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425 Third Street, SW | Suite 920 | Washington, DC 20024 | phone (202) 347-4664 | fax (202) 347-0047 | www.rsiweb.org

GRA, Incorporated Report for the RSI-CTC
Comparative Benefit-Cost Analysis of AAR Revised Appendix B vs. RSI-100

July 2019

The Railway Supply Institute's Committee on Tank Cars (RSI-CTC) engaged GRA, Incorporated (GRA) to conduct an analysis of the benefits and costs of the Association of American Railroads' (AAR) revision of Appendix B of its Specifications for Tank Cars, which is scheduled to go into effect on January 1, 2020 (hereafter "Revised Appendix B"). GRA also has evaluated the benefits and costs associated with an alternative approach to quality assurance developed by RSI, referred to hereafter as the "RSI-100." RSI initiated this effort in response to feedback it received from the U.S. Department of Transportation (DOT) when RSI raised concerns about the adverse impacts of the Pipeline and Hazardous Materials Safety Administration's (PHMSA) September 2018 regulatory interpretation of the term "tank car facility" and the AAR's proposed revisions to Appendix B.

The RSI is the international trade association of the railway supply industry. Its members provide all types of goods and services to freight and passenger railroads, rail shippers and freight car manufacturers and lessors. The members of the RSI Committee on Tank Cars ("RSI-CTC") collectively build more than ninety-five percent (95%) of all new railroad tank cars and own and provide for lease over seventy percent (70%) of railroad tank cars operating in North America. In addition, RSI's associate members include companies that manufacture various tank car components and companies that own and operate tank car repair facilities.

GRA is an expert economic consulting firm that specializes in the transportation industry. For the past 47 years, GRA has played a leading role in helping shape important industry developments including deregulation, privatization and international consolidation. GRA has completed cost-benefit studies that underlie regulatory modernization in the aviation, rail and trucking industries. The firm has undertaken numerous regulatory analysis assignments both for federal agencies and for industry, with all work being consistent with Office of Management and Budget (OMB) standards.

On October 24, 2018, AAR finalized its revisions to the existing tank car facility certification requirements contained in Appendix B of its Specification for Tank Cars. The Revised Appendix B expands AAR facility certification requirements (*i.e.*, M-1002 - Specification for Tank Cars certification and M-1003 - Specification for Quality Assurance certification) to manufacturers of all tank car components and imposes arbitrary constraints and limits around subcontracting. This action by AAR is paired with a recent interpretation of the term "tank car facility" by PHMSA that expands the definition of this term from manufacturing and repair facilities to include all manufacturers of all tank car components. Expanding the term "tank car facility" in this way obligates tank car component manufacturers to obtain AAR "approval" of their quality assurance programs to comply with federal regulations. AAR, in turn, requires facilities to obtain a mandatory AAR facility certification in accordance with AAR M-1002 and M-1003 requirements to obtain the federally mandated "approval."

RSI was and continues to be concerned about adverse impacts due to the expansion of the term "tank car facility" and these Revised Appendix B provisions on tank car repair cycle time, operational efficiency, and innovation. Specifically, RSI is concerned that expanding AAR facility certification requirements to all manufacturers of tank car components would have a significant negative impact on the tank car component supply chain, and may have a potential impact on safety as component suppliers exit the market.

Accordingly, RSI engaged GRA to conduct this analysis for two primary reasons. First, neither the DOT nor AAR has ever analyzed the costs associated with expanding the term "tank car facility" to include manufacturers of all tank car components and obligating these facilities to obtain AAR certification. Second, RSI sought to identify, evaluate, and quantify the industry-wide consequences of a potential shortage of component suppliers, should component suppliers exit the market. A reduction in component suppliers would impact safety and operations for tank car owners and lessors, as well as the shippers who lease and use the tank cars, if parts are not as widely or readily available for use and replacement. Reducing the availability of components and parts also means increased downtime for repairs and scheduled maintenance (i.e., qualification), car shortages, and the corresponding impact on commerce to move needed goods to market.

In this analysis, GRA compares the benefits and costs of both programs against the regulatory regime as it exists today. By design, the focus of the benefit-cost analysis presented here is restricted to analysis of the effects related to the inclusion of closures and fittings, and how the benefits and costs differ between Revised Appendix B and the RSI-100 alternative with respect to these tank car components. As detailed in this report, GRA concludes that the RSI-100 proposal is superior to Revised Appendix B from a benefit-cost standpoint. Both proposals are likely to have similar (though difficult to quantify) potential safety benefits. However, on the cost side, the Revised Appendix B proposal is likely to result in a costly short-term disruption to the supply of tank cars (in both the manufacturing and repair markets), and will also drive substantial long-term costs that eventually must be passed through to consumers. **GRA's analysis indicates that the 20-year net present value (NPV) costs of Revised Appendix B (estimated at $15.2 million) are approximately 9 times as high as RSI-100, and far in excess of any quantifiable estimate of benefits. Moreover, GRA estimates (based on results of an industry survey undertaken for this analysis) that over 30 percent of current non-certified suppliers will choose to exit the industry rather than undergo the AAR certification process given the costs involved relative to the size of their tank car business.**

RSI continues to work with both DOT and AAR to enhance the RSI-100 standard and ensure it is implemented in a meaningful way that preserves AAR's oversight over existing certified facilities while maintaining tank car component supply chain flexibility, which is critical to ensure the continued availability of tank car components and parts for purposes of manufacture, repair, and replacement. GRA's report is intended to serve as a tool for all interested stakeholders including regulators, elected officials, and industry participants, to evaluate the impacts and effectiveness of Appendix B as compared to the RSI-100 standard.

Comparative Benefit-Cost Analysis of AAR Revised Appendix B vs. RSI-100

July 10, 2019

Prepared for:

The Railway Supply Institute
425 Third Street, SW, Suite 920
Washington, D.C. 20024

Prepared by:

GRA, Incorporated

115 West Avenue • Suite 201 • Jenkintown, PA 19046 • ☏ 215-884-7500 • 🖷 215-884-1385 • www.gra-inc.com
Washington, DC Office: 1727 King Street • Suite 105 • Alexandria VA 22314 • ☏ 571-366-1766

Table of Contents

Exhibits

1. Introduction

GRA, Incorporated (GRA), an independent consulting firm specializing in economic analysis for the transportation industry, has been asked by the Railway Supply Institute (RSI) to assess the benefits and costs of the Association of American Railroads' (AAR) revision of Appendix B of its Specifications for Tank Cars, which is scheduled to go into effect on January 1, 2020 (hereafter "Revised Appendix B"). GRA has also evaluated benefits and costs associated with an alternative approach to quality assurance developed by RSI, referred to hereafter as the "RSI-100."

The Revised Appendix B was developed by the AAR's Tank Car Committee (TCC) and adopted through an interchange standard outside of the U.S. Department of Transportation's (DOT) notice and comment rulemaking process required by the Administrative Procedures Act.[1] This action by AAR, paired with a recent interpretation of the term "tank car facility" by the Pipeline and Hazardous Materials Administration (PHMSA),[2] requires, among other things, all facilities that manufacture and sell any tank car component, including components such as closures or fittings, to develop a quality assurance program meeting the requirements of the AAR Specification for Quality Assurance (hereafter, "M-1003"), obtain AAR certification of such a quality assurance program, and to obtain relevant activity code certifications under the AAR's Specification for Tank Cars (hereafter, "M-1002").[3]

For purposes of the analysis, GRA has focused on how the new requirements of Revised Appendix B could affect both purchasers and suppliers of the following types of closure and fitting components:

Blind Flange
Bottom Outlet Cap
Breather Vent Assembly (does not include "breather")
Eduction/Siphon Pipe (complete assembly – pipe welded to flange)
Eduction/Siphon Pipe Only
Fill Hole Cover (GP Car)
Fittings Plate (GP Car or Pressure)
Manway Cover Cast (GP Car)
Manway Cover Fabricated (GP Car)

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[1] *See* AAR CPC-1338, "Implementation of Revisions to MSRP Section C-III, Specification for Tank Cars (M-1002), Appendix B – Certification of Tank Car Facilities and Associated Chapter 1 Definitions" (Oct. 24, 2018).

[2] PHMSA September 4, 2018 Letter to RSI, Reference No. 18-0029 (hereafter "the PHMSA Letter").

[3] The term "M-1003" refers to the AAR's Manual of Standards and Recommended Practices ("MSRP"), Section J, M-1003, Specification for Quality Assurance. The term "M-1002" refers to the AAR MSRP, Section C-III, M-1002, Specification for Tank Cars.

Miscellaneous Fittings – non-welded (e.g., spool, tee, etc.)
Miscellaneous Fittings – welded (e.g., spool, tee, etc.)
Nozzle Flange – Flange Only
Rupture Disc Housing
Sample Line (complete assembly – welded)
Surge Suppression Device – non-pressure retaining
Threaded Plugs
Thermometer Well

Under the new Revised Appendix B requirements, suppliers of these closures and fittings components will need to become certified under AAR's Specification for Quality Assurance (i.e., M-1003). Most *purchasers* of the components are themselves M-1003 certified facilities with one or more of the following activity codes:[4]

- A19 – Manufacturer of Tank Cars
- B24 – Tank Car Repair Facility
- B82 – Manufacturer of Tank Car Tanks
- C4 – Manufacturer of Tank Car Service Equipment; includes C4a (assembly) and C4m (manufacture)

Within the Revised Appendix B, AAR has identified five service equipment (i.e., component) categories – closures (C) , fittings (F), instruments (I), safety relief devices (S) and valves (V) – for which a facility may be certified. Even in the case of a C4m-certified facility that manufactures its own components, it would need to become newly certified for specific categories of components, namely for Categories C and/or F. For purposes of this analysis, we have ignored these incremental certification costs that may ultimately be incurred by current C4 facilities.

Under the RSI-100 proposal, it would be up to existing AAR-certified facilities – primarily tank car manufacturers and repair facilities (i.e., purchasers) – to ensure that their closures and fittings suppliers meet quality assurance and purchase order-specific requirements. The RSI-100 proposal consists of four product quality certification plans that vary based on the risk posed by particular components,[5] a supplier quality assurance checklist for purchasers, and periodic surveillance audits of suppliers by purchasers. The RSI-100

[4] While it is likely that there are also a small number of other purchasers, RSI has suggested that facilities with these activity codes probably cover 95 percent of the demand for tank car closures and fittings.

[5] Under the RSI-100 Standard, component risk is evaluated based on the manufacturing complexity of the component, the ability to detect a manufacturing quality defect, and the likelihood that a defective component would be installed on a tank car by a certified facility in light of the compliance assurance activities the certified facility undertakes prior to introducing a marked tank car into service. These activities by the certified facility consist of verifying the conformance of components through incoming inspection, properly installing the components, and leak testing the components once they are installed on the tank car to ensure their integrity.

requirements, if implemented by DOT and AAR, would significantly enhance the detail and clarity of current facility audit criteria used by AAR auditors to oversee the already-certified M-1003 facilities mentioned above.

For this analysis (as discussed below in Section 4), the baseline is the regulatory regime as it exists today—without either the new requirements under Revised Appendix B or the RSI-100. By design, the focus of the benefit-cost analysis presented here is restricted to analysis of effects related to the use of closures and fittings, and how the benefits and costs differ as between Revised Appendix B and the RSI-100 alternative. RSI-100 is explicitly tailored to provide quality assurance for the design and manufacture of the closures and fittings listed above, but does not address other components. In contrast, the full scope of Revised Appendix B does include other categories of components beyond those listed in the RSI-100. However, the analysis presented below for Revised Appendix B does not encompass all of the benefits and costs associated with it, as compared to the baseline. A list of primary assumptions is included in the Appendix to this document.

To our knowledge, FRA has not articulated any specific market failure or other justification prompting the revisions to Appendix B. Nevertheless, for present purposes we have presumed that benefits associated with either Revised Appendix B or RSI-100 would be in the form of incremental safety improvements, which then can be assessed against the costs associated with each program. We again emphasize that these estimated benefits and costs are restricted to those related to the demand and supply for closures and fittings.

2. Summary of Findings

The analysis presented below demonstrates that the RSI-100 proposal is superior to Revised Appendix B from a benefit-cost standpoint. Both proposals are likely to have similar (though difficult to quantify) potential safety benefits. On the cost side, the Revised Appendix B proposal is likely to result in a costly short-term disruption to the supply of tank cars (in both the manufacturing and repair markets), and will also drive substantial long-term costs that eventually must be passed through to consumers. Our results are shown in Exhibit 1 below, indicating that the 20-year net present value (NPV) costs of Revised Appendix B are over 9 times as high as RSI-100, and far in excess of our quantifiable estimate of benefits.

Exhibit 1: Summary of Results

	Baseline	Revised Appendix B	RSI-100
20-Yr NPV of Benefits		$0.6M	$0.6M
20-Yr NPV of Costs		$15.2M	$1.7M
Short-Run Tank Car Market			
Avg Monthly Lease Rate	$658	$1,274	$857
Quarterly Deliveries + Repairs	8,379	5,103	6,872
Long-Run Tank Car Market			
Avg Monthly Lease Rate	$658	$769	$699
Quarterly Deliveries + Repairs	8,379	7,449	8,002
Non-Certified Suppliers Exiting the Market	0	45	0

Any potential short-run supply disruption from RSI-100 is likely to be small, and the long-term impacts of RSI-100 also are more modest than those under Revised Appendix B. The discounted present value of costs over 20 years is less than $2 million. Based on these results, it is clear that RSI-100 is the preferred alternative.

In addition, under Revised Appendix B, we estimate (based on an industry survey) that over 30 percent of current non-certified suppliers will choose to exit the industry rather than undergo the certification process given the costs involved relative to the size of their tank car business. While the benefit-cost analysis does not attribute certification costs to suppliers who drop out of the market, firms exiting the industry will lead to a decrease in the market supply of closures and fittings. The ultimate impacts of reduced availability of components and parts may also include increased downtime for repairs and scheduled maintenance (i.e., qualification), car shortages, and the corresponding impact on commerce to move needed goods to market.

Given the different structure and lower cost of the RSI-100 proposal, we do not anticipate significant disruptions to industry supply under the RSI-100 alternative.

The next section provides an overview of Federal guidance on benefit-cost analysis, which is followed by sections containing detailed analysis of the benefits and costs of both proposals.

3. Federal Guidance on Benefit-Cost Analysis

The Federal Government has published general guidelines for conducting benefit-cost analysis (BCA) and cost-effectiveness analysis for Federal programs under OMB Circular A-94 and OMB Circular A-4.[6,7] These documents serve as checklists to ensure that all

[6] U.S. Office of Management and Budget. *Circular No. A-94 Revised, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, 1992. Appendix C of this Circular is updated annually and provides current discount rates for cost-effectiveness, lease purchase and related analyses.

relevant elements of a proper BCA (or cost-effectiveness analysis) have been addressed. The guidelines in these documents are directly relevant to the current analysis.[8]

The FRA has published its own guidance document[9] which is consistent with the OMB Circulars referenced above and is tailored to rail projects and regulations. The explicit purpose of this document is to "provide a consistent approach for completing a benefit-cost analysis for passenger and freight rail project proposals." (p. 1). The FRA guidance focuses on a limited number of core principles that are typically important for evaluating rail projects, including:

- Discounting – this represents the time value of money and accounts for when different levels of benefits or costs occur over time;
- Use of nominal vs. real (constant) dollars – this accounts for inflation effects;
- Analysis period – for typical rail construction projects, FRA recommends an analysis period of at least 20 years;
- Benefit-cost analysis vs. economic impact analysis – a BCA should measure the value of a project's benefits and costs to society as a whole. This is in contrast to an economic impact analysis which measures changes in economic activity, typically utilizing metrics such as spending, business activity, jobs, and/or tax revenues;
- Baseline and alternatives – the analysis should include a well-defined baseline against which to measure costs and benefits, and if appropriate, alternate scenarios representing both more extreme and less extreme cases;
- Transparency and reproducibility – assumptions, inputs and outputs should be clearly defined and documented;
- Uncertainty and sensitivity analysis – if key data elements are uncertain, the analysis should include a sensitivity analysis showing how the results may be impacted by a change in those elements.

It is important to emphasize that the treatment of benefits and costs must be measured in terms of net effects to society as a whole. In the present case, the calculation of costs in particular may not directly reflect costs incurred by specific parties, but rather what economists refer to as "social welfare costs" as measured by losses in "economic surplus."

To analyze one or more proposed projects, standards or rules, a benefit-cost analysis identifies and values all of the relevant social benefits and costs in dollar terms, discounting the dollar values as needed to account for the value of time. Thus, the BCA will assess whether a decision is economically sound by determining if, and by how much, the

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[7] U.S. Office of Management and Budget, *Circular No. A-4, Regulatory Analysis*, 2003.

[8] In addition, Executive Order 13771 issued in 2017 directs Federal agencies to repeal two existing regulations for each new regulation issued. Executive Order 13777, issued at approximately the same time, establishes mechanisms to oversee the implementation of 13771.

[9] FRA. Benefit-Cost Analysis Guidance for Rail Projects, 2016.

discounted benefits outweigh the discounted costs. Furthermore, by comparing benefits and costs relative to a baseline or a set of alternatives, the analysis demonstrates which alternative is preferred from an economic perspective.

In certain cases, if it is difficult to evaluate and monetarily value the benefits, and/or the benefits are thought to be about the same across alternatives, then the emphasis will be placed on evaluating the costs. The alternative with the lowest discounted costs will be preferred.

The analysis presented below follows these principles as they specifically relate to the benefits and costs relevant in the market for tank car closures and fittings. At a high level, we find that either proposal is likely to result in the same modest safety benefits, primarily because there are few accidents or incidents to begin with that are likely the result of defective design or manufacture of closures or fittings. Conversely, the quantifiable costs associated with Revised Appendix B are significantly higher than those that would be incurred under RSI-100. A comparative review of the benefits and costs associated with both the Revised Appendix B and the RSI-100 is discussed in more detail below.

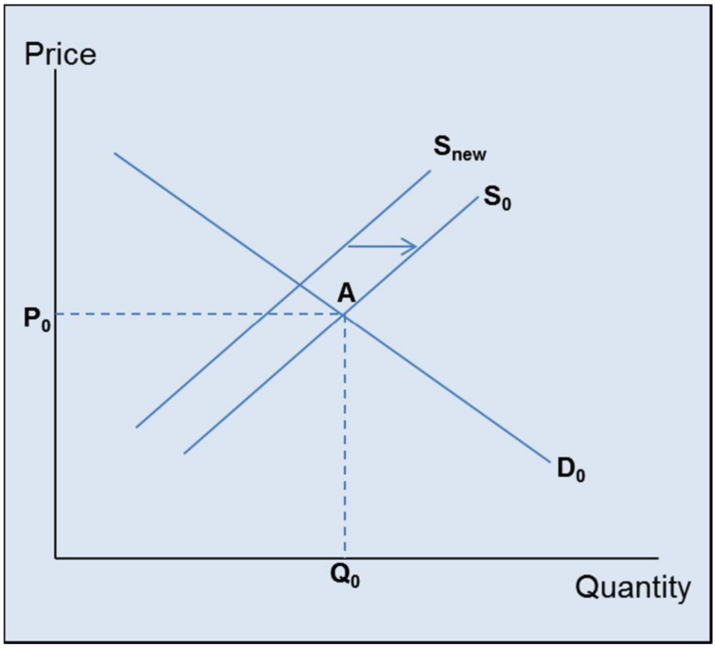
4. Current Baseline and Scope of Analysis

From a high-level perspective, we note that it is difficult to model the supply and demand of tank car usage and the potential costs associated with Revised Appendix B (and RSI-100) because rail freight transportation is an intermediate rather than a final good. Tank car usage is significant in this analysis because it directly relates to part replacement and therefore is a proxy for part demand. Tank car usage supply and demand ultimately depend on downstream demands for goods such as crude oil, ethanol, automobiles, housing, etc. As a result, the tank car market is quite cyclical and moves up and down with the larger economy. In addition, some of the commodities transported by tank cars must compete against other transportation alternatives such as trucks and pipelines.

Nevertheless, in this analysis, we make certain simplifying assumptions and use conventional techniques to estimate real economic effects. To begin the analysis, we identify a baseline which will allow us to assess the benefits and costs associated with implementing Revised Appendix B or RSI-100 against that baseline. Initially we focus on the aggregate short-run demand and supply for tank cars, as shown in Exhibit 2 below. The horizontal axis plots the quantity of tank cars and the vertical axis corresponds to tank car prices. We will use observed tank car lease rates as the relevant "price" for cars.[10]

[10] This is consistent with PHMSA's "rental cost of capital" approach described in HM-251, Final Regulatory Impact Analysis for *Hazardous Materials: Enhanced Tank Car Standards and Operational Controls for HHFTs*, May 2015.

Exhibit 2: Equilibrium Tank Car Supply and Demand



For present purposes, we are including both new car production and repair shop activities in the supply market. The market for repair of tank cars may be somewhat less volatile than the new car market because it is driven mostly by regulations which require periodic maintenance inspections and repair at least every ten years for tank cars (known as qualification). Thus, the rate of repair depends primarily on the stock and age of the entire tank car fleet. However, the 10-year qualification requirement[11] also suggests that volatility in the repair market will simply lag that in the new car market by 10 years (assuming a constant retirement rate).[12]

The supply curve S_{new} reflects the quantity of tank cars that manufacturers are willing to supply at any given price. For this analysis the quantity supplied by repair shops (which would not normally respond much to changes in current lease rental rates) can be treated as a fixed quantity, which we simply add horizontally to the new car supply curve. This results in the industry supply curve S_0. The corresponding demand curve D_0 reflects the quantity of cars that buyers are willing to purchase at any given price. Prior to the Revised

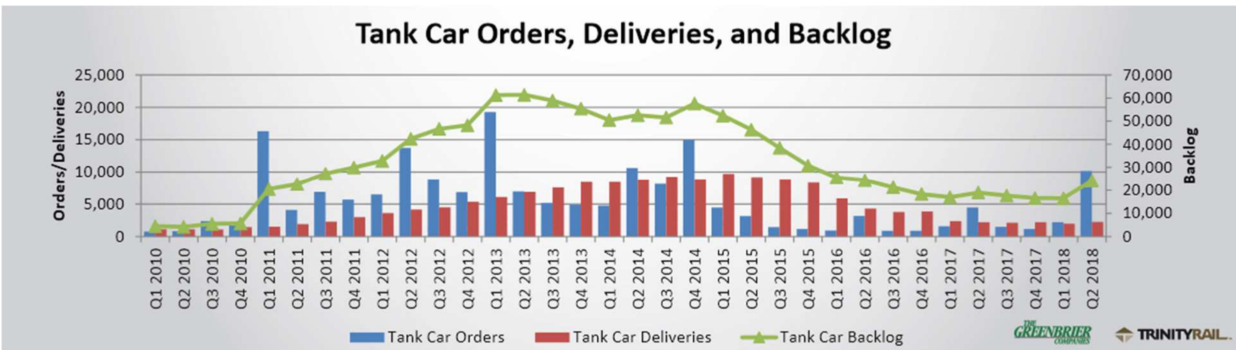
[11] Ten years is the maximum qualification interval. Many owners and shippers have shorter (three to five year) intervals. However, because these are not published, our analysis is conservatively based on a ten year interval. A shorter interval would result in a greater number of units in the repair market.

[12] In addition, the demand for tank car retrofits, which has increased substantially in recent years due to new DOT regulations, is an important source of repair shop activity. Pursuant to PHMSA's HM-251 rule, a significant portion of the tank car fleet is undergoing retrofits to modify existing DOT-111 tank cars to the new DOT-117R tank cars standard.

Appendix B requirements going into effect, the equilibrium occurs at the intersection point A where supply equals demand, yielding price P_0 and quantity Q_0.

To operationalize the analysis, GRA sought to develop supply and demand curves for tank cars that will be relevant beginning in 2020, when the Revised Appendix B is scheduled to go into effect. The relevant time horizon is 20 years (out through 2039), which is consistent with the recommendations from the FRA's aforementioned benefit-cost guidance document. We began by collecting historical data on observed prices and quantities of new tank car production. Exhibit 3 below shows quarterly tank car data for new orders, deliveries, and backlogs back to 2010. This graph is from the Rail Energy Transportation Advisory Committee (RETAC), which was established by the STB in 2007.[13]

Exhibit 3: RETAC Tank Car Data



Source: Surface Transportation Board, RETAC Railcars Update, Oct 2018.
https://www.stb.gov/stb/docs/RETAC/2018/October/Railcars Update.pdf

The volatility in the market during this period is best reflected in the tank car orders data, which in turn reflects: (1) changes in tank car demand caused by the shale oil boom; and (2) additional demand for the new DOT-117 cars mandated in the aftermath of the 2013 Lac-Mégantic accident. Looking at Exhibit 3, we note that the movement of tank car deliveries, while less volatile (since manufacturers smooth out production so as to minimize costs associated with starting and stopping), still follows trends in tank orders and therefore also varies significantly over time.

Public tank car pricing data is much more difficult to find, and difficult to assess. There is little publicly available data on new tank car prices or lease rates. The most visible prices in the industry are short-term tank car lease rates; these rates also can be quite volatile and they vary significantly between specific car types and depend on lease length. With the caveat that new car prices may be somewhat less volatile since they are typically bought outright by leasing companies with a longer-term industry view, or procured with longer-

[13] The graph itself is publicly available on STB's website. However, the actual data behind the graph is proprietary and available only to those who subscribe to receive it from the American Railway Car Institute (ARCI).

term full service leases, the most consistent history of recent lease rates we have found are the following estimates of lease rates from various issues of the publication *Railway Age*:

- June 2014 – standard Bakken crude car $1,600/month; coiled/insulated car $1,750/month
- June 2015 – Below $1,000/month; pressure cars $1,100-$1,400/month
- June 2016 – crude oil cars $500/month; pressure cars $850/month
- June 2017 – crude oil cars $400/month; non-crude cars $550/month
- June 2018 – DOT117 crude oil cars $700/month; DOT117 non-crude cars $600/month; pressure cars high-$400s/month

The high rates cited in 2014 are primarily due to the "crude-by-rail" boom that occurred as oil prices exceeded $100 per barrel. Since then, lease rates have declined substantially, but tank car manufacturing backlogs have begun to increase recently suggesting that, at least over the near term, lease rates may be on the upswing again.

After adjusting the above reported rates for inflation,[14] and then interpolating where needed, we developed a set of observations matching lease rates to the quarterly deliveries of new tank cars for the period 2013Q3 through 2018Q2. Based on our analysis during this time period, virtually all of the observed variation in new tank car quantities has been driven primarily by changes in downstream *demand* for tank cars, in particular the run-up and subsequent decline in crude oil demand. Conversely, we are not aware of any significant changes on the supply side of the industry in terms of industry structure or car production technologies. This implies that the supply curve for new tank cars has remained stable, and thus observed changes in orders and prices reflect movements along that supply curve as the demand curve shifts out or in.

Thus we can use the observations on new tank car deliveries and lease rates to estimate an equation for the supply curve of new tank cars. This is shown below in Exhibit 4, where each observation point represents a single quarter between 2013Q3 and 2018Q2 and the estimated supply curve is a best-fit curve through the observations.[15,16]

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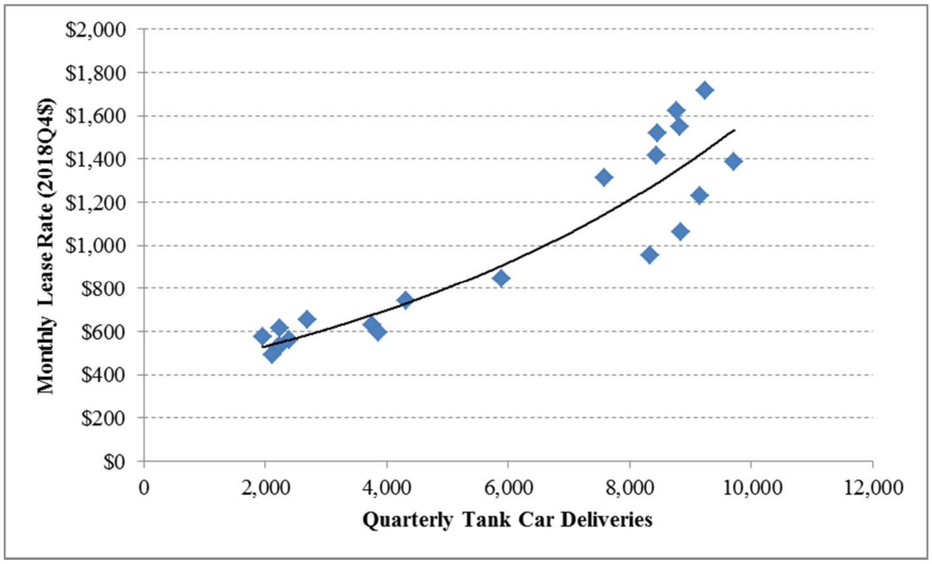
[14] The Implicit Price Deflator for Gross Domestic Product was used to convert to real 2018Q4 dollars.

[15] The observations shown actually pair a given quarter's supply quantities with the prior quarter's average lease rate estimate. This one-period lag results in a better fit for the supply curve.

[16] The curve was fit as an exponential function, which provided a better fit to the data than either a linear or constant elasticity function; the R^2 for the exponential supply curve equation is 0.90.

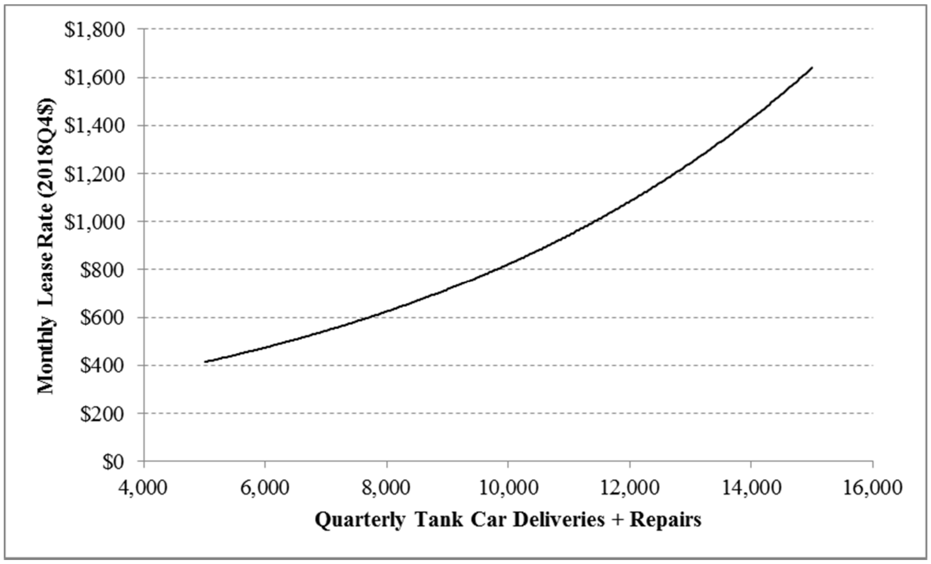
Exhibit 4: Supply Curve for New Tank Cars Derived from Observed Quantities and Average Lease Rates



To estimate the industry supply curve for 2020, we then add in the repair portion of the market, which shifts the curve horizontally to the right. RSI has provided repair shop projections for the base year 2020 based on an ongoing long-term analysis of tank car qualification and retrofit events. RSI's latest estimate of repair shop activity for 2020 (excluding DOT-117R retrofits) is 19,331 units.[17] (As noted earlier, this estimate is conservative because it is based on the maximum ten-year qualification interval.) Thus we add one quarter of that total to the estimated new car supply curve shown above in Exhibit 2 to get the industry supply curve for 2020 on a quarterly basis; this is shown below in Exhibit 5.

[17] To be conservative, retrofits were excluded entirely because the retrofit process often does not involve replacement of closures or fittings.

Exhibit 5: Industry Supply Curve for Tank Cars including Repair Market



Next we assessed the industry demand curve, which as noted above, likely has been shifting in and out over time. For present purposes, we assumed a constant elasticity curve.[18] Again noting that demand for tank cars is ultimately driven by downstream demands, we have reviewed a published paper by Beuthe, et al.[19] which presents a useful summary of many prior efforts to estimate freight demand elasticities (rail-specific estimates are provided as well). While the variation in estimates is quite wide, short-run estimates are typically inelastic while longer-run estimates become more and more elastic, which makes sense as firms can more readily adjust their behavior in response to price movements in the long run. For present purposes, the baseline analysis assumed a short-run demand elasticity for tank cars of -0.75.

With the industry supply and demand curves in hand, we can now find the baseline equilibrium price and quantity associated with point A in Exhibit 2 above. Keeping in mind that the Revised Appendix B is scheduled to go into effect in January 2020, we use a projection of 14,184 annual tank car deliveries for 2020 (from the same RSI source that provided the repair quantity). Adding in the fixed repair quantity yields a quarterly

[18] This implies that any given demand curve is completely specified once the constant elasticity estimate is combined with any given observed quantity on the supply curve. In empirical economic studies, a constant elasticity demand curve is often employed – particularly when considering relatively large changes in price as we are doing here – because it implies that consumers respond to proportionate rather than absolute changes in prices.

[19] Michel Beuthe, Bart Jourquin, and Nathalie Urbain. Measuring Freight Transport Elasticities with a Multimodal Network Model. Paper presented at the European Transport Conference, Frankfurt, September 30-October 2, 2013. https://aetransport.org/en-gb/past-etc-papers/conference-papers-2013?abstractId=174&state=b

industry total of 8,379 cars. We then identify the corresponding average monthly lease price on the supply curve, which is $658/month.

A further simplifying assumption is that there will be no further growth in tank car deliveries or repair activity for the foreseeable future, so that the baseline equilibrium identified above remains unchanged over the 20-year forecast period.[20]

To complete the baseline assessment, GRA undertook a survey of RSI members and their closures and fittings suppliers. We received responses from 75 different facilities, including 6 tank car manufacturing facilities out of 16 listed in the current AAR M-1003 Registry[21]; 30 repair shops out of 148 listed in the Registry; 8 service equipment manufacturers out of 35 in the Registry; and 31 other non-certified supplier facilities. In practice, some facilities act as both purchasers and suppliers of components, and certified facilities often utilize non-certified suppliers as subcontractors. Purchasers were asked to identify specific suppliers (both certified and non-certified) from which they buy closures and fittings; likewise, suppliers were asked to identify specific purchaser facilities to which they sell closures and fittings.

While it was not feasible to survey the actual quantities of components bought and sold (due to confidentiality and competitive concerns), the survey identified 101 unique purchasers and 133 unique suppliers (37 certified, 96 non-certified) of tank car closures and fittings. Given the survey coverage relative to the overall number of facilities listed in the Registry, it is likely that there are many additional non-certified suppliers beyond the 96 identified in the survey. To be conservative, our baseline assumption is that there is a population total of 150 unique non-certified suppliers.

To estimate the supplier share held by non-certified facilities, we counted the number of times such facilities were cited by buyers vs. the number of times certified facilities were cited. Although this method yields a rough measure, the results indicate a non-certified supply share of about 62 percent.

5. Benefits of Revised Appendix B and RSI-100

Neither DOT nor AAR has identified what benefits, if any, would arise out of the revisions to Appendix B. For this analysis, we have presumed that any benefits associated with the new requirements likely would be in the form of incidents (specifically “non-accidental releases” (NARs)) avoided. As will be discussed later, GRA anticipates that whatever benefits might arise from Revised Appendix B in terms of safety also could be achieved under the alternative RSI-100 proposal as they relate to closures and fittings.

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[20] This is a benign assumption since, as will be seen below, most of the variation between Revised Appendix B and RSI-100 is seen in the initial estimated supply disruption effects occurring in 2020.

[21] AAR’s M-1003 Registry is a public database containing the current listing of M-1003-certified facilities and the activities covered by their M-1003 certification.

To assess the potential extent of such benefits, we first reviewed 66 NTSB accident reports covering the period 2015-2017 and found 10 that involved railroad tank cars. None of these reported closures or fittings as a cause, or even a factor, in the accident.

Next, we reviewed DOT 5800.1 incident reports for rail. An incident report must be submitted for any unintentional release of a hazardous material during transportation that is not caused by a derailment, collision or other rail related accident. We reviewed incidents from 2010 through June 18, 2019. In an attempt to isolate incidents related to component quality, we restricted our review to those reports where the cause code was categorized as "Defective Component or Device," and where the Packaging Type code was listed as "Tank Car." This resulted in a total of 809 incidents over the almost-10 year period, with no fatalities involved. Of these, 534 included dollar estimates of the damages incurred, which totaled $6,449,276 in aggregate. The remainder reflects incidents with $500 or less of damages, which are not required to be reported. We then reviewed those incidents with $10,000 or more of reported damages; these 68 incidents represent 81.3 percent of the $6.5 million in aggregate damages.

Of the 68 incidents, we identified 21 where the "Most Important Failure Point" indicated a closure or fitting component; Exhibit 6 below identifies these 21 incidents.

Exhibit 6: Relevant DOT 5800.1 Incident Reports

Incident Number	Date	Total Damages (Current $)	Most Important Failure Point
I-2017030145	7/15/2013	$50,000	Manway or Dome Cover
X-2012100358	1/26/2011	$40,000	Gauging Device
E-2019040281	5/31/2017	$30,010	Bolts or Nuts
E-2018010189	8/22/2017	$25,100	Mounting Studs
E-2018090309	12/2/2010	$22,210	Hose Adaptor or Coupling
X-2010030156	4/6/2015	$21,002	Flange
I-2018050183	6/15/2018	$20,000	O-Ring or Seals
X-2017060587	1/31/2011	$20,000	Closure; Sample Line
E-2011090380	10/18/2013	$20,000	Sample Line
X-2012060086	12/7/2012	$17,553	Piping or Fittings; Weld or Seam
X-2016020359	7/18/2013	$16,494	Manway or Dome Cover; Liquid Valve
I-2011120037	3/27/2017	$15,000	Flange; Gasket
X-2013070320	3/29/2017	$15,000	Flange; Gasket
X-2011020091	5/23/2011	$15,000	Washout
X-2014100060	8/27/2014	$15,000	Flange
X-2014110134	5/3/2015	$14,005	Bottom Outlet Valve; Flange
E-2010060250	6/28/2010	$12,005	Manway Dome or Cover
X-2017060763	4/22/2011	$11,150	Flange; Gasket
X-2017060759	10/12/2017	$11,050	Thermometer Well
X-2010020079	1/28/2015	$10,000	O-Ring or Seals; Valve Stem
E-2017080705	4/11/2015	$10,000	Manway or Dome Cover; Gasket

Although the methodology described above permitted us to isolate incidents involving “defective” closures and fittings, the “Defective Component or Device” cause category is not defined by DOT, and these incident codes are self-reported and self-selected by the reporting entity. Moreover, none of the incident descriptions associated with the 21 incidents listed above identify or otherwise describe a design or manufacturing quality defect as the cause of the incident. As illustrated below by the excerpts from the “Description of Events” in a selection of these incident reports, the “defect” associated with the component is often attributable to improper use/securement or deterioration over time.

- X-2011020091 – “tank car of Petroleum Gases, Liquefied, was overweight”
- X-2017060759 – “pressure plate mounting nuts were less than tool tight”
- X-2013080219 – “two swing bolts on the manway were found less than tool tight”
- X-2014090003 – “mounting flange bolts … less than tool tight”
- X-2010070105 – “manway gasket was found to be in a deteriorated condition and falling apart”

These so-called “defects” are not manufacturing quality defects that would be addressed by either Revised Appendix B or the RSI-100 Standard. Thus, the benefit estimates which follow are based on generous assumptions regarding the extent of incidents potentially avoided by implementation of either proposal. The dollar damages of the 21 incidents identified above total $410,579. After converting all damage amounts to 2018Q4 dollars and expanding the total to cover the balance of damages from incidents not included in the 68 reviewed reports, we arrive at a total of $547,674 over approximately 9.5 years. This results in an annual average of $57,650. Assuming this figure holds constant for future years, and given the above caveats, it likely represents an upper limit on the benefits related to closures and fittings that could reasonably be expected from implementation of either Revised Appendix B or RSI-100. Assuming a 7 percent real discount rate and a 20-year time horizon, the result is a net present value of benefits of $610,744.

We also have reviewed AAR’s annual reports of non-accidental releases (NARs), which are based on the same incidents covered in the 5800.1 reports, with the following differences:

- AAR reports include incidents occurring in Canada
- AAR reports use Bureau of Explosives (BOE) cause codes

Unlike the 5800.1 database that includes individual incident reports, the AAR’s Annual Report of Non-Accident Releases of Hazardous Materials Transported by Rail for 2017 includes only aggregated statistics on NARs and some comparisons to prior years back to 2012. Exhibit 14 of this document, reprinted below as Exhibit 7, shows a summary of tank car NARs by source for each year from 2012 through 2017.

Exhibit 7: AAR Non-Accident Release Sources

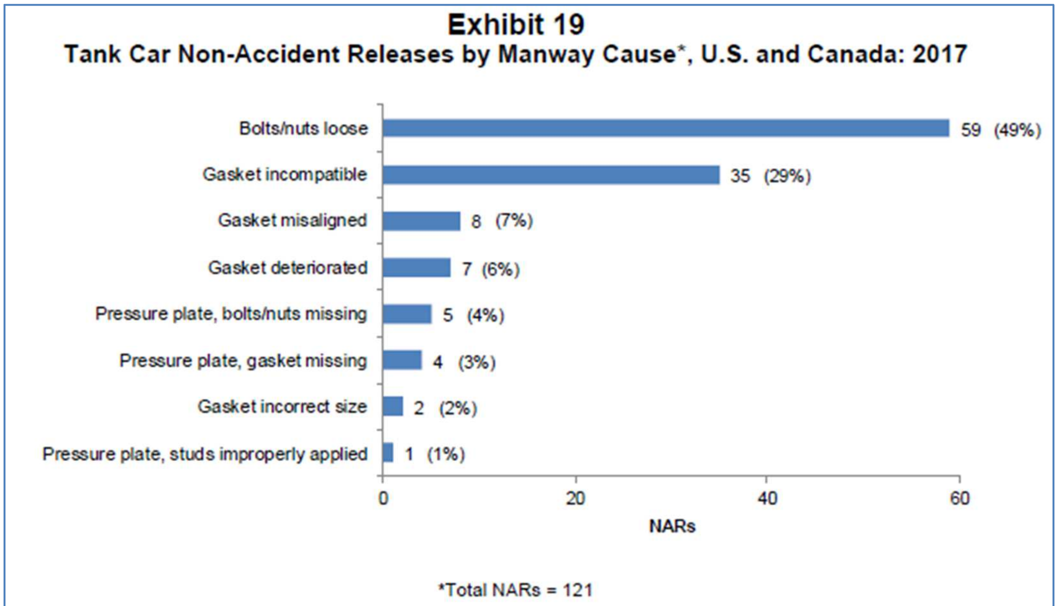
Exhibit 14
Sources of Tank Car Non-Accident Releases, U.S. and Canada: 2012-2017

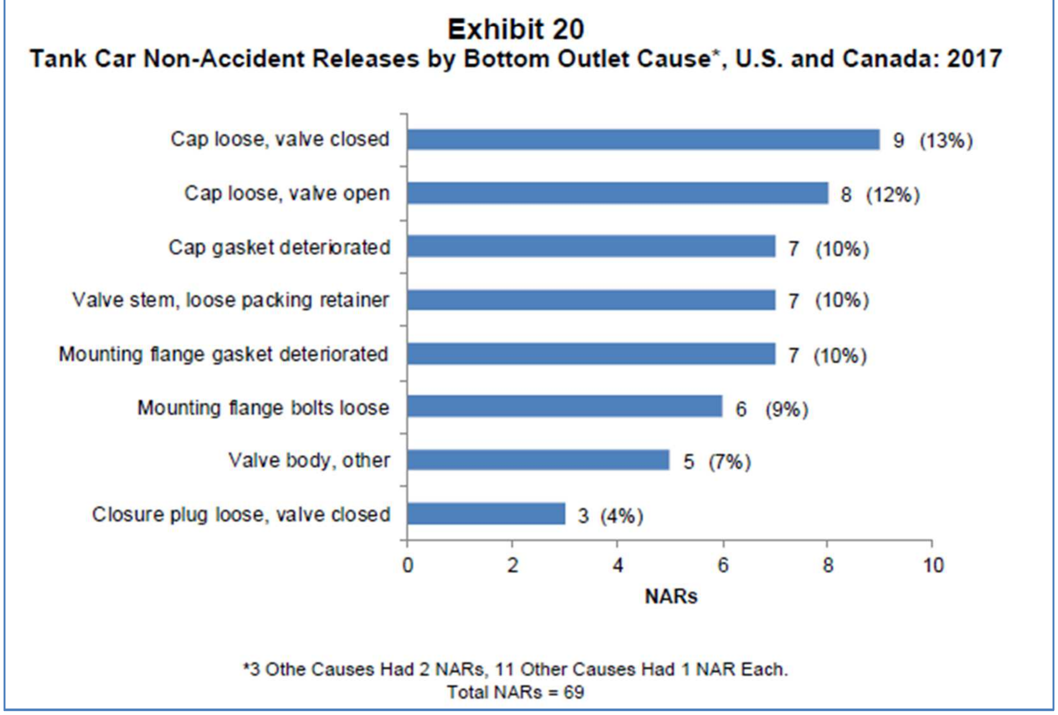
	U.S. & Canada					
NON-ACCIDENT RELEASES (NARs):	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total NARs in All Car Types	634	596	670	542	518	541
Total Number of Tank Cars with NARs	558	535	584	488	437	456
Total Number of Intermodal with NARs	53	42	64	45	69	64
Total Number of Other Cars with NARs	23	19	22	9	12	21
Sources of Tank-Car Non-Accident Releases:						
Pressure Relief Valve or Vent*	62	62	87	76	37	55
(Pressure Relief Valve)	*41*	*47*	*64*	*50*	*19*	*35*
(Disc Ruptured)	*16*	*14*	*18*	*16*	*14*	*18*
(Safety Vent - Other)	*5*	*1*	*5*	*10*	*4*	*2*
Manway/Pressure Plate	241	205	215	152	138	121
(Hinged & Bolted)	*231*	*196*	*210*	*145*	*129*	*111*
(Pressure Plate)	*10*	*9*	*5*	*7*	*9*	*10*
Fill Hole	9	10	13	18	25	15
Liquid Line	116	122	138	117	111	140
Without Valve	*18*	*25*	*23*	*17*	*23*	*23*
With Valve	*98*	*97*	*115*	*100*	*88*	*117*
Vapor Line	34	41	34	43	45	44
Without Valve	*4*	*3*	*3*	*3*	*1*	*2*
With Valve	*30*	*38*	*31*	*40*	*44*	*42*
Gauging Device	2	0	1	0	2	1
Sample Line	11	9	7	7	1	15
Thermometer Well	3	1	0	0	0	5
Vacuum Relief Valve	29	39	33	32	29	7
Bottom Fittings	76	66	91	53	52	69
Main Valve	*74*	*55*	*87*	*49*	*50*	*66*
Auxiliary Valve	*1*	*7*	*1*	*0*	*0*	*1*
Stuffing Box	*1*	*4*	*3*	*4*	*2*	*2*
Heater Coils	0	4	0	0	0	2
Washout	3	0	1	0	1	0
Sump	0	2	0	1	0	0
Shell or Head	8	6	7	9	6	6
Other	12	19	22	16	15	13
Total Tank Car Non-Accident Releases**	606	586	649	524	473	493
Tank Car Originations (thousands)	1,761	2,003	2,154	2,090	1,881	1,879
NARs in Tank Cars per 1,000 Originations	0.317	0.267	0.271	0.233	0.232	0.242

Figures in italics are a subset of the line immediately preceding them in the table
* Values have changed slightly due to the addition of category "Vacuum Relief Valve".
**Includes multiple sources of leaks from the same car, and for 2017 excludes 13 Class 1 railroad NARs that did not have a cause assigned.

For present purposes, we focus on NARs where the listed source is either Manway/Pressure Plate (121 NARs in 2017) or Bottom Fittings (69 NARs in 2017). These are two of the larger sources listed in the Exhibit, and they are the only listed closure/fitting components where a more detailed breakout is provided of the actual *cause* of the release. These cause tables for 2017 NARs (Exhibits 19 and 20 from the Report) are reprinted below as Exhibit 8.

Exhibit 8: NAR Manway and Bottom Outlet Causes





As with the DOT 5800.1 data, neither of these Exhibits indicates a component with a manufacturing quality defect as the cause of an NAR. Virtually all of the listed causes relate to missing or improperly installed items. The closest one could come to citing a manufacturing defect might be the listings for deteriorated gaskets, which in theory *could* be due to improper manufacture. The combined data indicate a total of 14 NARs in the U.S. and Canada in 2017 due to deteriorated gaskets. However, we note that Revised Appendix B does not explicitly cover the manufacture of gaskets.

Thus we conclude that none of the available historical data from the AAR report indicate that any NARs have been caused by defective, improperly manufactured closures or fittings.

After reviewing individual accident reports, individual incident reports, and the aggregated NARs report from AAR, it is apparent that any safety benefits in the form of reduced incidents would be modest and likely overstated. Moreover, it is reasonable to conclude that any safety benefits associated with Revised Appendix B as compared to the baseline, also will be achieved under the alternative RSI-100 proposal.

Accordingly, the quantifiable benefits associated with incident reduction for Revised Appendix B and the RSI-100 are likely to be the same. Moreover, as we discuss in the following sections, the RSI-100 alternative has much lower costs in both the short run and long run as compared to Revised Appendix B. Specifically, the welfare costs (loss in economic surplus) of RSI-100 are likely to be much less than under Revised Appendix B. Because the quantifiable benefits are likely to be the same, GRA concludes that the RSI proposal is the preferred method to ensure component quality as compared to Revised Appendix B.

6. Costs of Revised Appendix B

If Revised Appendix B goes into effect as currently scheduled on January 1, 2020, non-certified facilities who currently supply closures and fittings to tank car manufacturers and repair shops would face a decision: either undergo the process to become M-1003/M-1002 certified, or choose to exit the industry and forego production. In either case, market supply of these components would likely be affected as follows:

- In the short run, there is likely to be a disruption in the supply of closures and fittings to tank car manufacturers, repair shops, and other certified facilities, as component suppliers must undergo a certification process that often exceeds a year and can include several months while a facility waits for AAR to schedule a site visit to initiate this process. If existing suppliers cannot continue to sell tank car components until they are certified, this will likely lead to disruptions in the supply chains utilized for tank car production. Moreover, a component supplier shortage is likely to impact repair facilities' ability to release cars if they cannot get adequate components for repair and replacement. The inability to release tank cars would negatively impact rail shippers' ability to move products to customers. The extent of these disruptions will depend on a variety of factors, including whether tank car manufacturers and repair facilities can turn to suppliers who *are already* certified to produce the relevant parts.

- In addition, suppliers will face direct financial costs associated with becoming certified, which will consist of both one-time short-run costs of certification as well as ongoing long-run costs necessary to maintain the required quality assurance program. In the short run, any manufacturer of fittings and closures seeking AAR certification would need to create an AAR-specific quality program, which would be in addition to an ISO-based[22] (or other) quality system they may already have in place. The long-run costs incurred are likely to be passed forward and built into the cost structure of tank car manufacturers, but ultimately create an additional cost for tank car owners without any clear, quantifiable benefit. (This is discussed further below.)

- Some facilities will likely choose to exit the industry rather than undergo the certification process. This is because, for many of them, the amount of business they do in the tank car industry is a small part of their overall business, and so they will not perceive it to be in their interest to incur the certification costs required to continue. In the long run, this will lead to a decrease in the market supply of closures and fittings. Although these components are typically only a small fraction of the overall cost associated with producing or repairing tank cars, a limitation on component availability will impact the ability of AAR-certified facilities to release tank cars into transportation. Therefore, we account for this impact in the analysis.

The risk that short-run disruptions in the supply of closures and fittings could have a sizeable impact on the tank car market is consistent with the volatile nature of the industry. This is reflected in the significant swings that often occur in short-term lease rates for tank cars; these are essentially spot prices in the industry. Historically short term lease rates have gone up or down quickly in response to changing market conditions, including current and expected future tank car manufacturing backlogs (orders waiting to be fulfilled), changes in the market prices for crude oil or ethanol, new government regulations, and interest rates.[23]

With some simplifying assumptions, we utilize conventional market supply and demand analysis to assess the negative short-term effects described above. As described earlier, we are including both new car production and repair shop activities for this analysis. While the repair market operates somewhat independently from the new car market, a short-run supply disruption would have similar effects in both the new car and repair markets; in both cases, the demand for cars would exceed supply and short-term lease rental rates would likely be bid up.

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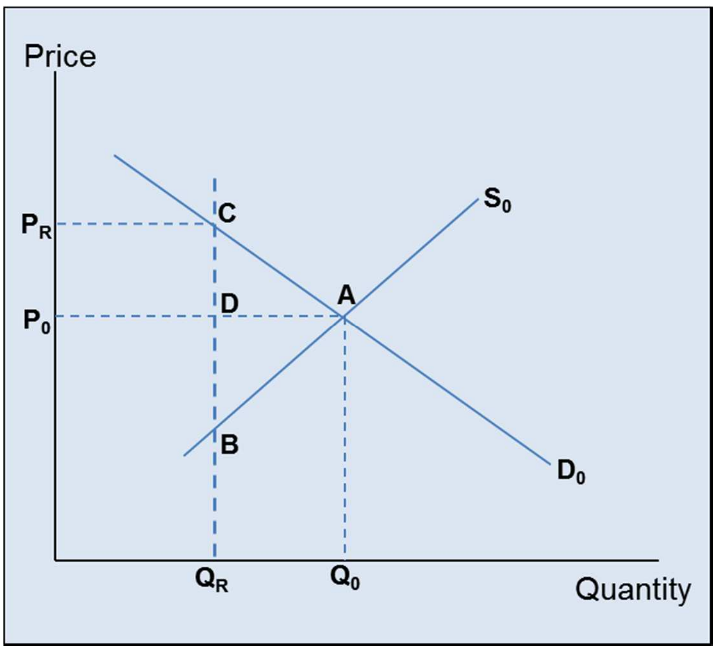
[22] ISO 9001 is an international standard that specifies fundamental quality management system requirements; organizations can become certified to the standard via independent third-party certification bodies.

[23] The volatility of short-term tank car lease rates, which primarily involve leases of used tank car stock, may not carry over completely to new car lease rates (which are more relevant for tank car manufacturers who would be impacted by a component supply disruption from the Revised Appendix B). New car lease rates are typically for longer terms (up to seven years for full-service leases).

Once the Revised Appendix B requirements are imposed, but before fittings and closures facilities can become certified (or if they choose to exit the industry), tank car manufacturers and repair shops will feel the effects as a supply chain disruption. To the extent tank car manufacturers and repair shops cannot obtain a sufficient number of needed parts and/or components, this consequence can be modeled as a restriction on the quantity of tank cars that manufacturers and repair shops can supply.

Exhibit 9 below includes the initial equilibrium at point A shown earlier in Exhibit 1, and adds in the restriction on supply. This restriction is reflected in the Exhibit by the dashed vertical line that hits the horizontal axis at a reduced quantity Q_R. A facility certification-induced supply shortage will cause suppliers to raise the price to P_R, reflecting what buyers will be willing to pay at the restricted quantity.[24]

Exhibit 9: Effect of a Market Supply Restriction



The welfare costs to society (or "loss in economic surplus") of the shortage can be measured in dollar terms as the area from Q_R to Q_0 between the supply and demand curves, shown in the Exhibit as the area ABC.[25]

[24] This approach abstracts from some common industry transactions where the major car manufacturers keep some of their production for their own leasing fleets and sell much of the rest to leasing companies (some with long-term purchase commitments). Nevertheless, if a short-term supply shortage were to develop, it is reasonable to assume that the inability to keep up with planned deliveries would feed through to affected customers and likely result in higher lease rates as shown in this modeling approach.

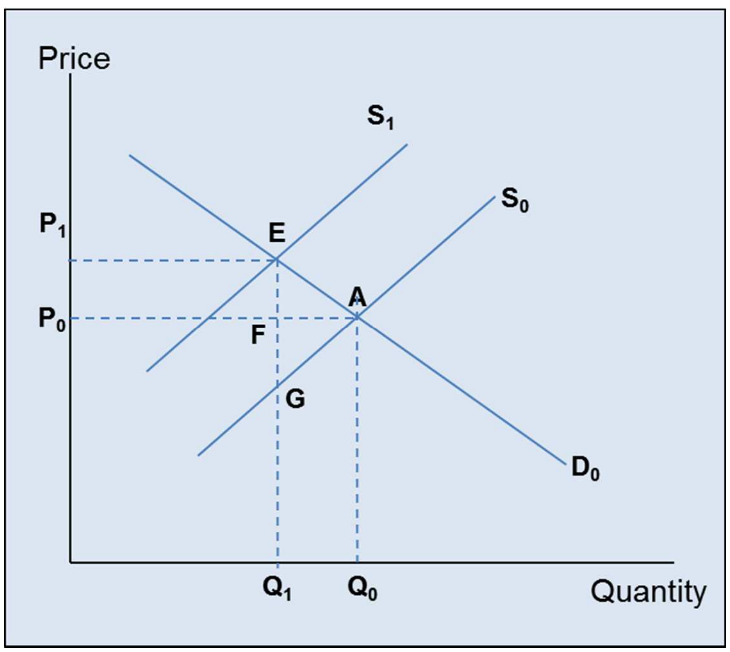
[25] The overall surplus area ABC is divided into two parts – the area ACD above the initial equilibrium price P_0 represents the loss in consumer surplus, while the area ABD below P_0 represents the loss in producer surplus.

Over time the shortage described above will lessen as more and more component suppliers become AAR-certified. This would be reflected by rightward shifts in the dashed vertical line and the movement of market prices along the demand curve back toward the initial equilibrium point A. Over time the triangular area reflecting losses in economic surplus will get smaller.

In this short-run environment, the economic costs are driven entirely by the supply shortage. The initial certification costs incurred by suppliers are *not* part of these economic costs; instead, they are comparable to a "lump-sum" tax (since they do not depend on the amount of goods sold). A lump-sum tax adds to a firm's fixed costs, but not its variable costs. For purposes of the benefit-cost analysis, these initial certification costs do not count toward the economic cost of Revised Appendix B because from society's point of view they are treated as simple transfer payments between parties for goods and services produced. (For example, the certification fees paid to AAR represent a cost to the supplier, but a benefit to AAR.)

Eventually, however, ongoing certification costs will be passed along to tank car manufacturers and repair shops in the form of higher prices since component suppliers must cover their fixed costs in the long run. This is shown in Exhibit 10 below, where the market supply curve is shifted up to S_1, reflecting the higher costs. This results in a new equilibrium at point E with price P_1 and quantity Q_1 reflecting increased prices just high enough to cover the fixed certification costs of the remaining component suppliers. In Exhibit 10, these fixed costs in total would be equal in size to the rectangular area P_1EFP_0.

Exhibit 10: Effect of Costs Passed Through to Manufacturers and Repair Shops



The lost economic surplus would be measured as the area EGA. To be conservative, however, when measuring economic surplus in the long run it is often assumed that the market supply curve will be infinitely elastic, reflecting a perfectly competitive market and no long-run surplus accruing to producers. In this case, the supply curves in Exhibit 10 would be redrawn as completely horizontal (still intersecting the demand curve at points A and E), and the total societal welfare change (loss in economic surplus) would be measured as the smaller area EFA, which we quantify below.

Even after including the repair market, this supply curve likely *underestimates* the size of the market that could be affected by a supply disruption. This is because tank car manufacturing is limited to a few large companies; these manufacturers do not have unlimited supply capacity, and there are typically fairly long lead times from order to delivery (as implied by Exhibit 3 above). Thus a component shortage affecting manufacturing is likely to spill forward and have consequential short-term pricing impacts downstream, even in the secondary leasing market. This is consistent with what has been observed in the industry over the past several years as lease rates for different car types and lease types (though at different absolute price levels) all move together in response to short-term disruptions.

In addition to the supply and demand curves, we also developed estimates of the long-run costs of certification. For present purposes we assumed that the costs associated with certification could be broken into the following short-run and long-run costs:

- We treated the entire initial upfront cost of certification as a short-run cost that could not be recouped by suppliers. We estimated these up-front certification costs to be approximately $150,000 per facility, which includes not only AAR fees and costs, but also internal costs such as development of a quality assurance manual, hiring a quality assurance manager, training, etc. (Again, we note that these costs do not count toward the social economic surplus losses accruing to Revised Appendix B.)

- In addition to upfront costs, maintaining AAR certification also requires subsequent recurring costs. We estimated these long-run costs to average around $95,000 annually for each supplier facility, which includes the annual cost for one full-time quality assurance manager plus required periodic audit fees and publications. As an example of audit fees, the fee costs for a single typical activity code could be over $12,000, comprised of the following items:
    - Technical review fee - $850
    - Facility administration fee - $500
    - M-1003 QA audit fee - $5,490
    - M-1002 technical audit fee for hazmat - $5,940 ($2,970 x 2 days)

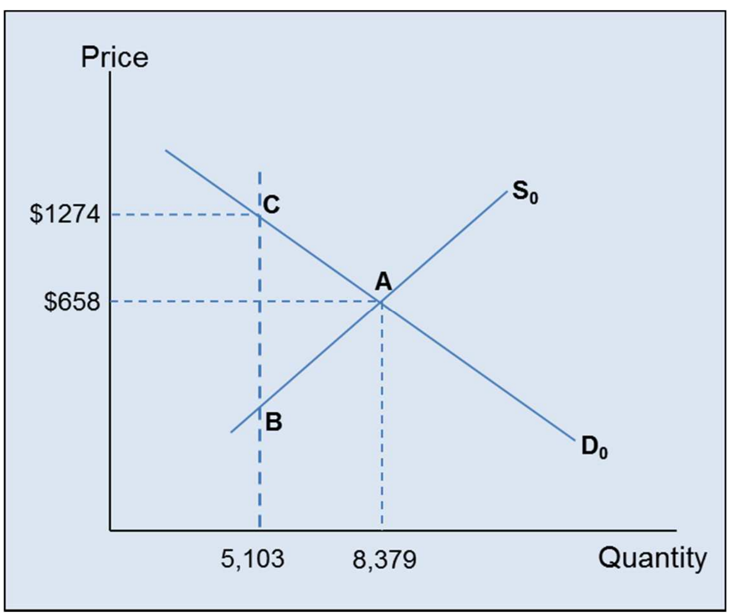
Short-Run Costs

With the industry supply and demand curves in hand, we can now proceed to assess how a supply restriction due to AAR's Revised Appendix B would impact economic surplus, which is the relevant measure of the costs of the new requirements. Referring back to Exhibit 9, the question is how far to the left of point A the vertical dashed line (representing the supply constraint) would be.

Utilizing additional results from our survey of purchasers and suppliers of closures and fittings, respondents reported that if they could no longer purchase closures and fittings from their non-certified suppliers, in 63 percent of cases it would be either "somewhat difficult" or "very difficult" to find a replacement supplier with an equivalent level of lead-time responsiveness.

We combined this survey result with the earlier reported estimate of non-certified supplier market share to calculate that a supply disruption might cause an initial decline in tank car manufacturing of about 39 percent. This reflects the assumption that none of the non-certified facilities would have their M-1003/M-1002 certifications in hand in the first quarter of 2020 (the starting date for the analysis). The scenario is shown in Exhibit 11 below by the vertical dashed line corresponding to 5,103 new and repair units for the first quarter. The corresponding demand price facing buyers is $1,274, which is a significant increase over the baseline rate of $658. This is due to the substantial short-run disruption in supply caused by the inability of non-certified suppliers to fulfill purchase orders made by tank car manufacturers and repair shops. We then calculated the surplus loss for the initial quarter by computing the size of the area ABC, which works out to approximately $3.7 million.

Exhibit 11: 2020 Tank Car Supply Disruption



Note: Figure not drawn to scale.

Long-Run Costs

To assess what would happen in the longer run, our survey provided suppliers with estimates of the costs and time needed to implement an AAR-approved certification program (including subsequent recurring audit fees and other ongoing costs), and then asked suppliers how likely they would be to undergo the certification process to enable them to continue to sell closures and fittings to the tank car industry. Among survey respondents, almost 32 percent of non-certified suppliers said they "definitely would not" obtain certification.[26] Another 32 percent responded that they were "somewhat unlikely" to obtain certification.

For purposes of this analysis, we made an operational assumption that the "long run" begins in 2021; thus all certifications are assumed to be complete by the end of 2020.[27] Recalling the earlier discussion about long-run fixed costs, our analysis also requires a projection of the aggregate *count* of suppliers who eventually become certified. From Section 4 above, our baseline estimate (which is likely conservative) is that there is an initial population of about 150 unique non-certified suppliers.

Based on the survey results indicating that approximately 30 percent would definitely exit the industry rather than incur certification costs, this implies that 45 would exit, leaving an industry total of 105 newly certified suppliers in the long run.

With these assumptions the annual long-run certification costs are estimated at $2.49 million per quarter (= 105 facilities * $95,000 per year per facility / 4 quarters). Referring back to Exhibit 10, we shift the industry supply curve to the point where, given the demand curve, the equilibrium price increases just enough to cover the quarterly new long-run industry costs related to certification. Based on these calculations, the equilibrium monthly lease rate must increase from $658 to $769 to cover these long-term costs, and the equilibrium quarterly quantity decreases from 8,379 to 7,449 (including deliveries and repairs). The corresponding loss in economic surplus (area EFA from Exhibit 10) works out to over $148,000 per quarter given the above assumptions.

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[26] Nearly half (15 of 33) of the non-certified facility respondents reported having an ISO 9001 quality assurance program already in place, which means that they would essentially have to create a second, parallel system under M-1003 in order to continue to sell fittings and closures in the tank car industry. Importantly, respondents with an ISO certification were just as likely as those without to report that they would choose to exit the industry rather than undergo M-1003 certification. Also, the direct certification costs of Revised Appendix B would fall on many small businesses, as 16 of the 28 non-certified suppliers who answered the question about facility size reported having fewer than 100 employees.

[27] This is a conservative assumption as it relates to long-run costs. The speed of facility certification is limited, in part, by the number of AAR auditors. Based on current facility audit cycle times which often exceed 12 months (as noted above) it is unlikely that all new facility certifications will be completed by the end of 2020.

A further simplifying assumption is that there will be no further growth in tank car deliveries or repair activity for the foreseeable future; under this scenario the remaining quarters out through 2039 would be duplicates of this calculation.

To transition from short-run to long-run costs, we assumed that the transition is linear over the second, third and fourth quarters of 2020. Thus the entire scope of economic costs resulting from the certification requirement is shown in Column A of Exhibit 12 below. To complete the cost analysis, these costs are discounted at an annual rate of 7 percent, following OMB and FRA guidelines;[28] the results are shown in Column B, with a resulting net present value of -$15.2 million. Accordingly, the estimate of the economic costs of Revised Appendix B is approximately $15.2 million.

Exhibit 12: Estimated Discounted Cash Flow Costs of Revised Appendix B

		Loss in Economic Surplus	
		(A)	**(B)**
Period	**Time Period**	**Nominal $**	**Discounted $**
0	2020Q1	-$3,712,898	-$3,712,898
1	2020Q2	-$2,821,782	-$2,773,250
2	2020Q3	-$1,930,666	-$1,864,826
3	2020Q4	-$1,039,550	-$986,829
Total Short-run costs:		*-$9,504,896*	*-$9,337,803*
4	2021Q1	-$148,434	-$138,483
5	2021Q2	-$148,434	-$136,101
6	2021Q3	-$148,434	-$133,760
7	2021Q4	-$148,434	-$131,460
8	2022Q1	-$148,434	-$129,199
9	2022Q2	-$148,434	-$126,976
10	2022Q3	-$148,434	-$124,793
11	2022Q4	-$148,434	-$122,646
...	...	...	...
76	2039Q1	-$148,434	-$39,712
77	2039Q2	-$148,434	-$39,029
78	2039Q3	-$148,434	-$38,357
79	2039Q4	-$148,434	-$37,698
Total Long-run costs:		*-$11,280,976*	*-$5,897,627*
Total Loss in Surplus:		***-$20,785,872***	***-$15,235,431***

We believe this is likely a conservative estimate for a number of reasons:

[28] The actual calculations are performed on quarterly data, so we use a quarterly interest rate of 1.75 percent; this results in an effective annual rate of 7.18 percent due to compounding. FRA recommends that a sensitivity analysis also should be presented using an annual discount rate of 3 percent; the results of such a sensitivity analysis are shown in the next section in Exhibit 13.

- We assume that the disruption is in full effect only for one quarter (2020Q1) and then disappears entirely by the first quarter of 2021. The short-term supply disruption would last longer if the relevant AAR certifications are not issued to component manufacturing facilities across the industry by the end of 2020.

- We have excluded the retrofit market from the analysis. To the extent that new closures and fittings components are utilized for certain retrofits, this would increase the estimate of the cost of the supply disruption.

- As noted earlier, a short-term supply disruption may affect the larger secondary lease market for tank cars, well beyond the new car and repair markets.

- We estimate the current total population of non-certified suppliers to be 150. The actual population of non-certified suppliers is likely higher given that nearly 100 unique suppliers were identified by the rather small sample (42) of purchasing facilities in our survey.

Sensitivity Analysis

To assess how sensitive the results are to the assumptions described above, we have carried out a series of sensitivity scenarios, altering the values of various parameters to evaluate their impact on the economic cost estimates presented above. Exhibit 13 below summarizes the impacts of utilizing less conservative assumptions, which leads to higher cost estimates.

Exhibit 13: Effect of Less Conservative Assumptions on Discounted Cash Flow Costs of Revised Appendix B

Default Discounted Cost = $15.2 million		
Default Assumption	Less Conservative Assumption	Discounted Cost
150 non-certified suppliers prior to 2020	175 non-certified suppliers prior to 2020	-$17.6 million
Supply disruption lasts 4 qtrs	Supply disruption lasts 6 qtrs	-$18.6 million
Exclude retrofits	Include retrofits	-$16.4 million
7% discount rate	3% discount rate	-$17.8 million
	All above assumptions together	-$25.7 million

Alternately, in Exhibit 14 below we also present the results of utilizing *more* conservative assumptions, leading to lower cost estimates.[29]

[29] The net impacts of alternate assumptions about the elasticity of the demand curve are ambiguous because it affects both short-run and long-run impacts, but in opposite directions. A higher elasticity (in absolute value) will lead to lower short-run consumer surplus losses, but higher long-run surplus losses, holding all else constant, and vice versa.

Exhibit 14: Effect of More Conservative Assumptions on Discounted Cash Flow Costs of Revised Appendix B

Default Discounted Cost = $15.2 million		
Default Assumption	More Conservative Assumption	Discounted Cost
150 non-certified suppliers prior to 2020	125 non-certified suppliers prior to 2020	-$13.4 million
Supply disruption lasts 4 qtrs	Supply disruption lasts 2 qtrs	-$11.8 million
Initial supply disruption = ~39%	Initial supply disruption = 25%	-$9.6 million
	All above assumptions together	-$6.4 million

As seen in these Exhibits, the assumptions that directly affect the short-run supply disruption (i.e., the size and length of the disruption) have the largest impacts on estimated costs. The impact to estimated costs associated with the estimate of the initial number of non-certified supplier population is more modest.

7. Costs of RSI-100

Under the RSI-100, existing AAR-certified tank car manufacturers and repair facilities would be responsible for ensuring that their closures and fittings suppliers meet quality assurance and purchase order-specific requirements. The basic tenants of the RSI-100 standard include:

- A uniform vendor approval and supplier quality assurance checklist – the purchaser will evaluate the supplier's quality assurance program to ensure that suppliers meet the requirements of RSI-100, which has 13 specific elements including requirements for contract review, design, material and document control, training, shipping, recordkeeping, etc.;

- Purchasing requirements for AAR-certified facilities – the purchaser must provide product specification requirements to the supplier (including material specifications and drawings) and one of four product quality certification plans is undertaken (depending on specific component being purchased);

- Periodic surveillance audits – the purchaser must conduct periodic on-site audits against the checklist.

Short-Run Costs

Based upon discussions with RSI and its member companies, we anticipate that the implementation of RSI-100 would not cause significant short-term disruptions in the market for tank car closures and fittings. This is because (1) the quality management system requirement of the RSI-100 program does not require certification by a third-party organization and (2) a facility with an existing ISO 9001 quality assurance program will have a significant amount of overlap with the RSI-100 quality management requirements.

It is possible that some suppliers may not currently have a quality assurance program of any type in place; these suppliers would not be able to participate in the market until they satisfy RSI-100 requirements.[30] To incorporate this assumption into our analysis, we again turn to our survey results, which indicated that about 46 percent of non-certified supplier respondents did have a valid ISO 9001 certification for quality management. Using the same approach that was used for the Revised Appendix B analysis above, the size of a potential supply disruption due to RSI-100 can be projected by combining estimated non-certified supplier market share, difficulty in finding replacements, and the share of suppliers without ISO certification; this results in an estimated short-term supply disruption of about 18 percent (compared to about 39 percent for Revised Appendix B).

This is a conservative assumption. Some RSI members have reported that they are already discussing quality assurance topics with their suppliers; and, GRA understands that many suppliers are in a position to quickly implement a satisfactory quality assurance program in a timely fashion that would meet all of the RSI-100 requirements. Unlike facilities seeking certification pursuant to the requirements of Revised Appendix B, suppliers operating under RSI-100 would not be subject to potential delays associated with the AAR certification process (i.e., delays associated with audit site visits, issuing audit reports, AAR Tank Car Committee balloting delays etc.). For this reason, we assume that a short-term disruption under RSI-100 would not last for more than one quarter. Using the same supply and demand curves as before, the initial restricted supply quantity works out to 6,872 tank cars (compared to 5,103 under Revised Appendix B) with a short-term demand price of $857 facing buyers (compared to $1,274 under Revised Appendix B). The corresponding surplus loss for the initial quarter is about $704,000 (compared to $3.7 million under Revised Appendix B).

Long-Run Costs

As with Revised Appendix B, there likely will be some ongoing costs associated with RSI-100. These costs would include both purchaser costs associated with preparing ongoing work order specifications and undertaking periodic audits, and incremental supplier costs for those facilities that had to develop or upgrade their quality assurance programs. In the long run, these costs must be passed forward to allow firms to cover their total costs of operation.

Considering purchasers first, RSI has projected that these costs might average approximately $2,000 annually for each non-certified supplier that a purchaser utilizes, although the actual costs for particular suppliers and purchasers could vary considerably based on the number of purchase orders, geographical proximity of the suppliers to the purchasers, and other factors.

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[30] To facilitate comparison to the results shown above for Revised Appendix B, we continue to assume that any impacts would begin in 2020.

Responses from our survey indicate that the average purchaser did business with an average of 8 different non-certified suppliers. If we apply this count to the universe of 199 tank car manufacturers, repair shops, and service equipment manufacturers who appear in the AAR Registry, this yields a total of 1,592 non-certified supplier contacts that would be impacted via RSI-100. At $2,000 per contact, this works out to an industry-wide total annual cost of $3.184 million. This is likely an overestimate of the total costs incurred for at least two reasons. First, using an average of 8 supplier contacts for every certified tank car manufacturer, repair shop and component manufacturer may be overstated because large facilities (who are likely to have a larger number of supplier contacts) are over-represented in our survey. Second, we estimate the total number of unique non-certified suppliers is approximately 150, which suggests that the total number of surveillance audits required may be well under 1,592.

Next we consider new long-run costs faced by current non-certified suppliers who do not have an ISO 9001 certification. We assume there are approximately 81 such firms (= 150 total non-certified suppliers in the industry * 54 percent who are not ISO certified according to the survey). This calculation also reflects the assumption that all such suppliers would be willing and able to operate under RSI-100 provisions in the long run, so there would be no exits from the industry. For present purposes we assume an average annual incremental cost of $10,000 incurred by each such supplier in order to implement or upgrade their current system to meet RSI-100 requirements. This yields a total annual industry-wide supplier cost of $810,000.

Adding the annual purchaser and supplier costs together yields a total estimate of about $4 million in annual long-run incremental costs. Following the same surplus loss approach described earlier results in an equilibrium monthly lease rate of $699 that would be required to cover the long-run costs associated with RSI-100, and a corresponding quantity of 8,002 (including deliveries plus repairs). The total discounted costs over 20 years at 7 percent, shown below in Exhibit 15, add up to less than $1.7 million, which is a fraction of the estimated $15+ million cost incurred under Revised Appendix B.

Exhibit 15: Estimated Discounted Cash Flow Costs of RSI-100

		Loss in Economic Surplus	
		(A)	(B)
Period	Time Period	Nominal $	Discounted $
0	2020Q1	-$703,864	-$703,864
Total Short-run costs:		-$703,864	-$703,864
1	2020Q2	-$23,081	-$22,684
2	2020Q3	-$23,081	-$22,294
3	2020Q4	-$23,081	-$21,911
4	2021Q1	-$23,081	-$21,534
5	2021Q2	-$23,081	-$21,164
6	2021Q3	-$23,081	-$20,800
7	2021Q4	-$23,081	-$20,442
8	2022Q1	-$23,081	-$20,090
9	2022Q2	-$23,081	-$19,745
10	2022Q3	-$23,081	-$19,405
11	2022Q4	-$23,081	-$19,071
...	...	...	...
76	2039Q1	-$23,081	-$6,175
77	2039Q2	-$23,081	-$6,069
78	2039Q3	-$23,081	-$5,965
79	2039Q4	-$23,081	-$5,862
Total Long-run costs:		*-$1,823,425*	*-$983,965*
Total Loss in Surplus:		***-$2,527,289***	***-$1,687,829***

Even under more conservative assumptions – such as a doubling of annual long-run costs per affected supplier to $20,000 – the RSI-100 costs would still be well below the Revised Appendix B costs reported earlier.

8. Conclusion

The analysis presented above demonstrates that the RSI-100 proposal is the preferred alternative as compared to Revised Appendix B because the quantifiable benefits are likely the same, while the RSI-100 proposal is less expensive from a social cost standpoint. Moreover, the Revised Appendix B proposal is likely to result in a costly short-term disruption to the supply of tank cars (in both the manufacturing and repair markets), and to induce substantial long-term costs that eventually must be passed through to consumers. In contrast, any potential short-run supply disruption from RSI-100 is likely to be modest, and its long-term costs are also relatively small, and significantly less than those associated with Revised Appendix B. Given that both proposals would have similar potential safety benefits (however measured), GRA concludes that RSI-100 is superior to Revised Appendix B from a benefit-cost standpoint.

Appendix: Primary Assumptions

1. Analysis restricted to benefits and costs associated with closures and fittings.
2. Analysis limited to effects on tank car manufacturing and repair markets; potential effects on retrofits not quantified and incorporated.
3. 2020 start date with time horizon of 20 years.
4. Real discount rate = 7 percent.
5. Static analysis after initial short-run and long-run effects accounted for (i.e., no industry growth).
6. Industry supply curve based on observed average lease rates for tank cars 2014-2018.
7. Constant-elasticity Industry demand curve (elasticity = -0.75).
8. Survey of RSI members and their suppliers utilized to assess number and type of facilities affected.
9. Estimated initial population of non-certified suppliers = 150.
10. Estimated non-certified supply share = 62 percent.
11. Quantifiable safety benefits derived from DOT 5800.1 incident reports, 2010-2019.
12. Safety benefits assumed to be the same under Revised Appendix B or RSI-100.
13. Under Revised Appendix B, initial supply disruption is 39 percent, declining gradually through 4 quarters ending 2020Q4.
14. Under RSI-100, initial supply disruption is 18%, lasts 1 quarter, i.e., 2020Q1.
15. Long-run exit of non-certified suppliers = 45 under Revised Appendix B, 0 under RSI-100.
16. Incremental long-run costs of both proposals passed through to manufacturers and repair shops.
17. Annual Revised Appendix B long-run costs = $95,000 per supplier facility.
18. Annual RSI-100 long-run costs = $2,000 per supplier contact for each purchaser, plus $10,000 for each supplier without existing ISO-9001 certification.