June 1, 2015

SAFETY AND GOATTHROAT PUMPS

While no safety incidents have occurred to our knowledge from the use of GT Pumps with combustible or flammable liquids, OSHA 29 CFR1910.106 requires use of inert gas pressure when dispensing them.

NFPA 30 -2015 changed its code to permit use of air pressure to move flammable liquids as per below:

18.4.4.1

Dispensing of Class I liquids from a container by means of air shall be permitted under the following
conditions:

(1) The pressure shall be generated by means of a listed hand-operated device.
(2) Pressure shall not exceed a gauge pressure of 6 psi (41 kPa) and pressure relief shall be provided.
(3) The container shall not exceed 119 gal (450 L) and shall be capable of withstanding the maximum pressure generated by the device.
(4) The device shall be bonded and grounded or shall be demonstrated as not being capable of generating a static charge under any operating condition
(5) The material of construction of the device shall be compatible with the liquid dispensed.

GoatThroat Pumps offers the SCP pump series to meet this requirement. As a sealed system, there is no chance for vapors and VOCs to escape the container, thereby significantly reducing the chance of an ignition event. The SCP-6500 components which come in contact with the liquid and each other are made of conductive plastic which meets/exceeds the NFPA77, Paragraph 6.4.1.3 recommendations that the total resistance of the path to ground be 1 megohm (10^6 ohms) or less. The SCP pump is sent to customers with attached grounding and bonding wires. For safe use, these pumps must be used with the appropriate o-ring seal, must be properly and securely attached to the vessel, and the pump's ground wire must be grounded.

On the following pages are the test results for the SCP-6500 pump from Ciba Expert Services, the Safety Testing Laboratory of Ciba Geigy. Included as well is the white paper by Dekra Chilworth concluding that the SCP series with (1) its internal pressure makes the vapor concentration too lean to ignite within the container and (2) the sealed system with no vapors released is much safer than a pump on a container which is open to the environment. As regards rotary and piston pumps, which are open systems, they state "…(the) gap around the bung … may allow a weak explosion occurring at a temperature near the flash point (LFL) to vent in the form of a flame jet exiting near the bung at high velocity and high temperature. … This jet could injure personnel working in close proximity to the container."

Regards,

Nancy Westcott
President

Ensuring worker safety and environmental compliance has never been easier.

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Title:	Resistance Measurements of GoatThroat Pumps		
Customer:	Nancy Westcott GoatThroat Pumps 184 West 10th Street New York, NY 10014 Ph: (646)486-3636 nwestcott@goatthroat.com		
CST Ref.:	105-08	**Customer Ref.**	
Lab Work:	M. Oliver		
Report By:	M. Oliver		
Date:	October 9, 2009		

1. Summary

Three pump heads and four tubes made from various materials were tested to determine if they are static conductive.

NFPA 77, Paragraph 6.4.1.3: "To prevent the accumulation of static electricity in conductive equipment, the total resistance of the ground path to earth should be sufficient to dissipate charges that are otherwise likely to be present. A resistance of 1 megohm (10^6 ohms) or less is generally considered adequate."

Only the head and tube marked "conductive" met the criteria. With the other materials, only with the leads attached on opposite sides of the same ends of the tube could a resistance less than 100 teraohms be measured.

Validity unknown

Digitally signed by Michael A. Oliver
DN: cn=Michael A. Oliver, o=Ciba Specialty Chemicals, ou=Ciba Safety Testing Laboratory, c=US
Date: 2009.10.13 08:55:55 -05'00'

Michael Oliver
Manager, Safety Testing
Ciba® Expert Services

Date

2. Samples for testing

Material of construction	Sample Description
Regular	Head and Tube
Containing Irgastat	Head and Tube
Containing other antistat	Tube only
Conductive	Head and Tube

3. Test Equipment

Resistance measurements were made with the following electrometers

1. Fluke 1520 Megaohm Meter: Range =250 kilohms to 4000 megohms
2. Keithley 6517B High Resistance Meter. 200 kilohms to 100 teraohms.
3. Fluke 87 III True RMS Multimeter: Range = 0-40 megohms.

4. Test Results

Three pump heads and four tubes made from various materials were tested to determine if they were conductive. This was accomplished by measuring the resistance across several points. See pictures on the next page for depiction of test points.

Test	Description
A	Resistance from head to ground wire (lead attached to foil wrapped around head)
B	Resistance from ground wire on head to end of tube
C	Resistance across length of tube
D	Resistance across end of Tube

Table 1: Test Results

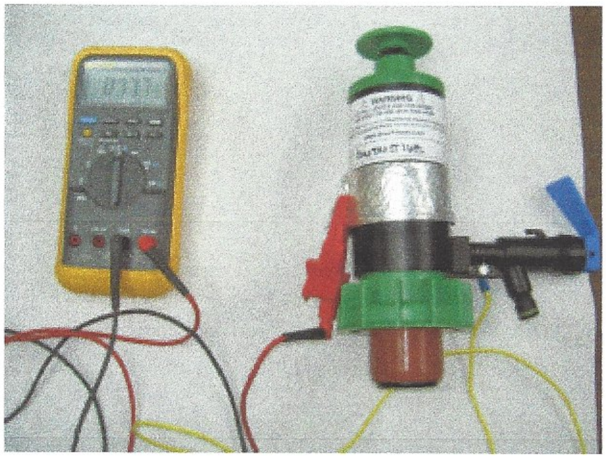
Test	A	B	C	D
Regular	>4 G[1]	>4 G[1]	> 100 T[2]	30 T[2]
Irgastat	>4 G[1]	>4 G[1]	> 100 T[2]	1.0 T[2]
Other Antistat	NA	NA	> 100 T[2]	1.9 T[2]
Conductive	78 K[3]	80 K[3]	4.7 K[3]	900[3]

1. Fluke 1520 Megohm Meter.
2. Keithley 6517B High Resistance Meter.
3. Fluke 87 III True RMS Multimeter.

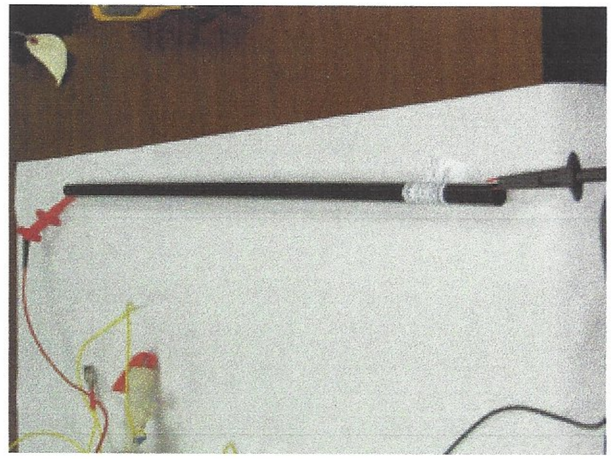
$K = 10^3$ $M = 10^6$
$G = 10^9$ $T = 10^{12}$

5. Test Description

Test A



Test C



Test B

Test D

Client: **Goat Throat Pumps**
60 Shell Avenue
Milford, CT 06460

Contact: Nancy Westcott
Job title: President
Report no: R/13756/0413/SJL
Report date: April 26, 2013
CTI Ref: GT/13756/SL

Risk Assessment of a Goat Throat hand SCP-6500 Pressure Pump for Dispensing Flammable and Combustible Liquids

Prepared by
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1 SUMMARY

The services of a Chilworth Technology Inc. (CTI) Senior Process Safety Specialist were requested by the Goat Throat Pump Co. to perform a risk assessment on their Model SCP-6500 pressure pump proposed for use in dispensing of Class I and Class II liquids in the industrial plant setting. The assessment considered the relative risk of flammable atmospheres, ignition sources, potential explosion severity and leakage/spill scenarios for traditional suction dispensing devices compared to the Goat Throat hand pump.

Based on the results of the risk assessment, use of the Goat SCP line of pressure pumps to dispense flammable or combustible liquids, at pressures up to 6 psig, is not considered to present any additional ignition, flammable atmosphere or leak/spill hazards when compared to suction pumps used for the same purpose. However, the severity of an ignition of a flammable atmosphere inside of a pressurized container may increase, slightly increasing the risk, when compared to an event occurring at atmospheric pressure. If the complete absence of ignition sources within the container can be assured, there will be no additional risk from the use of the Goat SCP line of pressure pumps.

Since the pump uses pressure to dispense Category 1 (Class I) liquids and the OSHA safety standards currently prohibit this practice a variance may be required in order to satisfy OSHA. The OSHA website www.OSHA.gov can be visited to obtain information regarding the variance procedure.

2 STATEMENT OF PROBLEM

The client, Goat Throat Pumps, manufactures a line of industrial, hand-operated drum pumps that dispense liquids, from containers up to 55 gallons in size, by developing small pressures (less than 6 psig) on the vapor space over the fluid in the container. According to Goat Throat, these types of pumps have been used for years to dispense Class I and Class II flammable liquids, without incident. Recently some of Goat Throat s' customers have requested that they engineer a pump which meets strict safety requirements for dispensing of these classes of liquids.

Currently NFPA 30, which is the governing standard for handling of flammable and combustible liquids, requires that:
(Section 18.3.4) Transfer of liquids among vessels, containers, tanks, and piping systems by means of air or inert gas pressure shall be permitted only under all of the following conditions:
(1) The vessels, containers, tanks, and piping systems shall be designed for such pressurized transfer and shall be capable of withstanding the anticipated operating pressure.
(2) Safety and operating controls, including pressure-relief devices, shall be provided to prevent overpressure of any part of the system.
(3) Only inert gas shall be used to transfer Class I liquids. Only inert gas shall be used to transfer Class II and Class III liquids that are heated above their flash points.

In addition, NFPA 30 also requires (Section 18.4.2.2) that a *"Means shall be provided to minimize generation of static electricity. Such means shall meet the requirements of 6.5.4"* Section 6.5.4 requires that equipment be designed to prevent electrostatic ignition and that all conductive parts be bonded and grounded.

Goat Throat has developed a pump (Model SCP-6500) which they believe can safely be used to dispense flammable and combustible liquids. They have also been in contact with the NFPA 30 technical committee regarding the pump's conformance to the standard requirements. According to Goat Throat [1], the NFPA committee is not aware of any hazard data, regulations, or other information regarding the use of low pressure air to move flammable liquids or combustible liquids heated above their flash points but the standard, as currently written, (Section 18.3.4 (3) requires use of inert gas to transfer Class I liquids or Class II and Class III liquids heated to temperatures above their flash point.

It should be noted , for the record, that OSHA safety standards prohibit transfer of flammable liquids using compressed air as follows:

29 CFR Part 1910.1061910.106(e) Industrial plants (2) Incidental Storage or Use of Flammable and combustible Liquids (iv) Handling Liquids at Point of Final use (d) Flammable liquids shall be drawn from or transferred into vessels, containers, or portable tanks within a building only through a closed piping system, from safety cans, by means of a device drawing through the top, or from a container or

[1] Letter from Goat Throat (Nancy Westcott-President) to Brian Kingsley of CTI dated March 2013.

portable tanks by gravity through an approved self-closing valve. Transferring by means of air pressure on the container or portable tanks shall be prohibited.

and

29 CFR 1910.106(g) Service Stations (3)Dispensing Systems (iv) Dispensing Units (c) Category 1 or 2 flammable liquids, or Category 3 flammable liquids with a flashpoint below 100 °F (37.8 °C), shall not be dispensed by pressure from drums, barrels, and similar containers. Approved pumps taking suction through the top of the container or approved self-closing faucets shall be used.

and

29 CFR 1910.106(h) Processing Plants (4) Liquid Handling (iii) Transfer (a) The transfer of large quantities of flammable liquids shall be through piping by means of pumps or water displacement. Except as required in process equipment, gravity flow shall not be used. The use of compressed air as a transferring medium is prohibited.

The committee suggested that a risk-based or technical analysis be prepared with the intent of demonstrating that the risk of using a pressure based pump, for dispensing of Class I and Class II liquids, is no greater than that posed by other liquid transfer systems, i.e., gravity dispensing or standard rotary or piston pumps. The committee has posed[2] the following questions:

(1) Does the Goat Throat pump, when used to transfer Class I flammable liquids, present a risk that is comparable to that posed by piston or rotary pumps (which pull liquids from their containers by suction) or does it present a significantly greater risk for spill or ignition?
(2) Does the operation of the Goat Throat hand-operated pump induce dangerous levels of static electric charge in the liquid as it is pumped, again to a risk level that is greater than would be posed by other pumps?

(3) Will a static conductive version of the pump present a risk that is comparable to that posed by FM approved metal pumps by piston or rotary pumps (which pull liquids from their containers by suction) or does it present a significantly greater risk for spill or ignition?

This report addresses the questions posed by the committee and includes a risk assessment regarding the operation of the pump for the dispensing of Class I and Class II liquids.

[2] Ibid Ref 1.

3 CODES AND STANDARDS

This risk assessment follows the guidance of the National Fire Protection Association (NFPA) consensus codes and standards for the processing and handling of combustible particulate solids. Specific codes and standards considered are listed below:

- 29 CFR Part 1910.106 *Flammable and Combustible liquids*
- NFPA 30 (2012) *"Flammable and Combustible Liquid Code"*
- NFPA 51B (2009) "*Fire Prevention During Welding, Cutting and other Hot Work"*
- NFPA 68 (2007) *"Standard on Explosion Protection by Deflagration Venting"*
- NFPA 70 (2011) *"The National Electrical Code"*
- NFPA 77 (2007) "*Recommended Practice on Static Electricity*"

4 RISK ASSESSMENT

Three elements are required for a fire (1) a fuel; (2) an oxidant, typically the oxygen in air; and (3) a sufficiently energetic ignition source. If any one of these three elements can be removed, fire cannot be initiated. The first two of these elements (fuel and oxidant) when in an appropriate ratio, are referred to as a flammable atmosphere.

For an explosion involving a flammable liquid to occur, two additional requirements are necessary: (4) mixing of the flammable liquid vapors in air above the lower explosive limit and (5) confinement. Mixing with air naturally occurs under steady state conditions and if the liquid is at a temperature above its flash point there will be sufficient vapor to burn if an ignition source is present. Under these conditions either a flash fire or explosion will result. If the event occurs in a confined space, such as inside of a vessel or a room that is not adequately vented, then pressure will develop that causes damage to the vessel or room. In this case the classical definition of explosion is met.

The risk of an event will be the product of the likelihood of the event multiplied by the severity of the event.

Risk = Likelihood*Severity

The likelihood component will be determined by examination of the potential for flammable atmosphere and a credible ignition source. The severity can be estimated by an understanding of the burning or explosibility characteristics of the fuel.

The purpose of the risk assessment is to analyze the liquid dispensing conditions with regard to suction pumps and the Goat Throat hand pressure pump and to identify and assess potential fire and explosion hazards, with regard to each, in order to make comparisons between the two systems. Currently piston and rotary hand pumps that employ suction to remove liquids from containers are accepted in the industry and judged to meet NFPA 30 requirements.

4.1 Flammable Atmosphere

The presence of a flammable atmosphere can be expected inside of a vessel containing a flammable liquid, at ambient temperatures, in many cases. Table 1 provides flammability data for selected flammable liquids to demonstrate this point. The Table lists both volume percentage and temperature flammability limits at ambient pressure (one atmosphere - 760 mm of mercury). The flash point is defined as the minimum temperature of a liquid at which sufficient vapor is given off to form an ignitible mixture with the air, near the surface of the liquid, or within the vessel used, as determined by an appropriate test procedure and apparatus as specified in Section 4.4 of the standard. It is important to note that an external ignition source must be present to ignite a mixture within the flammable limits. The temperatures listed in the Table for Lower Flammable Limit (LFL) are flash point temperatures.

Table 1 - Flammability/Ignitibility/Explosibility Properties of Selected Flammable Liquids

*HE No.	Liquid	LEL (vol%)	UEL (vol%)	LEL Temp (°C)	UEL Temp (°C)	LEL Temp (°F)	UEL Temp (°F)	**MIE (mJ)	***K_g bar·m/sec	***P_{max} (bar)
101	Methanol	7.3	36	12	42	54	108	0.14	75	7.5
103	Isopropyl Alcohol	2.3	12.7	12	38	53	102	0.65	83	7.8
104	Acetone	2.6	12.8	-17.8	7	0	45	1.15	NA	NA
106	Ethyl Acetate	2.5	9.0	5	18	41	64	0.46	NA	NA
107	Toluene	1.27	7.0	4.4	37	40	99	0.24	94	7.8
117	Ethanol	3.3	19	121.8	42	55	108	NA	78	7.0
119	Xylene	1.0	7.0	29	62	84	144	0.2	NA	NA
138	Hexane	1.2	7.4	-21.7	6	-7	43	0.24	NA	NA
139	Heptane	1.05	6.7	3.9	26	39	79	0.24	NA	NA

* Source - HERC Data Guides, Hercules Inc. PO Box 210, Cumberland, MD 21502

** Source - NFPA 77 - Annex B Table B-1

*** Source - NFPA 68 - Annex E - Table E.1

NA - not available

The flash point of a liquid increases with increased pressure. This is because the vapor pressure of the liquid is strictly dependent upon temperature. At the flash point, the vapor concentration is high enough such that, when mixed with air, the lower flammable limit exists. The volume percentage of the vapor can be calculated if the vapor pressure of the liquid at the flash point temperature is known. For example, from Figure 1(the flammability diagram for methanol, a Class I liquid (flash point below 37.8° C - 100°F)), at the flash point the vapor pressure of methanol at the flash point (12°C) is 55 mm mercury (Hg). The volume percent of methanol vapor can be calculated by dividing the vapor pressure by atmospheric pressure of 760 mm Hg. This produces a lower flammable limit of 7.3% methanol in air. At a system pressure of 6.0 psig (1070 mm Hg) and 12°C, the vapor pressure of methanol will still be 55 mm Hg, but the concentration of the vapors in the system will now be 55/1070*100% or 5.14%. This concentration is too lean to ignite. and it would be necessary to heat the liquid up to a higher temperature, to produce a vapor pressure of 78 mm Hg (0.073*1074 mm Hg), to create a flammable mixture in the vessel. This temperature would be about 15°C according to Figure 1. Figure 2[3] shows the effect of increasing system pressure for selected paraffinic hydrocarbons. It is also well known[4] that increasing pressure will increase the limits of flammability with the lower flammable limit decreasing slightly and the upper limit more significantly. Figure 3 shows this effect for mixtures of pentane, nitrogen, and air. The broadening of the flammable range due to small changes in system pressure (below 100 psig) is relatively insignificant, however.

[3] Bulletin 626 Bureau of Mines, "Flammability Characteristics of Combustible Gases and Vapors, Michael Zabetakis, Washington DC Dept of Interior, 1965 Page 28.
[4] ibid footnote 1, page 41.

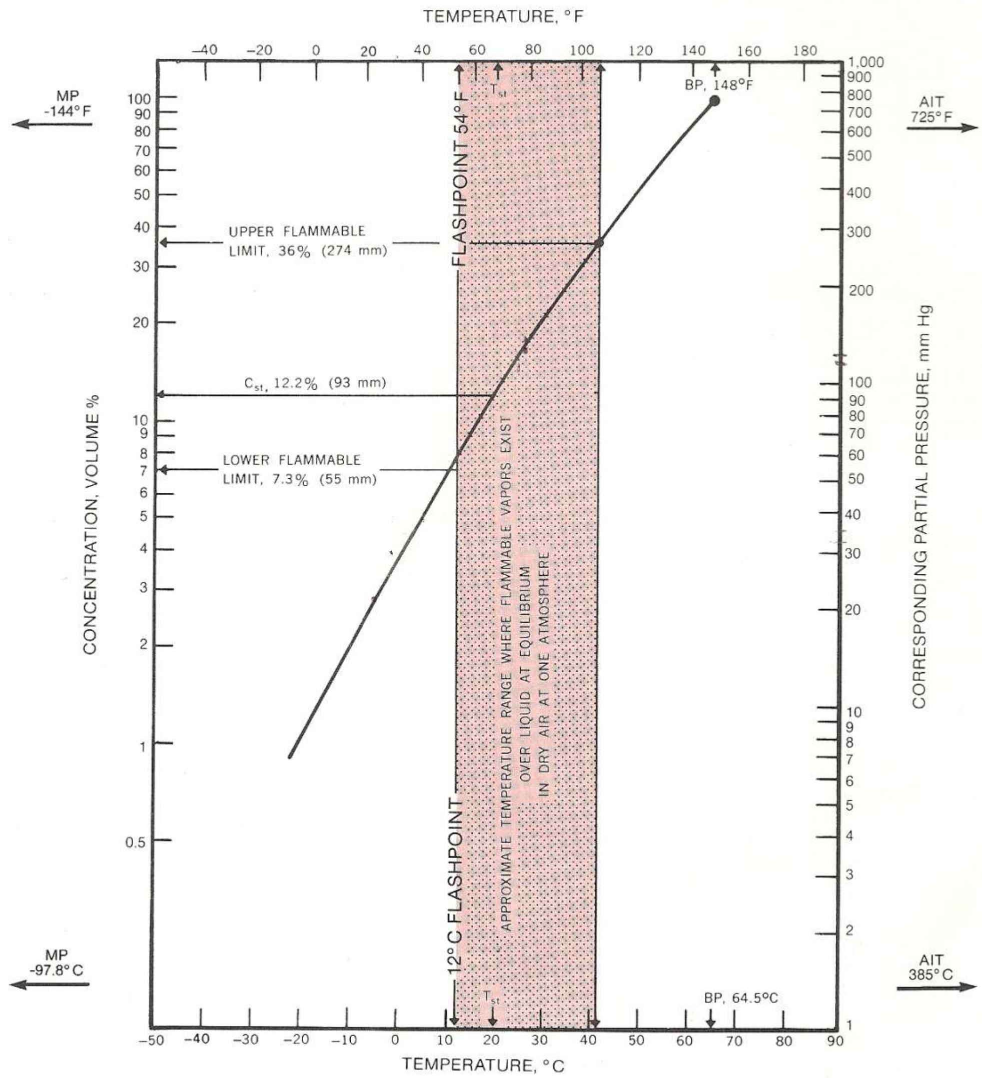

Figure 1 - Flammability Diagram - Methanol (Re: Hercules Data Sheet No. 101)

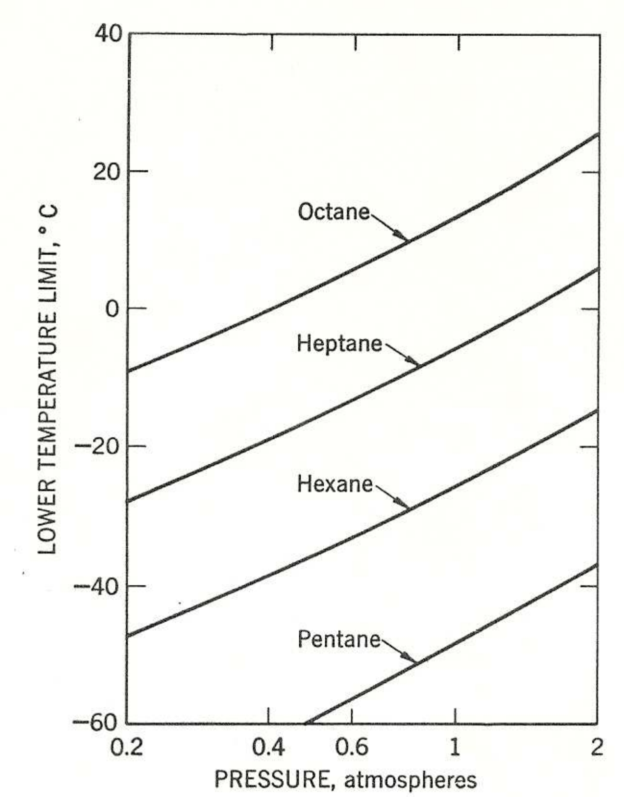

Figure 2 - [5]Effect of Pressure on Lower Temperature Limits of Flammability of Pentane, Hexane, Heptane and Octane in Air.

[5] Note these values may differ from temperature limit values reported in the literature since they were calculated based on equations designed to predict the behavior.

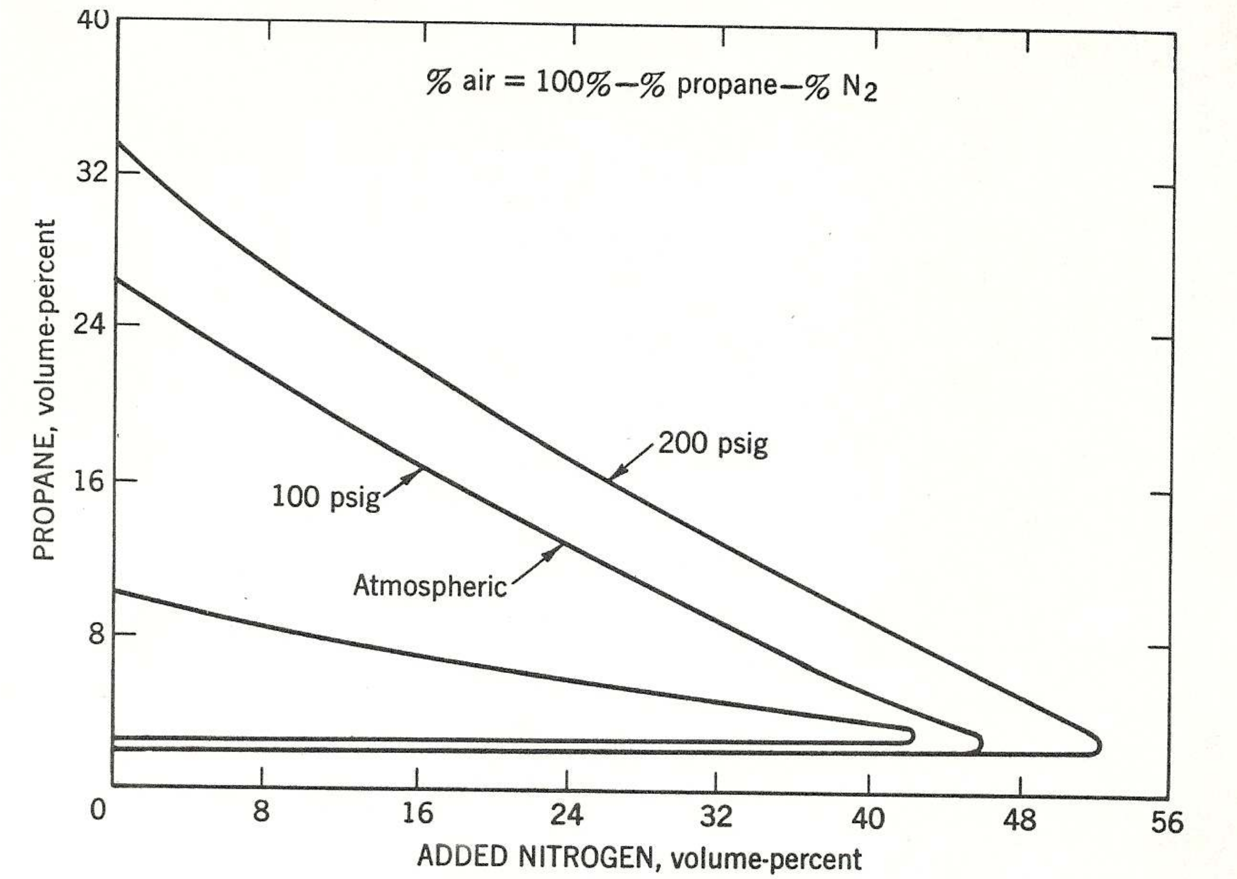

Figure 3 - Effect of Pressure on Limits of Flammability of Propane-Nitrogen Air Mixtures

The percentage of oxygen in a pressurized system will be dictated by the vapor temperature of the flammable or combustible liquid inside the vessel and the system pressure. Table 2 shows percentages of the three components at two system pressures. The percentage of oxygen can never exceed 21% regardless of the system pressure but will trend towards this value as the system pressure increases.

A flammable atmosphere will exist inside of vessels containing flammable liquids, in many cases. This atmosphere will not significantly change regardless of whether the vapor space is at ambient pressure or pressures above ambient. Furthermore, there is no oxygen enrichment at elevated pressures which could increase the sensitivity of the flammable atmosphere to ignition.

For these reasons, there is no additional flammability risk posed by using low pressure air (6 psig or less) to dispense liquids from the vessel compared to a dispensing system that uses suction.

Table 2 - Percentages of Methanol, Oxygen and Nitrogen in closed vessel at 12°C, 0 and 7.5 psig.

System Pressure (psig)	% methanol vapor in air	% oxygen	% Nitrogen
0	7.30	19.47	73.23
6.0	5.14	19.92	74.94

4.2 Control of Ignition Sources

The primary [6]basis of safety inside of a vessel containing a flammable atmosphere is prevention of ignition sources. Flammable vapors typically have Minimum Ignition Energies of less than 1 mJ (See Table 1) and can easily be ignited by weak electrostatic discharges including brush discharges generated from nonconductive materials such as plastics. At elevated pressures the MIE will decrease even further. Since the energy required to ignite flammable vapors at ambient pressure is so low, any further reduction of these energies, at elevated pressures, would not further increase the risk.

NFPA 30 requires (Section 18.4.2.2) a means to be provided that prevents static electricity during transfer/dispensing operations. Typical strategies include bonding and grounding of all conductive pump components and designing nonmetallic components of the system to prevent electrostatic ignition. The Goat Throat hand SCP-6500 pump is designed to prevent generation of electrostatic charges. The tap, body, siphon dip tube and pump components have been [7]tested and resistivity between parts does not exceed 1 megohm. This requirement originates from NFPA 77[8] which states (Section 7.4.1.3), *"To prevent the accumulation of static electricity in conductive equipment, the total resistance of the ground path to earth should be sufficient to dissipate charges that are otherwise likely to be present. A resistance of 1 megohm (10^6 ohms) or less generally is considered adequate."*

The Goat Throat hand pump is designed so that once connected there will be no movement of the siphon tube and thus no friction will be generated while operating. Other pumps such as rotary and piston pumps may generate small amounts of friction due to contact of moving components (vanes or pistons) with the pump housings but these movements are not considered to be able to produce significant friction that would be required to ignite a flammable vapor cloud. Both suction and pressure dispensing pumps that are designed for control of static electricity meet the intent of the standard. There is no additional static discharge risk associated with the use of the pressure pump in this case.

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[6] A Basis of Safety is a strategy that is employed to remove one or more of the legs of the fire triangle or explosion pentagon.
[7] Ciba Report 105-08, Resistance Measurements of Goat Throat Pumps, Ciba Expert Services, Ciba Safety Testing Laboratory, 1379 Ciba Rd., McIntosh, AL 36553.
[8] NFPA 77 (2007 Edition) "Recommended Practice on Static Electricity", The National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

Control of ignition sources is further addressed in areas where flammable liquids are being dispensed by both OSHA and the NFPA 30 standard. Both require use of electrical equipment rated for use in Class I atmospheres (Hazardous (classified locations)) where liquids are being dispensed or where flammable vapors can be released. In addition, OSHA requires that ignition sources be controlled in areas where flammable liquids are handled or dispensed as follows:

1910.106 (e) Industrial plants (6) "Sources of ignition" (i) "General." Adequate precautions shall be taken to prevent the ignition of flammable vapors. Sources of ignition include but are not limited to open flames; lightning; smoking; cutting and welding; hot surfaces; frictional heat; static, electrical, and mechanical sparks; spontaneous ignition, including heat-producing chemical reactions; and radiant heat.

1910.106 (f) Bulk plants (6) Sources of ignition. Category 1 or 2 flammable liquids, or Category 3 flammable liquids with a flashpoint below 100 °F (37.8 °C), shall not be handled, drawn, or dispensed where flammable vapors may reach a source of ignition. Smoking shall be prohibited except in designated localities. "No Smoking" signs shall be conspicuously posted where hazard from flammable liquid vapors is normally present.

1910.106 (g) Service Stations (8) "Sources of ignition." In addition to the previous restrictions of this paragraph, the following shall apply: There shall be no smoking or open flames in the areas used for fueling, servicing fuel systems for internal combustion engines, receiving or dispensing of flammable liquids. Conspicuous and legible signs prohibiting smoking shall be posted within sight of the customer being served. The motors of all equipment being fueled shall be shut off during the fueling operation.

Being compliant with the OSHA requirements will further reduce the likelihood of ignition inside of a vessel containing a flammable liquid when air is introduced into the vessel when dispensing using either a suction or pressure pump.

4.3 Explosion Severity

A property known as K_g or the deflagration index of a gas cloud is an excellent predictor of the violence or severity of an explosion for a particular gas or vapor. The index is a measure of the maximum rate of pressure rise (change in pressure over time) of a burning gas or vapor cloud in a confined atmosphere. The faster a flammable cloud burns the more propensity for damage. The property can be determined in a laboratory test vessel and is reported along with P_{max}, the maximum pressure developed in the test vessel. These two properties are used to design explosion vents for vessels requiring protection. (See Table 1 for K_g data on selected flammable liquid vapors) The test is performed at ambient conditions of pressure and temperature in the laboratory. The K_g and P_{max} values increase with increasing initial vessel pressure so at elevated pressures, such as would be produced inside a container where a pressure pump was being used, the rate of burning and maximum pressures that can be achieved will increase. The ideal gas law can be used to calculate the corresponding increase in K_g and P_{max}. For a drum containing methanol (K_g of 75 bar·m/sec and a P_{max} of 8.4 bar (122 psig)), for example, using a pressure dispensing pump that pressurized the container to 6 psig (0.41 bar), the K_g and P_{max} values would increase according to this equation ($P1_{abs}/P1_{max} = P2_{abs}/P2_{max}$). Thus:

$$\mathbf{(1bar_{abs})/(8.4 + 1\ bar) = (1\ bar + 0.41\ bar)/P2_{max}}$$

Solving for $P2_{max}$

$$\mathbf{P2_{max} = 1.41*9.4/1 = 13.25\ bar_{abs}\ or\ 12.25\ barg\ (177\ psig)}$$

K_g would increase correspondingly **$K_{g2} = K_{g1}*P_{2max}/P_{1max} = 75*1.41 = 106$ bar·m/sec.** This translates to an increase in rate of burning of about 41% compared to an ignition at ambient pressure.

It is problematical to predict or estimate whether or not the ignition of a flammable vapor inside of a vessel will cause the vessel to deform or rupture. There are many factors that will dictate the energy and pressure that can be produced by the ignition. These factors include the percentage of the vapor within the flammable range, the amount of liquid present inside the vessel, vessel pressure, turbulence and the design pressure of the vessel. A worst case scenario must be assumed as part of the risk assessment. In this scenario the effect of increased P_{max} on a pressurized container is not expected to significantly affect probability of the explosion damaging the container since the containers used for dispensing liquids are neither designed to be pressure vessels nor are they protected against damage from explosion through the use of a deflagration vent. They are tested at 15 or 30 psig (1 - 2 bar) and a vapor cloud explosion inside would be expected to develop pressures from 2 to 9 bar and in most cases rupture the container whether at ambient pressure or pressurized to a slight overpressure up to 1.41 bar (6 psig).

In the case of the container using a suction pump, there is a small gap around the bung where the dip tube enters that is used to allow air from the room to enter the container to replace the liquid that is being dispensed. This small opening may allow a weak explosion occurring at a temperature near the flash point (LFL) to vent in the form of a flame jet exiting near the bung at high velocity and high temperature. This jet could injure personnel working in close proximity to the container. A reduced risk would be expected where a pressure pump is being used and the vessel does not rupture as a result of an ignition inside. In this case, the energy from the ignition will be confined to the vessel and not escape to possibly injure personnel.

An explosion that occurs in a situation where the vapor is near the stoichiometric concentration will produce a fast burning, high pressure explosion that will likely deform or rupture the vessel since it will not be able to adequately vent the rapidly developing deflagration pressure. This would occur in either suction or pressure pumps. Deformation or rupture of the vessel will also be more likely if the vessel contains only a small amount of liquid. In this case a large volume of flammable vapor will exist generating a more energetic explosion. In the event of vessel rupture injury to personnel working nearby would be expected.

The effect of increased K_g at the elevated pressure would increase the risk slightly since increased K_g is proportional to increasing severity. If the likelihood factor is very small overall risk does not change significantly.

4.4 Leakage and Spills

4.4.1 Rotary and Hand Suction Pumps

Piston and rotary hand pumps are open systems that inherently have openings from the inside of the container to atmosphere. They dispense liquids from the containers using negative pressure. These methods require a path for air to ingress into the containers to replace the liquid being removed. Typically there is the small gap between the container opening (bung) and the pump dip tube that allows for this ingress of air. This opening naturally allows for some vapor release into the atmosphere when the pumps are not being used and are not disconnected from the container. If the vapor specific gravity is greater than 1.0 the amount of vapor leaking out should be insignificant.

In addition, the mechanism for removing liquids from containers used by these pumps allows for some spillage since there is no mechanism for sudden stoppage of flow once the pumps are primed. If a seal fails, it is also possible for liquid to be expelled from the containers.

4.4.2 Goat Throat Hand Pressure Pump

The Goat Throat hand pump is a sealed system designed with adapters to provide a tight fit between the liquid containing vessels. This design prevents liquid vapors from exiting the container when the pump is not being used. If a seal fails, it is possible for liquid to be expelled from the containers. The pump can be provided with seals manufactured with various elastomers that are compatible with the liquid being dispensed. The tap handle can be closed immediately in the event of an emergency, if attended, to prevent any further release of liquid from the container. Currently the pump incorporates a hold open latch for dispensing of liquids. This design allows for potential spillage of liquid if the operator leaves the location while dispensing activities are taking place. It is recommended that the tap be redesigned with a self-closing feature to prevent dispensing of liquids when personnel are not attending the pump.

The pump operates on the principal of pressurization of the inside of the vessel to dispense the liquid. A pressurized vessel is likely to release liquid if it leaks or fails. Pressures are regulated through use of a spring loaded pressure relief valve designed to relieve at 6 psig. The pump is also equipped with a manual pressure relief "O" ring valve designed to relieve pressure after dispensing operations are completed. This valve could also be employed in the event of a container leak to remove system pressure.

The Department of Transportation (DOT) requires testing of drums designed to handle liquids. The standard (See Appendix B) requires the containers to be tested at least 15 psig for at least 5 minutes (composites for 30 minutes). Since the containers that will be used with the pump require this testing and the test pressure is at least 250 % of the applied pressure, the risk of container failure during dispensing is very small.

NFPA 30 requires (Section 18.4.2) that provisions be made to promptly and safely mitigate and dispose of leakage and spills. Also (Section 18.4.3) requires the areas where Class I liquids are being used must be free of open flames and other ignition sources. Use of electrical equipment rated for Class I Division 1 areas is required where dispensing of flammable liquids takes place. The primary basis of safety for prevention of fires in these areas is control of ignition sources. This requirement affords additional protection against fire, in the event of a spill or leak.

The risk of leakage or spill associated with use of the pump is considered to be no greater than the risk associated with the use of suction pumps.

4.5 Conformance with NFPA 30

The Goat Throat hand SCP line pressure pumps are compliant with the following requirements of NFPA 30 with regard to dispensing of Class I and Class II liquids:

> ***18.4 Dispensing, Handling, Transfer, and Use.***
> *18.4.1 Class I liquids shall be kept in closed tanks or containers when not actually in use. Class II and Class III liquids shall be kept in closed tanks or containers when not actually in use when ambient or process temperature is at or above their flash point.*
> *18.4.2 Where liquids are used or handled, provisions shall be made to promptly and safely mitigate and dispose of leakage or spills.*
> *18.4.3 Class I liquids shall not be used outside closed systems where there are open flames or other ignition sources within the classified areas set forth in Chapter 7.*
> *18.4.4 Transfer of liquids among vessels, containers, tanks, and piping systems by means of air or inert gas pressure shall be permitted only under all of the following conditions:*
> *(2) Safety and operating controls, including pressure-relief devices, shall be provided to prevent overpressure of any part of the system.*
>
> ***18.5 Incidental Operations***
> *18.5.2.2 Means shall be provided to minimize generation of static electricity. Such means shall meet the requirements of 6.5.4.*
> *18.5.2.3 Where pumps are used for liquid transfer, means shall be provided to deactivate liquid transfer in the event of a liquid spill or fire.*

4.6 Non-Conformance with NFPA 30

The Goat Throat hand SCP line pressure pumps would not comply with the following requirement of NFPA 30 with regard to dispensing of Class I and Class II liquids:

> *18.4.4 Transfer of liquids among vessels, containers, tanks, and piping systems by means of air or inert gas pressure shall be permitted only under all of the following conditions:*
>
> *(3) Only inert gas shall be used to transfer Class I liquids. Only inert gas shall be used to transfer Class II and Class III liquids that are heated above their flash points.*

5 CONCLUSION

Table 3 compares operational features and fire and explosion hazard conditions for suction and the Goat Throat hand pressure pumps. Based on the results of the risk assessment, use of the Goat SCP line of hand pressure pumps to dispense flammable or combustible liquids, at pressures up to 6 psig, is not considered to present any additional ignition, flammable atmosphere or leak/spill hazards when compared to suction pumps used for the same purpose. However, the severity of an ignition of a flammable atmosphere inside of a pressurized container may increase, slightly increasing the risk, when compared to an event occurring at atmospheric pressure. If the complete absence of ignition sources within the container can be assured, there will be no additional risk from the use of the Goat SCP line of hand pressure pumps.

Since the pump uses pressure to dispense Category 1 (Class I) liquids and the OSHA safety standards currently prohibit this practice a variance may be required in order to satisfy OSHA. The OSHA website www.OSHA.gov can be visited to obtain information regarding the variance procedure.

Table 3 - Comparison of Flammable Liquid Dispensing Pumps from a Risk Standpoint

Pump Type	***Method of Delivery***	***Vapor Leakage***	***Flammable Atmosphere in Container***	***Ignition Sources***	***Spill or Leakage Risk***	***Damage from Explosion***
Piston	Suction	Some expected	In most cases, but depends upon limits of flammability.	None expected for pump meeting NFPA requirements for static control and bonding and grounding.	Small risk	Ignition of vapors likely to cause container damage/rupture. Personnel injury likely.
Plunger	Suction	Some expected	In most cases, but depends upon limits of flammability.	None expected for pump meeting NFPA requirements for static control and bonding and grounding.	Small risk	Ignition of vapors likely to cause container damage/rupture. Personnel injury likely.
Pressure	Pressure up to 6 psig	None expected	In most cases, but depends upon limits of flammability.	None expected for pump meeting NFPA requirements for static control and bonding and grounding.	Small risk	Effects of ignition inside container could be more severe, compared to suction or piston pump.

6 APPENDIX A - NFPA 30 REQUIREMENTS FOR DISPENSING, HANDLING, TRANSFER AND USE

18.4 Dispensing, Handling, Transfer, and Use.
18.4.1 Class I liquids shall be kept in closed tanks or containers when not actually in use. Class II and Class III liquids shall be kept in closed tanks or containers when not actually in use when the ambient or process temperature is at or above their flash points.
18.4.2 Where liquids are used or handled, provisions shall be made to promptly and safely mitigate and dispose of leakage or spills.
18.4.3 Class I liquids shall not be used outside closed systems where there are open flames or other ignition sources within the classified areas set forth in Chapter 7.
18.4.4 Transfer of liquids among vessels, containers, tanks, and piping systems by means of air or inert gas pressure shall be permitted only under all of the following conditions:
(1) The vessels, containers, tanks, and piping systems shall be designed for such pressurized transfer and shall be capable of withstanding the anticipated operating pressure.
(2) Safety and operating controls, including pressure-relief devices, shall be provided to prevent overpressure of any part of the system.
(3) Only inert gas shall be used to transfer Class I liquids. Only inert gas shall be used to transfer Class II and Class III liquids that are heated above their flash points.
18.4.5 Positive displacement pumps shall be provided with pressure relief that discharges back to the tank, pump suction, or other suitable location or shall be provided with interlocks to prevent overpressure.
18.4.6 Piping, valves, and fittings shall meet the requirements of Chapter 27.
18.4.7 Listed flexible connectors shall be permitted to be used where vibration exists. Approved hose shall be permitted to be used at transfer stations.
18.4.8* The staging of liquids in containers, intermediate bulk containers, and portable tanks shall be limited to the following:
(1) Containers, intermediate bulk containers, and portable tanks that are in use
(2) Containers, intermediate bulk containers, and portable tanks that were filled during a single shift
(3) Containers, intermediate bulk containers, and portable tanks needed to supply the process for one continuous 24-hour period
(4) Containers, intermediate bulk containers, and portable tanks that are stored in accordance with Chapter 9

18.4.9 Class I, Class II, or Class IIIA liquids used in a process and staged in the process area shall not be filled in the process area.
Exception No. 1: Intermediate bulk containers and portable tanks that meet the requirements of Chapter 9.
Exception No. 2: Intermediate products that are manufactured in the process area.

18.5 Incidental Operations.
18.5.1* This section shall apply to areas where the use, handling, and storage of liquids is only a limited activity to the established occupancy classification.

18.5.2 Class I liquids or Class II and Class III liquids that are heated up to or above their flash points shall be drawn from or transferred into vessels, containers, or portable tanks as follows:
(1) From original shipping containers with a capacity of 5.3 gal (20 L) or less
(2) From safety cans
(3) Through a closed piping system
(4) From portable tanks or containers by means of a device that has antisiphoning protection and that draws through an opening in the top of the tank or container
(5) By gravity through a listed self-closing valve or self-closing faucet
18.5.2.1 If hose is used in the transfer operation, it shall be equipped with a self-closing valve without a hold-open latch in addition to the outlet valve. Only listed or approved hose shall be used.
18.5.2.2 Means shall be provided to minimize generation of static electricity. Such means shall meet the requirements of 6.5.4.
18.5.2.3 Where pumps are used for liquid transfer, means shall be provided to deactivate liquid transfer in the event of a liquid spill or fire.

7 APPENDIX B - CONTAINER TESTING REQUIREMENTS (DOT TITLE 49, PART 178.605 TESTING STANDARD FOR DRUMS)

(d) Test method and pressure to be applied. Metal packagings and composite packagings other than plastic (e.g. , glass, porcelain or stoneware), including their closures, must be subjected to the test pressure for 5 minutes. Plastic packagings and composite packagings (plastic material), including their closures, must be subjected to the test pressure for 30 minutes. This pressure is the one to be marked as required in §178.503(a)(5). The receptacles must be supported in a manner that does not invalidate the test. The test pressure must be applied continuously and evenly, and it must be kept constant throughout the test period. In addition, packagings intended to contain hazardous materials of Packing Group I must be tested to a minimum test pressure of 250 kPa (36 psig). The hydraulic pressure (gauge) applied, taken at the top of the receptacle, and determined by any one of the following methods must be:
(1) Not less than the total gauge pressure measured in the packaging (i.e., the vapor pressure of the filling material and the partial pressure of the air or other inert gas minus 100 kPa (15 psi)) at 55 °C (131 °F), multiplied by a safety factor of 1.5. This total gauge pressure must be determined on the basis of a maximum degree of filling in accordance with §173.24a(d) of this subchapter and a filling temperature of 15 °C (59 °F);
(2) Not less than 1.75 times the vapor pressure at 50 °C (122 °F) of the material to be transported minus 100 kPa (15 psi) but with a minimum test pressure of 100 kPa (15 psig); or
(3) Not less than 1.5 times the vapor pressure at 55 °C (131 °F) of the material to be transported minus 100 kPa (15 psi), but with a minimum test pressure of 100 kPa (15 psig).

Packagings intended to contain hazardous materials of Packing Group I must be tested to a minimum test pressure of 250 kPa (36 psig).
(e) Criteria for passing the test. A package passes the hydrostatic test if, for each test sample, there is no leakage of liquid from the package.
Container Testing Requirements (DOT Title 49, Part 178.605 Testing standard for Drums)

(d) Test method and pressure to be applied. Metal packagings and composite packagings other than plastic (e.g. , glass, porcelain or stoneware), including their closures, must be subjected to the test pressure for 5 minutes. Plastic packagings and composite packagings (plastic material), including their closures, must be subjected to the test pressure for 30 minutes. This pressure is the one to be marked as required in §178.503(a)(5). The receptacles must be supported in a manner that does not invalidate the test. The test pressure must be applied continuously and evenly, and it must be kept constant throughout the test period. In addition, packagings intended to contain hazardous materials of Packing Group I must be tested to a minimum test pressure of 250 kPa (36 psig). The hydraulic pressure (gauge) applied, taken at the top of the receptacle, and determined by any one of the following methods must be:
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(e) Criteria for passing the test. A package passes the hydrostatic test if, for each test sample, there is no leakage of liquid from the package.

APPENDIX C – LEGAL DISCLAIMER AND LIABILITY

(a) Limitation of Liability. The consulting services conducted by Chilworth Technology Inc. (the “Company”) were performed using generally accepted guidelines, standards, and/or practices, which the Company considers reliable. Although the Company performed its consulting services pursuant to reliable and generally accepted practices in the industry, the Company does not guarantee or provide any representations or warranties with respect to Client’s use, interpretation or application of the findings, conclusions, and/or suggestions of the consulting services provided by the Company. Moreover, the findings, conclusions, and the suggestions resulting from the consulting service are based upon certain assumptions, information, documents, and procedures provided by the Customer. AS SUCH, IN NO EVENT AND UNDER NO CIRCUMSTANCE SHALL THE COMPANY BE LIABLE FOR SPECIAL, INDIRECT, PUNITIVE OR CONSEQUENTIAL DAMAGES OF ANY NATURE WHATSOEVER, INCLUDING WITHOUT LIMITATION, ANY LOST REVENUE OR PROFITS OF THE CUSTOMER OR ITS CUSTOMERS, AGENTS AND DISTRIBUTORS, RESULTING FROM, ARISING OUT OF OR IN CONNECTION WITH, THE SERVICES PROVIDED BY THE COMPANY. The Customer agrees that the Company shall have no liability for damages, which may result from Client’s use, interpretation or application of the consulting services provided by the Company.

(b) The Company’s pricing of the consulting services provided does not contemplate that the Company shall have any liability resulting from its performance of the consulting services, except as otherwise set forth in the Quotation from the Company. Accordingly, the Customer shall indemnify and hold harmless the Company, its shareholders, directors, officers, employees and agents (the “Indemnified Parties”) from and against any and all loss, cost, liability and expense, including reasonable attorney’s fees and costs, which any of the Indemnified Parties may incur, sustain or be subject to, as a result of any claim, demand, action, investigation or proceeding arising out of or relating to either: (a) the consulting services provided by the Company; or (b) any material, equipment, specifications or safety information (or lack thereof) supplied to the Company (or which should have been supplied to the Company) by Customer and/or any failure of such materials, equipment, specifications and safety information to comply with any federal, state or local law or safety standard.

(c) For additional terms and conditions, which apply with respect to the provision of this report, see the Quotation provided by the Company and executed by Customer. If any terms set forth in the Quotation conflict with the terms set forth herein, the terms set forth herein shall apply.