How to Design the Best Loading-Arm System for LPG Applications

ALL LPG TERMINALS ARE UNIQUE IN THEIR DESIGN AND LAYOUT, AND OPW ENGINEERED SYSTEMS CAN MEET THE VARIETY OF DEMANDS THROUGH ITS FULL PORTFOLIO OF LOADING-ARM SYSTEMS AND COMPONENTS

By David Morrow

Introduction

It wasn't too terribly long ago – April of 2011, to be exact – that, according to the U.S. Energy Information Administration, a "mere" 2.33 million barrels of liquefied petroleum gas (LPG), commonly known as propane, was being transported monthly in the United States via railroad. By January 2020, 10.17 million barrels of propane were transported in railcars. While the COVID-19 pandemic undoubtedly played a role in that number dropping to less than 6 million barrels mid-year, monthly propane shipments did rebound to 7.73 million barrels by 2020's end, which was higher than at any point from January 2010 to February 2016.

All of this means that there is always, particularly in recent years, a large amount of LPG on the move in the U.S. The question is, why are railcars such a popular form of transportation for LPG in bulk quantities, especially from the oilfield to storage terminals? The most basic answer has much to do with physics: in its gaseous form, LPG has a volume that is 270 times that of its liquid state, making it much more efficient to transport it in its more compact liquid form.

That's where railcars come in. These transport vessels – which must be pressurized in order to keep the LPG in a liquefied state – generally have a capacity of between 17,000 and 33,500 gallons (65,000 to 127,000 liters), which allows them to hold about 143,000 pounds (65 metric tons) of LPG. That means that a unit train with 100 high-capacity LPG-dedicated railcars can move 3.35 million gallons of product in one run.

The challenge in getting these high volumes of LPG safely to and unloaded at the storage terminal is ensuring that pressure is not lost in the railcar, from the point at which it is filled to the point at which it is unloaded. If pressure is lost, the LPG will begin to expand back to its gaseous state, which could result in an explosion.

For the operators of LPG storage terminals, this demands that they employ a loading-arm system that is compatible with the unique and stringent needs of LPG handling and transfer. This white paper will illustrate the best ways to design, outfit and operate the loading-arm system at an LPG terminal with ensuring a reliably safe and efficient operation the ultimate goal.

The Challenge

The most basic thing to acknowledge when designing a loading-arm system for an LPG terminal is that no two are the same, with every site being unique in its operational design and setup. Therefore, the terminals that are truly able to achieve and maintain elevated levels of efficiency, reliability, safety and ergonomic operation are those that take all of the site's specific needs into consideration when determining the best loading-arm system to install.

There are a few foundational items to consider before designing the loading-arm system. First, the overall number of loading/unloading positions must be determined. After that, the system designer must choose the best spot for the risers. When several loading arms will be used, all of the risers must be located so that they do not interfere with the operation of the arms. The arms must also be positioned so that they can be maneuvered around any possible obstructions, as well as fit under a roof or canopy in a covered setup.

Since LPG is transported in pressurized railcars, it must be unloaded through the top of the railcar via a manway that is outfitted with hard connection points. To develop the best loading-arm system design for the singular needs of the terminal facility, it is best to work backward from these connection points based on conversations you should have with the terminal operator and staff.

Over the years, driven by the preferences of many LPG terminal operators to increase throughput rates, the manufacturers of pressure railcars have begun building their equipment with three angle valves located on the manway. Two of these angle valves attach to loading-arm product lines that facilitate the unloading process – based on the simple fact that you can unload a railcar twice as fast with twice as many lines – while the third valve is used to connect with a vapor-recovery/vent hose that helps pressurize the railcar during unloading.

The connection from the end of the loading-arm hose to the angle valves is made through what is known as a "stabber pipe." Using Teflon® tape, the stabber pipe is threaded to the end of the angle valve and tightened manually with a pipe wrench. The challenge here is ensuring that the stabber pipe is attached correctly; if it isn't, the integrity of the connection may be compromised, which increases the chances that a product leak will occur. Also, the link between the loading arm and stabber pipe is typically completed through a quick hammer-union connection, but there is a growing trend toward the use of a dry-disconnect coupler in this area. The use of dry disconnects creates a "closed-loop" system that can help reduce the amount of LPG that is retained in or may leak from the hose when the loading arm is disconnected from the stabber pipe.

Top Considerations for LPG Loading-Arm System Design

1. **Define number of loading/unloading positions**
2. **Choose best spot for the risers to avoid possible obstructions**
3. **LPG must be unloaded through top of railcar via a manway**
4. **Work backward from connection points based on input from terminal staff**

The next consideration is whether or not any type of ancillary valving will be used. Typically, an emergency shutoff valve (ESV) will be designed into the system. This makes sense when dealing with LPG since you will need a way to shut off product flow in the case of an accident or broken valve. The simple reason for this is that when you're dealing with a potentially hazardous situation, you don't want a technician to be responsible for shutting off the product flow. There are areas of the country where LPG terminal operators do not to use ESVs, mainly based on the local regulatory requirements; again, asking the operator will let you know if they need to be part of the design.

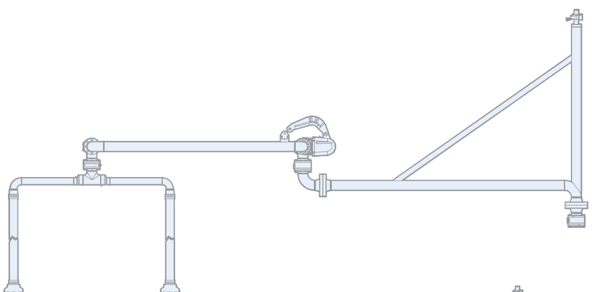
Another ancillary component to ask about is the safety breakaway. This piece of equipment is designed to separate the loading hose from the railcar in the case of an accident or a pull-away incident, which instantly halts the flow of the LPG. Again, this is a safety feature that many terminal operators choose to use, but others do not. In the end, all of these valving choices come down to the preferences of the site operator, as well as any local or state regulations and any site-specific design requirements.

Another challenge for the loading-arm system designer is the actual position of the angle valves in the manway on the top of the railcar. The one or two product valves are always plumbed in a position that is parallel with the length of the car. On the other hand, the vapor-recovery valve is situated in a perpendicular position, meaning it faces away from the center of the railcar. This makes the position of the railcar critical as it arrives at the loading rack. Sometimes the vapor valve may be positioned facing away from the loading platform or gangway; this means that an extra five feet of hose should be designed into the system so that failure-causing strain isn't put on the hose since it has to reach farther, and at an awkward angle, in order to reach the vapor valve. Not acknowledging this situation is a common design mistake, and one that must be considered if a proper loading-arm setup is to be achieved.

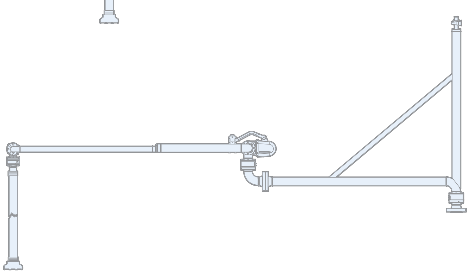
So, with the average LPG terminal having 12 to 14 unloading positions, and each position featuring three loading arms, there is a lot to consider when determining the best loading-arm system to design and deploy. In the end, though, all loading arms do essentially the same thing, it's up to the terminal operator to decide how it needs to be done, and to identify and work closely with a knowledgeable, reputable designer and manufacturer of loading-arm systems in order to create the best solution.

The Solution

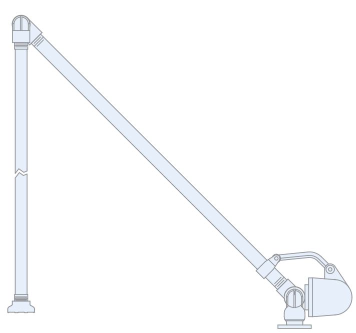
For more than 125 years, OPW has been defining what's next in the transport and safe handling of high-value fluids around the world, and OPW Engineered Systems is a leader in the design, engineering, manufacturing and servicing of loading-arm equipment and systems. In the realm of the LPG terminal, and depending on the needs of the operator, OPW recommends three types of top-loading arms:



- **"Bull Horn" Loading Arm:** This configuration features a single arm that divides into dual connections that can be attached to a pair of product lines, giving the loading arm setup a "U" shape reminiscent of a bull's horns. This is probably the most common terminal setup since it allows the combination of two product connections into a single arm, which reduces the overall number of arms that are required.



- **Single-Line Boom Arm:** These can be supported or unsupported and feature a single product hose for those applications that do not require dual-unloading capabilities. Available in 2-to 6-inch sizes, these arms are designed for use in variable-reach applications, specifically those with longer reach requirements that may put undo strain on other loading-arm styles.



- **"A" Frame Loader:** This style of loading arm is a popular choice because of its flexibility, long reach and easy maneuverability. Its design allows it to be stored in an upright, near-vertical position away from the railcar for safe clearance, while crossover of any obstructions can be readily achieved, which makes it ideal for rack setups that feature dual unloading lines. During the unloading process, it adjusts to the railcar's elevation or tilt so that a tight connection can be made to the valves in all instances. The arms are available with 2- to 4-inch hoses with the frame constructed of carbon steel, stainless steel or aluminum.

LPG Loading-Arm Equipment to Consider

Stabber Pipe	Emergency Shutoff Valve	Safety Breakaway	Product Loading Arms	Safety Breakaway
Connection from the end of the loading-arm hose to railcar angle valve	Allows shut off of product flow in the case of an accident	Designed to separate the loading hose from the railcar in the case of an accident or a pull-away incident	Two loading arm product lines are connected to angle valves in manway	Designed to separate the loading hose from the railcar in the case of an accident or a pull-away incident

As a designer, engineer and manufacturer of complete loading-arm systems, OPW also supplies all of the ancillary components that the operator may desire.

For the connection point between railcar and angle valve, OPW offers a variety of stabber-pipe options that can be selected based on the needs of the individual application. Though OPW does not make ESVs, it has the capability to supply the "Snappy Joe" ESV (Model No. N562) from Fisher Control Valves as part of its overall loading-arm package. The Snappy Joe ESV is an air-operated valve that is designed to close immediately when air pressure is lost. In addition, the valve has a fusible link that automatically shuts the valve in the event of a fire.

In the safety breakaway arena, OPW has direct-pull and cable-release coupling models, both of which are designed to separate in the event of an unintended railcar pull-away incident that could lead to an LPG release. When separated, the safety breakaway's non-return valve positively shuts down both ends of the connection for unbeatable protection for the equipment, site personnel, surrounding communities and the environment.

Finally, OPW offers ground-verification monitors from Civacon, another OPW company. These monitors do not allow LPG transfer to commence if a proper ground is not achieved, or if grounding is lost during the transfer process.

OPW's ultimate goal for its LPG-terminal customers is to compile enough from-the-field operational information to create a digital menu-based program that will aid in the creation of the perfect loading-arm system for the specific site. This menu will contain dropdown options where the user will be able to select such things as type of loading arms, what kind of couplings are being used, whether or not ESVs and safety breakaways are being used and, if so, which type are preferred, and a list of other ancillary components that can be added to the system. This menu-driven approach can also help ensure that every piece of the loading-arm system will fit and operate together seamlessly, which is critical to improving safety, reliability and efficiency.

5 Reasons to Choose OPW Loading-Arm Solutions

1. **OPW's 125+-year commitment to protecting people and the environment while enhancing business performance**
2. **Local factory support combined with 100-plus years of field experience that ensures the best outcome**
3. **In-house machining, welding, X-ray, assembly, testing and packaging with all components "Made in the USA"**
4. **The "OPW Promise" that guarantees the job is not completed until all expectations are met**
5. **Streamlined part selection that reduces ordering, delivery and installation time, along with maintenance, repair and inventory costs**

Conclusion

It appears likely that the production, transport, storage and use of LPG will continue to be a lynchpin in the U.S. economy for the foreseeable future. Therefore, it remains imperative that the terminals that receive LPG via rail must be outfitted with loading systems that can ensure its safe, reliable and efficient transfer from railcar to storage vessel. OPW aids in this process by developing and supplying loading-arm systems and components that have been engineered and designed to satisfy the needs of every unique LPG-terminal installation.

About the Author:

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