Evaluating and Reducing the Risks of Pneumatic Proof-Pressure Testing in Metal Expansion Joints

The pressure testing of Expansion Joints is essential in the industry.

It is important to distinguish between a Proof-Pressure Test and a Leak Detection Test. Expansion Joints need to be both, proof-pressure tested and tested for leak tightness, to ensure observance to regulations and safe and reliable operation.

A Proof-Pressure Test verifies if a component can withstand pressure above its intended operating pressure without permanent damage. It is a form of stress test to demonstrate the fitness of an Expansion Joint under the test pressure conditions.

The purpose of a leak detection test is obviously detecting and localizing leaks. In general, employed method of Leak Detection Test is Pneumatic at low pressure.

In this article, we will focus our attention in evaluating and reducing the risks of Pneumatic Proof-Pressure Testing in Expansion Joints.

The proof-pressure test shall always be hydrostatic, except where the hydrostatic pressure test is harmful or impractical or the Expansion Joint cannot safely be filled with water. In these instances, a pneumatic pressure test or other alternative tests may be performed.

When a hydrostatic pressure test cannot be performed, a pneumatic pressure test may be considered.

The stored energy of compressed gas is very high, so rupture of an Expansion Joint during a pneumatic pressure test can release much energy. Damage due to rupture can result from shock waves, flying projectile fragments from the ruptured unit, resulting in serious injuries and major equipment damage.

Safety considerations

The following are considered essential to minimize the risks of failure and injury during high pressure pneumatic testing:

Staff

Pneumatic testing must be conducted by internally experienced, trained and competent staff and supervised by one of the members of the MACOGA Quality Control Department.

Pre-test safety meeting and emergency response plan

A pre-test safety meeting should be conducted to ensure all personnel present on the site that may be exposed are aware of the hazards, mitigations and emergency response plan. Develop and deploy a site-specific test plan including descriptions of safety procedures and Requirements.

Comprehensive Test Procedure

Comprehensive testing and safety procedures must be formalized and implemented and must be available to all personnel involved in the testing activities.

Test procedures must clearly define the points in time during the test when test personnel are permitted to leave sheltered areas and enter the exclusion zone.

As a minimum, the test procedure must clearly indicate:

- Purpose
- Reference documents
- Personnel performance qualifications / training / capabilities
- Operating method
- Test sequence
- Applicable pressure test values
- Hazards & safety concerns during proof- pressure testing
- Safe distance
- Remote visual check if applicable
- Evaluation of results
- Certification

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Test media

Nitrogen should be the test medium since it cannot support combustion. Alternatively, clean, dry, oil-free air should be used. Caution should be used when air is used in any system that cannot be verified as being free of hydrocarbons since this could result in the formation of an explosive mixture.

Check of design and calculations

Engineers must provide a comprehensive design review report that includes evidence of suitability of existing designs under specified testing conditions. Verify that test equipment and materials are rated to withstand the test pressures. Design validation shall be performed under defined testing conditions and shall ensure that all parts of the expansion joints and the entire unit conform the code construction requirements. Pressure design calculations for both operating and test pressures must be documented and checked for all parts.

Check of materials

Materials received must be carefully checked to ensure compliance with material specifications (including review of all material test reports received). The project must have a suitable positive material identification (PMI) procedure in place that effectively ensures proper materials in the fabricated Expansion Joint.

For materials, whose resistance to brittle fracture at low temperature has not been enhanced, a test temperature above 60 °F (16 °C) should be used to reduce the risk of brittle fracture during the pneumatic test. Precautions taken to prevent gas expansion temperature drop and thermal stresses due to temperature gradients.

Safety relieve valves

Provision of pressure relief valves, which must be sized to handle the maximum output of the pressure source, to avoid excessive testing pressure.

Gauges

The gauges shall be positioned in such a location as to be readable by both the personnel controlling the pressurization and the test administrator. Only certified and calibrated gauges having a dial of a range neither less than 1 . nor more than 4 times the test pressure, will be used.

Fabrication tests

The use of non-destructive examination (NDE) must be maximized to ensure the quality of all welded joints in the system. Butt welded joints should be 100% ultrasonically or radiographically tested and all other welds should be 100% Penetrant Tested. The Expansion Joint fabrication tests (along with any necessary operational records) should be reviewed prior to testing.

Test area & exclusion zone

If available, carry out the test in a specific isolated test bunker with adequate lighting.

For pressure tests where the risk of injury from potential fragments, shockwaves, or other consequences of any pressurized system failure is determined to be unacceptable, a limited access area and pressure control point should be established. Keep unauthorized personnel out of the test area.

The minimum distance from the boundary of this area to the pressurized component should be calculated. The restricted distance is the distance from the item(s) under test at which barriers are placed to prohibit access, and the distance at which the test is monitored.

Precautions should be taken to see that persons directly or not directly engaged in the testing operations remain out of the test area during the test period. During pressure testing, distinct warning signs, such as DANGER – HIGH PRESSURE TESTING IN PROGRESS must be posted at the test site and additional locations identified in the job specific safety plan.

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Test time schedule

Schedule tests at optimum times to ensure safety. The risk of injury resulting from a test system failure can be dramatically reduced by testing at night or on weekends when fewer personnel are on (and possibly off) site.

Determination of the energy stored in the test fluid

The stored energy of the equipment or piping system should be calculated and converted to equivalent kilograms (pounds) of TNT (Trinitrotoluene). The potential risk from fragments and missiles and blast wave must be assessed. The stored energy is calculated and a minimum blast wave and fragment throw distance is determined. The maximum calculated stored energy should not be greater than 271 000 000 J (200,000,000 ft-lb). If the calculated stored energy is greater than, then one of the following shall occur: The system shall be divided into smaller volumes such that each subsystem has a stored energy not greater than 271.000.000 J, a minimum distance shall be calculated and kept or a barricade shall be installed.

Remote visual inspection

As no person is allowed in the exclusion area during the proof-pressure test, the test shall be observed and controlled at a safe distance by means of video cameras and video recording.

This a form of visual inspection which uses visual aids including video technology to allow an inspector to look at objects from a safety distance because the pneumatic test is dangerous.

The cameras will record and provide a clear view of the entire unit during pressurization, during the pressure test time and during depressurization.

The test shall always be carried out under controlled conditions, with appropriate safety precautions and equipment and in such a way that the persons responsible for the test can take adequate inspections of all pressurized parts.

Post-check inspection

The Proof-Pressure Test is considered satisfactory when there are no signs of any permanent damage in the entire element or any of its accessories.

Only access the testing area when the unit has been totally depressurized.

It is recommended to carry out a leak detection test to all welds after the proof-pressure test. The techniques involve the establishment of a pressure difference across the object wall and the observation of bubble formation in a liquid medium located on the low-pressure side. Bubble Test - Liquid application technique This technique involves the application of a liquid film (soap) to the surface of the test object. It is applicable to any object in which a pressure differential can be created across the boundary to be examined.

Other non-destructive tests may be performed to verify that during the proof-pressure test no welding or component has suffered permanent damage.

Pressure testing is a high-risk activity. If in doubt during a Pneumatic test, stop all activities, depressurize and report to a Supervisor.

More information available at www.macoga.com

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