Flaring Propane 101 *Ver. 1.04*

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The flaring or burning of propane through a flare stack is done for multiple reasons. When the propane industry needs to service a tank or move it they typically transfer the liquid to another tank to salvage the product and then burn off the remaining pressure. Responders on the other hand typically use flares to reduce a tanks volume or internal pressure due to some type of physical damage, a leak that can't be stopped or because the tank's been overfilled.

Figure 1 - 1" flare burning liquid

The bulk of the incidents that we respond to range from small cylinders to residential tanks (500 and 1000 gallon) and a small flare *may* be all you need given the tanks volume and flow capabilities. There are a couple of caveats: first, if the tanks been overfilled the faster you can gain vapor space the better (liquid removal). Or depending on the type of incident, you may need to force auto-refrigeration quickly to reduce internal pressure (vapor removal). Either way, *time and temperature are your enemy*. In these cases, the size of your flare matters a lot. The flares capacity needs to match or exceed the systems flow capacity. The quicker you can evacuate product the better. The goal is to complete the task at hand safely and as quickly as possible.

When you think about flares ask yourself this, can you have too much capacity? *The answer is NO!* Can you have more than you normally need? *That answer is YES*, and you should.

It doesn't matter what size the tank is, your flaring operation will always be limited to the capacity of the piping and appliances installed. For example, connecting a 1" flare to a 20-pound cylinder will not flow any more than the capacity of the valves and fittings installed. 29 CFR 1926.153 - Liquefied Petroleum Gas states – "Systems utilizing containers having a water capacity greater than 2 ½ pounds shall be equipped with excess flow valves".

So, what is an "Excess Flow Valve"? Excess flow valves or EFV's are in-line devices designed to reduce the flow of product when extreme flow rates occur. An example would be when a system valve is opened too fast or when damage to the system occurs and allows more flow than the EFV is rated for.

Figure 2-Excess Flow Valves

Once product flow exceeds a valves' rated capacity the valve shuts or seats reducing the flow down to the bleed orifice drilled into the valves disk or other designed bleed. If the downstream system is sealed and the pressure is allowed to equalize the excess flow valve will reopen. Bulk storage tanks and transport vehicles are required to have either internal valve with the excess flow as part of its assembly and an excess flow valve installed in any opening ¾ of an inch or larger.

As you can see in figure 3, flow rates are relative to pipe size and excess flow style (via part #). The rate of flow or gpm through an excess flow can be compared to water and a fire engine, you can't pump more than you can get into the pump. Using small capacity equipment when you need to move a large volume of propane would be comparable to connecting a 2 ½" to a hydrant and trying to feed a 1000 gpm master stream.

Inlet Connection MNPT	Outlet Connection FNPT	Approx Closing Flow Liquid GPM Propane	Part Number
3/4"	3/4"	4	12472
		10	3272E
		15	3272F
		20	3272G
1 1/4"	1 1/4"	30	3282A
		40	3282B
		50	3282C
1 1/2"	1 1/2"	90	7574
2"	2"	75	3292A
		100	3292B
		122	A3292C

Figure 3

In most cases, it's difficult or impossible to distinguish between an excess flow and a check valve without verifying the manufacturer's item number or specific knowledge of the installation. Both have very different jobs. While an excess flow valve allows product flow in both directions, a check valve only allows flow in one direction. If a flare is connected to a system and limited or no pressure is accessible the line could have a check valve installed instead of an excess flow valve.

If your flare has the capacity to flow more volume than the tanks excess flow valve is capable of, you will need to adjust the flow rate down to reach the maximum propane transfer just prior to the excess flow valve activating. To accomplish this, you may need to play with the system for a minute to find the sweet spot. Light the flares pilot burner, slowly open the systems valve until the excess flow slams. Identify the valve position and shut the valve. Once the excess flow valves disk opens back up (you should hear a click) make sure your pilot flame is burning and open the system valve just short of slamming the excess flow again.

Since October 1st 1998 all new DOT cylinders (4 to 40 pound) have been required to have an Overfill Protection Device (OPD) installed. The OPD is designed to stop product flow into the cylinder during the filling process in excess of the maximum permitted filling limit or 80% of the tanks capacity. Along with this change came the Federal regulation requiring that propane tanks with an OPD's must be re-certified 12 years from the date of manufacture stamped on the tank. Tanks that have been re-certified must then be re-certified every 5 years. This standard has changed to exclude horizontal tanks. This new style cylinder valve will have either a CGA (Compressed Gas Association) 791 (ACME threads) or a CGA 810 (push-pull, quick disconnect) connection device.

Figure 3 OPD

In addition to the 80% fill limiter, OPD valves contain a Discharge Check Valve. It's purpose is to prevent discharge from the cylinder unless there is a POL (Prest-O-Lite) or QCC type-1 fitting connected to the valve. When the connector is properly threaded onto the OPD valve it pushes open the Discharge Check Valve and allows propane to flow through the connector and to the attached appliance.

Figure 4-Discharge Check Valve

Currently OPD valves with the QCC (Quick Closing Coupling) Type-1 connector are still capable of receiving a male POL, this could change someday. But, for now if you need to flare a larger quantity of propane than the QCC Type-1 is capable of, you may be able to use a full flow POL (Figure 6, left hand thread).

Figure 5-Internal POL Threads

Figure 6-Full Flow POL Connector

NOTE: Understand, that in doing so removes the excess flow (safety) from the system.

Figure 7-Type 1 Connectors

Due to the flow requirements of different appliances, Type-1 connectors are available in three flow volumes. The connectors are color coded to indicate flow capacities. **BLACK** connectors flow enough propane to produce up to 100,000 BTU per hour or BTUH, **GREEN** to 200,000 BTUH and **RED** to 400,000 BTUH. To accomplish this the connector incorporates an excess flow as an integral part of the connector (Figure 8-Excess Flow, ball and spring). This excess flow operates like any other, if the flow rate exceeds the rated capacity it shuts down and limits the amount of propane down stream.

Figure 8-Excess Flow

So, if flows are determined by the systems excess flow valves capacity, the question is why would you want or need a flare large enough to exceed the system's full flow capacity? That's easy, volume. Not all incidents will have the same flow restrictions. For example, the flow capacity of a 20-lb. cylinder would not require a high capacity flare. A lower volume flare would be sufficient for operations where the rate of evacuation is not an issue such as burning off a tank for service work. But incidents involving systems with a larger tank openings will need a flare with a higher flow capacity to alleviate the hazard quickly.

Most departments have only a few tactical options available to them when they arrive on scene.

1) Identify the need for and contact additional resources.
2) Evacuate the immediate hazard area.
3) While continually monitoring downgrade and downwind for any signs of dangerous levels of propane vapor. Manage product vapors by dispersing them with a fog stream. Maintain the process until the tank vents itself completely, or at least down to a safe pressure to start dealing with the problem.
4) Under the protection of a fog stream gain access to the appropriate valving. Shut off the valve if possible and remove any nearby ignition sources that can be done safely.
Do 1 – 4 if possible and wait until additional help arrives.
6) If it's discovered that the leak cannot be stopped and you cannot accomplish 3 & 4, evacuate to a safe area and monitor downgrade and downwind.

Figure 9-Cadiz IN LP Incident 2008

This photo was taken during one such event. The dome of an underground storage tank was struck by a vehicle and the relief valve was broken off. The local VFD was dispatched and once on scene they requested the local HazMat team. HazMat arrived on scene and requested that downwind and downgrade be evacuated, air monitoring was set up and the local propane company contacted. Once the propane supplier arrived their flare was set up to start burning off tank pressure and aid in forcing auto-refrigeration. A wooden plug was driven into the remaining relief valve stem to slow the leak. After the tanks pressure had dropped to a safe level due to flaring and auto-refrigeration, the plug was removed and repairs were made. The total operation took about 9 hours.

Another option could have been to have the propane supplier set up a recovery tank and connect to the liquid withdrawal of the below ground tank to the fill opening of the recovery tank. Next set up a flare on the recovery tank and start flaring. This would reduce the pressure in the recovery tank would allow the below ground tank to push most of the liquid out and into the recovery tank (pressure differential transfer). The advantage would be that most of the propane in the below ground would be evacuated without causing auto-refrigeration considerably decreasing on scene time.

Let's look at another call. It's 08:30 hrs. and 65 degrees outside. The tones go off and you're dispatched to a 10,000-gallon bulk storage tank that had been overfilled the night before. It's now intermittently releasing liquid from the relief valve. You arrive on scene and realize you'll need to move a lot of product ASAP. To reduce the tanks volume down to where it should be (80%) you would need to remove 2000 gallons of propane. The sun's rising and it's expected to be 95 degrees by 13:00 hrs. You make the connections and open the appropriate valves, light your flare and wait. Can you flow enough to keep ahead of the expanding product? Maybe, hopefully, no matter the size of your flare, you must start applying cooling streams to the tank. An incident such as this would be a candidate for flares connected to both the liquid and a vapor operating up wind, uphill and at a safe distance. If you cannot keep ahead of the expanding propane a hydrostatic rupture is a possibility. *Again, time and temperature are not your friend….*

How do you know if the equipment you're using is flowing all the system is capable of? If you can fully open the valve on a tank and the flare and not slam the excess flow, your system is probably not big enough. What you need is a flare that will allow you to remove as much product as possible, as quickly as possible. Flares range in size from small ½"pipe, flares that utilize industry standard 1" transfer hose, large trailered flares (Figure 10) and fixed facility installations. No matter what system you use, you'll always be balancing the systems flow capability against the flares flow capacity.

Figure 10-Purgit Air Assisted Flare

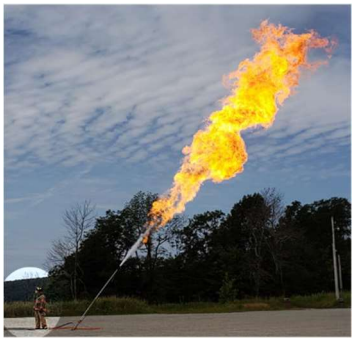
Flaring Vapor vs Liquid

When faced with a propane emergency one of your first questions must be, do I need to create vapor space by flaring liquid, or do I need reduced vapor pressure by forcing auto-refrigeration? What's the real hazard? Has the tank been overfilled and you need vapor space to stop a hydrostatic rupture? Or do you need to reduce vapor pressure so that a broken fitting can be changed out?

Utilizing a flare to reduce a tanks volume or internal pressure in cooperation with other tactical options should always be a consideration.

Your best tactic might be two flares: one connected to liquid to start gaining vapor space and a second to reduce vapor pressure forcing auto refrigeration and reducing internal pressure.

Liquid: Releasing liquid reduces a tanks volume much quicker than burning vapor allowing you to gain valuable vapor space. Propane dealers normally don't flare liquid, propane is money and when servicing equipment is the goal, there is little to no reason to waste product. Liquid is normally pumped out and a flare is set up to remove residual vapor pressure. Flaring liquid can and usually does pose a problem. When flaring liquid propane, the flare stack will normally be coated in ice that accumulates do to the expanding liquid (auto-refrigeration) and moisture in the air. As the system pressure drops, liquid propane will adhere to the lip of the burner, run down the flare stack and burn part if not all the way to the ground. The main burner of some flares are constructed from steel pipe and are not susceptible to flame damage as a result of run down like rubber hose. A flare that tilts will allow liquid droplets to be directed towards a safer area. When flaring liquid, responders have an option that the propane industry doesn't, we usually have access to a fire engine. Dealing with small ground fires due to run down may just be the cost of quickly managing the propane incident. Normally when responders are called it's because of an



emergency that most likely needs resolved or at least the bulk of the hazard alleviated as quickly as possible. When a tank has been over filled flaring liquid will gain vapor space much faster than burning vapor.

Vapor: But, if the incident requires you to reduce internal pressure as quickly as possible, flaring vapor will most likely be your best option. The benefit of this tactic will be lowering of the internal pressure to a level where it may be safe to repair a leak as explained above without completely emptying a tank. As you can see in Table 1 the lower the propane temperature the lower the vapor pressure. When vapor is released from a tank the propane boils causing auto-refrigeration that results in a pressure drop. Reducing vapor pressure causes the propane to boil reducing the tanks internal pressure quicker than flaring liquid. In some instances, depending on the volume of propane in the tank and your flares capacity it may take a while for the flaring operation to produce the needed result. If you intend to completely evacuate the tank start with liquid if possible.

Temperature	Approximate Pressure (psi)
-10	16
0	23
10	31
20	40
30	51
40	63
50	77
60	95
70	109
80	128
90	149
100	172
110	197
120	225
130	257

Table 1

Operating at a small flares' capacity is easy, you can open the valves completely and probably not activate the excess flow valve. But what happens when you respond to a bobtail, tanker or bulk storage tank that has pipe and fittings that have the capacity to flow larger volumes but your flare can't? This is where size really matters.

Flaring is a tactical option that all hazardous material teams should have in their tool box, the same could be said for fire departments that have been trained in this tactic. When the emergency requires a large capacity flaring system (1 inch or larger), time is usually not on your side. You may not have the time to wait on the County, District or State to bring you one.

Most if not all HazMat teams carry a "C" kit for the possibility of a leaking Chlorine container. But how many carry a flare for propane incidents capable of a full 1" flow (see Figure 2-1)? If you think about it, when was the last time you were on a chlorine release verses a propane incident. Propane trucks travel our roads every day. Homes, business and industry have bulk storage tanks that provide heat or manufacturing support. Each and every propane container has the potential to leak, are you ready?

When it comes to flaring capabilities

"It's better to have and not need, than to need and not have!"

> Fire fighters respond to propane incidents in the United States nearly once per day on the average. According to the National Fire Incident Reporting System (the data base of the U.S. Fire Administration), the number of propane incidents on an annual basis was 301 in 2005 and 317 in 2006; as all states do not require participation in this data base, the actual number of propane incidents responded to by fire departments may be higher. Unfortunately, firefighters and emergency responders have died responding to propane incidents. Many of these incidents occurred in rural locations. There are about 17.5 million propane installations in the United States (credit www.aristatek.com/Newsletter/JAN09/TechSpeak.pdf).

This document is not intended to teach all facets of dealing with a propane emergency, quality instruction and practical exercises must be included with every fire fighters regular training.

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