Cryogen Handling and Safety Training University of Nebraska-Lincoln

Presented by

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Praxair Distribution Inc.

Overview

- ***Dangers of Cryogenic liquids***
- ***Preventing Dangers***
- ***Proper PPE***
- ***Proper Handling and Transporting of cryogen liquids***

What is a CRYOGEN?

Cryogenic liquids are liquefied gases

Temperatures: below -73C (-100F) and a

Normal Boiling Point: below -150C (-123F)

<u>Cryogenic liquids commonly used at UNL include</u>:

****Liquid Nitrogen** ***Liquid Argon***

****Liquid Oxygen** ***Liquid Carbon Dioxide***

****Liquid Helium***

What Are The Dangers of Cryogens?

- ***Asphyxiation***
- ***Frostbite / Skin Damage***
- ***Over Pressurization***

Asphyxiation

Things that Endanger Your Life

- ***Three (3) Weeks without Food***
- ***Three (3) Days without Water***
- ***Three (3) Minutes without Air***
- *One (1) Breath without Oxygen*

Asphyxiation

- ***Asphyxiation Defined***
  - ***Oxygen deficiency - less than 19.5% oxygen in the atmosphere***
  - ***Can result in headache, drowsiness, dizziness, excitation, excess salivation, vomiting, unconsciousness…death***
    - *Asphyxiation can occur rapidly and without warning*
- ***Oxygen is normally present at about 21% of normal air. When it falls below 18% we do not have enough oxygen to function normally.***

Asphyxiation Incidents

- *IMPORTANT TO REMEMBER, EVEN IN AREAS WHERE TRAINING IS CONSTANT AND ONGOING…*
  Praxair Incidents over the years…
  - ***3 Fatalities***
  - ***3 rendered unconscious***
  - ***6 near miss with fatality potential***

Asphyxiation Incidents

It only takes a moment …

A man who was installing an M.R.I. machine at New York Presbyterian Hospital was killed yesterday, apparently after nitrogen he was using leaked from its tank, officials said. Six other people were injured in the incident. The worker, Paul Ambrose, 25, of England, died about 11:25 a.m., apparently from asphyxiation, while working in a poorly ventilated trailer alongside the hospital on 70th Street and York Avenue, said Mayor Rudolph W. Giuliani, who arrived at the hospital shortly after the incident occurred. Two other workers, after learning that Mr. Ambrose had not left the trailer, went back inside and found him unconscious, the authorities said. The two workers and four other people in the vicinity complained of varying degrees of lightheadedness. They were treated at the hospital and released.

21 September 2000; *NY Times* by Eun Lee Koh

Attempting to rescue the asphyxiated victim can lead to death of the rescuers if they do not have proper PPE! Lack of ventilation, even in a large space, significantly increases the risk

Asphyxiation Incidents

It only takes a moment …

Clinical and morphological aspects of death due to liquid nitrogen

International Journal of Legal Medicine **111**, 191 195 (1998)

A 24 year old student died while filling flasks with liquid nitrogen.…The student had worked alone …without a working ventilation system. While filling the third flask he lost consciousness. .. .The liquid nitrogen which was still escaping spread over the floor and vaporized. The student died from asphyxia due to oxygen deficiency in an atmosphere of nitrogen.

No back-up in the event of an emergency!

Lack of ventilation, even in a large space, significantly increases the risk of a fatality!

Preventing Asphyxiation

- ***Ensure well ventilated storage areas***
- ***DO NOT Enter a confined space***
- ***Rescue Efforts- Get Help***
  - ***More than 60% of confined space fatalities are the result of rescue attempts***
- ***Prevention***
  - ***Oxygen monitors- alarm when oxygen levels get below 19.5%, alerting anyone in the room of the oxygen-deficient atmosphere before dangerous levels are reached.***
  - ***Safety knowledge***
    - *Read labels and MSDS's carefully*

Asphyxiation Summary

- ***If you hear a gas leak***
- ***If you see cold vapors***
- ***If you have symptoms of general malaise***
- ***If a colleague lies unconscious***

Cryoburns/Frostbite

Cryogenic Liquids & Frostbite

- ***Cryogens Liquids are Extremely cold (less than -159 F, -60 C)***
- ***Contact with skin and eyes can cause immediate severe frostbite and damage.***

Ways to expose yourself to frostbite or cryoburns

1) Directly by touching the liquid with your skin

The low viscosity of cryogenic liquids means that they will penetrate woven or other porous clothing materials much faster than, for example, water.

2) Indirectly by touching something cooled by the cryogenic liquid, like a metal

3) Indirectly by exposure of skin or eyes to the cold gas coming out of a the pressure relief valve at the end of the transfer line.

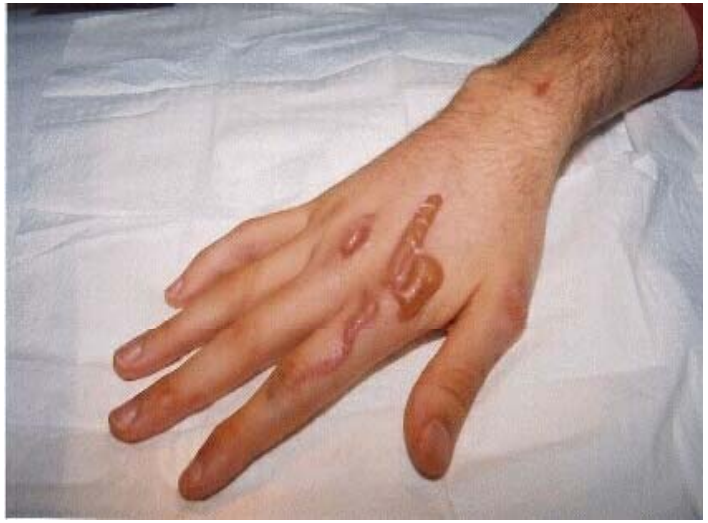
Frostbite / Skin Damage

- ***Preventing Frostbite / Skin Damage***
  - ***Safety Awareness***
  - ***Correct PPE (Personal Protective Equipment)***
    - *Remove Jewelry*
    - *Shoes*
    - *Long sleeves*
    - *Pants – no cuffs!*
    - *Face Shield*
    - *Eyewear*
    - *Gloves (loose fitting, insulated)*

Liquid Nitrogen Accident
UNSW School of Physics, May 2003

Injury-

The principal cause of the INJURY was liquid nitrogen caught in the glove from severe splashing. The glove was not inside the sleeve of the coat.



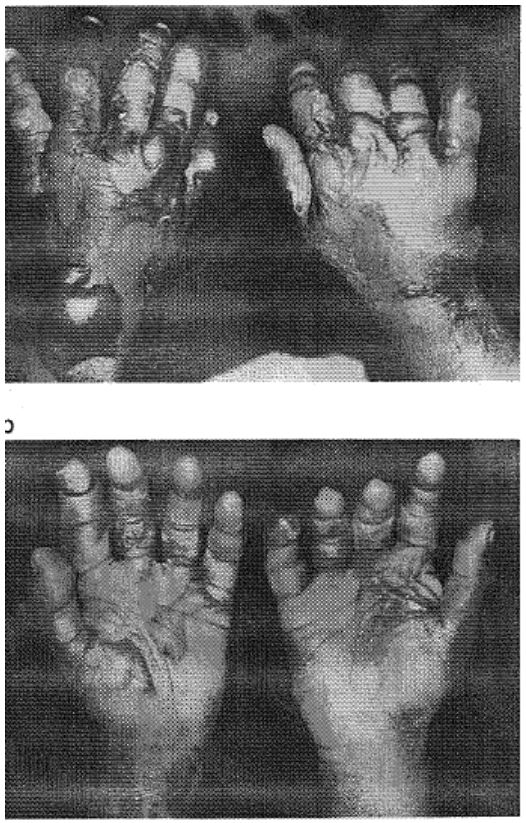
Liquid Helium Accident

Photograph of hands two days after exposure to LHe by spilling in gloves

(a) dorsal and

(b) palmar view.

Note the blister formation especially around the wrists



P. Kumar and P.T. Chirayil, "Helium Vapor Injury: A Case Report", Burns 25 (1999) 265

Overpressurization of Cryogen Storage Vessels

Cryogen Expansion

Gas	Boiling Point (F)	Expansion Ratio
Nitrogen (LN2)	77.4	684
Helium (LHE)	4.22	748

As a cryogen boils off, it's volume increases by a factor of 700 - This can result in high pressures that may cause explosions

Proper Handling is Critical !

Over Pressurization of Liquid Cryogens

- ***Rapid expansion ratio from liquid to gas up to 700 times***
- ***Store and use cryogenic liquids with adequate ventilation***
- ***Use Safety Devices to prevent pressure build up***
  - ***Pressure Controlling Valve***
  - ***Pressure Relief Device***

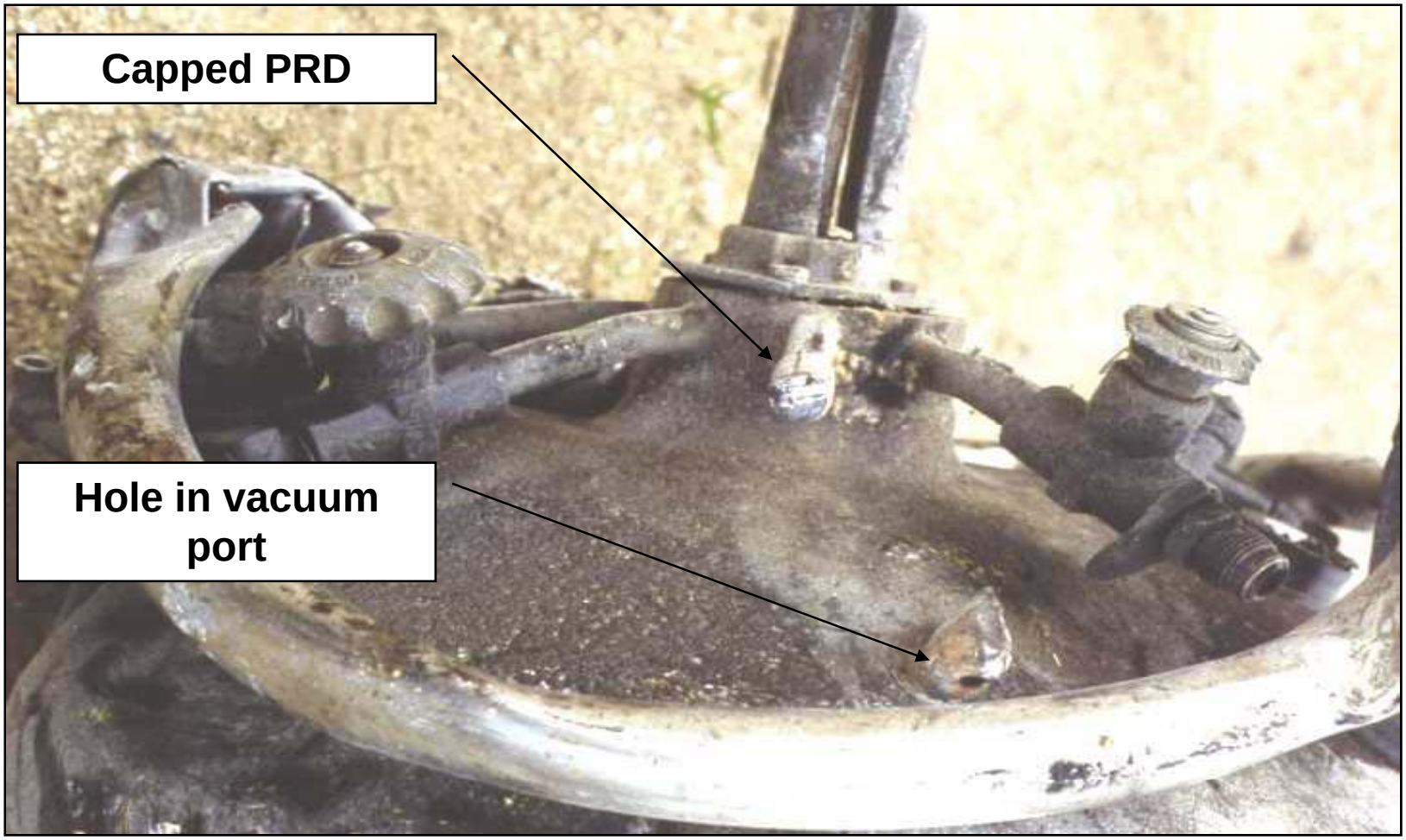
Cryogenic containers should not be filled past 80% of capacity to account for the expansion of gases.

Overpressurization-Explosion

By leaving a LHe or LH2 dewar transfer valve open such that as the initial boiloff decreases, air can get into the dewar and freeze solid, resulting in a plug inside the dewar. This prevents the pressure relief valves from working, resulting in a slow buildup of pressure!

The dewar on the right is what the dewar on the left looked like, prior to having its pressure relief valves sealed. This was after the dewar went through the floor above at Texas A&M University.

Overpressurization-Explosion



Overpressurization-Explosion

Overpressurization - Prevention

- ***All gas cylinders, containers, storage tanks and process systems must have PRDs installed***
- ***PRDs must be installed anywhere liquefied gases can be trapped***
- ***Thoroughly inspect cylinders for damage.***

Transfer – Transport - PPE

- ***Transfilling between small containers***

  ***Fill slowly – minimize the stress and reaction of a 'hot' vessel**

  ***Do not overfill – watch out – container lids have a necktube**

Transfer – Transport - PPE

- ***Transfilling from large storage dewar to small containers***

  ****Phase separate and transfill hose help control the process and reduce splash and sputter***

  ****Always follow instructions supplied with dewars and their accessories***

Protective Equipment

- ***Proper PPE includes long sleeves, pants with no cuffs, safety glasses, face shields, and cryogloves.***

PPE

Wear this PPE after removing all jewelry:

- ***Lab coat with sleeves fully extended to the wrists***
- ***Safety Glasses/splash goggles and Face Shield – Always wear a face shield during transfill process***
- ***Loose insulated gloves***
- ***Full-length pants***
- ***Rubber apron***
- ***Closed-toe shoes.***

Protective Equipment

- ***Oxygen Monitors for confined space environments***

Transporting Cryogens Safely

Transporting Cryogenic Liquid

Small Portable Containers

- ***Designed for little to no internal pressure***
- ***Keep containers upright, except when pouring liquid according to safe procedure***
- ***Use only loose-fitting neck tube core supplied with container***

Transporting Cryogenic Liquids

Large Storage Containers:

- ***Always use a cart – DO NOT "walk", roll or drag***
- ***Be vigilant against ice formation on valves***
- ***Always check that PRV/venting is not restricted***

First Aid Measures

- ***Inhalation***
  - ***Remove to fresh air***
  - ***Artificial Respiration***
  - ***Call for help***
- ***Skin Contact***
  - ***For liquid exposure- warm frostbite with warm water. Severe exposure, remove clothing while showering***
- ***Eye Contact***
  - ***Immediately flush eyes thoroughly with warm water for at least 15 minutes***
  - ***See physician.***

Emergency Considerations

- ***What is your Emergency Response Plan?***

Praxair contacts

Local Contact:	***Regional Contact:***
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