

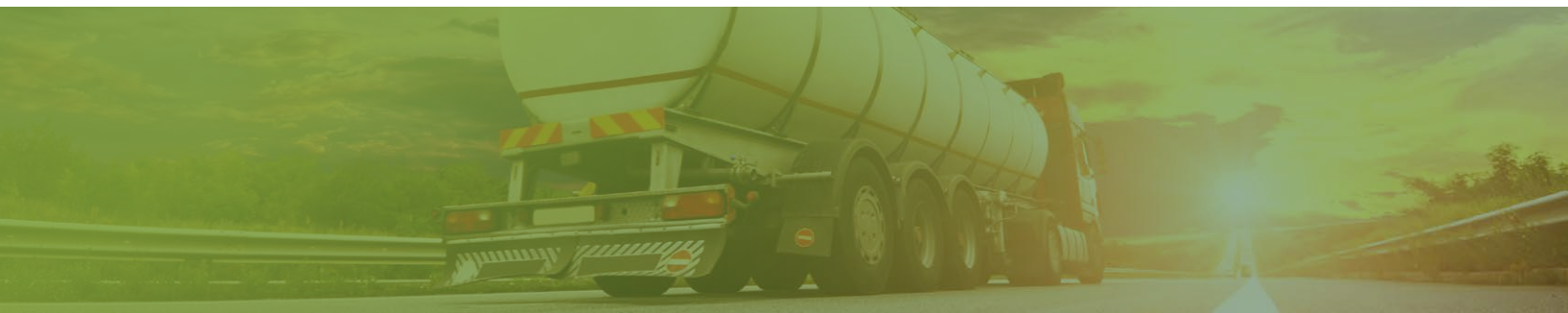
Fuels Institute

DFQC

**DIESEL FUEL
QUALITY COUNCIL**

Diesel Fuel Loading and Delivery

INDUSTRY PRACTICES TO MINIMIZE
DEGRADATION AND IMPROVE FUEL QUALITY



Introduction

New high-performance diesel engines are required to meet higher emissions and efficiency standards while also having a longer useful life. These modern diesel engines require a clean high-quality fuel and are likely more sensitive to fuel contamination.

This interplay between modern engine design and its fuel highlights the importance for improved diesel fuel quality delivered to the consumer at the fuel pump. Poor fuel quality increasingly causes more vehicle maintenance costs and downtime due to its negative impacts on engine performance, fuel filters, and fuel injection systems. Additionally, contaminants in the fuel can corrode and otherwise damage fuel storage and dispensing equipment, leading to unnecessary costs associated with repair and replacement of that equipment.

When loading diesel fuel at the terminal or unloading diesel fuel into a storage tank, take steps to ensure product integrity and mitigate the risk of comingling the diesel fuel with other products (such as gasoline) or introducing contaminants (such as water). Comingling of contaminants with fuel can introduce components that directly impact a fuel's physical properties (such as lowering the flashpoint or cetane value) or fuel quality (such as introducing adulterants and contaminants such as water or salts or enhancing microbiological growth).

Comingling can result during tanker loading from residual product left in a compartment, mislabeling of compartments, or cross-contamination of vapors between compartments. The introduction of water into the storage tank, the accidental unloading of the wrong product (such as gasoline) into the diesel tank, or the introduction of residual product remaining in the tanker manifold or delivery hose into the diesel tank can also result in comingling during tanker unloading into a storage tank.

Implementing the following recommended practices will best preserve the quality of diesel fuel from the time it is loaded at the distribution terminal to when it is delivered to a retail or commercial facility storage tank. To eliminate sources of impacts to diesel fuel quality, all of the procedures outlined in this best practice document should be incorporated, when applicable, into the routine loading and unloading procedures followed by tanker and tank truck drivers.

This set of best practices is focused on maintaining fuel quality. Health and safety best practices are of paramount concern, and drivers should review hazardous conditions and situations frequently. This is not a substitute for requirements from the Occupational Safety and Health Administration (OSHA) or U.S. Department of Transportation (USDOT) requirements, nor does this document contain health and safety measures. For information on maintaining fuel quality at retail, prior to end-user delivery, see [Diesel Storage Tanks: Industry Practices to Minimize Degradation and Improve Fuel Quality](#) | Fuels Institute.

Contents

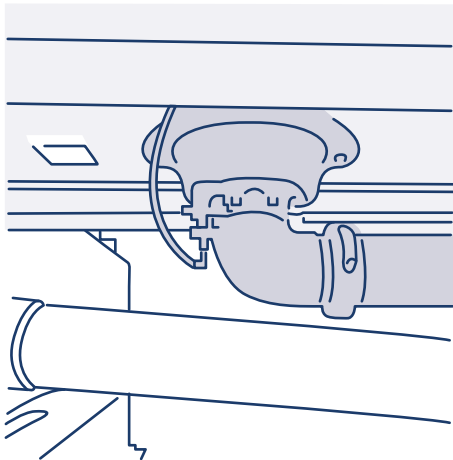
INTRODUCTION	1
TANKER AND EQUIPMENT	3
TERMINAL LOADING AND TRANSPORT	6
DIESEL FUEL DELIVERY	9
OTHER ISSUES TO CONSIDER	12
CONCLUSIONS	14

Tanker and Equipment

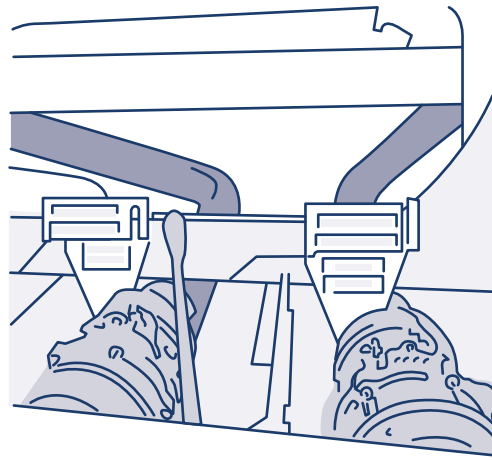
Recognizing vehicle and tank equipment is the first step in understanding and delineating fuel quality best practices.

The following examples are configuration and components of tanker trucks (single or multiple compartments) important to these best practices:

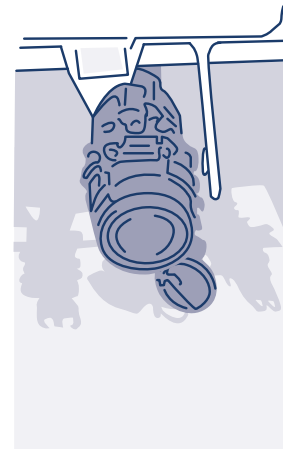
1. LOADING AND UNLOADING VALVES: Product is loaded and drained from the bottom of a compartment through an emergency valve (sometimes referred to as a belly valve) and then through a dedicated drain line to the loading and delivery valve (referred to as the API valve). In some older tanker trucks, the drain lines from the compartments may be manifolded to a common drain line with a single API valve. In the case of manifolded systems, separate valves should be associated with each compartment to isolate individual compartments during loading and unloading to avoid cross-contamination.



EMERGENCY VALVE

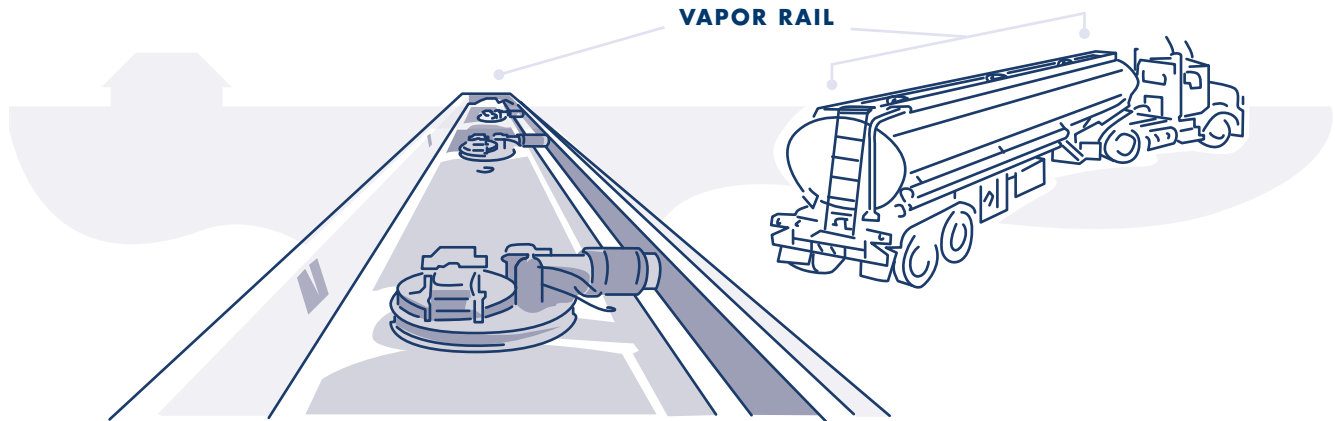


DRAIN LINE



API VALVE

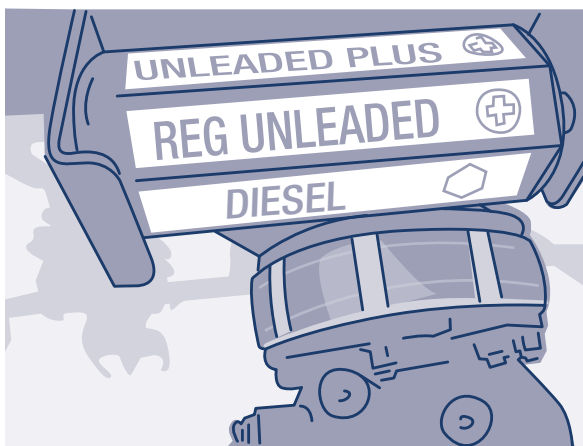
2. VAPOR RECOVERY: Vapors are recovered and flow through a vapor recovery vent that runs through a common vapor rail along the top of the tank down the back of the tank to a vapor return connection.



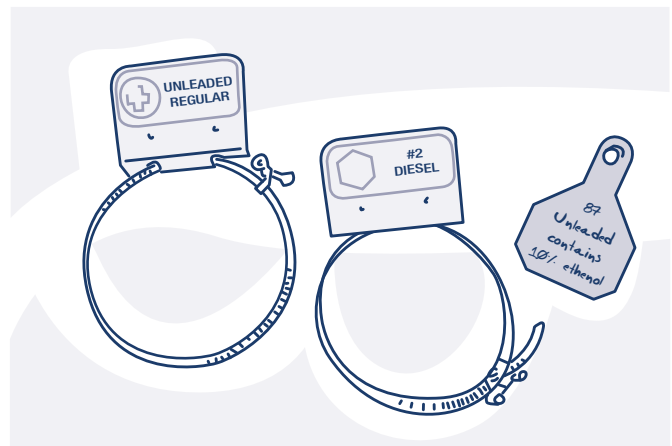
3. VALVE CONTROLS: Emergency valves and vent valve should be configured to allow each compartment to be controlled separately. The emergency valve, which also acts as a shear valve and vent valve for each compartment, is air controlled from an air control panel (older systems are cable controlled) with a main switch and individual compartment switches. The emergency valve and vent valve open and close simultaneously. In some cases, emergency valves and vent valves for all compartments are open or closed simultaneously when the gang box containing the valve switches is opened or closed or the main switch is used to open or close the valves.

4. DOUBLE BULKHEADS: A double bulkhead for at least one compartment is typically between an end compartment and an interior compartment. Some tanks have double bulkheads for all compartments.

5. PRODUCT LABELS: A product dial, product tag or label, or other method is used to identify the current contents of each compartment.

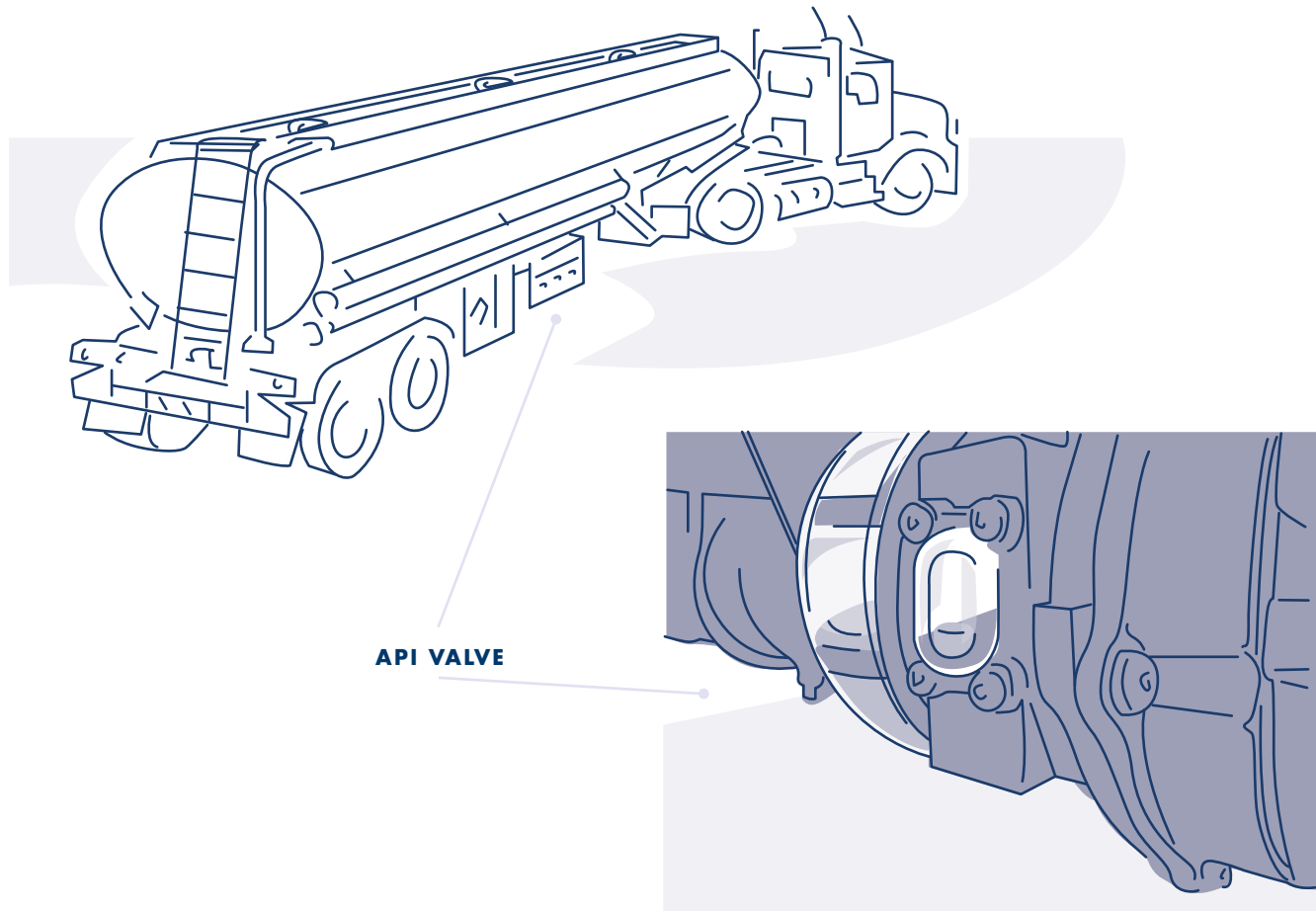


PRODUCT DIAL



PRODUCT TAGS AND LABELS

6. PRODUCT FLOW MONITORING: A sight glass on the API valve for each compartment is used to verify flow during delivery and an empty compartment.



7. RETAINED PRODUCT SENSORS: Some tankers may be equipped with a retained product sensor, which verifies an empty compartment and warns against product mixing. Typically associated with the compartment overfill sensor, the retained product sensor is designed to sense residual (retained) product in the bottom of a tank compartment. If there is retained product in a compartment prior to loading, the product loading can be stopped. Retained product indication also verifies that a complete delivery had been made and that the compartment is completely emptied of its cargo.

Terminal Loading and Transport

Unless a dedicated tanker or dedicated compartment of a tanker is used to transport diesel fuel from a terminal to a storage tank, there is a chance the diesel fuel can become contaminated with other products during loading.

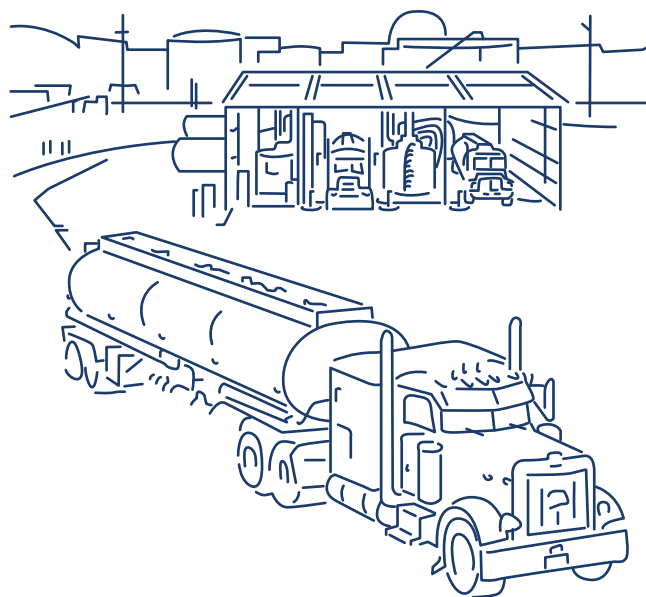
There are two primary ways this can occur:

1. SWITCH LOADING occurs when the tanker is used to deliver a variety of products, and residual product from a previous load remains in the compartment and is mixed with a new product load.

2. SPLIT LOADING occurs where multiple products, such as ultra-low-sulfur diesel (ULSD) and gasoline, are loaded into different compartments on the same tanker; while the tanker truck is driving, gasoline and possible ethanol vapors can contaminate the ULSD load by traveling through the common vapor rail.

Switch loading and split loading could involve either a full load of gasoline followed by a full load of diesel fuel, or a full load of gasoline or some combination of split loads followed by diesel fuel being loaded in to one or more compartments that previously held gasoline.

In cases where it is logistically and economically feasible, having a dedicated tanker truck or dedicated compartments of a tanker truck provides

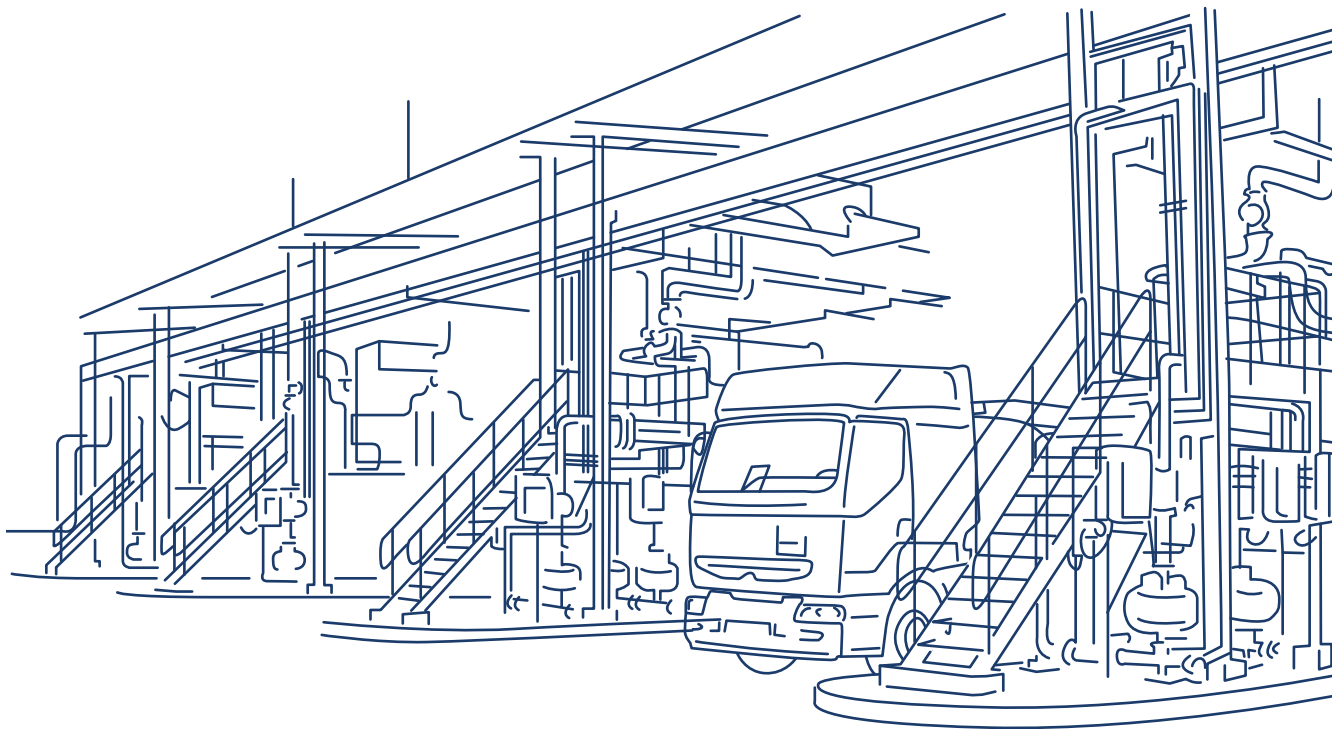


the best protection against inadvertent comingling of diesel fuel with other products. Dedicated tanker trucks or compartments are the exception and are typically associated with facilities with high volumes of diesel fuel (such as truck stops) or areas with a high density of diesel fueling locations where logistics can support the economics of dedicated tankers.

When loading diesel fuel onto a tanker or tank truck, ensure that it will not be comingled with other products, such as gasoline, even in small amounts. To ensure that the proper product and volume is loaded and fuel quality is not impacted during the loading process, incorporate the following practices into the tanker loading procedures while loading diesel fuel.

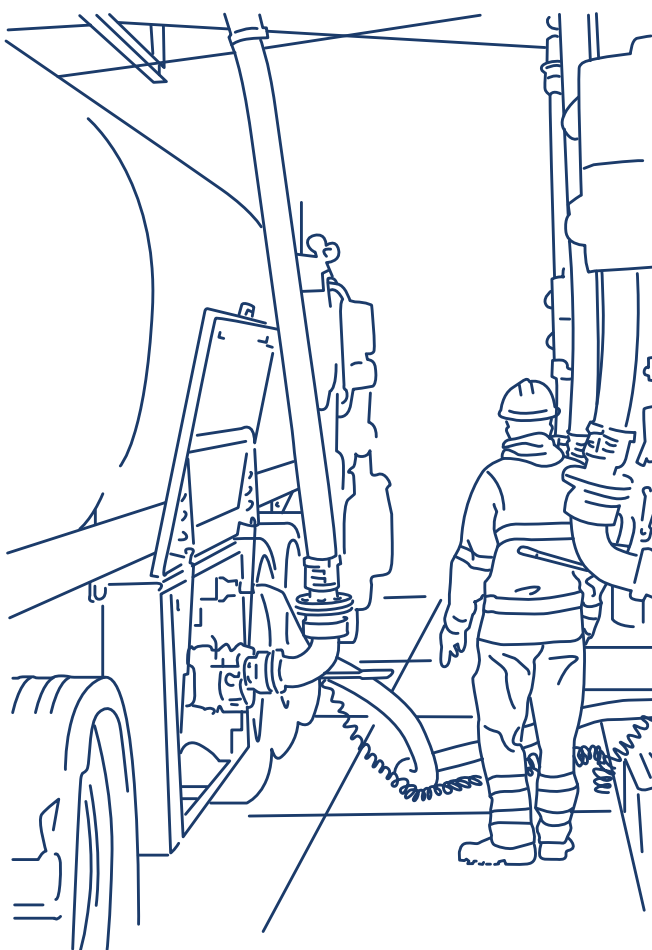
1. VERIFY THE PRODUCT AND VOLUME TO BE LOADED: For split loads, diesel fuel should be loaded into a compartment separated from gasoline or other products by a double-walled bulkhead. For switch loads where diesel fuel will be loaded into a compartment that previously held gasoline, fully load the compartment with diesel fuel (the volume of diesel fuel should equal the maximum available capacity of the compartment). This will minimize gasoline vapors remaining in the compartment and the effects of trace quantities of gasoline that may remain in the compartment from the previous load.

2. VERIFY THAT THE COMPARTMENT TO BE LOADED WITH DIESEL FUEL IS EMPTY: Use the sight glass on the API valve to check for remaining product. If the tanker is equipped with a retained product sensor, check the control panel to ensure it does not detect retained product. Do not load diesel fuel into a compartment that contains residual gasoline or other low-flash-point product. If residual product is present (other than the product to be loaded in that compartment), drain the compartment before loading additional product. This may be best accomplished prior to pulling under the load rack since many terminals do not have provisions for (and in many cases a prohibition against) draining any residual product once the tanker is under the load rack. While some terminals may have provisions for draining a compartment, that is not always the case, so the best opportunity to drain a compartment is during delivery to a storage tank (see the next section on “Diesel Fuel Delivery”).



3. IDENTIFY THE PRODUCT IN EACH COMPARTMENT: Add product identification to each compartment, such as a product dial (rotating product labels), or otherwise identify the product to be loaded into each compartment. Affix a product label or tag identifying the product to the API valve or dust cover for the diesel fuel compartment(s) in addition to the product dial.

4. LOAD DIESEL FUEL FIRST: To avoid gasoline vapors back-flowing into the diesel fuel compartment, diesel fuel should be loaded first. In cases where gasoline and diesel fuel loading arms are available at the same loading rack position, gasoline and diesel fuel should not be loaded simultaneously for the same reason.



Open only the emergency valve and vent valve for the compartment to be loaded. Make sure the vapor return line is properly connected regardless of the product being loaded. This will remove any gasoline vapors that may be present in the compartment and therefore minimize the potential for gasoline vapors to be pushed into a compartment loaded with diesel fuel.

After connecting the diesel fuel loading arm to the tanker compartment identified for diesel fuel, open only the API valve for the compartment(s) to be loaded. If there is a common manifold for the compartments, make sure valves to other compartments are closed.

5. CLOSE VALVES AND VERIFY PROPER COMPARTMENT IDENTIFICATION: After loading is complete and the API valve is closed, close the emergency valve and vent valve for the loaded compartment(s). Verify that the product dial and product tags/labels are correct for the product loaded into each compartment. It is recommended to use both the product dial and product tag/label for diesel fuel. To protect delivery hoses from collecting excess dust or getting wet (such as from rainfall, snowfall, or road spray), store them in a hose tube with end caps instead of in open racks.

Diesel Fuel Delivery

When unloading diesel fuel into a storage tank, ensure that water is not introduced in the storage tank and that the wrong product (such as gasoline) or residual product in the tanker manifold or delivery hose is not accidentally introduced into the diesel tank.

To ensure that the proper product and volume are unloaded, and fuel quality is not impacted during the unloading process, incorporate the following practices into the tanker unloading procedures and follow them while unloading diesel fuel.

1. IDENTIFY THE DIESEL FUEL STORAGE TANK:

Verify the storage tank to receive the diesel fuel using color code (API color code for diesel is yellow) and a product tag or label (see [API RP 1637](#)). In many cases, the storage tank is identified by both a color code and a tag or label or other marker with the product name or description. Product tags or labels may be located on the spill bucket cover, around the spill bucket cover, or around the fill pipe (look, for example, for a product ID band or fill pipe tag or label). If the tank fuel-type tags are not affixed or are illegible or if it is not clear which storage tank is to receive the delivery, verify the appropriate storage tank(s) and product(s) with site personnel. Where multiple storage tanks are present and multiple products are to be delivered, place a green/yellow cone (or other unique marker) on the diesel fuel storage tank fill to prevent confusion and avoid delivery of gasoline or other product into the diesel fuel storage tank. Recognize out of service or out of compliance tanks — many states have “red tag” rules (the tank



fill may be locked or a red tag placed on the fill) to indicate to the driver that fuel is not to be dropped. In some states, transporters may be held liable and penalized for not complying with red tag rules.

2. POSITION THE TANKER TO ENSURE PROPER DRAINAGE:

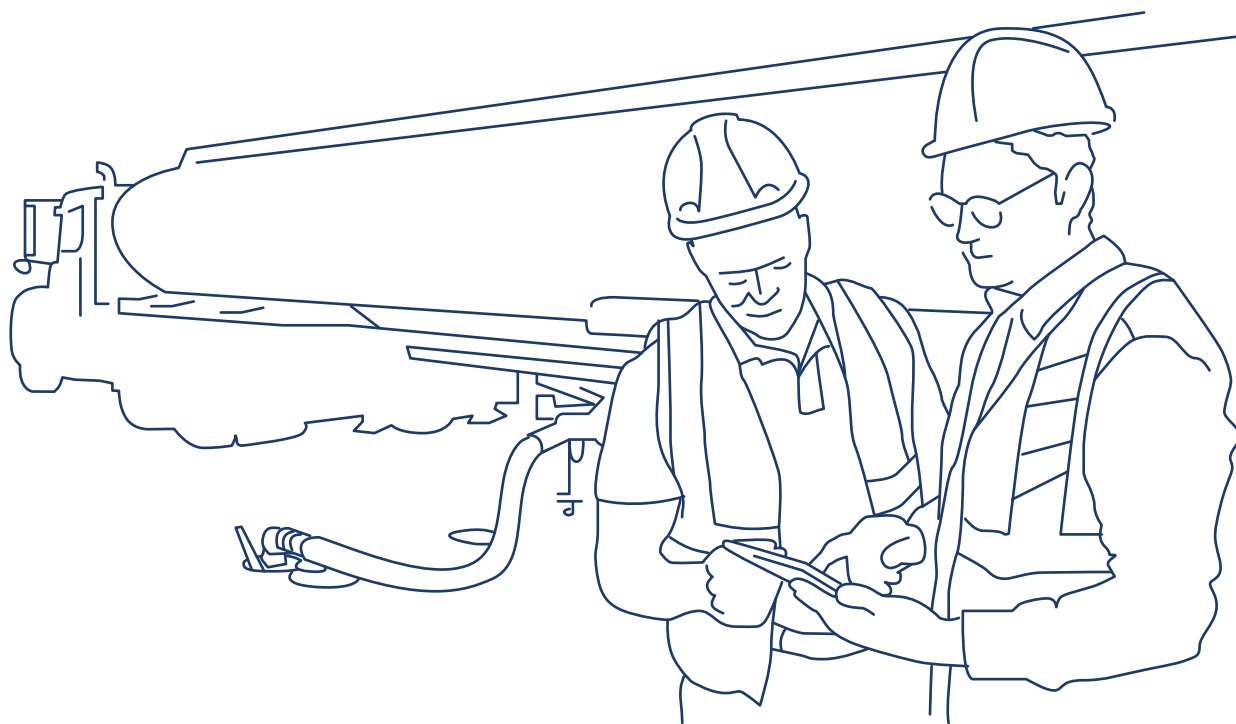
When positioning the tanker at the delivery site, ensure it is on a level surface to promote complete drainage from the compartment. If the tanker is not on a level surface, all product in a compartment may not drain from the compartment. This could result in residual product remaining in a compartment that may be a source of contamination of a future load of diesel fuel. If the delivery is a split load, unload diesel fuel first. Diesel fuel storage tanks typically do not have a vapor recovery connection, so unloading diesel first will keep recovered gasoline or other product vapors from being pushed into a compartment containing diesel fuel.

3. CHECK FOR WATER AND OTHER DEBRIS AROUND THE FILL PIPE: Before removing the fill cap, ensure there is no water in the spill bucket or puddled water on the surface that could make its way into the storage tank. If water is present in the spill bucket, dispose of it properly before delivering fuel into the tank (do NOT drain water into the tank). Check the fill cap gasket to make sure it is in good condition and will properly seal. During rain or snowfall, do not leave the fill pipe open for extended periods of time to minimize the chance of water entering the storage tank.

4. VERIFY AVAILABLE CAPACITY OF THE STORAGE AND CHECK FOR WATER: Prior to dropping the fuel, get a printout of the product level and water level from the automatic tank gauge (ATG), if the tank is equipped with one. Compare the volume of product to the volume recorded on the ATG. If an ATG is not present or accessible, stick the storage tank with an appropriate water-finding paste to determine

the volume of product in the storage tank and the presence of water. Even if an ATG is present at the site, the ATG information should be verified by sticking the storage tank. If there is a discrepancy between the ATG readings and the stick readings or if water is identified in the storage tank, notify site personnel and follow site procedures and direction with regard to unloading the fuel.

5. DO NOT OVERFILL THE STORAGE TANK: Do not deliver into the storage tank if the delivery would cause product level to exceed the maximum capacity for the storage tank established by the regulatory authority that has jurisdiction on the storage tank (for example, 90% or 95% of the tank capacity in accordance with [40 CFR § 280.20\(c\)](#), depending on method of overfill protection used). This is important to prevent overfills and, in the case of compartments containing other products, to ensure that residual product does not remain in the compartment after delivery.



6. MAKE SURE THE STORAGE TANK DOES NOT CONTAIN WATER:

Water is a contaminant in diesel fuel and a contributing factor to microbiological growth in diesel fuel storage tanks. Document any level of water encountered while sticking the tank or reviewing ATG readings. Site owners may ask that the tank be stuck at both ends to account for any tank tilt, if that is a possibility. In most situations, however, the tank will only have a single tank sticking access point. Notify the site operator of any water findings and, if excessive, suggest that the site operator contact a company fuel quality or compliance manager regarding the water. If water is present and the fuel has been dropped, per the site operator's authorization, document water levels on a delivery receipt and leave with the site operator.

7. REPORT ANY DAMAGED, CORRODED, OR OTHERWISE FAULTY EQUIPMENT IN OR AROUND THE MANWAY:

Report to the owner/operator any incidences of corrosion, water, bad seals, debris, cracked concrete, or any other equipment integrity issues in or around the manway.

8. MAKE PROPER CONNECTIONS AND OPEN VALVES:

Verify the compartment containing the product to be delivered to the storage tank, checking and comparing product dials and the product tag/label on the tanker truck compartment with color code and tag/label on the fill cap or fill pipe. Make proper connections between the tanker truck and the storage tank to minimize the introduction of water into the product and comingling of product vapors. Diesel fuel storage tanks typically do not have a vapor recovery connection, but if the tank does have one, do not

connect the vapor return line to the diesel fuel storage tank. To ensure a vacuum is not created in the compartment being delivered, remove the dust cover from the vapor return line on the tanker. To minimize the potential for gasoline vapors escaping from other compartments while delivering diesel fuel, open the emergency valve and vent valve only for the diesel fuel compartment(s) to be delivered, and then open the API valve next. Product flow can be observed in the sight glasses on the delivery elbow and the API valve.

9. VERIFY THE COMPARTMENT IS EMPTY:

When the drop is complete, check the sight glass on the API valve or the retained product sensor to ensure the compartment is empty. Close the API valve and disconnect the delivery hose from the tanker. Then, lift the delivery hose at the API valve and roll it toward the storage tank to drain any product remaining in the delivery hose into the tank.

10. VERIFY THE VOLUME OF DIESEL FUEL DELIVERED TO THE STORAGE TANK:

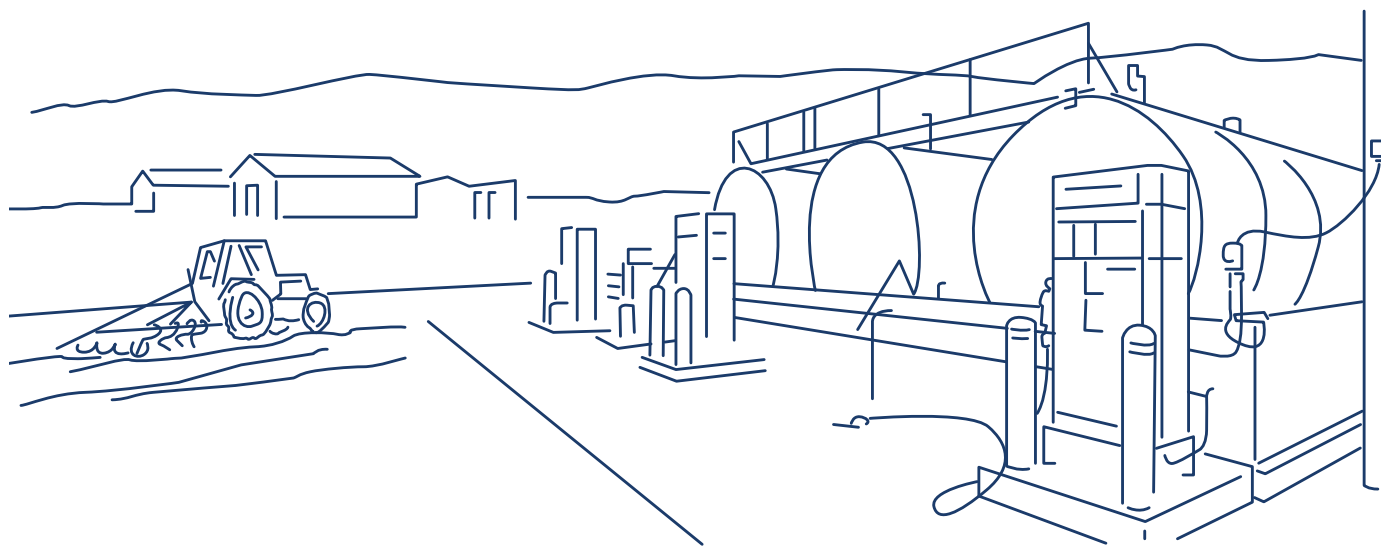
Finally, stick the storage tank and check the volume recorded on the ATG to confirm that the volume added to the storage tank matches the volume that was loaded into the compartment. If the volume added to the storage tank does not match (+/- 1%) the volume loaded into the compartment, residual product may remain in the compartment.

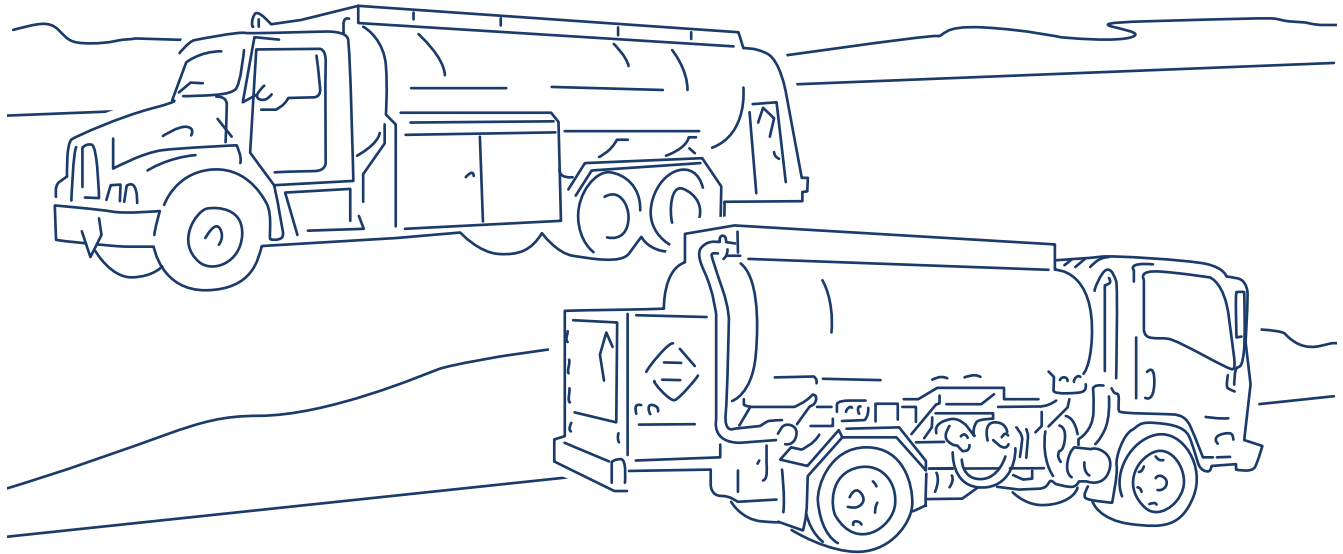
Other Issues to Consider

1. BULK PLANTS: In addition to delivering diesel fuel to a retail or commercial storage tank, tankers also deliver diesel fuel to bulk plants — storage facilities providing diesel fuel, heating oil, and other products to residential and rural retail and commercial storage tanks (such as rural areas or farms). Bulk plants can have underground storage tanks (USTs), aboveground storage tanks (ASTs), or both. Delivering diesel fuel into aboveground tanks at these locations is typically accomplished using the same pump at the bulk plant that is used to load a tank truck. Generally, the pumps are configured using a piping and valve configuration that allows the product to be pumped to or from the storage tank by adjusting the valves. The API valve and transfer hose are connected to product delivery couplers and

adapters designed to connect to the fill pipe of an AST. Tank identification uses similar color coding and tags or labels as for a retail or commercial storage tank.

Delivery to an AST storage tank at a bulk plant requires the diesel fuel to be pumped into the storage tank. If delivering to an AST, determine product level using the mechanical or electronic tank gauges. Water in an aboveground storage tank cannot be checked by the driver unless there is an electronic gauge with a water sensor. If a water level sensor is not available, check with the bulk plant operator to determine if water is present in the storage tank. Other procedures for the delivery of product to a retail or commercial storage tank would still apply.





2. TANK TRUCKS: Tank trucks are primarily used to deliver heating oil, kerosene, and diesel fuel (and sometimes gasoline) to smaller retail and commercial storage tanks (USTs or ASTs). Tank trucks are configured similar to tankers with 2,000- to 4,500-gallon tank capacity and multiple compartments. Tank trucks can be configured to bottom load or top load. In some cases, tank trucks will load at a terminal. These tank trucks are usually configured for bottom loading and would follow the same procedures as tankers loading at a terminal. For tank trucks equipped with top load, fuel is loaded through a compartment hatch on the top of the vehicle tank. When the hatch is open, the compartment can be visually inspected to ensure it is empty prior to loading. Loading procedures, however, are the same as for the tanker.

Unlike gravity fuel drops from a tanker, product deliveries from tank trucks are pumped and metered into the storage tank using a pump on the tank truck. If the delivery uses a tight fill connection at the storage tank, determine if the storage tank has an overfill device that is compatible with a pumped delivery. Vent line ball floats and, in many cases, drop tube flapper valves are incompatible with pumped deliveries. Because delivery hoses are greater than 50 feet and up to 200 feet in length and are connected directly to the meter, product will remain in the hose after a delivery. As a result, tank trucks typically have two pumps, meters, and delivery hoses. A jumper hose is used to connect the pump, meter, and hose to the appropriate tank compartment for delivery.



Conclusion

While fuel quality can be affected at any point along the distribution chain, the distributor plays a pivotal role in ensuring the integrity of the fuel from the terminal to the storage tank.

The introduction of water or the comingling of diesel fuel with other products such as gasoline can be a source of impacts to the quality of diesel fuel during the loading of a tanker or tank truck at a terminal and unloading to a storage tank.

Drivers must be aware of all the critical points during loading and unloading where diesel fuel can become contaminated and follow procedures to minimize or mitigate impacts to the fuel. This will ensure the delivery of quality fuel while minimizing the potential for effects to the operation of vehicles using the fuel and the liability of the fuel supplier, transporter, and retailer for potential damages.

About the Diesel Fuel Quality Council

The Diesel Fuel Quality Council is a non-advocacy organization comprised of a diverse range of stakeholders in the heavy-duty diesel industry. We got our start when in 2017, Mansfield Energy Corporation contacted the Fuels Institute to discuss a pervasive problem popping up amongst their customers. Many fleets were experiencing diesel engine problems and downtime presumably as a result of fuel quality. Perplexed as to why this was happening and looking for answers, Mansfield reached out to the Fuels Institute and asked us to start an industry-wide initiative to investigate the issue and see if we could come up with any mitigation strategies. Since then, we have been bringing stakeholders together to collaborate on research geared toward improving the relationship between diesel fuel quality and modern diesel engines. This report is the result of that initiative.

For more information on the Diesel Fuel Quality Council and a list of current members, please visit: fuelsinstitute.org/councils/fuel-quality-council

About the Fuels Institute

The Fuels Institute, founded by NACS in 2013, is a 501(c)(4) non-profit research-oriented think tank dedicated to evaluating the market issues related to vehicles and the fuels that power them. By bringing together diverse stakeholders of the transportation and fuels markets, the Institute helps to identify opportunities and challenges associated with new technologies and to facilitate industry coordination to help ensure that consumers derive the greatest benefit.

The Fuels Institute commissions and publishes comprehensive, fact-based research projects that address the interests of the affected stakeholders. Such publications will help to inform both business owners considering long-term investment decisions and policymakers considering legislation and regulations affecting the market. Research is independent and unbiased, designed to answer questions, not advocate a specific outcome. Participants in the Fuels Institute are dedicated to promoting facts and providing decision makers with the most credible information possible so that the market can deliver the best in vehicle and fueling options to the consumer.

For more about the Fuels Institute, visit fuelsinstitute.org.

FUELS INSTITUTE STAFF

John Eichberger
Executive Director
jeichberger@fuelsinstitute.org

Amanda Appelbaum
Director, Research
aappelbaum@fuelsinstitute.org

Jeff Hove
Vice President
jhove@fuelsinstitute.org

Donovan Woods
Director, Marketing and Communications
dwoods@fuelsinstitute.org

For a list of current Fuels Institute Board members and financial supporters, please visit fuelsinstitute.org.

Fuels Institute

OBJECTIVE • COLLABORATIVE • RESEARCH

(703) 518-7970
FUELSINSTITUTE.ORG
@FUELSINSTITUTE

1600 DUKE STREET
SUITE 700
ALEXANDRIA, VA 22314