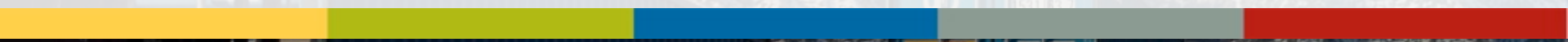


ASSOCIATION OF AMERICAN RAILROADS





AAR Locomotive Committee

H₂@Rail Workshop – Alternative Fuels Update

Michael Fore

Director – Technical Services-Locomotive Committee Manager

The Association of American Railroads

About Us and the Safety And Operations Department

- Founded in 1934, the Association of American Railroads (AAR) is the world's leading railroad policy, research, standard setting, and technology organization that focuses on the safety and productivity of the U.S. freight rail industry.
- AAR Full members include the major freight railroads in the United States, Canada and Mexico, as well as Amtrak.
- Affiliates and Associates include non-Class I and commuter railroads, rail supply companies, engineering firms, signal and communications firms, and rail car owners¹.
- At the AAR, the tasks of research, technological development support and standard setting are part of the **Safety and Operations Department (S&O)** mission. Within the S & O Department are the *Technical Services Committees* under the **Technical Services Group**.



The Association of American Railroads

Safety And Operations Department and The Technical Services Group

- The AAR's **Technical Services** group of committees are responsible for the development, maintenance, and enforcement of North American railroad interchange rules, mechanical standards, and component specifications that promote an acceptable level of safety and efficiency.
- Users of these publications include North American Class I, shortline, and regional railroads, Federal Railroad Administration, Transport Canada Railway Safety Directorate, private railcar owners, shippers, and freight car, locomotive, and component suppliers.



The Association of American Railroads

Safety And Operations Department and The Technical Services Group

- Technical Services Committee members include railroad and non-railroad experts in the areas shown in the accompanying organization chart. These technical experts provide direction on the development and maintenance of industry standards.



The Association of American Railroads

Safety And Operations Department -
The Technical Services Group and
The Locomotive Committee

- The Locomotive Committee's mission is to establish, improve, and maintain locomotive standards and rules.
- This Locomotive Committee develops and maintains standards, specifications, and recommended practices in **Section M, *Locomotives and Locomotive Equipment*, of the Manual of Standards and Recommended Practices (MSRP)**.
- These standards, specifications, and recommended practices are for the purpose of safety and interoperability.⁴



The Locomotive Committee (LC) and Alternative Fuels

The AAR Locomotive Committee (LC) has several dockets by and for the reporting and review of developments in alternative fuels.

The primary docket is the aptly named **LM-126 Alternative Fuels Issues (Biodiesel, Renewable, etc.)**

Two (2) other Committee docket items are linked to the Alternative Fuels Issues docket.

- **LM-121 Natural Gas Fuel Tenders.**
- **LM-139 LC & LMOA Projects Coordination**
 - (TAG Liaison & Updates)
- And at times. the **LM-013 Locomotive Emissions** docket has received updates about alternative fuels and the potential effect on locomotive emissions regulations



LC Alternative Fuels Docket Items:

LM-139 LC & LMOA Projects Coordination
(TAG Liaison & Updates)

- **LMOA** stands for *Locomotive Maintenance Officer's Association*.
- *The LMOA is a Non-Profit organization consisting of Railroaders and Rail Vendors for the sole mission to offer improvements and recommendations for a safer and more reliable Rail Operation².*
- Through mutual members, the AAR Locomotive Committee & the LMOA have developed and continue to grow a working linkage with the LMOA and its various technical subject matter experts and other interested parties on a variety of topics.
- Under LM-139 the LC can receive and consider LMOA input and recommendations for standard setting via AAR LC initiated requests for papers that the LMOA may choose to research and publish within their annual schedule.



LC Alternative Fuels Docket Items:

LM-121 Natural Gas Fuel Tenders.

AAR Natural Gas Fuel Tender TAG Mission Statement

Develop Standard(s) for future Natural Gas Fuel Tenders for the railroad industry to support the use of natural gas (methane) as an alternative locomotive fuel.

- Safety
 - Minimize risk of outer and inner tank breaches & pressure spikes
- Tender design and construction
- Tender-to-locomotive connections
- Tender-to-refueling
- Tender interoperability and interchangeability between railroads
- Maintainability

A significant effort resulted in draft specifications, and a safety analysis. Today's focus is on the standard.



LC Alternative Fuels Docket Items:

LM-121 Natural Gas Fuel Tenders.

AAR Manual of Standard and Recommended Practices (MSRP)

Section T -Interoperable Fuel Tenders for Locomotives,

Specification M-1004 – Specifications for Fuel Tenders

Note - Section T has not yet been published

1.6 Organization of this Specification

This specification is organized into the following chapters and appendices:

Chapters

- 1 Introduction and General Requirements
- 2 Fuel Tank Requirements for Liquefied Natural Gas
- 3 Fuel Tank Requirements for Compressed Gas
- 4 Fuel Tank Requirements for Other Alternate Fuels
- 5 Piping, Service Equipment and Protective Structures
- 6 Tender Control Unit
- 7 Tender-to-Locomotive Interface
- 8 Tender-Fill Interface
- 9 Car Body Structure and Design
- 10 Track Worthiness
- 11 Crashworthiness Requirements

Appendices

- A Tender Design Application Submission and Approval
- B Tender Design Attributes
- C Basic Process and Instrumentation Diagram
- D Tender End Plate Diagram
- E Locomotive End Plate Diagram
- F Tender-Fill Interface Connections
- G Wiring and Electrical Hardware
- H Painting and Stenciling
- I Drain and Purge Procedures for Fuel Tender Hose Assemblies
- J Inspections and Maintenance
- K Qualification
- L Documentation
- M Tender Health and Status Protocol
- N Prototype Tests for Compressed Gas Fuel Tanks
- O Fire Resistance/Bonfire Test



LC Alternative Fuels Docket Items:

LM-121 Natural Gas Fuel Tenders.

Specification M-1004 – Specifications for Fuel Tenders

Chapter 1, *Introduction and General Requirements*, covers:

- General Design Parameters
- Organization of the Specification
- AAR Approval Authority
 - AAR Locomotive Committee
 - AAR Tank Car Committee
 - AAR Equipment Engineering Committee
- Manufacturing Facility Requirements
- Definitions



LC Alternative Fuels Docket Items:

LM-121 Natural Gas Fuel Tenders.

Specification M-1004 – Specifications for Fuel Tenders

Chapter 2, *Fuel Tank Requirements for Liquefied Natural Gas*, covers:

- Operating Requirements
- Fuel Tank Design and Construction Requirements
 - Materials
 - Pressure
 - Welding and Heat Treatment
 - NDE and Pressure Testing

Table 2.1 LNG fuel tank operating requirements

Operating Requirements	LNG Fuel Tank
Design service temperature	-260 °F
Design test temperature	-320 °F
Maximum allowable operating pressure	Refer to Appendix B
Test pressure	Refer to Appendix B
Burst pressure (2.5 × test)	Refer to Appendix B
Water capacity (LNG inner tank)	34,500 US gallons (maximum)
Minimum outage (after fueling)	15% minimum. Alternatively, minimums less than 15% may be considered with the manufacturer's design submittal (provided all other requirements of this specification are met).
Fueling rate and pressure	Refer to Chapter 8



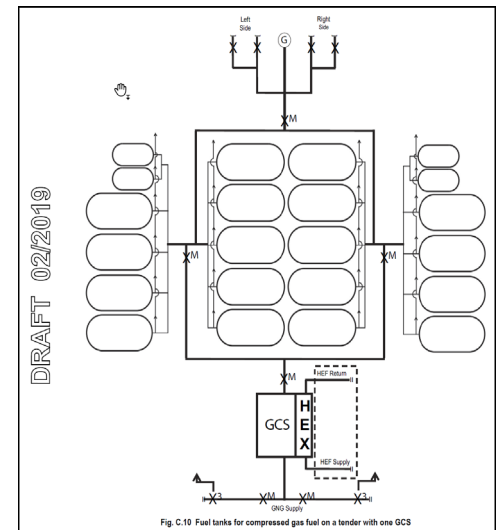
LC Alternative Fuels Docket Items:

LM-121 Natural Gas Fuel Tenders.

Specification M-1004 – Specifications for Fuel Tenders

Chapter 3, *Fuel Tank Requirements for Compressed Natural Gas:*

- *The NGFT has completed revisions to M-1004 to accommodate CNG tenders.*
- *The revisions have been issued on an AAR Circular Letter, for industry comment. The NGFT will begin addressing the comments, and expects to soon implement the revised M-1004 Specification.*



LC Alternative Fuels Docket Items:

LM-121 Natural Gas Fuel Tenders.

Specification M-1004 – Specifications for Fuel Tenders

Chapter 4, *Fuel Tank Requirements for Other Alternative Fuels*

Currently vacant and reserved for
future revisions to M-1004



LC Alternative Fuels Docket Items:

LM-126 Alternative Fuels Issues
(Biodiesel, Renewable, etc.)

- Under the Alternative fuels docket (LM-126), the LC now receives periodic updates from the LMOA's Fuels Lubrication and Environmental Committee about their activities on items of mutual interest.
- The docket also has a Task Force comprised of AAR LC & LMOA members addressing concerns with the effects of HDRD on locomotive equipment



LC Alternative Fuels Docket Items: Reviewed Oct 2015 @ LC F2F under LM-.126

INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 39 (2014) 19169–19181



Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/he



Hydrogen refueling station compression and storage optimization with tube-trailer deliveries



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Storage


ABSTRACT

Hydrogen refueling stations require high capital investment, with compression and storage comprising more than half of the installed cost of refueling equipment. Refueling station configurations and operation strategies can reduce capital investment while improving equipment utilization. Argonne National Laboratory developed a refueling model to evaluate the impact of various refueling compression and storage configurations and tube trailer operating strategies on the cost of hydrogen refueling. The modeling results revealed that a number of strategies can be employed to reduce fueling costs. Proper sizing of the high-pressure buffer storage reduces the compression requirement considerably, thus reducing refueling costs. Employing a tube trailer to initially fill the vehicle's tank also reduces the compression and storage requirements, further reducing refueling costs. Reducing the cut-off pressure of the tube trailer for initial vehicle fills can also significantly reduce the refueling costs. Finally, increasing the trailer's return pressure can cut refueling costs, especially for delivery distances less than 100 km. and in early markets, when



LC Alternative Fuels Docket Items: Reviewed Apr 2017 @ LC F2F under LM-013

3-page press release



NEWS RELEASE

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California's top air quality agency pushes for stricter locomotive emissions standards


CARB appeals to U.S. EPA, says new limits needed to meet clean air and climate change goals

SACRAMENTO - California Air Resources Board (CARB) chair Mary D. Nichols today requested the U.S. EPA take action to adopt more stringent emission standards for locomotives, saying that the move is needed to clean up the air in "high-risk" communities in and around the nation's railyards. The purpose of this request is to accelerate the movement to zero- or near-zero emission locomotives. Proposed emission standards would cut toxic and smog-causing emissions by 85% for diesel particulate matter (PM) and 66% for oxides of nitrogen (NOx) below current Tier 4 levels. Newly manufactured locomotives would have some zero-emission mile capability.

Reducing locomotive-related emissions and the resulting air toxic hot spots near railyards is a high priority for disadvantaged communities within California and around the nation.


Web search: carb locomotive petition

17-page petition to US EPA



Air Resources Board

Mary D. Nichols, Chair
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov



Edmund G. Brown Jr.
Governor

Matthew Rodriguez
Secretary for
Environmental Protection

April 13, 2017

The Honorable Scott Pruitt, Administrator
U.S. Environmental Protection Agency
Office of the Administrator, Mail Code: 1101A
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Dear Administrator Pruitt:

I am writing to urge the U.S. Environmental Protection Agency (U.S. EPA) to exercise its authority to again adopt more stringent emission standards for locomotives. Reducing locomotive-related emissions and the resulting air toxic hot spots near railyards is a high priority for disadvantaged communities within California and around the nation. In addition, developing technology offers an opportunity for significant fuel cost savings for rail operations. A formal petition for U.S. EPA rulemaking is enclosed.

The gradual introduction of new locomotives meeting U.S. EPA's current Tier 4 emission standards will substantially reduce per-locomotive emissions and partially mitigate projected increases in rail traffic. However, locomotive activity in both impacted communities and severely polluted regions must approach zero emissions to protect the public health and welfare of the nation, as well as achieve federal air quality standards set by U.S. EPA. Developing control technologies offer the opportunity to further reduce locomotive emissions of toxic and criteria air pollutants beyond Tier 4 levels. In addition, use of on-board batteries can support zero-emission rail operation in sensitive areas, as well as cut fuel consumption and greenhouse gas (GHG) emissions.



LC Alternative Fuels Docket Items:

Reviewed Apr 2017 @ LC F2F under LM-.013-contd.

Table 1:
Existing Federal Locomotive Emission Standards and Percent Control^{1,2}

Line Haul Locomotives							
Emission Tier	Year of Manufacture	NOx		PM		HC	
		Standard (g/bhp-hr)	Percent Control	Standard (g/bhp-hr)	Percent Control	Standard (g/bhp-hr)	Percent Control
Pre Tier 0	1973-1999	13.5 ¹	n/a	0.6 ¹	n/a	1.0	n/a
Tier 0 ⁰⁺	2000-2001	9.5	30	0.6	0	1.0	0
Tier 1 ¹⁺	2002-2004	7.1	45	0.45	25	0.55	45
Tier 2 ²⁺	2005-2011	5.5	59	0.2	67	0.3	70
Tier 3	2012-2014	5.5	59	0.1	83	0.3	70
Tier 4	2015	1.3	90	0.03	95	0.14	86

“Today”



LC Alternative Fuels Docket Items:

Reviewed Apr 2017 @ LC F2F under LM-.013-contd.

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"Today"

To be upgraded on overhaul

Table 2:
Potential Amended Emission Standards for Locomotives and Locomotive Engines

Tier Level	Year of Manufacture	NOx		PM		GHG		HC		Proposed Effective Date	
		Standard (g/bhp-hr) ²	Percent Control ²	Standard (g/bhp-hr) ²	Percent Control ²	Standard (g/bhp-hr) ²	Percent Control ²	Standard (g/bhp-hr)	Percent Control ²		
2++	2005-2011	1.3	90	0.03	95	NA	0	0.14	85	2023	
3+	2012-2014	1.3	90	0.03	95	NA	0	0.14	85	2023	
4+	2015-2024	0.3	99	<0.01	99	NA	0	0.05	95	2023	
NEW	5	2025	0.2	99+	<0.01	99	NA	10-25%	0.02	98	2025

"By 2023"

"By 2025"

With capability for zero emission operation in designated areas.



Challenges to Rail Implementation

- ❖ **Safety**
- ❖ **Energy Density**
- ❖ **Infrastructure**





THANK YOU

To learn more about the Association of American Railroads
go to:

www.aar.org

