

Lessons Learned

We Make the Employee Communication for Your Major Incident

Lesson Learned

Contractor Killed - Storage Tank Explodes During Cleaning

Natural Gas Wellsite

To prepare for cleaning, tank was:

- isolated from wellhead
- two hatches opened to ventilate
- tested for possible explosive atmosphere

Supervisor and another contractor were talking near the front open hatch.

Contractor was using a high-pressure water hose to clean the storage tank.

Tank had filled with sand, water, frac chemicals, etc. Cleaning contractors with a vacuum truck were on site to clean the tank.

The storage tank was a pressure vessel used to separate solids and liquids from natural gas.

The Air Sampling

Before cleaning started, another contractor (from an H₂S safety monitoring company) tested the atmosphere inside the tank.

His monitor recorded a LEL of 16% and alarmed for an explosive atmosphere.

The H₂S contractor told the supervisor about this high reading.

There is no record of anyone telling the cleaning contractors about the high reading.

No signs were posted.

The explosive force blew the contractor away from the hatch slamming him into a neighboring tank. It was this impact that killed him.

While the contractor was leaning inside the open hatch (hosing sand toward the drain) the tank exploded.

Ignition source never found.

The supervisor and another contractor were severely burned when the explosion also blew out through the front open hatch.

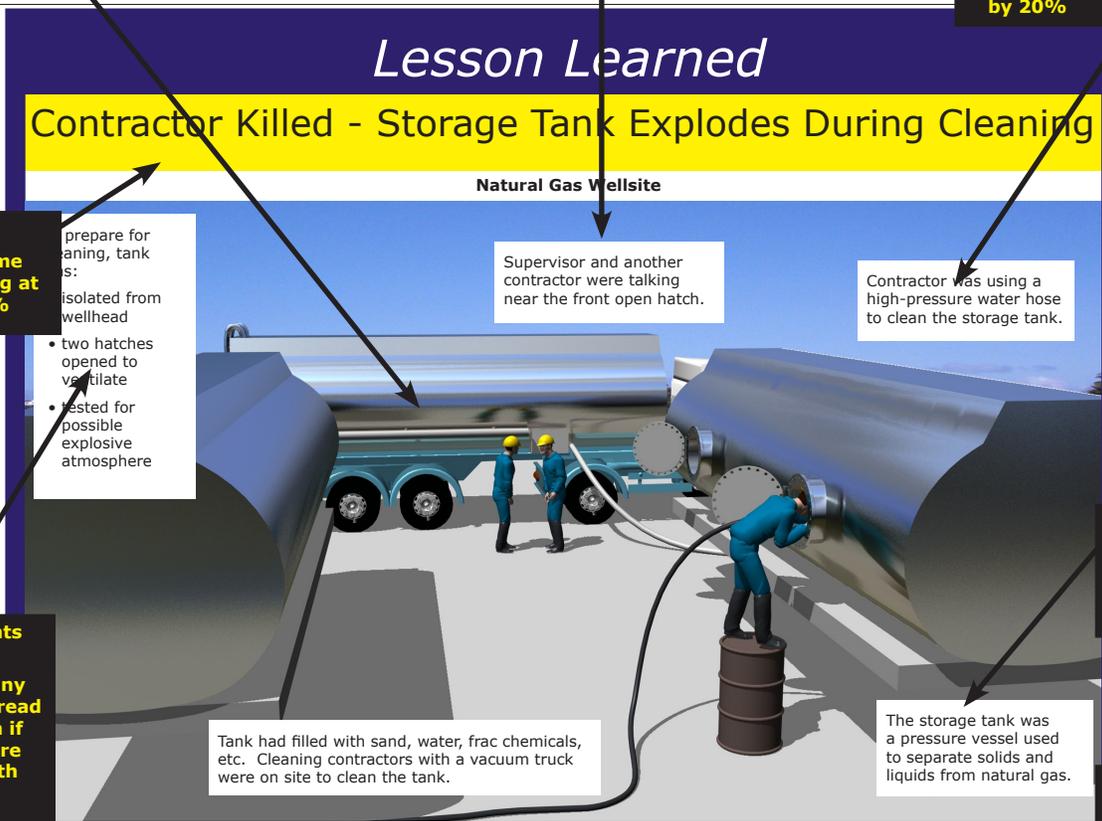
**We Start with Your Accident Investigation—Then We Make the Employee Communication
Communication Designed to Make Sure this Never Happens Again**

Communication Best Practice

Illustration
increases recall up to 800%

Writing Complexity
grade level 8;
50% of adults read at this level

Text Boxes
separating paragraphs into small text boxes increases comprehension by 20%



Color
increases time spent looking at page by 21%

prepare for cleaning, tank is:
isolated from wellhead
• two hatches opened to ventilate
• tested for possible explosive atmosphere

Lists/Dot Points
more than twice as many people will read a paragraph if sentences are replaced with a list or dot points

Supervisor and another contractor were talking near the front open hatch.

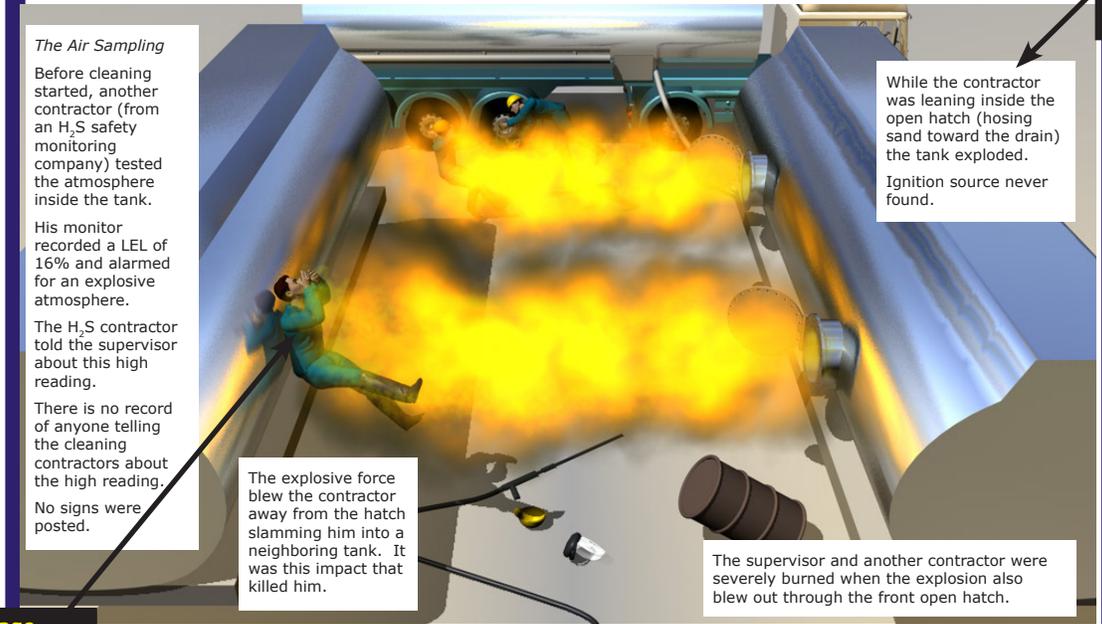
Contractor was using a high-pressure water hose to clean the storage tank.

Line Length
3½ inches best length for accurate reading

Tank had filled with sand, water, frac chemicals, etc. Cleaning contractors with a vacuum truck were on site to clean the tank.

The storage tank was a pressure vessel used to separate solids and liquids from natural gas.

Verdana Font
best font for reading online



The Air Sampling
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Disturbing Image
fear-appeal image makes it 50% more likely employees will change their behavior

Back Page
• talking points
• background information
• links to original document

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or tags attached.

in or water.

The vacuum truck was not grounded or bonded by cable to the tank or the ground.

Source: This Safety Meeting Paper is based on an accident investigated by WorkSafeBC. For more information, please visit the website: <http://www.worksafebc.com/pdfs/Investigation/030405/030405.pdf>

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Lessons Work When Leaders Talk About Them



$$r = -0.65$$

The correlation between supervisors' informal conversations about safety and serious accidents in eight Dutch chemical plants.

[Sicco van As: "Communication and Industrial Accidents." SOM Research Report, University of Groningen, The Netherlands.](#)

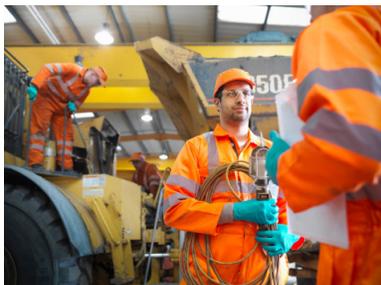
Only 3% of employees will change their behavior based solely on something they read.

70% of employees who change their behavior do so after a face-to-face conversation with their supervisor.



Rogers, E. M.: *Diffusion of Innovations*, New York, The Free Press, 1962.

[Clampitt, Phillip G.: "Employee Perception of the Relationship Between Communication and Productivity: A Field Study." The Journal of Business Communication, vol. 30, no. 1, 1993, p. 5-27.](#)



Compliance with written safety standards climbed from 47% to 74% when supervisors personally asked for the compliance.

[Wogalter, Michael S.; Vincent C. Conzola; Tonya L. Smith-Jackson: "Research-Based Guidelines for Warning Design and Evaluation." Applied Ergonomics, vol. 33, 2002, p. 219-230.](#)



When supervisors talk about safety, unsafe acts go down.

supervisors informal conversations about safety	unsafe material handling	$r = -0.75$
	unsafe electrical work	$r = -0.81$
	failing to use PPE	$r = -0.86$

[Zohar, Dov and Gil Luria: "The Use of Supervisory Practices as Leverage to Improve Safety Behavior: A Cross-level Intervention Model." March 2003](#)

Sample #1

Heat Exchanger Exploded
Seven Employees Killed
(Oil Refinery)

Communication Best Practice - Lesson Learned

Heat Exchanger Exploded - Seven Employees Killed (Oil Refinery)

Heat exchanger in oil refinery exploded.
 Seven employees killed.
 Heat exchanger located in the refinery's catalytic reformer/naphtha hydrotreater unit (NHT).

Background

Heat exchangers frequently leaked during startup.
 Leaks always stopped after heat exchangers reached their full operating temperature.

"Normal" Startup Practice

During startup, operators usually:

- stood near flanges where leaks were anticipated
- holding steam lances
- employees used the lances to more quickly heat the exchangers to their full operating temperatures
- also used the lances to extinguish any leaks or fires

Rupture - Explosion - Fireball

When the heat exchanger ruptured:

- large volume of hydrogen and naphtha at 500° F escaped from the exchanger
- these vapors ignited sending a large fireball through the entire heat exchanger area (3 floors; 2 exchangers on each floor).

Seven Fatalities

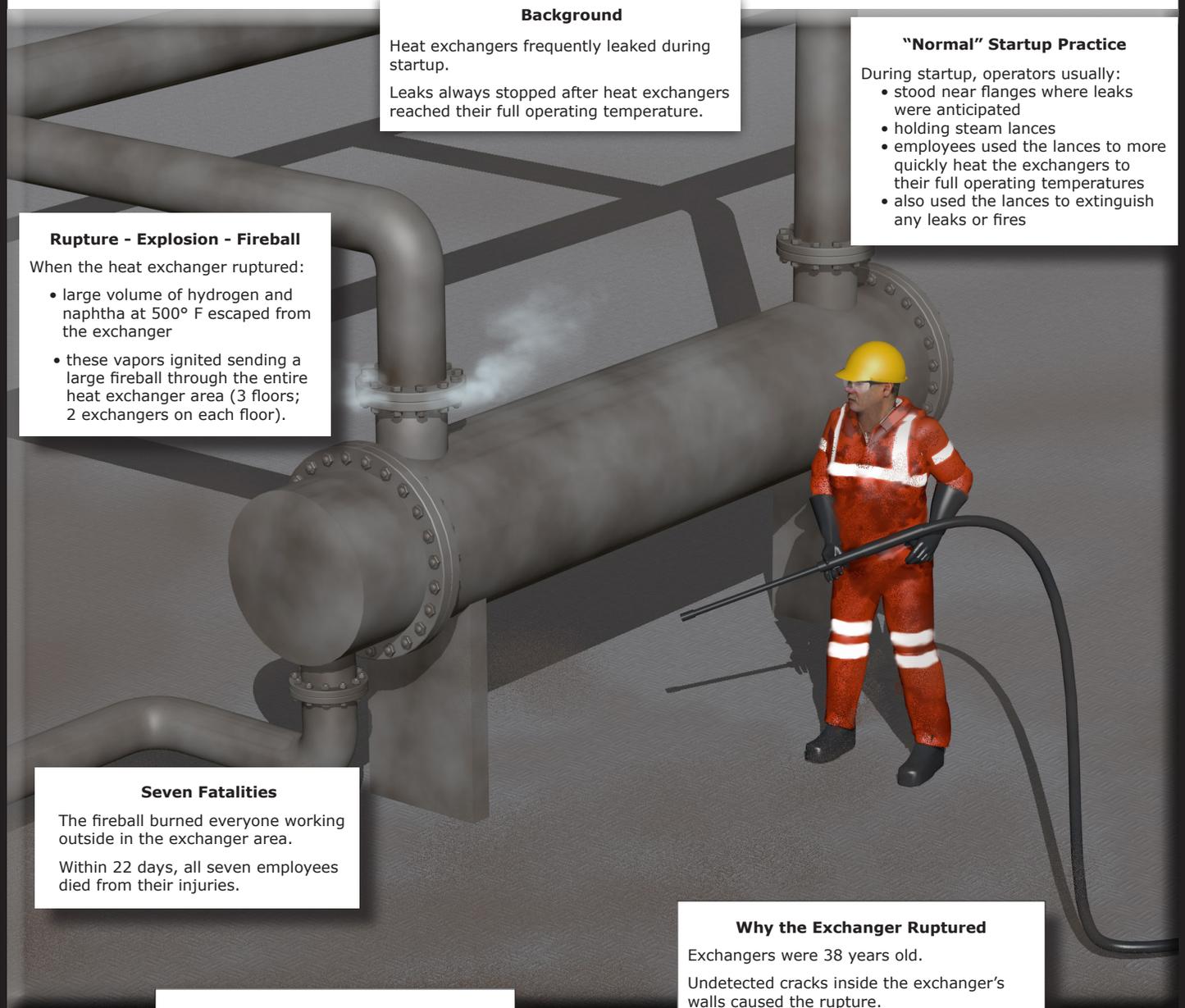
The fireball burned everyone working outside in the exchanger area.
 Within 22 days, all seven employees died from their injuries.

Vapors Autoignited

The vapors did not need an ignition source (spark).
 At high temperatures, the naphtha and hydrogen mixture will autoignite when exposed to the oxygen in the atmosphere.

Why the Exchanger Ruptured

Exchangers were 38 years old.
 Undetected cracks inside the exchanger's walls caused the rupture.
 Operators using the steam lances did not contribute to the heat exchange rupture—the exchanger would have ruptured anyway.
 However, the large number of fatalities was due to the many employees working in the exchanger area during the startup.



Communication Best Practice - Lesson Learned

Lessons: Heat Exchanger Exploded - Seven Employees Killed

Talking Point: When "Dangerous" Becomes "Normal"

Most experienced operators would not put seven people near a unit during a startup.

- startup is "non routine work"
- "non routine work" is 45 times more dangerous than continuous operation

([Process Improvement Institute](#))

Why did they put seven people near a unit in startup?

Because this dangerous practice had become "normal."

- employees said they did it this way for more than 10 years
- the formal written procedure called for one outside operator
- the normal practice was between four and seven outside operators

The technical term for this is: "normalization of deviance."

- over time, dangerous practices slowly become normal
- for those inside the organization—the danger becomes invisible
- "normalization of deviance" was made famous in the investigation of the Challenger space shuttle disaster ([The Challenger Launch Decision](#))

Let's talk about our practices.

What do we do that seems "normal" but is, in fact, "dangerous?"

What dangers are we blind to because we've done it this way so many times?

HTHA Caused the Exchanger Wall to Rupture

Investigation showed the insides of the exchanger walls were cracked.

Cracks were caused by HTHA (high temperature hydrogen attack). The carbon steel walls were susceptible to HTHA.

Hydrogen added to the naphtha feed interacted with the carbon steel walls to create methane gas.

The methane gas was trapped inside the exchanger walls creating fissures and eventually larger cracks.

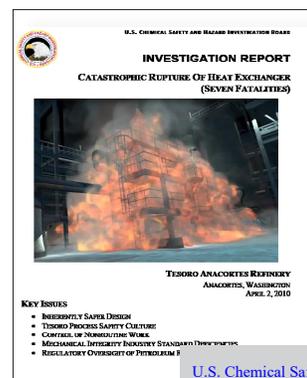
The standards used during inspections did not anticipate HTHA at the *design* temperatures for these exchangers.

Actual temperatures inside the exchangers were higher than the design temperatures.

HTHA was subsequently found in other exchangers within the same bank of exchangers.

After the incident, old exchangers were replaced with new exchangers made from steel less susceptible to HTHA.

Original Source for This Lesson Learned



Chemical Safety Board

[U.S. Chemical Safety and Hazard Investigation Board: "Investigation Report: Catastrophic Rupture of Heat Exchanger \(Seven Fatalities\)." Report 2010-08-1-WA, May 2014.](#)

Sample #2

Pneumatic Plug Fires From Pipe
One Employee Killed
(Oil Refinery)

Communication Best Practice - Lesson Learned

Pneumatic Plug Fires From Pipe and Kills Employee (Oil Refinery)

Employee was going to make a pipe tie-in. Welding was necessary.

- To prepare for this hot work, employee:
- installed a pneumatic plug into the pipe to block any explosive vapors
 - also did a nitrogen purge behind the plug to empty the pipe of any explosive vapors

As part of the nitrogen purge, employee opened this valve to vent the nitrogen.

During the purge, the control room operator remotely closed this valve—so nitrogen pressure began building up behind the plug.

Employee used nitrogen bottles for the purge.

Control room operator did not know the field employee was working on the pipe.

Control room operator prepared the pipe for a planned product transfer.

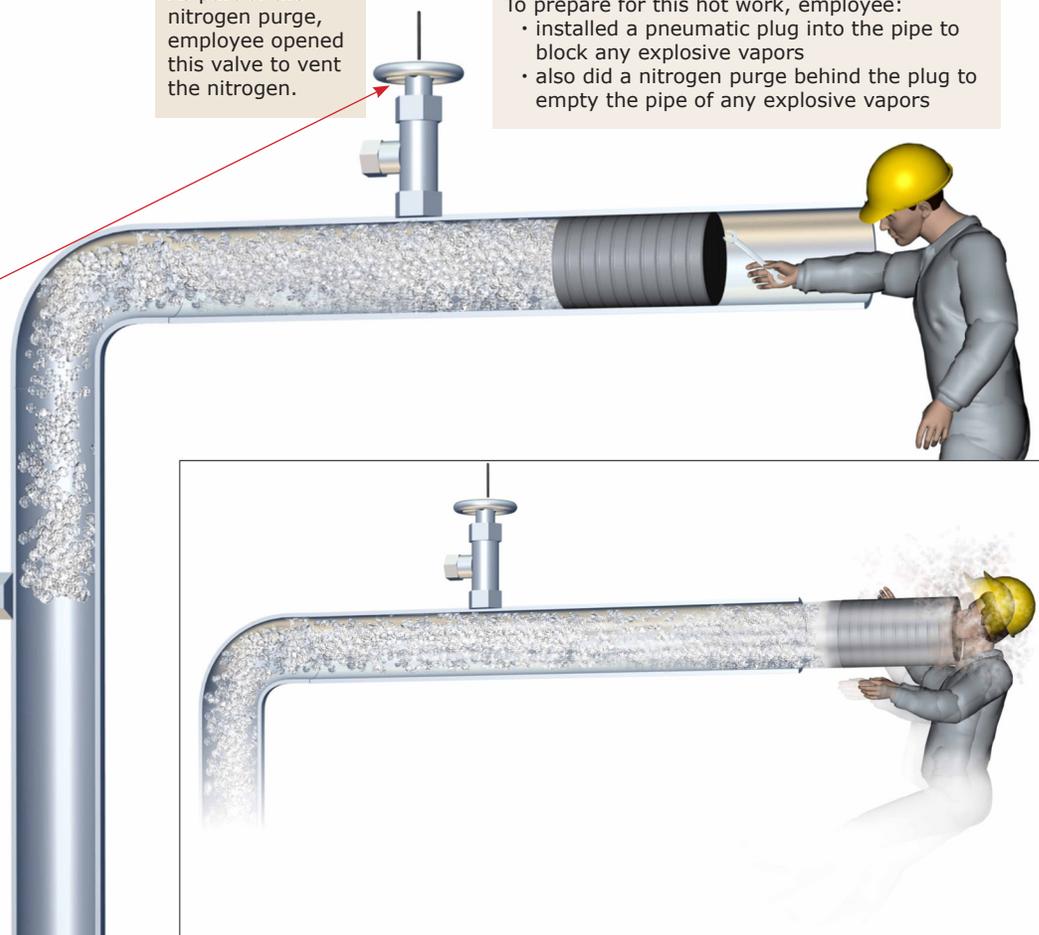
- the product transfer procedure required closing the valve

Control room operator closed the valve.

- value was motor-operated
- value could be remotely opened and closed from the control room

What Happened?

Employee heard the plug move inside the pipe.
 The plug shifted to an incorrect position.
 Employee decided to deflate the pneumatic plug to reposition it.
 As the plug deflated, the nitrogen pressure that had built up behind the plug fired the plug, at high speed, out the open end of the pipe.
 The flying plug hit the employee in the head, and he died from the injury.



Lessons - Pneumatic Plug Fires from Pipe

Talking Points: Who's in the Permit Process?

Control room operators were not included in the pipe tie-in work permit.

- control room operators had no idea anyone was working on the pipe
- maintenance team did not radio the control room operators saying they were working in their area
- control room operators were preparing to move product through that pipe— that's why they closed the valve

Could this happen at our site?

Let's discuss the work we did here last week...

1. Did we communicate this work to everyone who needed to know?
2. Does our permit process include all the right people?
3. How can we improve our communication around permits?

Team Did Not Lockout the Valve

Maintenance team should have locked out the valve before beginning the purge.

If the valve was locked open, the control room operators would not have been able to remotely close the valve.



Plug Was Not Inflated to Correct Pressure

The employee deflated the plug because he noticed the plug shifted inside the pipe.

The plug moved inside the pipe because it was under-inflated.

- instructions were to inflate the plug to 35 psig
- the employee inflated the plug only to 15 psig
- that's why the plug moved, had to be deflated, and then repositioned

When properly inflated, the plug was designed to withstand a backpressure up to 12 psig.

The backpressure from the nitrogen purge was estimated at only 2 to 6 psig.



pneumatic plug

No Pressure Gauge

A pressure gauge should have been installed.



This gauge would measure any pressure buildup behind the plug.

Employees would have noticed something was wrong if they saw increasing pressure building up behind the plug.



No Barriers Blocking the Line of Fire

The "line of fire" around the open end of the pipe is dangerous and should have been barricaded.

The line of fire is a cone-shaped area extending from the pipe opening.

While the plug was inflated, no one should be in this line-of-fire danger zone.

The pneumatic plug was attached to a long hose that allowed inflation and deflation without standing in the line-of-fire danger zone.

Sample #3

Storage Tank Exploded
One Contractor Killed
(Natural Gas Wellsite)

Communication Best Practice - Lesson Learned

Front

Contractor Killed When Storage Tank Exploded Natural Gas Wellsite

To prepare for cleaning, tank was:

- isolated from the wellhead
- two hatches opened to ventilate
- the inside of the tank was tested for possible explosive atmosphere

Supervisor and another contractor were talking near the front open hatch.

Contractor was using a high-pressure water hose to clean a storage tank.

Tank had filled with sand, water, frac chemicals, etc. Cleaning contractors and their vacuum trucks were on site to clean the tank.

The storage tank was a pressure vessel used to separate solids and liquids from natural gas.

The Air Sampling

Before the cleaning started, another contractor (from an H₂S safety monitoring company) tested the atmosphere inside the tank.

His monitor recorded a LEL of 16% and alarmed for an explosive atmosphere.

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While the contractor was leaning inside the open hatch (hosing sand toward the drain) the tank exploded.

The explosive force blew the contractor away from the hatch slamming him into a neighboring tank. It was this impact that killed him.

The supervisor and another contractor were severely burned when the explosion also blew out through the front open hatch.

Lessons - Contractor Killed When Storage Tank Explodes

Talking Points

When it comes to safety, are we "demanding" or "easy"?

During the incident investigation, the cleaning contractors said they followed safer procedures at other sites.

Why didn't they follow safer procedures at this site?

Because, they said: "the supervisor at this site did not demand safer procedures."

Many of us have experience at other sites.

When it comes to safety, what kind of site are we: "demanding" or "easy"?

Sampling Result Not Communicated

H₂S contractor found an explosive atmosphere inside the storage tank.

H₂S contractor told the supervisor about this dangerous result.

But, this dangerous result was not communicated to the cleaning contractors.

Worse, the dangerous result was not posted at the tank hatches.



Ignition Source Not Known

We don't know where the spark or flame came from.



Two possibilities are:

1. Static electricity between the vacuum truck and tank (truck was not bonded or grounded to the tank).
2. Flashback flame from the flare stack. Valve between the flare and tank was closed, but the closed valve did not seal properly leaving a ¼ inch gap still open.

Other Serious Problems

	no isolation		Values upstream and downstream of the tank were closed but no blinds or blanks were installed.
	no lockout		Values were closed but no locks or tags attached.
	no purging		Tank was not purged with nitrogen or water.
	no grounding		The vacuum truck was not grounded or bonded by cable to the tank or the ground.



Source: This Safety Meeting Topics is based on an accident investigated by WorkSafeBC.

Sample #4

Chemical Leak
Four People Killed
(Methyl Mercaptan)

Communication Best Practice - Lesson Learned

Chemical Leak Kills Four People

Methyl mercaptan
 Methyl mercaptan is a chemical used to make insecticides. It can be a liquid or gas. Methyl mercaptan is highly toxic and flammable.

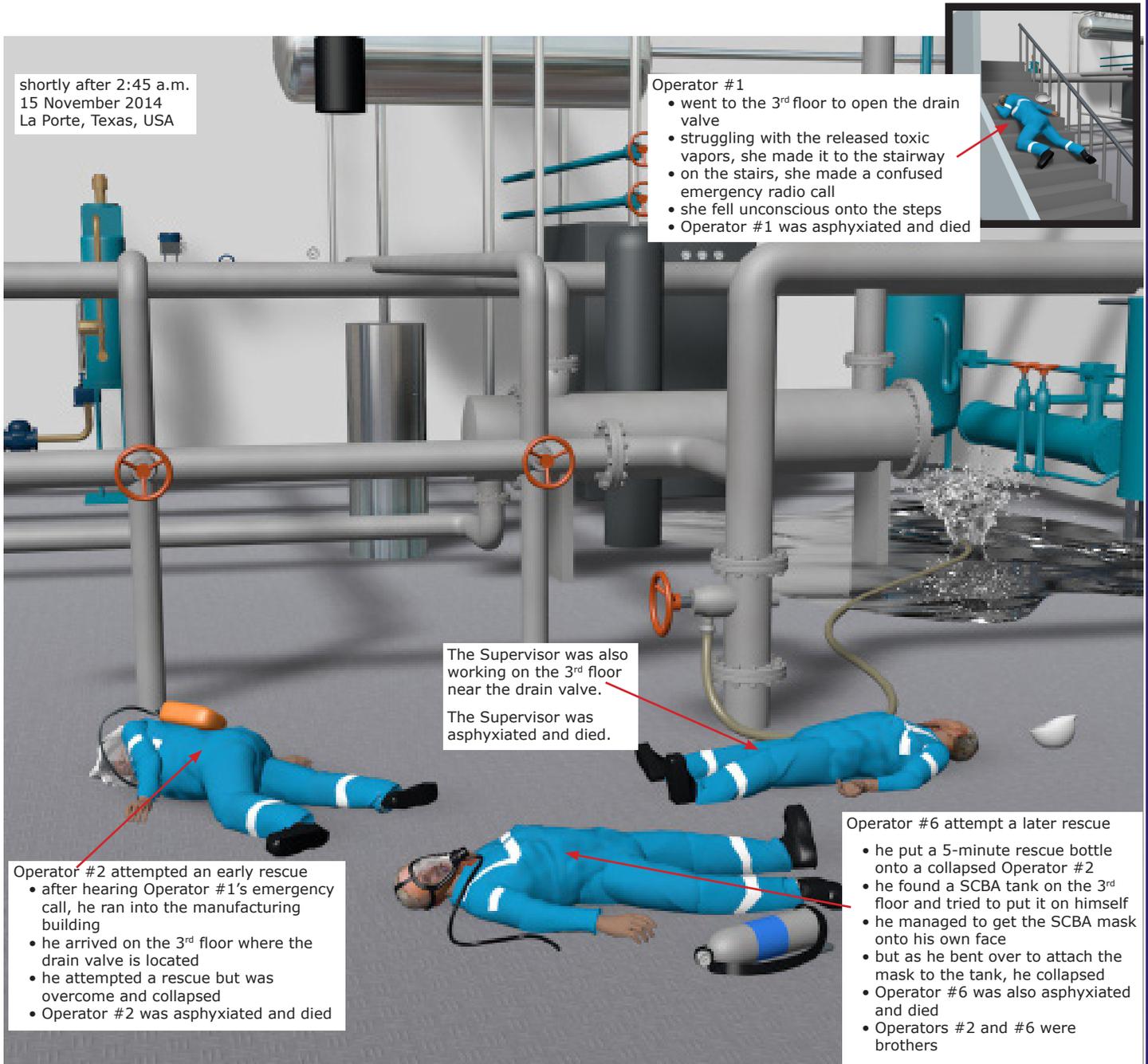
The Shift Supervisor and Operator #1 were responding to a high pressure alarm in a waste gas vent header area.

They went to the 3rd floor of the manufacturing building to open a drain valve.

As the valve was opened, a large amount of methyl mercaptan escaped. Methyl mercaptan may also have been leaking from other equipment in the area.

Both the supervisor and Operator #1 were asphyxiated and died.

Two other operators (#2 and #6) attempted a rescue but were also asphyxiated and died.



shortly after 2:45 a.m.
 15 November 2014
 La Porte, Texas, USA

Operator #1

- went to the 3rd floor to open the drain valve
- struggling with the released toxic vapors, she made it to the stairway
- on the stairs, she made a confused emergency radio call
- she fell unconscious onto the steps
- Operator #1 was asphyxiated and died



The Supervisor was also working on the 3rd floor near the drain valve.
 The Supervisor was asphyxiated and died.

Operator #2 attempted an early rescue

- after hearing Operator #1's emergency call, he ran into the manufacturing building
- he arrived on the 3rd floor where the drain valve is located
- he attempted a rescue but was overcome and collapsed
- Operator #2 was asphyxiated and died

Operator #6 attempt a later rescue

- he put a 5-minute rescue bottle onto a collapsed Operator #2
- he found a SCBA tank on the 3rd floor and tried to put it on himself
- he managed to get the SCBA mask onto his own face
- but as he bent over to attach the mask to the tank, he collapsed
- Operator #6 was also asphyxiated and died
- Operators #2 and #6 were brothers

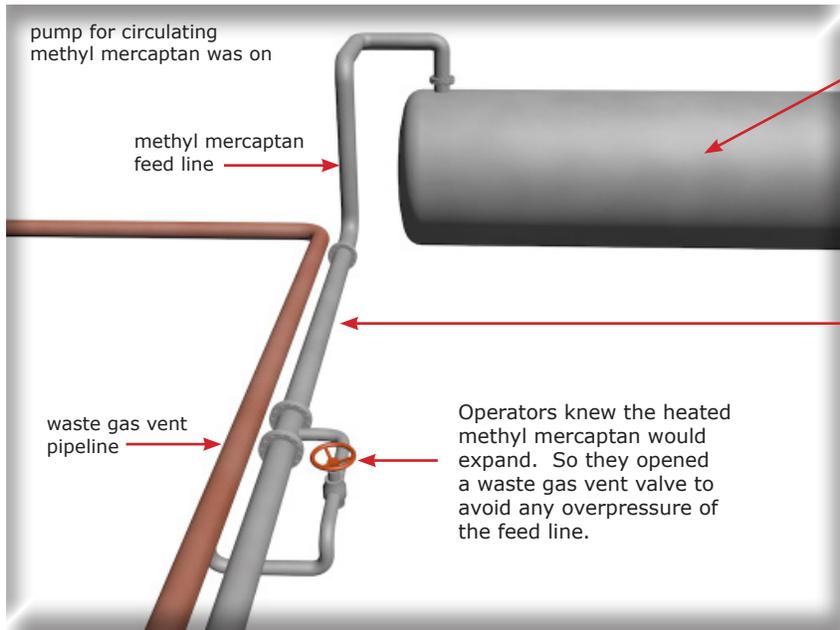
Derived from CSB Interim Recommendations

Communication Best Practice - Lesson Learned

Situation Leading Up to the Gas Leak

During normal operations, methyl mercaptan is pumped from a storage tank through a feed line into the process unit.

The operators were trying to start up this process unit after a shutdown.



During the shutdown, water was accidentally pumped into the methyl mercaptan storage tank.

When combined with water, methyl mercaptan will create a hydrate (freeze) at relatively warm temperatures (50°F).

Frozen methyl mercaptan plugged the feed line and blocked the flow into the process unit.

To melt the frozen methyl mercaptan, night shift operators were pouring hot water onto the feed line using a hose.

Around 1:30 a.m., the operators took a break, left the outside piping area, and went into the control room.

They left: hot water pouring onto the feed line, the pump on, valve into the process unit closed, and the valve to the waste gas vent pipeline open.

After the operators left the area: the methyl mercaptan melted, the blockage cleared, and the methyl mercaptan began to flow.

The methyl mercaptan liquid flowed through the open valve and into the waste gas vent pipeline.

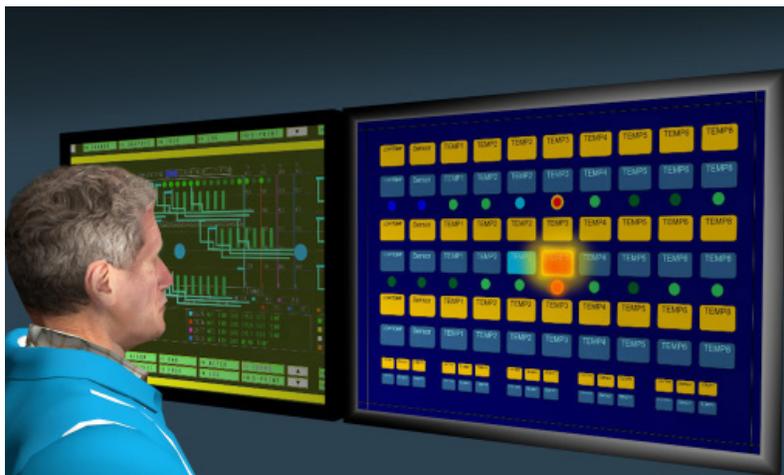
The waste gas vent pipeline traveled through a multi-story manufacturing building and eventually to an incinerator.

Alarms Began

Alarms inside the control room began showing a high pressure situation in the waste gas vent header located on the 3rd floor of the manufacturing building.

The incinerator at the end of the waste gas pipeline was installed four years earlier.

After installing the incinerator, high pressure alarms in the waste gas pipeline happened frequently.



This alarm had become "normal."

Almost daily, employees cleared this alarm by opening a drain valve on the 3rd floor of the manufacturing building.

On this night, the operators did not associate this alarm with their outside work heating the frozen methyl mercaptan.

Communication Best Practice - Lesson Learned

Gas Leak Began Asphyxiating People - Operators Attempted a Rescue

Supervisor and Operator #1 went to the 3rd floor of the manufacturing building to manually open a drain valve connected to the waste gas vent header piping.

Usually the drained liquid was water with a small amount of other chemicals. The liquid ran from the drain valve through a hose to a drain on the floor.

This time, however, a large amount of methyl mercaptan poured from the drain valve and deadly vapors filled the building.

Methyl mercaptan may also have been leaking from other nearby equipment.

The Supervisor was asphyxiated and fell near the drain valve.



Operator #1 began feeling disoriented, made her way to the staircase and attempted an emergency radio call.

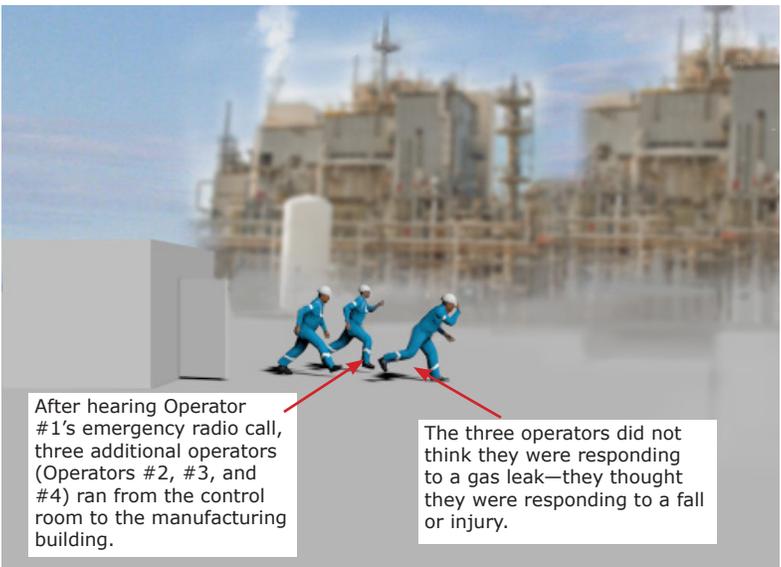
Her call was very unclear.

To those listening, it seemed someone may have fallen and was injured.

 An Operator #5 working on the 1st floor of the manufacturing building became disoriented, left the building, collapsed on the ground, and survived.

 Operator #3 attempting a rescue made it to the 3rd floor, he then:

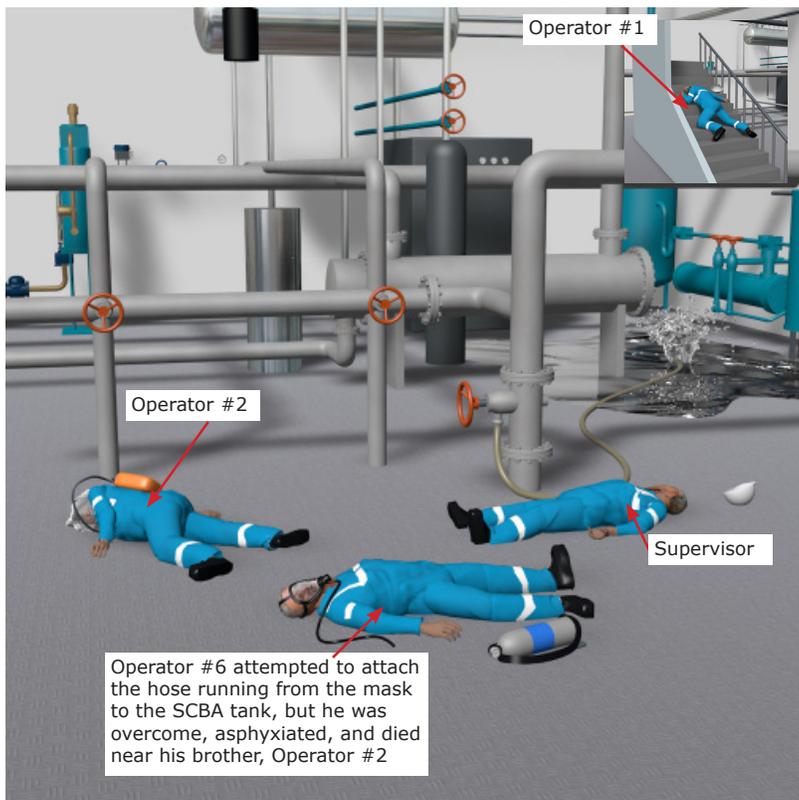
- began feeling light-headed
- tried to escape the 3rd floor
- fell unconscious in the stairway
- after 45 minutes regained consciousness
- managed to get out of the building
- taken to the hospital and survived



After hearing Operator #1's emergency radio call, three additional operators (Operators #2, #3, and #4) ran from the control room to the manufacturing building.

The three operators did not think they were responding to a gas leak—they thought they were responding to a fall or injury.

Operator #6 Attempted a Rescue



Operator #6 Attempted a Rescue

- the first three rescuers (Operators #2, #3, and #4) did not respond to radio calls
- Operator #6, still in the control room, then suspected a gas leak
- running to the manufacturing building, he grabbed three 5-minute air bottles
- other control room operators warned Operator #6 not to enter the building as the risks were too unknown—he ignored these warnings
- going up the stairs, he came across an unconscious Operator #4 (an earlier rescuer); Operator #6 put an air bottle on Operator #4
- with this air supply, Operator #4 left the building and survived
- Operator #6 then put the second air bottle on himself
- once on the 3rd floor, Operator #6 found his brother, Operator #2, and put the last air bottle on his brother
- when Operator #6's air bottle emptied; he found a SCBA tank located on the 3rd floor

When the emergency response team (ERT) arrived:

- they did not have adequate respiratory equipment to enter the building
- ERT thought they were responding to a fall
- 90 minutes later, ERT had proper respiratory PPE
- all four people were found unresponsive

Lessons - Chemical Leak Kills Four Workers

Talking Points

Risk Assessment

- These were experienced operators; average age was 47, supervisor was 60.
- A few moments of thinking may have revealed the likelihood of methyl mercaptan running into the waste gas vent pipeline - a gas pipeline not designed for large amounts of liquid methyl mercaptan
- Can't we occasionally stop work today and think a little harder about what we are doing? Just a moment or two to think about the risks?

Non-Routine Work is Dangerous source: <http://download.discover2.org/how-to-efficiently-perform-the-hazard-evaluation-pha-w36491/>

- This was the 1st time these operators melted hydrate on the methyl mercaptan feed line.
- 70% of major process safety accidents happen during non-routine work.
- What non-routine work do we have planned? How dangerous is this work?

Rescuers Often Die source: <http://www.cdc.gov/niosh/docs/86-110/>

- The first two people died after opening the drain valve—the other two deaths were rescuers.
- Rescuing is dangerous. For example, in confined-space fatalities, 60% of the people who die are rescuers.
- Do we have the discipline to stop and understand the situation before we try to do a rescue?

Biggest Senior Management Problem

Uneven Design Safety Across Business Units

Learning from the 1984 Bhopal disaster, this company decided to improve their design safety in business units using MIC (the chemical released in Bhopal).

A disaster similar to this methyl mercaptan tragedy probably could not happen in the MIC production areas of this plant.

These MIC design precautions (inherently safer design) were not applied to the methyl mercaptan business units.

Biggest Plant Management Problem

No Written Procedures

There were no written procedures for melting hydrate on the methyl mercaptan feed line.

There were no written procedures for draining the waste gas vent piping.

It is 50 times more likely an operator will make a serious mistake when they are doing work without written procedures.

source: <http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6883/cr6883.pdf>



This lesson learned is derived from a *CSB Interim Recommendation*:

[CSB: DuPont La Porte, Texas Chemical Facility Toxic Chemical Release, Sept 30, 2015](#)

The CSB has not previewed or approved our interpretation.

See the CSB's video animation of this accident:

<http://www.esb.gov/duPont-laportefacility-toxic-chemical-release/>

Sample #5

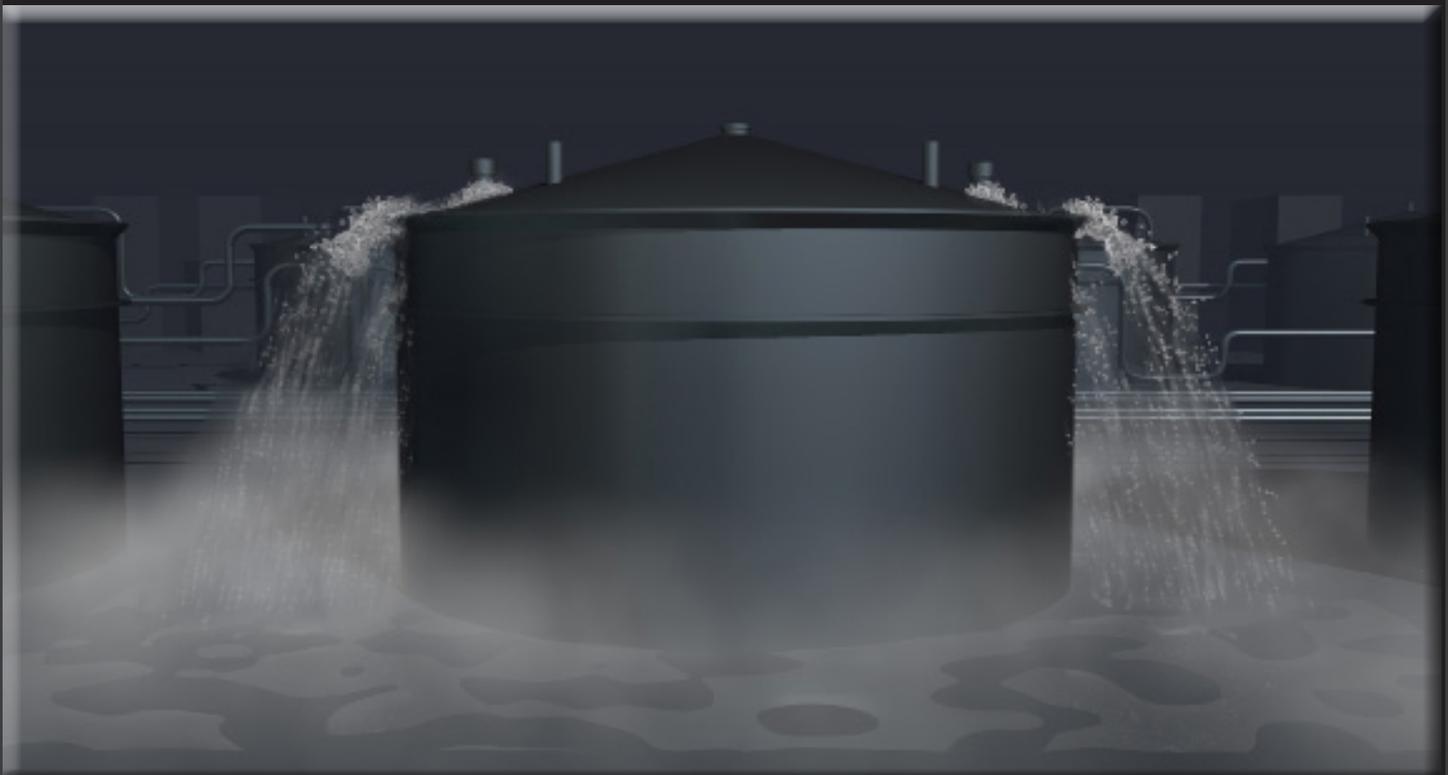
Petroleum Storage Tank Explodes

Buncefield Oil Depot

UK

Communication Best Practice - Lesson Learned

Petroleum Storage Tank Explodes - Buncefield Oil Depot UK



Derived Primarily from UK Competent Authority: Buncefield: Why Did it Happen?

Communication Best Practice - Lesson Learned

Summary - Petroleum Storage Tank Explodes

Details

- Sunday Morning 6:00 a.m.
- 11 December 2005
- Buncefield Oil Storage Depot
- Hemel Hempstead, UK
- tank capacity was 6 million liters
- filled with unleaded petroleum

IHLS Switch Not Operating

- the IHLS was accidentally left in test mode
- in test mode, the switch does nothing when petrol reaches the top of the tank
 - does not automatically close the input valve
 - does not sound an alarm

Automatic Tank Gauging Failed

- 2½ hours before the explosion, the ATG gauge "flatlined"
- gauge stuck and stopped showing the rising petrol level



Overflow

- tank filled to capacity
- then, fuel began spilling out through the breathing vents in the tank roof
- 250,000 liters poured over the roof edges and into the bund below
- tank overflowed for about 25 minutes before exploding

Other Containment Failures

- secondary containment (the bund) failed
- tertiary containment (drains, curbing, boundary walls) failed
- fuel and firefighting liquid entered the groundwater

The Explosion

Ignition

- vapor cloud (about 2 to 4 meters thick) extended out from the bund and across the street (filling an area roughly 500 meters by 400 meters)
- tanker drivers, arriving to fill their trucks, saw the vapor cloud and told the operators
- operators immediately turned on a firewater pump
- investigators think a spark from the firewater pump ignited the vapor cloud

Explosion

- measured 2.4 on the Richter scale
- biggest peacetime explosion ever recorded in the UK



Damage

- 20 fuel tanks engulfed
- entire oil depot destroyed
- 630 businesses damaged
- M1 Motorway closed
- \$1.5 billion in total damages

People

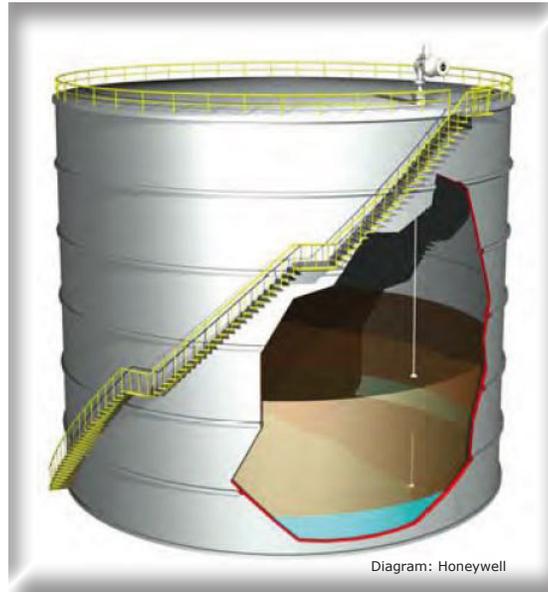
- no fatalities
- 41 people with minor injuries treated and released
- 2 people hospitalized with serious injuries
- 2,000 people evacuated from their homes
- more people would have been hurt or killed if the explosion happened during business hours (explosion happened at 6:00 a.m. on a Sunday morning)

Communication Best Practice - Lesson Learned

Problem: ATG Gauge Measuring Petroleum Level Stopped Working

How it Works - ATG

- an ATG servo gauge continuously measures the fluid level in a tank
- a weight is suspended by a wire, the wire is spooled around a drum
- the drum turns and lowers the weight into the tank
- when the weight hits the liquid, the weight becomes lighter
- motor detects the lighter weight and records the distance based on the number of turns used by the drum to lower the weight
- the drum keeps the weight resting on the liquid surface and gives a continuous reading of the fluid level



What Went Wrong - ATG

- this particular ATG servo gauge failed frequently (14 times in the previous 3 months)
- the weight would get stuck and the drum would no longer lower and raise the weight as the fluid level changed—operators called this “flatlining”
- operators could sometimes fix the flatlining by getting the drum to raise the weight to the very top and then lowering the weight again until it hit the fluid level (they called this “stowing”)
- unfortunately, the site did not keep an up-to-date fault log, so the eight supervisors working at the site did not know how unreliable the gauge had become

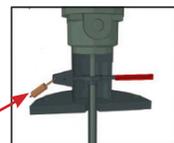
Problem: IHLS Doesn't Work in Test Mode

How it Works - IHLS

- this IHLS was the last barrier to an overflow
- IHLS sits on the tank roof dangling a disk into the tank
- if the fluid climbs high enough, the rising liquid pushes the disk upward
- as the disk rises, it pushes a magnet up to a reed switch
- the reed switch (when near the magnet) closes
- when the reed switch closes, it automatically closes the input valve (where the liquid enters the tank) and sounds an alarm



A padlock holds the handle securely in the horizontal position.

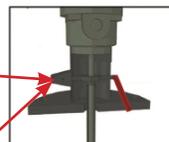


Handle Horizontal (in red)
This is the only handle position where the switch operates as intended.



Handle Up (in red)
This is high-level test mode; the switch will not operate.

Without the padlock, the handle could be accidentally left in the lower position.



Without the padlock, the handle could sometimes drop by itself into the lower position.

Handle Down (in red)
This is a low-level test mode (not used at the site), with handle down the switch will not operate.

What Went Wrong - IHLS

- this IHLS was installed about five months earlier
- the new IHLS had a latch for a padlock
- no one at the site knew what the padlock was for, and they didn't use a padlock
- operators assumed it was some sort of “anti-tamper device”
- everyone was critically wrong
- the padlock was an essential part of the IHLS, the padlock locked the handle in the horizontal “operating” position
- without the padlock, the handle could be accidentally left in a test mode—or even fall by itself into the lower test mode
- in the handle-down test mode, the reed switch did not operate, it did not close the input valve or sound the alarm
- after this accident, the manufacturer changed the design

Communication Best Practice - Lesson Learned

Lessons - Petroleum Storage Tank Explodes

Talking Points

Safety Critical Equipment

- No one knew why the IHLS had a padlock. No one knew a padlock was required to keep the handle in the correct operating position.
- We can't make that mistake here: we can't have safety critical equipment that operators don't understand.
- Today, we begin asking more questions about our safety critical equipment:
 - Which equipment is safety critical?
 - How does that equipment work?
 - What is the weakest part of that equipment?
 - What happens if it fails?

Communication Across Shifts—Fault Log

- Why didn't the supervisors know how unreliable the ATG had become?
- Because there was poor communication across shifts. Supervisors knew the gauge had problems, but during the investigation they were surprised to learn the ATG had failed 14 times in the 3 months before the explosion.
- What serious faults are happening at our site that we don't keep track of?

Offsite Operators Controlled Fuel Deliveries

Offsite operators at refineries controlled flows into the tank.

The onsite operators did not control timing, amount, or the flow rate into the tank that exploded.

Eight minutes before the explosion, offsite operators increased the flow of unleaded petrol from 550 m³/hr to 960 m³/hr - onsite operators had no idea this happened.

Not having much control or information, operators did their jobs by "working to the alarms." This practice meant the alarms (ATG and IHLS) were especially important.

This lack of control over fuel deliveries made the operators' jobs very stressful. Days before the explosion, the operations manager volunteered his resignation.

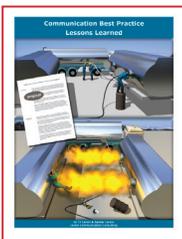
Buncefield Explosion Larger than Expected

Falling Petrol Increases the Vapor Cloud

Traditional estimates of explosions, based on vapor cloud size created by leaking tanks, may be too small.

Often these estimates rely on evaporation tests from a pool of hydrocarbons lying still in a bund.

Research, based on the Buncefield accident, shows vapor clouds form faster when the fuel is falling from a height.



Download More Samples:
Lessons Learned Brochure
www.Larkin.Biz



This lesson learned is derived primarily from:
[UK Competent Authority: Buncefield: Why did it happen?](#)

The Competent Authority has not reviewed or approved our interpretation.

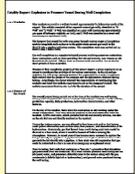
For the vapor cloud research, see:

[Atkinson, Graham: "Flammable Vapor Cloud Generation from Overfilling Tanks"](#)

How It Works

We Apply Communication Best Practice to Your Lesson Learned

Your Original Lesson Learned



You give us your original lesson learned.

You tell us why this lesson learned is especially important:

- people injured or killed
- damage to equipment
- near miss
- happening more frequently (trending)

We study it.

For more information, we speak with anyone you recommend.

Page 1: Incident

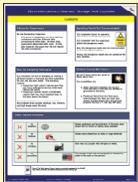


Page 1 tells: "What Happened".

The incident is told in a dramatic illustration.

Text boxes with supporting details are integrated into the illustration.

Page 2: Lessons



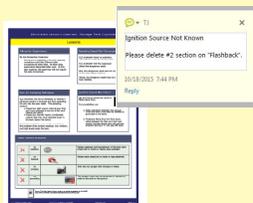
Page 2+ tell: "Lessons Learned"

Background information about the incident.

Talking Points to help supervisors begin a discussion.

Links to original source documents.

Revisions



We give you a first draft of the lesson learned.

You make any changes you wish.

We include these changes.

We return a final version to you.

Usual turnaround time is 10 business days.

Communicating



You distribute the lesson learned to your leaders.

This lesson learned is designed for projection and discussion.

Your leaders talk about the lesson during their regular safety meetings.

What To Do Next

Email or Call Us



We would be happy to speak with you about lessons learned or any of your safety communication needs.

You may schedule a telephone call or conference call for no charge.

Phone: 1-212-860-2939; Email: Larkin@Larkin.Biz

Other Services



Presentation

- 1 to 3 hours
- shows examples and research supporting communication best practice

Workshop

- 6 hours
- more hands on with a small group

Implementation Contract

- 2 weeks
- TJ moves inhouse, joins a project team, and works on a major communication project

Who We Are



Dr TJ Larkin



Sandar Larkin

Since 1985, we have been helping large companies improve communication with employees.

Book	<i>Communicating Change</i> , McGraw-Hill, New York
Most Read Paper	"Reaching and Changing Frontline Employees," <i>Harvard Business Review</i>
Newest Papers	Download our newest papers on communicating safety from our website: www.Larkin.Biz (no charge)
TJ's Background	Ph.D. in Communication (Michigan State University) M.A. in Sociology (University of Oxford)
Sandar's Background	Sandar is originally from Burma and worked with the Long Term Credit Bank of Japan before starting Larkin Communication Consulting with TJ.

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