



CVCSD

Bakersfield - March 19, 2015

Facility Incident Case Studies

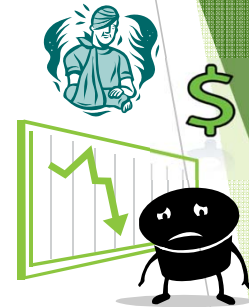
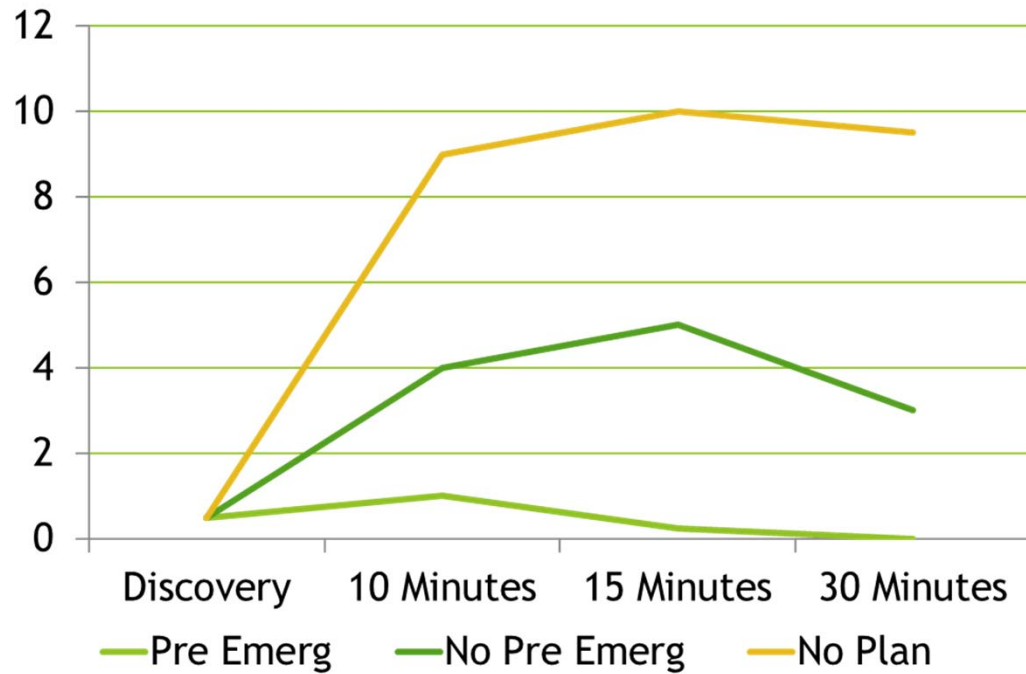
Discussion on two incidents:

- 1) Hydraulic Shock - Milard Refrigeration
- 2) Worker Death - Gibson Winery

Controlling Chaos!



Chaos Factor



Craig Miller

4/13/2015

Slide 1-1



Key Lessons to Prevent Hydraulic Shock

Millard Refrigerated Services Inc., located in Theodore, Alabama



9:00 am on the morning of August 23, 2010

- ▶ “hydraulic shock” which is defined as a sudden, localized pressure surge in piping or equipment resulting from a rapid change in the velocity of a flowing liquid. The highest pressures often occur when vapor and liquid ammonia are present in a single line and are disturbed by a sudden change in volume.
- ▶ often prior to a hydraulic shock incident there is an audible “hammering” in refrigeration piping

Hydraulic Shock

The reset triggered a valve to open and low temperature liquid ammonia was fed back into all four evaporator coils before removing the hot ammonia gas. This resulted in both hot, high-pressure gas and extremely low temperature liquid ammonia to be present in the coils and associated piping at the same time.

- ▶ Roof-mounted 12-inch suction pipe to catastrophically fail, resulting in the release of more than 32,000 pounds of anhydrous ammonia

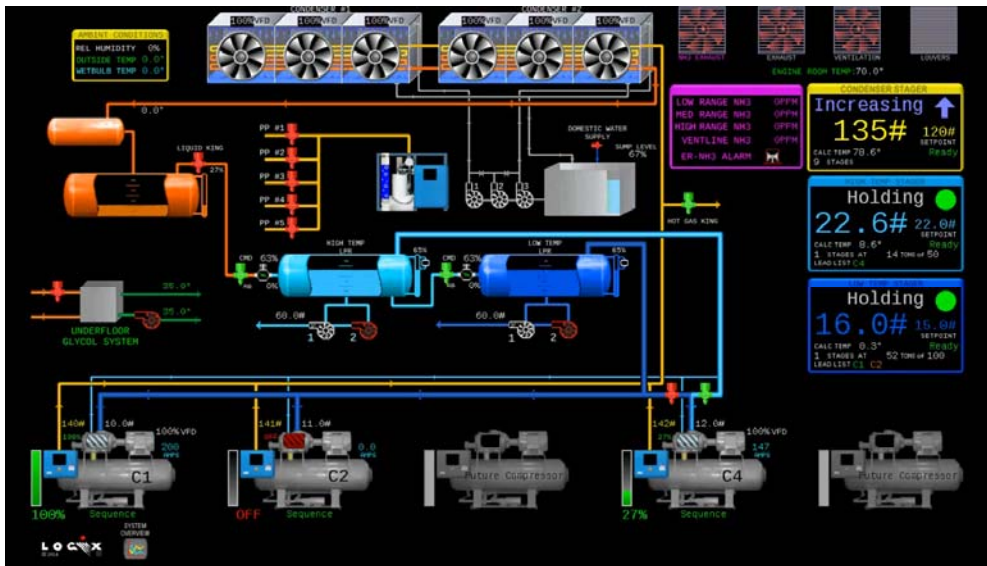


Hot high-pressure ammonia gas rapidly condensed into a liquid. Because liquid ammonia takes up less volume than ammonia gas - a vacuum was created where the gas had been. The void sent a wave of liquid ammonia through the piping - causing the "hydraulic shock."



Defrost Not Properly Timed - Hydraulic Shock

Operators reported some problems. While doing some troubleshooting an operator cleared alarms in the control system, which reset the refrigeration cycle on a group of freezer evaporators that were in the process of defrosting.



The control system reset caused the freezer evaporator to switch directly from a step in the defrost cycle into refrigeration mode while the evaporator coil still contained hot, high-pressure gas.

Cloud Movement

Large cloud traveled a quarter mile from the facility south



800 contractors - clean-up site for the Deepwater Horizon oil spill



A total of 152 offsite workers and ship crew members reported symptomatic illnesses from ammonia exposure.

Thirty two of the offsite workers required hospitalization, four of them in an intensive care unit.



Life Safety Assessment



Injuries

- ▶ One Millard employee sustaining injuries when he fell while attempting to escape from a crane after it became engulfed in the traveling ammonia cloud

Lessons Learned

- ▶ Value of Shelter-in-Place
- ▶ Need for community readiness
- ▶ Ability to assess risks
- ▶ Value of Emergency Shutdown



Lessons Learned

- ▶ “The CSB believes that if companies in the ammonia refrigeration industry follow the key lessons from its investigation into the accident at Millard Refrigeration Services, dangerous hydraulic shock events can be avoided - preventing injuries, environmental damage, and potential fatalities.”
- ▶ Millard facility experienced a loss of power that lasted over seven hours.
 - Refrigeration system was shut down
 - Next day the system regained power and was up and running
- ▶ Evaporators at the Millard facility were designed so that one set of valves controlled four separate evaporator coils
 - Contents of all four coils connected to that valve group were involved in the hydraulic shock event - leading to a larger, more hazardous pressure surge.
 - One key lesson is to avoid the manual interruption of evaporators in defrost and ensure control systems are equipped with password protection to ensure only trained and authorized personnel have the authority to manually override systems.
 - Each evaporator coil should be controlled by a separate set of valves

Emergency Shutdown

- ▶ The CSB found that immediately after discovering the ammonia release, a decision was made to isolate the source of the leak while the refrigeration system was still operating instead of initiating an emergency shutdown. Shutting down the refrigeration system may have resulted in a smaller release, since all other ammonia-containing equipment associated with the failed rooftop piping continued to operate.
- ▶ A final key lesson from the CSB's investigation is that an emergency shutdown should be activated in the event of an ammonia release if a leak cannot be promptly isolated and controlled. Doing so can greatly reduce the amount of ammonia released during an accident.

Example: Isolate flow, turn off Ammonia Pumps



Gibson Winery



Gibson Winery - Robert Munoz

Robert Munoz



Robert's life is worth some deep thought and consideration for safe work practices.

Lessons Learned

- ▶ Accidental release leads to an aerosol cloud entrapping Robert while he attempted to escape the bathroom.
- ▶ Operator who opened the wrong valve had done it 500 times...he was distracted by a conversation and opened the wrong one.
- ▶ Not sure why he could not close it. Perhaps it was not spring loaded. Perhaps ice was created by the pressure drop on the oil drain valve as the ammonia exited under system pressure.



Routine Operations of Heat Exchanger



Shell and Tube Exchanger



Cooling Liquids like Wine

- ▶ Wine flows through chiller - occasionally the wine freezes - hot gas is used to thaw the frozen wine
- ▶ The valves for hot gas control are located under the chiller adjacent to the oil drain control valve
- ▶ Hot gas and oil drain are globe valves - located next to each other with the same type and size of hand-wheel control

The Accident - A Tragedy and a Lesson

Operators face many tasks



Routine tasks can become dangerous

- ▶ Experienced Operator - performed hot gas valve operations 100's of times
- ▶ Was distracted while talking to another individual - opened wrong valve
- ▶ Oil drain valve opened fully and the Operator walked away with the individual
- ▶ Delay in oil plug release then a sudden hiss and cloud formed very quickly
- ▶ The operators escaped by running upwind

The Evacuation - Head Count - Rescue

Escaping the Aerosol Cloud



Escape Choices

- ▶ People evacuated using different escape path choices - all met in the parking lot
- ▶ Head count revealed one missing person;
- ▶ Workers spotted him down in a hallway outside of a bathroom - looks as if he may have collapsed hitting his head
- ▶ Employer adopted an Emergency ACTION Plan - no training or engagement for rescue
People attempted rescue without training or safety gear



Lessons: Prevent - Mitigate - Prepare

- ▶ Routine operation of valves located next to each other have consequences when the wrong valve is opened
 - Mitigate: Spring-loaded Valve for oil drain; oil drain line plugged when not in use
- ▶ Operator focus - Real-Time readiness while working on the systems
 - Prevention: Do not interrupt the Operator while he is operating the system; Operator attention to system operations while doing other tasks
- ▶ Options to consider when caught in Robert's position
 - Preparation: Never enter a dense gas cloud - shelter-in-place and get to water
- ▶ Rescue Operations: MUST consider a policy regardless of being non-response Emergency Action Plan
 - Preparation: Rescue procedure organized with fire department; use of fans and proper PPE, and MOST importantly an Emergency Shutdown procedure