Pressure Test Safety Awareness

Hartford Steam Boiler

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Anne Ehrmann

Risk Solutions

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HSB Pressure Test Safety
Identifying the Risk

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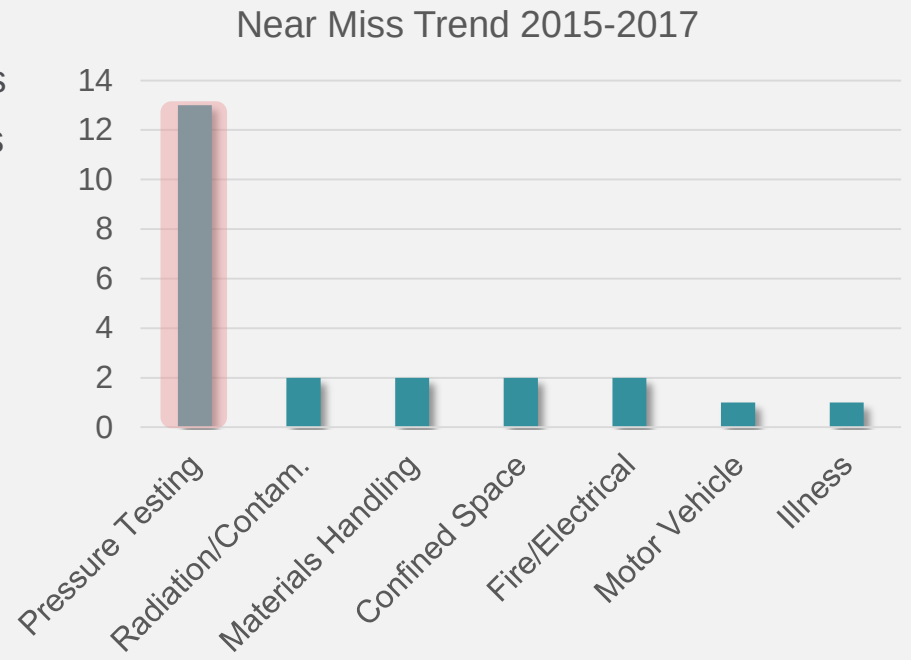
Hartford Steam Boiler Inspection & Insurance Company (HSB)

- Global inspection agency
- Witness hydrostatic and pneumatic pressure tests
- Pressure testing incidents have been identified as a problematic trend that cannot be ignored!
  - Global issue

- How can we as an organization protect our Authorized Inspectors (AIs) during these tests when we do not control the location?



HSB Pressure Test Safety
Addressing the Risk

- The primary action we took was to empower our inspection staff to STOP WORK if they believed their safety or well-being was ever threatened

- Next, the Safety Team set out to mitigate the risk by taking the following measures:
  - Collecting Field Data (We listened!)
    - The Safety Team traveled to company meetings around the world to pose the issue to our inspection staff and learn firsthand the dangers and issues related to pressure testing activities
  - Conducting Technical Research
    - We reviewed various state, federal and international regulations, guidance documents, incident reports, industry standards and codes
  - Providing Specialized Training
    - Using the information that was collected, we added pressure test safety to our Corporate Safety & Health Manual and augmented our training content to increase awareness and reduce the risk of injury

Pressure Test Incident Trends

- Failure to properly maintain test fittings (no Preventative Maintenance Plan)
- Failure to utilize the correct number and size of pressure-rated temporary closures/fittings
- Failure to stand back and away from test object while pressure is increased to test pressure
- Failure of installed safety restraints to contain fittings and equipment that can become projectiles
- Improper thread engagement: All threads of a bolt must be engaged with the nut
- Failure to maintain the pressure test rig or set-up
- Failure to verify the test pressure is accurate for the current test
- Failure to follow the applicable code regarding test temperature, water temperature, etc..
- Failure to stop the test and release pressure to zero prior to approaching the vessel to determine where the leak is located

Pressure Test Best Practice
General Requirements

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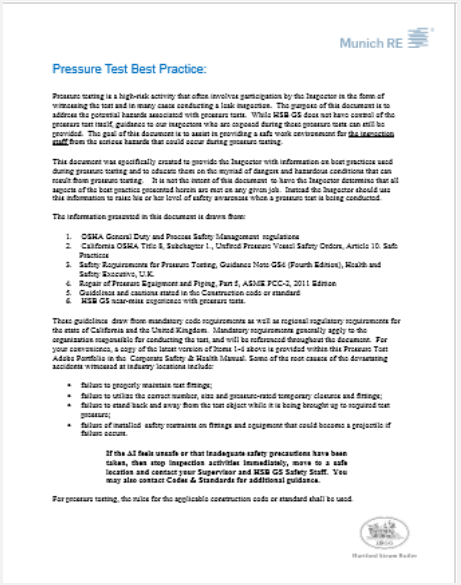
- Review the pressure test procedures
  - If a pressure test procedure is not available then one is needed. Immediately!
  - All test personnel roles are to be included
  - Include what happens if deviations to the procedure are made
  - Review Piping & Instrument Diagrams/valve open/close procedures
- Remember the purpose of the test!
  - Check for gross defects in design, materials or fabrication
  - Verify there is no leakage in welds or permanent mechanical joints
- Be aware of the danger at all times, do not become complacent!
  - Watch for: ruptures, release of permanent or temporary closures, fluid jets, other hazards



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Pressure Test Best Practice:

Pressure testing is a high-risk activity that often involves participation by the Inspector in the form of witnessing the test and in many cases conducting a leak inspection. The purpose of this document is to address the potential hazards associated with pressure tests. While MSB GS does not have control of the pressure test result, guidance to our inspectors who are exposed during these pressure tests can still be provided. The goal of this document is to assist in providing a safe work environment for the inspection staff from the serious hazards that could occur during pressure testing.

This document was specifically created to provide the Inspector with information on best practices used during pressure testing and to educate them on the myriad of dangers and hazardous conditions that can result from pressure testing. It is not the intent of this document to have the Inspector determine that all aspects of the best practice presented herein are met on any given job. Instead the Inspector should use this information to raise his or her level of safety awareness when a pressure test is being conducted.

The information presented in this document is drawn from:

1. OSHA General Duty and Process Safety Management regulations
2. California OSHA Title 8, Subchapter 1., Unfired Pressure Vessel Safety Orders, Article 10. Safe Practices
3. Safety Requirements for Pressure Testing, Guidance Note GS4 (Fourth Edition), Health and Safety Executive, U.K.
4. Repair of Pressure Equipment and Piping, Part 5, ASME PCC-2, 2011 Edition
5. Guidelines and cautions stated in the Construction code or standard
6. MSB GS near-miss experience with pressure tests.

These guidelines draw from mandatory code requirements as well as regional regulatory requirements for the state of California and the United Kingdom. Mandatory requirements generally apply to the organization responsible for conducting the test, and will be referenced throughout the document. For your convenience, a copy of the latest version of Items 1–4 above is provided within the Pressure Test Adobe Portfolio in the Corporate Safety & Health Manual. Some of the root causes of the devastating accidents witnessed at industry locations include:

- failure to properly maintain test fittings;
- failure to utilize the correct number, size and pressure-rated temporary clamps and fittings;
- failure to stand back and away from the test object while it is being brought up to required test pressure;
- failure of installed safety restraints on fittings and equipment that could become a projectile if failure occurs.

If the AI feels unsafe or that inadequate safety precautions have been taken, then stop inspection activities immediately, move to a safe location and contact your Supervisor and MSB GS Safety Staff. You may also contact Codes & Standards for additional guidance.

For pressure testing, the rules for the applicable construction code or standard shall be used.

Pressure Test Best Practice
General Requirements

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- Conduct a risk assessment
  - Utilize the “What if” approach to determine what could go wrong during the test and implement controls to eliminate or mitigate the risk
  - Include methods of protection from over-pressurization such as use of pressure relief valves or pressure regulating valves
  - Verify the safety relief valve discharge is led to a safe area

- Implement a change management program
  - Review all steps of the procedure and determine what could go wrong if you change test pressures, temperatures, test medium, filling rate and types of fittings, size of closures, vents, and vessels

- Train everyone involved in the test on the test procedure, awareness of the hazards involved and danger zone area

Pressure Test Best Practice
General Requirements

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- Verify the test location is remote enough and/or containment measures are adequate for the type of test and pressure *and* that the risk to you has been mitigated or eliminated
  - Use an adequate test bay wherever possible
  - Verify safe egress is available in the event of emergency

- Whenever possible, pressure needs to be controlled from a safe distance

- Recognize pneumatic tests present a significantly higher risk!
  - Should only be conducted if object cannot be hydrostatically tested
  - Will require use of physical safeguards and additional procedures because leak is more difficult to identify

Pressure Test Failures

- Ruptures
- Release of permanent or temporary closures
- Ejection of shrapnel
- Fluid jets
  - Fine streams of pressurized liquid (100 psi/7 bar)

Resulting in DEATH or serious injury!

Pressure Test Best Practice
Before the Pressure Test

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- Verify the pressure test calculations are accurate
- Verify all valves, fittings and flanges are properly rated for the test pressure
- Ensure there is a preventative maintenance plan in place for test fittings, test blinds, hoses and bolting that are reused
  - Include a recording of each use and replacement schedule
  - Inspected before each use with specified criteria that would take it out of service
- Check that all connections, piping and nearby equipment are secure and restrained against possible movement
- Verify ALL temporary closures are fully threaded, flanged with full bolting or attached with a full penetration weld AND the correct type, size and number of nuts/bolts/fasteners have been used
  - If not, provide calculations proving it is safe using less

Pressure Test Best Practice
Before the Pressure Test

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- Check pressure gauge to ensure it is within calibration and properly rated
- Verify the pressure test setup is adequate for the test pressure
  - Manufacture data sheets are available for all components of setup
- Ensure there is a provision for ensuring the object is properly vented
  - This can lead to catastrophic results if not done properly
- Keep all non-essential people far away from the testing area by use of information, warnings and barriers
- Any hoses used should be inspected prior to use and contain whip checks to prevent injury should they fail
- Conduct a Pre-Job Briefing so all personnel involved in the testing have been made aware of the hazards and the danger zone
- Test is conducted with water not less than ambient temperature but never less than 70º F (20º C) to prevent brittle fracture

Pressure Test Best Practice
During the Pressure Test

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- Stand at a distance or behind suitable shielding
  - Never stand in the line of fire!
  - If visual cannot be done from a distance then remote visual options should be considered

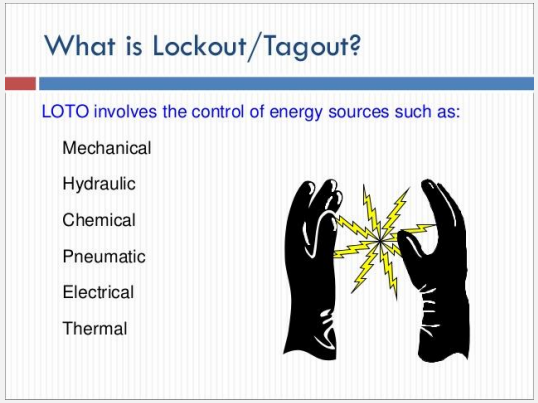
- Pressure is to be increased gradually to ensure the pressure gauge is working properly and the test vessel or object stabilizes as pressure increases

- The object should be held at test pressure for 10 minutes or the code required minimum to ensure it is stabilized *then* reduced

- The visual inspection shall be made only **after** the reduction of pressure

Pressure Test Best Practice
After the Pressure Test

- Follow lockout/tagout procedures for the safe dissipation of energy
- Test plugs and temporary closures shall be removed only when pressure is at 0
- Verify emptying rate is not too high to create a vacuum
- Utilize drain valves in appropriate places and be sure to drain properly



Common Pressure Test Issues/Safe Practices

- Pressure gauge is not working or not showing the correct pressure
  - Stop adding pressure!
  - Release the pressure *then* determine what is wrong to prevent sending someone into the danger zone or in the line of fire

- Never send someone to tighten a valve or fitting under pressure!
  - Utilize cameras that can provide close visual inspection to help determine source of leak
  - Reduce the pressure to 0 then proceed with tightening or replacement

- Test setup was built to serve a specific test then used continuously, test specifications change but test setup does not
  - Important to have a manufacturer specification/data sheet for each component within the test set-up and to conduct a risk assessment to ensure all equipment used in the pressure test is rated properly

Respect The Hazard!

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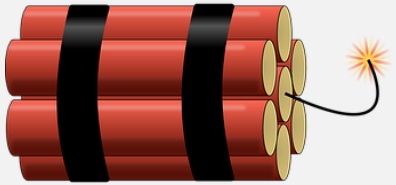
- Those responsible for the pressure test should state how the item under test can be safely
  - Energized
  - Monitored and
  - Vented/test medium discharged without placing people in the danger zone
- Those involved with the test must maintain respect for the full potential of the hazard!

Table 4.2. Stored Energy of Everyday Items

Item	Volume (ft^3)	Gas	Pressure (psig)	Stored Energy (lbf-ft)	Method
Compressed Gas Cylinder	1.42	Air	2500	982,500	Stored Energy Spreadsheet
Standard Air Compressor, 50 gal	6.68	Air	125	159,000	Stored Energy Spreadsheet
Standard Air Compressor, 20 gal	2.67	Air	125	64,000	Stored Energy Spreadsheet
Propane Tank (grill, compressed gas expansion only)	0.63	Propane	200	35,000	Stored Energy Spreadsheet
Paint Ball Tank (20 oz)	0.02	Air	3000	21,300	Stored Energy Spreadsheet
M-80 (2.5 grams of powder)	N/A	N/A	N/A	17,000	See Appendix A
State Limit for Third Party Inspection of ASME Coded Vessel	5	Air	15	9,700	Stored Energy Spreadsheet
Car Tire	0.97	Air	35	5100	Stored Energy Spreadsheet
Mountain Bike Tire	0.2	Air	65	2,230	Stored Energy Spreadsheet
CO2 2L Pop Bottle Bomb	0.05	CO2	150	1,750	Stored Energy Spreadsheet and Appendix A
Typical CO2 Cartridge (16 gram)	0.0047	CO2	900	1,263	Stored Energy Spreadsheet
STORED ENERGY LIMIT				**1000**	
BMX Bike Tire	0.11	Air	50	915	Stored Energy Spreadsheet
Road Bike Tire	0.04	Air	110	820	Stored Energy Spreadsheet
Typical CO2 Cartridge (12 gram)	0.0058	CO2	420	650	Stored Energy Spreadsheet
Typical Firecracker (50 mg powder)	N/A	N/A	N/A	340	See Appendix A
Dust Spray Can	0.02	Mix	85	335	Stored Energy Spreadsheet
Soccer Ball	0.215	Air	12	320	Stored Energy Spreadsheet
Party Balloon	2.42	Air	1	255	Stored Energy Spreadsheet
Basketball	0.26	Air	8	250	Stored Energy Spreadsheet



Solutions

- There is a professional and ethical responsibility to ensure the safety for those involved in the pressure test
- Allow personnel to raise concerns that affect them and others
- Speak up about concerns
- Share incident history and lessons learned to prevent future injuries or death

What is being done about it:

- ANSI Standards Committee developed
- IMEC hosting industry conferences to share information
- Future will hold more Pressure test conferences and forums

Resources

Contains several mandatory code requirements, regional regulatory requirements and best practices

- OSHA General Duty Clause, PSM 1910.119
- California OSHA Title 8
- U.K. HSE GS4 Safety Requirements for Pressure Testing
- Construction Codes/Standards
- HSB Near Miss History
- Department Of Energy Comparative Stored Energy Table
- IMEC Engineering conference guidance
- ASME Board Meeting Feedback

- Pressure testing can be done safely without incident under controlled procedures

Safety Never Ends