Can Automated Track Geometry Inspection Replace Traditional Manual Inspection?

An Update on the Industry's Track Inspection Initiative

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Methods of track inspection

1) Manual - inspection by a person either walking or riding in a hi-rail vehicle
2) Automated – using vehicle-mounted technology to measure various track geometry parameters
   a) Manned
   b) Autonomous (unmanned)

What do automated systems measure or evaluate?

Track geometry

- Gage
- Curvature
- Crosslevel
- Surface
- Alignment

More sophisticated systems also provide

- Rail profiles & wear
- Machine vision that looks at the condition of rail running surface, ties and fasteners
- Joint bar inspection
- Clearance measurements

Railroads proposed a “new operational approach” to track inspection

<u>The concept</u>

- Increase the frequency of automated (autonomous) track geometry testing and decrease the frequency of manual inspections.
- Determine the most effective combination of these two types of inspections.

BNSF, in 2018, was the first railroad to petition FRA for a temporary suspension of track inspection regulations. NS was the second, followed by CSX, CN, CP and UP.

FRA terminology

Railroads may petition FRA for a temporary suspension or a waiver.

Temporary suspension – allows a railroad to not comply with a specific part of the Track Safety Standards in order to perform a test (pilot).

Waiver of compliance – allows a railroad to not comply with a specific part of the TSS on a more permanent basis.

In both cases, FRA's on-going approval is dependent on the railroad meeting specified performance standards.

How heavily have RRs invested in autonomous testing?

- BNSF - 4 passenger coaches
- NS - 3 locomotives, 3 more being equipped
- CN - 10 box cars
- CSX - 5 box cars, 3 more being built
- UP - 2 box cars & 3 locomotives
- CP - 3 box cars

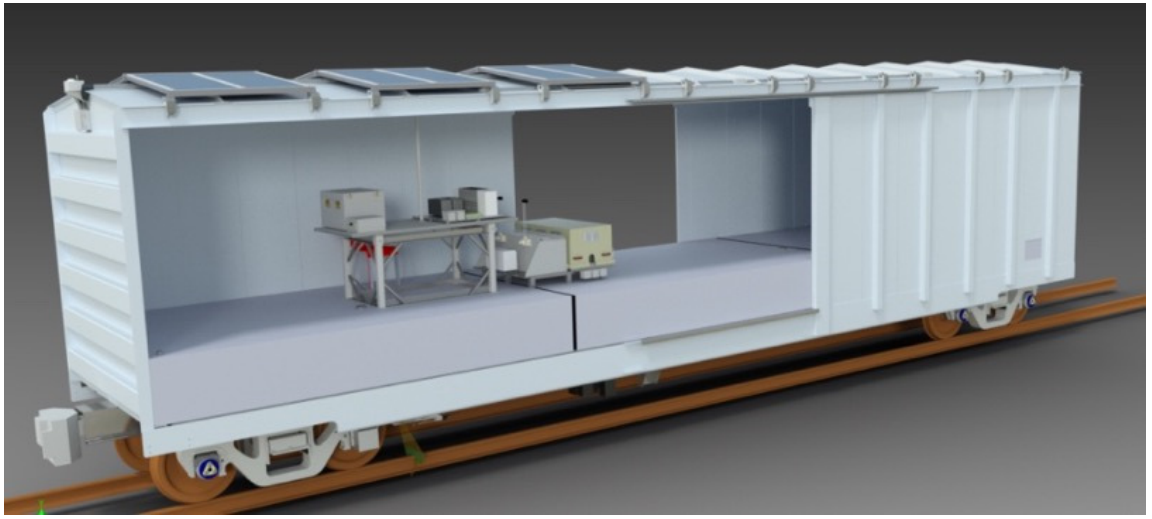
On BNSF, equipped passenger coaches are pulled in a dedicated geometry train

On NS, hardware is mounted under the front steps of an AC44C6M locomotive

CN, CP, UP & CSX use a box car equipped with an ENSCO geometry system

Can railroads increase autonomous testing without FRA approval?

Yes! Railroads, on their own, can perform as much autonomous testing as they wish.

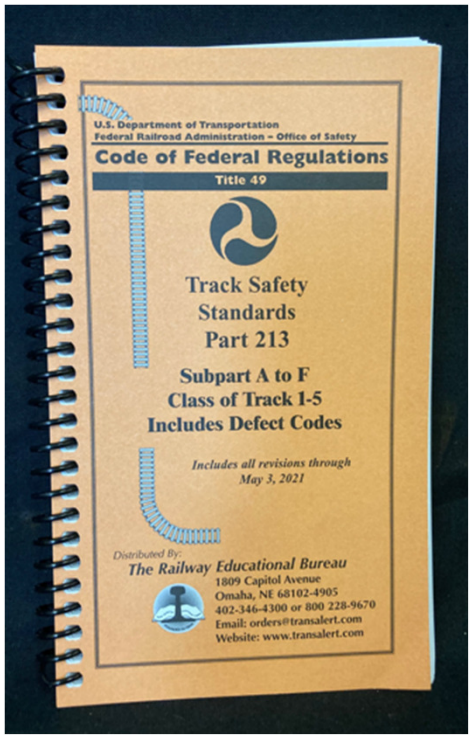


Can railroads reduce manual inspections without FRA approval?

No!

FRA's Track Safety Standards prescribe how track inspection must be performed and at what frequency.

An FRA suspension or waiver is required to supersede FRA's Track Safety Standards



What are the pertinent parts of the Track Safety Standards?

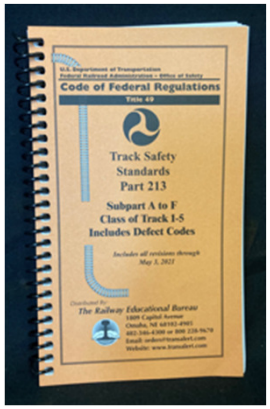
Part 213, Subpart F - Inspection

§ 213.233 Visual track inspections

(b) (3) Each main track must be traversed by the vehicle or inspected on foot at least once every two weeks, each siding must be traversed by the vehicle or inspected on foot at least once every month;

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

- Class 1, 2 and 3 track – weekly, or twice weekly if the track carries passenger trains or more than 10 MGT
- Class 4 and 5 track – twice weekly



Is there precedent for using automated inspections in place of manual inspections?

Yes – The Long Island Railroad

Since 1975, the LIRR has operated under a waiver that allows a single weekly walking inspection while performing quarterly automated geometry inspections

RailPictures.Net – Image William J Skeats 2022

How did the railroads justify this “operational approach” to FRA?

Track safety

- Automated testing is more effective than manual inspections at finding geometry exceptions
- More frequent automated inspections mean geometry defects will be found sooner (and exist in track for a shorter period)
- Using geometry data to find conditions that are getting close to defect level means they can be repaired before they become defects (“preventative intervention”)

How else did railroads justify this approach?

Additional safety considerations

- Reduced exposure to on-track accidents (with trains and vehicles at grade crossings) due to fewer hi-rail and walking inspections.

Improved track maintenance

- Resources deployed more effectively; inspectors can spend more time fixing exceptions rather than conducting redundant inspections that are driven by regulatory compliance (“finders become fixers”).

Improved operations efficiency

- Fewer inspection trips means less interference with trains and improved network fluidity.

What additional inspections did railroads promise to ensure operating safety?

1) Turnouts & joints – monthly walking inspection per TSS
2) Track geometry / ride quality – continue operating locomotive-mounted V/TI (Vehicle/Track Interaction) systems
3) Crossties – automated tie assessments using Georgetown Rail's Aurora and Xi systems
4) Rail flaw inspection – testing per current practice (frequency determined by rail flaw history)
5) Joint bar inspection – optical joint bar imaging system mounted on rail flaw test vehicle
6) Additional special inspections in response to hot & cold weather, flash flood warnings & storms

Did anyone argue against FRA granting a temporary suspension?

Yes. Rail labor (BMWED & BRS) made two arguments:

1. Inspectors look for conditions that are not detected by autonomous geometry cars, such as
   - Drainage & vegetation problems
   - Defective rails
   - Stripped joints, broken joint bars
   - Ballast & tie condition
   - Worn & broken switch points & frogs
   - Missing & broken fasteners
2. Geometry defects can develop quickly, sometimes in between twice-a-week inspections, which can be a problem if automated tests are made weekly or less frequently.

What was FRA's response?

"FRA has already seen the safety and operational benefits of using automated track inspection technologies, and data has shown that automated inspection technology is more effective in detecting track geometry conditions than visual inspections by track inspectors. Furthermore, evidence suggests that these new operational approaches may be as or more effective at detecting track defects while also decreasing service interruptions and reducing safety risks to railroad employees."

Karl Alexy, FRA, letter dated Jan 27, 2020 to Ed Boyle, NS, approving NS's petition for suspension to conduct a test program.

Photo from BMWED's comments in response to BNSF petition for waiver, Docket No. FRA-2020-0064

How did FRA and RRs agree to measure performance?

Unprotected defect - A condition requiring immediate remedial action (repair or s/o).

A defect found during an earlier inspection and properly slow-ordered is no longer an unprotected defect when reported during a subsequent inspection

Baseline - The number of unprotected defects found by automated geometry cars (and manual inspectors) at the start of the test program.

Both normalized to defects/100 miles.

Monitor the unprotected defect rate throughout the test program. If the test rate is less than the baseline rate…. Success!

A measure of defect severity: a two (or more) class drop

For example, say a VXL (warp) 62 of 1.85” is measured in Class 5 track.

VXL 62 limits

Class 5 – 1.5” Class 4 – 1.75” Class 3 – 2.0”

The measured condition meets Class 3, representing a two-class drop.

BNSF has touted the reduction in multi-class drops as an indicator of the success of its autonomous testing program. Along their waiver routes, BNSF achieved 0 multi-class drop defects over two months in early 2022 (never been done before)

FRA may include defect severity as a future reporting metric.

Photo: Gary. Wolf, Principles of Track Track Components & Geometry, WRI 4-29-20

How is the autonomous geometry data handled (on NS)?

On the locomotive….

- Class 4 exceptions are identified
- Cell modem transmits exceptions + 1000 ft. of data to back office

In the back office….

- Exceptions are evaluated automatically with respect to actual track class and FRA track safety standards to identify FRA defects
- Defects are validated manually by track geometry staff
- Validated defects are emailed to field personnel

In the field

- Defects are found and remedied

NS's commitment to FRA was to do all of this within 24 hours.

"Phased implementation" - a typical test program (NS)

Phase	Months	Inspection Frequency	Metric
1	1 - 3 (3 months)	* Maintain manual inspections @ 2X/week * Maintain monthly turnout & joint inspections * Autonomous 3X/month mains &1X/mo sidings	Establish baseline defect rate (unprotected FRA defects per 100 miles). Obtain FRA approval for Phase 2

Note: Main track autonomous testing must have 8 - 12 days between tests

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2	4 - 6 (3 months)	* Reduce manual inspections to 1X/week * Maintain monthly turnout & joint inspections * Autonomous 3X/month mains & 1X/mo sidings	Compare actual defect rate to baseline. If same or improved, obtain approval from FRA for Phase 3.

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3	7 - 12 (6 months)	* Reduce manual inspections to 2X/month * Maintain monthly turnout & joint inspections * Autonomous 3X/month mains & 1X/mo sidings	Compare actual defect rate to baseline. If same or improved, continue with Phase 3.

Note: Main track autonomous testing must have 8 - 12 days between tests

What happens if the automated schedule cannot be met?

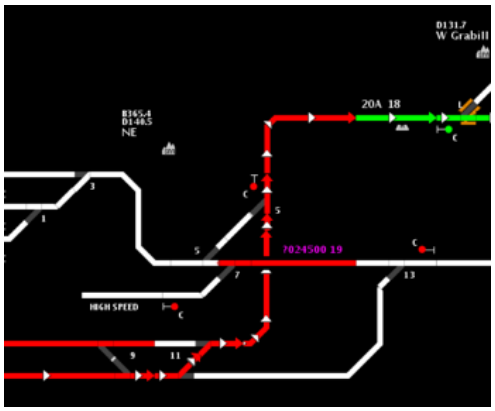
If automated geometry testing does not meet frequency because….

- a track or siding is missed in multiple track territory
- the interval between tests exceeds the phasing plan
- data is not collected because of an equipment failure……

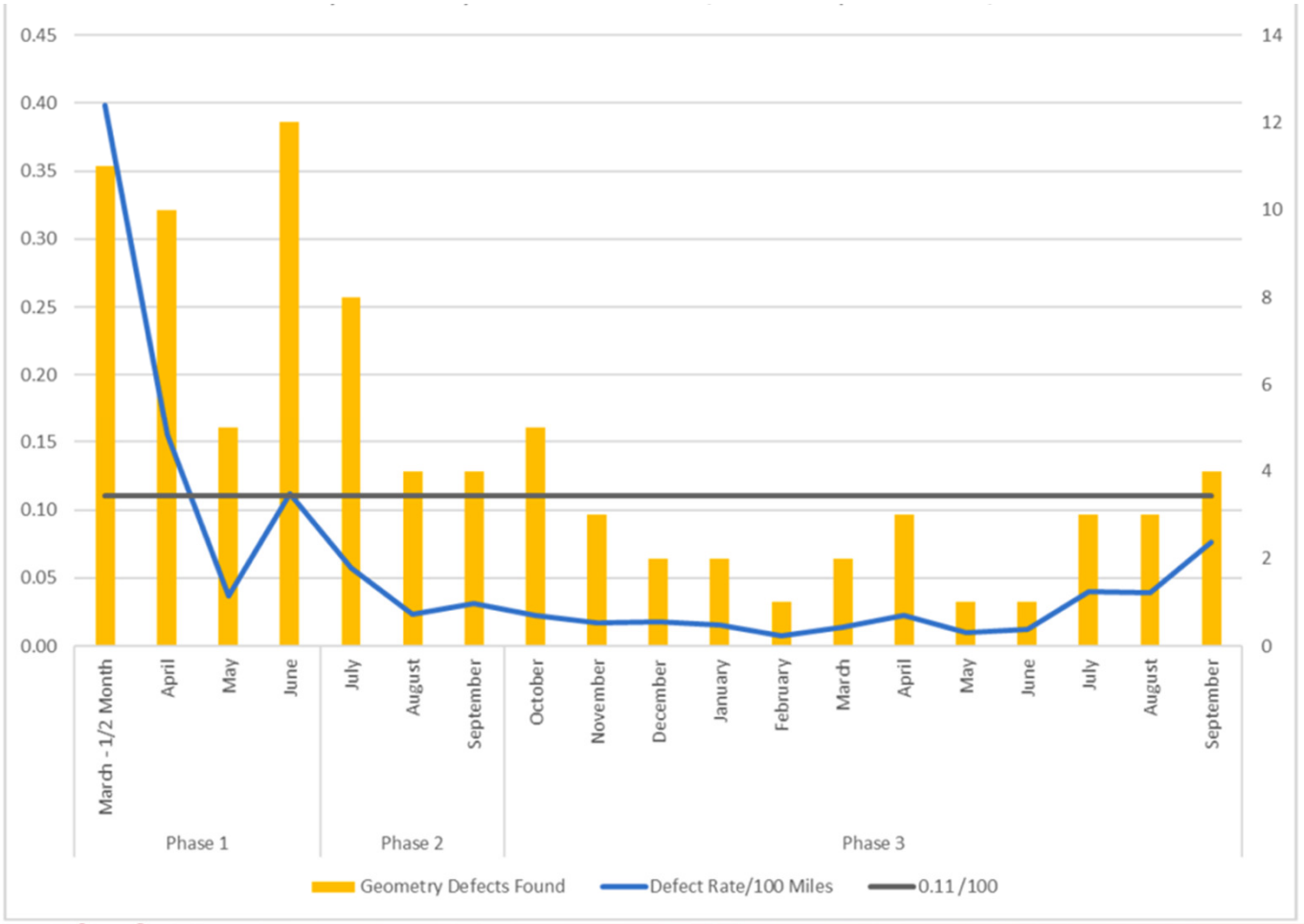
Manual inspections must resume according to the Track Safety Standards until automated testing can again meet schedule.

Challenges to autonomous testing

- Having Transportation reserve the instrumented locomotive for the designated route.
- Having Transportation include the instrumented car in a train traveling the designated route.
- Ensuring the test train is routed via the correct track in multiple-track territory.
- Snow can interfere with optical gage measurement.
- To satisfy the 24-hour response commitment, geometry data must be reviewed twice a day 7 days a week (on days a test vehicle is operating)



Test results: Monthly geometry defects & rates, Mar 2020–Sept 2021



Railroad: NS

<u>Defect rates/100 miles</u>

Phase 1 (baseline): 0.11

Phase 2: 0.04

Phase 3: 0.02

All railroads have reported similarly dramatic decreases in defect rates

RSAC Track Safety Standards working group presentation, 4-12-22

What other data is FRA interested in seeing?

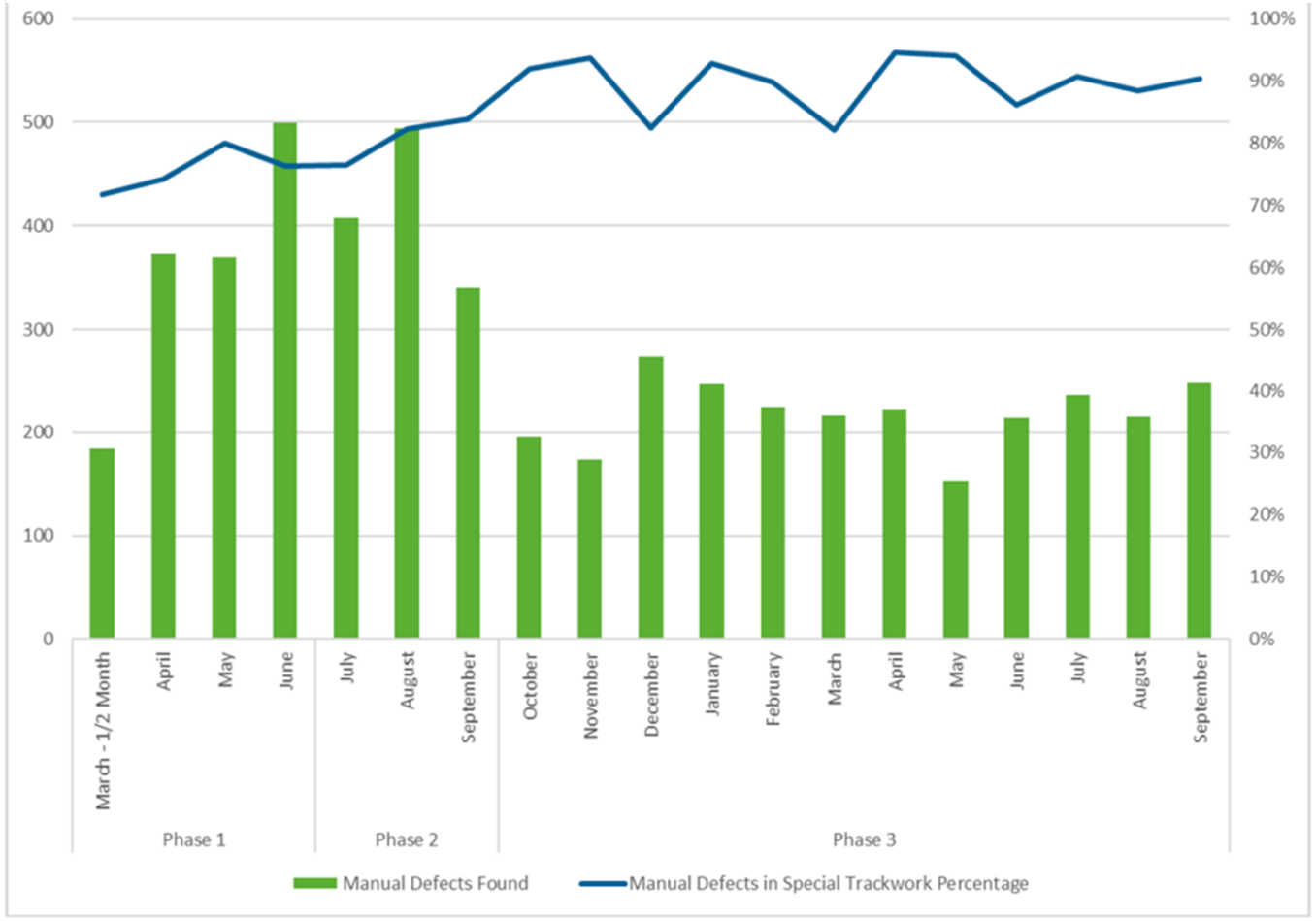
All defects found during manual inspections.

The defects reported by inspectors were typically non-geometry, such as

- Loose or missing bolts
- Loose stock rail braces
- Broken frogs
- Cracked or broken joint bars
- Broken rails

Photos Transportation Safety Board of Canada R15H0092

Test results: Monthly manual defects, Mar 2020–Sept 2021



Railroad: NS

The number of reported manual defects decreased in Phase 3.

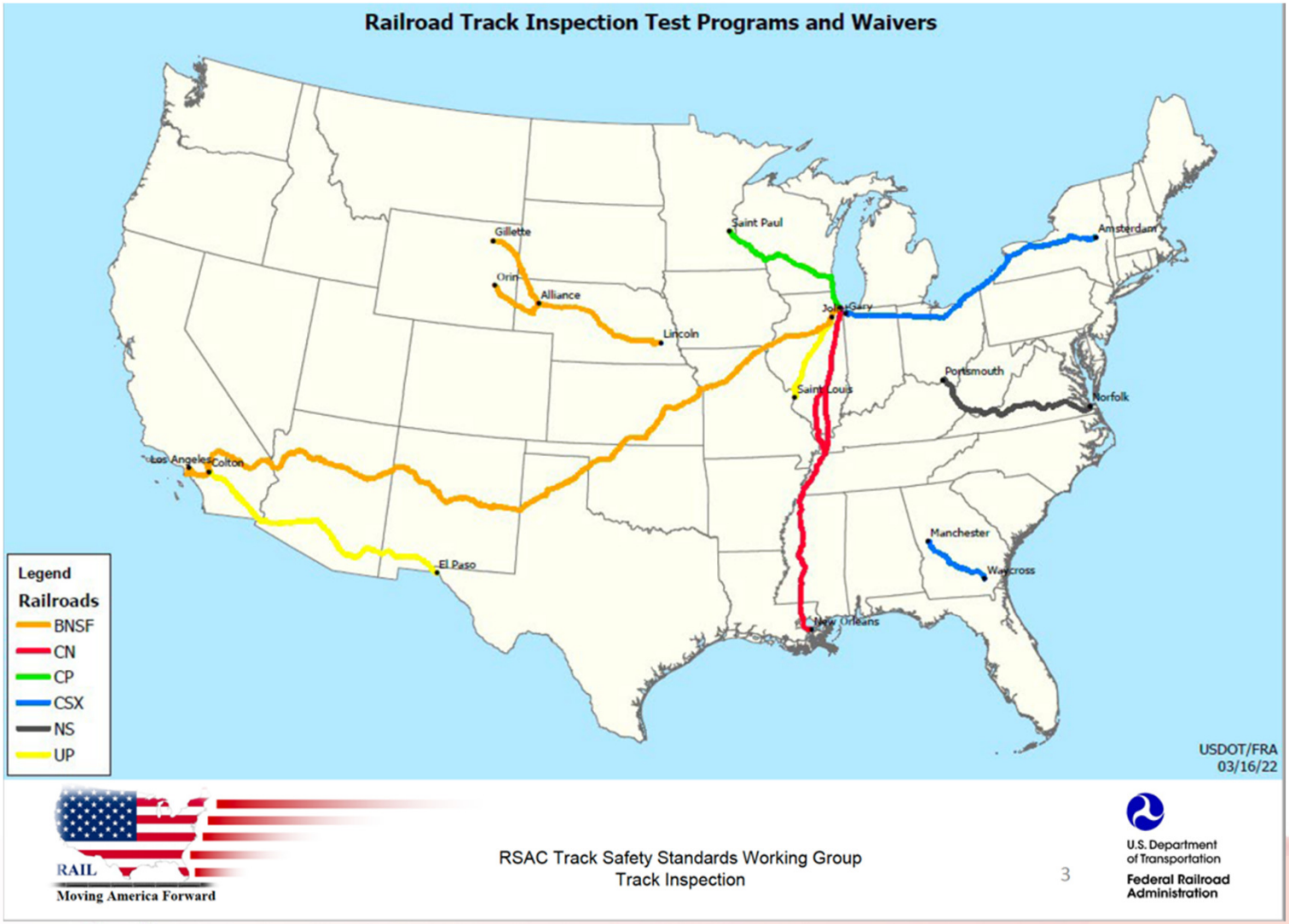
In Phase 3, 90% of defects reported during manual inspections were found in special trackwork (typical of other RRs).

RSAC Track Safety Standards working group presentation, April 12, 2022

What is the current status of this “operational approach”?

FRA support for this “operational approach” was quite strong in 2018-2020 but then evaporated in 2021.

Currently, FRA is allowing railroads to complete their current test programs but will not approve either extensions to temporary suspensions or longer-term waivers.



BNSF – 2 waivers

NS – test program complete, resumed manual inspections

CN, CP, CSX & UP: test programs due to end Nov 23, 2022

RSAC Track Safety Standards working group presentation, 4-12-22

Current Status of Test Programs and Waivers

(as of March 24, 2022)

Railroad	*Test Program Phase*	*Notes*
BNSF	Completed 5 of 5	Began November 1, 2018, Completed January 31, 2021, Approved for a waiver on two territories, Waiver expansion request dismissed
NS	Completed 3 of 3	Began March 16, 2020 Completed September 30, 2021 Waiver request dismissed
CN	3 of 4	Began April 16, 2020, Expires November 23, 2022
CSX	2 of 3	Began March 16, 2020 Expires November 23, 2022
UP	1 of 2	Began June 15, 2020, Expires November 23, 2022 (Requested to move to phase 2 on March 24, 2022)
CP	2 of 3	Began August 1, 2020 Expires November 23, 2022

RSAC – Railroad Safety Advisory Committee

Track Safety Standards Working Group was assigned task 19-05, Track Inspection

Purpose

- ✓ To develop rules to enhance rail safety by improving track inspection methods, frequency & documentation

Objectives

- ✓ Examine the feasibility of using automated track inspection technologies to fulfill certain inspection requirements in lieu of some visual inspections.
- ✓ Recommend changes to Part 213, subpart F.

RSAC – Railroad Safety Advisory Committee

The RSAC Working Group has offered this proposed text of a new section in the TSS:

§ 213.236 Alternative Track Inspection Methods

(a) Frequency of Inspections – Track owners may elect to use one of the following combinations of track inspection methods in lieu of the visual track inspection requirements under 49 CFR 213.233(b)(3) and (c). In each of these combinations the defect metric must be maintained at or below __ defects per 1000 miles of Track Geometry Measurement System (TGMS) testing, calculated monthly and the multiclass drop defect metric must be maintained at or below __ defects per 100 miles of TGMS testing, calculated monthly.

Two options for inspection frequency:

- FRA-prescribed frequencies (both geometry car and manual inspections).
- A performance-based regulation that allows a railroad to determine frequencies based on defect reporting.

What are the next steps?

Railroads will continue to expand their autonomous testing capabilities.

Why? Two reasons.

1) Increased automated testing does enhance safety
2) Railroads want to be prepared to substitute automated testing for manual inspections on a wider scale, should FRA's position evolve.

Thank you!