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WORKING GROUP ON GAS RECEPTACLES AND MULTIPLE ELEMENTS GAS CONTAINERS (MEGCS)

Risk Assessment on the Use of Pressure Relief Devices on Pressure Receptacles

Informal document transmitted by the European Industrial Gases Association (EIGA)

1. Introduction

The Working Group is confronted with two well-established practices; North American which fits pressure relief devices to nearly all gas cylinders and the practice in Europe, Africa, China, India and S E Asia where pressure relief devices are rarely used. Clearly, both practices are considered safe in their respective regions of the world, so the arguments for and against their use are finely balanced. This paper attempts to assist the working group to reach a conclusion in its consideration of this matter by summarising the arguments in the form of a qualitative risk assessment. It concludes that the balance of risks to the public favours the elimination of pressure relief devices except in a few specific circumstances. This opinion is shared by all the major international industrial gases companies.

This paper is concerned only with compressed, liquefied and dissolved gases and does not refer to refrigerated liquefied gases. Also, it does not address the issue in relation to LPG, for which product EIGA is not expert, however other liquefied gases are covered. The pressure relief devices considered are bursting discs, fusible plugs and spring loaded pressure actuated valves.

The first step in risk assessment is to identify the hazards. The table in section 2 lists all the safety hazards associated with product and pressure containment during the transport and use of gas cylinders. Hazards irrelevant to product containment, such as injuries caused by manual handling cylinders, are therefore excluded.

Following the table is a discussion of the risks associated with each hazard as they relate to the fitting of pressure relief devices. The final column of the table lists the paragraph of section 3 of this paper where the risk discussion is presented.

2. Hazard identification chart

The derivation of this list has taken into account, normal and abnormal use, normal transport, traffic accidents and fire engulfment in both transport and use.

Hazard	How caused	Controls in place	PRD relevant	Discussion section no.
Normal transport and use				
Product release	Leaking valve (excluding the PRD)	Fill procedures, periodic inspection,	No	3.1
	Leaking neck thread	Fill procedures, periodic inspection,	No	3.1
	Mishandling causing valve or cylinder damage	Fill procedures, valve design and protection, stowage, cylinder design standard	No	3.1
	Hole in cylinder	Design, manufacture and test standard, control of moisture, fill procedures, periodic inspection,	No	3.2
	Leaking or failed PRD	Fill procedures, periodic inspection,	Yes	3.3
Catastrophic failure of the cylinder	Overfilling	Fill procedures	Yes	3.4
	Overheating	Fill procedures, storage regulations	Yes	3.5
	Manufacturing defect	Design, manufacture and test standard, periodic inspection	No	3.6
	Internal corrosion	Product quality control, periodic inspection, positive pressure non return valve	No	3.6
	External corrosion	Fill procedures, periodic inspection,	No	3.6
	Previous fire damage	Fill procedures, periodic inspection,	No	3.6
Fire engulfment				
Product release	PRD operates	Storage regulations in use, Stowage regulations in transport	Yes	3.7
Catastrophic failure of the cylinder	Pressure rise causes over pressure	Storage regulations in use, Stowage regulations in transport	Yes	3.7
Major impact (e.g. Road traffic accident, building collapse)				
Product release	Valve or cylinder damage	Stowage regulations, valve guards, valve design	No	3.8
Catastrophic failure of the cylinder	Crushing of cylinder	Stowage regulations, PRD protects against very slow pressure rise only	No	3.8

3 Risk Assessment

3.1 Product release caused by leaking valve or neck thread, mishandling damage

The pressure relief device fitted to gas receptacles has no effect on this form of product release. The causal factors all relate to mechanical effects and not influenced by over-pressure protection.

3.2 Product release caused by a hole in the receptacle

The controls listed in section 2 all play a part in ensuring the integrity of the receptacle. Modern cylinders such as those manufactured according to the ISO standards have much greater consistency than in the past; seamless cylinders are subject to mandatory ultrasonic testing and steels are much cleaner. The material properties are specified such that the cylinders will tolerate defects which lead to holes in the wall without catastrophic failure, the so-called 'leak before burst' behaviour.

Modern gas production techniques also give greater purity and consistent dryness of the gas so the risks of corrosion damage compromising the integrity of the receptacle are much reduced. In those service conditions where moisture or other back feed of contaminants is known to be a problem, the industry has sponsored the development and use of positive pressure non return valves which ensure that a residue of clean gas is always present in the receptacle.

Against this background, the presence of a PRD is irrelevant. The mechanisms of defect propagation are related to the metallurgy of the receptacle, the chemical environment, time and stress. Normally managed compressed gas cylinders are highly stressed when filled and the stress level diminishes during use until refilled. Cylinders containing liquefied gases spend their lives at a more or less constant pressure and hence stress (except when emptied of liquid). Receptacle over-pressure will only occur during incorrect operation or abuse and the relative time spent at abnormal stress levels will be too short to have a significant effect on the defect propagation. Once a defect has started to propagate, it will eventually propagate to receptacle failure or until detection during periodic inspection. The possible contribution over pressure might make to any process of degradation is negligible, so the PRD, in relieving over-pressure does not contribute to the reduction of risk from product release through a hole in the receptacle.

3.3 Leaking PRD's

Leaking PRD's are the most obvious downside of their use. Leakage can occur at any time in the life cycle of the PRD and invariably add to the risk of transport and use. The causes of leakage are grouped by PRD type:

Bursting disc

Vibration causing fatigue of the bursting element;
Corrosion of the external surface of the disc due to atmospheric effects and weathering;
Corrosion of the or internal surface due to stress corrosion cracking;
Failure at a reduced pressure due to manufacturing variation in thickness;
Leakage from the threaded attachment to the cylinder or valve body.

Fusible plugs

Extrusion of the fusible element due to vibration, particularly during transport;
Leakage from the threaded attachment to the cylinder or valve body.

Spring loaded devices

Failure of the spring due to corrosion, crack propagation or other change of properties with time such as creep;
Deterioration of he seat either due to atmospheric and temperature effects or due to degradation of its properties with time;
Contamination of the seat with debris;
Leakage from the threaded attachment to the cylinder or valve body.

The leakage of these devices is by no means uncommon. Numerical data on the frequency of leakage from PRDs on cylinders is not available to us but it clearly is one of the leading causes of quality non conformance in the supply of gases in cylinders.

One of the frustrations for industrial gas companies is that there are no effective means of inspecting these devices to detect imminent failure. The only remedy, apart from routine replacement at periodic inspection, is removal from service when leakage is found when inspecting, filling, transporting or as a customer complaint.

The consequence of leakage depends upon the chemical nature of the gas, but in all cases, the risks in transportation and use are increased due to product release causing the hazards of asphyxiation, increased oxidation rate, fire, explosion and poisoning. The harm caused is influenced by nature of the space occupied by the cylinder and the size of the leak. The premature operation of a bursting disc always involves a large gas release, although other forms of release are usually relatively slow. When the space is confined, however, even a slow release can cause a severe hazard. It should be remembered, that the UN Model Regulations are aimed at multi-modal transport and in some modes, the release from a PRD may not disperse safely.

In use, the dispersal of such leaks is always problematic. By definition, use involves the presence of some person or persons in the vicinity. Although purpose built storage is well ventilated, small volume users tend to store cylinders in spaces not designed for the purpose and run the risk of exposure to the hazards of PRD leaks.

In summary, the aim of all suppliers of gases in receptacles is to provide a safe and leak-free package. The widespread use of PRDs causes a large number of incidents of leakage which the European practice virtually eliminates.

3.4 Overfilling

Overfilling can lead to receptacle failure and a PRD will prevent this. Fitting a PRD is not a proper method of controlling the risks of overfilling, that must be achieved by a safe filling process, but when that process breaks down, the PRD will prevent receptacle failure. However, for the reasons given above,

fitting PRDs gives the disadvantages of product release and leakage. Consideration of the risks of overfilling falls into two distinct categories, depending upon whether the gas liquefies under pressure or not.
The filling process of compressed gas can be readily controlled by pressure so that inaccuracy in meeting the target settled pressure is very modest and gross overfilling is a very rare event. It usually occurs only in the case when the filler misidentifies the cylinder working pressure and in practice, normal filling controls and checks prevent such gross errors. Because the developed pressure of compressed gases follows the gas laws, changes in ambient temperature do not lead to over-stressing of the receptacle even when the filling pressure controls have allowed a filling pressure at the top end of the range of variability. Experience has shown that the risks of failure of the receptacle due to overfilling compressed gases are very low and do not warrant the known frequent risk of PRD unreliability.

Gases which liquefy under pressure are usually filled by weight. Although weight can be controlled accurately, problems of correctly identifying the tare can lead to errors in filling. If a liquefied gas is overfilled, as ambient temperature rises and the liquid expands to fill the receptacle, the pressure subsequently rises very rapidly. In low pressure liquefied gas receptacles, the welded steel construction can accommodate this expansion by stretching the receptacle wall to the limits of its ductility before failure occurs. High pressure liquefied gases such as carbon dioxide and nitrous oxide, however, are contained in thick walled seamless receptacles which cannot expand plastically to the same extent before failure, and for this reason EIGA recommends that PRDs in the form of bursting discs should be fitted. This recommendation extends only to non flammable and non toxic gases. The risks of product release outweighing the benefit for other gases.

3.5 Overheating

The filling rules for gases are designed to allow for ambient temperatures up to 65°C, and in practice the circumstances in which this temperature can be exceeded are very rare and are outside all the regulations and guidance (e.g. NFPA 55) given for transport, storage and use. In practice, the incidence of adverse events due to overheating is so low that the fitting of PRDs is not warranted. Typically, a PRD would only come into play when the receptacle had been both overfilled as well as overheated.

By way of illustration, compressed gases behave in a close approximation to an ideal gas and a modern 200 bar cylinder will burst at 550 bar. In order to develop this burst pressure, a cylinder filled at 15°Celsius (288°K) would need to be heated to (550 x 288)/200 degrees Kelvin = 519°C. At temperatures as high as this, the non metallic components of the valve will decompose allowing gas to escape, providing some relief of pressure and further delay in failure of the receptacle.

3.6 Cylinder Defects

The presence of a PRD is irrelevant to the incidence of failure due to the defects caused by manufacturing, internal or external corrosion, or fire damage. As discussed in section 3.2, the mechanisms of defect propagation will not be influenced to any measurable degree by the PRD's limiting excessive stress during the brief periods of receptacle abuse.

3.7 Fire Engulfment

Fire engulfment is the prime circumstance which is widely believed to merit the fitting of PRD. A PRD

will delay bursting of the receptacle. It will not, however, eliminate bursting and many cases have been reported of cylinders with PRDs bursting as the fire progresses.
In practice, the advantage gained by the delay in bursting of the cylinder is more theoretical than real. Since every cylinder is likely to fail catastrophically in a fire, the emergency services must treat all as if their failure was imminent. When the fire fighters arrive at an incident in progress, they cannot calculate the time for which the receptacle has been exposed to high temperature, nor can they know how long it will be before catastrophic failure occurs. The only safe course, which is adopted universally, is to deluge the receptacle with water from a distance and this will mitigate the hazard regardless of whether a PRD is fitted or not.

One of the key parameters in a fire emergency is how long is available to evacuate personnel from the area of danger. PRD's releasing product in the early stages of a fire compromise this evacuation time by creating additional risk to personnel. European experience of rescuing people from fires is that there is sufficient time before receptacle failure to evacuate the premises.

The calculation given in section 3.5 shows that compressed gas cylinders have to be elevated to high temperature before they will burst and this will take a considerable time.

The downside of PRDs in a fire is that product is released, adding to the hazardous conditions in an unpredictable way. If the contents are flammable, a minor fire can be turned into an inferno, leading to very rapid escalation of the emergency and rendering control of the situation more difficult. Toxic releases create an obvious hazard over a wide area. Even non toxic non flammable gases can be hazardous, oxygen will obviously add to the fire intensity and other gases may cause an unexpected asphyxiation hazard.

Dissolved acetylene deserves a special mention. Whereas the practice in the mainland of Europe has been to not fit PRDs to acetylene cylinders, the UK followed the North American practice of fitting PRDs. As a consequence of harmonisation in Europe, the UK had to reconsider its practice and this lead to an extensive piece of experimental research conducted by the UK's Health and Safety Executive. Briefly, the work concluded that the fitting of PRDs to acetylene cylinders did not prevent the catastrophic failure caused by either pool fires or flame impingement. The HSE now supports the removal of PRDs from existing acetylene cylinders. EIGA hopes that this work will be presented by the UK delegation to the Working Group.

3.8 Major Impact

Any impact on a receptacle in a transport or use accident which is likely to crush a receptacle will occur at such a high rate that the rise in pressure will be very fast. The PRD would be unable to cope with the flow necessary to release the product and thus, the receptacle will still be liable to burst whether or not a PRD is fitted.

4.0 Conclusions

4.1. Of all the hazard scenarios which have been identified, PRDs are of value only in the circumstances of fire engulfment and overfilling.

4.2. The use of PRDs to delay or eliminate the bursting of a receptacle engulfed in fire is, however, of questionable value. The value of the delay is compromised because the emergency services cannot estimate for how long they can safely approach the receptacle. The only safe action is to deluge the receptacle with water from a distance. Compressed gas cylinders take a long time to reach their burst pressure in a fire.

4.3. The PRD's early release of product in a fire can complicate or compromise the evacuation of personnel. The release of oxidising, flammable and toxic gases will always increase the risks to evacuating personnel and fire fighters.

4.4. PRDs have value in eliminating rupture due to overfilled receptacles containing high pressure liquefied non flammable non toxic gases. The balance of risks in use and transport suggests that they should not be fitted to low pressure liquefied gases. PRDs have very limited value in controlling the risks associated with overfilling compressed gases and the benefit of their use is too small to counterbalance their associated risk of product release and leakage.

4.5. A UK government sponsored experimental research programme to determine the value of PRDs in dissolved acetylene service concluded that their use was not justified since they did not prevent catastrophic cylinder rupture in a fire.

4.6. All the major international gas companies have the opinion that PRDs should be eliminated whenever possible. In order to support its view, Air Products, for example, have prepared a quantitative study, based on US practice. A copy is attached for information.

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Air Products Position Statement on the Removal of Pressure Relief Devices from Cylinders

Question:
Should pressure relief devices (PRDs) be installed on cylinders and tube trailers covered by CGA S1.1?

Answer:
No. Air Products recommends that PRDs be removed from all cylinders and tube trailers covered by CGA S1.1, except for those containing high-pressure, liquefied compressed gases that are non-toxic and non-flammable.

Reasons:
The risk associated with the premature failure of a PRD is greater than the risk associated with the rupture of a cylinder or tube trailer. The attached analysis provides a quantified assessment of the relative risk and consequences associated with these two events. The attached is a relative risk analysis for cylinders only (A-size and smaller). However, similar relative risk analysis and conclusions can also be drawn on tube trailers.

Background:
The purpose of a pressure relief device on a cylinder is to relieve an overpressure which might otherwise rupture the wall of the cylinder. The rupture of a cylinder causes rapid energy release of the expanding gas (PV blast) and may release fragments from the cylinder wall. This constitutes a mechanical hazard to people in the vicinity of the cylinder(s).

For cylinders containing hazardous lading, a rupture of the cylinder wall may also raise the concentration of lading in the air to toxic, explosive, flammable, corrosive, or asphyxiating levels. This constitutes an additional chemical hazard to people in the vicinity of the cylinder(s).

Sources of overpressure include: external fire, overfilling a cylinder, warming a cylinder due to ambient temperature rise, and internal reaction of the contents. This analysis will only consider external fire. Cylinders in most services are protected by fusemetal devices that are designed to only operate in a fire. Other sources of overpressure must be prevented with proper operating procedures, and relief devices or controls installed in the filling equipment, not on the cylinder.

Current requirements for pressure relief devices:
CGA S1.1 Pressure Relief Device Standards Part 1- Cylinders for Compressed Gases lists the required relief devices for cylinders based on the lading. Relief devices are **prohibited** on cylinders containing toxic substances

(LC50 <200 ppm). Relief devices are **not required** on cylinders containing approximately 40 other substances and relief devices are **required** on cylinders containing the remaining substances. The relief device types include: rupture disks (CG-1), fusible plugs (CG-2, 3, and 9), rupture disks with fusible alloy backing (CG-4 and 5), pressure relief valves (CG-7), and rupture disks used in series with pressure relief valves (CG-8).

Relief devices are **not** mandatory in countries covered by the European Industrial Gases Association (EIGA) and are generally not used. Only cylinders containing carbon dioxide and nitrous oxide are commonly and voluntarily fitted with relief devices. These are high-pressure, non-toxic, non-flammable liquefied compressed gases which can develop pressures higher than the test pressure of the cylinder if the reference temperature (65°C/149°F) or the maximum allowed filling ratio is exceeded. A small number of countries also mandate devices on liquefied propane gas and acetylene.

Premature Failures of Relief Devices:
Based on historical data, premature failures of devices are far more prevalent than vessel overpressures due to fire. Failure mechanisms include disk failures due to fatigue or corrosion, fusemetal extrusion at ambient temperatures, relief valve seat leakage, physical damage to devices, and thread leakage where the device is connected to the cylinder.

Dispersion of Lading due to Premature Failure of Relief Devices:
A premature failure of a relief device releases lading to the atmosphere when no overpressure situation exists. People can be exposed to a hazard without prior warning, and may not have the opportunity to protect themselves from injury. All dispersion calculations done in this analysis are based on a release through a 1/4" diameter orifice that is dispersed per EPA's RMP alternate release scenario (atmospheric stability - D, wind speed - 3 m/s) listed in RMP Offsite Consequence Analysis Guidance, Docket A-91-73 Category VIII-A, Environmental Protection Agency, Washington, DC, May 24, 1996.

Note that this analysis assumes cylinders in an open field. If cylinders are located within a building, the consequences of a premature PRD failure will likely be worse.

Evacuation Time and Distance from a Pool Fire:
When a cylinder **without a PRD** is engulfed in a pool fire, there is approximately **five minutes** (see ** below) available to evacuate the area to a safe location before a vessel rupture occurs. This is based on an analysis using NRC's Guideline for Hypothetical Transportation Accidents (10 CFR Part 71.73). During this five minutes, people will naturally be driven from the pool fire surrounding the cylinders to a distance where the radiant heat is tolerable (less than 800 BTU/ft^2-hr). By modeling the fire as a point source using experimental data from the Shell Research Limited Report (Work Package No. FL1), February 1991, it can be determined that a person will be driven **22 feet** from a one meter diameter pool fire.

Note that if a cylinder **is** equipped with a PRD, the vessel wall may not rupture in a fire (if the device is working properly), but the PRD will release the contents of the cylinder more quickly and people will have less time to evacuate the area and protect themselves from the chemical hazards associated with the lading.

** Actual cases of cylinders engulfed in fire indicate that the five minutes shown here is conservative and actual evacuation times are approximately 15-30 minutes.

Relative risk:

If the premature failure of a relief device and dispersion of the lading poses a greater risk to people than the rupture of a cylinder wall, then the device should be removed. The components in the risk assessment include the relative frequency of occurrence of the event (premature relief device failure versus engulfing fire which results in vessel rupture), the consequence of the event, the area affected by the event, and the probability that someone will be inside the affected area.

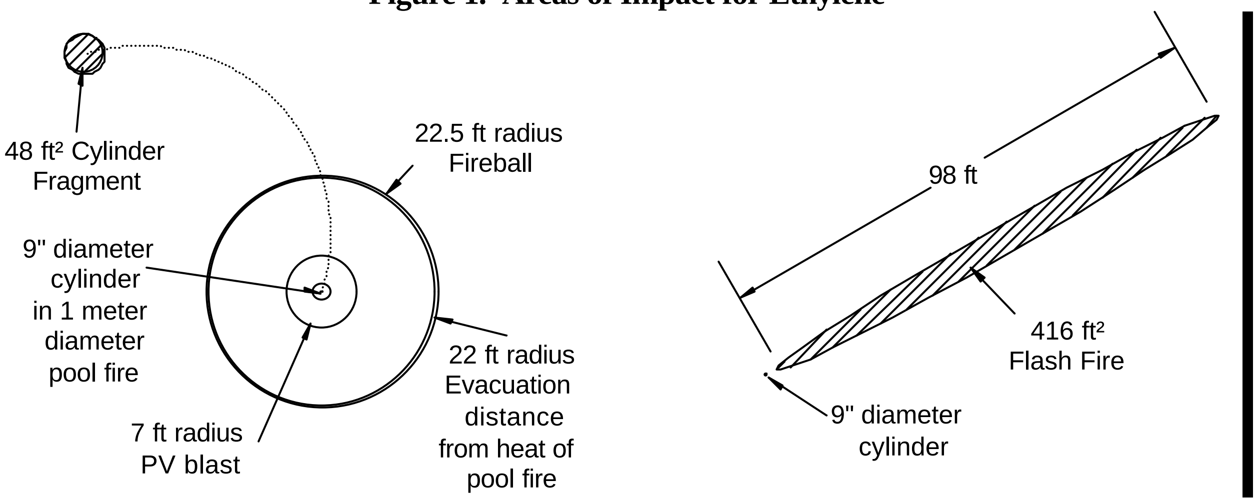
Assessment of Relative Risk for Flammable Lading:

If a cylinder with no PRD and flammable lading is engulfed in a pool fire, the consequences may include PV blast, fireball, and the projection of cylinder fragment(s). If a cylinder with a PRD has a device that fails prematurely, the consequence may be a flash fire that extends to a point where the concentration of the gas falls below the Lower Flammability Limit (LFL). Figure 1 illustrates these areas for ethylene. If a person is located inside the "area of impact", then serious injury is likely.

Note that the PV blast and fireball radii of impact are approximately less than or equal to 22 feet, which means a person will be driven out beyond the danger area by the heat of the pool fire. In order to have a serious injury for a cylinder without a PRD, a person would have to be located in the 48 ft^2 area where an airborne A-sized cylinder fragment landed.

For all flammable gases studied, the area of impact for a failed relief device is greater than the area of impact for a cylinder with no PRD. This indicates that it is more hazardous to have a relief device than to remove it.

Figure 1. Areas of Impact for Ethylene



Consequence of Pool Fire
(lower frequency event, time available to evacuate)

Consequence of PRD Failure
(higher frequency event, limited warning/time to evacuate)

Assessment of Relative Risk for Toxic Lading (LC50<200 ppm):
Premature release of toxic substances is a serious hazard, and is the basis for the CGA and EIGA prohibiting relief devices in these services. Table 1 shows that if a 1/4" diameter device was allowed and it failed prematurely, the area with a toxic concentration higher than the IDLH (Immediately Dangerous to Life or Health) value is significant. Since the frequency of occurrence of a relief device failure is much higher than the frequency of occurrence of a vessel rupture, it is clearly more hazardous to have a relief device than to prohibit it.

Table 1. Toxic Gases (LC50<200 ppm)
Consequences of Engulfing Fire versus Relief Device Failure

Name of gas	Cylinder Size	Pressure at 70° F (psig)	IDLH (ppm)	Area above IDLH (sq. ft.)	Effects of exposure
Arsine	D	205	3	240540	Strong hemolytic agent and nerve poison
Fluorine	A	400	25	70872	Extremely irritating & corrosive to tissues
Phosphine	D	593	50	50604	Irritation, central nervous & GI systems

Assessment of Relative Risk for Toxic Lading (200 ppm< LC50<5000 ppm):
Premature release of toxic substances with LC50 between 200 ppm and 5000 ppm can still present a serious hazard, but relief devices for these substances are not prohibited by the CGA. Table 2 shows that if a 1/4" diameter device fails prematurely, the area with a toxic concentration higher than the IDHL is still significant, and in the case of boron trifluoride, it is greater than the areas associated with fluorine and phosphine (gases that are prohibited from having PRDs). Since the area of impact is large and the frequency of occurrence of a relief device failure is much higher than the frequency of occurrence of a vessel rupture, it is still more hazardous to have a relief device than to prohibit it.

Table 2. Toxic Gases (200 ppm < LC50 < 5000 ppm)

Consequences of Engulfing Fire versus Relief Device Failure

Name of gas	Cylinder Size	Pressure at 70° F (psig)	IDLH (ppm)	Area above IDLH (sq. ft.)	Effects of exposure
Boron Trifluoride	B	1000	25	128840	Irritation
Hydrogen Bromide	B	320	30	30864	Eye, skin, respiratory tract irritation
Hydrogen Sulfide	A	247	100	9046	Sudden death; nervous system
Carbon Monoxide	A	2000	1200	6229	Anoxia; cardiovascular & nervous system

Assessment of Relative Risk for Oxidizer and Inert Lading:

Premature releases of oxidizers can lower the flammability limit of substances in the area and promote rapid combustion. Premature releases of inert substances can displace oxygen and present an asphyxiation hazard. Many inerts are colorless and odorless and victims of asphyxiation will have no prior warning. Although Table 3 shows that the area of impact for a premature release of oxygen and nitrogen is less than the area of impact of a cylinder fragment, the risk may still be greater since the frequency of occurrence of a relief device failure is significantly greater than the frequency of occurrence of a vessel overpressure.

Table 3. Oxygen and Nitrogen Cylinders

Consequences of Engulfing Fire versus Relief Device Failure "A" sized cylinders at 2400 psig

Name of gas	Consequence of Cylinder Rupture (no PRD)	Area of impact of fragment (sq ft)	Consequence of PRD failure	O2 Mole% of Concern	Area impacted by PRD failure (sq. ft.)	Area ratio (PRD: No PRD)
Oxygen	Cylinder Fragment	48	Promoted Ignition	30%	43	0.89
Nitrogen	Cylinder Fragment	48	Asphyxiation	12%	12	0.24

Conclusions:

If a cylinder with **no PRD** is exposed to a pool fire, people will be driven away by the heat of the fire to a distance that protects them from two hazards (PV blast and fireball). They will also have a minimum of five minutes to initiate evacuation procedures to protect themselves from the remaining hazards: projection of cylinder fragment(s) and release of dangerous concentrations of lading into the air.

For a cylinder is equipped with a PRD, there is the added hazard of a premature PRD failure which will release the contents of the cylinder with little or no warning. In the cases of flammable and toxic lading, the area of impact is large and the chance of serious injury due to a flash fire or a toxic concentration is much greater than the chance of serious injury due to being hit by a cylinder fragment. Even in the cases of oxidizer and inert lading, the chance of serious injury due to promoted ignition or asphyxiation may be much greater than that of being hit by a cylinder fragment. This can be quantified if data can be collected to confirm that PRDs fail much more frequently than cylinders are engulfed in fires.

PRDs are already prohibited on cylinders with toxic lading because the risk of premature release is greater than the risk of vessel rupture. The same logic can clearly be applied to flammable and less-toxic substances. The data is less clear for oxidizer and inert substances, but failure frequency data on PRDs is likely to support removal of PRDs in these services, too.