Scope:

This document provides the necessary recommendations that allow recognized Technical Services to perform periodic requalification of Chart HLNG vehicle tanks according to the requirements of UNECE Regulation No. 110.

General information:

1.1. Inspection intervals

Each tank shall be visually inspected at least every 120 months after its entry into service on the vehicle, and at the time of any reinstallation. The inspection date is listed on the tanks data plate which is welded onto the tank shroud.

1.2. Conditions that require an immediate inspection

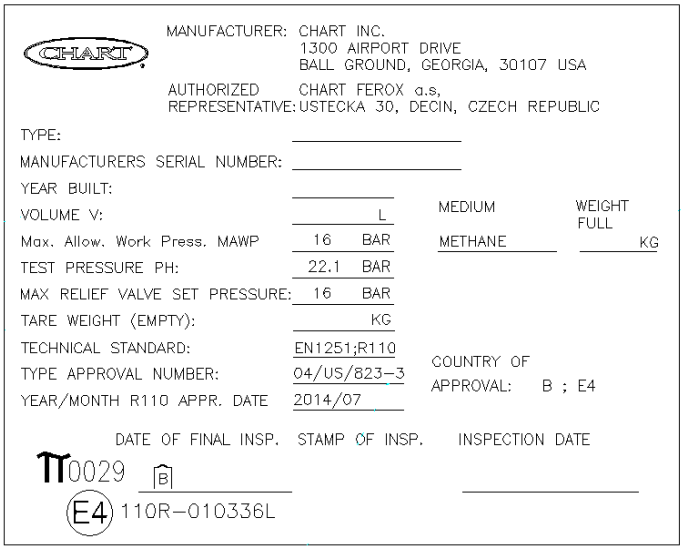
Tanks involved in fires and/ or collisions shall be immediately inspected before putting them back in service. If the tanks involved in collisions have not suffered any apparent visual damage, they may be put back in service. Reference Chart VT-006 damage criteria for inspection requirements.

Marking:

1.3. ECE R110 LNG tank data plate

An example of Chart's ECE R110 tanks data plate can be seen below:

This procedure is intended for use by trained technicians with experience on systems using LNG. Review all applicable safety documents before beginning this procedure.



1.4. Inspection Mark

Before returning the tank to service, the Technical Service's inspector shall put an inspection mark on the tank showing that it passed. A tag, label or other permanent marking shall be used, as long as it specifies the responsible Technical Service and the new due inspection date.

Inspection process:

1.5. Inspection of the fuel system

1.5.1. Visual inspection

The vehicle fuel system shall be visually inspected as follows:

- Check tank data plate and ensure that it is easily accessible and legible and that there are no signs of tampering.
- Check that the fuel system contains at least the following R110 approved components:
    - LNG tank(s);
    - LNG heat exchanger;

This procedure is intended for use by trained technicians with experience on systems using LNG. Review all applicable safety documents before beginning this procedure.

- LNG primary and secondary pressure relief valves;
- LNG vent receptacle;
- LNG fill receptacle;
- LNG excess flow valve (excess flow limiting device);
- LNG liquid and vent manual shutoff valves;
- LNG automatic fuel shut off valve;
- LNG fill check valve;
- LNG fuel level sender/ indicator.

Any modification to the original pressure relief system or to the manual shutoff valves fixation to the tank, shall not be accepted. The specific criteria has to be that of Chart's VT-0005.

- Inspect the outer tank for damage according to Chart's VT-0006.
- Inspect the pump-out port or cap for signs of damage or tampering. Half round cap must be intact and secured to the tank.
- Inspect the primary relief valve pipe away tubing, looking for signs of cracked, pinched or kinked tubing. Check the orientation and cleanliness of the low point moisture drain hole in the primary relief valve pipe away tubing. Reference VT-0020.
- Inspect the presence of the red cap on the secondary relief valve. If the red cap would be missing, an inspection of the primary relief valve as per Chart's VT-0035.
- Check the fill receptacle for secure mounting. Check for presence of dust cap and security cable.
- Check the heat exchanger mounting system for security and signs of looseness.

1.5.2. Vacuum Test

Perform a vacuum test as per Chart's VT-0019-003.

1.5.3. Leak Test

- Confirm that the tank(s) pressure is equal or greater than 3 barg.
- Remove the tank's shroud door.
- Start the vehicle's engine and let it idle for at least 30 seconds so that the plumbing gets pressurized. Turn the engine off. Ensure that plumbing lines and components are de-frosted in order to allow for proper visual inspection.
- Using snoop leak tester or a similar leak detection fluid, apply in all plumbing connections. The test will be deemed as passed if no bubble formation is immediately detectable.

Decommissioning of LNG vehicle fuel systems:

In case decommissioning/ scrapping of an LNG vehicle tank is necessary, follow the procedure in VT-0012.

Examples of the relevant bulletins are shown on the following pages.

	VT-0005	000	11/17	BBK
CHART®	Relief Valve Identification for R110 Tanks			

Purpose

This document will provide key information to help identify the correct model, design and part number of the primary and secondary relief valves and system parts for R110 tanks. The parts identified are only those provided on a new Chart LNG vehicle tank that was originally designed under R110 certification.

Overview

Many different companies manufacture relief valves, and many varying models and sizes exist. Chart LNG vehicle fuel tanks utilize two main relief devices. A primary relief valve and its pipe away components, and a secondary relief valve and its protective cap. Tanks covered by this bulletin are certified and tested to meet the standards outlined under R110 regulations. Therefore it is imperative that the relief valves and parts used in the original manufacture of, and aftermarket repairs/service, are of the original specification and meet the R110 specifications for the tank. Use the following steps to help identify if the correct relief valves are present on the tank.

Identification

The primary relief valve used on R110 tanks appears to be the same relief valve as is used on many other cryogenic tanks, however the specifications are unique to the tank and cannot be altered, substituted or eliminated.

Part Numbers

Primary Relief Valve 16BAR Chart Part Number 20537940
Secondary Relief Valve 24BAR Chart Part Number 13907496

Both parts should be purchased through Chart Parts
http://www.chartparts.com/

Examples of each relief valve are shown on the following pages.

This procedure is intended for use by trained technicians with experience on systems using LNG. Review all applicable safety documents before beginning this procedure.

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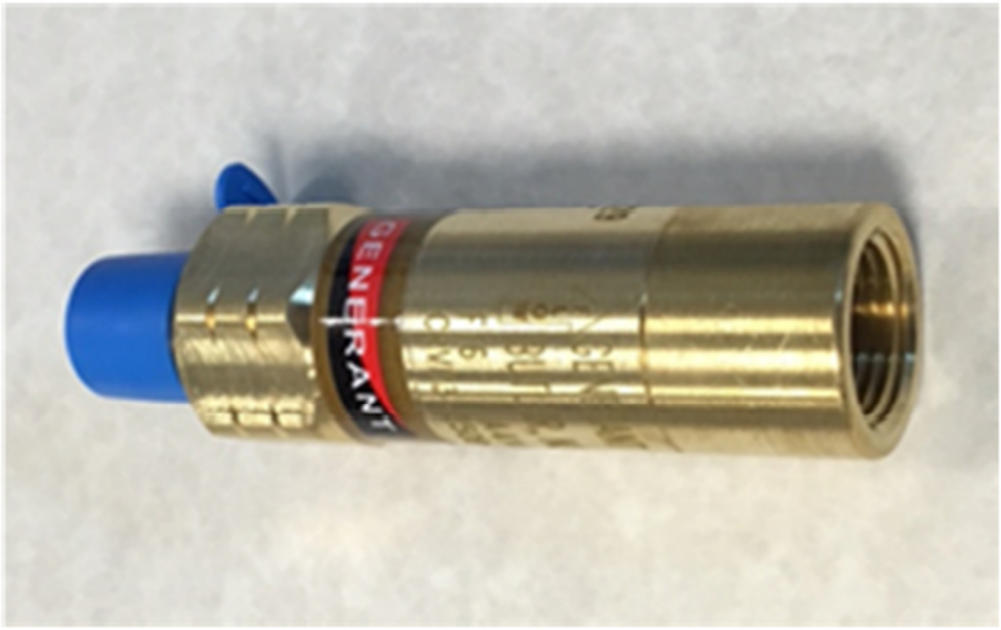
CHART®	VT-0005	000	11/17	BBK
	Relief Valve Identification for R110 Tanks			

Primary relief valve 16 BAR Chart Part number 20537940
Has hash marks on wrench flats. Also has pipe away adapter to accept pipe away elbow and tubing.



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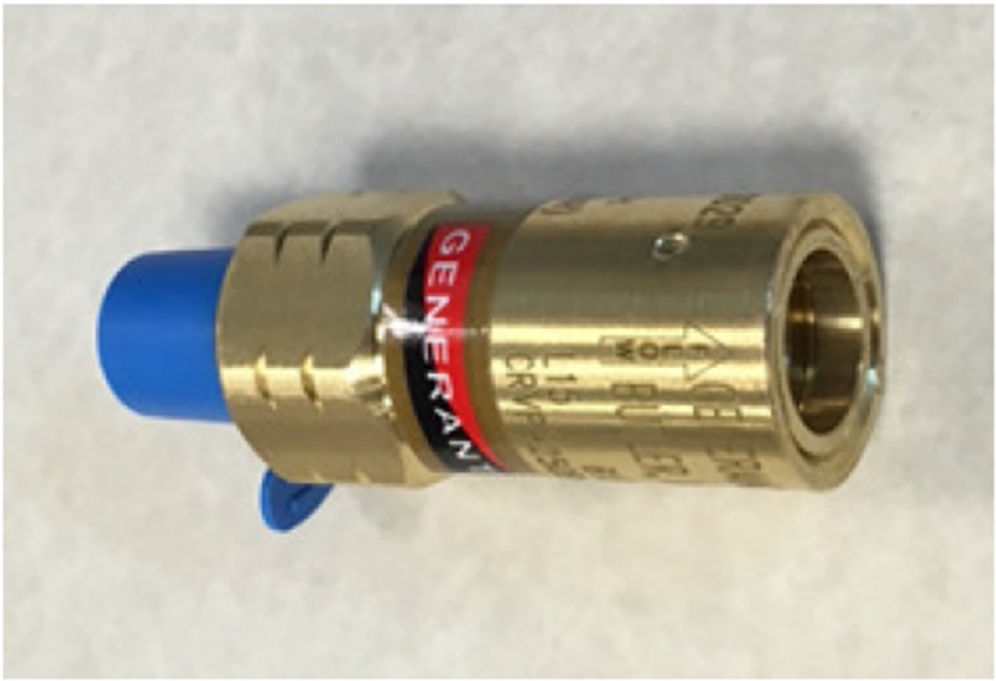
	VT-0005	000	11/17	BBK
CHART®	Relief Valve Identification for R110 Tanks			

Secondary relief valve 24 BAR Chart part number 13907496
Has hash marks in wrench flats. Does not have a pipe away adapter. Also has insert in the end to cover the threads, so it cannot be piped away.



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	VT-0006R110	000	07/17	BBK
CHART®	Damage Identification on Chart LNG Vehicle Tanks			

Purpose: This document is being provided to help identify standards related to accident damage found on Chart LNG vehicle tanks. Damage can occur in many forms and many different areas of the tank. Therefore the tank must be thoroughly inspected to ensure any unsafe conditions do not exist. This document covers damage to the tank structure only, any damages to the mounting brackets or hardware should be referred to the vehicle manufacturer or system installer for their recommendations regarding acceptable damage.

Tools or supplies needed:
Creeper
Flashlight
Straightedge ruler
Tape measure
Digital camera

Overview: Chart LNG vehicle tanks are robust and durable, however occasionally a tank may become damaged and require an inspection to determine its future disposition. The photos below will help identify different types of damage and whether or not the damage falls within one of three categories.

The three damage categories are:

Level I damage: An inspection was performed. No further action is necessary, return the tank to service.

Level II damage: An inspection was performed. Action is necessary; the tank has damage that will require it to be repaired before returning it to service.

Level III damage: An inspection was performed. Action is necessary. The tank is not able to be repaired, and will need to be removed from service and scrapped per Chart recommendations.

Tank visual Inspection: Tank visual inspections may be required if the vehicle is involved in an accident or fire. An inspection may also be required as regulatory or interval requirements dictate. Any damage found should be noted as a follow up item and thoroughly inspected to determine the severity and the category the damage may fall into.

The damage inspection will require the tank to be clean so that an accurate visual inspection can be performed. If necessary, the tank can be pressure washed prior to performing the inspection to remove any mud, dirt or grime. When pressure washing, care must be taken to ensure the plumbing components are not directly impacted by hot water (above 65C) or high pressure. Doing so could damage the sealant/seals and some of the electrical components.

The visual inspection will most likely require the technician to use a creeper and flash light in order to view the entire length and circumference of the tank. The inspection should include the front and rear heads of the tank, the shroud, all of the welds. Additionally the shroud and any components mounted to the shroud should be inspected, as well as the shroud (plumbing) cover and all of the plumbing and electrical components inside the

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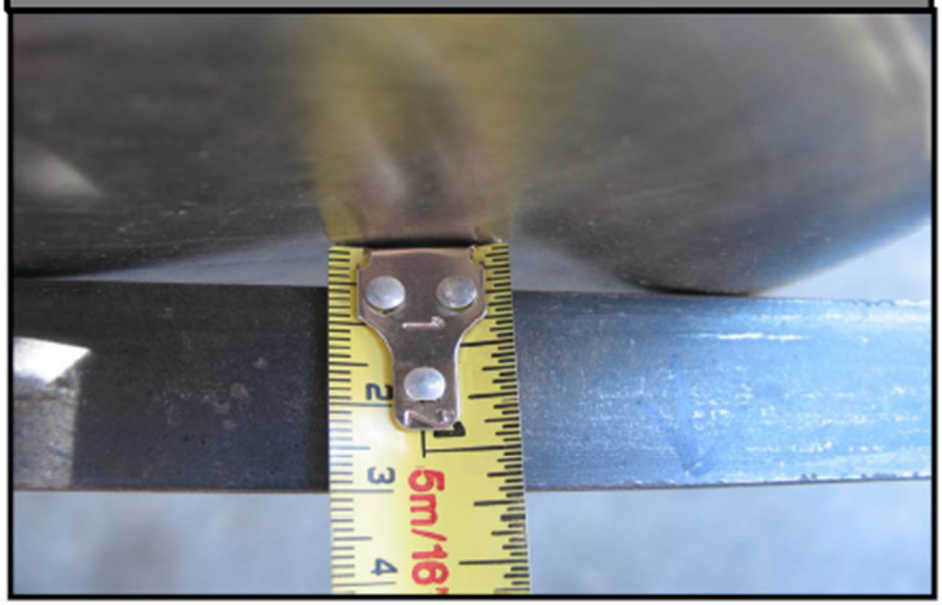
shroud. Any damage found should be noted and then referred to the severity determination below. If at any time questions exist as to the level of the damage found please take digital photos and send them to a Chart technical service advisor for further consultation.

Damage severity Determination

Level I damage: Category I damage is defined as minor dents or scratches that do not jeopardize the structural integrity of the tank, nor do they affect the tank performance. Photo 1 below shows Level I damage in the form of a dent in the outer shell of the tank. A straight edge is placed across the dent and the depth of the dent is measured with a tape measure or straight rule. In this case the dent is just under 7mm deep and is acceptable. If there are no signs of frost or sweating the tank can be returned to normal service. Photo 2 shows Level I damage in the form of surface scratches to the outer tank shell.

Photo 1 – Level I

Dent in outer shell less than 7mm deep



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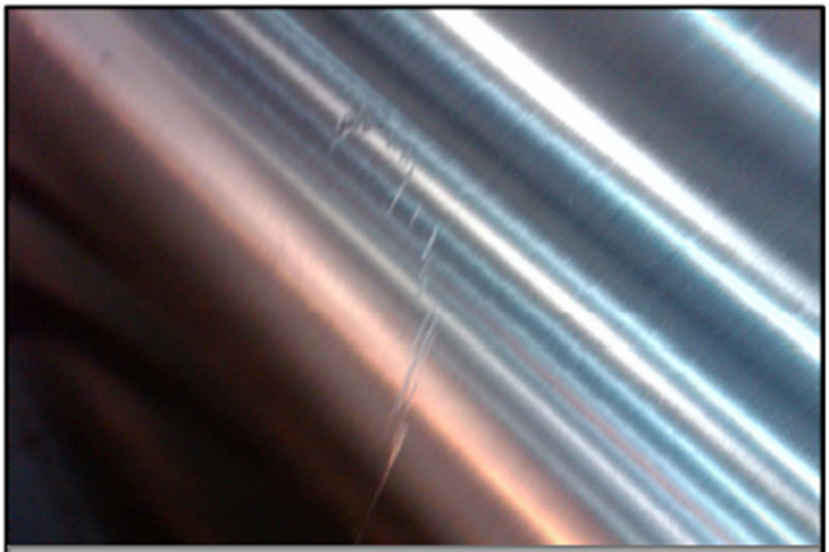

Photo 2 – Level I

Scratches in outer shell of tank

Level II damage:

Category II damage can be defined as any of the following.

- Any dent in the outer shell deeper than 7mm.
- Any visual ice or frost spot(s) on the outer shell or heads (excluding knuckle and its mounted plumbing)
- Any dent (regardless of depth) on a weld.
- Any dent (regardless of depth) on either of the front or rear heads.
- Dents in the protective shroud.
- Damage to the fill receptacle and/or vent receptacle.
- Damage to any of the plumbing or fittings.
- A fire where the tank was hot enough to cause any discoloration to the tank surfaces, plumbing or damage to wiring or hoses.
- Any damage on welds.
- Any visible crack in a weld, or any other tank component. This includes any leak at a welded component.

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Level II damage cont.

Photo 3 – Level II

Damaged outer shell, rear head and welds

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Photo 4 – Level II

Damaged tank outer shell damaged (frosted), front head and weld damaged

Level III Damage:

Level III damage is considered as a tank that is too badly damaged to repair or return to use. In all Level III damage cases the tank needs to be immediately de-fueled if safe to do so. Then it needs to be purged, removed from service and scrapped.

Photo 5 – Level III
Extensive damage to shroud, front head and tank support

Photo 6 – Level III

Extensive damage to outer shell, rear head and tank support

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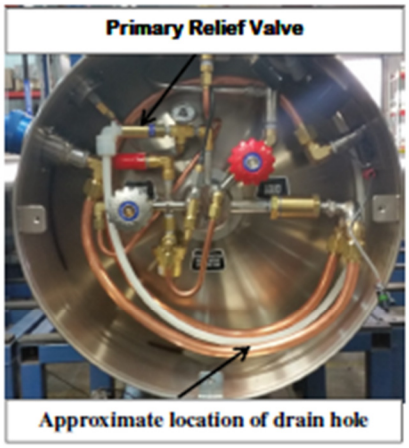
	VT-0020	001	03/18	BBK
CHART®	Primary Relief Valve Vent Tube Drain Hole			

OVERVIEW

Chart LNG vehicle tanks utilize a primary relief valve with a nylon vent tube. The vent tube ensures any relief valve discharge gas is vented to a safe location. This document is intended to give important information pertaining to the purpose of these components.

Standard Tank



Integrated Tank

The Primary Relief Valve is a brass cryogenic relief valve set at the maximum allowable working pressure (MAWP) for the tank. Its function is to vent product to atmosphere if the tank pressure exceeds the MAWP. It is connected to the top fill line so it also provides additional safety against over pressurizing the tank during filling operations.

The Primary Relief Valve is equipped with a pipeaway adapter to permit piping the relief valve gas to a safe location above the vehicle. Because methane gas is lighter than air, it will rise when discharged into the atmosphere. The relief valve discharge gas is typically piped to a vent stack that exhausts at the top of the vehicle with flow directed upwards. Since there is a possibility of relieving liquid through this line, its discharge path should be away from persons, ignition sources, or materials that could be damaged by exposure to cryogenic temperatures.

To prevent the possibility of water accumulating and freezing in the relief valve nylon tube, the relief valve pipe away tubing should include provisions for excluding rain and wash water from the line. The nylon tube on all

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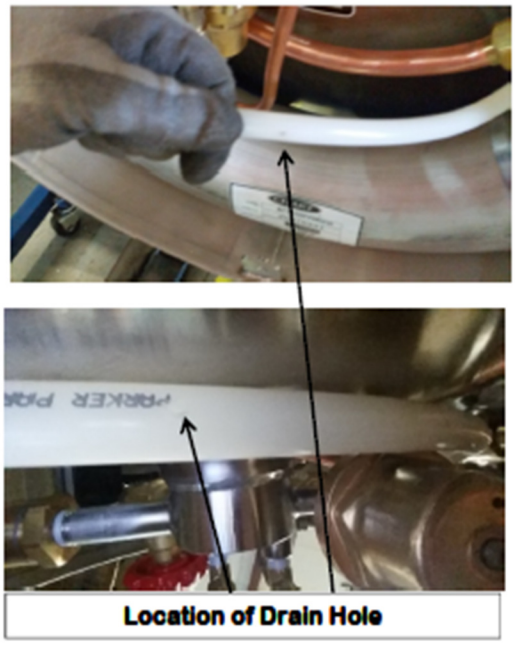
	VT-0020	001	03/18	BBK
CHART	Primary Relief Valve Vent Tube Drain Hole			

Chart LNG vehicle tanks incorporates a low point water drain hole. It is a 3mm predrilled drain hole located at the lowermost portion of the nylon tubing, it allows water and moisture to drain from the line.
When the primary relief valve opens, the vast majority of gas goes out through the nylon tube and toward the vent stack outlet, however a small amount may be discharged out of the drain hole. This is a normal function of the tube.



Location of Drain Hole

DO NOT PLUG OR BLOCK THE MOISTURE DRAIN HOLE!
IT IS AN INTEGRAL PART OF THE TANK DESIGN.

Safety: Always wear appropriate safety equipment, appropriate clothing and eye protection when performing any maintenance checks.

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	VT-0035R110	000	05/14	BBK
CHART	Relief Valve (PRD) Diagnosis			

Purpose
The purpose of this document is to outline standard requirements for relief valves used on Chart LNG vehicle tanks, to include inspection, operation, and troubleshooting steps.

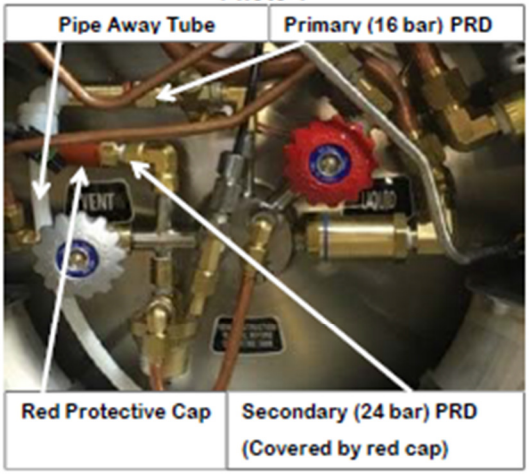
Help
If questions arise while reviewing this document or performing any of the steps or inspections, please call Chart LNG at 800-838-0856.

Overview
Pressure Relief Devices (PRD's) are a critical part of the many safety features incorporated into the Chart LNG vehicle tank. The Chart LNG vehicle tank uses two PRD's, they are a primary relief valve and a secondary relief valve. The primary PRD is set to operate (open) at ~16 bar or higher, the secondary is set to operate (open) at ~24 bar or higher. The primary PRD should always be piped away to a vent stack per regulations. The primary PRD vent tubing inside the shroud is designed to prevent moisture from entering the primary PRD. The tubing has a small hole at the lowermost portion of the tubing inside the shroud to allow any moisture or debris to drain, and not accumulate in the tube. If properly designed and installed, the vent tubing and stack will pipe away any vented methane to a safe location above the vehicle and operator. The secondary PRD is not piped away and must always have a red protective cap covering it (see photo 1). The purpose of the red cap is to keep moisture and contaminants out of the secondary PRD. The red cap on the secondary PRD also gives an indication as to whether or not the secondary PRD has opened. If the secondary PRD has opened (red cap missing) it would indicate the primary did not open when it was supposed to, and the pressure in the tank has subsequently risen high enough to open the secondary PRD and blow off the red cap.

IF THE RED CAP IS EVER FOUND TO BE MISSING FROM THE 24 BAR RELIEF VALVE, THE VEHICLE MUST BE IMMEDIATEY PLACED OUT OF SERVICE AND A FOLLOW UP INVESTIGATION PERFOMED TO DETERMINE A ROOT CAUSE FOR THE MISSING RED CAP.

FAILURE TO REMOVE THE VEHICLE FROM SERVICE AND MONITOR THE TANK PRESSURE CAN RESULT IN TANK OVER PRESSURIZATION AND/OR RUPTURE.

Photo 1



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	VT-0035R110	000	05/14	BBK
CHART®	Relief Valve (PRD) Diagnosis			

Inspection

Chart requires the vehicle operator to perform a visual inspection of the relief valve system while doing their daily pre-trip inspection. The inspection is also to be included as part of any preventive maintenance inspection performed on the LNG system.

The red cap must be installed completely onto the secondary PRD and not show any signs of damage or cracking. The pipe away tube must be present and not visually kinked or damaged. (See photo 1)

IF THE RED CAP IS EVER FOUND TO BE MISSING FROM THE 24 BAR RELIEF VALVE, THE VEHICLE MUST BE IMMEDIATELY PLACED OUT OF SERVICE AND A FOLLOW UP INVESTIGATION PERFOMED TO DETERMINE A ROOT CAUSE FOR THE MISSING RED CAP.

If a tank is identified as having a missing or damaged red cap, the vehicle must be placed out of service until a follow up inspection can be performed. The follow up inspector must identify the reason for the red cap being discharged. When placing the vehicle out of service a tank pressure inspection must be performed to ensure the tank pressure is not in an over pressurized condition. If the tank is above 14 bar it must be vented down to 10.5 bar and monitored/vented daily until the inspection/repairs can be completed.

FAILURE TO REMOVE THE VEHICLE FROM SERVICE AND MONITOR THE TANK PRESSURE CAN RESULT IN TANK OVER PRESSURIZATION AND/OR RUPTURE.

The entire system should be inspected by a qualified technician.

NOTE: Always wear required safety gear and eye protection when working around LNG Tanks or using compressed air.

The technician should inspect the following: (refer to photo 1 as needed)

1. Remove primary PRD nylon pipe away tube and elbow to inspect for signs of dirt or debris inside the barrel of the PRD. Use a flashlight to inspect for moisture, water or ice inside the PRD. Use shop air to lightly blow into the barrel of the PRD and determine if any moisture is present.
2. Inspect the secondary PRD for signs of dirt or debris inside the barrel of the PRD. Use a flashlight to inspect for moisture, water or ice inside the PRD. Use shop air to lightly blow into the barrel of the PRD and determine if any moisture is present.
3. Inspect the entire length of pipe away tubing from the primary PRD elbow to the outlet at the top of the vehicle. Look for any areas or signs of pinched or kinked tubing.

Primary Relief Valve Vent Stack

The *Primary Relief Valve* should be piped to a safe point on the vehicle. Since methane gas rises it is typically piped to a vent stack that exhausts at the top of the vehicle with flow directed upwards. Since there is a possibility of

This procedure is intended for use by trained technicians with experience on systems using LNG. Review all applicable safety documents before beginning this procedure.

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relieving liquid through this line its discharge path should be away from persons, ignition sources or materials that could be damaged by exposure to cryogenic temperatures. To prevent the possibility of water accumulating and freezing in the relief valve line the vent stack should include provisions for excluding rain and wash water from the line and incorporate a low point water drain. The minimum recommended size for vent stack is 13mm tubing.
The tubing connecting the *Primary Relief Valve* pipe away to the vent stack can be either metallic or non-metallic tubing suitable for low temperature methane service. The minimum tubing size is 13mm.

4. Use a blow gun to blow through the entire length of primary PRD tubing from the nylon elbow to the outlet on top of the vehicle. Ensure no restrictions are apparent. It is normal for a small hole to be present at the lower most portion of the nylon tubing inside the shroud, the hole acts as water/moisture drain.
5. Reinstall the elbow and tighten it hand tight into the primary PRD, then install the nylon tubing into the elbow and tighten its securing nut by hand.
6. The tanks vacuum system must be checked for excessive pressure rise. Refer to Chart LNG service bulletin VT-0019 for proper pressure rise testing procedures.

Corrective Actions

1. If the tubing is damaged or kinked make the necessary repairs. Do not attempt to reuse any kinked or crushed tubing; rather replace the crushed or kinked tubing. If no moisture, ice or dirt were present in either of the PRD's during inspection steps 1 and 2 above proceed as follows. Lightly blow out both primary and secondary PRD's using shop air and a blow gun; install a new red cap on the secondary PRD.
2. If moisture or dirt/debris is apparent inside either of the PRD's defuel the tank and replace both PRD's (primary and secondary) as a set and install a new red cap on the secondary PRD.
3. If no problems are apparent with the pipe away or tubing de-fuel the tank and replace both PRD's as a set. Then install a new red cap on secondary PRD.

   NOTE: Always replace both PRD's as a set at the same time.

4. Ensure the nylon pipe away elbow and tubing has been reinstalled correctly onto the primary PRD, and all connections are hand tight. Do not use a wrench to tighten the elbow or tubing nut as doing so could crack or damage the threads.

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	VT-0019R110	003	BBK
CHART®	RECOGNIZING SOFT VEHICLE TANK VACUUMS		

This procedure addresses recognizing soft vacuum in vehicle tanks manufactured by Chart or NexGen Fueling. Use this procedure to identify if vacuum maintenance in LNG vehicle fuel tanks is needed.

1) Inspect the vehicle tank for the following events before it is sent into service for the shift:
   a. Observe exterior of tank for sweating.
   b. Touch the metallic shroud surface of the tank with one hand. Then with the same hand touch the metallic outer shell. Is there a noticeable difference in temperature between the tank shell and shroud? Is there a noticeable difference between the tank being inspected and tanks on other vehicles in the fleet?
   c. Read pressure on the vehicle tank pressure gauge. Is the tank pressure higher than that of the rest of the fleet?
   d. Check if tank is venting through vehicle tank relief valves.

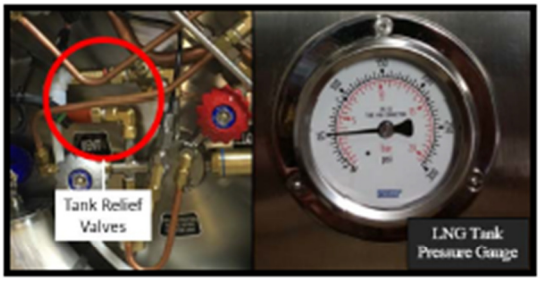

Figure 1

2) Test the tank pressure rise. Refer to Operations Manual for proper tank testing procedures. Check tank for the following items before conducting test.
   a. Ensure vehicle tank is between ½ to ¾ full.
   b. Drive vehicle for 10 minutes to stabilize the tank pressure and temperature.
   c. Ensure vehicle tank is at normal operating pressure. (economizer set point)
3) Allow vehicle to sit motionless for 15 minutes to stabilize the system.
4) Record tank pressure and time at which pressure was taken.
5) Allow tank to set for at least 8 hours.
6) Record vehicle tank pressure and time at which pressure was taken.

Rate of Pressure Rise	Recommended Service Action
Rise/8hrs = less than 0.7 bar	Tank is normal
Rise/8hrs = greater than 0.7 bar, but less than 2 bar	Monitor tank and include vacuum maintenance at next periodic service for vehicle
Rise/8hrs = greater than 2 bar	Perform vacuum maintenance as soon as possible

This procedure is for use by trained mechanics experienced with using Liquefied Natural Gas systems and vacuum technology. Review all pertinent safety documents before starting this procedure.