U.S. Department
of Transportation
Federal Railroad
Administration

Office of Research,
Development and Technology
Washington, DC 20590

Stakeholder Perceptions of Longer Trains

DOT/FRA/ORD-22/43

Final Report | December 2022

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*

2. REPORT TYPE
Technical Report

3. DATES COVERED *(From - To)*
May 2021–May 2022

4. TITLE AND SUBTITLE
Stakeholder Perceptions of Longer Trains

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Jordan Multer (0000-0002-7818-110X)
Gina Melnik (0000-0001-6006-5189)
Hadar Safar (0000-0002-8881-4142)
Savana King (0000-0003-3230-0844)

5d. PROJECT NUMBER
RR04AB

5e. TASK NUMBER
UM172, VM172

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Volpe National Transportation Systems Center
55 Broadway
Cambridge, MA 02142

8. PERFORMING ORGANIZATION REPORT NUMBER
DOT-VNTSC-FRA-22-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Department of Transportation
Federal Railroad Administration
Office of Railroad Policy and Development
Office of Research, Development, and Technology
Washington, DC 20590

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
DOT/FRA/ORD-22/43

12. DISTRIBUTION/AVAILABILITY STATEMENT
This document is available to the public through the FRA website.

13. SUPPLEMENTARY NOTES
COR: Jason Wornoff

14. ABSTRACT
This report documents stakeholder perceptions emerging from focus groups about very long trains (VLTs) with participants from three labor unions, the Federal Railroad Administration (FRA), and two freight railroads. All stakeholders expressed uncertainty about how to define a VLT and noted that the safety of longer trains is related to additional contextual factors beyond train length.

Views on specific safety concerns varied by stakeholder category. Railroad manager participants asserted that increasing train length does not pose new safety concerns. FRA participants shared some concerns, but their perspectives varied. Labor participants strongly asserted that VLT operations present new or increased safety concerns.

The diverse set of factors identified as affecting safety do not fit easily into a framework for understanding the relationship between train length and safety. Further study is needed, and the Appendix include a list of questions to support future research.

15. SUBJECT TERMS
Safety, human factors, very long trains, VLT, train length, communications, in-train forces, blocked crossings, precision scheduled railroading, PSR

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
UNC	UNC	UNC		41	Jordan Multer
					19b. TELEPHONE NUMBER *(Include area code)* 617.494.2573

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

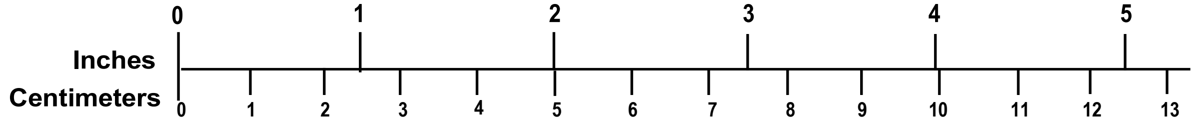
VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSIO

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286

Updated 6/17/98

Acknowledgments

The research team would like to thank the stakeholder groups for participating in this work. Special thanks to the focus group participants for sharing their knowledge and experience on this subject. The information provided allowed the research team to document stakeholders' perceptions of train length.

Contents

Illustrations

Tables

Executive Summary

From May 2021 through May 2022, the Federal Railroad Administration (FRA) contracted human factors researchers at the Volpe National Transportation Systems Center to document stakeholder perspectives regarding the safety of running very long trains (VLTs). The Volpe team conducted eight virtual focus groups: three with labor groups, three with FRA's Office of Railroad Safety staff, and two with Class I freight railroad managers.

Opinions on VLT safety varied by stakeholder. Railroad managers did not raise safety concerns and asserted VLT safety is well managed in accordance with general railroad safety management practices. FRA stakeholders shared some concerns, but differed on the severity of certain safety issues. FRA stakeholders noted that they lack the necessary data to determine safety consequences of VLTs, and, in some cases, they also lack the regulatory authority to act on them if these safety consequences exist. Labor groups firmly believed VLT operations present safety concerns that need to be addressed.

Opinions on safety shared by both labor and FRA included:

- **Blocked crossings:** They may occur more often because of VLTs.
- **Communications losses:** Crews experience (1) losses in radio communications and (2) losses in train communications that support braking.
- **Fatigue:** VLT operations may contribute to (1) hours of service (HOS) violations for crews and (2) non-regulatory fatigue issues for those without HOS protections (e.g., car inspectors)
- **Infrastructure limitations:** Infrastructure (e.g., sidings, yards, placement of lights) may not be designed to accommodate VLTs.
- **Crew training/experience:** Some crews may not be adequately prepared to run VLTs due to (1) insufficient training and (2) insufficient experience manually running trains to safely permit crews to take over running VLTs in the event that in-cab technology (e.g., Positive Train Control, distributed power) fails
- **Car inspection and maintenance:** Unqualified staff perform some car inspections (e.g., conductors); insufficient time allotted for proper car inspections.
- **Train makeup:** Poor train makeup with some VLTs make them susceptible to increased in-train forces that are difficult for crews to manage.

Class I railroad participants claimed no direct relationship exists between safety risk and train length. They posited that the safety problems raised in the focus groups could affect trains of any length. Railroads also shared what they perceived as the safety and efficiency *benefits* of operating VLTs.

Two notable themes applied for all stakeholder categories:

- Stakeholders agreed there was no commonly accepted definition of a "very long train."
- The safety of a given train was dependent on contextual factors that go beyond train length.

Two high-level themes emerged from the focus groups:

- Train lengths increased before infrastructure, technology, equipment, and operating practices could accommodate them.
- Resource reductions increased operational intensity.

FRA and others can use these findings to inform future research on VLTs. Appendix A contains a list of potential research questions for a future study.

1. Introduction

This report documents stakeholder perspectives associated with very long trains (VLTs).[1] A research team from the Volpe National Transportation Systems Center (Volpe) used the terms "very long trains" and "VLTs" to broadly characterize the subject of increasingly long freight trains which the authors explored with stakeholders. The working definition of a very long train is addressed in Section 3.1.1, No Common Definition of a VLT.

1.1 Background

Data from the Association of American Railroads suggest train length has been gradually increasing over time. For example, a small number of trains (23 to 28 per day) increased in length from 11,500 feet to over 12,500 feet between 2010 and 2019 (Moller, 2019). The Government Accountability Office (GAO) (2019) reported that in 2017 average train lengths for two Class I railroads were between 1.2 and 1.4 miles – a 25 percent increase since 2008. And a recent study quantifying trends by train type indicates unit trains exceeding 140 railcars have become more frequent over the past 10 years (Dick, 2021).

While longer trains are more efficient, some stakeholders asserted that they also present safety risks. Train length has emerged as a topic of interest by several organizations, such as Congress, the Federal Railroad Administration (FRA), GAO, and labor crafts. Articles in trade publications (Stagl, 2018; Machalaba, 2018) and congressional testimony (Passenger and Freight Rail, 2020) document labor groups' safety concerns associated with increased train length. These concerns include:

- Radio communication exceeding limits
- Additional in-train forces that make it difficult to keep trains intact
- Increased blocked crossings
- Decreased maintenance standards
- Insufficient training for VLT crews

Train length emerged as a potential safety concern within FRA's Office of Railroad Safety (RRS) in 2016 (Prabhakaran, 2016). FRA's Office of Research, Development, and Technology (RD&T) initiated a study to examine the use of air brakes as train length increased up to and beyond 200 control valves (Federal Railroad Administration, 2021). Additionally, a 2019 GAO report (GAO, 2019) described several potential safety risks associated with the operation of longer trains, including problems associated with train handling, crew training, communications, as well as impacts on the communities through which the trains operate.

More recently, Cothen (2022) asserted there are safety risks in operating VLTs, given the state of technology and the railroads' operational practices – specifically, the failure of technology to compensate for the higher in-train forces of heavier and longer trains.

[1] Within the railroad industry, there is no commonly accepted definition of a "very long train" and this term is not universally accepted by all stakeholders. Railroad manager participants indicated they do not define or classify trains in terms of length.

Following an FRA-led "listening session" with labor representatives from the Brotherhood of Locomotive Engineers and Trainmen (BLET), International Association of Sheet Metal, Air, Rail, and Transportation Workers (SMART), and Transportation Communications Union (TCU) to share their VLT safety concerns, FRA tasked Volpe to conduct focus groups to investigate further. This report describes the focus group discussions.

1.2 Objectives

The objective of this research was to document different railroad industry perspectives related to operating VLTs.

1.3 Overall Approach

The Volpe team conducted focus groups to document perspectives related to increasing train length as described by representatives from three groups: labor unions, Class I railroads, and FRA RRS. The methodology used in this work is covered in more detail in Section 2.

1.4 Scope and Limitations

The scope was limited to documenting perspectives related to VLTs in U.S. freight operations.

The focus group discussions may have captured a range of issues deemed important to the stakeholders, but did not necessarily reflect the frequency with which they occur within the industry and across different railroads because:

- Focus group discussions were limited to a small group of participants within each stakeholder category. Therefore, it is not clear how pervasive these issues are within one stakeholder category or across the industry.
- Labor focus groups represented many different Class I railroads. Railroad focus groups represented only two Class I railroads.

This study did not collect data that quantifies the trends in train length over time. Additionally, researchers did not relate the focus group discussions with accident/incident data, data from inspections, or performance indicators that measured operational safety.

1.5 Organization of the Report

This report is organized into the following sections:

- Section 2 describes the study methodology.
- Section 3 presents the content of the focus groups.
- Section 4 synthesizes the focus group content and identifies potential areas for further consideration.
- Section 5 makes concluding remarks.
- Appendix A contains a list of potential questions for future research based on the current work.

2. Method

The impetus for these focus groups emerged from a virtual listening session on May 19, 2021, with FRA senior managers and BLET, SMART, and TCU representatives in attendance. The session conducted by FRA provided an opportunity for labor representatives to share their perspectives related to the operation of VLTs. In response, FRA set up focus groups to better understand perspectives on long trains.

As shown in Table 1, stakeholder representatives included participants from three groups: RRS (including two inspector groups and staff directors), and two Class I freight railroads.[2] Labor representatives represented craft employees at Class I freight railroads.

Table 1. Focus Group Representatives by Stakeholder Category

Stakeholder Category	Representatives	Total = 28
Labor[3]	BLET, SMART, TCU	13
RRS	Motive power and equipment (MP&E) and operating practices (OP) inspectors, and staff directors	9
Railroads	Two Class I freight railroads	6

Each focus group consisted of four to eight participants. The Volpe team facilitated conversation with a small number of additional people present (i.e., members of FRA's RD&T and notetakers transcribing the session).

The Volpe team posed open-ended questions. Questions varied by stakeholder group (i.e., based on differing participant job functions and areas of expertise), but covered the same topics. Volpe researchers sought independent input from each stakeholder group, so participants were not asked to directly respond to concerns or statements made in other focus group sessions.

Interviewees received their questions approximately 24 hours before their session.

All focus group sessions were conducted remotely over Microsoft Teams and lasted between 1.5 and 2 hours. Facilitators informed participants in advance that their information and responses would be de-identified.

An FRA contractor provided transcripts of each focus group to the Volpe team. Using the transcripts and supplementary notes, the team summarized each focus group. The Volpe team briefed participants on the summary content and participants also reviewed a draft of this Technical Report.

[2] The Volpe team omitted the specific division names of participating staff directors (i.e., which inspectors they oversee), as well as names of participating railroads, to better protect confidentiality.

[3] In reporting combined findings from all three labor groups participating in this project (BLET, SMART, and TCU), the Volpe team may refer to them by their respective stakeholder, i.e., "labor."

3. Focus Group Summaries

Stakeholders' feedback on VLTs varied widely. Labor participants focused on safety while railroad participants believed the safety topics discussed could occur for trains of any length. FRA inspector participants shared some of labor's perspective; their views were informed by their experiences in the field and the particular railroad for which they inspected. FRA staff directors were informed by past field experiences and the safety data and inspection reports they received from multiple regions.

3.1 Focus Group Content Applicable across Stakeholder Groups

In most instances, labor, railroad manager, and FRA participants expressed different perspectives during the focus groups. However, some content was common in all focus groups.

3.1.1 No Common Definition of a VLT

The Volpe team asked participants in each stakeholder group to share their personal definition of a "very long train." One point shared across stakeholder groups was the lack of an accepted definition. Some participants defined VLTs either by car count or train length. See Figure 1 for a graphical depiction of the different definitions by car count and train length as described by labor participants.[4]

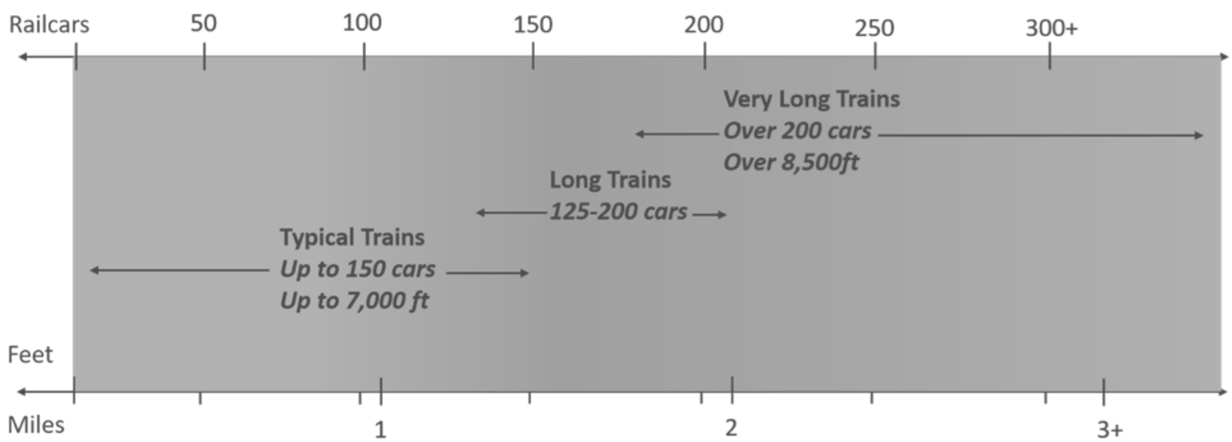


Figure 1. VLTs as Defined by Car Number and Length by Labor Participants

Labor participants representing train crews were more likely to talk about VLT safety from the perspective of train length. They related safety concerns in terms of train handling and the distance a conductor might walk from one end of the train to the other. Similarly, labor participants representing car inspectors focused on the number of cars in the consist. They related safety concerns in terms of how many cars to inspect and the time needed to accomplish this task.

[4] Note that these represent definitions provided by individual focus group participants from different labor groups. These are not official definitions provided by individuals on behalf of labor groups.

Other labor participants offered specific safety-related contextual factors to define a VLT, as shown in Table 2.

Table 2. Example VLT Definitions Based on Participant Safety Considerations

Safety Consideration	Participant Definitions
Infrastructure	Any train that is longer than a standard yard or siding.
Train Handling	Any train that requires repeaters or distributed power units (DPUs).
Communication	Any train that loses communication from the front to the back end.
Blocked Crossings	Any train that blocks a grade crossing for an excessive amount of time.
Training/Experience	Any train that is significantly longer/different what you're used to/trained on.
Fatigue/Hours of Service (HOS)	Any train that is too long to fit into a siding, which causes congestion on the mainline and result in HOS violations.

Railroad participants challenged the notion that defining certain trains as "very long" was a useful concept for understanding safety, noting that tonnage was a more important consideration than train length for the safe makeup of trains. Focus group participants from both railroads provided examples to illustrate that a train should not be thought of as being easy or difficult to run based simply on its length.

3.1.2 VLTs Perceived to Be More Common

Despite the lack of an established definition of VLTs, focus group participants from all stakeholder groups agreed that train lengths have increased.[5] Participants shared a variety of reasons for increasing train length, including technology advancements that enable the operation of longer trains (e.g., distributed power [DP], couplers that can withstand heavier cars). Some participants attributed the increasing use of VLTs to customer needs, and some attributed it to the rise of Precision Scheduled Railroading (PSR).[6]

3.1.3 Safety Is Context-Dependent

Stakeholders agreed that context is an important consideration in determining the safe operation of trains, regardless of length. According to stakeholders, contextual factors that can increase safety risk include the territory characteristics over which the train operates, track infrastructure, equipment and technology, train makeup, and operational practices.

---

[5] Data to confirm this and show the extent of the change is lacking, further complicated by the lack of a VLT definition that would be needed to enable data collection.

[6] PSR is an operating method that involves maximizing asset use by running trains on a fixed schedule, emphasizing point-to-point movement of car loads rather than the entire train (in lieu of dispatching trains after accumulating a sufficient number of loaded cars) (Baudendistel, 2022).

Stakeholders from labor unions and railroads talked about contextual factors in different ways. Labor group representatives spoke to the circumstances that make operating a VLT difficult, highlighting the contextual factors that create the potential for unsafe situations. They stressed how the interactions of two or more contextual factors could increase safety risk. For example, they voiced concerns that technology may fail when operating a VLT through certain mountainous territory, and that braking equipment may not work properly in certain weather conditions (e.g., slack adjusters can freeze in extreme cold weather, causing air brake failures).

Railroad participants underscored the processes and contextual considerations that help them determine the safe makeup and length of a train. For example, they discussed modeling software that considers territory and infrastructure when making up trains.

3.2 Perspectives from Labor

Stakeholders from BLET, SMART, and TCU discussed operational considerations and safety concerns regarding VLTs. Overall, these labor groups presented similar perspectives, often sharing the same or related concerns.

Labor expressed concerns with operational aspects related to VLT operations. These operational considerations provide helpful context for labor's safety concerns, presented in Section 3.2.2:

- **Territory characteristics and weather exacerbate the complexity of VLT operations.** Mountains, curves, and tunnels create complexity for all trains, but labor asserts that these complexities may be exacerbated for VLTs. Weather is another important safety consideration for trains regardless of length. Together, territory characteristics and weather contribute to safety issues particularly surrounding equipment, as well as training for crews. Labor representatives pointed out that air brake performance degrades in cold weather.
- **Infrastructure may not be able to accommodate VLTs.** While trains have grown longer, railroad infrastructure has largely remained unchanged. This has implications particularly for sidings and yards, where VLTs may not fit. Infrastructure limitations were a contributing factor to safety concerns with blocked crossings. Labor participants shared their belief that deficiencies across the railroad system render VLTs as inherently unsafe. Labor described safety concerns related to:
- Training
- Blocked Crossings
- Communications
- Train Control Technologies
- Strain on Equipment
- Car Inspection and Maintenance
- Fatigue and Workload

Within these areas, labor groups shared examples of safety concerns that are not exclusive to VLTs, but which are exacerbated by VLT operations. They also described new concerns that they say resulted from VLT operations.

Training

Labor asserted that the training railroads provide is insufficient for VLT operations, which it said is qualitatively different than for non-VLT trains.

Labor stakeholders stated that their railroads provided some additional training, whether in the classroom, in a simulator, on-the-job, or some mix of the three. However, they agreed it was not enough to account for the challenges of VLT operations.

Labor focus group participants also indicated they do not receive sufficient training for in-cab technologies and equipment (e.g., energy management systems [EMS], PTC, DPU). Many stakeholders stated these technologies cut in and out on VLTs and are a source of distraction to the engineer, and that the additional workload brought on by these technologies contributes to mental fatigue. The sections on Communications and Train Control Technologies discusses these issues in more detail.

Blocked Crossings

Blocked crossings occur with trains of all sizes. However, labor said VLTs create new opportunities for crossings to become blocked. Labor also stated they believe there has been an increase in blocked crossings with the introduction of VLTs.

Labor suggested VLTs exacerbate the existing reasons that non-VLTs block crossings because they:

- **Block crossings for longer periods.** Longer trains take more time to get through a crossing than shorter trains.
- **Exacerbate negative driver behaviors at grade crossings.** Labor stated VLTs increase community frustration and may tempt drivers to "beat the train" because of delays.

Labor explained that VLTs block crossings for reasons that are different than non-VLTs:

- **A VLT may block several (or all) crossings in a town instead of just one** (or some) whereas a non-VLT would not.
- **Infrastructure limitations** is another reason VLTs block crossings where non-VLTs may not. When VLTs cannot fit into a yard or a siding they stick out onto the main line. If a yard or siding is adjacent to a crossing and cannot accommodate the full length of the train, the train can block a crossing. Similarly, if a yard can only accommodate one train, then the remaining trains waiting in the queue to enter the yard are tied down. On the other hand, shorter trains could fit between crossings when tied down.
- **VLTs parked on the mainline.** Related to infrastructure limitations, labor also described instances where railroads prefer to park trains and double them up on the main line to avoid slowing production in the yard. Participants stated such trains could block crossings for hours. According to labor, fines for blocked crossings were not a deterrent.
- **Initial congestion may contribute to further congestion due to HOS limitations.** According to focus group transcripts, congestion and bottlenecks, such as those related to infrastructure limitations, may result in crews running up against their HOS limitations. It takes time to get new crews out to the train, and the train is tied down at the location

where it is stopped. When this happens while a train is over a grade crossing, it can extend the length of time the train blocks the crossing for hours or even days.

- **VLTs stopped at a signal.** Labor said that when a VLT is stopped at a signal located near a grade crossing, a non-VLT may have been able to stop at that signal without blocking the crossing. But due to its increased length, the VLT will block the crossing.

Labor expressed concern for local communities where VLTs blocking grade crossings can restrict emergency vehicle access and segment towns for extended periods. Labor also expressed concern for train crews.

Communications

Labor participants discussed two categories of concerns related to communications: radio communications between the crew and communication between the front end of the train and end-of-train (EOT) devices.

Radios

Communication is a critical aspect of safe train operations and even more so on a VLT when an engineer cannot see or "feel" what is happening farther back in the train. Labor representatives reported that radio communications often fail on VLTs because:

- Radio range is insufficient to cover the train length.
- The train is operating in territory (e.g., tunnels, mountains, curves) that interferes with the radio signal.
- PTC interference with communication. Several labor stakeholders said they observed this but did not know why and did not provide evidence.

In cases where workarounds fail, labor explained that crews may be left in situations where they cannot openly discuss safety concerns with co-workers or the public.

End-of-Train Devices

Labor stakeholders noted that EOT devices were not reliable on VLTs largely because of the loss of communication resulting from territory characteristics like mountains and tunnels. When EOT devices fail, they said, crews may be unable to initiate emergency braking, exacerbating the risk of derailment. The extent to which EOT devices are being used depends on the railroad and subdivision. Some stakeholders stated they rarely see EOT devices in use on VLTs, while others said they often operated trains with EOT devices.

Train Control Technologies

Labor stakeholders shared several safety concerns with train control technologies (e.g., PTC, EMS) and shared examples where they fail during VLT operation. These failures may also happen with non-VLTs. However, labor asserted that these safety consequences are exacerbated when running trains that are longer and heavier than the trains these technologies were designed to support.

Labor claimed that train and energy management control systems frequently fail or switch over to manual control. When this happens, they said, engineers must act quickly to gain control of the train.

In addition to sudden failures, labor stated that some EMS fail consistently when the train is moving under 10 mph. Such failures often occur when a slow order is in place or going downhill.

Labor claimed these automated systems are sometimes responsible for trains breaking in two, either directly or indirectly (i.e., the system handed off manual control to the engineer, but the engineer was unable to regain control because the in-train forces had already built up). Labor asserted that the railroads often cite train handling as causal factors in these situations.

Strain on Equipment

Labor stakeholders said they witnessed more damage to equipment (e.g., rolling stock) with VLTs, including general wear-and-tear as well as more specific issues such as broken knuckles and train separations.

Equipment Exceeding Limitations

According to the labor focus groups, one reason for the perceived increase in damaged equipment that was *not* caused by VLTs: the reduction in resources, such as railcars, power (e.g., locomotives), and labor. This reduction contributed to an increased use of remaining resources, with implications for its integrity and time available for maintenance.

Train Makeup and In-Train Forces:

In addition to general wear-and-tear, stakeholders stated they see more broken/cracked knuckles and damage to wheels and other railcar components during VLT operations than during non-VLT operations. Labor attributed such damage to the increased in-train forces experienced by VLTs and using certain problematic train makeup practices on VLTs.

Train makeup and in-train forces are closely linked. Labor explained that trains with poor makeup experience unbalanced forces resulting from loads, empties, and engines not being properly placed across the consist. Specifically, labor stated in-train forces increase when empties are not placed in the rear. Additionally, they stated that complications can arise because cars of different lengths have draft gears arranged differently. These combinations can cause excessive lateral forces between connected cars.

Another reason for unbalanced forces, according to labor, is due to the use of end-of-car cushioning units on VLTs. Labor said that these units lead to VLTs having more slack than non-VLTs, making equipment move less predictably. Participants said this makes train handling more challenging for engineers and can put conductors at an increased risk during shoving movements. In-cab technologies may also contribute to this issue (as discussed in the Train Control Technologies section), they claimed.

Labor focus group participants said increased tonnage of VLTs, combined with operating in complex territories, creates challenges associated with in-train forces. Labor noted that VLTs may experience a wider range of forces when operating through difficult (e.g., mountainous and curvaceous) terrain due to their length.

Finally, labor hypothesized that increased in-train forces on VLTs may damage equipment. Damaged equipment could be a consequence of the equipment not being designed to withstand the types of forces VLTs impose.

Car Inspection and Maintenance

Labor stakeholders discussed the car inspection processes in terms of how mechanical inspections are conducted, who does the inspections, and instances where needed inspections may not occur.

According to labor, railroads have changed their inspection and maintenance operations. Labor asserts that VLT operations are harder on equipment because the same equipment is expected to perform to a certain standard when trains contain an ever-greater number of cars and amount of tonnage. This may result in more mechanical defects on the cars receiving greater use. (See labor concerns under Strain on Equipment for more on this.) Additionally, labor groups stated that railroads have reduced the number of carmen available to conduct inspections.

Inspection Processes

Labor stakeholders asserted that procedures for mechanical inspections are insufficient to find defects. Specific concerns include:

- **Insufficient time for carmen to conduct adequate inspections:** Labor representatives said staff reductions have resulted in too few carmen available to inspect each car properly. Although carmen are instructed to inspect each car in the same manner for all trains, labor asserted that carmen are often not given the additional time needed to conduct inspections on VLTs (which typically contain many more cars than a non-VLT).
- **Wayside detectors may be less effective:** Labor stated the length of VLTs makes it difficult to detect equipment defects, since wayside detectors may be less effective when a defect is identified further along a train.
- **Avoiding Inspection Points:** Finally, labor stated that railroads may route trains to avoid yards where they would be inspected.

Delays in Addressing Defects

Labor stakeholders also noted that VLTs may be associated with delays in car maintenance. In the past, labor participants said, most terminals had shops and a qualified mechanical employee who could either fix the issue or shop the train.

Workload and Fatigue

Labor expressed concerns about workload and employee fatigue specific to VLTs and to trains in general, but which may be more pronounced during VLT operations. Many of the topics covered here also relate to safety concerns discussed by labor in other parts of Section 3.2.2.

Running VLTs More Challenging for Engineer

Labor stated that running VLTs can be more challenging for the engineer in a variety of ways that increase general workload and fatigue. These include:

- **Differences in general train handling:** Labor stakeholders stated that running a VLT is different from running a non-VLT. They said train handling must be approached differently and shared some examples. Engineers cannot "feel" what is happening farther back in the train. To compensate, they said engineers may try to minimize air brake use and rely more on dynamic braking. Labor groups were especially concerned about possible train handling errors because they may take longer to recover from on a VLT than on a non-VLT.

In focus groups with labor, participants focused on engineers' stress and mental fatigue inherent to VLT operation, compounded when VLT-specific training is lacking or not provided. (See the Training section for more on this topic.)

- **Running multiple locomotives concurrently:** VLTs often use DP, which requires engineers to manipulate more than one locomotive at a time. Labor participants stated that this creates more workload and more heads-down time as part of managing that extra workload. Engineers may need to do different things with the locomotives at the same time depending on where they are in the consist (e.g., if one locomotive is going down a grade while another locomotive is going up a grade), adding complexity to running two or more locomotives concurrently.

  Multiple locomotives with EMS all have different "fences" (i.e., programs operating each consist independently). Labor stated that when something prompts the engineer to manually disengage the system, they must do it for each fence separately and with multiple locomotives, resulting in extra work at a critical moment.

  Additionally, labor talked about how they are required to use EMS and that each of the locomotives they run has an EMS that is running separately, which adds to the engineer's mental workload.

VLTs Lead to More Work for Conductors

Labor pointed to additional work for VLT conductors, contributing to increased workload and fatigue. This additional work includes:

- **More work to manage train consist:** The conductor is responsible for the train consist, which includes ensuring proper train makeup in terms of loaded and empty cars as well as the location of hazmat cars. Labor stated that longer trains require more work to manage the entire consist.

  Stakeholders stated that the increased workload inherent in longer consists is further complicated by railroads pushing for trains to leave before their preparations are complete. This means that as workload is increasing, conductors say they need more time to accomplish their work.

- **Walking the train takes longer and has more risk:** The conductor's workload also includes walking the train. This is a more substantial task as train lengths increase.

  Labor participants stressed that walking the train also carries increased risk as train lengths increase, particularly when radio communication is lost. They cited risks to conductor safety, stating that the workaround of relaying with the dispatcher may not work, and having to walk the train when communications are down carries inherent risk. (These concerns overlap with the labor concerns discussed in the Communications section.)

- **Conductors may be asked to do car inspections:** As discussed in the Car Inspection and Maintenance section, conductors may be asked to take on the work of inspecting train cars. Even for non-VLTs, this is substantial additional work.

VLTs Combine with Other Factors to Increase HOS Violations for Train Crews

Labor stated one consequence of VLT operations is train crews running up against HOS rules more frequently. Due to the infrastructure limitations discussed earlier, including sidings and yards that cannot accommodate VLTs, congestion and bottlenecks on the track are more frequent. A train that cannot fit into a siding or a yard sticks out onto the mainline, causing traffic to back up. As trains get tied up on the mainline, crews are more likely to face HOS violations. Labor gave examples where train crews ran up against their HOS and were unable to get to the terminal for over 24 hours because of VLT-related congestion.

Labor suggested these problems are exacerbated by the industry's workforce reductions. Labor also talked about the fatigue resulting from workforce reductions. Engineers and conductors are called to work more frequently, and this can start 10 hours after their prior shift ends.

VLTs Contribute to Overtime for Carmen

Labor stated reductions in yard crew staffing have resulted in carmen working overtime, particularly because yard crews do not have HOS regulations. Labor noted that these reductions have resulted in increased worker fatigue. This is not a concern exclusive to VLTs. However, participants raised this issue in describing how things have changed with the advent of VLTs.

3.3 Perspectives from Railroads Focus Group Participants

Railroad managers who participated in the focus groups believe VLT safety is well-managed in accordance with general railroad safety management practices. They specified that they do not believe there are safety concerns particular to longer trains. Rather, the safety concerns that exist must be managed irrespective of train length.

This section reports on what the Volpe team learned from railroad manager focus groups and shares railroad participant perspectives regarding increasing train length. It begins with background information about the trend toward longer trains, and then discusses the process and considerations that go into planning for longer trains and other actions taken that support the use of longer trains. It concludes with the safety and efficiency benefits of running longer and fewer trains, as described by railroad participants.

3.3.1 Reasons for Increasing Train Length

According to railroad participants, train length has grown for two reasons:

1. A focus on customer needs
2. Technology advances have made longer trains possible.

Railroads adapted to meet customers' production needs by operating longer trains that enable them to move freight more quickly and efficiently. Participants stated that operating longer, but fewer, trains has allowed railroads to reduce the number of trains on the network, resulting in a less complicated and more efficient network. These changes have resulted in better service for their customers.

Railroad participants also pointed to technical advances that have allowed them to increase train length safely. For example, DP increases dynamic braking capabilities throughout the train, which enables longer and heavier trains. Other advances supporting longer trains include train control technologies (e.g., EMS and PTC), increases in horsepower capabilities, stronger couplers, and the use of modeling software. Section 3.3.2 discusses modeling software further.

3.3.2 Train Makeup Process and Considerations

Railroad managers shared insight into the processes they use to make up trains.[7] Though processes differ slightly by railroad, managers indicated that careful planning and use of modeling software mitigates VLT risk.

According to railroad managers, new train build[8] concepts are driven by customer needs and then carefully considered in a range of ways. This can include validating new train builds by using modeling software to ensure safety. Additionally, the process considers operational needs and safety. Table 3 includes some of the safety considerations railroad managers raised during focus group discussions.

Table 3. Railroad Considerations for Train Builds

Customer Needs	Physical Territory
Schedule	Length of Haul
Impact on the Network	Train Makeup
Infrastructure	Power
Train Type: Intermodal or Unit	Tonnage
Car Types	

Managers from one railroad stated all the trains they run are verified in their models. Managers from the other railroad specified that any train that is changed is run through the model. Both railroads were clear that modeling train builds is a critical step in determining if a new train build can be done safely. Modeling software considers factors such as train consist and tonnage, car placement, territory, and infrastructure. Different departments use modeling data to consider other factors – including in-train forces, train handling, and train integrity of the constructed train – to assess safety.

Railroad stakeholders suggested locomotive engineers also have a say in determining whether a particular train build is safe. One railroad includes a supervised run and event recorder data review as the last step of a new train build process. A train crew accompanied by a supervisor

[7] Train makeup refers to the distribution within the train of railroad cars that are empty or loaded, short or long, or that have other characteristics affecting their ability to negotiate railroad track while subject to "draft" (stretching) forces and "buff" (compressive) forces within the train. Improperly assembled trains are more susceptible to derailment, depending upon grade, curvature, train handling (use of the throttle, independent brake, dynamic brake and automatic braking system), and other factors (Federal Railroad Administration, 2005).

[8] In building a train, designers are concerned not only with train makeup, but also with additional considerations such as picking up and setting out cars, placement of hazmat cars in the consist, infrastructure consideration such as siding yard length and terminal characteristics, territory characteristics, and customer needs.

takes the new train on a test run to verify the train handles as the model predicted, and gathers feedback from the locomotive engineer. After the test run, railroad managers review the trip report and event recorder data. If both the trip report data and engineer feedback is satisfactory, the new build is approved for revenue service.

3.3.3 Training, Infrastructure, Equipment, and Operational Safety

This section covers training, grade crossings, communications, car inspection and maintenance, and fatigue.

Training

Railroad managers described training that supports VLT operations. Railroad managers mentioned two training topics as helpful for VLT operations:

- **Operating rules:** Railroad managers stated operating rules dictate train handling and are not driven by train length. Compliance with operating rules represents a key component for training crews to be able to operate any train, regardless of length.
- **Distributed power:** Railroad managers stated that the biggest difference in operating longer trains compared to shorter trains relates to the use of DP, so they incorporate appropriate training into their curricula.

Railroads provide other types of training in addition to classroom-based training, including:

- **Simulator training:** Railroad managers stated simulators do a good job of mimicking terrain and simulating in-train forces. One railroad stated that simulator training helps crews learn to use DP.
- **On-the-job training (OJT):** Railroad managers talked about OJT as being an important aspect of training for operating VLTs, particularly for learning how to use DP.
- **Supervisor runs:** Beyond OJT, a manager at one railroad indicated a supervisor will ride with the engineer the first time they operate a new train or over a new route. Supervisors then solicit feedback from the train crew. In subsequent trips, if train crews had concerns on a route, they could request a supervisor ride the route with them.
- **Playbooks:** One railroad stated they create playbooks for train crews based on best practices gathered during supervisor runs. The playbook is meant to walk the crew through the route and provide tips to the engineer, for example, based on territory characteristics.

At one railroad, a manager stated if employees felt they needed more training, they received it.

Grade Crossings

Railroad participants noted that trains may block grade crossings regardless of length. The factors that cause a longer train to block a grade crossing are no different than those causing any train to stop at and block a crossing.

Railroad participants asserted that longer trains necessarily mean fewer trains, thus reducing instances of blocked crossings. Railroad managers also talked about other mitigation strategies used to address blocked crossings:

- **Infrastructure investments,** including increasing the length of some sidings and constructing grade separations, in partnership with local communities
- **Providing guidance for train crews regarding where to stop the train to avoid blocking crossings, when possible.** For example, one railroad stated it provides guidance on where to stop a train for staging so it will not block a busy crossing, or as many crossings. Another example is a protocol where a grade crossing is running over a single track and siding, the train will stop short of entering that siding or crossing until the train moving in the opposite direction is approaching.
- **Employing a network of rapid responders to assist trains.** One railroad discussed having rapid responders along their network who can be dispatched immediately to assist a train when necessary. They can be deployed, for example, if a train experiences a mechanical failure while in a grade crossing.

Communications

Railroad participants stated that communication challenges have been a longstanding issue regardless of train length. Factors such as territory/topography and the range of communication devices were mentioned as things that can hamper communications. Railroad managers discussed a variety of actions they have taken to remedy or reduce the communication challenges their crews experience.

Railroad participants stated they improved communications by investing in upgraded communications equipment. Participants from both railroads talked about upgrading their DP platform to one that provides better communications capabilities (in addition to advanced locomotive control). Through this system, they have stronger repeater capabilities, including the ability to switch between channels to find the strongest signal and cutting the communication distance in half. This technology works well even in mountainous terrain and tunnels, where radio communication is notoriously difficult.

Regarding radio communication, one railroad also stated it puts radios in the mid and rear locomotives to mitigate communication challenges faced by conductors walking the train.

Railroad managers also talked about communication loss for DPUs and EOT devices. For DP, one railroad talked about being more proactive in terms of working with the manufacturer to test for communication issues. Regarding EOT, one railroad talked about upgrades to their EOT devices, having upgraded their EOT device fleet to 8 watts, which can transmit over greater distances.

Finally, railroad participants stated an additional way they address communication issues is through OP rules and protocols. Managers said their operating rules provide instructions to train crews on dealing with areas known for communication loss, as well as rules that require crews to adjust train speed based on the integrity of telemetry signals.

Car Inspection and Maintenance

Railroad managers stated they do not believe VLT operations hinder or otherwise affect car inspection or maintenance. They stated the process for car inspection is the same regardless of train length. Managers at one railroad stated they adjust manpower requirements and scheduling requirements based on the train’s inspection needs, and that this is done in the planning stage.

Railroad managers stated that they maintain all cars according to Federal safety standards, and that train length is not a factor.

Fatigue

Railroad managers stated they do not see any connection between train length and fatigue. They stated that HOS rules are followed, and that these rules are the same regardless of train length.

Managers shared their belief that their employees are professionals who know how to operate trains. Managers stated they have not heard any concerns from their employees related to fatigue.

3.3.4 VLT Safety and Efficiency Benefits

While railroad managers said that the driving factors behind increasing train length are customer needs and technology advances, they also shared their belief that VLT operation, specifically, operating longer but fewer trains, offers safety and efficiency benefits. This section discusses the benefits as stated by railroad participants.

Resource Benefits

Railroad managers said that operating longer trains enables railroads to make more efficient use of their resources. Cited examples include:

- **Fewer T&E crews needed:** Railroads benefit from reduced staffing needs, particularly during difficult labor markets and the COVID-19 pandemic.
- **Less wear-and-tear on the track:** DPUs pulling and pushing longer trains result in less track damage because DP trains reduce drag and curve resistance.
- **More time for certain maintenance-related tasks:** Operating fewer trains can mean more open blocks for mainline maintenance and/or additional maintenance windows for locomotives.

Reducing Risk on the Network

- **Fewer interactions at grade crossings:** Railroad managers said the greatest number of injuries in train operations occur at grade crossings. Therefore, they believe reducing the number of trains passing through grade crossings will improve safety by reducing the *opportunities* for accidents and incidents at grade crossings to occur in the first place.
- **Fewer trains on the track:** Railroad managers stated that operating longer but fewer trains contribute to a less complex network – with less congestion and a reduction in exposures of all types. This means fewer opportunities for things to go wrong, they claimed.

Environmental Benefits

Railroad participants shared that operating fewer, but longer, trains leads to decreased fuel consumption, which has environmental benefits.

3.4 Perspectives from FRA Focus Group Participants

Focus group participants from FRA's Office of Railroad Safety (RRS) shared elements from both labor and railroad manager perspectives, and there were more varied perspectives across the three FRA sub-groups.

3.4.1 Safety and VLT Operation

RRS participants shared several concerns related to VLTs. In many cases these were issues that were not exclusive to VLTs, but issues that stakeholders thought VLTs exacerbated.

Experience, Skill, and Training

All three FRA stakeholder sub-groups – OP and MP&E inspectors and staff directors – found VLT crew experience and training to be lacking. They stated that operating a VLT can be different from operating a shorter train and that crews may be put in the position of operating VLTs without adequate preparation. This may be related to staffing shortages.

Some FRA participants expressed concern about what will happen if the technology fails. Much skill is needed to manipulate locomotive power over a grade as the train is going uphill in the front and downhill in another place at the end. It is possible that an engineer accustomed to running VLTs using DP, EMS, and PTC may struggle to run it if one of these technologies suddenly fails.

FRA stakeholders also expressed concern over a regulatory issue: that some railroads have not sufficiently updated their training programs to address VLT operations. Locomotive engineer certification requirements state the operator must be qualified and able to operate the most demanding train they could be called on to operate. They said some railroads are not sufficiently training crews on running VLTs to meet this requirement.

Infrastructure Limitations

Some FRA participants shared concerns that, in many places and as trains lengths have grown, railroads did not modify their physical infrastructure prior to their adoption of VLTs. FRA noted the safety implications of this on main lines, at sidings, and in yards.

Infrastructure limitations came up most often when discussing blocked grade crossings. (See the Blocked Crossings section for specific examples of how infrastructure limitations can affect blocked crossings.) FRA participants also noted that VLTs used in places with infrastructure limitations can make it more difficult to get track time near yards for signal testing, track inspections, and track maintenance. This has occurred when trains could not properly fit within the yard limits and instead occupied mainline track.

Blocked Crossings

All three FRA stakeholder sub-groups discussed concerns with blocked crossings. They sensed that blocked crossings are more frequent and that crossings are being blocked for longer periods. Some FRA stakeholders suggested the perceived increase in blocked crossings is related to VLTs. However, as some noted, there is no objective data to support or refute any claim that crossings are blocked more often or for longer periods with or without VLTs in operation.

Given that blocked crossings can and do happen with trains of any length, the conversation focused on blocked crossings related to VLTs. Participants were asked to think about if there were reasons why VLTs may block crossings because of their greater length (i.e., reasons that go beyond why any train might block a crossing). Participants shared the following examples of VLT-specific reasons for blocked crossings:

- **Congestion in terminals causing VLTs to sit on main line:** When the terminals cannot take a train upon arrival, it waits on the mainline track. For VLTs, that may mean the train extends back into grade crossings that would not otherwise be blocked when shorter trains are in the same situation.
- **Sidings cannot accommodate VLTs:** A siding set up to accommodate shorter trains may mean that a train hangs out of the siding and continues down the track and blocks a crossing.
- **Distance between signals and crossings too small to accommodate longer trains:** When stopped at a signal, a VLT may extend back into a crossing that would not be blocked if the train were shorter.
- **Choice of pickup point:** Choice of pickup point combined with train length may lead to a blocked crossing.

FRA participants also discussed railroad-community discourse on blocked crossings. When asked how railroads respond to local concerns about blocked crossings, some FRA participants believed the railroads did not find this to be an issue.

FRA participants highlighted two additional points about a general lack of communication between local governments and railroads. First, railroads do not generally inform local communities about increasing train lengths or about how these longer trains may affect them. Second, local community leaders also need to communicate better with railroads about development efforts. Towns and cities may make development plans, such as planning to build a large development immediately along the right-of-way near a crossing, without asking the railroad to attend a planning meeting nor asking the railroad if they have concerns. FRA stakeholders maintained that better communication between railroads and local governments could benefit both parties.

Communications

FRA participants discussed communications considerations related to EOT devices and handheld radios.

Many participants felt that VLTs exacerbate communication problems. However, FRA stakeholders also made it clear that communications considerations are complex and their occurrence relates to issues that include, and go far beyond, train length.

EOT Communications

Radio communications between the head-end telemetry and EOT telemetry support the application of emergency braking, so that air brakes are vented in the rear of the train at the same time as the air brakes in the front of the train. This communication may be particularly important on VLTs. FRA participants noted that even with an EOT device, communication losses can still occur on VLTs.

Factors other than length can also affect EOT communication losses (e.g., type of EOT device, territory). There may not be a "one size fits all" train length at which EOT communications are problematic.

FRA stakeholders mentioned that the loss of communication with the EOT device can reduce an engineer's ability to apply the emergency brakes. This is a concern for any train, but FRA participants cited it as particularly concerning for VLT operations. In addition, participants expressed concern about the length of time that elapses before an engineer is notified of an EOT communication loss – a problem not limited to VLTs.

Participants also described other factors that affect EOT communications:

- **The box in the head-end may need to be "swapped out":** OP inspectors mentioned that sometimes changing the boxes on the head-end would result in a better connection with the EOT.
- **Type of EOT device:** Some OP inspectors stated that moving to air-driven EOT devices without batteries has resolved many of the issues.
- **Terrain:** Terrain that causes the locomotive to lose line-of-sight with the EOT may result in communication loses (e.g., traveling on a curve in a canyon). Terrain is an important consideration in VLT operations and is a major factor in determining the need for repeaters.

The most frequently mentioned mitigating factor regarding EOT communications problems was the use of repeaters. Repeaters relay the signal between the locomotive and EOT and reduce or eliminate EOT communication losses. Repeaters may be placed along the route where the terrain poses particular difficulty or in other trouble areas (e.g., in tunnels).

Although EOT communications concerns were raised by many FRA participants, there were mixed opinions about the extent to which EOT communications are a concern.

Radios

FRA stakeholders also raised concerns about radio communications in VLT operations. The issues raised are not exclusive to VLTs, but were mentioned as issues that have the potential to be more problematic with longer trains. In addition to concerns over general loss of radio communications, stakeholders mentioned particular concern about such occurrences during shoving moves where conductors may have to hold up their radios to get a signal.

Repeaters were discussed as a solution that can greatly improve radio communications. DP locomotives are very often used in VLT operations, and those with repeater capability may greatly reduce radio communications loss. In addition to repeater capabilities on some DPUs, repeater towers can also be used for this purpose.

Other steps that some railroads take to reduce the likelihood that radio communications will fail include stronger radios that can reach farther as well as antennas to expand the range of handheld radios. Stakeholders stated that antennas significantly extend transmission distances.

Much like EOT communication loss, terrain can greatly compound radio communications issues, since losing line-of-sight interferes with signal strength regardless of radio strength or antennas. The combined effects of terrain and increased train length concerned FRA stakeholders.

FRA stakeholders did not reach consensus on the extent to which VLTs experience communications problems. They did agree that train length is one of several factors that can affect communications.

Train Makeup

FRA stakeholders discussed train makeup as important for all trains since it affects in-train forces and train handling. Train makeup was discussed as one of the considerations that may be especially important with VLTs.

There is no Federal requirement for train makeup and the rules vary across railroads. Some participants shared concerns that despite railroads having train makeup rules, they may not always adhere to them. Two examples were shared:

- Railroads may hand off trains to each other despite having different makeup requirements.
- Computer systems designed not to allow certain train makeups may not be followed in some cases (e.g., moving a car in the system so the computer will "take it").

Car Inspections and Maintenance

FRA participants stressed that the requirements for railroad inspectors have not changed with train length. Inspectors must complete Class I air brake testing and mechanical training for all trains, regardless of length. Therefore, railroad car inspectors do not need additional training to inspect VLTs. However, participants shared two concerns related to the quality of the car inspections:

- **Is the person doing the car inspection qualified?** FRA participants claimed conductors are being asked to do car inspections – a task for which they are not qualified.

Participants stated that this occurs because there are not enough mechanical inspectors. The issue is compounded by the larger number of cars in VLT consists.

- **Is enough time being allotted for car inspections?** Many FRA participants shared concerns that car inspections may not be done thoroughly. They asserted that car inspectors may be conducting inspections quickly. There is no regulation about how long a car inspection should take, but staff stressed that very often the time allotted is insufficient.

Participants perceived that rushed inspections are partly due to lack of personnel and time pressures to move trains.

Fatigue and Workload

FRA stakeholders indicated that fatigue problems experienced during VLT operations were similar to those that may occur during non-VLT operations. However, stakeholders did raise some VLT-specific concerns on fatigue and workload.

For Train Crews

Several stakeholders shared concerns that VLTs can contribute to more HOS violations. They said this could happen when dispatchers struggle to fit a VLT in the yard and the train waits on the main line long enough to push the crew up against HOS limits. Additionally, stakeholders stated VLTs may take longer to depart from a terminal and may experience other train-length-related challenges along the way.

FRA stakeholders also shared a fatigue-related issue of a different nature. Controlling a VLT may cause more stress and fatigue than what the operator would experience driving a non-VLT.

One FRA stakeholder expressed another concern that engineers using DP must simultaneously control more than one locomotive. Running multiple locomotives in a consist requires extra work compared to running a single locomotive; the participant said some staff may not be adequately trained to manage it.

For Car Inspectors

FRA participants' opinions varied on fatigue issues for the mechanical crafts. One perspective was that carmen have always worked when called upon, so the hours are not different in that way. The HOS law does not apply to the mechanical crafts. Inspection requirements are the same for cars regardless of the length of the train, so the work is the same. Therefore, mechanical and MP&E staff do not experience any fatigue-related concerns with VLTs that are different than those associated with non-VLTs.

In a second perspective, some stakeholders expressed concerns that even though inspection requirements are the same for all cars, longer trains create a much bigger workload when those long trains come into the yards. In the current environment, with fewer carmen than in past years, inspecting longer trains can lead to carmen working overtime, which can contribute to greater fatigue for inspectors.

3.4.2 Comments Related to Regulations

FRA participants often framed responses to safety-related questions in terms of whether the issue was subject to FRA's current regulatory authority. Where issues were not subject to current regulatory authority, stakeholders often stated that they do not have concerns because relevant regulatory guidelines do not exist.

3.5 Additional Findings

Volpe's synthesis of the focus group discussions suggests that multiple factors interact with train length to potentially increase safety risks. The issues are more complex than train length alone.

Volpe's synthesis revealed two themes that warrant further discussion and research. They are not safety concerns per se, but many stakeholders discussed these trends in terms of VLT safety concerns:

- Train length increased before the railroad system could safely accommodate them (e.g., infrastructure, technology, equipment, OP).
- Resource reductions are increasing operational intensity.

Both themes were discussed in conjunction with safety concerns. Many stakeholders connected these issues to PSR; however, notably, some did not.

3.5.1 Train Length and Infrastructure, Technology, Equipment, and OP

There was agreement across stakeholder categories that train length has increased (see Section 3.1.2), although the magnitude of this increase is unclear. Labor and some FRA stakeholders suggested these train length increases have occurred without proper consideration of track infrastructure limitations, technology and equipment capabilities, and the OP necessary to support longer trains. Safety concerns that support this perspective include:

- **Crossings blocked due to infrastructure limitations:** Labor and FRA stakeholders said VLTs block crossings often because of the gap between longer trains and the infrastructure required to accommodate them (e.g., yards and sidings).
- **Communication equipment unable to accommodate VLTs:** Labor and FRA stakeholders stated the primary reason VLTs experience communication losses is because radio and EOT devices are often working at their limits and may not be able to accommodate the increased challenges related to growing train lengths.
- **Train makeup practices may be insufficient to limit in-train forces, and equipment may not be designed to accommodate increased in-train forces:** Labor and FRA stakeholders stated improper train makeup was the primary reason for increases in in-train forces, which in turn can damage equipment (e.g., broken and cracked knuckles).
- **Training programs not sufficiently updated to address VLTs:** Labor and FRA stakeholders stated that railroad training programs have not been updated to provide adequate, or, in some cases, any additional training for crews responsible for operating longer trains.

3.5.2 Resource Reductions Are Increasing Operational Intensity

Both labor and railroad focus group participants talked about resource reductions. Labor participants framed these reductions as negative (i.e., constraints). Railroad participants framed these reductions as benefits (i.e., asset maximization). Labor and some FRA stakeholders suggested these reductions, coupled with increasing train lengths, increase operational intensity. Stakeholder concerns that support this perspective include:

- **Reductions in employees:**
  - Railroads employ fewer employees (including car inspectors and train crews), resulting in greater work demands and increased fatigue and stress.
  - Fewer car inspectors result in train crews being asked to do work previously done by car inspectors.
- **Reductions in equipment:**
  - Railroads have reduced available cars and power, which are in turn used more intensively. Therefore, equipment wears out faster.
- **Reductions to slack in the schedule:**
  - Railroads prioritize adhering to schedules which can result in:
    - Pressure to operate more quickly.

- Car inspectors (or train crews in the yard) that lack sufficient time to properly inspect all cars.

4. Discussion

This section identifies six potential areas for further consideration related to stakeholder perceptions of VLTs.

Understanding Stakeholder Perspectives

Labor and railroad stakeholders rarely shared similar perspectives of VLTs. When railroads acknowledged an issue related to longer trains, such as fitting a train in a siding that is too short to accommodate the train, managers indicated they either did not operate trains on lines where the trains could not fit in the siding, or they increased the length of the siding to accommodate these longer trains. Managers also indicated that potential communications issues have been addressed by deploying repeaters and providing better equipment to improve the range of communication devices.

VLT Definition

There is no common definition of what constitutes a very long train. Stakeholders agreed the concept is unclear and shared a wide variety of personal definitions.

Some stakeholders referred to train length in terms of *physical* length. However, railroads may not think about trains in terms of length or maintain data that quantifies train length in consistent ways to enable data synchronization across the industry. So, although train length seems like a straightforward way to think about what makes a VLT, the lack of available data renders it unfeasible.

Other stakeholders defined a VLT based on the number of cars in the consist. This information is more accessible, which is why some have used the number of cars as a proxy for train length (Government Accountability Office, 2019). However, train cars of different types vary in length. Therefore, two trains with the same number of cars can vary in length based on the types of cars in the consist.

Some stakeholders suggested it may be better to think about weight (tonnage) rather than train length. Tonnage represents another metric by which railroads report traffic volumes. Other stakeholders defined VLTs in relation to one or more operational issues (e.g., trains that do not fit into sidings).

Finally, some stakeholders rejected the idea that trains of a certain length were somehow different from those that were shorter. Those stakeholders did not offer any suggestions on how to define a VLT.

A "very long train" is an ambiguous term with no clear definition. A key challenge in future research will be to identify a better framework for discussing the safety issues associated with train length and asking research questions that will lead to useful outcomes.

Understanding the Safety of VLT Operations

Future research should explore to what constitutes safe operating parameters for VLTs. Research should explore the operational considerations that influence safety outcomes, e.g., infrastructure conditions.

Even without a VLT definition, conditions related to some factors may be easier to answer, e.g., sidings must be long enough to accommodate the train. However, for other factors, where much research is needed, it will be challenging to determine the conditions for safe VLT operations without a common VLT definition. In such cases, one path is to consider train lengths in terms of ranges.[9] This allows for researchable questions such as:

- Under what conditions can a 7,500-foot train run safely?
- Under what conditions can a 15,00–20,000-foot train run safely?

Managing Safety

Many of the safety concerns discussed fall outside current FRA regulations. As multiple stakeholders indicated, trains of *any* length can block highway-railroad grade crossings. Currently, there are no regulations specifying the duration that a train may block a crossing. Nevertheless, blocked crossings pose hazards to the pedestrians who may attempt to pass under or over a train blocking a crossing and to drivers who may feel increased motivation to try to "beat the train" by getting through a grade crossing before the train arrives. Blocked crossings also impair first responders' ability to quickly reach emergency locations that require crossing the tracks.

FRA participants also pointed out there is no regulation addressing the time needed to perform a mechanical inspection. Future research may consider what constitutes a proper inspection and what is the minimum amount of time required per car (on average).

Changes in Organizational Practices

Train length and tonnage has been growing over many decades, made possible by new technology and changing organizational practices. The interaction between new technology and organizational practices contributes to a constantly evolving railroad industry. Changing economic conditions, workforce demographics, and environmental conditions also contribute to evolving railroads operations. These dynamic interactions can influence safety in complex ways that are not clearly understood. For example, stakeholders described the recent adoption of DP locomotives and software for modeling the physical forces of in-train forces that have enabled the railroads to increase train length. At the same time, the freight railroads have changed how they operate their trains. To what extent have new technologies and organizational practices interacted to contribute to perspectives raised in the focus groups?

The Need for Data

More quantitative data is needed to gain a fuller picture of the safety implications of running longer trains. How has the distribution of train length changed over time? Has the overall safety of train operations changed? How have changes in technology and OP – and the interactions between them – affected safety? Are long trains more vulnerable to certain safety risks? What

[9] Train length ranges could be determined based on simple parsing of distance in equal increments or based on subject matter expert input. Additionally, consideration would be needed as to how large the ranges should be. Questions listed here are intended as examples and not recommendations for train length categories.

data is available that can identify precursors to accidents? Without proper data researchers cannot quantify trends relating to VLTs.

5. Conclusion

This research study conducted focus groups with labor representatives from train operations and maintenance, FRA's Office of Railroad Safety (responsible for enforcement and compliance with Federal regulations), and two Class I railroads to examine perspectives on train length and safety. Table 4 lists potential safety concerns, as identified by the focus group participants, that require further study.

Table 4. Potential Safety Concerns for Future Research

Blocked Crossings
Car Inspection and Maintenance
Communications
Equipment and Train Makeup
Train Control Technology
Training/Experience
Workload and Fatigue

This list of safety concerns is not necessarily unique to VLTs. This may be due, in part, to the lack of an agreed-upon definition of a VLT. Some of these safety considerations could arise for trains of varying lengths. The manifestation of a given safety concern depends on conditions present.

The data collected for this study consisted of a small number of participants in each group; due to the small size of the groups, more data needs to be collected for the results to be generalizable. Further, the lack of objective data on the nature of the relationship between train length and safety suggests avenues to pursue.

Some stakeholders' safety concerns emerged in the context of technological and organizational change. The themes arising from the focus groups suggest a variety of research opportunities to pursue to better understand the factors that contribute to the identified safety issues. Appendix B suggests some research questions for FRA and interested parties to consider.

6. References

Baudendistel, M. (2020, January 9). *What Is Precision Scheduled Railroading (PSR)?* *Freight Waves*.

Cothen Jr., G. C. (2022, June 13). Management of In-Train Forces: Challenges and Directions. *Railway Age*.

Dick, C. T. (2021). Quantifying Recent Trends in Class 1 Freight Railroad Train Length and Weight by Train Type. *Transportation Research Record: Journal of the Transportation Research Board, 2675*(12), 890–903. doi:https://doi.org/10.1177/03611981211031534

Federal Railroad Administration. (2005, June). Safe Placement of Train Cars: A Report. Washington, DC: U.S. Department of Transportation, Federal Railroad Administration.

Federal Railroad Administration. (2021). FRA Research, Development and Technology – Current Research Projects. Washington, DC: Federal Railroad Administration.

Government Accountability Office. (2019, May 30). Rail Safety: Freight Trains Are Getting Longer and Additional Information Is Needed to Assess Their Impact [Report No. GAO-19-443]. Washingon, DC: U.S. Government Accountability Office.

Hollis, M. (2022, April 26). Urgent Issues in Freight Rail Service. Surface Transportation Board, April 26–27, 2022. Testimony of Matt Hollis. Ex Part No. 770. Rockville, MD: International Association of Machinists and Aerospace Workers.

Machalaba, D. (2018, June 18). Why Railroads Are Making Freight Trains Longer and Longer. *The Wall Street Journal*.

Moller, J. (2019, August 6). Train Length Discussion. Washington, DC.

International Brotherhood of Teamsters. (2020). U.S. Senate Committee on Commerce, Science, and Transportation Committee, Hearing on: Passenger and Freight Rail the Current Status of the Rail Network and the Track Ahead. Teamsters Rail Conference. International Brotherhood of Teamsters, Committe of Commerce, Science and Transportation.

Prabhakaran, A. (2016, August 26). Emerging Long(er) Train Operations: Internal Discussion Office of Safety and R&D. Washington, DC: U.S. Department of Transportation, Federal Ralroad Administration.

Stagl, J. (2018, July). Class I Railroads Continue the Longer-Train Trend. *Progressive Railroading*.

Appendix A.
Potential Research Questions

The research questions identified here are based on themes identified from focus groups with labor crafts (TCU, BLET, and SMART), RRS (MP&E inspectors, OP inspectors, and staff directors), and two Class I railroads.

Definition of VLT and Overarching Questions

Some of the research questions in this document assume one can define what constitutes a "very long train." Therefore, questions related to conceptualizing and defining a VLT are highly relevant. These include:

1. Is the concept of train length a useful framework for conducting safety research, given the safety concerns expressed around this topic? Under what circumstances? What are the variables (e.g., distance measured in feet, number of cars, tonnage) that capture the concept of train length?
2. Is train length a proxy or mediating variable for some other causal relationship between safety and the one or more variables?
    - What is the evidence demonstrating a relationship between train length and safety?
    - What data would be needed to examine whether such a relationship exists?
3. How have trends in train length varied over time and how has the distribution of train lengths varied?
4. What is the relationship between train length and different types of accidents? What can FRA learn by examining these accidents/incidents?
5. What performance indicators can measure safety performance impacts associated with themes identified by focus group participants?
6. How does operating fewer but longer trains change safety risks?

Grade Crossings

1. Where are blocked crossings occurring? What is their frequency and duration? What are their causes? (e.g., are they happening because VLTs in the yard extend on to the main line?)
2. What is the impact on the local community when blocked crossings occur? Is the impact felt differently with VLTs?
3. To what extent should railroads inform communities about VLT activities?
    - How can FRA facilitate this kind of communication between towns and railroads?
    - Is development near grade crossings exacerbating the impact of blocked crossings?
    - To what extent are issues of train length and trespassing related?
4. To what extent is there a relationship between blocked crossings and variables related to a community's socioeconomic status?

- Are blocked crossings disproportionately problematic for less affluent/powerful communities?[10]

5. To what extent do drivers change behavior when railroads shift from more trains that are shorter to fewer trains that are longer?
    - Does running longer, fewer trains result in fewer driver violations at grade crossings? Fewer Accidents?
    - Are people more likely to try to "beat the train" if they know the train coming through may be very long (and thus take longer to move through the crossing)?

Communications

1. What are the communication range limits for EOT devices, two-way radios, and DPUs?
2. What factors disrupt communication for these devices?
3. What are the proposed/currently used strategies and solutions to the communication issues crews experience?
    - How widely used is each strategy or solution?
    - How effective is each solution? Are there situations where a given strategy or solution may work better than another?

In-Cab Technology

1. As train length has increased, how has incorporating technology such as DP and PTC affected safety?
2. What are the failure rates for in-cab technologies (e.g., PTC and EMS) as train lengths vary?
3. Under what conditions do in-cab technologies fail?
    - What can be learned by collecting data on the probability of failure under real-world conditions?
4. In what ways does an engineer's workload change when operating multiple locomotives using DPUs?
    - What is the maximum number of combined locomotives (lead plus DPUs) that an engineer can safely manage? Does that vary by other conditions (e.g., territory)?

Equipment

1. To what extent are equipment failure rates correlated with varying train lengths?
    - What equipment or components are more prone to failure, and what are the conditions that contribute to failures?

---

10. This research question is less about safety, but is included because it aligns with the Secretary's goal of supporting equity in transportation.

2. What is the relationship between train separations and train length, tonnage, and train makeup?

Infrastructure

1. What are the impacts of operating VLTs on track infrastructure?
   - What is the relationship between train length and track degradation?
   - What is the impact of VLT on track inspection? (e.g., if VLTs routinely overhang sidings or extend beyond yard limits, do they occupy blocks that might otherwise be given time for MOW employees to perform maintenance? Because fewer trains are operating, do MOW employees have more or different access to the track to perform maintenance work?)
2. As train lengths have increased, have reductions in resources (human, equipment, infrastructure) also reduced safety?

Train Makeup

1. How does train makeup affect VLT operations?
   - What are best practices for train makeup? What strategies are employed by railroads to balance safety and productivity when assembling trains?
   - How and to what extent does an engineer account for train makeup when managing in-train forces?

Car Inspection

1. What factors influence the time required to conduct car inspections? Is there a *minimum* amount of time per car needed?
2. What is the relationship between inspection time (average time allotted per car) and defect detection? Does the probability of false alarms and missed defects in mechanical inspections vary with inspection time?

Training

1. Do railroad employees need training for VLTs that is different than what they currently receive?
   - If so, what content should be included?
2. To what extent is simulator training effective for learning to run VLTs?
   - Evaluate the effectiveness of simulator training for in-train forces of various train makeups for VLTs.
3. Are changes in training needed to prepare engineers in the event of a technology failure?

Fatigue

1. What is the relationship between VLT operation and crew fatigue?
2. What is the relationship between VLT operation and yard crew fatigue?

Additional Questions

1. What are the hazards of operating VLTs that do not exist when operating non-VLTs? Besides not operating VLTs, are there ways to mitigate the risks associated with these hazards?
2. How have railroads incorporated the risks associated with train length into their SMS, and what mitigations have they implemented to address them?
3. What are the implications of VLTs on the conductor's job? Have operating practices been updated to take these into account?
   - Do conductors need more time for VLT job safety briefings?
   - What are the safety implications for conductors on VLTs who need to walk the train when equipment malfunctions occur? What protocols and safety measures have railroads implemented?
4. What can we learn from how other countries characterize, operate, and regulate VLTs?
   - What are the circumstances under which other countries are running VLTs? How do those compare to the circumstances under which VLTs are being used in the US?
   - Have those other countries put restrictions on the circumstances where they may be used?
   - Do those railroads have any procedural best practices?

Abbreviations and Acronyms

ACRONYMS	EXPLANATION
BLET	Brotherhood of Locomotive Engineers and Trainmen
DP	Distributed Power
DPU	Distributed Power Unit
EMS	Energy Management Systems
EOT	End-of-Train Device
FRA	Federal Railroad Administration
GAO	Government Accountability Office
HOS	Hours of Service
MP&E	Motive Power and Equipment
NTSB	National Transportation Safety Board
RD&T	Office of Research, Development, and Technology
OJT	On-the-Job Training
OP	Operating Practices
PTC	Positive Train Control
PSR	Precision Scheduled Railroading
SMART	International Association of Sheet Metal, Air, Rail, and Transportation Workers
TCU	Transportation Communications Union
VLT	Very Long Train
Volpe	Volpe National Transportation Systems Center