“Compliance” does not mean “Safe”

Mary Beth Mulcahy, PhD
Chemical Incident Investigator
U.S. Chemical Safety & Hazard Investigation Board

ACS National Meeting
August 2015
Chemical Safety Board (CSB)

- Independent Federal Agency
- Non-regulatory

Mission
To prevent chemical accidents
- Conducting root cause investigations
- Reporting findings publicly
- Making recommendations to organizations and agencies that can affect change
  - Companies
  - Government Agencies (local, state and federal)
  - Standard setting, i.e. American Petroleum Institute (API)
Facebook knows…

Well that explains the horrible traffic. Thank goodness I was on a bike!

One person seriously injured in 'minor' Amgen lab blast in South San Francisco
mercurynews.com
Two people were injured Wednesday afternoon in a 'minor' laboratory explosion at biotech firm Amgen's South San Francisco lab facility, a fire

Like · Comment · Share · 10 hours ago ·

E likes this.

M Thank goodness you don't work at Amgen.
12 minutes ago · Like

M The description sounds like when that Mary Beth girl blew herself up in grad school.
11 minutes ago · Like

A Exactly what I was thinking, mix organic solvent with oxidizing agent...go boom.
7 minutes ago via mobile · Like · 1
<table>
<thead>
<tr>
<th>Patient: MULCAHY, MARY</th>
<th>Unit #: X000-51-64-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>HISTORY: Rule out foreign body.</td>
<td></td>
</tr>
<tr>
<td>FINDINGS: No radiopaque foreign body is seen projected over the abdomen.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pt SS#</th>
<th>Carrier#1</th>
<th>Policy #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CU STUD</td>
<td></td>
</tr>
</tbody>
</table>

| HISTORY: Rule out fracture. |
| FINDINGS: Osseous structures are intact without evidence of fractures. |

<table>
<thead>
<tr>
<th>HISTORY OF PRESENT ILLNESS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The patient was working in the lab</td>
<td></td>
</tr>
<tr>
<td>Nitric acid placed in the above-mentioned injuries to left elbow and left flank. She denies other injuries. No facial trauma. The patient was treated with brisk shower and irrigation at the scene, was transported by EMS after an IV was placed and stable vital signs in route without further complaint other than localized pain.</td>
<td></td>
</tr>
</tbody>
</table>
Training?
Hazard Analysis?
Procedure?

Cleaning Glassware:
1. Nitric acid
2. HNO₃ + Ethanol 50/50
3. 3 acetone rinse, 3 hexane, 3 acetone
4. overnight in oven

HARCH:
- repeated exposure may cause allergic retn
- corrosive (oxidizer)
- If inhaled, remove to fresh air
- Skin contact: rinse w/ copious amounts of H₂O for 15 min
- use a fume hood
- moisture sensitive, light sensitive

Citric acid:
- relatively harmless
- incompatibilities: strong oxidant, reducing agents, bases

Toluene:
- incompatible with strong ox
- strong base
- irritant
- flash exposed vac/HTC
“Compliance” does not mean “Safe”

- Minimal Compliance: Regulations are Insufficient
  - Nuclear Power Plant

- Minimal Compliance: Check-the-Box Activity
  - Chevron Refinery

- Compliance without Focus: Under-the-Radar
  - Macondo Blowout
Why You Haven’t Heard About Onagawa Nuclear Power Station after the Earthquake and Tsunami of March 11, 2011

Nuclear Safety Culture in TEPCO and Tohoku Electric Power Company: The root-cause of the different fates of Fukushima Daiichi Nuclear Power Plant and Onagawa Nuclear Power Station

By
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aryu@usc.edu & meshkati@usc.edu

Vitebi School of Engineering
University of Southern California (USC)
March 11, 2011 Earthquake

- Largest in recorded Japanese history
- 142 ft (43.3 m) tsunami traveled 6 miles (10 km) inland
- 20,000 people dead or missing
Fukushima Daiichi Power Plant

- 114 miles (183 km) from epicenter
- Built 1967, operating 1971
- Tsunami 43 ft (13.1 m)
Boiling Water Nuclear Reactor
Before the Earthquake

Under inspection

In operation

Normal Operation and electricity output

2:46 PM: Earthquake

Automatic Emergency Shutdown
Describe the site

3:37 PM: Tsunami Hits

Lose AC Power

Lose All Power
Days Following

Onagawa Nuclear Power Station

- 60km closer to the epicenter than Fukushima
- 3 reactors; operating since 1984
- Tsunami 4 ft higher than at Fukushima
- “shut down safely”
- “remarkably undamaged”
Permit to Construct Fukushima

- “there is no recorded history of a severe earthquake in the immediate vicinity”

- No consideration of the tsunami controls to mitigate the potential hazard

- “The plant met all government standards at the time of its construction” – Tepco Spokesperson

Permit to Construct Onagawa

- Permit issued for height of 9.1 meters, but the plant built higher due to additional surveys and simulations it conducted
Fukushima: Removal of Seawall

- Place power plant on bedrock
- Make it easier to transport equipment and pump seawater to reactors

http://online.wsj.com/news/articles/SB10001424052702303982504576425312941820794
Minimal Compliance: Regulations are Insufficient

Onagawa NPS

“If you do not think about tsunamis in Tohoku [the Onagawa power plant], what are you thinking?”
Project Participant of the Onagawa NPS

Fukushima NPS

“[Fukushima] was a profoundly manmade disaster – that could and should have been foreseen and prevented.”
Chairman of the Fukushima Nuclear Accident Independent Investigation Commission
Minimal Compliance: Check-the-Box

Chevron Richmond Refinery Fire

- August 6, 2012
- Process pipe ruptured
  - Flammable hydrocarbons
  - Vapor cloud ignited
  - Uncharacterized plume
  - 15,000 sought medical treatment
Well-Understood Failure Mechanism: Sulfidation Corrosion
## Minimal Compliance: Check-the-Box

<table>
<thead>
<tr>
<th>Contra Costa County Checklist Question</th>
<th>Chevron IST Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Corrosion resistant materials?</td>
<td>Vessel specifications and piping classifications include a conservative wall thickness and an appropriate corrosion allowance for each service.</td>
</tr>
<tr>
<td>Use smallest diameter piping?</td>
<td>Piping sizes are the smallest possible for the capacity of the unit.</td>
</tr>
<tr>
<td>Substitute less hazardous raw materials?</td>
<td>Raw materials in use are of minimal hazard.</td>
</tr>
<tr>
<td>Dilute hazardous raw materials?</td>
<td>Raw materials currently dilute where applicable.</td>
</tr>
<tr>
<td>Minimize off-site impacts?</td>
<td>#4 Crude Unit is located at a distance from public areas.</td>
</tr>
<tr>
<td>Easy operation of valves designed to prevent inadvertent error?</td>
<td>In general, valves are arranged in a logical manner.</td>
</tr>
<tr>
<td>Increasing wall strength?</td>
<td>Piping classifications include a conservative wall thickness and an appropriate corrosion allowance for each service.</td>
</tr>
</tbody>
</table>
Compliance without Focus: Under the Radar

Macondo Well Blowout

- April 20, 2010
- Gulf of Mexico
- 11 deaths
- 17 serious injuries
- ~ 3-5 mm barrels of oil spilled
BOP Emergency Systems that Close the Blind Shear Ram

**Manually Activated by Crew**
- Emergency Disconnect System (EDS)

**Automatically Activated**
- AMF/deadman
- Autoshear
# BOP Design Limitations

## Daily Drilling Report

<table>
<thead>
<tr>
<th>NO</th>
<th>512100-000027-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEASE</td>
<td>QC5GG32306</td>
</tr>
<tr>
<td>OPERATOR</td>
<td>BP Exploration</td>
</tr>
<tr>
<td>BP Exploration REPRESENTATIVE</td>
<td></td>
</tr>
<tr>
<td>CONTRACTOR</td>
<td>Transocean</td>
</tr>
<tr>
<td>WATER DEPTH</td>
<td>4992</td>
</tr>
<tr>
<td>DATE</td>
<td>26 Feb 2010</td>
</tr>
</tbody>
</table>

### Drilling Assembly

<table>
<thead>
<tr>
<th>CODE NO. - OPERATION</th>
<th>NIGHT</th>
<th>DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rig Up and Tear Down</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2. Drill Actual</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3. Reaming</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

### Bit Record

<table>
<thead>
<tr>
<th>ITEM</th>
<th>LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit</td>
<td>1.350</td>
</tr>
<tr>
<td>IB STAB</td>
<td>7.200</td>
</tr>
<tr>
<td>NON MAG CROSSO</td>
<td>1.880</td>
</tr>
<tr>
<td>DIRECTIONAL</td>
<td>8.970</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ITEM</th>
<th>LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIZE</td>
<td>18.5</td>
</tr>
</tbody>
</table>

### Mud Record

<table>
<thead>
<tr>
<th>ITEM</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IADC CODE</td>
<td></td>
</tr>
<tr>
<td>MANUFACTURER</td>
<td>HUGHES</td>
</tr>
<tr>
<td>PRESSURE</td>
<td>.5824</td>
</tr>
<tr>
<td>GRADIENT</td>
<td></td>
</tr>
<tr>
<td>WEIGHT</td>
<td>11.2</td>
</tr>
</tbody>
</table>

### Pum No. & Pum Manufacturer

<table>
<thead>
<tr>
<th>PUM NO.</th>
<th>PUMP MANUFACTURER</th>
<th>TYPE</th>
<th>STROKE LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Continental Emsco</td>
<td>Triplex</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>Continental Emsco</td>
<td>Triplex</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>Continental Emsco</td>
<td>Triplex</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>Continental Emsco</td>
<td>Triplex</td>
<td>15</td>
</tr>
</tbody>
</table>
How could I get the chart in this attachment to change color on the 4614 psi for shearing the 6.625 [6 5/8"] pipe to RED. Would Cameron have to edit this chart? That is what Rod wants. He says if we can’t shear it then it should be RED...

- 6 5/8” drill pipe exceeded capabilities of BOP
Compliance without Focus: Under the Radar

- A documented inability to reliably shear the drillpipe used for an extended period during the Macondo drilling process
- A planned 2-step workaround to use in the event of an emergency that actually would have a likelihood of failure if either the AMF/deadman or autoshear had been activated
• Minimal Compliance: Regulations are Insufficient
• Minimal Compliance: Check-the-Box Activity
• Compliance without Focus: Under-the-Radar
Major Accident (Disasters)

On the subject of disasters, it is very common for [...] managers to say ‘this won’t happen.’ I have sympathy with this. What they really mean is, it’s highly improbable...

This creates a kind of vacuum in terms of what to focus on so it’s easier to say, either out loud or in your private thoughts, ‘this won’t happen’. The way to avoid this trap is to say, yes, it will happen. It will happen to somebody, somewhere, at some point in time. That’s all but guaranteed. Now, what are we going to do to make sure it doesn’t happen to us?

It’s a subtle but profound shift in thinking.

–Kevin Lacy, Essay for DecomWorld

Hazard/Top Event

- Health Hazard (carcinogen, toxin, irritants, etc.)
- Physical Hazard (flammable, explosive, etc.)

When do you have to change your response?
- Threshold amount
- Loss of containment
- Loss of utilities
Barriers

Top Event
Loss of Control

Major Accident
Barriers

Alarms  
Preventative  
Maintenance

Back-up  
Systems

Top Event  
Loss of  
Control

Evacuation  
PPE  
Automatic  
Shutdown  
System

Preventative  
Mitigative

Major  
Accident
Management Systems

- Hazard Identification
- Procedures
- Incident Investigations
- Indicators