0.6 g peak-to-peak	10 Hz 1 sec window	The peak-to-peak accelerations, measured as the algebraic difference between the two extreme values of measured acceleration in a one second time period, shall not exceed 0.6 g.
Truck Lateral ³	≤ 0.4 g RMS mean-removed	10 Hz 2 sec window	Truck hunting ⁴ shall not develop below the maximum authorized speed.

¹The lateral and vertical wheel forces shall be measured with instrumented wheelsets with the measurements processed through a low pass filter with a minimum cut-off frequency of 25 Hz. The sample rate for wheel force data shall be at least 250 samples/sec.

²Carbody lateral and vertical accelerations shall be measured near the car ends at the floor level.

³Truck accelerations in the lateral direction shall be measured on the truck frame. The measurements shall be processed through a filter having a pass band of 0.5 to 10 Hz.

⁴Truck hunting is defined as a sustained cyclic oscillation of the truck which is evidenced by lateral accelerations in excess of 0.4 g root mean square (mean-removed) for 2 seconds.

[63 FR 34029, June 22, 1998; 63 FR 46102, Aug. 28, 1998]

Federal Railroad Administration, DOT

§ 213.335

§ 213.334 Ballast; general.

Unless it is otherwise structurally supported, all track shall be supported by material which will—

(a) Transmit and distribute the load of the track and railroad rolling equipment to the subgrade;

(b) Restrain the track laterally, longitudinally, and vertically under dynamic loads imposed by railroad rolling equipment and thermal stress exerted by the rails;

(c) Provide adequate drainage for the track; and

(d) Maintain proper track crosslevel, surface, and alinement.

§ 213.335 Crossties.

(a) Crossties shall be made of a material to which rail can be securely fastened.

(b) Each 39 foot segment of track shall have—

(1) A sufficient number of crossties which in combination provide effective support that will—

(i) Hold gage within the limits prescribed in § 213.323(b);

(ii) Maintain surface within the limits prescribed in § 213.331; and

(iii) Maintain alinement within the limits prescribed in § 213.327.

(2) The minimum number and type of crossties specified in paragraph (c) of this section effectively distributed to support the entire segment; and

(3) Crossties of the type specified in paragraph (c) of this section that are(is) located at a joint location as specified in paragraph (e) of this section.

(c) For non-concrete tie construction, each 39 foot segment of Class 6 track shall have fourteen crossties; Classes 7, 8 and 9 shall have 18 crossties which are not—

(1) Broken through;

(2) Split or otherwise impaired to the extent the crossties will allow the ballast to work through, or will not hold spikes or rail fasteners;

(3) So deteriorated that the tie plate or base of rail can move laterally $\frac{3}{8}$ inch relative to the crossties;

(4) Cut by the tie plate through more than 40 percent of a crosstie's thickness;

(5) Configured with less than 2 rail holding spikes or fasteners per tie plate; or

(6) So unable, due to insufficient fastener toeload, to maintain longitudinal restraint and maintain rail hold down and gage.

(d) For concrete tie construction, each 39 foot segment of Class 6 track shall have fourteen crossties, Classes 7, 8 and 9 shall have 16 crossties which are not—

(1) So deteriorated that the prestress strands are ineffective or withdrawn into the tie at one end and the tie exhibits structural cracks in the rail seat or in the gage of track;

(2) Configured with less than 2 fasteners on the same rail;

(3) So deteriorated in the vicinity of the rail fastener such that the fastener assembly may pull out or move laterally more than $\frac{3}{8}$ inch relative to the crosstie;

(4) So deteriorated that the fastener base plate or base of rail can move laterally more than $\frac{3}{8}$ inch relative to the crossties;

(5) So deteriorated that rail seat abrasion is sufficiently deep so as to cause loss of rail fastener toeload;

(6) Completely broken through; or

(7) So unable, due to insufficient fastener toeload, to maintain longitudinal restraint and maintain rail hold down and gage.

(e) Class 6 track shall have one non-defective crosstie whose centerline is within 18 inches of the rail joint location or two crossties whose center lines are within 24 inches either side of the rail joint location. Class 7, 8, and 9 track shall have two non-defective ties within 24 inches each side of the rail joint.

(f) For track constructed without crossties, such as slab track and track connected directly to bridge structural components, the track structure shall meet the requirements of paragraphs (b)(1)(i), (ii), and (iii) of this section.

(g) In Classes 7, 8 and 9 there shall be at least three non-defective ties each side of a defective tie.

(h) Where timber crossties are in use there shall be tie plates under the running rails on at least nine of 10 consecutive ties.

§ 213.337

(i) No metal object which causes a concentrated load by solely supporting a rail shall be allowed between the base of the rail and the bearing surface of the tie plate.

§ 213.337 Defective rails.

(a) When an owner of track to which this part applies learns, through inspection or otherwise, that a rail in that track contains any of the defects

49 CFR Ch. II (10–1–11 Edition)

listed in the following table, a person designated under § 213.305 shall determine whether or not the track may continue in use. If the person determines that the track may continue in use, operation over the defective rail is not permitted until—

- (1) The rail is replaced; or
- (2) The remedial action prescribed in the table is initiated—

Federal Railroad Administration, DOT

§ 213.337

183

REMEDIAL ACTION

Defect	Length of defect (inch)		Percent of rail head cross-sectional area weakened by defect		If defective rail is not replaced, take the remedial action prescribed in note
	More than	But not more than	Less than	But not less than	
Transverse fissure			70	5	B, A2, A.
			100	70	
				100	
Compound fissure			70	5	B, A2, A.
			100	70	
				100	
Detail fracture Engine burn fracture Defective weld			25	5	C, D, [A2] or [E and H], [A] or [E and H].
			80	25	
			100	80	
				100	
Horizontal split head Vertical split head Split web Piped rail Head web separation	1	2			If and F, I and G, B, A.
	2	4			
	4	(¹)			
	(¹)				
Half hole crack	3/4	1			H and F, H and G, B, A.
	1	1 1/4			
	1 1/4	(¹)			
	(¹)				
Broken base	1	6			D, [A] or [E and I].
	6				
Ordinary break					A or E.
Damaged rail					D.
Flattened rail	Depth > 1/8 and Length > 8				H.

(¹) Break out in rail head.

Notes: A. Assign person designated under § 213.305 to visually supervise each operation over defective rail.

A2. Assign person designated under § 213.305 to make visual inspection. That person may authorize operation to continue without visual supervision at a maximum of 10 m.p.h.

§ 213.337

for up to 24 hours prior to another such visual inspection or replacement or repair of the rail.

B. Limit operating speed over defective rail to that as authorized by a person designated under § 213.305(a)(1)(i) or (ii). The operating speed cannot be over 30 m.p.h.

C. Apply joint bars bolted only through the outermost holes to defect within 20 days after it is determined to continue the track in use. Limit operating speed over defective rail to 30 m.p.h. until joint bars are applied; thereafter, limit speed to 50 m.p.h. When a search for internal rail defects is conducted under § 213.339 and defects are discovered which require remedial action C, the operating speed shall be limited to 50 m.p.h., for a period not to exceed 4 days. If the defective rail has not been removed from the track or a permanent repair made within 4 days of the discovery, limit operating speed over the defective rail to 30 m.p.h. until joint bars are applied; thereafter, limit speed to 50 m.p.h.

D. Apply joint bars bolted only through the outermost holes to defect within 10 days after it is determined to continue the track in use. Limit operating speed over the defective rail to 30 m.p.h. or less as authorized by a person designated under § 213.305(a)(1)(i) or (ii) until joint bars are applied; thereafter, limit speed to 50 m.p.h.

E. Apply joint bars to defect and bolt in accordance with § 213.351(d) and (e).

F. Inspect rail 90 days after it is determined to continue the track in use.

G. Inspect rail 30 days after it is determined to continue the track in use.

H. Limit operating speed over defective rail to 50 m.p.h.

I. Limit operating speed over defective rail to 30 m.p.h.

(b) As used in this section—

(1) *Transverse fissure* means a progressive crosswise fracture starting from a crystalline center or nucleus inside the head from which it spreads outward as a smooth, bright, or dark, round or oval surface substantially at a right angle to the length of the rail. The distinguishing features of a transverse fissure from other types of fractures or defects are the crystalline center or nucleus and the nearly smooth surface of the development which surrounds it.

(2) *Compound fissure* means a progressive fracture originating in a horizontal split head which turns up or down in the head of the rail as a smooth, bright, or dark surface progressing until substantially at a right angle to the length of the rail. Compound fissures require examination of both faces of the fracture to locate the

horizontal split head from which they originate.

(3) *Horizontal split head* means a horizontal progressive defect originating inside of the rail head, usually one-quarter inch or more below the running surface and progressing horizontally in all directions, and generally accompanied by a flat spot on the running surface. The defect appears as a crack lengthwise of the rail when it reaches the side of the rail head.

(4) *Vertical split head* means a vertical split through or near the middle of the head, and extending into or through it. A crack or rust streak may show under the head close to the web or pieces may be split off the side of the head.

(5) *Split web* means a lengthwise crack along the side of the web and extending into or through it.

(6) *Piped rail* means a vertical split in a rail, usually in the web, due to failure of the shrinkage cavity in the ingot to unite in rolling.

(7) *Broken base* means any break in the base of the rail.

(8) *Detail fracture* means a progressive fracture originating at or near the surface of the rail head. These fractures should not be confused with transverse fissures, compound fissures, or other defects which have internal origins. Detail fractures may arise from shelly spots, head checks, or flaking.

(9) *Engine burn fracture* means a progressive fracture originating in spots where driving wheels have slipped on top of the rail head. In developing downward they frequently resemble the compound or even transverse fissures with which they should not be confused or classified.

(10) *Ordinary break* means a partial or complete break in which there is no sign of a fissure, and in which none of the other defects described in this paragraph (b) are found.

(11) *Damaged rail* means any rail broken or injured by wrecks, broken, flat, or unbalanced wheels, slipping, or similar causes.

(12) *Flattened rail* means a short length of rail, not a joint, which has flattened out across the width of the rail head to a depth of $\frac{3}{8}$ inch or more below the rest of the rail. Flattened

Federal Railroad Administration, DOT

§213.341

rail occurrences have no repetitive regularity and thus do not include corrugations, and have no apparent localized cause such as a weld or engine burn. Their individual length is relatively short, as compared to a condition such as head flow on the low rail of curves.

(13) *Bolt hole crack* means a crack across the web, originating from a bolt hole, and progressing on a path either inclined upward toward the rail head or inclined downward toward the base. Fully developed bolt hole cracks may continue horizontally along the head/web or base/web fillet, or they may progress into and through the head or base to separate a piece of the rail end from the rail. Multiple cracks occurring in one rail end are considered to be a single defect. However, bolt hole cracks occurring in adjacent rail ends within the same joint shall be reported as separate defects.

(14) *Defective weld* means a field or plant weld containing any discontinuities or pockets, exceeding 5 percent of the rail head area individually or 10 percent in the aggregate, oriented in or near the transverse plane, due to incomplete penetration of the weld metal between the rail ends, lack of fusion between weld and rail end metal, entrapment of slag or sand, under-bead or other shrinkage cracking, or fatigue cracking. Weld defects may originate in the rail head, web, or base, and in some cases, cracks may progress from the defect into either or both adjoining rail ends.

(15) *Head and web separation* means a progressive fracture, longitudinally separating the head from the web of the rail at the head fillet area.

[63 FR 34029, June 22, 1998; 63 FR 51638, Sept. 28, 1998]

§213.339 Inspection of rail in service.

(a) A continuous search for internal defects shall be made of all rail in track at least twice annually with not less than 120 days between inspections.

(b) Inspection equipment shall be capable of detecting defects between joint bars, in the area enclosed by joint bars.

(c) Each defective rail shall be marked with a highly visible marking on both sides of the web and base.

(d) If the person assigned to operate the rail defect detection equipment being used determines that, due to rail surface conditions, a valid search for internal defects could not be made over a particular length of track, the test on that particular length of track cannot be considered as a search for internal defects under §213.337(a).

(e) If a valid search for internal defects cannot be conducted for reasons described in paragraph (d) of this section, the track owner shall, before the expiration of time limits—

(1) Conduct a valid search for internal defects;

(2) Reduce operating speed to a maximum of 25 miles per hour until such time as a valid search for internal defects can be made; or

(3) Remove the rail from service.

§213.341 Initial inspection of new rail and welds.

The track owner shall provide for the initial inspection of newly manufactured rail, and for initial inspection of new welds made in either new or used rail. A track owner may demonstrate compliance with this section by providing for:

(a) *In-service inspection.* A scheduled periodic inspection of rail and welds that have been placed in service, if conducted in accordance with the provisions of §213.339, and if conducted not later than 90 days after installation, shall constitute compliance with paragraphs (b) and (c) of this section;

(b) *Mill inspection.* A continuous inspection at the rail manufacturer's mill shall constitute compliance with the requirement for initial inspection of new rail, provided that the inspection equipment meets the applicable requirements specified in §213.339. The track owner shall obtain a copy of the manufacturer's report of inspection and retain it as a record until the rail receives its first scheduled inspection under §213.339;

(c) *Welding plant inspection.* A continuous inspection at a welding plant, if conducted in accordance with the provisions of paragraph (b) of this section, and accompanied by a plant operator's report of inspection which is retained as a record by the track owner, shall

§ 213.343

constitute compliance with the requirements for initial inspection of new rail and plant welds, or of new plant welds made in used rail; and

(d) *Inspection of field welds.* An initial inspection of field welds, either those joining the ends of CWR strings or those made for isolated repairs, shall be conducted not less than one day and not more than 30 days after the welds have been made. The initial inspection may be conducted by means of portable test equipment. The track owner shall retain a record of such inspections until the welds receive their first scheduled inspection under § 213.339.

(e) Each defective rail found during inspections conducted under paragraph (a) or (d) of this section shall be marked with highly visible markings on both sides of the web and base and the remedial action as appropriate under § 213.337 will apply.

§ 213.343 Continuous welded rail (CWR).

Each track owner with track constructed of CWR shall have in effect and comply with written procedures which address the installation, adjustment, maintenance and inspection of CWR, and a training program for the application of those procedures, which shall be submitted to the Federal Railroad Administration by March 21, 1999. FRA reviews each plan for compliance with the following—

(a) Procedures for the installation and adjustment of CWR which include—

(1) Designation of a desired rail installation temperature range for the geographic area in which the CWR is located; and

(2) De-stressing procedures/methods which address proper attainment of the desired rail installation temperature range when adjusting CWR.

(b) Rail anchoring or fastening requirements that will provide sufficient restraint to limit longitudinal rail and crosstie movement to the extent practical, and specifically addressing CWR rail anchoring or fastening patterns on bridges, bridge approaches, and at other locations where possible longitudinal rail and crosstie movement associated with normally expected train-induced forces, is restricted.

49 CFR Ch. II (10–1–11 Edition)

(c) Procedures which specifically address maintaining a desired rail installation temperature range when cutting CWR including rail repairs, in-track welding, and in conjunction with adjustments made in the area of tight track, a track buckle, or a pull-apart. Rail repair practices shall take into consideration existing rail temperature so that—

(1) When rail is removed, the length installed shall be determined by taking into consideration the existing rail temperature and the desired rail installation temperature range; and

(2) Under no circumstances should rail be added when the rail temperature is below that designated by paragraph (a)(1) of this section, without provisions for later adjustment.

(d) Procedures which address the monitoring of CWR in curved track for inward shifts of alignment toward the center of the curve as a result of disturbed track.

(e) Procedures which control train speed on CWR track when—

(1) Maintenance work, track rehabilitation, track construction, or any other event occurs which disturbs the roadbed or ballast section and reduces the lateral and/or longitudinal resistance of the track; and

(2) In formulating the procedures under this paragraph (e), the track owner shall—

(i) Determine the speed required, and the duration and subsequent removal of any speed restriction based on the restoration of the ballast, along with sufficient ballast re-consolidation to stabilize the track to a level that can accommodate expected train-induced forces. Ballast re-consolidation can be achieved through either the passage of train tonnage or mechanical stabilization procedures, or both; and

(ii) Take into consideration the type of crossties used.

(f) Procedures which prescribe when physical track inspections are to be performed to detect buckling prone conditions in CWR track. At a minimum, these procedures shall address inspecting track to identify—

(1) Locations where tight or kinky rail conditions are likely to occur;

(2) Locations where track work of the nature described in paragraph (e)(1) of

Federal Railroad Administration, DOT

§213.343

this section have recently been performed; and

(3) In formulating the procedures under this paragraph (f), the track owner shall—

(i) Specify the timing of the inspection; and

(ii) Specify the appropriate remedial actions to be taken when buckling prone conditions are found.

(g) The track owner shall have in effect a comprehensive training program for the application of these written CWR procedures, with provisions for periodic re-training, for those individuals designated under §213.305(c) of this part as qualified to supervise the installation, adjustment, and maintenance of CWR track and to perform inspections of CWR track.

(h) The track owner shall prescribe recordkeeping requirements necessary to provide an adequate history of track constructed with CWR. At a minimum, these records shall include:

(1) Rail temperature, location and date of CWR installations. This record shall be retained for at least one year; and

(2) A record of any CWR installation or maintenance work that does not conform with the written procedures. Such record shall include the location of the rail and be maintained until the CWR is brought into conformance with such procedures.

(i) As used in this section—

(1) *Adjusting/de-stressing* means the procedure by which a rail's temperature is re-adjusted to the desired value. It typically consists of cutting the rail and removing rail anchoring devices, which provides for the necessary expansion and contraction, and then re-assembling the track.

(2) *Buckling incident* means the formation of a lateral mis-alignment sufficient in magnitude to constitute a deviation of 5 inches measured with a 62-foot chord. These normally occur when rail temperatures are relatively high and are caused by high longitudinal compressive forces.

(3) *Continuous welded rail (CWR)* means rail that has been welded together into lengths exceeding 400 feet.

(4) *Desired rail installation temperature range* means the rail temperature range, within a specific geographical

area, at which forces in CWR should not cause a buckling incident in extreme heat, or a pull-apart during extreme cold weather.

(5) *Disturbed track* means the disturbance of the roadbed or ballast section, as a result of track maintenance or any other event, which reduces the lateral or longitudinal resistance of the track, or both.

(6) *Mechanical stabilization* means a type of procedure used to restore track resistance to disturbed track following certain maintenance operations. This procedure may incorporate dynamic track stabilizers or ballast consolidators, which are units of work equipment that are used as a substitute for the stabilization action provided by the passage of tonnage trains.

(7) *Rail anchors* means those devices which are attached to the rail and bear against the side of the crosstie to control longitudinal rail movement. Certain types of rail fasteners also act as rail anchors and control longitudinal rail movement by exerting a downward clamping force on the upper surface of the rail base.

(8) *Rail temperature* means the temperature of the rail, measured with a rail thermometer.

(9) *Tight/kinky rail* means CWR which exhibits minute alignment irregularities which indicate that the rail is in a considerable amount of compression.

(10) *Train-induced forces* means the vertical, longitudinal, and lateral dynamic forces which are generated during train movement and which can contribute to the buckling potential.

(11) *Track lateral resistance* means the resistance provided to the rail/crosstie structure against lateral displacement.

(12) *Track longitudinal resistance* means the resistance provided by the rail anchors/rail fasteners and the ballast section to the rail/crosstie structure against longitudinal displacement.

(j) Track owners shall revise their CWR plans to include provisions for the inspection of joint bars in accordance with §§213.119(g) and (i)(3).

[63 FR 34029, June 22, 1998; 63 FR 45959, Aug. 28, 1998, as amended at 70 FR 66298, Nov. 2, 2005]

§213.345**§213.345 Vehicle qualification testing.**

(a) All rolling stock types which operate at Class 6 speeds and above shall be qualified for operation for their intended track classes in order to demonstrate that the vehicle dynamic response to track alignment and geometry variations are within acceptable limits to assure safe operation. Rolling stock operating in Class 6 within one year prior to the promulgation of this subpart shall be considered as being successfully qualified for Class 6 track and vehicles presently operating at Class 7 speeds by reason of conditional waivers shall be considered as qualified for Class 7.

(b) The qualification testing shall ensure that, at any speed less than 10 m.p.h. above the proposed maximum operating speed, the equipment will not exceed the wheel/rail force safety limits and the truck lateral accelerations specified in §213.333, and the testing shall demonstrate the following:

(1) The vertical acceleration, as measured by a vertical accelerometer mounted on the car floor, shall be limited to no greater than 0.55g single event, peak-to-peak.

(2) The lateral acceleration, as measured by a lateral accelerometer mounted on the car floor, shall be limited to no greater than 0.3g single event, peak-to-peak; and

(3) The combination of the lateral acceleration (L) and the vertical acceleration (V) within any period of two consecutive seconds as expressed by the square root of ($V^2 + L^2$) shall be limited to no greater than 0.604, where L may not exceed 0.3g and V may not exceed 0.55g.

(c) To obtain the test data necessary to support the analysis required in paragraphs (a) and (b) of this section, the track owner shall have a test plan which shall consider the operating practices and conditions, signal system, road crossings and trains on adjacent tracks during testing. The track owner shall establish a target maximum testing speed (at least 10 m.p.h. above the maximum proposed operating speed) and target test and operating conditions and conduct a test program sufficient to evaluate the operating limits of the track and equipment. The test program shall dem-

49 CFR Ch. II (10-1-11 Edition)

onstrate vehicle dynamic response as speeds are incrementally increased from acceptable Class 6 limits to the target maximum test speeds. The test shall be suspended at that speed where any of the safety limits specified in paragraph (b) are exceeded.

(d) At the end of the test, when maximum safe operating speed is known along with permissible levels of cant deficiency, an additional run shall be made with the subject equipment over the entire route proposed for revenue service at the speeds the railroad will request FRA to approve for such service and a second run again at 10 m.p.h. above this speed. A report of the test procedures and results shall be submitted to FRA upon the completions of the tests. The test report shall include the design flange angle of the equipment which shall be used for the determination of the lateral to vertical wheel load safety limit for the track/vehicle interaction safety measurements required per §213.333(1).

(e) As part of the submittal required in paragraph (d) of the section, the operator shall include an analysis and description of the signal system and operating practices to govern operations in Classes 7 and 8. This statement shall include a statement of sufficiency in these areas for the class of operation. Operation at speeds in excess of 150 m.p.h. is authorized only in conjunction with a rule of particular applicability addressing other safety issues presented by the system.

(f) Based on test results and submissions, FRA will approve a maximum train speed and value of cant deficiency for revenue service.

[63 FR 34029, June 22, 1998; 63 FR 54078, Oct. 8, 1998]

§213.347 Automotive or railroad crossings at grade.

(a) There shall be no at-grade (level) highway crossings, public or private, or rail-to-rail crossings at-grade on Class 8 and 9 track.

(b) If train operation is projected at Class 7 speed for a track segment that will include rail-highway grade crossings, the track owner shall submit for FRA's approval a complete description of the proposed warning/barrier system to address the protection of highway

Federal Railroad Administration, DOT**§ 213.353**

traffic and high speed trains. Trains shall not operate at Class 7 speeds over any track segment having highway-rail grade crossings unless:

(1) An FRA-approved warning/barrier system exists on that track segment; and

(2) All elements of that warning/barrier system are functioning.

§ 213.349 Rail end mismatch.

Any mismatch of rails at joints may not be more than that prescribed by the following table—

Class of track	Any mismatch of rails at joints may not be more than the following—	
	On the tread of the rail ends (inch)	On the gage side of the rail ends (inch)
Class 6, 7, 8 and 9	1/8	1/8

§ 213.351 Rail joints.

(a) Each rail joint, insulated joint, and compromise joint shall be of a structurally sound design and dimensions for the rail on which it is applied.

(b) If a joint bar is cracked, broken, or because of wear allows excessive vertical movement of either rail when all bolts are tight, it shall be replaced.

(c) If a joint bar is cracked or broken between the middle two bolt holes it shall be replaced.

(d) Each rail shall be bolted with at least two bolts at each joint.

(e) Each joint bar shall be held in position by track bolts tightened to allow the joint bar to firmly support the abutting rail ends and to allow longitudinal movement of the rail in the joint to accommodate expansion and contraction due to temperature variations. When no-slip, joint-to-rail contact exists by design, the requirements of this section do not apply. Those locations, when over 400 feet long, are considered to be continuous welded rail track and shall meet all the requirements for continuous welded rail track prescribed in this subpart.

(f) No rail shall have a bolt hole which is torch cut or burned.

(g) No joint bar shall be reconfigured by torch cutting.

§ 213.352 Torch cut rail.

(a) Except as a temporary repair in emergency situations no rail having a torch cut end shall be used. When a rail end with a torch cut is used in emergency situations, train speed over that rail shall not exceed the maximum allowable for Class 2 track. All torch cut

rail ends in Class 6 shall be removed within six months of September 21, 1998.

(b) Following the expiration of the time limits specified in paragraph (a) of this section, any torch cut rail end not removed shall be removed within 30 days of discovery. Train speed over that rail shall not exceed the maximum allowable for Class 2 track until removed.

§ 213.353 Turnouts, crossovers, and lift rail assemblies or other transition devices on moveable bridges.

(a) In turnouts and track crossings, the fastenings must be intact and maintained so as to keep the components securely in place. Also, each switch, frog, and guard rail shall be kept free of obstructions that may interfere with the passage of wheels. Use of rigid rail crossings at grade is limited per § 213.347.

(b) Track shall be equipped with rail anchoring through and on each side of track crossings and turnouts, to restrain rail movement affecting the position of switch points and frogs. Elastic fasteners designed to restrict longitudinal rail movement are considered rail anchoring.

(c) Each flangeway at turnouts and track crossings shall be at least 1½ inches wide.

(d) For all turnouts and crossovers, and lift rail assemblies or other transition devices on moveable bridges, the track owner shall prepare an inspection and maintenance Guidebook for use by railroad employees which shall be submitted to the Federal Railroad

§ 213.355**49 CFR Ch. II (10–1–11 Edition)**

Administration. The Guidebook shall contain at a minimum—

(1) Inspection frequency and methodology including limiting measurement values for all components subject to wear or requiring adjustment.

(2) Maintenance techniques.

(e) Each hand operated switch shall be equipped with a redundant operating

mechanism for maintaining the security of switch point position.

§ 213.355 Frog guard rails and guard faces; gage.

The guard check and guard face gages in frogs shall be within the limits prescribed in the following table—

Class of track	Guard check gage—The distance between the gage line of a frog to the guard line ¹ of its guard rail or guarding face, measured across the track at right angles to the gage line, ² may not be less than—	Guard face gage—The distance between guard lines, ¹ measured across the track at right angles to the gage line, ² may not be more than—
Class 6 track	4'6½"	4'5"
Class 7 track	4'6½"	4'5"
Class 8 track	4'6½"	4'5"
Class 9 track	4'6½"	4'5"

¹ A line along that side of the flangeway which is nearer to the center of the track and at the same elevation as the gage line.

² A line ⅜ inch below the top of the center line of the head of the running rail, or corresponding location of the tread portion of the track structure.

§ 213.357 Derails.

(a) Each track, other than a main track, which connects with a Class 7, 8 or 9 main track shall be equipped with a functioning derail of the correct size and type, unless railroad equipment on the track, because of grade characteristics cannot move to foul the main track.

(b) For the purposes of this section, a derail is a device which will physically stop or divert movement of railroad rolling stock or other railroad on-track equipment past the location of the device.

(c) Each derail shall be clearly visible. When in a locked position, a derail shall be free of any lost motion which would prevent it from performing its intended function.

(d) Each derail shall be maintained to function as intended.

(e) Each derail shall be properly installed for the rail to which it is applied.

(f) If a track protected by a derail is occupied by standing railroad rolling stock, the derail shall be in derailing position.

(g) Each derail on a track which is connected to a Class 7, 8 or 9 main track shall be interconnected with the signal system.

§ 213.359 Track stiffness.

(a) Track shall have a sufficient vertical strength to withstand the maximum vehicle loads generated at maximum permissible train speeds, cant deficiencies and surface defects. For purposes of this section, vertical track strength is defined as the track capacity to constrain vertical deformations so that the track shall return following maximum load to a configuration in compliance with the vehicle/track interaction safety limits and geometry requirements of this subpart.

(b) Track shall have sufficient lateral strength to withstand the maximum thermal and vehicle loads generated at maximum permissible train speeds, cant deficiencies and lateral alignment defects. For purposes of this section lateral track strength is defined as the track capacity to constrain lateral deformations so that track shall return following maximum load to a configuration in compliance with the vehicle/track interaction safety limits and geometry requirements of this subpart.

§ 213.361 Right of way.

The track owner in Class 8 and 9 shall submit a barrier plan, termed a "right-of-way plan," to the Federal Railroad Administration for approval. At a minimum, the plan will contain provisions in areas of demonstrated need for the prevention of—

Federal Railroad Administration, DOT**§ 213.369**

- (a) Vandalism;
- (b) Launching of objects from overhead bridges or structures into the path of trains; and
- (c) Intrusion of vehicles from adjacent rights of way.

§ 213.365 Visual inspections.

(a) All track shall be visually inspected in accordance with the schedule prescribed in paragraph (c) of this section by a person designated under § 213.305.

(b) Each inspection shall be made on foot or by riding over the track in a vehicle at a speed that allows the person making the inspection to visually inspect the track structure for compliance with this part. However, mechanical, electrical, and other track inspection devices may be used to supplement visual inspection. If a vehicle is used for visual inspection, the speed of the vehicle may not be more than 5 miles per hour when passing over track crossings and turnouts, otherwise, the inspection vehicle speed shall be at the sole discretion of the inspector, based on track conditions and inspection requirements. When riding over the track in a vehicle, the inspection will be subject to the following conditions—

(1) One inspector in a vehicle may inspect up to two tracks at one time provided that the inspector's visibility remains unobstructed by any cause and that the second track is not centered more than 30 feet from the track upon which the inspector is riding;

(2) Two inspectors in one vehicle may inspect up to four tracks at a time provided that the inspector's visibility remains unobstructed by any cause and that each track being inspected is centered within 39 feet from the track upon which the inspectors are riding;

(3) Each main track is actually traversed by the vehicle or inspected on foot at least once every two weeks, and each siding is actually traversed by the vehicle or inspected on foot at least once every month. On high density commuter railroad lines where track time does not permit an on track vehicle inspection, and where track centers are 15 foot or less, the requirements of this paragraph (b)(3) will not apply; and

(4) Track inspection records shall indicate which track(s) are traversed by the vehicle or inspected on foot as outlined in paragraph (b)(3) of this section.

(c) Each track inspection shall be made in accordance with the following schedule—

Class of track	Required frequency
6, 7, and 8	Twice weekly with at least 2 calendar-day's interval between inspections.
9	Three times per week.

(d) If the person making the inspection finds a deviation from the requirements of this part, the person shall immediately initiate remedial action.

(e) Each switch, turnout, track crossing, and lift rail assemblies on moveable bridges shall be inspected on foot at least weekly. The inspection shall be accomplished in accordance with the Guidebook required under § 213.353.

(f) In track Classes 8 and 9, if no train traffic operates for a period of eight hours, a train shall be operated at a speed not to exceed 100 miles per hour over the track before the resumption of operations at the maximum authorized speed.

[63 FR 34029, June 22, 1998; 63 FR 45959, Aug. 28, 1998]

§ 213.367 Special inspections.

In the event of fire, flood, severe storm, temperature extremes or other occurrence which might have damaged track structure, a special inspection shall be made of the track involved as soon as possible after the occurrence and, if possible, before the operation of any train over that track.

§ 213.369 Inspection records.

(a) Each owner of track to which this part applies shall keep a record of each inspection required to be performed on that track under this subpart.

(b) Except as provided in paragraph (e) of this section, each record of an inspection under § 213.365 shall be prepared on the day the inspection is made and signed by the person making the inspection. Records shall specify the track inspected, date of inspection, location and nature of any deviation from the requirements of this part, and

Pt. 213, App. A

49 CFR Ch. II (10–1–11 Edition)

the remedial action taken by the person making the inspection. The owner shall designate the location(s) where each original record shall be maintained for at least one year after the inspection covered by the record. The owner shall also designate one location, within 100 miles of each state in which they conduct operations, where copies of record which apply to those operations are either maintained or can be viewed following 10 days notice by the Federal Railroad Administration.

(c) Rail inspection records shall specify the date of inspection, the location and nature of any internal defects found, the remedial action taken and the date thereof, and the location of any intervals of track not tested per §213.339(d). The owner shall retain a rail inspection record for at least two years after the inspection and for one year after remedial action is taken.

(d) Each owner required to keep inspection records under this section shall make those records available for inspection and copying by the Federal Railroad Administrator.

(e) For purposes of compliance with the requirements of this section, an owner of track may maintain and transfer records through electronic transmission, storage, and retrieval provided that—

(1) The electronic system be designed such that the integrity of each record maintained through appropriate levels of security such as recognition of an electronic signature, or other means, which uniquely identify the initiating person as the author of that record. No two persons shall have the same electronic identity;

(2) The electronic storage of each record shall be initiated by the person making the inspection within 24 hours following the completion of that inspection;

(3) The electronic system shall ensure that each record cannot be modified in any way, or replaced, once the record is transmitted and stored;

(4) Any amendment to a record shall be electronically stored apart from the record which it amends. Each amendment to a record shall be uniquely identified as to the person making the amendment;

(5) The electronic system shall provide for the maintenance of inspection records as originally submitted without corruption or loss of data; and

(6) Paper copies of electronic records and amendments to those records, that may be necessary to document compliance with this part, shall be made available for inspection and copying by the FRA and track inspectors responsible under §213.305. Such paper copies shall be made available to the track inspectors and at the locations specified in paragraph (b) of this section.

(7) Track inspection records shall be kept available to persons who performed the inspection and to persons performing subsequent inspections.

(f) Each vehicle/track interaction safety record required under §213.333 (g), and (m) shall be made available for inspection and copying by the FRA at the locations specified in paragraph (b) of this section.

**APPENDIX A TO PART 213—MAXIMUM
ALLOWABLE CURVING SPEEDS**

Federal Railroad Administration, DOT

Pt. 213, App. A

TABLE 1—THREE INCHES UNBALANCE
[Elevation of outer rail (inches)]

Degree of curvature	0	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6
(12) Maximum allowable operating speed (mph)													
0°30'	93	100	107	113	120	125	131	136	141	146	151	156	160
0°40'	80	87	93	98	103	109	113	118	122	127	131	135	139
0°50'	72	78	83	88	93	97	101	106	110	113	117	121	124
1°00'	66	71	76	80	85	89	93	96	100	104	107	110	113
1°15'	59	63	68	72	76	79	83	86	89	93	96	99	101
1°30'	54	58	62	66	69	72	76	79	82	85	87	90	93
1°45'	50	54	57	61	64	67	70	73	76	78	81	83	86
2°00'	46	50	54	57	60	63	66	68	71	73	76	78	80
2°15'	44	47	50	54	56	59	62	64	67	69	71	74	76
2°30'	41	45	48	51	54	56	59	61	63	66	68	70	72
2°45'	40	43	46	48	51	54	56	58	60	62	65	66	68
3°00'	38	41	44	46	49	51	54	56	58	60	62	64	66
3°15'	36	39	42	45	47	49	51	54	56	57	59	61	63
3°30'	35	38	40	43	45	47	50	52	54	55	57	59	61
3°45'	34	37	39	41	44	46	48	50	52	54	55	57	59
4°00'	33	35	38	40	42	44	46	48	50	52	54	55	57
4°30'	31	33	36	38	40	42	44	45	47	49	50	52	54
5°00'	29	32	34	36	38	40	41	43	45	46	48	49	51
5°30'	28	30	32	34	36	38	40	41	43	44	46	47	48
6°00'	27	29	31	33	35	36	38	39	41	42	44	45	46
6°30'	26	28	30	31	33	35	36	38	39	41	42	43	45
7°00'	25	27	29	30	32	34	35	36	38	39	40	42	43
8°00'	23	25	27	28	30	31	33	34	35	37	38	39	40
9°00'	22	24	25	27	28	30	31	32	33	35	36	37	38
10°00'	21	22	24	25	27	28	29	31	32	33	34	35	36
11°00'	20	21	23	24	26	27	28	29	30	31	32	33	34
12°00'	19	20	22	23	24	26	27	28	29	30	31	32	33

TABLE 2—FOUR INCHES UNBALANCE
[Elevation of outer rail (inches)]

Degree of curvature	0	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6
0°30'													
0°40'													
0°50'													
1°00'													
1°15'													
1°30'													
1°45'													
2°00'													
2°15'													
2°30'													
2°45'													
3°00'													
3°15'													
3°30'													
3°45'													
4°00'													
4°30'													
5°00'													
5°30'													
6°00'													
6°30'													
7°00'													
8°00'													
9°00'													
10°00'													
11°00'													
12°00'													

Pt. 213, App. A

49 CFR Ch. II (10–1–11 Edition)

TABLE 2—FOUR INCHES UNBALANCE—Continued
[Elevation of outer rail (inches)]

Degree of curvature	0	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6
0°30'	107	113	120	125	131	136	141	146	151	156	160	165	169
0°40'	93	98	104	109	113	118	122	127	131	135	139	143	146
0°50'	83	88	93	97	101	106	110	113	117	121	124	128	131
1°00'	76	80	85	89	93	96	100	104	107	110	113	116	120
1°15'	68	72	76	79	83	86	89	93	96	99	101	104	107
1°30'	62	65	69	72	76	79	82	85	87	90	93	95	98
1°45'	57	61	64	67	70	73	76	78	81	83	86	88	90
2°00'	53	57	60	63	65	68	71	73	76	78	80	82	85
2°15'	50	53	56	59	62	64	67	69	71	73	76	78	80
2°30'	48	51	53	56	59	61	63	65	68	70	72	74	76
2°45'	46	48	51	53	56	58	60	62	64	66	68	70	72
3°00'	44	46	49	51	53	56	58	60	62	64	65	67	69
3°15'	42	44	47	49	51	53	55	57	59	61	63	65	66
3°30'	40	43	45	47	49	51	53	55	57	59	61	62	64
3°45'	39	41	44	46	48	50	52	53	55	57	59	60	62
4°00'	38	40	42	44	46	48	50	52	53	55	57	58	60
4°30'	36	38	40	42	44	45	47	49	50	52	53	55	56
5°00'	34	36	38	40	41	43	45	46	48	49	51	52	53
5°30'	32	34	36	38	39	41	43	44	46	47	48	50	51
6°00'	31	33	35	36	38	39	41	42	44	45	46	48	49
6°30'	30	31	33	35	36	38	39	41	42	43	44	46	47
7°00'	29	30	32	34	35	36	38	39	40	42	43	44	45
8°00'	27	28	30	31	33	34	35	37	38	39	40	41	42
9°00'	25	27	28	30	31	32	33	35	36	37	38	39	40
10°00'	24	25	27	28	29	30	32	33	34	35	36	37	38
11°00'	23	24	25	27	28	29	30	31	32	33	34	35	36
12°00'	22	23	24	26	27	28	29	30	31	32	33	34	35

Federal Railroad Administration, DOT

Pt. 213, App. B

APPENDIX B TO PART 213—SCHEDULE OF CIVIL PENALTIES

Section	Violation	Willful Viola- tion ¹
Subpart A—General:		
213.4(a) Excepted track ²	\$2,500	\$5,000
213.4(b) Excepted track ²	2,500	5,000
213.4(c) Excepted track ²	2,500	5,000
213.4(d) Excepted track ²	2,500	5,000
213.4(e):		
(1) Excepted track	5,000	7,500
(2) Excepted track	7,000	10,000
(3) Excepted track	7,000	10,000
(4) Excepted track	5,000	7,500
213.4(f) Excepted track	2,000	4,000
213.7 Designation of qualified persons to supervise certain renewals and inspect track	1,000	2,000
213.9 Classes of track: Operating speed limits	2,500	2,500
213.11 Restoration or renewal of track under traffic conditions	2,500	2,500
213.13 Measuring track not under load	1,000	2,000
Subpart B—Roadbed:		
213.33 Drainage	2,500	5,000
213.37 Vegetation	1,000	2,000
Subpart C—Track Geometry:		
213.53 Gage	5,000	7,500
213.55 Alinement	5,000	7,500
213.57 Curves; elevation and speed limitations	2,500	5,000
213.59 Elevation of curved track; runoff	2,500	2,500
213.63 Track surface	5,000	7,500
Subpart D—Track surface:		
213.103 Ballast; general	2,500	5,000
213.109 Crossties		
(a) Material used	1,000	2,000
(b) Distribution of ties	2,500	5,000
(c) Sufficient number of nondefective ties	1,000	2,000
(d) Joint ties	2,500	5,000
(e) Track constructed without crossties	2,500	5,000
213.113 Defective rails	5,000	7,500
213.115 Rail end mismatch	2,500	5,000
213.118 Continuous welded rail plan (a) through (e)	5,000	7,500
213.119 Continuous welded rail plan contents (a) through (k)	5,000	7,500
213.121 (a) Rail joints	2,500	5,000
213.121 (b) Rail joints	2,500	5,000
213.121 (c) Rail joints	5,000	7,500
213.121 (d) Rail joints	2,500	5,000
213.121 (e) Rail joints	2,500	5,000
213.121 (f) Rail joints	2,500	5,000
213.121 (g) Rail joints	2,500	5,000
213.121 (h) Rail joints	5,000	7,500
213.122 Torch cut rail	2,500	5,000
213.123 Tie plates	1,000	2,000
213.127 Rail fastenings	2,500	5,000
213.133 Turnouts and track crossings, generally	1,000	1,000
213.135 Switches:		
(a) through (g)	2,500	5,000
(h) chipped or worn points	5,000	7,500
213.137 Frogs	2,500	5,000
213.139 Spring rail frogs	2,500	5,000
213.141 Self-guarded frogs	2,500	5,000
213.143 Frog guard rails and guard faces; gage	2,500	5,000
Subpart E—Track appliances and track-related devices:		
213.205 Derails	2,500	5,000
Subpart F—Inspection:		
213.233 Track inspections	2,000	4,000
213.235 Switches, crossings, transition devices	2,000	4,000
213.237 Inspection of rail	2,500	5,000
213.239 Special inspections	2,500	5,000
213.241 Inspection records	1,000	1,000
Subpart G—High Speed:		
213.305 Designation of qualified individuals; general qualifications	1,000	2,000
213.307 Class of track; operating speed limits	2,500	5,000
213.309 Restoration or renewal of track under traffic conditions	2,500	5,000
213.311 Measuring track not under load	1,000	2,000
213.319 Drainage	2,500	5,000
213.321 Vegetation	1,000	2,000

Pt. 214

49 CFR Ch. II (10–1–11 Edition)

Section	Violation	Willful Violation ¹
213.323 Track gage	5,000	7,500
213.327 Alinement	5,000	7,500
213.329 Curves, elevation and speed limits	2,500	5,000
213.331 Track surface	5,000	7,500
213.333 Automated vehicle inspection systems	5,000	7,500
213.335 Crossties		
(a) Material used	1,000	2,000
(b) Distribution of ties	2,500	5,000
(c) Sufficient number of nondefective ties, non-concrete	1,000	2,000
(d) Sufficient number of nondefective concrete ties	1,000	2,000
(e) Joint ties	2,500	5,000
(f) Track constructed without crossties	2,500	5,000
(g) Non-defective ties surrounding defective ties	2,500	5,000
(h) Tie plates	2,500	5,000
(i) Tie plates	1,000	2,000
213.337 Defective rails	5,000	7,500
213.339 Inspection of rail in service	2,500	5,000
213.341 Inspection of new rail	2,500	5,000
213.343 Continuous welded rail (a) through (h)	5,000	7,500
213.345 Vehicle qualification testing (a) through (b)	5,000	7,500
(c) through (e)	2,500	5,000
213.347 Automotive or railroad crossings at grade	5,000	7,500
213.349 Rail end mismatch	2,500	5,000
213.351 (a) Rail joints	2,500	5,000
213.351 (b) Rail joints	2,500	5,000
213.351 (c) Rail joints	5,000	7,500
213.351 (d) Rail joints	2,500	5,000
213.351 (e) Rail joints	2,500	5,000
213.351 (f) Rail joints	5,000	7,500
213.351 (g) Rail joints	5,000	7,500
213.352 Torch cut rails	2,500	5,000
213.353 Turnouts, crossovers, transition devices	1,000	2,000
213.355 Frog guard rails and guard faces; gage	2,500	5,000
213.357 Derails	2,500	5,000
213.359 Track stiffness	5,000	7,500
213.361 Right of way	5,000	7,500
213.365 Visual inspections	2,500	5,000
213.367 Special inspections	2,500	5,000
213.369 Inspections records	2,000	4,000

¹ A penalty may be assessed against an individual only for a willful violation. The Administrator reserves the right to assess a penalty of up to \$100,000 for any violation where circumstances warrant. See 49 CFR part 209, appendix A.

² In addition to assessment of penalties for each instance of noncompliance with the requirements identified by this footnote, track segments designated as excepted track that are or become ineligible for such designation by virtue of noncompliance with any of the requirements to which this footnote applies are subject to all other requirements of Part 213 until such noncompliance is remedied.

[63 FR 34029, June 22, 1998; 63 FR 45959, Aug. 28, 1998, as amended at 70 FR 66299, Nov. 2, 2005; 73 FR 79701, Dec. 30, 2008; 74 FR 43006, Aug. 25, 2009]

PART 214—RAILROAD WORKPLACE SAFETY

Subpart A—General

Sec.

- 214.1 Purpose and scope.
- 214.3 Application.
- 214.4 Preemptive effect.
- 214.5 Responsibility for compliance.
- 214.7 Definitions.

Subpart B—Bridge Worker Safety Standards

- 214.101 Purpose and scope.
- 214.103 Fall protection, generally.
- 214.105 Fall protection systems standards and practices.
- 214.107 Working over or adjacent to water.

214.109 Scaffolding.

214.111 Personal protective equipment, generally.

214.113 Head protection.

214.115 Foot protection.

214.117 Eye and face protection.

Subpart C—Roadway Worker Protection

214.301 Purpose and scope.

214.302 Information collection requirements.

214.303 Railroad on-track safety programs, generally.

214.305 Compliance dates.

214.307 Review and approval of individual on-track safety programs by FRA.

214.309 On-track safety program documents.

214.311 Responsibility of employers.

Appendix J

AREMA Practical Guide to Railway Engineering – 2003, Section 8.2.3 Bridge Deck

CHAPTER 8 - STRUCTURES

The nature of the obstacle being crossed will drive most superstructure design decisions with the ultimate goal to achieve the least overall lifecycle cost for the structure. For short (height) structures, trestle construction is favored due to the economies of pile bents. Conversely, taller structures over good footing are likely to be viaducts with longer spans supported by towers. Where there is insufficient clearance over navigable waterways, moveable spans may be necessary. The addition of longer or moveable spans to clear main channels does not significantly affect the design of the balance of the structure. However, as the structure becomes taller, the economies of pile bents are diminished due to the need to strengthen the relatively slender components.

The alternative to conventional trestle construction is trestle on towers, otherwise known as viaducts. Trestle on towers can offer a significant reduction in footprint for only a moderate increase in span requirements. It is customary for the spans to be of alternating lengths, with the short span over the tower equal to the leg spacing at the top of the tower. This ensures that each span remains a simple span with full bearing at the ends of the span. Of course, trestle construction represents the typical site conditions. More demanding site conditions may require exotic solutions. For example, very tall, very short (length) conditions may lend themselves to arch construction, whereas for transit operations, very long main span requirements may lend themselves to suspension type construction and some trestles on towers may be better constructed as a series of arches.

8.2.3 Bridge Deck

The bridge deck is that portion of a railway bridge that supplies a means of carrying the track rails. In comparison to the rest of the superstructure design, bridge deck decisions are relatively simple. The choices are open deck and ballast deck. On open deck bridges (Figure 8-5), the rails are anchored directly to timber bridge ties supported directly on the floor system of the superstructure. On ballasted bridge decks, the rails are anchored directly to timber track ties supported in the ballast section. The ballasted bridge decks require a floor to support the ballast section and such floors are designated by their types, such as timber floors, structural plate floors, buckle plate floors or concrete slab floors, all of which transfer loads directly to the superstructure.

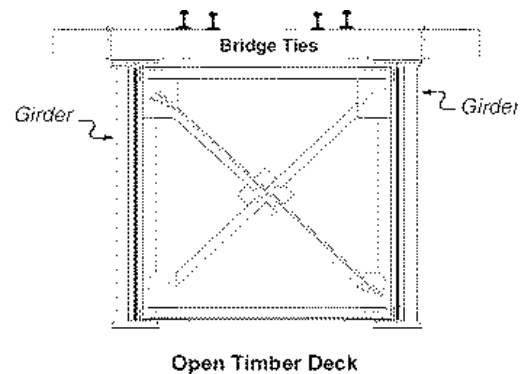


Figure 8-5 Open Deck Structure - Courtesy of Canadian National

CHAPTER 8 - STRUCTURES

Variations from the two general types of bridge deck construction consist of track rails anchored directly to steel or concrete-slab superstructures (direct fixation) and the several types of concrete-encased beam spans or concrete-filled steel-trough superstructures on which the ballast section is placed. The latter types of structures have many examples still in service today, but are not generally cost-effective for new construction.

Some might consider the notion of bridge railings to be an odd bridge design consideration. Railway bridges traditionally have not been designed for the conveyance of anything other than railway traffic, which does not in and of itself, require any sort of railing whatsoever. Recently, however, a greater focus upon railway worker safety has resulted in railings being widely incorporated.

Open Bridge Decks

Many different considerations enter into the choice of open or ballast decks, and the selection usually is governed by the requirements of each individual structure. Open decks are less costly and are free draining (Figure 8-6), but their use over streets and highways requires additional measures such as canopies, plates or wooden flooring to protect highway traffic from falling objects, water or other materials during the movement of trains.



Figure 8-6 Open Deck Bridge - Courtesy of Metra

Open-deck construction establishes a permanent elevation for the rails. Normal surfacing and lining operations, particularly in curves, eventually result in line swings leading into the fixed bridge. The grade frequently is raised to the extent that the bridge eventually becomes low. The bridge dumps are of a different modulus than the rigid deck. Thus, it becomes difficult to maintain surface off of the bridge as well. This equates to extensive maintenance costs that shortly will surpass the first cost savings gained by installing an open deck bridge over a ballast deck bridge. In welded rail, tight rail conditions can occur at the fixed ends of an open deck bridge, thus requiring an increased level of surveillance in hot weather.

Requirements for Ties

For ballast deck structures, bridge ties are no different than those found in traditional track construction. However, in track constructed with concrete ties, the track is often times transitioned to timber ties before crossing the structure. Some railway companies and agencies have had difficulty with fouled ballast, track alignment and deck surface

CHAPTER 8 - STRUCTURES

damage resulting from the use of concrete ties on bridges. Individual railway companies have established policies relating to the use of concrete ties on or around bridge structures that should be reviewed prior to design.

Bridge ties are commonly 10 – 12 feet long and range from 8” by 8” in section to 8” by 14”. Longer ties are utilized for bridge walkways. The tie spacing is typically 4 inches between ties for open deck bridges and the usual track tie spacing for ballast deck bridges. It must be recognized that the tie functions as a beam and it must withstand bending and shear stresses, hold the rail to gage and transfer the rail load to the supporting members of the floor system. Open deck bridge ties typically utilize a softwood species of timber.

Superelevation on Decks

The superelevation of curved track on a bridge is obtained by:

- Sloping the pile or post cut-off of timber trestles.
- Tilting the superstructures of I-beam and shallow girder spans.
- Framing the floor system out of level transversely on through spans.
- Tapering the bridge ties.
- Increasing the depth of ballast under one rail on a ballasted-deck bridge.

Framing the floor system involves significant detailing and fabrication and is not often performed. The other methods are commonly employed.

High speeds in all classes of train service greatly intensify the problems connected with superelevation and alignment on curves. The eccentricity between the curve alignment and that of the bridge structure produces differences in stress in similar members of a floor system, dependent upon their location. Careful analysis must be done to insure that none of these members are overstressed.

Bridge Tie Framing

Bridge ties sometimes are dapped where they contact the supporting steel as an aid in maintaining good track alignment over the bridge. This necessitates adzing the tie bottom at each flange edge, which may result in undesirable horizontal shear cracks extending inward from the bottom of the dap. AREMA recommends that the dap not exceed the flange width by greater than 1/2 inch and that the depth of the dap be not more than 1/2 inch. Where dapping is practiced, the depth should be held to the very minimum required and careful check should be made to determine that the remaining depth of the tie is ample to carry the loads. Where cover plates do not extend the full length of the span, wood shims or steel plates may be added to bring the tie support

surface to the same plane, or specially-framed wood shims of proper thickness may be fastened with metal straps to the bottoms of bridge ties to bring all ties to the required surface. Procedures for dapping and/or shimming ties for superelevation are covered in Chapter 7 of the AREMA Manual for Railway Engineering, Section 1.14.7.

Ballasted Decks

A ballasted deck (Figure 8-7) provides a better riding track. The track modulus is consistent on the dumps of the bridge as well as across the bridge. Thus, one is unlikely to have surface runoff problems on the bridge dumps. Surfacing and lining operations can continue across the bridge unimpeded. However, care must be exercised to maintain a permanent grade line in the vicinity of and over a ballasted deck bridge to be certain that excessive quantities of ballast are not accumulated on the bridge structure through track raises during successive reballasting operations.

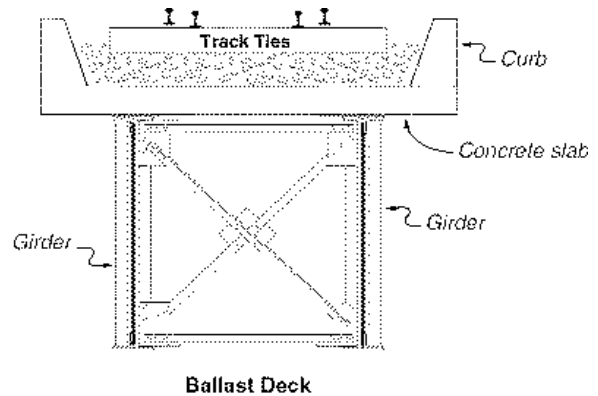


Figure 8-7 Ballast Decked Bridge. – Courtesy of Canadian National

Ballasted decks (Figure 8-8), irrespective of the type of bridge floor, afford a considerable measure of protection to the steel floor system against damage from derailed car wheels traveling across the bridge. Over roadways, vehicles and the public are protected from dropping ballast and material off of the cars.

Ballast

The depth of ballast contributes to the satisfactory functioning of ballasted decks on railway bridges. It is generally agreed that 6 inches to 12 inches of ballast under the ties is adequate and that more than 12 inches is undesirable because of the potential of overload involved, except when provision is made in the design for a greater load. Many designers calculate the dead load on the basis of 18 inches to 24 inches of ballast to accommodate future raises.



Figure 8-8 Ballast Decked Structure - Courtesy of Metra

CHAPTER 8 - STRUCTURES

Bridge Floors

A bridge floor for a ballasted-deck span is designed, such that as nearly as possible, the bridge track section replicates the track conditions on the adjoining bridge dumps. The ballast pan must have sufficient capacity to carry the heavy dead load of the floor and the ballast, and also to properly distribute the live and dead loads from various types of bridge floors to the supporting superstructure. The arrangement of the members in a floor system supporting a bridge floor is different from the arrangement of longitudinal stringers and transverse floorbeams, which make up the floor system of many open-deck spans.

A bridge floor for a ballasted deck may conform to one of several types including:

- a) Concrete segmented girder spans incorporating the concrete ballast pan within the segmented unit.
- b) Creosoted timber planks laid transversely to the track and supported on a suitable floor system of timber or steel.
- c) Reinforced concrete slabs laid transversely to the track and supported on deck-plate girder spans or on a specially designed floor system of through-girder and through-truss spans.
- d) Structural plates (Figure 8-9) supported by stringers (longitudinal I-beams) for short spans, and floor beams (I-beams placed transversely to the track and framed to longitudinal members) for longer spans.
- e) Structural troughs placed longitudinally for short spans and transversely for the longer spans, with concrete filling in the down troughs and covering the entire floor area.
- f) Structural plates, which bare on a series of transverse tees, the vertical legs of which vary in height and also are tapered. The result is a floor sloped for drainage in both directions, and the bases of which are supported by wide flange beam sets or structural plates, which bear on transverse I-beams supported on deck girders.



Figure 8-9 Ballast Pan on Stringers - Courtesy of Metra

Trough Floors

The steel-trough bridge floor has been used in the past primarily for ballasted deck structures over city streets, particularly in connection with track elevation work.

Although more cost effective designs are available today for new construction, there are large numbers of this type of deck structure still in existence in major urban areas. Longitudinal troughs are used at locations where crossings intersect at approximately right angles and where columns are permitted at the center of the street. Such troughs are supported on cross girders framed to the columns, while the outside legs of the two outside troughs are extended upward to form the ballast stops.

After erection, the down-troughs are filled with concrete, which also covers the entire area to a depth of about 3 inches above the tops of the troughs at the end of the bridge, and about 4 inches above the troughs at the center of the bridge. Along the sides, the concrete filling is flared up against the ballast stops for varying distances above the top of the rail. The concrete filling is sloped for drainage in such a manner as to permit delivery of the water to drain pipes located below the bridge seat level. Suitable reinforcement should be provided immediately below the top of the concrete filling, particularly in the area above the cross girders; otherwise, deflection under live loads will cause transverse cracks in the concrete. The use of trough floors at locations, where the intersecting angle with the street is acute, or where roadways of unusual width are required, necessitates placing the troughs transversely to the track and framing them to through girders or to through trusses. The design details of these floors are essentially the same as for longitudinal troughs, the exception being the necessity for drain holes through the floors to avoid long, flat slopes for drainage, which in turn, requires the installation of a drainage system to dispose of the accumulated water.

Drainage

The primary requisites for bridge floors are economy, minimum weight and water tightness, together with strength and shallow depth. Comparisons of economy should include cost of materials, fabrication and erection. Bridge floors not only catch water but also retain it. As the track must be removed prior, replacement and maintenance of the bridge decks can be difficult and expensive. Every precaution should be taken to insure long life, which requires that all bridge floors be protected by waterproofing. Water falling on the track percolates through the ballast to the waterproofing where it remains, unless some suitable means for quick runoff has been provided. Quick runoff of precipitation is dependent upon clean ballast and a well-designed drainage system delivering water to outlets through the floor or to drain pipes located at the back of the abutments.

Open Deck vs. Ballast Deck

In addition to the obvious weight and construction costs, each of the span alternatives has their unique safety, environmental and maintenance concerns. In some instances, these intangible factors can carry more weight than the resulting cost implications. Only the governing railway can provide guidance as to the importance of these and related issues.

CHAPTER 8 - STRUCTURES

Concrete ballast decks are almost never cast in place in railway structures. They are typically precast or prestressed sections placed on the structure after steel erection. This means they cannot be considered part of a composite structure and offer no structural benefit, as would a similar concrete deck in the highway counterpart.

There are also operating disadvantages to the use of open deck bridges that may not be readily apparent. Bridge maintenance must often be performed under contractual agreements by bridge and building department forces. Thus, any operation involving an open bridge deck, e.g., renewal of plate cut ties, must be performed by bridge department personnel. As the adjacent track is also affected by anything affecting the elevation of the rails running across the bridge deck, track department forces must also be involved. Most railways have severely reduced their bridge gang rosters. Thus, it becomes a real logistics problem to have both groups present at the same time. On ballast deck structures, the ballasted trackage is considered track department work. Thus, surfacing operations and tie change-out can proceed unhindered.

Anchorage of Bridge Ties

Bridge ties on open-deck spans are held in position by bolts through the ties in line with the edge of supporting members (i.e., stringers). Usually two hook bolts are used on every third, fourth or fifth tie. The rail may or may not incorporate rail anchors. Anchoring rail on longer open deck structures can create alignment problems resulting from the thermal expansion of the rail. Most traditional mechanisms for fixing the bridge ties to the bridge cannot effectively transfer longitudinal forces. The servicing railroad guidelines pertaining to the anchorage of rail over both ballast and open deck structures should be consulted for guidance in this area.

Guard Timbers

Bridge ties are held to a uniform spacing by longitudinal timbers, called "guard timbers," placed outside of the track rails and fastened to the ties by bolts or lag screws. These guard timbers may be 4" x 8" or 6" x 8" in size. The 4" guard timbers are not dapped over the ties, while the 6" timbers generally are dapped (Check with individual railway standards).

Inner Guard Rails

In addition to the guard timbers, two lines of inner guard rails (Figure 8-10) are often used on each track on open and ballasted-deck bridges of such length as individual railways require. The two types commonly used are structural angles with a backing timber (found often on branch lines) and T-rails. On new installations, T-rails are generally used, even to the extent of replacing the angle guards when their renewals are necessary.

Scrap rails of a rail section smaller than the running rails are often used for inner guard rail. Each rail is placed on the inside of the running rail, often without the use of tie plates. Guard rails should be spiked to every tie and spliced at every joint. They should extend beyond the bridge ends in the direction of approaching traffic. The ends should terminate in a frog point or be joined and securely fastened so that a derailed truck will be straightened in direction and guided into the space between the running rail and the guard rail, thereby minimizing the damage that otherwise might result.

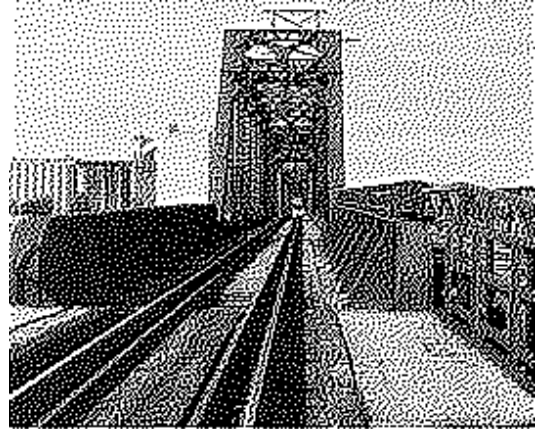


Figure 8-10 Inside Tee Guard Rails - Courtesy of BNSF

8.3 Bridge Types

8.3.1 Timber Trestles

The term, trestle, is commonly applied to a railway bridge with relatively short spans, constructed of timber, concrete or steel.

While the advent of economical steel construction has more or less eliminated timber from new mainline structures of any size, the lower initial cost and ease of construction still makes timber construction attractive for many light density lines. Additionally, because of the relative ease of repair, many significant older timber structures remain in service today.

In all of North America, timber trestles are the preponderant type of structure still found on branch lines, short lines and at temporary crossings. The timber used for timber trestles should be of a firm, close texture, which will afford strong structural members and offer maximum resistance to decay. A dense grade of Southern Pine, Douglas Fir or White Oak is suitable for this purpose. The timber selected should be sound, free from knots, pitch pockets and other imperfections that might impair its strength or durability. There is seldom justification for using untreated timber.

Terminology

The trestle supports are designated as "bents." (Figure 8-11) Each bent consists of posts (commonly four to six, but may be more or less depending on the design), transversely secured at the top with a member called a cap. The number of posts

Exhibit B

VERIFIED STATEMENT OF ELIZABETH REILLEY

BEFORE THE
SURFACE TRANSPORTATION BOARD

FD 36472

CSX CORPORATION AND CSX TRANSPORTATION, INC., ET AL.

—CONTROL AND MERGER—

PAN AM SYSTEMS, INC., PAN AM RAILWAYS, INC., BOSTON AND MAINE
CORPORATION, MAINE CENTRAL RAILROAD COMPANY, NORTHERN RAILROAD,
PAN AM SOUTHERN LLC, PORTLAND TERMINAL COMPANY, SPRINGFIELD
TERMINAL RAILWAY COMPANY, STONY BROOK RAILROAD COMPANY, AND
VERMONT & MASSACHUSETTS RAILROAD COMPANY

Exhibit B

Verified Statement of Ms. Elizabeth Reilley

I am Elizabeth Reilley, Director, Environmental Quality at the Massachusetts Water Resources Authority (“MWRA”). I oversee staff whose work includes identifying public health issues, coordinating sampling to monitor, detect and track contaminants, and participating in remediation efforts. I am also involved with emergency planning efforts at MWRA as it relates to water quality. Those efforts include developing emergency response plans and actions in the event of a release or spill. Having detailed information regarding the materials that are transported through the watershed is critical to MWRA’s emergency planning efforts. Such information allows staff to better plan and prepare for, and respond to, any potential incidents or events including public health assessments, detection, monitoring, and remediation and clean up. With such information drills and exercises may be tailored to respond to the release of specific contaminants. This information is necessary to identify appropriate measurements to detect the contaminant, obtain instrumentation needed to perform the measurement, and train staff to learn

how to use the instrumentation. It is also needed to assess the potential public health impacts, and to assess the ability of our current treatment processes to mitigate the impacts.

VERIFICATION

I, Elizabeth Reilley, verify under penalty of perjury that I have read the foregoing Verified Statement offered on behalf of the the Massachusetts Water Resources Authority (“MWRA”), that I know the contents thereof, and that the same are true and correct. Further, I certify that I am qualified and authorized to file this statement on behalf of MWRA.

/s/ Elizabeth Reilley, Ph.D.
Elizabeth Reilley, Ph.D.

Dated: August 26, 2021