U.S. Chemical Safety and Hazard Investigation Board

Final Public Meeting – July 16, 2014

AL Solutions, Inc.
Metal Dust Explosion

New Cumberland, West Virginia

December 9, 2010

Meeting Agenda

- Investigation Team Presentation
- Board Questions
- Public Comment
- Board Vote
- Short Intermission
- Freedom Industries Update
- Closing Statements

Investigation Team

- Johnnie Banks, Team Lead
- Mark Wingard
- Lucy Tyler
- Christina Morgan – Recommendations Specialist

Investigation Team Presentation

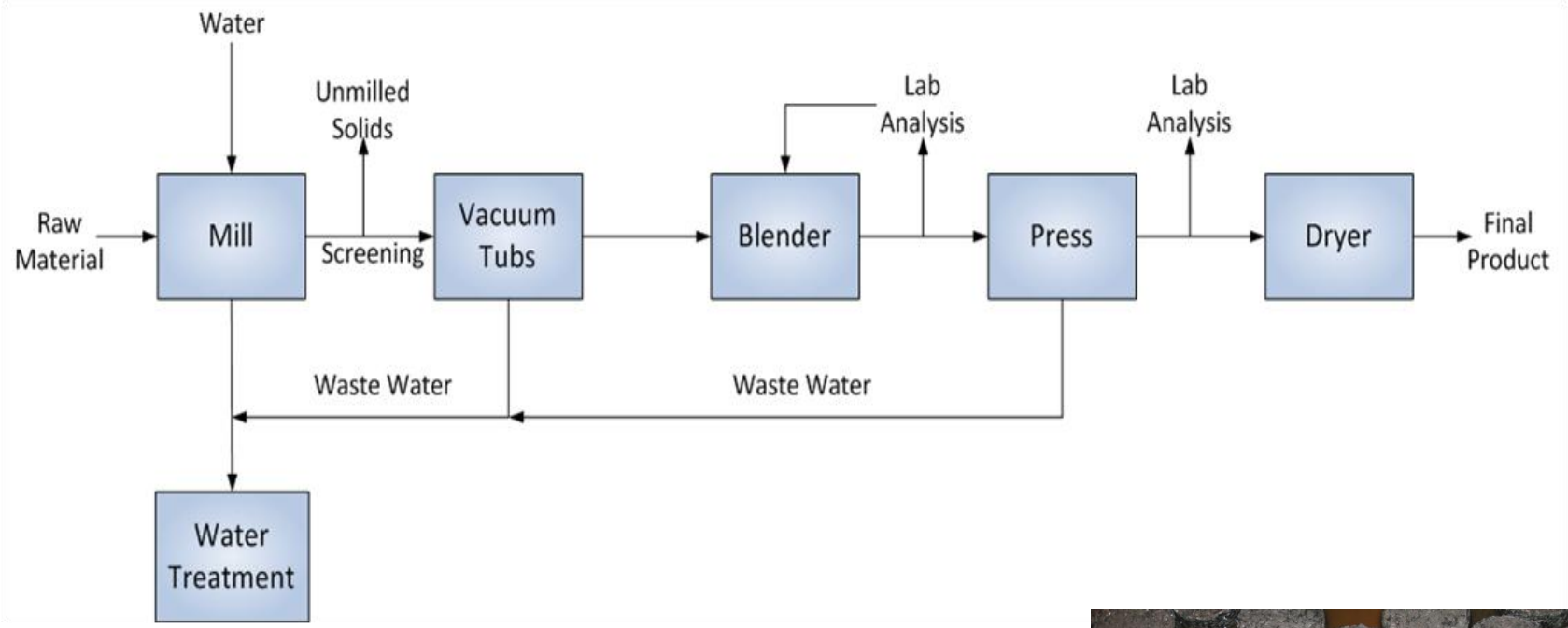
- Company Background
- Facility and Process Overview
- Incident Animation
- Investigation Findings
- Proposed Recommendations

Company Overview

- Processes titanium and zirconium scrap metal into pressed compacts that are used as aluminum additives
- AL Solutions operated two metal processing facilities in 2010
  - —New Cumberland, WV
  - – Washington, MO
- New production facility in Burgettstown, PA

New Cumberland, WV Production Facility

Process Overview



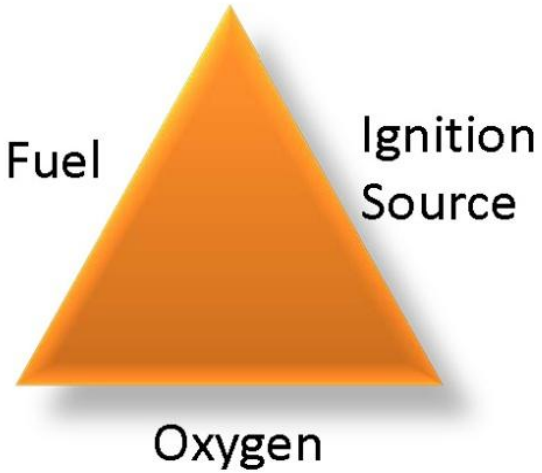
Raw Material

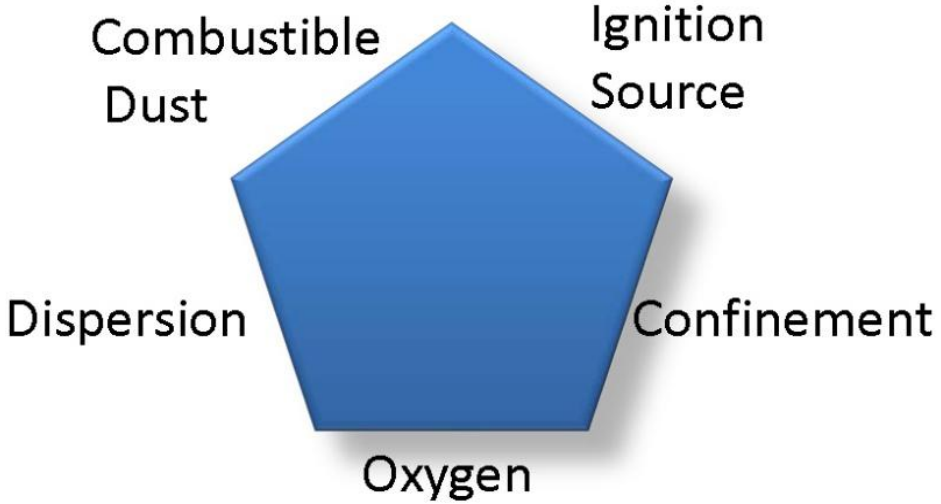
Final Product

Metal Properties

- **Titanium (Ti)**
  - **Particles are easily ignited in air, may spontaneously combust.**
  - **Water should be avoided when extinguishing Ti fires as it may produce explosive hydrogen gas.**
- **Zirconium (Zr)**
  - **Particles can spontaneously combust at room temperature.**
  - **Explosion hazard at certain moisture levels.**

Dust Explosions





Incident Animation

Likely Ignition Point

- Metal blender blades impacted metal blender walls for weeks prior to incident
- Friction likely ignited zirconium in blender

Likely Initiation Point

- Indications of burning and charring on the ceiling and wall near the blender consistent with dust explosion scenario.
- Explosivity testing of titanium and zirconium samples concluded metal powder was combustible.

Controlling Dust Accumulations

- The AL Solutions facility had no dust collection system to collect and control metal dusts.
- Operators relied on water hoses to wash down equipment.
  - Hydrogen formation
- No mechanical ventilation system to control hydrogen gas.

Previous Incidents at AL Solutions

- Propane explosion lead to secondary combustible titanium dust explosion in 1995.
  - 1 fatality, 1 injury
- Flash fire in blender during operation in 1996.
- Dust explosion in mill tank in 2006.
  - 1 fatality

Dust Incidents in Industry

- **From 2008-2013**
  - **29 deaths**
  - **161 injuries**
  - **50 incidents**

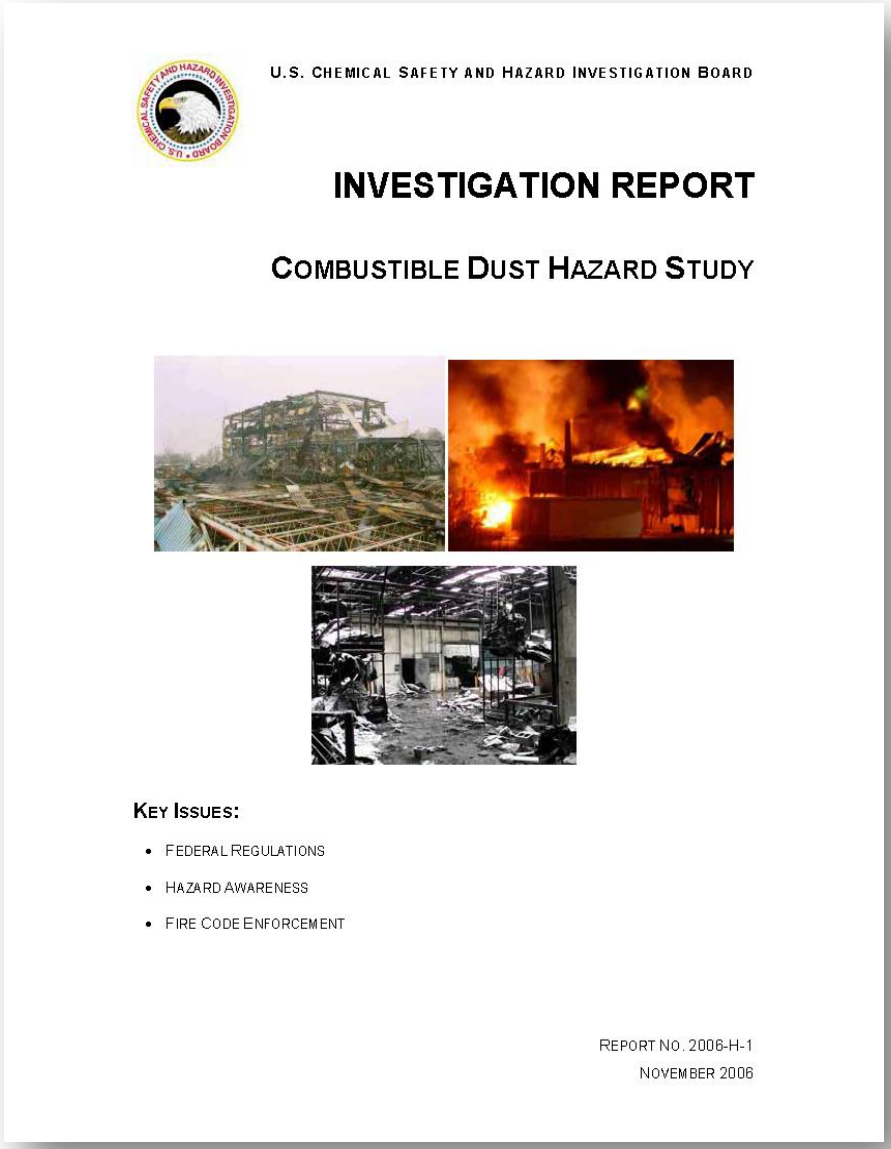
Hoeganaes Dust Explosions: 5 killed in 2010

Imperial Sugar: 14 killed, 36 injured in 2008

CTA Acoustics: 7 killed in 2003

CSB Combustible Dust Investigations

- Three catastrophic dust incidents in 2003.
  - 14 fatalities
- The CSB recommended OSHA develop Combustible Dust Rule in 2006.



U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD

INVESTIGATION REPORT

COMBUSTIBLE DUST HAZARD STUDY

KEY ISSUES:

- FEDERAL REGULATIONS
- HAZARD AWARENESS
- FIRE CODE ENFORCEMENT

REPORT NO. 2006-H-1

NOVEMBER 2006

Nov 2006 - CSB recommends OSHA develop combustible dust rule

Apr 2009 - OSHA rulemaking initiated

Sept 2009 - CSB recommends OSHA "proceed expeditiously" with dust rule

Apr 2010 - OSHA calls dust standard a "long-term action," but postpones next steps

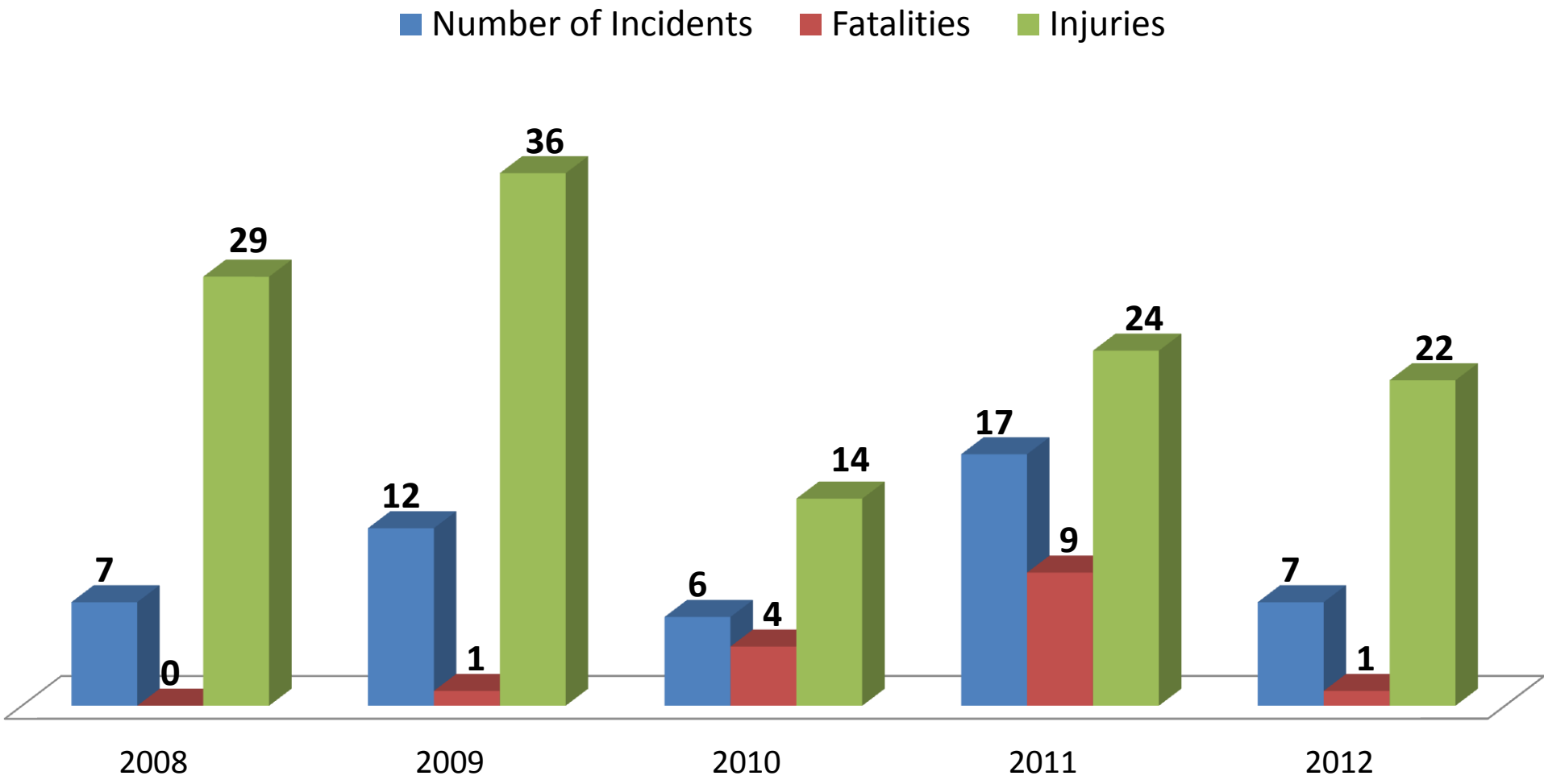
June 2012 - OSHA states it "cannot commit" to a date for the proposed rule "but it remains a top priority for the agency."

2008

2012

50 combustible dust incidents

Combustible Dust Incident Data 2008-2012



*2008 data includes incidents after the reissuance of OSHA Combustible Dust NEP in March 2008.

Source: CSB Incident Screening Database

CSB Most Wanted Program

- In July 2013 the CSB adopted the recommendation for a combustible dust standard as a "Most Wanted Chemical Safety Improvement."
- The formation of a combustible dust standard remains a high priority for the CSB.

Investigation Key Findings

Key Findings

1. The explosion in the production building was caused by combustible titanium and zirconium dusts that were processed at the facility.

Key Findings

2. The explosion likely originated in a blender containing milled zirconium particulates and ignited by frictional heating of the zirconium arising from defective blender equipment.

Key Findings

3. The hydrogen gas produced by the reaction of molten titanium or zirconium metal and water, possibly from wash-down operations or the water deluge system, may have also contributed to the explosion.

Key Findings

4. Testing conducted after the incident determined that titanium and zirconium samples collected from the AL Solutions facility were combustible and were capable of causing an explosion when lofted near heat or an ignition source.

Key Findings

5. AL Solutions did not mitigate the hazards of metal dust explosions through engineering controls, such as a dust collection system. Specifically, AL Solutions did not adhere to the practices recommended in NFPA 484 for controlling combustible metal dust hazards.

Key Findings

6. The West Virginia Area Office of OSHA did not conduct a Combustible Dust NEP inspection at AL Solutions before the 2010 incident, despite the company's history of metal dust incidents. The Combustible Dust NEP inspections are based on a randomized selection of facilities regardless of previous incidents, unless initiated by a complaint or referral.

Key Findings

7. Combustible dust incidents continue to occur throughout susceptible industries, but the next steps of the OSHA rulemaking process for promulgating a general industry combustible dust standard have been delayed.

Recommendations

Reiterated Recommendation to the Occupational Safety and Health Administration (OSHA)

Recommendation No. 2006-1-H-R1:

- An OSHA general industry standard for combustible dust is needed to prevent future tragedies
- The CSB is reiterating its 2006 recommendation to OSHA, which is currently designated with the status "Open- Unacceptable Response."
- A dust standard is the first item on the CSB "Most Wanted Chemical Safety Improvement" List.
- This will be the first recommendation ever reiterated by the CSB.

Reiterated Recommendation to OSHA:

Issue a standard designed to prevent combustible dust fires and explosions in general industry. Base the standard on current National Fire Protection Association (NFPA) dust explosion standards (including NFPA 654 and NFPA 484), and include at least

- hazard assessment
- engineering controls
- housekeeping
- building design
- explosion protection
- operating procedures
- worker training

New Recommendation to AL Solutions, Inc.

Recommendation No. 2011-3-I-WV-R1:

For all new and existing equipment and operations at AL Solutions facilities that process combustible metal dusts or powders, apply the following chapters of NFPA 484-2012, *Standard for Combustible Metals:*

- Chapter 12, Titanium
- Chapter 13, Zirconium
- Chapter 15, Fire Prevention, Fire Protection, and Emergency Response
- Chapter 16, Combustible Metal Recycling Facilities

New Recommendation to AL Solutions, Inc.

Recommendation No. 2011-3-I-WV-R2:

Develop training materials that address combustible dust hazards and plant-specific metal dust hazards and then train all employees and contractors. Require periodic (e.g., annual) refresher training for all employees and contractors.

New Recommendation to the AL Solutions Burgettstown, PA Facility

Recommendation No. 2011-3-I-WV-R3:

Prohibit the use of sprinkler systems and water deluge systems in all buildings that process or store combustible metals.

New Recommendation to the AL Solutions Burgettstown, PA Facility

Recommendation No. 2011-3-I-WV-R4: Conduct a process hazard analysis as defined in NFPA 484, Section 12.2.5, and submit a copy to the local fire department or the enforcing authority for the fire code.

Board Questions

Board Questions

AL Solutions Public Comments

Board Vote on AL Solutions

Freedom Industries Investigation Update

Charleston, West Virginia

January 9, 2014

Incident Description

- On January 9, 2014, an estimated 10,000 gallons of 4-Methylcyclohexanemethanol (MCHM) mixed with 5.6% propylene glycol phenyl ethers(PPH) released into the Elk River.
- The mixture leaked from a 48,000-gallon capacity aboveground storage tank (AST) at the Etowah River Terminal Facility.
- The mixture migrated through soil, gravel and water systems under the facility prior to entering the Elk River.

Incident Description

- The MCHM and PPH leaked 1.5 miles upstream of water treatment intake at the WV American Water Co. water treatment center
  - Serves 580,000 people in WV
  - Residents and industrial clients
- Leak contaminated drinking water for up to 300,000 WV residents in 9 counties

Community Notification

- WV DEP identified the MCHM release at 11:15 am on January 9, 2014.
- WV American Water Co. did not notify the public of the "Do Not Use" Order until over 5 hours after becoming aware of the release.
- At 9:30 pm the Governor issued a State of Emergency Order for West Virginia
- On January 10, President Obama declared a Federal Disaster Area for the nine impacted counties.

Water Advisory Timeline

1/13/2014
WV AWC advises flushing water systems

→

1/15/2014
CDC issues water advisory to pregnant women

→

1/21/2014
PPH detected in the water supply

↓

2/5/2014 CDC announces water is “appropriate for use”

→

2/21/2014 CDC describes water as “safe.”

→

2/28/2014
WV Governor lifts State of Emergency Order

↓

3/3/2014
CDC: no acute health effects from MCHM below 10 ppb

Community Notification

- **The residents continue to distrust information that the water is safe to drink.**
  - **A lingering odor remained in the water after CDC declared the water appropriate for use.**
  - **The long-term health impact of MCHM and PPH at low concentrations remains unknown.**

Public Health Impact – Preliminary Data

- The WV Bureau of Public Health and the CDC analyzed medical reports.
  - 369 patients treated for possible exposure
  - 13 were hospitalized
- Reported routes of exposure:
  - 52.6% exposed while bathing
  - 43.9% exposed when ingesting water
  - 14.6% exposed from inhalation

Public Health Impact – Preliminary Data

- Common symptoms reported
  - Nausea (38%)
  - Skin rash (28.5%)
  - Vomiting (28%)
- Reported symptoms are consistent with known acute health effects of MCHM.
  - Based on limited animal studies

Preliminary Findings

- There is limited toxicological information on MCHM, PPH and chemical constituents.
  - There is limited information available on the long-term health impact of MCHM at low concentrations.
  - The material safety data sheets (MSDSs) did not provide information on the potential health hazards to assist in a timely notification of water usage restrictions.

Tank Inspections

- The CSB commissioned an inspection of the tank from which the leak occurred and similar tanks at Freedom Industries
  - Scanned tank interior and surrounding topography of river bank
  - Collected tank samples for metallurgical analysis

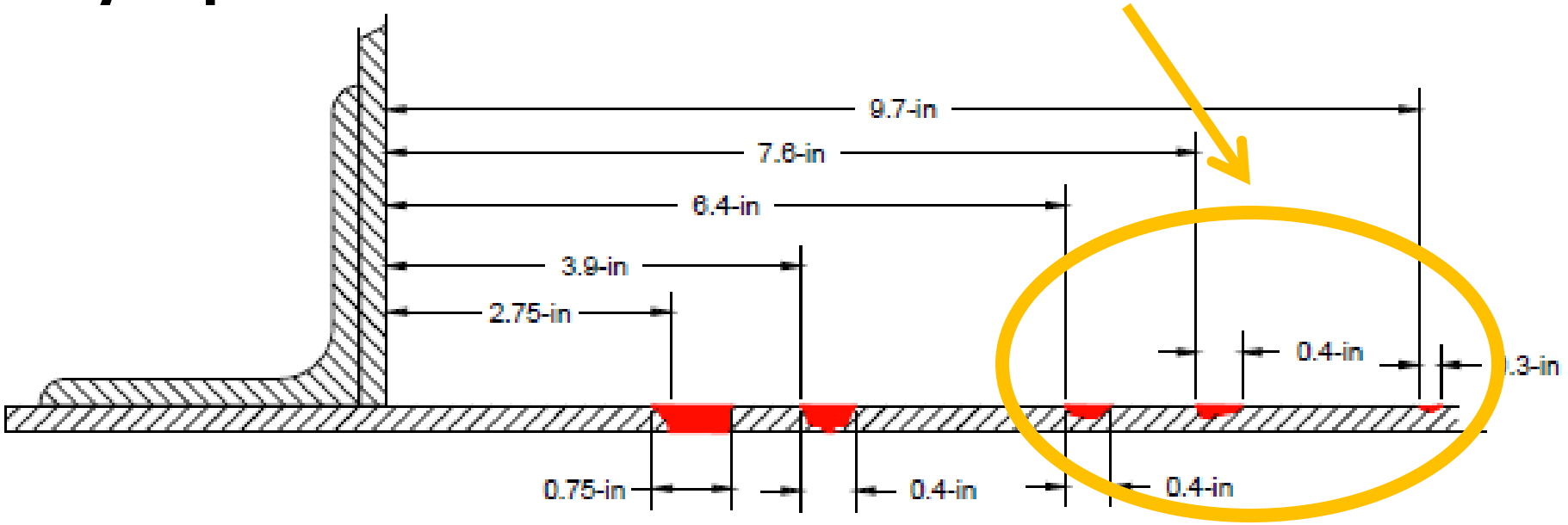
Metal Coupon Extraction Video

Preliminary Findings

- The CSB observed visible metallurgical failures on the bottom interior surface of the tank that leaked into the Elk River.
- Holes and pits on the tank floor are a likely source of the MCHM leak.

Preliminary Findings

- The holes likely initiated from the interior of the tank due to corrosion associated with water pooling.
- Pitting observed from tank interior had not yet penetrated the bottom in other areas.



Preliminary Findings

- The CSB found no record of inspections performed on the tanks prior to the January 9, 2014 release.
- There was a lack of engineering inspections, and uncertain inspection frequency or rigor of inspections.
- Holes on the roofs likely provided a source for corrosion inducing water into the tanks.

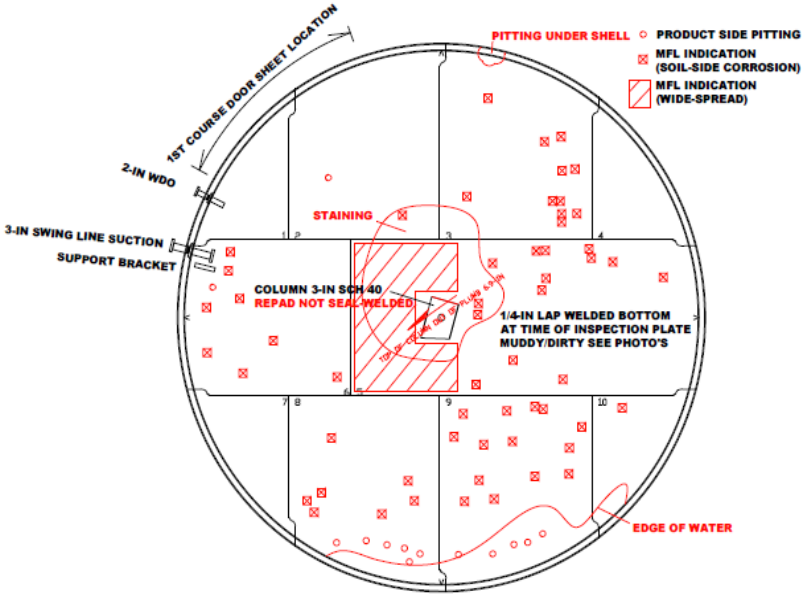
Preliminary Findings

- Tank 397, another tank also containing the MCHM and PPH mixture, had a hole penetrating the bottom of the tank similar to the holes identified in Tank 396, the tank involved in the release.
- Due to extensive corrosion the CSB suspects that the leaks existed prior to January 9th

Preliminary Findings

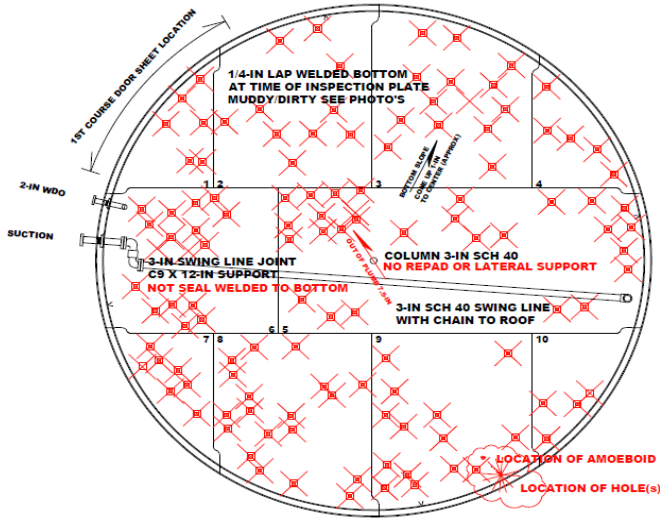
- **Multiple pitting and metallurgical damage in T-396 and other tanks containing MCHM.**

T-395



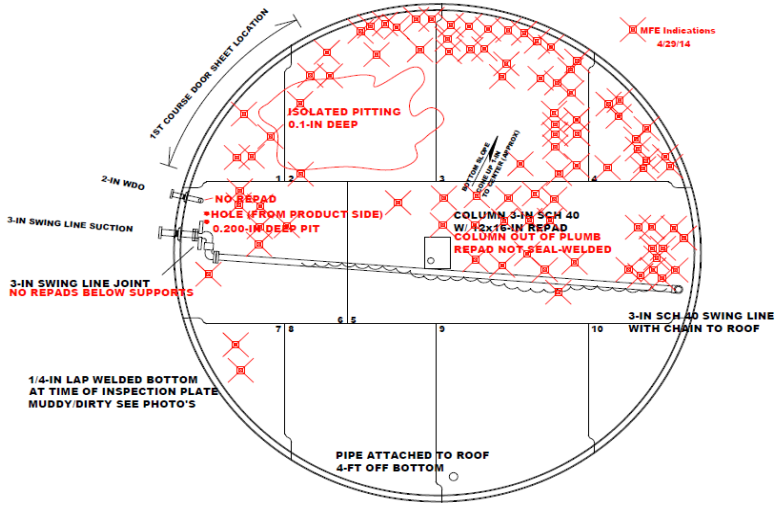
BOTTOM CORROSION M

T-396



BOTTOM CORROSION MAP

T-397



BOTTOM CORROSION MAP

Continuing Investigation

- Metallurgical examination
- Computer modeling of release
- Consideration of public health impact
- Regulation of above-ground storage tanks
- Tank siting upstream of the water intake
- Evaluation of water treatment intake systems
- Emergency planning and notification

Board Questions

Public Comment

Closing Comments

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