Pressure Test Safety Awareness

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- 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

- 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
General Requirements

- 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

- 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

- 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

- 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

- 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
Those responsible for the pressure test should state how the item under test can be safely:

- Energized
- Monitored
- 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

<table>
<thead>
<tr>
<th>Item</th>
<th>Volume (ft³)</th>
<th>Gas</th>
<th>Pressure (psig)</th>
<th>Stored Energy (Btu/ft³)</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed Gas Cylinder</td>
<td>1.4</td>
<td>Air</td>
<td>2500</td>
<td>982,500</td>
<td>Stored Energy Spreadsheet</td>
</tr>
<tr>
<td>Standard Air Compressor, 50 gal</td>
<td>6.6</td>
<td>Air</td>
<td>125</td>
<td>158,000</td>
<td>Stored Energy Spreadsheet</td>
</tr>
<tr>
<td>Standard Air Compressor, 20 gal</td>
<td>2.6</td>
<td>Air</td>
<td>125</td>
<td>64,000</td>
<td>Stored Energy Spreadsheet</td>
</tr>
<tr>
<td>Pressure Tank (w/comp. gas expansion) on bbl</td>
<td>0.63</td>
<td>Prop</td>
<td>200</td>
<td>35,000</td>
<td>Stored Energy Spreadsheet</td>
</tr>
<tr>
<td>Paint Ball Tank (36 gal)</td>
<td>0.02</td>
<td>Air</td>
<td>1500</td>
<td>21,500</td>
<td>Stored Energy Spreadsheet</td>
</tr>
<tr>
<td>M400 (5 grams of powder)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>17,000</td>
<td>See Appendix A</td>
</tr>
<tr>
<td>State Limit for Third Party Inspection of ASME Codeed Vessel</td>
<td>5</td>
<td>Air</td>
<td>15</td>
<td>9,700</td>
<td>Stored Energy Spreadsheet</td>
</tr>
<tr>
<td>Car Tire</td>
<td>0.97</td>
<td>Air</td>
<td>1500</td>
<td>5100</td>
<td>Stored Energy Spreadsheet</td>
</tr>
<tr>
<td>Mountain Bike Tire</td>
<td>0.2</td>
<td>Air</td>
<td>85</td>
<td>2250</td>
<td>Stored Energy Spreadsheet</td>
</tr>
<tr>
<td>CO2 2L Pug Bottle Bomb</td>
<td>0.05</td>
<td>CO2</td>
<td>150</td>
<td>1,750</td>
<td>Stored Energy Spreadsheet and Appendix A</td>
</tr>
<tr>
<td>Typical CO2 Cartridges (16 grams)</td>
<td>0.0047</td>
<td>CO2</td>
<td>900</td>
<td>1,260</td>
<td>Stored Energy Spreadsheet</td>
</tr>
<tr>
<td>STORED ENERGY LIMIT</td>
<td></td>
<td></td>
<td></td>
<td>1080</td>
<td></td>
</tr>
<tr>
<td>BMX Bike Tire</td>
<td>0.11</td>
<td>Air</td>
<td>30</td>
<td>915</td>
<td>Stored Energy Spreadsheet</td>
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<tr>
<td>Road Bike Tire</td>
<td>0.04</td>
<td>Air</td>
<td>110</td>
<td>870</td>
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<tr>
<td>Typical CO2 Cartridges (12 grams)</td>
<td>0.0018</td>
<td>CO2</td>
<td>420</td>
<td>650</td>
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<tr>
<td>Typical Fire extinguisher (50 mg powder)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>300</td>
<td>See Appendix A</td>
</tr>
<tr>
<td>Dust Spray Can</td>
<td>0.02</td>
<td>Misc</td>
<td>85</td>
<td>335</td>
<td>Stored Energy Spreadsheet</td>
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<tr>
<td>Soccer Ball</td>
<td>0.215</td>
<td>Air</td>
<td>12</td>
<td>320</td>
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<tr>
<td>Party Balloon</td>
<td>2.42</td>
<td>Air</td>
<td>8</td>
<td>250</td>
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<td>Basketball</td>
<td>0.76</td>
<td>Air</td>
<td>8</td>
<td>250</td>
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</table>
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
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